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sacramento
ASIAN PACIFIC
chamber of commerce

sacasiancc.org

2012 H Street, Suite 101 | Sacramento, CA 95811 | Phone: (916) 446-7883 | Fax: (916) 446-7098

January 27, 2014

The Honorable Kevin Johnson
Mayor, City of Sacramento
915 I Street
Sacramento, CA 95814-2604

Dear Mayor Johnson:

I am writing this letter on behalf of the Sacramento Asian Pacific Chamber of Commerce to urge your support for the proposed McKinley Village project in the City of Sacramento.

McKinley Village is a thoughtfully designed, well planned infill neighborhood proposed to be built in the heart of the Sacramento region. It will provide homes close to employment centers, schools, shopping, restaurants, and other services. The project will increase housing choices within our urban core, offering energy efficient homes with modern amenities and assisting the City in meeting its need for new housing.

Located on 48 acres adjacent to the McKinley Park neighborhood, this smart growth community of 336 homes - with tree lined streets and homes reflective of the character of surrounding neighborhoods – is consistent with the Sacramento Area Council of Government's Sustainable Communities Strategy. The design and location of McKinley Village will help our region meet its goals of reducing vehicle miles travelled and improving air quality.

McKinley Village will create a significant investment in and economic benefit to the Sacramento area. During construction, McKinley Village is projected to generate approximately $207 million in economic output within Sacramento County and create critically needed jobs.

For the above reasons, the Sacramento Asian Pacific Chamber of Commerce urges approval of McKinley Village.

Thank you for your consideration.

Sincerely,

Pat Fong Kushida

Pat Fong Kushida
President/CEO

Cc: Max Fernandez – Community Development Dir.
David Kwong – Planning Director
Greg Bitter - Associate Planner
John Shirey - City Manager
Fran Halbakken - Downtown Railyards Project Manager
Ryan Fong- River Rock Development Company
Megan Norris- Riverview Capital Investments

SACRAMENTO HISPANIC CHAMBER OF COMMERCE
Est. 1972

February 13, 2014

Dear Mayor and Councilmember's:

The Sacramento Hispanic Chamber of Commerce supports the proposed McKinley Village project in the City of Sacramento.

McKinley Village will provide new homes in the heart of the Sacramento region close to jobs, schools, shopping, restaurants, and other services. The project will increase housing choices for residents desiring to live near our urban core, offer energy efficient homes with modern amenities, and assist the City in meeting its need for new housing.

The Sacramento Area Council of Governments has determined that this smart growth community, located on 48 acres adjacent to the McKinley Park neighborhood, is consistent its Sustainable Communities Strategy, thereby helping our region meet its goals of reducing vehicle miles travelled and improving air quality.

McKinley Village will create a significant investment in our local economy and will provide a needed economic boost to the Sacramento area. During construction, McKinley Village is projected to generate approximately $207 million in economic output within Sacramento County and create critically needed jobs.

For the above reasons, the Sacramento Hispanic Chamber of Commerce urges approval of McKinley Village.

Thank you for your consideration.

Sincerely,

ALice Perez
President / CEO
Sacramento Hispanic Chamber of Commerce
1491 River Park Drive Ste 101
Sacramento, CA 95815
(916) 486-7700 x222

downtown
SACRAMENTO PARTNERSHIP

November 08, 2013

Mayor Johnson and City Council
915 I Street, 5th Floor
Sacramento, CA 95814

Subject: **McKinley Village Project**

Dear Mayor Johnson and Members of the City Council:

On behalf of the Downtown Sacramento Partnership's (DSP) Board of Directors, I would like to offer our support for the proposed McKinley Village project. While the project lies outside the DSP's formal boundaries, the nexus for support lies in the need for sustainable housing options in close proximity to the City's downtown core.

McKinley Village will be a modern urban neighborhood in the core of the Sacramento region just adjacent to Sacramento's Central City. The project will combine the qualities of the city's most successful urban neighborhoods with design features that give this new neighborhood its own distinctive characteristics. This smart growth, infill community of 328 homes has been designed to fit into Sacramento's urban fabric, to complement nearby neighborhoods, and to continue Sacramento's tradition of livable neighborhoods close to our city's center. Our recommendation was based on the following key themes:

- The project is consistent with the Sacramento Area Council of Government's Sustainable Communities Strategy and Blueprint principles.
- The project offers a mix of housing types that are difficult to find in close proximity to downtown.
- Given the history of the proposed site, this project addresses concerns related to density and land use types.
- Although not located within or adjacent to DSP boundaries, the project will create diverse housing options for downtown commercial and employment users.

While we are well aware of concerns from surrounding neighborhoods and understand that further analysis and review of impacts are underway, we urge the development team to continue to work with and address concerns with interested stakeholders.

We urge your support for the McKinley Village Project as a development that is consistent with Blueprint and smart growth principles, will create jobs, while providing a mix of housing choices that will allow new opportunities for residents to live close to Sacramento's downtown core.

Sincerely,

Michael Ault
Executive Director

CC DSP Board of Directors
Evan Compton, Associate Planner, City of Sacramento

916 442.8575
FAX 916 442 2053
980 9th Street Suite 100
Sacramento CA 95814

downtownsac.org

BURNETT MILLER
1224 40TH STREET
SACRAMENTO, CA 95819

Honorable Mayor and City Councilmembers
City Hall
915 I Street
Sacramento, CA 95814

It was my honor to serve as the City Councilmember from the East Sacramento and River Park neighborhoods from 1971 to 1977 and as Mayor of our city in 1982 and 1983. It was a privilege to serve the community, working to strengthen our local economy and preserving our exceptional quality of life.

Over the past decades, there have been numerous proposals to develop the property south of the Capital City Freeway and north of the Cannery Business Park. I did not support these proposals. It is my opinion the McKinley Village is the best project we can expect for the development of this important infill site.

It is compatible with nearby neighborhoods and that will add to the vitality and strength of our city. In this respect, I believe that McKinley Village will be good for our community and our city.

McKinley Village is a well-designed, urban infill neighborhood that will provide homes close to jobs, schools, shopping, restaurants, and other services. The project will increase housing opportunities within our central city, offering energy efficient homes with modern amenities to prospective homebuyers. Importantly, the Sacramento Area Council of Governments has determined that McKinley Village is consistent with the region's Sustainable Communities Strategy.

McKinley Village will create a significant economic benefit to the Sacramento area. In addition to expanding our tax base, McKinley Village is projected to generate approximately $207 million in economic output and create critically needed jobs during its construction.

I support the proposed McKinley Village project.

Sincerely,

Burnett Miller
Sacramento City Councilmember, 1971-1977
Sacramento Mayor, 1982-1983

Josh Pane
1701 37th Street
Sacramento, California
95816

October 21, 2013

Honorable Mayor Johnson, Vice Mayor Ashby,
Members of the City Council
City of Sacramento, City Hall
915 I Street
Sacramento, CA 95814

Re: Support of proposed McKinley Village Neighborhood project

Dear Mayor and Members of Council:

I write to urge your support of the proposed McKinley Village neighborhood project.

In 1992, when I represented East Sacramento and Midtown on the City Council, I led the charge to oppose and ultimately reject the "Centrage" project, a massive high rise development proposed for the 48 acres just north of McKinley Park. This is the same site that now has been proposed as the McKinley Village neighborhood. At the time, we pushed for a more moderate project, similar to our surrounding neighborhoods in scope, size and density. The McKinley Village neighborhood now is just that type of project. It deserves your support.

It is consistent with our City and the region's vision to encourage infill development, reduce vehicle miles travelled, and improve air quality. For these reasons, SACOG has determined that the project is consistent with its Sustainable Communities Strategy. It will provide housing near jobs and within blocks of schools, shopping, restaurants, and other services. The McKinley Village neighborhood is proposed with tree lined and shaded streets, homes with front porches, a recreation/community center and pool, bikeways and parks. It will, in short, emulate and enhance our own neighborhoods.

McKinley Village will become a place where our friends and family will live and a new generation will rear their children. And conveniently we will have access to this new neighborhood and therefore a new walking, jogging and bicycling route via "C" Street from East Sacramento to the American River, Sutter's Landing Regional Park, the Skate and Dog Parks and Bocce Courts. It will thereby take traffic off of Midtown streets.

I am confident that McKinley Village will become one of the great neighborhoods of our City. Please call upon me should you have questions.

Respectfully,

JOSH PANE
Member of City Council, 1989-1994
Member of the Sacramento County Board Of Education, 1985-1989

DOUGLAS N. POPE
5633 Caleb Avenue
Sacramento, California 95819
916.456.4910

October 22, 2013

Mayor and City Council Members
915 I Street
Sacramento, California 95814

RE: McKinley Village

Dear Mayor and Council Members:

From 1977 to 1989, I had the honor of representing East Sacramento and River Park on the Sacramento City Council. It was a privilege to serve the community in which I was born and raised and to work with neighbors to preserve our exceptional quality of life as our community grew and evolved.

Over the last two decades, there have been numerous proposals to develop the 48 acre property north of the Cannery Business Park and south of the Capital City Freeway. There is no question that this site will ultimately be developed – in fact, it has been slated for urbanization in the City's General Plan for over two decades and the site is currently zoned for heavy industrial uses.

It's in the interest of the community as a whole and our neighborhood to see the right kind of development in this location – development that is compatible with nearby neighborhoods and that will add to the strength and vitality of our city. I believe that the proposed McKinley Village project is the right project at the right time for our community and our city. McKinley Village is a thoughtfully designed, well planned infill neighborhood proposed to be built in the heart of the Sacramento region. It will provide homes close to jobs, schools, shopping, restaurants, and other services. The project will increase housing choices within our urban core, offering energy efficient homes with modern amenities and assisting the City in meeting its need for new housing.

This smart growth community of 328 homes - with tree lined streets and homes that are consistent with the character and quality of surrounding neighborhoods - meets the standards of the Sacramento Area Council of Government's Sustainable Communities Strategy. Front entries and porches on the street, a neighborhood recreation center and pool, and attractive parks and green spaces will create a pedestrian friendly environment. Bikeways and walkways will stitch together the neighborhood and connect McKinley Park, McKinley Village, Sutter's Landing Park, and the American River Parkway. The design and location of McKinley Village will help our region meet its goals of reducing vehicle miles travelled and improving air quality.

McKinley Village will create a significant investment in and economic benefit to the Sacramento area. During construction, McKinley Village is projected to generate approximately $207million in economic output in Sacramento County and create critically needed jobs.

For the above reasons, I support the McKinley Village project and look forward to this neighborhood joining the family of neighborhoods that make up our East Sacramento community.

Sincerely,

Doug Pope
Sacramento City Councilmember, 1977-1989

October 21, 2013

The Honorable Steve Cohn
City of Sacramento
915 I Street, 5th Floor
Sacramento, CA 95814

Dear Steve,

On behalf of the Board of Directors of The River District, I would like to offer support for the McKinley Village project. As an up-and-coming central city district, we see the benefits of infill development as a means of reaching the smart growth goals outlined in the City's General Plan and in the SACOG Blueprint.

The development of McKinley Village will enhance livability in and around the project. Its residents will support our local economy by providing homes close to employment centers, schools, shopping, restaurants, and other services. The project will increase housing choices within our urban core, offering energy efficient homes with modern amenities and assisting the City in meeting its need for new housing.

Developers, architects and engineers of the project are presenting a project that will provide modern homes designed to fit with the character of other established neighborhoods and will provide residents with the amenities that offer a desirable living environment.

As the River District continues its transformation into an eclectic, mixed-use area, we welcome McKinley Village as a neighboring in-fill project that will create a significant investment in and economic benefit to the Sacramento area.

Sincerely,

Patty Kleinknecht
Executive Director

c: Mayor Kevin Johnson
Megan Norris, Riverview Capital Investments
Greg Bitter, City of Sacramento Community Development

International Association
of Sheet Metal,
Air, Rail and
Transportation
Workers

Sheet Metal Workers'
Local Union No. 104
2610 Crow Canyon, Ste. 300
San Ramon, California 94583-1547
Tel: (925) 314-8600 • Fax: (925) 314-8620

Bruce Word
President/Business Manager

October 21, 2013

Honorable Mayor Johnson
City Council Members
Members of Planning and Design Commission
City Hall
915 I Street
Sacramento, CA 95814

Dear Mayor Johnson, City Council and Planning and Design Commission Members:

I am writing this letter to express our support for the proposed McKinley Village development in the City of Sacramento.

McKinley Village is a well-planned infill neighborhood proposed to be built in the heart of the Sacramento region. It will provide homes close to employment centers, schools, shopping, restaurants, and other services. The project will increase housing choices within our urban core, offering energy efficient homes with modern amenities and assisting the City in meeting its need for new housing.

In addition, McKinley Village will create a significant investment in the Sacramento area. During construction, McKinley Village is projected to generate approximately $207million in economic benefit to Sacramento County, including over $84 million in wages. The construction of this project will create critically needed jobs at good wages in our community.

Located on 48 acres adjacent to the McKinley Park neighborhood, this smart growth community of 328 homes—with tree lined streets and homes that are consistent with the character of surrounding neighborhoods—meets the standards of the Sacramento Area Council of Government's Sustainable Communities Strategy. McKinley Village is not only good for the economy, it will help our region meet its goals of reducing vehicle miles travelled and improving air quality.

For the above reasons, Sheet Metal Workers' Local 104 urges your support of McKinley Village.

Sincerely,

Bruce Word
President/Business Manager

International Brotherhood of Electrical Workers
Local Union 340

2840 El Centro Road, Suite 115, Sacramento, CA 95833
Phone (916) 927-IBEW • FAX (916) 927-1074 • www.ibewlocal340.org

October 21, 2013

Honorable Mayor Johnson and
Members of the City Council
915 I Street
Sacramento, CA 95814

Dear Mayor Johnson and Members of the City Council:

I am writing today on behalf of the Officers and members of the International Brotherhood of Electrical Workers Local Union No. 340, Sacramento in support of the proposed McKinley Village project. We have been watching this project develop over the years and feel it is a well-designed infill neighborhood that will provide homes close to jobs, schools, shopping, restaurants, and other services.

McKinley Village is both an example of smart growth, consistent with the Sacramento Area Council of Government's Sustainable Communities Strategy, and an opportunity for economic development which is vitally needed as the Sacramento community emerges from years of recession.

The construction of McKinley Village is projected to generate approximately $207 million in economic benefit in Sacramento County, including over $84 million in wages. The construction of this project will create critically needed jobs at good wages in our community.

Clearly, McKinley Village is good for our economy and it will help our region meet its goals of reducing vehicle miles travelled and improving air quality.

The International Brotherhood of Electrical Workers (IBEW) Local 340 urges your support of McKinley Village. Thank you for your consideration and if you have any questions, please don't hesitate to call.

Sincerely,
Electrical Workers' Union
Local No. 340

Tom Okumura
Business Manager

TO/pp opeiu #29 afl-cio

LABORERS LOCAL 185
JUSTICE • HONOR STRENGTH
Serving 20 Northern California Counties

CONSTRUCTION AND GENERAL LABORERS' LOCAL 185
Affiliated with Laborers' International Union North America
DOYLE S. RADFORD, SR.
Business Manager/Secretary Treasurer

October 22, 2013

Honorable Mayor Johnson and
Members of the City Council
915 I Street
Sacramento CA 95814

Juan McKnight
President
Armando Calzada
Vice President
Armando "A.C." Covarrubias
Recording Secretary
John Flem
Executive Board
Gary Sharette
Executive Board
Doyle S. Radford, Jr
Executive Board
Johnnie Leggett
Auditor
Stan Swiger
Auditor
Jeremy Jimenez
Auditor
Ivan Rabb
Sergeant-at-Arms

You will soon be hearing the proposed McKinley Park Village project. I am writing to urge your support on behalf of Laborers' Local #185 and working families throughout Sacramento.

This smart-growth in-fill neighborhood in the center of the Sacramento region presents a great opportunity for quality, environmentally responsible in-fill development for Sacramento, providing homes close to jobs, shopping, restaurants, schools and other services.

Additionally, it represents a significant investment in our community, projected to generate approximately $207 million in economic benefit in Sacramento County, including over $84 million in wages. These are jobs we badly need as we try to emerge from the lingering economic recession.

Again, on behalf of Laborers' Local #185, I urge your support of McKinley Village.

Sincerely,

Doyle S. Radford, Sr.
Business Manager
Secretary-Treasurer

DSR:sb
opeiu#29

1320 National Drive • Sacramento, CA 95834-1908 • PHONE (916) 928-8300 • FAX (916) 928-8311
www.laborerslocal185.org

National Electrical Contractors Association Inc.
Greater Sacramento Chapter
SACRAMENTO & RENO DIVISIONS
FRAN MCDERMOTT, EXECUTIVE DIRECTOR

1129 D Street
Sacramento, CA 95814
Phone: (916) 449-1322
Fax (916) 449-1328
Reno: (775) 329-7008
Redding: (888) 449-1322
website:www.necasac.org

October 20, 2013

Honorable Mayor Johnson and Members of the City Council
City Hall
915 I Street
Sacramento, CA 95814

I am writing to express the support of the National Electrical Contractors Association (NECA) for the proposed McKinley Village project in the City of Sacramento.

The Sacramento region has been hard hit by the recent recession. Opportunities to build quality, smart-growth construction projects that will benefit our community for generations have been sparse to non-existent. McKinley Village is just that sort of project and represents a significant investment in our community. The construction of McKinley Village is projected to generate approximately $207 million in economic benefit in Sacramento County, including over $84 million in wages. The construction of this project will create critically needed jobs at good wages in our community.

McKinley Village is a well-designed infill neighborhood. It will provide homes close to jobs, schools, shopping, restaurants, and other services. It will provide increased housing opportunities within our urban core, offering energy efficient homes with modern features and assisting the City in meeting its need for housing.

This smart growth community of 328 homes meets the standards of the Sacramento Area Council of Government's Sustainable Communities Strategy. McKinley Village is not only good for the economy – it will help our region meet its goals of reducing vehicle miles travelled and improving air quality.

For the above reasons, NECA urges your support of McKinley Village.

Sincerely,

Fran McDermott
Executive Director
NECA – Greater Sacramento

Operating Engineers Local Union No. 3

3920 LENNANE DRIVE, SACRAMENTO, CA 95834 • (916) 993-2055 • FAX (916) 419-3491

Jurisdiction: Northern California, Northern Nevada, Utah, Hawaii, and the Mid-Pacific Islands

October 21, 2013

Honorable Mayor Johnson and Members of the City Council
City Hall
915 I Street
Sacramento, CA 95814

Dear Mayor Johnson and Members of the Sacramento City Council:

I am writing on behalf of Operating Engineers Local 3 to urge your support for the proposed McKinley Village.

McKinley represents an opportunity for the City of Sacramento to embrace a well-designed infill development project that will provide homes close to jobs, schools, shopping, restaurants, and other services. While meeting the standards of the Sacramento Area Council of Government's Sustainable Communities Strategy, the project will provide increased housing opportunities within our urban core, offering energy efficient homes with modern features and assisting the City in meeting its need for housing.

Additionally, McKinley Village represents a significant investment in our community at a time when we continue to struggle with job growth. It is projected to generate approximately $207 million in economic benefit in Sacramento County, including over $84 million in wages. The construction of this project will create critically needed jobs at good wages in our community.

On behalf of Operating Engineers Local 3, and working families throughout our community, I urge your support of McKinley Village.

Sincerely,

Rob Carrion
District Representative
Operating Engineers, Local 3

October 24, 2013

Kiyomi Burchill, Chair
Planning and Design Commission
City of Sacramento
300 Richards Blvd, 3rd Floor
Sacramento, CA 95811

As a long time regional resident that grew up Placer County and now lives in McKinley Park, I've seen the impacts of suburban greenfield development that have occurred throughout our region. We chose to live in East Sacramento to avoid commute traffic and have the convenience to downtown amenities.

McKinley Village appears to be a thoughtfully designed, well-planned infill neighborhood proposed in the heart of the Sacramento region. It will provide homes close to employment centers, schools, shopping, restaurants, and other services.

Located adjacent to the McKinley Park neighborhood, this community has tree-lined streets and home designs that are consistent with the character of surrounding neighborhoods. In addition, it is consistent with the important work of Sacramento Area Council of Government's Sustainable Communities Strategy.

As a nearby resident of the proposed project, my interest also is in how the project might improve community amenities. I understand the project includes a bike/pedestrian tunnel under the UPRR track at the current terminus of Alhambra. This will provide a much safer and pleasant route for East Sacramento residents to get to the Sutter's Landing Park, which includes a dog park and is a gateway to the American River Parkway. Access to the river has long been a missing element for East Sacramento residents and it's thoughtful this project will provide this important linkage. I also understand that other amenities like a park and recreational facility will be included and available to community members.

I am aware that a detailed traffic study is being completed and will be incorporated into the Draft EIR. I am confident these analyses will adequately address any perceived traffic issues.

For the above reasons, as a resident of the City of Sacramento, I support this urban infill project.

Sincerely,

Jared D. Ficker

Jared Ficker
3310 H Street
Sacramento, CA 95816

CATHERINE A. TAYLOR

1216 55th Street, Sacramento, CA 95819

catherine-taylor@comcast.net

(916) 803-4194

October 21, 2013

Dear Members of the Planning Commission:

I am writing to encourage your favorable review of the McKinley Village project application, and to proceed with the planning and studies necessary to resolve any remaining concerns among the parties. It is critical for this property to be developed in a way that is beneficial for the residents of East Sacramento, and economically-viable for the developer and the City at-large. I believe that is possible, and every effort should be made to create a development that is positive for our City.

As proposed, the McKinley Village project is thoughtfully designed, and represents the values contained in the City's General Plan – urban infill, close to employment, schools, shopping and dining. The project represents smart growth concepts in that the houses are consistent in character with the surrounding neighborhood, and it meets SACOG's Sustainable Communities Strategy.

I encourage the Planning Commission to vote favorably on this project to move it forward to the next step.

Sincerely,

Catherine A. Taylor

CFY DEVELOPMENT

October 8, 2013

RE: McKinley Village Development

To Whom It May Concern:

McKinley Village is a thoughtfully designed, well planned infill neighborhood proposed to be built in the heart of the Sacramento region. It will provide homes close to employment centers, schools, shopping, restaurants, and other services. The project will increase housing choices within our urban core, offering energy efficient homes with modern amenities and assisting the City in meeting its need for new housing.

Located on 48 acres adjacent to the McKinley Park neighborhood, this smart growth community of 328 homes - with tree lined streets and homes that are consistent with the character of surrounding neighborhoods - meets the standards of the Sacramento Area Council of Government's Sustainable Communities Strategy.

As an infill housing developer myself, I appreciate the thoroughness of this project's design and the positive impact that it will have on our local economy. McKinley Village will create a significant investment in and economic benefit to the Sacramento area.

As a resident of Marshall School/Midtown, I am excited to see this development move forward in my "backyard." It is with great enthusiasm that I support this urban infill project.

Sincerely,

Ali Youssefi
Ary12383@gmail.com
(916) 446-4040

1006 4th ST, SUITE 701 | SACRAMENTO, CA | 95814
PHONE: 916-446-4040 | FAX: 916-446-4044

REEDS
Gourmet Meat Co.

PREMIUM AGED BEEF

October 1, 2013

I am a business owner in East Sacramento. I own Reeds Gourmet Meat Company. I fully support the McKinley Village project for the type of housing, density and infill it provides for the city of Sacramento.

McKinley Village is a thoughtfully designed, well planned infill neighborhood proposed to be built in the heart of the Sacramento region. It will provide homes close to employment centers, schools, shopping, restaurants, and other services. The project will increase housing choices within our urban core, offering energy efficient homes with modern amenities and assisting the City in meeting its need for new housing.

The project on 48 acres, adjacent to the McKinley Park neighborhood, is a smart growth community of 328 homes that are consistent with the character of surrounding neighborhoods - meets the standards of the Sacramento Area Council of Government's Sustainable Communities Strategy.

McKinley Village will create a significant investment in and economic benefit to the Sacramento area. During construction, McKinley Village is a project that will create critically needed jobs, in our community.

For the above reasons, I support this urban infill project.

Sincerely,

Sam Manolakas
Reeds Gourmet Meat Company
1210 66th Street
Sacramento, CA 95819

☐ Please keep me informed

WINN COMMUNITIES

McKinley Village is a thoughtfully designed, well planned infill neighborhood proposed to be built in the heart of the Sacramento region. It will provide homes close to employment centers, schools, shopping, restaurants, and other services. The project will increase housing choices within our urban core, offering energy efficient homes with modern amenities and assisting the City in meeting its need for new housing.

Located on 48 acres adjacent to the McKinley Park neighborhood, this smart growth community of 328 homes - with tree lined streets and homes that are consistent with the character of surrounding neighborhoods - meets the standards of the Sacramento Area Council of Government's Sustainable Communities Strategy.

McKinley Village will create a significant investment in and economic benefit to the Sacramento area. During construction, McKinley Village is projected to generate approximately $207 million in economic output in Sacramento County and create critically needed jobs.

For the above reasons, as a resident of the [City of Sacramento East Sacramento/Midtown], I support this urban infill project.

Sincerely,

Thomas P. Winn

Winn Communities
3001 I Street Suite 300
Sacramento, CA 95816
(916) 930-0925
(916) 930-0927 Fax
tom@winncommunities.com

☐ Please keep me informed

October 17, 2013

To: Sacramento City Planning Commission

Re: McKinley Village Neighborhood

To Whom it May Concern:

I am a resident of the City of Sacramento and live in Mid-Town. My family and I support the proposed McKinley Village infill neighborhood. We regularly use the facilities at Mc Kinley Park and realize the dire need for a well planned development that allows for off street parking that mitigates congestion. The current neighborhoods date back to the coming of the railroads and were designed for horse and buggy travel and were not designed to the state of the art environmental standards designed into McKinley Village.

McKinley Village a well planned environmentally friendly development is located on a 48 acre site adjacent to the East Sacramento and McKinley Park neighborhoods. The 328 homes are designed to fit into our urban fabric and complement adjoining neighborhoods without contributing to congestion.

Sincerely,

Erik S Emblem
414 18th Street
Sacramento, CA 95811
916-400-4498
eemblem@gmail.com

As a resident, property and business owner in the City of Sacramento, I support McKinley Village, a proposed infill neighborhood located on a 48 acre site adjacent to the East Sacramento and McKinley Park neighborhoods. This smart growth community of 328 homes is designed to fit into Sacramento's urban fabric and complement adjoining neighborhoods.

Sincerely,

Signature

SOTIRIS K. KOLOKOTRONIS

Name

SKK Developments
1121 18th Street
Sacramento, CA 95811
(916) 449-8989 (916) 449-8865 Fax

6/15/2013 VIA EMAIL

Evan Compton, Associate Planner
Community Development Department
City of Sacramento
300 Richards Blvd
Sacramento, CA 95814

RE: McKinley Village (P08-086))

Dear Mr. Compton:

WALKSacramento appreciates the opportunity to review the project routing for McKinley Village. We also appreciate the applicant and their design team meeting with us to discuss the project revisions made since the application to the City in 2008. The project proposes development of 328 single-family homes on a 48-acre vacant site bounded by Capital City Freeway to the north and the Union Pacific Railroad tracks to the south. Sutter's Landing Regional Park is north -west of the site on the other side of the freeway, and East Sacramento is south and east of the site on the other side of the UPRR tracks.

Development projects that lead to more walking and active travel are critical to our community's future. Human beings need moderate exercise, such as walking, for about 30 minutes a day in order to prevent the development of chronic disease and overweight. Only 38% of the population in the Sacramento region is active at this minimal level, often due to limitations placed by a built environment not suited to walking and other types of physically active travel. A 30-minute walk is about one and a half miles. If more people could obtain regular exercise by walking and bicycling to their regular destinations, in lieu of driving, it could yield significant health improvements to the resident population of this area. Reduced driving would also decrease vehicle emissions and the prevalence of asthma, cardiovascular disease, and other air pollution-related conditions. More trips by walking and bicycling could help reduce the current expensive burden on the health care system of providing medical care to more and more people with chronic conditions due to inactivity and poor air quality.

Infill development can contribute to an increase in walking and physical activity when more people live or work close to a variety of destinations. The lack of connectivity to the surrounding area and few nearby destinations to the north suggest that McKinley Village has a mix of infill and edge-of-city qualities. Therefore, it's very important to enhance the limited connectivity proposed for the project.

The project proposes to provide all-mode access to the site at the west end via A Street and at the east end via a new 40th Street undercrossing. Pedestrian and bicycle access is proposed via a new undercrossing at the north end of Alhambra Boulevard.

The bridge over the Capital City Freeway at A Street should include sidewalks on both sides of the bridge with at least five feet clear width after subtracting shy distances in each direction, and bicycle lanes on both sides that will accommodate most skill levels.

It is important to provide clear lines of sight to destinations at each end of the railroad track undercrossing at Alhambra Boulevard and at 40th Street. Pedestrians will feel more comfortable using an undercrossing if they can clearly see the other end. Curves in the street or trail approaches, as shown on the site plans, diminish the line of sight and may discourage use of the undercrossing.

Consider using a roundabout at the intersection of A Street and Street 1. Not only would a roundabout provide better traffic calming than a side-street or all-way stop controlled intersection, but it may also provide improved pedestrian and bicycle mobility. A roundabout should permit removal of the curve in bike/ped trail on the north side of the Alhambra undercrossing. A roundabout should also allow for a safer transition to A Street and Street 1 for bicyclists. WALKSacramento will be happy to provide a sketch illustrating how this intersection might be configured.

As the last of our concerns, we're not sure there will be much benefit from the 10-foot-wide multi-use trail along A Street. It might be better to construct 7.5 foot sidewalks on both sides of A Street, or increase the planter width on each side by 2.5 feet.

Even though we have made several recommendations to improve the McKinley Village project, we'd like to recognize one important change that was made since the 2008 proposal. The conceptual site plan shows many street trees, and the greatest improvement is the addition of trees on the alleys. These trees will cool and beautify the alleys for pedestrians, in addition to providing air quality and energy-use benefits.

WALKSacramento is working to support increased physical activity such as walking and bicycling in local neighborhoods as well as helping to create community environments that support walking and bicycling. The benefits include improved physical fitness, less motor vehicle traffic congestion, better air quality, and a stronger sense of cohesion and safety in local neighborhoods.

Thank you for your consideration of these comments and recommendations. If you have questions or need additional information, please contact me at (916) 446-9255 or cholm@walksacramento.org.

Sincerely,

Chris Holm
Project Analyst

Enclosure: Development Checklist for Biking and Walking

DEVELOPMENT CHECKLIST for BIKING and WALKING

Prepared by WALKSacramento and SABA (Sacramento Area Bicycle Advocates)
September 2012

This checklist is provided to give an indication of design, engineering, and policy elements that we consider when reviewing development projects.

POLICIES

- ❑ Walking and biking is a priority
- ❑ Adopted a policy to develop a full multi-modal and ADA accessible transportation system

Project Review and Comment

POLICY CONSIDERATIONS

- ❑ Pedestrian Master Plan
- ❑ Bicycle Master Plan
- ❑ Regional Blueprint
- ❑ Regional Blueprint Consistent General Plans
- ❑ Adopted Climate Action Plans
- ❑ Subdivision ordinances to support pedestrian and bicycle access and safety
- ❑ Zoning ordinance to support pedestrian and bicycle access and safety

ENGINEERING

- ❑ SIDEWALKS & BIKELANES ON BOTH SIDES OF MAJOR ROADWAYS
  - Pedestrian Level of Service “C” or better on arterials
  - Bicycle Level of Service “C” or better on arterials
- ❑ SAFE CROSSINGS FOR PEDESTRIANS
  - every 300-600 feet on major arterials
  - well lit, marked crosswalks
  - audible signals & count-down signals
  - median refuge islands
- ❑ SPEED MANAGEMENT
  - Speed limits based on safety of pedestrians and bicyclists
  - Implement “road diets” where there is excess lane capacity
- ❑ STREET DESIGN STANDARDS
  - Maximize pedestrian and bicyclist safety
  - Sidewalks buffered by trees and landscaping on major arterials
  - Vertical curbs
  - 5’ minimum sidewalk widths, 8’ in front of schools
  - 6’ minimum bike lanes on busy streets

- INTERSECTIONS
  - Median refuge islands for pedestrians
  - Signal timing to enable safe passage
  - Signal detection for bicyclists
  - Crossings on all 4 legs of intersections

- ELIMINATE BARRIERS
  - Freeway, railroad, river and creek crossings
  - Obstructions in sidewalks and bike lanes

NEW DEVELOPMENT – REQUIRE

- Walking & bicycling circulation plans for all new development
- Direct and convenient connections to activity centers, including schools, stores, parks, transit
- Mixed uses and other transit supporting uses within ¼ mile of light rail stations or bus stops with frequent service
- Minimum width streets
- Maximum block length of 400'
- 4-lane maximum for arterials; Recommend 2 lanes wherever possible

NEW DEVELOPMENT – DISCOURAGE

- Cul-de-sacs (unless it includes bike/ped connections)
- Gated and/or walled communities
- Meandering sidewalks
- Inappropriate uses near transit (gas stations, drive-thru restaurants, mini storage and other auto dependent uses)

BUILDINGS – REQUIRE

- Direct access for pedestrians from the street
- Attractive and convenient stairways
- Bicycle parking – long & short term
- Shower & clothing lockers

OLDER NEIGHBORHOODS

- Improve street crossings
- Reduce speeds
- Provide new connections
- Create short cuts for walkers and bicyclists by purchase of properties or other means
- Provide sidewalks on both sides of major streets

Policy Review and Comment

ENFORCEMENT & MAINTENANCE

- Enforce speed limits
- Enforce crosswalk rules – conduct crosswalk sting operations
- Enforce restrictions against parking on sidewalks
- Enforce bicycle rules including riding with traffic, lights at night, stopping at red lights
- Implement CVC 267 setting speed limits based on pedestrian and bicyclist safety
- Sweep streets and fix hazards
- Repair and replace broken sidewalks

EDUCATION

- Train staff on pedestrian and bicycle facility design.
- Train development community about pedestrian and bicycle planning and safety issues
- Bicycle skills training

FUNDING

- Include pedestrian and bicycle facilities in capital improvement programs
- Include pedestrian and bicycle facilities as a part of roadway widening and improvement projects
- Support Measure A pedestrian and bicycle facility allocation
- Set priorities based on safety and latent demand
- SACOG Community Design grants & Bike/Ped grants
- California Bicycle transportation Account
- Safe Routes to School

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Evan Compton

From: bethfoster@frys.com
Sent: Friday, June 28, 2013 11:05 AM
To: Evan Compton
Subject: Mc Kinley Village Traffic Access

Dear Mr. Compton, As a resident of midtown at 27th and C Streets I am not opposed to the general plan for housing at the McKinley Village site. I am concerned about the 28th Street access as one of two auto pathways into the project. I acknowledge the expense of an Alhambra Blvd tunnel but feel the bike access should be at the park entrance on 28th Street and the auto entrance at Alhambra--not the other way around. Merely saying that an idea is too expensive is not a valid reason to the community. This is a cost of the developer and needs to be viewed as a construction cost.
Thank you for considering this opinion. Sincerely, Beth Foster

Ellen Trescott
2014 C Street
Sacramento, CA 95811
eltrescott@hotmail.com

June 28, 2013

VIA E-MAIL

Evan Compton, Associate Planner
City of Sacramento, Community Development Department
ecompton@cityofsacramento.org

RE: Comments on project application for the McKinley Village Project

Mr. Compton,

Please accept these comments on the planning permit application for the McKinley Village project ("Project"). I understand that the CEQA scoping comment period has been extended for another few weeks, and I request that the City consider all scoping comments as they are relevant to processing the requested permits and project approvals for the Project.

Flood Control

Generally, I consider it very poor policy to allow residential development, or any development, on the river-ward side of the railroad levee in Sacramento. This levee provides significant flood protection to north midtown and east Sacramento, including operative flood gates, and it is irresponsible for the City to consider siting homes outside of this protective levee. The City's Parks and Recreation department recently rejected a proposal to study the relocation of Land Park Zoo to the Sutter's Landing Park area, primarily based on flood control concerns. The proposed Project site is in an overland flood setback zone and retention area, and for the safety and security of all residents of the City this entire area should be dedicated to parks and habitat, and nothing more.

With the increasing burden on local governments, including the City and the Sacramento Area Flood Control Agency ("SAFCA"), to pay for the costs of providing flood control for residents, the Project represents a potential liability for the City, both in terms of future financial requirements, levee maintenance and repairs, and liability for potential property damage after a flood. The City and SAFCA should study what effects this Project might have on the City's potential flood liability, including what changes may be needed to the City's flood control plan, under the general principles articulated in the well-known *Paterno v. State of California* case.

The increased maintenance and operations costs of the Project, including the maintenance of a new flood gate in east Sacramento, should be paid for by the residents of the Project, through special fees or assessments. Furthermore, the City should assure that an accurate and up-to-date FEMA floodplain designation is in place for the Project site, and that the Flood Insurance Rate Maps ("FIRMs") for the Project site are updated and accurate. Close consultation with SAFCA is essential.

Vehicle Access

The current proposal to route the Project's traffic along A Street to 28th Street is a slap in the face to midtown residents. Essentially, the Project will provide benefits to east Sacramento, such as school fees, pedestrian upgrades, stormwater retention, etc., while north midtown will receive nothing more but a snake of traffic and car exhaust. This is an east Sacramento project and both the benefits *and the burdens* of the Project should remain there.

I support the comments of the Marshall and New Era Park Neighborhood Associations, which have requested a full, complete, and "accessible to the public" traffic study and Project alternatives analysis that considers (1) the potential impacts (including cumulative impacts) on local traffic, air quality, biological resources, pedestrian and bicycle safety, and recreation in north midtown; (2) the feasibility and desireability of a Project alternative with vehicle access to and from Alhambra Boulevard, whether under the railroad tracks or over the railroad tracks, instead of A Street; (3) a Project alternative that includes new freeway on- and off-ramps, such as those proposed for the previous version of the Project; (4) if A Street is the only feasible access point, routing traffic to 29th Street instead of 28th Street, whether by routing traffic along B street or by installing a new railroad underpass or overpass; (5) expansion of the traffic management program in north midtown, particularly to include C Street, and the installation of stop signs and other traffic calming measures; and (6) consideration of other traffic (and other impact) reduction measures for north midtown, such as relocating the City corp. yard at Sutter's Landing, and the potential transition of the Bel Marine facility to a habitat mitigation bank or parkland.

I regularly visit Sutter's Landing and Stanford Parks, and witness the significant car, train, and pedestrian traffic that uses the streets at and around B and 28th Streets. In particular, when there is a play at the B Street Theater, a sports game or practice session at Stanford Park, a skate event at the skate park, a hot day when river access is at a premium, or during peak rush-hour traffic times when many people take their dogs to the dog park, this area is frequently congested with people and cars. For a prime example, visit there on the 4th of July. There are no sidewalks along 28th Street in this location. There is not much parking south of B Street. I along with others are very concerned about the potential safety issues of routing thousands of cars through this intersection daily.

Moreover, the hostility and/or erratic behavior of drivers who have to wait for a passing freight train should not be underestimated. I live near the intersection of 20th and C Streets, and I am very familiar with the trains that travel through Sacramento, including the east-west Union Pacific line that separates the Project site from the rest of Sacramento. These are not always "passing" trains. For various reasons, including train traffic backups along the line, trains frequently stop at or near the 20th and 28th Street crossings, and the signal arms are down for 20 to 30 minutes. It is an unavoidable fact that train crossings will force Project residents to turn their cars around, whether leaving or entering the Project site, and will also cause significant traffic backups, probably ten times daily. It is my observation that the Union Pacific rail line is used by trains much more frequently than the BNSF rail line that runs north to south through Sacramento.

It just doesn't make sense, from a City planning perspective, to allow Project site access from A Street.

Biological Resources

The Swainson's Hawk is a precious and beautiful species of concern, and we are lucky to have these hawks residing and foraging on the Project site and in nearby Sutter's Landing Park and the surrounding area. It is well know that the Project site provides crucial foraging habitat, if not nesting habitat, for these birds. The Project should not be developed on this site and eliminate this large open area for protected species' foraging. If the Project is developed, the City should work with the developer to create a habitat mitigation plan that completely and conservatively offsets the loss of this habitat. Because of the detriment and disturbance caused by removing the habitat, and the presumed quality of the habitat, the City, in consultation with the California Department of Fish and Wildlife and the Friends of the Swainson's Hawk, should require habitat mitigation of 2 new acres preserved for every 1 acre destroyed. The least disruptive mitigation plan would be for this new habitat to adjoin the current habitat area in Sutter's Landing Park. There is plenty of land now occupied by Bel Marine, PG&E, Union Pacific, Blue Diamond, and others that could be concurrently used for permanent foraging habitat protection. Habitat mitigation must lead to the permanent protection of currently non-protected property.

The proposed access point at A Street will create adverse impacts to Swainson's Hawk and potentially other species of concern. These hawks regularly forage on the former landfill adjacent to A Street, and they nest nearby. The streetlights, headlights, car and truck noise, and exhaust will degrade the adjacent habitat and deter the hawks from using this area. These impacts must be considered when analyzing the potential alternatives for project access routes.

Public Service Impacts, including parks and recreation impacts

The Project applicant must be required to study and offset the impacts of the project on nearby parks, as well as public services such as water, sewer, and stormwater infrastructure. The applicant should be required to pay adequate park impact fees for the three public parks located very close to the Project site, and/or install park improvements to offset the increased visitor use and traffic impacts that the Project will have on these parks.

Economic Viability and Project Site Plans

The size of the proposed houses, as well as the proposed price point, and the refusal of the applicant to incorporate affordable housing, is somewhat alarming. I encourage the City to require an economic feasibility study for the Project, that takes into consideration the awkward location of the Project (next to a freeway and train tracks, and not walkable to midtown restaurants and shopping), and the marketability of similar new housing stock in the area. The applicant has represented that the houses will sell for somewhere around $700,000. A recently constructed new home on 20th Street between C and D, at the same price point, has been on the market for months and has not sold. The "Sutter Brownstones" project has had similar problems reaching completion and selling many of its units. Despite the rebounding housing market, I am skeptical that the Project will be as viable as the applicant believes.

The City should explain how the proposed Project will conform to the planning objectives of SB 375, to encourage transit-oriented urban infill developments. The Project does not appear to meet the goals of this new important law, and it will not contribute to the type of infill housing projects that are needed in Sacramento in order to curb California's contribution to global climate change.

Finally, the landscape plan for the Project should require trees in the same proportion as neighboring east Sacramento and midtown neighborhoods. Tree-lined streets are an important component of energy savings. As required by the Subdivision Map Act, City staff should carefully consider this and other Project design options that will incorporate all feasible passive and natural heating and cooling opportunities.

Thank you for considering my comments and forthcoming CEQA scoping comments.

Sincerely,

Ellen Trescott

Ellen Trescott

Evan Compton

From: george raya <georgeraya@yahoo.com>
Sent: Friday, June 28, 2013 7:28 AM
To: Evan Compton
Subject: RE: McKinley Village (P08-086) - Comments

McKinley Village (P08-086) - Comments

I am a long time resident of he Marshall School neighborhood and the former co-chair of the Marshall School/New Era Park Neighborhood Association and provide comments for the McKinley application submitted to the Planning Department.

The McKinley Village project is claimed by the developer, Phil Angelides, as an "East Sacramento" project. This "East Sacramento" project, however, will have a detrimental impact in the northeastern part of Midtown called "Marshall School/New Era Park" due to the proposed access point at 28th and A Streets.

On the topic of traffic impacts, Mr. Angelides is quoted in a recent Sacramento News & Review article as saying, ""[W]e live in an urban area, we share streets," he said. "If we're going to have urban infill, we're going to have to find smart ways to handle traffic and still keep our neighborhoods livable." To date, Mr. Angelides has offered no "smart ways to handle traffic."

Access has long been a challenge to this site. This same issue came up in the last iteration of this project in 2006-2008. Mr. Angelides and his group had five years to come up with innovative ideas to overcome the traffic problems that will be created by this project. In that five years, Mr. Angelides has come up with no new ideas or proposals to deal with the access issue.

To date, Mr. Angelides has demonstrated little or no interest in working with Midtown residents to solve these access issues. We are left to figure out solutions without the expertise of Mr. Angelides' consultants.

The Marshall School/New Era Park neighborhood will be greatly impacted by the project and we've only been given two opportunities to discuss our concerns with the developer. Our concerns should come as no surprise since they were mentioned five years ago when this project was last submitted to the Planning Department.

Simply put, McKinley Village is not a shining example of "Smart Growth." There is no commercial businesses within the project so the residents of McKinley Village will get in their cars for every gallon of milk, every cup of coffee, or trip to school. This is a very car-centric development that offers no ready access to transit services either.

Midtown residents know "Smart Growth" when they see it. The project at 2500 R Street will be "first Net Zero Energy community in Sacramento's midtown district. Net Zero Energy means that over the course of a year, each unit generates all the electricity you'll need and emit net zero carbon emissions." Mr. Angelides' project makes little effort to offer any innovations to off-set the car-centric nature of this project.

Traffic/Access/Circulation Issues

According to the City of Sacramento Notice of Intent to Establish a Quiet Zone dated March 1, 2012, there were 1777 cars traveling across the 28th and B Street rail crossing. If no reduction of traffic is addressed before the project commences then traffic volume will double across the 28th Street rail crossing.

The traffic increases from the project will have a far reaching impact on the northeastern corner of Midtown. To properly evaluate those impacts, the traffic study should be expanded to include the following areas: 20th Street to 29th Street and C Street to I Streets. My neighbors and I expect to see a very thorough and "accessible" traffic study that explains its assumptions and conclusions in language that residents can easily understand.

Please consider the following vehicle access proposals:

Alhambra Blvd.
A western vehicle entrance to the project should include Alhambra Blvd. Alhambra Blvd. is a commercial corridor and access would alleviate some traffic concerns for 28th Street and 40th Street.

If Mr. Angelides and Riverview Capital Investment, argues that this alternative is infeasible and impractical, please provide detailed information from Union Pacific Railroad regarding the challenges of this access so that the community can make an informed decision regarding this access.

If a vehicle tunnel is not feasible, consider a vehicle over-grade access at Alhambra instead.
Study the viability of a third one-way vehicle access at Alhambra Blvd. With 43 trains a day at the 28th Street rail crossing, McKinley Village residents need an additional entry point for emergency vehicles.
Will the developer be responsible for funding the necessary measures to offset increased traffic?

29th Street
Study vehicle access at 29th Street as an alternative to Alhambra Blvd. Currently 29th Street is a one-way street with synchronized traffic signals that provides freeway access and access to commercial corridor with limited impact to the residential neighborhood to the west.

If a tunnel is not feasible, consider a vehicle over-grade crossing at 29th Street instead.
Will the developer be responsible for funding the necessary measures to offset increased traffic?

28th Street
How will the increased traffic volume impact the safety of drivers and the trains at the at-grade crossing at 28th Street?
- Study employing traffic calming measures to alleviate traffic on 28th Street from the McKinley Village project by doing the following:

1) Make improvements at B Street in order to add a half street closure at B Street and direct southbound traffic to 29th Street. Currently 29th Street is a one-way street with synchronized traffic

signals that provides freeway access and access to commercial corridor with limited impact to the residential neighborhood to the west.

Developer or City to assist Bell Marine to relocate the business to offset traffic and provide mitigation for loss of Swainson's Hawk foraging territory at McKinley Village project site. In addition, the City should relocate the City Corp yard to further minimize traffic impacts.

2) De-designate C Street as a truck route.

Additional traffic calming measures such as stop signs and pedestrian islands should be employed along C Street and 28th Street to ensure the safety of pedestrians, Midtown residents, and Sutter's Landing Park users.
Study how much money is needed for traffic mitigation (calming, routing, signs, crosswalks, lights)?

With 43 trains per day at the 28th and B Street rail crossing, what are the potential traffic congestion impacts on 28th Street, into Sutter's Landing Park and leaving the McKinley Village project?

With 43 trains per day at the 28th and B Street rail crossing, what are the potential air quality impacts of stalled vehicles on 28th Street, into Sutter's Landing Park and leaving the McKinley Village project?

How will access to emergency services be impacted by 43 trains a day crossing at 28th Street and B Street?

With limited access from 28th Street due to train traffic, how will the 40th Street access point be impacted? The 50/50 traffic allocation of 2008 traffic study is not realistic.

What measures are being taken to ensure the A Street Bridge is Americans with Disabilities Act ("ADA") compliant?

Consider additional traffic implications of the opening of the Sutter General Hospital facility at 28th and K Streets, the new Downtown Arena, and the Sacramento Natural Food Co-Op and how it will increase traffic. Please combine the results of these traffic increases to give true picture of traffic overall in the next five years (with these developments).

Are there other vehicle access scenarios that could be considered?

Will the developer be responsible for funding the necessary measures to offset increased traffic?

Proposed Alhambra Blvd. Bike/Pedestrian Access
Access should be ADA compliant.

Proposed access needs to be safe for public use. The bike tunnel at 14th and C Streets has been closed for a number of years due to criminal activity. What measures will be taken to ensure the safety of residents using this proposed access.

If built, the bike and pedestrian tunnel should be a part of phase 1 of the project not the final phase. If residents don't have access to the tunnel at the beginning of the project, it will only reinforce use of vehicles to access nearby schools and retail services. Study the impacts of making the tunnel part of the later phase of construction.
Business 80
What are the impacts of the E Street on-ramp with the addition of this project?
If the California Department of Transportation closes the E Street on-ramp, what will be in the impact to the surface street adjacent to the freeway (i.e., 28th Street, 29th Street, and 30th Street)? The traffic study should include an alternative that closes the E Street on ramp.

What will be the traffic impacts to the H Street on and off-ramps?

What will be the traffic impacts to the J Street on-ramp?

Sutter's Landing Expressway
If the Sutter's Landing Expressway is built to allow McKinley Village residents to have access to the River District and surrounding areas, what will be the impact to the residential community adjacent to the proposed expressway © Street, 20th Street & 28th Street).
Affordable Housing
I object to "Affordable by Design" as a path to providing truly affordable housing for people living on low-incomes. Granny flats, otherwise known as accessory units, should not be counted as affordable units as proposed by Mr. Angelides.

In the case of McKinley Village, they would add up to more than one-third of the development's affordable housing obligation without actually serving the purpose for which they are being counted. There are no rental limits proposed on these units and because of their size, they are not geared towards housing low-income families. I believe that affordable units in new housing developments, such as McKinley Village, should be regulated, well managed and focus on families by including at least two or three bedrooms.

As for other suggested "Affordable by Design" housing units such as, small lot single family homes, attached homes such as townhomes, condominiums, duplexes, triplexes, etc., they too are not considered affordable, by design or otherwise, as they will sell at a market-rate per square foot well above the reach of low-income families and would also have unencumbered rental rates.
In an affluent community like McKinley Park, or even in other lower-income communities across Sacramento, homes without an "affordability" encumbrance rent and sell beyond the financial means of low-income families in Sacramento. According to the City's own fact sheet, "As of 2000, the City has a barbell-shaped income distribution. At one end, 50% of all households earn less than 80% of the Area Median Income (AMI) or less than $50,000 for a four person household." These homes will not provide housing that is affordable for more than half of the population of people who currently reside in the City of Sacramento. We must build housing for persons of all income levels in Sacramento. "Affordable by Design" does not meet the City's housing affordability needs in concept or in practice.

George Raya
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Sacramento, CA 95816
Cell:916-508-5232

MARSHALL SCHOOL/NEW ERA PARK
NEIGHBORHOOD ASSOCIATION
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June 28, 2013

VIA EMAIL AND FIRST CLASS MAIL

Evan Compton
Associate Planner
City of Sacramento
Community Development Department
300 Richards Boulevard, 3rd Floor
Sacramento, CA 95811

Re: McKinley Village – File No P08-86

Dear Mr. Compton:

The Marshall School/New Era Park Neighborhood Association ("MSNE") offers the following comments regarding the McKinley Village project proposed by Phil Angelides and Riverview Capital Investments.

Midtown Sacramento has been a community transformed by infill development. As a community we have seen empty lots, such as the lot at 18th and L Streets transformed into the 1801 L Street complex, providing our neighborhood with buildings that resemble New York City brownstones and in keeping with the flavor of our community. The 1801 L Street project has housing with a mix of businesses that are supported by residents and visitors to the neighborhood. The 1801 L Street project has helped transform that block and Midtown as a whole. Vision took a lot at 27th and N Street and turned it into the Sutter Brownstone project. Both projects are within walking distance of employment centers, public transportation and walking distance of retail and restaurants.

Midtown Sacramento embodies the tenants of Smart Growth organically. Our neighborhood is walkable, transit is nearby, and we are near the employment centers. Midtown itself is also an employment center because of the mixed use opportunities that exist in our community. People who choose to live in Midtown do so to be close to jobs and within walking distance of entertainment options such as the Sacramento Community Center, B Street Theatre, and a host of music venues of all sizes. Therefore, Midtown Sacramento residents are keenly aware of the true benefits of smart growth and, and they "walk the walk and talk the talk" so to speak.

Over the past 25 years, a number of developers have turned their attention to the "Lanatt site" with the hope of developing this 48-acre sliver of land located in East

Sacramento. The continuing fundamental flaw in this sliver of land is access to the land. The "Lanatt site" has no freeway access and no direct access to the surrounding community other than a small concrete bridge over Business 80 into Midtown. It is sliver of land on the freeway but with no freeway access.

Simply put, McKinley Village, in its current iteration, is not a shining example of "Smart Growth." There are no commercial businesses within the project so the residents of McKinley Village will get in their cars for every gallon of milk, every cup of coffee, or trip to school. This is a very car-centric development that offers no ready access to transit services either.

It is with this keen awareness; we offer the following comments and questions regarding Phil Angelides and Riverview Capital Investments' McKinley Village project.

Traffic/Access/Circulation Issues

According to the City of Sacramento Notice of Intent to Establish a Quiet Zone dated March 1, 2012, there were 1777 cars traveling across the 28th and B Street rail crossing. If no reduction of traffic is addressed before the project commences then traffic volume could double across the 28th Street rail crossing.

The traffic increases from the project will have a far reaching impact on the northeastern corner of Midtown. To properly evaluate those impacts, the traffic study should be expanded to include the following areas: **20th Street to 29th Street and C Street to I Streets**. We expect to see a very thorough and "accessible" traffic study that explains its assumptions and conclusions in language that residents can easily understand.

Please consider the following access proposals:

Alhambra Blvd.

A western vehicle entrance to the project should include Alhambra Blvd. Alhambra Blvd. is a commercial corridor and access would alleviate some traffic concerns for 28th Street and 40th Street.

If Mr. Angelides and Riverview Capital Investment, argues that this alternative is infeasible and impractical, please provide detailed information from Union Pacific Railroad regarding the challenges of this access so that the community can make an informed decision regarding this access.

If a vehicle tunnel is not feasible, consider a vehicle over-grade access at Alhambra instead.

Study the viability of a third one-way vehicle access at Alhambra Blvd. With an average of 43 trains a day at the 28th Street rail crossing, McKinley Village residents need an additional entry point for emergency vehicles.

Will the developer be responsible for funding the necessary measures to offset increased traffic?

29th Street

Study vehicle access at 29th Street as an alternative to Alhambra Blvd. Currently 29th Street is a one-way street with synchronized traffic signals that provides freeway access and access to commercial corridor with limited impact to the residential neighborhood to the west.

If a tunnel is not feasible, consider a vehicle over-grade crossing at 29th Street instead.

28th Street

How will the increased traffic volume impact the safety of drivers, pedestrian, bicyclists, and the trains at the at-grade crossing at 28th Street?

Study employing traffic calming measures to alleviate traffic on 28th Street from the McKinley Village project by doing the following:

1) Make improvements at B Street in order to add a half street closure at B Street and direct southbound traffic to 29th Street. Currently 29th Street is a one-way street with synchronized traffic signals that provides freeway access and access to commercial corridor with limited impact to the residential neighborhood to the west.

Developer or City to assist Bell Marine to relocate the business to offset traffic and provide mitigation for loss of Swainson's Hawk foraging territory at McKinley Village project site. In addition, the City should relocate the City Corp yard to further minimize traffic impacts.

2) De-designate C Street as a truck route.

Additional traffic calming measures such as stop signs and pedestrian islands should be employed along C Street and 28th Street to ensure the safety of pedestrians, Midtown residents, and Sutter's Landing Park users.

Study how much money is needed for traffic mitigation (calming, routing, signs, crosswalks, lights).

With an average of 43 trains per day at the 28th and B Street rail crossing, what are the potential traffic congestion impacts on 28th Street, into Sutter's Landing Park and leaving the McKinley Village project?

With an average of 43 trains per day at the 28th and B Street rail crossing, what are the potential air quality, biological, and parks and recreational impacts of stalled vehicles on 28th Street, into Sutter's Landing Park and leaving the McKinley Village project?

How will access to emergency services be impacted by an average of 43 trains a day crossing at 28th Street and B Street?

With limited access from 28th Street due to train traffic, how will the 40th Street access point be impacted? The 50/50 traffic allocation of 2008 traffic study is not realistic.

Consider additional traffic implications of the opening of the Sutter General Hospital facility at 28th and K Streets, the new Downtown Arena, relocation of the B Street theatre to 27th and Capitol Avenue, and the Sacramento Natural Food Co-Op (to 28th and S Streets) and how traffic will increase. Please combine the results of these traffic increases to give true picture of traffic overall in the next five years (with these developments).

Are there other vehicle access scenarios that could be considered? For instance, the Business 80 on and off-ramps were included in the previous project proposal for this site

The proposed 28th Street access point is unrealistic, unsafe, and unduly burdensome on the Midtown community. The City must require the developer to conduct a thorough alternatives analysis that explores other options. This is an East Sacramento project, and project-generated traffic should be routed through East Sacramento. Midtown residents should not be required to absorb the problems of the project without obtaining any of the benefits.

We expect that, if the 28th Street access proposal is accepted as the *preferred project alternative*, an expanded traffic management program within this area of Midtown will be required, particularly along C Street and 28th Street, which was not included in the traffic management program installed here in the '90s.

Will the developer be responsible for funding the necessary measures to offset increased traffic?

C Street

According to the Central City Community Plan that is a part of the General Plan 2030, C Street is designed as a "C Street Central City Housing." Is the increased traffic from

McKinley Village in line with the General Plan's goals for new housing opportunities on C Street?

A Street Bridge

It should be thoroughly evaluated by a qualified bridge engineering firm for safe load rating, seismic safety and remaining service life.

What measures are being taken to ensure the A Street Bridge is *Americans with Disabilities Act* ("ADA") compliant?

This bridge will be heavily used by automobiles, bicycles, and pedestrians especially in rush hour. The bridge should be widened to safely accommodate all three in both directions.

This bridge will be heavily used by 70,000 lbs. Fire Trucks and other emergency vehicles. The bridge should be evaluated by a qualified bridge engineering firm for safe load rating, seismic safety and remaining service life to accommodate emergency vehicles.

The traffic study needs to display traffic delays and the resulting shortcuts through neighborhoods that will happen at 28th St (C St, F St) and the Elvas / 40th area.

40th Street Access

What measures are being taken to ensure the 40th Street tunnel is *Americans with Disabilities Act* ("ADA") compliant?

Proposed access needs to be safe for public use. The bike tunnel at 14th and C Streets has been closed for a number of years due to criminal activity. The existing tunnel at 16th and C Streets is widely perceived as unclean and unsafe for pedestrians. What measures will be taken to ensure the safety of residents using this proposed tunnel access?

Are there other access scenarios that could be considered?
Evaluate the need for an East Sacramento Transportation Management District that would help to calm traffic throughout East Sacramento and provide funding for onsite and connecting transit service.

Create a median along Elvas from McKinley to C Street to slow traffic.

Will the developer be responsible for funding the necessary measures to offset increased traffic?

Proposed Alhambra Blvd. Bike/Pedestrian Access

What measures are being taken to ensure the Alhambra Blvd. tunnel is *Americans with Disabilities Act* ("ADA") compliant?

Proposed access needs to be safe for public use. The bike tunnel at 14th and C Streets has been closed for a number of years due to criminal activity. The existing tunnel at 16th and C Streets is widely perceived as unclean and unsafe for pedestrians. What measures will be taken to ensure the safety of residents using this proposed access?

If built, the bike and pedestrian tunnel should be a part of phase 1 of the project not the final phase. If residents don't have access to the tunnel at the beginning of the project, it will only reinforce use of vehicles to access nearby schools and retail services. Study the negative impacts of making the tunnel part of the later phase of construction.

Business 80

What are the impacts of the closure of the E Street on-ramp with the addition of this project?

If the California Department of Transportation closes the E Street on-ramp, what will be in the impact to the surface street adjacent to the freeway (i.e., 28th Street, 29th Street, and 30th Street)? The traffic study should include an alternative that closes the E Street on ramp.

What will be the traffic impacts to the H Street on and off-ramps?

What will be the traffic impacts to the J Street on-ramp?

Regional Transit/Other Transportation

There is no proposed access to Regional Transit (RT) to McKinley Village.
RT access would offset some of the possible vehicle trips from McKinley Village.

What is the expense of running a shuttle bus and bus lines to J Street? Require transit funding district.

Will the street size of the project be sufficient to accommodate a full sized bus or shuttle bus?

Is there a Regional Transit Master Plan for East Sacramento and Midtown routes?

What is the cost of a freeway on/off ramp serving the McKinley Village site?

Sutter's Landing Park

The proposed A Street access will run parallel to "The Mound" that is a part of Sutter's Landing Park. The increased noise, light, and traffic congestion will disturb the Swainson's Hawks from foraging on the area called "The Mound." What will be done to address this impact?

There are also concerns about how increased traffic and noise will impact the Burrowing Owl, White Tailed Kite, Red Shouldered Hawk, Red Tailed Hawk, American Kestrel. Osprey may also be affected by the project. Other known users of the area include coyote. Consider the potential impacts to these species and other unknown species. **Require extensive biological surveys *as a part of project planning and not after project approval*.**

The addition of McKinley Village residents' vehicle traffic will impact the ability of Midtown residents to use Sutter's Landing Park. There are no sidewalks along 28th Street so pedestrian users of the park from Midtown must walk in the street to gain access to the park. There are also no designated bike lanes. If the 28th Street access alternative goes forward, will the developer make improvements to improve bike and pedestrian safety for Midtown users of the Sutter's Landing Park?

McKinley Village residents will also use Sutter's Landing Park. How will increased user-ship impact Sutter's Landing Park and the American River Parkway?

It appears that the access via A Street would be on land zoned and in the General Plan as Park land. It is on land under regulation by the State as a closed landfill. What landfill closure regulations apply to the A Street access? Is such access consistent with the City's permit for the landfill closure?

There needs to be complete disclosure of what lies beneath the surface of the proposed A Street access and adjacent land. Is it even feasible to construct the expected roadway (how many lanes including vehicles, bike and pedestrian) in this location? What will be the impact of landfill settling over time on the proposed transportation facility?

According to the Sutter's Landing Park Background report dated October 2008 (Ex. 4), a portion of the McKinley Village project is actually Park land (where the detention basis will be located). What compensation will the developer provide for taking public park land for this access road and detention basis? What impact will traffic on A Street have on the foraging values of the grassy mound for wildlife and on wildlife movement and safety? What mitigation can compensate for these impacts?

This project will take several years to complete. Please have the developer provide an implement plan that controls noise and pollution to have the least possible impact on the Swainson's Hawk nests at Sutter's Landing Park.

Swainson's Hawks Foraging on Project Site

There are numerous eyewitness accounts of Swainson's Hawks foraging on the McKinley Village site. The construction of these homes will mean the loss of approximately 48 acres of Swainson's Hawk foraging area. How will the developer off-set this loss?

Will a buffer zone be created within the project so that some foraging ground can be preserved? Will offsetting mitigation land be permanently protected nearby, and incorporated into Sutter's Landing Park.

There are also eyewitness accounts of a Swainson's Hawk next nest near the proposed 40th Street entrance. How will the construction noise impact the nest? What measures will be taken to protect and preserve this nest?

Project construction will disturb nearby nesting sites for Swainson's Hawk and other raptors for several years. How will the project buffer construction impacts on nearby nesting activities? What mitigation will be provided for disturbed nesting?

American River Parkway

The project site is obviously an important area for wildlife in the narrow restricted American River corridor, which is surrounded by urbanization. The urbanization of the project site will have significant impacts on wildlife survival in the city. The Planning Dept.. should address the impact and appropriate mitigation in the American River corridor to offset the impact on wildlife, including raptors, to less than significant.

McKinley Park

McKinley Village residents will also use McKinley Park. How will increased user-ship impact McKinley Park?

Schools

Consider the impact of additional students on Sacramento City Unified School District, including impact on Theodore Judah and Sutter Middle School; include cost, new school needs, over population and safety of children walking to school. Extend study to twenty year forecast.

Inclusionary Housing

City Staff should review the proposed project for consistency with policies relating to mix of housing types and densities and providing housing for low income residents. The developer has chosen to link this project with Midtown by using 28th Street as a primary access point. Midtown offers a wide variety of housing at various price points.

While City staff indicated recently that the Inclusionary Ordinance does not apply here, totally ignoring affordable housing is not the approach that should be taken.

The developer has indicated that "granny flats" on top of garages could be considered low income housing. We agree, but only if they are actually built and actually dedicated "inclusionary housing." The project proponent used that rationale for his previous development, Laguna West. However, the "granny flats" on top of garages were an extra cost option which was seldom chosen. In order to provide affordable housing, a certain percentage of the units which can accommodate garage "granny flats" should be required to have them. In addition, the "granny flats" should be dedicated "inclusionary housing" for a period of 10 years from date of close of escrow in order to increase the stock of inclusionary housing in East Sacramento.

In addition, the proposed three-car garages are not a sustainability feature and should be eliminated. This project is car-centric enough without encouraging additional automobile trips with three-car garages. One-car garages for some of the units should be considered and analyzed from a trip generation perspective. In addition, a one-car garage is reflective of the surrounding communities of East Sacramento and Midtown. Is it possible that the same number of units be placed on half the land with a higher density design that reduced impacts?

Noise

The project proposes landscape buffers, earth berms and sound walls for noise attenuation. The analysis of this project must contain a comprehensive on-site noise study which fully documents current as well as projected freeway and railroad traffic noise, both inside, as well as outside, project structures. The noise level reductions provided by the proposed setbacks, earth berms and sound walls must be fully documented. Nighttime disruptive train whistle noise impact on adjacent residential uses must also be addressed. Construction of the project should be conditioned on the City obtaining the "quiet zone" train horn permit.

In addition, City Staff needs to consider the impact of construction noise will impact the businesses and residents in the area adjacent to the project site.

Please study noise wall buffers and the cumulative impact on wildlife in the area.

Vibration

Vibration from the railroad is an issue for current residents as much as a block or more south of the railroad alignment. The proposed Courtyard units are separated from the UPRR right-of-way by an eight foot landscaped buffer. These units will undoubtedly experience excessive levels of vibration. An on-site vibration study must be undertaken with full disclosure of what construction measures are necessary to reduce vibration to a level that does not impact the structural integrity of the units or damage personal possessions.

Cultural Resources

Confirm whether this area was historically a Native American site.

Other

There are several homeless people who have made this site their home. They live in the grove of trees by the freeway. Please have the developer help them to find transitional homes and make sure their dogs are cared for as well.

Please make sure that real estate brokers are also informed of what will happen if there is a flood. They will then be responsible to inform prospective buyers within McKinley Village and East Sacramento buyers that the flood gates will be closed leaving only one exit point 28th Street.

Flood Threats

Study response, alarms, openings and closings of existing flood gates.

Study how the developer can dialogue with FEMA about plans and development. Request an analysis from both FEMA and the Sacramento Area Flood Control Agency ("SAFCA") regarding the safety of constructing the project in front of the railroad levees, the impact of constructing at least one new flood gate beneath the railroad grade, and the policy implications of allowing development in this area of Sacramento.

Study and define emergency plan needed for completed development.

Study developer insurance needs against litigation in the event of flooding or, other possible structural issues and failures.

Storm and Sewer Runoff

Study effects on current sewer system.

Study storm scenarios considering current projections re: climate change.

Study ground water and water table pollution.

Study upgrades needed and effect on East Sac system.

Study soil for pollution.

Study funding needed by project to protect East Sacramento from costs when the storm system fails and McKinley Village is identified as a contributor to the flooding.

Health Risk Assessment

The proposed project lies between two major sources of diesel particulate emissions, the Capital City Freeway and the heavily utilized Union Pacific Railroad (UPRR) line. While a Health Risk Assessment (HRA) would normally be required, I believe actual on-site monitoring of these emissions is necessary for this project.

Typical Health Risk Assessments are based upon modeling which in this case may not provide accurate information. Trains traversing this area have as many as five locomotives, which in all likelihood would not be reflected in typical HRA modeling. Also, relying on Union Pacific to provide information on the number and type of trains / locomotives could lead to further controversy, since the community does not trust the accuracy of information originating from Union Pacific.

The Capital City Freeway is also a unique source. The Capital City Freeway is very congested adjacent to this proposed project, exacerbating the impact of these emissions on the project site. These congested, often parking lot like, conditions would also not be addressed accurately in typical HRA modeling. The Health Risk Assessment to include **all the potential health risks of particulate pollution exposure** at this location, not just cancer risk and not just diesel exhaust.

The Air Resources Board handbook recommends 500 foot setback from roadways/rail. (Table 1.1 "Avoid siting new sensitive land uses within 500 feet of a freeway, urban roads with 100,000 vehicles/day, or rural roads with 50,000 vehicles/day.")

Community Outreach

The Marshall School/New Era Park Neighborhood Association understands the inherent value in working with our business neighbors. In the past several years, we have established good working relationships with several of the businesses in the 28th and J Street area. In years past, the relationships with prior business owners were acrimonious and unproductive. Without the help of this neighborhood association, the current owner of Harlow's would like have walked away from the purchase of Harlow's until he sought the support of the neighborhood association to overcome regulatory hurdles. The owners of Red Rabbit Kitchen & Bar and Blue Cue has seen the value of working with the community to further their business endeavors. It is our hope that Mr. Angelides and Riverview Capital Investment will follow these examples and work with our neighborhood. It is our hope that Mr. Angelides will take a more active role in doing outreach to the Midtown area. We live here and can provide the most realistic view of the challenges of this area.

As stated by Matis Echanove & Rahul Srivasta in *What We See: Advancing the Observations of Jane Jacobs*: "[L]ocal knowledge and expertise can contribute to the planning process. Ignoring local actors comes at a high cost, accompanied by strong oppositions." We would ask that City Staff require Mr. Angelides and Riverview Capital Investment meet with local residents and inform residents of upcoming deadlines regarding the environmental review process by sending city-approved mailers to all residents living within the proposed traffic study area described above.

The residents of the Marshall School/New Era Park neighborhoods love this community and strive for its betterment every day. It is the hope of our organization that you and your colleagues at the Planning Department will help Mr. Angelides address the issues and questions outlined above so that we can have a project that the entire community can be proud to call it a neighbor.

Very truly yours,

Julie A. Murphy

Julie A. Murphy
Co-Chair

Very truly yours,

Edward Trujillo

Edward Trujillo
Co-Chair

msne

Michael Murphy
2731 G Street, Sacramento, CA 95816
916-447-8178
Michaelmmurphy4@gmail.com

June 28, 2013

VIA EMAIL

Evan Compton
Associate Planner
City of Sacramento
Community Development Department
300 Richards Boulevard, 3rd Floor
Sacramento, CA 95811

Re: McKinley Village – File No P08-86

Dear Mr. Compton:

I am resident of the Marshall School neighborhood and a member of the Marshall School/New Era Park Neighborhood Association. I offer the following comments and questions regarding the McKinley Village project offered by Phil Angelides and Riverview Capital Investment.

Outreach

In 2013, Mr. Angelides and Riverview Capital Investment have made little effort to reach out to the communities most greatly impacted by this project, the Marshall School and New Era Park neighborhoods. As a life-long resident of Sacramento, Mr. Angelides hopefully shares the community pride in what Midtown Sacramento has become due to the hard work of Midtown residents. We also hope that once made aware of the potential impacts this project will have our neighborhoods, Mr. Angelides and Riverview Capital Investment will work with us to resolve the issues.

A source of disappointment and frustration for my neighbors and I stems from the fact that Mr. Angelides and his team have incorporated none of the suggestions made by residents into the application currently being considered by the Planning Department. This is a larger project that either Midtown or East Sacramento has seen in the time I've lived in Midtown. I had hoped that as a local, favorite son, Mr. Angelides would take care to engage Midtown to discuss this project and our concerns. It is my hope that City Staff will assist Mr. Angelides and his team in sending out city-approved mailers notifying people of the upcoming environmental review process and provide contact information for City Staff members so that citizens can get their questions answered.

StoneBridge Properties and Petrovich Development Company have set a high bar regarding community outreach for their respective projects. It is my hope that Mr. Angelides will rise to the challenge as well.

Traffic/Access/Circulation Issues

According to the City of Sacramento Notice of Intent to Establish a Quiet Zone dated March 1, 2012, there were 1777 cars traveling across the 28th and B Street rail crossing. If no reduction of traffic is addressed before the project commences then traffic volume could double across the 28th Street rail crossing.

The traffic increases from the project will have a far reaching impact on the northeastern corner of Midtown. To properly evaluate those impacts, the traffic study should be expanded to include the following areas: 20th Street to 29th Street and C Street to I Streets. We expect to see a very thorough and "accessible" traffic study that explains its assumptions and conclusions in language that residents can easily understand.

Please consider the following access proposals:

Alhambra Blvd.

A western vehicle entrance to the project should include Alhambra Blvd. Alhambra Blvd. is a commercial corridor and access would alleviate some traffic concerns for 28th Street and 40th Street.

If Mr. Angelides and Riverview Capital Investment, argues that this alternative is infeasible and impractical, please provide detailed information from Union Pacific Railroad regarding the challenges of this access so that the community can make an informed decision regarding this access.

If a vehicle tunnel is not feasible, consider a vehicle over-grade access at Alhambra instead.

Study the viability of a third one-way vehicle access at Alhambra Blvd. With 43 trains a day at the 28th Street rail crossing, McKinley Village residents need an additional entry point for emergency vehicles.

Will the developer be responsible for funding the necessary measures to offset increased traffic?

29th Street

Study vehicle access at 29th Street as an alternative to Alhambra Blvd. Currently 29th Street is a one-way street with synchronized traffic signals that provides freeway access and access to commercial corridor with limited impact to the residential neighborhood to the west.

If a tunnel is not feasible, consider a vehicle over-grade crossing at 29th Street instead.

Will the developer be responsible for funding the necessary measures to offset increased traffic?

28th Street

How will the increased traffic volume impact the safety of drivers and the trains at the at-grade crossing at 28th Street?

- Study employing traffic calming measures to alleviate traffic on 28th Street from the McKinley Village project by doing the following:

1) Make improvements at B Street in order to add a half street closure at B Street and direct southbound traffic to 29th Street. Currently 29th Street is a one-way street with synchronized traffic signals that provides freeway access and access to commercial corridor with limited impact to the residential neighborhood to the west.

Developer or City to assist Bell Marine to relocate the business to offset traffic and provide mitigation for loss of Swainson's Hawk foraging territory at McKinley Village project site. In addition, the City should relocate the City Corp yard to further minimize traffic impacts.

2) De-designate C Street as a truck route.

Additional traffic calming measures such as stop signs and pedestrian islands should be employed along C Street and 28th Street to ensure the safety of pedestrians, Midtown residents, and Sutter's Landing Park users.

Study how much money is needed for traffic mitigation (calming, routing, signs, crosswalks, lights)?

With 43 trains per day at the 28th and B Street rail crossing, what are the potential traffic congestion impacts on 28th Street, into Sutter's Landing Park and leaving the McKinley Village project?

With 43 trains per day at the 28th and B Street rail crossing, what are the potential air quality impacts of stalled vehicles on 28th Street, into Sutter's Landing Park and leaving the McKinley Village project?

How will access to emergency services be impacted by 43 trains a day crossing at 28th Street and B Street?

With limited access from 28th Street due to train traffic, how will the 40th Street access point be impacted? The 50/50 traffic allocation of 2008 traffic study is not realistic.

What measures are being taken to ensure the A Street Bridge is *Americans with Disabilities Act* ("ADA") compliant?

Consider additional traffic implications of the opening of the Sutter General Hospital facility at 28th and K Streets, the new Downtown Arena, and the Sacramento Natural Food Co-Op and how it will increase traffic. Please combine the results of these traffic increases to give true picture of traffic overall in the next five years (with these developments).

Are there other vehicle access scenarios that could be considered?

Will the developer be responsible for funding the necessary measures to offset increased traffic?

C Street

According to the Central City Community Plan that is a part of the General Plan 2030, C Street is designed as a "C Street Central City Housing." Is the increased traffic from McKinley Village in line with the General Plan's goals that home housing opportunity be developed on C Street?

A Street Bridge

It should be thoroughly evaluated by a qualified bridge engineering firm for safe load rating, seismic safety and remaining service life.

This bridge will be heavily used by automobiles, bicycles and pedestrians especially in rush hour. The bridge should be widened to safely accommodate all three in both directions.

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There are numerous eyewitness accounts of Swainson's Hawks foraging on the McKinley Village site. The construction of these homes will mean the loss of approximately 48 acres of Swainson's Hawk foraging area. How will the developer off-set this loss?

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City Staff should review the proposed project for consistency with policies relating to mix of housing types and densities and providing housing for low income residents. The developer has chosen to link this project with Midtown by using 28th Street as a primary access point. Midtown offers a wide variety of housing at various price points.

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trips with three-car garages. One-car garages for some of the units should be considered and analyzed from a trip generation perspective. In addition, a one-car garage is reflective of the surrounding communities of East Sacramento and Midtown. Is it possible that the same number of units be placed on half the land with a higher density design that reduced impacts?

Additional Outreach

Please make sure that real estate brokers are also informed of what will happen if there is a flood. They will then be responsible to inform prospective buyers within McKinley Village and East Sacramento buyers that the flood gates will be closed leaving only one exit point 28th Street.

There are several homeless people who have made this site their home. They live in the grove of trees by the freeway. Please have Mr. Angelides help them to find transitional homes and make sure their dogs are cared for as well.

McKinley Village is an important project for Midtown, as well as East Sacramento. Its proximity to the American River and Sutter's Landing Park are also key issues to consider. We are taking some of the remaining open land near the American River and converting it into housing. We are only going to get once chance to create a project that we can all be proud of for generations to come. This process is not about building houses, it is about building a community that will blend in with the heritage neighborhoods of Midtown and East Sacramento. The stakes are high and it is vital that all issues be considered and we get this right.

Very truly yours,

Michael Murphy

mm

From: Gary Stock
To: Evan Compton
Cc: amhunt@up.com
Subject: Re: Stop the Train Horns & McKinley Village (P08-086) - comments are due tomorrow to the Planning Dept.
Date: Monday, July 01, 2013 3:00:34 PM

I apologize for the glitch in sending my last e-mail (or rather, attempting to send). I simply wanted to respond, as part of the midtown community, regarding the train horns and attempts at finding a solution for quieting the noise. I fully understand a warning horn on occasion or in certain areas (intersections, etc.). However, the use of the horns by many of the conductors is simply rediculous. Some of these instances involve the horn being, literally, laid on throughout the course of travel through the area (I live on 23rd and I, and my sister lives on 21st and C). As I have stated, as the trains are a part of our community, it is understandable that we will hear their presence. However, it is important for them to respect us as a part of the community as well. Quieting measures would be greatly appreciated in the midtown area. Thank you for your time and efforts in this matter. Sincerely, Gary Stock

Sent from my iPhone

On Jul 1, 2013, at 13:20, Evan Compton <ECompton@cityofsacramento.org> wrote:

> Hi Gary,
>
> Sorry, I did not receive your full email message. Could you please resend?
>
> Thanks,
>
> Evan Compton
> Associate Planner
> ecompton@cityofsacramento.org
>
> <image001.jpg>
> Community Development Department
> 300 Richards Boulevard, 3rd Floor
> Sacramento, CA 95811
>
> **From:** Gary Stock [mailto:garystock73@gmail.com]
> **Sent:** Friday, June 28, 2013 2:08 PM
> **To:** Evan Compton; amhunt@up.com
> **Subject:** Stop the Train Horns & McKinley Village (P08-086) - comments are due tomorrow to the Planning Dept.
>
> Dear Evan Compton and Arron Hunt,

Evan Compton

From: vitosgromo <vsgromo11@comcast.net>
Sent: Monday, July 08, 2013 12:06 AM
To: Dana Allen; Evan Compton; Steve Cohn; Sue Brown; 'Jameson Parker'; Peter Fenolio; ILee Muller; Anne Romo; Consuelo Hernandez
Cc: 'Alan Parker'; 'Dale Kooyman'; 'Vickie Valine'; mhvaline@gmail.com; 'Burgua William'; 'Karen Jacques'; 'Smith Clara'; smdtyler@aol.com; berdany@aol.com
Subject: McKinley Village Proposal Response
Attachments: SACRAMENTO.docx; MCkinley Village Response 7 7 2013.docx; CA-HSR.pdf; Doc2.docx; Sacramento-Roseville 3rd Track Project.pdf; SR 51 PI Final Signed 01-08-13.pdf

July 7, 2013

Dana L. Allen, Associate Planner
Environmental Planning Services
Community Development Department
City of Sacramento
300 Richards Blvd., 3rd Floor
Sacramento, CA 95811

McKinley Village Proposal Response PO8-086

I am writing to respond to the proposal by River West Investments to build 325 homes at the Assessor's Parcel Number 001-0170-028.The project site is bounded on the south and east by the elevated portion of the UPRR tracks and on the north and west by the Capitol City Freeway.

If approved as proposed, this project has major negative impacts to several regional development projects and future area transportation expansions.

1. Sutter Landing Parkway (Richards Boulevard Connector).

The General Plan (http://www.sacgp.org/index.html) has identified the future development of a parkway road, Sutter Landing Parkway (Richards Boulevard Connector) as a road that must be built to connect the I50 Highway to the Sutter Landing Regional Park, Route 160, to the major Railyard Central City Development and the new proposed arena and surrounding Downtown entertainment district. The Sutter Landing parkway is critical to the development of a regional park, the largest urban infill project in the West Coast and the new arena.

Negative Impact: McKinley Village Proposal would if approved would eliminate the Sutter Landing Parkway by abandoning the ELvas Roadway and Lanett route and eliminating the needed land inside the proposed McKinley Village Proposal.

Recommendation: River West Investments must alter their plans by allow enough land for the future Sutter Landing Parkway and abandon the 40th Street underpass and use Lanett Street as the underpass to connect to Elvas Boulevard Road.

2. Union Pacific Railroad Expansion

UP is planning additional train lines (see attached reports, Sacramento Roseville 3rd Track and CAL HSR).

Negative Impacts: River West Investments must set aside sufficient land to allow UP to expand. Also these additional train lines and the train traffic will eliminate the use of 28th Street as an access point for the McKinley Village Housing Proposal.

Recommendation: River West Investments must set aside sufficient land to ensure UP can add the additional tracks. Also River West Investments must designate 28th Street as a bike and pedestrian access since in the near future it will no longer be available for automobile traffic and enlarge the opening at Alhambra for 2 way auto traffic.

3. Caltrans I80 Expansion

Caltrans is planning a future expansion of the I 80 Highway that borders the McKinley Village Project (See attachment SR 51 PL Final 01-08-13). This should include on and off ramps to connect to the Sutter Park Landing Parkway.

Negative Impacts: River West Investments has not allowed sufficient land to allow Caltrans to expand I80 thereby improving a bottleneck highway, reducing pollution and connecting with the Sutter Landing Parkway.

Recommendation: River West Investments has to redesign its housing proposal to allow sufficient land for the Caltrans expansion and the addition of an on and off ramps to connect to the Sutter Landing Parkway.

4. Traffic Impacts to Local Streets

River West Investments is funding a traffic study on the impacts of their proposal to access 28th and 40th Streets for automobile access to the McKinley Village housing project. According to the General Plan (http://www.sacgp.org/index.html) both streets are designated as local streets.

Negative Impacts: Although the traffic study has not been completed, the increase traffic could potentially exceed the capacity of the local streets.

Recommendation: River West Investments should re-design the access points into their proposed housing developments to connect with city streets designated as collectors or artilleries such as ELvas Boulevard through Lanett and to Alhambra Boulevard.

5. Caltrans New Proposed Capitol Railyard

Caltrans is currently examining the use of the land River West Investments has proposed for their housing project for a major new railyard and maintenance facility for Amtrak trains. Caltrans needs to build a new maintenance facility for Amtrak's Capital Corridor and San Joaquin Corridor trains (See attached Sacramento Bee Article, Friday July 5, 2013)

Negative Impacts: River West Investments if approved would have a very serious impact to the expansion of train transportation in Northern and Central California.

Recommendation: Place a temporary hold on any approval for the River West Investments McKinley Village Proposal until City and State officials determine the final location of the Capitol Railyard.

Conclusion

McKinley Village proposal if approved in its current design would negatively impact several major transportation and development plans including the development of the UP Central City Railyard Infill Project and Arena Entertainment District that are larger in scale than the McKinley Village Project and have not only city but regional impacts.

For the greater good of the city of Sacramento and Northern California I suggest that McKinley Village Project be placed on hold until the new Capitol Railyard location is finalized. Also if the McKinley Village Project is still planned for the current suggested site it must alter its design to allow sufficient land for transportation rail and road expansions and relocation of automobile access to Alhambra Boulevard and Lanett Streets that are designated to handle the increased traffic.

Let me know if you have any questions or if you need further information.

Thank you.

Vito Sgromo

Cell 916 719-1477

From: Claudia Bordin
To: Evan Compton
Subject: McKinley Village - smart growth??
Date: Friday, September 27, 2013 10:40:23 AM

Evan,
East Sac Preservation posted this email which I think is very accurate. As a planner working for the City of Sacramento, how do *you* justify this
as "smart growth" ?
-Claudia

East Sacramento Preservation

Posted: 26 Sep 2013 06:00 PM PDT

There's a great deal of information to cover about Smart Growth, so in the interest of expediency I will be shortening the project's name, McKinley Village, into simply "McVillage."

The McVillage website states that, quote, "this **smart growth**, infill community of 328 homes is designed to fit into Sacramento's urban fabric and complement adjoining neighborhoods."

Unfortunately, smart growth is a phrase that has lost much of its meaning over the last several years. Nearly every project, of every scale, in any location, gets described by its developer as smart growth so that there can be the illusion of forward-thinking, green development. **Like the Mercy Hospital expansion**, this project is no exception.

According to SACOG, the Sacramento Area Council of Governments, quote, “the goal of smart growth is to preserve and enhance the quality of life for the region’s citizens. Good growth does this by promoting a sense of community in new and expanding areas **while protecting the integrity and vitality of existing communities**—thereby strengthening the region as a whole,” unquote. SACOG has provided a list of its principles for smart growth development in our region.

Let’s examine these principles of Smart Growth from SACOG and see how McVillage measures up to meeting them:

1. **Provide a <u>mix</u> of land uses; that is, residential, commercial and workplaces**

There are no uses within McVillage other than residential properties and related functions such as a community center and small parks. No retail space or workplaces are planned. Period.

2. **Utilize compact building design to foster <u>distinctive</u>, <u>attractive</u> communities with a <u>strong sense of place</u>**

The McVillage houses are all single-family detached structures on lots with landscaping on all 4 sides. Frankly, it is a fairly typical auto-oriented, suburban, subdivision with every house having a 2- or 3-car garage. The only **distinctive elements** are a few alleys and some garages that are set back from the street to avoid the "snout" house where the garage is the most prominent feature. At price points between 350 and 650 thousand dollars, I am sure that there will be many **attractive features** of the community. Unfortunately, **any potential strong sense of place** may be overwhelmed by its adjacency to a busy freeway and railroad.

3. **Create a range of housing opportunities, costs and choices**

With the loss of redevelopment funding and current market conditions, the City has stated that there needs to be effective programs that produce affordable workforce housing. No affordable workforce housing is proposed here nor will there be any apartments, townhouses, condos, or senior housing. The **choices** that the developer is proposing are homes in variations of four floor plans in Tudor, Craftsman, and Tuscan flavors. There will be an option for some buyers to build granny flats over their garages, which the developer claims could be considered affordable housing, **but only** if buyers pay extra to have them built.

4. **Create walkable neighborhoods well-connected to existing communities**

Walkability is a conscious choice. I can't think of a more walkable/bikeable location for this meeting than this building yet I'll bet many of us drove here. **Will McVillage residents be any likely to walk more?** To put that in context, it is about ¾ of a mile from the center of

McVillage to both Theo Judah and Compton's. Even if residents can use the Alhambra pedestrian tunnel (which won't be built until the project's 3rd phase,) it is about ¾ miles to this building and 0.9 miles to both Sutter Middle School and Safeway. Very few people carry groceries a mile on foot and based on my experience living near Judah, just about all parents will be driving their kids to school. Vehicular connectivity to the existing community is at only two locations placing significant impacts on neighbors, especially near those points of connection. They claim that McVillage is "designed to fit into Sacramento's urban fabric" yet this project only provides 2.5 points of connectivity. Compare that to existing neighborhood connectivity as shown on this slide with 16 points of connection. Does it really fit into our urban fabric?

5. **Provide a variety of transportation choices, not just personal vehicles**

The ability of the development to provide transportation choices other than vehicles will be dependent on the new residents ignoring what is sitting in their 2-and 3-car garages and embracing a transit, pedestrian and bicycle lifestyle. Generally urban planners assume that people are willing to walk about ¼ mile to good public transit, otherwise they will not use it. The nearest bus line (#34) that runs down McKinley Blvd. is 0.7 miles away from the center of McVillage. This bus only runs once per hour and it may be going away once Sutter Memorial Hospital closes, in which case bus lines on J Street are a full mile from the McVillage center. The developer has indicated no interest in providing a dedicated shuttle for residents to connect them to public transportation and neighborhood services.

6. **Preserve open space, farmland, natural beauty, and critical environmental areas**

The site was previously **100% open space** as it was a functioning orchard until acquired by

the current owner. Then the vegetation was removed and seasonal wetlands were plowed under. For natural beauty, the developer will plant 2,000 trees that may provide some tree canopy after several decades and may eventually help buffer pollution from the highway.

7. **Strengthen and direct development towards existing communities**

The project provides **only impacts to the existing communities and is unlikely to strengthen those neighborhoods**. There are no features or uses of the project that are being included for the benefit of adjacent neighborhoods' residents. The community center and pool will be owned and operated by the McVillage homeowner's association. You probably won't be welcome to swim there.

8. **Encourage community collaboration in development decisions**

The developer states that there have been over 30 meetings with community groups and leaders since this project began. The problem is that the project was presented to these groups when the design was essentially finished. That results in decisions that have been cast in concrete with little opportunity for revision. Neighborhood associations have been reactive participants instead of proactive partners. Potentially constructive suggestions, such as full vehicular access at Alhambra, have been rejected by the developer as too expensive or too impractical. The developer simply has too much invested in this particular plan to make any significant changes at this point in the process. It is useful to contrast the less inclusive, more contentious process for this project with the successful, collaborative path taken by the developers of the infill residential proposal on the Sutter Memorial Hospital site.

Finally, by any measure, McVillage demonstrates a weak commitment to most of these Smart Growth principles. The project is also construed as urban infill, albeit of a very suburban character, but do the 328 residences here really do anything to counter the 10,000 houses being proposed for eastern Sacramento County, one thousand of which are to be constructed by this same homebuilder? Against that imbalance, does the relatively tiny amount of vehicular trip-miles saved by this project really make a difference in the ongoing deterioration of our regional environment? Will this project alleviate <u>any</u> traffic on our highways? Is this part of a truly sustainable regional approach to growth or is it simply just more growth with a "green" label?

In summary, allow me to use an analogy here: McVillage is to Smart Growth as a McDonald's

Big Mac is to a smart, healthy meal.

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Evan Compton

From: Kyle Williams <kylew36@aol.com>
Sent: Friday, October 11, 2013 10:16 AM
To: Evan Compton
Subject: McKinley Village

You cant be serious,

My Number is below, if you'd like to call I would love it.

I just have one question for you - How many of the Developers are going to live at the supposedly wonderful site.

My guess is none - Who in there right mind would live in-between a Rail road and a Freeway.

My suggestion to you is- require that 1/3 rd of the people involved in the project, purchase and live at the project for 5 yrs.

Prove to us how much they like - the location !!!!!!!.

Sincerely Kyle
Kyle Williams
Bring It !
(916) 444-6300
kylew36@aol.com

From:	Martin Palomar
To:	Evan Compton
Subject:	Project P08-086 McKinley Village
Date:	Tuesday, October 15, 2013 11:47:22 PM

Dear Planning and Design Commision,

I oppose entirely the proposed McKinley Village project. This project should not be allowed for rezoning nor be designated for residential land. Here are my reasons:

1)The project will have a negative impact on the existing infrastructure that is old and decript in the neighborhood. In fact, last year our street, San Miguel Way, flooded twice due to a broken water line. One time at the corner of "H" Street and San Miguel and later at the corner of "D" and San Miguel Way. One of my neighbors filed a lawsuit against the city of Sacramento and won. This proposed project will only negatively impact our existing drainage, sewer, and water lines. No matter what tipe of draining system they developer plans to use on the 328 homes and the recreational center, the project will negatively impact the old infrastructure on our streets. Please do not approve the project as proposed!

2) The proposed project will negatively impact the traffic on our streets and into the Midtown area. Several years ago, the city of Sacramento spent thousands of dollars developing circular islands to deter traffic and minize the flow of traffic into the Midtown and downtown area. Well, now this proposed project will destroy those communty efforts and money spent on those islands, especially since the proposed project does have include access to public transportation. Every home will have one to two car garages, which means that all residents will be driving in and out of the area into H Street, Mckinley Blvd., or Elvas Blvd. Consequently, this proposed project will create more traffic and air pollution into the neighborhood. I urge you, please, not to approve the project as proposed.

Respectfully,

Martin Palomar
425 San Miguel Way,
Sacramento, CA 95819

From:	Robert Finley
To:	Evan Compton
Subject:	Re: McKinley Village: Notification of Public Hearing on October 24
Date:	Wednesday, October 23, 2013 9:06:57 AM
Attachments:	NUSG What is Smart Growth.pdf

Evan,

Here's the document we'd like distributed to the commission.

Thanks again,

Rob

From: Evan Compton <ECompton@cityofsacramento.org>
To: 'Rob Finley' <rob.finley@att.net>
Sent: Tuesday, October 22, 2013 4:08 PM
Subject: RE: McKinley Village: Notification of Public Hearing on October 24

Rob,

Thank you for the email. Yes, you can distribute information. We would need 17 hardcopies minimum to pass out. You may hand it to the Admin staff member at the left of the podium on the night of the hearing or you can email it to me in advance (no later than noon on Thursday, please) and I will send it to them for you.

Thanks,

Evan Compton
Associate Planner
916-808-5260
ecompton@cityofsacramento.org

City of SACRAMENTO
Community Development Department
300 Richards Boulevard, 3rd Floor
Sacramento, CA 95811

From: Rob Finley [mailto:rob.finley@att.net]
Sent: Tuesday, October 22, 2013 3:47 PM
To: Evan Compton
Subject: Re: McKinley Village: Notification of Public Hearing on October 24

Hi Evan,

Neighbors United for Smart Growth

What is Smart Growth?

There is no one definition that fits the concept of "smart growth." As stated by regional planning groups, the meaning of smart growth depends on context, perspective and timeframe.

The basic elements of smart growth include utilization of areas within the urban core to emphasize mixed land uses while taking advantage of various transportation modes to reduce or eliminate car travel as the primary mode of travel. According to the Urban Land Institute, notwithstanding these core elements, a key to smart growth is that it seeks to "involve all stakeholders in the planning process. Common ground between groups is identified, allowing developers, environmentalists, civic organizations, public officials, and citizens find solutions to guide and shape future growth."

As the Sacramento Area Council of Governments (SACOG) directs, this growth needs to promote "a sense of community in new and expanding areas while protecting the integrity and vitality of existing communities."

Why McKinley Village is Not Smart Growth

As currently proposed, the McKinley Village project is not smart growth. The proposed project is designed primarily for higher-end residential housing and does not include an adequate mix of land uses that would reduce or eliminate car travel as the primary mode of transportation. In its somewhat isolated location, the McKinley Village project appears to actually increase the need for car travel as it is cut-off from any employment or retail centers and is unconnected to inter modal transportation options.

Furthermore, the McKinley Village project does not reflect the consensus planning principles of smart growth. The current version of the proposed project did not include meaningful stakeholder input in the planning process, whereby early input could have been incorporated in design elements to truly reflect smart growth.

Not only does the proposed project do little to promote a sense of community in its isolated location completely surrounded by the highway and railroad levees, it does not protect the integrity and vitality of the surrounding neighborhoods. Instead, the McKinley Village Project is expected to create adverse side-effects to the existing Midtown and East Sacramento communities by forcing higher levels of car travel on the local road system, increasing traffic on already crowded neighborhood streets (and adding the air, noise, and safety impacts that come with an increase in traffic), as well as placing an additional burden on existing public services, especially related to neighborhood schools.

To learn more about NUSG, visit nusg.org or facebook.com/nusg.org. You can also email us at nusg.sacramento@gmail.com

McKinley East Sacramento Neighborhood Association
P.O. Box 160222, Sacramento, Ca. 95816

October 24, 2013

Mr. Evan Compton
Ms. Dana Allen
Associate Planners
300 Richards Blvd., 3rd Floor
Sacramento, Ca. 95811

Re: McKinley Village

Dear David and Dana

The McKinley East Sacramento Neighborhood Association (MENA) respectfully asks the City of Sacramento Planning and Design Commission to carefully consider the comments made by East Sacramento residents and businesses at your hearing on the project this evening. We would appreciate if you could present this document to the Commission for their review and consideration.

The MENA Board has not yet taken a formal position on the project and will be continuing to monitor available information in the months ahead. MENA has met with Riverview Properties several times this year and conducted a public meeting with another neighborhood association which allowed the developer to present the project to the community. That meeting generated significant comment, much of which was forwarded to the planning department for inclusion in the DEIR review.

Our most recent meeting with Riverview Properties, President, Phil Angelides on October 16th focused on the design of the proposed residences. MENA noted that the four models proposed may not be sufficient for a project of this size and that inclusion of some senior/handicapped residences could enhance the project. MENA has previously indicated that enhanced bicycle access could benefit the greater community. Riverview Properties presented a future bicycle link to the American River and is reviewing options to provide a bicycle/pedestrian lane over the A Street bridge to link Sutter Landing Park with the project.

At prior meetings, Riverview Properties has discussed the potential availability of their drainage retention pond as a site for a larger retention basin needed by the City of Sacramento and in particular East Sacramento. This city basin is desperately needed to address long term stormwater inundation in East Sacramento. MENA has been advised that the Department of Utilities is in discussion with Riverview Properties on this issue.

MENA received a majority of public comments on transportation issues at our earlier public hearing and is awaiting the release of the DEIR to better understand those issues and their potential impact on the neighboring communities. MENA believes that a comprehensive examination of those potential impacts should be required of city planning staff and the Dapartment of Transportation.

MENA has appreciated the information provided on McKinley Village by the community, developer, home builder and planning staff. We look forward to continuing that information sharing process in the months ahead as the community evaluates this urban infill sight. MENA will continue to share information on the project with our membership and the general community through our e-mail blast network and community meetings.

Sincerely,

Deane Dana, President, MENA

SACRAMENTO AREA
BICYCLE ADVOCATES

909 12th St, Ste. 116
Sacramento, CA 95814

sacbike.org
saba@sacbike.org
916 444-6600

October 24, 2013

Kiyomi Burchill
Chair, Sacramento Planning and Design Commission
910 I Street
Sacramento, CA 95814

Subject: P08-086 McKinley Village Project

Dear Ms. Burchill,

I'm writing on behalf of Sacramento Area Bicycle Advocates to share our thoughts about the preliminary design for McKinley Village to be discussed at tonight's commission meeting.

We've met with the development team several times since last spring to learn about the project, identify project features and issues related to bicycle access, and discuss possible improvements. I've found the team to be interested in and responsive to our perspective, concerns and suggestions. I look forward to seeing this dialogue continue as the project plans continue to evolve.

Our interest in the project focuses on these three aspects: access for bicycling within the project area, access for bicycling at the neighborhood entrances, and the bicycle-pedestrian tunnel.

Bike access within the project area

Providing comfortable conditions for all bike-riders, especially families with children and others known to be most sensitive to traffic-related stressors, ensures that streets remain fully accessible for bicycling, while also minimizing the hazards of riding on sidewalks. The development team has modified the street design by adding bulb-outs, chokers and traffic circles that would help calm traffic and make streets throughout the neighborhood comfortable for bike-riders of all types. We hope to continue working with the development team on details related to street design.

Connectivity throughout the neighborhood ensures that bicycling is as convenient as possible. The development team added a bike path to connect a cul-de-sac and the main east-west street at the west end of the neighborhood. The team also dedicated space for a path to the site of the proposed bike bridge that will cross the Capital City Freeway and the American River at the east end of the neighborhood.

Bike access at the neighborhood entrances

The two points where traffic enters and leaves the neighborhood present the most noteworthy potential for bike-car conflicts. We look forward to seeing how the soon-to-be-released traffic study addresses these two access points.

For the proposed segment of 40th Street between C Street and the railroad berm, the development team has responded favorably to our suggestion to remove parallel vehicle parking and shared lane markings ("sharrows") for bike-riders in favor of dedicated bike lanes and no parallel parking, although this improvement is still conceptual and not currently part of the project plans. Dedicated bike lanes with no adjacent parking are associated with lower bicyclist injury rates and also help slow traffic by visually narrowing the traffic lane, which would make the street more comfortable to bike-riders of all types.

SACRAMENTO AREA
BICYCLE ADVOCATES

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916 444-6600

For the 28th & A streets access point, we look forward to seeing how the traffic study addresses the impacts of rail traffic, including the frequency and duration of blockages at 28th Street, and how those might affect traffic patterns into and out of the neighborhood. While overall traffic levels for this neighborhood are expected to be low, traffic favoring one access point over the other could indicate the need for additional measures to safeguard people traveling on bikes.

Because of its location, McKinley Village would provide a convenient, low-traffic connection between East Sacramento and Sutter's Landing Park for drivers and bike-riders from outside the neighborhood, especially those wishing to avoid the congestion and conflicts on the streets adjacent to and passing under the Capital City Freeway (including the freeway ramps). We want to see how the traffic study addresses the potential for cut-through traffic and its impacts on bike access at neighborhood entrances and within the neighborhood.

Bicycle-pedestrian tunnel at Alhambra Blvd.

We've raised a number of specific concerns related to the tunnel. Citing the presence of water and sewer infrastructure, requirements for accommodating train traffic, significant potential impacts on adjacent properties, and low projected traffic volumes, the development team was unable to accommodate our request to make this tunnel a third access point for vehicle traffic into the neighborhood, as a way to spread traffic impacts over more access points and thus reduce the impacts to bike-riders at any one point.

We're pleased to see the team reorient houses to face the biking and walking path leading to the north tunnel entrance, as this will help improve security for path users. The team has accommodated our suggestions about the design for the south tunnel entrance (at Alhambra and B Street) to eliminate a bollard meant to prevent vehicle access, as bollards are uniquely hazardous for bike-riders.

The project proposal currently calls for construction of the tunnel in the final phase of construction. We believe travel habits by residents would be firmly established by the time the tunnel opened, thus defeating the purpose of providing this feature as a way to encourage biking and walking to nearby services; we feel the 28th and 40th street entrances are not particularly convenient for reaching nearby shopping and other services by bike or on foot. We continue to encourage the team to look for ways to open the tunnel during an earlier phase of construction.

I'm grateful for this chance to comment on the project. Please feel welcome to contact me any time with questions, thoughts or suggestions.

Respectfully,

Jim Brown
Executive Director
916-444-6600
jim@sacbike.org

CC: Ryan Fong, River Rock Development Company
Evan Compton, Planning Department, City of Sacramento

downtown
SACRAMENTO PARTNERSHIP

October 22, 2013

City of Sacramento Planning and Design Commission
300 Richards Boulevard
Sacramento, CA 95814

Subject: McKinley Village Project

Dear Chair Burchill and Planning and Design Commissioners:

On behalf of the Downtown Sacramento Partnership's (DSP) Strategic Development Committee (SDC), I would like to offer our support for the proposed McKinley Village project. While the project lies outside the DSP's formal boundaries, the SDC reviewed and unanimously supported the project. The DSP Executive Committee will review the recommendation in November and finalize a formal position of the organization.

McKinley Village will be a modern urban neighborhood in the core of the Sacramento region just adjacent to Sacramento's Central City. The project will combine the qualities of the city's most successful urban neighborhoods with design features that give this new neighborhood its own distinctive characteristics. This smart growth, infill community of 328 homes has been designed to fit into Sacramento's urban fabric, to complement nearby neighborhoods, and to continue Sacramento's tradition of livable neighborhoods close to our city's center. The SDC recommendation was based on the following key themes:

- The project is consistent with the Sacramento Area Council of Government's Sustainable Communities Strategy and Blueprint principles.
- The project offers a mix of housing types that are difficult to find in close proximity to downtown.
- Given the history of the proposed site, this project addresses concerns related to density and land use types.
- Although not located within or adjacent to DSP boundaries, the project will create diverse housing options for downtown commercial and employment users.

While we are well aware of concerns from surrounding neighborhoods and understand that further analysis and review of impacts are underway, we urge the development team to continue to work with and address concerns with interested stakeholders.

The SDC recommends the DSP support the McKinley Village Project as a development that is consistent with Blueprint and smart growth principles, will create jobs, while providing a mix of housing choices that will allow new opportunities for residents to live close to Sacramento's downtown core.

Sincerely,

Kevin Greene
Senior Policy Manager

CC: DSP Board of Directors
Mayor Kevin Johnson and Members of the Sacramento City Council
Evan Compton, Associate Planner, City of Sacramento

916 442.8575
FAX 916 442.2053
980 9th Street, Suite 400
Sacramento, CA 95814
downtownsac.org

From:	Marshall New Era
To:	Evan Compton
Subject:	Fwd: Comments for 10/24 - Planning Commission meeting
Date:	Thursday, October 24, 2013 3:12:38 PM
Attachments:	Train Count and Sutter"s Landing Park (00032540).pdf

Evan:

Attached are comments I forwarded to the Planning Commissioners today.

Julie Murphy

---------- Forwarded message ----------
From: **Marshall New Era** <marshall.newera@gmail.com>
Date: Thu, Oct 24, 2013 at 10:17 AM
Subject: Comments for 10/24 - Planning Commission meeting
To: Kiyomi Burchill <burchillcitypc@gmail.com>, Edmonds Chandler <ed@loftgardens.com>, Douglas Covill <dcovill@cbnorcal.com>, Rommel Declines <sacplanning_declines@me.com>, Philip Harvey <pharveycitypc@aol.com>, Todd Kaufman <todd.s.kaufman@gmail.com>, "Meeta V. Lele" <othermeeta@gmail.com>, Alan LoFaso <ALofaso@sbcglobal.net>, Kim Mack <kimjoanmc@att.net>, Phyllis Newton <phyllis@phyllisnewton.com>, David Nybo <dnybo@wateridge.net>, John Parrinello <jparrinello08@comcast.net>, Timothy Ray <timothy.ray@att.com>

Dear Commissioners:
The following comments are offered on behalf of the Board for the Marshall School/New Era Park Neighborhood Association in Midtown. Our neighborhood is located in the northeast corner of Midtown and 28th Street is one of the proposed access points for the McKinley Village subdivsion.

The “Project Site” description in the Staff Report does not adequately describe the “Midtown” side of this project. The 28th Street Landfill, as described by City Staff, is actually a multi-use area. There is a currently a community park called Sutter’s Landing Park that has an active dog park, sports courts, a skate park, and access to the American River. Someday, it may turn into the Sutter’s Landing Regional Park with the proper funding and vision but currently is a community park used by residents of Midtown and dog owners throughout the region (see Sac Bee article).

In addition, a portion of the former “28th Street Landfill” functions as the City’s Corporation Yard with City vehicles access the area throughout the day and night, seven days a week. Finally, there is also a privately owned concrete recycling business whose customers access the business from 28th Street. To simply call the western portion of the project as the “former 28th Street Landfill” deprives the Commissioners of a detailed understanding of the current uses of this portion of 28th Street and how those uses will be impacted by the McKinley Village project. The rail crossing at 28th Street, at the entrance to Sutter’s Landing Park, is also a heavily traveled rail line with over 40 trains a day based upon the U.S. Dept. of

Transportation Inventory dated 7/10/13 (see attached).

For many familiar with this project in its current, or former, iterations, access remains the major obstacle to the development of this site. The access issue remains the largest flaw in its design. Bad planning decisions were made over 50 years ago regarding the access to this site and for the past 25 years this community has struggled with how to incorporate this site into our community.

As currently proposed, there are only two vehicle access points: 28th Street and proposed tunnel connecting the project at 40th Street. The impacts of these design choices will be more fully articulated in the Draft EIR set to be released in the near future. Suffice it to say, access and the vehicle traffic impacts weigh heavily on the minds of the Midtown residents. As a matter of fact, I think most Midtown and East Sacramento residents feel that vehicle access at Alhambra Blvd. is vital to this project. The community would appreciate any ideas that you might have as to how to overcome this access issue.

The architectural plans for this project were only released a few weeks ago and we have not had a significant amount of time to review and digest the plans. However, we do have share some concerns articulated in the Staff Report.

1. The entire 328-house subdivision consists of 2-story homes. This is not reflective of the diversity of Midtown neighborhoods. Midtown neighborhoods are celebrated for the diversity of housing sizes and architectural options from cottages to Victorian mansions. With the ageing population, this project will offer no appeal for seniors either.

2. McKinley Village offers only three building types. Mr. Angelides' group states that there will be 11 different architectural styles for buyers to select.

The Planned Unit Development (PUD) guidelines, however, **do not** mandate that any of the architectural elements (decorative shutters, brick accents, etc.) actually be required. The PUD states that all of the architectural selections **"may"** be used. There are only a few sections where certain elements such as roof material will be employed. Even then the language states that roof materials **"should be used."** If there is no requirement of materials or minimum requirement of design elements the community could be stuck with 328 stucco boxes instead of finely constructed homes that reflect the surrounding community. In addition, there is no requirement that high quality building products be used. Use of these materials is **"encouraged"** but not required.

A major concern is that the project will lack architectural diversity because of lack of

builder oversight as to the grouping of different architectural styles. Again the PUD does nothing to eliminate the concern. The PUD guidelines simply state that "**the same house plan, or closely similar elevation, may not be placed on two adjacent or consecutive lots."** Once again, it is troubling that the builder is not employing stronger language to ensure the project does not become a sea of stucco boxes. How do we ensure the builder will create an architecturally diverse community without binding language in the PUD?

There is also an error on Figure 25 regarding the Phasing Plan. There is no specific phase identified for the proposed bike/ped tunnel. As echoed by the community, we would prefer this be truly multi-model and include vehicle access.

3. A sense of community and connectivity is encouraged when houses have active use windows. Several of the housing styles proposed have few sets of windows in the front of the house. Those windows are for a den or bedroom option so will not provide "eyes on the street" as opposed to having the family room or other day time use room in the front of the house - as reflective of the homes in the surrounding communities.

4. Another great element of Midtown architecture is front porches. Porches further encourage interaction with the community. Staff articulates concerns regarding the functionality of some of the porches for the "Courtyard" models. We share those concerns as well.

5. The other troubling design element is the garages. Older houses in Midtown and East Sacramento have detached garages, not attached garages. Once again, this design element is not reflective of the surrounding neighborhood. It does not create connectivity between the occupant and the community.

6. An issue raised in the NOP notice was increasing the diversity of housing options at various price points for the community. The City is moving away from requiring developers to build affordable housing and moving towards paying fees. That policy shift has not been approved yet by the City Council. Mr. Angelides' group has indicated that "affordable housing" could be built if buyers select the option to build an optional unit over the house. Considering the lot size, how will this be accomplished? Also, even if the unit is built there is no assurance from the builder that the community will receive the benefit of affordable housing for those in need.

\

7. The non-standard street sizes proposed by the developer will possibly inhibit the ability for Regional Transit vehicles from accessing the property. How do we make this a less car-dependent subdivision when RT vehicles cannot adequately access the property?

For our community, the access issue looms largely in our thinking of this project. We hope that the Planning Commission will devote its collective wisdom and experience to help this project overcome a fundamental planning flaw. We've spent the last 25 years struggling with the original planning mistakes and we really hope that we can avoid making planning mistakes that will haunt our community for decades to come.

Thank you.

Julie Murphy

Co-Chair

U.S. DOT - CROSSING INVENTORY INFORMATION
AS OF 10/23/2013

Crossing No.: *762357T* Update Reason: *Changed Crossing* Effective Begin-Date of Record: *07/10/13*
Railroad: *UP* *Union Pacific RR Co. [UP]* End-Date of Record:
Initiating Agency *State* Type and Positiion: *Public At Grade*

Part I Location and Classification of Crossing

Division:	*SACRAMENTO*	State:	*CA*
Subdivision:	*MARTINEZ*	County:	*SACRAMENTO*
Branch or Line Name:		City:	*In SACRAMENTO*
Railroad Milepost:	*0090.99*	Street or Road Name:	*28TH ST*
RailRoad I.D. No.:		Highway Type & No.:	
Nearest RR Timetable Stn:	*ELVAS*	HSR Corridor ID:	
Parent Railroad:		County Map Ref. No.:	*SH 1D3*
Crossing Owner:		Latitude:	*38.5830990*
ENS Sign Installed:		Longitude:	*-121.4642030*
Passenger Service:		Lat/Long Source:	*Neither*
Avg Passenger Train Count:	*38*	Quiet Zone:	*No*
Adjacent Crossing with Separate Number:			

Private Crossing Information:

Category: Public Access: *Unknown*

Specify Signs: Specify Signals:

	ST/RR A	ST/RR B	ST/RR C	ST/RR D
Railroad Use:				
State Use:				

Narrative:

Emergency Contact: *(800)848-8715* Railroad Contact: State Contact: *(415)703-3722*

Part II Railroad Information

Number of Daily Train Movements: Less Than One Movement Per Day: *No*

Total Trains: *41* Total Switching: *2* Day Thru: *39*

Typical Speed Range Over Crossing: From *10* to *35* mph Maximum Time Table Speed: *35*

Type and Number of Tracks: Main: *2* Other *1* Specify: *SID*

Does Another RR Operate a Separate Track at Crossing? *No*

Does Another RR Operate Over Your Track at Crossing? *Yes: CCT ATK*

html
THE SACRAMENTO BEE sacbee.com

Dog park at Sutter's Landing brings hounds and people for fun, companionship

eortiz@sacbee.com

Published Tuesday, Aug. 20, 2013

It would be easy to dismiss as an afterthought the 2.5-acre strip of land at Sutter's Landing Park where the city built a dog park.

After all, the landscape, north of C Street and south of the American River, is largely forgettable. Here dusty decomposed granite and cinder chips define the ground. The only grass to be found is what the city used to cap off a landfill nearby.

However, the Sutter's Landing dog park is an elegant example of how people, not landscape, make an environment.

On most midweek evenings a dedicated group, usually numbering more than 20 people, bring their dogs to this off-leash park with its separate areas for large and small canines.

The crowd that gathers in the small-dog area is a portrait of human and canine diversity. Here can be found full breeds and mixes of Chihuahuas, huskies, French bulldogs and schnauzers. On the human side lawyers, students and state workers look after them.

At the core, or so it seems for the humans, is a desire to belong. So having a dog is not necessary.

"I actually don't even have a dog," said midtown resident Donny Daniels, 27. "I'm just checking it out."

A respiratory technician at Mercy General Hospital, Daniels tracked the dogplay from behind his sunglasses. It was his first time at the park, having been invited by a friend. Daniels said he will return, despite feeling slightly uncomfortable about coming solo.

"I like the energy here. I'm a dog lover, so I'll come and pet the dogs and talk to the owners," Daniels said. "I'm going to recommend it to people I know that have dogs."

Many regular visitors attend solo, said Chris Nelson, a French teacher at Rosemont High School, and single.

"I wouldn't call this a singles scene – but it is an optimal place to meet someone," Nelson said. "It's a nice social outlet to meet people from all walks of life."

Nelson lives in south Sacramento, passing by two closer dog parks: Partner Park off South Land Park Drive and Jacinto Creek Park on West Stockton Boulevard, to get to Sutter's Landing, where he prefers the small-dog scene. He likes to get to the park around 6:30 p.m. and stay late – often until 10 p.m. If the social scene is really coming together, he'll stay later.

"For me, how long I stay depends on if someone brings a light," Nelson said.

One of the most colorful attendees, and most committed to the park, is east Sacramento resident Bill Nilva, 64. Easy to spot, he's the one holding and lovingly stroking his 12-year-old long-haired Chihuahua, Chandra Levy. Two of his other dogs – Hymie and Moishe – frolic nearby.

"They're all Jewish, my dogs. I name them after people I've known – including Chandra Levy," said Nilva. Hymie was named after his father, Moishe after an uncle. Chandra was an acquaintance.

Chandra Levy was an intern at the Federal Bureau of Prisons in Washington, D.C., who disappeared in that city's Rock Creek Park in 2001. Her body was found a year later.

"I named her Chandra a couple of months before that happened," said Nilva. "I did it because I thought it was the worst Jewish name I'd ever heard."

Nilva has been coming to the park for a year.

"One of the things I really liked about the people here is that they didn't talk about their dogs," said Nilva. "We all socialize, but it is not any of this dog-fanatic stuff."

Nonetheless, he considers himself somewhat of a fanatic about dogs and the point person for all things dog. Nilva used to show big and small dogs at such high-watt shows as the Westminster Kennel Club dog show.

"I started showing a poodle that won Westminster before I owned it and won Westminster when I had it," he said. A Dalmatian and German short-haired pointer that he owned were also winners, he said.

"Everyone in my neighborhood now has a dog because of me. I ask them to name the dog they want and I get one for them," Nilva said.

The Sutter's Landing dog park opened in 2009 and cost $1.2 million. It remains one of the costliest dog parks the city has built. The price tag was twice that of a typical dog park due to the fact it is built in a landfill area where there are concerns about methane gas, said Gary Hyden, supervising landscape architect for Sacramento's Department of Parks and Recreation.

As is the standard with landfills, methane that builds within must be vented to avoid an explosion.

At the dog park there are two large, black tubes that periodically vent methane. No one seemed bothered by the venting that was under way one recent day.

"It's a hard place to find," said Alana Perez. "Before I came here I thought 'What else can be back here but a dump?'"

But one man's dump is another's treasure. Perez had heard about the park and Googled the location. Once there she found a best friend: 27-year-old Ally Yada, also a longtime park visitor, and one so devoted to her terrier that his likeness adorns a panel of her handbag.

"Ally and I, we were the only people here one night, so we were forced to have a conversation," said Perez. "We found out we had a lot in common – like our religious views. We even cook similar food."

The two now see each other four times a week.

"The only person I see more than Ally is my husband," Perez said.

For others at Sutter's Landing dog park, attending has become a form of therapy. That's how 63-year-old Tina Powers sees it.

In 1999, Powers was stabbed at a gas station outside Vacaville. It was a random incident. Soon she became wheelchair-reliant. She suffered from post-traumatic stress, which led to her becoming a recluse. The only time she left her downtown home was for doctor appointments.

Then she got a dog.

"When you have dogs you have to walk them – and that's what helped me get back into society," said Powers.

She calls her rat terrier Bosco her "therapy dog." Powers said she is grateful Bosco led her to the Sutter's Landing dog park, where she says she belongs.

"For me this park has been a blessing," she said.

GALLERY: For more photos of dog owners and their furry friends, go to Sutter's Landing dog park.

Call The Bee's Edward Ortiz, (916) 321-1071. Follow him on Twitter @edwardortiz.

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From: MICHAEL RAGUSA
To: Evan Compton
Subject: public meeting Mckinley village
Date: Friday, October 25, 2013 5:03:29 PM

P08-086
dear sirs: I am a sacramento native and grew up in river park, riding my bike to McKinley Lib
with a stop to see grandpa on 40th street as a kid. I now live around the block from grandpas
house, he passed in 2005. I recall reading books in that library age 12 about Jules Verne and
where he looked out his window and wrote his fiction books, never going places but looking at
river and imagining the world outside...yrs later I stood at his window of his house in France looking
at his desk, his window and river of imagination. I oppose the housing plans but favor the use
of the land for a park, business with less traffic like Amtrak, etc.
would you please go to McKinley Blvd or 28/ Alhambra and watch the traffic at 4 pm and tell me
why you would want 1,000 more cars per day around there? are you nuts?
I meant to make the meeting but had to go out fair oaks blvd near sac state University H/J street
and ran into that mess and got froze in traffic...so here you want to make more cars and people
in east sacramento, and I can not get to your meeting because I am caught in the traffic monster!!
I passed a nice piece of property at 47th Ave/65th street.....it has housing near by, all infrastructure
so why does the developer not go build there; I have been riding bike downtown on weekends, going by
bookstores, museums, mall...we need some good city planners to draw up some ideas for downtown,
and get these people who want to build to do something down there....a sports arena is not the solution
to sacramento woes downtown...build some housing downtown and then state workers can live and walk
and not even own a car....
*Presently we have people racing through our streets to go to the cannery to work, I report this to security
at cannery C street, the guard says: "oh that's the state workers you tailed into here"...yes I followed them and
reported the color and car type. By opening this neighborhood to cross traffic , all you will do is ruin a lovely
neighborhood, that is safe, quiet. The owner of the land wants to make money, that is his motivation, not
to find a good use for the land. I would like my voice heard, I would like to attend a

meeting on this and I tried.
That land has been set up for non--housing! It should stay that way. You do not have proper street access and
none exists or can be created without harming the other areas. Most the new homes would be close to highway,
with air quality/noise issues...who wants to live/sleep there? ---Michael Ragusa, 256 San Antonio way/PO Box
19151,SAC,CA 95819 tel 731-8090

From:	Will H. Green
To:	kimjoanmc@att.net; phyllis@phyllisnewton.com; dnybo@wateridge.net; jparrinello08@comcast.net; ed@loftgardens.com; burchillcitypc@gmail.com; dcovill@cbnorcal.com; sacplanning_declines@me.com; parveycitypc@aol.com; todd.s.kaufman@gmail.com; othermeeta@gmail.com; ALofaso@sbcglobal.net
Cc:	Steve Cohn; Evan Compton; Ellen Cochrane; Harry Wang; ktitus@sacbreathe.org
Subject:	McKinley Village Project (P08-086), and Health Risks
Date:	Wednesday, October 30, 2013 12:25:54 PM
Importance:	High

Dear Commissioners, thanks for your time and service to our great city in your assigned roles. I appreciate the opportunity to have my 3 minutes before you last week in the initial hearing phase.

My 3 mins as compared to 45 minutes by the developer. How fair is this process?

My concerns are real, the lives of over 1,000 innocent people will be affected if this proposed SITE is REZONED for RESIDENTIAL use.

Please see the following link to recent scientific conclusions in regard to the health risk associated to Particulate emissions and air pollution.

http://www.cancertreatment.net/news/all-cancers/air-pollution-joins-asbestos-plutonium-top-human-carcinogen

From PSR's webpage: www.psr.org

"Particulate matter, also known as particle pollution, is made up of a mixture of solid particles and liquid droplets suspended in the air. While some particles such as dust and soot are large enough to be seen with the naked eye, others are so tiny that they can only be viewed with the aid of a microscope. Produced primarily by the combustion of fossil fuels by cars, power plants, and industry, particulate matter is one of the nation's deadliest air pollutants. Each year, particle pollution causes an estimated 60,000 premature deaths. Exposure to particulate matter also exacerbates respiratory and cardiovascular diseases and can cause heart attacks, strokes, asthma attacks, and lung cancer. Fine particles are especially dangerous because they can bypass the body's natural defenses to lodge deep in the lungs where they can pass easily into the bloodstream."

Another reference: Not to beat a dead horse/ but read this study released from Mass Institute of Technology August 29th, 2013

http://lae.mit.edu/?p=2821

200,000 premature deaths in the USA are related to Air Pollution

approx 1/4 or 52,000 of these deaths are in CA found to be related to car emission pollution

Air QUALITY/Pollution is a major issue with the proposal of

this location for RESIDENTIAL DEVELOPMENT!!!!

If you would like more time with me, please
email and or call me at (916) 202-7956.

Will Green, MD, retired physician, resident of East Sac 40yrs.
Past Pres or East Sacramento Preservation,Inc.
Physician for Social Responsibility, member

cc. to ESP, PSR,Sac, and Breathe Sacramento

Christopher J. Butcher
701 41st Street
Sacramento, CA 95819

November 7, 2013

Dana Allen, Associate Planner
City of Sacramento
Community Development Department
300 Richards Blvd., Third Floor
Sacramento, CA 95811

RE: Support for McKinley Village Project

Dear Ms. Allen:

I recently purchased a home at 701 41st Street in East Sacramento. I decided to move to East Sacramento because my wife and I enjoy urban living and the associated proximity to cultural, culinary and entertainment options. It is important to us that these cultural, culinary and entertainment options remain within our community. Bringing additional residents to East Sacramento is a crucial component of ensuring that existing businesses continue to thrive and that new businesses continue to open. I believe the McKinley Village Project is well designed and well suited for East Sacramento. The Project will bring new residents to the area and add to the customer base supporting surrounding businesses.

I recognize that adding additional residents adds additional cars to the road. However, I believe traffic is a reality of living in an urban center. And, as an avid biker, I am hopeful that more East Sacramento residents will consider alternative transportation modes as congestion naturally increases in East Sacramento (with or without the McKinley Village Project).

In addition, maintaining and enhancing the quality of the schools in East Sacramento is very important to both me and my wife. Increasing the number of school children within East Sacramento (and hopefully increasing the number of parents that donate their time to the neighborhood schools) is an important part of ensuring the success of our local schools. Therefore, I am equally excited that the McKinley Village will increase the number of school-aged children living within the McKinley Park area of East Sacramento.

Thank you for considering my comments. I urge the City to approve the McKinley Village Project.

Sincerely,

Chris Butcher

From:	Susie Williams
To:	Gregory Bitter
Cc:	Dana Allen; Tom Buford; Evan Compton; Lindsey Alagozian
Subject:	Re: McKinley Village Comments
Date:	Tuesday, November 12, 2013 12:11:26 PM

Mr. Bitter: Thank you for sharing the information from Mr. Angelides. The issue of the development needing to be served by at least two viable access points involves traffic management but perhaps more importantly it involves basic issues of good planning and public safety. I still think an independent engineer should be engaged to review the feasibility of creating a shoofly around two simultaneous underpass construction sites at 40th and at Alhambra to ascertain if done in that way could the shoofly reintegrate with the main railroad without having to go over I-80. Access at Alhambra probably would require orphaning B street
and that might inconvenience those living on B Street nearest Alhambra. But the need to find a way to provide legitimate 24/7 access to the project at a minimum of two points is paramount.

Susie Williams

On Nov 12, 2013, at 9:46 AM, Gregory Bitter
<GBitter@cityofsacramento.org> wrote:

> Ms. Williams,
>
> Attached is the email related to the feasibility of constructing
underpass at Alhambra to access the McKinley Village property.
>
> Gregory Bitter, AICP
>
> Principal Planner |
> Community Development Department; City of Sacramento |
> 300 Richards Blvd, 3rd Floor | Sacramento, CA 95811 |
> phone 916.808.7816 |
> gbitter@cityofsacramento.org |
>
>
>
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>
>
> -----Original Message-----
> From: Susie Williams [mailto:susiewil@surewest.net]
> Sent: Thursday, October 31, 2013 9:47 AM
> To: Dana Allen
> Cc: Gregory Bitter
> Subject: Fwd: McKinley Village Comments
>
> Dana: I wanted to share with you a letter I sent to Planning
Commission members. Also, would you please send me a copy of the "white paper" Mr. Angelides has submitted to City Planning and the commission regarding feasibility of constructing a car underpass at Alhambra. As you know, it is public information and falls under the California Public Records Act. This is my second request for the document.
>

> Thanks in advance for responding to this request.
>
> Susie Williams
> <mime-attachment>

From:	vitosgromo
To:	Dana Allen; Evan Compton; Steve Cohn; Sue Brown; "Jameson Parker"; Peter Fenolio; ILee Muller; Anne Romo; Consuelo Hernandez; Steve Hansen
Cc:	"Alan Parker"; "Dale Kooyman"; "Vickie Valine"; mhvaline@gmail.com; "Burgua William"; "Karen Jacques"; "Smith Clara"; smdtyler@aol.com; berdany@aol.com; "BUSS Margaret"; "Smith Clara"; "Ed Trujillo"; Anne Romo; "DAMJANOVIC Martha"; "Rhee, Foon"; "Paul Harriman"; "Laurie Litman"; "Paul Tsamtsis"; "Winger Robert"; "Marion Millin"
Subject:	McKinley Village Proposal Response January 9, 2014
Date:	Thursday, January 09, 2014 11:35:57 PM
Attachments:	SACRAMENTO.docx MCkinley Village Response 7 7 2013.docx CA-HSR.pdf Doc2.docx Sacramento-Roseville 3rd Track Project.pdf SR 51 PI Final Signed 01-08-13.pdf
Importance:	High

January 9, 2014

Dana L. Allen, Associate Planner
Environmental Planning Services
Community Development Department
City of Sacramento
300 Richards Blvd., 3rd Floor
Sacramento, CA 95811

McKinley Village Proposal Response PO8-086

I am resubmitting my July 7, 2013, see below and attached, response with amendments.

Amendments:

1. Traffic Study.

Study Flaws: The traffic study completed for the McKinley Village project has failed to consider several major urban planning and traffic models that are critical to determine accurate automobile traffic volumes.

Pass-By Traffic
According to the Institute of Transportation Engineers two major considerations for any traffic study that includes new access roads between two established city sections should include, “pass-by” traffic. New developments such as the McKinley Village Project will create a new artery of traffic between the central city and East Sacramento, River Commons and eastern sections of the city of Sacramento, This will have a **20% to 25 %** of increase of traffic above the increases created by daily trips of residents within the housing developments of McKinley Village.

Future Growth
According to the Urban Planning Institute, The Institute of Transportation Engineers and American Association of State Highway and Transportation Officials Guidelines, all new development traffic studies must include calculations for future growth of the

proposed new development and the surrounding jurisdictions. According to the existing City of Sacramento General Plan, the Central City current population will grown from approximately 48,000 to 135,000 by 2013. This will be caused mainly by the UP Central City Railyard Infill Project. Also increased east west traffic will also be the result of the Arena Entertainment District. Access to these two major developments will require utilization of the roads that are now planned to connect the McKinley Village project with Midtown and East Sacramento. The traffic study failed to calculate this major impact that can also increase traffic by **20% to 30 %.**

Due to these two major flaws the traffic study has grossly underestimated the full impact of the McKinley Village traffic on the nearby residential streets zoned for only local traffic volumes. If these two factors are used to augment the projected traffic volumes from the completed McKinley Village traffic study then the volume of traffic will exceed the capacity of the locally zoned residential streets.

Recommendation:

River West Investments should re-design the access points into their proposed housing developments to connect with city streets designated as collectors or artilleries such as ELvas Boulevard through Lanett and to Alhambra Boulevard.

Vito Sgromo
Cell 916 719-1477

I am writing to respond to the proposal by River West Investments to build 325 homes at the Assessor's Parcel Number 001-0170-028.The project site is bounded on the south and east by the elevated portion of the UPRR tracks and on the north and west by the Capitol City Freeway.

If approved as proposed, this project has major negative impacts to several regional development projects and future area transportation expansions.

1. Sutter Landing Parkway (Richards Boulevard Connector).

The General Plan (http://www.sacgp.org/index.html) has identified the future development of a parkway road, Sutter Landing Parkway (Richards Boulevard Connector) as a road that must be built to connect the I50 Highway to the Sutter Landing Regional Park, Route 160, to the major Railyard Central City Development and the new proposed arena and surrounding Downtown entertainment district. The Sutter Landing parkway is critical to the development of a regional park, the largest urban infill project in the West Coast and the new arena.

Negative Impact: McKinley Village Proposal would if approved would eliminate the Sutter Landing Parkway by abandoning the ELvas Roadway and Lanett route and eliminating the needed land inside the proposed McKinley Village Proposal.

Recommendation: River West Investments must alter their plans by allow enough land for the future Sutter Landing Parkway and abandon the 40th Street underpass and use Lanett Street as the underpass to connect to Elvas Boulevard Road.

2. Union Pacific Railroad Expansion

UP is planning additional train lines (see attached reports, Sacramento Roseville 3rd Track and CAL HSR).

Negative Impacts: River West Investments must set aside sufficient land to allow UP to expand. Also these additional train lines and the train traffic will eliminate the use of 28th Street as an access point for the McKinley Village Housing Proposal.

Recommendation: River West Investments must set aside sufficient land to ensure UP can add the additional tracks. Also River West Investments must designate 28th Street as a bike and pedestrian access since in the near future it will no longer be available for automobile traffic and enlarge the opening at Alhambra for 2 way auto traffic.

3. Caltrans I80 Expansion

Caltrans is planning a future expansion of the I 80 Highway that borders the McKinley Village Project (See attachment SR 51 PL Final 01-08-13). This should include on and off ramps to connect to the Sutter Park Landing Parkway.

Negative Impacts: River West Investments has not allowed sufficient land to allow Caltrans to expand I80 thereby improving a bottleneck highway, reducing pollution and connecting with the Sutter Landing Parkway.

Recommendation: River West Investments has to redesign its housing proposal to allow sufficient land for the Caltrans expansion and the addition of an on and off ramps to connect to the Sutter Landing Parkway.

4. Traffic Impacts to Local Streets

River West Investments is funding a traffic study on the impacts of their proposal to access 28th and 40th Streets for automobile access to the McKinley Village housing project. According to the General Plan (http://www.sacgp.org/index.html) both streets are designated as local streets.

Negative Impacts: Although the traffic study has not been completed, the increase traffic could potentially exceed the capacity of the local streets.

Recommendation: River West Investments should re-design the access points into their proposed housing developments to connect with city streets designated as collectors or artilleries such as ELvas Boulevard through Lanett and to Alhambra Boulevard.

5. Caltrans New Proposed Capitol Railyard

Caltrans is currently examining the use of the land River West Investments has proposed for their housing project for a major new railyard and maintenance facility

for Amtrak trains. Caltrans needs to build a new maintenance facility for Amtrak's Capital Corridor and San Joaquin Corridor trains (See attached Sacramento Bee Article, Friday July 5, 2013)

Negative Impacts: River West Investments if approved would have a very serious impact to the expansion of train transportation in Northern and Central California.

Recommendation: Place a temporary hold on any approval for the River West Investments McKinley Village Proposal until City and State officials determine the final location of the Capitol Railyard.

Conclusion

McKinley Village proposal if approved in its current design would negatively impact several major transportation and development plans including the development of the UP Central City Railyard Infill Project and Arena Entertainment District that are larger in scale than the McKinley Village Project and have not only city but regional impacts.

For the greater good of the city of Sacramento and Northern California I suggest that McKinley Village Project be placed on hold until the new Capitol Railyard location is finalized. Also if the McKinley Village Project is still planned for the current suggested site it must alter its design to allow sufficient land for transportation rail and road expansions and relocation of automobile access to Alhambra Boulevard and Lanett Streets that are designated to handle the increased traffic.

Let me know if you have any questions or if you need further information.

Thank you.

Vito Sgromo

Cell 916 719-1477

July 7, 2013

Dana L. Allen, Associate Planner
Environmental Planning Services
Community Development Department
City of Sacramento
300 Richards Blvd., 3rd Floor
Sacramento, CA 95811

McKinley Village Proposal Response PO8-086

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River West Investments is funding a traffic study on the impacts of their proposal to access 28th and 40th Streets for automobile access to the McKinley Village housing project. According to the General Plan (http://www.sacgp.org/index.html) both streets are designated as local streets.

Negative Impacts: Although the traffic study has not been completed, the increase traffic could potentially exceed the capacity of the local streets.

Recommendation: River West Investments should re-design the access points into their proposed housing developments to connect with city streets designated as collectors or artilleries such as ELvas through Lanett and to Alhambra Boulevard.

5. Caltrans New Proposed Capitol Railyard

Caltrans is currently examining the use of the land River West Investments has proposed for their housing project for a major new railyard and maintenance facility for Amtrak trains. Caltrans needs to build a new maintenance facility for Amtrak's Capital

Corridor and San Joaquin Corridor trains (See attached Sacramento Bee Article, Friday July 5, 2013)

Negative Impacts: River West Investments if approved would have a very serious impact to the expansion of train transportation in Northern and Central California.

Recommendation: Place a temporary hold on any approval for the River West Investments McKinley Village Proposal until City and State officials determine the final location of the Capitol Railyard.

Conclusion

McKinley Village proposal if approved in its current design would negatively impact several major transportation and development plans including the development of the UP Central City Railyard Infill Project and Arena Entertainment District that are larger in scale than the McKinley Village Project and have not only city but regional impacts.

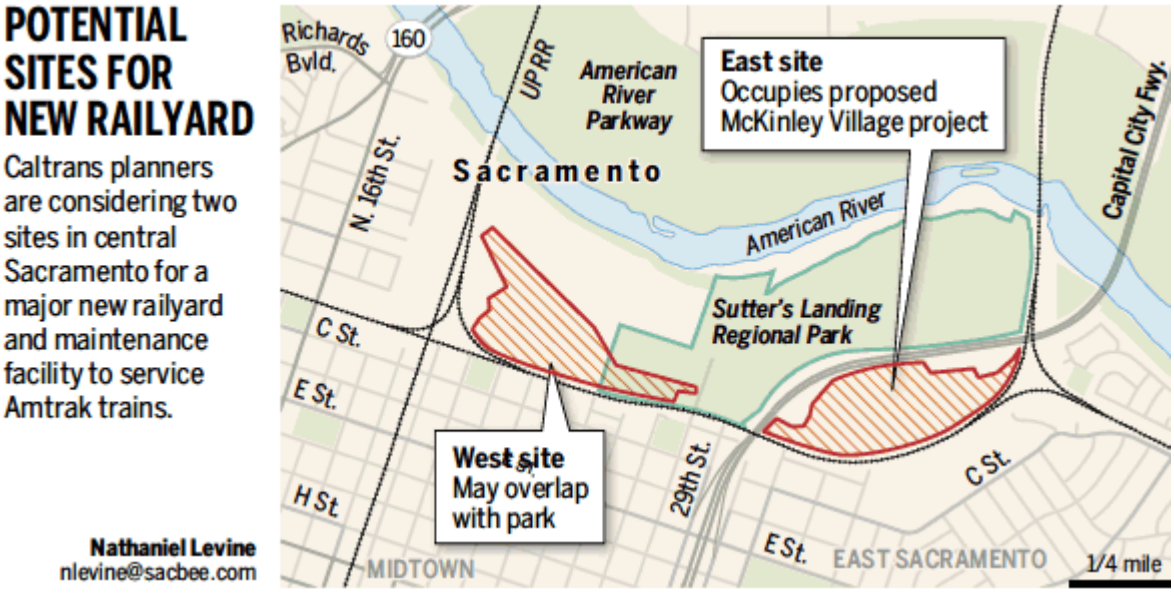
For the greater good of the city of Sacramento and Northern California I suggest that McKinley Village Project be placed on hold until the new Capitol Railyard location is finalized. Also if the McKinley Village Project is still planned for the current suggested site it must alter its design to allow sufficient land for transportation rail and road expansions and relocation of automobile access to Alhambra Boulevard and Lanett Streets that are designated to handle the increased traffic.

SACRAMENTO

State wants new capital railyard

CALTRANS LOOKS AT CITY PARK OR FORMER CENTRAGE SITE AS PLACE TO SERVICE AMTRAK TRAINS

By Hudson Sangree hsangree@sacbee.com



Sacramento has spent decades cleaning up and finding new uses for two historic city railyards. Now the state of California wants to build a new one in the urban core.

State transportation planners are looking at sites in east Sacramento and at Sutter's Landing Regional Park along the American River, as places to build a major new railyard and maintenance facility for Amtrak trains.

Word of the state Department of Transportation's plans spread in the last few days and surprised city officials and developers hoping to build hundreds of homes on the east Sacramento site.

"We just learned about it this week," said Megan Norris, vice president of Riverview Capital Investments. The firm, headed by former state Treasurer Phil Angelides, has been promoting plans to build Mc-Kinley Village, a 328-home development, on the vacant swath of land by the Capital City Freeway. The property is commonly known as Centrage, after one of several failed projects there.

Sacramento City Councilman Steve Cohn, whose district contains both areas under consideration, said the revelation that Caltrans was looking at the sites to service Amtrak trains "came as news to me."

He said any plans to put a railyard at Sutter's Landing Park, built atop a former landfill, would be unacceptable. A map of the proposal suggests the railyard could impinge on city parkland. Even if it didn't, Cohn said the city is planning to expand the park by acquiring acreage now in private hands. "We spent a lot of time and effort to convert an industrial facility into a park," he said.

Caltrans spokesman Mark Dinger said the department's plans are preliminary, with the two Sacramento locations being evaluated.

"We are going to be in discussions with the city of Sacramento on the proposed sites," he said. "However, it will be some time before a determination is made."

Caltrans, he said, needs to build a new maintenance facility for Amtrak's Capital Corridor and San Joaquin Corridor trains. The current maintenance facility in Oakland is at or near capacity, he said. "They want to develop another one for future needs."

A Caltrans project description says the Federal Railroad Administration last year awarded it a $168 million grant to buy six locomotives and 42 passenger cars to bolster the two lines, and the Oakland facility will be unable to maintain all the new cars.

A new facility would provide inspections and repair, along with refueling, food restocking and cleaning of the interior and exterior of trains.

A Caltrans rendering of the proposed maintenance facility on the 48-acre McKinley Village site shows 28 tracks with shops to service locomotives and coaches. It includes buildings for contractors and administrators, employee parking and a train wash.

Cohn said he would be open to the facility at the Mc-Kinley Village site, where some neighbors oppose the proposed housing development. The area is walled off from existing neighborhoods by a 20-foot elevated rail line and sits beside speeding freeway traffic. Noise mitigation measures might be put in place, and modern rail facilities tend to be cleaner than their 19th and 20th century predecessors, Cohn said.

News that central Sacramento might get a new rail-yard arrived the same week that state environmental officials approved a toxic cleanup plan for the central shops section of the downtown Sacramento railyard. The area was a locomotive manufacturing and railroad maintenance facility for 130 years, leaving numerous contaminants in the soil. The 240-acre former Southern Pacific railyard is being readied for redevelopment as an extension of downtown with housing, offices and stores, as well as a major railroad technology museum.

At another former railyard in the Curtis Park neighborhood, developer Paul Petrovich spent $30 million cleaning toxics from the soil. He plans to build 268 homes and retail shops on 72 acres near Sacramento City College. Construction is expected to start soon.

To address the prospect of a new railyard, Cohn and city staff members are planning to meet with Caltrans officials Monday to learn more about their plans.

“We know our region better than they do,” Cohn said.

McKinley Village developer Norris said she had spoken briefly with Caltrans officials earlier this week. She said she came away with the idea that they preferred the approximately 54-acre site at Sutter’s Landing because it is at-grade with the existing rail line.

“If they decide it’s going to be our site, we could have to look at it,” she said.

The McKinley Village site was once owned by Caltrans but is now controlled by developer Angelo K. Tsakopoulos. The former peach orchard has seen a series of development plans defeated by neighborhood opposition.

The failures included a high-rise office, apartment and hotel development plan in the early 1990s called Centrage. Many area residents still know the land by that name.

The current housing plan has already ignited debate about whether it’s the best use for the awkward site.

Norris said the property remains zoned industrial and could easily accommodate the rail plan. But the McKinley Village plan for leafy residential streets, with a central park and walking paths is a better option, she said.

“We have every intention to move forward with this project,” Norris said. “We think it’s a great project and the best fit for the surrounding neighborhood.”

Call The Bee’s Hudson

Sangree, (916) 321-1191. Bee staff writer Tony Bizjak contributed to this report.

PLACER COUNTY
TRANSPORTATION
PLANNING AGENCY

MEMORANDUM

TO: **PCTPA Board of Directors** **DATE: March 27, 2013**

FROM: **Celia McAdam, Executive Director**

SUBJECT: **PRESENTATION: THIRD TRACK RAIL PROJECT BETWEEN SACRAMENTO AND ROSEVILLE**

ACTION REQUESTED

None. For discussion only.

BACKGROUND

The Board has a long-standing policy to aggressively pursue additional passenger rail service to Placer County. This has involved working closely with the Capitol Corridor Joint Powers Authority (CCJPA) in addressing the interests and needs of Union Pacific (UPRR) as we pursue their permission to add passenger trips. After more than 20 years of these efforts, we still remain at one round trip per day.

Hopes were rekindled in 2008 when Union Pacific has expressed a willingness to discuss additional passenger service as part of a package of improvements that would benefit both freight and passenger capacity. The improvements can be roughly categorized as follows:

Donner Project

UPRR has long been interested in double tracking an approximately 10 mile segment of their rail line in the Donner Summit area as a way of improving their freight capacity. Trade Corridor Improvement Fund (TCIF) under Proposition 1B was identified by UPRR as a promising source of financing. Requirements for the TCIF include sponsorship by a public agency and a 50% match from UPRR.

CCJPA, with PCTPA concurrence, agreed to sponsor and support UPRR's bid for TCIF funding for the Donner project provided that UPRR allow a second Capitol Corridor round trip to Auburn.

Sacramento-Roseville Third Track Project

Full implementation of the CCJPA Business Plan includes 10 round trips daily to Roseville. It has long been challenging to negotiate this with UPRR, as Roseville is home to the largest freight yard west of the Mississippi, providing a convergence of UPRR's Donner and Feather River routes that connect California to the rest of the US. The Sacramento – Roseville section is a particular area of freight traffic congestion that UPRR would like to address.

The specific project being considered to improve both passenger and freight rail capacity is to add a third track between Sacramento and Roseville, and potentially move the Roseville rail station to a location that would reduce impacts to freight traffic.

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www.pctpa.net

In 2002, PCTPA programmed $3 million in Regional Choice funds and the Caltrans Division of Rail programmed $3.3 million in Interregional funds in the State Transportation Improvement Program (STIP) for environmental clearance and design of the Third Track Project.

After many years of delays, work is now underway on the environmental phase, including Federal compliance, with completion expected in 2014. Design, right of way, and construction will follow. CCJPA is in the lead for this project, with consulting assistance from HDR Engineering. PCTPA and the City of Roseville are key partners in the effort.

DISCUSSION

In early March, CCJPA and PCTPA were advised that UPRR elected to withdraw their offer to provide the required matching funds for the Donner Project. As a result, the project is no longer eligible to be considered for Proposition 1B funding.

Jim Allison, CCJPA Director of Planning, will provide the Board with a presentation on the Sacramento-Roseville Third Track Project environmental process, along with the identified alternatives and issues.

CM:ss

Caltrans

2013

STATE ROUTE 51 PRELIMINARY INVESTIGATION

Approvals:

JEFF PULVERMAN, **District 3 Deputy Director** **Planning and Local Assistance**	1-8-13 **Date**	**JODY JONES,** **District Director**	1-8-13 **Date**

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INTRODUCTION

The State Route (SR) 51 Preliminary Investigation (PI) is one of a series of studies being conducted by Caltrans District 3, in coordination and consultation with major stakeholder partners, to determine the feasibility and prioritization of improvements to the State Highway System within a segment of the larger corridor defined within the 2009 *Interstate 80 and Capital City Freeway Corridor System Management Plan* (I-80/SR 51 CSMP), as shown in Figure 1. The PI is the first stage of the project initiation document process, which is the linkage between planning and project development. The PI provides critical initial project scoping and assurances regarding project feasibility and selection, and significantly improves and streamlines the development of the subsequent Project Initiation Document (PID), thereby focusing resources on achieving the most mobility benefits for the least amount of cost.

The SR 51 PI addresses the need for operational and capacity improvements for the entire segment of SR 51 in the City of Sacramento. Candidate improvement projects include Transportation Operation System (TOS) elements, High Occupancy Vehicle (HOV, Bus/Carpool) lanes, and auxiliary/transition lanes.

PRELIMINARY INVESTIGATION NEED AND PURPOSE

There is a need to address the traffic conditions on SR 51 which is currently operating beyond capacity, and congestion and delay will be exacerbated by proposed local land use development in the vicinity and by population growth. Planned development, particularly at Cal Expo, will increase traffic which will degrade travel times, average speed, and other traffic performance measures. The *2009 Mobility Performance Report* (*MPR*) identified SR 51 as having five of District 3's top 10 bottlenecks.

The purpose of the SR 51 PI is to create a planning approach that focuses on gaining early consensus regarding needed improvements, determine feasibility, and prioritize projects to reduce congestion and improve traffic operations. This will allow for a coordinated approach to programming (funding) the capital investments to achieve an efficient transportation system based on the most effective improvements. Early and consistent collaboration with local partners and stakeholders is needed to gain a consensus on a funding and programming approach to implement needed improvements within SR 51 to ensure the timely implementation of improvements for continued efficient operation of the highway.

CORRIDOR BACKGROUND

As shown in Figure 2, SR 51 is located in the City of Sacramento and is officially signed as part of Business Loop 80 and named the Capital City Freeway. SR 51 is a route of vital importance to regional and interregional travel and goods movement. It provides a vital link for downtown Sacramento, Cal Expo, and Arden Mall, and it connects two major highways, US Highway 50 (US 50) and Interstate 80 (I-80). It is a heavily traveled facility and experiences significant congestion during peak periods. As growth continues, local land use development will put additional pressure on SR 51.

The 8.9-mile urban arterial freeway runs southwest to northeast and begins at the junction of US 50 and SR 99 as an elevated 6-lane freeway with one Bus/Carpool lane and auxiliary lane in each direction. Between Exposition Boulevard (Bl.) and SR 160, the facility is five lanes until SR 160 when SR 51 becomes an 8-lane facility and then narrows to and remains a 6-lane freeway from SR 160 to its eastern junction with I-80. Bus/Carpool lanes exist between SR 99 and J Street (St.), and auxiliary lanes run in the north and southbound directions between SR 99 and J St. as well as between the Arden Way and Marconi Avenue (Av.) interchanges. The lane configuration diagram is shown in Figure 3.

Figure 1: Interstate 80/Capital City Freeway Corridor System Management Plan Network

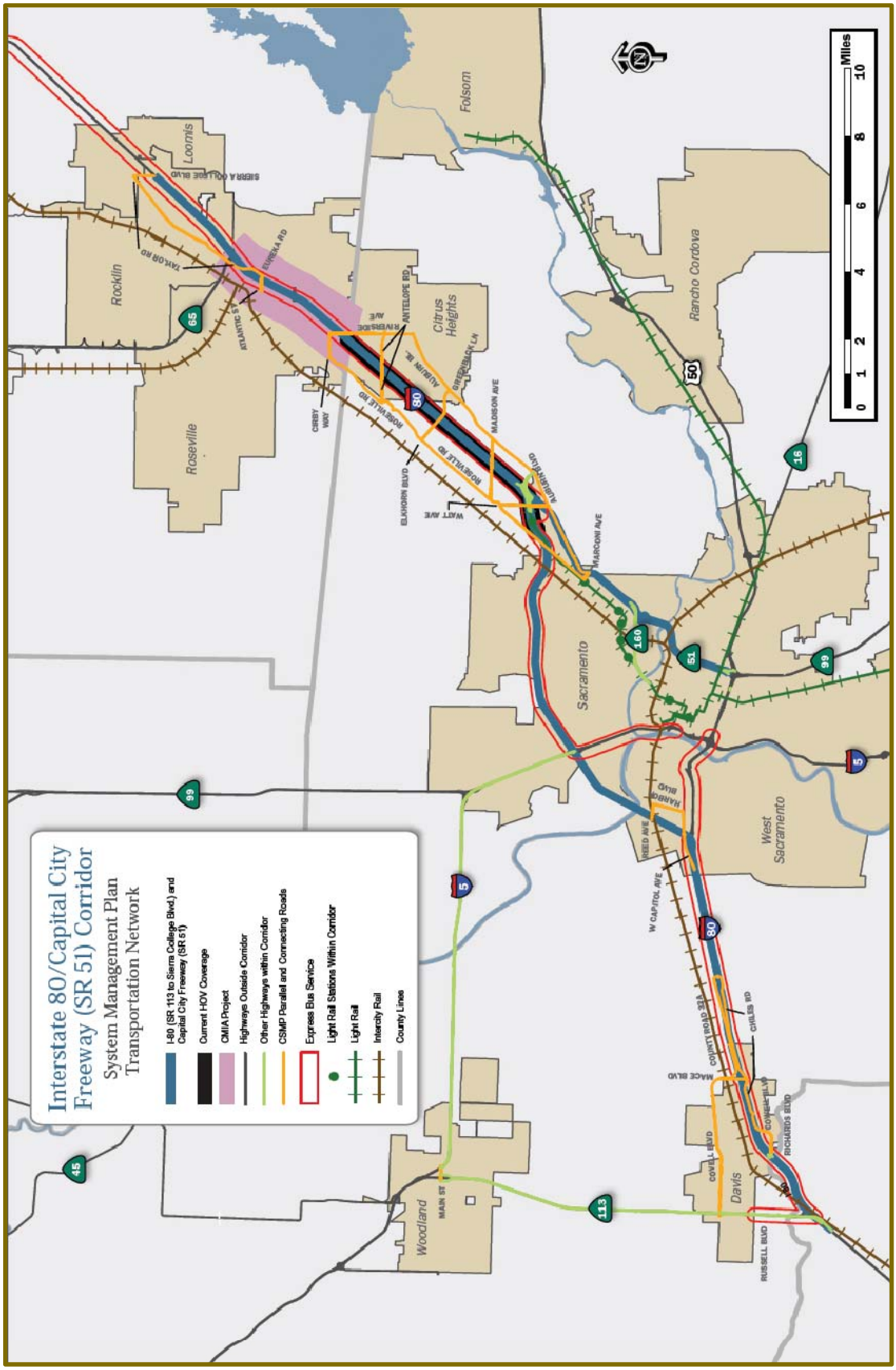


Figure 2: SR 51 PI Project Area

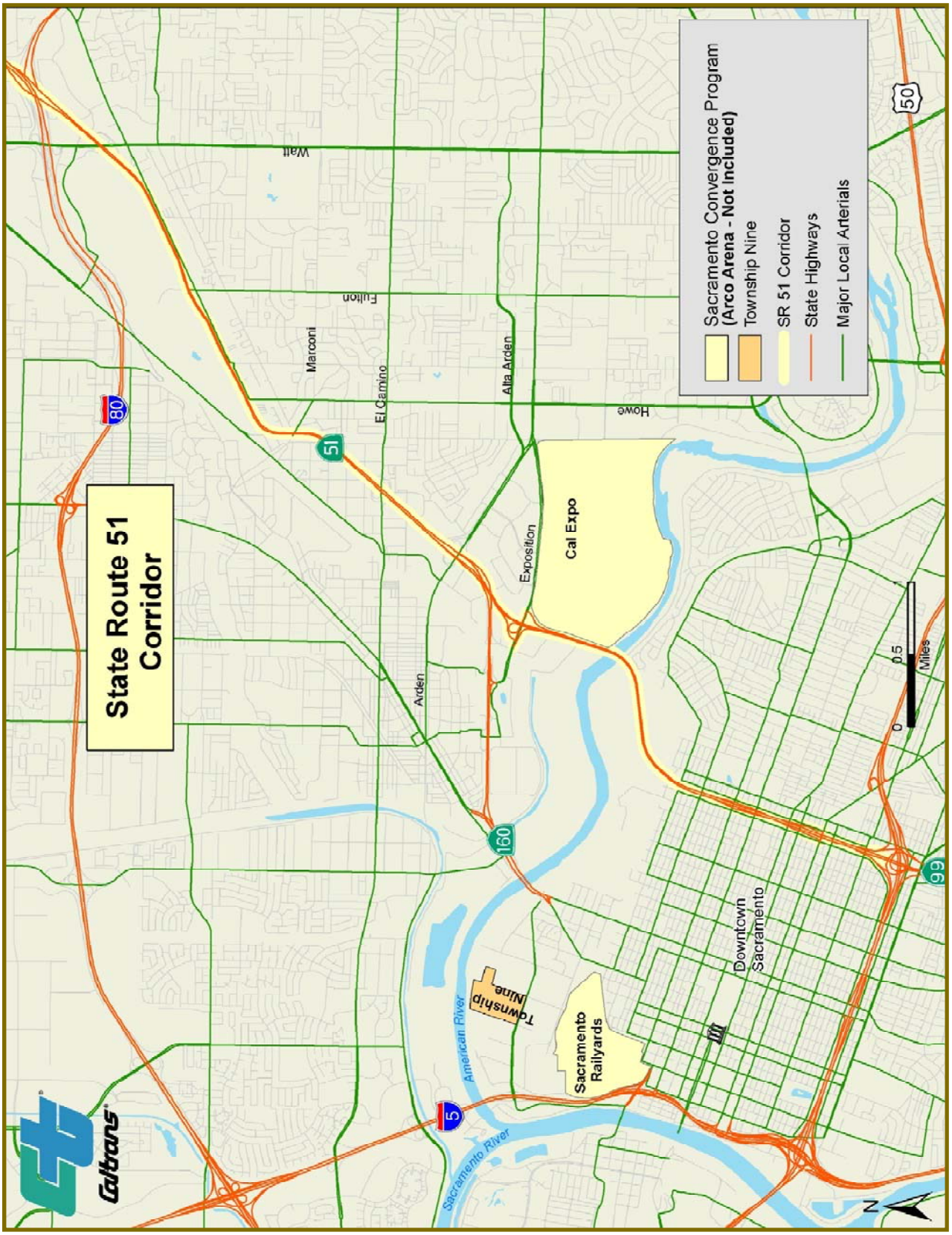
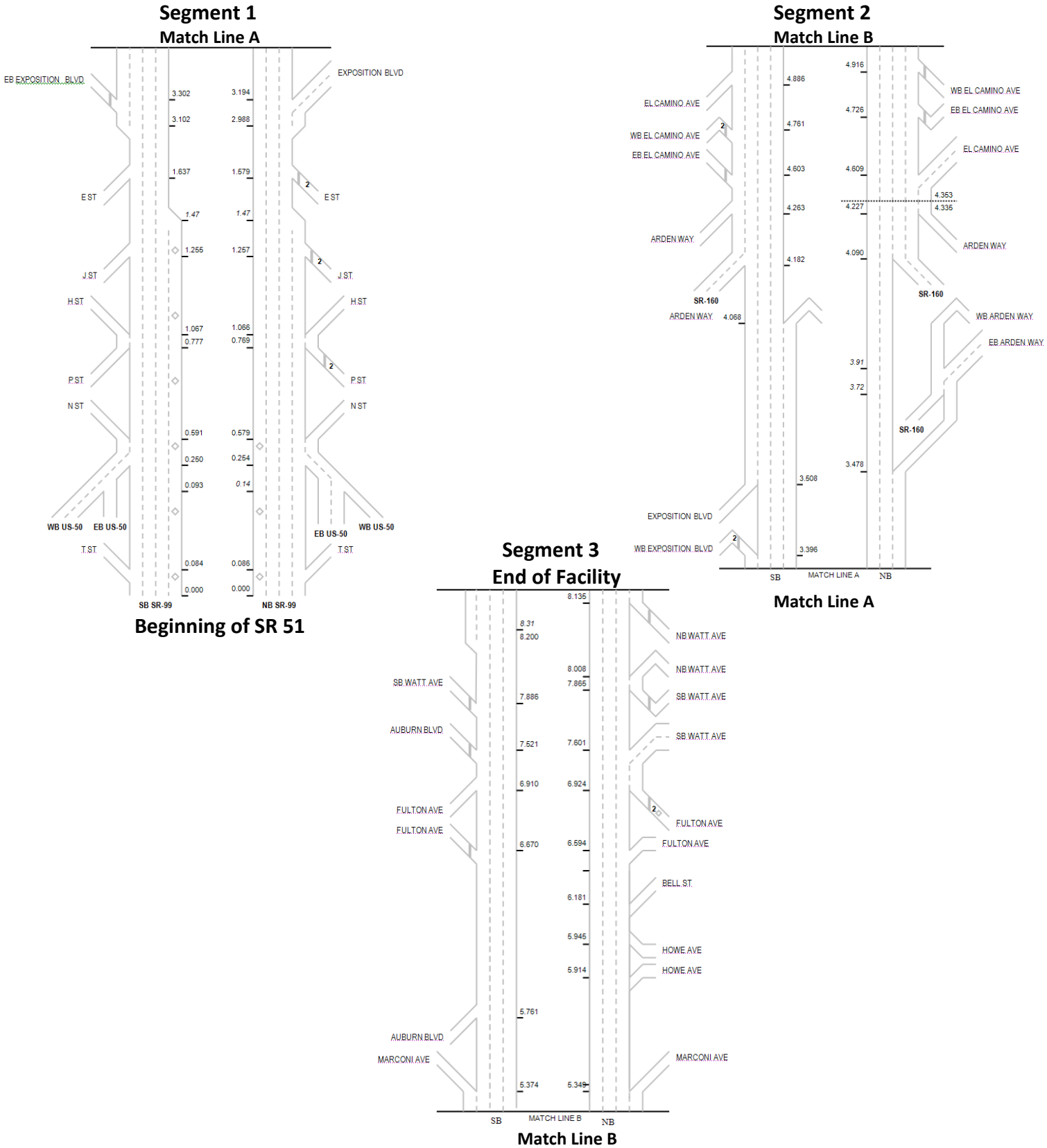


Figure 3: SR 51 Lane Configuration Diagram



EXISTING AND FUTURE CONDITIONS

EXISTING CONDTIONS

The PI used existing data supplied in the 2009 *I-80/SR 51 Corridor System Management Plan*, the 2011 *I-80/SR 51 State of the Corridor Report*, and the 2012 *SR 51 Preliminary Investigation Modeling Report*. It should be noted that some of the existing facility performance data is several years old. However, the current economic recession has resulted in stagnant growth and traffic volumes have remained relatively flat. Therefore, the performance data is still valid. These Plans and Reports show that SR 51 is currently operating with low free flow speeds, stop-and-go traffic, bottlenecks, and significant vehicle hours of delay. There were approximately 855,000 annual vehicle hours of delay in 2009 for both directions on the corridor. The cost of these vehicle hours of delay are calculated by factoring lost time, fuel consumed, and wear and tear on the vehicle. Vehicle hour of delay cost equals $17.35 based on the vehicle mix of trucks and cars, the price of fuel, value of time and wages, and vehicle repairs. In sum, annual vehicle hours of delay on SR 51 cost $14.8 million in 2009, as shown in Table 1.

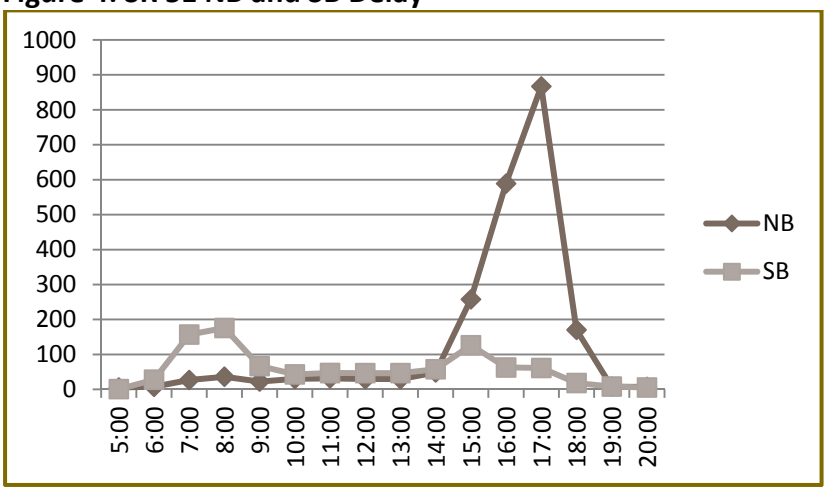
Table 1: Existing Facility Conditions

Segment	Post Miles	Location Description	Existing LOS	Existing Facility	Total Annual Vehicle Hours of Delay (60 mph) SR 51 NB, 2009	Total Annual Vehicle Hours of Delay (60 mph) SR 51 SB, 2009	Cost of Delay per Hour	Total Annual Cost of Delay, NB and SB, 2009
1	0.0/4.4	US 50/SR 99/ SR 51 IC to Arden Way	F	6F + 2 HOV to N St + 2 Aux to J St., 6F to Arden Way	437,000	171,000	$17.35	$10,548,800
2	4.4/8.9	Arden Way to I-80	F	6F + 2 Aux to Marconi Av., 6F to I-80	150,000	97,000	$17.35	$4,285,450

The more recent *MPR* identified an increase in annual vehicle hours of delay for both directions in 2011 to approximately 959,693. This equates to an even greater annual cost of $16.7 million.

Southbound (SB) daily delay increases steadily throughout the week with the lowest delays occurring on Monday and the highest delays on Fridays. Northbound (NB) daily delay remains fairly constant throughout the week. The NB direction of SR 51 experiences minor delay in the morning peak period and major delay in the afternoon, peaking between 3:15 and 6:15 p.m. As shown on Figure 4, the SB direction experiences peaking between 6:00 and 9:00 A.M. and 3:00 and 6:00 P.M..

Figure 4: SR 51 NB and SB Delay



Vehicle Hours of Delay under 65 MPH by Time of Day, April 1-14, 2008

BOTTLENECK ANALYSIS

The *2000 Highway Capacity Manual* defines a bottleneck as "a road element on which demand exceeds capacity." Bottleneck locations and causality were identified for SR 51 as part of the development of the *I-80/SR 51 CSMP*. Bottleneck locations identified in the CSMP were determined using a combination of Caltrans Performance Measurement System (PeMS) data, the Highway Congestion Monitoring Program (HICOMP) report, probe vehicle tachometer ("tach") runs, and field observations. Causalities for these major bottlenecks range from high traffic demand (congestion), heavy weaving/merging areas, or physical constraints such as lane drops, incomplete Bus/Carpool lane network, and incomplete Auxiliary/Transition Lane network. Minor or hidden bottlenecks are less pronounced but may result in a major bottleneck if another major bottleneck is removed or not activated. These minor bottlenecks include the termination of auxiliary lanes. The report compared the tach run data, field observations, and the number of days a particular bottleneck occurs to determine the severity of the bottlenecks. Table 2 shows a summary of the SR 51 bottlenecks.

Table 2: SR 51 Bottlenecks

Location	Post Miles	PeMS Speed Contours		Caltrans Probe Vehicle Runs		Cause
		AM	PM	AM	PM	
Northbound						
E St.	2	Minor	Major		Major	The upstream lane drop combined with the increase in traffic from E St and the short merge at the E St. on-ramp.
Exposition Bl.	2.5	Minor	Minor		Minor	Exiting vehicles at Exposition Bl., as well as the lane drop at the Arden off-ramp.
El Camino Av.	4.5	Minor	Major			The increase in traffic demand from El Camino Av. causes the bottleneck at El Camino Av.. Also, the lane drop and horizontal curve at the Marconi Bridge cause a reduction in capacity, resulting in a bottleneck and a queue that extends back to El Camino, and sometimes to the SR 51/SR 160 merge point.
Marconi Av.	5.5	Minor	Minor			The termination of the auxiliary lane at Marconi Av. and a horizontal curve on SR 51 just past the Marconi Av. interchange.
Watt Av.	8				Major	Vehicles exiting and entering at Watt Ave create a merging and weaving
Southbound						
Watt Av.	7	Major		Major		The increase in traffic entering from Watt Ave and is perpetuated by the upstream lane drop and heavy volumes from I-80.
El Camino Av.	4.5	Major		Major		Weaving vehicles headed to Arden or SR 160, along with vehicles entering from El Camino and the lane drop at SR 160.
Exposition Bl.	3		Major		Major	The increase in traffic entering from Exposition Bl., the heavy volume exiting at Exposition, heavy demand from Arden, and the downstream lane drop.
E St.	2	Minor			Minor	The narrowing of the freeway right-of-way as it crosses under the railway and service bridges while rounding a corner.

The more recent *2011 MPR* and 2012 PeMs data identified an additional SB AM bottleneck at Auburn Bl. (PM 7.6), NB and SB PM bottlenecks between E St. and the American River Bridge, and NB and SB PM bottlenecks by T St. (PM 0.1).

FUTURE CONDITIONS

Overall traffic has increased and will continue to increase due to development within the corridor. Table 3 depicts the current and forecasted data for the facility as identified in the *I-80/SR 51 CSMP*. Traffic volumes are forecasted to increase 40 percent (%) in the twenty years from 2007 to 2027 for both the peak hour traffic and the average annual daily traffic. While the actual volume increases between 2007 and 2027 will likely be smaller due to the downturn of the economy, there will still be significant increased demand. Along with this, the volume over capacity (V/C) ratio will significantly increase from 1.02 to 1.29 on Segment 1 and from 1.08 to 1.54 on Segment 2. With such large increases, it is imperative to provide improvements that will ensure the continued functionality and operating efficiency of SR 51.

Table 3: Current and Future Travel Conditions

County	Location	Current Traffic Data—2007					Future Traffic Data — 2027[4]			
		% of Trucks	Peak Directional Split[1]	Peak Hour Traffic	Average Annual Daily Traffic[2]	Volume over Capacity[3]	Peak Hour Traffic (Build)	Average Annual Daily Traffic (Build)[2]	Volume over Capacity (No-Build)[3]	Volume over Capacity (Build)[3]
SAC	Segment 1: US 50/SR 99 to Arden Way/SR 51/ 160 IC	4%	59%	13,000	166,000	1.02	18,200	232,400	1.29	1.29
	Segment 2: Arden Way/ SR 51/ 160 IC to I 80	4%	59%	11,800	151,000	1.08	16,520	211,400	1.54	1.54

[1] Peak Directional Split: The percentage of total traffic in the heaviest traveled direction during the peak hour.
[2] Average Annual Daily Traffic (AADT): The average number of vehicles per day in both directions.
[3] Volume over Capacity (V/C): The volume of traffic compared to the capacity of the roadway.
[4] Data derived from *SACMET Travel Demand* modal

PROJECT IMPROVEMENTS AND PRIORITIZATION PROCESS

A prioritized list of candidate improvement projects was developed based on the following process:

A SR 51 PI Project Development Team (PDT) composed of representatives from Caltrans' Planning, Right-of-Way, Environmental, and Traffic Operations, as well as the City of Sacramento, Sacramento Regional Transit District (SacRT), and the Sacramento Area Council of Governments (SACOG) participated in a series of meetings where they identified the scope, desired outcomes, resource needs, and a candidate list of improvements to SR 51. The improvements included traffic operations system (TOS) elements, auxiliary/transition lanes, Bus/Carpool lanes, and widening of structures, and are depicted in Figure 5.

Once the candidate improvement projects were identified, they were analyzed to identify their incremental contribution toward corridor mobility and prioritized based on the results of the individual and aggregated analyses. Transportation modeling applications, including micro simulation analysis, were used to quantify the benefits and determine the prioritization of the auxiliary/transition lanes and Bus/Carpool lane projects. Ramp metering and Intelligent Transportation System projects were not included in the micro simulation analysis, but are the highest priority based on their relatively low cost and high benefits.

The micro simulation modeling determined the traffic impacts and measures of effectiveness of specific/packaged projects on the SR 51 mainline and interchanges. The modeling incorporated PeMS count data, manual counts, origin/destination data, and projected growth from the SACMET travel demand model.

The modeling was conducted in two separate studies. The first focused on alternatives associated with adding a transition lane in the NB direction from E St. to the American River (Am. River) Bridge. The second examined the benefits of adding auxiliary/transition lanes compared to adding Bus/Carpool lanes on all of SR 51. The E St. NB transition lane project was separated from the second modeling study because it involved the possible closure of the E St. on-ramp and, therefore, would require unique considerations.

The final list of prioritized projects is indicated in Table 4.

Figure 5: SR 51 PI Improvement Projects

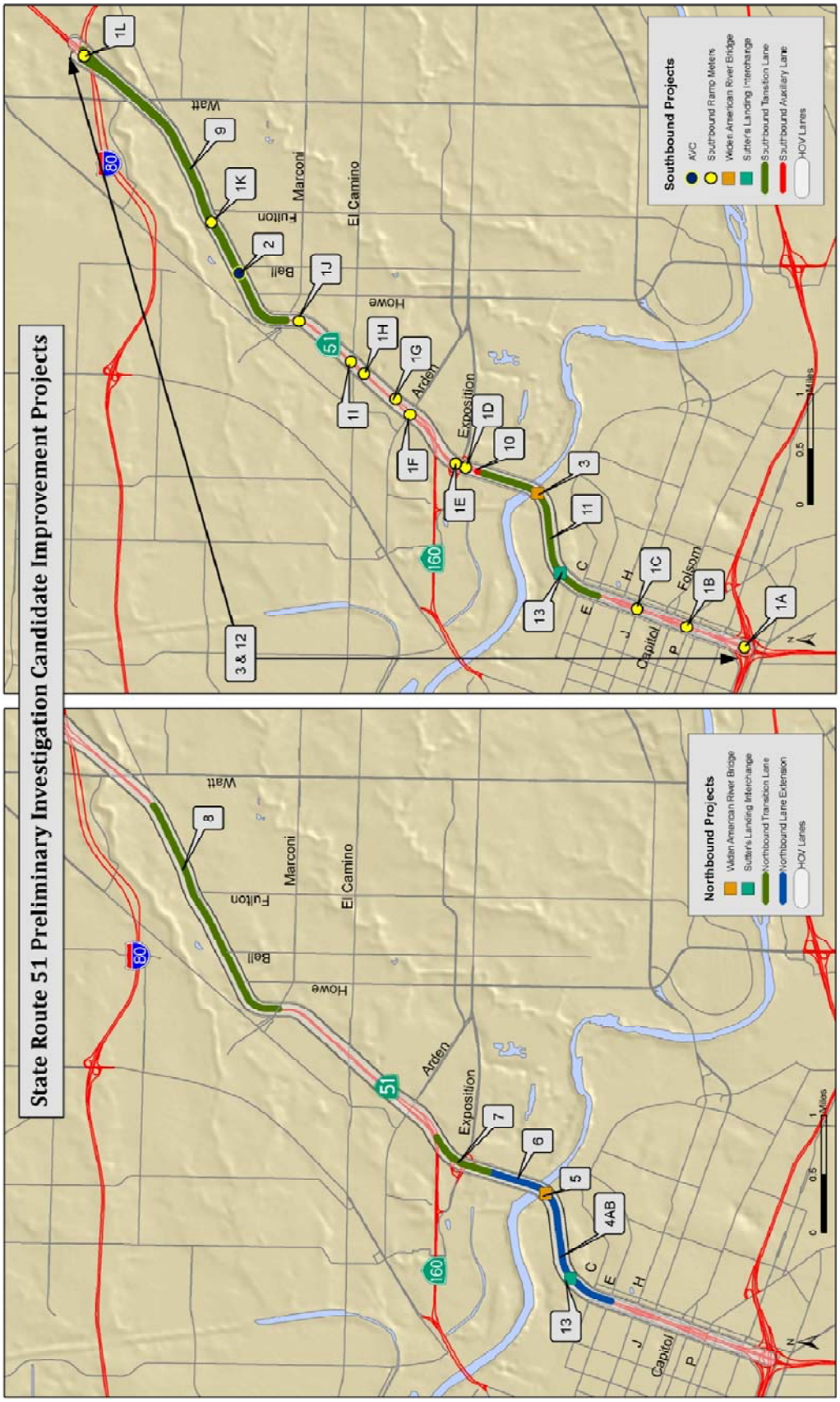


Table 4: SR 51 PI Prioritized Projects

Project #		Post Mile	Location	Description	Cost Estimates ($1,000)①					
					Road	Structures	# Parcels Impacted	ROW	Subtotal (capital costs)	TOTAL (with support)
Ramp Metering Projects②										
1	A	0.1	T St.	Add Ramp Meter, southbound (SB)					$500	**$660**
	B	0.6	N St.	Add Ramp Meter, SB					$500	**$660**
	C	1.1	H St.	Add Ramp Meter, SB					$500	**$660**
	D	3.3	Exposition Bl.	Add Ramp Meter, northbound (NB)					$500	**$660**
	E	3.4	Exposition Bl.	Add Ramp Meter, SB					$500	**$660**
	F	4.1	Arden Way	Add Ramp Meter, SB					$500	**$660**
	G	4.2	Arden Way	Add Ramp Meter, NB					$500	**$660**
	H	4.6	El Camino Av.	Add Ramp Meter, NB					$500	**$660**
	I	4.8	El Camino Av.	Add Ramp Meter, SB					$500	**$660**
	J	5.4	Marconi Av.	Add Ramp Meter, SB					$500	**$660**
	K	6.7	Fulton Av.	Add Ramp Meter, SB					$500	**$660**
	L	8.6	SR 244	Add Ramp Meter, SB					$500	**$660**
Intelligent Transportation System (ITS) Projects										
2		6.22	Bell St.	Convert Traffic Monitoring Station to Automatic Vehicle Counter for improved vehicle classification data set.	$60	0	0	0	$60	**$79**
3		0.0/8.8	US 50 to I-80	Install fiber-optic communication lines along corridor to connect all ITS elements, and improve communication and reliability. Also, add Blue Tooth reader for improved travel time measurement.	$880	0	0	0	$880	**$1,300**
E Street Transition Lane Project										
4A		1.4/2.6	E St to the Am. River Bridge	Add NB Transition Lane. This Project alternative assumes that the E St. On-Ramp will remain open. Additional Structural and ROW costs will become necessary to lengthen B St. and Elvas St. underpasses, and A St. overcrossing (OC).	$3,780	$8,600	11 to 20	$35,000 +/- $15,000	$47,380	**$62,500**
4B		1.4/2.6	E St to the Am. River Bridge	Add NB Transition Lane. This Project alternative assumes design exceptions for reduced lane width in certain locations and that the E St. NB On-Ramp will close. No additional Structural and ROW costs will become necessary.	$2,940	$0	$0	$0	$2,940	**$3,900**
American River Bridge Project③										
5		2.6	Am. River Bridge	Widen from 3- to 5-lanes in each direction for phased inclusion of Transition and Bus/Carpool lanes.	$2,700	$91,300	1 to 10	$3,000 +/- $2,000	$97,000	**$128,000**
Transition and Auxiliary Lane Projects④										
6		2.6/3.1	Am. River Bridge to Exposition Bl.	Add NB Transition lane.	$2,700	$0	1 to 10	$3,000 +/- $2,000	$5,700	**$7,500**
7		3.1/3.7	NB Exposition Bl. to SR 160	Add NB Transition lane. Widen NB SR 160 SEP to 4-lanes	$3,000	$31,500	0	$25 +/- $25	$34,525	**$45,600**
8		5.5/7.6	Marconi Av. to Watt Av.	Add NB Transition lane. Lengthen Marconi, Fulton & Watt Avs. OC. Reconstruct Howe & Bell Avs. Ramps. Lengthen SB on-ramp from Auburn/Watt Av. ramp flyover ramp. Widen Arcade Creek Bridge to 4-lanes each direction.	$19,500	$21,200	1 to 10	$3,000 +/- $2,000	$43,700	**$57,700**
9		5.5/8.7	Watt Av. to Marconi Av.	Add SB Transition lane. Lengthen Marconi, Fulton & Watt Avs. OC. Lengthen SB on-ramp from Auburn/Watt Av. ramp flyover ramp.	$17,500	$0	1 to 10	$3,000 +/- $2,000	$20,500	**$27,000**
10		3.0/3.2	Exposition Bl.	Add Auxiliary lane SB between ramps. Modify EB Exposition Bl. loop on-ramp.	$9,000	$0	0	$500 +/- $500	$9,500	**$12,500**
11		1.4/3.1	Exposition Bl. to E St.	Add SB Transition lane. Lengthen B St. underpass. Lengthen A St. OC. Extend Bus/Carpool lane. This Project Alternative assumes completion of Project 2B. Structures work not required if Project 2A completed.	$5,200	$8,600	11 to 20	$50,000	$63,800	**$84,200**
Bus/Carpool Lane Projects⑤										
12		0.0/8.2	US 50 to I-80	Add Bus/Carpool lanes	$150,100	$76,500	100 +	$50,000+	$276,600	**$365,100**
Other Projects										
13		1.8	Sutter's Landing IC & Parkway	Construct a full interchange and 4-lane parkway from SR 160 to SR 51 (City of Sacramento Project)	$100,000	TBD	21 to 50	$35,000 +/- $15,000	$135,000	**$178,200**

① Cost Estimates include roadways, structures, right of way (ROW), and support costs (32%). Roadway costs include retaining and sound walls, and ramps. Structures costs include over and under crossings, separations, connections, bridges, and demolitions. For the Bus/Carpool Lane Project, ROW acquisition costs and the number of parcels impacted are based on ROW needs of 300 feet from the centerline to the north and south (600 total), and include commercial, residential, railroad, State, and other public lands. Actual costs and number of impacted parcels should be substantially less. ROW costs do not include utility conflicts and/or relocation costs, if any, but do include environmental permits and mitigation. For all projects, the average ROW cost from the cost range was used to determine the total cost. All costs are planning-level rough estimates and have been rounded. Actual costs may vary. More precise cost estimates will be determined at the projects' PID and PA&ED phases.

② A Project Initiation Document (PSR/PDS) is currently being prepared for Ramp Meters at Various Locations (EA 03-0F350) and include Projects 1A, 1B, 1C, and 1G. Ramp metering cost estimates do not include any potential structure and roadway costs.

③ It is assumed that the bridge structure will only be widened once to accommodate the ultimate 4-lane addition (2-Auxiliary/Transition and 2-Bus/Carpool) with standard shoulders. Roadway costs are for Transition lanes only. Additional roadway costs will be required for Bus/Carpool lane additions.

④ Structure work required for Projects 7 and 10 have been combined into Project 7, and Structure work required for Projects 8 and 9 have also been combined into Project 8 as it is assumed that overcrossings, separations, and demolitions cannot be completed for just the NB or SB direction only. The apparent high ROW costs for Project 11 are due to the need to reconstruct two railroad grades (geometry, ballast, track, signal equipment, and flagging around $8.6 million) and landfill acquisition.

⑤ Bus/Carpool lanes will be constructed in phases. Structure costs assume completion of Project 5 (Am. River bridge). Roadway costs include $16.2 million for retaining/sound walls. This cost can be reduced if coordinated with the retaining/sound walls required in the transition/auxiliary lane Projects 8, 9, and 10.

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E STREET TRANSITION LANE MODELING

The purpose of modeling the E St. to Am. River Bridge transition lane as an individual project was to evaluate and compare the two alternatives for the project: adding the transition lane and closing the E St. on-ramp or adding the transition lane with the on-ramp open. The modeled scenarios were as follows:

- 2020 Future Base (No Build)
- 2020 Future Base + Transition lane with E St. on-ramp open
- 2020 Future Base + Transition lane with E St. on-ramp closed

The study area for this analysis was NB SR 51 from the P St. on-ramp to the end of the proposed transition lane, the beginning of the Am. River Bridge, a distance of 1.8 miles. The Study area also included the P St., J St., and E St. on-ramps. The PM peak period (3:00 P.M. – 7:00 P.M.) was chosen as the analysis time period because the PM has much higher congestion in the study area than the AM peak period.

The models were developed using Paramics micro simulation software and produced several measures of effectiveness, including traffic volumes, average speeds, travel times, and delays. Figure 6 compares the total vehicle hours of delay (all vehicles) per day for each scenario. Figure 7 compares the vehicles hours of delay for each scenario based on facility type.

Figure 6: PM Total Delay Comparison

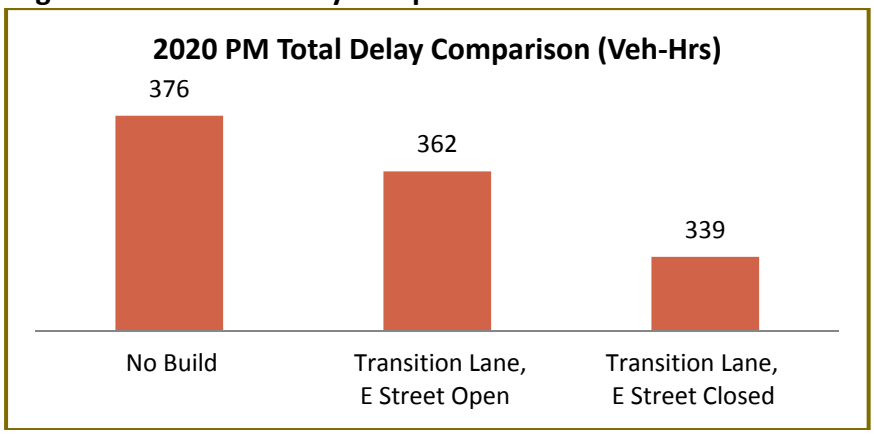
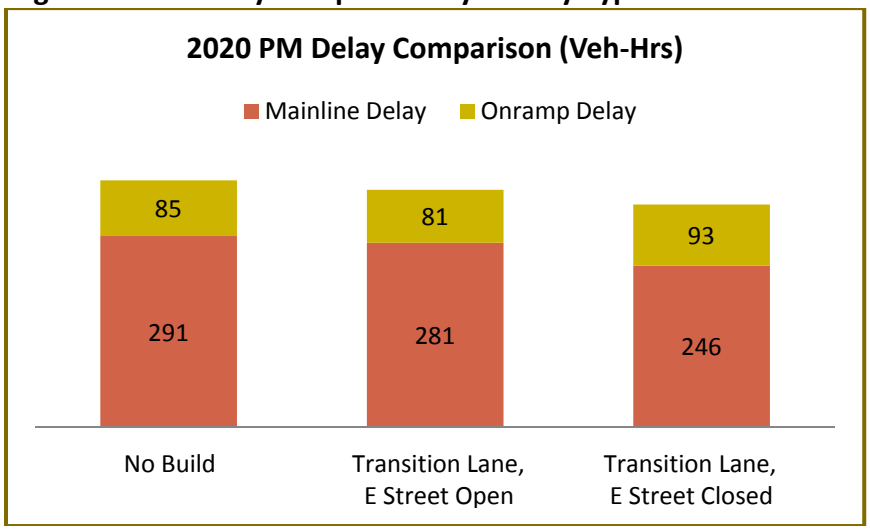


Figure 7: PM Delay Comparison by Facility Type

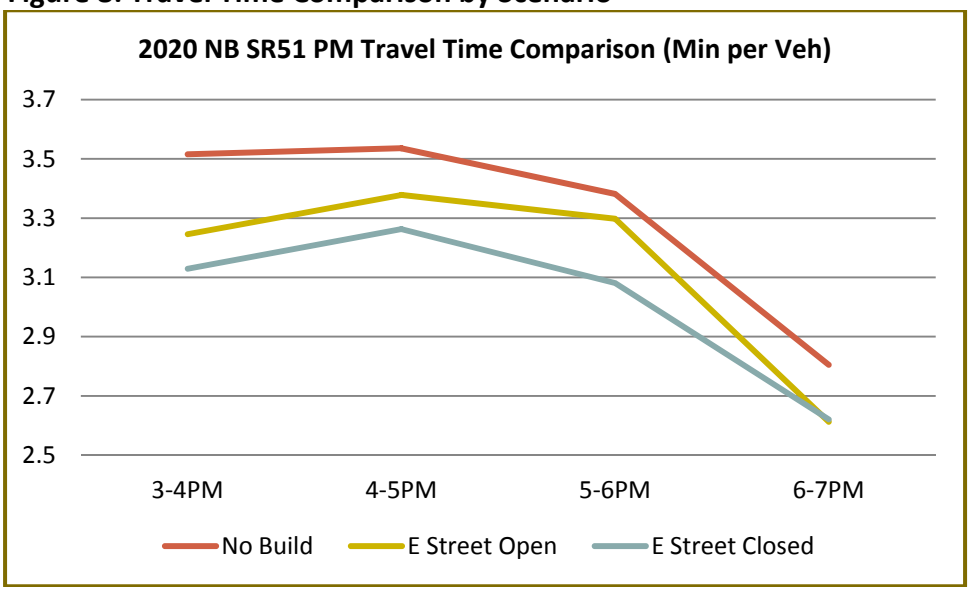


The addition of the transition lane reduced overall mainline delay for both scenarios. In comparison to the "No Build" scenario, the transition lane with the E St. on-ramp open reduced overall vehicle hours of delay by 4 percent (%). The transition lane eliminated the bottleneck upstream of the E St. on-ramp, which is caused by a lane drop from 4 to 3 lanes and merging from the J St. on-ramp. The project does create a new bottleneck at the Am. River Bridge where the transition lane ends, but the new bottleneck is not as intense as the existing bottleneck.

The transition lane with the E St. on-ramp closed reduces overall vehicle hours of delay by 10%. This scenario eliminates the same bottleneck as the E St. on-ramp open scenario plus removes the congestion caused by the merging from the E St. on-ramp. Vehicles flow with no congestion due to weaving or merging until the end of the transition lane. This scenario also creates a new bottleneck at the Am. River Bridge that is not as intense as the existing lane drop bottleneck. As expected, the elimination of the E St. onramp does increase the delay on the J St. on-ramp slightly; however because freeway access is reduced, the mainline delay reduction is more substantial than with E St. on-ramp open. Our initial modeling also indicates we would be able to meter traffic onto the freeway at a rate which prevents any queuing to the local street system and still maintain substantive mainline freeway benefits which exceed those with the E St. off-ramp remaining open.

Figure 8 compares the PM peak period travel times for all three alternatives on NB SR 51. The transition lane with the E Street on ramp closed decreases the travel time per vehicle more than the other two scenarios especially during the 5:00 P.M. – 6:00 P.M. peak hour. The peak hour travel time reduced by 3% with E St. open, which is less than the 9% reduction with E St. closed. Adding the transition lane and closing E St. provides more congestion relief and costs much less than leaving E St. open.

Figure 8: Travel Time Comparison by Scenario



BUS/CARPOOL LANE-TRANSITION LANE COMPARISON MODELING

This modeling study focused on the SR 51 corridor as a whole and the cumulative traffic impacts of the proposed projects. The *I-80/SR 51 CSMP* micro simulation models included base year, future year, and project specific future year scenarios and modeled the entire SR 51 corridor as well as its connections to I-80, SR 99, and US 50. The CSMP modeling effort had two additional future scenarios available for the I-80/SR 51 corridor, which were used to derive the performance measures in this report. Table 5 shows the proposed projects that were modeled.

Table 5: Projects Modeled

Project #	Post Miles	Location	Project Description
4A	1.4/2.6	E St. to the American River Bridge	Add NB Transition Lane with E Street on-ramp open.
4B	1.4/2.6	E St. to the American River Bridge	Add NB Transition Lane with E Street on-ramp closed.
5	2.6	American River Bridge	Widen to 4-lanes in each direction
6	2.6/3.1	American River Bridge to Exposition Bl.	Add NB transition lane.
7	3.1/3.7	NB Exposition Bl. to SR 160	Add NB transition lane and widen NB SR 160 SEP to 4-lanes.
8	5.5/7.6	Marconi Av. to Watt Av.	Add NB transition lane. Lengthen Marconi, Fulton & Watt Avs. OC. Reconstruct Howe & Bell Avs. Ramps. Lengthen SB on-ramp from Auburn Bl./Watt Av. ramp flyover ramp. Widen Arcade Creek Bridge to 4-lanes each direction
9	5.5/8.7	Watt Av. to Marconi Av.	Add SB transition lane. Lengthen Marconi, Fulton & Watt Avs. OC. Lengthen SB on-ramp from Auburn Bl./Watt Av. ramp flyover ramp
10	3.0/3.2	Exposition Bl.	Add auxiliary (aux) lane SB between ramps. Modify EB Exposition Bl. loop on-ramp.
11	1.4/3.1	Exposition Bl. to E St.	Add SB transition lane and lengthen B St underpass. Lengthen A St. overcrossing. Extend Bus/Carpool lane.
12	0.0/8.9	US 50 to I 80	Add Bus/Carpool lanes.

The study combined the proposed projects into the scenarios described below because only two future scenarios were available:

- 2020 Future Base plus key CSMP projects (No Build)
- 2020 No Build plus projects 4-11 (All Aux/Transition lanes)
- 2020 No Build plus project 12 (Bus/Carpool Lane)

The study area for this analysis was the entire SR 51 corridor (NB and SB) as well as all of the on and off ramps. The AM and PM peak period (6:00 – 10:00 A.M. and 3:00 – 7:00 P.M.) were used as the analysis time period. The models were developed using Paramics micro simulation software and produced several measures of effectiveness, including traffic volumes, average speeds, travel times, and delays. Figures 9 through 12 compare the mainline vehicle hours of delay for all three modeled alternatives for each peak period. On- and off-ramp delay stayed consistent for all three scenarios.

Figure 9: 2020 AM Delay - NB/SB

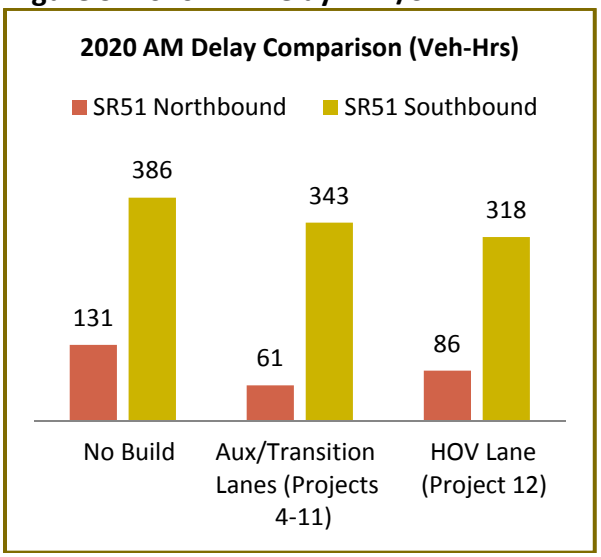


Figure 10: 2020 AM Delay - Combined

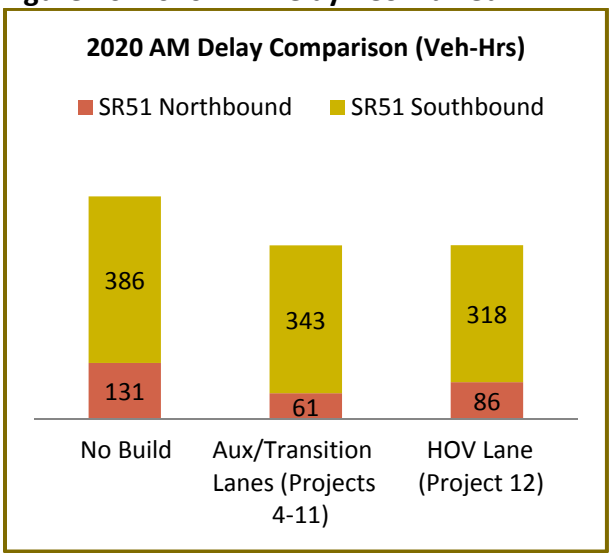


Figure 11: 2020 PM Delay – NB/SB

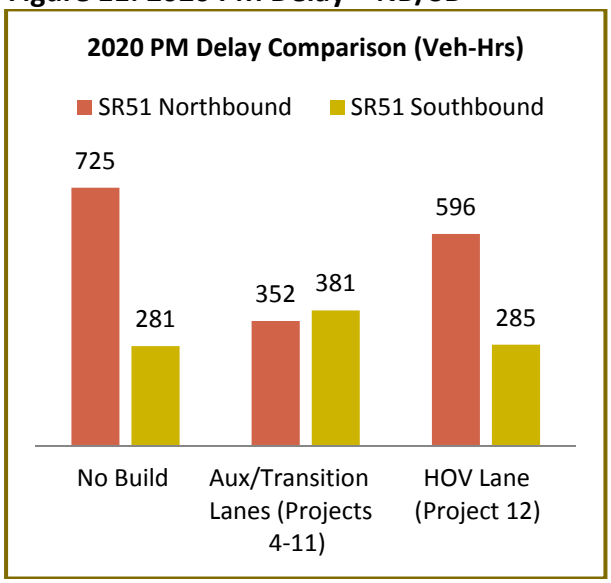
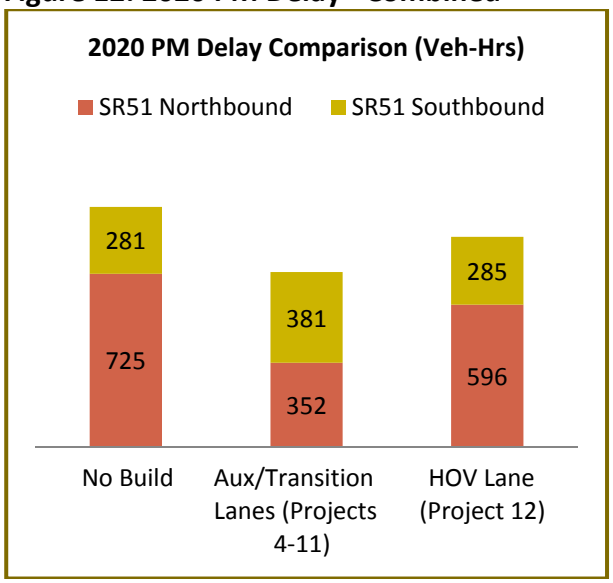


Figure 12: 2020 PM Delay - Combined



Overall delay was reduced significantly in most scenarios. For example, the NB PM delay reduced by 52% with the Aux/Transition lanes alternative and 18% with the Bus/Carpool lane alternative. SR 51 NB AM also saw major delay savings of 54% and 34% with the Aux/Transition lanes and Bus/Carpool lane alternative.

Delay in the SB AM on SR 51 decreased by 11% with the Aux/Transition lanes and 18% with the Bus/Carpool lane added to the network. Unexpectedly, the PM delay in the SB direction increased by 36% with the Aux/Transition

lanes alternative and 2% with the Bus/Carpool lane alternative. The increase in delay for SB SR 51 was due to additional congestion caused by weaving and merging between Marconi Av. and SR 160. Even though there was no specific mainline improvement, vehicles in the model approached this section from an additional lane and changed the lane distribution of vehicles. This created additional lane changes and weaving through the section. In addition to this preliminary analysis, further analysis is needed to determine the causality of the congestion and identify any potential improvements that would alleviate the potential congestion on this section of SR 51.

During the PM Peak Period, overall delay for both directions was reduced by 27% Aux/Transition lanes alternative and 12% in the Bus/Carpool lane alternative. During the AM Peak Period, overall delay for both directions was reduced by 22% in both alternatives. Figures 13 and 14 compare the PM travel times for all three alternatives on NB and SB SR 51.

Figure 13: 2020 Northbound PM Travel Time Comparison

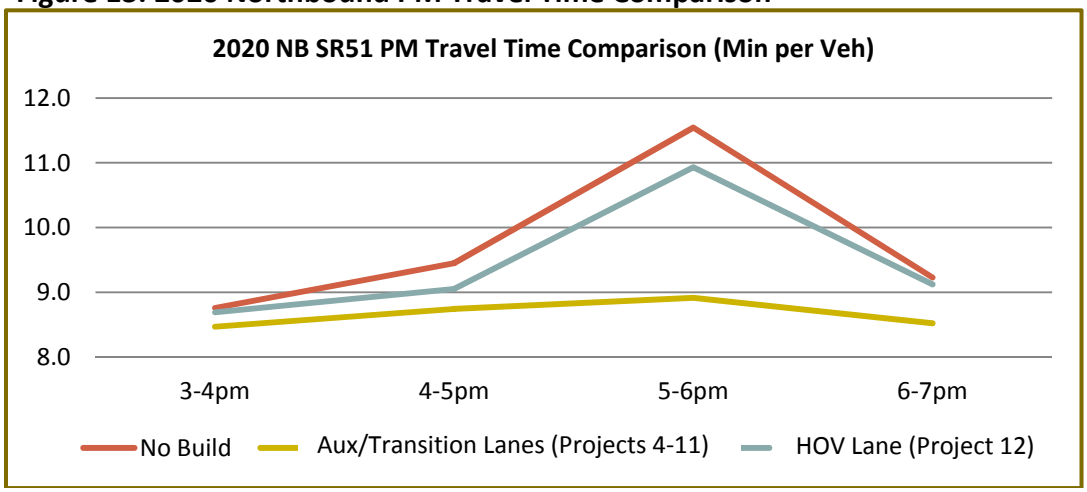
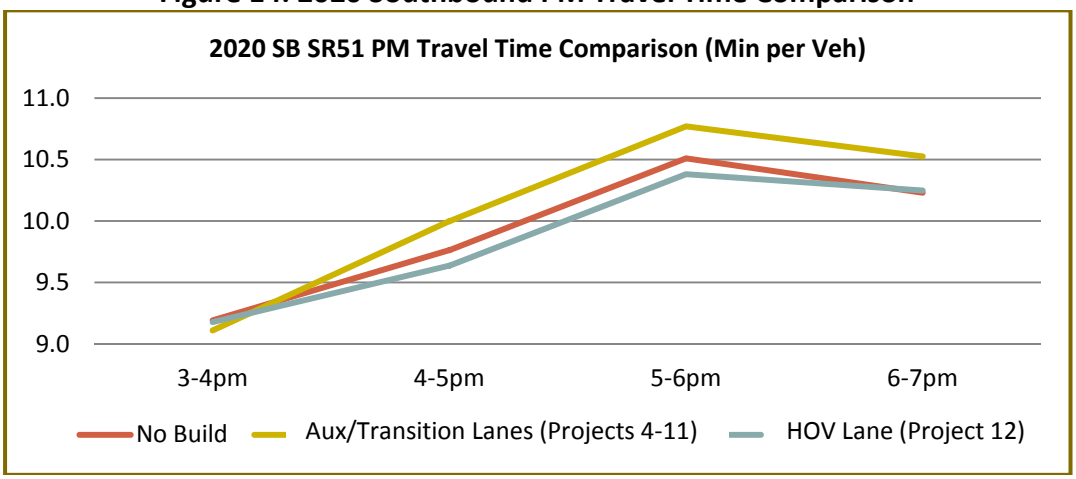


Figure 14: 2020 Southbound PM Travel Time Comparison



The NB PM peak hour travel time improved by 23% with the Aux/Transition lanes alternative and over 5% with the Bus/Carpool lane alternative. Because of the additional weaving and merging, the SB travel times increased by 2.5% with the Aux/Transition lanes alternative and decreased by 1% with the Bus/Carpool lane alternative. The AM scenarios saw travel time improvements in both SB and NB directions.

Both the Aux/Transition Lanes and Bus/Carpool Lane project scenarios provide significant congestion relief. However, since the Aux/transition lane alternatives are substantially lower in cost, they are prioritized higher than the Bus/Carpool lanes. Combining both the Aux/Transition lanes and the Bus/Carpool lanes offer significant cost-efficiencies, though, because widening the American River Bridge is assumed to only occur with the Aux/Transition Lanes and Bus/Carpool Lane combined project scenario.

CORRIDOR CHALLENGES

Improvements to SR 51 face a number of significant challenges associated with its constrained location and high traffic volumes. The lack of multiple American River crossings in the Sacramento urban core and limited parallel roadway capacity contribute toward high travel demand on SR 51. SR 51, along with I-5, SR 160, Jibboom St., J St., Watt Av., and Howe Av., is one of only a few vehicle crossings of the American River in the City of Sacramento. In addition, because the corridor passes through downtown Sacramento, there are several challenges to implement improvements, such as land use, financial, limited right-of-way (ROW), environmental and geometric constraints, and high construction costs.

LAND USE

There are several challenges along this corridor that stem from land use and environmental issues. In terms of land use, SR 51 traverses the eastern boundary of downtown Sacramento with its high and medium density residential, commercial, and industrial uses. There are also large trip generators along the corridor, namely retail shopping in Arden, the State Fair site at Cal Expo, and more commercial, retail, and housing to its connection with I-80, which provides interstate travel opportunities. Land use adjacent to SR 51 is built out with the exception of the State-owned Cal Expo property and 48 acres of property located near Sutter's Landing Park on the southeast side of SR 51. Numerous development proposals for this Sutter's Landing property have been submitted to the City of Sacramento over the years ranging from a 397 dwelling units project to a mixed-use project with 1.0 million square feet (sq. ft.) of office space, over 400,000 sq. ft. of retail/restaurant space, a 350 room hotel, and 900 dwelling units. The most current proposal includes solar panels to be constructed on the site. Several proposals have been made for the Cal Expo property, such as an arena for the local professional basketball team. Such a large trip generator would pose several challenges for the corridor. Any large proposal would create another large trip generator.

FINANCIAL AND ROW

It is anticipated that several funding sources will be needed to support the needed improvements to SR51, including Congestion Mitigation and Air Quality Improvement (CMAQ), Regional Surface Transportation Program (RSTP), developer fees, and other local and regional transportation dollars. Funding these projects will most likely require phasing or incremental improvements to the facility due to funding limitations.

In part, these financial constraints stem from the ROW challenges on the corridor. The facility is surrounded almost in its entirety by developed private lands with high land values. The high land costs and potential disruption in those communities would pose several challenges to any facility expansion project.

A creative solution to the financial and ROW problems for one of the key projects has already been proposed. This is the proposed E St. on-ramp closure. At this location, there is not sufficient ROW for an auxiliary/transition lane, and purchasing new ROW would be prohibitively expensive. Further, widening would require the expansion and reconstruction of the A St., B St., and Elvas St. crossing, which would be very costly. Instead, this PI has analyzed

the closure of the E St. on-ramp. The ROW from the acceleration lane would be used for the auxiliary/transition lane. It would not require the reconstruction of the crossings, thus saving significant funds. This, however, would require design exceptions for 11 foot wide lanes under the structures. Also, this would impact two SacRT bus routes that use this on-ramp. This closure would require SacRT to re-route busses to the J St. on-ramp. Caltrans will continue to explore this option with the City of Sacramento and SacRT.

NEXT STEPS

The projects identified in the SR 51 PI will take many years to implement and will require several different funding sources to bring to fruition. Caltrans will continue to work with its local and regional partners to plan, program, and construct individual projects and segments as upcoming transportation funding opportunities become available.

In addition, Caltrans will continue to remain engaged with the City of Sacramento as developments are proposed which may impact SR 51. This will allow Caltrans, the City, and the applicant developer to review, analyze, and coordinate the mitigation of direct and cumulative significant impacts to SR51 relating to the specific land use proposal and, as appropriate and indicated by an objective nexus study, provide for developer contributions for the needed improvements to SR 51. It is hoped that this PI can be used to streamline that process.

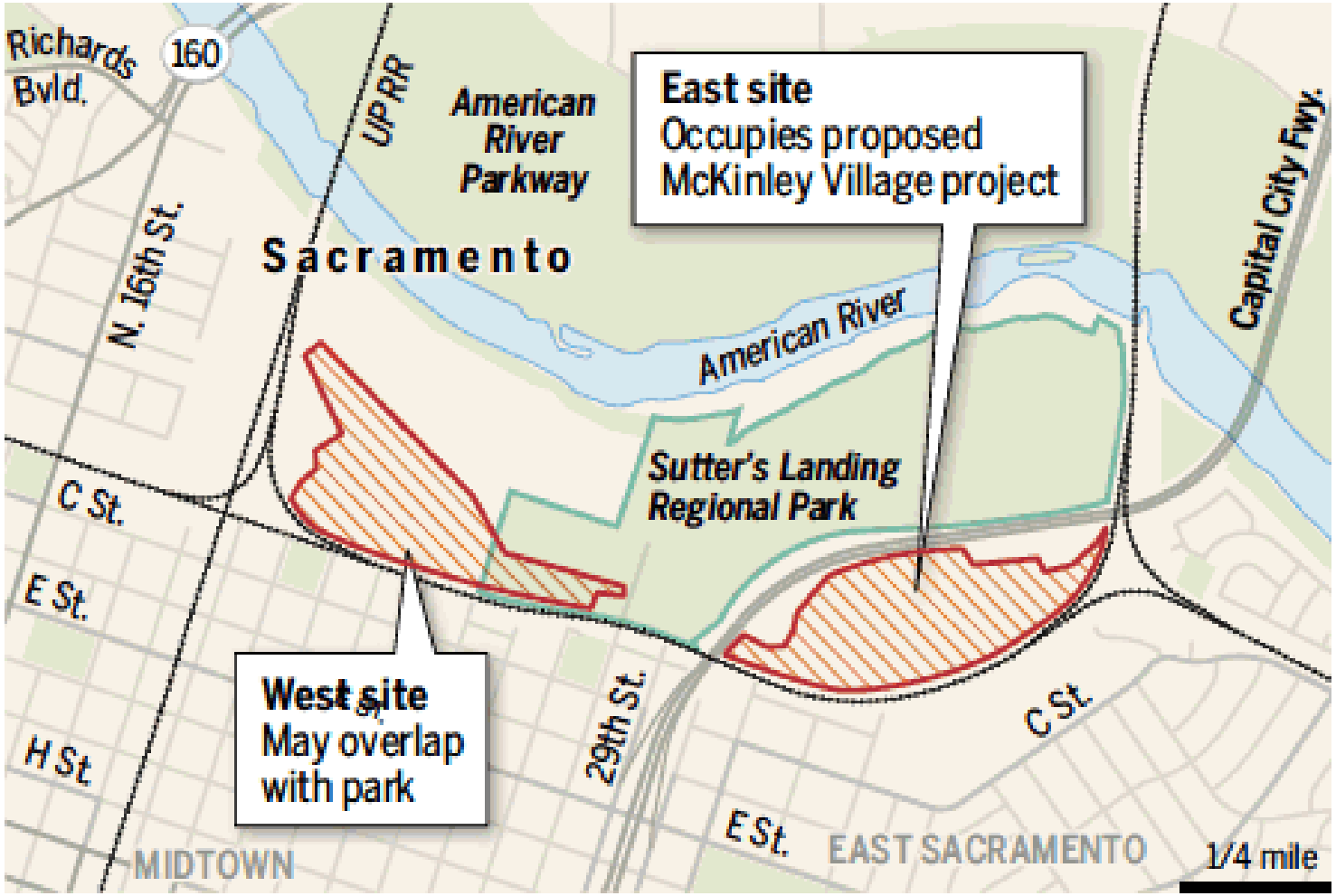
Prior to programming and constructing the proposed improvement projects, a Project Initiation Document (PID) must be prepared for each project or group of projects to identify the purpose and need, scope, cost, and schedule. As an initial step, Caltrans will begin to include the highest priority projects into the Three-Year PID Work Plan. This allows resources to be allocated for PID development and to compete for funding. Projects identified in this SR 51 PI that are included in the Fiscal Year 2012/13 Non SHOPP Three-Year PID Work Program include many of the Ramp Metering Projects (Project 1), the E St. to the Am. River Bridge NB Transition Lane Project (Project 4A/4B), the Am. River Bridge Widening Project (Projects 5), the Am. River Bridge to Exposition Bl. NB Transition Lane Project (Project 6), the Exposition Bl. to SR 160 NB Transition Lane and widening the NB SR 160 Separator Project (Project 7), and the Marconi Av. to Watt Av. NB Transition Lane Project (Project 8). Caltrans will add the remaining SR 51 projects in future PID Work Programs. The planned completion dates of the aforementioned PIDs range from June 30, 2013 to June 30, 2016, though contingent on available PID resources.

It is likely that Caltrans will propose funding for the first phase project development (Project Approval and Environmental Document – "PAED") for the northbound extension of the transition lane from E Street to the American River Bridge through the next SACOG programming cycle in 2013. During this process, a substantive public and stakeholder outreach dialogue would occur regarding the project and, specifically, the alternative which includes closing the E St. on-ramp. Also, more detailed micro simulation modeling would be performed to assess the impacts to the J St. interchange and the surrounding local street network. Consideration should also be given to an innovative project funding strategy which would allow for the programming of full project funding during the upcoming SACOG programming cycle to ensure the timely completion of final project design and construction immediately following the PAED phase based on the selected alternative.

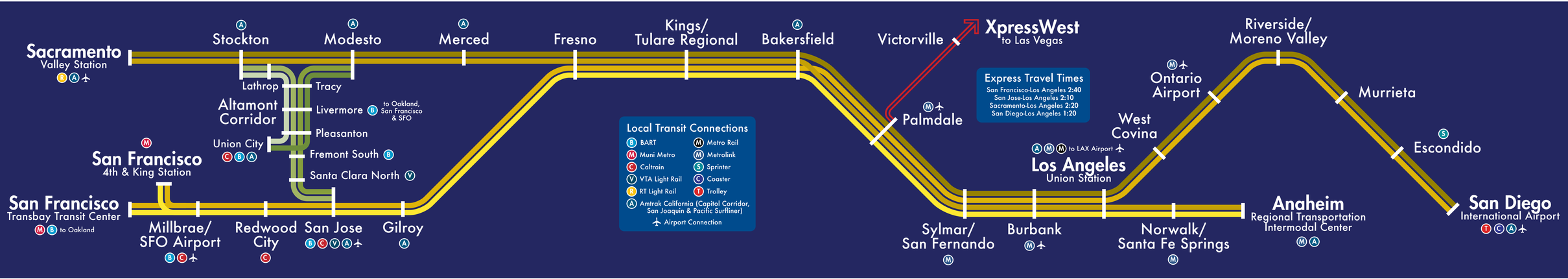
POTENTIAL SITES FOR NEW RAILYARD

Caltrans planners are considering two sites in central Sacramento for a major new railyard and maintenance facility to service Amtrak trains.

Nathaniel Levine
nlevine@sacbee.com



CALIFORNIA High-Speed Rail



This diagram shows the complete CAHSR system as currently planned, with stations assumed where locations have not yet been finalized. The system will be built in phases, starting with an initial operating segment between Merced and the San Fernando Valley. Northern California semi-high-speed rail (Altamont Corridor) alignments and station locations have not been finalized, and some transit connections remain in planning stages. For more information, see cahighspeedrail.ca.gov. Map copyright © 2008-2012, Steve Boland, sfcityscape.com.

1/10/2014 VIA EMAIL

Evan Compton, Associate Planner
City of Sacramento
Community Development Department
300 Richards Blvd, 3rd Floor
Sacramento, CA 95814

RE: McKinley Village (P08-086)

Dear Mr. Compton:

WALKSacramento has reviewed the December 2013 revised drawings for McKinley Village. Thank you for the opportunity to provide the following comments on the project design.

We observed in a previous letter that while the McKinley Village project is infill, it will have a mix of infill and edge-of-city qualities. Therefore, enhancing connectivity and mobility for pedestrians is especially important. Because the project site is inside a nearly continuous barrier created by the freeway and railroad tracks, external connectivity and internal mobility are critical to encouraging walk trips.

External connectivity has been improved with the revisions to the trail on each side of the tunnel under the UPPR tracks. On the Alhambra Boulevard side, the trailhead has been widened and split to reduce directional travel conflicts. On the McKinley Village side, the trail has been straightened to provide a safer environment with better line-of-sight and "eyes-on-the-trail."

The internal mobility has a good foundation provided by the street grid and traffic calming features. To improve the walkability of the project site, we offer the following comments.

Traffic Calming Exhibit:

1. Wherever possible, place chokers directly across the street from corner curb extensions at the following intersections: Street 1 at Street 2, Street 3, Street 6 and Street 9, A Street at Street 3 (west of park), Street 3 (east of park), Street 9, 40th Street and Street 8, and Street 8 at Street 2, Street 4 and Street 6.

Placing chokers across from curb extensions will provide two additional benefits beyond traffic calming. One, it will provide street crossing paths for pedestrians that are orthogonal to the street, and two, it will prevent parking in the crosswalk.

Regardless of whether crosswalks have curb extensions at some or all endpoints, curb ramps should be installed at all T-intersections to provide access for all pedestrians at logical crossings.

2. Add curb extensions on A Street at west side of Street 2 and east side of Street 6.

A Street to the west of Street 2 and to the east of Street 6 is six feet wider than A Street on the block east of Street 2 and the block west of Street 6. The wide street on one side of each of the intersections could reduce the effectiveness of the traffic circle. We recommend adding curb extensions to the corners of the wider segment of A Street to provide an intersection with similar travel lane widths on both sides.

Tentative Subdivision Map

3. The "Bike/Ped. Tunnel" detail still shows 12'x12' but other exhibits indicate the tunnel is a 25'-diameter half round.

Floor Plans

5. Add additional floor plans with "eyes on the street" to the A Street "Park Homes" facing Central Park and Recreation Center.

The floor plans for the "Park Homes" do not have any "active" space at the front of the houses. By "active" space, we mean space that is used by all of the family or residents during many times of the day. Kitchens and family rooms provide such active space.

Three of the four plans for the "Village Homes" have a study/bedroom and external door on the first floor at the front of the house; the fourth plan doesn't have the option for a bedroom in place of the study.

We recommend adding one or two floor plans with a kitchen or family room at the front of the house to provide "eyes on the street" that could occur at any time of the day.

WALKSacramento is working to support increased physical activity such as walking and bicycling in local neighborhoods as well as helping to create community environments that support walking and bicycling. The benefits include improved physical fitness, less motor vehicle traffic congestion, better air quality, and a stronger sense of cohesion and safety in local neighborhoods.

Thank you for your consideration of these comments and recommendations. If you have questions or need additional information, please contact me at (916) 446-9255.

Sincerely,

Chris Holm
Project Analyst

Enclosure: Development Checklist for Biking and Walking

DEVELOPMENT CHECKLIST for BIKING and WALKING

Prepared by WALKSacramento and SABA (Sacramento Area Bicycle Advocates)
September 2012

This checklist is provided to give an indication of design, engineering, and policy elements that we consider when reviewing development projects.

POLICIES

- Walking and biking is a priority
- Adopted a policy to develop a full multi-modal and ADA accessible transportation system

Project Review and Comment

POLICY CONSIDERATIONS

- Pedestrian Master Plan
- Bicycle Master Plan
- Regional Blueprint
- Regional Blueprint Consistent General Plans
- Adopted Climate Action Plans
- Subdivision ordinances to support pedestrian and bicycle access and safety
- Zoning ordinance to support pedestrian and bicycle access and safety

ENGINEERING

- SIDEWALKS & BIKELANES ON BOTH SIDES OF MAJOR ROADWAYS
  - Pedestrian Level of Service “C” or better on arterials
  - Bicycle Level of Service “C” or better on arterials
- SAFE CROSSINGS FOR PEDESTRIANS
  - every 300-600 feet on major arterials
  - well lit, marked crosswalks
  - audible signals & count-down signals
  - median refuge islands
- SPEED MANAGEMENT
  - Speed limits based on safety of pedestrians and bicyclists
  - Implement “road diets” where there is excess lane capacity
- STREET DESIGN STANDARDS
  - Maximize pedestrian and bicyclist safety
  - Sidewalks buffered by trees and landscaping on major arterials
  - Vertical curbs
  - 5’ minimum sidewalk widths, 8’ in front of schools
  - 6’ minimum bike lanes on busy streets

- INTERSECTIONS
  - Median refuge islands for pedestrians
  - Signal timing to enable safe passage
  - Signal detection for bicyclists
  - Crossings on all 4 legs of intersections

- ELIMINATE BARRIERS
  - Freeway, railroad, river and creek crossings
  - Obstructions in sidewalks and bike lanes

NEW DEVELOPMENT – REQUIRE

- Walking & bicycling circulation plans for all new development
- Direct and convenient connections to activity centers, including schools, stores, parks, transit
- Mixed uses and other transit supporting uses within ¼ mile of light rail stations or bus stops with frequent service
- Minimum width streets
- Maximum block length of 400'
- 4-lane maximum for arterials; Recommend 2 lanes wherever possible

NEW DEVELOPMENT – DISCOURAGE

- Cul-de-sacs (unless it includes bike/ped connections)
- Gated and/or walled communities
- Meandering sidewalks
- Inappropriate uses near transit (gas stations, drive-thru restaurants, mini storage and other auto dependent uses)

BUILDINGS – REQUIRE

- Direct access for pedestrians from the street
- Attractive and convenient stairways
- Bicycle parking – long & short term
- Shower & clothing lockers

OLDER NEIGHBORHOODS

- Improve street crossings
- Reduce speeds
- Provide new connections
- Create short cuts for walkers and bicyclists by purchase of properties or other means
- Provide sidewalks on both sides of major streets

Policy Review and Comment

ENFORCEMENT & MAINTENANCE

- Enforce speed limits
- Enforce crosswalk rules – conduct crosswalk sting operations
- Enforce restrictions against parking on sidewalks
- Enforce bicycle rules including riding with traffic, lights at night, stopping at red lights
- Implement CVC 267 setting speed limits based on pedestrian and bicyclist safety
- Sweep streets and fix hazards
- Repair and replace broken sidewalks

EDUCATION

- Train staff on pedestrian and bicycle facility design.
- Train development community about pedestrian and bicycle planning and safety issues
- Bicycle skills training

FUNDING

- Include pedestrian and bicycle facilities in capital improvement programs
- Include pedestrian and bicycle facilities as a part of roadway widening and improvement projects
- Support Measure A pedestrian and bicycle facility allocation
- Set priorities based on safety and latent demand
- SACOG Community Design grants & Bike/Ped grants
- California Bicycle transportation Account
- Safe Routes to School

www.walksacramento.org
Teri Duarte, Executive Director
WALKSacramento
909 12th Street, Suite 122
Sacramento, CA 95814
(916) 446-9255
tduarte@walksacramento.org

www.sacbike.org
Tricia Hedahl, Executive Director
Sacramento Area Bicycle Advocates
909 12th Street, Suite 116
Sacramento, CA 95814
(916) 444-6600
tricia@sacbike.org

From:	LINDA CARPENTER
To:	Dana Allen
Cc:	Evan Compton; Steve Cohn
Subject:	McKinley Village proposal comment
Date:	Friday, January 10, 2014 2:29:51 PM

The McKinley Park area is one of Sacramento's loveliest neighborhoods. We have lived here since 1981 and raised our family here. We support infill development and have witnessed proposals beginning with Centrage in the late 80's and culminating with the current McKinley Village project. Our concerns revolve around the impact of additional traffic on our quiet neighborhood streets.

<!--[if !supportLineBreakNewLine]-->
<!--[endif]-->
According to the McKinley Village EIR Report and the staff report issued for the Oct.24, 2013 meeting;

-[if !supportLists]-->• * <!--[endif]-->The 40th Street access route into the development will result in traffic congestion not only on the C St./Elvas route, but throughout our neighborhoods as commuters try to avoid the busiest streets. Westbound traffic will certainly use 39th, 35th, and 33rd streets to reach McKinley Blvd in addition to 40th St.and Alhambra Blvd.

-[if !supportLists]-->• *<!--[endif]-->Two intersections close to the 40th St. access; 40th St/36th Way and San Antonio/36th Way, are not stop controlled (EIR 4.9-10). Two others; Meister Way/36th Way and Tivoli Way/36th Way are two-way stop controlled, which will result in commute time traffic back-ups as cars flood out to access McKinley Blvd.

-[if !supportLists]-->• * <!--[endif]-->McKinley Village developers stress the importance of alternative transportation options, and yet just west of Lanatt St. (close to the 40th St. development access route) the two lanes of east-bound C St. widen to four lanes for about 2,000 ft. and for that distance the bicycle lanes end. (EIR 4.9-9, refer also to Figure 4.9-4/Existing Bicycle Facilities, which indicates an intact bike path)

-[if !supportLists]-->• *<!--[endif]-->Also, the bike/pedestrian undercrossing at the north end of Alhambra Blvd. will be constructed only if approved by UPRR (EIR 4.9-3). If it is not approved, access to public transit and bike lanes will be seriously reduced, resulting in a more car-centric development. This railroad levee also provides secondary flood protection to our neighborhood.

-[if !supportLists]-->• *<!--[endif]-->Developers indicate easy access to Hwy. 50 via Elvas Ave and 65th St. The transportation and circulation portion of the EIR did not analyze this route. Morning traffic is particularly heavy along Elvas Ave. as St. Francis High School uses it as their main entrance and exit.

Thank you for considering our concerns;

David Carpenter
Linda Carpenter

From:	margaret buss
To:	vito gromo
Cc:	clara smith; Steve Cohn; Paul Harriman; DAMJANOVIC Martha; Laurie Litman; BUSS Margaret; Sue Brown; Evan Compton; ILee Muller; Dale Kooyman; Marion Millin; Steve Hansen; Paul Tsamtsis; mhvaline@gmail.com; smdtyler@aol.com; Karen Jacques; Burgua William; Dana Allen; Alan Parker; Peter Fenolio; Winger Robert; Ed Trujillo; Anne Romo; berdany@aol.com; Vickie Valine; Rhee, Foon; Consuelo Hernandez; Jameson Parker
Subject:	Re: McKinley Village Proposal Response January 9, 2014
Date:	Friday, January 10, 2014 8:52:01 AM

Nice research job, Vito

On Jan 9, 2014 11:36 PM, "vitosgromo" <vsgromo11@comcast.net> wrote:

> January 9, 2014
>
> Dana L. Allen, Associate Planner
>
> Environmental Planning Services
>
> Community Development Department
>
> City of Sacramento
>
> 300 Richards Blvd., 3rd Floor
>
> Sacramento, CA 95811
>
> McKinley Village Proposal Response PO8-086
>
> I am resubmitting my July 7, 2013, see below and attached, response with amendments.
>
> Amendments:
>
> 1. Traffic Study.
>
> Study Flaws: The traffic study completed for the McKinley Village project has failed to consider several major urban planning and traffic models that are critical to determine accurate automobile traffic volumes.

Pass-By Traffic

According to the Institute of Transportation Engineers two major considerations for any traffic study that includes new access roads between two established city sections should include, “pass-by” traffic. New developments such as the McKinley Village Project will create a new artery of traffic between the central city and East Sacramento, River Commons and eastern sections of the city of Sacramento, This will have a **20% to 25 %** of increase of traffic above the increases created by daily trips of residents within the housing developments of McKinley Village.

Future Growth

According to the Urban Planning Institute, The Institute of Transportation Engineers and American Association of State Highway and Transportation Officials Guidelines, all new development traffic studies must include calculations for future growth of the proposed new development and the surrounding jurisdictions. According to the existing City of Sacramento General Plan, the Central City current population will grown from approximately 48,000 to 135,000 by 2013. This will be caused mainly by the UP Central City Railyard Infill Project. Also increased east west traffic will also be the result of the Arena Entertainment District. Access to these two major developments will require utilization of the roads that are now planned to connect the McKinley Village project with Midtown and East Sacramento. The traffic study failed to calculate this major impact that can also increase traffic by **20% to 30 %.**

Due to these two major flaws the traffic study has grossly underestimated the full impact of the McKinley Village traffic on the nearby residential streets zoned for only local traffic volumes. If these two factors are used to augment the projected traffic volumes from the completed McKinley Village traffic study then the volume of traffic will exceed the capacity of the locally zoned residential streets.

Recommendation:

River West Investments should re-design the access points into their proposed housing developments to connect with city streets designated as collectors or artilleries such as ELvas Boulevard through Lanett and to Alhambra Boulevard.

Vito Sgromo

Cell 916 719-1477

I am writing to respond to the proposal by River West Investments to build 325 homes at the Assessor's Parcel Number 001-0170-028.The project site is bounded on the south and east by the elevated portion of the UPRR tracks and on the north and west by the Capitol City Freeway.

If approved as proposed, this project has major negative impacts to several regional development projects and future area transportation expansions.

1. Sutter Landing Parkway (Richards Boulevard Connector).

The General Plan (http://www.sacgp.org/index.html) has identified the future development of a parkway road, Sutter Landing Parkway (Richards Boulevard Connector) as a road that must be built to connect the I50 Highway to the Sutter Landing Regional Park, Route 160, to the major Railyard Central City Development and the new proposed arena and surrounding Downtown entertainment district. The Sutter Landing parkway is critical to the development of a regional park, the largest urban infill project in the West Coast and the new arena.

Negative Impact: McKinley Village Proposal would if approved would eliminate the Sutter Landing Parkway by abandoning the ELvas Roadway and Lanett route and eliminating the needed land inside the proposed McKinley Village Proposal.

Recommendation: River West Investments must alter their plans by allow enough land for the future Sutter Landing Parkway and abandon the 40th Street underpass and use Lanett Street as the underpass to connect to Elvas Boulevard Road.

2. Union Pacific Railroad Expansion

UP is planning additional train lines (see attached reports, Sacramento Roseville

3rd Track and CAL HSR).

Negative Impacts: River West Investments must set aside sufficient land to allow UP to expand. Also these additional train lines and the train traffic will eliminate the use of 28th Street as an access point for the McKinley Village Housing Proposal.

Recommendation: River West Investments must set aside sufficient land to ensure UP can add the additional tracks. Also River West Investments must designate 28th Street as a bike and pedestrian access since in the near future it will no longer be available for automobile traffic and enlarge the opening at Alhambra for 2 way auto traffic.

3. Caltrans I80 Expansion

Caltrans is planning a future expansion of the I 80 Highway that borders the McKinley Village Project (See attachment SR 51 PL Final 01-08-13). This should include on and off ramps to connect to the Sutter Park Landing Parkway.

Negative Impacts: River West Investments has not allowed sufficient land to allow Caltrans to expand I80 thereby improving a bottleneck highway, reducing pollution and connecting with the Sutter Landing Parkway.

Recommendation: River West Investments has to redesign its housing proposal to allow sufficient land for the Caltrans expansion and the addition of an on and off ramps to connect to the Sutter Landing Parkway.

4. Traffic Impacts to Local Streets

River West Investments is funding a traffic study on the impacts of their proposal to access 28th and 40th Streets for automobile access to the McKinley Village housing project. According to the General Plan (http://www.sacgp.org/index.html) both streets are designated as local streets.

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Caltrans is currently examining the use of the land River West Investments has proposed for their housing project for a major new railyard and maintenance facility for Amtrak trains. Caltrans needs to build a new maintenance facility for Amtrak's Capital Corridor and San Joaquin Corridor trains (See attached Sacramento Bee Article, Friday July 5, 2013)

Negative Impacts: River West Investments if approved would have a very serious impact to the expansion of train transportation in Northern and Central California.

Recommendation: Place a temporary hold on any approval for the River West Investments McKinley Village Proposal until City and State officials determine the final location of the Capitol Railyard.

Conclusion

McKinley Village proposal if approved in its current design would negatively impact several major transportation and development plans including the development of the UP Central City Railyard Infill Project and Arena Entertainment District that are larger in scale than the McKinley Village Project and have not only city but regional impacts.

For the greater good of the city of Sacramento and Northern California I suggest that McKinley Village Project be placed on hold until the new Capitol Railyard location is finalized. Also if the McKinley Village Project is still planned for the current suggested site it must alter its design to allow sufficient land for transportation rail and road expansions and relocation of automobile access to Alhambra Boulevard and Lanett Streets that are designated to handle the increased traffic.

Let me know if you have any questions or if you need further information.

Thank you.

Vito Sgromo

Cell 916 719-1477

From:	Robert Winger
To:	Dana Allen; "vitosgromo"; Evan Compton; Steve Cohn; Sue Brown; "Jameson Parker"; Peter Fenolio; ILee Muller; Anne Romo; Consuelo Hernandez; Steve Hansen
Cc:	"Alan Parker"; "Dale Kooyman"; "Vickie Valine"; mhvaline@gmail.com; "Burgua William"; "Karen Jacques"; "Smith Clara"; smdtyler@aol.com; berdany@aol.com; "BUSS Margaret"; "Smith Clara"; "Ed Trujillo"; Anne Romo; "DAMJANOVIC Martha"; "Rhee, Foon"; "Paul Harriman"; "Laurie Litman"; "Paul Tsamtsis"; "Marion Millin"
Subject:	RE: McKinley Village Proposal Response January 9, 2014
Date:	Friday, January 10, 2014 2:06:19 PM

Dana Allen

I agree with what Vito Sgromo statement. I am also a property manager in the midtown and east Sacramento area. I also own a house on 232 40h Street which I will be moving into next year. This will hurt a great area. It is a wonderful place to live now.

Thanks Robert Winger (916)446-6663

From: Dana Allen [mailto:DAllen@cityofsacramento.org]
Sent: Friday, January 10, 2014 9:11 AM
To: vitosgromo; Evan Compton; Steve Cohn; Sue Brown; 'Jameson Parker'; Peter Fenolio; ILee Muller; Anne Romo; Consuelo Hernandez; Steve Hansen
Cc: 'Alan Parker'; 'Dale Kooyman'; 'Vickie Valine'; mhvaline@gmail.com; 'Burgua William'; 'Karen Jacques'; 'Smith Clara'; smdtyler@aol.com; berdany@aol.com; 'BUSS Margaret'; 'Smith Clara'; 'Ed Trujillo'; Anne Romo; 'DAMJANOVIC Martha'; 'Rhee, Foon'; 'Paul Harriman'; 'Laurie Litman'; 'Paul Tsamtsis'; 'Winger Robert'; 'Marion Millin'
Subject: RE: McKinley Village Proposal Response January 9, 2014

Thank you for your comments Vito

Dana

From: vitosgromo [mailto:vsgromo11@comcast.net]
Sent: Thursday, January 09, 2014 11:36 PM
To: Dana Allen; Evan Compton; Steve Cohn; Sue Brown; 'Jameson Parker'; Peter Fenolio; ILee Muller; Anne Romo; Consuelo Hernandez; Steve Hansen
Cc: 'Alan Parker'; 'Dale Kooyman'; 'Vickie Valine'; mhvaline@gmail.com; 'Burgua William'; 'Karen Jacques'; 'Smith Clara'; smdtyler@aol.com; berdany@aol.com; 'BUSS Margaret'; 'Smith Clara'; 'Ed Trujillo'; Anne Romo; 'DAMJANOVIC Martha'; 'Rhee, Foon'; 'Paul Harriman'; 'Laurie Litman'; 'Paul Tsamtsis'; 'Winger Robert'; 'Marion Millin'
Subject: McKinley Village Proposal Response January 9, 2014
Importance: High

January 9, 2014

Dana L. Allen, Associate Planner
Environmental Planning Services
Community Development Department
City of Sacramento
300 Richards Blvd., 3rd Floor

Sacramento, CA 95811

McKinley Village Proposal Response PO8-086

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Amendments:

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Cell 916 719-1477

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Thank you.

Vito Sgromo

Cell 916 719-1477

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Version: 2014.0.4259 / Virus Database: 3658/6990 - Release Date: 01/09/14

MARSHALL SCHOOL/NEW ERA PARK NEIGHBORHOOD ASSOCIATION

P. O. Box 162271
Sacramento, CA 95819
916-919-6656
marshall.newera@gmail.com

January 24, 2014

VIA EMAIL

Evan Compton
Associate Planner
City of Sacramento
Community Development Department
300 Richards Boulevard, 3rd Floor
Sacramento, CA 95811

Re: McKinley Village – File No P08-86

Dear Mr. Compton:

Please find the attached comments to the Planning Unit Development Guidelines for McKinley Village. Overall, the document is a major disappointment and offers the community no assurances that Mr. Angelides and *The New Home Company* plan to actually build homes of architectural distinction at McKinley Village. Simply put there is very little declarative language regarding the architectural guidelines for the homes. The word **"may"** is littered throughout the document when the words **"shall"** or **"will"** should be used instead.

In the last decade we have seen fortunes rise and fall with regard to the housing market. Home builders and developers have gone out of business or sold their land holdings to survive the storm. It is not beyond the realm of possibilities that Mr. Angelides could sell McKinley Village if the entitlements are granted. The Planned Unit Development Guidelines, as written, offer the community no assurances that the builder will even use "high quality" materials to build the houses.

I urge a careful and comprehensive review of the Planned Unit Development Guidelines and the word **"may"** be replaced with the words **"shall"** or **"will"** to assure the community we will not be left to live with over 328 stucco boxes adjacent to heritage neighborhoods such as Midtown or East Sacramento.

Very truly yours,

Julie A. Murphy
Co-Chair

jam
Enclosures

Marshall School/New Era Park N.A.
Comments to the Planned Unit Development Guidelines and Planning Application

McKinley Village | Draft PUD Guidelines	Comments and Suggested Revisions
These guidelines shall be applied to all development within the project to ensure that McKinley Village develops as a cohesive community. The Guidelines, once approved, are binding on the project, and shall be implemented consistent with the provisions set forth in the City's Municipal Code.	These guidelines will be binding upon whoever eventually develops this project. The real estate market is still recovering and fortunes change. There is no guarantee that Mr. Angelides and his development team will complete the project. The community must have assurances that this subdivision will reflect the architectural diversity of Midtown and East Sacramento. As written, these design guidelines fail to protect the architectural legacies of heritage neighborhoods such as Midtown and East Sacramento.
1.2 Community Master Plan Mixing the varying single-family lot sizes and housing types encourages a diverse community, allowing for a range of housing opportunities and lifestyle options within the neighborhood.	This project consists of 328 two-story homes which is not reflective of the architectural diversity in the community. With an aging population seeking smaller, one-story houses, this project provides no appealing options. With housing priced between $300,000 and $700,000, this project fails to provide affordable housing options. The median income for a family of 4 in Sacramento County is $76,100 as per the 2010 U.S. Census. This project does nothing to improve the stock of affordable housing in the City of Sacramento.
1.2.1. Vision and Objectives Stimulate alternative transportation use; Provide convenient access to surrounding amenities like the Sutter's Landing Park, and McKinley Park, the American River Parkway, and downtown Sacramento;	This project current offers no transit access to the project and the proposed bike tunnel, at Alhambra Blvd., is not scheduled until Phase 3. The applicant should work with Regional Transit to create a shuttle that will connect McKinley Village residents with employment centers such as Mercy Hospital, Sutter Hospital, and the 29th Street Light Rail station to connect residents with Central Business District employees.

McKinley Village | Draft PUD Guidelines	Comments and Suggested Revisions
	The construction of the bike tunnel should be constructed during Phase 1 of the project, not Phase 3 if the developer is actually interested in encouraging alternative transportation. As currently designed, this project will offer no opportunities
2.1 Residential District The guidelines that follow provide clear standards for the development of a well-designed project: housing type compatibility with adjacent uses, contribution to the character of the streetscape, and an energetic community that encourages alternative modes of transportation.	The PUD Guidelines, as a whole, lack declarative language that provides the community assurances that the project will "provide clear standards for the development of a well-designed project: housing type." Currently, the word "may" is used to describe all of the architectural elements in the project. The word "shall" must be employed to guarantee some level of architectural diversity.
2.2 Development Standards The McKinley Village community proposes three single-family housing types.	The entire project consists of two-story homes. This is not reflective of the architecture of Midtown and East Sacramento. As the population ages, people are looking for one-story homes and downsize into smaller houses.
2.3.1 Guidelines The following guidelines are provided to create a framework within which developers, builders and designers can have flexibility to create unique homes.	
Form & Orientation	
Variable building and garage orientations are encouraged along the streets to create visual diversity and interesting streetscapes. The same house plan, or closely similar elevation, may not be placed on two adjacent or consecutive lots.	The language, as stated, does not create visual diversity. Proposed revised language is in bold: The same house plan, or closely similar elevation, **will** not be placed on **three** adjacent or consecutive lots.
Use of roof overhangs, porches, balconies,	Proposed revised language is in bold:

McKinley Village | Draft PUD Guidelines	Comments and Suggested Revisions
trellises, patios, and low walls are encouraged to add interest to the streetscape.	Use of roof overhangs, porches, balconies, trellises, patios, and low walls **will be used** to add interest to the streetscape.
Enhanced side and rear elevations may be required whenever those elevations face a public or private street, park, or other public space.	Proposed revised language is in bold: Enhanced side and rear elevations **will** be required whenever those elevations face a public or private street, park, or other public space.
Roof lines may be made interesting by use of gables, hips, dormers, and roof planes that create variations in planes. Roof pitch, elevation styles, and materials should be consistent with the architectural style of the building.	Proposed revised language is in bold: Roof lines **will** be made interesting by use of gables, hips, dormers, and roof planes that create variations in planes. Roof pitch, elevation styles, and materials **will** be consistent with the architectural style of the building.
Materials	
Use of high quality materials such as stucco, brick, stone, and wood is encouraged.	Proposed revised language is in bold: Use of high quality materials such as stucco, brick, stone, and wood **will be used at this subdivision.** With regard to the use of stucco, stucco is not necessarily a "high quality material." It is important that when it is used, that it not be machine applied, because historically stucco homes in East Sac were hand-troweled as they should be for this project.
Accent materials may include stone veneer, painted wood trim, and shutters.	Proposed revised language is in bold: Accent materials **will** include stone veneer **(river rock or brick)**, painted wood trim, and shutters.
Roofing material shall be consistent with the architectural style of the building.	Proposed revised language is in bold:

McKinley Village | Draft PUD Guidelines	Comments and Suggested Revisions
	Roofing material shall be consistent with the architectural style of the building. **Roofing materials must have a minimum 30-year guarantee. Roofing with a 40-year guarantee or greater is encouraged.** **Roofing shall be concrete tile to help mitigate railroad and highway noise and vibration.**
Colors	
Color selection should match the overall neighborhood design theme palette, and be consistent with the building's architectural style.	The color palette has not been included in the design guidelines. The developer needs to provide additional information regarding these design selections. Proposed revised language is in bold: The community requires assurances that houses will not be painted identical colors. There needs to be visual diversity using paint colors within the three various building types. Proposed revised language is in bold: Color selection **will** match the overall neighborhood design theme palette, and be consistent with the building's architectural style.
Buildings should be painted with a variety of color palettes to provide diversity, visual interest and to make each individual building distinct.	Proposed revised language is in bold: Buildings **will be** painted with a variety of color palettes to provide diversity, visual interest and to make each individual building distinct.
4.1.2 Bicycle & Pedestrian Circulation	
A bicycle and pedestrian tunnel from the open space south of 'A' Street provides a linkage under the Union Pacific Railroad tracks to Alhambra Boulevard. (Figure 24) Lighting will be provided within the tunnel as well as the path leading to the structure, for the safety of cyclists and pedestrians. This tunnel and path	The design guidelines do not elaborate on safety measures to be taken regarding this bike/pedestrian tunnel. The bike/pedestrian tunnel at 14th and C Streets has been closed for a number of years because the City was unable to ensure the safety of

McKinley Village | Draft PUD Guidelines	Comments and Suggested Revisions
is envisioned as a key component to providing access to East Sacramento and Midtown, encouraging non-motorized transportation choices.	people using the tunnel. This situation has repeatedly been brought to the attention of the applicant. The applicant should physically inspect the conditions of the 14th Street tunnel so they design a tunnel that is not an attractive nuisance. The developer needs to better articulate the safety measures to be employed, including security cameras to ensure the safety of the people using this tunnel for access to the project.

Marshall School/New Era Park N.A.
Comments to Planned Unit Development Guidelines – Architectural Styles

Architectural Style as Referenced in the PUD Guidelines	**Proposed Changes in Text in Architectural Style Referenced in the PUD Guidelines**
a. California Cottage Drawing from California's rich architectural history, the California Cottage combines components of the historic cottages interlaced within the surrounding neighborhoods. With clean forms and lines, a distinctly modern interpretation of the cottage vernacular will be created for the community. The following architectural elements **may** apply to California Cottage homes within McKinley Village: ·Flat tile or composition roofing material ·Gable roof forms ·Stucco exterior ·Horizontal siding detail ·Wood railing and posts ·Decorative shutters	With clean forms and lines, a distinctly modern interpretation of the cottage vernacular will be created for the community. The following architectural element **will** apply to California Cottage homes within McKinley Village: Flat tile or composition roofing material with a minimum of 30-year guarantee. Roofing with a 40-year guarantee or greater is encouraged. The three of the following architectural elements **will** apply to base model for the California Cottage homes within McKinley Village: ·Gable roof forms ·Stucco exterior ·Horizontal siding detail ·Wood railing and posts ·Decorative shutters
b. Colonial Reflecting the historic character of existing nearby neighborhoods, McKinley Village's Colonial maintains detailing typically found within the vernacular style. The following architectural elements **may** apply to Colonial homes within McKinley Village: ·Gable roof ·Flat tile or composition roofing material ·Stucco exterior ·Horizontal siding detail ·Classically-inspired entry portico ·Decorative shutters ·Stone or Brick accent	The following architectural elements **will** apply to Colonial homes within McKinley Village: Gable roof with a flat tile or composition using roofing material with minimum of 30-year guarantee. Roofing with a 40-year guarantee or greater is encouraged. The three of the following architectural elements **will** apply to base model for the Colonial homes within McKinley Village: ·Stucco exterior ·Horizontal siding detail ·Classically-inspired entry portico ·Decorative shutters ·Stone or Brick accent
c. Craftsman Reflecting the character of existing nearby	The following architectural elements **will** apply to Craftsman homes within McKinley Village:

Architectural Style as Referenced in the PUD Guidelines	Proposed Changes in Text in Architectural Style Referenced in the PUD Guidelines
neighborhoods, McKinley Village's Craftsman draws upon the architectural details typically found within the style vernacular. The design will be updated through clean lines and simplified forms, resulting in a distinctly new aesthetic for the community. The following architectural elements **may** apply to Craftsman homes within McKinley Village: ·Low pitched gable roof ·Flat tile or composition roofing material ·Stucco exterior ·Horizontal siding detail ·Classically-inspired entry portico ·Decorative shutters ·Stone or Brick accents	·Low pitched gable roof with a flat tile or composition using roofing material with minimum of 30-year guarantee. Roofing with a 40-year guarantee or greater is encouraged. The three of the following architectural elements **will** apply to base model for the Colonial homes within McKinley Village: ·Stucco exterior ·Horizontal siding detail ·Classically-inspired entry portico ·Decorative shutters ·Stone or Brick accents
d. English Revival Representative of a quintessentially English vernacular, McKinley Village's English Revival draws upon architectural detailing typically characteristic of the style. The following architectural elements **may** apply to English Revival homes within McKinley Village: ·Flat tile or composition roofing material ·Steep gable roof forms ·Metal roof elements ·Exposed rafter tails ·Stucco exterior ·Arched forms ·Half-timber detail ·Precast elements ·Brick accents	The following architectural elements **will** apply to English Revival homes within McKinley Village: ·Flat tile or composition roofing material ·Steep gable roof forms ·Metal roof elements Roofing material with minimum of 30-year guarantee will be used. Roofing with a 40-year guarantee or greater is encouraged. The three of the following architectural elements will apply to base model for the English Revival homes within McKinley Village: ·Exposed rafter tails ·Stucco exterior ·Arched forms ·Half-timber detail ·Precast elements ·Brick accents

Architectural Style as Referenced in the PUD Guidelines	**Proposed Changes in Text in Architectural Style Referenced in the PUD Guidelines**
e. European Cottage Inspired by a blend of European architectural styles, and the character of the surrounding neighborhoods, the European Cottage provides an historic sense of charm to the McKinley Village development. The following architectural elements **may** apply to European Cottage homes within McKinley Village: ·Flat tile or composition roofing material ·Steep roof pitches ·Tight rakes ·Stucco exterior ·Decorative shutters ·Gable end siding detail ·Arched forms ·Brick accents	The following architectural elements **will** apply to European Cottage homes within McKinley Village: ·Flat tile or composition roofing material ·Steep roof pitches Roofing material with minimum of 30-year guarantee will be used. Roofing with a 40-year guarantee or greater is encouraged. The three of the following architectural elements will apply to base model for the European Cottage homes: ·Tight rakes ·Stucco exterior ·Decorative shutters ·Gable end siding detail ·Arched forms ·Brick accents
f. French Country Influenced by the surrounding neighborhood context, but drawing specifically from the French vernacular and its essential components, McKinley Village's French Country is composed of carefully articulated massing and forms, resulting in a beautifully executed aesthetic for the community. The following architectural elements **may** apply to French Country homes within McKinley Village: ·Flat tile or composition roofing material ·Metal roof accents ·Tight rakes ·Stucco exterior ·Decorative shutters ·Gable end detail ·Arched forms ·Stone or Brick accents	The following architectural elements **will** apply to French Country homes within McKinley Village: ·Flat tile or composition roofing material ·Metal roof accents Roofing material with minimum of 30-year guarantee will be used. Roofing with a 40-year guarantee or greater is encouraged. The three of the following architectural elements **will** apply to base model for the French Country homes within McKinley Village: ·Tight rakes ·Stucco exterior ·Decorative shutters ·Gable end detail ·Arched forms ·Stone or Brick accents

Architectural Style as Referenced in the PUD Guidelines	Proposed Changes in Text in Architectural Style Referenced in the PUD Guidelines
g. Italian Drawing from the richness of Italian architecture, McKinley Village's Italian homes reflect the quintessential aspects characteristic of the style, while relying on the use of simplified forms and an artfully selected material palette. The end result offers a refined Italian aesthetic for the project. The following architectural elements **may** apply to Italian homes within McKinley Village: ·S-tile roof ·Hip roof forms ·Built up eaves ·Stucco exterior ·Ornamental column detail ·Wrought iron accents and detailing ·Arched forms at entry and windows	The following architectural elements **will** apply to Italian homes within McKinley Village: ·S-tile roof ·Hip roof forms ·Built up eaves Roofing material with minimum of 30-year guarantee will be used. Roofing with a 40-year guarantee or greater is encouraged. The three of the following architectural elements **will** apply to base model for the Italian homes within McKinley Village: ·Stucco exterior ·Ornamental column detail ·Wrought iron accents and detailing ·Arched forms at entry and windows
h. Modern Prairie Revitalizing the Prairie architecture found within the surrounding neighborhoods, McKinley Village's Modern Prairie is a composition of well-purposed massing, simplified forms, and a fresh material palette, adding to the historic and progressive array of architectural styles for the community. The following architectural elements **may** apply to Modern Prairie homes within McKinley Village: ·Flat tile or composition roofing material ·4:12 roof pitch ·Hip roof ·Stucco exterior ·Horizontal detailing and massing ·Horizontal siding accents ·Stone or Brick accents	The following architectural elements **will** apply to Modern Prairie homes within McKinley Village: ·Flat tile or composition roofing material ·4:12 roof pitch ·Hip roof Roofing material with minimum of 30-year guarantee will be used. Roofing with a 40-year guarantee or greater is encouraged. The three of the following architectural elements **will** apply to base model for the Modern Prairie homes within McKinley Village: ·Stucco exterior ·Horizontal detailing and massing ·Horizontal siding accents ·Stone or Brick accents

Architectural Style as Referenced in the PUD Guidelines	**Proposed Changes in Text in Architectural Style Referenced in the PUD Guidelines**
i. Monterey Drawing from the historical context of the surrounding architecture, McKinley Village's Monterey offers an artfully composed and updated version of this uniquely Californian style. Comprised of the components typically true of the vernacular, the project's Monterey is made distinct through the juxtaposition of a traditional material palette and simplified, updated forms. The following architectural elements **may** apply to Monterey homes within McKinley Village: ·Flat tile, s-tile or composition roofing material ·Gable roof forms ·Stucco exterior ·Horizontal siding or Board and Batten accents ·Balcony at upper floor ·Stone or Brick accents ·Decorative shutters	The following architectural **will** apply to Monterey homes within McKinley Village: Roofing material with minimum of 30-year guarantee will be used. Roofing with a 40-year guarantee or greater is encouraged. The three of the following architectural elements **will** apply to base model for the Monterey homes within McKinley Village: ·Stucco exterior ·Horizontal siding or Board and Batten accents ·Balcony at upper floor ·Stone or Brick accents ·Decorative shutters
j. Spanish Innately Californian and representative of architecture found within the surrounding neighborhoods, McKinley Village's Spanish is a reflection of the quintessential characteristics of the style. While updated through the use of simplified forms and massing, the style pays homage to its rich architectural heritage and grounds the community within the context of its location. The following architectural elements **may** apply to Spanish homes within McKinley Village: ·S-tile roof ·Gable roof forms ·Stucco exterior ·Arched forms ·Wrought iron details	The following architectural elements **will** apply to Spanish homes within McKinley Village: ·S-tile roof ·Gable roof forms Roofing material with minimum of 30-year guarantee will be used. Roofing with a 40-year guarantee or greater is encouraged. The three of the following architectural elements **will** apply to base model for the Spanish homes within McKinley Village: ·Stucco exterior ·Arched forms ·Wrought iron details
k. Urban Farmhouse	The following architectural elements **will** apply to Urban Farmhouse homes within McKinley

Marshall School/New Era Park N.A.
Comments to Planned Unit Development Guidelines

Architectural Style as Referenced in the PUD Guidelines	**Proposed Changes in Text in Architectural Style Referenced in the PUD Guidelines**
A modern take on the quintessential farmhouse, the Urban Farmhouse seamlessly blends the new and the old. Drawing from a rich material palette, the style provides all the warmth and character innately found within the vernacular while modifying its rustic roots through precise lines and forms, resulting in a more versatile, fresh aesthetic. The following architectural elements **may** apply to Urban Farmhouse homes within McKinley Village: ·Flat tile or composition roofing material ·Gable roof forms ·Metal roof element over porch ·Stucco exterior ·Board and Batten accents ·Dormer elements ·Porch element ·Stone or Brick accents	Village: ·Flat tile or composition roofing material ·Gable roof forms Roofing material with minimum of 30-year guarantee **will** be used. Roofing with a 40-year guarantee or greater is encouraged. The three of the following architectural elements **will** apply to base model for the Urban Farmhouse homes within McKinley Village: ·Metal roof element over porch ·Stucco exterior ·Board and Batten accents ·Dormer elements ·Porch element ·Stone or Brick accents

From:	Matthew Piner
To:	Evan Compton
Subject:	McKinley Village Design Issues
Date:	Thursday, January 30, 2014 2:35:43 PM

Evan -
I have not yet had time to vet this project with the Midtown Neighborhood Association (I am Co-Chair)- so these comments are strictly my own.
In the interest of saving time - I am copying and pasting my letter to Julie Murphy regarding her (much more comprehensive) comments.

Julie -
You have done an admirable and thorough job with all of your comments - your dedication and time commitment is remarkable!
I will have to say that I cannot add much nor have time to do so in as complete a way - but I will offer some language here from my point of view.
I'll see if I can make time to get this into a format that can be submitted - but it may not be what our "Board" thinks is appropriate.

As an Architect and Educator, I have my own "subjective" issues with the repeated use of historic forms - but like to think of issues that are more objective as to "green" or "sustainable" ways to design and build in a timeless, non style oriented way. This is non-negotiable in my opinion. New construction is always an opportunity to get things right - but in most cases with profit oriented and risk averse developers and builders - the opportunities are lost or squandered.

• Energy and water conservation are not only code issues but are legacy issues for what we leave to future inhabitants.
• I like the style that Mogavero Notestine used for the Rec. Center - since the glass is shaded and overhangs are used to protect walls and windows from the summer sun. While it is a commercial building and more of a "mid century modern" look - it seems better suited as a contemporary design for our time and place.
• The historic styles are not necessarily suited to Sacramento and our temperate climate (with the exception of the "modern prairie design") - they are chosen for their "marketability" and are the "safe" bet for approval since they break no new ground. These styles can (and are) built all over the country for their curb appeal - not for their suitability to the region and climate.
• My opinion - this is the 21st Century, let's build something that 100 years from now says something about our understanding of where we are in time and technology and leaves a legacy of some quality and thoughtfulness. For example any development should include timeless features that allow outdoor living (porches) and support a good community (pedestrian and street life, eyes on the street, crime prevention, etc.).
• Quality of construction and materials matters! These homes should not be falling apart in 20 years! Stucco can be a lasting material - as you say - but only if applied in a system that nets about a 1" thickness.
• ALL homes should be passive and active solar - and oriented to allow good solar access for all.
• Passive cooling by way of shading and use of light colors for roofs, etc. needs to be incorporated - as do overhangs, awnings and other shading.

• West facing glass should be avoided or eliminated unless effectively shaded.
• Trees need to be mostly of a large canopy type, no small ornamentals - unless it is deemed necessary for solar access considerations.

I personally cannot get over the issue of “who would want to live there” (!) - no matter WHAT style of home - when your neighborhood is bound by a busy and dirty freeway and train tracks. Since we live a mere block away from the 40th Street entrance, I can attest to the noise from the trains - it is significant (doesn’t bother me - but that’s another subjective issue.)

That’s all I have time for now - I would like to take this up with our Board.
So appreciate all you’ve done Julie!

Best regards,

Matthew Piner
pinerworks@sbcglobal.net

Office: 916-444-7115
Cell: 916-802-7863
Matthew Piner
pinerworks@sbcglobal.net

Office: 916-444-7115
Cell: 916-802-7863

From:	Planning
To:	Evan Compton; Dana Allen
Cc:	Planning
Subject:	FW: Mckinley village
Date:	Tuesday, February 18, 2014 11:49:00 AM

fyi

From: BtAuble@aol.com [mailto:BtAuble@aol.com]
Sent: Tuesday, February 18, 2014 9:39 AM
To: Planning
Subject: Mckinley village

We have a water supply problem. Why keep building more houses and putting a drain on our water resources? Thank You for your time.

EAST SACRAMENTO
CHAMBER OF
COMMERCE

Established in 1996 by members of the local business community, the mission of the East Sacramento Chamber of Commerce is to promote East Sacramento businesses, whose merchants are dedicated to maintaining the neighborhood values that make East Sacramento an attractive place to live and conduct business.

March 12, 2014

Mayor and City Council
City Hall
915 I Street
Sacramento, CA 95814

Sacramento City Planning & Design Commission
300 Richards Boulevard
Third Floor
Sacramento, CA 95811

Re: McKinley Village Proposal

Dear Mayor, Council Members and Commission Members:

The East Sacramento Chamber of Commerce Board of Directors wishes to tender public support for the McKinley Village Development project. Accordingly, please accept this letter as an official expression of the Chamber's support for the current proposal by River View Capital.

Our Chamber's membership consists primarily of businesses, merchants, and professionals working in the East Sacramento area. Please note that most of those members are residents of the East Sacramento, River Park or Midtown neighborhoods. Our Chamber also has resident members living in East Sacramento not affiliated with a particular business.

A vote was taken among our board members attending the Chamber's March 5 board meeting and the McKinley Village proposal received unanimous support. Our board members believe that the proposal in its current form will be a net positive for our local businesses and will be a valuable addition to the neighborhood.

However, our board does strongly urge the City of Sacramento to continue investigating options for vehicular, bicycle and pedestrian access to the project at Alhambra Boulevard.

Finally, we want to express our thanks to the Mayor and the City Council for their continued and tireless efforts to improve our great city.

Very truly yours,

Brad McDowell
President, East Sacramento Chamber

3104 "O" Street #222, Sacramento, California 95816

From:	Fr. James Retelas
To:	Evan Compton
Subject:	McKinley Village
Date:	Monday, March 17, 2014 2:21:01 PM

Please allow me to express my unqualified support for the proposed McKinley Village housing development. I can think of no better use for a 48 parcel so close to the urban core of Sacramento. It is well designed and adheres closely to the smart growth policies already in place for the City and County of Sacramento. I drive by the site almost every day and look forward to the day this oversized "weed patch" is replaced with homes and families.

Rev. James Retelas

From:	jmamalis@comcast.net
To:	Evan Compton
Subject:	Fwd: McKinley Village
Date:	Monday, March 17, 2014 11:54:18 PM

From: jmamalis@comcast.net
To: burchillcitypc@gmail.com
Sent: Monday, March 17, 2014 11:50:58 PM
Subject: McKinley Village

TO:

Evan Compton, City Planner

I support the development of McKinley Village because I believe it will be an asset for the City of Sacramento. The development will be an enhancement, providing needed, smart-growth housing to an area that is unsightly and neglected. It is time for this project to proceed!

Julie Mamalis

From: Judith Lamare
To: Evan Compton
Subject: McKinley Village
Date: Monday, March 17, 2014 1:36:57 PM

Dear Mr Compton

I have heard from friends that you advised them

This email is to notify you that the McKinley Village project has been scheduled for a final Planning and Design Commission hearing on **Thursday, March 27, 2014**. The hearing will be held at New City Hall, 915 I Street and will begin at 5:30 pm. The project will also require a City Council hearing which will be noticed at a later date. Please see the public notice attached for more information.

The Final EIR is still not available to the public, nor I assume to the Commissioners. What is the City's policy about availability of FEIR prior to Planning Commission hearing?

Jude Lamare

Judith Lamare, President
Friends of the Swainson's Hawk
717 K Street, Ste 529
Sacramento, CA 95814
916 447 4956
www.swainsonshawk.org
swainsonshawk@sbcglobal.net

From:	lauraapple@aol.com
To:	Evan Compton; Steve Cohn
Cc:	Sue Brown; sullivan.heather@gmail.com; donoghue.tony@gmail.com; robferrera@icloud.com
Subject:	Re: McKinley Village - Planning and Design Commission Hearing
Date:	Monday, March 17, 2014 9:54:41 AM

Hi Evan,

You may have heard this from other people as well, but I wanted to make sure you are aware this meeting date is in direct conflict with Theodore Judah's Annual Spring Arts and Music Festival. This art and music festival has 600 kids performing and displaying their art. It is so heavily attended that it has had to be moved to Kit Carson Middle School and has two separate performances in order to accommodate the community. Knowing that this project will most directly impact the families who live and attend school within the Theodore Judah boundary, I am formally requesting a change of date for the Planning Commission meeting regarding McKinley Village. This is such an important meeting and so many people will not be able to attend due to this school conflict.

Please consider changing this meeting to a day that can truly accommodate our community so that we can have the equal opportunity to attend this Commission meeting and support our children.

Thank you,

Laura Barrett on behalf of Love East Sac

-----Original Message-----
From: Evan Compton <ECompton@cityofsacramento.org>
To: Evan Compton <ECompton@cityofsacramento.org>
Sent: Mon, Mar 17, 2014 9:44 am
Subject: McKinley Village - Planning and Design Commission Hearing

This email is to notify you that the McKinley Village project has been scheduled for a final Planning and Design Commission hearing on **Thursday, March 27, 2014**. The hearing will be held at New City Hall, 915 I Street and will begin at 5:30 pm. The project will also require a City Council hearing which will be noticed at a later date. Please see the public notice attached for more information.

Thanks,

Evan Compton
Associate Planner
916-808-5260
ecompton@cityofsacramento.org

City of SACRAMENTO

Community Development Department
300 Richards Boulevard, 3rd Floor
Sacramento, CA 95811

From: Mark Chrisler
To: Evan Compton
Subject: McKinley Village
Date: Monday, March 17, 2014 3:32:36 PM

Hi Evan,

I have worked with you many times over the past 3 years but this time I am writing to voice my support for McKinley Village. I think we should look to infill spots for some projects instead of always stretching out further and further from the city center. The mindless building of shopping centers and homes that we don't really need out in the county and beyond is hard to sustain in terms of fuel costs to get there, taking away valuable agricultural land etc…

This project is thoughtful and well planned not to mention very nice looking. Neighbors always object to new building near where they live. I wish they would put the same energy into saving our open space. I rent in East Sac and it is hard for me to imagine that this project will have a major impact on traffic and the livability of the area. The area will easily absorb the new people. In fact I am interested in perhaps purchasing there because I have been shut out of the overpriced housing market in this neighborhood.

I urge a yes vote on this valuable project of reasonably priced homes for people like me who want to live in East Sac but can't afford it.

Best Regards,
Mark

Mark Chrisler

From:	Sam Manolakas
To:	Evan Compton
Subject:	RE: Support of McKinley Village
Date:	Monday, March 17, 2014 1:11:10 PM

Thank you for consideration supporting the project.
Sam

From: Evan Compton [mailto:ECompton@cityofsacramento.org]
Sent: Monday, March 17, 2014 1:04 PM
To: 'Sam Manolakas'
Subject: RE: Support of McKinley Village

Thank you for your email.

From: Sam Manolakas [mailto:sam@brookrest.com]
Sent: Monday, March 17, 2014 1:02 PM
To: Evan Compton
Subject: Support of McKinley Village

Dear Mr. Compton:

I am a business owner in East Sacramento and I am in support of McKinley Village. I believe it would provide the East Sacramento community with the best use of that 48 acres of land, with the least amount of impact on the surrounding neighborhoods. While there will be additional traffic, the traffic will be at a minimum compared to other uses that have been proposed at that site. It seems the opposition, doesn't want any development and the land to be kept vacant, which is unreasonable. I look forward to potential additional business in our neighborhood from the development.

Sincerely,

Sam Manolakas

President Reeds Gourmet Meat Co.

Sam Manolakas
Reeds Gourmet Meat Co
1210 66th Street
Sacramento, CA 95819
916.638.0733

From:	David Baumgartner
To:	Evan Compton; John F. Shirey; Angelique Ashby; Darrell Fong; Kevin McCarty; Jay Schenirer; Steve Cohn; Allen Warren; Bonnie Pannell
Subject:	re project proposal P08-086. McKinley environmental .
Date:	Tuesday, March 18, 2014 2:22:02 PM

Greetings to all:

I am not a person who has always lived in linoleum, carpet and manicured lawn areas."Condoland" or Tall apartment buildings deep within cities, although I have that experience also.

I have trodden the back roads, fields, forests bramble patches, sands and jungles and marshlands and alpine areas of many states and countries. I am a naturalist among other things. I am also "Streetwise"

1) If Mckinleyproject is next to the freeway? How is traffic on foot or via vehicle to be denied access to the area if sdeveloped? I used to live at extended Stay on truxel ave when I first moved here. I lived there for over a month. I saw much go right through the fence to the waiting Whisky / moonshine type seller or consumer, illegal cigarrette types, drug dealers or just roaming hikers or teens.

Will there be a very tall soundwall?

California Native Plant Society, business and church land purchasers will be contacted as well as the California Native Plant Society and the Indians. Also, I have already queried persons of two denominations. One of the greek orthodox first observed the Freeway proximity and sees the possible problems. L.D.S. persons have also been queried for reaction and do note, they are the largest land holder in Florida.

2) Some will note the horizontal nature of the tract. It is not a vertical highrise complex with lots of parkland.

More observations wiill follow. Beware small toy planes that can relay baggies of drugs to waiting residents of ANY income level.

David Baumgartner , also noting no NA CA AA or CMA or HA clubhouse on the plan proposal.

From: Margaris, Steve@DOT
To: Evan Compton
Subject: McKinley Village
Date: Tuesday, March 18, 2014 10:55:40 AM

Dear Mr. Compton,
I 'm writing in **support** of McKinley Village project.
This project will provide more housing opportunities in our City's center and bring new life to the mid town area. This is smart growth and important to keep Sacramento a vibrant city. I hope you can support this wonderful infill project.
Thank you much,
Steve Margaris

From:	Nikki Paschal
To:	Evan Compton
Subject:	Support for McKinley Village
Date:	Tuesday, March 18, 2014 4:43:45 PM

Dear Mr. Compton,

I am writing to express my support for the McKinley Village project when it comes before the Planning Commission on March 27.

This infill project represents the very type of smart growth that is needed to maintain Sacramento's quality of life as our region grows.

McKinley Village appropriately models the aesthetic feel of the surrounding East Sacramento neighborhoods, while incorporating 21st century green features.

As a homeowner downtown, I'm encouraged that the project team has made such extensive efforts to engage the larger community in creating such a forward-thinking project. Bike and pedestrian access to the surrounding neighborhoods and the American River Parkway are amenities that will enhance quality of life for the larger Sacramento community for generations.

Thank you,

Nikki Paschal
972 Q street
Sacramento, 95811

From:	Peter Yellowlees
To:	Evan Compton; burchillcitypc@gmail.com; Claire Yellowlees
Subject:	McKinley Village proposal
Date:	Wednesday, March 19, 2014 9:21:25 PM

Dear Sirs

As residents of East Sacramento we are writing to strongly support the planning application for McKinley Village. We have reviewed the plans, personally inspected the site and surrounding area and attended a community meeting at the Clunie Hall to hear both sides of the debate about the proposal. We feel that the McKinley Village development will substantially improve our residential area and will bring, in particular, more young families and their children into an area that desperately needs them, and which has an aging population.
Thank you indeed for listening so carefully to both sides of the debate but please do remember that the relatively vociferous group of individuals who are against the proposal are mainly the same group that object to any innovation and to any change, and that the vast majority of citizens who live in the area are like us, in support of this exciting development.

Yours Sincerely

Barb and Peter Yellowlees
1217 41st St
Sacramento
Ca 95819
--

From:	Jay Tingle
To:	Evan Compton; burchillcitypc@gmail.com
Subject:	Pro McKinley Village
Date:	Wednesday, March 19, 2014 10:27:44 AM

I'm writing to show my support for McKinley Village. I live on 33rd Street across from McKinley Park. I have seen a few bad projects proposed for this site and have hoped for a development such as this one. Smart growth, thoughtful design and JOBS.

Thanks for your consideration,

Jay Tingle
649 33rd Street
Sacramento California

From:	Tom Griffith
To:	Evan Compton
Cc:	Paul Noble
Subject:	Your Support for McKinley Village
Date:	Thursday, March 20, 2014 10:34:48 AM

Mr. Compton -
As a member of the board of the East Sacramento Improvement Association, I have had numerous opportunities to meet with Phil Angelides and his capable staff. I have found them to be genuinely interested in our concerns and responsive to our recommendations. They have made MANY positive modifications to their plans in response to requests from ESIA and other neighborhood associations. These include reducing the housing density by 15%, adding a bicycle/pedestrian tunnel through the railroad embankment at Alhambra Boulevard, committing significant funds to a Neighborhood Traffic Management Fund, and working to assure that the school impact fees are allocated to local schools.

This project has an important advantage we haven't seen in previous proposals and may never see again - a developer who lives among us and has a personal stake in making this project the best that it can be. Phil Angelides has an excellent reputation. His responsiveness has demonstrated that he cares about the impact of the project and will continue to address concerns during and after construction. I hope you agree and will lend your support to McKinley Village.
Tom Griffith,
ESIA Board Member

metrochamber
SACRAMENTO METROPOLITAN CHAMBER OF COMMERCE

February 27, 2014

Chair Kyomi Burchill,
Members of the Planning & Design Commissioners
300 Richards Boulevard
Sacramento CA 95814

RE: McKinley Village | Strong Support

Dear Chair Burchill and Planning and Design Commissioners:

On behalf of the Sacramento Metro Chamber Board of Directors, I want to convey our strong support for the McKinley Village project that seeks to bring a Blueprint consistent-infill project to East Sacramento.

McKinley Village is a 336 unit residential development located just north of the East Sacramento. The project has a density of 11 dwelling units to the acre (higher than East Sacramento's 9DUAs's but lower than Midtown's 15 DUAs). The project is served by two vehicle access points and a bike/pedestrian access point at Alhambra. The project includes housing types ranging from 1200 to 3000 square feet priced $350,000 - $750,000. Amenities will include park spaces, a recreation center with a full sized swimming pool and limited retail space.

McKinley Village will offer increased housing choices for downtown visitors and employees. As previously mentioned, the project is consistent with the Sacramento Area Council of Government's Sustainable Communities Strategy and Blueprint principles and will offer a mix of housing types that are currently difficult to find in close proximity to downtown.

Given the history of the proposed site, this project addresses concerns related to density and land use. We know there are ongoing concerns from neighborhood groups and applaud the efforts of the development team to ensure issues are addressed. While traffic impacts inevitably dominate the conversation, the environmental documents required by the project show that any substantial impacts can be mitigated and the project will not exceed city standards on impacted roadways and intersections.

We urge your support for the McKinley Village Project as a development that is consistent with Blueprint and smart growth principles, will create jobs, and provide a mix of housing choices that will allow new opportunities for residents to live near the core of the region.

Sincerely,

Roger Niello
President & CEO

CC: John Shirey, City Manager
Max Fernandez, CDD Director
Fran Halbakken, Department of Transportation
David Kwong, Planning Director
Greg Bitter, Principal Planner

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3fold Communications

PROGRAMS & EVENTS
Patrick Mulvaney
Culinary Specialists & Mulvaney's B&L

PUBLIC POLICY
Stan Van Vleck
Van Vleck Ranch
Downey Brand, LLP
Cal Connected, LLC

SMALL BUSINESS
Chris Johnson
The Johnson Group, Inc.

ARDEN ARCADE BUSINESS COUNCIL
Tim Cahill
Charles C. Bell, Inc.

AT-LARGE REPRESENTATIVES
Brian Dowd
Granite Construction Company

Timothy Murphy
Aerojet Rocketdyne

Ann Madden Rice
UC Davis Medical Center

Shelly Schlenker
Dignity Health

Robert Swanson
Boutin Jones Inc.

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City of Sacramento
Community Development Department
300 Richards Blvd., 3rd Floor
Sacramento, CA 95811

March 21,2014

Dear Sirs,

I am writing to express my concern about the proposed McKinley Village project. As a disabled home owner close to the proposed site I feel it will cause me much inconvenience and danger.

The Police can't keep the traffic under control as is, the traffic circles to "slow" traffic are posted at seventeen MPH. I hear cars racing and squealing around the one close to my house all the time. Some have even gone over it flowers and all. Traffic in town goes way to fast circles or not. this will be worse if you put the outlet for McKinley Village close to my home as proposed.

Infilling projects have caused danger. The city hasn't protected the blind and disabled in the past. Both rail tracks crossing side walks and the alley infilling aren't posted correctly under the Americans With Disabilities Act. When I pointed this out to the City their lawyer only told me I should "be aware" when I cross these places. The city apparently doesn't care if children, the elderly the disabled, or anyone else gets killed crossing the areas they haven't bothered to post or mark correctly. The alley's should be marked as streets if they are to be used as roads with infilling.

The alleys are used as streets. The streets are unsafe too. I was hit when crossing a street near where this new McKinley Village increased traffic outlet is to be. I was crossing the street properly. The light changed and both me and my guide dog were hit. Both the "white cane law" and the fact that I had "possession" of the cross walk should have protected me. I was in the right. I did everything properly. Yet the woman who hit me and my guide dog tried to leave me injured in the street.

The McKinley Village will put more tons of steel flying down the streets with little protection for pedestrians.It took six months to recover when I was hit.My guide dog and I were house bound while recovering from that crazy driver's negligence.

McKinley Village will make every day more dangerous.

How will McKinley Village affect my property value? I worked very hard to own my home. I believe the huge increase of units will drop my house value. This village may even end up being a slum. Since it is on the other side of the levy will the opening increase risk of my own home being flooded? Will my flood insurance go up if you put this in? Why would I want to gamble just so some developers make a bundle?

What good will McKinley Village do for me personally? I see mostly harm it will do to the disabled in the area. The city has a history of not protecting the disabled. McKinley Village only seems to make things worse.

I view these extra Village people as taking jobs away from those of us in Mid-Town. Why would I want more competition and less opportunity? I see the profits going into the pockets of the developer and McKinley Village leaving the residents of Mid-town with problems.

In closing I have many objections to the McKinley Village project; endangering me, harming my house value, taking jobs from my family, and not helping the disabled and older residents a single bit. There are to many negatives to allow this McKinley Village to be built.

Sincerely,

Pete Eckert
421 26th Street
Sacramento, CA 95816

From: Mkeith2001@aol.com
To: Evan Compton; burchillcitypc@gmail.com
Subject: Re: McKinley Village
Date: Tuesday, March 25, 2014 7:58:36 PM

City Planning and Design Commission,

Hello,
I'd like to support the plan for McKinley Village.

It's been a process that worked through some issues
for public comfort, safety and esthetics.
Great plan, lovely process.
Congratulations.

Some good work done.

I understand it's been approved by others already,
however, do bring it on to fruition soon?
I'd like to walk the streets and see it real.

Thank you,

East Sacramento,
River Park resident,
Mary Keith

County of Yolo

Office of the County Counsel

625 COURT STREET, ROOM 201 WOODLAND, CALIFORNIA 95695 TELEPHONE: (530) 666-8172
DIRECT: (530) 666-8275
FACSIMILE: (530) 666-8279

ROBYN TRUITT DRIVON
COUNTY COUNSEL

Philip J. Pogledich, Senior Deputy

March 26, 2014

VIA E-MAIL ONLY

Mr. Tom Buford, Senior Planner
City of Sacramento
Community Development Department
Environmental Planning Services
300 Richards Boulevard, 3rd Floor
Sacramento, CA 94811

Re: McKinley Village Project (SCH 2008082049)
Out-of-County Mitigation and Yolo County Ordinance No. 1426

Dear Mr. Buford:

The purpose of this letter is to advise the City of Sacramento that the County of Yolo has an ordinance (the "Habitat Mitigation Ordinance") that requires a use permit for mitigation efforts that rely on land in Yolo County to mitigate impacts to biological resources located outside the County. A copy of the Habitat Mitigation Ordinance is enclosed herewith.

As I understand it, proposed Mitigation Measure 4.2-1(b) for the above-referenced project requires the preservation of about 50 acres of Swainson's hawk foraging habitat by recording a habitat conservation easement on suitable land within 10 miles of the project site. Both the Draft and Final EIR (Response to Comments) expressly allow the applicant to use land outside of Sacramento County and to the west of the Sacramento River to satisfy this requirement. This approach to mitigation—if pursued in Yolo County—will trigger application of the Habitat Mitigation Ordinance and the use permit process described therein.

Please include this letter in the administrative record for the project and ensure that the applicant is made aware of the Habitat Mitigation Ordinance. You may contact me at (530) 666-8275 or via e-mail at philip.pogledich@yolocounty.org if you have any questions.

Very truly yours,

Robyn Truitt Drivon
County Counsel

Philip J. Pogledich
Senior Deputy County Counsel

Enclosure

FILED

JAN 3 0 2013

BY Lupita Ramirez
DEPUTY CLERK OF THE BOARD

ORDINANCE NO. 1426

An Ordinance Regulating Habitat Mitigation Projects

The Yolo County Board of Supervisors hereby ordains as follows:

Section One. Findings and Authority.

A. The unincorporated area is increasingly becoming the subject of mitigation projects and similar efforts that arise in connection with impacts to biological resources occurring largely or entirely outside of the County. Such projects include mitigation banks as well as habitat projects associated with the Bay Delta Conservation Plan ("BDCP") and the federal biological opinions for Delta smelt, salmonids, and other aquatic species. Other forms of "out of county" mitigation—for example, the direct purchase of a fee or easement interest by a public or private entity to discharge an existing or anticipated mitigation obligation associated with an out-of-county project—are expected to be proposed in the County in the foreseeable future.

B. The conversion of local farmland to habitat or to less productive agricultural uses is a likely consequence of some proposals included in draft elements of the BDCP. For example, the draft BDCP includes a conservation measure that proposes an array of changes within the Yolo Bypass to provide benefits to aquatic species, including the enhancement of seasonal floodplain habitat. The extent of such conversions as part of the BDCP (and other projects, such as mitigation banks) could greatly impact the local agricultural economy in many ways. Habitat conversions can also alter drainage patterns and otherwise impact neighboring properties and land uses. These are just a handful of the potential effects of a large-scale conversion of local farmland to habitat or less productive agricultural uses.

C. Existing habitat for various species could also be significantly impacted by such projects. This includes habitat for species protected under state and federal endangered species laws, such as the Swainson's hawk and giant garter snake, and habitat for migratory waterfowl. These existing habitats are directly threatened by actions and measures included within the BDCP and the federal biological opinions, as well as related projects that may proceed in advance of the completion of the BDCP and even unrelated projects occurring in connection with conventional development in other jurisdictions.

D. The projects covered by this ordinance are likely to create a number of additional land use conflicts and challenges within the County. For example, large-scale projects within the Yolo Bypass—particularly those that could disrupt existing agricultural practices and introduce new vegetation or erosion—could compromise the flood protection function of that facility and complicate efforts to maintain and restore its conveyance capacity. Out of county mitigation projects could also reduce the assessed value of affected lands, diminishing local property tax revenues and further jeopardizing the County's ability to provide basic services to its constituents. Many other policy concerns have also been documented in the Board letters presented by County staff to the Board of Supervisors in connection with prior discussions of this topic.

E. In many ways, the foregoing concerns are somewhat unique to the out of county mitigation projects that are the focus of this Ordinance. The internal mitigation needs of the County, the cities of Davis, Woodland, West Sacramento and Winters, and other local agencies are relatively modest by comparison. Such mitigation needs also pose far less risk of a significant conversion of farmland for reasons explained in the Board letter prepared in connection with the moratorium adopted on October 12, 2010. The County also has substantial input into how local mitigation needs are addressed in the unincorporated area. Finally, out of county mitigation is also unique in that mitigation banks and other forms of such mitigation facilitate urban development of some areas while restricting land uses and activities—and impacting the existing habitat values of farmland and open space—in other places such as Yolo County. Yet while jurisdictions approving such development receive additional tax revenues and other benefits, the jurisdictions hosting related habitat mitigation projects typically receive no such benefits. This furnishes yet another example of how extraterritorial mitigation differs from local or "in-county" mitigation.

F. Additional detail on these matters, is included in Board letters dated October 28, 2008, September 15, 2009, September 28, 2010, October 12, 2010, November 9, 2010, October 23, 2012, and January 29, 2013, all of which shall be considered part of the record of this item. The Board of Supervisors hereby incorporates that material by reference herein as support for the foregoing findings. The Board of Supervisors further finds that this Ordinance is consistent with the General Plan and exempt from CEQA on the grounds described in the January 29, 2013 Board letter.

Section Two. Definitions. The following definitions shall be added to Title 8, Chapter 2, of the Yolo County Code, with appropriate section numbering added at the time of codification:

Sec. 8-2.____. Covered Habitat Mitigation Project.

A "covered habitat mitigation project" is any mitigation bank or other project within the County that is undertaken to mitigate impacts to biological resources occurring largely or entirely outside of the County. A "covered habitat mitigation project" also includes all other habitat restoration, creation, enhancement, or preservation activities (including the sale of a conservation easement or interest therein) carried out within the County in connection with projects or other actions impacting biological resources in locations outside of the County. This includes, among other things, any such project that implements actions described in a Habitat Conservation Plan/Natural Communities Conservation Plan or in a biological opinion issued by the United States Fish and Wildlife Service or other federal agency. This term is to be interpreted broadly, consistent with the intent of this ordinance, to include all projects, plans, and activities that are substantially similar to any of the foregoing, regardless of whether they are specifically described herein.

Section Three. Minor Use Permit Required. A minor use permit, as that term is defined in Yolo County Code Section 8-2.270.9, shall be required for any covered habitat mitigation project of less than 40 acres. Accordingly, the following sections of the Yolo County

Code shall be amended to include this requirement by adding an appropriately-lettered subsection followed by the words "Covered habitat mitigation projects, as defined in Yolo County Code Section 8-2.___, of less than 40 acres. Such projects are subject to Title 10, Chapter 10 of this Code":

- Section 8-2.404 (Agricultural Preserve)
- Section 8-2.504 (Agricultural Exclusive)
- Section 8-2.604 (Agricultural General)
- Section 8-2.614 (Agricultural Industry)
- Section 8-2.1914 (Public Open Space)
- Section 8-2.1922 (Open Space)

Section Four. Major Use Permit Required. A major use permit, as that term is defined in Yolo County Code Section 8-2.270.3, shall be required for any covered habitat mitigation project of 40 or more acres. Accordingly, the following sections of the Yolo County Code shall be amended to include this requirement by adding an appropriately-lettered subsection followed by the words "Covered habitat mitigation projects, as defined in Yolo County Code Section 8-2.___, of 40 or more acres. Such projects are subject to Title 10, Chapter 10 of this Code":

- Section 8-2.404.5 (Agricultural Preserve)
- Section 8-2.504.5 (Agricultural Exclusive)
- Section 8-2.604.5 (Agricultural General)

In addition, the following sections shall be added to the Yolo County Code, shall be entitled "Major Use Permit," and shall identify "Covered habitat mitigation projects, as defined in Yolo County Code Section 8-2.___, of 40 or more acres as a major conditional use in subsection (a) or (b) thereof, as appropriate:

- Section 8-2.614.5 (Agricultural Industry)
- Section 8-2.1914.5 (Public Open Space)
- Section 8-2.1922.5 (Open Space)

Each subsection shall state that such projects are subject to Title 10, Chapter 10 of this Code.

Section Five. Addition of Chapter 10 to Title 10 of the Yolo County Code. The following Chapter is added to Title 10 of the Yolo County Code:

Chapter 10. Habitat Mitigation Ordinance

Article 1. Title and Purposes.

Sec. 10-10.101. Title.

This Chapter shall be known as the "Habitat Mitigation Ordinance" of the County.

Sec. 10-10.102. Purposes.

The County's land use planning efforts have consistently anticipated that local landowners—often in conjunction with assistance from non-profits and state agencies—will voluntarily undertake a modest amount of habitat creation, restoration, enhancement, and preservation actions. Similarly, the County has long coordinated urban development and related land use planning matters with the incorporated cities of Woodland, Davis, Winters, and West Sacramento. Projects within these jurisdictions have occasionally impacted biological resources, and the County intends to continue to accommodate the preservation of land in the unincorporated area as compensatory mitigation for such local habitat impacts.

In the foreseeable future, however, the County expects that the unincorporated area will increasingly be the subject of mitigation projects and similar efforts that arise in connection with impacts to biological resources occurring largely or entirely outside the geographic boundaries of the County. Such projects include mitigation banks with service areas extending far beyond the County—of which there are already a number—as well as various other endeavors to create, restore, enhance, and preserve habitat as a consequence of projects and activities occurring in locations outside of the County. These projects are the focus of this Chapter, while other purely local preservation and mitigation efforts are generally outside of its scope.

This Chapter provides for limited County regulation of certain habitat projects taking place within the County in connection with projects and activities occurring largely or entirely outside of the County. Such projects are unique in many respects. For example, wetland habitat projects can provide important habitat areas for fish, wildlife, and plants. They can also help maintain and enhance water quality, facilitate groundwater recharge, mitigate flooding, and control erosion. Some wetland habitat projects can also provide educational, scientific study, and recreational opportunities. The same is true of other types of habitat projects undertaken as compensatory mitigation. For these and other reasons, such projects can thus be a significant asset to the environment and the general public so long as they adequately replace the habitat area, values, and functions lost due to urban development or other projects or activities.

Nonetheless, to assure these projects benefit the County and do not unduly interfere with its land use planning efforts or the eventual implementation of the Yolo Natural Heritage Program, careful planning is necessary. Attention to matters of location, design, construction, and long-term monitoring and management is essential. Particularly for larger projects, early consideration of ways to integrate appropriate educational, recreational, scientific, and other opportunities is also desirable. Finally, the potential local and regional environmental and economic impacts of habitat projects—such as the conversion of farmland and existing species habitat, as well as conflicts with surrounding land uses and activities—deserves close attention and consideration. It is for these reasons that the Delta Reform Act of 2009 states that the goals of "providing a more reliable water supply for California and protecting, restoring, and enhancing the Delta ecosystem" are to be achieved in a manner "that protects and enhances the unique cultural, recreational, natural resource, and agricultural values of the Delta as an evolving place."

Accordingly, this Chapter is intended to promote the foregoing objectives and to achieve the following purposes:

(a) To help ensure that out of county mitigation projects are located, constructed, and managed in a manner that is consistent with the General Plan and the developing Yolo Natural Heritage Program, compatible with surrounding land uses to the extent feasible, and sensitive to the need for a strong local economy, the protection of existing biological resources, flood protection, vector control, and other appropriate local and regional concerns.

(b) To encourage the proponents of such habitat projects—particularly large out of county mitigation projects—to design and implement projects that achieve multiple environmental and community objectives, and that include management plans or similar means of ensuring the responsible stewardship of such projects over time.

(c) To ensure that habitat projects undertaken in furtherance of the "coequal goals" and the habitat restoration objectives of the Delta Reform Act proceed in a manner that is faithful to the Act in its entirety, including its basic policy direction that the coequal goals of "providing a more reliable water supply for California and protecting, restoring, and enhancing the Delta ecosystem" are to be achieved in a manner "that protects and enhances the unique cultural, recreational, natural resource, and agricultural values of the Delta as an evolving place."

(d) To expand opportunities for the County and interested citizens to participate in the process of reviewing such habitat projects by establishing a permitting process that includes public hearing requirements and other opportunities for public input.

(e) To continue to encourage wildlife-friendly agricultural practices and voluntary habitat restoration and preservation efforts, and to continue to accommodate other habitat projects undertaken in connection with impacts to biological resources arising from local projects and actions.

Nothing in this Chapter is intended to restrict or in any way affect or impair the agricultural use of land within the County. In some cases, state and federal laws may regulate certain types or characteristics of projects covered by this Chapter. This Chapter shall be construed to provide the County with the maximum control consistent with such other laws.

Article 2. Definitions

For the purposes of this Chapter, the following terms shall have the meanings stated below:

Sec. 10-10.201. Agriculture or Agricultural.

"Agriculture" or "agricultural" shall have the meaning set forth in Yolo County Code Section 8-2.208.

Sec. 10-10.202. Applicant.

"Applicant" shall mean a person who files an application for a permit under this Chapter and who is either the owner of the site, a vendee of that person pursuant to a contract of sale for the site, or an authorized agent for either of those persons.

Sec. 10-10.203. Covered Habitat Mitigation Project

A "covered habitat mitigation project" is any project within the scope that term as it is defined in Title 8, Chapter 2 of the Yolo County Code.

Sec. 10-10.204. Create or Creation.

"Create" or "creation," in the context of a habitat project, shall mean to construct or otherwise introduce new habitat area, functions, and values by excavating, flooding, or otherwise altering land not currently or historically occupied by such habitat.

Sec. 10-10.205. Deciding Authority.

"Deciding Authority" shall mean the public official(s) or County employee with authority to decide an application for a permit under this Chapter.

Sec. 10-10.206. Director.

"Director" shall mean the Director of the Planning and Public Works Department, or his or her designee or successor in function.

Sec. 10-10.207. Enhance or Enhancement.

"Enhance" or "enhancement," in the context of a habitat project, shall mean to rehabilitate a degraded or disturbed natural habitat area to bring back one or more functions or values that have been partially or completely lost due to natural causes or actions such as draining, grading, or other land uses and activities. Any project that changes the function or values of an existing habitat type so that it more closely resembles the natural (i.e., prior to disturbance by human activities) condition of a site shall be considered a habitat enhancement project for the purposes of this Ordinance.

Sec. 10-10.208. General Plan.

"General Plan" shall mean the adopted General Plan of Yolo County, as may be amended from time to time.

Sec. 10-10.209. Grading.

"Grading" shall have the same meaning as in Appendix J of the California Building Code, 2007 edition, as may be amended from time to time.

Sec. 10-10.210. Habitat.

"Habitat" shall mean the environmental factors that support one or more plant or wildlife species at a particular place or region, providing food, water, cover, and space needed for survival and reproduction.

Sec. 10-10.211. Person.

"Person" shall mean an individual, firm, partnership, corporation, or local agency (as defined in Government Code Section 53090), their successors or assigns, or the agent of any of the foregoing, and shall include any applicant or permit holder under this Chapter.

Sec. 10-10.212. Preserve or Preservation.

"Preserve" or "preservation" means the permanent protection of ecologically important habitat resources through the implementation of appropriate legal and physical mechanisms, including but not limited to conservation easements.

Sec. 10-10.213. Project.

"Project" shall mean the whole of any activity or activities undertaken in connection with creating, enhancing, restoring, or preserving habitat on a site, and shall be interpreted broadly to include all related activities. This includes, by way of example only and without limitation, activities such as pilot projects, conservation easement transactions, grading, tree or vegetation removal, and the creation, restoration, or enhancement of associated buffer areas.

Sec. 10-10.214. Restore or Restoration.

"Restore" or "restoration," in the context of a habitat project, shall mean to restore lost habitat area, generally by excavating, flooding, and otherwise manipulating the physical, chemical, or biological characteristics of a site with the goal of reestablishing the natural or historic habitat values and functions of that area.

Sec. 10-10.215. Site.

"Site" shall mean all areas of real property that are within the boundaries of a proposed project, and may include more than one legal parcel.

Sec. 10-10.216. Substantial Evidence.

"Substantial evidence" includes facts, a reasonable assumption predicated upon facts, or expert opinion supported by facts. Substantial evidence is not argument, speculation, unsubstantiated opinion or narrative, or evidence that is clearly inaccurate or erroneous.

Article 3. Permits

Sec. 10-10.301. Permit Requirement; Exemptions and Excluded Activities.

(a) *Generally.* Subject to the exemptions set forth below, no person shall engage in grading, clearing, or other activities, including the recordation of a conservation easement, with the intent to implement a covered habitat mitigation project without first applying for and receiving a use permit under this Chapter, together with any other approvals required by federal, state, or local law.

(b) *Advisory Determination Regarding Coverage.* A prospective project applicant may seek a pre-application consultation regarding the need for a use permit under this Chapter or other potential County approvals. This consultation may be initiated by contacting the Planning and Public Works Department.

(c) *Exemptions.* The following projects shall be exempt from the use permit requirement and the other provisions of this Chapter:

(i) All covered habitat mitigation projects that do not create 10 or more acres of habitat.

(ii) All covered habitat mitigation projects that do not enhance, restore, or preserve 40 or more acres of habitat. This exemption may not be combined with the exemption in subsection (a), above, to exempt any covered habitat mitigation project that creates, enhances, restores, or preserves 40 or more acres of habitat.

(iii) Covered habitat mitigation projects that create, enhance, restore, or preserve riparian, oak woodland, vernal pool, or native grassland/prairie habitats, unless any such project also includes one or more other habitat types that exceed the acreage limits set forth in subsections (a) or (b), above. The proponent of any project that qualifies for this exemption shall provide notice to the County of the proposed project before commencing construction or other activities in furtherance of the project.

(iv) Any covered habitat mitigation project that received all necessary County approvals prior to the effective date of this Chapter, or for which a complete application for such approval(s) was submitted prior to effective date (for projects of less than 160 acres only) of Yolo County Ordinance No. 1401, which established a moratorium on certain types of habitat projects.

(v) Any covered habitat mitigation project(s) undertaken by a person that entered into a Memorandum of Understanding or similar written agreement with the County addressing the implementation of such project(s) during the term of Yolo County Ordinance No. 1401 (including the term extension approved pursuant to Ordinance No. 1402), which established a moratorium on certain types of habitat projects. This

exemption shall be limited in scope to the project and/or other activities specifically described in the Memorandum of Understanding.

(vi) Limited term pilot projects undertaken for scientific research and related purposes, including feasibility assessments, in connection with the potential future implementation of a covered habitat mitigation project. Such projects are not covered by this Chapter so long as they occur in a time and manner that does not substantially interfere with the reasonable agricultural use of the pilot project site or adversely affect surrounding lands.

(vii) Activities that require discretionary approval pursuant to Chapters 3, 4, or 5 of this Title 10.

Notwithstanding the foregoing, any expansion or other change to a covered habitat mitigation project previously covered by one or more of these exemptions shall require a use permit if the proposed expansion or other change would remove the project, viewed as a whole, from the scope of these exemptions.

(d) *Activities Not Covered.* The following activities do not constitute covered habitat mitigation projects and are not subject to regulation under this Chapter so long as they are undertaken in the usual and customary manner prevailing in the County at the time this Chapter was adopted:

(i) All activities undertaken in connection with, and in furtherance of, the agricultural use of land. This includes, but is not limited to, the construction and maintenance of stock ponds and small reservoirs, tail-water ponds, irrigation canals and sloughs, rice fields, and similar activities.

(ii) Projects undertaken for the primary purpose of flood control, flood protection, or related matters of flood safety and the protection of life and property.

(iii) The winter flooding of agricultural fields for the primary purpose of providing temporary habitat for migratory waterfowl, provided such flooding does not occur in a time or manner that prevents or substantially interferes with the reasonable agricultural use of the site or adversely affect surrounding lands.

Sec. 10-10.302. Permit Contents, Processing, and Decisions

(a) *Applications, generally.* Applications for a use permit under this Chapter shall be submitted to the Director, together with payment of all application fees established by the Board of Supervisors. Except as otherwise provided in this Chapter, all provisions of the Yolo County Code relating generally to use permits shall apply to the review, issuance, and amendment or revocation of permits covered hereunder.

(b) *Application contents.* An application for a use permit shall include all of the following:

(i) A completed application for a permit under this Chapter, on a form provided by the County, together with payment of the application fee established by resolution of the Board of Supervisors.

(ii) Completed applications for any other required County approvals, such as a grading permit or Flood Hazard Development Permit, together with payment of the application fee(s) established by resolution of the Board of Supervisors. In addition, both with the initial application and thereafter, the applicant shall provide copies of all completed applications for other federal, state, and local approvals associated with the proposed project to facilitate coordination between the County and other agencies.

(iii) Appropriate site-specific technical reports, including but not limited to such documents as a biological resources analysis, a hydrology analysis, a geotechnical analysis, and an engineered excavation plan. The types of reports that may be required should be uniform for applications that are similar in nature, but may vary to the extent that the features of a proposed project or the characteristics of the project site and surrounding lands are unique. Upon request, the Director will advise an applicant of the types of reports that should be submitted with a permit application or, in appropriate instances, in connection with environmental review of a proposed project or at other times as specified by the Director in his or her sole discretion. In some instances, the applicant may be able to satisfy this requirement by providing documents prepared in connection with applications to other federal, state, or local agencies relating to the project.

(iv) A site plan showing property lines, assessor's parcel numbers, onsite and adjoining land uses, topography, access, and existing/proposed patterns of vegetation.

(v) A proposed management plan that identifies how the project will be operated and managed over time. Among other things, the plan should explain how the project will be actively operated and managed in perpetuity to ensure that its environmental and other benefits are realized on a continuous basis, how vector control issues will be addressed, if applicable, and how any unanticipated events and impacts to surrounding land uses will be addressed. The proposed management plan shall also include measures to address crop depredation to the extent it is a reasonably foreseeable consequence of the proposed project. The plan should also state whether the operation and management of the project will be supported by an endowment or other established source of funds.

In addition to the foregoing, the Director may require such other and further information relevant to the project as needed to perform appropriate

environmental analysis, to determine whether the proposal may affect public health, safety, and welfare, and for other good cause as determined by the Director in his or her sole discretion.

(c) *Yolo Natural Heritage Program.* In addition to referrals to other County departments, as may be appropriate in the discretion of the Director, all permit applications shall be promptly referred to the Executive Director of the Yolo Natural Heritage Program. The referral shall include a request for comments regarding whether the application is consistent with the Habitat Conservation Plan/Natural Communities Conservation Plan (HCP/NCCP) or, prior to its adoption, other matters of consistency with the developing HCP/NCCP. The purpose of this provision is to encourage coordination between applicants and the Executive Director, who may also refer the application to his or her staff or to committees participating in the development of the HCP/NCCP.

(d) *Deciding Authority.* The Deciding Authority for permit applications shall be as follows:

(i) For projects of less than 40 acres, the Zoning Administrator shall be the Deciding Authority.

(ii) For projects of between 40 and 159 acres, the Planning Commission shall be the Deciding Authority. For projects that are 160 or more acres, the Planning Commission shall act in an advisory capacity to the Board of Supervisors. Acting in such capacity, the Planning Commission shall hold at least one noticed public hearing on the project prior to making a recommendation to the Board of Supervisors. The recommendation of the Planning Commission shall be in writing and shall include a detailed statement of the grounds for the recommendation.

(iii) For projects that are 160 or more acres or that include a proposed alternative approach to addressing the conversion of farmland (as set forth in Section 10-10.303(h), below), the Board of Supervisors shall be the deciding authority. The Board of Supervisors shall hold at least one noticed public hearing on the project prior to making a final decision on the application.

(d) *Decision.* After considering the application materials and, if applicable, the recommendations of County staff and the Planning Commission, the Deciding Authority shall issue, conditionally issue, or deny the application by a written decision supported by findings that address the criteria set forth in Section 10-10.303, below. Due to the unique nature of projects covered by this Chapter, the general conditions that typically apply to the review and approval or denial of a use permit, set forth in Yolo County Code Section 8-2.2804, shall not apply.

(e) *Costs and expenses.* The applicant shall reimburse all costs and expenses reasonably incurred by the County in reviewing applications under this Chapter,

including but not limited to staff time and costs and expenses associated with environmental review. At the discretion of the Director, the applicant may be required to provide a reasonable deposit for such costs, enter into a reimbursement agreement with the County, or both.

Sec. 10-10.303. Decisionmaking Criteria

A permit applied for under this Chapter shall be approved if, taking all feasible mitigation measures, conditions of approval, and other relevant facts into account, the Deciding Authority makes all of the following determinations based on substantial evidence in the record:

(a) That the project applicant has substantially complied with the requirements of this Chapter, including but not limited to provisions addressing the submission and contents of a management plan;

(b) That the project would not significantly conflict with surrounding land uses;

(c) That the project would not have a significant adverse effect on biological resources and, in addition, is not reasonably expected to significantly conflict with the Yolo Natural Heritage Program (HCP/NCCP);

(d) That the project would not significantly compromise flood safety and the protection of life and property;

(e) That the project would not have a significant adverse economic effect—either by itself or cumulatively—within the County or region. This factor shall only be considered for projects that convert 40 or more acres of farmland;

(f) That the project, if undertaken in furtherance of the "co-equal goals" and the habitat restoration objectives of the Delta Reform Act, will proceed in a manner that is faithful to the Act in its entirety, including its basic policy direction that the coequal goals of "providing a more reliable water supply for California and protecting, restoring, and enhancing the Delta ecosystem" are to be achieved in a manner "that protects and enhances the unique cultural, recreational, natural resource, and agricultural values of the Delta as an evolving place";

(g) If the project site is subject to a Williamson Act contract, that the project is an "open space use" under Government Code Section 51201(o) or that it would not otherwise cause a material breach of the contract. Any project that is an "open space" use under Section 51201(o) shall also require approval of an amended Williamson Act contract or other appropriate action to authorize the open space use;

(g) That any conversion of farmland to habitat or other non-agricultural uses will be mitigated in accordance with Yolo County Code Section 8-2.2416 (notwithstanding anything to the contrary set forth therein regarding its application to habitat projects) or, subject to the approval of the Board of

Supervisors, that the applicant will implement an alternative approach to addressing the conversion of farmland that provides an equal or greater level of mitigation; and

(h) That the project would not significantly conflict with other relevant considerations of public health, safety, or welfare, sufficient to require preparation of a statement of overriding considerations pursuant to the California Environmental Quality Act.

Written findings addressing each of these matters shall be prepared in connection with a decision on a permit application.

If the Deciding Authority (other than the Board of Supervisors) finds that a project cannot be approved because one or more of these determinations cannot be made, the permit shall be referred to the Board of Supervisors for consideration at a noticed public hearing. The Board of Supervisors may approve a permit even if it finds that one or more of these determinations cannot be made, provided it finds that issuance of the permit is consistent with the purposes of this Chapter and all applicable provisions of local, state, and federal law. Any decision of the Board of Supervisors following its deliberation of these issues shall include written findings based on substantial evidence that address all of the criteria and other matters set forth above, together with an explanation of any decision to approve or deny a permit.

Sec. 10-10.304. Permit Term; Amendments

(a) *Term.* The use authorized by a permit issued under this Chapter shall commence within one to five years, as may be appropriate taking all circumstances relating to the project into account. In particular, covered habitat mitigation projects that require numerous federal, state, and local agency approvals that can take a long time to acquire may warrant an initial permit term of up to five years, in the sole discretion of the Deciding Authority. Once the authorized use commences, a permit shall be perpetual in term unless otherwise indicated at the time of its original approval.

(b) *Amendments, generally.* An amendment to an existing permit issued under this Chapter shall be required for any significant change to an approved covered habitat mitigation project. This shall include, but is not limited to, any change in the size or operation of an approved project that could have a significant effect on the environment. The Director shall have the discretion to determine whether an amendment to an existing permit is required.

(c) *Applications for amendments; processing.* Applications for amendments to previously issued permits shall be submitted to the Director on forms provided by the County. An application to amend a previously issued permit shall also be accompanied by the appropriate fee, as established by resolution of the Board of Directors. In addition, the Director may require any or all of the additional information and documents described in Section 10-10.302(b), above, that may be reasonably necessary for consideration of the application. An application for an

amendment shall be handled in the same manner as an original permit application, as described in Section 10-10.302(b)-(e), above.

Article 4. Appeals

Sec. 10-10.401. Appeal Procedure

Any decision made pursuant to this Chapter may be appealed pursuant to Yolo County Code Section 8-2.3301, which shall apply to all appeals arising under this Chapter.

Article 5. Violations

Sec. 10-10.501. Generally

Any violation of this Chapter shall be subject to the administrative code enforcement ordinance of the County, set forth in Chapter 5 of Title 1 of the Yolo County Code.

Sec. 10-10.502. Public Nuisance

Any activity in violation of this Chapter or any permit issued hereunder shall be considered a public nuisance. In his or her sole discretion, the Director may take any action authorized by law to address the public nuisance, including but not limited to referral of the matter to the District attorney for civil or criminal action.

Article 6. Periodic Reviews; Mapping

Sec. 10-10.601 Initial Review

Five years after this Chapter becomes effective, the Board of Supervisors shall hold a public hearing for the purpose of considering its effectiveness at achieving the purposes set forth in Article 1 hereof. During such hearing, the Board of Supervisors may identify matters that require further consideration and provide appropriate direction to staff. In addition, the Board of Supervisors may direct staff to prepare an ordinance amending, superseding, or deleting this Chapter, and it may take such other actions as may be necessary and appropriate.

Sec. 10-10.602 Future Reviews

Every five years after the initial review under Section 10-10.601, above, the Board of Supervisors shall review this Chapter at a public hearing for the reasons described in that Section, particularly to ensure its continued effectiveness in achieving the purposes described in Article 1.

Sec. 10-10.603 Failure to Conduct Reviews

The failure to conduct a review in the time or manner required by this Article shall not affect the continuing validity of this Chapter, not shall it have any affect on the status of a permit issued hereunder.

Sec. 10-10.604 Project Mapping

The Director shall maintain a map reflecting the location of each project approved pursuant to this Chapter. Other relevant information may also be included on the map, such as the location of preexisting mitigation banks, conservation easements, and other matters. The map shall be provided to the Deciding Authority in conjunction with each permit application presented for consideration. It shall also be provided to the Board of Supervisors as part of each periodic review.

Section Six. Severability.

If any section, subsection, sentence, clause or phrase of this Ordinance is held by court of competent jurisdiction to be invalid, such decision shall not affect the remaining portions of this ordinance. The Board of Supervisors hereby declares that it would have adopted this Ordinance and each section, sentence, clause or phrase thereof irrespective of the fact that one or more sections, subsections, sentences, clauses or phrases be declared invalid.

Section Seven. Effective Date.

This Ordinance shall take effect and be in force thirty (30) days following its adoption and, prior to the expiration of fifteen (15) days after its adoption, it shall be published once in the Davis Enterprise, a newspaper of general circulation, printed and published in the County of Yolo, with the names of the Board members voting for and against the Ordinance.

PASSED AND ADOPTED by the Board of Supervisors of the County of Yolo, State of California, this 29th day of January, 2013, by the following vote:

AYES: McGowan, Saylor, Rexroad, Provenza, Chamberlain.
NOES: None.
ABSENT: None.
ABSTAIN: None.

By _____
Duane Chamberlain, Chairman
Yolo County Board of Supervisors

Attest:
Julie Dachtler, Deputy Clerk
Board of Supervisors

By _____
Deputy (Seal)

Approved as to Form:
Robyn Truitt Drivon, County Counsel

By: _____
Philip J. Rogledich, Senior Deputy

MARSHALL SCHOOL/NEW ERA PARK NEIGHBORHOOD ASSOCIATION

P. O. Box 162271
Sacramento, CA 95819
916-919-6656
marshall.newera@gmail.com

March 26, 2014

VIA EMAIL

Kiyomi Burchill, Chair
and Members of the Planning Commission
300 Richards Boulevard
Sacramento, CA 95811

Re: McKinley Village – File No P08-86

Dear Chair Burchill and Members of the Planning Commission:

The following comments to the McKinley Village project are offered by the Marshall School/New Era Park Neighborhood Association, located in the northeastern corner of Midtown. Our neighborhood will act as the western access to the McKinley Village project via 28th Street to the A Street Bridge at Sutter's Landing Park. McKinley Village will forever suffer from comparison to StoneBridge Properties' Sutter Park Home project. Mr. Angelides missed his window of opportunity to roll out McKinley Village. If he had sought approval of this project prior to anyone knowing about Sutter Park Homes then he would not suffer from the evitable comparisons to Sutter Park.

The Sutter Park project was recently approved by Planning Commission with complete support for the neighborhood organizations and residents of East Sacramento. How was this feat accomplished? The steady and consistent use of shoe leather was employed to gain community support. Imagine the revolutionary notion of listening to people prior to undertaking a project. What was the reward for this undertaking? Sutter Park developers received unanimous support from the community and approval from the Planning Commission. Several of the Planning Commissioners lauded the StoneBridge team for setting the "gold standard" for community outreach. It is our wish that Mr. Angelides would have done more "listening" during the course of this project then "talking." We would, perhaps, had a different project to consider today.

Alhambra Blvd. Vehicle Access

The single most challenging aspect of this piece of property remains the access. Vehicle access at Alhambra Blvd. is vital to the long term connectivity. It is an idea share by residents of both Midtown and East Sacramento. The 38.5ft tunnel option described in the "Alhambra Underpass at UPRR" should be seriously considered to address the long term connectivity problems associated with this subdivision. Mr. Angelides had five years to figure out a better access design for his project and adding a bicycle/pedestrian tunnel at Alhambra Blvd. is simply not good enough. Even the Sacramento Bee Editorial Board thinks Alhambra Blvd. vehicle access is a good idea (see attached). Please make construction of a vehicle access at Alhambra Blvd. a condition of approval that should occur during the second phase of construction. Vehicle access at Alhambra Blvd. is important to improving the livability within McKinley Village and maintaining the livability of the neighborhoods outside McKinley Village.

Park Impact Fees

Second, the park impact fees for this project should be directed to Sutter's Landing Park. Approximately 1,800 cars per day will use the A Street Bridge to access McKinley Village. With current car traffic (approx. 800 cars) and the McKinley Village residents, Sutter's Landing Park will see 2,600 car trips to and from the entrance of Sutter's Landing Park. This traffic load will negatively impact the park users of Sutter's Landing Park and the wildlife that makes its home at Sutter's Landing Park. The park impact fees generated by this project should be directed to improve the experience of Sutter's Landing Park for McKinley Village residents and all other park users. This portion of 28th Street is no longer used exclusively by commercial interests and should reflect that by adding sidewalks and curbs in and around Sutter's Landing Park to make Sutter's Landing Park, 28th Street, and the A Street Bridge more inviting and safe for pedestrians and bicyclists to use.

Pedestrian Safety/A Street Bridge

In addition, it is important to improve the overall safety of 28th Street with the increase of vehicle traffic. Midtown is a very walkable community and adding additional nighttime vehicle traffic will compromise the safety of pedestrians using 28th Street and C Street. Adding streetlights on 28th Street, from C Street to G Street, would increase the visibility of pedestrians. Street lights should also be included on C Street west of Stanford Park to further enhance pedestrian safety.

Also, we have concerns about the A Street, which is a very busy at-grade train crossing at 28th Street (over 40 trains per day). We live in this neighborhood. We use Sutter's Landing Park and know that the trains present problems on a daily basis entering and exiting the park (see train count attached). A recent news segment (transcript attached) illustrates the daily reality of using the at-grade crossing at 28th Street. http://fox40.com/2014/02/17/neighbors-still-have-concerns-about-mckinley-village/. Also, we must have assurances of the soundness and longevity of the A Street Bridge. A Street Bridge is almost 60-years old and will see approximately 1,800 cars per day (657,000 cars per year). It is not enough to say "it's good for now." The community needs to know the useful life of this bridge. Who is responsible for repairs in five years – Caltrans (i.e. the taxpayers) or the developer?

Traffic Calming/Mitigation

Traffic calming measures and mitigation must be employed in Midtown to address the approximately 1,800 additional cars per day projected to use the A Street Bridge and the residential streets of our neighborhood. Ideally, a half street closure at B Street should be included with this project to lessen the livability impacts on Midtown residents. Other traffic calming measures, as recommended by City Staff, should be employed on C Street and 28th Street to help slow down the vehicle traffic generated by McKinley Village. In addition, the amount the developer is contributing to traffic calming efforts must be increased. According to the July 2007 DEIR for the Mercy Hospital and Sacred Heart school projects ("Mercy"), the existing daily traffic before their project was 9,650 trips. (Table 5.7-18) The daily traffic under post-project conditions was projected to be 10,578 trips. (Table 5.7-19) The net increase in traffic was projected to be 928 daily trips.

If the Mercy NTMP contribution was $200,000 for an additional 928 daily trips through East Sacramento, the McKinley Village project (generating over 3500 car trips per day) should contribute a higher amount to the NTMP fund. The current contribution of $150,000 to be divided between Midtown and East Sacramento (or $75,000 each) is not sufficient to address the needs of the community. The total

contribution should be $400,000, divided equally between the two impacted neighborhoods. We are concerned about maintaining the livability of our community and need your assistance in addressing these concerns.

PUD Guidelines

Mr. Angelides and the McKinley Village team promise a community that will be "21st century urban village . . . Inspired by the adjoining East Sacramento and McKinley Park neighborhoods." This is a lofty goal that again suffers when compared to the work done by StoneBridge Properties. The McKinley Village Planned Unit Development (PUD) Guidelines remain deficient when compared to the PUD Guidelines for Sutter Park. While Mr. Angelides has added some declarative language regarding the architectural features that will be part of each house style, the McKinley Village PUD Guidelines offer very little assurances for the community that stucco boxes will not be built at McKinley Village. On the other hand, the Sutter Park PUD guidelines offer incredible detail as to what should be included with each architectural style with minimum and enhanced elements. The community is provided four pages of details for the Sutter Park homes will look like, along with detailed drawings. The McKinley Village "Styles" offer a number of elements that will be included but does not provide any minimum standard. The lack of detail in the McKinley Village is breathtaking when compared to the substantive detail provided by the StoneBridge PUD Guidelines provided for Sutter Park (see two samples attached). Again, McKinley Village suffers greatly when compared to the work done by StoneBridge Properties. With Sutter Park, the community will get a community that will seamlessly integrate into the existing community. Without your intervention and demand for higher standards, the community will end up with a subdivision that is just "good enough" for the developer to make his money and move on.

Infill development has been a benefit to Midtown. We understand it and want to strike a balance between the new development and maintaining the livability of our community. We do this every day in Midtown. We love this community and have something to offer for its betterment. It is our hope that vehicle access at Alhambra Blvd. will be required and the tools will be provided to make that a reality for the community. A closer look at the PUD Guidelines is urged so that we get a community that we will be proud to call a neighbor. Sutter's Landing Park should receive the park impact fees generated from this project to offset the challenges this project will bring to the users of Sutter's Landing Park. Improvements to pedestrian safety by slowing cars down with traffic calming devices and installing new streetlights will be needed as well to help preserve the livability of the Marshall School/New Era Park neighborhood. We appreciate your efforts to advocate on our behalf and hope that you'll support vehicle access at Alhambra Blvd. It is what the community wants and the community needs.

Very truly yours,

Julie A. Murphy
Co-Chair

jam
Enclosures
cc: Evan Compton, Associate Planner

U.S. DOT - CROSSING INVENTORY INFORMATION
AS OF 3/13/2014

Crossing No.: *762357T* Update Reason: *Changed Crossing* Effective Begin-Date of Record: *07/10/13*
Railroad: *UP* *Union Pacific RR Co. [UP]* End-Date of Record:
Initiating Agency *State* Type and Positiion: *Public At Grade*

Part I Location and Classification of Crossing

Division:	*SACRAMENTO*	State:	*CA*
Subdivision:	*MARTINEZ*	County:	*SACRAMENTO*
Branch or Line Name:		City:	*In SACRAMENTO*
Railroad Milepost:	*0090.99*	Street or Road Name:	*28TH ST*
RailRoad I.D. No.:		Highway Type & No.:	
Nearest RR Timetable Stn:	*ELVAS*	HSR Corridor ID:	
Parent Railroad:		County Map Ref. No.:	*SH 1D3*
Crossing Owner:		Latitude:	*38.5830990*
ENS Sign Installed:		Longitude:	*-121.4642030*
Passenger Service:		Lat/Long Source:	*Neither*
Avg Passenger Train Count:	*38*	Quiet Zone:	*No*
Adjacent Crossing with Separate Number:			

Private Crossing Information:

Category: Public Access: *Unknown*

Specify Signs: Specify Signals:

	ST/RR A	ST/RR B	ST/RR C	ST/RR D
Railroad Use:				
State Use:				

Narrative:

Emergency Contact: *(800)848-8715* Railroad Contact: State Contact: *(415)703-3722*

Part II Railroad Information

Number of Daily Train Movements: Less Than One Movement Per Day: *No*
Total Trains: *41* Total Switching: *2* Day Thru: *39*
Typical Speed Range Over Crossing: From *10* to *35* mph Maximum Time Table Speed: *35*
Type and Number of Tracks: Main: *2* Other *1* Specify: *SID*

Does Another RR Operate a Separate Track at Crossing? *No*
Does Another RR Operate Over Your Track at Crossing? *Yes: CCT ATK*

U.S. DOT - CROSSING INVENTORY INFORMATION
Continued

Crossing *762357T*

Effective Begin-Date of Record: *07/10/13*

End-Date of Record:

Part III: Traffic Control Device Information

Signs:

Crossbucks:	*0*	Highway Stop Signs:	*0*
Advanced Warning:	*Yes*	Hump Crossing Sign:	
Pavement Markings:	*Stop Lines and RR Xing Symbols*	Other Signs: *0* *0*	Specify:

Train Activated Devices:

Gates:	*2*	4 Quad or Full Barrier:	*No*
Mast Mounted FL:	*0*	Total Number FL Pairs:	*8*
Cantilevered FL (Over):	*2*	Cantilevered FL (Not over):	*0*
Other Flashing Lights:	*0*	Specify Other Flashing Lights:	
Highway Traffic Signals:	*0*	Wigwags: *0*	Bells: *2*
Other Train Activated Warning Devices:		Special Warning Devices Not Train Activated:	
Channelization:	*None*	Type of Train Detection:	*Constant Warning Time*
Track Equipped with Train Signals?	*Yes*	Traffic Light Interconnection/Preemption:	*N/A*

Part IV: Physical Characteristics

Type of Development:	*Commercial*	Smallest Crossing Angle:	*60 to 90 Degrees*
Number of Traffic Lanes Crossing Railroad:	*2*	Are Truck Pullout Lanes Present?	*No*
Is Highway Paved?	*Yes*		
Crossing Surface:	*Concrete*	If Other:	
Nearby Intersecting Highway?	*N/A*	Is it Signalized?	
Does Track Run Down a Street?	*No*	Is Crossing Illuminated?	
Is Commercial Power Available?	*Yes*		

Part V: Highway Information

Highway System:	*Non-Federal-aid*	Functional Classification of Road at Crossing:	*Urban Local*
Is Crossing on State Highway System:	*No*		
Annual Average Daily Traffic (AADT):	*000826*	AADT Year:	*2013*
Estimated Percent Trucks:	*25*	Avg. No of School Buses per Day:	*0*
Posted Highway Speed:	*0*		

B Street Half-Street Proposal – presented to Traffic Engineer

1. Southbound traffic leaving Sutter's Landing Park on 28th Street wouldn't have a stop sign. This would prevent southbound traffic from queuing up on to the railroad tracks because cars would free flow onto B Street.

2. The stop sign at 29th and C Street would change directions allowing traffic on 29th Street to free flow to 29th and E Street where the traffic lights are synchronized.

3. Bold traffic signage would be put in place to make it clear that southbound traffic must turn left at 28th and B Street.

4. Traffic calming devices would be employed to slow traffic coming down the berm from the railroad tracks; perhaps rumble strips could be employed.

5. Bold signage would inform northbound traffic heading to Sutter's Landing Park on 28th Street that southbound traffic will not stop.

6. Unlike other half street closures, a large sign could be put in place at 28th and B Street, since there will be no right hand turns. The sign must make it clear traffic needs to turn left.

7. The half street closure could be recessed back to address safety concerns. The half-street closures are also designed so that bike (and skateboard traffic) could still proceed southbound unimpeded.

8. B Street, between 28th Street and 29th Street, could be made into a one way street and the parking spaces eliminated by the military depot. This would make for a safer road on B Street.

9. Traffic calming measures (traffic circle, stop sign, pedestrian island) would be placed on C Street to eliminate cut through traffic.

10. Developer to pay for sidewalk on 29th Street and improvements to B Street.

j. Monterey

Drawing from the historical context of the surrounding architecture, McKinley Village's Monterey offers an artfully composed and updated version of this uniquely Californian style. Comprised of the components typically true of the vernacular, the project's Monterey is made distinct through the juxtaposition of a traditional material palette and simplified, updated forms. An appropriate mix of the following elements shall apply to Monterey homes within McKinley Village:

- Flat tile, s-tile or composition roofing material
- Gable roof forms
- Stucco exterior
- Horizontal siding or Board and Batten accents
- Balcony at upper floor
- Stone or Brick accents
- Decorative shutters

Figure 21

Monterey Representative Photo

The Monterey

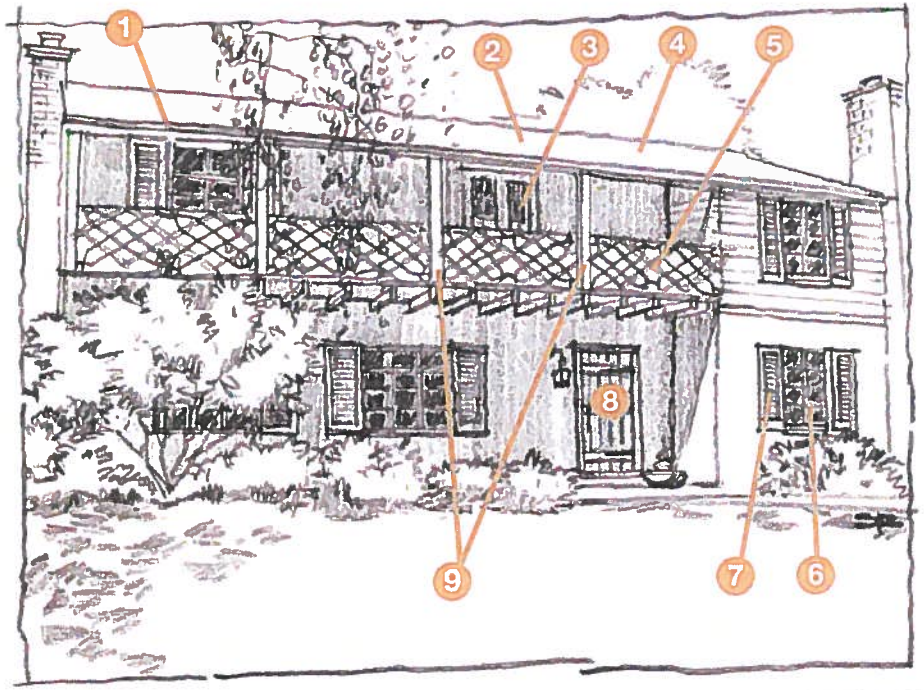
HISTORY AND INTENT

The Monterey style blends the Hispanic cultures of the early California residents with the influences brought to the west by the first European settlers. These homes are a juxtaposition of local indigenous materials, with colonial detailing applied. The dominant feature of the Monterey style is the always present upper story balcony element, which is contained within the principal roof form, and cantilevered. The balcony is of heavy timbered construction, defining the structure.

The Monterey style of the Sutter Park Neighborhood is a direct link to the colonial heritage of California. These homes will be found on the larger lot sizes of the neighborhood, to provide an authentic representation of the style, and its horizontal nature.

Distinctive Style Elements

1. Thin Eaves
2. Low Pitched Roof
3. French Doors Accessing Balcony
4. Two-Story Rectangular Form
5. Cantilevered Second-Story Balcony
6. Vertical Divided Light Windows
7. Louvered Shutters
8. Rustic Plank Entry Door
9. Decorative Posts and Beams at Cantilever



THE MONTEREY

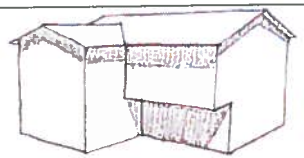
Style Elements	Minimum Elements	Enhanced Elements[1]
Form	• Two-story, rectangular form. • Principal side gabled roof. • Cantilevered second story balcony covered by principal roof.	• L-shaped form with front facing cross gable.
Roof	• Low-pitched gabled roofs (4:12 to 5:12). • Slate-look tile roof. • 12" to 16" overhangs. • Exposed rafter tails. • Thin eaves with either a half-round or ogee gutter.	• S-tile roof. • Boosted roof tiles.
Walls	• Smooth or imperfect smooth stucco is the dominant exterior finish.	• Brick at first floor that may be painted. • Horizontal wood siding at the upper floor. • Thickened walls.
Windows & Doors	• Paired windows in groups of twos or threes. • Tall vertical windows. • At least one pair of French doors accessing the balcony. • Rustic plank wood entry door.	• First floor arched picture window at cross gable. • Accent colored window frames.
Details	• Fixed panel or louvered wood shutters (each shutter must be sized to one-half of entire adjacent window width). • Wood railing at balcony to match posts and beams.	• Exposed decorative wood elements at balconies. • Ornate wrought iron railing at balcony.

[1] Minimum three enhanced elements per house are required.

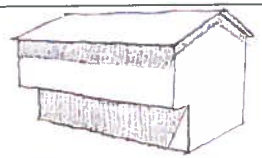
[2] All corner lots must employ at least four enhancements from the enhanced elements list on all street-adjacent building faces (in addition to the minimum enhancements required for all homes).

THE MONTEREY

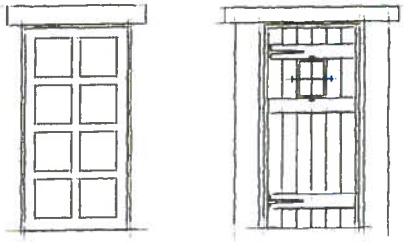
CROSS GABLE



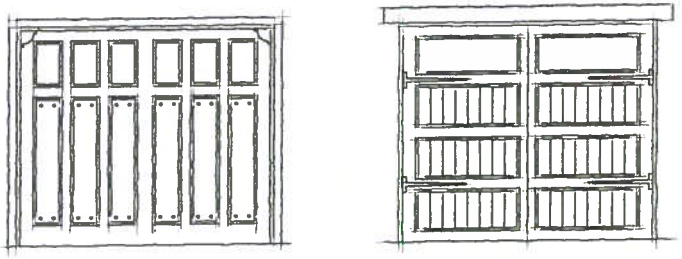
SIDE GABLE



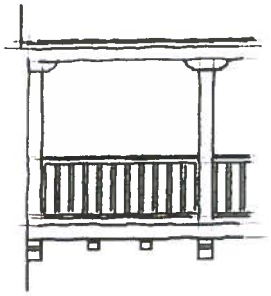
Entry Doors and Surrounds



Garage Doors

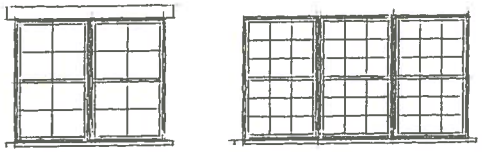


Porch Columns

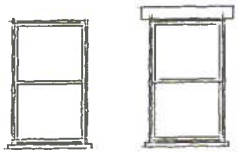


Window Patterns

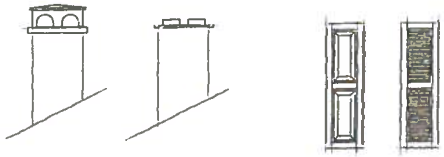
Window Groupings



Window Surrounds

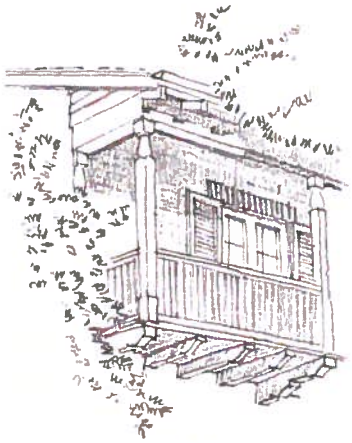


Chimneys & Shutters

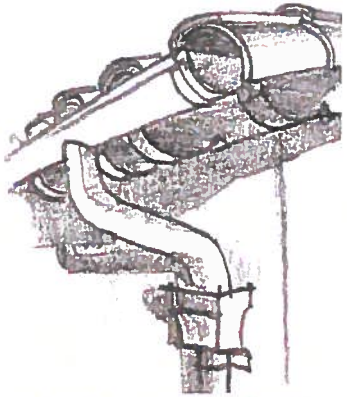


THE MONTEREY

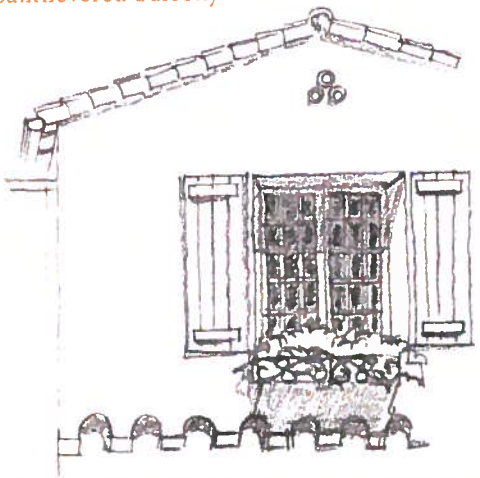
DETAILS



Cantilevered Balcony



Rafter Tail and Downspout



Gable with Canales, Shutters, and Deep Recess

PICTORIAL EXAMPLES

Historical Representation

Present Day Interpretation

f. French Country

Influenced by the surrounding neighborhood context, but drawing specifically from the French vernacular and its essential components, McKinley Village's French Country is composed of carefully articulated massing and forms, resulting in a beautifully executed aesthetic for the community. An appropriate mix of the following elements shall apply to French Country homes within McKinley Village:

- Flat tile or composition roofing material
- Metal roof accents
- Tight rakes
- Stucco exterior
- Decorative shutters
- Gable end detail
- Arched forms
- Stone or Brick accents

Figure 17

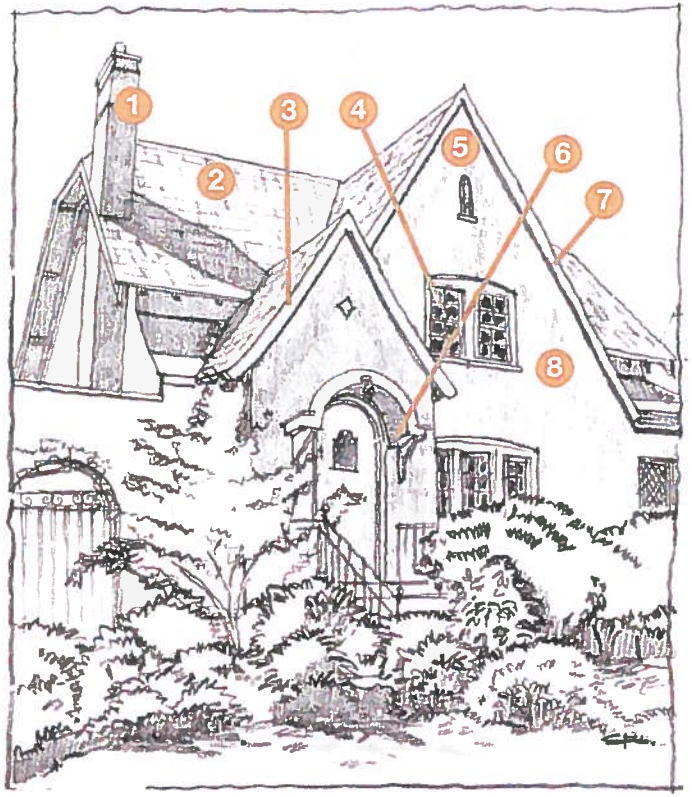
French Country Representative Photo

The French Cottage

HISTORY AND INTENT

The French Cottage is cozy, charming, and understated, more refined and sophisticated than the English Cottage, yet still picturesque, recalling a storybook village. As with the English Cottage, the French Cottage is reminiscent of the European villages visited by the soldiers in World War I, and returned to the States with them. The Sacramento park neighborhoods are peppered with quaint examples, adding to the eclectic streetscape that is so admired.

The Sutter Park Neighborhood aims to bring that nostalgic streetscape character to the next generation of Sacramento neighborhoods through a simple and idyllic representation of the French Cottage. This style is less rustic than its English counterpart, with an emphasis on more refined stucco and masonry applications.



Distinctive Style Elements

1	Chimney as Vertical Element
2	Hipped Gable as Dominant Roof Form
3	Bell Cast Eave
4	Divided Light Windows
5	Steeply Pitched Forward Gable
6	Recessed Covered Entry Door
7	Tight Gable Overhangs
8	Imperfect Smooth Stucco

THE FRENCH COTTAGE

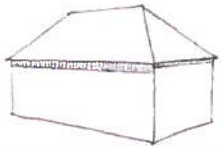
Style Elements	Minimum Elements	Enhanced Elements[1]
Form	• One- or two-story. • Asymmetrical massing with steep hip roofs. • Deep recessed entry door.	• Asymmetrical gabled projection with bellcast eaves and sculpted stucco walls. • Turret element.
Roof	• Steeply pitched roof (8:12 to 12:12). • Hip roof as dominant roof form, although gables can be introduced as accent elements. • Prominent dormers in a variety of forms: shed, hip, or gabled. • Tight gable overhangs (4" max) with slender, understated fascias (4" max). Eave overhangs can be broader (12" to 24") with a thin, crisp fascia line. • Composition shingle roofing.	• Hipped gables. • Eyebrow dormers. • Hip roof with engaged wall dormers. • Flared eaves. • Composition roofing materials rolled around eaves and rakes to suggest a thatched roof. • Slate or material mimicking slate.
Walls	• Smooth or imperfect smooth stucco or cement plaster as primary exterior finish material with stone or brick as accent materials. (Stone or brick scattered over stucco to mimic building age is not appropriate.)	• Smooth or imperfect smooth stucco, brick, or stone exterior material combinations with wood siding accents. • Painted brick.
Windows & Doors	• Casement and single-hung windows, arched accent windows enhanced with divided lights. • Traditional wood window head, jamb, and sill trims. • Tall window and/or French door assemblies in the front elevation. • Heavy wood paneled arched entry doors with metal detailing. • Arched entryways.	• Windows with wood planter boxes or embellished plant shelf details. • Round or oval accent windows. Accent windows may also be arched flanked with arched wood shutters (each shutter must be sized to one-half of entire adjacent window width). • Brick or stone window and door surrounds. • Balcony or windows with decorative metal railings and French doors. • Accent colored window frames.
Details	• Chimney. • Recessed gable vent. • Leader heads at downspouts.	• Stone elements that mimic "built over time" architecture. (Stone or brick scattered over stucco to mimic building age is not appropriate.) • Copper detailing (i.e. dormer roof). • Brick or stone detailed chimney. • Heavy timber post and beam construction.

[1] Minimum three enhanced elements per house are required.

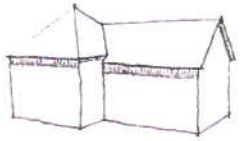
[2] All corner lots must employ at least four enhancements from the enhanced elements list on all street-adjacent building faces (in addition to the minimum enhancements required for all homes).

The French Cottage

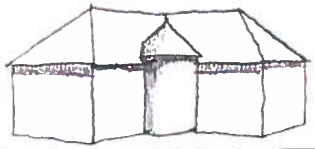
SYMMETRICAL HIP



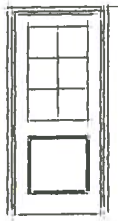
ASYMMETRICAL



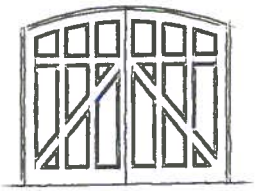
TOWERED



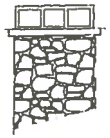
Entry Doors and Surrounds



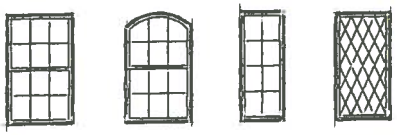
Garage Doors



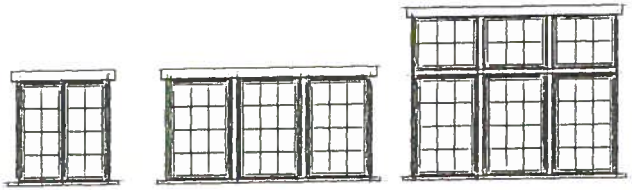
Chimneys



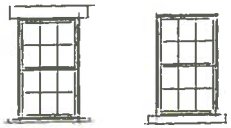
Window Patterns



Window Groupings



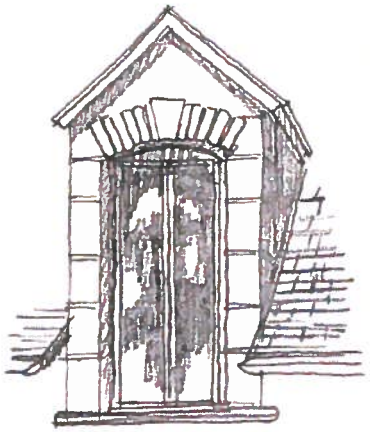
Window Surrounds



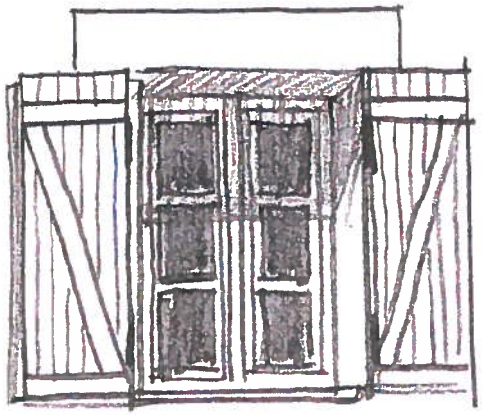
Shutters

THE FRENCH COTTAGE

DETAILS



Dormer



Recessed Window with Shutters

PICTORIAL EXAMPLES

Historical Representation

Present Day Interpretation

Sacramento Bee Editorial: Work to improve McKinley Village, not torpedo it

By the Editorial Board
Published: Monday, Nov. 18, 2013 - 12:23 am
Last Modified: Tuesday, Nov. 19, 2013 - 2:09 pm

To grow without growing out, Sacramento must take advantage of old, vacant land within the core city to build the homes and neighborhoods of the future.

Whether it is the Curtis Park railyard or northwest Land Park site of the old Setzer plant, the city seeks a mix of housing types and affordability for families of different incomes to meet the need for a projected 24,100 homes within the next eight years.

The city planning commission and City Council soon will consider a proposal in east Sacramento for 328 homes on a vacant 48-acre, eye-shaped piece of land, surrounded by the Capital City Freeway and the Union Pacific railroad tracks.

Over the years, this has been the site of many ambitious, unfulfilled plans, including 15- to 20-story towers. Now comes along a more down-to-earth project – McKinley Village – a residential neighborhood with densities and character similar to McKinley Park, east Sacramento and midtown.

The proposal, by Riverview Capital Investments and led by Phil Angelides, is not perfect. But it would provide needed development in Sacramento's urban core (as opposed to the sprawl of Cordova Hills or Dunnigan Hills) with a short distance to downtown, hospitals, schools and the nearby Cannery business complex that employs 1,200 people.

The city's much-awaited draft environmental impact report came out last Tuesday. A 45-day public comment period begins. This is a workable project. Remaining issues can be worked out before the proposal goes to the planning commission in February, then the City Council.

The report deals with access issues that have dogged the site from the beginning because of the freeway and railroad embankment. The plan calls for two ways in and out: on the east end at 40th Street, through a tunnel that would be built under the railroad tracks, and at the west end over the A Street bridge.

On that front, opponents of the project have pointed to potential floods that would require evacuation. The report points out that the railroad embankment and nearby Sutter's Landing Regional Park are above 100-year flood depths and would be considered "safe haven" areas during a flood. If the 40th Street tunnel were closed during a flood, residents would exit via the A Street Bridge.

In this, McKinley Village would be similar to River Park, which is bordered by the American River on the north and the railroad on the west.

Access is no reason to reject the project, though the developer and city planners should continue to explore a third access point at Alhambra Boulevard.

Opponents also have observed that the proposed development is car-oriented. Three bus routes run nearby, but bus stops are a quarter-mile walking distance. **Why not explore a shuttle to the 29th Street light-rail station?**

Nothing jumps out in the traffic study that should stop the project. The city would require the developer to pay for monitoring and retiming of a handful of traffic lights, and contribute toward a traffic signal at McKinley Boulevard and 33rd Street.

What's missing in the proposed project is a true mix of housing types and affordability, including homes for lower-income families. The proposal includes several styles of single-family homes ranging in cost from $300,000 to $700,000, but no townhouses or mixed-use housing with streetfront commercial space. Instead, McKinley Village proposes to offer "granny flats" on top of garages.

Sacramento will need 8,400 homes for lower-income families and 4,500 for those with moderate income by 2022. McKinley Village should contribute to that.

Efforts should go toward improving the proposal, not trying to derail it. The city needs housing, and McKinley Village would be a fine new neighborhood.

• Read more articles by the Editorial Board

Read more here: http://www.sacbee.com/2013/11/18/5916889/editorial-work-to-improve-mckinley.html#storylink=cpy

Neighbors Still Have Concerns about McKinley Village

SACRAMENTO-

Hotter than normal temperatures mean flowers are popping up in east Sacramento near McKinley Park.

Hotter than normal tempers mean certain signs are, as well – ones that say 'Stop McVillage' -as homeowners brace for problems from a planned housing development.

"They'll get in their cars to and go through our neighborhood to get to theirs," Katie McClean, who's been in her East sac home since 1967, said Monday.

Congestion concerns – the focus of a meeting planned for Thursday in Midtown.

It's not the site of McKinley Village, dubiously dubbed McVillage, but it is the place that could absorb 52 percent of the traffic from hundreds of new homes.

Much of that new traffic could be at B and 28th streets.

"Eighteen hundred cars at this intersection. We have a lot of concerns," Julie Murphy, the co-chair of Midtown's Marshall School – New Era Park neighborhood association said.

One of her biggest concerns? The trains that zoom through the area just above B Street.

Though the environmental impact report for the project references trains that zip through in seconds.

FOX40 cameras spotted one Monday afternoon that took more than five minutes to pass during the evening commute – a potential disaster for hundreds of drivers trying to turn onto one of only two planned access routes for McKinley Village.

Murphy can't imagine what might happen if an emergency vehicle was trying to get through.

"This is just a site that cries out for a third access point," she said.

Murphy believes a tunnel at Alhambra and B now slated for bikes could be the answer.

Homeowners want it widened for cars to take the pressure off of other routes.

Folks in Midtown have also suggested that northbound drivers on B street face a stop sign at 28th and southbound travelers be directed through an industrial area to 29th Street, skipping residential streets.

It's another solution they've offered, but say they can't get any real dialogue from developer Phil Angelides.

They say all they've heard is 'we'll get back to you.'

"We're coming up on the end of this. This is going to council in the middle of April. People don't want to live with this uncertainty anymore. What is going to happen to our neighborhood," said Murphy.

The developer has said in the past that they are surprised by homeowners' complaints because they have maintained an open dialogue.

Thursday's community meeting on the matter will be held at the Hart Center in Midtown from 6pm – 7:30pm.

Read more: http://fox40.com/2014/02/17/neighbors-still-have-concerns-about-mckinley-village/#ixzz2x0eKD0Zz

From:	Robert Finley
To:	burchillcitypc@gmail.com; jparrinello08@comcast.net; dcovill@cbnorcal.com; ALofaso@sbcglobal.net; dnybo@wateridge.net; todd.s.kaufman@gmail.com; othermeeta@gmail.com; phyllis@phyllisnewton.com; sacplanning_declines@me.com; kimjoanmc@att.net; pharveycitypc@aol.com; ed@loftgardens.com; tr5753@att.com
Cc:	Dana Allen; Evan Compton; Steve Cohn; Sue Brown
Subject:	McKinley Village Mitigation
Date:	Wednesday, March 26, 2014 11:45:16 AM
Attachments:	NUSG Alhambra Mitigation.pdf

Dear Planning & Design Commissioners,
Neighbors United for Smart Growth (NUSG) wishes to share with you our proposed mitigation document pertaining to the McKinley Village project.

At the meeting tomorrow, NUSG will ask for a continuance of the meeting due to the hundreds of Theodore Judah Elementary parents that won't be represented at the meeting due to the fundraiser (children's performance + art auction) their school will be hosting at the same time as the Commission meeting. The fundraiser supports Judah's PTA-funded programs such as science, garden, music and art programs -- all of which are currently in jeopardy due to lack of classroom space at the school.

As you know, Judah is the school (made up of Midtown and east Sacramento families) that will be most impacted by the McKinley Village project.

Thank you for your consideration.

Sincerely,
Neighbors United for Smart Growth

Neighbors United for Smart Growth
For Presentation at Sacramento Planning and Design Commission Meeting

McKinley Village Modifications
March 25, 2014

REQUEST FOR CONTINUANCE

REQUEST FOR PROJECT MODIFICATIONS
The Steering Committee of Neighbors United for Smart Growth (NUSG) requests the Planning and Design Commission and the City Council require the McKinley Village applicant to commit to the follow modifications as a condition of approval of the project:

Alhambra Boulevard Access:

1. Applicant shall obtain approval from Union Pacific Railroad, and all other right-of-way clearances as appropriate, for construction of a vehicular access tunnel at Alhambra Boulevard that connects McKinley Village to east Sacramento. Such approval shall be satisfied prior to issuance of grading permits for construction of housing.

2. The tunnel shall be at least a 38 foot wide vehicular access point. The City, Project Proponent and other appropriate entities shall continue to explore the possibility of a two lane access at this location consistent with engineering and financial feasibility considerations.

3. Construction of this vehicular access at Alhambra Boulevard shall commence during construction of roads for the project and be complete prior to issuance of building permits for the project.

Neighborhood Traffic Mitigation Fund:

1. Prior to the recordation of the final subdivision map, the Applicant shall deposit $300,000 into a Neighborhood Traffic Management fund that will be used to pay for the study, design, and construction of pedestrian safety, traffic control, and traffic calming measures within the affected streets in east Sacramento and Midtown Sacramento. The fund shall be split into two accounts of $150,000 each with one account designated for the area east of the Capital City Freeway and one designated for the west side of the freeway. Such improvements shall include traffic calming measures for residential streets located directly south of the main project entrance, e.g., Tivoli and 40th Street. The City staff shall organize a committee of neighborhood residents to receive input as to proper and best use of the funds but decision-making on fund expenditures will remain with the City of Sacramento.

2. To help avoid confusion to drivers new to the area and to reduce unnecessary trips on the blocks of 40th Street that are located south of C Street, the project's primary access road from C Street into McKinley Village, which is labeled "40th Street" in the application materials and draft EIR, shall be given a new and original name.

3. The McKinley Village homeowners' association shall provide an assessment that is sufficient to establish and operate a shuttle service to and from Theodore Judah Elementary School.

4. Applicant representative Phil Angelides shall use his best efforts to ensure that all school impact fees are reserved for use by the schools most directly impacted by the project, particularly Theodore Judah Elementary and Sutter Middle schools.

From: popstmd@comcast.net
To: Evan Compton
Cc: Norris, Megan
Subject: McKinley Village
Date: Wednesday, March 26, 2014 3:30:37 PM

---

i have lived at 30th/c st for 30 yrs i am a 4th generation living in this house my great grandmother bought in 1935 i am in total support of McKinley Village it will brighten and clean up the north end of Alhambra blvd. it's been dead around here for years no more homeless walking around at night and going in and out of the storage place. Mckinley Village is the Right choice at the right place and the right time BUILD IT AND LET THEM COME

From: Jean DeCamilla
To: Evan Compton; burchillcitypc@gmail.com
Subject: in support of McKinley Village
Date: Wednesday, March 26, 2014 2:52:40 PM

Mr. Compton and Ms. Burchill,

As a 35 year resident of East Sacramento (37th, 40th and 41st Streets) I want to encourage you to approve the McKinley Village project. Our neighborhood, city and region need to take advantage of what this new and exciting project offers. Namely it provides much needed infill development, respect for existing architecture and neighborhood traditions, an incremental tax base and revenue. We are all fortunate to have Mr. Angelides, an East Sacramento native, as the developer. We will never get another developer as able and as sensitive to the traditions and needs of our neighborhood and city.

I know my neighborhood will be improved by McKinley Village and I encourage you to approve it without further delay.

David DeCamilla
President, DeCamilla Capital Management
Owner, Panama Pottery
Owner, Brickhouse Art Gallery and Studios
Chair, Sacramento City Employee Pension Fund

From:	jill shortley
To:	Evan Compton
Cc:	megan@riverviewci.com
Subject:	McKinley Village
Date:	Wednesday, March 26, 2014 9:28:50 AM

Dear Mr. Compton:

As a long-time resident of East Sacramento and a native Sacramentan, I have worked, played and raised a family in various neighborhoods in Sacramento. I currently have lived in East Sacramento for more than 21 years and have witnessed the evoloution of our city as it continues to grow and improve, especially with regards to in-fill projects in East Sacramento, Midtown and Downtown. I have never been interested in residing in the suburbs. I long for a city that has a vital downtown region along with centrally-located family-run businesses and above all a connection to community.

I have been perplexed by the negativity and ill-conceived perceptions that McKinley Village conjures when speaking to friends and neighbors. I have seen a plethora of signs rejecting the project without any real understanding. I saw this same reaction to Mercy Hospital and the 65th and Folsom development, both welcome additions to East Sacramento. This particular plot of land has been unused for a number of years. I used to actually witness a herd of goats set loose on the land to mow down the weeds! It was entertaining, but I believe this section of town could benefit many growing families once McKinley Village is realized. More importantly I believe that a town must evolve, rather than smother from stagnation. Sacramento is a living organism and we have watched it stumble through the years. It is only the most recent developments that have revitalized our humble Downtown, modernized our "historical" hospitals and created more housing choices for urban renters. East Sacramentans are often guilty of clinging to the status quo, but I believe this lack of imagination harms our city, more than it enhances it's possibilities.

While I have no illusions regarding the motivations of any development, I would much rather see this section of land be converted to housing; a neighborhood (one that has put a lot of thought into detail, architecture and recreation) rather than a Walmart, or mini-mall, or some other high-end use that in no way benefits the tranquil surroundings neighborhoods. I enthusiastically support McKinley Village.

Sincerely,

Jill Shortley

From: Jean DeCamilla
To: Evan Compton; burchillcitypc@gmail.com
Subject: in support of McKinley Village
Date: Wednesday, March 26, 2014 2:52:40 PM

Mr. Compton and Ms. Burchill,

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David DeCamilla
President, DeCamilla Capital Management
Owner, Panama Pottery
Owner, Brickhouse Art Gallery and Studios
Chair, Sacramento City Employee Pension Fund

From:	Lorna Westrick
To:	Evan Compton
Subject:	McKinley Village
Date:	Wednesday, March 26, 2014 7:41:26 AM

Dear Mr. Compton,

The purpose of this correspondence is to offer my support for development of McKinley Village.

The last thing we need is another commercial/office building in the area, there is plenty of existing empty commercial space to be filled. The property is an eyesore in it's current state.

Our local economy is still struggling. The population of McKinley Village would help support local businesses. New Home Construction positively impacts the economy.

I believe the location is a perfect extension of the East Sac community and offers an alternative to the older housing in East Sac. and midtown. Many people purchase homes in the outlying areas of Roseville and Folsom to be able to procure a new single family home and then commute to the downtown area. This increases traffic on our highways and Sacramento loses the revenue as most people shop close to home.

Best Regards,

Lorna Westrick
928 Sonoma Way
Sacramento, CA 95819

From:	Margarita Jakovas
To:	burchillcitypc@gmail.com; Evan Compton
Subject:	McKinley Village
Date:	Wednesday, March 26, 2014 3:31:10 PM

Dear Evan and Kyomi,

I support the McKinley Village project for its location and plan. I also support smart growth. Thank you,

Margarita Jakovas

From:	Onstead, Michael
To:	Evan Compton
Subject:	McKinley Village
Date:	Wednesday, March 26, 2014 3:38:08 PM

Mr. Compton,

I would like to voice my support of McKinley Village. This parcel will be developed at some point and the current plan for McKinley Village is the best use of the land that I have seen. It is a thoughtful design that fits well into the area and existing neighborhoods and addresses the needs and desires of the buyers in the "urban core" area.

I strongly urge approval of this project.

Regards,

Michael Onstead | Director
COLDWELL BANKER DEVELOPMENT SERVICES

730 Alhambra Blvd. | Sacramento, CA 95816
direct: 916.601.5699 | efax: 916.290.0253

DRE# 01222608 | michael.onstead@cbnorcal.com
MichaelOnstead.com | CaliforniaMoves.com

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"Nothing in this email shall be deemed to create a binding contract to purchase/sell real estate. The sender of this email does not have the authority to bind a buyer or seller to a contract via written or verbal communications including, but not limited to, email communications."

From: Nechelle
To: Evan Compton
Subject: McKinley Village
Date: Wednesday, March 26, 2014 4:24:35 PM

Dear Mr. Compton,

I am a long time resident of Midtown and I strongly support McKinley Village. I believe we need more housing in our urban area. Further, recent publicized traffic studies have convinced me the effect on traffic will be minimal. Additionally, I plan to hopefully buy a house in McKinley Village. I hope the Council votes to approve this worthy project.

Sincerely.

Nechelle Bixby

From:	Tamalon Littlefield
To:	burchillcitypc@gmail.com; Evan Compton
Subject:	McKinely Village
Date:	Wednesday, March 26, 2014 3:52:24 PM

To whom it may concern:
I live in the East Sacramento area (47th and Flosom Blvd) and I am writing in support of building McKinley Village. More housing in the Sacramento urban area is healthy for all of us. Urban living allows us to commute less, walk more and have greater opportunities to interact with our community.
Please vote in favor of the Village and when designing it keep the architectural integrity of the beautiful homes in the surrounding neighborhoods.
Thank you
Tamalon Littlefield

RUTAN
RUTAN & TUCKER, LLP

Ash Pirayou
Direct Dial: (650) 320-1515
E-mail: apirayou@rutan.com

March 27, 2014

VIA EMAIL & MESSENGER DELIVERY

Hon. Chair Kiyomi Burchill and Members of
the Planning and Design Review Commission
City of Sacramento
915 I Street, 1st Floor
Sacramento, CA 95814

Re: McKinley Village Project, March 27, 2014 Agenda Item 3

Dear Honorable Members of the City of Sacramento Planning and Design Commission:

This firm represents East Sacramento Partnerships for a Livable City ("ESPLC"). ESPLC is a growing grassroots organization of East Sacramento citizens who are committed to working with various stakeholders in the community in an effort to preserve and enhance the quality of life in East Sacramento—in part, by ensuring that a sensible, comprehensive approach is taken to planning and land use decisions affecting East Sacramento.[1] On behalf of ESPLC, this firm previously submitted comments on the Draft Environmental Impact Report ("DEIR") for the McKinley Village Project (the "Project"), identifying a number of serious deficiencies in the DEIR and urging the City to correct those deficiencies and circulate a revised DEIR before taking action on the Project.

Critically, ESPLC was not alone in questioning the adequacy of the DEIR or objecting to the proposed Project. To the contrary, the City received more than 120 comments on the Proposed project, many of which raised serious concerns regarding the Project's environmental impacts. Unfortunately, instead of revising the DEIR to address those concerns and disclose the true impacts of the Project, the Final Environmental Impact Report ("FEIR") largely brushes them aside. As a result, the FEIR fails as an informational document, and fails to require sufficient mitigation to mitigate the Project's impacts.

[1] ESPLC is the amended name for East Sacramento Residents for a Better Community, which submitted comments to the City relating to the above-listed project.

For the reasons set forth below, as well as in the attached letters prepared by Terra Nova Planning & Research, Inc. ("Terra Nova"), a professional planning and CEQA firm, and Hexagon Transportation Consultants, Inc. ("Hexagon"), a traffic engineering firm (attached hereto, respectively, as Exhibits 1 and 2)[2] and in our comments submitted in connection with the DEIR, ESPLC continues to oppose the Project, as currently defined. The City has not adequately complied with CEQA, and cannot approve the Project until it does so, including by correcting and recirculating the EIR. Moreover, the Project, as currently designed, cannot and should not be approved, because it is inconsistent with numerous goals and policies set forth in the City's General Plan, and will negatively impact the quality of life in East Sacramento for both current and future residents.[3] Accordingly, ESPCL respectfully requests that the Planning Commission decline to recommend the approval of the Project to the City Council, and urges the City to address the concerns set forth herein, including by correcting and recirculating the EIR.

I. <u>The EIR Fails to Disclose or Mitigate the Project's True Transportation Impacts</u>

As noted in our comments on the DEIR, because ESPLC members live and work and are engaged in East Sacramento, an area that already suffers from significant traffic problems, the Project's traffic impacts are of particular concern to ESPLC. For that reason, ESPLC engaged not one, but two separate traffic experts to review the DEIR, both of whom provided extensive comments on the DEIR. (*See* RTC, pp. 3-489 to 3-507.) Unfortunately, the FEIR fails to resolve the concerns set forth in those comments, and indeed, includes new information demonstrating that the Project will have significant unmitigated impacts on traffic and transit.

For example, the FEIR reveals that C Street, between Alhambra and 33rd Street, which the DEIR indicated would operate at LOS A, ***will actually operate at LOS F***. (FEIR, p. 2-26; Terra Nova Letter, p. 7.) This is a significant unmitigated impact that the DEIR failed to disclose, and thus, constitutes significant new information requiring recirculation of the EIR. (CEQA Guidelines § 15088.5(a)(1).) This is not the only significant impact to local streets. As discussed in our comments on the DEIR, a number of other residential streets will be negatively, and significantly, impacted by the Project. (*See* January 10, 2014 letter at FEIR, p. 3-462.) The FEIR fails to adequately respond to those comments. (Hexagon Letter, p. 1, Terra Nova Letter, pp. 7-8.)

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[2] The Hexagon letter contains extensive exhibits. In order to avoid overburdening the City with paper, those exhibits are omitted from the copies of this letter provided for individual members of the Commission. A copy containing all exhibits will be delivered to the City Clerk for inclusion in the Administrative Record.

[3] Alberto Torrico, local counsel to ESPLC, will appear at the March 27, 2014 hearing to speak on behalf of ESPLC.

The FEIR also includes new information confirming that ***the Project will have significant impacts to transit***. Under the threshold of significance identified in the DEIR, a failure "to adequately provide access to transit" is a significant impact. (DEIR, p. 4.9-46.) And pursuant to the City's General Plan, all new neighborhoods are "to include transit stops that connect to and support a citywide transit system and are within a ½-mile walking distance of all dwellings." (Land Use Policy 4.5.6.) Thus, the Project will have a significant impact, unless all new homes contained within the Project are within ½-mile walking distance from adequate public transit.

The DEIR stated there was no such impact, and indicated that existing transit stops would be available only about a ¼-mile from the Project. (DEIR, p. 4.6-15.) The FEIR clarifies, however, that those existing stops are up a ½-mile from the access points to the Project. (FEIR, p. 2-23.) Further, the FEIR reveals that due to the planned closure of several stops, the closest northbound stops will be nearly ***a mile away*** from the entrance to the Project. (FEIR, p. 2-23.) Moreover, as explained by Terra Nova, calculating those distances from the entrance to the Project is improper and misleading because distances within the Project area can add up to ¼-mile to a trip. "Therefore, the closest bus stop is actually up to ¾-miles from the project site" for southbound travel, and "up to 1 ¼-miles" for northbound travel. (Terra Nova Letter, p. 3.) This is a significant unmitigated impact that was not identified and properly disclosed in the EIR. (Hexagon Letter, p. 1.)

In addition, in response to many of the questions and comments raised in connection with the DEIR, the FEIR's Responses to Comments merely repeat text contained in the DEIR, or insist that there is no issue, without providing any evidence to back up that assertion. (*See* Hexagon, p. 1.) To provide just one example, based on the information provided in the DEIR, Hexagon concluded certain mitigation measures discussed in the DEIR would require the elimination of existing bike lanes, which would constitute a significant impact under the thresholds identified in the DEIR. (FEIR, p. 3-503; DEIR, 4.9-46.) The RTC dismisses that comment by stating the DEIR "does not propose to eliminate existing bike lanes," but does not provide any evidence to demonstrate that the proposed improvements could be constructed without impacting the bike lanes. (FEIR, p. 3-582; Hexagon, p. 1.) These types of vague and unsupported responses make it impossible for even outside traffic experts—let alone the general public and the City's decisionmakers—to understand the Project's true traffic impacts. (Hexagon, p. 1; Terra Nova, pp. 7-8.)

II. <u>The EIR Fails to Properly Disclose or Mitigate Impacts to Future Residents</u>

ESPLC is concerned not only about preserving and enhancing quality of life for existing East Sacramento neighborhoods, but about the quality of life for future residents, as well.

Because the Project is squeezed into an area completely surrounded by I-80 and the Union Pacific Railway lines, future residents will be exposed to significant amounts of pollution and noise that will impact their health and overall quality of life. Unfortunately, in the FEIR, the City continues to insist that such impacts are "beyond the scope of required California Environmental Quality Act (CEQA) review." (FEIR, p. 3-509 [citing *Ballona Wetlands Land Trust v. City of Los Angeles* (2011) 201 Cal.App.4th 455].)

The City's position is contrary to the CEQA Guidelines, which expressly require that an EIR "analyze ***any*** significant environmental effects the project might cause by bringing development and people into the area affected." (Guidelines, § 15126.2, emph. added.) Further, the City's assertion that the law is settled on this issue is simply not true. In fact, the issue of whether and when CEQA "require[s] an analysis of how existing environmental conditions will impact future residents or users (receptors) of a proposed project" is currently before the California Supreme Court. (*California Building Industry Association v. Bay Area Air Quality Management District*, Case No. S213478.) If the Supreme Court disagrees with the City's narrow interpretation of CEQA, the EIR will be clearly defective based upon its repeated reliance on *Ballona*.

A. Cancer Risks

Perhaps the most alarming aspect of the City's insistence that it is not required to analyze impacts on future residents of the Project is the (irresponsible) minimization of the increased cancer risk to which those residents will be exposed. The FEIR indicates that residents of the Project would be exposed to an ***increased cancer risk of up to 120 cases per million***. (FEIR, p. 2-12.) As explained by Terra Nova, "under any scientifically-grounded threshold of significance, a cancer risk of 80 to 120 cases per million is considered a significant impact." (Terra Nova, p. 5.) Nonetheless, the City avoids characterizing this as a significant impact by (irresponsibly) applying a vague, unscientific and unsupportable threshold of significance.

The City's analysis of cancer risk was heavily criticized by multiple (objective, third party) commenters on the DEIR, including, significantly, a critical stakeholder in the community: the Sacramento Metropolitan Air Quality Management District ("SMAQMD"), which warned that the DEIR's discussion of SMAQMD's evaluation criterion constituted "a ***serious misinterpretation*** of our guidance." (FEIR, p. 3-107, emph. added.) Of even "greater concern," according to SMAQMD was the City's inappropriate attempt to "deemphasiz[e]" and "downplay[]" cancer risk results through the use of improper comparisons. (FEIR, p. 3-107 ["risk assessment norms dictate that cancer risk be plainly stated"].) SMAQMD also questioned the appropriateness of the City's discussion of "cancer burden" in concluding no significant

impact existed, and opined that the EIR should require specified mitigation measures to reduce pollution exposure to Project residents. (FEIR, p. 3-107, 3-108.)

Further, as noted in the comments submitted by the Environmental Council of Sacramento ("ECOS") the EIR's analysis of cancer risk is similar to one that was ***successfully challenged*** in court after the City approved the Delta Shores project (which included housing near a freeway) several years ago. (*See* Exhibit 3, Notice of Entry of Judgment in *Stone Lakes National Wildlife Refuge Association et al. v. City of Sacramento*.) The City claims it used a different threshold here than in that case, but if anything, the vague threshold the City relied on in finding no significant impact here is ***much less protective than that struck down by the court in the Stone Lakes case***. Moreover, the result of the *Stone Lakes* case was that the City was ultimately required to use a threshold of 10 cases per million. (*See* Exhibit 4.) The City provides absolutely no explanation for its decision to use a vastly more lenient threshold of significance here than what the community has been advised per a court decision should be deemed acceptable.

Moreover, the City's conclusion that a cancer risk of 120 cases per million is insignificant is largely based on its calculation of a purported "cancer burden"—calculated by multiplying the cancer risk by the project population—of less than 1. (FEIR, p. 2-13.) But as set forth in guidance issued by the California Air Pollution Control Officers Association (CAPCOA), an association made up of the air pollution control officers from all 35 local air quality agencies throughout California, the use of such methodology to minimize cancer risk is ***"misleading and not scientifically supported"***:

> One inappropriate calculation is to calculate the cancer risk using the 70-year exposure timeframe, but then reduce the risk values by dividing the risk values by the number of receptors in the subdivision. Doing so is misleading and not scientifically supported. Potential cancer risk should be expressed as probability per million, based upon OEHHA recommendations

(Exhibit A to Exhibit 1, Health Risk Assessments for Proposed Land Use Projects, CAPCOA, p. 23, emph. added.)

As discussed in detail by Terra Nova, the threshold that should be used is the 10 cases per million standard the City was ultimately forced to use in the *Stone Lakes* case. That threshold is consistent with the thresholds established by the two largest air quality management districts (the Bay Area AQMD and the South Coast AQMD) and is regularly used to evaluate cancer risk from mobile sources throughout the state. (Terra Nova, p. 6.) Given that ***the acknowledged cancer***

risk to future residents of the Project is twelve times higher than that threshold of significance, the FEIR's conclusion that the cancer risk to future residents is insignificant is simply unsupportable and unlawfully minimizes this significant health risk.

B. Noise Impacts

As discussed by Terra Nova, the EIR fails to include mitigation to reduce exterior noise to acceptable levels for a single family neighborhood. In fact the noise levels of 65-68 dBA far exceed the 60 dBA standard set forth in the City's General Plan. This is a significant impact that the EIR fails to adequately disclose and/or mitigate.

III. The EIR Must Be Revised and Recirculated

A. Recirculation is Required Because the FEIR Reveals Significant New Impacts

"A lead agency is required to recirculate an EIR when significant new information is added to the EIR after public notice is given of the availability of the draft EIR for public review under Section 15087 but before certification. As used in this section, the term 'information' can include changes in the project or environmental setting as well as additional data or other information." (CEQA Guidelines Section 15088.5(a).) As explained by the Court of Appeal, "[i]f, subsequent to the period of public and interagency review, the lead agency adds 'significant new information' to an EIR, the agency must issue new notice and must 'recirculate' the revised EIR, or portions thereof, for additional commentary and consultation. (*Save Our Peninsula Committee v. Monterey County Bd. of Supervisors* (2001) 87 Cal. App. 4th 99, 131.) "The revised environmental document must be subjected to the same 'critical evaluation that occurs in the draft stage,' ***so that the public is not denied an 'opportunity to test, assess, and evaluate the data and make an informed judgment as to the validity of the conclusions*** to be drawn therefrom.'" (*Id.*, emph. added [holding EIR adding new information about matter of significant public concern should have been recirculated to allow "further discussion and analysis and an opportunity for public response"].)

"Significant new information" requiring recirculation includes, but is not limited to, information showing that:

> (1) A new significant environmental impact would result from the project or from a new mitigation measure proposed to be implemented.
>
> (2) A substantial increase in the severity of an environmental

> impact would result unless mitigation measures are adopted that reduce the impact to a level of insignificance.
>
> (3) A feasible project alternative or mitigation measure considerably different from others previously analyzed would clearly lessen the significant environmental impacts of the project, but the project's proponents decline to adopt it.
>
> (4) The draft EIR was so fundamentally and basically inadequate and conclusory in nature that meaningful public review and comment were precluded.

(CEQA Guidelines, § 15088.5(a).)

Here, as discussed above and in the Terra Nova and Hexagon letters, the FEIR reveals new significant environmental impacts that were not disclosed in the DEIR, including traffic impacts to C Street and impacts to transit. The FEIR also confirms that there will be significant impacts to future residents that have not been properly disclosed. Accordingly, recirculation of the EIR is required under Section 15088.5(a)(1) of the Guidelines.

B. Changes to the Project Description Require Recirculation

"[A]n accurate, stable and finite project description is the *sine qua non* of an informative and legally sufficient EIR." (*County of Inyo v. City of Los Angeles* (1977) 71 Cal.App.3d 185, 199.) "[O]nly through an accurate view of the project may the public and interested parties and public agencies balance the proposed project's benefits against its environmental cost, consider appropriate mitigation measures, assess the advantages of terminating the proposal and properly weigh other alternatives." (*City of Santee v. County of San Diego* (1989) 214 Cal.App.3d 1438, 1454; *San Joaquin Raptor Rescue Center v. County of Merced* (2007) 149 Cal. App. 4th 645, 655.) Among other things, a Project Description must include "[a] list of permits and other approvals required to implement the project." (CEQA Guidelines, § 15124(d)(1)(B); *Rialto Citizens for Responsible Growth v. City of Rialto* (2012) 208 Cal. App. 4th 899, 925-926 [finding a project description was incomplete, where it failed to identify a development agreement as an approval necessary to implement the project].)

Here, as detailed in the Terra Nova letter, the FEIR contains extensive changes to the DEIR. (Terra Nova Letter, pp. 4-5.) These include the revelation that the Project will require numerous discretionary city approvals that were not disclosed or analyzed in the DEIR, including, but not limited to, a development agreement, a Bikeway Master Plan amendment,

subdivision modifications, and driveway variances. As a result, the DEIR's project description was clearly deficient. (*Rialto Citizens for Responsible Growth v. City of Rialto* (2012) 208 Cal. App. 4th 899, 925-926.) Furthermore, in contrast to *Rialto Citizens for Responsible Growth*, where the court ultimately found the failure of an EIR to discuss a development agreement was "not prejudicial," the failure to disclose the various necessary approvals here concealed substantive, physical features of the Project, including the fact that the Project will include sub-standard intersections, roadway configurations, and turnarounds, and that it will require variances from Sacramento City Code requirements for driveway width. (*See* Terra Nova Letter, p. 4.) The DEIR did not analyze the impacts of any of these features, and the public and other interested parties were not given an opportunity to comment on those project features in connection with the DEIR. Thus, the EIR should be recirculated with the updated Project Description in order to provide that opportunity.

IV. <u>Other Issues</u>

As discussed by Terra Nova, the Project is inconsistent with numerous policies in the City's general plan. (*See* Terra Nova Letter, pp. 1-3.) The City may not lawfully approve a proposed development that would be inconsistent with the General Plan. California courts have been clear in emphasizing this fundamental concept; the proposed project must be "compatible with the objectives, policies, general land uses and programs specified in the General Plan." (*Families Unafraid to Uphold Rural etc of Placer County v. Board of Supervisors* (1998) 62 Cal.App.4th 1332, 1336.) Indeed, even in the absence of an outright or explicit conflict, a local agency may not approve a project that is not compatible with, or would frustrate, the General Plan's goals and policies. (*Napa Citizens for Honest Government v. Napa County Board of Supervisors* (2001) 91 Cal.App.4th 342, 378-79 [holding county abused its discretion in adopting a specific plan that permitted development without "definite affirmative commitments to mitigate" impacts to traffic and housing that could interfere with achieving policies and objectives set forth in its general plan].) Thus, the City cannot approve the Project, as proposed, for this reason, as well.

In addition, as noted above, the Staff Report indicates the Project will require variances. In order to grant a variance, the City must make all of the following findings:

> a. The parcel has physical characteristics, including its location, shape, size, topography, and surroundings, that do not generally exist in other properties in the vicinity with the same zoning classification; and

b. Due to these physical characteristics, strict compliance with this title would deprive the subject parcel of development opportunities enjoyed by comparable parcels in the vicinity with the same zoning classification; and

c. Approval of the requested variance will directly address the development impediments created by strict application of this title due to the physical characteristics of the subject parcel, but will not result in development advantages for the subject parcel inconsistent with the limitations imposed by this title on comparable parcels in the vicinity with the same zoning classification; and

d. Approval of the requested variance will not be detrimental to the public health, safety, convenience, or welfare of persons residing, working, visiting, or recreating in the surrounding neighborhood and will not result in the creation of a nuisance; and

e. Approval of the requested variance will not allow a use or activity on the subject parcel that is not otherwise expressly authorized by this title; and

f. Approval of the requested variance authorizes development that is consistent with the general plan and any applicable specific plan or transit village plan.

(City of Sacramento Planning & Development Code § 17.808.210; *see also* Gov. Code § 65906. Moreover, such findings must be supported by substantial evidence and must "bridge the analytic gap between the raw evidence and ultimate decision or order." (*Topanga Assn. for a Scenic Community v. County of Los Angeles* (1974) 11 Cal. 3d 506, 515 [overturning grant of variance where city failed to make adequate findings supporting its issuance].)

Here, the City's Staff Report indicates driveway variances are necessary, but fails to analyze any of the criteria necessary to grant such variances, instead merely stating staff does not object to them. (Staff Report, p. 17.) Further, the draft resolution granting the variance includes only some of the required findings, and is not supported by any evidence. Moreover, given the nature of the requested variances, it does not appear possible for the City to make all of the required findings, and thus, such variances cannot lawfully be approved.

V. Conclusion

Based upon the FEIR's failure to address many of the issues raised in ESPLC's comments on the DEIR, as well as issues raised by other commenters, ESPLC continues to oppose the Project, as currently defined. Indeed, the new information disclosed in the FEIR only heightens ESPLC's concerns about the Project and its impacts.

For all of the reasons set forth herein, and in the attached letters from Terra Nova and Hexagon, the Planning Commission cannot, and should not, recommend approval of the Project. Accordingly, ESPCL respectfully requests that the Planning Commission decline to recommend the approval of the Project to the City Council, and urges the City to address the concerns set forth herein, including by correcting and recirculating the EIR.

Very truly yours,

RUTAN & TUCKER, LLP

Ash Pirayou

AP:kfw

cc: Shirley Concolino, City Clerk, *via email and messenger delivery*
(original, containing all exhibits, to be lodged in the public record)
James Sanchez, City Attorney, *via email only*
Evan Compton, Associate Planner, *via email only*
Dana L. Allen, Associate Planner, *via email only*

EXHIBIT 1

TERRA NOVA PLANNING & RESEARCH, INC.

March 23, 2014

Honorable Chair Burchill and Members of the Planning & Design Commission
City of Sacramento
915 I Street
Sacramento, CA 95814

RE: P08-086, McKinley Village Project

Chair Burchill and Members of the Planning & Design Commission:

On behalf of the East Sacramento Partnerships for a Livable City, we have reviewed the Final Environmental Impact Report and Staff Report for the McKinley Village project. Our analysis has found the project Environmental Impact Report (EIR) deficient, and the land use analysis associated with the project insufficient, as described below.

Land Use Concerns

The Final EIR (FEIR) repeatedly states that the fact that the proposed project is inconsistent with the General Plan's Goals and Policies is not relevant under CEQA. The FEIR goes on to state that our concerns regarding these inconsistencies will be provided to the Commission and Council for consideration in their policy review. However, our comments are not provided to the Commission in the body or any appendix to the staff report. We therefore reiterate our concerns:

"The guiding vision of the General Plan is that ***Sacramento will be the most livable city in America.***"

The Vision statement also states:

> *"The Vision and Guiding Principles are applicable to the context of the city as a whole as well as its community plan areas and neighborhoods."*

The proposed project will locate 336 residences, and over 900 new residents on a parcel that is surrounded by heavily traveled freeway and rail lines. The staff report and EIR assert that the project will comply with the General Plan, but do not address the following questions, as they relate to the project's consistency with the General Plan.

1. *Will the project "promote the health and well-being of the community and…the long-term safety" of its residents? (Vision Statement, page 2)*

   The project will expose over 900 people to carcinogens, a higher than normal risk of cancer, noise levels that will make it impossible to hold a conversation in one's back yard, and hazards that include explosion due to methane build-up.

2. *Will the location of medium density, single family homes within 30 feet of the BUS-80 freeway right of way provide a livable environment for residents? (Vision Statement, page 1; Guiding Principles page 3)*

   The EIR provides no mitigation for exterior noise levels, although it states that the noise levels in back yards, after the construction of 13 foot high walls, will be 65-68 dBA. The General Plan standard for single family homes is 60 dBA. The noise levels have not been mitigated, and the residents will not be able to enjoy a peaceable environment in their back yards.

3. *Is it 'livable' to look at a 13 foot high wall or a passing freight train 20 to 30 feet above you from your back yard?*

   There is no way to mitigate for the elevated railroad tracks. The residents of the project – not only those immediately adjacent, but those several hundred feet from the track – will see, feel and hear the railroad, the freight trains and the dirty emissions spewing from the locomotives. Similarly, the view from the bedrooms of the northern homes will be of the freeway, and if they can see it, they can hear it. It will be impossible for these residents to open their windows and enjoy fresh air.

4. *Will traveling through an enclosed tunnel provide a safe environment for pedestrians and bicyclists? (Guiding Principles, page 3)*

   The applicant has added lighting to the pedestrian and bicycle tunnels. However, when a tunnel is over 100 feet in length, the fact that it is lighted does nothing to prevent criminal activity. Although the staff report and EIR repeatedly explain that the orientation of the homes will provide 'eyes on the tunnel,' it is ludicrous to think that residents in their homes will be able to see 25, 50 or 75 feet into the tunnel.

5. *Will the proposed project provide for the "equitable distribution of affordable housing throughout the City"? (Guiding Principles, page 3)*

   The proposed project is a single family tract – no more, no less. The FEIR repeatedly states that the City's inclusionary housing ordinance does not apply to the proposed project, and that the applicant has agreed to comply if the ordinance is expanded City-wide. This does not address the need for affordable housing, particularly in close proximity to the City's center, where housing prices are inflated.

6. *How does the project "protect the pattern and character of Sacramento's traditional neighborhoods"? (Land Use Policy 4.3.1)*

7. *How will an isolated, land-locked project "integrate the area with adjacent existing neighborhoods and development"? (Land Use Policy 4.5.1)*

The proposed project is entirely and completely isolated. It does nothing to enhance or protect the character of existing neighborhoods, since it will significantly impact neighborhood streets and increase hazards to local pedestrians and bicyclists.

8. *How will the proposed project, as a 'new neighborhood' be "within ½ mile of a central gathering place on a collector or minor arterial…that includes public space, shopping areas, access to transit, and community-supportive facilities and services"? (Land Use Policy 4.5.4)*

9. *How will the proposed project "include transit stops that connect to and support a city-wide transit system and are within a ½ mile walking distance <u>of all dwellings</u>"? (Land Use Policy 4.5.6, emphasis added)*

   The FEIR adds an exhibit showing the distance of shopping, transit and other facilities from the project site, and repeatedly states that the project will be within the minimum distances. What the FEIR ignores is that the distances were calculated from the entry points to the project closest to these services. It does not describe the distances from within the project, which can add as much as ¼ mile to a person's trip. Therefore, the closest bus stop is actually up to ¾ miles from the project site, contrary to the statement in the EIR that the closest bus stop is "a quarter mile to a ½ mile" away; and the distance to a 'central gathering place' is well over a mile, south of J Street.

   Furthermore, although the FEIR states that the E Street ramp closure will remove two bus routes' stops from proximity to the project, increasing the distance to these bus routes to one mile from the entrance to the project and up to 1 ¼ miles from dwellings within the project, it does not declare, as it should, that the proposed project will be inconsistent with General Plan Land Use policies 4.5.4 and 4.5.6. This blatant inconsistency represents a significant impact that has not been mitigated. The City cannot consider the project until the EIR is amended to include mitigation measures to bring the project into conformance with General Plan requirements.

10. *Will the project meet the development guidelines for Traditional Neighborhood land use designation, including a mix of single family homes, second units, duplexes, tri-plexes, four-plexes <u>and</u> apartments (emphasis added); have transit and schools within walking distance; and have safe streets for pedestrians and bicyclists? (General Plan page 2-46)*

    The proposed project has been suddenly modified to include 24 attached condominiums, to replace 16 single family homes in the center of the project. These units are still for-sale units, continuing the "standard tract" concept, and not adding to the diversity of housing required by the General Plan.

<u>Pedestrian and Bicycle Access Has Been Reduced</u>
The FEIR makes two changes throughout the EIR document:

- It eliminates the sidewalk on the north side of A Street across the A Street bridge, and
- It eliminates the sidewalk on the south side of A Street through the project.

As a result, not only will residents not have sidewalk access within the project, they will have to cross A Street if they plan on walking or bicycling over the bridge. These proposed changes further reduce the connectivity of the project, and significantly diminish the claims of the project and the EIR that the project supports pedestrian and bicycle access.

Inconsistencies Relating to Sump 99

The FEIR states that the developer is willing to contribute to the construction of facilities relating to Sump 99. However, the Conditions of Approval provided to the Planning Commission include no such requirement. Therefore, the statement made in the FEIR is without basis, and cannot be enforced.

Alhambra Pedestrian Underpass

The EIR goes to great length to state that the Alhambra pedestrian crossing will be built "if approved by UP and other governmental agencies." The City cannot compel this approval, and the underpass is therefore not a credible or assured component of the project. Yet the FEIR relies on this underpass to demonstrate that the project will be accessible to bus stops and other community facilities.

CEQA Concerns

First and foremost, there is no question that the extensive changes in the FEIR require that the EIR be recirculated:

1. The DEIR did not disclose that the project included a Development Agreement to assure the developer vested rights.
2. The DEIR did not disclose that the project required an amendment to the Bikeway Master Plan.
3. The DEIR did not disclose that the applicant was requesting Subdivision Modifications for sub-standard intersections.
4. The DEIR did not disclose that the applicant was requesting Subdivision Modifications for sub-standard roadway configurations and turnarounds.
5. The DEIR did not disclose that the applicant was requesting Subdivision Modifications for sub-standard dead end streets.
6. The DEIR did not analyze any of these sub-standard design requests, or their impact on public safety (including access for fire department and police department apparatus and personnel).
7. The DEIR did not disclose that Driveway Variances were required, nor did it analyze the impacts of those Variances on traffic, parking or emergency access.
8. The FEIR provides substantial changes in the analysis of storm flows, resulting in a 20% increase in storm flows, but no change in the capacity requirement of detention tanks, without explanation or analysis.
9. The DEIR does not disclose the existence of a Sewer Master Plan prepared in June of 2013, well before the Technical Memorandum Preliminary Sewer Plan dated September of 2013 (and therefore available during the preparation of the DEIR).
10. The DEIR incorrectly identified C Street's roadway classification between Alhambra and 33rd as a Major Collector. In actual fact, it is a Local. As a result of this error, C Street

will operate at LOS F under cumulative conditions, as described in the FEIR. This represents a significant, unmitigated impact for the neighborhood, but the FEIR offers no mitigation.

11. The FEIR revises the CalEEMod air quality in its entirety.
12. The FEIR revises the HRA in its entirety.
13. The FEIR provides a Sustainable Community Strategy consistency analysis not provided in the DEIR.
14. The FEIR includes an additional 40 pages of information relating to the closed landfill that was not included in the DEIR.
15. The FEIR includes 45 pages of changes to the DEIR text.
16. The FEIR changes the Zone Change from all R-1 to include R-2 as well for a new land use: the parkside flats.

Cancer Risk

While the FEIR claims that the criteria used in the DEIR to analyze cancer risk at the project site was correct, it provides a substantially re-written Health Risk Assessment that identifies cancer risk at 80 to 120 cases per million at the project site. As explained below, under any scientifically-grounded threshold of significance, a cancer risk of 80 to 120 cases per million is considered a significant impact. Nonetheless, despite acknowledging the project will result in an increased cancer risk to future residents of up to 120 cases per million, the FEIR continues to insist that this is not a significant impact, by relying on thresholds of significance that are both inconsistent with accepted practice and unsupported by any science.

First, the FEIR continues to assert that this risk level is below the AQMD criterion of 276 cases per million, and is therefore a less than significant impact. As made clear in the comment letter submitted by AQMD, however, the AQMD criterion is not to be used as a threshold of significance, and the EIR's citation to that criterion "is a serious misinterpretation of [AQMD] guidance." In fact, the City's use of that criterion as a threshold of significance for another project located near a freeway several years ago was struck down by the Sacramento Superior Court, in *Stone Lakes National Wildlife Refuge et. al. vs. City of Sacramento ("Stone Lakes").* Significantly, *Stone Lakes* resulted in the City having to redo its cancer risk assessment using a scientifically-supportable threshold of significance of 10 cases per million.

Second, the FEIR improperly minimizes the cancer risk by creating an unsupported "cancer burden" calculation of 0.08 for the project. This methodology is not supported in science, and in fact, has been expressly identified as inappropriate by the California Air Pollution Control Officers Association (CAPCOA), an association made up of the air pollution control officers from all 35 local air quality agencies throughout California. As explained in CAPCOA guidance:

> *One inappropriate calculation is to calculate the cancer risk using the 70-year exposure timeframe, but then reduce the risk values by dividing the risk values by the number of receptors in the subdivision. Doing so is misleading and not*

> *scientifically supported. Potential cancer risk should be expressed as probability per million, based upon OEHHA recommendations.*[1]

CAPCOA goes on to state:

> *"Thresholds can be based on a specific risk level such that a 10 per million excess cancer risk and an acute and chronic hazard index of one should not be exceeded. These thresholds tend to be consistent with the Hot Spot Program thresholds."*[2]

The threshold that should be used to evaluate cancer risks is the 10 cases per million standard the City was ultimately forced to use in the *Stone Lakes* case. That threshold is consistent with thresholds established and utilized to analyze similar projects throughout the State. Most significantly, the two largest Air Quality Management Districts (AQMD) in California – the Bay Area AQMD and the South Coast AQMD, -- have both established thresholds for cancer risk at 10 cases per million for any source, whether mobile or stationary[3]. Moreover, cancer risk has been evaluated at this threshold in EIRs and Initial Studies throughout the State, even in areas where no threshold exists[4]. The Health Risk Assessments identified in the footnote below are appended to this letter. The web link for the complete documents are shown below, and are included in their entirety by this reference.

Under the 10 cases per million threshold commonly used throughout the State (and which the City was required to use in the *Stone Lakes* case) the proposed project will have a significant impact on residents, and that impact has not been mitigated. There is no scientific justification for the FEIR's conclusion that a cancer risk 12 times higher than that threshold of significance is insignificant. As a result, the City has not met its burden under CEQA, and the project cannot be considered for approval until the EIR mitigates the impact to a less than significant level by demonstrating, based on scientific analysis, that the impact can be reduced to less than 10 cases per million.

Storm Water Management

In response to our concerns regarding storm water impacts on the already impacted City CSS, the FEIR states that a number of potential factors will assure that impacts to the CSS are less than significant:

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[1] Health Risk Assessments for Proposed Land Use Projects, CAPCOA, attached hereto as Exhibit A, and Air Toxics Hot Spots Program Risk Assessment Guidelines, OEHHA, attached as Exhibit B.

[2] Ibid.

[3] CEQA Handbook Significance Thresholds, South Coast Air Quality Management District , attached hereto as Exhibit C, and Recommended Methods for Screening and Modeling Local Risks and Hazards, Bay Area Air Quality Management District, attached hereto as Exhibit D.

[4] Health Risk Assessments from, Visalia, Los Angeles and San Jose, are attached hereto as Exhibits E-F. The Visalia Walmart EIR can be accessed at http://www.ci.visalia.ca.us/depts/community_development/planning/walmart_expansion_project.asp. The Los Angeles Ponte Vista EIR can be accessed at http://cityplanning.lacity.org/eir/PonteVistaProj2/DEIR/DEIR%20Ponte%20Vista%20Project.html. The San Jose Initial Study can be accessed at http://www.sanjoseca.gov/index.aspx?nid=2165

> Dewatering discharges to the City's CSS during construction are not anticipated because the initial phases of construction, including utilities, would occur during the dry season (May through November) and because dewatering discharges, if needed, would most likely be made t another part of the site…

Yet there is no mitigation measure in the EIR, nor are there conditions of approval in the staff report that require either construction during the summer months or discharge on other parts of the site. The FEIR treats assumptions as fact, and cannot assure that either of these assumptions will occur. Therefore, unless mitigation measures are added to the EIR, impacts associated with dewatering remain potentially significant.

Noise

The FEIR incorrectly states that long term noise impacts associated with residents adjacent to the freeway have been mitigated. That is untrue. The DEIR states that exterior noise levels in outdoor areas adjacent to the freeway will be 65-68 dBA. The City's General Plan standard for single family homes is 60 dBA. The only mitigation measures in the EIR relate to interior noise levels. No mitigation is provided for exterior noise levels, other than a requirement that buyers be notified that they will be living next to high noise generators. This is not a mitigation measure, since it does nothing to reduce the impact. Impacts associated with outdoor noise levels remain significant, and have not been mitigated.

Traffic

The traffic analysis was inadequate in the DEIR, as identified by the California Department of Transportation, in their comments on the EIR, and by many others. We continue to assert that the EIR's reliance on both SCS conformity and General Plan Policy M 1.2.2 are inappropriate. The City cannot rely on these two conditions to allow a project to have significant impacts on traffic and circulation without mitigating those impacts, as required under CEQA.

The FEIR states that a traffic study was indeed prepared, and that 'model outputs' were included in the appendix of the DEIR. The FEIR, however, does not produce this traffic study, but instead claims that the analysis in the DEIR is sufficient demonstration of the adequacy of the traffic analysis.

Of critical importance, a significant, unmitigated impact is identified for the first time in the FEIR: C Street, between Alhambra and 33rd Street, will operate at LOS F. Although the FEIR makes this statement, it does not propose any mitigation for this completely unacceptable failure. The EIR cannot claim that consistency with the SCS allows it to avoid analysis of this impact, because C Street is a local roadway, not a part of the regional roadway system that the EIR insists does not require analysis or mitigation. . Nor can the City claim that Policy M 1.2.2 (b) would apply in this case. Policy M 1.2.2.(b) is designed to address General Plan roadway segments and intersection on arterials and collectors, not impacts on local streets. The FEIR does not mitigate this significant impact to the local roadway system, or offer any explanation as to why the significant impact has not been addressed. The impacts to residents of the neighborhood on and surrounding C Street must be considered, and mitigation measures must be developed.

Further, the FEIR states that the mitigation measures proposed for Alhambra and H Street, and Alhambra and E Street have been reviewed by the City Engineer, and found to be feasible. If the plans for the mitigation have been developed to such a detail that the City Engineer is able to determine that they are feasible, those plans must be provided to the public and decision makers for their consideration. How can the Planning & Design Commission and City Council reach that conclusion without understanding what those designs will be?

In response to our concerns regarding the potential for conflict between the Sutter's Landing interchange and the proposed project, the FEIR simply states that the project and the interchange will not conflict with each other. No evidence to support this claim has been provided. There is no evidence that the interchange design will not impact the proposed project, or that the proposed project will not negatively impact the interchange. This must be addressed with demonstrated evidence provided by graphic depiction of both the interchange design and the proposed project's improvements.

Change in Project Objectives

The FEIR conveniently changes the Project Objectives because the project now includes 'parkside flats.' The Objectives are amended to read: "Provide a range of single family home and lot types, as well as attached condominium units." Yet the EIR Alternatives section has not been modified to consider this change in Project Objectives, and how it may impact Alternative 4 in particular.

Conclusion

The McKinley Village project analysis is incomplete and inadequate, both from a land use and a CEQA perspective. The Planning & Design Commission should consider the evidence provided and ask City staff to analyze the land use implications of the project, its lack of consistency with the General Plan, and its inappropriate location. The Commission should also insist that the Environmental Impact Report be corrected and properly recirculated. Until such time as these tasks are completed, there should be no recommendation to the City Council, and the project should be tabled.

Sincerely,

Nicole Sauviat Criste
Principal

EXHIBIT A

Health Risk Assessments for Proposed Land Use Projects

CAPCOA Guidance Document

CAPCOA
CALIFORNIA AIR POLLUTION CONTROL OFFICERS ASSOCIATION

Prepared by:
CAPCOA Planning Managers

Approved for Release
July 2009

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Glossary

Acute Hazard Index	Acute Hazard Index is the ratio of the average short term (generally one hour) ambient concentration of an acutely toxic substance(s) divided by the acute reference exposure level set by the Office of Environmental Health Hazard Assessment. If this ratio is above one, then adverse health effects may occur.
Background Risk	Background risk is the risk level found throughout an area. This risk is not caused by a particular facility; it is the cumulative risk and may be partly due to air pollution from vehicle traffic.
Cancer Risk	Cancer risk is defined as the probability that an individual will contract cancer usually expressed as so many chances per million persons exposed to a specified concentration of carcinogenic substance(s).
Chronic Hazard Index	Chronic Hazard Index is the ratio of the average annual ambient concentration of a chronically toxic substance(s) divided by the chronic reference exposure level set by the Office of Environmental Health Hazard Assessment. If this ratio is above one, then adverse health effects may occur.
Commenting Agency	A commenting agency is any public agency that comments on a CEQA document, but is neither a lead agency nor a responsible agency. For example, a local air district, as the agency with the responsibility for air pollution control, could review and comment on an air quality analysis in a CEQA document, even though the project was not subject to an air permit or other air pollution control requirements.
Cumulative impact	Cumulative impacts represent the risks from all onsite sources and from sources near enough to the project to significantly contribute to the total risk levels.
Hot Spots Program	Health and Safety Code §44300-44394, Program which requires existing sources to inventory toxic emissions, prepare risk assessments, notify significantly exposed receptors, and prepare and implement risk reduction plans.
Lead Agency	A lead agency is the public agency that has the principal responsibility for carrying out or approving a project that is subject to CEQA. In general, the land use agency is the preferred public agency serving as lead agency, because it has jurisdiction over general land uses. The lead agency is responsible for determining the appropriate environmental document, as well as its preparation.

Receptors	Receptors include sensitive receptors and worker receptors. Sensitive receptors refer to those segments of the population most susceptible to poor air quality (i.e., children, the elderly, and those with pre-existing serious health problems affected by air quality). Land uses where sensitive individuals are most likely to spend time include schools and schoolyards, parks and playgrounds, daycare centers, nursing homes, hospitals, and residential communities (these sensitive land uses may also be referred to as sensitive receptors). Worker receptors refer to employees and locations where people work.
Responsible Agency	A responsible agency is a public agency, other than the lead agency, with discretionary approval authority over a project that is subject to CEQA (i.e., project requires a subsequent permit).
Risk Assessment	An evaluation that assesses the impact of toxic substances affecting receptors. A risk assessment can include minimal input parameters resulting in conservative results (screening risk assessment) or include increasingly detailed input parameters (refined risk assessment).
Source	A source is referred to as the locality where toxic emissions originate and are released into the atmosphere. Sources of emissions are categorized into groups such as point source (e.g., refinery) or line source (e.g., roadway).
Type A Project	Land use project that impacts receptors near the project.
Type B Project	Land use project with receptors that are impacted by nearby, existing toxics sources.

Acronyms

ARB:	California Air Resources Board
ATCM:	Air Toxic Control Measure
CAPCOA:	California Air Pollution Control Officers Association
CEQA:	California Environmental Quality Act
DPM:	Diesel Particulate Matter
EIR:	Environmental Impact Report
EPA:	U.S. Environmental Protection Agency
HRA:	Health Risk Assessment
OEHHA:	California Office of Environmental Health Hazard Assessment
PM:	Particulate Matter
REL:	Reference Exposure Level
TAC:	Toxic Air Contaminant
TBACT:	Toxic Best Available Control Technology

Executive Summary

This guidance was prepared to assist Lead Agencies in complying with the requirements of the California Environmental Quality Act (CEQA)[1]. CEQA requires environmental impacts of a proposed project be identified, assessed, and avoided or mitigated (as possible) if these impacts are significant. To determine the impact of airborne toxic emissions [i.e., toxic air contaminants (TACs)] for CEQA purposes, health risk assessments must be prepared. This document describes when and how a health risk assessment should be prepared and what to do with the results.

In 2005, the California Air Resources Board (ARB) prepared the ***Air Quality and Land Use Handbook: a Community Health Perspective*** **(ARB Handbook)**[2], to help readers understand the potential cancer risks from some common sources of toxic emissions such as:

- Freeways and High Traffic Volume Roads,
- Goods Distribution Centers,
- Rail Yards,
- Ports,
- Refineries,
- Chrome Platers,
- Dry Cleaners using Perchloroethylene, and
- Gasoline Dispensing Facilities.

The ARB Handbook identified the potential cancer risks at various distances from these sources and recommended buffer distances between those sources and receptors.

Recent air pollution studies have shown an association between respiratory and other non-cancer health effects and proximity to high traffic roadways. Other studies have shown that diesel exhaust and other cancer-causing chemicals emitted from cars and trucks are responsible for much of the overall cancer risk from airborne toxics in California.

While local air districts have ample experience evaluating and mitigating toxic emissions from permitted stationary sources, most have limited experience preparing or reviewing risk assessments associated with multiple toxic sources or assessments for exhaust from mobile sources that are typically found when evaluating health risks to proposed land use projects.

In order to provide consistency to lead agencies, project proponents and the general public throughout the state, the California Air Pollution Control Officers Association (CAPCOA) formed a subcommittee composed of representatives from the Planning Managers Committee and the Toxic Risk Managers Committee to develop guidance on assessing the health risk impacts from and to proposed land use projects. This CAPCOA guidance document focuses on the acute, chronic, and cancer impacts of sources affected by CEQA. It also outlines the

[1] Title 14 California Code of Regulations, Chapter 3. Guidelines for Implementation of the California Environmental Quality Act.

[2] Air Quality and Land Use Handbook: a Community Health Perspective, CARB, April 2005, http://www.arb.ca.gov/ch/handbook.pdf

recommended procedures to identify when a project should undergo further risk evaluation, how to conduct the health risk assessment (HRA), how to engage the public, what to do with the results from the HRA, and what mitigation measures may be appropriate for various land use projects. With respect to health risks associated with locating sensitive land uses in proximity to freeways and other high traffic roadways, HRA modeling may not thoroughly characterize all the health risk associated with nearby exposure to traffic generated pollutants.

This guidance does not include how risk assessments for construction projects should be addressed in CEQA. As this is intended to be a “living document”, the risks near construction projects are expected to be included at a later time as the toxic emissions from construction activities are better quantified. State risk assessment policy is likely to change to reflect current science, and therefore this document will need modification as this occurs.

1.0 Requirements to Evaluate Health Risks in CEQA

This guidance was prepared to assist Lead Agencies in complying with the requirements of the California Environmental Quality Act (CEQA)[3]. CEQA requires that environmental impacts of proposed projects be identified, assessed, avoided and/or mitigated (as possible) if the environmental impacts are significant.

Section 15126.2(a) requires the following: *"An Environmental Impact Report (EIR) shall identify and focus on the significant environmental effects of the proposed project. In assessing the impact of a proposed project on the environment, the lead agency should normally limit its examination to changes in the existing physical conditions in the affected area as they exist at the time the notice of preparation is published, or where no notice of preparation is published, at the time environmental analysis is commenced. Direct and indirect significant effects of the project on the environment shall be clearly identified and described, giving due consideration to both the short-term and long-term effects. The discussion should include relevant specifics of the area, the resources involved, physical changes, alterations to ecological systems, and changes induced in population distribution, population concentration, the human use of the land (including commercial and residential development), health and safety problems caused by the physical changes, and other aspects of the resource base such as water, historical resources, scenic quality, and public services. The EIR shall also analyze any significant environmental effects the project might cause by bringing development and people into the area affected. For example, an EIR on a subdivision astride an active fault line should identify as a significant effect the seismic hazard to future occupants of the subdivision. The subdivision would have the effect of attracting people to the location and exposing them to the hazards found there."*

This language is included here to clearly show that risk assessments can be required for <u>both</u> projects that will impact nearby receptors (Type A), and projects that will be impacted by nearby sources (Type B).

[3] Pub. Resources Code § 21067; 14 Cal. Code Regs., §§ 15150, 15367.

2.0 Overview of the Process

Figure 1 shows an overview of the proposed Health risk Assessment (HRA) process. There are basically two types of land use projects that have the potential to cause long-term public health risk impacts:

Type A - Land use projects with toxic emissions that impact receptors, and
Type B - Land use project that will place receptors in the vicinity of existing toxics sources.

Type A project examples (project impacts receptors):

- combustion related power plants,
- gasoline dispensing facilities,
- asphalt batch plants,
- warehouse distribution centers,
- quarry operations, and
- other stationary sources that emit toxic substances.

Type B project examples (project impacted by existing nearby toxic sources):

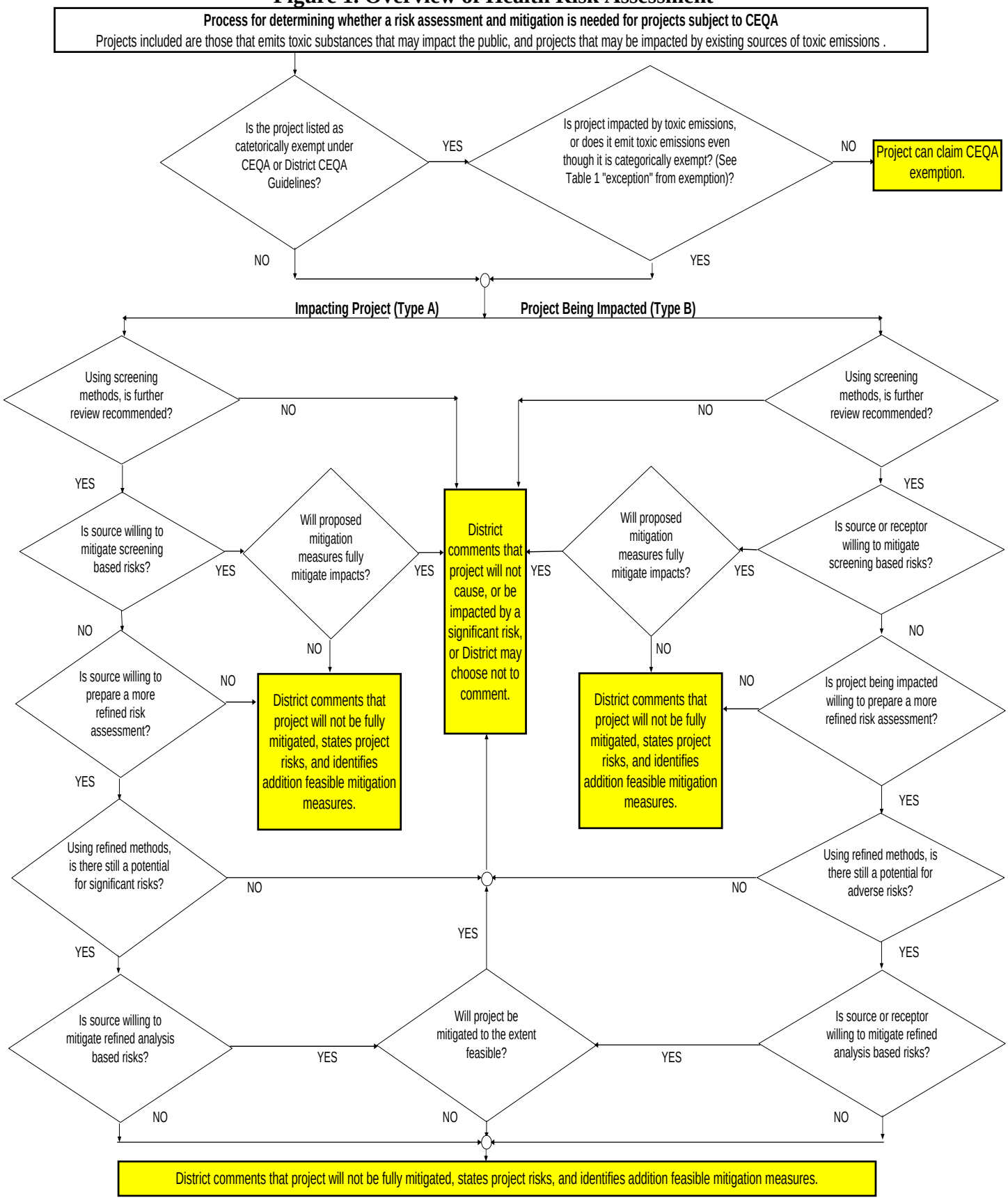
- residential, commercial, and institutional developments proposed to be located in the vicinity of existing toxic emission sources such as:
  - stationary sources,
  - high traffic roads
  - freeways,
  - rail yards, and
  - ports.

The flowchart (Figure 1) shows how to proceed with the CEQA process when either a Type A or Type B related project is proposed. The following summarizes the process for proceeding through the flowchart:

- First determine if the project is categorically exempt from CEQA;
- Next, determine if the project is impacting, or being impacted (Type A or B);
- Using screening methods, calculate acute, chronic, and cancer risk;
- If the screening analysis indicates significant health risk as defined by the lead agency, demonstrate that risks will be mitigated with all feasible measures even though a refined risk assessment may show that less mitigation is needed;
- Or, conduct a refined screening risk assessment; and,
- If the risk continues to be deemed significant by the lead agency even with the refined screening, demonstrate that the risks will be adequately mitigated with feasible measures.

Air districts, in their role as either a responsible agency or a commenting agency, should review the HRA and communicate to the lead agency their evaluation of the risk assessment and whether it is fully described (e.g., methodology, assumptions and resulting risk values) and mitigated with all feasible measures.

Figure 1. Overview of Health Risk Assessment



3.0 Overview of Risk Assessment Methodology and Guidance Documents

This document bases the risk assessment methodology on the procedures developed by the California Office of Environmental Health Hazard Assessment (OEHHA) to meet the mandates of the Air Toxics "Hot Spots" Information and Assessment Act (AB 2588). The Hot Spots program applies to stationary sources and requires affected facilities to prepare a toxic emissions inventory, and if the emissions are significant, that a risk assessment be prepared. The OEHHA procedures can be found at http://www.oehha.ca.gov/air/hot_spots/index.html and describe:

- The toxicity factors associated with various substances,
- How these toxicity factor are to be used to determine the acute, chronic, and cancer risks associated with downwind concentrations of chemicals in the air at various receptors, and
- Dispersion modeling procedures.

4.0 CEQA Exemptions

The first step in a risk analysis is to determine if the project is statutorily or categorically exempt from CEQA. There are no exceptions to statutorily exempt projects, however, certain projects that are categorically exempt under the state or air district guidelines, may emit toxic emissions or may be impacted by existing toxic sources. Table 1 shows the exceptions from categorical exemptions where an HRA evaluation is needed. These are situations where a project proponent or lead agency may not rely on a categorical exemption because the health risk may trigger an exception (CEQA §15300.2), preventing their use. In such cases, a negative declaration or environmental impact report should be prepared.

Table 1
Categorical Exemptions Requiring HRA Evaluation[4]

Categorical Exemption	Exempt Activity with *Possible Impact*
15301. Existing Facilities	This exemption also allows use of a single-family residence as a day care facility without CEQA review. *However, such uses near existing TAC emissions may warrant further review.*
15302. Replacement or Reconstruction	This exemption allows the replacement or construction of existing schools and hospitals in certain cases without CEQA review. *However, locating new facilities near existing TAC emissions may warrant further review.*
15303. New Construction or Conversion of Small Structures	This exemption class allows small new construction projects to proceed without CEQA review. *However, projects claiming this exemption should be reviewed for possible TAC impacts from ongoing nearby sources.*
15314. Minor Additions to Schools	This exemption class allows small school addition projects to proceed without CEQA review. *However, projects claiming this exemption should be reviewed for possible TAC impacts from ongoing nearby sources.*
15316. Transfer of Ownership of Land in Order to Create Parks	Exemptions in this class should be reviewed for *possible impacts from locating near ongoing sources of TAC.*
15332. In-Fill Development Projects.	This exemption class allows certain in-fill development projects to proceed without CEQA review. *However, projects claiming this exemption should be reviewed for possible TAC impacts from ongoing nearby sources such as high volume roadways and freeways.*

[4] Although methodology for assessing health risk for construction projects is not included in this document, lead agencies under CEQA are required to identify health risk from construction activities or projects and mitigate if they are deemed significant.

5.0 Screening Risk Assessments

Various tools already exist to perform a screening analysis from stationary sources impacting receptors (Type A projects) as developed for the AB2588 Hot Spots and air district permitting programs. Local air districts should be contacted for appropriate screening tools for proposed projects. Screening tools may include: prioritization charts, SCREEN3 and various spreadsheets.

For projects being impacted by existing sources (Type B projects), one screening tool is contained in the ARB Handbook[4]. The handbook includes a table (reproduced in these guidance documents as Table 2) with recommended buffer distances associated with various types of common sources. ARB's Handbook focuses on community health and provides important public health information to land use decision makers. In this document, ARB's primary goal is to provide information that will help keep California's children and other vulnerable populations out of harm's way with respect to nearby sources of air pollution.

For example, as shown in Table 2, ARB recommends avoiding siting new sensitive land uses such as residences, schools, daycare centers, playgrounds, or medical facilities within 500 feet of a freeway, urban roads with traffic volumes exceeding 100,000 vehicles/day, or rural roads with volumes greater than 50,000 vehicles/ day. Therefore, siting a residential project within 500 feet of a freeway, and the associated public health risks, should be disclosed as such in a CEQA document. Re-designing the project so that sensitive receptors are moved greater than 500 feet away from such roadways may mitigate the risk. Other non-sensitive land uses such as commercial uses may be sited in this area. ARB recommends that their guidelines be considered by the decision makers along with housing needs, economic development priorities, and other quality of life issues. It should also be noted that health risk assessments conducted on sensitive land uses in close proximity to freeways and other high traffic roadways may not thoroughly characterize all the health risk associated with nearby exposure to traffic generated pollutants.

Table 2
Recommendations on Siting New Sensitive Land Uses Such As Residences, Schools, Daycare Centers, Playgrounds, or Medical Facilities [5]

Source Category	Advisory Recommendations
Freeways and high-traffic roads	• Avoid siting new sensitive land uses within 500 feet of a freeway, urban roads with 100,000 vehicles/day, or rural roads with 50,000 vehicles per day.
Distribution centers	• Avoid siting new sensitive land uses within 1,000 feet of a distribution center (that accommodates more than 100 trucks per day, more than 40 trucks with operating transport refrigeration units (TRUs) per day, or where TRU unit operations exceed 300 hours per week). • Take into account the configuration of existing distribution centers and avoid locating residences and other new sensitive land uses near entry and exit points.
Rail yards	• Avoid siting new sensitive land uses within 1,000 feet of a major service and maintenance rail yard. • Within one mile of a rail yard, consider possible siting limitations and mitigation approaches.
Ports	• Avoid siting of new sensitive land uses immediately downwind of ports in the most heavily impacted zones. Consult local air districts or the ARB on the status of pending analyses of health risks.
Refineries	• Avoid siting new sensitive land uses immediately downwind of petroleum refineries. Consult with local air districts and other local agencies to determine an appropriate separation.
Chrome platers	• Avoid siting new sensitive land uses within 1,000 feet of a chrome plater.
Dry cleaners using perchloroethylene	• Avoid siting new sensitive land uses within 300 feet of any dry cleaning operation. For operations with two or more machines, provide 500 feet. For operations with 3 or more machines, consult with the local air district. • Do not site new sensitive land uses in the same building with perc dry cleaning operations.
Gasoline dispensing facilities	• Avoid siting new sensitive land uses within 300 feet of a large gas station (defined as a facility with a throughput of 3.6 million gallons per year or greater). A 50 foot separation is recommended for typical gas dispensing facilities.

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- These recommendations are advisory. Land use agencies have to balance other considerations, including housing and transportation needs, economic development priorities, and other quality of life issues.
- Recommendations are based primarily on data showing that the air pollution exposures addressed here (i.e., localized) can be reduced as much as 80% with the recommended separation.
- The relative risk for these categories varies greatly. To determine the actual risk near a particular facility, a site-specific analysis would be required. Risk from diesel PM will decrease over time as cleaner technology phases in.
- These recommendations are designed to fill a gap where information about existing facilities may not be readily available and are not designed to substitute for more specific information if it exists. The recommended distances take into account other factors in addition to available health risk data (see individual category descriptions).
- Site-specific project design improvements may help reduce air pollution exposures and should also be considered when siting new sensitive land uses.
- This table does not imply that mixed residential and commercial development in general is incompatible. Rather it focuses on known problems like dry cleaners using Perchloroethylene that can be addressed with reasonable preventative actions.
- A summary of the basis for the distance recommendations can be found in the ARB Handbook.

6.0 Refined Risk Assessments

If a screening risk assessment shows that a risk is a concern, then a more refined analysis may be prepared. The refined analysis for the project may show lower risks, and provide more accurate information for decision makers. The screening assessment uses more conservative assumptions and thus gives higher risk than refined assessment. Risk assessments are normally prepared in a tiered manner, where progressively more input data is collected to refine the results. These guidelines include the evaluation of both mobile and stationary sources.

Attachment 1 to this document consists of the ***Technical Modeling and Risk Assessment Guidance*** which address various air quality dispersion modeling issues pertinent to California and is based primarily on information found in ARB, EPA and OEHHA guidance.

Appendix A, ***Meteorological Data,*** provides information on preparing meteorological data, mixing height and upper air data and land use characterization.

Appendix B, ***Modeling and Exposure Assessment Input and Output Data,*** is a checklist of parameters designed to provide an overview of all information that should be submitted for a refined air dispersion modeling assessment.

7.0 Risk Thresholds

An air district can set CEQA significant risk thresholds (e.g. the excess cancer risk shall be less than ten per million, the acute or chronic hazard index shall be less than one, or other significance levels as arrived at through a public process) that are used on a per-project basis. If the air district's governing board has adopted specific risk thresholds, the lead agency may choose to use them to determine acceptable risk levels. Additionally, clear risk thresholds are helpful when mitigation measures are necessary. The degree of mitigation can be clearly defined when a risk threshold has been determined before a project is proposed.

The absence of a risk threshold does not relieve an agency of its obligation to address toxic emissions from projects under CEQA. The implications of not having a threshold are different depending on the role the agency has under CEQA – whether it is acting as a commenting agency, as a responsible agency, or as a lead agency.

7.1 Significant Risk Thresholds - Type A (Impacting Sources)

For Type A projects, those that generate toxic air contaminants (such as gasoline stations, distribution facilities or asphalt batch plants), air districts are uniform in their recommendation to use the significance thresholds that have been established under each district's "Hot Spots" and permitting programs. For the majority of the air districts the **excess cancer risk** significance threshold is set at **10 in a million**. For toxic air contaminants with acute and chronic, non-carcinogenic health effect, a **hazard index of one** must not be exceeded. Depending on the substances being emitted, a project with a hazard index greater than one could result in adverse health effects of various sorts. It should be noted that a hazard index exceeding one may need additional analysis to determine whether the acceptable level of acute or chronic risk could be higher depending upon the safety factors that were incorporated into the reference exposure levels (RELs) associated with the hazard index results. This additional analysis could be considered an additional refinement tier.

It should be noted that these thresholds may be applied differently for air district permitting, the Hot Spots program, and CEQA. For air district permitting, the thresholds apply only to individual permit units. For the Hot Spots program, the thresholds apply to the entire facility excluding vehicle emissions. Neither the permitting programs nor the Hot Spots program apply to vehicle emissions. For CEQA, the thresholds apply to <u>all</u> facilities including vehicle emissions, and road related emissions.

7.2 Significant Risk Thresholds - Type B (Projects Impacted by Existing Sources)

For Type B projects, those that are impacted by existing sources, air districts are not uniform in their recommendation on what significance threshold should be adopted or what processes should be undertaken when disclosing potential risks.

The CEQA statutes encourage an air district or any lead agency to establish significance thresholds under CEQA for any pollutant. While there are considerations that support the establishment of thresholds, there is no obligation to do so. The absence of a threshold does not relieve agencies of their obligations to address toxic emissions from projects under CEQA. The implications of not having a threshold are different depending on the role the agency has under CEQA – whether it is acting in commenting agency, as a responsible agency, or as a lead agency.

An air district or other lead agency may elect not to establish significance thresholds for a number of reasons.

A lead agency or air district may also determine there is insufficient information to support selecting one specific threshold over another. Air districts have historically recommended CEQA thresholds for air pollutants in the context of the air district's clean air attainment plan, or (in the case of toxic air pollutants) within the framework of a rule or policy that manages risks and exposures due to toxic pollutants.

Significance levels have been approached differently by air districts as enumerated below:

- Thresholds can be based on a specific risk level such that a 10 per million excess cancer risk and an acute and chronic hazard index of one should not be exceeded. These thresholds tend to be consistent with the Hot Spot Program thresholds.
- Thresholds can also be based on the region's existing background cancer risk value if one exists.
    - One option is to establish a risk level equal to a region's background risk level.
    - Another option is to establish a risk level equal to twice a region's background risk level.
    - Still another option is to look at the ambient risk in the immediate vicinity of the project area rather than the regional risk level.
- Case by case thresholds may also be defined.

8.0 Mitigation Measures

CEQA requires that adverse environmental impacts of a proposed project be identified, assessed, avoided, and, if deemed significant, mitigated (as feasible) to a level that is considered less than significant. "'Feasible' means capable of being accomplished in a successful manner within a reasonable period of time, taking into account economic, environmental, legal, social, and technological factors" (CEQA Guidelines §15364).

In cases where significant adverse impacts are not avoided or substantially lessened, the public agency may approve the project if it first adopts a "statement of overriding considerations." The statement of overriding considerations sets forth the specific reasons why the public agency found the project's benefits outweigh its unavoidable adverse environmental effects (CEQA Guidelines§15043).

In addition to being a CEQA requirement, mitigating public exposure to toxic air pollution is needed to achieve air district goals. All potentially significant emission sources must be mitigated to the greatest extent feasible, including placing people out of harm's way.

Table 3 presents mitigation measures that are currently considered to be feasible to reduce health risk from both Type A and Type B projects. The mitigation measures included in the table are not considered to be exhaustive. The lead agency and project proponents are encouraged to think creatively in devising measures to mitigate air quality impacts. However, the air districts recognize that the final determination of feasibility for a project will be determined by the lead agency. Aside from the mitigation measures shown below, knowing about the regulatory programs to reduce air pollutant emissions through statewide strategies provide information to local air districts and lead agencies to help assess and mitigate cumulative air pollution impacts as well.

8.1 Mitigations due to Air Toxic Control Measures

ARB has been developing Air Toxic Control Measures (ATCMs) for many years. Many of these measures have a phase-in schedule. Implementation of others has already been completed. While cancer and non-cancer risks from the air toxic sources implementing ATCMs are expected to decrease with time, the Office of Environmental Health Hazard Assessment (OEHHA) recommends that it is inappropriate to assume these yet-to-be realized emissions reductions in a health-risk assessment. However, the project proponent is encouraged to become familiar with existing and proposed ATCMs in order to determine if any of the ATCMs affect project-specific emissions.

8.2 Mitigating Through Land Use and Design

To a certain extent, the long-term air quality impact of a project is a function of its design. The layout of streets, the mix of land uses, and the placement of homes and businesses can all affect overall project emissions. Yet in many instances, the air quality impacts of a project are not considered until well after a project has been designed. At such a late stage, it can be very difficult to make any substantial changes to the project to reduce the project's air quality impact.

As indicated throughout the ARB Handbook, land use agencies are strongly encouraged to consult early and often with local air districts. Including air quality considerations during the initial design phase can help an applicant to implement design features that will reduce its air quality impact.

In addition to considering the suitability of the project location, opportunities for mitigation of air pollution impacts through design should be considered. In some cases, control devices and changes in processes may be implemented at the source in order to reduce the risk from toxic air contaminant emissions. Examples of land-use based air quality specific performance standards include the following:

- Placing a process vent away from the direction of nearby receptors, or increasing the stack height so that emissions are dispersed to reduce the emissions impact on the immediate surroundings.
- Limiting the hours of operation of a facility to avoid excess emissions exposure to nearby individuals.
- An ordinance that requires fleet operators to use cleaner vehicles before project approval (if a new business), or when expanding the fleet (if an existing business).
- Providing alternate routes for truck operations that discourage detours into sensitive receptor neighborhoods.

While such measures may reduce the dimensions of a buffer zone, they do not obviate the need to maintain buffer zones to protect public health and safety. This is particularly true in situations where a sensitive receptor is encroaching on an existing source of toxic air contaminant. Also note disclosure statements, community alert procedures, etc., that are targeted at potential receptors are not appropriate mitigations to be used in lieu of buffer zones or technical controls.

Table 3 below contains examples of both project and program-level mitigation measures.

- Project-level mitigation measures are applicable to development which results in the implementation or modification of a land use which creates unacceptable levels of risk. Examples include redesigning the project to locate receptors away from TAC sources, the installation of barriers and/or vegetation and indoor air filtration.

- Program-level mitigation measures, on the other hand, are applicable to long-range community planning such as General Plans, and address land use incompatibility at a much earlier stage. Examples of program-level mitigation measures include rezoning vacant land adjacent to high-volume roadways, ports, railroads or heavy industry to avoid future proposed siting of residential and/or sensitive receptors.

8.3 Mitigation Effectiveness

The mitigation measures identified in Table 3 include both quantifiable and unquantifiable measures.

8.3.1 Quantifiable Mitigation Measures

The effect of quantifiable mitigation measures can be modeled or calculated beyond a reasonable doubt. As pertaining to health risk impacts, quantifiable mitigation measures generally result in a measurable reduction of toxic air contaminant emissions (such as DPM), or a measurable decrease in exposure to such emissions through increased buffer distances, reduced exposure durations or control devices having a certified control effectiveness.

Examples of quantifiable mitigation measures include:

- Diesel particulate filters: as of 2008, DPFs reduce the emissions of diesel particulate matter up to 85% as verified by the CARB.
- Increasing the distance between a TAC source and receptor may reduce the receptor's level of exposure to TACs; the effect of this mitigation measure can be estimated through dispersion modeling;
- Idling restrictions can greatly reduce or completely eliminate DPM emissions from stationary trucks; if such restrictions are quantitative and include a concrete limit on the number of minutes a truck (or similar) is allowed to idle, the benefits of this mitigation measure can be modeled.

Several cautionary notes regarding estimating the effectiveness of mitigation measures are warranted:

- Clearly explain the assumptions underlying the environmental document's analysis of mitigation measure effectiveness. The analysis should specifically describe the mitigation measure, identify the source(s) of air pollutants that are expected to be affected by the measure, clearly explain how and to what extent the measure will affect the source(s), and identify the basis for the estimate (empirical observations, computer modeling, case studies, etc.). Critical assumptions should be linked to the mitigation monitoring and reporting program.

- Be specific regarding implementation of mitigation measures. The environmental document should describe each mitigation measure in detail, identify who is responsible for implementing the measure, and clearly explain how and when the measure will be implemented. Methods for assessing the measure's effectiveness once it is in place, and possible triggers for additional mitigation if necessary, may be needed. This level of detail regarding mitigation measure implementation frequently is not addressed until the preparation of the mitigation monitoring and reporting program, which often takes place very late in the environmental review process. In order to reliably assess the effectiveness and feasibility of mitigation

measures, however, air agencies believe it is necessary to consider the specifics of mitigation measure implementation as early in the environmental review process as possible.

- Be sure not to double count the effect of proposed mitigation measures. The project description and assumptions underlying the analysis of project impacts should be carefully considered when estimating the effect of mitigation measures. If certain conditions or behavior are assumed in the impact analysis, then credit may not be claimed when proposing mitigation measures.

- Health risk assessments discussed in this document estimate outdoor risk. While some mitigation measures may reduce risks by filtering outdoor air to be used indoors, they do nothing to reduce the risk assessment values for outdoor air.

8.3.2 Unquantifiable Mitigation Measures

In some cases, it simply may not be possible to quantify the effect of proposed mitigation measures. It may be that the specific conditions surrounding a particular project are so unique as to render extrapolation from other examples unreliable. A proposed measure may be innovative, with little precedent. The combined effects of a package of measures may be too difficult to quantify. While a certain degree of professional judgment is usually involved in estimating the effectiveness of mitigation measures, speculative estimates should be avoided. If the project proponent cannot quantify mitigation effectiveness with a reasonable degree of certainty, the environmental document should at least address effectiveness qualitatively. If the lead-agency makes a finding that non-quantified mitigation measures reduce an impact to a level of insignificance, the document should provide a detailed justification of that conclusion.

8.3.2.1 Effects of Vegetation Next to Roadways

The Sacramento Air District funded a study to measure the removal rates of particulate matter passing through leaves and needles of vegetation. Particles were generated in a wind tunnel and a static chamber and passed through vegetative layers at low wind velocities. Redwood, deodar cedar, live oak, and oleander were tested. The results from this study indicate that all forms of vegetation able to remove 65-85 percent of very fine particles at wind velocities below 1.5 meters per second (roughly 3 miles per hour) with redwood and deodar cedar being the most effective.

This study supports the effectiveness of planting finely needled trees along sources of toxic particulate matter as an air toxics mitigation measure. Though further studies that reflect actual roadway conditions are needed to better quantify the real-world effectiveness of this mitigation measure, projects that propose sensitive receptors adjacent to sources of particulate matter such as freeways, major roadways, rail lines, and rail

yards should consider tiered plantings of redwood and/or deodar cedar in order to reduce toxic exposures.

8.3.2.2 No Idle Zone

California law currently places restrictions on idling of heavy-duty diesel motor vehicles to reduce health risk impacts from diesel emissions. The 2003 school bus idling airborne toxic control measure (ATCM) requires a driver of a school bus or vehicle, transit bus, or other commercial motor vehicle to manually turn off the bus or vehicle engine upon arriving at a school and to restart no more than 30 seconds before departing. A driver of a school bus or vehicle is subject to the same requirement when operating within 100 feet of a school and is prohibited from idling more than five minutes at each stop beyond schools, such as parking or maintenance facilities, school bus stops, or school activity destinations.

California's more recent anti-idling regulations (with some exemptions) require that drivers of diesel-fueled commercial vehicles weighing more than 10,000 pounds:

- Shall not idle the vehicle's primary diesel engine for greater than 5 minutes at any location,
- Shall not use diesel-fueled auxiliary power units for more than 5 minutes to power a heater, air conditioner, or any ancillary equipment on the vehicle equipped with a sleeper berth, at any location.

Lead agencies may place additional requirements on heavy duty diesel delivery and haul trucks less than 10,000 pounds, and create "no idle" zones at locations where there is a potential for significant health risk. It may not be possible to quantify the emission reductions associated with the creation of a no idling zone. However, this feasible mitigation measure may eliminate idling emissions and may avoid potentially significant health risk impacts.

Table 3
Mitigation Measures

Source Category	Mitigation Measure (listed in order of effectiveness by category)
Stationary Sources Type A (Sources Impacting receptors) (e.g., Auto body shops, Gas Stations, Manufacturers, Metal Platers, Chemical Producers, Rock Quarries, Incinerators, Power Plants, Diesel Engines)	1. Move source location to provide effective buffer zone. 2. Reduce throughput. 3. Install Toxic Best Available Control Technology (TBACT) to reduce the risks to below significance. 4. Install other than TBACT air pollution control devices or process operation modifications. 5. Address Diesel vehicle engines as listed below.

Source Category	Mitigation Measure (listed in order of effectiveness by category)
Onsite Diesel Truck Activities (including transport refrigeration units)	<u>Idling Mitigation Measures:</u> 1. Move source location to provide effective buffer zone. 2. Establish truck parking restrictions. 3. Provide utility hook-ups for trucks that need to cool their load. 4. Limit truck idling to <5 minutes (State law limits to 5 minutes of idling, and includes various exemptions). 5. Require Trucks to operate an Auxiliary Power Unit. 6. Require the installation of electrical hookups at loading docks and the connection of trucks equipped with electrical hookups to eliminate the need to operate diesel-powered TRUs at the loading docks. <u>Onsite Truck Traveling Emissions:</u> 1. Move source location to provide effective buffer zone. 2. Restrict operation to 2007 model year or newer trucks. 3. Require or provide incentives to use Diesel Particulate Filters for truck engines. 4. Re-route truck traffic by adding alternate access for truck traffic or by restricting truck traffic on certain sensitive routes. 5. Improve traffic flow by signal synchronization. 6. Implement incentive for improved communications of fluctuating demand forecasts for labor and equipment among carriers and operators.
High-traffic road vehicle emissions impacting adjacent receptors	1. Move receptors or source to provide effective buffer zone between the source and the receptor. 2. Improve traffic flow by signal synchronization. 3. Plant vegetation between receptor and roadway. 4. Construct wall barriers between receptor and roadway. 5. Install newer electrostatic filters in adjacent receptor buildings. 6. Fund “clean” street sweepers. 7. Improve road infrastructure to facilitate improved traffic flow without inducing capacity. 8. Improve alternative transportation options
Freeway vehicle emissions impacting adjacent receptors	1. Move receptors or source to provide effective buffer zone between the source and the receptor. 2. Plant vegetation between receptor and roadway. 3. Construct wall barriers between receptor and roadway. 4. Install newer electrostatic filters in adjacent receptor buildings. 5. Improve road infrastructure to facilitate improved traffic flow.
Marine Vehicles (e.g., recreational boating, commercial marine operations, hoteling operations, loading and unloading services)	1. Move receptors or source to provide effective buffer zone between the source and the receptor. 2. Require or provide incentives to install add-on Diesel Particulate Matter control devices or cleaner engines or boilers. 3. Require use of electric power when berthed. 4. Require cleaner fuels. 5. Limit vessel speed.

Source Category	Mitigation Measure (listed in order of effectiveness by category)
Railroad (i.e., switch yards, maintenance yards, intermodal centers)	1. Move receptors or source to provide effective buffer zone between the source and the receptor. 2. When ambient temperatures are above 50 deg F, minimize locomotive engine idling by shutting down and re-starting engines. 3. Require Idle Reduction Technologies - The rail industry has developed and designed a new Auxiliary Power Unit (APU) system that provides power during idling conditions and shuts down the main locomotive engine. Installing APU system reduces locomotive PM emissions by 84 percent. 4. Require new engine technologies be applied to the engines - Modifying fuel injectors, which includes fuel injection pressure, fuel spray pattern, injection rate and timing, has been found to reduce emissions from locomotive diesel engines. 5. Require hybrid switcher locomotives. 6. Require use of locomotive technology that meets or exceeds the latest EPA emission regulations for locomotives. 7. Apply the 1998 Railroad MOU for South Coast Air Basin. 8. Apply the 2005 Statewide MOU for Rail Yard Risk Reduction.

8.4 Mitigation Monitoring and Reporting

8.4.1 Primary Mitigation Measures

As part of CEQA environmental review procedures, Pubic Resources Code Section 21081.6 requires a public agency to adopt a monitoring and reporting program for assessing and ensuring efficacy of mitigation measures applied to the proposed project. Specifically, the lead or responsible agency must adopt a reporting or monitoring program for mitigation measures incorporated into a project or imposed as conditions of approval. The program must be designed to ensure compliance during project implementation. As stated in Public Resources Code, Section 21081.6 (a) (1):

"The public agency shall adopt a reporting or monitoring program for the changes made to the project or conditions of project approval, adopted in order to mitigate or avoid significant effects on the environment. The reporting or monitoring program shall be designed to ensure compliance during project implementation. For those changes which have been required or incorporated into the project at the request of a responsible agency or a public agency having jurisdiction by law over natural resources affected by the project, that agency shall, if so requested by the lead agency or a responsible agency, prepare and submit a proposed reporting or monitoring program."

This requirement is intended to assure that mitigation measures included as conditions of project approval are indeed implemented. A mitigation monitoring and reporting program should include the following components:

- A description of each mitigation measure adopted by the Lead Agency.
- The party responsible for implementing each mitigation measure.
- A schedule for the implementation of each mitigation measure.
- The agency or entity responsible for monitoring mitigation measure implementation.
- Criteria for assessing whether each measure has been implemented.
- Enforcement mechanism(s).

The mitigation monitoring and reporting program is not required to be included in the environmental document, but its inclusion will encourage the Lead Agency and other entities to specifically consider the feasibility and effectiveness of each mitigation measure while the environmental analysis is still underway. If a responsible agency or any agency having jurisdiction over natural resources affected by the project proposes mitigation measures, the Lead Agency may require that agency to prepare a monitoring and reporting program for those mitigation measures.

8.4.2 Contingency Mitigation Measure

A mitigation implemented to reduce health risk for a particular project may degrade or fail over time. Continuous monitoring and enforcement programs are recommended to ensure the ongoing effectiveness of all mitigation measures over the project life. In the instance that one or more mitigation measures fail or become ineffective, they should be replaced with mitigation measures of equal or greater effectiveness.

Examples of health risk mitigation measures subject to degradation and/or failure include:

- Vegetation barriers, which may die due to natural causes or lack of upkeep;
- Particulate filters, which may become clogged, mechanically damaged or simply reach the end of their design life; and,
- Indoor air filtration systems, which may become clogged or fail completely due to lack of regular maintenance.

9.0 Public Participation

As emphasized in the ARB Handbook, community involvement is an important part of the overall land use approval process. Public participation is critical when proposed projects could create increased health risk to the individuals or the community. To that extent, engaging community members during the initial phase of the project evaluation process provides a communication conduit between impacted individuals, project proponents and the decision makers. This dialog aims to expand the community's overall understanding of the risk assessment process and the resulting health impact values. While the air district is not typically the lead agency for a project undergoing health risk evaluation, it plays a critical role in working with the impacted community to explain the technical modeling tools and assumptions used to calculate the overall risk values that are ultimately provided to local decision makers for approval action.

Active public participation requires engaging individuals in ways that do not require prior knowledge of air pollution issues impacting their communities. Information should be provided to illustrate how a land use decision can affect the health of the community due to emission impacts from Type A or to Type B projects. Due to the overly technical nature of health risk assessments, air districts need to take specific efforts to develop messages and outreach tools that will assist to convey complex issues to a non-technical community. The outreach process needed to build effective community participation requires data, methodologies and formats customized to the needs of the specific community. Depending on the community characteristics cultural barriers, such as translation to another language, need to be assessed prior to conducting community outreach. More importantly, it requires the strong collaboration of community members and agencies that review and approve projects and land uses of the local community.

The ARB Handbook's Table 7-1, Public Participation Approaches includes some general outreach strategies that air districts might consider in designing an outreach program to increase understanding of the air pollution impacts to specific land use projects. Such a program could consider the preparation and presentation of information in a way that supports sensible decision-making and public involvement. In order to build community trust in the health risk assessments being conducted for proposed development, public participation should occur at the initial phases of project evaluation and continue throughout the approval process.

10.0 HRA Issues in the CEQA Process

There are number of issues that have been encountered at the local decision making level that present challenges during the evaluation of health risk impacts from proposed land use projects. To provide more assistance to air districts, lead agencies and community members on how to overcome these challenges, this chapter outlines a few issues that have been encountered during the project evaluation phase, as well as potential solutions to reduce health risk, minimize errors and assist decision makers in their final action.

10.1 Smart Growth

Land use planners, developers, public health agencies and environmentalists alike all struggle with the apparent dichotomy between the public health benefits of limiting development adjacent to freeways and major roadways, and the public health benefits of smart growth strategies which call for development closer in to the urban core, often adjacent to major travel corridors, as a way to reduce overall emissions. Guidance that helps local planners disclose potential risk, and/or seeks to limit development adjacent to freeways and major roadways appears to conflict with smart growth policies, especially when the guidance affects small projects.

A potential solution to this dilemma is the identification and implementation of effective mitigation measures that will help reduce impacts to sensitive receptors, thereby supporting smart growth policies. Table 3 contains program-level TAC mitigation measures. Such measures are applicable to long-range community planning programs such as General Plans and address land use incompatibility at an early stage. These measures are particularly effective in that they can prevent many high-risk projects from being considered or proposed in the first place, thereby eliminating the necessity for project-level mitigation which may not always be feasible or sufficiently effective. Examples of program-level mitigation measures include rezoning vacant land adjacent to freeways, high-volume roadways, ports, railroads or heavy industry to avoid future proposed siting of residential and/or sensitive receptors.

10.2 Less than Lifetime Cancer Risk Exposures

The standard OEHHA 70 year exposure timeframe for HRAs is often vigorously challenged as to whether it is reasonable to base residential cancer risk on a 70 year, 24 hour per day, seven day per week exposure. A 70-year lifetime exposure is a worst-case assumption. Shorter exposure periods can be appropriate depending on the situation. The cancer risks caused by projects impacting offsite workers can be factored in accordance with guidance provide in the State Office of Environmental Health Hazard Assessment provided a document called the *Air Toxic Hot Spots Program Guidance Manual for the Preparation of Health Risk Assessments*, August 2003. This guidance document also describes how the exposure period can be reduced from 70 year to shorter periods for Type A projects that will operate for periods less than 70 years. This information is also included in the ***Technical Modeling and Risk Assessment Guidance*** component of this document in Attachment 1.

10.3 Mitigating Roadway Toxics

As discussed above, lead agencies often struggle with requiring mitigation when, due to a lack of a threshold, the roadway toxics impacts are not considered "significant." At other times, lead agencies are eager to require mitigation, but feel most comfortable being able to point to studies that quantify the actual mitigation levels before asking project proponents to bear the additional costs of the mitigation. In addition, lead agencies often do not feel comfortable asking a project to make changes via implementing mitigation when the project complies with existing zoning requirements and does not request exemptions. While this is a contentious issue, districts may choose to suggest mitigation measures regardless of whether a health risk determination was made by the lead agency.

10.4 Existing Background Risk

Often, environmental documents with site specific HRAs contain lengthy discussions comparing a project's health risk to the existing background health risk levels, and often, potential project-specific cancer risk levels are expressed as a percentage of the existing background risk without disclosure of the actual additional risk due to the project. It is the actual additional risk due to the project (Type A), or the risk to the project (Type B) that must be disclosed and compared to CEQA significance thresholds.

10.5 Inappropriate Discounting of Risks

Standardized health risk assessment methodologies have been developed to reduce inconsistencies between HRAs and aid in comparing impacts on receptors. However, in practice inappropriate HRA calculations are still carried out and presented as the basis for public disclosure and notification. Such inappropriate HRA calculations are most often made in an attempt to present reduced risk values compared to the higher results produced by standard methodologies. This is a significant concern, especially with respect to health risks associated with locating sensitive land uses in proximity to freeways and other high traffic roadways, where even the standardized HRA modeling methods may not thoroughly characterize all the health risk associated with nearby exposure to traffic generated pollutants.

Inappropriate HRA methodologies often result in protracted controversy, which is sometimes played out in the public arena - for example, at project approval hearings. To minimize these situations, the HRA preparer should adhere to the standard risk calculation methodologies set forth by OEHHA, the Air Resources Board, and the local air district, and as described in this document.

Examples of some mistakes to avoid are described in the following paragraphs.

- One inappropriate calculation is to calculate the cancer risk using the 70-year exposure timeframe, but then reduce the risk values by dividing the risk values by the number of receptors in the subdivision. Doing so is misleading and not scientifically supported. Potential cancer risk should be expressed as probability per million, based upon OEHHA recommendations.

- For Type A projects, it is also inappropriate to present risk values as a percentage of some existing risk value, such as the existing background risk. Often this is done in an attempt to persuade readers that the project specific risk is of little consequence because the increased risk is small compared to the background risk. In cases where project specific risk is compared to other risks or expressed as a percentage of the existing background, it should be made clear that the project specific risk is in addition to the existing background risk.

- Another inappropriate calculation sometimes included in risk assessments is to base emissions on emission factors that may result from future actions, such as emission reduction rules that have not yet gone into effect, or expected emission reductions due to expected market forces.

10.6 Misleading Comparison of Cancer Risks

Comparing cancer risks can be misleading in a CEQA document. Some CEQA documents discuss a variety of cancers and the prevalence of it in our population. It's sometimes stated, for example, that currently throughout the United States, one in three or four persons will experience cancer sometime during their lifetime. This can be a misleading statistic if it is used to imply that the incremental probability of increased cancer cases due to toxic airborne emissions are very small compared to the overall probability of cancer. For example, a Health Risk Assessment may find that the increased probability of cancer cases is 200 in one million for certain sensitive receptors located near a busy freeway. To compare that HRA result with the overall population's cancer incidence would discount the risk unfairly. The CEQA document should disclose the risk without any such comparisons.

10.7 "Experts Disagree"

When project proponents submit HRAs and related materials that are developed via methodologies not supported by the air district or OEHHA, protracted controversy can result. One air district noted that, despite comment from OEHHA and ongoing district comments on the inappropriate discounting of a project's HRA results, those results remained unchanged in the Final EIR. The Final EIR discussed the nature of the disagreement, citing Section 15151 of the CEQA Guidelines which states that disagreement among experts "does not make an EIR inadequate, but the EIR should summarize the main points of disagreement among experts." Ultimately, the lead agency will make a land use decision based on their understanding. But for sources that need an air district permit, the applicable air district's risk assessment procedures will apply.

11.0 Conclusion

The study of the impact of toxic air emissions on sensitive receptors is an evolving one. Air districts in the state of California generally have had a consistent way of performing health risk assessments of stationary sources on nearby sensitive receptors (Type A projects). However, with the publication in 2005 of ARB's Handbook, the issue of the effect of mobile sources on sensitive receptors (Type B projects) required air districts to augment their guidance. This CAPCOA guidance reflects the fact that currently, the various air districts in the state have different approaches to the topic. For example, some districts have developed a threshold of significance for these projects and some have not. Despite these differences, this document offers some common guidance about the need to analyze the impacts, to disclose the risk to decision makers and to mitigate it. As health risk analysis tools, methodology, and protocol as developed, the document will be revised.

Attachment 1

Technical Modeling and Risk Assessment Guidance

Prepared by
CAPCOA Planning Managers
HRA Subcommittee

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Preface

The document shows how to model emissions of toxic substances from various source types to determine the cancer risk, acute risk, and noncancer chronic risk impacting nearby receptors. It can also be used to determine the impacts to new receptors (such as housing projects) proposed to be built next to existing sources that emit toxic substances. These guidelines were prepared to assist in complying with the requirements of the California Environmental Quality Act (CEQA). CEQA requires that environmental impacts of a proposed project be identified, assessed, and mitigated (as possible) if the environmental impacts are significant.

This document consists of three components:

- Modeling Guidelines,
- Exposure Assessment Guidelines, and
- Appendices describing how to determine the emissions and risks from common source categories. Examples of these sources categories include:
  - Roadways,
  - Facilities with onsite truck travel and idling,
  - Stationary diesel engines, and
  - Fast food and other restaurants.

The modeling guidelines are based on a document entitled "Provision of Services to Develop Guidance for Air Dispersion Modeling," developed by Dr. Jesse Thé of Lakes Environmental Software. They have been modified to include various air quality dispersion modeling issues pertinent to California, and are based primarily on information found in EPA's Guideline on Air Quality Models (Appendix W of Part 51 of Title 40 of the Code of Federal Regulations). The modeling components are intended to provide insight into recommended modeling approaches and provide consistency in the modeling methods used.

The Exposure Assessment components are based on the procedures developed by the California Office of Environmental Health Hazard Assessment (OEHHA). These calculation methodologies may change over time as the OEHHA refines the methodologies. **It is important that the air district be contacted before any risk assessment calculations are prepared, so that the most current methodologies are applied.**

This document is not designed to provide theoretical background on the models it discusses. Technical documents covering these topics can be easily obtained from several U.S. EPA sources and are listed as references in this document. This document does provide details on performing a successful modeling study including:

- Model Backgrounds and Applicability,
- Model Selection and Study Approach,
- Tiered Approach to Assessing Compliance,
- Model Input Data Requirements,
- Geographical Information,
- Meteorological Data Requirements and Acquisition, and
- Information/Parameters for Inclusion in an Assessment.

Glossary of Terms

AERMAP: The terrain preprocessor for AERMOD, AERMAP allows the use of digital terrain data in AERMOD.

AERMET: The meteorological preprocessor for AERMOD.

AERMIC: American Meteorological Society/Environmental Protection Agency Regulatory Model Improvement Committee.

AERMOD: A new air dispersion model developed by AERMIC. It is intended to replace the ISCST model.

Air Emissions: Release of pollutants into the air from a source.

Albedo: Portion of the incoming solar radiation reflected and scattered back to space.

Ambient Air: Air that is accessible to the public.

AMS: American Meteorological Society.

CAL3QHCR: CAL3QHCR is derived from CAL3QHC which is also derived from CALINE3. CALINE3 is a Carbon Monoxide (CO) model with queuing, hot spot calculations, and a traffic model to calculate delays and queues that occur at signalized intersections. CAL3QHCR is a more refined version requiring local meteorological data.

Calm: Cessation of horizontal wind.

Complex Terrain: Terrain exceeding the height of the stack being modeled.

DEM: Digital Elevation Model. Digital files that contain terrain elevations typically at a consistent interval across a standard region of the Earth's surface.

Dispersion Model: A group of related mathematical algorithms used to estimate (model) the dispersion of pollutants in the atmosphere due to transport by the mean (average) wind and small scale turbulence.

Emission Factor: An estimate of the rate at which a pollutant is released to the atmosphere

Flagpole Receptor: Any receptor located above ground level.

Inversion:	An increase in ambient air temperature with height. This is the opposite of the usual case.
ISCST:	Industrial Source Complex – Short Term Dispersion Model.
Lee side:	The lee side of a building is the side that is sheltered from the wind.
Mixing Height:	Top of the neutral or unstable layer and also the depth through which atmospheric pollutants are typically mixed by dispersive processes.
Monin-Obukhov Length:	A constant, characteristic length scale for any particular example of flow. It is negative in unstable conditions (upward heat flux), positive for stable conditions, and approach infinity as the actual lapse rate for ambient air reaches the dry adiabatic lapse rate.
NWS:	National Weather Service. A U.S. government organization associated with the National Oceanic and Atmosphere Administration.
PCRAMMET:	Meteorological program used for regulatory applications capable of processing twice-daily mixing heights (TD-9689 FORMAT) and hourly surface weather observations (CD-144 format) for use in dispersion models such as ISCST, CRSTER, MPTER and RAM.
Preferred Model:	A refined model that is recommended for a specific type of regulatory application.
Primary Pollutant:	Substance emitted from the source.
Regulatory Model:	A dispersion model that has been approved for use by the regulatory offices of the U.S. EPA, specifically one that is included in Appendix A of the Guideline on Air Quality Models (Revised), such as the ISC model.
Screening Technique:	A relatively simple analysis technique to determine if a given source is likely to pose a threat to air quality. Concentration estimates from screening techniques are conservative.
Simple Terrain:	An area where terrain features are all lower in elevation than the top of the stack of the source.
Upper Air Data (soundings):	Meteorological data obtained from balloon-borne instrumentation that provides information on pressure, temperature, humidity and wind away from the surface of the earth.

U.S. EPA:	United States Environmental Protection Agency.
Worst Case:	The maximum exposure, dose, or risk that can conceivably happen to specific receptors.

Chapter 1. A Tiered Approach to Risk

1.0 Modeling and Exposure Assessment Tiers Overview

Risk assessments are normally prepared in a tiered manner, where progressively more input data is collected to refine the results. Both the modeling component and the exposure assessment component are based on a tiered method. This document shows how to:

- Model the downwind concentrations of pollutants using each of the four modeling tiers (levels), then
- Use tiers to prepare the exposure assessment part of the risk assessment.

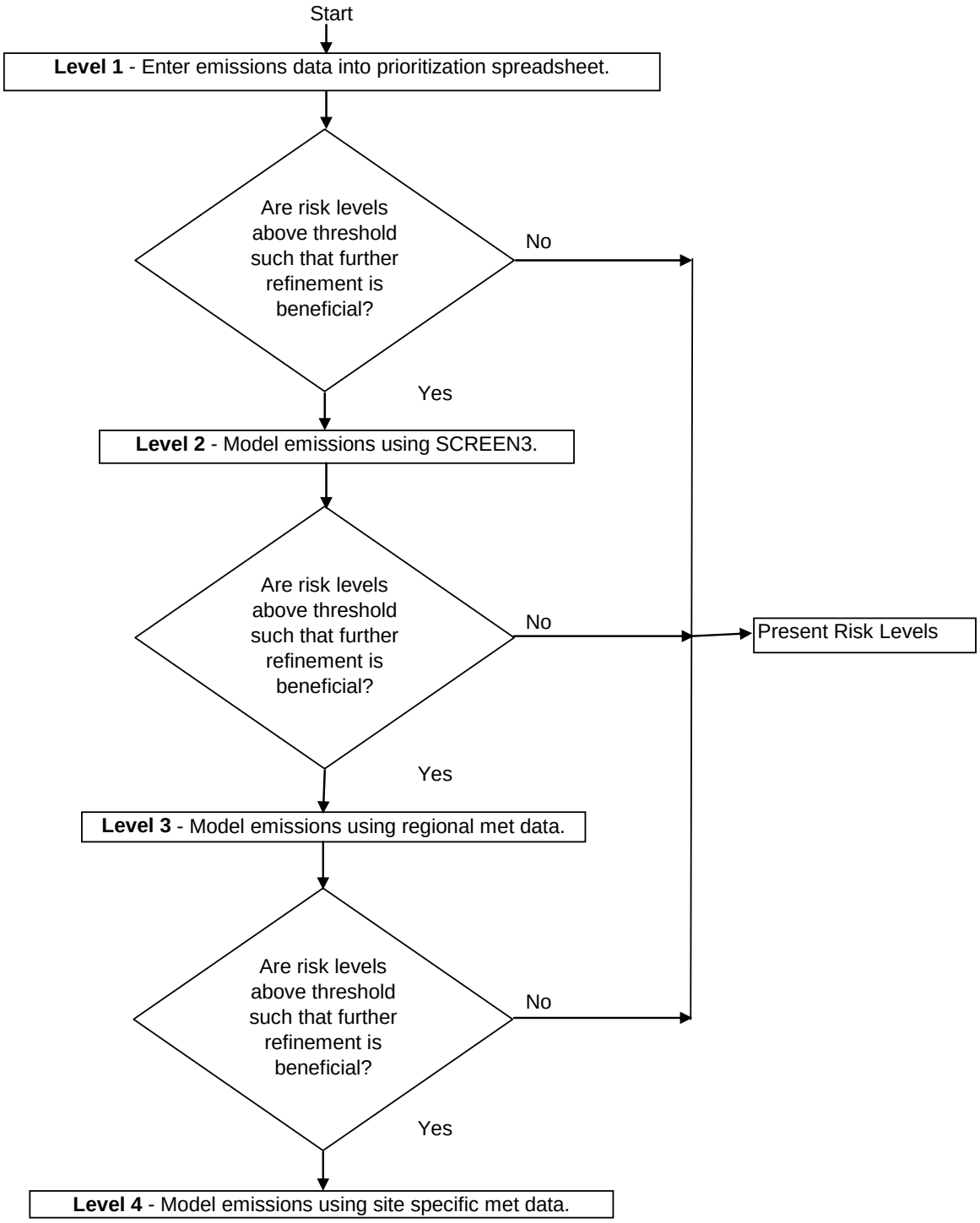
The models described in the document include:

- Screening models:
  - SCREEN3, and
  - AERSCREEN

- Refined models:
  - ISCST3,
  - ISC-PRIME, and
  - AERMOD
  - CAL3QHCR

A tiered approach to air dispersion modeling is presented in Figure 1. The level of effort generally increases with level number. It should be noted that any of the tiers or levels can provide risk assessment results, although the higher the tier or level the more accurate the results. Linear progression through each tier or level is not necessary. For example, a refined modeling analysis can be prepared without first preparing a screening analysis.

Figure 1 - Tiered approach to modeling for risk assessments:



1.1 Dispersion Models used for each TIER:

1.1.1 Level 1 – Prioritization Screening

A Level 1 analysis utilizes the CAPCOA prioritization methodology (http://www.arb.ca.gov/ab2588/RRAP-IWRA/priguide.pdf), or an air district's prioritization procedure to determine the potential impact from a facility's operation based on the quantity of emissions emitted and proximity to a receptor(s) and release height. But before preparing a Level 1 analysis, the air district should be consulted. A prioritization calculation is a screening tool that identifies whether a source has the possibility to exceed a prioritization score that represents the need for further analysis, usually this level is a score of ten

The following input data must be included in a prioritization calculation:

- The nearest receptor (residential or offsite worksite) must be used to represent all other receptors; regardless of the location of the receptor to the proposed project.
- Emissions should represent the "worst case" emissions estimate. Worst case for cancer risk is based on 70 years of exposure. Worst case for acute adverse health effects is based on the hour with the highest emissions. Worst case for chronic adverse health effects is based on the annual average emissions. These emissions should be based on actual expected worst case emissions, rather than a theoretical potential to emit estimate. The emissions should be routine and predictable.
- The prioritization calculations must follow those in the CAPCOA Prioritization Guidelines or the district's prioritization guidelines.

1.1.2 Level 2 - SCREEN3 Modeling

A Level 2 analysis is a screening level analysis using the U.S. EPA's SCREEN3 model, which includes all potential worst-case meteorological conditions. If a risk assessment based on SCREEN3 modeling shows risks below significance thresholds, then there is no need for additional modeling.

Note: At the time of writing this document, AERSCREEN remains unavailable and is currently in development. When AERSCREEN becomes available, it may be substituted for SCREEN3 in the multi-tier approach.

1.1.3 Level 3 – CAL3QHCR, ISCST3, or AERMOD modeling using Regional Met Data

A Level 3 analysis is a more refined analysis using CAL3QHCR, ISCST3, or AERMOD and regional hourly meteorological data. Contact the District regarding the availability of preprocessed meteorological data sets.

1.1.4 Level 4 - CAL3QHCR, ISCST3 or AERMOD Modeling using Site Specific Met Data

A Level 4 analysis is a more refined analysis using CAL3QHCR, ISCST3, or AERMOD and site specific hourly meteorological data. Contact the District regarding the availability of preprocessed meteorological data sets. This data typically must be pre-processed by the modeler or a meteorological data provider such as the National Weather Service (NWS). Local meteorological data sets include site-specific parameters and meteorological characteristics that directly represent the site of consideration with a greater level of detail than most regional data sets. A Level 4 analysis also encompasses modeling analyses that make use of any alternative models.

1.2 Exposure Assessment Tiers

When substances are emitted that can affect intake pathways other than inhalation, the use of the latest version of the Hot Spots Analysis and Reporting Program (HARP) modeling and risk assessment software is recommended. The latest version of HARP can be downloaded at http://www.arb.ca.gov/toxics/harp/harp.htm. If the emissions consist of only substances that enter the body through the inhalation pathway, other risk assessment methodologies consistent with the methodologies approved for the Air Toxics "Hot Spots" Emissions Inventory and Risk Assessment Program can be used. Most substances enter the body only through the inhalation pathway. Ingestion, dermal absorption, and other pathways are not usually significant pathways for emitted gases. Therefore, if all the substances impacting receptors only enter the body through inhalation, then the risk assessment preparation effort can be minimized. If just one substance can enter the body through another pathway, then a multipathway analysis must be prepared. An exception to this is diesel particulate, which is modeled only through the inhalation pathway.

The toxicity values that are used must be those that the California Office of Environmental Health Hazard Assessment (OEHHA) has identified. These toxicity values can be found at (http://www.arb.ca.gov/toxics/healthval/healthval.htm). If a substance is emitted and toxicity values have not been identified by OEHHA, other sources of data can be applied.

Although more detailed information can be found by directly reviewing the latest OEHHA risk assessment procedures, what follows is a description of the tiers associated with a multipathway exposure assessment. Additional information can be found at ARB's HARP websites and OEHHA's websites.

There are four basic tiers or levels that can be applied in the exposure assessment portion of the risk assessment:

Tier 1 -Point Estimate, Default Intake Values
The easiest tier to complete assumes various intake default values, and calculates the risk as a single value rather than a distribution curve.

Tier 2 -Point Estimate, Site Specific Intake Values
The next tier requires site specific information to determine intake values, but continues to apply single intake values to the risk values.

Tier 3 -Distribution Curve Risk Estimate, Default Distribution Curve Intake Values
The third tier applies default distribution curve values to determine a distribution curve risk result.

Tier 4 -Distribution Curve Risk Estimate, Site Specific Distribution Curve Intake Values

The fourth tier applies site specific distribution curve values to determine a distribution curve risk result.

1.3 Exposure Duration Adjustment (Cancer Only)

Cancer risk calculations are based on a 70 year lifetime exposure. In some limited cases, it may be appropriate to also use either 9 or 40 years exposure in the calculation. The 9 year exposure scenario is based on exposure to children during the first 9 years of life. Some districts use the 9 year exposure scenario to model short term projects The 40 year exposure scenario can be used to represent the risk to nearby workers. The local district should be contacted before using any exposure duration less than 70 years. In no case should an exposure period of less than 9 years be used.

Chapter 2. Application of Models

2.0 Modeling Overview

Air dispersion modeling is the mathematical estimation of pollutant impacts from emissions sources within a study area. Several factors impact the fate and transport of pollutants in the atmosphere including, but not limited to meteorological conditions, site configuration, emission release characteristics, and surrounding terrain.

2.1 Preferred Models

Preferred Models are defined as standard models that are expected to be used for air quality studies. Alternative models may be used if conditions warrant their use. These are outlined in Section 2.3. The U.S. EPA's preferred models include SCREEN3 for screening analyses and AERMOD for refined modeling analyses. For CEQA, CAL3QHCR, ISCST, and ISC-PRIME may also be used.

For efficient risk assessment processing, the district should be consulted to determine the appropriateness of the model proposed for use. A brief overview of each of these models can be found below. For appropriate model selection, please review the section that outlines:

2.1.1 AERMOD

The American Meteorological Society/EPA Regulatory Model Improvement Committee (AERMIC) Regulatory Model, AERMOD[1,2,3] was specially designed to support the U.S. EPA's

[1] U.S. Environmental Protection Agency, 1998. Revised Draft - User's Guide for the AMS/EPA Regulatory Model – AERMOD. Office of Air Quality Planning and Standards, Research Triangle Park, NC.

[2] Paine, R.J., R.W. Brode, R.B. Wilson, A.J. Cimorelli, S.G. Perry, J.C. Weil, A. Venkatram, W.D. Peters and R.F. Lee, 2003. AERMOD: The Latest Features and Evaluation Results. Paper # 69878 presented at the Air and Waste Management Association 96th Annual Conference and Exhibition, June 22-26, 2003. Air and Waste Management Association, Pittsburgh, PA 15222.

[3] Cimorelli, A.J., S.G. Perry, A. Venkatram, J.C. Weil, R.J. Paine, R.B. Wilson, R.F. Lee, W.D. Peters, R.W. Brode, J.O. Paumier, 2002: AERMOD: Description of Model Formulation. U.S. Environmental Protection Agency, EPA-454/R-02-002d (draft dated October 31, 2002). Available from http://www.epa.gov/scram001.

regulatory modeling programs. AERMOD is the next-generation air dispersion model that incorporates concepts such as planetary boundary layer theory and advanced methods for handling complex terrain. AERMOD was developed to replace the Industrial Source Complex Model-Short Term (ISCST3) as U.S. EPA's preferred model for most small-scale regulatory applications.[4,5] The latest versions of AERMOD also incorporate the Plume Rise Model Enhancements (PRIME) building downwash algorithms, which provide a more realistic handling of downwash effects than previous approaches.

The PRIME model was designed to incorporate two fundamental features associated with building downwash:

- Enhanced plume dispersion coefficients due to the turbulent wake.
- Reduced plume rise caused by a combination of the descending streamlines in the lee of the building and the increased entrainment in the wake.

AERMOD contains basically the same options as the ISCST3 model with a few exceptions, which are described below:

- Currently, the model only calculates concentration values. Dry and wet deposition algorithms were not implemented at the time this document was written.
- AERMOD requires two types of meteorological data files, a file containing surface scalar parameters and a file containing vertical profiles. These two files are produced by the U.S. EPA AERMET meteorological preprocessor program[4].
- For applications involving elevated terrain, the user must also input a hill height scale along with the receptor elevation. The U.S. EPA AERMAP terrain-preprocessing program[6] can be used to generate hill height scales as well as terrain elevations for all receptor locations.

The options AERMOD has in common with ISCST3 and ISC-PRIME are described in the next section.

2.1.2 ISCST3 & ISC-PRIME Overview

The ISCST3 dispersion model is a steady-state Gaussian plume model, which can be used to assess pollutant concentrations and/or deposition fluxes from a wide variety of sources associated with an industrial source complex. The ISCST3 dispersion model from the U.S. EPA was designed to support the EPA's regulatory modeling options, as specified in the Guidelines on Air Quality Models (Revised)[7].

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[4] U.S. Environmental Protection Agency, 1995. User's Guide for the Industrial Source Complex (ISC3) Dispersion Models (Revised), Volume 1. EPA-454/B-95-003a. Office of Air Quality Planning and Standards, Research Triangle Park, NC.

[5] U.S. Environmental Protection Agency, 1995. User's Guide for the Industrial Source Complex (ISC3) Dispersion Models, Volume II – Description of Algorithms. U.S. Environmental Protection Agency, Research Triangle Park, NC 27711. Available from website http://www.epa.gov/scram001 as of January 2003.

[6] U.S. Environmental Protection Agency, 1998. Revised Draft - User's Guide for the AERMOD Terrain Preprocessor (AERMAP). Office of Air Quality Planning and Standards, Research Triangle Park, NC.

[7] U.S. Environmental Protection Agency, 1986. Guidelines on Air Quality Models (Revised) and Supplement A. EPA-450/2-78-027R. U.S. Environmental Protection Agency, Research Triangle Park, NC.

The PRIME algorithms have been integrated into the ISCST3 (Version 96113) model. This integrated model is called ISC-PRIME[8]. The ISC-PRIME model uses the standard ISCST3 input file with a few modifications in the Source Pathway section. These modifications include three new inputs that which are used to describe the building/stack configuration.

To be able to run the ISC-PRIME model, you must first perform building downwash analysis using the Building Profile Input Program (BPIP). For more information on building downwash please refer to Section 3.8 - Building Impacts.

Some of the ISCST3/ISC-PRIME modeling capabilities are:

- ISC-PRIME model may be used to model primary pollutants and continuous releases of toxic and hazardous pollutants.
- ISC-PRIME model can handle multiple sources, including point, volume, area, and open pit source types. Line sources may also be modeled as a string of volume sources or as elongated area sources.
- Source emission rates can be treated as constant or may be varied by month, season, hour-of-day, or other periods of variation. These variable emission rate factors may be specified for a single source or for a group of sources.
- The model can account for the effects of aerodynamic downwash due to nearby buildings on point source emissions.
- The model contains algorithms for modeling the effects of settling and removal (through dry deposition) of large particulates and for modeling the effects of precipitation scavenging for gases or particulates.
- Receptor locations can be specified as gridded and/or discrete receptors in a Cartesian or polar coordinate system.
- ISC-PRIME incorporates the COMPLEX1 screening model dispersion algorithms for receptors in complex terrain.
- ISC-PRIME model uses real hourly meteorological data to account for the atmospheric conditions that affect the distribution of air pollution impacts on the modeling area.
- Results can be output for concentration, total deposition flux, dry deposition flux, and/or wet deposition flux. Until AERMOD has incorporated deposition, ISC-PRIME would be the preferred model for applications such as risk assessment where deposition estimates are required.

Unlike AERMOD, the ISC models do not contain a terrain pre-processor. As a result, receptor elevation data must be obtained through alternative means. The use of an inverse distance algorithm for interpolating representative receptor elevations is an effective method.

[8] U.S. Environmental Protection Agency, 1997. Addendum to ISC3 User's Guide – The Prime Plume Rise and Building Downwash Model. Submitted by Electric Power Research Institute. Prepared by Earth Tech, Inc., Concord, MA.

2.1.3 SCREEN3 Overview

The SCREEN3 model was developed to provide an easy-to-use method of obtaining pollutant concentration estimates. These estimates are based on the document "Screening Procedures for Estimating the Air Quality Impact of Stationary Sources"[9].

SCREEN3, version 3.0 of the SCREEN3 model, can perform all the single source short-term calculations in the EPA screening procedures document, including:

- Estimating maximum ground-level concentrations and the distance to the maximum.
- Incorporating the effects of building downwash on the maximum concentrations for both the near wake and far wake regions.
- Estimating concentrations in the cavity recirculation zone.
- Estimating concentrations due to inversion break-up and shoreline fumigation.
- Determining plume rise for flare releases.

EPA's SCREEN3[10] model can also:

- Incorporate the effects of simple elevated terrain (i.e., terrain not above stack top) on maximum concentrations.
- Estimate 24-hour average concentrations due to plume impaction in complex terrain (i.e., terrain above stack top) using the VALLEY model 24-hour screening procedure.
- Model simple area sources using a numerical integration approach.
- Calculate the maximum concentration at any number of user-specified distances in flat or elevated simple terrain, including distances out to 100 km for long-range transport.
- Examine a full range of meteorological conditions, including all stability classes and wind speeds to find maximum impacts.
- Include the effects of buoyancy-induced dispersion (BID).
- Explicitly calculate the effects of multiple reflections of the plume off the elevated inversion and off the ground when calculating concentrations under limited mixing conditions.

2.1.4 CAL3QHCR Overview

"CAL3QHCR is a refined version of the original CALINE (California Line Source Dispersion Model) that was developed as a modeling tool to predict roadside CO concentrations. CAL3QHCR can be used to estimate ambient PM concentrations and to process hourly meteorological data over a year, hourly emissions, traffic volume, and signal data. The model can be obtained from EPA at http://www.epa.gov/scram001/dispersion_prefrec.htm.

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[9] U.S. Environmental Protection Agency, 1992: Screening Procedures for Estimating the Air Quality Impact of Stationary Sources, Revised, October 1992 (EPA-450/R-92-019),
User's Guide for the Industrial Source Complex (ISC2) Dispersion Models: Volume II—Description of Model Algorithms. U.S. Environmental Protection Agency, OAQPS, Research Triangle Park, NC 27711. Publication No. EPA-450/4-92-008b.

[10] U.S. Environmental Protection Agency, 1995. SCREEN3 Model User's Guide. EPA-454/B-95-004. Office of Air Quality Planning and Standards, Research Triangle Park, NC.

2.2 ISC and AERMOD Model Comparison

The ISC and AERMOD models share several similarities:

- Both are steady state plume models
- AERMOD input and output are intentionally similar to ISC for ease of use

AERMOD is a next-generation model, and while input and output may share similarities in format, there are several differences as detailed in the table below.

Table 2 – Differences between ISCST3 and AERMOD

ISCST3	AERMOD
Plume is always Gaussian	Plume is non-Gaussian when appropriate
Dispersion is function of six stability classes only	Dispersion is function of continuous stability parameters and height
Measured turbulence cannot be used	Measured turbulence can be used
Wind speed is scaled to stack height	Calculates effective speed through the plume
Mixing height is interpolated	Mixing height is calculated from met data
Plume either totally penetrates the inversion, or not at all	Plume may partially penetrate the inversion at the mixing height
Terrain is treated very simplistically	More realistic terrain treatment, using dividing streamline concept
Uses single dispersion for all urban areas	Adjusts dispersion to size of urban area
Cannot mix urban and rural sources	Can mix urban and rural sources

2.3 Alternative Models

Alternative models may also be accepted to determine health risks for CEQA projects. Please see the Guideline on Air Quality Models (published as Appendix W of 40 CFR Part 51) for terms of appropriate use and required supporting explanations. **Please note,** pre-approval is normally sought from the district before using alternative models.

2.4 Model Validations

The U.S. EPA ISCST3 / ISC-PRIME and AERMOD models are some of the most studied and validated models in the world. Studies have typically demonstrated good correlation with real-world values. AERMOD particularly handles complex terrain very well, closely matching the trends of field observations from validation studies.

ISC-PRIME differs from ISCST3 primarily in its use of the PRIME downwash algorithm. A model evaluation study was carried out under the auspices of the Electric Power Research Institute

(EPRI). The report[11] is available from EPRI and from the U.S. EPA SCRAM website http://www.epa.gov/scram001. The report analyzed comparisons between model predictions and measured data from four databases involving significant building downwash. This is in addition to 10 additional databases that were used during the development of ISC-PRIME. The study found that ISC-PRIME performed much better than ISCST3 under stable conditions, where ISCST3 predictions were very conservative (high). In general, ISC-PRIME was unbiased or somewhat over predicting. Also, ISC-PRIME showed a statistically better performance result than ISCST3 for each database in the study.

The U.S. EPA performed the evaluation of AERMOD. A summary of the evaluation studies was prepared by Paine, et al[12]. This and more detailed reports can be found at the U.S. EPA SCRAM website. Five databases were used during the development of the model. Five additional non-downwash databases were used in the final evaluation. For cases involving building downwash, four developmental databases were used to check the implementation of PRIME into AERMOD as it was accomplished. Three additional databases were reserved for the final evaluation. AERMOD remained unbiased for complex terrain databases as well as flat terrain, while ISCST3 severely over-predicted for complex terrain databases.

Chapter 3. MODEL INPUT DATA

3.0 Comparison of Screening and Refined Model Requirements

The use of the screen model requires the least amount of effort to calculate risks but produces the most conservative results. The SCREEN3 model input requirements are described in the next section.

Refined air dispersion modeling using the U.S. EPA AERMOD or ISCST3 / ISC-PRIME models can be broken down into a series of steps. These are outlined in Sections 3.2 and 3.3.

A general overview of the process typically followed for performing an air dispersion modeling assessment is present in Figure 3.1 below. The figure is not meant to be exhaustive in all data elements, but rather provides a picture of the major steps involved in an assessment.

[11] Paine, R.J. and F. Lew, 1997. Results of the Independent Evaluation of ISCST3 and ISC-PRIME. EPRI Paper No. TR2460026, WO3527-02, Final Report. Electric Power Research Institute, Palo Alto, CA 94304.

[12] Paine, R.J., R.W. Brode, R.B. Wilson, A.J. Cimorelli, S.G. Perry, J.C. Weil, A. Venkatram, W.D. Peters and R.F. Lee, 2003. AERMOD: The Latest Features and Evaluation Results. Paper # 69878 presented at the Air and Waste Management Association 96th Annual Conference and Exhibition, June 22-26, 2003. Air and Waste Management Association, Pittsburgh, PA 15222.

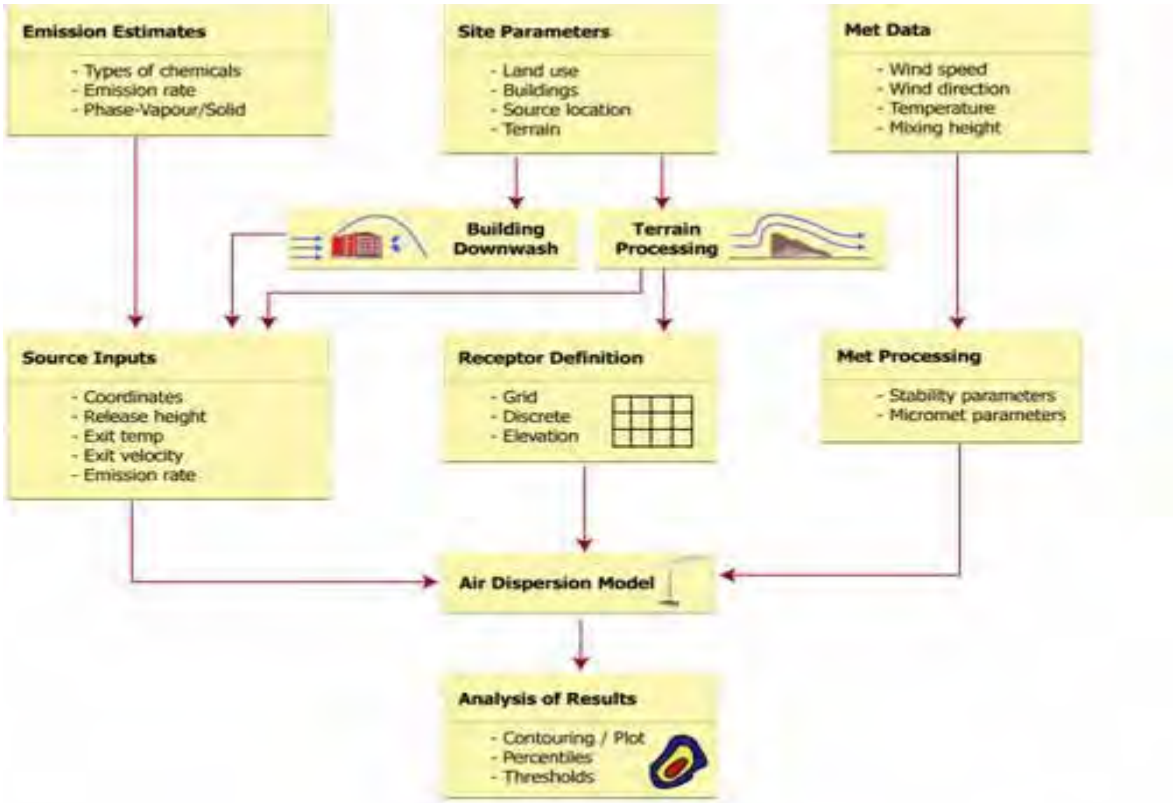

Figure 3.1 - Generalized process for performing a refined air dispersion modeling assessment.

3.1 SCREEN3

The SCREEN model[13] was developed to provide an easy-to-use method of obtaining pollutant concentration estimates. This model is normally used as an initial screening tool to assess **single sources** of emissions. SCREEN3 can be applied to multi-source facilities by conservatively summing the maximum concentrations for the individual emissions sources.

To perform a modeling study using SCREEN3, data for the following input requirements must be supplied:

- Source Type (Point, Flare, Area or Volume)
- Physical Source and Emissions Characteristics.
  (For example, a point source requires:
  - Emission Rate
  - Stack Height
  - Stack Inside Diameter
  - Stack Gas Exit Velocity
  - Stack Gas Exit Temperature
  - Ambient Air Temperature

[13] U.S. Environmental Protection Agency, 1995. SCREEN3 Model User's Guide. EPA-454/B-95-004. Office of Air Quality Planning and Standards, Research Triangle Park, NC.

- Receptor Height Above Ground
- Meteorology: SCREEN3 can consider all conditions, or a specific stability class and wind speed can be provided.
  - If a single wind speed/stability combination is used, the predicted concentration should only be used to determine hourly concentration, as the factors used to convert hourly concentration to annual concentrations are only valid when SCREEN3 is ran with full meteorological data selected.
- Building Downwash: If this option is used then building dimensions (height, length and width) must be specified.
- Terrain: SCREEN3 supports flat, elevated and complex terrain. If elevated or complex terrain is used, distance and terrain heights must be provided.
- Fumigation: SCREEN3 supports shoreline fumigation. If used, distance to shoreline must be provided.

As can be seen above, the input requirements are minimal to perform a screening analysis using SCREEN3. The refined models discussed in the next sections, have much more detailed options allowing for greater characterization and more representative results.

3.2 AERMOD

The supported refined models have many input options, and are described further throughout this document as well as in their own respective technical documents[14,15,16,17]. An overview of the modeling approach and general steps for using each refined model are provided below. The general process for performing an air dispersion study using AERMOD includes:

- Meteorological Data Processing (AERMET is used for this)
- Obtain Digital Terrain Elevation Data (If terrain is being considered)
- Building Downwash Analysis (BPIP-PRIME is used for this) – Project requires source and building information
- Final site characterization – complete source and receptor information
- AERMAP – Perform terrain data pre-processing for AERMOD air dispersion model if required.
- AERMOD – Run the model.
- Visualize and analyze results.

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[14] Cimorelli, A.J., S.G. Perry, A. Venkatram, J.C. Weil, R.J. Paine, R.B. Wilson, R.F. Lee, W.D. Peters, R.W. Brode, J.O. Paumier, 2002: AERMOD: Description of Model Formulation. U.S. Environmental Protection Agency, EPA-454/R-02-002d (draft dated October 31, 2002). Available from http://www.epa.gov/scram001.

[15] U.S. Environmental Protection Agency, 1995. User's Guide for the Industrial Source Complex (ISC3) Dispersion Models (Revised), Volume 1. EPA-454/B-95-003a. Office of Air Quality Planning and Standards, Research Triangle Park, NC.

[16] U.S. Environmental Protection Agency, 1995. User's Guide for the Industrial Source Complex (ISC3) Dispersion Models, Volume II – Description of Algorithms. U.S. Environmental Protection Agency, Research Triangle Park, NC 27711. Available from website http://www.epa.gov/scram001 as of January 2003.

[17] U.S. Environmental Protection Agency, 1997. Addendum to ISC3 User's Guide – The Prime Plume Rise and Building Downwash Model. Submitted by Electric Power Research Institute. Prepared by Earth Tech, Inc., Concord, MA.

As can be seen above, the AERMOD modeling system is comprised of 3 primary components as outlined below and illustrated in Figure 3.2:

- AERMET – Meteorological Data Preprocessor
- AERMAP – Digital Terrain Preprocessor
- AERMOD – Air dispersion model

To successfully perform a complex terrain air dispersion modeling analysis-using AERMOD, you must complete the processing steps required by AERMET and AERMAP. See Appendix A for more information on meteorological data.

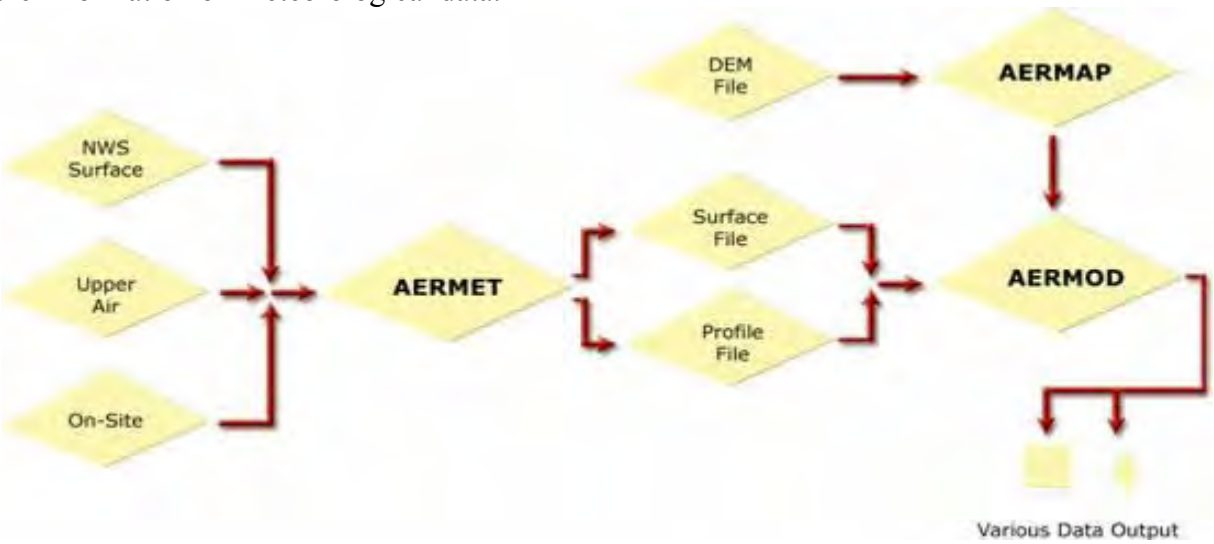

Figure 3.2 - The AERMOD air dispersion modeling system.

3.3 ISC-PRIME

The ISC-PRIME model has very similar input requirements when compared with AERMOD. These include:

- Meteorological Data Processing - PCRAMMET
- Obtain Digital Terrain Elevation Data (If terrain is being considered)
- Building Downwash Analysis (BPIP-PRIME) – Project requires source and building information
- Final site characterization – complete source and receptor information
- ISC-PRIME – Run the ISC-PRIME model.
- Visualize and analyze results.

As can be seen above, the ISC and AERMOD models follow a very similar approach to perform an air dispersion modeling project. The primary difference between running the ISC and AERMOD models is that ISC does not require a terrain preprocessor, such as AERMAP. Furthermore, ISC relies on a different meteorological preprocessor known as PCRAMMET. The components of meteorological data pre-processing using PCRAMMET are illustrated in Figure 3.3 below. For a complete outline on how to obtain meteorological data, please see Appendix A.

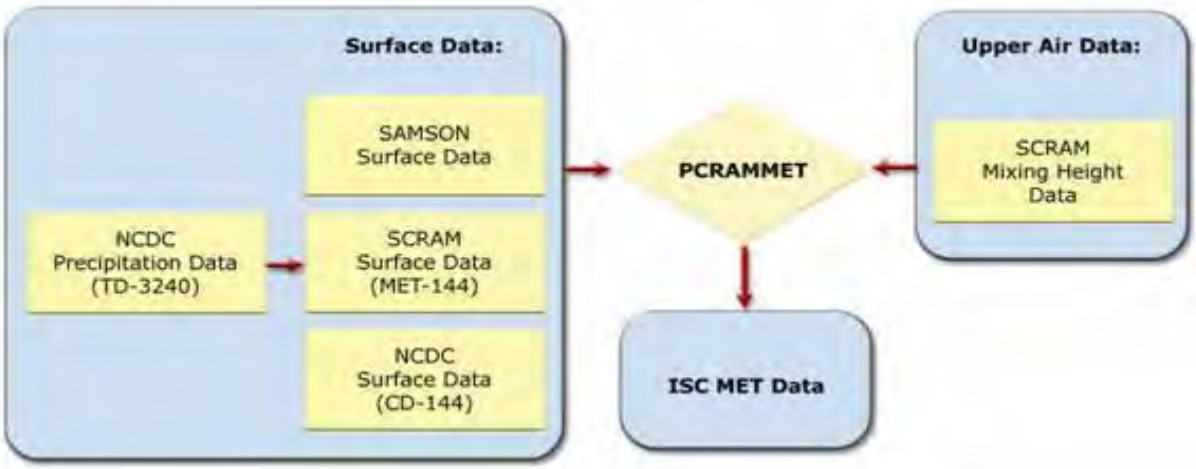

Figure 3.3 - Meteorological data pre-processing flow diagram for the U.S. EPA ISC models

3.4 Regulatory and Non-Regulatory Option Use

The ISC-PRIME and AERMOD models contain several regulatory options, which are set by default, as well as non-regulatory options. Depending on the model, the non-regulatory options can include:

- No stack-tip downwash (NOSTD)
- Missing data processing routine (MSGPRO)
- Bypass the calms processing routine (NOCALM)
- Gradual plume rise (GRDRISM)
- No buoyancy-induced dispersion (NOBID)
- Air Toxics Options (TOXICS)
- By-pass date checking for non-sequential met data file (**AERMOD**)
- Flat terrain (FLAT) (**AERMOD**)

The use of any non-regulatory default option(s) must be justified through a discussion in the modeling report and approved by the district before performing any modeling runs. Regulatory models that account for elevated terrain should be used when appropriate.

3.5 Coordinate System

Any modeling assessment will require a coordinate system to be defined in order to assess the relative distances from sources and receptors and, where necessary, to consider other geographical features. Employing a standard coordinate system for all projects increases the efficiency of the review process while providing real-world information about the site location. The AERMOD model's terrain pre-processor, AERMAP, requires digital terrain in Universal Transverse Mercator (UTM) coordinates. The UTM system uses meters as its basic unit of measurement and allows for more precise definition of specific locations than latitude/longitude.

For more information on coordinate systems and geographical information inputs, see Section 6.

3.6 Averaging Times

A key advantage to the more refined air dispersion models is the ability to compare effects-based standards with appropriate averaging times. OEHHA assigns different exposure periods to different health effects. For example, cancer risks are assessed for "lifetime" exposure. Chronic noncancer health effects are calculated for long-term, but not necessarily lifetime exposures. Acute noncancer health effects are usually based on a maximum 1-hour exposure, but there are some exceptions, such as benzene which is based on a maximum 6 hour exposure. Use of effects-based averaging times enables a contaminant to be assessed using modeled exposure concentrations for the appropriate averaging period for that contaminant and endpoint.

In addition to enabling the use of appropriate model averaging times, refined models allow the input of variable emission rates, where appropriate, for assessing concentrations over different averaging times. That is, a source that operates only during certain hours of the day can be modeled using only those hours of meteorology data.

The ability to assess air quality using the most appropriate effects-based averaging time means the refined air dispersion models provide a more representative assessment of health and environmental impacts of air emissions from a facility.

3.7 Defining Sources

3.7.1 Point, Area, Volume, and Flare Emissions Release Parameters Required for each Model

The U.S. EPA SCREEN3, ISCST3, ISC-PRIME and AERMOD models support a variety of source types that can be used to characterize most emissions within a study area. The following sections outline the primary source types and their input requirements for both screening and refined models. Detailed descriptions on the input fields for these models can be found for SCREEN3 in U.S. EPA[18], for ISC-PRIME in U.S. EPA[19,20], and for AERMOD in U.S. EPA[21].

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[18] U.S. Environmental Protection Agency, 1995. SCREEN3 Model User's Guide. EPA-454/B-95-004. Office of Air Quality Planning and Standards, Research Triangle Park, NC.

[19] U.S. Environmental Protection Agency, 1995. User's Guide for the Industrial Source Complex (ISC3) Dispersion Models (Revised), Volume 1. EPA-454/B-95-003a. Office of Air Quality Planning and Standards, Research Triangle Park, NC.

[20] U.S. Environmental Protection Agency, 1997. Addendum to ISC3 User's Guide – The Prime Plume Rise and Building Downwash Model. Submitted by Electric Power Research Institute. Prepared by Earth Tech, Inc., Concord, MA.

[21] Cimorelli, A.J., S.G. Perry, A. Venkatram, J.C. Weil, R.J. Paine, R.B. Wilson, R.F. Lee, W.D. Peters, R.W. Brode, J.O. Paumier, 2002: AERMOD: Description of Model Formulation. U.S. Environmental Protection Agency, EPA-454/R-02-002d (draft dated October 31, 2002). Available from http://www.epa.gov/scram001.

3.7.1.1 Point Sources

Point sources are typically used when modeling releases from sources like stacks and isolated vents. Input requirements for point sources include:

SCREEN3

- **Emission Rate** [g/sec]: The emission rate of the pollutant.
- **Stack Height** [m]: The stack height above ground.
- **Stack Inside Diameter** [m]: The inner diameter of the stack.
- **Stack Gas Exit Velocity** [m/s] or Stack Gas Exit Flow Rate [m3/s]: Either the stack gas exit velocity or the stack gas exit flow rate should be given. The exit velocity can be determined from the following formula:

  $Vs = 4*V/(\pi*(d_s\text{^}2))$

  Where,

  V_s = Exit Velocity
  V = Flow Rate
  d_s = Stack Inside Diameter

- **Stack Gas Temperature** [K]: The temperature of the released gas in degrees Kelvin.
- **Ambient Air Temperature** [K]: The average atmospheric temperature (K) in the vicinity of the source. If no ambient temperature data are available, assume a default value of 293 degrees Kelvin (K). For non-buoyant releases, the user should input the same value for the stack temperature and ambient temperature.

AERMOD/ISCST/ISC-PRIME

- **Source ID**: An identification name for the source being defined, up to 8 characters in length.
- **X Coordinate**: The x (east-west) coordinate for the source location in meters (center of the point source).
- **Y Coordinate**: Enter here the y (north-south) coordinate for the source location in meters (center of the point source).
- **Base Elevation** [m]: The source base elevation. The model only uses the source base elevation if Elevated terrain is being used.
- **Release Height above Ground** [m]: The source release height above the ground in meters.
- **Emission Rate** [g/sec]: The emission rate of the pollutant in grams per second. Stack Gas Exit Temperature [K]: The temperature of the released gas in degrees Kelvin.
- **Stack Gas Exit Velocity** [g/sec]: The stack gas exit velocity in meters per second or the stack gas flow rate (see above section on SCREEN3).
- **Stack Inside Diameter** [m]: The inner diameter of the stack.

3.7.1.2 Area Sources

Area sources are used to model releases that occur over an area (e.g., landfills, storage piles, slag dumps, and lagoons). SCREEN3 allows definition of a rectangular area, aligned with the north-

south axes, while the ISC-PRIME and AERMOD models accept rectangular areas that may also have a rotational angle specified relative to a north-south orientation, as well as a variety of other shapes.

SCREEN3

- **Emission Rate** [g/(s-m^2)]: The emission rate of the pollutant. The emission rate for area sources is input as an emission rate per unit area (g/(s-m^2)).
- **Source Release Height** [m]: The source release height above ground.
- **Longer Side Length of Rectangular Area** [m]: The longer side of the rectangular source in meters.
- **Shorter Side Length of Rectangular Area** [m]: The shorter side of the rectangular source in meters.
- **Wind Direction Search Option**: Since the concentration at a particular distance downwind from a rectangular area is dependent on the orientation of the area relative to the wind direction, the SCREEN model provides the user with two options for treating wind direction. The regulatory default option is "yes" which results in a search of a range of wind directions. See U.S. EPA[22] for more detailed information.

AERMOD/ISC-PRIME

- **Source ID**: An identification name for the source being defined, up to 8 characters in length.
- **X Coordinate**: The x (east-west) coordinate for the vertex (corner) of the area source that occurs in the southwest quadrant of the source. Units are in meters.
- **Y Coordinate**: The y (north-south) coordinate for the vertex (corner) of the area source that occurs in the southwest quadrant of the source. Units are in meters.
- **Base Elevation** [m]: The source base elevation. The model only uses the source base elevation if elevated terrain is being used. The default unit is meters.
- **Release Height above Ground** [m]: The release height above ground in meters.
- **Emission Rate** [g/(s-m^2)]: Enter the emission rate of the pollutant. The emission rate for Area sources is input as an emission rate per unit area. The same emission rate is used for both concentration and deposition calculations.
- Options for Defining Area: In ISC-PRIME the only option for defining the area is a rectangle or square. The maximum length/width aspect ratio for area sources is 10 to 1. If this is exceeded, then the area should be divided to achieve a 10 to 1 aspect ratio (or less) for all sub-areas. See U.S. EPA[23] for more details on inputting area data. In addition to the rectangular area, AERMOD can have circular or polygon areas defined (see U.S. EPA[24] for details).

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[22] U.S. Environmental Protection Agency, 1995. Quality Assurance Handbook for Air Pollution Measurement Systems. Vol. IV, Meteorological Measurements. EPA/600/R-94/038d, U.S. Environmental Protection Agency, Research Triangle Park, NC 27711. Also available from the following website as of February 2003: http://www.epa.gov/scram001.

[23] U.S. Environmental Protection Agency, 1995. User's Guide for the Industrial Source Complex (ISC3) Dispersion Models (Revised), Volume 1. EPA-454/B-95-003a. Office of Air Quality Planning and Standards, Research Triangle Park, NC.

[24] Cimorelli, A.J., S.G. Perry, A. Venkatram, J.C. Weil, R.J. Paine, R.B. Wilson, R.F. Lee, W.D. Peters, R.W. Brode, J.O. Paumier, 2002: AERMOD: Description of Model Formulation. U.S. Environmental Protection Agency, EPA-454/R-02-002d (draft dated October 31, 2002). Available from http://www.epa.gov/scram001.

Note: There are no restrictions on the location of receptors relative to area sources. Receptors may be placed within the area and at the edge of an area. The U.S. EPA models (ISCST3, ISC-PRIME, and AERMOD) will integrate over the portion of the area that is upwind of the receptor. The numerical integration is not performed for portions of the area that are closer than 1.0 meter upwind of the receptor. Therefore, caution should be used when placing receptors within or adjacent to areas that are less than a few meters wide.

3.7.1.3 Volume Sources

Volume sources are used to model releases from a variety of industrial sources, such as building roof monitors, fugitive leaks from an industrial facility, multiple vents, and conveyor belts.

SCREEN3

- **Emission Rate** [g/sec]: The emission rate of the pollutant in grams per second (g/s).
- **Source Release Height** [m]: The source release height above ground surface at the center of the volume.
- **Initial Lateral Dimension** [m]: See Table 3.1 below for guidance on determining initial dimensions. Units are meters.
- **Initial Vertical Dimension** [m]: See Table 3.1 below for guidance on determining initial dimensions. Units are meters.

Table 3.1 Summary of Suggested Procedures for Estimating Initial Lateral Dimension ($_{yo}$) and Initial Vertical Dimension ($_{zo}$) for Volume and Line Sources.

Type of Source	Procedure for Obtaining Initial Dimension
Initial Lateral Dimension	
Single Volume Source	S_{yo} = (side length)/4.3
Line Source (Represented by Adjacent Volume Sources)	S_{yo} = (side length)/2.15
Line Source (Represented by Separated Volume Sources)	S_{yo} = (center to center distance)/2.15
Initial Vertical Dimension	
Surface-Based Source ($h_e \sim 0$)	S_{zo} = (vertical dimension of source)/2.15
Elevated Source ($h_e > 0$) on or Adjacent to a Building	S_{zo} = (building height)/2.15
Elevated Source ($h_e > 0$) not on or Adjacent to a Building	S_{zo} = (vertical dimension of source)/4.3

AERMOD/ISCST3/ISC-PRIME

- **Source ID**: An identification name for the source being defined, up to 8 characters in length.
- **X Coordinate**: The x (east-west) coordinate for the source location in meters. This location is the center of the volume source.
- **Y Coordinate**: The y (north-south) coordinate for the source location in meters. This location is the center of the volume source.
- **Base Elevation** [m]: The source base elevation. The model only uses the source base elevation if elevated terrain is being used. The default unit is meters.
- **Release Height above Ground** [m]: The release height above ground surface in meters (center of volume).
- **Emission Rate** [g/s]: The emission rate of the pollutant in grams per second. The same emission rate is used for both concentration and deposition calculations.
- **Length of Side** [m]: The length of the side of the volume source in meters. The volume source cannot be rotated and has the X side equal to the Y side (square).
- **Building Height** (If On or Adjacent to a Building) [m]: If your volume source is elevated and is on or adjacent to a building, then you need to specify the building height. The building height can be used to calculate the Initial Vertical Dimension of the source. Note that if the source is surface-based, then this is not applicable.
- **Initial Lateral Dimension** [m]: This parameter is calculated by choosing the appropriate condition in Table 3.1 above. This table provides guidance on determining initial dimensions. Units are in meters.
- **Initial Vertical Dimension** [m]: This parameter is calculated by choosing the appropriate condition in Table 3.1 above. This table provides guidance on determining initial dimensions. Units are in meters.

3.7.2 Source Grouping

Source groups enable modeling results for specific groups of one or more sources. The default in AERMOD and ISCST3/ISC-PRIME is the creations of a source group “ALL” that considers all the sources at the same time.

Analysis of individual groups of sources can be performed by using the SRCGROUP option. One example may be assigning each source to a separate source group to determine the maximum concentration generated by each individual source.

3.7.3 Special Considerations

During some air quality studies, modelers may encounter certain source configurations that require special attention. Some examples include horizontal sources or emissions from storage tanks. The following sections outline modeling techniques to account for the special characteristics of such scenarios.

3.7.3.1 Multiple Stacks

When the plumes from multiple closely spaced stacks or flues merge, the plume rise can be enhanced. Briggs[25] has proposed equations to account for this. The reader is referred to that document for further details. Most models do not explicitly account for enhanced plume rise from this cause, and most regulatory agencies do not permit it to be accounted for in regulatory applications of modeling, with one exception. That exception is the case of a single stack with multiple flues/multiple stacks very close together (less than one stack diameter apart). In these cases, the multiple plumes may be treated as a single plume. To do this, a pseudo stack diameter is used in the calculations, such that the total volume flow rate of the stack gases is correctly represented.

3.7.3.2 Horizontal Sources and Rain Caps

This section is intended to provide guidance for modeling a stack with a rain cap that is located on top of a building.

When emissions are released through a stack with a rain cap, the rain cap redirects the vertical release into a horizontal release, as shown in Figure 3.4.

The presence of a rain cap or any obstacle at the top of the stack hinders the momentum of the exiting gas. Therefore, assuming that the gas exit velocity would be the same as the velocity in a stack without an obstacle is an improper assumption. The extent of the effect is a function of the distance from the stack exit to the obstruction and of the dimensions and shape of the obstruction.

On the conservative side, the stack could be modeled as having a non-zero, but negligible exiting velocity, effectively eliminating any momentum rise. Such an approach would result in final plume heights closer to the ground and therefore higher concentrations nearby.

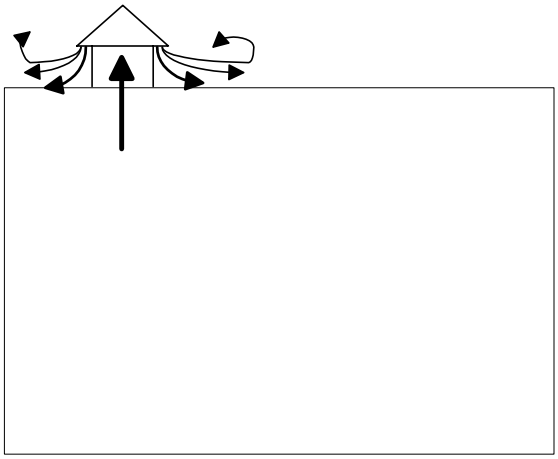

Figure 3.4

Plume buoyancy is not strongly reduced by the occurrence of a rain cap. Therefore if the plume rise is dominated by buoyancy, it is not necessary to adjust the stack conditions. (The air dispersion models determine plume rise by either buoyancy or momentum, whichever is greater.)

The stack conditions should be modified when the plume rise is dominated by momentum and in the presence of a rain cap or a horizontal stack. Sensitivity studies with the SCREEN3 model, on a case-by-case basis, can be used to determine whether plume rise is dominated by buoyancy or momentum. The District should be consulted before applying these procedures.

[25] Briggs, G.A., 1974. Diffusion Estimation for Small Emissions. In ERL, ARL USAEC Report ATDL-106. U.S. Atomic Energy Commission, Oak Ridge, TN.

- Set exit velocity to 0.001 m/sec
- Turn stack tip downwash off
- Reduce stack height by 3 times the stack diameter

Stack tip downwash is a function of stack diameter, exit velocity, and wind speed. The maximum stack tip downwash is limited to three times the stack diameter in the ISC3 air dispersion model. In the event of a horizontal stack, stack tip downwash should be turned off and no stack height adjustments should be made.

Note: This approach may not be valid for large (several meter) diameter stacks.

An alternative, more refined, approach could be considered for stack gas temperatures which are slightly above ambient (e.g., ten to twenty degrees Fahrenheit above ambient). In this approach, the buoyancy and the volume of the plume remains constant and the momentum is minimized.

- Turn stack tip downwash off
- Reduce stack height by 3 times the stack diameter ($3D_o$)
- Set the stack diameter (D_b) to a large value (e.g., 10 meters)
- Set the stack velocity to $V_b = V_o (D_o/D_b)^2$

Where:

V_o and D_o are the original stack velocity and diameter, and
V_b and D_b are the alternative stack velocity and diameter for constant buoyancy.

This approach is advantageous when $D_b >> D_o$ and $V_b << V_o$ and should only be used with District approval.

Reference: Technical Support Document for Exposure and Stochastic Analysis, Office of Environmental Health Hazard Assessment, September 2000, p. 2-39 and p. 2-40.

3.7.3.3 Modeling Bay Door or Window Openings (Volume Source)

This section is intended to provide guidance for modeling openings such as doors and windows as a volume source. When determining how to model an opening, first determine how the emissions are being released from the opening. If a profile of the emissions (% of substance and heat at different levels) is not provided, then assume that emissions are being released at all levels of the opening, and that the emissions are going out some distance from the opening before they are mixed with the outside air. Thus the release from the opening resembles a volume source where the height is the height of the opening, and the width is the width of the opening, and length is also the width of the opening. Volume source modeling requires the width and length to be equal.

Based on these assumptions, the height of the volume is equal to the height of the opening, the width of the volume is equal to the width of the opening, and the length of the volume is equal to the distance from the opening to the nearest edge of the building, see Figure 3.5.

Volume Source: (Open Door)

Height = H (V) - Height of the Door
Length = L(V) - Distance from the door to the nearest building edge.
Width = W(V) - Width of the door

Note: The above values need to be adjusted as instructed by the Modeling Guidelines.

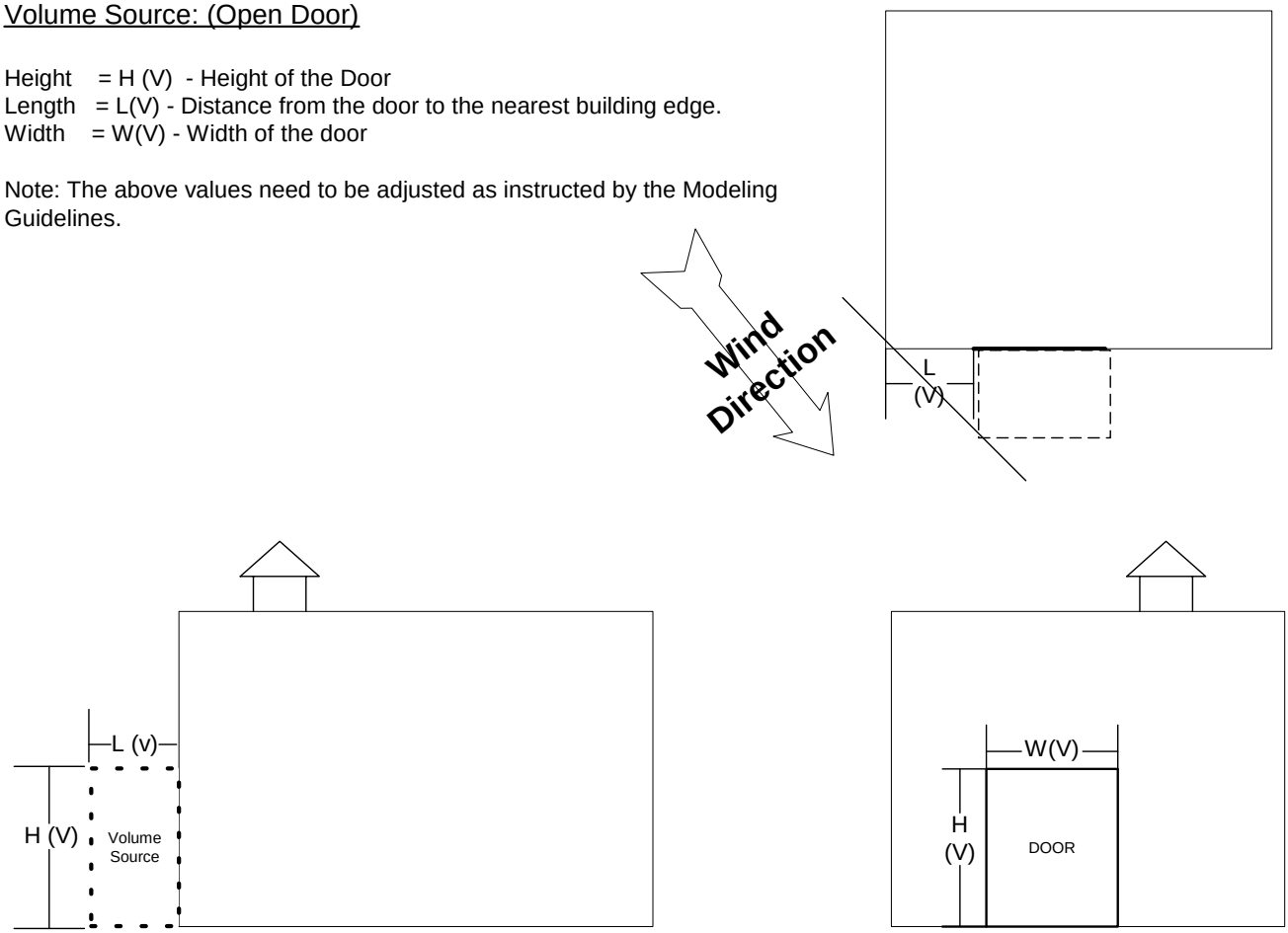

Figure 3.5

3.7.3.4 Liquid Storage Tanks

Storage tanks are generally of two types—fixed roof tanks and floating roof tanks. In the case of fixed roof tanks, most of the pollutant emissions occur from a vent, with some additional contribution from hatches and other fittings. In the case of floating roof tanks, most of the pollutant emissions occur through the seals between the roof and the wall and between the deck and the wall, with some additional emissions from fittings such as ports and hatches.

Approaches for modeling impacts from emissions from various types of storage tanks are outlined below.

Fixed roof tanks:
Model fixed roof tanks as a point (stack) source (representing the vent), which is usually in the center of the tank, and representing the tank itself as a building for downwash calculations.

Floating roof tanks:
Model floating roof tanks as a circle of eight (or more) point sources, representing the tank itself as a building for downwash calculations. Distribute the total emissions equally among the circle of

point sources. Additionally, a floating roof tanks can be modeled as a circle (polygon) area source representing the diameter of the tank with a height of the tank.

All tanks:
There is virtually no plume rise from tanks. Therefore, the stack parameters for the stack gas exit velocity and stack diameter should be set to near zero for the stacks representing the emissions. In addition, stack temperature should be set equal to the ambient temperature. This is done in ISCST3 and AERMOD by inputting a value of 0.0 for the stack gas temperature.

Note that it is very important for the diameter to be at or near zero. With low exit velocities and larger diameters, stack tip downwash will be calculated. Since all downwash effects are being calculated as building downwash, the additional stack tip downwash calculations would be inappropriate. Since the maximum stack tip downwash effect is to lower plume height by three stack diameters, a very small stack diameter effectively eliminates the stack tip downwash.

Table 3.2 - Stack parameter values for modeling tanks

Velocity	Diameter	Temperature
Near zero i.e. 0.001 m/s	Near zero i.e. 0.001m	Ambient – 0.0 sets models to use ambient temperature

3.7.4 Variable Emissions

The ISCST3 and AERMOD models both contain support for variable emission rates. This allows for modeling of source emissions that may fluctuate over time. Emission variations can be characterized across many different periods including hourly, daily, monthly and seasonally. For risk assessments, only the annual average or the maximum hourly emission rates are to be modeled. If a variable emission rate is to be used, the District must be consulted.

3.7.4.1 Wind Erosion

Modeling of emissions from sources susceptible to wind erosion, such as coal piles, can be accomplished using variable emissions.

The ISCST3 and AERMOD models allow for emission rates to be varied by wind speed. This allows for more representative emissions from sources that are susceptible to wind erosion, particularly waste piles that can contribute to particulate emissions. Once a correlation between emissions and wind speed categories is established, the models will then vary the emissions based on the wind conditions in the meteorological data.

3.7.4.2 Non-Continuous Emissions

Sources of emissions at some locations may emit only during certain periods of time. Emissions can be varied within the ISCST3 and AERMOD models by applying factors to different time periods.

For example, for a source that is non-continuous, a factor of 0 is entered for the periods when the source is not operating or is inactive. Model inputs for variable emissions rates can include the following time periods:

- Seasonally
- Monthly
- Hourly
- By Season and hour-of-day
- By Season, hour-of-day, and day-of-week
- By Season, hour, and week

3.7.4.3 Plant Shutdowns and Start-Ups

Plant start-ups and shutdowns can occur due to maintenance, designated vacation periods, or upset conditions. Emissions during shutdown and startup are usually higher than during normal operation. Process upsets or control equipment breakdowns can also increase emissions. Such upsets can result in the release of uncontrolled emissions. The ISC and AERMOD models allow the use of variable emission rates for hours of the day, day of the week, and season of the year. The example below illustrates the use of this feature to model emissions that vary by the time of the day.

Example:
Assume that a gas turbine operates 14 hours per day (1 startup, 1 shutdown, and 12 hours of normal operation

Given:
Emission Rate = 1 g/s (emissions rate during normal operation)
Operation Schedule = 6 AM – 8PM
Startup/Shutdown Emissions are twice that of normal operating emissions

The model will adjust the emissions rate using the data found in the table below:

Calculation:
Modeled Emissions Rate * Emission Rate Adjustment Factor

Emissions Rate for 1 AM – 6 AM = 1 g/s * 0 = 0 g/s
Emissions Rate for 6 AM – 7 AM = 1 g/s * 2 = 2 g/s
Emissions Rate for 7 AM – 7 PM = 1 g/s * 1 = 1 g/s
Emissions Rate for 7 PM – 8 PM = 1 g/s * 2 = 2 g/s

Non-Continuous Emissions (Hours of Day):

Morning Hours		Afternoon Hours	
Hour of the Day	**Emissions Rate Adjustment Factor**	**Hour of the Day**	**Emissions Rate Adjustment Factor**
1:00 am	0	1:00 pm	1
2:00 am	0	2:00 pm	1
3:00 am	0	3:00 pm	1
4:00 am	0	4:00 pm	1
5:00 am	0	5:00 pm	1
6:00 am	2	6:00 pm	1
7:00 am	1	7:00 pm	2
8:00 am	1	8:00 pm	0
9:00 am	1	9:00 pm	0
10:00 am	1	10:00 pm	0
11:00 am	1	11:00 pm	0
Noon	1	Midnight	0

3.7.4.4 Seasonal Variations

Industrial processes often fluctuate depending on supply and demand requirements. This affects some sectors seasonally, particularly facilities involved in food processing. For example, soup production makes use of agricultural produce which is at its highest in the late summer. Production schedules for soup production typically ramp up resulting in different emissions during the late summer and early fall than at mid to late winter.

These emission differences can be accounted for by the application of variable emission factors, with control over the following time periods:

- By Season and hour-of-day
- By Season, hour-of-day, and day-of-week
- By Season, hour, week

3.8 Building Impacts

Buildings and other structures near a relatively short stack can have a substantial effect on plume transport and dispersion, and on the resulting ground-level concentrations that are observed. . There has long been a “rule of thumb” that a stack should be at least 2.5 times the height of adjacent buildings. Beyond that, much of what is known of the effects of buildings on plume transport and diffusion has been obtained from wind tunnel studies and field studies.

When the airflow meets a building (or other obstruction), it is forced up and over the building. On the lee side of the building, the flow separates, leaving a closed circulation containing lower wind

speeds. Farther downwind, the air flows downward again. In addition, there is more shear and, as a result, more turbulence. This is the turbulent wake zone (see Figure 3.6).

If a plume gets caught in the cavity, very high concentrations can result. If the plume escapes the cavity, but remains in the turbulent wake, it may be carried downward and dispersed more rapidly by the turbulence. This can result in either higher or lower concentrations than would occur without the building, depending on whether the reduced height or increased turbulent diffusion has the greater effect.

The height to which the turbulent wake has a significant effect on the plume is generally considered to be about the building height plus 1.5 times the lesser of the building height or width. This results in a height of 2.5 building heights for cubic or squat buildings, and less for tall, slender buildings. Since it is considered good engineering practice to build stacks taller than adjacent buildings by this amount, this height came to be called "good engineering practice" (GEP) stack height.

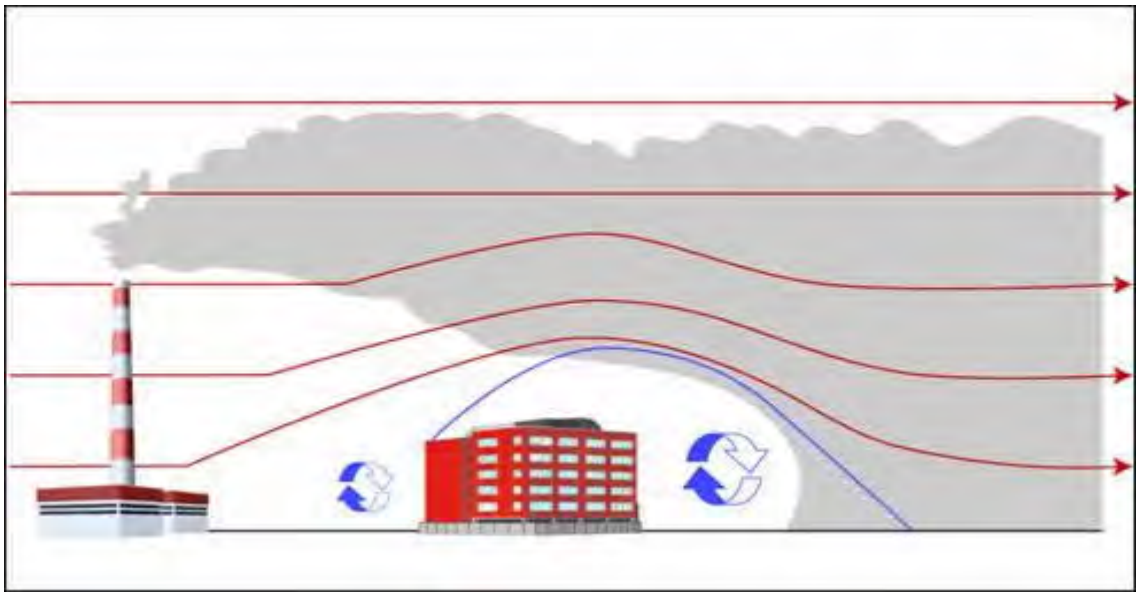

Figure 3.6 - The building downwash concept where the presence of buildings forms localized turbulent zones that can readily force pollutants down to ground level.

3.8.1 Good Engineering Practice (GEP) Stack Heights and Structure Influence Zones

The U.S. EPA[26] states that "If stacks for new or existing major sources are found to be less than the height defined by the EPA's refined formula for determining GEP height, then air quality impacts associated with cavity or wake effects due to the nearby building structures should be determined."

The U.S. EPA's refined formula for determining GEP stack height is:

GEP Stack Height = H + 1.5L

[26] U.S. Environmental Protection Agency, 1990. Stack Heights, Section 123, Clean Air Act, 40 CFR Part 51. U. S. Environmental Protection Agency, Research Triangle Park, NC.

where,

GEP = Good Engineering Practice

H = Building/Tier Height measured from ground to the highest point

L = Lesser of the Building Height (PB) or Projected Building Width (PBW)

Building downwash for point sources that are within the Area of Influence of a building should be considered. For U.S. EPA regulatory applications, a building is considered sufficiently close to a stack to cause wake effects when the distance between the stack and the nearest part of the building is less than or equal to five (5) times the lesser of the building height or the projected width of the building.

$Distance_{stack\text{-}bldg} <= 5L$

For point sources within the Area of Influence, building downwash information (direction-specific building heights and widths) should be included in your modeling project. Using BPIP-PRIME, you can compute these direction-specific building heights and widths.

Structure Influence Zone (SIZ): For downwash analyses with direction-specific building dimensions, wake effects are assumed to occur if the stack is within a rectangle composed of two lines perpendicular to the wind direction, one at 5L downwind of the building and the other at 2L upwind of the building, and by two lines parallel to the wind direction, each at 0.5L away from each side of the building, as shown below. L is the lesser of the height or projected width. This rectangular area has been termed a Structure Influence Zone (SIZ). Any stack within the SIZ for any wind direction is potentially affected by GEP wake effects for some wind direction, or range of wind directions, see Figure 3.7 and Figure 3.8.

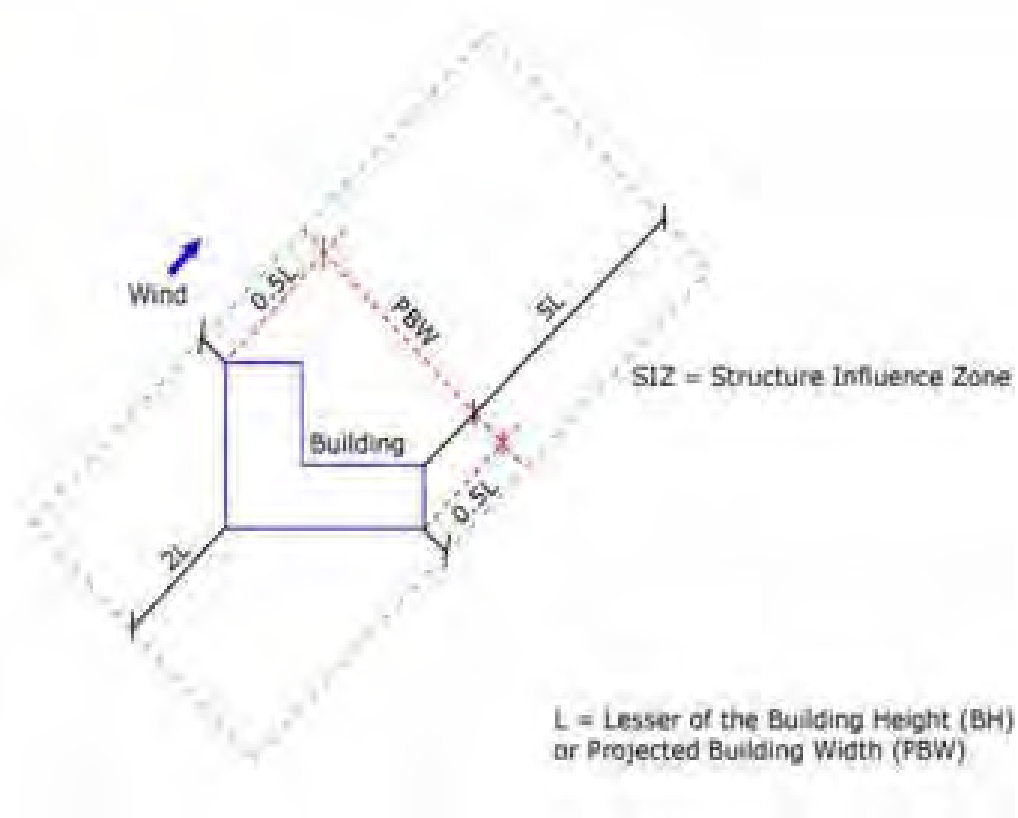

Figure 3.7 - GEP 5L and Structure Influence Zone (SIZ) Areas of Influence

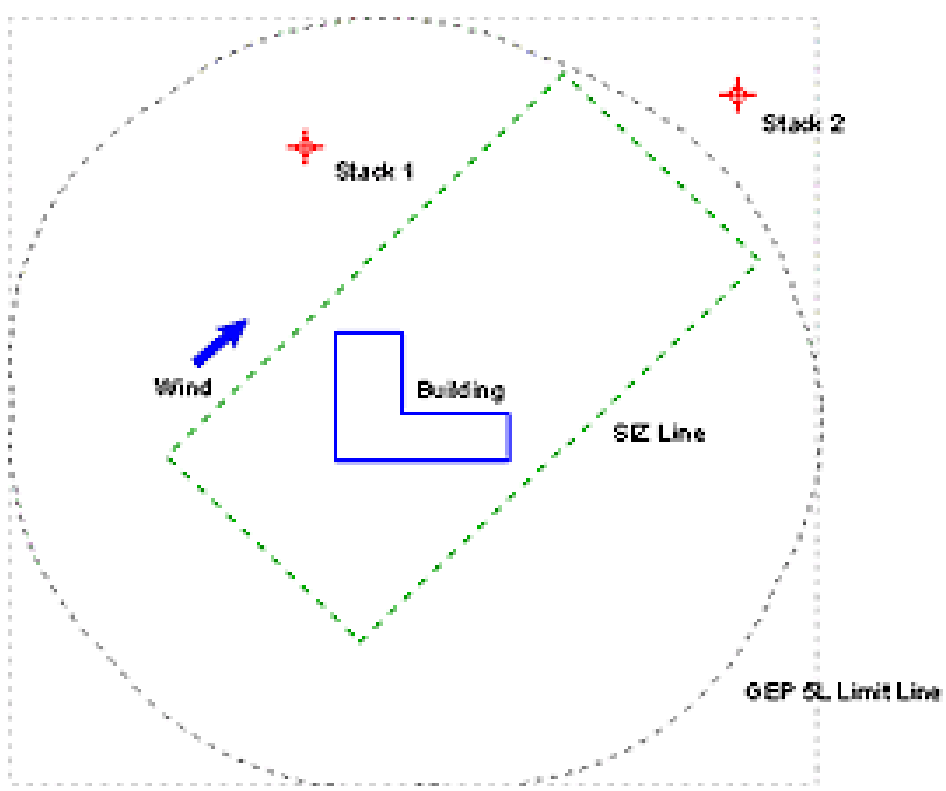

Figure 3.8 -GEP 360° 5L and Structure Influence Zone (SIZ) Areas of Influence

3.8.2 Defining Buildings

The recommended screening and refined models all allow for the consideration of building downwash. SCREEN3 considers the effects of a single building while AERMOD and ISCST3/ISC-PRIME can consider the effects of complicated sites consisting of up to hundreds of buildings. This results in different approaches to defining buildings as outlined below.

3.8.2.1 SCREEN3 Building Definition

Defining buildings in SCREEN3 is straightforward, as only one building requires definition. The following input data is needed to consider downwash in SCREEN3:

- Building Height: The physical height of the building structure in meters.
- Minimum Horizontal Building Dimension: The minimum horizontal building dimension in meters.
- Maximum Horizontal Building Dimension: The maximum horizontal building dimension in meters.

For Flare releases, SCREEN assumes the following:

- an effective stack gas exit velocity (V_s) of 20 m/s,
- an effective stack gas exit temperature (T_s) of 1,273 K, and
- an effective stack diameter based on the heat release rate.

Since building downwash estimates depend on transitional momentum plume rise and transitional buoyant plume rise calculations, the selection of effective stack parameters could influence the estimates. Therefore, building downwash estimates for flare releases should be used with extra caution[27].

If using Automated Distances or Discrete Distances option, wake effects are included in any calculations made. Cavity calculations are made for two building orientations, first with the minimum horizontal building dimension along wind, and second with the maximum horizontal dimension along wind. The cavity calculations are summarized at the end of the distance-dependent calculations (see SCREEN3 User's Guide[32] Section 3.6 for more details).

3.8.2.2 AERMOD and ISC-PRIME Building Definition

The inclusion of the PRIME (Plume Rise Model Enhancements) algorithm[28] to compute building downwash has produced more accurate results in air dispersion models. Unlike the earlier algorithms used in ISC3, the PRIME algorithm:

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[27] U.S. Environmental Protection Agency, 1995. SCREEN3 Model User's Guide. EPA-454/B-95-004. Office of Air Quality Planning and Standards, Research Triangle Park, NC.

[28] Schulman, L.L., D.G. Strimaitis and J.S. Scire, 2000: Development and evaluation of the PRIME plume rise and building downwash model. Journal of the Air & Waste Management Association, 50:378-390.

- accounts for the location of the stack relative to the building;
- accounts for the deflection of streamlines up over the building and down the other side;
- accounts for the effects of the wind profile at the plume location for calculating plume rise;
- accounts for pollutants captured in the recirculation cavity to be transported to the far wake downwind (this is ignored in the earlier algorithms); and
- avoids discontinuities in the treatment of different stack heights, which were a problem in the earlier algorithms.

Refined models allow for the consideration of downwash effects from multiple buildings. AERMOD and ISCST3/ISC-PRIME require building downwash analysis to first be performed using BPIP-PRIME[28]. The results from BPIP-PRIME can then be incorporated into the modeling studies for consideration of downwash effects.

The U.S. EPA Building Profile Input Program – Plume Rise Model Enhancements (BPIP-PRIME) was designed to incorporate enhanced downwash analysis data for use with the U.S. EPA ISC-PRIME and current AERMOD models. Similar in operation to the U.S. EPA BPIP model, BPIP-PRIME uses the same input data requiring no modifications of existing BPIP projects. The following information is required to perform building downwash analysis within BPIP:

- X and Y location for all stacks and building corners.
- Height for all stacks and buildings (meters). For building with more than one height or roofline, identify each height (tier).
- Base elevations for all stacks and buildings.

The BPIP User's Guide[29] provides details on how to input building and stack data to the program.

The BPIP model is divided into two parts.

- Part One: Based on the GEP technical support document[30], this part is designed to determine whether or not a stack is subject to wake effects from a structure or structures. Values are calculated for GEP stack height and GEP related building heights (BH) and projected building widths (PBW). Indication is given to which stacks are being affected by which structure wake effects.
- Part Two: Calculates building downwash BH and PBW values based on references by Tickvart[31,32] and Lee[33]. These can be different from those calculated in Part One. The calculations are performed only if a stack is being influenced by structure wake effects.

In addition to the standard variables reported in the output of BPIP, BPIP-PRIME adds the following:

- BUILDLEN: Projected length of the building along the flow.

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[29] U.S. Environmental Protection Agency, 1995. User's Guide to the Building Profile Input Program, EPA-454/R-93-038, Office of Air Quality Planning and Standards, Research Triangle Park, N.C.

[30] U.S. Environmental Protection Agency, 1985. Guideline for Determination of Good Engineering Practice Stack Height (Technical Support Document for the Stack Height Regulations) – Revised EPA-450/4-80-023R, U.S. Environmental Protection Agency, Research Triangle Park, NC.

[31] Tickvart, J. A., May 11, 1988. Stack-Structure Relationships, Memorandum to Richard L. Daye, U.S. EPA.

[32] Tickvart, J. A., June 28, 1989. Clarification of Stack-Structure Relationships, Memorandum to Regional Modeling Contacts, Regions I-X, U.S. EPA.

[33] Lee, R. F., July 1, 1993. Stack-Structure Relationships – Further clarification of our memoranda dated May 11, 1988 and June 28, 1989, Memorandum to Richard L. Daye, U.S. EPA.

- XBADJ: Along-flow distance from the stack to the center of the upwind face of the projected building.
- YBADJ: Across-flow distance from the stack to the center of the upwind face of the projected building.

For a more detailed technical description of the EPA BPIP-PRIME model and how it relates to the EPA ISC-PRIME model see the Addendum to ISC3 User's Guide[34].

3.9 Multiple Pollutants

3.9.1 Modeling Multiple Pollutants from Multiple Sources

Industrial processes often emit multiple pollutants through one or several emission sources. The U.S. EPA models are not equipped to automatically perform modeling of different pollutants that may share the same emission source but have unique emission rates.

Traditional approaches to this scenario resulted in modelers performing separate model runs for each specific pollutant type, even though all other model site parameters remain the same. For projects consisting of many pollutants, this approach results in the modeler needing not only to be extremely organized but also requires high levels of computer resources as the project would need to be run separately for each pollutant scenario.

An alternative approach is applying unitized emission rate and summation concepts, which drastically reduce the computational time for large multiple pollutant projects.

3.9.1.1 Standard Approaches to Modeling Multiple Toxic Pollutants from Multiple Sources

For industrial processes that emit multiple pollutants through one or several emission sources, the following approach should be followed.

- Dispersion modeling should be conducted as outlined in this guidance document using a unit (normalized) emissions rate of 1 g/s, or 1/g/s/m^2 for area sources.
- All chemical analysis / risk calculations should be processed through the CARB HARP program http://www.arb.ca.gov/toxics/harp/harp.htm.
- Exceptions (Must be given prior approval by the district):
  - Analysis of multiple pollutants that only affect one acute toxicological endpoint or the same endpoints.
  - Analyses of multiple pollutants that only affect one chronic toxicological endpoint or the same endpoint and do not have a chronic oral value.
  - Analysis of multiple pollutants that are not multi-pathway (only inhalation)
    - One dispersion modeling run for

[34] Schulman, et al., 1997. Addendum - User's Guide for the Industrial Source Complex (ISC3) Dispersion Models, Volume 1. Office of Air Quality Planning and Standards, Research Triangle Park, NC.

- Acute Hazard Index,
- Chronic Hazard Index, and
- Cancer Risk.

3.9.2 Unitized (Normalized) Emission Rate and Summation Concepts

It is a well-known fact that air dispersion modeling is a non-linear process. The modeled site may have random meteorological variations, the dispersion process is non-linear, and the terrain elevations at the site may assume unlimited shapes. However, once the calculations to a receptor in space are complete, all chemical concentration levels vary linearly with their source release rate. Figure 3.9 helps visualize this concept, by describing an emission rate of 1 g/s.

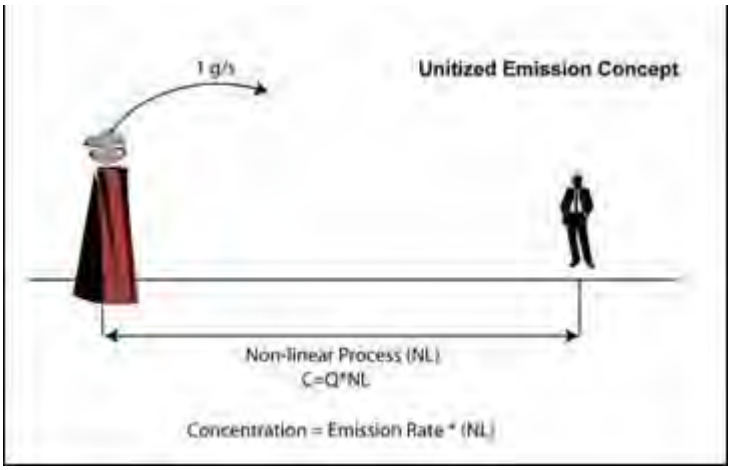


Figure 3.9 - Unitized Emission Rate Concept (1 g/s)

The Unitized Emission Rate Concept only applies to single sources. For assessments with multiple sources the authors recommend that each source be modeled independently, using unitized emission rate (1 g/s). The concentration at the receptor can then be multiplied by the actual chemical emission rate, and the final result from all the sources will be superimposed. This is called the Summation Concept, where the concentration and deposition fluxes at a receptor are the linear addition of the resulting values from each source. Figure 3.10 depicts the Summation concept.

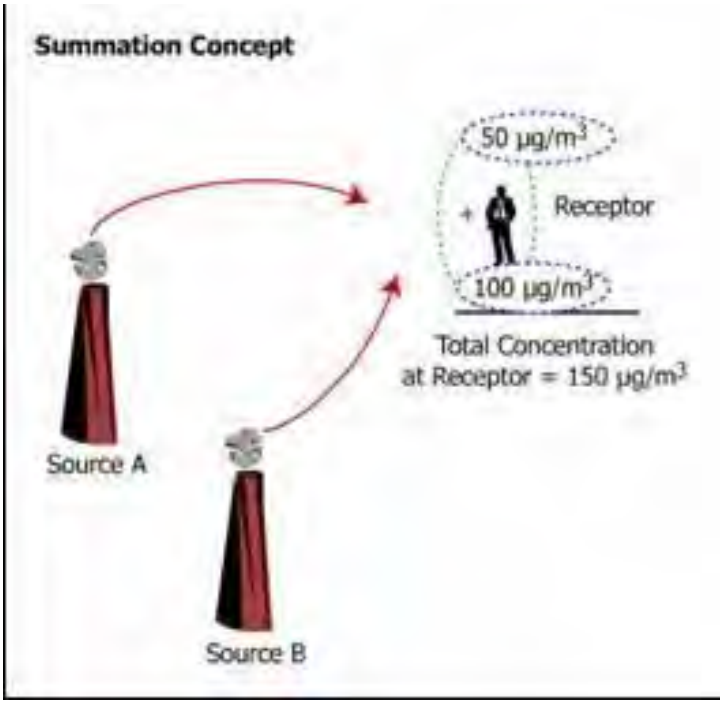


Figure 3.10 - The Summation Concept for two sources

A post-processor is needed to effectively process model results that have been performed using unitized emission rate and summation concepts. Final output will provide results for pollutant specific scenarios from multiple sources.

3.10 Modeling Roads

There are a number of dispersion models that can be used to predict concentrations from roadway emissions. Some models such as CAL3QHCR were developed solely for use in modeling roadway emissions. They use a line source algorithm. CAL3QHCR is a preferred/recommended U.S. Environmental Protection Agency (EPA) model for roadway modeling that uses local meteorology. EPA also recommends the CALINE3 model. But, CALINE3 does not use local meteorology. It is included in CAL3QHCR. The Industrial Source Complex – Short-Term (ISCST3) and the AERMOD models can be used to model roadways as a line of volume sources. AERMOD is the recommended EPA model. However, some Districts still use ISCST3 because they do not yet have the meteorological data needed for AERMOD. The methodology for modeling using AERMOD is the same as that for using ISCST3. The input data is almost identical because AERMOD was designed to use input similar to that used by ISCST3 and to provide similar outputs. The major differences between the inputs to the two models are the meteorological data sets. During the preparation of this guideline, an analysis was conducted to compare concentrations predicted by all three models for a specific example. This analysis showed that all three models provided similar concentration estimates, and that any of the three models could be used effectively to predict pollutant concentrations and the resulting risk from roadway emissions.

In the discussion below, use of CAL3QHCR is described first. That discussion includes a description of data sources to estimate emissions. The same approach can be used to develop emissions estimates for ISCST3/AERMOD.

3.10.1 Modeling Roads using CAL3QHCR

3.10.1.1 Introduction

This step by step guidance explains how to use the CAL3QHCR line source model to carry out diesel particulate matter air dispersion modeling, and how to calculate potential cancer risk. Nine potential receptors are assumed to lie directly south of an east-west free-flow freeway with a peak hour traffic count of 11,900 vehicles. The freeway is assumed to be 120 feet wide, with an additional 10 feet on each side to account for the wake of moving vehicles[35], making for a total link width of 140 feet.

This example represents one specific scenario. For guidance on other CAL3QHCR modeling scenarios not contained herein, contact your local air district or consult the User's Guide to CAL3QHC, Version 2.0 [36].

3.10.1.2 Data Sources

This example scenario relies on basic information needed to complete the site specific HRA. Such information includes:

- meteorological data,
- traffic data (from Caltrans), later developed into hourly data,
- vehicle emissions (derived from EMFAC),
- location of the nearest sensitive receptor to the edge of the travel lane, in addition to the generic receptor locations, if required (for example, at 10, 25, 50, 100, 200, 300, 400 and 500 feet) in X-Y coordinates, and
- roadway orientation in terms of its X-Y coordinates (arbitrary origin / 0,0), including length and width.

The above information, including additional information required by the model, is further discussed in the ensuing sections of this document.

3.10.1.3 Finding the Peak Hour Traffic Count

The peak hour traffic count nearest to the proposed receptors is used to develop the hourly traffic count information for input into CAL3QHCR. The peak hour traffic count should be found on Caltrans's website at http://www.dot.ca.gov/hq/traffops/saferesr/trafdata/index.htm. Select back peak hour for projects south or west of the nearest milepost location. For projects north or east of the nearest milepost location, select ahead peak hour.

[35] The mixing zone is an area where dispersion results are considered to be inaccurate.
[36] User's Guide to CAL3QHC Version 2.0, EPA-454/R-92-006 (Revised, with CAL3QHCR addendum), September 1995.

For the scenario considered herein, the Caltrans's data indicates a peak hour traffic count of 11,900 vehicles.

Running EMFAC to Produce Hourly PM10 Emissions and Data on Vehicle Miles Traveled

The most current version of EMFAC should be run to determine preliminary vehicle miles traveled (VMT) and emissions data. The VMT data will be used to develop the hourly traffic count information required by CAL3QHCR, and the PM10 exhaust emissions data will be used to determine the hourly PM10 emissions rates for input into CAL3QHCR.

The EMFAC run should be based on the following parameters:

- Year: first year of project build out,
- Season: annual,
- Burden: standard, and
- Output Frequency: hourly.

The following data from the EMFAC output file will be used:

- VMT/1000 for each hour,
- PM10 emissions for each hour.

Figure 3.11 is a screen shot of the first page of the EMFAC output file. The circled hourly data is the data that will be used.

This methodology is a **screening method** to determine the cancer risk from diesel exhaust assuming that all vehicles traveling the roadway segment are diesel vehicles.

A refinement of the emission calculations can be made by using data on percentages of truck traffic from Caltrans and assuming that all trucks are diesel. If better data is not available, 10% is sometimes assumed as the diesel truck fraction of vehicles.

To refine the emissions calculations further to account for diesel emissions from diesel trucks, and to account for the emissions of the highest priority toxic substances (1,3 butadiene, acrolein, acetaldehyde, formaldehyde, and benzene) from all vehicles, the procedure in Appendix B should be followed.

Contact the local district to determine which method should be used to estimate diesel truck travel.

Figure 3.11: Example Scenario EMFAC Output, Page 1

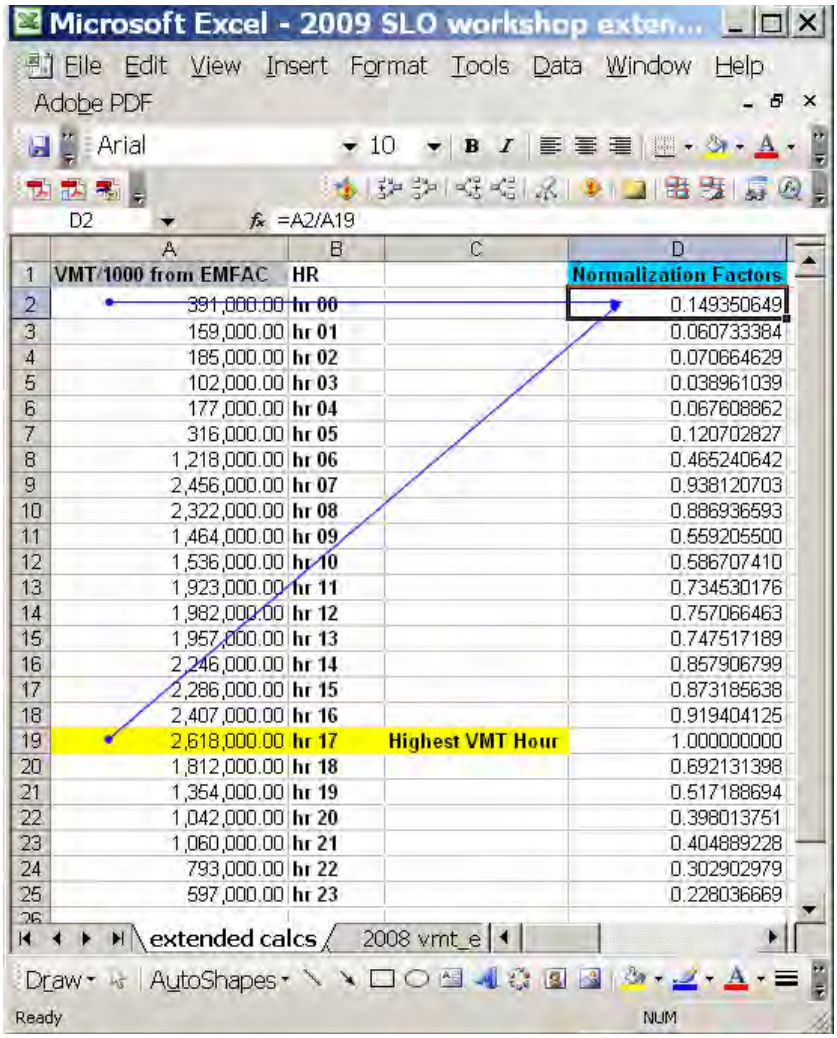
Version : Emfac2007 V2.3 Nov 1 2006
Run Date : 2008/02/06 15:08:23
Scen Year: 2009 -- All model years in the range 1965 to 2009 selected
Season : Annual
Area : Sacramento Metropolitan AQMD Averag
I/M Stat : Enhanced Interim (2005) -- Using I/M schedule for area 31 Sacramento (SV)
Emissions: Tons Per Hr00

	- - - Light Duty Passenger Cars - - -				- - - - - Light Duty Trucks - - - - -				- - - - - Medium Duty Trucks - - - -				- - - - Heavy Duty Trucks - - - ----- Gasoline Trucks ------							
	Non-cat	Cat	Diesel	Total	Non-cat	Cat	Diesel	Total	Non-cat	Cat	Diesel	Total	Non-cat	Cat	Total	Diesel Trucks	Total HD Trucks	Urban Buses	Motor-cycles	All Vehicles
Vehicles	7632.	483025.	1673.	492331.	5806.	307893.	8213.	321912.	1391.	117094.	9051.	127537.	1330.	11346.	12677.	18201.	30878.	371.	34494.	1007520.
VMT/1000	1.	160.	0.	162.	1.	109.	2.	112.	0.	41.	21.	63.	0.	1.	1.	50.	51.	0.	3.	391.
Trips	256.	25555.	78.	25889.	198.	16328.	423.	16950.	76.	8729.	3082.	11887.	326.	1629.	1954.	965.	2920.	16.	580.	30344.
Total Organic Gas Emissions																				
Run Exh	0.01	0.01	0.00	0.02	0.01	0.01	0.00	0.02	0.00	0.01	0.00	0.01	0.00	0.00	0.00	0.03	0.04	0.00	0.01	0.10
Idle Exh	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00
Start Ex	0.00	0.02	0.00	0.02	0.00	0.01	0.00	0.01	0.00	0.01	0.00	0.01	0.01	0.01	0.02	0.00	0.02	0.00	0.00	0.07
Total Ex	0.01	0.03	0.00	0.04	0.01	0.02	0.00	0.03	0.00	0.02	0.00	0.03	0.01	0.01	0.02	0.04	0.06	0.00	0.01	0.17
Diurnal	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00
Hot Soak	0.00	0.00	0.00	0.01	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.01
Running	0.01	0.02	0.00	0.02	0.00	0.02	0.00	0.02	0.00	0.01	0.00	0.01	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.05
Resting	0.00	0.01	0.00	0.01	0.00	0.01	0.00	0.01	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.03
Total	0.02	0.06	0.00	0.08	0.01	0.05	0.00	0.06	0.00	0.03	0.00	0.04	0.01	0.01	0.02	0.04	0.06	0.00	0.02	0.26
Carbon Monoxide Emissions																				
Run Exh	0.10	0.36	0.00	0.45	0.08	0.31	0.00	0.39	0.05	0.14	0.02	0.20	0.01	0.01	0.03	0.15	0.18	0.00	0.14	1.37
Idle Exh	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.01	0.01	0.00	0.00	0.01
Start Ex	0.01	0.21	0.00	0.22	0.01	0.16	0.00	0.17	0.00	0.18	0.00	0.18	0.06	0.19	0.25	0.00	0.25	0.00	0.01	0.82
Total Ex	0.10	0.57	0.00	0.67	0.09	0.47	0.00	0.56	0.05	0.31	0.02	0.38	0.07	0.20	0.28	0.16	0.44	0.00	0.15	2.21
Oxides of Nitrogen Emissions																				
Run Exh	0.01	0.04	0.00	0.05	0.00	0.05	0.00	0.06	0.00	0.03	0.11	0.14	0.00	0.01	0.01	0.73	0.74	0.01	0.00	1.00
Idle Exh	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.02	0.02	0.00	0.00	0.02
Start Ex	0.00	0.01	0.00	0.01	0.00	0.01	0.00	0.01	0.00	0.02	0.00	0.02	0.00	0.01	0.01	0.00	0.01	0.00	0.00	0.06
Total Ex	0.01	0.05	0.00	0.06	0.01	0.06	0.00	0.07	0.00	0.05	0.11	0.16	0.00	0.02	0.02	0.76	0.77	0.01	0.00	1.08
Carbon Dioxide Emissions (000)																				
Run Exh	0.00	0.06	0.00	0.06	0.00	0.05	0.00	0.05	0.00	0.03	0.01	0.04	0.00	0.00	0.00	0.09	0.09	0.00	0.00	0.25
Idle Exh	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00
Start Ex	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.01
Total Ex	0.00	0.06	0.00	0.06	0.00	0.05	0.00	0.05	0.00	0.03	0.01	0.04	0.00	0.00	0.00	0.09	0.09	0.00	0.00	0.25
PM10 Emissions																				
Run Exh	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.02	0.02	0.00	0.00	0.03
Idle Exh	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00
Start Ex	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00
Total Ex	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.02	0.02	0.00	0.00	0.03
TireWear	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00
BrakeWr	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.01
Total	0.00	0.01	0.00	0.01	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.02	0.02	0.00	0.00	0.04
Lead	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00
SOx	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00
Fuel Consumption (000 gallons)																				
Gasoline	0.08	6.49	0.00	6.57	0.07	5.48	0.00	5.55	0.03	2.91	0.00	2.94	0.03	0.13	0.16	0.00	0.16	0.02	0.07	15.32
Diesel	0.00	0.00	0.01	0.01	0.00	0.00	0.08	0.08	0.00	0.00	1.11	1.11	0.00	0.00	0.00	8.26	8.26	0.07	0.00	9.53

Title : 2009 info
Version : Emfac2007 V2.3 Nov 1 2006
Run Date : 2008/02/06 15:08:23
Scen Year: 2009 -- All model years in the range 1965 to 2009 selected
Season : Annual
Area : Sacramento Metropolitan AQMD Averag
I/M Stat : Enhanced Interim (2005) -- Using I/M schedule for area 31 Sacramento (SV)
Emissions: Tons Per Hr01

3.10.1.4 Preparing the Hourly Traffic Count Data

To develop hourly traffic count values needed by CAL3QHCR, first find the highest hourly Vehicle Miles Traveled (VMT) count reported by EMFAC. Figure 3.12 shows an example. In this example, the highest hourly VMT count is 2,618,000 miles, which falls on Hour 17, 5:00 pm. Next, divide each hourly VMT value from EMFAC by the highest hourly VMT count (2,618,000 miles). Each result is known as a normalization factor.



	A	B	C	D
1	VMT/1000 from EMFAC	HR		Normalization Factors
2	391,000.00	hr 00		0.149350649
3	159,000.00	hr 01		0.060733384
4	185,000.00	hr 02		0.070664629
5	102,000.00	hr 03		0.038961039
6	177,000.00	hr 04		0.067608862
7	316,000.00	hr 05		0.120702827
8	1,218,000.00	hr 06		0.465240642
9	2,456,000.00	hr 07		0.938120703
10	2,322,000.00	hr 08		0.886936593
11	1,464,000.00	hr 09		0.559205500
12	1,536,000.00	hr 10		0.586707410
13	1,923,000.00	hr 11		0.734530176
14	1,982,000.00	hr 12		0.757066463
15	1,957,000.00	hr 13		0.747517189
16	2,246,000.00	hr 14		0.857906799
17	2,286,000.00	hr 15		0.873185638
18	2,407,000.00	hr 16		0.919404125
19	2,618,000.00	hr 17	Highest VMT Hour	1.000000000
20	1,812,000.00	hr 18		0.692131398
21	1,354,000.00	hr 19		0.517188694
22	1,042,000.00	hr 20		0.398013751
23	1,060,000.00	hr 21		0.404889228
24	793,000.00	hr 22		0.302902979
25	597,000.00	hr 23		0.228036669

Figure 3.12: Example Scenario Development of Normalization Factors

Next multiply each normalization factor times the project's peak hour traffic count provided in this example by Caltrans (11,900 vehicles/hour during hour 17, 5:00 pm), Table 3.3. The results are normalized hourly traffic volumes for input into CAL3QHCR.

Time of day	Traffic Count (vehicles/hour)
Hr 00	1777
Hr 01	723
Hr 02	841
Hr 03	464
Hr 04	805
Hr 05	1436
Hr 06	5536
Hr 07	11164
Hr 08	10555
Hr 09	6655
Hr 10	6982
Hr 11	8741
Hr 12	9009
Hr 13	8895
Hr 14	10209
Hr 15	10391
Hr 16	10941
Hr 17	**11900**
Hr 18	8236
Hr 19	6155
Hr 20	4736
Hr 21	4818
Hr 22	3605
Hr 23	2714

Table 3. 3: Example Scenario Normalized Traffic Counts

3.10.1.5 Preparing the Hourly Emissions Data

PM10 emissions data is reported by EMFAC in tons/hour and needs to be converted to grams/hour. The grams/hour values then need to be divided by the overall VMT per hour for each hour (as reported by EMFAC), to obtain grams per vehicle mile needed for input into CAL3QHCR.

3.10.1.6 Defining the Calculational Domain for the Input File

The CAL3QHCR input file requires data that defines the calculational domain. The X-Y coordinates at the beginning and at the end of the roadway section need to be defined. These have an arbitrary origin, with the y axis aligned with north.

Additionally, the width (mixing zone) of the roadway needs to be defined. Always allow for an additional 10 feet added to the edge of nearest travel lane to the receptors to account for the wake of moving vehicles.

The minimum roadway length is 10,000 feet.

The elevation of the roadway compared to the surrounding area needs to be specified. For roadways at grade the height is 0; for elevated roadways the relative height is positive; and for depressed roadways the relative height is negative.

The z-coordinate (receptor breathing height) also needs to be defined. The default recommendation is 1.5 meters, or 6 feet.

In this scenario, the freeway is 120 feet wide, and after accounting for the wake, the total link width becomes 140 feet.

The length of the roadway modeled is 10,000 feet, or 5,000 feet on each side from the center point.

The roadway is at grade.

A receptor has been placed at the edge of the roadway to define the roadway dimensions; however the dispersion results for this receptor should be discarded as they are not accurate at roadway edges. See Figure 3.13 below.

Other parameters required by the model need to be defined. Table 3.4 below discusses recommended and/or default parameters. Any changes to the default recommended values should be thoroughly explained.

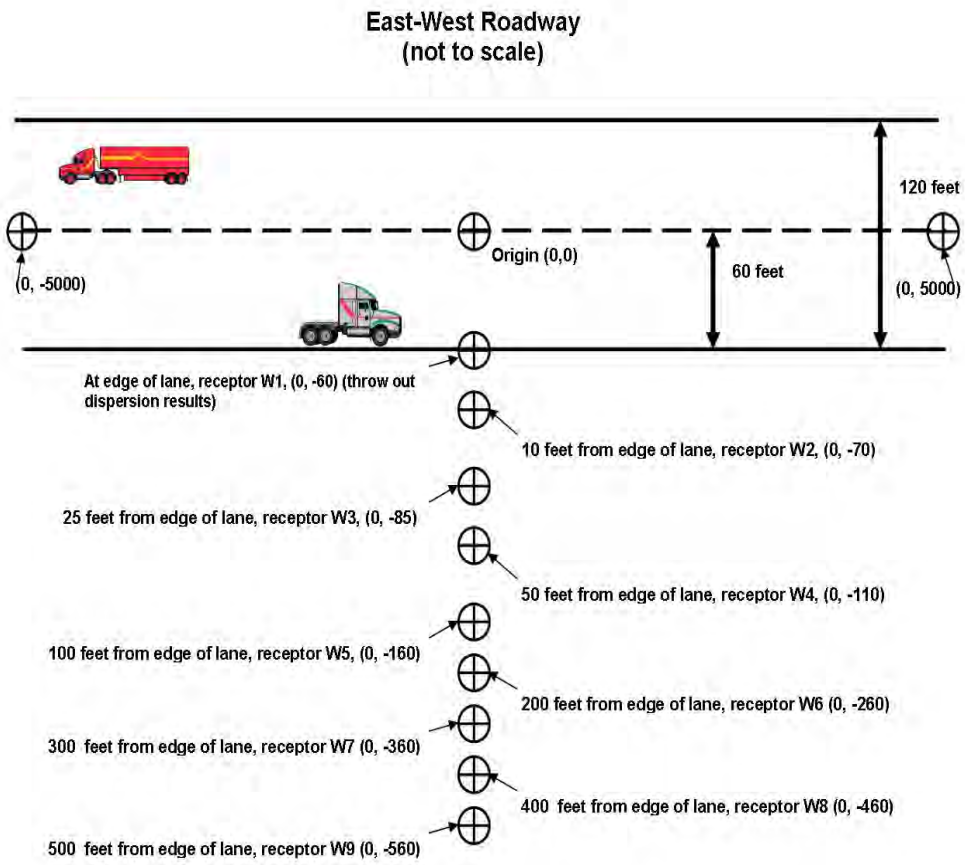


Figure 3.13: Example Scenario East-West Roadway and Receptors Illustration

Table 3.4: Other Recommended Parameters for Input into CAL3QHCR

Parameter	Default	
Calculation averaging time (min)	60	
Surface roughness (cm, from 3 to 400). For mixed uses and others not listed here, the modeler should make a reasonable assumption.	single family	108
	offices	170
	apartments	370
Settling velocity (cm/s)	0	
Deposition velocity (cm/s)	0	
Site setting (U=urban, R=rural)	U	
Form of traffic volume, emission rate data (1=one hour's data, 2=one week of hourly data)	2	
Pollutant (P for PM10 to give output in $\mu g/m^3$)	P	
Hourly ambient background concentration ($\mu g/m^3$)	0	
Roadway height indicator (AG=at grade, FL=elevated and filled, BR=bridge, DP=depressed)	AG	
Roadway height (ft, 0 if AG, relative height if FL, BR, or DP)	0	

3.10.1.7 Preparing the CAL3QHCR Files

3.10.2.7.1Downloading CAL3QHCR

Download the CAL3QHCR model from EPA's Preferred/Recommended Dispersion Models website at www.epa.gov/scram001/dispersion_prefrec.htm. There are five files needed to run the program:

- input file (.inp),
- batch file (.bat),
- control file (.ctl),
- meteorological data file (.asc), and
- executable file (.exe).

Decide on a name for the run. The name of the example scenario run is "2009south11900k".

Note that in setting up your run, you will be editing over data already present in the files.

Prepare the Batch File (.bat)**.**
The batch file is the DOS file batch command.

Right click on the file to open it for editing. (Note that opening or double clicking on the file will cause the program to run. If this happens, simply delete the files the program creates and start again.) Once the file is open, type in the name of your run after the word "Copy". Save the file with the name of the run. See Figure 3.14 below for the example scenario batch file.

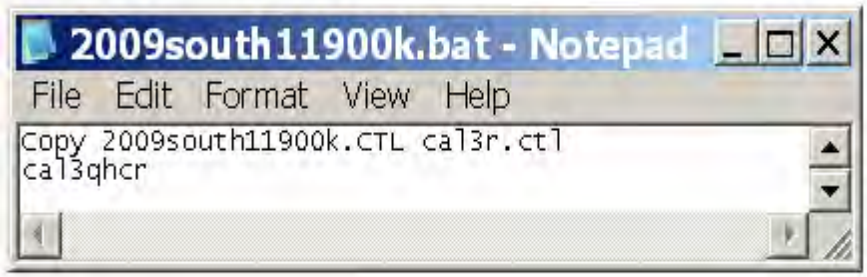


Figure 3.14: Example Scenario Batch File

3.10.1.7.2Prepare the Control File (.ctl)

CAL3QHCR looks to the control file to find the file names that are read into the program and outputted by the program.

Type the name of your run in front of each file extension, except the .ASC file, where you will type in the meteorological data file name. Save the control file with the name of your run. See Figure 3.15 below for the example scenario control file.

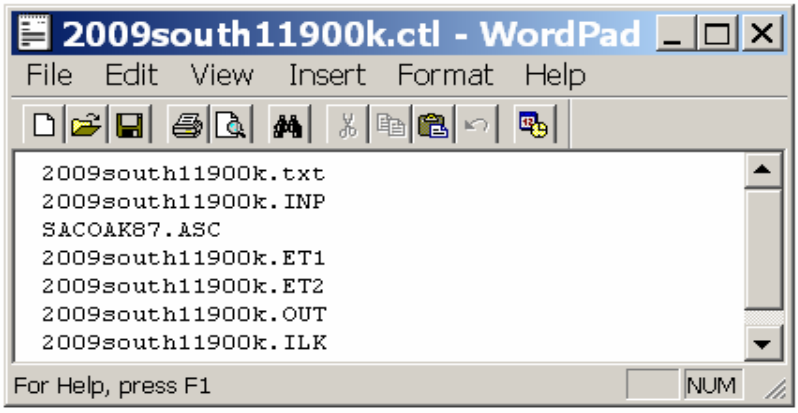


Figure 3.15: Example Scenario Control File

3.10.1.7.3Meteorological File (.asc)

The meteorological file should be in the .asc format. Contact your local air district for the recommended meteorological file. This file will not be edited.

3.10.1.7.4Executable File (.exe)

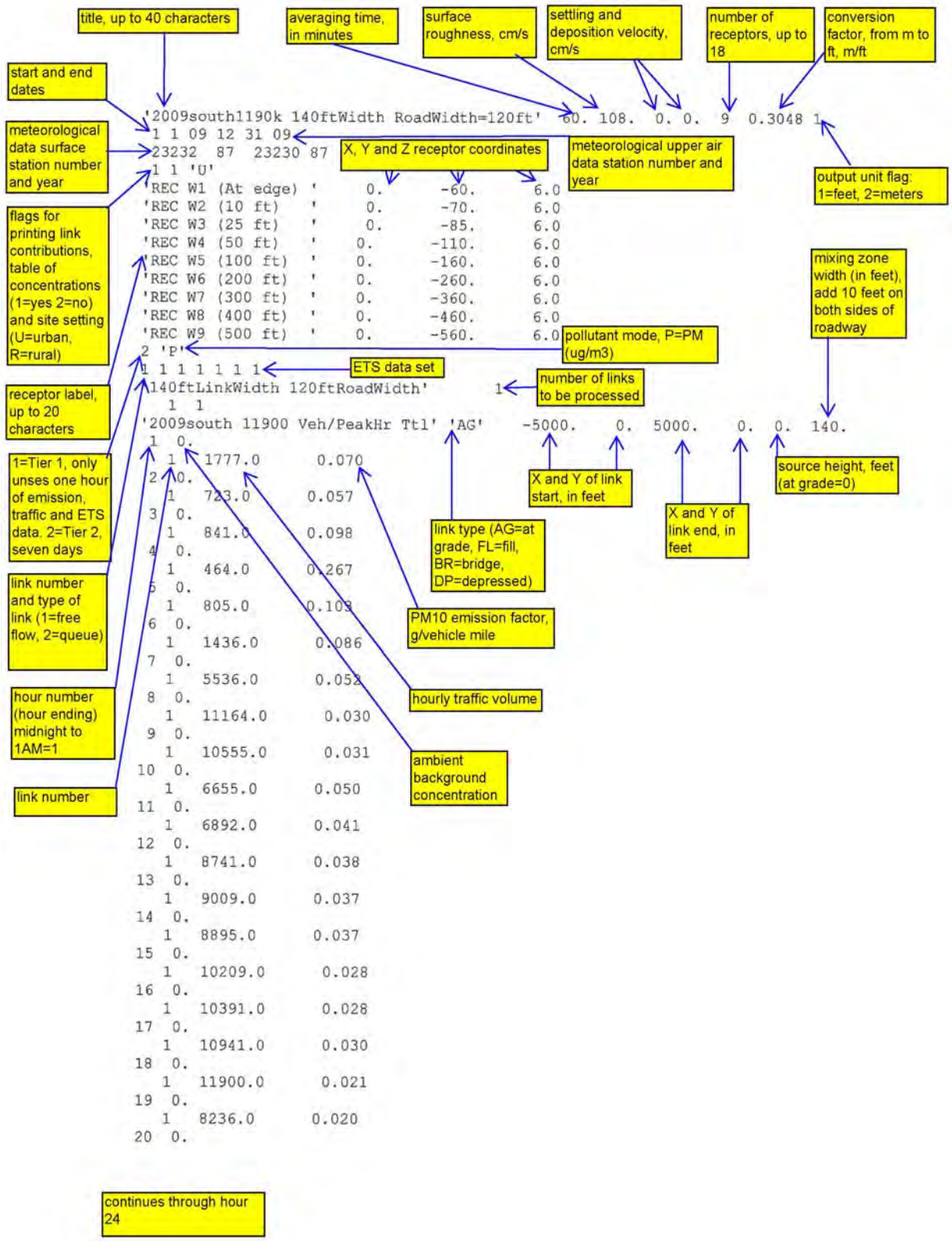
The executable file runs the program. This file will not be edited.

3.10.1.7.5 Prepare the Input File (.inp)

The input file contains scenario parameters.

Prepare the input by editing over an example file provided with the model download, or by editing over a file provided by the local air district that more closely reflects the setup needed for this type of roadway modeling. Save the input file with the name of your run. See Figure 3.16 below for the example scenario input file and input explanations.

Figure 3.16: Example Scenario Input File and Input Explanations




```
'2009south1190k 140ftWidth RoadWidth=120ft'  60. 108.  0. 0.  9  0.3048 1
1 1 09 12 31 09
23232  87  23230 87
1 1 'U'
'REC W1 (At edge) '     0.      -60.      6.0
'REC W2 (10 ft)   '     0.      -70.      6.0
'REC W3 (25 ft)   '     0.      -85.      6.0
'REC W4 (50 ft)   '     0.     -110.      6.0
'REC W5 (100 ft)  '     0.     -160.      6.0
'REC W6 (200 ft)  '     0.     -260.      6.0
'REC W7 (300 ft)  '     0.     -360.      6.0
'REC W8 (400 ft)  '     0.     -460.      6.0
'REC W9 (500 ft)  '     0.     -560.      6.0
2 'P'
1 1 1 1 1 1 1
140ftLinkWidth 120ftRoadWidth'          1
  1  1
'2009south 11900 Veh/PeakHr Ttl' 'AG'    -5000.    0.  5000.    0.  0.  140.
 1  0.
  1   1777.0       0.070
 2  0.
  1    723.0       0.057
 3  0.
  1    841.0       0.098
 4  0.
  1    464.0       0.267
 5  0.
  1    805.0       0.103
 6  0.
  1   1436.0       0.086
 7  0.
  1   5536.0       0.052
 8  0.
  1   11164.0       0.030
 9  0.
  1   10555.0       0.031
10  0.
  1   6655.0       0.050
11  0.
  1   6892.0       0.041
12  0.
  1   8741.0       0.038
13  0.
  1   9009.0       0.037
14  0.
  1   8895.0       0.037
15  0.
  1   10209.0       0.028
16  0.
  1   10391.0       0.028
17  0.
  1   10941.0       0.030
18  0.
  1   11900.0       0.021
19  0.
  1   8236.0       0.020
20  0.
```

3.10.1.8 Running the Model and Calculating Potential Cancer Risk

Double click on the .bat file to run the model. The model will produce a series of files with extensions .ET1, .ET2, .ILK, .OUT, .txt, and .ctl. Open the .txt and check to be sure the run was error-free.

The output file (.OUT) will show, among other information, the highest annual average concentrations. See Figure 3.17 below for the relevant section of the example scenario output file.

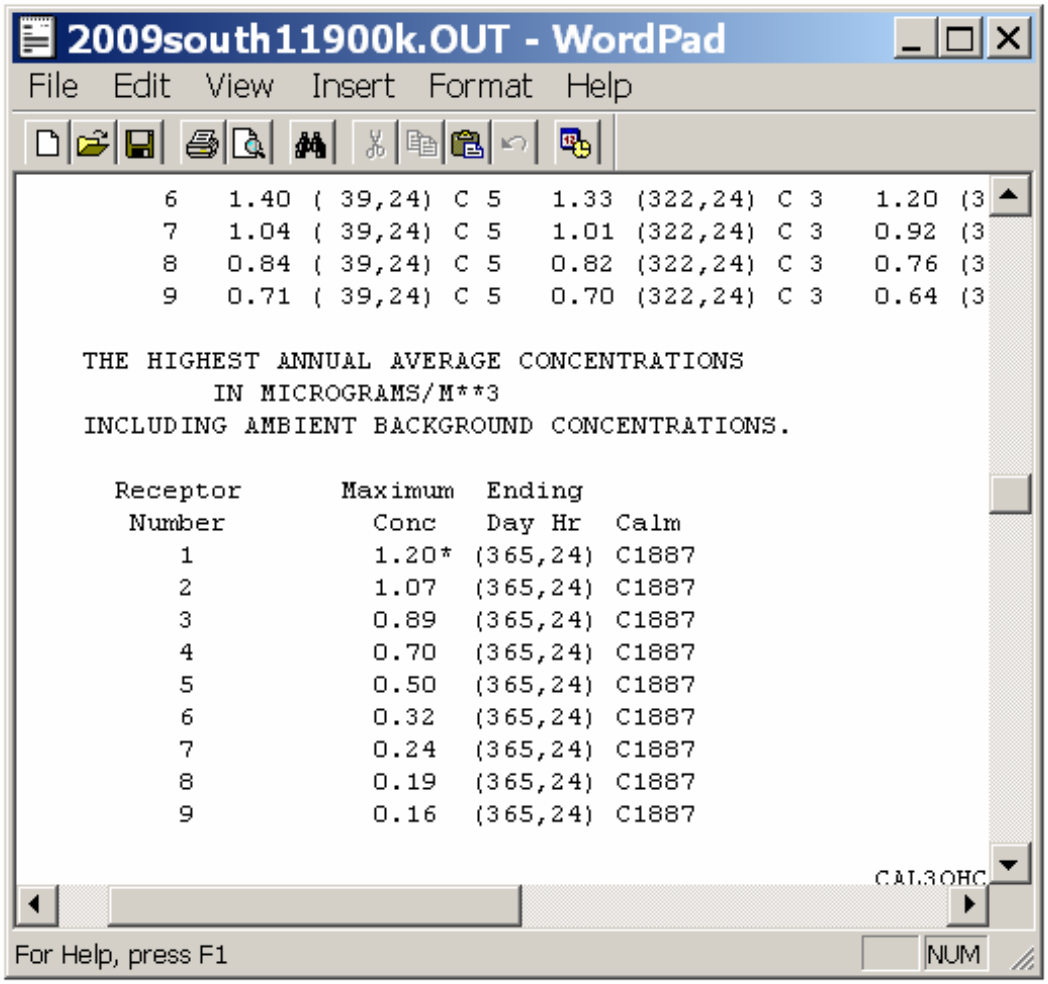


Figure 3.17: Example Scenario Output File, Highest Annual Average Concentrations

The example above shows downwind concentrations of diesel particulate matter at various receptor locations. The cancer risk due for diesel particulate is calculated by assuming that only the inhalation pathway applies. The default cancer risk calculation is based on the 80th percentile breathing rate, as recommended by the Office of Environmental Health Hazard Assessment. The cancer risk is calculated for receptor 4 (0.70 ug/m^3) as follows:

$$\textbf{Cancer Risk} = S_i * C_i * DBR * A * EF * ED / AT$$

Where:

S_i =	Cancer Potency Slope Factor for DPM	=	1.1 $(mg/kg\text{-}d)^{-1}$
C_i =	Concentration in the air of DPM	=	0.70 ug/m^3
DBR =	Daily Breathing Rate (default 80th %ile): (Residential Receptors)	=	302 L/kg-day
	(Some districts may require the use of the 95th %ile):	=	393 L/kg-day
A =	Inhalation Absorption Rate	=	1
EF =	Exposure Frequency: (Residential Receptors)	=	350 days
ED =	Exposure Duration: (Residential Receptors)	=	70 years
AT =	Averaging Time (70 years)	=	25,550 days

Cancer Risk:

$= (1.1\ (mg/kg\text{-}d)^{-1})(0.70\ ug/m^3)(302\ L/kg\text{-}day)(1)(350\ days)(70\ years)/(25{,}550\ days)$

= 223 per million

3.10.1.9 Other CAL3QHCR Features

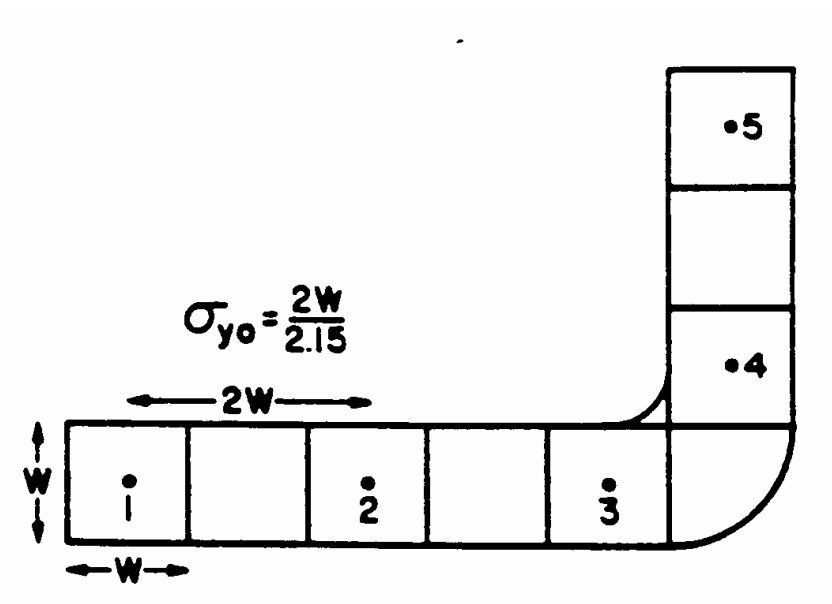
CAL3QHCR offers many other features that allow modeling traffic intersections, traffic signaling, and traffic queuing. Employing these features is quite site-specific. If these features must be employed, the user's guide should be consulted.

3.10.2 Modeling Roads using ISCST3 or AERMOD

CAL3QHCR is a roadway model. It can be used only to model highways. Often a project for which a health risk assessment is being prepared has additional sources. For example, a commercial development will have toxic emissions from truck idling, operation of transportation refrigeration units (TRUs), fast food restaurants, gasoline dispensing facilities, and dry cleaning operations. Large commercial operations may also have emergency diesel-fired internal combustion engines. These additional sources could be modeled in ISCST3 or AERMOD and their predicted risks superimposed upon those predicted by CAL3QHCR. Alternatively, all the sources including the roadways could be modeled using ISCST3 and AERMOD. The results of roadway modeling using ISCST3 and AERMOD are consistent with those from using CAL3QHCR. The procedures for using ISCST3 and AERMOD to model emissions from roadways are discussed below.

3.10.2.1 Introduction

ISCST3 and AERMOD can be used to predict the concentrations of pollutants emitted from vehicles on roads. These models have 4 basic types of sources (i.e., point, area, volume, and open pit). Emissions from idling vehicles located at a loading dock can be modeled as point sources. Area sources have been used in the past to model emissions from parking lots. The best method for modeling emissions from travelling vehicles is to use a line source or a series of multiple volume sources, as shown below.



View looking down along the length of a road segment (L_{RS})

The following steps can be used to construct a line source that represents diesel PM emissions from diesel trucks traveling along a road segment:

1. Determine the total emissions for the diesel trucks traveling along the road segment.

   E_T = Emissions total for road segment

2. Using the width of the road as the length of the side (W) of a single volume source, determine the number of volume sources along the length of the road by dividing the length of the road by 2W. Round the number of volume sources either up or down.

   W = Width of the road
   L_{RS} = Length of the road segment
   N = Number volume sources
   $N = L_{RS} / 2W$

3. Calculate the initial lateral dispersion:

$\sigma_y = 2W / 2.15$

3. Estimate the initial vertical dispersion using the height of the truck exhaust divided by 4.3.

   $\sigma_z = H / 4.3$
   $= 13 \text{ feet} / 4.3$
   $= 3.01 \text{ feet}$

4. Calculate the emission rate for each volume source by dividing the total emissions for the road segment by the number of volume sources.

   E_{VS} = Emission rate for each volume source
   $E_{VS} = E_T / N$

5. Model each individual volume source using ISCST or AERMOD separately, but as a group, using actual emissions for each volume source.

6. Identify the predicted concentrations at each receptor.

7. Next, calculate the risk at each receptor using the procedure outlined above in Section 3.10.1.8.

3.10.2.2 Data Requirements

The data that are required to model roadway emissions using ISCST3 and AERMOD are similar to those required for using CAL3QHCR. They include the following:

- **Meteorological data** – If the air district cannot provide preprocessed meteorological data, then nearby airport or monitored surface data from a meteorological station can be processed for use in ISCST3 or AERMOD. Contact your local district for availability of appropriate met data. Information on processing met data can be found in Appendix A.
- **Traffic data and vehicle emissions** – The same data as discussed above for the CAL3QCHR model are used.
- **Roadway configuration** – The width of the roadway is used as the length of a side for each volume source. Receptors should be located the same as with the CAL3QCHR model.
- **Terrain data** – For ISCST3, elevation data must be entered manually. AERMAP is used to generate the elevations and hill slopes for receptors and sources for input to the AERMOD model. Digital Elevation Model (DEM) files for use in AERMAP are available from a variety of sources.

Third-party software used to prepare the input file for ISCST3, and used to allow the model results to be viewed graphically, can also be used to determine terrain elevations using DEM files.

Once these data are assembled, the model input file can be created.

3.10.2.3 Preparing the Model Input File

The input files for ISCST3 and AERMOD are very similar. In the discussion below, only the input file for the ISCST3 model will be described.

The input file must contain the following components or sections:

CO – for overall job control options
SO – for source information
RE – for receptor information
ME – for meteorological data
TG – for a terrain grid (optional)
OU – for output options

Each of these sections is discussed briefly below. For more detailed information, the *User's Guide for the Industrial Source Complex (ISC3) Dispersion Models: Volume I – User Instructions* (EPA-454/B-95-003a) should be consulted.

3.10.2.3.1 Control Option Section

Each section begins with a STARTING command and ends with a FINISHED command. Model options that must be specified include: a title; model options such as default or "regulatory" dispersion options, rural or urban dispersion coefficients, and concentration or deposition estimates; the averaging time (period or annual for carcinogenic risk); the pollutant identification; and the RUNORNOT option. The following is a sample input for the example discussed above:

```
CO STARTING
   TITLEONE 2009south1190k
   MODELOPT DFAULT CONC  URBAN
   AVERTIME PERIOD
   POLLUTID DPM
   TERRHGTS ELEV
   FLAGPOLE 1.80
   RUNORNOT RUN
   ERRORFIL Road.err
CO FINISHED
```

In this sample input file, the regulatory default options are used. The model will calculate concentrations of DPM (i.e., diesel particulate matter) using urban dispersion coefficients. The receptors will all be modeled with a default height of 6 ft or 1.8 m. The model will run to completion and will output an error file.

3.10.2.3.2 Source Section

As discussed above, a series of volume sources will be modeled to simulate the roadway. The sample input file for this section is the following:

```
SO STARTING
** Source Location **
** Source ID - Type - X Coord. - Y Coord. **
** Line Source represented by Separated Volume Sources
** ---------------------------------------------------------------------
** LINE Source ID = SLINE1
** DESCRSRC 2009south1190k
** Length of Side = 36.58
** Emission Rate = 0.123435368
** Elevated
** Vertical Dimension = 0.85
** SZINIT = 0.20
** Nodes = 2
** 309476.00, 3916500.00, 0.00, 3.66, 0.0
** 312527.00, 3916500.00, 0.00, 3.66, 33.38
** ---------------------------------------------------------------------
   LOCATION L0000001 VOLUME 309494.288 3916500.000 0.00
   LOCATION L0000002 VOLUME 309566.060 3916500.000 0.00
   LOCATION L0000042 VOLUME 312436.939 3916500.000 0.00
   LOCATION L0000043 VOLUME 312508.711 3916500.000 0.00
** End of Line Source
** Source Parameters **
   SRCPARAM L0000001 0.00287058995348837 3.66 33.38 0.85
   SRCPARAM L0000002 0.00287058995348837 3.66 33.38 0.85
   SRCPARAM L0000042 0.00287058995348837 3.66 33.38 0.85
   SRCPARAM L0000043 0.00287058995348837 3.66 33.38 0.85
** Variable Emissions Type: "By Hour-of-Day"
** Variable Emission Scenario: "Scenario 1"
   EMISFACT L0000001 HROFDY 0.53 0.176 0.351 0.528 0.353 0.526
   EMISFACT L0000001 HROFDY 1.227 1.427 1.395 1.418 1.204 1.416
   SRCGROUP SRCGP1 L0000001 L0000002 L0000003 L0000004 L0000005 L0000006
   SRCGROUP SRCGP1 L0000043
SO FINISHED
```

In the above sample input, all lines with "**" are comments. This file was generated using an interface program for the model. In this interface, the information for the line source is input, and the program automatically generates the individual volume sources. As can be seen from the input file, there are 43 separate volume sources in this "line source". The location of the center of each volume source and its base elevation (i.e., 0 m) is given on the LOCATION command. The SRCPARAM commands specify the emission rate, the release height, the initial lateral dimension, and the initial vertical dimension. The average emission rate calculated from the information provided above was used. The program divides the emission rate for the line source by the number of volume sources.

A **release height** of 12 ft or 3.66 m was used to approximate the height of the plume from a heavy-duty diesel truck.

The width of the roadway was used as the **length of the side for each volume source**.

The length of the side is used to calculate an initial lateral dimension. For this example, the **initial lateral dimension** is 34.03 m or 2 x 36.58/2.15. (The initial lateral dimension actually used is 33.38 m to ensure that there are an equal number of volume sources in the length of road. This small difference in the calculated initial lateral dimension and the one actually used would not significantly affect the concentrations estimated.)

Based on this release height, an **initial vertical dimension** of 0.85 m or 3.66/4.3 was used.

Variable emission factors (EMISFACT) by the hour of the day (HROFDAY) were used to adjust the average emission rate by the appropriate factor based upon the discussion above for the CAL3QCHR run.

3.10.2.3.3Receptor Section

Receptors were located at the distances specified above in the discussion of CAL3QCHR modeling. The sample input file for this section is the following:

```
RE STARTING
** DESCRREC "FENCEGRD" "Receptors generated from Fenceline Grid"
   DISCCART    312530.00   3916454.00    0.00    1.80
   DISCCART    312505.15   3916454.00    0.00    1.80
** DESCRREC "FENCEPRI" "Cartesian plant boundary Primary Receptors"
   DISCCART    309473.00   3916457.00    0.00    1.80
   DISCCART    312530.00   3916457.00    0.00    1.80
   DISCCART    312530.00   3916543.00    0.00    1.80
   DISCCART    309473.00   3916543.00    0.00    1.80
** DESCRREC "FENCEINT" "Cartesian plant boundary Intermediate Receptors"
   DISCCART    309497.85   3916457.00    0.00    1.80
   DISCCART    309522.71   3916457.00    0.00    1.80
   DISCCART    309473.00   3916478.50    0.00    1.80
RE FINISHED
```

The interface program used allows the automatic creation of a telescopic fenceline grid around a facility. This feature was used to create the receptors in this sample input.

First, primary plant boundary receptors were located around the highway. The “plant boundary” was assumed to be the edge of the roadway (i.e., 10 ft on each side of the road from the roadway’s width).

Intermediate receptors were located at a distance of 25 m between receptors along the edge of the roadway.

Then, tiers of receptors at distances of 10 ft, 25 ft, 50 ft, 100 ft, 200 ft, 300 ft, 400 ft, and 500 ft from the roadway edge were entered.

These grid receptors were converted to discrete receptors, and any extraneous receptors were removed.

Note that specific receptors for residences or other **sensitive receptors** could be modeled directly with the ISCST3/AERMOD model.

The **elevation of receptors** was assumed to be zero.

A **receptor height** of 6 ft or 1.8 m was used to approximate the breathing height.

3.10.2.3.4Meteorology Section

The meteorology section specifies the meteorological data to be used. The sample input file for this section is the following:

```
ME STARTING
   INPUTFIL C:\MODELI~1\SACOAK85.asc
   ANEMHGHT 10 METERS
   SURFDATA 23232 1985 SACRAMENTO/EXECUTIVE_ARPT
   UAIRDATA 23230 1985 OAKLAND/WSO_AP
ME FINISHED
```

For this sample input file, the 1985 meteorological data from Sacramento was downloaded from the District's website. In the input file, the name and location of the met data file is specified. The height of the anemometer is given. (Most anemometers at airport weather stations are 10 m high.) And, the station number, year and name of the surface data and upper air stations are identified.

3.10.2.3.4Output Section

The output section specifies the files or reports to be output. The sample input file for this section is the following:

```
OU STARTING
** Auto-Generated Plotfiles
   PLOTFILE PERIOD SRCGP1 ROAD.IS\PE00G001.PLT
OU FINISHED
```

ISCST3/AERMOD have a variety of files and reports that can be output. One of the most useful filetypes that can be output is the plotfile. A plotfile has the following information:

```
* ISCST3 (02035): 2009south1190k
* MODELING OPTIONS USED:
*  CONC                    URBAN ELEV  FLGPOL DFAULT
*         PLOT FILE OF PERIOD VALUES FOR SOURCE GROUP: SRCGP1
*         FOR A TOTAL OF  2236 RECEPTORS.
*         FORMAT: (3(1X,F13.5),1X,F8.2,2X,A6,2X,A8,2X,I8.8,2X,A8)
*        X             Y      AVERAGE CONC   ZELEV     AVE     GRP      NUM HRS   NET ID
*  ___________  ___________  ___________  ______  ______  ________  ________  _______
  312530.00000 3916454.00000       0.13119     0.00  PERIOD  SRCGP1    00008760     NA
```

For each receptor and each specified source group, this file contains the highest predicted concentration for the specified averaging time. Multiple files can be created for multiple source groups (which can be single sources or multiple sources depending upon those specified by the user) and for each averaging time modeled. These plotfiles can be used to generate a *.XOQ file for input into the Hot Spots Analysis and Reporting Program (HARP). They also can be used by graphics programs incorporated into the model interface programs or software such as SURFER to generate isopleths of concentration for a visual display of the results.

3.10.2.4 Analyzing Model Results

Concentrations predicted by ISCST3/AERMOD can be used to estimate risk using the procedure discussed above for cancer risk from emissions of diesel particulate matter. The plotfiles generated by the models can be used to create an input file for HARP. Importing the results into HARP can be useful if there are other sources that may contribute to the total risk (e.g., in the case of a commercial development). All sources can be modeled in ISCST3/AERMOD while only the roadway sources can be modeled in CAL3QCHR.

Chapter 4. Geographical Information Inputs

4.1 Comparison of Screening and Refined Model Requirements

Geographical information requirements range from basic for screening analyses to advanced for refined modeling. SCREEN3 makes use of geographical information only for terrain data for complex or elevated terrain where it requires simply distance from source and height in a straight-line. The AERMOD and ISCST3/ISC-PRIME models make use of complete three-dimensional geographic data with support for digital elevation model files and real-world spatial characterization of all model objects.

4.2 Coordinate System

4.2.1 Local

Local coordinates encompass coordinate systems that are not based on a geographic standard. For example, a facility may reference its coordinate system based on a local set datum, such as a predefined benchmark. All site measurements can relate to this benchmark which can be defined as the origin of the local coordinate system with coordinates of 0.0 m. All facility buildings and sources could then be related spatially to this origin.

However, local coordinates do not indicate where in the actual world the site is located. For this reason, it is advantageous to consider a geographic coordinate system that can specify the location of any object anywhere in the world with precision. The coordinate system most commonly used for air dispersion modeling is the Universal Transverse Mercator system.

4.2.2 UTM

As described earlier, the Universal Transverse Mercator (UTM) coordinate system uses meters as its basic unit of measurement and allows for more precise definition of specific locations than latitude/longitude. Google Earth may be used to determine the UTMs or latitude/longitude coordinates.

Ensure all model objects (sources, buildings, receptors) are defined in the same horizontal datum. Defining some objects based on a NAD27 (North American datum of 1927) while defining others within a NAD83 (North American datum of 1983) can lead to significant errors in relative locations.

4.3 Terrain

4.3.1 Terrain Concerns in Short-Range Modeling

Terrain elevations can have a large impact on the air dispersion and deposition modeling results and therefore on the estimates of potential risk to human health and the environment. Terrain elevation is the elevation relative to the facility base elevation.

The following section describes the primary types of terrain. The consideration of a terrain type is dependant on your study area, and the definitions below should be considered when determining the characteristics of the terrain for your modeling analysis.

4.3.2 Flat and Complex Terrain

The models consider three different categories of terrain as follows:
Complex Terrain: as illustrated in Figure 4.1, where terrain elevations for the surrounding area, defined as anywhere within 50 km from the stack, are above the top of the stack being evaluated in the air modeling analysis.

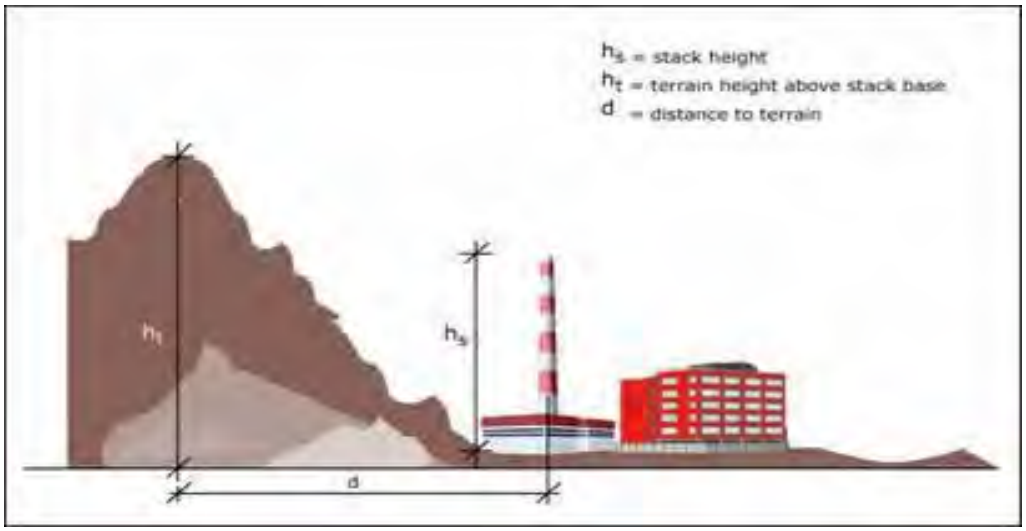


Figure 4.1 - Complex terrain conditions.

Simple Terrain: where terrain elevations for the surrounding area are not above the top of the stack being evaluated in the air modeling analysis. The "Simple" terrain can be divided into two categories:

- Simple Flat Terrain is used where terrain elevations are assumed not to exceed stack base elevation. If this option is used, then terrain height is considered to be 0.0 m.
- Simple Elevated Terrain, as illustrated in Figure 4.2 is used where terrain elevations exceed stack base but are below stack height.

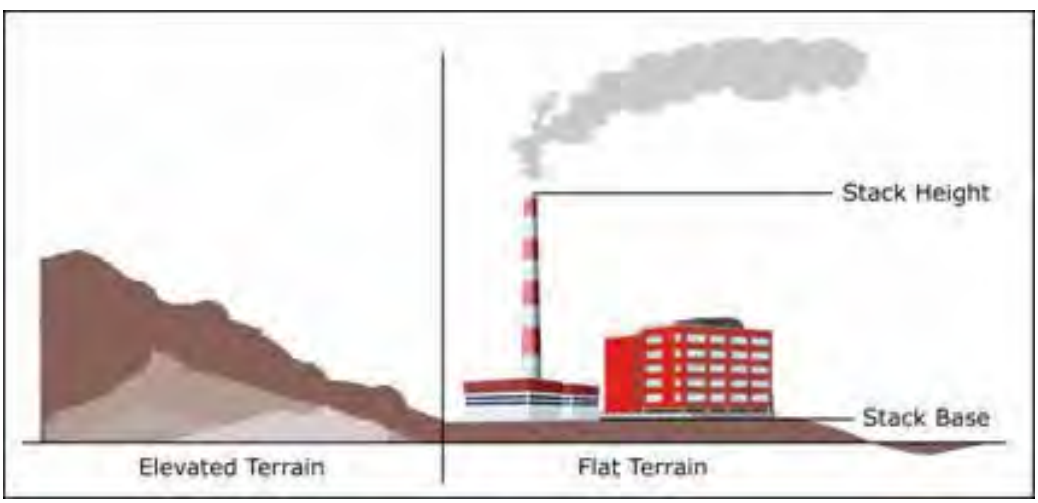


Figure 4.2 –Elevated and flat terrain conditions.

4.3.3 Criteria for Use of Terrain Data

Evaluation of the terrain within a given study area is the responsibility of the modeler. Complex terrain may need to be considered even in areas that appear to be relatively flat. It should be remembered that complex terrain is any terrain within the study area that is above the source release height.

The appropriate terrain environment can be determined through the use of digital elevation data or other geographic data sources. It should be noted that the refined models, ISCST3/ISC-PRIME and AERMOD, have similar run times regardless of whether or not terrain data is used. However AERMAP, the terrain pre-processor for AERMOD, does require additional time. If analysis of the terrain environment is performed using digital terrain data, minimal resources are required to execute a model run using that digital terrain dataset.

4.3.4 Obtaining Terrain Data

Terrain data that are input into the AERMOD and ISCST3/ISC-PRIME models should be provided in electronic form. Digital elevation terrain data is available from a variety of vendors in several different formats.

Digital elevation model (DEM) data are available for free from Lakes Environmental's Web GIS web page http://www.webgis.com.

4.3.5 Preparing Terrain Data for Model Use

It is strongly suggested that the 7.5-minute data be used in dispersion modeling rather than the coarse resolution 1 degree data. Keep in mind that the USGS DEMs can be in one of two horizontal datums. Older DEMs were commonly in NAD27 (North American Datum of 1927) while many of the latest versions are in NAD83 (North American Datum of 1983).

4.3.5.1 ISC / HARP

The ISCST3 model accepts elevation data for receptors and sources. This data should be obtained from the USGS topographic maps or Digital Elevation Model (DEM) files. USGS DEMs are available for California from ARB at (http://www.arb.ca.gov/toxics/harp/maps.htm) in 7.5-minute format for use in the ARB HARP program and from Lakes Environmental at http://www.webgis.com in 7.5 minute and 1 degree formats.

4.3.5.2 AERMOD

AERMAP is the digital terrain pre-processor for the AERMOD model. It analyzes and prepares digital terrain data for use within an air dispersion modeling project. AERMAP requires that the digital terrain data files be in native (non SDTS) USGS 1-degree or 7.5-minute DEM format.

4.4 Defining Urban and Rural Conditions

The classification of a site as urban or rural can be based on the Auer method specified in the EPA document *Guideline on Air Quality Models (40 CFR Part 51, Appendix W)*[37]. From the Auer's method, areas typically defined as Rural include:

[37] U.S. Environmental Protection Agency, 2001. Appendix W to Part 51 Guideline on Air Quality Models, 40 CFR Part 51. U. S. Environmental Protection Agency, Research Triangle Park, NC.

- Residences with grass lawns and trees
- Large estates
- Metropolitan parks and golf courses
- Agricultural areas
- Undeveloped land
- Water surfaces

Auer suggests that an area can be classified as Urban if it has less than 35% vegetation coverage or the area falls into one of the following use types:

Table 4.1 - Urban Land use

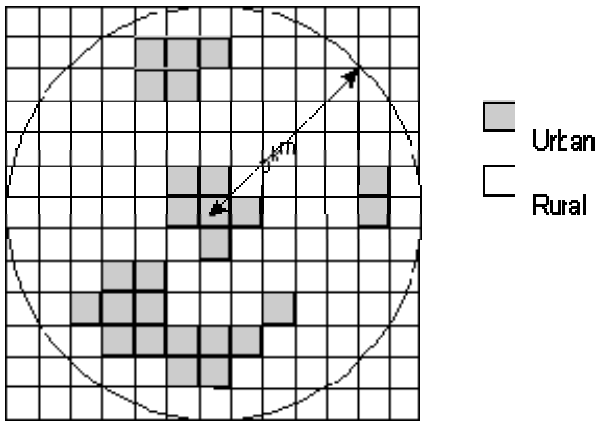
Type	Use and Structures	Vegetation
I1	Heavy industrial	Less than 5%
I2	Light/moderate industrial	Less than 5%
C1	Commercial	Less than 15%
R2	Dense single / multi-family	Less than 30%
R3	Multi-family, two-story	Less than 35%

Follow the Auer's method, explained below, for the selection of either urban or rural dispersion coefficients:

Step 1: Draw a circle with a radius of 3 km from the center of the stack or centroid of the polygon formed by the facility stacks.

Step 2: If land use types I1, I2, C1, R2, and R3 account for 50% or more of the area within the circle, then the area is classified as Urban, otherwise the area is classified as Rural.

To verify if the area within the 3 km radius is predominantly rural or urban, overlay a grid on top of the circle and identify each square as primarily urban or rural. If more than 50% of the total number of squares is urban than the area is classified as urban; otherwise the area is rural.[35]



An alternative approach to Urban/Rural classification is the Population Density Procedure: Compute the average population density, p, per square kilometer.

- If p > 750 people/km^2, select the Urban option,
- If p <= 750 people/km^2, select the Rural option.

Of the two methods above, the land use procedure is considered a more definitive criterion. The population density procedure should be used with caution and should not be applied to highly industrialized areas where the population density may be low and thus a rural classification would be indicated, but the area is sufficiently built-up so that the urban land use criteria would be satisfied. In this case, the classification should already be Urban and urban dispersion parameters should be used.

Prior to using either of the above methods, contact the district to determine whether the area in question has already been designated as urban or rural.

Chapter 5. Meteorological Data

5.0 Comparison of Screening and Refined Model Requirements

Meteorological data is essential for air dispersion model modeling as it describes the primary environment through which the pollutants being studied migrate. Similar to other data requirements, screening model requirements are less demanding than refined models.

SCREEN3 provides 3 methods of defining meteorological conditions:

- Full Meteorology: SCREEN will examine all six stability classes (five for urban sources) and their associated wind speeds. SCREEN examines a range of stability classes and wind speeds to identify the "worst case" meteorological conditions, i.e., the combination of wind speed and stability that results in the maximum ground level concentrations.
- Single Stability Class: The modeler can select the stability class to be used (A through F). SCREEN will then examine a range of wind speeds for that stability class only.
- Single Stability Class and Wind Speed: The modeler can select the stability class and input the 10-meter wind speed to be used. SCREEN will examine only that particular stability class and wind speed.

Contact the district for guidance if full meteorology is not being used in SCREEN.

See Appendix A for information on preparing meteorological data for refined modeling (AERMOD and ISC.

Chapter 6. Receptor Locations

6.0 Receptors

A receptor is defined as a point where an actual person (residential or worker) may be located for a given period of time. The period of time is based on the type of assessment that is being performed. When an acute (1-hour or longer, as applicable) risk assessment is to be prepared, all locations where a person could be located for a one hour period needs to be identified. When a cancer or chronic risk assessment is to be prepared, all locations where a person could be located for extended periods of time, such as a residence or workplace, need to be identified.

6.0.1 Residential Receptors

Homes, apartments, motels, trailer parks, residential camp grounds, and other places where people reside for long periods are defined as residential receptors. When a cancer risk is prepared, the exposure period should be 70 years. For acute risk assessments, the exposure period should be 1 hour for those substances with acute toxicity values based on one hour exposure periods.

6.0.2 Worker Receptors

Worksites, schools, and other locations where people are exposed for long periods of time are defined as worker receptors. When a cancer risk is prepared, the exposure period should be 40 years. For acute risk assessments, the exposure period should be 1 hour for those substances with acute toxicity values based on one hour exposure periods.

6.0.3 Offsite Receptors

Offsite receptors are included in risk assessments when they are not employed by the project.

6.0.4 Onsite Receptors

Onsite receptors are included in risk assessments if they are persons not employed by the project.

6.0.5 Sensitive Receptors

Sensitive receptors are defined as the following:

- Schools
- Daycare facilities other than home based
- Hospitals
- Care facilities (adult/elderly)

At the present time, the risk assessment calculations do not calculate different risk values for sensitive receptors compared to other receptors. However, sensitive receptors must be identified. Contact the district to determine the area in which sensitive receptors must be identified. Some

commonly used criteria are out to a distance of 2 kilometers from a project emission source or within the 1 in a million risk isopleth.

6.1 Receptor Grids

6.1.1 Cartesian Receptor Grids

Cartesian receptor grids are receptor networks that are defined by an origin with receptor points evenly (uniform) or unevenly (non-uniform) spaced around the origin. Figure 6.1 illustrates a sample uniform Cartesian receptor grid.

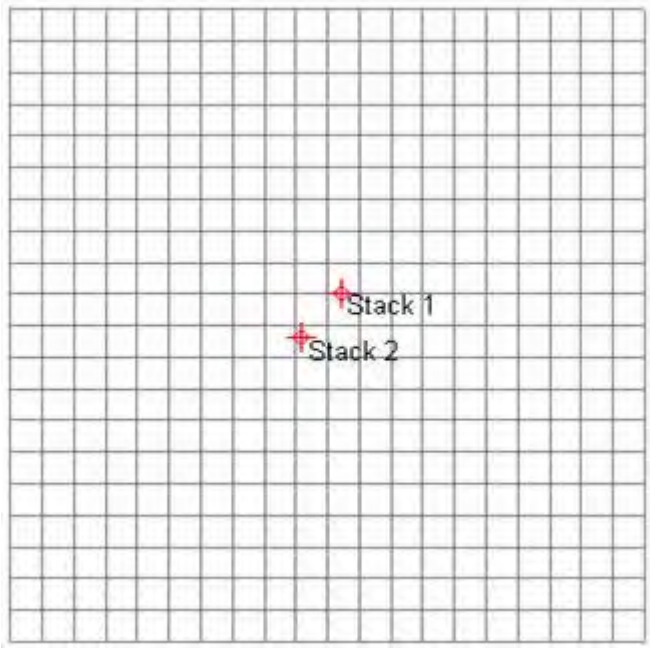


Figure 6.1 – Example of a Cartesian grid.

Tall stacks could require grids extending 1 to 3 km, while the grid for shorter stacks (10 to 20 m above ground) might only need to be extended a km or less from the property line.

6.1.2 Polar Receptor Grids

Polar receptor grids are receptor networks that are characterized by an origin with receptor points defined by the intersection of concentric rings, which have defined distances in meters from the origin, with direction radials that are separated by specified degree spacing. Figure 6.2 illustrates a sample uniform polar receptor grid.

Polar grids are a reasonable choice for facilities with only one source or one dominant source. However, for facilities with a number of significant emissions sources, receptor spacing can become too coarse when using polar grids. As a result, polar grids should generally be used in conjunction with another receptor grid, such as a multi-tier grid, to ensure adequate spacing.

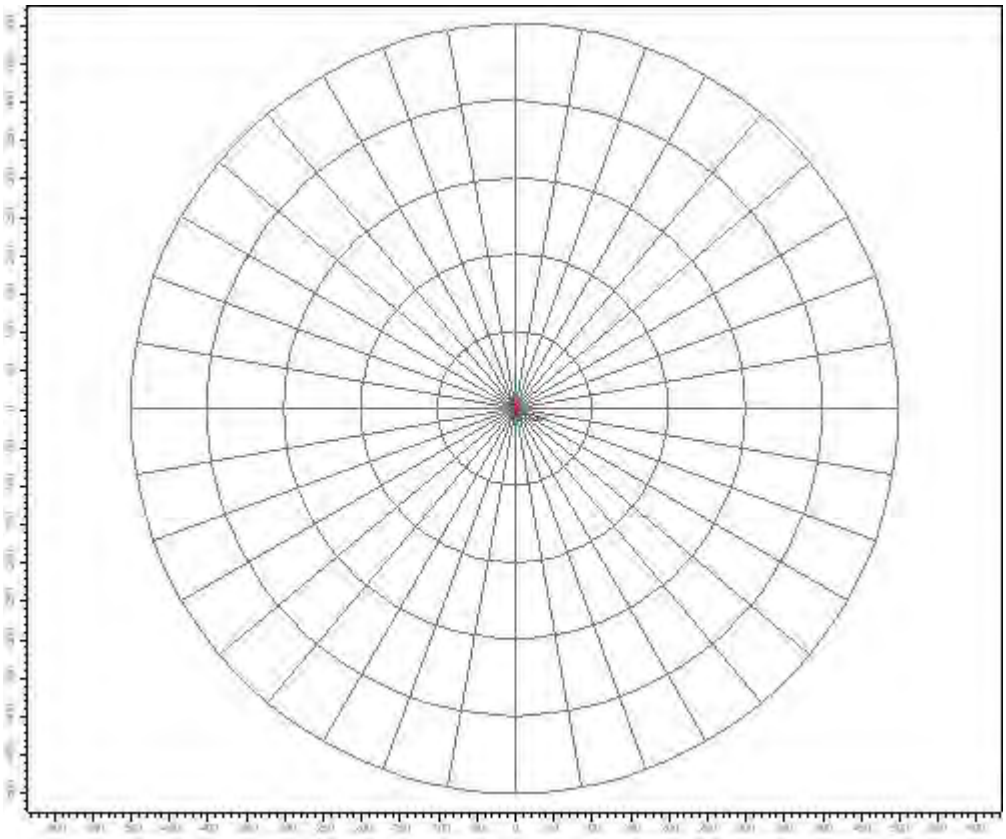


Figure 6.2 – Example of a polar grid.

6.1.3 Multi-Tier Grids

Each receptor point requires computational time. Consequently, it is not optimal to specify a dense network of receptors over a large modeling area; the computational time would negatively impact productivity and available time for proper analysis of results. An approach that combines aspects of coarse grids and refined grids in one modeling run is the multi-tier grid.

The multi-tier grid approach strives to achieve proper definition of points of maximum impact while maintaining reasonable computation times without sacrificing sufficient resolution. Figure 6.3 provides an example of a multi-tier grid.

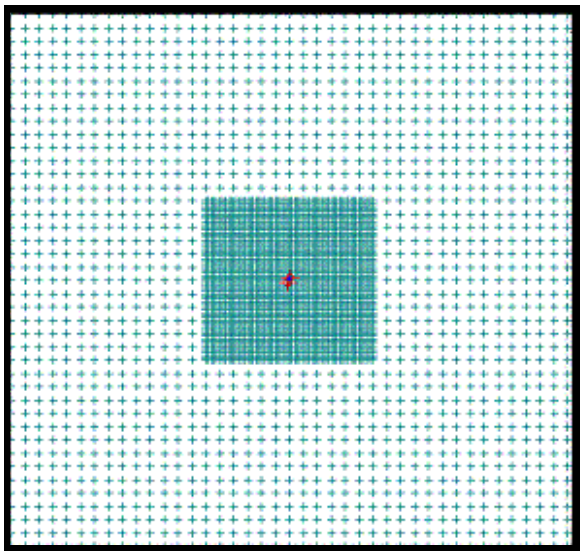


Figure 6.3 - Sample Multi-Tier Grid with 2 tiers of spacing.

6.1.4 Fence line Receptors

Unless on-site receptors are present, it is not necessary to model the locations within a property boundary. If on-site receptors may be present, contact the District concerning receptor placement. If a fence line receptor point does not represent an existing or reasonably anticipated person, it is not necessary to consider these results to determine the Maximum Exposed Individual (MEI), but fence line exposure should be considered to determine the Point of Maximum Impact (PMI).

A receptor network based on the shape of the property boundary that has receptors parallel to the boundaries is often a good choice for receptor geometry. The receptor spacing can then progress from fine to coarse spacing as distance increases from the facility, similar to the multi-tier grid.

6.1.5 Discrete & Sensitive Receptors

Receptor grids do not always cover precise locations that may be of interest in modeling projects. Specific locations of concern can be modeled by placing single receptors, or additional refined receptor grids, at desired locations. This enables the modeler to generate data on specific points for which data is especially critical. Examples of specific locations can include:

- Apartments,
- Residential zones,
- Schools,
- Apartment buildings,
- Day care centers,
- Air intakes on nearby buildings,
- Hospitals,
- Parks,
- Care Facilities, or

- Elevated receptors, such as balconies or air intakes on multilevel buildings, as concentrations of toxic substances can be higher there than at ground level.

Depending on the project resolution and location type, these can be characterized by discrete receptors, a series of discrete receptors, or an additional receptor grid.

6.2 Variable Receptor Spacing to include the Point of Maximum Impact (PMI)

The receptor grid must be designed to include the Point of Maximum Impact (PMI). For facilities with more than one emission source, the receptor network should include Cartesian or multi-tier grids to ensure that maximum concentrations are obtained. An indication as to the PMI can be determined by using SCREEN3 or AERSCREEN applied to the most significant sources at a facility.

The model could be first run with a coarser grid, and then run with finer grids in the areas showing the highest impacts. If this method is used, finer grids, as described above, should be used for all areas with high concentrations, not just the single highest area.

The densities of the receptors can progress from fine resolution near the source, centroid of the sources, or most significant source (not from the property line for polar grid) to coarser resolution farther away. Section 6.1.3 shows an example of multiple grid spacing to ensure that the maximum ground level offsite property concentrations are captured.

Receptors should also be placed along the property boundaries. The spacing of these receptors depends on the distance from the emission sources to the facility boundaries. For cases with emissions from short stacks or vents and a close property line, a receptor spacing of 25 m might be required. For taller stacks and greater distances to the property boundary, a receptor spacing greater than 25 m might be appropriate.

It is the responsibility of the modeler to demonstrate that the PMI has been identified and that the modeling includes all areas where Hazard Indices are above one, and the cancer risk is above ten per million, or other district standards.

6.2.1 Example Polar Grid Spacing

- 36 Directional Radials
- Radial Distances:
  - 25 m
  - 50 m
  - 100 m
  - 250 m
  - 500 m

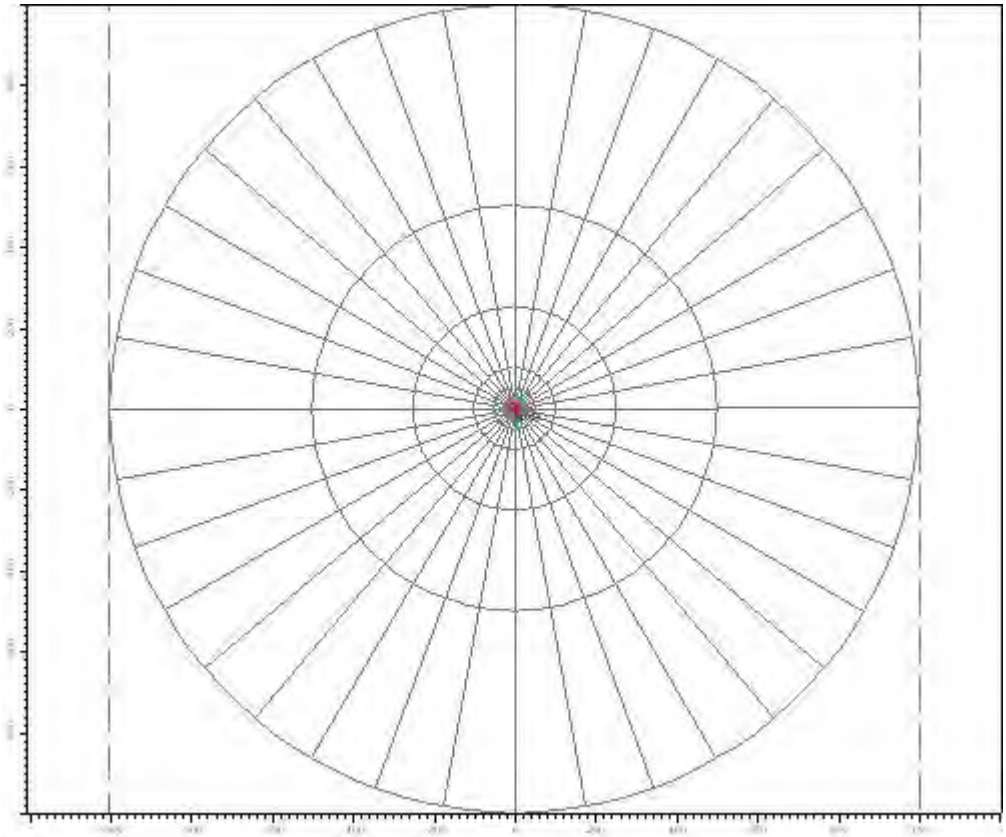


Figure 6.4 – Sample Polar Grid receptor grid layout.

Chapter 7. Other Modeling Considerations

7.0 Alternative Model Use

Due to some limitations inherent in AERMOD (and most other plume models), there are some situations where the use of an alternative model may be appropriate. Acceptable Alternative Models and their use are further described on EPA's Support Center for Regulatory Atmospheric Modeling (SCRAM) web page.

AERMOD is a steady-state plume model. For the purpose of calculating concentrations, the plume is assumed to travel in a straight line without significant changes in stability as the plume travels from the source to a receptor. At distances on the order of tens of kilometers downwind, changes in stability and wind are likely to cause the accuracy to deteriorate. For this reason, AERMOD should not be used for modeling at receptors beyond 50 kilometers. AERMOD may also be inappropriate for some near-field modeling in cases where the wind field is very complex due to terrain or a nearby shoreline.

AERMOD does not treat the effects of shoreline fumigation. Shoreline fumigation may occur along the shore of the ocean or large lake. When the land is warmer than the water, a sea breeze will form as the warmer lighter air inland rises. As the stable air from over the water moves inland, it is heated from below, resulting in a turbulent boundary layer of air that rises with downwind distance from the shoreline. The plume from a stack source located at the shoreline may intersect

the turbulent layer and be rapidly mixed to the ground, a process called "fumigation," resulting in high concentrations. In these and other situations, the use of alternative models may be desired.

The use of any alternative model should first be reviewed by the district for suitability to the study application. If an alternative model is used the reasons and argument for its use over a preferred model must be discussed. An understanding of the alternative model, its data requirements, and the quality of data applied with the model must be demonstrated.

7.1 Use of Modelled Results in Combination with Monitoring Data

Monitoring and modeling should be considered complementary tools to assess potential impacts on the local community.

Monitoring data could be used to provide verification of model results if sufficient monitoring data is available at locations impacted by facility emissions. Decisions on the adequacy of the monitoring data would be made on a case-by-case basis. Comparisons between measured and modeled results would depend on the amount of monitored data available. Advance consultation with the district is advisable if a comparison of model results with monitoring data is undertaken.

If model results do not agree with measured data, the facility source characteristics and emission data should be reviewed.

For cases where reliable information is available on the emission rates and source characteristics for a facility, modeled results can identify maximum impact areas and concentration patterns that could assist in siting monitors. Model runs using a number of years of meteorological data would show the variations in the locations and the magnitude of maximum concentrations and can also provide information on the frequency of high concentrations.

The U.S. EPA Guideline on Air Quality Models states that modeling is the preferred method for determining concentrations and that monitoring alone would normally not be accepted for determining emission limitations.

When monitoring data are used to verify modeling results for averaging times from 1 to 24 hours, more robust comparisons would be achieved using a percentile of the data rather than only the maximum concentrations. Percentile comparisons reduce the impacts of outliers in either the monitoring or the model results. For some contaminants, the impact of background sources on measured concentrations might need to be taken into consideration.

7.2 Information for Inclusion in a Modeling Assessment

A suggested checklist of parameters designed to provide an overview of all information that should be submitted for a refined air dispersion modeling assessment is outlined in Appendix B.

The checklist should not be considered exhaustive for all modeling studies; it provides the essential requirements for a general assessment. All sites can have site-specific scenarios that may call for additional information and result in a need for different materials and data to be submitted.

It is the responsibility of the submitter to ensure proper completion and analysis of any air dispersion modeling assessment delivered for review.

7.3 Level of Detail of Health Risk Assessments

Generally, a health risk assessment for CEQA purposes must include all sources of emissions that will emanate from a project. This includes existing and proposed facility-wide emissions. This includes all sources of potential emissions whether or not the project is subject to district permitting requirements. Additionally, all substances that the Office of Environmental Health Hazard Assessment has identified as having toxicity values must be included in the health risk assessment; some districts may allow a less detailed risk assessment.

It is not permissible to omit permitted sources in a CEQA risk assessment, even if these sources will be evaluated during the permit process. The permitting process does not evaluate the cumulative risk associated with the entire facility, only the individual permit unit. A challenge to the completeness of the risk assessments can be made if these sources are not included in the analysis.

It is also not permissible to omit criteria pollutants in the facility risk assessment, assuming that these emissions will be evaluated separately. Criteria pollutants have OEHHA approved RELs that must be included in the chronic and acute hazard indices. Again, a challenge to the completeness of the risk assessments can be made if these substances are omitted.

Chapter 8. Exposure Assessment Procedures

8.0 Cancer Risk Assessment Procedure for Inhalation Only Pathway Pollutants

The following procedure may be used to assess the health risks from facilities for which diesel particulate matter is emitted or other substances identified as only entering the body through the inhalation pathway. Risk Assessments involving substances that enter the body through other pathways must be analyzed for each pathway. A risk assessment involving multipathway substances can to be prepared using the HARP program available through the California Air Resources Board.

Cancer Risk Procedure for Inhalation only Substances:

- Model emissions to determine both the:
  - annual average ground-level concentrations, and the
  - one hour maximum concentration (or other period depending on the acutely toxic substance)
- Create a plot file for these ground-level concentrations.
- Open the plot file using Microsoft EXCEL or another spreadsheet program.
- Copy the data from the plot(s) into Excel.
- To determine the cancer risk, apply the following formula to each ground-level concentrations:

Cancer Risk = S_i * C_i * DBR * A * EF * ED *10^{-6} / AT

Where:

S_i = Slope Factor for substance i
C_i = Concentration in the air of substance i
DBR = Daily Breathing Rate:

Residential Receptors = 302 L/kg-day (default 80th %ile)
= 393 L/kg-day (95th %ile)

Worker Receptors = 149 L/kg-day

A = Inhalation Absorption Rate = 1

EF = Exposure Frequency:

Residential Receptors = 350 days

Worker Receptors = 245 days

ED = Exposure Duration:

See Section 1.3

AT = Averaging Time = 25,550 days

The result will be cancer risk for each source and receptor combination modeled.

For worker exposures, in addition to adjusting the breathing rate, exposure frequency, and exposure duration for workers bersus residents, the emission rate must be adjusted to ensure that he worker risk is based upon the pollutant concentrations to which the worker is exposed. For additional information, see Section 8.2.2b of OEHHA's Air Toxics Hot Spots Program Risk Assessment Guidelines: The Air Toxics Hot Spots Program Guidance Manual for Preparation of Health Risk Assessments, August 2003.

8.1 Cancer Risk Assessment Procedure for Multi-Pathway Pollutants

The procedure for preparing a multi-pathway risk assessment can be complex. The HARP User Guide and the OEHHA Air Toxics Hot Spots Program Risk Assessment Guidelines contains a detailed discussion of how to prepare multi-pathway risk assessments. These documents and others can be found on the CARB website at http://www.arb.ca.gov/toxics/harp/docs.htm.

8.2 Chronic Noncancer Health Impacts

The procedure for determining the impact of chronically toxic substances is described in detail in the OEHHA state guidelines[38]. Noncancer chronic inhalation impacts are calculated by dividing the annual average concentration by the REL (Reference Exposure Level) for that substance. The REL is defined as the concentration at which no adverse noncancer health effects are anticipated. For a single substance, this result of this calculation is called the Hazard Quotient. The following equation is used to calculate the Hazard Quotient:

Hazard Quotient = C_i/REL_i

Where:
C_i = Concentration in the air of substance i
REL_i = Chronic noncancer Reference Exposure Level for substance i

For multiple substances, the Hazard Index (HI) is calculated. The HI is calculated by summing the HQs from all substances that affect the same organ system. HQs for different organ systems are not added, for example, do not sum respiratory irritation HQs with cardiovascular effects. The following equation is used to calculate the Hazard Index for the eye irritation endpoint:

Hazard Index (HI_{eye}) = $HQ_{\text{substance 1(eye)}} + HQ_{\text{substance 2(eye)}}$

No exposure duration adjustment (e.g., 9/70) should be made for noncancer assessments.

For a chronic noncancer assessment involving multipathway pollutants, the California Air Resources Board HARP model can be used.

8.3 Acute Noncancer Health Impacts

The procedure for determining the impact of acutely toxic substances is also described in detail in the OEHHA state guidelines[39]. The calculation of acute noncancer impacts is similar to the procedure for chronic noncancer impacts. In most cases, for a single substance, the acute Hazard Quotient is the highest one hour air concentration divided by the acute REL for that substance. There are a few substances that have acute RELs for exposure periods other than 1 hour. In those cases, the maximum air concentration for the appropriate exposure period (e.g., 8 hours) is divided by the acute REL.

As with the chronic noncancer calculation, for multiple substances that impact the same organ system, the individual substance HQs are summed to determine the HI.

No exposure period adjustments are necessary for acute health impact calculations.

Acute exposures are calculated for the inhalation pathway only.

[38] OEHHA Air Toxics Hot Spots Program Guidance Manual for the Preparation of Risk, June 2002

Appendix A

Meteorological Data

1.0 Preparing Meteorological Data for Refined Modeling

AERMOD and ISC models require actual hourly meteorological conditions as inputs. The refined models require pre-processed meteorological data that contains information on surface characteristics and upper air definition. This data is typically provided in a raw or partially processed format that requires processing through a meteorological pre-processor. The ISC models make use of a pre-processor called PCRAMMET, while AERMOD uses a pre-processor known as AERMET described further in the following sections.

Airport surface data is available from the National Climatic Data Center (NCDC) and other sources. Mixing height data or upper air data were available from NCDC. If mixing heights have not been calculated for the year of interest, mixing height software is available from EPA for use in calculating mixing heights from upper air data. AERMET is used to process upper air and surface data for use in AERMOD. Unlike PCRAMMET, AERMET produces 2 files: a surface file (*.sfc) and a profile file (*.pfl).

1.1 Surface Data

1.1.1 Screening Meteorological Data

Screening surface data may be used in ISC when no applicable surface data is available for the area to be modeled. Most user interface on the market today can generate screening meteorological data for ISC. Please contact the district before using screening meteorological data to ensure that no data is available for the area of concern.

1.1.2 Hourly Meteorological Data

Hourly surface data is supported in several formats including:

- CD-144 – NCDC Surface Data: This file is composed of one record per hour, with all weather elements reported in an 80-column card image. Table 1.0 lists the data contained in the CD-144 file format that is needed to pre-process your meteorological data.

Table 1.0 – CD-144 Surface Data Record (80 Byte Record)

Element	Columns
Surface Station Number	1-5
Year	6-7
Month	8-9
Day	10-11
Hour	12-13
Ceiling Height (Hundreds of Feet)	14-16
Wind Direction (Tens of Degrees)	39-40
Wind Speed (Knots)	41-42
Dry Bulb Temperature (° Fahrenheit)	47-49
Opaque Cloud Cover	79

- MET-144 – SCRAM Surface Data: The SCRAM surface data format is a reduced version of the CD-144 data with fewer weather variables (28-character record). Table 1.1 lists the data contained in the SCRAM file format.

Table 1.1 - SCRAM Surface Data Record (28 Byte Record)

Element	Columns
Surface Station Number	1-5
Year	6-7
Month	8-9
Day	10-11
Hour	12-13
Ceiling Height (Hundreds of Feet)	14-16
Wind Direction (Tens of Degrees)	17-18
Wind Speed (Knots)	19-21
Dry Bulb Temperature (° Fahrenheit)	22-24
Total Cloud Cover (Tens of Percent)	25-26
Opaque Cloud Cover (Tens of Percent)	27-28

- The SCRAM data does not contain the following weather variables, which are necessary for dry and wet particle deposition analysis:
  - Surface pressure: for dry and wet particle deposition;
  - Precipitation type: for wet particle deposition only; or
  - Precipitation amount: for wet particle deposition only.

- SAMSON Surface Data: The SAMSON data contains all of the required meteorological variables for concentration, dry and wet particle deposition, and wet vapor deposition.
- NCDC data can be purchase online from the following web site: http://cdo.ncdc.noaa.gov/qclcd/QCLCD

If the processing of raw data is necessary, the surface data must be in one of the above formats in order to successfully pre-process the data using PCRAMMET or AERMET.

2.0 Mixing Height and Upper Air Data

Upper air data, also known as mixing height data, are required for pre-processing meteorological data required to run the ISC models. It is recommended that only years with complete mixing height data be used. In some instances, mixing height data may need to be obtained from more than one station to complete multiple years of data.

Mixing height data are available from:

- SCRAM BBS –download free of charge, mixing height data for the U.S. for years 1984 through 1991.
- WebMET.com –download free of charge, mixing height and upper air data from across North America, including Ontario.
- Free Upper air data can be downloaded from following web site (FSL Format) http://raob.fsl.noaa.gov/
- Table 2.1 lists the format of the mixing height data file used by PCRAMMET.

Table 2.1 - Upper Air Data File (SCRAM / NCDC TD-9689 Format)

Element	Columns
Upper Air Station Number (WBAN)	1-5
Year	6-7
Month	8-9
Day	10-11
AM Mixing Value	14-17
PM Mixing Value (NCDC)	25-28
PM Mixing Value (SCRAM)	32-35

AERMOD requires the full upper air sounding, unlike ISCST3/ISC-PRIME, which only require the mixing heights. The upper air soundings must be in the NCDC TD-6201 file format or one of the FSL formats.

2.1 AERMET and the AERMOD Model

The AERMET program is a meteorological preprocessor that prepares hourly surface data and upper air data for use in the U.S. EPA air quality dispersion model AERMOD. AERMET was designed to allow for future enhancements to process other types of data and to compute boundary layer parameters with different algorithms.

AERMET processes meteorological data in three stages:

- The first stage (Stage1) extracts meteorological data from archive data files and processes the data through various quality assessment checks.
- The second stage (Stage2) merges all data available for 24-hour periods (surface data, upper air data, and on-site data) and stores these data together in a single file.
- The third stage (Stage3) reads the merged meteorological data and estimates the necessary boundary layer parameters for use by AERMOD.

Out of this process two files are written for AERMOD:

- A Surface File of hourly boundary layer parameters estimates;
- A Profile File of multiple-level observations of wind speed, wind direction, temperature, and standard deviation of the fluctuating wind components.

2.2 PCRAMMET

The PCRAMMET program is a meteorological preprocessor, which prepares NWS data for use in the various U.S. EPA air quality dispersion models such as ISCST3/ISC-PRIME.

PCRAMMET is also used to prepare meteorological data for use by the CAL3QHCR model.

The operations performed by PCRAMMET include:

- Calculating hourly values for atmospheric stability from meteorological surface observations;
- Interpolating the twice daily mixing heights to hourly values;
- Optionally, calculating the parameters for dry and wet deposition processes;
- Outputting data in the standard (PCRAMMET unformatted) or ASCII format required by regulatory air quality dispersion models.

The input data requirements for PCRAMMET depend on the dispersion model and the model options for which the data is being prepared. The minimum input data requirements for PCRAMMET are:

- The twice-daily mixing heights,
- The hourly surface observations of: wind speed, wind direction, dry bulb temperature, opaque cloud cover, and ceiling height.

For dry deposition estimates, station pressure measurements are required. For wet deposition estimates, precipitation type and precipitation amount measurements for those periods where precipitation was observed are required.

The surface and upper air stations should be selected to ensure they are meteorologically representative of the general area being modeled.

2.3 Regional Meteorological Data

The district has/may prepare regional meteorological data sets for use in Tier 2 modeling in several formats. Please contact the District to determine what data is available:

- Regional pre-processed model ready data for AERMOD, with land characteristics for RURAL and URBAN conditions.
- Regional Merge files enabling customized surface characteristics to be specified and processed through AERMET Stage3.
- Hourly surface and upper air data files preprocessed for use in ISCST.

2.3.1 Pre-Processing Steps

Regional data for AERMOD can be processed in 2 forms:

- Merged: Data that has been processed through Stage2 of AERMET (AERMET stages are described in Section 7.1.3) to produce a "Merge" file. This file can then be processed through AERMET Stage3 with custom surface condition data to produce a meteorological data set specific to the site for use with AERMOD (Tier 3).
- Regional: Data that has been processed through Stage3 of AERMET with predefined Land Use characteristics for "Urban" and "Rural" environments. This data is ready for use with AERMOD (Tier 2).

2.3.1.1 Regional Meteorological Data Processing Background

Regional meteorological datasets are generated in AERMET, Stage3 processing step, using different wind independent surface conditions. It is assumed that surface conditions can be a weighted average over a radius of 3 km from the meteorological station and split into 12 sectors, or processed with other parameters approved by the district. The surface conditions needed are the albedo (A), the Bowen ratio (Bo) and the surface roughness (Zo). These parameter values can be derived from data in Tables 6.1, 6.2, 6.3 and 4.3 of the AERMET User's Guide[1].

[1] U.S. Environmental Protection Agency, 1998. Revised Draft - User's Guide for the AERMOD Meteorological Preprocessor (AERMET). Office of Air Quality Planning and Standards, Research Triangle Park, NC.

2.4 Availability and Use of District Meteorological Data

The district may provide meteorological data sets that can be used for air quality studies using ISCST or AERMOD. The data sets should not be modified. Use of custom meteorological data that is locally representative of site conditions can be created and applied for Tier 3 modeling analyses with district approval.

Meteorological data quality is of critical importance, particularly for reliable air dispersion modeling using refined models such as AERMOD. Meteorological data should be collected, processed and analyzed throughout the entire creation phase for completeness and quality control. Missing meteorological data and calm wind conditions can be handled by using EPA's missing data guidance document written by Russ Lee or guidance provided by the District.

The following factors determine the appropriateness of a meteorological data set, the:

- proximity of the meteorological site to the area being modeled,
- complexity of the terrain,
- exposure of the meteorological measurement site, and the
- time period of the data collection.

It should be emphasized that both the spatial and temporal aspects of the data set are the key requirement for determining the appropriateness of a meteorological data set. Not one, but all of these factors must be considered.

The meteorological data that is input to a model should be selected based on its appropriateness for the modeling project. More specifically, the meteorological data should be representative of the wind flow in the area being modeled, so that it can properly represent the transport and diffusion of the pollutants being modeled.

2.5 Expectations for Local Meteorological Data Use

Local meteorological data must be quality reviewed and the origin of the data and any formatting applied to the raw data must be outlined. The regulatory agency should review the plans to use local meteorological data prior to submission of a modeling report.

The sources of all of the data used including cloud data and upper air data must be documented. The proponent also needs to describe why the site chosen is representative for the modeling application. This would include a description of any topographic impacts or impacts from obstructions (trees, buildings etc.) on the wind monitor. Information on the heights at which the wind is measured is also required. The time period of the measurements along with the data completeness and the percentage of calm winds should be reported.

Wind roses showing the wind speed and directions should be provided with the modeling assessment. If wind direction dependent land use was used in deriving the final meteorological file, the selection of the land use should be described.

3.0 Land Use Characterization (AERMOD only)

Land use plays an important role in air dispersion modeling from meteorological data processing to defining modeling characteristics such as urban or rural conditions. Land use data can be obtained from digital and paper land-use maps.

These maps will provide an indication into the dominant land use types within an area of study, such as industrial, agricultural, forested and others. This information can then be used to determine dominant dispersion conditions and estimate values for parameters such as surface roughness, albedo, and Bowen ratio.

- Surface Roughness Length [m]: The surface roughness length, also referred to surface roughness height, is a measure of the height of obstacles to the wind flow. Surface roughness affects the height above local ground level that a particle moves from the ambient airflow above the ground into a "captured" deposition region near the ground. This height is not equal to the physical dimensions of the obstacles, but is generally proportional to them. Table 1.4 lists typical values for a range of land-use types as a function of season.

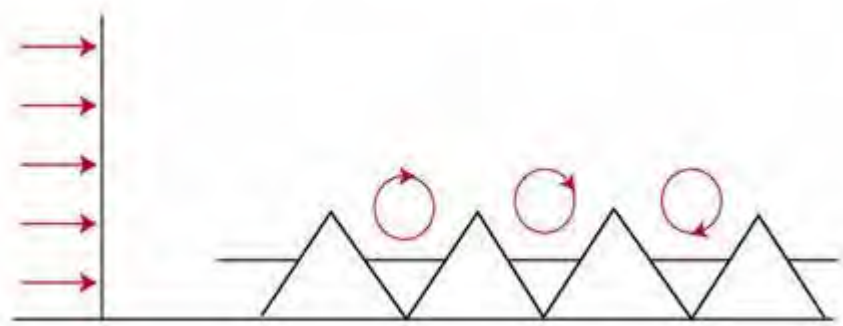


Figure 1.0 - For many modeling applications, surface roughness can be considered to be on the order of one tenth of the height of the roughness elements.

EPA has developed a modeling tool called AERSURFACE[2] to aid in obtaining realistic and reproducible surface characteristic values of albedo, Bowen ratio, and surface roughness length, for input to AERMET. The tool uses publicly available national land cover datasets and look-up tables of surface characteristics that vary by land cover type and season. AERSURFACE calculates the following 3 parameters for input into AERMET:

[2] AERSURFACE User's Guide, EPA-454/B-08-001 January 2008, http://www.epa.gov/scram001/dispersion_related.htm#aersurface

- Surface Roughness:
  The determination of the surface roughness length should be based on an inverse distance weighted geometric mean for a default upwind distance of 1 kilometer relative to the measurement site. Surface roughness length may be varied by sector to account for variations in land cover near the measurement site; however, the sector widths should be no smaller than 30 degrees.

- Bowen Ratio:
  The determination of the Bowen ratio should be based on a simple unweighted geometric mean (i.e., no direction or distance dependency) for a representative domain, with a default domain defined by a 10km by 10km region centered on the measurement site.

- Albedo:
  The determination of the albedo should be based on a simple unweighted arithmetic mean (i.e., no direction or distance dependency) for the same representative domain as defined for Bowen ratio, with a default domain defined by a 10km by 10km region centered on the measurement site.

AERMOD allows wind direction dependent surface characteristics to be used in the processing of the meteorological data. The AERMET procedure also uses the area-weighted average of the land use within 3 km of the site. The selection of wind direction dependent sectors is described in sections 3.1 to 3.3.

Alternative methods of determining surface roughness height may be proposed. The district should review any proposed values prior to use.

Table 3.1 –USGS NLCD92 Land Cover Categories used in AERSURFACE

Classification	Class Number	Land Cover Category
Water	11	Open Water
	12	Perennial Ice/Snow
Developed	21	Low Intensity Residential
	22	High Intensity Residential
	23	Commercial/Industrial/Transportation
Barren	31	Bare Rock/Sand/Clay
	32	Quarries/Strip Mines/Gravel Pits
	33	Transitional
Forested Upland	41	Deciduous Forest
	42	Evergreen Forest
	43	Mixed Forest
Shrubland	51	Shrubland
Non-natural Woody	61	Orchards/Vineyards/Other
Herbaceous Upland	71	Grasslands/Herbaceous
Herbaceous Planted/Cultivated	81	Pasture/Hay
	82	Row Crops
	83	Small Grains
	84	Fallow
	85	Urban/Recreational Grasses
Wetlands	91	Woody Wetlands
	92	Emergent Herbaceous Wetlands

Table 3.2 –AERSURFACE Seasonal Category Description

Seasonal Category	Season Description	Default Month Assignments
1	Midsummer with lush vegetation	Jun, Jul, Aug
2	Autumn with unharvested cropland	Sep, Oct, Nov
3	Late autumn after frost and harvest, or winter with no snow	Dec, Jan, Feb
4	Winter with continuous snow on ground	Dec, Jan, Feb
5	Transitional spring with partial green coverage or short annuals	Mar, Apr, May

Table 3.3 AERSURFACE Seasonal Values of Surface Roughness for the NLCD92 21-Land Cover Classification System

Class Number	Class Name	Seasonal Surface Roughness (m)				
		1	*2*	*3*	*4*	*5*
11	Open Water	0.001	0.001	0.001	0.001	0.001
12	Perennial Ice/Snow	0.002	0.002	0.002	0.002	0.002
21	Low Intensity Residential	0.54	0.54	0.50	0.50	0.52
22	High Intensity Residential	1	1	1	1	1
23	Commercial/Industrial/Transportation (Site at airport)	0.1	0.1	0.1	0.1	0.1
	Commercial/Industrial/Transportation (Not at airport)	0.8	0.8	0.8	0.8	0.8
31	Bare Rock/Sand/Clay (Arid Region)	0.05	0.05	0.05	NA	0.05
	Bare Rock/Sand/Clay (Non-arid Region)	0.05	0.05	0.05	0.05	0.05
32	Quarries/Strip Mines/Gravel Pits	0.3	0.3	0.3	0.3	0.3
33	Transitional	0.2	0.2	0.2	0.2	0.2
41	Deciduous Forest	1.3	1.3	0.6	0.5	1
42	Evergreen Forest	1.3	1.3	1.3	1.3	1.3
43	Mixed Forest	1.3	1.3	0.95	0.9	1.15
51	Shrubland (Arid Region)	0.15	0.15	0.15	NA	0.15
	Shrubland (Non-arid Region)	0.3	0.3	0.3	0.15	0.3
61	Orchards/Vineyards/Other	0.3	0.3	0.1	0.5	0.2
71	Grasslands/Herbaceous	0.1	0.1	0.01	0.005	0.05
81	Pasture/Hay	0.15	0.15	0.02	0.01	0.03
82	Row Crops	0.2	0.2	0.02	0.01	0.03
83	Small Grains	0.15	0.15	0.02	0.01	0.03
84	Fallow	0.05	0.05	0.02	0.01	0.02
85	Urban/Recreational Grasses	0.02	0.015	0.01	0.005	0.015
91	Woody Wetlands	0.7	0.7	0.6	0.5	0.7
92	Emergent Herbaceous Wetlands	0.2	0.2	0.2	0.1	0.2

- Noon-Time Albedo:

Noon-time albedo is the fraction of the incoming solar radiation that is reflected from the ground when the sun is directly overhead. Table 3.4 lists typical albedo values as a function of several land use types and season. For practical purposes, the selection of a single value for noon-time albedo, for a land use types and season combination, to process a complete year of meteorological data is desirable. If other conditions are used, the district should review the proposed noon-time albedo values used to pre-process the meteorological data.

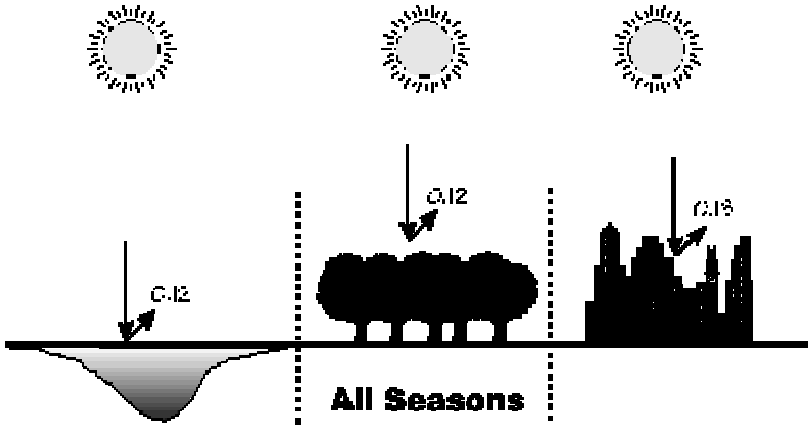


Table 3.4 AERSURFACE Seasonal Values of Albedo for the NLCD92 21-Land Cover Classification System

Class Number	Class Name	Seasonal Albedo Values				
		1	*2*	*3*	*4*	*5*
11	Open Water	0.1	0.1	0.1	0.1	0.1
12	Perennial Ice/Snow	0.6	0.6	0.7	0.7	0.6
21	Low Intensity Residential	0.16	0.16	0.18	0.45	0.16
22	High Intensity Residential	0.18	0.18	0.18	0.35	0.18
23	Commercial/Industrial/Transportation (Site at airport)	0.18	0.18	0.18	0.35	0.18
	Commercial/Industrial/Transportation (Not at airport)	0.18	0.18	0.18	0.35	0.18
31	Bare Rock/Sand/Clay (Arid Region)	0.2	0.2	0.2	NA	0.2
	Bare Rock/Sand/Clay (Non-arid Region)	0.2	0.2	0.2	0.6	0.2
32	Quarries/Strip Mines/Gravel Pits	0.2	0.2	0.2	0.6	0.2
33	Transitional	0.18	0.18	0.18	0.45	0.18
41	Deciduous Forest	0.16	0.16	0.17	0.5	0.16
42	Evergreen Forest	0.12	0.12	0.12	0.35	0.12
43	Mixed Forest	0.14	0.14	0.14	0.42	0.14
51	Shrubland (Arid Region)	0.25	0.25	0.25	NA	0.25
	Shrubland (Non-arid Region)	0.18	0.18	0.18	0.5	0.18
61	Orchards/Vineyards/Other	0.18	0.18	0.18	0.5	0.14
71	Grasslands/Herbaceous	0.18	0.18	0.2	0.6	0.18
81	Pasture/Hay	0.2	0.2	0.18	0.6	0.14
82	Row Crops	0.2	0.2	0.18	0.6	0.14
83	Small Grains	0.2	0.2	0.18	0.6	0.14
84	Fallow	0.18	0.18	0.18	0.6	0.18
85	Urban/Recreational Grasses	0.15	0.15	0.18	0.6	0.15
91	Woody Wetlands	0.14	0.14	0.14	0.3	0.14
92	Emergent Herbaceous Wetlands	0.14	0.14	0.14	0.3	0.14

- Bowen Ratio:

The Bowen ratio is a measure of the amount of moisture at the surface. The presence of moisture at the earth's surface alters the energy balance, which in turn alters the sensible heat flux and Monin-Obukhov length. Table 3.5 lists Bowen ratio values as a function of land-use types, seasons and moisture conditions. Bowen ratio values vary depending on the surface wetness. Average moisture conditions would be the usual choice for selecting the Bowen ratio. If other conditions are used the district should review the proposed Bowen ratio values used to pre-process the meteorological data.

Table 3.5 AERSURFACE Seasonal Values of Bowen Ratio for the NLCD92 21-Land Cover Classification System - Average moisture conditions

Class Number	Class Name	Seasonal Bowen Ratio Values-Average				
		1	*2*	*3*	*4*	*5*
11	Open Water	0.1	0.1	0.1	0.1	0.1
12	Perennial Ice/Snow	0.5	0.5	0.5	0.5	0.5
21	Low Intensity Residential	0.8	1	1	0.5	0.8
22	High Intensity Residential	1.5	1.5	1.5	0.5	1.5
23	Commercial/Industrial/Transportation (Site at airport)	1.5	1.5	1.5	0.5	1.5
	Commercial/Industrial/Transportation (Not at airport)	1.5	1.5	1.5	0.5	1.5
31	Bare Rock/Sand/Clay (Arid Region)	4	6	6	NA	3
	Bare Rock/Sand/Clay (Non-arid Region)	1.5	1.5	1.5	0.5	1.5
32	Quarries/Strip Mines/Gravel Pits	1.5	1.5	1.5	0.5	1.5
33	Transitional	1	1	1	0.5	1
41	Deciduous Forest	0.3	1	1	0.5	0.7
42	Evergreen Forest	0.3	0.8	0.8	0.5	0.7
43	Mixed Forest	0.3	0.9	0.9	0.5	0.7
51	Shrubland (Arid Region)	4	6	6	NA	3
	Shrubland (Non-arid Region)	1	1.5	1.5	0.5	1
61	Orchards/Vineyards/Other	0.5	0.7	0.7	0.5	0.3
71	Grasslands/Herbaceous	0.8	1	1	0.5	0.4
81	Pasture/Hay	0.5	0.7	0.7	0.5	0.3
82	Row Crops	0.5	0.7	0.7	0.5	0.3
83	Small Grains	0.5	0.7	0.7	0.5	0.3
84	Fallow	0.5	0.7	0.7	0.5	0.3
85	Urban/Recreational Grasses	0.5	0.7	0.7	0.5	0.3
91	Woody Wetlands	0.2	0.2	0.3	0.5	0.2
92	Emergent Herbaceous Wetlands	0.1	0.1	0.1	0.5	0.1

Table 3.6 AERSURFACE Seasonal Values of Bowen Ratio for the NLCD92 21-Land Cover Classification System - Wet moisture conditions

Class Number	Class Name	Seasonal Bowen Ratio Values-Wet				
		1	*2*	*3*	*4*	*5*
11	Open Water	0.1	0.1	0.1	0.1	0.1
12	Perennial Ice/Snow	0.5	0.5	0.5	0.5	0.5
21	Low Intensity Residential	0.6	0.6	0.6	0.5	0.6
22	High Intensity Residential	1	1	1	0.5	1
23	Commercial/Industrial/Transportation (Site at airport)	1	1	1	0.5	1
	Commercial/Industrial/Transportation (Not at airport)	1	1	1	0.5	1
31	Bare Rock/Sand/Clay (Arid Region)	1.5	2	2	NA	1
	Bare Rock/Sand/Clay (Non-arid Region)	1	1	1	0.5	1
32	Quarries/Strip Mines/Gravel Pits	1	1	1	0.5	1
33	Transitional	0.7	0.7	0.7	0.5	0.7
41	Deciduous Forest	0.2	0.4	0.4	0.5	0.3
42	Evergreen Forest	0.2	0.3	0.3	0.5	0.3
43	Mixed Forest	0.2	0.35	0.35	0.5	0.3
51	Shrubland (Arid Region)	1.5	2	2	NA	1
	Shrubland (Non-arid Region)	0.8	1	1	0.5	0.8
61	Orchards/Vineyards/Other	0.3	0.4	0.4	0.5	0.2
71	Grasslands/Herbaceous	0.4	0.5	0.5	0.5	0.3
81	Pasture/Hay	0.3	0.4	0.4	0.5	0.2
82	Row Crops	0.3	0.4	0.4	0.5	0.2
83	Small Grains	0.3	0.4	0.4	0.5	0.2
84	Fallow	0.3	0.4	0.4	0.5	0.2
85	Urban/Recreational Grasses	0.3	0.4	0.4	0.5	0.2
91	Woody Wetlands	0.1	0.1	0.1	0.5	0.1
92	Emergent Herbaceous Wetlands	0.1	0.1	0.1	0.5	0.1

Table 3.7 AERSURFACE Seasonal Values of Bowen Ratio for the NLCD92 21-Land Cover Classification System - Dry moisture conditions

Class Number	Class Name	Seasonal Bowen Ratio Values-Dry				
		1	*2*	*3*	*4*	*5*
11	Open Water	0.1	0.1	0.1	0.1	0.1
12	Perennial Ice/Snow	0.5	0.5	0.5	0.5	0.5
21	Low Intensity Residential	2	2.5	2.5	0.5	2
22	High Intensity Residential	3	3	3	0.5	3
23	Commercial/Industrial/Transportation (Site at airport)	3	3	3	0.5	3
	Commercial/Industrial/Transportation (Not at airport)	3	3	3	0.5	3
31	Bare Rock/Sand/Clay (Arid Region)	6	10	10	NA	5
	Bare Rock/Sand/Clay (Non-arid Region)	3	3	3	0.5	3
32	Quarries/Strip Mines/Gravel Pits	3	3	3	0.5	3
33	Transitional	2	2	2	0.5	2
41	Deciduous Forest	0.6	2	2	0.5	1.5
42	Evergreen Forest	0.6	1.5	1.5	0.5	1.5
43	Mixed Forest	0.6	1.75	1.75	0.5	1.5
51	Shrubland (Arid Region)	6	10	10	NA	5
	Shrubland (Non-arid Region)	2.5	3	3	0.5	2.5
61	Orchards/Vineyards/Other	1.5	2	2	0.5	1
71	Grasslands/Herbaceous	2	2	2	0.5	1
81	Pasture/Hay	1.5	2	2	0.5	1
82	Row Crops	1.5	2	2	0.5	1
83	Small Grains	1.5	2	2	0.5	1
84	Fallow	1.5	2	2	0.5	1
85	Urban/Recreational Grasses	1.5	2	2	0.5	1
91	Woody Wetlands	0.2	0.2	0.2	0.5	0.2
92	Emergent Herbaceous Wetlands	0.2	0.2	0.2	0.5	0.2

3.1 Wind Direction Dependent Land Use

AERMET also provides the ability to specify land characteristics for up to 12 different contiguous, non-overlapping wind direction sectors that define unique upwind surface characteristics. The following properties of wind sectors must be true:

- The sectors are defined clockwise as the direction from which the wind is blowing, with north at 360°.
- The sectors must cover the full circle so that the end value of one sector matches the beginning of the next sector.

- The beginning direction is considered part of the sector, while the ending direction is not.

Each wind sector can have a unique albedo, Bowen ratio, and surface roughness. Furthermore, these surface characteristics can be specified annually, seasonally, or monthly to better reflect site conditions.

3.2 Mixed Land Use Types

Study areas may contain several different regions with varying land use. This can be handled by AERMET through the use of wind sector specific characterization, as described in the previous section.

For models such as ISCST3/ISC-PRIME that do not take advantage of sector-specific characterization, the most representative conditions should be applied when land use characteristics are required.

The surface characteristics need to be assessed in a circle with a radius of one to three kilometers from the source. Contact the District to determine the appropriate parameters for meteorological data in accordance with EPA guidance. Data should be chosen for a meteorological data site with surface characteristics similar to those of the area around the source. To prepare the surface data, use the AERSURFACE module of AERMOD or perform a site survey using the standard land uses defined in the AERSURFACE documentation and the default surface roughness length for those land uses.

The surface characteristics are determined by assessing the land use across the monitoring site area and applying the appropriate values to the land characteristic parameters. A weighted average is then computed based on the area of each land use category.

For example: If the area under review is 15% cultivated land, 5% desert shrub land, and 80% Urban, the same weighted percentages would be used to derive a weighted average albedo, Bowen ratio, and surface roughness parameters.

3.3 Seasonal Land Use Characterization

Land use characteristics can be susceptible to seasonal variation. For example, winter conditions can bring increased albedo values due to snow accumulation.

AERMET allows for season-specific values for surface roughness, albedo, and Bowen ratio to be defined. Other models, such as ISCST3/ISC-PRIME, do not support multiple season surface characteristics to be defined. In such a case, the most representative conditions should be applied when land use characteristics are required.

3.4 Standard and Non-Default Surface Characteristics

The generation of local meteorological data files can incorporate site-specific surface characteristics. It should be noted that any local meteorological files generated for air dispersion modeling should provide a clear reasoning for the values used to describe surface characteristics. The district should review any proposed surface characteristics prior to submission of a modeling report.

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The following information must be submitted with a risk assessment. It provides the essential requirements for a general assessment. Site-specific scenarios may call for additional information and result in a need for different materials and data to be submitted. It is the responsibility of the submitter to ensure proper completion and analysis of any air dispersion modeling assessment delivered for review. *Consultation with your local air district is strongly recommended.*

1.0 General Information

1.0.1 Submittal Date
1.0.2 Facility/Project Name
1.0.3 Facility/Project Location
1.0.4 Risk Assessor Name

1.1 Hazard Identification

1.1.1 Table of all toxic air contaminants (TAC) emitted by the Facility/Project including:

- CAS number,
- Chemical name(s) – include appropriate common names,
- Physical state as emitted.

1.1.2 Table of carcinogens,
1.1.3 Table of acutely toxic TACs, and
1.1.4 Table of chronically toxic non-carcinogenic TACs.
1.1.5 Table showing the processes and the TACs emitted from each process.

1.2 Exposure Assessment

1.2.1 Air Dispersion Model Options

1.2.1.1 Model Used

- AERMOD - version number,
- ISCST - version number,
- Other Model - Specify name, version number, and reason for use.

1.2.1.2 Regulatory Options Used

- Yes
- No - Provide justification for use of non-regulatory options. Note that use of non-regulatory options requires prior approval from the regulatory agency.

1.2.1.3 Dispersion Coefficients Used, and How they were Determined

- Urban
- Rural

(Urban or Rural conditions can be determined through the use of an Auer Land Use or Population Density analysis.)

1.2.1.4 Coordinate System Used

- UTM Coordinates
- Local Coordinates
- Other

(AERMOD requires UTM coordinates be used to define all model objects. Use of an alternative coordinate system requires advance consultation with the regulatory agency.)

1.2.2 Source Information

1.2.2.1 Source Summaries

Create tables which show the following point, area, volume, line, or flare modeling parameters. Following the tables must be a description of the reasoning for each modeling parameter chosen.

Point Sources Summary

- Source name
- Source location coordinates
  - X (m)
  - Y (m)
- Table showing the names of each TAC modeled and max hourly and annual emission rate in grams per second.
- Stack heights in meters
- Stack Diameter in meters
- Stack Exit Temperature in degrees K
- Stack Exit Velocity in meters per second
- Stack direction
  - Vertical exhaust direction
  - Horizontal exhaust direction
- Rain Cap Present
  If the stack is either horizontal in orientation or has a rain cap, stack parameters must be adjusted as per guidance.
- Operating Schedule.
  Create tables showing how the normal emission rates vary by source.

Area Sources Summary

- Source name
- Source location coordinates (Southwest Vertex):
  - X (m)
  - Y (m)
- Table showing the names of each TAC modeled and emission rate in grams per second-meter^2.
- Exhaust height in meters
- Easterly Dimension in meters
- Northerly Dimension in meters
- Initial Vertical Dimension in meters
- Angle from North in degrees.
- Operating Schedule.
  Create tables showing how the normal emission rates vary by source.

Volume Sources Summary

- Source name
- Source location coordinates (Center of Source):
  - X (m)
  - Y (m)
- Table showing the names of each TAC modeled and emission rate in grams per second.
- Source height in meters
- Initial Horizontal Dimension in meters
- Initial Vertical Dimension in meters

- Operating Schedule.
  Create tables showing how the normal emission rates vary by source.

Line Sources Summary (CAL3QHCR specific; for step by step guidance according to SMAQMD recommendations, see CAPCOA's CEQA Risk Assessment Guidelines)

- Source name (highway, freeway, or major roadway)
- Roadway compass orientation (in terms of x,y; arbitrary origin of 0,0)
- Location of nearest receptor to source and other receptors as required by local air district
- Calculation averaging time (such as 60 min)
- Surface roughness (cm, from 3 to 400)
- Settling velocity (cm/s)
- Deposition velocity (cm/s)
- Site setting, rural or urban
- Form of traffic volume (recommended: 1 for one hour's data)
- Pollutant (P for PM10)
- Hourly ambient background (0 or as recommended by air district)
- Roadway height indicator (AG for at grade; FL for elevated and filled; BR for bridge; DP for depressed)
- Roadway height (AG is 0)

Other input parameters are required for CAL3QHCR. See CAPCOA's CEQA Risk Assessment Guidelines or contact your local air district.

1.2.2.2 Emissions Profile during Abnormal Operations Start-Up or Shutdown

Create table showing how abnormal emission rates vary by source. Abnormal emission rates include start-up or shutdown.

1.2.2.3 Building Downwash

- Describe whether the stack(s) are located within 5L of a structure that is at least 40% of the stack height (L is the lesser of the height or the maximum projected building width for a structure).
- If it is, then prepare a building downwash analysis using the current version of the Building Profile Input Program – PRIME (BPIP-PRIME) and include results in air dispersion modeling assessment.

1.2.2.4 Scaled Plot Plan

Provide a scaled plot plan, preferably in electronic format, displaying:

- Emission release locations,
- Buildings (On site and neighboring),
- Tanks (On site and neighboring),
- Property boundaries,
- Model receptor locations,
- Sensitive receptors locations,
- Fenceline receptors locations.

1.2.2.5 Sensitive Receptors locations

Describe the location and nature of all nearby sensitive receptors (e.g. residences, schools, hospitals, etc...)

1.2.2.6 Points of Maximum Impact

Demonstrate that the actual point of maximum impact, residential point of maximum impact, and the offsite worker point of maximum impact have been reached.

1.2.3 Terrain Conditions

1.2.3.1 Elevated or complex terrain

Describe whether the modeled area contains elevated or complex terrain, and provide a discussion on the approach used to determine terrain characteristics of the assessment area.

1.2.3.2 Digital Terrain Data

Describe whether the data for digital terrain is:

- CDED 1-degree,
- CDED 15-minute,
- USGS 7.5-minute Ontario dataset, or
- Other, and describe other.

1.2.3.3 Elevation data import

Describe the technique used to determine elevations of receptors and related model entities such as sources.

1.2.4 Meteorological Data

1.2.4.1 Regional Meteorological data

Specify what Regional Meteorological data set was used and note the period of the record.

1.2.4.2 Was a Regional Meteorological Merge data file used?

Specify the Meteorological Data Set Merge file used and summarize land characteristics specified in its processing. This information should be reviewed by the District prior to submission of a modeling report.

1.2.4.3 Meteorological data preparation

Specify the Meteorological Data files used and summarize all steps and values used in processing these standard meteorological data files. This information should be reviewed by the District prior to submission of a modeling report.

1.2.4.4 Local Meteorological data

Specify the source, reliability, and representativeness of the local meteorological data as well as a discussion of data QA/QC and processing of data. State the time period of the measurements, wind direction dependent land use (if used), and any topographic or shoreline influences. This information should be reviewed by the District prior to submission of a modeling report.

1.2.4.5 Wind Information

The following items should be provided and discussed where applicable:

- Speed and direction distributions (wind roses),
- Topographic and/or obstruction impacts,
- Data completeness,

- Percentage of calms

1.2.4.6 Temperature, clouds, and upper air data

The following items should be provided and discussed where applicable:

- Data completeness,
- Mixing layer heights,
- Diurnal and seasonal variations.

1.2.4.7 Turbulence

The following should be provided and discussed if site specific data is being used:

- Frequency distributions,
- Diurnal and seasonal variations.

1.2.5 Dispersion Model Results

1.2.5.1 Modeling files

The following electronic model input and output files are to be provided:

- BPIP-PRIME - Input and Output files.
- ISCST3/ISC-PRIME or AERMOD - Input and Output files.
- ISCST3/ISC-PRIME or AERMOD - Plot files
- SCREEN3 - Input and Output files if applicable

1.2.5.2 Meteorological Data

The electronic meteorological data files must be provided.

1.2.5.3 Terrain Data

Digital elevation terrain data files must be provided if included in the analysis.

1.2.5.3 Plots and Maps

Include the following:

- Drawing/site plan with modeling coordinate system noted (digital format preferred).
- Plots displaying concentration/deposition results across study area.

1.2.5.5 Emission Summary

An emission summary table must be provided.

1.2.5.6 Discussion

The results overview should include a discussion of the following items, where applicable:

- The use of alternative models,
- The use of any non-default model options,
- Topographic effects on the predictions,
- All predicted concentrations based on the REL based exposure period.

1.3 Toxicity Data

1.3.1 Toxicity Values for Each TAC Emitted

A table must be provided that shows the following data for each TAC emitted:

- The cancer potency factors,
- The acute and chronic RELs,
- The averaging times for the acute RELs,

- The pathways the TAC enters the body, and
- The date these factors were updated.

1.3.2 Target Organ Systems for Each Acute and Non-Carcinogenic Chronic Substance

A table must be provided that shows the target organs and body systems each acute and non-carcinogenic chronic impact.

1.4 Risk Characterization

1.4.1 Points of Maximum Impact

The following points of maximum impact need to be identified:

- The Points of Maximum Impact (PMI),
- The Maximum Exposed Individual - Residential (MEIR), and
- The Maximum Exposed Individual – Worker (MEIW).

At these locations the following data must be provided:

- Locations (UTM coordinates, or Latitude/Longitude coordinates, or other coordinates),
- Cancer risk, acute and chronic hazard indices,
- Sources and pollutants that contribute to risks which exceed the district's cancer risk, or acute, or chronic hazard index significance levels.

1.4.2 Exposure Pathways

Identify each pathways used to determine the cancer risk and chronic hazard indices. Provide all assumptions used for pathways (e.g., the percentage of home-grown vegetables consumed locally, etc…).

1.4.3 Graphical Presentations

Maps must be provided which show the following:

- Locations of sensitive receptors,
- Location of PMI, MEIR, and MEIW for cancer, acute, and non-cancer chronic risks,
- Isopleth lines showing cancer risk, acute, and chronic hazard indices in magnitudes specified by the Air District (e.g., cancer risk starting at 10 per million and increasing by tens per million.)

1.4.4 Guidelines and Software

Specify:

- Describe whether these CAPCOA Guidelines have been applied or other Guidelines were applied,
- The risk assessment software utilized (e.g., Hot Spots Analysis and Reporting Program or HARP),
- If risk assessment software other than HARP is used, then and provide a demonstration that the results will show the same results as HARP,
- Discuss any software used to import model results into HARP.

2.0 Modeling Files

The following files from the air quality dispersion model and risk assessment software should be provided:

Air quality dispersion model (if HARP is not used)

- Input file (*.inp, *.ADI, *.dat)
- Output file (*.out, *.ADO, *.lst)
- Meteorological files

- Plotfiles

Building Downwash Analysis (BPIP) (if HARP is not used)

- Input file
- Output file

Risk assessment software (i.e., HARP):

- Transaction files for the facilities, buildings, and property boundaries (*.tra)
- Transaction files for the source receptors (*.rec)
- Facility database for included facilities building, and property boundaries (*.mdb) as an alternative to the transaction files
- Health factor database (Health.mdb)
- ISC Workbook file with all ISC parameters (*.isc)
- ISC input file generated by HARP when ISC is run (*.inp)
- ISC output file generated by HARP when ISC is run (*.out)
- List of error messages generated by ISC (*.err)
- Plot file generated by ISC (*.plt)
- Representative meteorological data used for the facility air dispersion modeling (*.met)
- Any digital elevation model files (if applicable) (*.dem)
- Average and maximum χ/Q for each source-receptor combination; generated by ISC (*.xoq)
- ISC binary output file (FOR REFINED ACUTE ANALYSIS ONLY); holds χ/Q data for each hour (*.bin)
- Source/receptor file; contains list of sources and receptors for the ISC run; generated by HARP when you set up ISC (*.src)
- Emission Rate files (if changes were made to database) (*.ems)
- Site-specific parameters used for all receptor risk modeling (*.sit)
- (Screening) Adjustment factor files (IF SCREEN MET IS USED) (*.adj)
- Point estimate risk reports generated by HARP; this file is updated automatically each time you perform one of the point estimate risk analysis functions ((e.g., acute, chronic, cancer, derived (adjusted). Etc.)) (*.rsk)
- Database for Census (population) file (census.mdb)
- Map file used to overlay facility and receptors (*.map)
- HARP Exception Report (ExceptionReport.txt)
- Risk result text files for key receptors (STANDARD REPORT SET) (*.txt)
- STOCHASTIC Raw sample file (*.csv)
- STOCHASTIC Sample file (*.spl)
- STOCHASTIC Summary report (*.txt)
- Equivalent files for software other than HARP

EXHIBIT B

Air Toxics Hot Spots Program Risk Assessment Guidelines

Technical Support Document for Exposure Assessment and Stochastic Analysis

Scientific Review Panel Draft
June, 2012

Secretary for Environmental Protection
California Environmental Protection Agency
Matthew Rodriquez

Acting Director
Office of Environmental Health Hazard Assessment
George V. Alexeeff, Ph.D., D.A.B.T.

Air Toxics "Hot Spots" Program Risk Assessment Guidelines

Technical Support Document for

Exposure Assessment and Stochastic Analysis

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1. Introduction

The Air Toxics "Hot Spots" Information and Assessment Act (AB 2588, Connelly, stat. 1987; Health and Safety Code Section 44300 et seq.) is designed to provide information on the extent of airborne emissions from stationary sources and the potential public health impacts of those emissions. Facilities provide emissions inventories of chemicals specifically listed under the "Hot Spots" Act to the local Air Pollution Control and Air Quality Management Districts (Districts) and ultimately to the state Air Resources Board. Following prioritization of facilities by the Districts, facilities may be required to conduct a health risk assessment.

Health risk assessment involves a comprehensive analysis of the dispersion of the specific facility's air emissions, and the extent of human exposure via all relevant pathways (exposure assessment), the toxicology of those chemicals (dose-response assessment), and the estimation of cancer risk and noncancer health impacts to the exposed community (risk characterization). Most "Hot Spots" risk assessments are conducted by contractors for the facility; some are conducted in-house and some by the local air districts. AB-2588 mandates the Office of Environmental Health Hazard Assessment (OEHHA) to review Hot Spots risk assessments and the findings are conveyed to the District by letter. The District may require the facility to notify the impacted public if the risk assessment shows risks above a level deemed acceptable by the District.

The Air Toxics "Hot Spots" Act was amended to require that the Office of Environmental Health Hazard Assessment (OEHHA) develop risk assessment guidelines for the Air Toxics "Hot Spots" program (SB 1731, Calderon, stat. 1992; Health and Safety Code Section 44360(b)(2)). The amendment specifically requires OEHHA to develop a "likelihood of risks" approach to health risk assessment. Therefore, the OEHHA developed a stochastic, or probabilistic, approach to exposure assessment to fulfill this requirement. The previous version of this document, the *Technical Support Document for Exposure Assessment and Stochastic Analysis,* was final in September 2000 (OEHHA, 2000a). This revision of the document updates OEHHA 2000a by incorporating scientific advances in the field of exposure assessment, and newer data on exposure variates. Exposure variates are consumption estimates for various media and values for fate and transport modeling such as fish bioaccumulation factors.

All facilities are required to conduct a point estimate risk assessment using OEHHA's recommended exposure variates. Fcilities may choose to also conduct a stochastic assessment of exposure (and risk) to provide more information to the risk managers and the public. The stochastic approach described in this document provides guidance to the facility operators who want to conduct a stochastic risk assessment, and facilitates use of supplemental information to be considered in the health risk assessment. It provides a method for quantification of the portion of exposure variability for which sufficient data exist to permit estimation. This document does not present an approach for quantification of uncertainty in exposure assessment.

OEHHA has developed a series of documents describing the information supporting the dose-response assessment for "Hot Spots" chemicals and the exposure assessment methodologies. The Children's Environmental Health Protection Act (SB-25) was passed in 1999 and mandated that OEHHA ensure that our risk assessment procedures were protective of children's health. OEHHA developed the methodology presented in the *Air Toxics Hot Spots Risk Assessment Guidelines Technical Support Document for the Derivation of Non-cancer Reference Exposure Levels* (RELs) (OEHHA, 2008) to ensure that our procedures for REL development were protective of children. The 2008 document supersedes the earlier documents for acute RELS, (OEHHA 1999a) and chronic RELS (OEHHA, 2000b). However, RELs developed under the previous OEHHA Guidance (1999a and 2000b) that have not undergone re-evaluation under the OEHHA (2008) updated methodology remain in effect for the Hot Spots program. New and revised RELs are being developed using the 2008 Guidelines and periodically released for public comment and review by the State's Scientific Review Panel on Toxic Air Contaminants (SRP).

OEHHA also developed the *Technical Support Document for Cancer Potency Factors: Methodologies for Derivation, Listing of Available Values, and Adjustments to Allow for Early Life Stage Exposures* (OEHHA, 2009) after the passage of SB-25 to ensure that cancer dose-response takes into account the vulnerability of children. The 2009 document supersedes the *Technical Support Document for Determining Cancer Potency Factors* (OEHHA, 1999b).

This revision of the *Technical Support Document for Exposure Assessment and Stochastic Analysis* describes the exposure algorithms, and point estimates and distributions of key exposure variates that can be used for the exposure analysis component of Air Toxics "Hot Spots" risk assessments. OEHHA reassessed exposure variates for children to ensure they would not underestimate exposure under our SB-25 mandate. We also incorporated advances in the field of exposure assessment since the previous version of the document. The document includes a description of the point estimate and stochastic multipathway exposure assessment approaches and a brief summary of the information supporting the selection of default assumptions. OEHHA developed this document in consultation with the Air Resources Board (ARB) and the California Air Pollution Control Officers Association (CAPCOA). The ARB provided Chapter 2 and associated appendices describing the air dispersion and deposition modeling.

A tiered approach to risk assessment, which allows for both consistency and flexibility, is described in Section 1.4. OEHHA's proposed algorithms, default point estimates and distributions of variates for each major exposure pathway are described in Chapters 3 through 10. The algorithms, with one exception, are identical to the previous version of this document (OEHHA, 2000). We condensed portions of the algorithm for dermal absorption, simplifying the equation and calculation. The algorithms used in our exposure model are largely consistent with the U.S. EPA (1991) Risk Assessment Guidance for Superfund Sites, with some modifications. The point estimates and distributions were updated based on newer data.

Finally, we are updating the *Air Toxics 'Hot Spots' Risk Assessment Guidance Manual* (OEHHA, 2003). This updated document, which will be available soon for public comment and peer review by the SRP, contains the essential information to conduct a health risk assessment based on the three technical support documents described above.

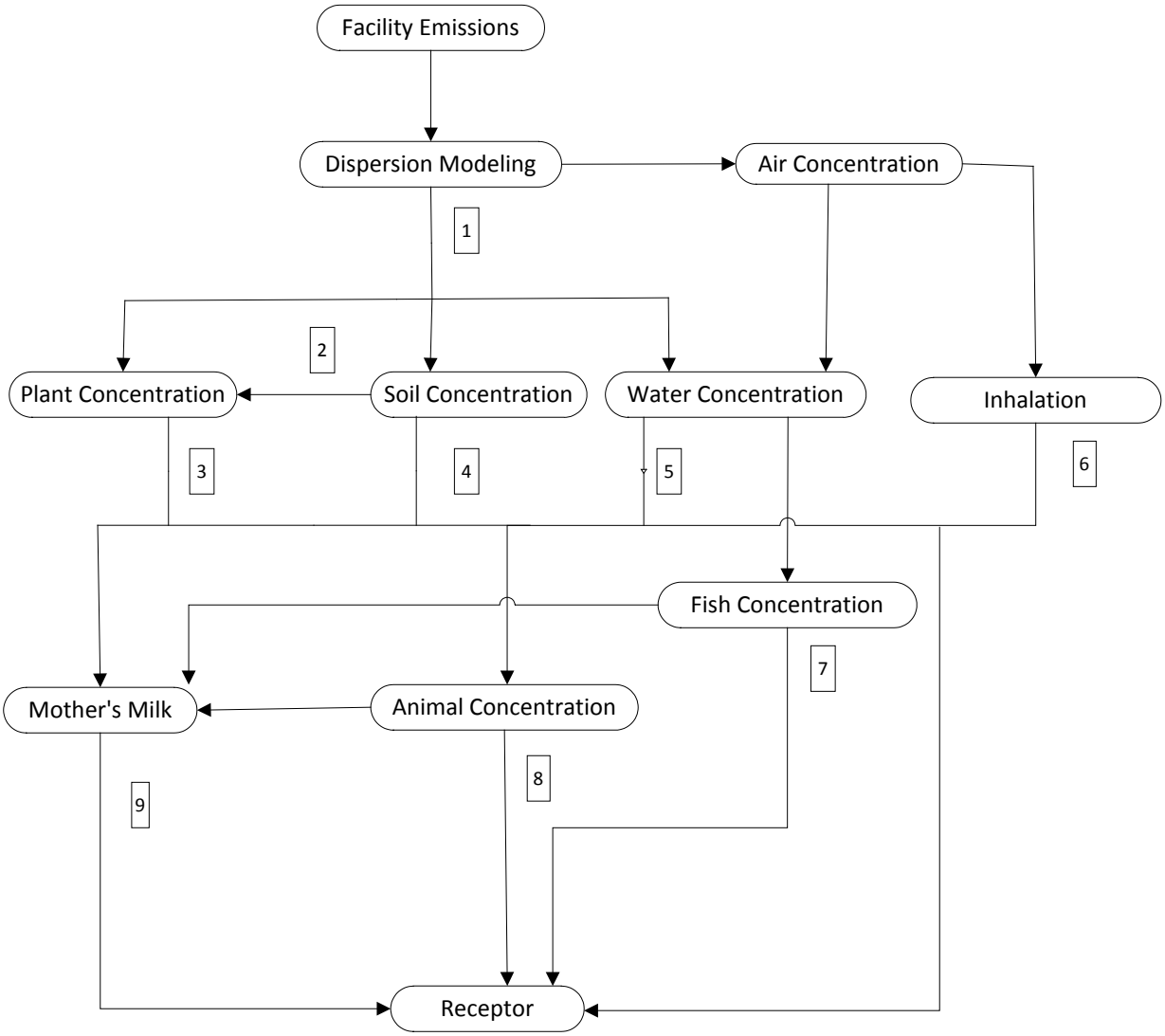
1.1 Multipathway Nature of Exposure Assessment

Exposure assessment of airborne emissions includes not only an analysis of exposure via the inhalation pathway, but also noninhalation pathways of indirect exposure to airborne toxicants. There are data in the literature demonstrating that for some compounds, significant exposure occurs following deposition of airborne material onto surface water, soils, edible plants (both food, pasture and animal feed), and through ingestion of breast milk. Examining both direct inhalation and indirect noninhalation exposure pathways reveals the full extent of exposure to airborne emissions (see Figure 1.1).

However, only certain chemicals are evaluated via the multipathway approach in the Air Toxics "Hot Spots" risk assessments. In general, there is a higher potential for indirect exposure to chemicals which tend to bioconcentrate or bioaccumulate (e.g., lipophilic semi-volatile organics), or otherwise accumulate in the environment (e.g., metals). Semi-volatile and non-volatile organic and metal toxicants can be directly deposited onto surface waters, soil, leaves, fruits and vegetables, grazing forage, and so forth. This is particularly important when these chemicals are associated with particulate matter. Cows, chickens, and other food animals can become contaminated through inhalation, and ingestion of contaminated surface water, pasture, feed and soil. Fish can become contaminated via bioconcentration from water and bioaccumulation from their food. Produce can become contaminated via root uptake from soils and direct deposition. Thus, humans can be exposed through ingestion of contaminated meat, fish, produce, water and soil, as well as from breathing contaminated air, and via dermal exposure. In addition, nursing infants can be exposed via breast milk.

The exposure variates are presented by chapter in this Document roughly in order of importance to an Air Toxics Hot Spots facility risk assessment. The breathing rate (Chapter 3) is the most important pathway; all chemicals must include an inhalation assessment. The breathing rate chapter is followed by chapters discussing the pathways that are automatically included if a risk assessment finds semi- or non-volatile Hot Spots chemicals: the soil ingestion pathway (Chapter 4), the mother's milk pathway (Chapter 5), and the dermal exposure pathway (Chapter 6). The remaining chapters contain the pathways that are only presented in a risk assessment in cases where it has been shown that these exposure pathways exist: the home-produced food pathway (Chapter 7), the water intake pathway (Chapter 8), and the fish consumption pathway (Chapter 9).

Figure 1.1 Exposure Routes



1. Deposition
2. Root Uptake by plants.
3. Human Consumption of Leafy, Protected, Exposed and Root Produce. Animal consumption of pasture and feed.
4. Soil Ingestion by humans and animals, and dermal exposure to soil.
5. Water consumption from surface water sources
6. Inhalation by humans and animals
7. Fish consumption
8. Consumption of beef, chicken and pork.
9. Mother's milk consumption.

Inhalation exposure is assessed for all "Hot Spots"-listed chemicals which have either Cancer Potency Factors and/or Reference Exposure Levels (see the Technical Support Documents mentioned in paragraph 2 for information on these values (OEHHA,2008, 2009), available at http://www.oehha.ca.gov/air/hot_spots/index.html). The noninhalation exposures are assessed only for semivolatile organics and metals listed in Appendix E, Table E.2. These chemicals have oral RELs and/or oral cancer potency factors. Appendix E contains a description of the process used to decide which chemicals should be evaluated by multipathway exposure assessment.

Only the exposure pathways which exist at a particular site need to be assessed in the Air Toxics Hot Spots program. For example, if a fishable body of water is impacted by facility emissions, then exposure through consumption of angler-caught fish is assessed. Otherwise, that pathway may be omitted from the risk assessment. Likewise if no backyard or local commercial produce or animals are raised in the impacted area, then the risk assessment need not consider dose through the ingestion of animal food products or produce. The "Hot Spots" program does not currently assess run off into surface drinking water sources because of the complex site-specific information required. The water consumption of surface waters pathway is rarely invoked in the "Hot Spots" program.

All risk assessments of facilities emitting chemicals listed in Table E.2 need to include an evaluation of exposure from breast milk consumption, soil ingestion, and dermal absorption from soil, since these exposure pathways are likely to exist at all sites. Table E.3 lists the chemicals that should be evaluated by the breast milk exposure pathway. The determination of the appropriate exposure pathways for consideration in the risk assessment should be made in conjunction with the local Air Pollution Control or Air Quality Management District. Justification for excluding an exposure pathway should be clearly presented.

1.2 The Point Estimate Approach

The point estimate approach is the traditional approach for site-specific risk assessments (sometimes referred to as deterministic) in the Hot Spots program. In the point estimate approach, a single value is assigned to each variate in the model (e.g., a breathing rate in L/kg BW-day). The point estimates chosen sometimes represent upper-end values for the variate and sometimes reflect a mean or central tendency estimate. The outcomes of a point estimate model are single estimates of either cancer risk or of the hazard index for noncancer effects. The point estimates of risk are generally considered near the high-end of the range of estimated risks, based on variability in exposure; quantitative information on population variability is generally lacking. However, the older point estimate approach to exposure assessment left open the question of variability in exposures of the general population. For example, it was unclear what percentage of the population would breathe more or less than a 20 m^3/day inhalation rate. The research stimulated by the desire to incorporate population variability in stochastic approaches has allowed informed selection of point estimates

that cover a defined percentage of the population, within the limitations and uncertainties of the available scientific data.

1.2.1. Need for Exposure Variates for Specific Age Groupings

In the previous exposure guideline, we presented distributions and point estimates for use in exposure assessment for children less than 12 years of age and for adolescents and adults up to age 70 years. Risk assessments were conducted for different durations of exposure based on estimates of how long people live at a single location (9 years for the average, 30 years for a high end estimate, and 70 years for a lifetime).

This update retains the evaluation of the 9, 30 and 70 year exposure durations, which represent approximately the mean, 90th and lifetime of residence time. However, *The Technical Support Document for Cancer Potency Factors: Methodologies for Derivation, Listing of Available Values, and Adjustments to Allow for Early Life Stage Exposures* (OEHHA, 2009) concludes that the potency of carcinogens, and thus cancer risk, varies based on the lifestage at exposure. To address this concern, OEHHA applies a weighting factor to early life exposures, termed the Age Sensitivity Factor (ASF) (see OEHHA, 2009 for details). Cancer risk is multiplied by an ASF of ten to weight lifetime risk from exposures occurring from the third trimester of pregnancy to age less than 2. Likewise, for exposure from age 2 to less than 16 years, an ASF of three is applied.

Using these Age Sensitivity Factors (ASFs) requires a different approach to calculation of cancer risk from the traditional methods. Accounting for effects of early-in life exposure requires accounting for both the increased potency of early in life exposure to carcinogens and the greater exposure on a per kg body weight that occurs early in life due to behavioral and physiological differences between infants and children, and adults.

The lifetime risk is a summation of risks from the third trimester to age 2 yrs, 2 to age 16 and 16 to age 70 years. Similarly, when estimating cancer risk for a 9 year (average duration living at given residence) exposure to facility emissions or a 30 year (high-end duration living at a given residence) exposure to facility emissions, the cancer risks are similarly summed, starting with early-in-life exposures. These calculations are as follows:

9-year exposure duration - Calculation of Cancer Risk from the Third Trimester to Age Nine:

$$\text{Cancer Risk} = [(ADD_{\text{third trimester}} \times CPF \times 10)\cancel{0} \times 0.3\ \text{yrs}/70\ \text{yrs}] + [(ADD_{0\ \text{to}\ <2\text{yrs}} \times CPF \times 10) \times 2\ \text{yrs}/70\ \text{yrs}] + [(ADD_{2 < 9\text{yrs}} \times CPF \times 3) \times 7\ \text{yrs}/70\ \text{yrs}]$$

30-year exposure duration - Calculation of Cancer Risk from Third Trimester to Age 30:

Cancer Risk = [($ADD_{third\ trimester}$ X CPF X 10) X 0.3 yrs/70 yrs] + [($ADD_{0\ to\ <2yrs}$ X CPF X 10) X 2 yrs/70 yrs] + [($ADD_{2\ <\ 16yrs}$ X CPF X 3) X 14 yrs/70 yrs] + [($ADD_{16\ <\ 30yrs}$ X CPF X 1) X 14yrs/70 yrs

Lifetime (70 year) exposure duration - Calculation of Cancer Risk from Third Trimester to Age 70:

Cancer Risk = [($ADD_{third\ trimester}$ X CPF X 10) X 0.3 yrs/70 yrs] + [($ADD_{0\ to\ <2yrs}$ X CPF X 10) X 2 yrs/70 yrs] + [($ADD_{2\ <\ 16yrs}$ X CPF X 3) X 14 yrs/70 yrs]+ [($ADD_{16\ <\ 70yrs}$ X CPF X 1) X 54 yrs/70 yrs

where:

ADD = Average Daily Dose, mg/kg-d, for the specified time period (estimated using the exposure variates presented in the TSD)
CPF = Cancer Potency Factor $(mg/kg\text{-}d)^{-1}$
Age Sensitivity Factor third trimester to less than 2 years = 10
Age Sensitivity Factor age 2 to less than 16 years = 3
Age Sensitivity Factor age 16 to less than 70 years = 1

Exposure from all pathways evaluated by the Hot Spots program tends to be greater for children on per kilogram body weight basis, particularly for the third trimester to less than age 2 years. Therefore exposure variates are needed for the third trimester (mother's exposure), ages 0 to <2 years, 2 to <9 years, 2 < 16 years,16 to <30 years, and 16 to 70 years in order to properly estimate cancer risk for the age ranges specified in OEHHA (2009) as well as the residential exposure duration periods (9, 30, and 70 years). This document presents intake rates for the necessary age groupings for inhalation, food consumption, drinking water consumption, breast milk consumption, inadvertent soil ingestion, and dermal exposure useful to estimate exposure and thus cancer risk.

Estimating dose for the fetus during the third trimester of pregnancy is not easy because it will vary from chemical to chemical depending on the toxicokinetics. An approximation of the dose during the third trimester can be made by assuming the dose (mg/kg body weight) is the same as the mother's dose (mg/kg-body weight). The mother is assumed to fall into the age range sixteen to less than thirty. This approximation is uncertain and will over or underestimate dose in some instances. The dose during the third trimester tends to be considerably less than the dose during ages zero to less than two, so separate calculations of dose during the third trimester and ages zero to two years are needed.

The point estimate approach has the advantages of simplicity and consistency, and in the Air Toxics "Hot Spots" program consistent application across the state is critical to comparing risks across facilities for the notification and risk reduction provisions of the statute. Risk communication is relatively straightforward with a point estimate approach. However, a single point estimate approach does not provide information on

the variability in the dose or risk estimates. Some Information about the potential range of risks in the population can be presented as average or high-end point estimates of risk.

1.3 The Stochastic Approach ("Likelihood of Risks" Approach)

As noted earlier, the amended Act specifically requires OEHHA to develop a "likelihood of risks" approach to health risk assessment. Therefore, the OEHHA developed a stochastic, or probabilistic, approach to exposure assessment to fulfill this requirement. The stochastic approach to Hot Spots risk assessment developed by OEHHA estimates the population variability in cancer risk resulting from variability in intake rates such as breathing rate, infant breast milk ingestion, and meat and produce ingestion. The data on variability in risk assessment variates are largely limited to intake rates of contaminated media. Data are particularly sparse on the variability in fate and transport variates (e.g., soil half life). Therefore only a portion of the overall variability in exposure can be characterized in our model. However, for the less complicated pathways such as the inhalation pathway, the variability in breathing rate probably represents a major portion of the overall variability in exposure.

As noted in U.S. EPA (1995), true uncertainty represents lack of knowledge about a variate or factor that impacts risk which may be reduced by further study. There are uncertainties associated with measurement, with models of environmental fate (e.g., air dispersion models), and with dose-response models. Uncertainty may stem from data gaps that are filled by the use of assumptions. Although methods such as expert elicitation have been occasionally used to try to quantify true uncertainty in individual risk assessments, the cost of such methods is outside the scope of what would be reasonable for the Hot Spots program.

Variability can be measured empirically in data describing an exposure variate. Variability arises from true heterogeneity in characteristics of a population such as differences in rate of intake of various media (air, water, food, soil). The stochastic analysis approach presented in this document attempts to quantify some of the variability in exposure in the risk estimates by using measured variability in data describing key exposure variates. A parametric model (e.g., lognormal) can be fit to measures of, for example, food consumption in a representative sample of a population in order to characterize the variability of that variate for a population. The stochastic approach uses a distribution of values, or a parametric model for the distribution, as input for one or more variates in the model. Risk estimates can be expressed as a distribution by propagating the variance of exposure variates through the model using Monte Carlo simulation. This allows estimation of some of the variability in exposure in the risk estimate.

The primary benefits of stochastic analysis are the quantitative treatment of some of the variability in risk estimates and the increase in information on which to base decisions. The risk manager can determine what percentage of the population would be protected if emissions were reduced by a certain amount. However, it can be difficult to

communicate the results of a stochastic risk assessment to the public and risk managers.

Better characterization of total variability in exposure would require more research. Typical intake rates for various age ranges and longitudinal data on the same individuals over time are not usually available. Short term survey data on representative samples of populations of interest are all that are available for many variates. Such data can overestimate exposure particularly in the upper percentiles when considerable intraindividual variability occurs. Some important exposure variates such as soil ingestion lack sufficient data to characterize variability.

Neither the stochastic approach nor the point estimate approach to exposure assessment presented in this document deals with uncertainty or variability in the dose-response assessment. While human variability in response to toxicants is an increasingly active area of research, more data are needed to better account for human interindividual variability in risk assessments. We have evaluated the impact of age-at-exposure on carcinogenic potency (OEHHA, 2009). As noted above, that analysis resulted in application of ASFs to account semi-quantitatively for variability in response to carcinogens due to age. OEHHA also modified the methodology for developing Reference Exposure Levels (OEHHA, 2008) to more explicitly account for potential sensitivity of infants and children.

OEHHA carefully evaluated the available literature characterizing variability for important exposure variates. In some cases, we obtained unpublished raw data from published studies or performed our own analyses on publically available databases such as the Continuing Survey of Food Intake for Individuals (CSFII) or the National Health and Nutrition Examination Survey (NHANES). The methodology is described in the individual chapters in this document as well as in the peer reviewed scientific literature for some variates. If the data or studies were not adequate to characterize varia~~i~~bility in a variate (e.g., soil ingestion) point estimates were recommended. Even though in some cases there were studies presenting valid parametric models for exposure variates in the literature, the age ranges did not correspond to our current needs.

We have taken the approach that enough data must be available to adequately characterize a distribution. While some papers in the risk assessment literature make speculative assumptions about the shape of an input distribution in the absence of data, this cannot be readily justified in most cases. Additional assumptions regarding a distribution in the absence of data may increase uncertainty and may not improve the knowledge about the range of risks in a population.

Distributions of exposure variates are presented in this document for the age ranges needed to assess cancer risk using the age sensitivity factors for specific age groups. Thus, estimation of dose using the stochastic approach for the various age groupings is similar to the point estimate approach. The intake distributions for ages 16 to 30 years

are used for the third trimester. Distributions for the ages specified In Section 1.2.1 above should be used to determine the dose ranges.

1.4 Tiered Approach to Risk Assessment

During the development of risk assessment guidelines for the Hot Spots program, a number of stakeholders wanted the option of using non-default site-specific point estimates and distributions for assessing exposure where more appropriate. Thus OEHHA developed a tiered approach to accommodate this concern (Table 1). The first Tier is the simplest point estimate approach to estimating exposure to facility emissions. In Tier 1, the risk assessor must use the point estimates developed by OEHHA for all exposure variates, other than obvious site-specific parameters such as the volume of a body of impacted water. Tier ~~3~~ 2 allows use of site-specific point estimates of exposure variates as long as these estimates can be justified. The risk assessor must supply the data and methods used for the site-specific estimates, and the site-specific estimates must be reproducible and justified, and approved by OEHHA. Tier ~~2~~ 3 allows use of OEHHA-derived distributions of a number of exposure variates so that a "likelihood of risks" approach can be utilized, as called for in the statutory language. This allows one to estimate risk based on a distribution of exposures, rather than a single point estimate. Tier 4 allows use of site-specific distributions of exposure parameters as long as they can be justified and are approved by OEHHA. The risk assessor must supply the data and methods used for the site-specific distributions for exposure variates, and the site-specific estimates must be reproducible and justified.

Most facilities in the Air Toxics "Hot Spots" program may not require a complicated stochastic analysis for sufficient characterization of risks from emissions. In order to allow the level of effort in a risk assessment to be commensurate with the importance of the risk management decision, a tiered approach to risk assessment is recommended. The tiers are meant to be applied sequentially to retain consistency across the state in implementing the Air Toxics "Hot Spots" program while allowing flexibility.

The benefits of a tiered approach to site-specific risk assessment include consistency across the state, comparability across facilities, and flexibility in the approach to assessing risks. A simple health-protective point estimate risk assessment will indicate whether a more complex approach is warranted, and will help prioritize limited resources. The tiered risk assessment approach facilitates use of site-specific supplemental information in the risk assessment to better characterize the risks. Finally, more information is available to risk managers and the public when a tiered approach is fully utilized.

Table 1 – The Tiered Approach to Risk Assessment

Tier	Description	When Applied
Tier 1	Utilizes OEHHA default point estimates of exposure variates	All risk assessments must include a Tier 1 assessment
Tier 2	Utilizes site-specific point estimates for exposure variates (justified and approved by OEHHA)	If desired by risk assessor, a Tier 2 approach may also be presented
Tier 3	Utilizes OEHHA distributions of exposure variates	A Tier 3 approach may be presented in addition to Tier 1
Tier 4	Utilizes site-specific justified distributions of exposure variates (justified and approved by OEHHA)	A Tier 4 approach may be presented in addition to Tier 1

1.4.1 Tier 1

Tier 1 is the first step in conducting a comprehensive risk assessment with a point estimate approach, using algorithms and point estimates of input values presented in the following chapters. Each facility conducts a Tier 1 risk assessment to promote consistency across the state for all facility risk assessments and allow comparisons across facilities.

Condensed guidance, including tables of the point estimate values recommended by OEHHA in the following chapters, is given in the companion document *Air Toxics Hot Spots Risk Assessment Guidance Manual*, which we are in the process of updating. Site-specific values (e.g. the volume of water in an impacted lake) have to be provided by the risk assessor.

Mean and high-end point estimates for key exposure variates were estimated by OEHHA from available data. To be health-protective, high-end estimates for the key intake exposure variates are used for the dominant pathways in Tier 1.

If a risk assessment involves multipathway exposures, then the risk assessor needs to evaluate which pathways are dominant by conducting an initial assessment using the high-end point estimates for those key intake variates, that have been evaluated by OEHHA. Dominant pathways are defined for these purposes as the two pathways that contribute the most to the total cancer risk estimate when using high-end estimates of key intake variates. High-end estimates for key intake variates for the two dominant

pathways and mean values for key variates in the exposure pathways that are not dominant are then used to estimate risks. If the food pathway is the dominant pathway then the highest single produce or meat type (e.g., exposed produce) using the high end estimates should be determined. The risk for the other food pathways then should be estimated using the average intake values.

This approach will lessen the problem of compounding high-end exposure estimates while still retaining a health-protective approach for the more important exposure pathway(s). It is unlikely that any one person would be on the high-end for all the intake variates. It is our experience that inhalation is generally a dominant pathway posing the most risk in the Air Toxics "Hot Spots" program; occasionally risks from other pathways may also be dominant for lipophilic compounds or metals. Therefore, for many facilities emitting volatile chemicals, the inhalation pathway will be the only pathway whose risks are assessed using a high-end intake estimate. For the Air Toxics "Hot Spots" program, the point of maximum impact for cancer risks is the location with the highest risks using this method.

OEHHA is recommending the hazard index (HI) approach to assess the potential for noncancer health impacts (OEHHA, 2008). The hazard index is calculated by dividing the concentration in air by the Reference Exposure Level for the substance in question and summing the ratios for all chemicals impacting the same target organ. (OEHHA, 2008)

There may be instances where a noninhalation pathway of exposure contributes substantially to a noncancer chronic hazard index. In these cases, the high-end estimate of dose is appropriate to use for the two dominant pathways' noninhalation hazard indices. The point of maximum impact for noncancer chronic health effects is the modeled point having the highest non cancer chronic hazard index (adding noninhalation and inhalation hazard indices when appropriate for systemic effects). The inhalation chronic HI calculation does not involve a high end and average inhalation rate, as the airborne concentration is divided by the REL to calculate an HI (OEHHA, 2008).

There are 8-hour RELs for a number of chemicals. These RELs can be used in different exposure scenarios , such as, to evaluate noncancer risk to offsite workers (and other offsite receptors impacted routinely by facility emissions) who are repeatedly exposed for approximately eight hours at the workplace. The 8 hr RELs may also be useful for assessing impacts to residents when assessing the emissions from a non-continuously operating facility (see Chapter 2) . In cases where there are only chronic RELs for a chemical, the Hazard Index for offsite workers can be calculated by adding the Hazard Quotient for a chemical with an 8-hour REL to a chemical where only a chronic REL is available. Eventually 8-hour and chronic RELs will be developed for all Hot Spots chemicals as OEHHA completes its evaluation of RELs under SB-25. There are no noninhalation pathways to consider in calculation of acute hazard indices.

The relatively health-protective assumptions incorporated into the Tier 1 risk assessment (e.g., high-end values for key variates in the driving pathways) make it unlikely that the risks are underestimated for the general population. If the results indicate that a facility's estimated cancer risk and noncancer hazard are below the level of regulatory concern, further analysis may not be warranted. If the results are above a regulatory level of concern, the risk assessor may want to proceed with further analysis as described in Tier 2 or a more resource-intensive stochastic modeling effort described in Tiers 3 and 4 to provide the risk manager with more information on which to base decisions. While further evaluation may provide more information to the risk manager, the Tier 1 evaluation is useful in comparing risks among a large number of facilities.

1.4.2 Tier 2

The risk assessor may want to analyze the risks using point estimates more appropriate for the site being evaluated. This second tier approach would replace some of the defaults recommended in this document with values more appropriate to the site. A Tier 2 risk assessment would use the point estimate approach with justifiable point estimates for important site-specific variates. Use of this supplemental site-specific information may help to better characterize the risks.

Certain exposure variates such as breast milk consumption or inhalation rate would not be expected to vary much from site to site. Other variates for which OEHHA has provided point estimates may vary significantly from site-to-site. If the facility has data indicating that an OEHHA point estimate value is not appropriate in their circumstance, they may provide an alternative point estimate value. For example, if there are data indicating that consumption of fish from an impacted fishable body of water is lower than the OEHHA-recommended fish consumption rate, then the facility can use that data to generate a point estimate for fisher-caught fish consumption from that body of water.

If site-specific values are substituted this should be justified. All data and procedures used to derive them should be clearly documented, and reasonable justification should be provided for using the alternative value. The Districts and OEHHA should be able to reproduce the point estimate from the data presented in the risk assessment. As noted above, OEHHA must approve the site-specific point estimates.

In a Tier 2 approach, the risk assessor may want to present multiple alternative point estimate scenarios with several different assumptions encompassing reasonable "average" and "high-end" exposures for important pathways. This may be an issue in the case where data on a key exposure variate for that particular site are lacking. For example, in a case where soil ingestion is a dominant pathway, if a key variate in the model is the number of days children spend outdoors in contact with soil, it may be most appropriate to run the model more than once using several different assumptions about the exposure frequency. Such scenario development is easily communicated to the risk manager and the public, and serves as a semi-quantitative analysis of the exposure variability using a point estimate approach to risk assessment. In any risk assessment where alternative point estimates representing different exposure scenarios are

presented, all information used to develop the point estimates needs to be presented clearly in the risk assessment. Also, a justification for the exposure scenarios needs to be included.

If the risk is below a level of regulatory concern, further analysis may not be warranted. If the risk estimate is still above a level of concern, then the risk assessor may want to proceed with a more complex stochastic analysis as described in Tier 3 to get a fuller characterization of the variability in the exposure estimate.

1.4.3 Tier 3

The third tier risk assessment involves stochastic analysis of exposure using algorithms and distributions for the key exposure variates specified in this document. Point estimates specified in this document for those exposure variates without distributions should be used. Since a stochastic approach to risk assessment provides more information about the range and probability of risk estimates, Tier 3 can serve as a useful supplement to the Tier 1 and 2 approach. In the third tier, variance propagation methods (e.g., Monte Carlo analysis) are used to derive a range of risk estimates reflecting the known variability in the inputs as described in the distributions characterized in this document. Recommended distributions for use in a stochastic analysis and the scientific bases for these distributions are provided in Chapters 3 through ~~11~~ 9 of this document.

OEHHA is recommending that a stochastic analysis be performed for cancer risk assessment only. OEHHA has not currently identified a stochastic approach to the exposure part of noncancer risk assessment that would provide value. OEHHA is recommending a point estimate approach only for assessing the impact of AB-2588 facilities on workers employed at nearby work sites (i.e., the offsite worker). We have not developed a breathing rate distribution that would be appropriate for a stochastic offsite worker risk assessment.

Commercial software is available that can be used to conduct a stochastic analysis. The Air Resources Board has developed the Hot Spots Analysis and Reporting Program (HARP) that can perform Tier 3 stochastic analyses as well as Tier 1 risk assessments. The HARP software includes an air modeling module and emissions reporting modules.

1.4.4 Tier 4

OEHHA's stochastic model is based on the best available scientific data that have undergone public comment and peer review. However, a fourth tier risk assessment could also be conducted if site-specific conditions suggest that alternative or additional distributions (and point estimates) for variates may be more appropriate than those provided by OEHHA. In a Tier 4 risk assessment, the risk assessor could characterize the distribution of variates that are important to the overall calculation of risk for which OEHHA provides only a point estimate. Or, the risk assessor may wish to use distributions other than those supplied by OEHHA for important variates that impact the

risk. The scientific basis and documentation for alternative and additional distributions should be presented clearly in the risk assessment. Clear, reasonable justification would need to be provided in the risk assessment for using alternative distributions or point estimates, and OEHHA must approve the site-specific distributions. Such distributions would be based on data from the literature or site-specific data gathered by the facility.

The quality of data would need to be sufficient to reasonably justify the selection of the parametric model (e.g., normal, lognormal, etc.) used to characterize the empirical distribution. It is not necessary, however, that the data fit a given parametric model as defined by conservative statistical criteria such as the Kolmogrov-Smirnoff test. If a distribution is nonparametric, it may be used as a custom distribution in a variance propagation model such as a Monte Carlo simulation.

In each case where alternate distributions or point estimates are used, it is important that the results be compared with the results obtained using any point estimates and/or distributions recommended in this document by OEHHA (e.g., the Tier 1 and 3 risk assessments). This is necessary to identify the contribution of the new information to the risk assessment. The District and OEHHA staff and any interested parties should be able to easily verify the assumptions, and duplicate the results.

1.5 Exposure Assessment Pathways

Chapters 3 through ~~11~~ 9 are organized by exposure pathway, and present the algorithms used for both the point estimate and stochastic approach to exposure assessment. The scientific basis for each recommended point estimate and distribution for key variates is presented. In the instances where the variate is site-specific (e.g., volume of a body of water), default point estimates or distributions are not provided. In general, key studies used in evaluating a point estimate value or distribution are briefly discussed along with procedures used to characterize the distribution. OEHHA procedure for significant figures is to round at the end of any calculation. Thus the exposure variates are generally rounded to 2 or 3 significant figures. The risk estimates are generally rounded to 1or 2 significant figures in the risk assessments conducted by facilities.

1.6 Individual Risk, versus Population Risk, and Duration of Exposure to Facility Emissions

In past practice, the risk managers generally made decisions on the lifetime cancer risk to the “Maximally Exposed Individual” at the site of highest modeled concentration(s) of carcinogen(s). However, relying on estimated cancer risk to the maximally exposed individual is problematic for scenarios where there may be a risk of cancer that falls below the typical risk management threshold of 10^{-5}, but a large number of people are exposed at that level. Facilities with cancer risks estimated above 10^{-5} but that expose few people may face risk management actions, but a facility that exposed thousands of people just below the risk management threshold would not. Both the concept of

population risk and individual risk are important for public health protection (discussed in Chapter 11).

In trying to resolve this dilemma, OEHHA reconsidered the issues of individual risk, population risk, duration of time at a single residence and activity patterns. The previous recommendation for risk managers was to rely on the 70 year risk estimate without consideration of whether or not people resided at the same address for 70 years, or were away from home parts of the day. The previous guidelines also suggested estimating cancer risk for shorter residence times (9 and 30 years, based on EPA analyses of duration of residence at a single address). Thirty years is approximately the 90th percentile of residency in California, according to newer data and is consistent with estimates of thirty years for the 90th percentile of residency duration nationally, and is thus a more realistic portrayal of the maximum reasonable length of exposure that would occur at the residential point of maximal impact. The previous recommendation of relying on the cancer risk estimate to the maximally exposed individual for a 70 year exposure duration contained an element of protection for the population since individual exposure was defined as an entire lifetime, although the risk was likely spread over different individuals living at the maximally exposed location since very few people live at the same address longer than 30 years. Presenting individual cancer risk as a thirty year risk rather than a seventy year risk is easier from a risk communication standpoint because it is a more realistic exposure scenario. OEHHA is thus suggesting that the risk manager when making a decision based on cancer risk to the MEIR use the risk estimated for a 30 year exposure scenario. However, this lessens the element of protection for the population – someone is always living around a given facility. Thus, OEHHA ~~sees a need~~makes a recommendation to consider population risk separately in assessing public health impacts (Chapter 11).

In the example above, there will be more theoretical cancer cases when a larger facility with estimated cancer risk just under the 10^{-5} threshold has a large populated zone of impact, than for the small facility impacting a few people with a cancer risk estimate just over the 10^{-5} threshold. The public health impacts may not be adequately addressed if the cancer risks at the residential or worker point of maximum impact are below the level of significant risk determined by the District. It is important to look at improved methods of assessing the public health impact of facilities with more diffuse emissions impacting larger areas with large impacted populations. Therefore, OEHHA recommends that the number of people residing within the 1×10^{-6} and greater cancer risk isopleths be determined using census data and that the risk managers use this information to decide on appropriate risk management. This is in addition to simply basing a risk management decision on the cancer risk to the maximally exposed individual without regard to the size of the zone of impact and the population exposed. Strengthening population protection will help protect public health.

1.7 SB-352

SB-352 was passed in 2003 and requires California school districts to perform a risk assessment for proposed school sites located within 500 feet, or 150 m, of a freeway or busy roadway. SB-352 specifies that OEHHA's Hot Spots risk assessment guidance procedures be used for the assessment. School children and staff are present at the school site for less than 24 hours so hourly breathing rates that reflect playground activities and classroom activities are appropriate for such assessments. We have included recommended breathing rates in Chapter 3 of this document for appropriate age ranges for elementary, junior high and high school and staff at such schools for such assessments. The age ranges provided also allow for early-in-life exposure age ranges. The South Coast Air Quality Management District has a document that discusses air quality concerns when selecting school sites (SCAMD, 2005).

1.8 Summary

This revision of the Exposure Assessment and Stochastic Analysis Document allows estimation of exposure for age ranges of children. In addition we have incorporated advances in the field of exposure assessment since the last revision and new point estimates and distributions of exposure variates, based on new data. The Exposure Assessment and Stochastic Analysis document retains the option of tiered risk assessment so that site-specific factors can be taken into account.

OEHHA has reviewed and incorporated the extensive body of exposure assessment literature that has been published since the 2000 Exposure and Stochastic Analysis Technical Support Document in order to refine our exposure assessment model.

1.6 References

OEHHA (1999a). *Air Toxics Hot Spots Risk Assessment Guidelines Part I: Technical Support Document for the Determination of Acute Reference Exposure Levels for Airborne Toxicants*. Office of Environmental Health Hazard Assessment, Cal/EPA. March 1999.

OEHHA (1999b). *Air Toxics Hot Spots Risk Assessment Guidelines Part II: Technical Support Document for Describing Available Cancer Potency Factors*. Office of Environmental Health Hazard Assessment, Cal/EPA. April 1999.

OEHHA (2000a). *Air Toxics Hot Spots Risk Assessment Guidelines Part IV: Technical Support Document for Exposure Assessment and Stochastic Analysis*, Office of Environmental Health Hazard Assessment, Cal/EPA.

OEHHA (2000b). *Air Toxics Hot Spots Risk Assessment Guidelines Part III: Technical Support Document for the Determination of Noncancer Chronic Reference Exposure Levels for Airborne Toxicants*. Office of Environmental Health Hazard Assessment, Cal/EPA. February 2000.

OEHHA (2008). *Air Toxics Hot Spots Risk Assessment Guidelines. Technical Support Document for the Derivation of Non-cancer Reference Exposure Levels.* Office of Environmental Health Hazard Assessment, Cal/EPA.

OEHHA (2009). *Air Toxics Hot Spots Risk Assessment Guidelines.. Technical Support Document for Cancer Potency Factors: Methodologies for Derivation, Listing of Available Values, and Adjustments to Allow for Early Life Stage Exposures* Office of Environmental Health Hazard Assessment, Cal/EPA.

SCAQMD (2005) South Coast Air Quality Management District (SCAQMD) Air Quality Issues in School Site Selection Guidance Document June 2005 www.aqmd.gov/prdas/aqguide/doc/School_Guidance.pdf

U.S. EPA (1991) Risk Assessment Guidance for Superfund: Volume I –Human Health Evaluation Manual. Office of Emergency and Remedial Response, U.S. Environmental Protection Agency, Washington, DC 20460 EPA/540/R-92/003 Publication 9285.7-01 B December 1991

U.S. EPA (1995). Policy for Risk Characterization at the U.S. Environmental Protection Agency. Memorandum from Carol Browner to Administrators, U.S. Environmental Protection Agency, Washington, D.C., March 21, 1995.

2. Air Dispersion Modeling

2.1 Air Dispersion Modeling in Risk Assessment: Overview

Estimates of air concentrations of emitted toxicants in the surrounding community from a facility's air emissions are needed ~~In~~ in order to determine cancer and noncancer risks. One approach to determining the concentration of air pollutants emitted from the facility is to do air monitoring in the surrounding community. However, there are a number of disadvantages to this approach. Ambient air monitoring is costly because good estimates of an annual average concentration typically require monitoring at least one day in six over a year. Because it is costly, monitoring is usually limited to a select number of pollutants, and a limited number of sites. There can be significant risks from some chemicals at or even below the monitoring detection limit, which can add considerable uncertainty to risk estimates if many of the measurements are below or near the detection limit. Monitoring measures not only facility emissions but also general ambient background as well. It can be difficult and expensive to distinguish between the two using monitoring, particularly if general ambient background levels are high relative to the contribution of facility emissions. These limitations often make it impractical to use monitoring in a program such as the Air Toxics Hot Spots program with hundreds of facilities.

Air dispersion models have several advantages over monitoring. Modeling can provide greater spatial detail and the costs are relatively cheap by comparison. For example, dispersion models can estimate the pollutant concentration in air at many receptor locations (hundreds to thousands) and for a multitude of averaging periods. Air dispersion models have been validated using air monitoring.

There are, however, ~~significant~~ uncertainties associated with the typical usage of air dispersion modeling. The use of meteorological data ~~typically~~ from the nearest airport may not ideally be the best representation of ~~reflect~~ localized conditions. Gaussian plume air dispersion models ignore calm hours. This can bias model predictions towards underestimation. Some dispersion models offer limited chemical reactions within the algorithms; however, we generally assume the pollutant is inert for the near-field atmospheric travel time. This may ~~has the tendency to~~ bias estimated concentrations towards over-prediction for those pollutants that are highly reactive in the atmosphere. Air dispersion model results are only as good as the emissions estimates and emissions estimates can be uncertain. However, on the whole, the advantages of air dispersion modeling for a program like the Air Toxics Hot Spots far out weigh the disadvantages.

Professional judgment is required throughout the dispersion modeling process. The local air quality district has final authority on modeling protocols. The following guidance is intended to assist in the understanding of dispersion modeling for risk assessments.

Air dispersion modeling includes the following steps (see Figure 1):

(1) Create an emission inventory of the toxic releases (Section 2.2)

(2) Identify the source types (Section 2.3)

(3) Identify the terrain type (Section 2.4)

(4) Determine the detail needed for the analysis: screening or refined (Section 2.5)

(5) Identify the population exposure (Section 2.6)

(6) Identify the receptor network (Section 2.7)

(7) Obtain meteorological data (for refined air dispersion modeling only) (Section 2.8)

(8) Select an air dispersion model (Section 2.9)

(9) Prepare a modeling protocol and submit to the local Air District (hereafter referred to as “the District”) (Section 2.14)

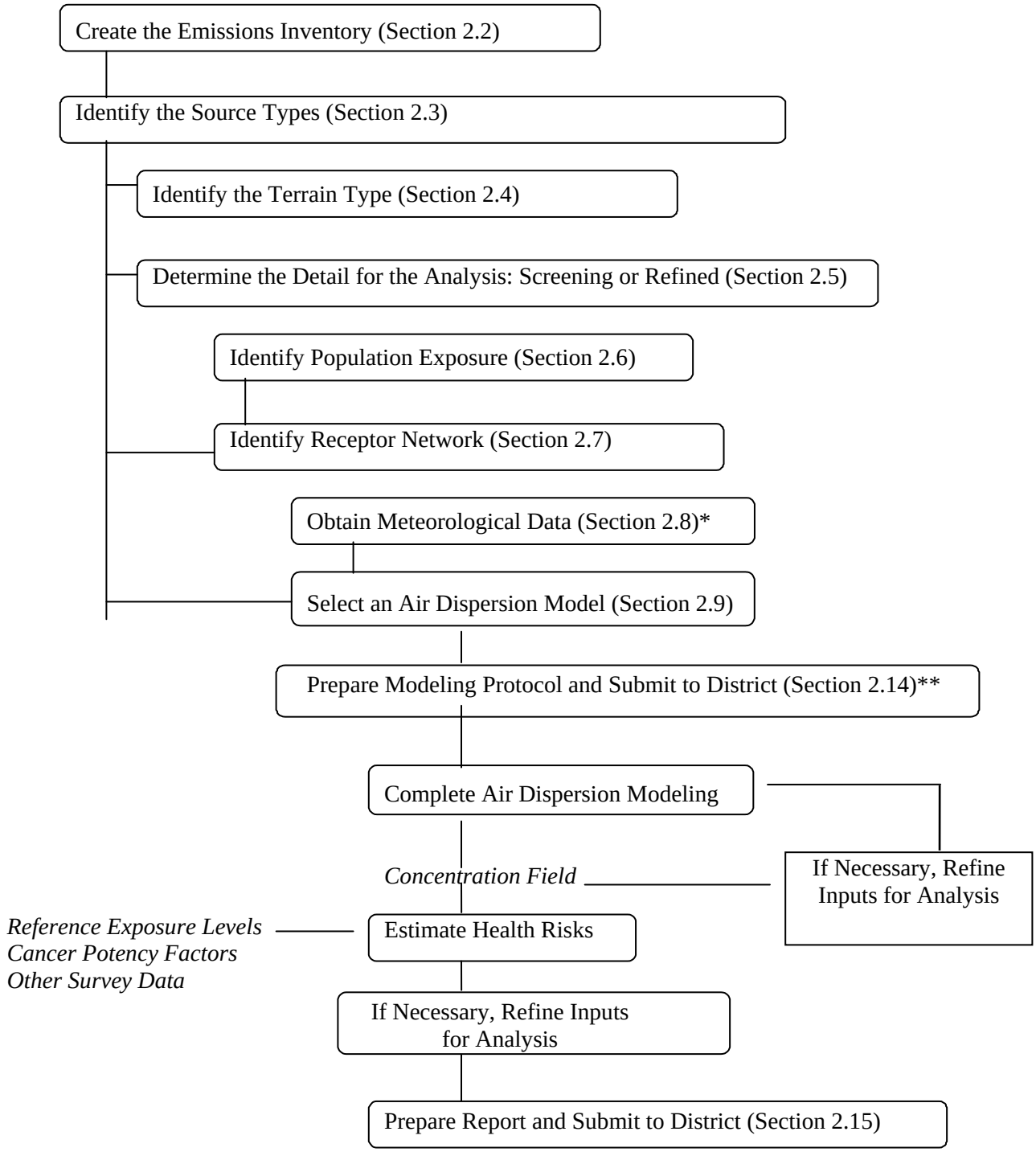
(10) Complete the air dispersion analysis

(11) If necessary, redefine the receptor network and return to Step 10

(12) Complete the risk assessment

(13) If necessary, refine the inputs and/or the model selection and return to Step 8

Figure 1. Overview of the Air Dispersion Modeling Process.



*Some screening models do not require any meteorological data.
** Optional but strongly recommended.

The output of the air dispersion modeling analysis includes a receptor field of ground level concentrations of the pollutant in ambient air. These concentrations can be used

to estimate an inhaled dose for estimation of inhalation cancer risk, or used to determine a hazard index for acute, and chronic noncancer risks. It should be noted that in the Air Toxics "Hot Spots" program, facilities simulate the dispersion of the chemical emitted as an inert compound, and do not model any atmospheric transformations or dispersion of products from such reactions. The U.S. EPA Guideline on Air Quality Models (U.S. EPA, 2005) should be consulted when evaluating reactive pollutants for other regulatory purposes.

2.2 Emission Inventories

The Emission Inventory Reports ("Inventory Reports"), developed under the Air Toxics "Hot Spots" Information and Assessment Act (AB2588), contain data that are used in air dispersion modeling and risk assessment evaluations. The Inventory Reports include emission sources, emitted substances, emission rates, emission factors, process rates, and release parameters (area and volume sources may require additional release data generally available in Emissions Inventory Reports). This information is developed according to the California Air Resources Board (CARB) Emission Inventory Criteria and Guidelines ("Inventory Guidelines") Regulation[1] and the Emission Inventory Criteria and Guidelines Report ("Inventory Guidelines Report"), which is incorporated by reference into the Regulation.

Updated emission data for process changes, emission factor changes, material/fuel changes, or shutdown must be approved by the District prior to the submittal of the health risk assessment (HRA). Ideally, the District review of updated emissions could be completed within the modeling protocol. In addition, it must be stated clearly in the risk assessment if the emission estimates are based on updated or revised emissions (e.g., emission reductions). This section summarizes the requirements that apply to the emission data which are used for Air Toxics "Hot Spots" Act risk assessments.

2.2.1 Air Toxics "Hot Spots" Emissions

2.2.1.1 Substances Emitted

The risk assessment should identify all substances emitted by the facility which are on the Air Toxics "Hot Spots" Act list of substances (Appendix A I-III, Inventory Guideline Report). The list of substances is compiled by the CARB for the Air Toxics "Hot Spots" Program.

The Inventory Guidelines specify that Inventory Reports must identify and account for all listed substances used, manufactured, formulated, or released during the routine and predictable operations of the facility (e.g., including, but not limited to, continuous and intermittent releases and predictable process upsets or leaks). Under the regulations, the list is divided into three groups for reporting purposes[2]. The first group (listed in Appendix A-I of the Inventory Guidelines Report) has all pollutants whose emissions

[1] Title 17, California Code of Regulations, Sections 93300-93300.5
[2] The most recent amendments became effective September 26, 2007.

must be quantified. The second group (listed in Appendix A-II of the Inventory Guidelines Report) includes substances where emissions do not need to be quantified; however, facilities must report whether the substance is used, produced, or otherwise present on-site. The third group (listed in Appendix A-III of the Emissions Inventory Guidelines Report) includes substances whose emissions need not be reported unless the substance is manufactured by the facility. Chemicals or substances in the second and third groups should be listed in a table in the risk assessment.

Facilities that must comply with the Resource Conservation and Recovery Act and Comprehensive Environmental Response, Compensation and Liability Act (RCRA/CERCLA) requirements for risk assessment need to consult the Department of Toxic Substances Control (DTSC) Remedial Project Manager to determine which substances must be evaluated in their risk assessment in addition to the list of "Hot Spots" chemicals. Some RCRA/CERCLA facilities may emit chemicals that are not currently listed under the "Hot Spots" Program.

2.2.1.2 Emission Estimates Used in the Risk Assessment

The risk assessment must include emission estimates for all substances that are required to be quantified in the facility's emission inventory report. Specifically, risk assessments should include both the annual average emissions and maximum 1-hour emissions for each pollutant. Emissions for each substance must be reported for the individual emitting processes and devices within a facility. Total facility emissions for an individual air contaminant will be the sum of emissions reported, by process, for that facility. Information on daily and annual hours of operation and relative monthly activity must be reported for each emitting process. Devices and emitting processes must be clearly identified and described and must be consistent with those reported in the emissions inventory report.

The HRA should include tables that present the emission information (i.e., emission rates for each substance released from each process) in a clear and concise manner. The District may allow the facility operator to base the HRA on more current emission estimates than those presented in the previously submitted emission inventory report (i.e., actual enforceable emission reductions realized by the time the HRA is submitted to the District). If the District allows the use of more current emission estimates, the District must review and approve the new emissions estimates prior to use in the risk assessment. The risk assessment report must clearly state what emissions are being used and when any reductions became effective. Specifically, a table identifying both the previous and current emission estimates should be included. The District should be consulted concerning the specific format for presenting the emission information.

Facilities that must also comply with RCRA/CERCLA requirements for risk assessments need to consult the DTSC Remedial Project Manager to determine what constitutes appropriate emissions data for use in the risk assessment. Source testing may be required for such facilities even if it is not required under the "Hot Spots" Program.

Additional requirements for statistical treatment of source test results may also be imposed by the DTSC on RCRA/CERCLA facilities.

2.2.1.3 Emission Release Parameters

Emission release parameters (e.g., stack height and inside diameter, stack gas exit velocity, release temperature and emission source location in UTM coordinates) are needed as inputs to the air dispersion model. The Inventory Guidelines specify the release parameters that must be reported for each stack, vent, ducted building, exhaust site, or other site of exhaust release. Additional information may be required to characterize releases from non-stack (volume and area) sources; see U.S. EPA dispersion modeling guidelines or specific user's manuals. This information should also be included in the air dispersion section of the risk assessment. This information must be presented in tables included in the risk assessment. Note that some dimensional units needed for the dispersion model may require conversion from the units reported in the Inventory Report (e.g., Kelvin (K) vs. degrees Fahrenheit (°F)).

2.2.1.4 Operation Schedule

The risk assessment should include a discussion of the facility operation schedule and daily emission patterns. Weekly or seasonal emission patterns may vary and should be discussed. This is especially important in a refined risk assessment. Diurnal emission patterns should be simulated in the air dispersion model because of diurnal nature of meteorological observations. A table should be included with emission schedule on an hourly and yearly basis. In addition, for the purposes of exposure adjustment, the emission schedule and exposure schedule should corroborate any exposure adjustment factors. For more information about exposure adjustment factors, see Section 2.8(a). Alternatively, exposure adjustment can be made through refining the air dispersion analysis. See Section 2.11.1.2(h) for special case modeling.

2.2.1.5 Emission Controls

The risk assessment should include a description of control equipment, the emitting processes it serves, and its efficiency in reducing emissions of substances on the Air Toxics “Hot Spots” list. The Inventory Guidelines require that this information be included in the Inventory Reports, along with the emission data for each emitting process. If the control equipment did not operate full-time, the reported overall control efficiency must be adjusted to account for downtime of control equipment. Any entrainment of toxic substances to the atmosphere from control equipment should be accounted for; this includes fugitive releases during maintenance and cleaning of control devices (e.g., baghouses and cyclones).

2.2.2 Landfill Emissions

Emission estimates for landfill sites should be based on testing required under Health and Safety Code Section 41805.5 (AB 3374, Calderon) and any supplemental AB 2588 source tests performed to characterize air toxics emissions from landfill surfaces or through off-site migration. The District should be consulted to determine the specific Calderon data to be used in the risk assessment. The Air Toxics "Hot Spots" Program risk assessment for landfills should also include emissions of listed substances for all applicable power generation and maintenance equipment at the landfill site. Processes that need to be addressed include stationary IC engines, flares, evaporation ponds, composting operations, boilers, and gasoline dispensing systems.

2.3 Source Characterization

Pollutants are released into the atmosphere in many different ways. The release conditions need to be properly identified and characterized to appropriately use the air dispersion models.

2.3.1 Source Type

Source types can be identified as point, line, area, or volume sources for input to the air dispersion model. Several air dispersion models have the capability to simulate more than one source type.

2.3.1.1 Point Sources

Point sources are probably the most common type of source and most air dispersion models have the capability to simulate them. Typical examples of point sources include: isolated vents and stacks.

2.3.1.2 Line Sources

In terms of modeling, line sources are treated as a special case of either an area or a volume source. Consequently, they are normally modeled using either an area or volume source model as described below. Examples of line sources include: conveyor belts and rail lines, freeways, and busy roadways. Mobile sources and rail lines do not come under the purview of the Hot Spots program, but they are required to be evaluated under SB-352. SB-352 requires a risk assessment performed under the Hot Spots risk assessment guidance for proposed school sites within 500 feet of a busy roadway. Dedicated air dispersion models are available for motor vehicle emissions from roadways which are a special type of line source. These models (i.e., CALINE3, CAL3QHCR, and CALINE4) are designed to simulate the mechanical turbulence and thermal plume rise due to the motor vehicle activity on the roadway. However, these dedicated models use the Pasquill-Gifford dispersion stability classes for dispersion; the AERMOD dispersion model uses a more advanced continuous stability estimation method based on observations. The limitation with AERMOD is that the user needs to estimate initial mixing (Szo, and Syo) for mechanical turbulence and thermal plume rise

is not available. Consult with the District prior to conducting roadway modeling to determine model use.

For practical information on how to simulate roadway emission dispersion using these models, see the California Air Pollution Control Officer's Association (CAPCOA) website at http://www.capcoa.org or the Sacramento Metropolitan AQMD (SMAQMD) website at http://www.airquality.org/ceqa/RoadwayProtocol.shtml. The SMAQMD has a document titled, "Recommended Protocol for Evaluating the Location of Sensitive Land Uses Adjacent to Major Roadways"(January, 2010). The ARB recommends this document for SB-352 risk assessments.

2.3.1.3 Area Sources

Emissions that are to be modeled as area sources include fugitive sources characterized by non-buoyant emissions containing negligible vertical extent of release (e.g., no plume rise or distributed over a fixed level).

Fugitive particulate ($PM_{2.5}$, PM_{10}, TSP) emission sources include areas of disturbed ground (open pits, unpaved roads, parking lots) which may be present during operational phases of a facility's life. Also included are areas of exposed material (e.g., storage piles and slag dumps) and segments of material transport where potential fugitive emissions may occur (uncovered haul trucks or rail cars, emissions from unpaved roads). Fugitive emissions may also occur during stages of material handling where particulate material is exposed to the atmosphere (uncovered conveyors, hoppers, and crushers).

Other fugitive emissions emanating from many points of release may be modeled as area sources. Examples include fugitive emissions from valves, flanges, venting, and other connections that occur at ground level, or at an elevated level or deck if on a building or structure. Modern dispersion models include an option for an initial vertical extent (Szo) where needed.

2.3.1.4 Volume Sources

Non-point sources where emissions include an initial vertical extent should be modeled as volume sources. The initial vertical extent may be due to plume rise or a vertical distribution of numerous smaller sources over a given area. Examples of volume sources include buildings with natural fugitive ventilation, building roof monitors, and line sources such as conveyor belts and rail lines.

2.3.2 Quantity of Sources

The number of sources at a facility may influence the selection of the air dispersion model. Some dispersion models are capable of simulating only one source at a time, and are therefore referred to as single-source models (e.g., AERSCREEN).

In some cases, for screening purposes, single-source models may be used in situations involving more than one source using one of the following approaches:

- combining all sources into one single “representative” source

  In order to be able to combine all sources into one single source, the individual sources must have similar release parameters. For example, when modeling more than one stack as a single “representative” stack, the stack gas exit velocities and temperatures must be similar. In order to obtain a conservative estimate, the values leading to the higher concentration estimates should typically be used (e.g., the lowest stack gas exit velocity and temperature, the height of the shortest stack, and a receptor distance and spacing that will provide maximum concentrations, etc.).

- running the model for each individual source and superimposing results

  Superimposition of results of single sources of emissions is the actual approach followed by all the Gaussian models capable of simulating more than one source. Simulating sources in this manner may lead to conservative estimates if worst-case meteorological data are used or if the approach is used with a model that automatically selects worst-case meteorological conditions, especially wind direction. The approach will typically be more conservative the farther apart the sources are because each run would use a different worst-case wind direction.

Additional guidance regarding source merging is provided by the U.S. EPA (1995a). It should be noted that depending upon the population distribution, the total burden can actually increase when pollutants are more widely dispersed. If the total burden from the facility or zone of impact (see Section 2.6.1) could increase for the simplifying modeling assumptions described above, the District should be consulted.

2.4 Terrain Type

Two types of terrain characterizations are needed for input to the appropriate model. One classification is made according to land use and another one according to topography.

2.4.1 Terrain Type – Land Use

Some air dispersion models (e.g., CALINE) use different dispersion coefficients (sigmas) depending on the land use over which the pollutants are being transported. The land use type is also used by some models to select appropriate wind profile exponents. Traditionally, the land type has been categorized into two broad divisions for the purposes of dispersion modeling: urban and rural. Accepted procedures for determining the appropriate category are those suggested by Irwin (1978): one based on land use classification and the other based on population.

The land use procedure is generally considered more definitive. Population density should be used with caution and should not be applied to highly industrialized areas where the population density may be low. For example, in low population density areas a rural classification would be indicated, but if the area is sufficiently industrialized the classification should already be "urban" and urban dispersion parameters should be used.

If the facility is located in an area where land use or terrain changes abruptly, for example, on the coast, the District should be consulted concerning the classification. If need be, the model should be run in both urban and rural modes and the District may require a classification that biases estimated concentrations towards overprediction. As an alternative, the District may require that receptors be grouped according to the terrain between source and receptor.

AERMOD is the recommended model for a wide range of applications in rural or urban conditions. AERMOD uses a planetary boundary layer scaling parameter to characterize stability. This approach is a departure from stability categories estimated with the land use procedures. Rather AERMOD preprocessors, AERMET and AERMAP, are used to characterize land type as they process meteorological data and terrain receptors, respectively.

As it applies to plume models other than AERMOD, the Land Use Procedure is described as follows.

2.4.1.1 Land Use Procedure

(1) Classify the land use within the total area A, circumscribed by a 3 km radius circle centered at the source using the meteorological land use typing scheme proposed by Auer (1978) and shown in Table 2.1.

(2) If land use types I1, I2, C1, R2 and R3 account for 50 percent or more of the total area *A* described in (1), use urban dispersion coefficients. Otherwise, use appropriate rural dispersion coefficients.

2.4.1.2 Population Density Procedure

(1) Compute the average population density (*p*) per square kilometer with *A* as defined in the Land Use procedure described above. (Population estimates are also required to determine the exposed population; for more information see Section 2.6.3.)

(2) If *p* is greater than 750 people/km^2 use urban dispersion coefficients, otherwise, use appropriate rural dispersion coefficients.

Table 2.1 Identification and classification of land use types (Auer, 1978)

***Used to define rural and urban dispersion coefficients in certain models*.**

Type	Use and Structures	Vegetation
I1	*Heavy Industrial* Major chemical, steel and fabrication industries; generally 3-5 story buildings, flat roofs	Grass and tree growth extremely rare; <5% vegetation
I2	*Light-moderate industrial* Rail yards, truck depots, warehouses, industrial parks, minor fabrications; generally 1-3 story buildings, flat roofs	Very limited grass, trees almost totally absent; <5% vegetation
C1	*Commercial* Office and apartment buildings, hotels; >10 story heights, flat roofs	Limited grass and trees; <15% vegetation
R1	*Common residential* Single family dwelling with normal easements; generally one story, pitched roof structures; frequent driveways	Abundant grass lawns and light-moderately wooded; >70% vegetation
R2	*Compact residential* Single, some multiple, family dwelling with close spacing; generally <2 story, pitched roof structures; garages (via alley), no driveways	Limited lawn sizes and shade trees; <30% vegetation
R3	*Compact residential* Old multi-family dwellings with close (<2 m) lateral separation; generally 2 story, flat roof structures; garages (via alley) and ashpits, no driveways	Limited lawn sizes, old established shade trees; <35% vegetation
R4	*Estate residential* Expansive family dwelling on multi-acre tracts	Abundant grass lawns and lightly wooded; >80% vegetation
A1	*Metropolitan natural* Major municipal, state, or federal parks, golf courses, cemeteries, campuses; occasional single story structures	Nearly total grass and lightly wooded; >95% vegetation

A2	*Agricultural rural*	Local crops (e.g., corn, soybean); >95% vegetation
A3	*Undeveloped* Uncultivated; wasteland	Mostly wild grasses and weeds, lightly wooded; >90% vegetation
A4	*Undeveloped rural*	Heavily wooded; >95% vegetation
A5	*Water surfaces* Rivers, lakes	

2.4.2 Terrain Type - Topography

Surface conditions and topographic features generate turbulence, modify vertical and horizontal winds, and change the temperature and humidity distributions in the boundary layer of the atmosphere. These in turn affect pollutant dispersion and models differ in their need to take these factors into account.

The classification according to terrain topography should ultimately be based on the topography at the receptor location with careful consideration of the topographical features between the receptor and the source. Differentiation of simple versus complex terrain is unnecessary with AERMOD. In complex terrain, AERMOD employs the well-known dividing-streamline concept in a simplified simulation of the effects of plume-terrain interactions. For other plume models, such as SCREEN3, topography can be classified as follows:

2.4.2.1 Simple Terrain (also referred to as "Rolling Terrain")

Simple terrain is all terrain located below stack height including gradually rising terrain (i.e., rolling terrain). Note that *Flat Terrain* also falls in the category of simple terrain.

2.4.2.2 Intermediate Terrain

Intermediate terrain is terrain located above stack height and below plume height. The recommended procedure to estimate concentrations for receptors in intermediate terrain is to perform an hour-by-hour comparison of concentrations predicted by simple and complex terrain models. The higher of the two concentrations should be reported and used in the risk assessment.

2.4.2.3 Complex Terrain

Complex terrain is terrain located above plume height. Complex terrain models are necessarily more complicated than simple terrain models. There may be situations in which a facility is "overall" located in complex terrain but in which the nearby surroundings of the facility can be considered simple terrain. In such cases, receptors close to the facility in this area of simple terrain will "dominate" the risk analysis and

there may be no need to use a complex terrain model. It is unnecessary to determine which terrain dominates the risk analysis for users of AERMOD.

2.5 Level of Detail: Screening vs. Refined Analysis

Air dispersion models can be classified according to the level of detail which is used in the assessment of the concentration estimates as "screening" or "refined". Refined air dispersion models use more robust algorithms capable of using representative meteorological data to predict more representative and usually less conservative estimates. Refined air dispersion models are, however, more resource intensive than their screening counterparts. It is advisable to first use a screening model to obtain conservative concentration estimates and calculate health risks. If the health risks are estimated to be above the threshold of concern, then use of a refined model to calculate more representative concentration and health risk estimates would be warranted. There are situations when screening models represent the only viable alternative (e.g., when representative meteorological data are not available).

It is acceptable to use a refined air dispersion model in a "screening" mode for this program's health risk assessments. In this case, a refined air dispersion model is used:

- with worst-case meteorology instead of representative meteorology
- with a conservative averaging period conversion factor to calculate longer term concentration estimates

Note that use of worst case meteorology in a refined model is not the normal practice in New Source Review or Ambient Air Quality Standard evaluation modeling.

2.6 Population Exposure

The level of detail required for the analysis (e.g., screening or refined), and the procedures to be used in determining geographic resolution and exposed population require case-by-case analysis and professional judgment. The District should be consulted before beginning the population exposure estimates and as results are generated, further consultation may be necessary. Some suggested approaches and methods for handling the breakdown of population and performance of a screening or detailed risk analysis are provided in this section.

In addition to estimating individual cancer risk at specific points such as the MEI (maximally exposed individual), OEHHA recommends determining the number of people who reside with the 1×10^{-6}, 1×10^{-5}, 1×10^{-4}, and higher cancer risk isopleths. The information can be used to assess the population risk.

2.6.1 Zone of Impact

As part of the estimation of the population exposure for the cancer risk analysis, it is necessary to determine the geographic area affected by the facility's emissions. An initial approach to define a "zone of impact" surrounding the source is to generate an isopleth where the total excess lifetime cancer risk from inhalation exposure to all

emitted carcinogens is greater than 10^{-6} (one in 1,000,000). For noncarcinogens, a second and third isopleth (to represent both the chronic and acute impacts) should be created to define the zone of impact for the hazard index from both inhalation and noninhalation pathways greater than or equal to 1.0. For clarity these isopleths may need to be presented on separate maps in the HRA.

The initial "zone of impact" can be determined as follows:

- Use a screening dispersion model (e.g., AERSCREEN) to obtain concentration estimates for each emitted pollutant at varying receptor distances from the source. Several screening models feature the generation of an automatic array of receptors which is particularly useful for determining the zone of impact. In order for the model to generate the array of receptors the user needs to provide some information normally consisting of starting distance, increment and number of intervals.

- Calculate total cancer risk and hazard index (HI) for each receptor location by using the methods provided in the risk characterization sections of the Air Toxics Hot Spots Risk Assessment Guidance Manual.

- Find the distance where the total inhalation cancer risk is equal to 10^{-6}; this may require redefining the receptor array in order to have two receptor locations that bound a total cancer risk of 10^{-6}. Secondly and thirdly, find the distance where the chronic and acute health hazard indices are declared significant by the District (e.g., acute or chronic HI = 1.0).

Some Districts may prefer to use a cancer risk of 10^{-7} as the zone of impact. Therefore, the District should be consulted before modeling efforts are initiated. If the zone of impact is greater than 25 km from the facility at any point, then the District should be consulted. The District may specify limits on the area of the zone of impact. Ideally, these preferences would be presented in the modeling protocol (see Section 2.14).

Note that when depicting the risk assessment results, risk isopleths must present the total cancer and noncancer risk from both inhalation and noninhalation pathways. The zone of impact should be clearly shown on a map with geographic markers of adequate resolution (see Section 2.6.3.1).

2.6.2 Population Estimates for Screening Risk Assessments

A screening risk assessment should include an estimate of the maximum exposed population. For screening risk assessments, a detailed description of the exposed population is not required. The impact area to be considered should be selected to be health protective (i.e., will not underestimate the number of exposed individuals). A health-protective assumption is to assume that all individuals within a large radius of the facility are exposed to the maximum concentration. If a facility must also comply with

the RCRA/CERCLA risk assessment requirements, health effects to on-site workers may also need to be addressed. The DTSC's Remedial Project Manager should be consulted on this issue. The District should be consulted to determine the population estimate that should be used for screening purposes.

2.6.3 Population Estimates for Refined Risk Assessments

The refined risk assessment requires a detailed analysis of the population that is exposed to emissions from the facility. Where possible, a detailed population exposure analysis provides estimates of the number of individuals in residences and off-site workplaces, as well as at sensitive receptor sites such as schools, daycare centers and hospitals. The District may require that locations with high densities of sensitive individuals be identified (e.g., schools, daycare centers, hospitals). The overall exposed residential and worker populations should be apportioned into smaller geographic subareas. The information needed for each subarea is:

(1) the number of exposed persons, and
(2) the receptor location where the calculated ambient air concentration is assumed to be representative of the exposure to the entire population in the subarea.

A multi-tiered approach is suggested for the population analysis. First, the census tracts impacted by the facility should be identified (see Section 2.6.3.1). A census tract may need to be divided into smaller subareas if it is close to the facility where ambient concentrations vary widely. The District may determine that census tracts provide sufficient resolution near the facility to adequately characterize population exposure. The HARP software will provide population estimates that are consistent with the methodology discussed in this document.

Further downwind where ambient concentrations are less variable, the census tract level may be acceptable to the District. The District may determine that the aggregation of census tracts (e.g., the census tracts making up a city are combined) is appropriate for receptors which are considerable distances from the facility. If a facility must also comply with the RCRA/CERCLA risk assessment requirements, health effects to on-site workers may also need to be addressed. The DTSC's Remedial Project Manager should be consulted on this issue. In addition, the district should be consulted about special cases where evaluation of on-site receptors is appropriate, such as facilities frequented by the public or where people may reside (e.g., military facilities).

2.6.3.1 Census Tracts

For a refined risk assessment, the boundaries of census tracts can be used to define the geographic area to be included in the population exposure analysis. Digital maps showing the census tract boundaries in California can be obtained from "The Thomas Guide"® on the World Wide Web. Statistics for each census tract can be obtained from the U.S. Census Bureau. The website address for the U.S. Census Bureau is http://www.census.gov. Numerous additional publicly accessible or commercially available sources of census data can be found on the World Wide Web. A specific

example of a census tract is given in Appendix J. The HARP software includes U.S. census data and is a recommended tool for performing population exposure estimates.

The two basic steps in defining the area under analysis are:

(1) Identify the "zone of impact" (as defined previously in Section 2.6.1) on a map detailed enough to provide for resolution of the population to the subcensus tract level. (The U.S. Geological Survey (USGS) 7.5-minute series maps and the maps within the HARP software provide sufficient detail.) This is necessary to clearly identify the zone of impact, location of the facility, and sensitive receptors within the zone of impact. If significant development has occurred since the USGS survey, this should be indicated. A specific example of a 7.5-minute series map is given in Appendix J.

(2) Identify all census tracts within the zone of impact using a U.S. Bureau of Census or equivalent map (e.g., Thomas Brothers, HARP Software). If only a portion of the census tract lies within the zone of impact, then only the population that falls within the isopleth should be used in the population estimate or burden calculation. To determine this level of detail, local planning and zoning information may need to be collected. When this more detailed information is not available, then a less refined approach is to include the census data if the centroid of the census block falls within the isopleths of interest. The census tract boundaries should be transferred to a map, such as a USGS map (referred to hereafter as the "base map".)

An alternative approach for estimating population exposure in heavily populated urban areas is to apportion census tracts to a Cartesian grid cell coordinate system. This method allows a Cartesian coordinate receptor concentration field to be merged with the population grid cells. This process can be computerized and minimizes manual mapping of centroids and census tracts. The HARP software includes this function and will provide population estimates that are consistent with the methodology discussed here.

The District may determine that aggregation of census tracts (e.g., which census tracts making up a city can be combined) is appropriate for receptors that are located at considerable distances from the facility. If the District permits such an approach, it is suggested that the census tract used to represent the aggregate be selected in a manner to ensure that the approach is health protective. For example, the census tract included in the aggregate that is nearest (downwind) to the facility should be used to represent the aggregate.

2.6.3.2 Subcensus Tract

Within each census tract are smaller population units. These units [urban block groups (BG) and rural enumeration districts (ED)] contain about 1,100 persons. BGs are further broken down into statistical units called blocks. Blocks are generally bounded by

four streets and contain an average of 70 to 100 persons. However, the populations presented above are average figures and population units may vary significantly. In some cases, the EDs are very large and identical to a census tract.

The area requiring detailed (subcensus tract) resolution of the exposed residential and worker population will need to be determined on a case-by-case basis through consultation with the District. The District may determine that census tracts provide sufficient resolution near the facility to adequately characterize population exposure.

Employment population data can be obtained at the census tract level from the U.S. Census Bureau or from local planning agencies. This degree of resolution will generally not be sufficient for most risk assessments. For the area requiring detailed analysis, zoning maps, general plans, and other planning documents should be consulted to identify subareas with worker populations.

The boundaries of each residential and employment population area should be transferred to the base map.

2.6.4 Sensitive Receptor Locations

Individuals who may be more sensitive to toxic exposures than the general population are distributed throughout the total population. Sensitive populations may include young children and chronically ill individuals. The District may require that locations with high densities of sensitive individuals be identified (e.g., schools, daycare centers, hospitals). The risk assessment should state what the District requirements were regarding identification of sensitive receptor locations.

Although protection of sensitive individuals is incorporated into OEHHA's risk assessment methodology in both cancer risk and noncancer risk assessment, the assessment of risk at the specific location of such sensitive individuals (e.g., schools, hospitals, or nursing homes) may be useful to assure the public that such individuals are being considered in the analysis. For some chemicals (e.g., mercury and manganese) children have been specifically identified as the sensitive subpopulation for noncancer health impacts, so it can be particularly appropriate to assess school sites.

2.7 Receptor Siting

2.7.1 Receptor Points

The modeling analysis should contain a network of receptor points with sufficient detail (in number and density) to permit the estimation of the maximum concentrations. Locations that must be identified include the maximum estimated off-site risk or point of maximum impact (PMI), the maximum exposed individual at an existing residential receptor (MEIR) and the maximum exposed individual at an existing occupational receptor (worker) (MEIW). All of these locations (i.e., PMI, MEIR, and MEIW) must be identified for assessing cancer and noncancer risks. It is possible that the estimated

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2.7.1.1 Receptor Height

To evaluate localized impacts, receptor height should be taken into account at the point of maximum impact on a case-by-case basis. For example, receptor heights may have to be included to account for receptors significantly above ground level. Flagpole receptors at the height of the breathing zone of a person may need to be considered when the source receptor distance is less than a few hundred meters. Consideration must also be given to the noninhalation pathway analysis which requires modeling of chemical deposition onto soil or water at ground level as a first step. A health protective approach is to select a receptor height from 0 meters to 1.8 meters that will result in the highest predicted downwind concentration. Final approval of this part of the modeling protocol should be with the District, or reviewing authority.

2.7.2 Centroid Locations

For each subarea analyzed, a centroid location (the location at which a calculated ambient concentration is assumed to represent the entire subarea) should be determined. When population is uniformly distributed within a population unit, a geographic centroid based on the shape of the population unit can be used. If only a

portion of the census tract lies within the isopleth or area of interest, then only the population that falls within the isopleth should be used in the calculation for population exposure. To determine this level of detail, local planning and zoning information may need to be collected. Where populations are not uniformly distributed, a population-weighted centroid may be used. Another alternative uses the concentration at the point of maximum impact within that census tract as the concentration to which the entire population of that census tract is exposed. While this less refined approach is commonly accepted, Districts should be contacted to approve this method prior to its use in a risk assessment.

The centroids represent locations that should be included as receptor points in the dispersion modeling analysis. Annual average concentrations should be calculated at each centroid using the modeling procedures presented in this chapter.

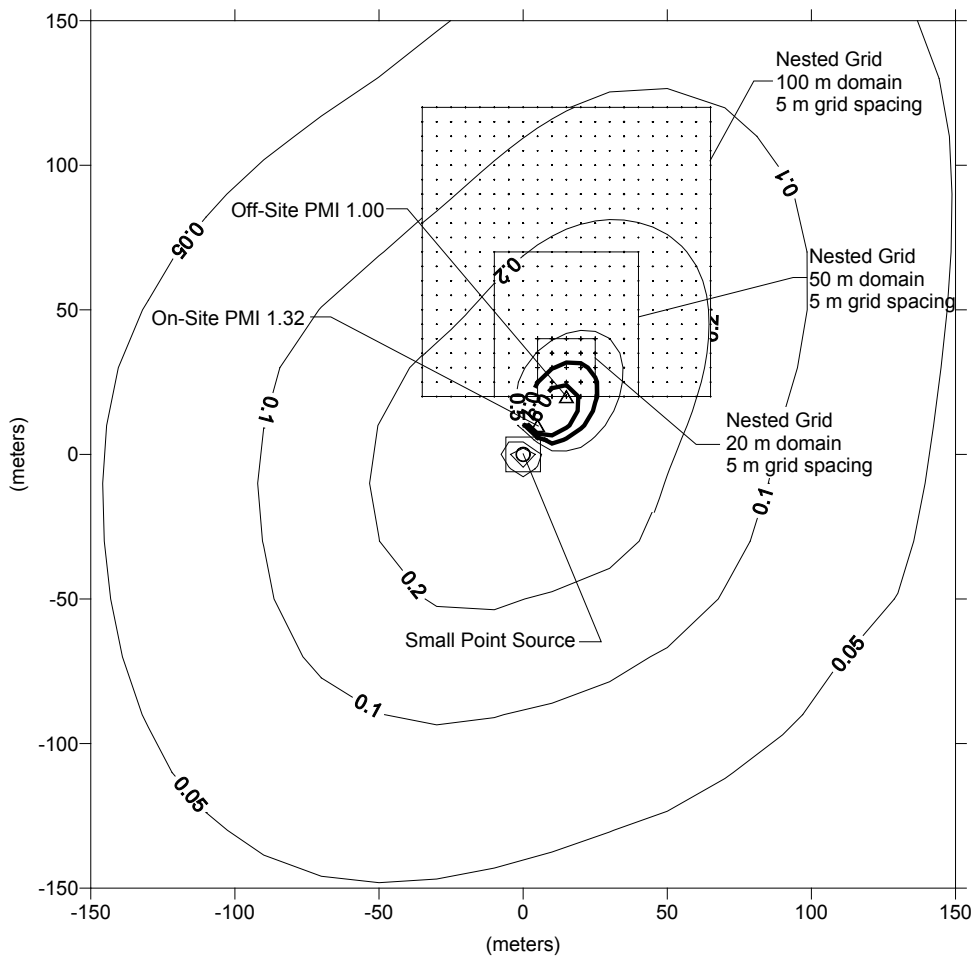
For census tracts and BG/EDs, judgments can be made using U.S. census data, census tracts maps, and street maps to determine the centroid location. At the block level, a geographic centroid is sufficient.

2.7.3 Spatial Averaging of Modeling Results

Since the inception of the “Hot Spots” and the air toxics programs in California, health risk assessment (HRA) results for an individual have typically been based on air dispersion modeling results at a single point or location. With a few exceptions, this method has been traditionally used for all types of receptors (e.g., PMI, MEIR, MEIW, pathway receptors, etc.). The assumptions used in risk assessment are designed to prevent underestimation of health impacts to the public – a health protective approach.

To identify the individual receptor (e.g., PMI, MEIR, etc), air dispersion modeling of pollutant emissions estimate ground level concentrations (GLC) at downwind receptors, which are distributed in a grid pattern of sufficient size and density to capture the maximum concentration. Figure 2 shows an example of the PMI and concentration isopleths. Under some conditions, the PMI may be significantly higher than receptors only a few meters away. In these cases, it may be unrealistic for the PMI to represent the 70-year exposure for long-term risk calculations.

Figure 2 – Concentration Isopleths



It is prudent public health practice to err on the side of public health protection in face of uncertainty; however, when exposure models can be refined, better scientific estimates of exposure and risk can be obtained. Basing risk estimates on a single highest point (PMI, MEIR, or MEIW) does not take into account that a person does not remain at one location on their property, or often in one location at the workplace over an extended period of time. Thus, using a single point with the highest air concentration that is not representative of the average concentration at a residence will tend to overestimate exposure and risk. One to five years of meteorological data do not necessarily fully characterize the variability in meteorological conditions over longer periods (e.g., 30 to 70 years) and thus the concentrations at a single point are likely to be more diffuse than the modeling estimates based on one year of meteorological data. U.S.EPA modeling guidance suggests that five years of consecutive meteorological data strongly represent a longer average such as 70 years. The average air concentration over a small area is likely to be more representative than the determination the air concentration at a single point, particularly in those situations where the concentrations falls off rapidly around the single point.

In order to understand how spatial averaging would impact air dispersion modeling results with various types of facilities, the ARB, in conjunction with the OEHHA, performed sensitivity analyses to evaluate the impacts of spatially averaging air dispersion modeling results. That information is presented in detail in Appendix C. Based on these sensitivity analyses, we feel it is reasonable and appropriate to include spatial averaging techniques in air toxic risk assessments as supplemental information to Tier 1 information (i.e., modeling results that are based on the air concentration from a single point or location). While all risk assessments must include results based on Tier 1 methodology, the spatially-averaged concentrations around the point of interest (e.g., PMI, MEIR, MEIW, multipathway exposure evaluations, etc.) could also be included as an option in risk assessments and for risk management decisions subject to approval by the District or reviewing agency.

A few reasons that support the inclusion of spatially-averaged modeled concentrations in risk assessment include the following.

- Averaging results over a small domain will give a more representative picture of individual exposure and risk than an estimate based on one single location within their property.
- Spatial averaging will allow air dispersion modeling and risk assessment results to be characterized as the estimated concentration and risk in a discrete area of interest, rather than an exact value for a single location.
- From a risk communication standpoint, the ARB and OEHHA feel it is more appropriate to present the modeling output and the calculated health impacts as the potential impacts within a small or discrete area, rather than an exact value at a specific point on a grid or map.
- Spatial averaging is the recommended procedure in ARB's Lead Risk Management Guidelines (2001) and has been used in several complex source HRAs [e.g., Roseville Railyard (2004), Ports of LA/LB (2006), Port of Oakland (2008)].
- Spatially averaging the deposition concentrations over pasture land or a water body for multipathway exposure scenarios is a planned upgrade for the HARP Software. This will provide an option that will appropriately refine multipathway exposure assessments. Average deposition on a water body is not necessarily well represented by the single highest point of deposition, or deposition at the geographic center of the water body. Likewise, since produce is grown over the entire surface of the garden and cows graze the entire pasture, deposition is better estimated by evaluating the entire area rather than using a single point.

2.7.4 Spatial Averaging Method

The spatial averaging sensitivity study in Appendix C is based on simulating emissions from a point, volume, area, and line sources. Each source type (e.g., point) is simulated as a small, medium or large source. Line sources are only simulated as small and large. In addition, meteorological data collected at five different locations in California were used. Nested spatial average grids of various domains were used to study the

differences on the spatial average concentration. In the case of the 20 meter by 20 meter spatial average nested grid, the spatial average concentration showed little change over the PMI for medium and large sources. In the case for small sources, the spatial average concentration is 45% to 80% of the PMI concentration. Individual source type and meteorological conditions will cause variations in these results.

The results of the spatial averaging sensitivity study in Appendix C shows that sources with low plume rise that result in a PMI, MEIW, or MEIR located at or near the property fence line are most sensitive to spatial averaging. Source types with high plume rise (e.g., tall stacks) show a PMI far downwind where the concentration gradient is more gradual and therefore spatial averaging has a lesser effect. While spatial averaging can be used regardless of source size or the location of the PMI, the following conditions generally apply when a source is a good candidate for spatial averaging

- The MEIR, MEIW, or PMI is located at the fence line or close to the emission source.
- The concentration gradient is high near the PMI. This is more associated with low level plumes such as fugitive, volume, area, or short stacks.
- A long term average is being calculated to represent a multi-year risk analysis based on one to five years of meteorological data. Note that spatial averaging should **not** be used for short term (acute) calculations.

2.7.4.1 Residential Receptors

To remain health protective when evaluating a residential receptor, spatial averaging should not take place using large nested domains. The domain used for spatial averaging should be no larger than 20 meters by 20 meters with a maximum grid spacing resolution of five meters. This domain represents and area that is approximately the size of a small urban lot.

In general, the method for calculating the spatial average in air toxic risk assessments includes the following steps.

1. Locate the off-site PMI, MEIW, or MEIR with a grid resolution spacing of no greater than five meters. Two or more model runs with successively finer nested grid resolutions centered on the new PMI may be required to locate the final PMI.
2. Center the spatial average nested grid on the off-site receptors about the PMI, MEIW, or MEIR. Limit the nested grid to no larger than 20 meters by 20 meters. The grid resolution spacing should be no greater than five meters. With a five meter grid resolution, the 20 meter by 20 meter nest will result in 25 receptors.
3. Some configurations of source activity and meteorological conditions result in a predominant downwind plume center line that is significantly askew from one of the four ordinate directions. In this case, a tilted nested grid is necessary to coincide with the dominant plume centerline. Polar receptors

are easier to implement than a tilted rectangular grid. The domain of the polar receptor field should be limited to a 15 meter radius. See Appendix C for detailed instructions on tilted polar receptors.

4. Calculate the arithmetic mean of the long term period average concentration (e.g., annual average) of the nested grid of receptors to represent the spatial average.

Appendix C shows explicit details for selecting, placing, and tilting a nested grid for rectangular or polar receptor grids. In addition, the sensitivity study is also available.

2.7.4.2 Worker Receptors

Offsite worker locations (e.g. MEIW) may also be a candidate for spatial averaging. However, workers can be at the same location during almost their entire work shift (e.g., desk/office workers). When this is the situation, then a single location and corresponding modeled concentration are appropriate to use. If spatial averaging is used, care should be taken to determine the proper domain size and grid resolution that should be used. To be consistent with the residential receptor assumptions and remain health protective, a maximum domain size should be no larger than 20 meters by 20 meters with a maximum grid spacing resolution of five meters. However, if workers routinely and continuously move throughout the worksite over a space greater than 20 meters by 20 meters, then a larger domain may be considered. The HRA or modeling protocol shall support all assumptions used, including, but not limited to, documentation for all workers showing the area where each worker routinely performs their duties. The final domain size should not be greater than the smallest area of worker movement. Other considerations for determining domain size and grid spacing resolution may include an evaluation of the concentration gradients across the worker area. The grid spacing used within the domain should be sufficient in number and detail to obtain a representative concentration across the area of interest. The size of the domain and resolution of points shall be subject to approval by the District, ARB, or other reviewing authority.

2.7.4.3 Pastures or Water Bodies

The simplified approach of using the deposition rate at the centroid, a specific point of interest, or the PM location for an area being evaluated for noninhalation exposures(e.g. a body of water used for fishing, a pasture used for grazing, etc) is still acceptable for use in HRA. However, evaluating deposition concentrations over pasture land or a water body for multipathway exposure scenarios using spatial averaging could give more representative estimates of the overall deposition rate. Use of spatial averaging in this application is subject to approval by the District, ARB, or other reviewing authority.

When using spatial averaging over the deposition area, care should be taken to determine the proper domain size to make sure it includes all reasonable areas of potential deposition. The size and shape of the pasture or water body of interest should be identified and used for the modeling domain. The grid spacing or resolution used

within the domain should be sufficient in detail to obtain a representative deposition concentration across the area of interest. One way to determine the grid resolution is to include an evaluation of the concentration gradients across the deposition area. The HRA or modeling protocol shall support all assumptions used, including, but not limited to, documentation of the deposition area (e.g., size and shape of the pasture or water body, maps, representative coordinates, grid resolution, concentration gradients, etc.). The size of the domain and grid resolution are subject to approval by the reviewing authority.

In lieu of the details required in the above description, the approach used for the other receptors (e.g., MEIR, MEIW) that uses a domain size not greater than 20 meters by 20 meters, centered on the PMI or point of interest, with a maximum grid spacing resolution of five meters can be used. This default refined approach would apply to deposition areas greater than 20 meters by 20 meters. For smaller deposition areas, the simplified approach of using the PMI or the actual smaller domain can be used.

The HRA or modeling protocol shall support all assumptions used, including, but not limited to, documentation of the deposition area (e.g., size and shape of the lake or water body, maps, representative coordinates, etc.). Other considerations for determining domain size and grid spacing resolution should include an evaluation of the concentration gradients across the deposition area. The grid spacing used within the domain should be sufficient in number and detail to obtain a representative deposition concentration across the area of interest. This information should also be included in the HRA and modeling protocols

2.8 Meteorological Data

Refined air dispersion models require hourly meteorological data. The first step in obtaining meteorological data should be to check with the District for data availability. Other sources of data include the National Weather Service (NWS), National Climatic Data Center (NCDC), Asheville, North Carolina, military stations and private networks. Meteorological data for a subset of NWS stations are available from the U.S. EPA Support Center for Regulatory Air Models (SCRAM). The SCRAM can be accessed at www.epa.gov/scram001/main.htm. All meteorological data sources should be approved by the District. Data not obtained directly from the District should be checked for quality, representativeness and completeness. U.S. EPA provides guidance (U.S. EPA, 1995e) for these data. The risk assessment should indicate if the District required the use of a specified meteorological data set. All memos indicating District approval of meteorological data should be attached in an appendix. If no representative meteorological data are available, screening procedures should be used.

The analyst should acquire enough meteorological data to ensure that the worst-case meteorological conditions are represented in the model results. The US-EPA Guideline on Air Quality Models (U.S. EPA 2005) prefers that the latest five years of consecutive meteorological data be used to represent long term averages (i.e., cancer and chronic). Previous OEHHA guidance allowed the use of the worst-case year to save computer

time. The processing speed of modern computers has increased to the point where processing five years of data over one year is no longer burdensome. However, the District may determine that one year of representative meteorological data is sufficient to adequately characterize the facility's impact. This may especially be the case when five years of quality consecutive data are not available.

During the transitional period from night to day (i.e., the first one to three hours of daylight) the meteorological processor may interpolate some very low mixing heights. This is a period of time in which the mixing height may be growing rapidly. When predicted concentrations are high and the mixing height is very low for the corresponding averaging period, the modeling results deserve additional consideration. For receptors in the near field, it is within the model formulation to accept a very low mixing height for short durations. However, it would be unlikely that the very low mixing height would persist long enough for the pollutants to travel into the far field. In the event that the analyst identifies any of these time periods, they should be discussed with the District on a case-by-case basis.

~~*2.8.1 Modeling to Obtain Annual Average Concentrations for Shorter Durations (e.g., 8-Hours)*~~

2.8.1 Modeling to Obtain Concentrations used for Various Health Impacts

The following section outlines how air dispersion modeling results are used or adjusted for a receptor that is exposed to either a non-continuous or continuously emitting source.

2.8.1.1 Modeling and Adjustments for Inhalation Cancer Risk at a Worksite

Modeled long-term averages are typically used for cancer risk assessments. In an inhalation cancer risk assessment for an offsite worker, the long-term average should represent what the worker breathes during their work shift. However, the long-term averages calculated from AERMOD typically represent exposures for receptors that were present 24 hours a day and seven days per week (i.e., residential receptors). To estimate the offsite worker's concentration, there are two approaches. The more refined, complex, and time consuming approach is to post-process the hourly raw dispersion model output and examine the hourly concentrations that fall within the offsite worker's shift. See Appendix M for information on how to simulate the long-term concentration for the offsite worker that can be used to estimate inhalation cancer risk.

In lieu of post-processing the hourly dispersion model output, the more typical approach is to obtain the long-term average concentration as you would for modeling a residential receptor and approximate the worker's inhalation exposure using an adjustment factor. The actual adjustment factor that is used to adjust the concentration may differ from the example below based on the specifics of the source and worker receptor (e.g., work-shift overlap). Once the worker's inhalation concentration is determined, the

inhalation dose is calculated using additional exposure frequency and duration adjustments. See Chapter 3 for more information on the inhalation dose equation.

Non-Continuous Sources

When modeling a non-continuously emitting source (e.g., operating for eight hours per day and five days per week), the modeled long-term average concentrations are based on 24 hours a day and seven days per week for the period of the meteorological data set. Even though the emitting source is modeled using a non-continuous emissions schedule, the long-term concentration is still based on 24 hours a day and seven days per week. Thus, this concentration includes the zero hours when the source was not operating. For the offsite worker inhalation risk, we want to determine the long-term concentration the worker is breathing during their work shift. Therefore, the long-term concentration needs to be adjusted so it is based only on the hours when the worker is present. For example, assuming the emitting source and worker's schedules are the same, the adjustment factor is 4.2 = (24 hours per day/8 hours per shift)x(7 days in a week/5 days in a work week). In this example, the long term residential exposure is adjusted upward to represent the exposure to a worker. Additional concentration adjustments may be appropriate depending on the work shift overlap. These adjustments are discussed below.

The calculation of the adjustment factor from a non-continuous emitting source is summarized in the following steps.

a. Obtain the long-term concentrations from air dispersion modeling as is typical for residential receptors (all hours of a year for the entire period of the meteorological data set).

b. Determine the coincident hours per day and days per week between the source's emission schedule and the offsite worker's schedule.

c. Calculate the worker adjustment factor (WAF) using Equation 2.1. When assessing inhalation cancer health impacts, a discount factor (*DF*) may also be applied if the offsite worker's schedule partially overlaps with the source's emission schedule. The discount factor is based on the number of coincident hours per day and days per week between the source's emission schedule and the offsite worker's schedule (see Equation 2.2). The DF is always less than or equal to one.

Please note that worker adjustment factor does not apply if the source's emission schedule and the offsite worker's schedule do not overlap. Since the worker is not around during the time that the source is emitting, the worker is not exposed to the source's emission (i.e., the DF in Equation 2.2 becomes 0).

$$WAF = \frac{H_{residential}}{H_{source}} \times \frac{D_{residential}}{D_{source}} \times DF \qquad \text{Eq. 2.1}$$

Where:

WAF = the worker adjustment factor
$H_{residential}$ = the number of hours per day the long-term residential concentration is based on (always 24 hours)
H_{source} = the number of hours the source operates per day
$D_{residential}$ = the number of days per week the long-term residential concentration is based on (always 7 days).
D_{source} = the number of days the source operates per week.
DF = a discount factor for when the offsite worker's schedule partially overlaps the source's emission schedule. Use 1 if the offsite worker's schedule occurs within the source's emission schedule. If the offsite worker's schedule partially overlaps with the source's emission schedule, then calculate the discount factor using Equation 2.2 below.

$$DF = \frac{H_{coincident}}{H_{worker}} \times \frac{D_{coincident}}{D_{worker}} \qquad \text{Eq. 2.2}$$

Where:

DF = the discount factor for assessing cancer impacts
$H_{coincident}$ = the number of hours per day the offsite worker's schedule and the source's emission schedule overlap
$D_{coincident}$ = the number of days per week the offsite worker's schedule and the source's emission schedule overlap.
H_{worker} = the number of hours the offsite worker works per day
D_{worker} = the number of days the offsite worker works per week.

d. The final step is to estimate the offsite worker's inhalation concentration by multiplying the worker adjustment factor with the long-term residential concentration. The worker's concentration is then plugged into the dose equation and risk calculation.

The HARP software has the ability to calculate worker impacts using an approximation factor and, in the future, it will have the ability to post-process refined worker concentrations using the hourly raw results from an air dispersion analysis.

Continuous Sources

If the source is continuously emitting, then the worker is assumed to breathe the long-term annual average concentration during their work shift. Equation 2.1 becomes one and no concentration adjustments are necessary in this situation when estimating the inhalation cancer risk. Note however, if an assessor does not wish to apply the assumption the worker breathes the long-term annual average concentration during the work shift, then a refined concentration can be post-processed as described in

Appendix M. All alternative assumptions should be approved by the reviewing authority and supported in the presentation of results.

2.8.1.2 Modeling and Adjustments for 8-Hour RELs

For 8-hour noncancer health impacts, we evaluate if the receptor (e.g., worker or resident) is exposed to a daily (e.g., 8-hour) average concentration that exceeds the 8-hour REL. For ease, we use a worker receptor in this discussion and in the discussion below for a non-continuously emitting source. The daily average concentration is intended to represent the long-term average concentration the worker is breathing during their work shift. In general, there are two approaches for estimating the concentration used for the 8-hour hazard index. The more refined, complex, and time consuming approach is to post-process the hourly dispersion model output and use only the hourly concentrations that are coincident with the offsite worker hours to obtain the long-term concentration. See Appendix M for information on how to simulate the daily average concentration through air dispersion modeling. Before proceeding through a refined analysis described in Appendix M, the assessor may wish to approximate the long-term concentration, as described below, and calculate the 8-hour hazard index. Based on those results, the assessor can contact OEHHA for assistance in determining whether further evaluation may be necessary. The results from the 8-hour hazard index calculations are not combined with the chronic or acute hazard indices. All potential noncancer health impacts should be reported independently.

In lieu of post-processing the hourly dispersion model output described in Appendix M, the more typical approach is to obtain the long-term average concentration as you would for modeling a residential receptor and approximate the worker's inhalation concentration using an adjustment factor. The method for applying the adjustment factor is described below.

Non-Continuous Sources

When modeling a non-continuously emitting source (e.g., operating for eight hours per day and five days per week), the modeled long-term average concentrations are based on 24 hours a day and seven days per week for the period of the meteorological data set. Even though the emitting source is modeled using a non-continuous emissions schedule, the long-term concentration is still based on 24 hours a day and seven days per week. Thus, this concentration includes the zero hours when the source was not operating. For the offsite worker 8-hour hazard index, we want to determine the long-term average daily concentration the worker may be breathing during their work shift. This is similar to the cancer approximation adjustment method with one difference; there is no adjustment for partial overlap between the worker's schedule and the source's emission schedule. The reason for difference in methodology is because the 8-hour REL health factors are designed for repeated 8-hour exposures and cannot readily be adjusted to other durations of exposure.

When calculating the long-term average daily concentration for the 8-hour REL comparison, the long-term residential concentration needs to be adjusted so it is based only on the operating hours of the emitting source with the assumption the offsite worker's shift falls within the emitting source's schedule. For example, assuming the emitting source operates 8 hours per day, 5 days per week and the offsite worker's schedules fall within this period of emissions, then the adjustment factor is 4.2 = (24 hours per day/8 hours of emissions per day)x(7 days in a week/5 days of emissions per week). In this example, the long term residential exposure is adjusted upward to represent the 8-hour exposure to a worker. No adjustments are applied for partial work shift overlap with the emitting source. If the source emits at night, then see Appendix N for additional recommendations.

Using the approximation factor is a screening method. If the 8-hour hazard index is above a threshold of concern with this method, the district or assessor should contact OEHHA for further guidance regarding the substance of concern. If necessary, further evaluation can be performed using the refined daily average modeling methodology discussed in Appendix M.

The calculation of the adjustment factor from a non-continuous emitting source is summarized in the following steps.

a. Obtain the long-term concentrations from air dispersion modeling as is typical for residential receptors (all hours of a year for the entire period of the meteorological data set).

b. Calculate the worker adjustment factor (WAF) using Equation 2.3. The source's emission schedule is assumed to overlap offsite worker's schedule. Note that the worker adjustment factor and the 8-hour REL do not apply if the source's emission schedule and the offsite worker's schedule do not overlap at some point.

$$WAF = \frac{H_{residential}}{H_{source}} \times \frac{D_{residential}}{D_{source}} \qquad \text{Eq. 2.3}$$

Where:

WAF = the worker adjustment factor
$H_{residential}$ = the number of hours per day the long-term residential concentration is based on (always 24 hours)
H_{source} = the number of hours the source operates per day
$D_{residential}$ = the number of days per week the long-term residential concentration is based on (always 7 days).
D_{source} = the number of days the source operates per week

c. The final step is to estimate the offsite worker's daily average inhalation concentration by multiplying the WAF with the long-term residential concentration. The worker's concentration is then used to calculate the

8-hour hazard index. This method using the approximation factor is a screening method. If the 8-hour hazard index is above a threshold of concern, the district or assessor should contact OEHHA for further guidance regarding the substance of concern.

In the future, the HARP software will have the ability to use 8-hour RELs, calculate worker impacts using an approximation factor, and to post-process worker concentrations using the hourly raw results from an air dispersion analysis.

Continuous Sources

If the source is continuously emitting, then the worker is assumed to breathe the long-term annual average concentration during their work shift and no concentration adjustments are made when estimating 8-hour health impacts. Note however, if an assessor does not wish to assume the worker breathes the long-term annual average concentration during the work shift, then a refined concentration can be post-processed as described in Appendix M. All alternative assumptions should be approved by the reviewing authority and supported in the presentation of results.

Eight-hour RELs are not used for residential receptors that are exposed to continuously emitting sources. In this situation, chronic RELs are used.

2.8.1.3 Modeling and Adjustment Factors for Chronic RELs

Potential chronic noncancer health impacts use the long-term annual average concentration regardless of the emitting facility's schedule. No adjustment factors should be used to adjust this concentration. Chronic RELs are used to assess both residential or worker health impacts. The results from the chronic hazard index calculations are not combined with the 8-hour or acute hazard indices. All potential noncancer results should be reported independently.

2.8.1.4 Modeling and Adjustments for Oral Cancer Potencies and Oral RELs

When estimating the cancer risk or noncancer health impacts from noninhalation pathways, no adjustment is made to the long-term annual average concentration regardless of the emitting facility's schedule. Since the media (e.g., soil) at the receptor location where deposition takes place for noninhalation pathways is continuously present, the concentrations used for all noninhalation pathways are not adjusted (up or down) by an adjustment factor. However, some adjustments are made to the concentration once the pollutants reach the media, for example, pollutants undergo decay in soils. In addition, when the dose for each pathway is calculated, exposure adjustments may also be made. See the individual chapters for each exposure pathway to get more information on these types of adjustments. Oral cancer potencies and oral RELs are used to assess both residential or worker health impacts.

~~The exposure duration for the 8-hour RELs is daily 8-hour exposures including weekends for a significant fraction of a lifetime. Therefore, the air concentration that the~~

~~offsite workers are exposed to during their presumed 40 hour workshift must be averaged with the zero concentration that they will be exposed to when away from the worksite over the weekend. Thus for offsite workers, the operating schedule of the adjacent facility, and work schedule for the offsite workers are two determinants of exposure. The annual average concentration during work shift multiplied by 5/7 to adjust for the weekend time away from the worksite is what needs to be divided by the 8 hour REL. The exposure duration for the 8-hour RELs is daily 8-hour exposures including weekends. A facility that only emits Monday through Friday during the day will have no emissions during the weekend and since the offsite workers are typically not exposed during the weekend, the air concentration that the workers are exposed to during the week needs to be reduced by 5/7 before it is compared to the REL. For estimating residential noncancer chronic risks and inhalation cancer risk the air dispersion modeling results are based on the facility's hourly emission profile coincident with hourly meteorological data for a complete year (or more) of simulations, to give an annual average air concentration. However, when evaluating the offsite worker receptor, we need the average concentration that the offsite worker is exposed to (i.e., breathing) during their shift.~~

~~There are two approaches for estimating the concentration for the offsite worker exposure. The more complex approach is to post process the hourly dispersion model output and selectively sample the hourly concentrations that are co-incident with the offsite worker hours. The long term exposure to offsite workers is the average of the sampled hourly concentrations. See Appendix M for information on how to simulate the long term concentration for the offsite worker that can be used to estimate the carcinogenic or chronic impacts. This approach is the most refined and can be time consuming.~~

~~In lieu of these special modeling runs, the more typical approach is to obtain the annual average concentration as you would for modeling a residential receptor and approximate the worker's 8-hour concentration using an adjustment factor. The adjustment factor is a function of exposure assumptions and whether you are calculating carcinogenic or non carcinogenic impacts. The HARP software has the ability to calculate worker impacts using an approximation or to model special scenarios for determining concentrations for shorter durations.~~

~~Residents can be exposed to emissions from facilities operating 8 hours a day, five days a week. The 8-hour RELs can be used to assess chronic risks to residents in this case. The annual average concentration during the 8 hours that the facility operates multiplied time 5/7 can be used if the facility does not operate during the weekend. The 8-hour RELs can be used to assess noncancer chronic risks for facilities that emit up to 12 hours a day. If the facility emits more than 12 hours a day, the chronic REL should be used with the 24 hour annual average air concentration.~~

- ~~Adjustment Factor for Continuously Emitting Source~~

~~For a continuously emitting source (i.e., facility operating 24 hours a day, 7 days a week), no adjustment factor is used with this scenario to estimate the concentration the offsite worker is exposed to for either cancer risks or chronic noncancer risks (including use of the 8-hour RELs for workers) . The annual average air concentration from the modeling output should be used for estimating both cancer and non-cancer impacts.~~

- ~~Adjustment Factor for a Non-Continuously Emitting Source when using 8-hour RELs~~

~~For a non-continuously emitting source where the impacted offsite worker has an overlapping schedule (i.e., emitting facility is operating during part or all of shift for the impacted offsite worker), the annual average concentration from the modeling output should be multiplied by a factor of 3, or 24 hours/8 hours. An additional factor of 5/7 should be used to account for the absence of the workers on the weekend. This will result in an approximation of the long term 8-hour exposure of a coincident schedule between the emitting facility and an offsite work shift lasting 8 hours. If the offsite workers are only present during part of the time that the facility is operating, the air concentration for the eight hours that the worker is present can be adjusted downward. For example, if offsite workers and the facility emissions only overlap for 4 hours then the air concentration during the four hours could be divided by 2 to give an average 8-hour concentration.~~

~~For estimating cancer risks, If the facility only operates 5 days a week, then (in addition to the factor of 3 (24 hours/8 hours), a factor of 7 days/5 days, or 1.4, should also be multiplied times the annual average. Typically, the total adjustment factor applied to the modeled annual average air concentration will be 4.2. This 4.2 approximation factor was evaluated with the AERMOD model to determine how it compares with 8-hour concentrations from actual meteorological data. Based on the evaluation, the 4.2 approximation factor is suitable for most cases. However, in the event of predominant night time emissions and worker schedule or if only one year of meteorological data are available, then we recommend using a 4.8 approximation factor for 8-hour work shifts. See Appendix N for a discussion of the 4.2 approximation factor sensitivity analysis.~~

~~For carcinogenic calculations, the 4.2 approximation factor can be adjusted to account for partial overlap of the workers schedule and the schedule of the emitting facility. For example, if the worker is always only present for four of the eight hours that a facility is emitting, then a factor of 0.5 (4 hours/8 hours) could be multiplied against the 4.2 factor, yielding an adjustment factor of 2.1. The reason these worker-related adjustments can be applied is because cancer risk is assumed proportional to lifetime average daily dose. See the OEHHA~~

~~Guidelines Document for more detailed discussions related to calculating potential carcinogenic impacts.~~

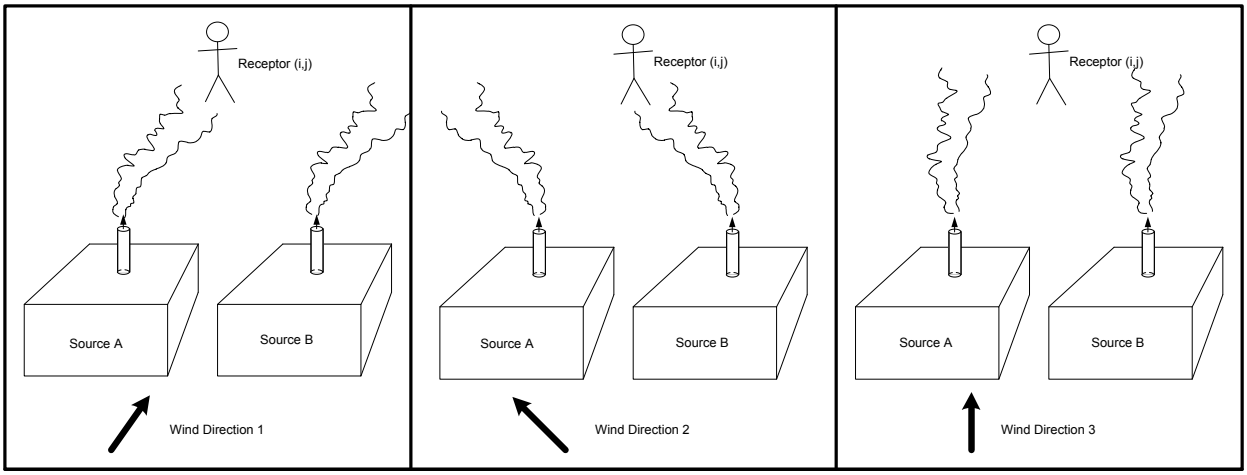
2.8.2 Modeling One-Hour Concentrations using Simple and Refined Acute Calculations

Modeled one-hour concentrations are needed for the acute health hazard index calculations. HARP has two methods to calculate this concentration; Simple and Refined. As an aid to understanding the differences between Simple and Refined, Figure 3 shows three possible conditions showing how wind direction may vary and impact a downwind receptor (i,j) differently from just two sources (A and B).

For the Simple calculation, HARP stores only the maximum one-hour concentration at each receptor (i,j) from each source (A and B) as the dispersion model marches down each hour of the simulation (e.g., one to five years of hourly data). At the end of the simulation period, HARP reports back only the maximum impacts at each receptor from each source regardless of which hour of the simulation period this occurred. For example, the Simple Maximum Acute Impacts would be the summation of Source A impacts from Wind Direction 1 and Source B impacts from Wind Direction 2 as shown in Figure 3.

For the Refined simulation, HARP stores each hourly concentration at each receptor (i,j) from each source. At the end of the simulation period, HARP evaluates the coincident impact at each receptor from all sources for each hour of the simulation period. In this case the maximum impacts will be identified by a particular hour of the period with associated wind speed, direction, and atmospheric conditions. For example, the Refined Maximum Acute impact from Sources A and B on receptor (i,j) could be from any wind direction (1,2, or 3) as shown in Figure 3. As HARP stores all simulations for all sources – at all receptors – for all hours to calculate the refined impacts, there is great potential to fill large amounts of disk storage space. However the Refined simulation provides a more representative picture of the Maximum acute hazard index from a facility. The Simple calculation will provide an upper bound to the acute hazard index.

Figure 3 – Acute Scenarios



The following sections, taken mostly from the document "On-Site Meteorological Program Guidance for Regulatory Modeling Applications" (U.S. EPA, 1995e), provide general information on data formats and representativeness. Some Districts may have slightly different recommendations from those given here.

2.8.3 Meteorological Data Formats

Most short-term dispersion models require input of hourly meteorological data in a format which depends on the model. U.S. EPA provides software for processing meteorological data for use in U.S. EPA recommended dispersion models. U.S. EPA recommended meteorological processors include the Meteorological Processor for Regulatory Models (MPRM), PCRAMMET, and AERMET. Use of these processors will ensure that the meteorological data used in an U.S. EPA recommended dispersion model will be processed in a manner consistent with the requirements of the model.

Meteorological data for a subset of NWS stations are available on the World Wide Web at the U.S. EPA SCRAM address, http://www.epa.gov/scram001.

2.8.4 Treatment of Calms

~~Calms are normally considered to be wind speeds below the starting threshold of the anemometer or vane (whichever is greater).~~ Calms are hours when the wind speed is below the starting threshold of the anemometer. Gaussian plume models require a wind speed and direction to estimate plume dispersion in the downwind direction. U.S. EPA's policy is to disregard calms until such time as an appropriate analytical approach is available. The recommended U.S. EPA models contain a routine that eliminates the effect of the calms by nullifying concentrations during calm hours and recalculating short-term and annual average concentrations. Certain models lacking this built-in feature can have their output processed by U.S. EPA's CALMPRO program (U.S. EPA, 1984a) to achieve the same effect. Because the adjustments to the concentrations for calms are made by either the models or the postprocessor, actual

measured on-site wind speeds should always be input to the preprocessor. These actual wind speeds should then be adjusted as appropriate under the current U.S. EPA guidance by the preprocessor.

Following the U.S. EPA methodology, measured on-site wind speeds of less than l.0 m/s, but above the instrument threshold, should be set equal to l.0 m/s by the preprocessor when used as input to Gaussian models. Calms are identified in the preprocessed data file by a wind speed of 1.0 m/s and a wind direction equal to the previous hour. For input to AERMOD, no adjustment should be made to the site specific wind data. AERMOD can produce model estimates for conditions when the wind speed may be less than 1 m/s but still greater than the instrument threshold. Some air districts provide pre-processed meteorological data for use in their district that treats calms differently. Local air districts should be consulted for available meteorological data.

If the fraction of calm hours is excessive, then an alternative approach may need to be considered to characterize dispersion. The Calpuff model modeling system can simulate calm winds as well as complex wind flow and therefore is a viable alternative. The local air district should be consulted for alternative approaches.

2.8.5 Treatment of Missing Data

Missing data refer to those hours for which no meteorological data are available from the primary on-site source for the variable in question. When missing values arise, they should be handled in one of the following ways listed below, in the following order of preference:

(1) If there are other on-site data, such as measurements at another height, they may be used when the primary data are missing. If the height differences are significant, corrections based on established vertical profiles should be made. Site-specific vertical profiles based on historical on-site data may also be appropriate to use if their determination is approved by the reviewing authority. If there is question as to the representativeness of the other on-site data, they should not be used.

(2) If there are only one or two missing hours, then linear interpolation of missing data may be acceptable, however, caution should be used when the missing hour(s) occur(s) during day/night transition periods.

(3) If representative off-site data exist, they may be used. In many cases this approach may be acceptable for cloud cover, ceiling height, mixing height, and temperature. This approach will rarely be acceptable for wind speed and direction. The representativeness of off-site data should be discussed and agreed upon in advance with the reviewing authority.

(4) Failing any of the above, the data field should be coded as missing using missing data codes appropriate to the applicable meteorological pre-processor.

Appropriate model options for treating missing data, if available in the model, should be employed. Substitutions for missing data should only be made in order to complete the data set for modeling applications, and should not be used to attain the "regulatory completeness" requirement of 90%. That is, the meteorological data base must be 90% complete on a monthly basis (before substitution) in order to be acceptable for use in air dispersion modeling.

2.8.6 Representativeness of Meteorological Data

The atmospheric dispersion characteristics at an emission source need to be evaluated to determine if the collected meteorological data can be used to adequately represent atmospheric dispersion for the project.

Such determinations are required when the available meteorological data are acquired at a location other than that of the proposed source. In some instances, even though meteorological data are acquired at the location of the pollutant source, they still may not correctly characterize the important atmospheric dispersion conditions.

Considerations of representativeness are always made in atmospheric dispersion modeling whether the data base is "on-site" or "off-site." These considerations call for the judgment of a meteorologist or an equivalent professional with expertise in atmospheric dispersion modeling. If in doubt, the District should be consulted.

2.8.6.1 Spatial Dependence

The location where the meteorological data are acquired should be compared to the source location for similarity of terrain features. For example, in complex terrain, the following considerations should be addressed in consultation with the District:

- Aspect ratio of terrain, i.e., ratio of:
  - Height of valley walls to width of valley;
  - Height of ridge to length of ridge; and
  - Height of isolated hill to width of hill at base.
- Slope of terrain
- Ratio of terrain height to stack/plume height.
- Distance of source from terrain (i.e., how close to valley wall, ridge, isolated hill)
- Correlation of terrain feature to prevailing meteorological conditions

Likewise, if the source is located on a plateau or plain, the source of meteorological data used should be from a similar plateau or plain.

Judgments of representativeness should be made only when sites are climatologically similar. Sites in nearby, but different air sheds, often exhibit different weather patterns.

For instance, meteorological data acquired along a shoreline are not normally representative of inland sites and vice versa.

Meteorological data collected need to be examined to determine if drainage, transition, and synoptic flow patterns are characteristics of the source, especially those critical to the regulatory application. Consideration of orientation, temperature, and ground cover should be included in the review.

An important aspect of space dependence is height above the ground. Where practical, meteorological data should be acquired at the release height, as well as above or below, depending on the buoyancy of the source's emissions. AERMOD at a minimum requires wind observations at a height above ground between seven times the local surface roughness height and 100 meters.

2.8.6.2 Temporal Dependence

To be representative, meteorological data must be of sufficient duration to define the range of sequential atmospheric conditions anticipated at a site. As a minimum, one full year of on-site meteorological data is necessary to prescribe this time series. Multiple years of data are used to describe variations in annual and short-term impacts. Consecutive years from the most recent, readily available 5-year period are preferred to represent these yearly variations.

2.8.6.3 Further Considerations

It may be necessary to recognize the non-homogeneity of meteorological variables in the air mass in which pollutants disperse. This non-homogeneity may be essential in correctly describing the dispersion phenomena. Therefore, measurements of meteorological variables at multiple locations and heights may be required to correctly represent these meteorological fields. Such measurements are generally required in complex terrain or near large land-water body interfaces.

It is important to recognize that, although certain meteorological variables may be considered unrepresentative of another site (for instance, wind direction or wind speed), other variables may be representative (such as temperature, dew point, cloud cover). Exclusion of one variable does not necessarily exclude all. For instance, one can argue that weather observations made at different locations are likely to be similar if the observers at each location are within sight of one another - a stronger argument can be made for some types of observations (e.g., cloud cover) than others. Although by no means a sufficient condition, the fact that two observers can “see” one another supports a conclusion that they would observe similar weather conditions.

Other factors affecting representativeness include change in surface roughness, topography and atmospheric stability. Currently there are no established analytical or statistical techniques to determine representativeness of meteorological data. The

establishment and maintenance of an on-site data collection program generally fulfills the requirement for "representative" data. If in doubt, the District should be consulted.

2.8.7~~6~~ Alternative Meteorological Data Sources

It is necessary, in the consideration of most air pollution problems, to obtain data on site-specific atmospheric dispersion. Frequently, an on-site measurement program must be initiated. As discussed in Section 2.8.5, representative off-site data may be used to substitute for missing periods of on-site data. There are also situations where current or past meteorological records from a National Weather Service station may suffice. These considerations call for the judgment of a meteorologist or an equivalent professional with expertise in atmospheric dispersion modeling. More information on Weather Stations including: National Weather Service (NWS), military observations, supplementary airways reporting stations, upper air and private networks, is provided in "On-Site Meteorological Program Guidance for Regulatory Modeling Applications" (U.S. EPA, 1995e).

2.8.7~~6~~.1 Recommendations

On-site meteorological data should be processed to provide input data in a format consistent with the particular models being used. The input format for U.S. EPA short-term regulatory models is defined in U.S. EPA's MPRM. The input format for AERMOD is defined in the AERMET meteorological pre-processor. Processors are available on the SCRAM web site. The actual wind speeds should be coded on the original input data set. Wind speeds less than 1.0 m/s but above the instrument threshold should be set equal to 1.0 m/s by the preprocessor when used as input to Gaussian models. Wind speeds below the instrument threshold of the cup or vane, whichever is greater, should be considered calm, and are identified in the preprocessed data file by a wind speed of 1.0 m/s and a wind direction equal to the previous hour. For input to AERMOD, no adjustment should be made to the site specific wind data. AERMOD can produce model estimates for conditions when the wind speed may be less than 1 m/s but still greater than the instrument threshold.

If data are missing from the primary source, they should be handled as follows, in order of preference: (I) substitution of other representative on-site data; (2) linear interpolation of one or two missing hours; (3) substitution of representative off-site data; or (4) coding as a missing data field, according to the discussions in Section 2.8.5.

If the data processing recommendations in this section cannot be achieved, then alternative approaches should be developed in conjunction with the District.

2.8.8~~6~~ Quality Assurance and Control

The purpose of quality assurance and maintenance is the generation of a representative amount (90% of hourly values for a year on a monthly basis) of valid data. For more information on data validation consult reference U.S. EPA (1995e). Maintenance may

be considered the physical activity necessary to keep the measurement system operating as it should. Quality assurance is the management effort to achieve the goal of valid data through plans of action and documentation of compliance with the plans.

Quality assurance (QA) will be most effective when following a QA Plan which has been signed-off by appropriate project or organizational authority. The QA Plan should contain the following information (paraphrased and particularized to meteorology from Lockhart):

1. Project description - how meteorology data are to be used
2. Project organization - how data validity is supported
3. QA objective - how QA will document validity claims
4. Calibration method and frequency - for data
5. Data flow - from samples to archived valid values
6. Validation and reporting methods - for data
7. Audits - performance and system
8. Preventive maintenance
9. Procedures to implement QA objectives - details
10. Management support - corrective action and reports

It is important for the person providing the quality assurance (QA) function to be independent of the organization responsible for the collection of the data and the maintenance of the measurement systems. Ideally, the QA auditor works for a separate company.

2.9 Model Selection

There are several air dispersion models that can be used to estimate pollutant concentrations and new ones are likely to be developed. U.S. EPA added AERMOD, which incorporates the PRIME downwash algorithm, to the list of preferred models in 2005 as a replacement to ISCST3. CalPuff was added in 2003. The latest version of the U.S. EPA recommended models can be found at the SCRAM Bulletin board located at http://www.epa.gov/scram001. However, any model, whether a U.S. EPA guideline model or otherwise, must be approved for use by the local air district. Recommended models and guidelines for using alternative models are presented in this section. All air dispersion models used to estimate pollutant concentrations for risk assessment analyses must be in the public domain. Classification according to terrain, source type and level of analysis is necessary before selecting a model (see Section 2.4). The selection of averaging times in the modeling analysis is based on the health effects of concern. Annual average concentrations are required for an analysis of carcinogenic or other chronic effects. One-hour maximum concentrations are generally required for analysis of acute effects.

2.9.1 Recommended Models

Recommended air dispersion models to estimate concentrations for risk assessment analyses are generally referenced in US EPA's Guideline on Air Quality Models available at http://www.epa.gov/scram001. Currently AERMOD is recommended for most refined risk assessments in flat or complex terrain and in rural or urban environments[3]. In addition, CalPuff is available where spatial wind fields are highly variable or transport distances are large (e.g., 50 km). AERSCREEN is a screening model based on AERMOD. AERSCREEN can be used when representative meteorological data are unavailable. CTSCREEN is available for screening risk assessments in complex terrain. The most current version of the models should be used for risk assessment analysis. Some facilities may also require models capable of special circumstances such as dispersion near coastal areas. For more information on modeling special cases see Sections 2.12 and 2.13.

Most air dispersion models contain provisions that allow the user to select among alternative algorithms to calculate pollutant concentrations. Only some of these algorithms are approved for regulatory application such as the preparation of health risk assessments. The sections in this guideline that provide a description of each recommended model contain information on the specific switches and/or algorithms that must be selected for regulatory application.

To further facilitate the model selection, the District should be consulted for additional recommendations on the appropriate model(s) or a protocol submitted for District review and approval (see Section 2.14.1).

2.9.2 Alternative Models

Alternative models are acceptable if applicability is demonstrated or if they produce results identical or superior to those obtained using one of the preferred models referenced in Section 2.9.1. For more information on the applicability of alternative models refer to the following documents:

- U.S. EPA (2005). "Guideline on Air Quality Models" Section 3.2.2
- U.S. EPA (1992). "Protocol for Determining the Best Performing Model"
- U.S. EPA (1985a). "Interim Procedures for Evaluating Air Quality Models – Experience with Implementation"
- U.S. EPA (1984b). "Interim Procedures for Evaluating Air Quality Models (Revised)"

2.10 Screening Air Dispersion Models

A screening model may be used to provide a maximum concentration that is biased toward overestimation of public exposure. Use of screening models in place of refined modeling procedures is optional unless the District specifically requires the use of a refined model. Screening models are normally used when no representative

[3] AERMOD was promulgated by U.S. EPA as a replacement to ISCST3 on November 9, 2006.

meteorological data are available and may be used as a preliminary estimate to determine if a more detailed assessment is warranted.

Some screening models provide only 1-hour average concentration estimates. Other averaging periods can be estimated based on the maximum 1-hour average concentration in consultation and approval of the responsible air district. Because of variations in local meteorology, the exact factor selected may vary from one district to another. Table 2.2 provides guidance on the range and typical values applied. The conversion factors are designed to bias predicted longer term averaging periods towards overestimation.

Table 2.2. Recommended Factors to Convert Maximum 1-hour Avg. Concentrations to Other Averaging Periods (U.S. EPA, 2011, 1995a; ARB, 1994).

Averaging Time	Range	Typical SCREEN3 Recommended	AERSCREEN Recommended
3 hours	0.8 - 1.0	0.9	1.0
8 hours	0.5 - 0.9	0.7	0.9
24 hours	0.2 - 0.6	0.4	0.6
30 days	0.2 - 0.3	0.3	
Annual	0.06 - 0.1	0.08	0.1

AERSCREEN automatically provides the converted concentration for longer than 1-hour averaging periods. For area sources, the AERSCREEN 3, 8, and 24-hour average concentration are equal to the 1-hour concentration. No annual average concentration is calculated. SCREEN3 values are shown for comparison purposes.

2.10.1 AERSCREEN

The AERSCREEN (U.S. EPA, 2011) model is now available and should be used in lieu of SCREEN3 with approval of the local District. AERSCREEN is a screening level air quality model based on AERMOD. AERSCREEN does not require the gathering of hourly meteorological data. Rather, AERSCREEN requires the use of the MAKEMET program which generates a site specific matrix of meteorological conditions for input to the AERMOD model. MAKEMET generates a matrix of meteorological conditions based on local surface characteristics, ambient temperatures, minimum wind speed, and anemometer height.

AERSCREEN is currently limited to modeling a single point, capped stack, horizontal stack, rectangular area, circular area, flare, or volume source. More than one source may be modeled by consolidating the emissions into one emission source.

2.10.2 Valley Screening

The Valley model is designed to simulate a specific worst-case condition in complex terrain, namely that of a plume impaction on terrain under stable atmospheric conditions. The algorithms of the VALLEY model are included in other models such as SCREEN3 and their use is recommended in place of the VALLEY model. The usefulness of the VALLEY model and its algorithms is limited to pollutants for which only long-term average concentrations are required. For more information on the Valley model consult the user's guide (Burt, 1977).

Regulatory Options

Regulatory application of the Valley model requires the setting of the following values during a model run:

- Class F Stability (rural) and Class E Stability (urban)
- Wind Speed = 2.5 m/s
- 6 hours of occurrence of a single wind direction (not exceeding a 22.5 deg sector)
- 2.6 stable plume rise factor

2.10.3 CTSCREEN

The CTSCREEN model (Perry et al., 1990) is the screening mode of the Complex Terrain Dispersion Model (CTDMPLUS). CTSCREEN can be used to model single point sources only. It may be used in a screening mode for multiple sources on a case by case basis in consultation with the District. CTSCREEN is designed to provide conservative, yet theoretically more sound, worst-case 1-hour concentration estimates for receptors located on terrain above stack height. Internally-coded time-scaling factors are applied to obtain other averages (see Table 2.3). These factors were developed by comparing the results of simulations between CTSCREEN and CTDMPLUS for a variety of scenarios and provide conservative estimates (Perry et al., 1990). CTSCREEN produces identical results as CTDMPLUS if the same meteorology is used in both models. CTSCREEN accounts for the three-dimensional nature of the plume and terrain interaction and requires detailed terrain data representative of the modeling domain. A summary of the input parameters required to run CTSCREEN is given in Table 2.4. The input parameters are provided in three separate text files. The terrain topography file (TERRAIN) and the receptor information file (RECEPTOR) may be generated with a preprocessor that is included in the CTSCREEN package. In order to generate the terrain topography file the analyst must have digitized contour information.

Table 2.3. Time-scaling factors internally coded in CTSCREEN

Averaging Period	Scaling Factor
3 hours	0.7
24 hour	0.15
Annual	0.03

Table 2.4. Input Parameters Required to Run CTSCREEN

Parameter	File
Miscellaneous program switches	CTDM.IN
Site latitude and longitude (degrees)	CTDM.IN
Site TIME ZONE	CTDM.IN
Meteorology Tower Coordinates (user units)	CTDM.IN
Source Coordinates: x and y (user units)	CTDM.IN
Source Base Elevation (user units)	CTDM.IN
Stack Height (m)	CTDM.IN
Stack Diameter (m)	CTDM.IN
Stack Gas Temperature (K)	CTDM.IN
Stack Gas Exit Velocity (m/s)	CTDM.IN
Emission Rate (g/s)	CTDM.IN
Surface Roughness for each Hill (m)	CTDM.IN
Meteorology: Wind Direction (optional)	CTDM.IN
Terrain Topography	TERRAIN
Receptor Information (coordinates and associated hill number)	RECEPTOR

2.11 Refined Air Dispersion Models

Refined air dispersion models are designed to provide more representative concentration estimates than screening models. In general, the algorithms of refined models are more robust and have the capability to account for site-specific meteorological conditions.

2.11.1 AERMOD

For a wide variety of applications in all types of terrain, the recommended model is AERMOD. AERMOD is a steady-state plume dispersion model for assessment of pollutant concentrations from a variety of sources. AERMOD simulates transport and dispersion from multiple point, area, or volume sources based on an up-to-date characterization of the atmospheric boundary layer. Sources may be located in rural or urban areas and receptors may be located in simple or complex terrain. AERMOD accounts for building wake effects (i.e., plume downwash) based on the PRIME building downwash algorithms. The model employs hourly sequential preprocessed meteorological data to estimate concentrations for averaging times from one hour to one year (also multiple years). AERMOD is designed to operate in concert with two pre-processor codes: AERMET processes meteorological data for input to AERMOD, and AERMAP processes terrain elevation data and generates receptor information for input to AERMOD. Guidance on input requirements may be found in the AERMOD Users Guide.

2.11.1.1 Regulatory Options

U.S. EPA regulatory ~~Regulatory~~ application of AERMOD requires the selection of specific switches (i.e., algorithms) during a model run. All the regulatory options can be set by selecting the DFAULT keyword. The U.S. EPA regulatory options, automatically selected when the DFAULT keyword is used, are:

- Stack-tip downwash
- Incorporates the effects of elevated terrain
- Includes calms and missing data processing routines
- Does not allow for exponential decay for applications other than a 4-hour half life for SO_2

Additional information on these options is available in the AERMOD User's Guide.

2.11.1.2 Special Cases

a. Building Downwash

AERMOD automatically determines if the plume is affected by the wake region of buildings when their dimensions are given. The specification of building dimensions does not necessarily mean that there will be downwash. See section 2.12.1 for guidance on how to determine when downwash is likely to occur.

b. Area Sources

The area source algorithm in AERMOD does not account for the area that is 1 m upwind from the receptor and, therefore, caution should be exercised when modeling very small area sources (e.g., a few meters wide) with receptors placed within them or within 1 m from the downwind boundary.

c. Volume Sources

The volume source algorithms in AERMOD require an estimate of the initial distribution of the emission source. Tables that provide information on how to estimate the initial distribution for different sources are given in the AERMOD User's Guide (U.S. EPA, 2004a).

d. Line Sources

Line sources are a special case of a series of volume or area sources. Where the emission source is neutrally buoyant, such as a conveyor belt, AERMOD can be used according to the user guide. In the event that the line source is a roadway, then additional considerations are required.

At the present time, CALINE (CALINE3, CAL3QHCR, and CALINE4) is the only model dedicated to modeling the enhanced mechanical and thermal turbulence created by motor vehicles traveling on a roadway. Of these, CAL3QHCR is the only model that accepts hourly meteorological data and can estimate annual average concentrations. However, CALINE uses the Pasquill-Gifford stability categories which are used in the ISCST model. AERMOD is now the preferred plume model over ISCST3 with continuous plume dispersion calculations based on observations but AERMOD does not include the enhanced roadway turbulence. ~~Therefore, roadway modeling should be treated on a case-by-case basis in accordance with the District.~~

In the case where roadway emissions dominate the risk assessment, it may be most important to simulate the enhanced thermal and mechanical turbulence from motor vehicles with the CAL3QHCR model. In the case where roadway emissions are a subset of all emissions for the risk assessment, in the case of including roadway emissions along with facility emissions, it may be best to use AERMOD for all emissions, roadway and facility, in order to maintain continuity with one dispersion model for the risk assessment. Most importantly, roadway modeling should be treated on a case-by-case basis in consultation with the District.

Line sources inputs include a composite fleetwide emission factor, roadway geometry, hourly vehicle activity (i.e., diurnal vehicle per hour pattern), hourly meteorological data, and receptor placement. For practical information on how to simulate roadway emissions using these models, see CAPCOA's website at http://www.capcoa.org or the Sacramento Metropolitan AQMD (SMAQMD) website at http://www.airquality.org/ceqa/RoadwayProtocol.shtml. The SMAQMD has a document titled, "Recommended Protocol for Evaluating the Location of Sensitive Land Uses Adjacent to Major Roadways"(January , 2010).

e. Complex Terrain

AERMOD uses the Dividing Streamline (H_c) concept for complex terrain. Above H_c, the plume is assumed to be "terrain following" in the convective boundary layer. Below H_c, the plume is assumed to be "terrain impacting" in the stable boundary layer. AERMOD computes the concentration at any receptor as a weighted function between the two plume states (U.S. EPA, 2004b)

f. Deposition

AERMOD contains algorithms to model settling and deposition and require additional information to do so including particle size distribution. For more information consult the AERMOD User's Guide (U.S. EPA, 2004a).

g. Diurnal Considerations

Systematic diurnal changes in atmospheric conditions are expected along the coast (or any large body of water) or in substantially hilly terrain. The wind speed and direction are highly dependent on time of day as the sun rises and begins to heat the Earth. The sun heats the surface of the land faster than the water surface. Therefore the air above the land warms up sooner than over water. This creates a buoyant effect of warm air rising over land and the cool air from over water moves in to fill the void. Near large bodies of water (e.g., the ocean) this is known as a sea breeze. In complex terrain this is known as upslope flow as the hot air follows the terrain upwards. When the sun sets and the surface of the land begins to cool, the air above also cools and creates a draining effect. Near the water this is the land breeze; in complex terrain this is known as downslope or drainage flow. In addition, for the sea breeze, the atmospheric conditions change rapidly from neutral or stable conditions over water to unstable conditions over land.

Near the large bodies of water the sea breeze is typical in the afternoon and the land breeze is typical for the early morning before sunrise. In complex terrain upslope flow is typical in the afternoon, while drainage flow is typical at night. For these reasons, it is especially important to simulate facility emissions with a hourly diurnal pattern reflective of source activity so that the risk assessment is representative of daily conditions.

h. 8-hour Modeling for the Offsite Worker's Exposure and Residential Exposure

If the ground level air concentrations from a facility operation 5 days a week/ 8 hours per day have been estimated by a 24 hour per day annual average, an adjustment factor can be applied to estimate the air concentration that offsite worker with the same schedule would be exposed to. The 24 hour annual average concentration is multiplied times 4.2.

If the meteorology during the time that the facility is emitting is used, hourly model simulations need to be post-processed to cull out the data needed for the offsite worker exposure. See Appendix M for information on how to calculate the refined offsite worker concentrations using the hourly raw results from the AERMOD air dispersion model. For more discussion on worker exposure, see Section 2.8.1.

2.11.5 CTDMPLUS

CTDMPLUS is a Gaussian air quality model for use in all stability conditions in complex terrain. In comparison with other models, CTDMPLUS requires considerably more detailed meteorological data and terrain information that must be supplied using specifically designed preprocessors.

CTDMPLUS was designed to handle up to 40 point sources.

2.12 Modeling Special Cases

Special situations arise in modeling some sources that require considerable professional judgment; a few of which are outlined below. It is recommended that the reader consider retaining professional consultation services if the procedures are unfamiliar.

2.12.1 Building Downwash

The entrainment of a plume in the wake of a building can result in the “downwash” of the plume to the ground. This effect can increase the maximum ground-level concentration downwind of the source. Therefore, stack sources must be evaluated to determine whether building downwash is a factor in the calculation of maximum ground-level concentrations.

The PRIME algorithm, included with AERMOD, has several advances in modeling building downwash effects including enhanced dispersion in the wake, reduced plume rise due to streamline deflection and increased turbulence, and continuous treatment of the near and far wakes (Schulman, 2000).

Complicated situations involving more than one building may necessitate the use of the Building Profile Input Program (BPIP) which can be used to generate the building dimension section of the input file of the ISC models (U.S. EPA, 1993). The BPIP program calculates each building’s direction-specific projected width. The Building Profile Input Program for PRIME (BPIPPRM) is the same as BPIP but includes an algorithm for calculating downwash values for input into the PRIME algorithm which is contained in such models as AERMOD. The input structure of BPIPPRM is the same as that of BPIP.

2.12.2 Deposition

There are two types of deposition; wet deposition and dry deposition. Wet deposition is the incorporation of gases and particles into rain-, fog- or cloud water followed by a precipitation event and also rain scavenging of particles during a precipitation event. Wet deposition of gases is therefore more important for water soluble chemicals; particles (and hence particle-phase chemicals) are efficiently removed by precipitation events (Bidleman, 1988). Dry deposition refers to the removal of gases and particles from the atmosphere.

In the Air Toxics "Hot Spots" program, deposition is quantified for particle-bound pollutants and not gases. Wet deposition of water-soluble gas phase chemicals is thus not considered. When calculating pollutant mass deposited to surfaces without including depletion of pollutant mass from the plume airborne concentrations remaining in the plume and deposition to surfaces can be overestimated, thereby resulting in overestimates of both the inhalation and multi-pathway risk estimates. However, neglecting deposition in the air dispersion model, while accounting for it in the multi-pathway health risk assessment, is a conservative, health protective approach (CAPCOA, 1987; Croes, 1988). Misapplication of plume depletion can also lead to possible underestimates of multi-pathway risk and for that reason no depletion is the default assumption. If plume depletion is incorporated, then some consideration for possible resuspension is warranted. An alternative modeling methodology accounting for plume depletion can be discussed with the Air District and used in an approved modeling protocol.

Although not generally used, several ~~Several~~ air dispersion models can provide downwind concentration estimates that take into account the upwind deposition of pollutants to surfaces and the consequential reduction of mass remaining in the plume ~~(e.g., ISCST3)~~. ~~Deposition algorithms are unavailable in the initial release of AERMOD. U.S. EPA is developing deposition algorithms for AERMOD. Check with U.S. EPA for availability.~~ Air dispersion models having deposition and plume depletion algorithms require particle distribution data that are not always readily available. These variables include particle size, mass fraction, and density for input to AERMOD. In addition, the meteorological fields need to include additional parameters including relative humidity, precipitation, cloud cover, and surface preasure. Consequently, depletion of pollutant mass from the plume often is not taken into account.

~~There are two types of deposition; wet deposition and dry deposition. Wet deposition is the incorporation of gases and particles into rain-, fog- or cloud water followed by a precipitation event and also rain scavenging of particles during a precipitation event. Wet deposition of gases is therefore more important for water soluble chemicals; particles (and hence particle-phase chemicals) are efficiently removed by precipitation events (Bidleman, 1988). Dry deposition refers to the removal of gases and particles from the atmosphere.~~

In conclusion, multipathway ~~Multipathway~~ risk assessment analyses normally incorporate deposition to surfaces in a screening mode, specifically by assigning a

default deposition velocity of 2 cm/s for controlled sources and 5 cm/s for uncontrolled sources in lieu of actual measured size distributions (ARB, 1989). For particles (and particle-phase chemicals), the deposition velocity depends on particle size and is minimal for particles of diameter approximately 0.1-1 micrometer; smaller and larger particles are removed more rapidly.

~~In the Air Toxics "Hot Spots" program, deposition is modeled for particle-bound pollutants and not gases. Wet deposition of water-soluble gas phase chemicals is thus not considered. When calculating pollutant mass deposited to surfaces without including depletion of pollutant mass from the plume, an inconsistency occurs in the way deposition is treated in the risk analysis, specifically, airborne concentrations remaining in the plume and deposition to surfaces can both be overestimated, thereby resulting in overestimates of both the inhalation and multi-pathway risk estimates. However, neglecting deposition in the air dispersion model, while accounting for it in the multi-pathway health risk assessment, is a conservative, health protective approach (CAPCOA, 1987; Croes, 1988). Misapplication of plume depletion can also lead to possible underestimates of multi-pathway risk and for that reason no depletion is the default assumption. If plume depletion is incorporated, then some consideration for possible resuspension is warranted. An alternative modeling methodology accounting for plume depletion can be discussed with the Air District and used in an approved modeling protocol.~~

2.12.3 Short Duration Emissions

Short-duration emissions (i.e., much less than an hour) require special consideration. In general, "puff models" provide a better characterization of the dispersion of pollutants having short-duration emissions. Continuous Gaussian plume models have traditionally been used for averaging periods as short as about 10 minutes and are not recommended for modeling sources having shorter continuous emission duration.

2.12.4 Fumigation

Fumigation occurs when a plume that was originally emitted into a stable layer in the atmosphere is mixed rapidly to ground-level when unstable air below the plume reaches plume level. Fumigation can cause very high ground-level concentrations. Typical situations in which fumigation occurs are:

- Breaking up of a nocturnal radiation inversion by solar warming of the ground surface (rising warm unstable air); note that the break-up of a nocturnal radiation inversion is a short-lived event and should be modeled accordingly.

- Shoreline fumigation caused by advection of pollutants from a stable marine environment to an unstable inland environment

- Advection of pollutants from a stable rural environment to a turbulent urban environment

SCREEN3 incorporates concentrations due to inversion break-up and shoreline fumigation and is limited to maximum hourly evaluations. The Offshore and Coastal Dispersion Model incorporates overwater plume transport and dispersion as well as changes that occur as the plume crosses the shoreline – hourly meteorological data are needed from both offshore and onshore locations.

2.12.5 Raincap on Stack

The presence of a raincap or any obstacle at the top of the stack hinders the momentum of the exiting gas. The extent of the effect is a function of the distance from the stack exit to the obstruction and of the dimensions and shape of the obstruction.

On the conservative side, the stack could be modeled as having a non-zero, but negligible exiting velocity, effectively eliminating any momentum rise. Such an approach would result in final plume heights closer to the ground and therefore higher concentrations nearby. There are situations where such a procedure might lower the actual population-dose and a comparison with and without reduced exit velocity should be examined.

Plume buoyancy is not strongly reduced by the occurrence of a raincap. Therefore, if the plume rise is dominated by buoyancy, it is not necessary to adjust the stack conditions. (The air dispersion models determine plume rise by either buoyancy or momentum, whichever is greater.)

The stack conditions should be modified when the plume rise is dominated by momentum and in the presence of a raincap or a horizontal stack. Sensitivity studies with the SCREEN3 model, on a case-by-case basis, can be used to determine whether plume rise is dominated by buoyancy or momentum. The District should be consulted before applying these procedures.

- Set exit velocity to 0.001 m/sec
- Turn stack tip downwash off
- Reduce stack height by 3 times the stack diameter

Stack tip downwash is a function of stack diameter, exit velocity, and wind speed. The maximum stack tip downwash is limited to three times the stack diameter in the AERMOD air dispersion model. In the event of a horizontal stack, stack tip downwash should be turned off and no stack height adjustments should be made.

Note: This approach may not be valid for large (several meter) diameter stacks.

An alternative, more refined, approach could be considered for stack gas temperatures which are slightly above ambient (e.g., ten to twenty degrees Fahrenheit above

ambient). In this approach, the buoyancy and the volume of the plume remains constant and the momentum is minimized.

- Turn stack tip downwash off
- Reduce stack height by 3 times the stack diameter ($3D_o$)
- Set the stack diameter (D_b) to a large value (e.g., 10 meters)
- Set the stack velocity to $V_b = V_o (D_o/D_b)^2$

Where V_o and D_o are the original stack velocity and diameter and V_b and D_b are the alternative stack velocity and diameter for constant buoyancy. This approach is advantageous when $D_b >> D_o$ and $V_b << V_o$ and should only be used with District approval.

In the presence of building downwash and in the event that PRIME downwash is being utilized in AERMOD, an alternative approach is recommended. PRIME algorithms use the stack diameter to define initial plume radius and to solve conservation laws. The user should input the actual stack diameter and exit temperature but set the exit velocity to a nominally low value (e.g., 0.001 m/s). Also since PRIME does not explicitly consider stack-tip downwash, no adjustments to stack height should be made.

Currently US-EPA is BETA testing options for capped and horizontal releases in AERMOD. It is expected that these options will replace the above guidance when BETA testing is complete.

2.12.6 Landfill Sites

Landfills should be modeled as area sources. The possibility of non-uniform emission rates throughout the landfill area should be investigated. A potential cause of non-uniform emission rates would be the existence of cracks or fissures in the landfill cap (where emissions may be much larger). If non-uniform emissions exist, the landfill should be modeled with several smaller areas assigning an appropriate emission factor to each one of them, especially if there are nearby receptors (distances on the same order as the dimensions of the landfill).

2.13 Specialized Models

Some models have been developed for application to very specific conditions. Examples include models capable of simulating sources where both land and water surfaces affect the dispersion of pollutants and models designed to simulate emissions from specific industries.

2.13.1 Buoyant Line and Point Source Dispersion Model (BLP)

BLP is a Gaussian plume dispersion model designed for the unique modeling problems associated with aluminum reduction plants, and other industrial sources where plume rise and downwash effects from stationary line sources are important.

2.13.1.1 Regulatory Application

Regulatory application of BLP model requires the selection of the following options:

- rural (IRU=l) mixing height option;
- default (no selection) for all of the following: plume rise wind shear (LSHEAR), transitional point source plume rise (LTRANS), vertical potential temperature gradient (DTHTA), vertical wind speed power law profile exponents (PEXP), maximum variation in number of stability classes per hour (IDELS), pollutant decay (DECFAC), the constant in Briggs' stable plume rise equation (CONST2), constant in Briggs' neutral plume rise equation (CONST3), convergence criterion for the line source calculations (CRIT), and maximum iterations allowed for line source calculations (MAXIT); and
- terrain option (TERAN) set equal to 0.0, 0.0, 0.0, 0.0, 0.0, 0.0

For more information on the BLP model consult the user's guide (Schulman and Scire, 1980).

2.13.2 Offshore and Coastal Dispersion Model (OCD)

OCD (DiCristofaro and Hanna, 1989) is a straight-line Gaussian model developed to determine the impact of offshore emissions from point, area or line sources on the air quality of coastal regions. OCD incorporates "over-water" plume transport and dispersion as well as changes that occur as the plume crosses the shoreline. Hourly meteorological data are needed from both offshore and onshore locations. Additional data needed for OCD are water surface temperature, over-water air temperature, mixing height, and relative humidity.

Some of the key features include platform building downwash, partial plume penetration into elevated inversions, direct use of turbulence intensities for plume dispersion, interaction with the overland internal boundary layer, and continuous shoreline fumigation.

2.13.2.1 Regulatory Application

OCD has been recommended for use by the Minerals Management Service for emissions located on the Outer Continental Shelf (50 FR 12248; 28 March 1985). OCD is applicable for over-water sources where onshore receptors are below the lowest source height. Where onshore receptors are above the lowest source height, offshore plume transport and dispersion may be modeled on a case-by-case basis in consultation with the District.

2.13.3 Shoreline Dispersion Model (SDM)

SDM (PEI, 1988) is a hybrid multipoint Gaussian dispersion model that calculates source impact for those hours during the year when fumigation events are expected using a special fumigation algorithm and the MPTER regulatory model for the remaining hours.

SDM may be used on a case-by-case basis for the following applications:

- tall stationary point sources located at a shoreline of any large body of water;
- rural or urban areas;
- flat terrain;
- transport distances less than 50 km;
- 1-hour to 1-year averaging times.

2.14 Interaction with the District

The risk assessor must contact the District to determine if there are any specific requirements. Examples of such requirements may include: specific receptor location guidance, specific usage of meteorological data and specific report format (input and output).

2.14.1 Submittal of Modeling Protocol

It is strongly recommended that a modeling protocol be submitted to the District for review and approval prior to extensive analysis with an air dispersion model. The modeling protocol is a plan of the steps to be taken during the air dispersion modeling process. Following is an example of the format that may be followed in the preparation of the modeling protocol. Consult with the District to confirm format and content requirements or to determine the availability of District modeling guidelines before submitting the protocol.

Emissions

- Specify that emission estimates for all substances for which emissions were required to be quantified will be included in the risk assessment. This includes both annual average emissions and maximum one-hour emissions of each pollutant from each process.

- Specify the format in which the emissions information will be provided (consult with the District concerning format prior to submitting the protocol).

- Specify the basis for using emissions data, other than that included in the previously submitted emission inventory report, for the risk assessment (consult with the District concerning the use of updated emissions data prior to submitting the protocol).

- Specify the format for presenting release parameters (e.g., stack height and diameter, stack gas exit velocity, release temperature) for each process as part of the risk assessment (consult with the District concerning the format prior to submitting the protocol).

- A revised emission inventory report must be submitted to the District and forwarded by the District to the CARB if revised emission data are used.

Models

- Identify the model(s) to be used, including the version number.

- Identify any additional models to be run if receptors are found above stack height.

- Specify which model results will be used for receptors above stack height.

- Specify the format for presenting the model options selected for each run (consult with the District concerning the format prior to submitting the protocol).

Meteorological Data

- Specify type, source, and year (e.g., hourly surface data, upper air mixing height information).

- Evaluate whether the data are representative.

- Describe QA/QC procedures.

- Identify any gaps in the data; if so, describe how the data gaps are filled.

Deposition

- Specify method to calculate deposition (if applicable).

Receptors

- Identify the method to determine maximum exposed individual for residential and occupational areas for long-term exposures (e.g., a Cartesian grid at 20-meter grid increments).

- Identify whether spatially averaged supplemental results will be submitted in addition to the modeling results from the maximum concentration at the single location. Identify the spatial average grid receptor domain and resolution and procedure for centering the grid on the maximum concentration. For tilted spatial average fields, identify whether rectangular or polar fields will be used. This information should be

provided for each receptor type (e.g., PMI, MEIR, and MEIW) and any water body or pasture land that will use spataial averaging for determining multipathway disposition exposure.

- Identify method to determine maximum short-term impact.

- Identify the methods and data sources for population and land-use that will be used to evaluate cancer risk in the vicinity of the facility for purposes of calculating cancer burden or population exposure estimates (e.g., centroids of the census tracts in the area within the zone of impact).

- Specify that UTM coordinates and street addresses, where possible, will be provided for specified receptor locations.

Maps

- Specify which cancer risk isopleths will be plotted (e.g., 10^{-6}, 10^{-7}; see Section 2.6.1).

- Specify which hazard indices will be plotted for acute and chronic (e.g., 0.1, 1, 10).

2.15 Report Preparation

This section describes the information related to the air dispersion modeling process that needs to be reported in the risk assessment. The District may have specific requirements regarding format and content (see Section 2.14). Sample calculations should be provided at each step to indicate how reported emissions data were used. Reviewing agencies must receive input, output, and supporting files of various model analyses on computer-readable media (e.g., CD). See the Air Toxics Risk Assessment Guidance Manual on the ARB website (http://www.arb.ca.gov/toxics/harp/harp.htm) for information on which files that should be included with a HARP risk assessments.

2.15.1 Information on the Facility and its Surroundings

Report the following information regarding the facility and its surroundings:

- Facility Name
- Location (UTM coordinates and street address)
- Land use type (see Section 2.4)
- Local topography
- Facility plot plan identifying:
    - source locations
    - property line
    - horizontal scale
    - building heights
    - emission sources

2.15.2 Source and Emission Inventory Information†

Source Description and Release Parameters

Report the following information for each source in table format:

- Source identification number used by the facility
- Source name
- Source location using UTM coordinates
- Source height (m)
- Source dimensions (e.g., stack diameter, building dimensions, area size) (m)
- Exhaust gas exit velocity (m/s)
- Exhaust gas volumetric flow rate (ACFM)
- Exhaust gas exit temperature (K)

Source Operating Schedule

The operating schedule for each source should be reported in table form including the following information:

- Number of operating hours per day and per year (e.g., 0800-1700, 2700 hr/yr)
- Number of operating days per week (e.g., Mon-Sat)
- Number of operating days or weeks per year (e.g., 52 wk/yr excluding major holidays)

Emission Control Equipment and Efficiency

Report emission control equipment and efficiency by source and by substance

Emissions Data Grouped By Source

Report emission rates for each toxic substance, grouped by source (i.e., emitting device or process identified in Inventory Report), in table form including the following information:

- Source name
- Source identification number
- Substance name and CAS number (from Inventory Guidelines)
- Annual average emissions for each substance (lb/yr)
- Hourly maximum emissions for each substance (lb/hr)

Emissions Data Grouped by Substance

Report facility total emission rate by substance for all emitted substances listed in the Air Toxics "Hot Spots" Program including the following information:

- Substance name and CAS number (from Inventory Guidelines)
- Annual average emissions for each substance (lb/yr)
- Hourly maximum emissions for each substance (lb/hr)

Emission Estimation Methods

Report the methods used in obtaining the emissions data indicating whether emissions were measured or estimated. Clearly indicate any emission data that are not reflected in the previously submitted emission inventory report and submit a revised emission inventory report to the district. A reader should be able to reproduce the risk assessment without the need for clarification.

List of Substances

Include tables listing all "Hot Spots" Program substances which are emitted, plus any other substances required by the District. Indicate substances to be evaluated for cancer risks and noncancer effects.

2.15.3 Exposed Population and Receptor Location

- Report the following information regarding exposed population and receptor locations:

- Description of zone of impact including map showing the location of the facility, boundaries of zone of impact, census tracts, emission sources, sites of maximum exposure, and the location of all appropriate receptors. This should be a true map (one that shows roads, structures, etc.), drawn to scale, and not just a schematic drawing. USGS 7.5 minute maps or GIS based maps are usually the most appropriate choices. (If significant development has occurred since the user's survey, this should be indicated.)

- Separate maps for the cancer risk zone of impact and the hazard index (noncancer) zone of impact. The cancer zone of impact should include isopleths down to at least the 1/1,000,000 risk level. Because some districts use a level below 1/1,000,000 to define the zone of impact, the District should be consulted. Two separate isopleths (to represent both chronic and acute HI) should be created to define the zone of impact for the hazard index from both inhalation and noninhalation pathways greater than or equal to 0.5. The point of maximum impact (PMI), maximum exposed individual at a residential receptor (MEIR), and maximum exposed individual worker (MEIW) for both cancer and noncancer risks should be located on the maps.

- Tables identifying population units and sensitive receptors (UTM coordinates and street addresses of specified receptors)

- Heights or elevations of the receptor points

- For each receptor type (e.g., PMI, MEIR, and MEIW) that will utilize spatial averaging, the domain size and grid resolution must be clearly identified. If another domain or grid resolution other than 20 meters by 20 meters with 5-meter grid spacing will be used for a receptor, then care should be taken to determine the proper domain size and grid resolution that should be used. For a worker, the HRA shall support all assumptions used, including, but not limited to, documentation for all workers showing the area where each worker routinely performs their duties. The final domain size should not be greater than the smallest area of worker movement. Other considerations for determining domain size and grid spacing resolution may include an evaluation of the concentration gradients across the worker area. The grid spacing used within the domain should be sufficient in number and detail to obtain a representative concentration across the area of interest. When spatial averaging over the deposition area of a pasture or water body, care should be taken to determine the proper domain size to make sure it includes all reasonable areas of potential deposition. The size and shape of the pasture or water body of interest should be identified and used for the modeling domain. The grid spacing or resolution used within the domain should be sufficient in detail to obtain a representative deposition concentration across the area of interest. One way to determine the grid resolution is to include an evaluation of the concentration gradients across the deposition area. The HRA shall support all assumptions used, including, but not limited to, documentation of the deposition area (e.g., size and shape of the pasture or water body, maps, representative coordinates, grid resolution, concentration gradients, etc.). The use or spatial averaging is subject to approval by the reviewing authority. This includes the size of the domain and grid resolution that is used for spatial averaging of a worksite or multipathway deposition area.

2.15.4 Meteorological Data

If meteorological data were not obtained directly from the District, then the report must clearly indicate the data source and time period used. Meteorological data not obtained from the District must be submitted in electronic form along with justification for their use including information regarding representativeness and quality assurance.

The risk assessment should indicate if the District required the use of a specified meteorological data set. All memos indicating the District's approval of meteorological data should be attached in an appendix.

2.15.5 Model Selection and Modeling Rationale

The report should include an explanation of the model chosen to perform the analysis and any other decisions made during the modeling process. The report should clearly indicate the name of the models that were used, the level of detail (screening or refined analysis) and the rationale behind the selection.

Also report the following information for each air dispersion model used:

- version number
- selected options and parameters in table form

2.15.6 Air Dispersion Modeling Results

- Maximum hourly and annual average concentrations of chemicals at appropriate receptors such as the residential and worker MEI receptors

- Annual average and maximum one-hour (and 30-day average for lead only) concentrations of chemicals at appropriate receptors listed and referenced to computer printouts of model outputs

- Model printouts (numbered), annual concentrations, maximum hourly concentrations

- Disk with input/output files for air dispersion program (e.g., the AERMOD input file containing the regulatory options and emission parameters, receptor locations, meteorology, etc.)

- Include tables that summarize the annual average concentrations that are calculated for all the substances at each site. The use of tables that present the relative contribution of each emission point to the receptor concentration is recommended. (These tables should have clear reference to the computer model which generated the data. It should be made clear to any reader how data from the computer output was transferred to these tables.) [As an alternative, the above two tables could contain just the values for sites of maximum impact (i.e., PMI, MEIR and MEIW), and sensitive receptors, if required. All the values would be found in the Appendices.]

(†) Health and Safety Code section 44346 authorizes facility operators to designate certain "Hot Spots" information as trade secret. Section 44361(a) requires districts to make health risk assessments available for public review upon request. Section 44346 specifies procedures to be followed upon receipt of a request for the release of trade secret information. See also the Inventory Guidelines Report regarding the designation of trade secret information in the Inventory Reports.

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Chapter 3 Daily Breathing Rates

3.1 Introduction

This chapter presents age-specific breathing rates for use in health risk assessments for short-term exposure to maximum 1-hour facility emissions and for long-term daily average exposures resulting from continuous or 8-hour intermittent exposure. The specified age ranges of toxicological interest in the "Hot Spots" program are ages third trimester, 0<2, 2<9, 2<16, 16<30 and 16-70 years.

The term ventilation rate has been frequently used for the metric of volume of air inhaled per minute (i.e., mL/min) and is used in this document to describe short-term, one hour exposures. For chronic daily exposures, the term "breathing rate" is applied both to the metric of volume of air inhaled per day (L/day) and the volume of air inhaled per kg body weight per day (L/kg-day). The normalized daily breathing rate in L/kg-day is the preferred metric for use in the "Hot Spots" program.

The 8-hour breathing rates were developed for specialized exposure scenarios that involve exposures only during facility operations of about 8-12 hours/day. Eight-hour breathing rates reflect exposures to off-site workers or exposures that may occur in schools when class is in session. Ventilation rates for 1-hour exposure were developed to meet the SB-352 mandate for school districts to conduct a risk assessment at school sites located within 100 meters of a freeway or busy roadway. These ventilation rates were developed for exposures to 1-hour maximum facility emissions that may occur during passive activities such as sitting at a desk during class instruction or during higher intensity activities such as play during recess.

OEHHA recommends the breathing rates presented in Section 3.2. Various published methods for deriving daily breathing rates and their advantages and limitations are discussed in Sections 3.3 to 3.7. Where possible, the breathing rates from these reports were re-evaluated to correspond with the five specific age groups used in OEHHA's risk assessment guidelines.

At elevations above 5000 feet, the breathing rate will increase due to lower air pressure (NOLS, 2012). The respiratory rate at this elevation peaks at one week and then slowly decreases over the next few months, although it tends to remain higher than its normal rate at sea level. There have been a few facilities located at 5000 feet or higher that have been required to produce a Hot Spots risk assessment. However, long-term residents at high altitude will have breathing rates near what is found in residents at sea level. OEHHA does not anticipate any adjustments will be needed to the breathing rates at higher altitudes in California, although ~~T~~the Districts should consider this issue and adjust if needed for very high altitude facilities.

3.2 Breathing Rate Recommendations

[Note: this section was moved from the back to the front]

3.2.1 Long-Term Breathing Rates

The recommended long-term daily breathing rate point estimates in Table 3.1 are based on a mean of two different methods used to determine daily breathing rates, the doubly labeled water method and an energy intake approach based on food consumption data from the Continuing Survey of Food Intake of Individuals (CSFII). These methods are described in detail below. The recommended distributions for stochastic analysis are presented in Tables 3.2a-b. The breathings rates normalized to body weight are expressed in L/kg-day, and the non-body weight-normalized breathing rates are expressed in m^3/day. All values were rounded to two or three significant figures.

Table 3.1. Recommended Point Estimates for Long-Term Daily Breathing Rates

	3rd Trimester	**0<2 years**	**2<9 years**	**2<16 years**	**16<30 years**	**16<70 years**
		L/kg-day				
Mean	225	658	535	452	210	185
95th Percentile	361	1090	861	745	335	290
		m^3/day				
Mean	15.3	6.2	10.7	13.3	15.0	13.9
95th Percentile	23.4	11.2	16.4	22.6	23.5	22.9

OEHHA calculated mean and high breathing rates for the third trimester assuming the dose to the fetus during the third trimester was the same as that to the mother.

TABLE 3.2a. Recommended Breathing Rate Distributions (L/kg-day) by Age Group for Stochastic Analysis

	3rd Trimester	**0<2 years**	**2<9 years**	**2<16 years**	**16<30 years**	**16-70 years**
Distribution	Max extreme	Max extreme	Max extreme	Log-normal	Logistic	Logistic
Minimum	78	196	156	57	40	13
Maximum	491	2,584	1,713	1,692	635	860
Scale	59.31	568.09	125.59		40.92	36.19
Likeliest	191.50	152.12	462.61			
Location				-144.06		
Mean	225	658	535	452	210	185
Std Dev	72	217	168	172	75	67
Skewness	0.83	2.01	1.64	1.11	0.83	1.32
Kurtosis	3.68	10.61	7.88	6.02	5.17	10.83

Percentiles						
5%	127	416	328	216	96	86
10%	142	454	367	259	118	104
25%	179	525	427	331	161	141
50%	212	618	504	432	207	181
75%	260	723	602	545	252	222
80%	273	758	631	572	261	233
90%	333	934	732	659	307	262
95%	361	1090	861	745	335	290
99%	412	1430	1,140	996	432	361

TABLE 3.2b. Recommended Breathing Rate Distributions (M^3/day) by Age Group for Stochastic Analysis

	3rd Trimester	0<2 years	2<9 years	2<16 years	16<30 years	16-70 years
Distribution	Logistic	Log-normal	Log-normal	Log-normal	Logistic	Log-normal
Minimum	4.0	0.8	2.7	2.7	1.5	1.8
Maximum	29.0	20.1	31.7	52.3	75.4	75.4
Scale	2,403.72				2,992.97	
Location		-650.7	-1,072.82	598.92		-8,251.33
Mean	15.1	6.2	10.7	13.3	15.0	13.9
Std Dev	4.3	2.6	3.1	4.9	5.4	5.4
Skewness	0.48	1.06	0.912	1.39	1.16	1.42
Kurtosis	3.73	4.69	5.18	7.14	12.22	11.19
Percentiles						
5%	8.6	2.9	6.1	6.9	6.4	6.3
10%	10.4	3.3	6.9	8.1	8.5	7.6
25%	12.3	4.4	8.5	9.9	11.8	10.3
50%	15.1	5.8	10.4	12.3	14.7	13.6
75%	17.6	7.6	12.4	15.9	18.0	16.8
80%	18.2	8.1	13.0	16.7	18.9	17.6
90%	21.4	9.6	14.8	19.5	21.5	20.1
95%	23.4	11.2	16.4	22.6	23.5	22.9
99%	28.8	13.9	20.0	28.1	29.9	28.0

3.2.2. Eight-hour Breathing Rate Point Estimates

The 8-hour breathing rates are based on minute breathing rates derived by U.S. EPA (2009). The minute ventilation rates, presented in Section 3.6, were multiplied by 480 (60 min x 8) to generate 8-hour breathing rate point estimates shown in Table 3.3. The 8-hour breathing rates may be useful for cancer risk assessment for the off-site worker exposure scenario, and school exposures to facility emissions. They may also be useful for evaluating residential exposures where the facility operates non-continuously. The 8-hour breathing rates vary depending on the intensity of the activity. Exposed individuals may be engaged in work activities ranging from watching TV to desk work, which would reflect breathing rates of sedentary/passive or light activities, to yard work or farm worker activities, which would reflect breathing rates of moderate intensity or greater. Breathing rates resulting from high intensity activities generally cannot be sustained for an 8-hour period (see Section 3.6).

OEHHA recommends using point estimate 8-hour breathing rates in L/kg-8-hrs based on the mean and 95th percentile of moderate intensity activities, 170 and 230 L/kg-8-hrs, respectively, for screening level risk assessments. Point estimates for lower breathing rates of sedentary/passive and light intensity work activities may be used in site-specific scenarios (i.e., work in which activity is limited to desk jobs or similar work). Pregnant women will generally participate in lower intensity activities than non-pregnant women, but as shown in Tables 3.1 and 3.2, breathing rate normalized to body weight will be slightly greater than breathing rates of adult men and non-pregnant women combined. OEHHA recommends using the mean and 95th percentile 8-hour breathing rates based on moderate intensity activity for third trimester women.

Table 3.3a. Eight Hour Breathing Rate (L/kg-8 Hr) Point Estimates for ~~(~~Males and Females Combined~~)~~

	0<2 years	**2<9 years**	**2<16 years**	**16<30 years**	**16-70 years**
	Sedentary & Passive Activities (METS ≤ 1.5)				
Mean	200	100	80	30	30
95th Percentile	250	140	120	40	40
	Light Intensity Activities (1.5 < METs ≤ 3.0)				
Mean	490	250	200	80	80
95th Percentile	600	340	270	100	100
	Moderate Intensity Activities (3.0 < METs ≤ 6.0)				
Mean	890	470	380	170	170
95th Percentile	1200	640	520	240	230

Table 3.3b. Eight-Hour Breathing Rate (M^3/8-Hr) Point Estimates for ~~Estimating Breathing Rates During the School Day~~ , ~~(~~Males and females Combined~~)~~

	0<2 years	**2<9 years**	**2<16 years**	**16<30 years**	**16-70 years**
	Sedentary & Passive Activities (METS ≤ 1.5)				
Mean	1.86	2.24	2.37	2.33	2.53
95th Percentile	2.69	2.99	3.20	3.23	3.34
	Light Intensity Activities (1.5 < METs ≤ 3.0)				
Mean	4.61	5.44	5.66	5.72	6.03
95th Percentile	6.51	7.10	7.52	7.75	7.80
	Moderate Intensity Activities (3.0 < METs ≤ 6.0)				
Mean	8.50	10.20	10.84	12.52	12.94
95th Percentile	12.36	13.47	14.52	18.08	18.07

~~For facility emissions that occur only during waking hours, 8-hour breathing rates based on light activities (METs values exceeding 1.5 to ≤3.0) or moderate activities (METs values exceeding 3.0 to ≤6.0) should be used. Basing 8-hour breathing rates on high intensity activities (MET values >6.0) were not considered here because even at the 95th percentile, U.S. EPA (2009) showed that individuals spent only about 1 hour or less per day at this intensity. For moderate intensity activities, the 95th percentile was at or~~

~~near 8 hours/day for some age groups. For the most activities that occur around the home or workplace, such as outdoor chores around the house or farming/service/machinist jobs (as discussed below in Section 3.6), using the mean or 95th percentile minute breathing rate of moderate intensity activities is recommended. The 95th percentile for light activities may be chosen for such activities as reading, completing homework and administrative office work~~.

3.2.3. Short-term (1-Hour) Ventilation Rate Point Estimates

One-hour breathing rates (Tables 3.4a-b) were calculated from U.S. EPA (2009) minute ventilation rates (e.g., minute ventilation rate x 60) to meet the SB-352 mandate for school districts to conduct a risk assessment for school sites located within 100 M of a freeway or busy roadway. These breathing rates allow assessment of exposures to facility emissions during the course of the school day.

The age groups for children mostly deviate from those child age groupings designed for AB2588. The 1-hour age groups attempt to address specific school categories (e.g., kindergarten, grade school, high school) under SB-352. However, if 1-hr breathing rates are required that fit the AB2588 age groups, 1-hr breathing rates can be calculated from the 8-hr breathing rates shown in Tables 3.28a-b.

Table 3.4a. One-Hour Breathing Rates for SB352 School Sites in L/kg-60 min (Males and Females Combined)

	0<2 Years	**2<6 years**	**6<11 years**	**11<16 years**	**16-70 years**
	Sedentary & Passive Activities (METS ≤ 1.5)				
Mean	25	17	10	6	4
95th Percentile	31	23	14	8	5
	Light Intensity Activities (1.5 < METS ≤ 3.0)				
Mean	61	41	23	14	10
95th Percentile	75	54	32	19	13
	Moderate Intensity Activities (3.0 < METS ≤ 6.0)				
Mean	110	76	44	28	21
95th Percentile	140	100	62	39	29
	High Intensity Activities (METS ≥ 6.0)				
Mean	-	140	82	55	38
95th Percentile	-	190	110	80	56

Table 3.4b. One-Hour Breathing Rates for SB352 School Sites in M^3/60 min (Males and Females Combined)

	0<2 Years	2<6 years	6<11 years	11<16 years	16-70 years
	Sedentary & Passive Activities (METS ≤ 1.5)				
Mean	0.23	0.27	0.29	0.33	0.32
95th Percentile	0.34	0.36	0.39	0.45	0.42
	Light Intensity Activities (1.5 < METS ≤ 3.0)				
Mean	0.58	0.68	0.68	0.76	0.75
95th Percentile	0.81	0.86	0.91	1.03	0.97
	Moderate Intensity Activities (3.0 < METS ≤ 6.0)				
Mean	1.06	1.25	1.30	1.50	1.62
95th Percentile	1.54	1.63	1.73	2.05	2.26
	High Intensity Activities (METS ≥ 6.0)				
Mean	-	2.24	2.49	2.92	3.01
95th Percentile	-	2.98	3.51	4.18	4.39

For children at school, MET activity levels equivalent to sitting at a desk during instruction and outside at play can be used as guidance for determining 1-hour breathing rates. As shown in Table 3.26 below, sitting was assigned a MET of 1.5, while play outdoors, recess and physical education had mean MET values in the range of 4.5 to 5.0 (U.S. EPA, 2009). Thus, 1-hour breathing rates based on sedentary/passive or light activities to represent activities within the class room and moderate intensity activities to represent activities during recess and some physical education classes, are recommended.

U. S. EPA (2009) also determined ventilation rates for high intensity activities with MET values ≥ 6.0. The distributions generated by U.S. EPA for hrs/day spent at MET values ≥6.0 for infants (age 0<2 yrs) suggests that this level of activity is unlikely for this age group. However, there is a subgroup of children in the older child age groups that exercise at this level for at least one hr/day, although this level of activity may not happen all in one hour's time. OEHHA recommends using 1-hr high intensity breathing rates for after-school sports and training that require high energy output such as track, football, tennis etc. This MET category may also be used for demanding sports during physical education classes.

3.~~2~~3 ~~Methods Used to~~ Estimati~~on~~one ~~of~~ Daily Breathing Rates

3.3.1 Inhalation Dose and Cancer Risk

The approach to estimating cancer risk from long-term inhalation exposure to carcinogens requires calculating a range of potential doses and multiplying by cancer potency factors in units of inverse dose to obtain a range of cancer risks. This range reflects variability in exposure rather than in the dose-response. In equation 3-1, the daily breathing rate (L/kg BW-day) is the variate which is varied for each age group.

The general algorithm for estimating dose via the inhalation route is as follows:

$$DOSEair = Cair \times [BR/BW] \times A \times EF \times (1 \times 10^{-6}) \quad \textbf{(Eq. 3-1)}$$

where:

DOSEair	= dose by inhalation (mg/kg BW-day)
Cair	= concentration in air (µg/m^3)
[BR/BW]	= daily breathing rate normalized to body weight (L/kg BW-day)
A	= inhalation absorption factor, if applicable (default = 1)
EF	= exposure frequency (days/365 days)
1×10^{-6}	= conversion factors (mg to µg, m^3 to L)

The inhalation absorption factor (A) is a unitless factor that is only used if the cancer potency factor itself includes a correction for absorption across the lung. It is inappropriate to adjust a dose for absorption if the cancer potency factor is based on applied rather than absorbed dose. The exposure frequency (EF) is set at 350 days per year (i.e., per 365 days) to allow for a two week period away from home each year. (US EPA, (1991). Another factor may come into consideration in the inhalation dose equation, the fraction of time at home (FAH). See Chapter 11 for more details.

For cancer risk, the risk is calculated for each age group using the appropriate age sensitivity factors (ASFs) and the chemical-specific cancer potency factor (CPF), expressed in units of (mg/kg-day)$^{-1}$.

$$RISKair = DOSEair * CPF * ASF * ED/AT \quad \textbf{(Eq. 3-2)}$$

RISK is the predicted risk of cancer (unitless) over a lifetime as a result of the exposure, and is usually expressed as chances per million persons exposed (e.g., 5×10^{-6} would be 5 chances per million persons exposed).

The dose-response phase of a cancer risk assessment aims to characterize the relationship between an applied dose of a carcinogen and the risk of tumor appearance in a human. This is usually expressed as a cancer potency factor, or CPF, in the above equation. The CPF is the slope of the extrapolated dose-response curve and is expressed as units of inverse dose (mg/kg-d)$^{-1}$, or inverse concentration (µg/m^3)$^{-1}$.

Exposure duration (ED) is the number of years within the age groupings. In order to accommodate the use of the ASFs (OEHHA, 2009), the exposure for each age grouping must be separately calculated. Thus, the DOSEair and ED are different for each age grouping. The ASF, as shown below, is 10 for the third trimester and infants 0<2 years of age, is 3 for children age 2<16 years of age, and is 1 for adults 16 to 70 years of age.

ED = exposure duration (yrs):

0.25 yrs for third trimester	(ASF = 10)
2 yrs for 0<2 age group	(ASF = 10)

7 yrs for 2<9 age group (ASF = 3)
14 yrs for 2<16 age group (ASF = 3)
14 yrs for 16<30 age group (ASF = 1)
54 yrs for 16-70 age group (ASF = 1)

AT, the averaging time for lifetime cancer risks, is 70 years in all cases. To determine lifetime cancer risks, the risks are then summed across the age groups:

$$RISKair_{(lifetime)} = RISKair_{(3rdtri)} + RISKair_{(0<2\ yr)} + RISKair_{(2<16\ yr)} + RISKair_{(16\text{-}70yr)} \quad \textbf{(Eq. 3-3)}$$

As explained in Chapter 1, we also need to accommodate cancer risk estimates for the average (9 years) and high-end (30 years) length of time at a single residence, as well as the traditional 70 year lifetime cancer risk estimate. For example, assessing risk in a 9 year residential scenario assumes exposure during the most sensitive period, from the third trimester to 9 years of age and would be presented as follows:

$$RISKair_{(9\text{-}yr\ residency)} = RISKair_{(3rdtri)} + RISKair_{(0<2\ yr)} + RISKair_{(2<9\ yr)} \quad \textbf{(Eq. 3-4)}$$

For 30-year residential exposure scenario, the 2<16 and 16<30 age group RISKair would be added to the risk from exposures in the third trimester and ages 0<2yrs. For 70 year residency risk, Eq 3-3 would apply.

3.3.2 Methods for Estimating Daily Breathing Rates

Two basic techniques have been developed to indirectly estimate daily breathing rates: the time-activity-ventilation (TAV) approach and an energy expenditure derivation method. Ideally, daily breathing rates would be directly measured. However, the equipment for direct measurement is bulky and obtrusive and thus impractical for measuring breathing rates over an entire 24-hour period, especially on children performing their typical activities. Thus, ventilation measurements are typically taken for shorter time periods under specific conditions (e.g., running or walking on a treadmill).

The TAV approach relies on estimates or measurements of ventilation rates at varying physical activity levels, and estimates of time spent each day at those activity levels. An average daily breathing rate is generated by summing the products of ventilation rate (L/min) and time spent (min/day) at each activity level.

The second approach derives breathing rates based on daily energy expenditure and was first proposed by Layton (1993). Layton reasoned that breathing rate is primarily controlled by the amount of oxygen needed to metabolically convert food into energy the body can use. Because the volume of oxygen required to produce one kcal of energy and the ratio of the volume of oxygen consumed to the volume of air inhaled per unit time are both constant values, the amount of energy a person expends is directly proportional to the volume of air the person breathes. Layton (1993) developed an

equation that models this relationship and that can be used to derive breathing rates from energy expenditure data:

$$VE = H \times VQ \times EE \qquad \text{(Eq. 3-~~1~~5)}$$

where:

VE = the volume of air breathed per day (L/day),
H = the volume of oxygen consumed to produce 1 kcal of energy (L/kcal),
VQ = the ratio of the volume of air to the volume of oxygen breathed per unit time and is referred to as the breathing equivalent (unitless)
EE = energy (kcal) expended per day

Layton calculated an H value of 0.21 L/kcal for noninfant children. Arcus-Arth and Blaisdell (2007) calculated essentially the same H value of 0.22 L/kcal from data of non-breastfed infants based on food surveys. For VQ, Layton calculated a value of 27 from adult data. Children have different respiratory minute ventilation rates, as well as other respiratory parameter values, relative to adults. Therefore, children's VQ values can be different from those of adults. Arcus-Arth and Blaisdell (2007) calculated VQ values for children from which daily breathing rates can be derived (Table 3.~~1~~5).

Table 3.~~1~~5. Mean VQ Values Calculated for Children

	Weighted mean VQ	**Recommended VQ**
Infants 0-11 mo.	nd[a]	33.5
Boys & girls 1-3 yrs	nd[a]	33.5
Boys & girls 4-8 yrs	33.5	33.5
Boys 9-18 yrs	30.6	30.6
Girls 9-18 yrs	31.5	31.5

[a] Insufficient or no data

Three variations of estimating EE have been used based on conversion of metabolic energy to derive a breathing rate: (1) from the caloric content of daily food intake, (2) as the product of basal metabolic rate (BMR) and ratios of average daily energy expenditure to BMR, and (3) as time-weighted averages of energy expenditure (expressed as multiples of BMR) across different levels of physical activity during the course of a day. Published reports applying these variations in metabolic energy conversion to arrive at breathing rates using Layton's equation are summarized below.

In addition to using energy intake data with Layton's method to derive breathing rates, an approach called the doubly labeled water (DLW) technique has also been used to derive total energy expenditure and is summarized below. The DLW data have been shown to be quite accurate, but the approach has only been applied to specific sub-populations.

3.~~3~~4 Available Daily Breathing Rate Estimates

There are a number of sources of information on daily breathing rates for various age groups and other subpopulations that have been derived via the methods described above. Some sources have compiled breathing rates from other studies.

3.~~3~~4.1 Traditional Breathing Rate Estimation

The book Reference Man (Snyder et al., 1975), a report by the International Commission on Radiological Protection (ICRP), presents breathing rates based on about 10 limited studies. Using an assumption of 8 hour (hr) resting activity and 16 hr light activity and the breathing rates (see Table 3.6), ICRP recommended daily breathing rates of 23 m^3/day for adult males, 21 m^3/day for adult females, and 15 m^3/day for a 10 year old child ~~(Table 3.2)~~. In addition, assuming 10 hr resting and 14 hr light activity each day, ICRP recommends a daily breathing rate of 3.8 m^3/day for a 1 year old. Finally, assuming 23 hr resting and 1 hr light activity, ICRP recommends a daily breathing rate of 0.8 m^3/day for a newborn. The breathing rates estimated by the ICRP used sources that had a small sample size and were limited in scope. Table 3.~~2~~6 is the minute volume data upon which the daily breathing rates were based.

Table 3.~~2~~6. Minute Volumes from ICRP'S Reference Man [a]

	Resting L/min (m^3/hr)	Light Activity L/min (m^3/hr)
Adult male	7.5 (0.45)	20 (1.2)
Adult female	6.0 (0.36)	19 (1.14)
Child, 10 yr	4.8 (0.29)	13 (0.78)
Child, 1 yr	1.5 (0.09)	4.2 (0.25)
Newborn	0.5 (0.03)	1.5 (0.09)

[a] Data compiled from available studies measuring minute volume at various activities by age/sex categories

This report provided the approach used in traditional risk assessment, in that a single estimate of daily breathing was employed, often 20 m^3/day for a 70-kg person.

3.~~3~~4.2 Daily Breathing Rate Estimates Based on Time-Activity-Ventilation (TAV) Data

3.~~3~~4.2.1 Marty et al. (2002)

Marty et al. (2002) derived California-specific distributions of daily breathing rates using estimates and measurements of ventilation rates at varying physical activity levels, and estimates of time spent each day at those activity levels. Two activity pattern studies were conducted in which activities of a randomly sampled population of 1762 adults and 1200 children were recorded retrospectively for the previous 24 hours via telephone interview (Phillips et al., 1991; Wiley et al., 1991a; Wiley et al., 1991b; Jenkins et al., 1992). Measured breathing rates in people performing various laboratory and field protocols were conducted by Adams et al. (1993). The subjects in this study were 160 healthy individuals of both sexes, ranging in age from 6 to 77 years. An additional forty 6 to 12 year olds and twelve 3 to 5 year olds were recruited for specific protocols.

For adults, each activity was assigned to a resting, light, moderate, moderately heavy, or heavy activity category to reflect the ventilation rate that could reasonably be associated with that activity. For children there were only resting, light, moderate, and heavy activity categories. The ventilation rates were classified into similar levels (e.g., the lying down protocol was considered the resting category of ventilation rate). The measured ventilation for each individual in the lab and field protocols was divided by that person's body weight. For each individual, the time spent at each activity level was summed over the day. The mean ventilation rate for each category (resting, etc.) was then multiplied by the summed number of minutes per day in that category to derive the daily breathing rate for each category. The breathing rates were then summed over categories to give a total daily breathing rate. The moments and percentiles for the raw derived breathing rates as well as for the breathing rates fit to a gamma distribution are presented in Tables 3.~~3~~7 and 3.~~4~~8 for the combined group of adolescents and adults (i.e., >12 years age) and for children (<12 years age). OEHHA staff also derived distributions of breathing rates for the equivalent of a 63-kg adult and an 18-kg child. These breathing rates form the basis of the current risk assessment guidelines (OEHHA, 2000), which this document is revising.

Table 3.~~3~~ 7 Children's (<12 Years) Daily Breathing Rates (L/Kg-Day)

	Moments and Percentiles from Empirical Data	**Moments and Percentiles, Fitted Gamma Parametric Model**	**Breathing Rate Equivalent for a 18 kg Child, m^3/Day (Empirical Data)**
N	1200		
Mean	452	451	8.1
Std Dev	67.7	66.1	1.22
Skewness	0.957	0.9	
Kurtosis	1.19	4.32	
%TILES	**L/kg-day**		
1%	342.5	(not calculated)	6.17
5%	364.5	360.3	6.56
10%	375	374.9	6.75
25%	401.5	402.7	7.23
50%	441	440.7	7.94
75%	489.5	488.4	8.81
90%	540.5	537.9	9.73
95%	580.5	572.1	10.5
99%	663.3	(not calculated)	11.9
Sample Max	747.5		13.5

Table 3.~~4~~ 8 Adult/Adolescent (>12 Years) Breathing Rates (L/kg-Day)

	Moments and Percentiles from Empirical Data	**Moments and Percentiles, Fitted Gamma Parametric Model**	**Breathing Rate Equivalent for a 63 kg Adult, m^3/Day**
N	1579		
Mean	232	233	14.6
Std Dev	64.6	56.0	4.07
Skewness	2.07	1.63	
Kurtosis	6.41	6.89	
%TILES	**L/kg-day**		
1%	174	(Not calculated)	11.0
5%	179	172.3	11.3
10%	181	178.0	11.4
25%	187	192.4	11.8
50%	209	218.9	13.2
75%	254	257.9	16.0
90%	307	307.8	19.3
95%	381	342.8	24.0
99%	494.0	(Not calculated)	31.1
Sample Max	693		43.7

Advantages of these rates are that the activity pattern data were from a large randomly sampled population of California adults and children, and that ventilation rates were normalized by body weight for each individual in the ventilation rate study. However, body weight information was not available for the activity pattern subjects. Measured breathing rates during specified activities were also collected from California participants with the intention that the data would be used in conjunction with the activity pattern data to derive daily breathing rates.

Limitations include the use of one-day activity pattern survey data that may tend to overestimate long-term daily breathing rates because both intraindividual variability and interindividual variability are poorly characterized. However, intraindividual variability is believed to be small relative to interindividual variability, which would make the breathing rate distributions reasonably accurate for chronic exposure assessment. Despite these limitations, the derived breathing rates were reasonably similar to those measured by the doubly-labeled water method (described in (OEHHA, 2000)).

Because the time-weighted average method involves professional judgment in assigning a breathing rate measured during a specific activity to various other types of activities, some uncertainty is introduced into the resulting daily breathing rates. Lastly, there is a paucity of breathing rate data for specific activities in children in the 3 to 6

year age range, and no data for children and infants younger than 3 years old. Thus, only a broad age range (i.e., < 12 years old) could be used for estimating daily breathing rates in children. Daily breathing rates cannot be reliably estimated from this study for children and infants over narrow age ranges, such as the critical 0<2 year age group.

3.~~3~~4.2.2 Allan et al. (2008)

Allan et al. (2008) also estimated breathing rates for specified age groups by the TAV approach, but employed a greater number of time-activity data sets than that used by Marty et al. (2002). This study updated TAV inhalation rate distributions from a previous report by Allan and Richardson (1998) by incorporating supplemental minute volume and time-activity data, and by correlating minute volume with metabolic equivalents (METs) for performing the physical activities at the time of measurement. Published time-activity and minute volume data used by Marty et al. (2002) were also used by the authors to develop the distributions (Wiley et al., 1991a; Wiley et al., 1991b; Adams, 1993), but also a number of other reports primarily conducted in the USA and Canada.

Their TAV approach calculated mean expected breathing rates for five different activity levels (i.e., level 1 – resting; level 2 – very light activity; level 3 – light activity; level 4 – light to moderate activity, level 5 – moderate to heavy activity). For infants, only three levels of activity were defined (i.e., sleeping or napping, awake but not crying, and crying).

Probability density functions describing 24-hour inhalation rates were generated using Monte Carlo simulation and can be described with lognormal distributions. Table 3.~~5~~ 9 presents the estimated breathing rates in m^3/day for males and females (combined) by age groupings commonly used in Canada for risk assessment purposes. In their report, Allan et al. (2008) also provided breathing rates for males and females separately. However, breathing rate distributions adjusted for body weight (**m^3**/day-kg) were not included in the report.

Table 3.~~5~~9. Allan et al. (2008) TAV-Derived Daily Breathing Rates (m^3/Day) for Males And Females Combined

Age Category	**Males and Females Combined (m^3/day)**			
	Mean + SD	**50%-ile[a]**	**90%-ile[a]**	**95%-ile[a]**
Infants (0-6 mo)	2.18 ± 0.59	2.06	2.87	3.12
Toddlers (7 mo-4 yr)	8.31 ± 2.19	7.88	10.82	11.72
Children (5-11 yr)	14.52 ± 3.38	13.95	18.49	19.83
Teenagers (12-19 yr)	15.57 ± 4.00	14.80	20.09	21.69
Adults (20-59 yr)	16.57 ± 4.05	15.88	21.30	22.92
Seniors (60+ yr)	15.02 ± 3.94	14.35	19.72	21.36

[a] Percentiles provided courtesy of Allan (e-mail communication)

Allen et al. (2008) compared the breathing rate distribution derived by the DLW method (see below, Table 3.12) to their TAV breathing rate probability density function results and found that there appeared to be longer tails in the upper bounds for all age groups

except teenagers and infants for the TAV method, suggesting the TAV distribution gives a better representation of the more exposed members of the population such as athletes. For teenagers, the TAV and DLW distributions show considerable overlap. But for infants, lower breathing rates were observed by the TAV approach compared with the DLW approach. The authors could not explain this discrepancy. Unlike the Marty et al. (2002) study, daily breathing rates could be estimated in infants and toddlers. However, there is still a shortage of TAV data in children in the younger age groups relative to adults.

Uncertainty was reduced by grouping activities by expected METs. However, Allen et al. (2008) noted that there is still uncertainty about actual physical exertion at an activity level because of the way some source studies grouped activities (e.g., grouping walking with running). Uncertainty was also reduced by using, wherever possible, studies that documented all activities over a multi-day period rather than studies that considered only a few hours of behavior. Nevertheless, there is some uncertainty in combining data from disparate studies and in assigning ventilation rates to activities that are not described by energy expenditure levels. In particular, interpolations and extrapolations were used to fill in minute volume data gaps and may have resulted in overestimates or underestimates. For example, minute volume data for some activity levels in toddlers and children were considered insufficient to adequately characterize their minute volumes.

3.~~3~~4.3 Daily Breathing Rate Estimates Based on Energy Expenditure

As discussed above, Layton (1993) developed a mathematical equation to estimate daily breathing rates based on energy expenditure. The paper also presented examples of breathing rates that had been derived using this method.

3.~~3~~4.3.1 Layton (1993)

Layton took three approaches to estimating breathing rates from energy estimates. The first approach used the U.S.D.A.'s National Food Consumption Survey (1977-78) data to estimate energy (caloric) intake. The National Food Consumption Survey used a retrospective questionnaire to record three days of food consumption by individuals in households across the nation, and across all four seasons. Layton recognized that food intake is underreported for individuals 9 years of age and older in these surveys and therefore adjusted the reported caloric intake for these ages. These data are no longer the most current population based energy intake data available. Further, the breathing rates are not normalized to body weight.

The second approach to estimating breathing rates multiplied the BMR estimated for a given age-gender group by the estimated ratio of energy intake to basal metabolic rate (EFD/BMR) for that age-gender group. The BMR can be determined as a linear function of body weight, after accounting for gender and age. An activity multiplier can then be applied which is derived from previously reported ratios of daily food intake to

BMR. The advantages of this approach include linking breathing rates to BMR, which is valuable since breathing rates are considered to be determined primarily by BMR.

However, the BMR for each age-gender group was calculated from equations derived from empirical but non-representative data. Further, these data were collected using techniques that may be outdated (e.g., for the 0-3 year age group, 9 of the 11 studies were conducted between 1914 and 1952). These data may no longer be representative of the current population. The EFD/BMR ratios for males and females over 18 years of age were estimated from data collected over one year in one study while those for other age groups were estimated based on the consistency of the value in calculating energy expenditures similar to other studies. Average body weights do not capture the variability of body weights in the population. Thus the BMR values may not be as accurate as current technology can provide nor are they representative of the population.

Layton's third approach to calculate daily breathing rates involves the metabolic equivalent (MET) approach, which is a multiple of the BMR and reflects the proportional increase in BMR for a specific activity. For example, the MET for standing is 1.5 (i.e., 1.5*BMR), and the MET for cycling and swimming is 5.3. Layton categorized METs into 5 levels (from light activity with a MET = 1 to very strenuous activities with a MET = 10). MET levels were then assigned to each activity in a study that had categorized activities by energy expenditure level and recorded the time study participants spent at each activity. The energy expended at each activity was converted to a breathing rate and then summed over the day to give a daily breathing rate. However, the time-activity data used in this approach were only available for ages over 18 years.

The results of Layton's approaches are presented in Table 3.~~6~~10. Layton did not report statistical distributions of the breathing rates that he derived. Other limitations, for our purposes, are that the breathing rates in Table 3.6 are not representative of the current U.S. population, are not normalized to body weight, and were for broad age ranges. In addition, no distributions were reported in the paper.

Table 3.~~6~~10. Layton (1993) Estimates of Breathing Rate Based on Caloric and Energy Expenditure

Method	Breathing Rate – Men m^3/day	Breathing Rate – Women m^3/day
Time-weighted average lifetime breathing rates based on food intake	14	10
Average daily breathing rates based on the ratio of daily energy intake to BMR	13-17 (over 10 years of age)	9.9-12 (over 10 years of age)
Breathing rates based on average energy expenditure	18	13

Finley et al. (1994) presented probability distributions for several exposure factors, including inhalation rates. Based on the data Layton used to derive point estimates via his third approach (i.e., with energy expenditure equivalent to a multiple of BMR), Finley et al. (1994) expanded on Layton's results to develop a probability distribution for breathing rate for several age groups (Table 3.~~7~~11).

Table 3.~~7~~11. Selected Distribution Percentiles from Finley et al. (1994) for Breathing Rates by Age

Age Category (years)	Percentile (m^3/day)		
	50th	90th	95th
<3	4.7	6.2	6.7
3 -10	8.4	10.9	11.8
10 – 18	13.1	17.7	19.3
18 – 30	14.8	19.5	21.0
30 – 60	11.8	15.4	16.7
>60	11.9	15.6	16.7

Because Finley largely used the same data as Layton to develop breathing rate distributions, the same limitations apply.

3.~~3~~4.3.2 Arcus-Arth and Blaisdell (2007)

Arcus-Arth and Blaisdell (2007) derived daily breathing rates for narrow age ranges of children and characterized statistical distributions for these rates. The rates were derived using the metabolic conversion method of Layton (1993) and energy intake data (calories consumed per day) from the Continuing Survey of Food Intake of Individuals (CSFII) 1994–1996, 1998 conducted by the USDA (2000). The CSFII provided the most recent population based energy data at the time. The CSFII dataset consisted of two days of recorded food intake for each individual along with self-reported body weights. The individual data allowed for the assessment of interindividual variability. Because one-day intakes may be less typical of average daily intake, the two-day intakes were averaged to obtain a better estimate of typical intake available from these limited repeated measures. The CSFII energy intakes were weighted to represent the U.S. population. The rates were intended to be more representative of the current U.S. children's population than prior rates that had been derived using older or non-representative data.

The premise for Layton's equation is that breathing rate is proportional to the oxygen required for energy expenditure. While there are no energy expenditure data that are representative of the population, there are population representative energy intake data (i.e., calories consumed per day). Energy intake data can be used in Layton's equation when energy intake equals energy expenditure. Energy intake is equal to energy expended when the individual is neither gaining nor losing body weight (i.e., all energy intake is expended). Because the percentage of daily energy intake that is needed to result in a discernible change in body weight for adults is very small, it can be assumed that for adults energy intake equals energy expended. However, in young infants, a

significant portion of their daily energy intake is deposited in new tissue (e.g., adipose, bone and muscle). The deposited energy is referred to as the energy cost of deposition (ECD). Therefore, the daily energy intake needed for normal growth of infants is used both for energy expenditure (EE) and ECD (i.e., energy intake = EE + ECD). If the breathing rate is to be estimated by the caloric intake approach for growing infants, the ECD must be subtracted from the total daily energy intake in order to determine an accurate breathing rate.

Accounting for the ECD is primarily important for newborn infants (Butte et al., 1990; Butte et al., 2000). For example, at ages 3 and 6 months the energy cost for growth constituted 22 and 6%, respectively, of total energy requirements. In older children the energy cost is only 2-3% of total energy requirements. By the age of 25 years in males and 19 years in females, the ECD has essentially decreased to zero and remains at that level throughout adulthood (Brochu et al., 2006a).

Because Layton's equation requires only energy expenditure to derive the breathing rate, a small modification to Eq. 3-~~1~~ 5 is made when deriving the infant breathing rate using the caloric intake approach:

$$VE = H \times VQ \times (TDEI - ECD) \times 10^{-3} \qquad \text{(Eq. 3-~~2~~6)}$$

where:

TDEI = Total daily energy intake (kcal/day)
ECD = Daily energy cost of deposition (kcal/day)

Arcus-Arth and Blaisdell (2007) subtracted the ECD from the TDEI to give a more accurate estimate of energy expended. The ECD for each month of age for infants up to 11 months of age was estimated from Scrimshaw et al. (1996). Although there is typically a burst of growth just prior to and during adolescence, Arcus-Arth and Blaisdell did not subtract the ECD during adolescence because investigators considered it negligible relative to total energy intake (Spady, 1981; Butte et al., 1989).

Layton (1993) reported on the bias associated with underreporting of dietary intakes by older children. He calculated a correction factor for this bias (1.2) and multiplied the daily energy intake of each child nine years of age and older by 1.2. Arcus-Arth and Blaisdell, having evaluated the literature and finding Layton's adjustment to be reasonable, likewise multiplied daily energy intake of adolescent ages by 1.2.

Arcus-Arth and Blaisdell (2007) also evaluated the numerical values used by Layton for the VQ and H conversion factors in his metabolic equation. Their estimated value for the conversion factor H was similar to that found by Layton. However, they found data in the literature indicating that other values of VQ may be more specific to children than those used by Layton (see Table 3.~~1~~5). The VQ values Arcus-Arth and Blaisdell calculated were used to derive breathing rates.

Non-normalized (L/day) and normalized (L/kg-day) breathing rates shown in Tables 3.8a-e) were derived for both children and adults from the CSFII dataset using the methodology described in Arcus-Arth and Blaisdell (2007). Briefly, the CSFII used a multistage complex sampling design to select individuals to be surveyed from the population. The CSFII recommended using a Jacknife Replication (JK) statistical method (Gossett et al., 2002; Arcus-Arth and Blaisdell, 2007), which is a nonparametric technique that is preferred to analyze data from multistage complex surveys.

For each age group, the mean, standard error of the mean, percentiles (50th, 90th, and 95th) of nonnormalized and normalized breathing rates, derived as described, are presented in Tables 3.~~8~~ 12a and 3.~~9~~12b, respectively. Child breathing rates are for males and females combined, except for the 9-18 yr adolescent age group breathing rates shown at the bottom of the tables.

TABLE 3.~~8~~12a. Non-Normalized Daily Breathing Rates (L/Day) for Children and Adults Using CSFII Energy Intake and Layton's Equation

Age	Sample Size Nonweighted	Mean	SEM	50%-ile	90%-ile	95%-ile	SE of 95%-ile
Age (months)	**Infancy**						
0-2	182	3630	137	3299	5444 [1]	7104 [1]	643
3-5	294	4920	135	4561	6859	7720	481
6-8	261	6089	149	5666	8383	9760	856
9-11	283	7407	203	6959	10,212	11,772	**
0-11	1020	5703	98	5323	8740	9954	553
Age (years)	**Children**						
1	934	8770	75	8297	12,192	13,788	252
2	989	9758	100	9381	13,563	14,807	348
3	1644	10,642	97	10,277	14,586	16,032	269
4	1673	11,400	90	11,046	15,525	17,569	234
5	790	12,070	133	11,557	15,723	18,257	468
6	525	12,254	183	11,953	16,342	17,973	868
7	270	12,858	206	12,514	16,957	19,057	1269
8	253	13,045	251	12,423	17,462	19,019	1075
9	271	14,925	286	14,451	19,680	22,449 [1]	1345
10	234	15,373	354	15,186	20,873	22,898 [1]	1021
11	233	15,487	319	15,074	21,035	23,914 [1]	1615
12	170	17,586	541	17,112	25,070 [1]	29,166 [1]	1613
13	194	15,873	436	14,915	22,811 [1]	26,234 [1]	1106
14	193	17,871	615	15,896	25,748 [1]	29,447 [1]	4382
15	185	18,551	553	17,913	28,110 [1]	29,928 [1]	1787
16	201	18,340	536	17,370	27,555	31,012	2065
17	159	17,984	957	15,904	31,421 [1]	36,690 [1]	**
18	135	18,591	778	17,339	28,800 [1]	35,243 [1]	4244
0<2	1954	7502	75	7193	11,502	12,860	170
2<16	7624	14,090	120	13,128	20,993	23,879	498
	Adolescent Boys						
9-18	983	19,267	278	17,959	28,776	32,821	1388
	Adolescent Girls						
9-18	992	14,268	223	13,985	21,166	23,298	607

[1] Value may be less statistically reliable than other estimates due to small cell size

** Unable to calculate

Table 3.~~9~~12b. Normalized Daily Breathing Rates (L/kg-Day) for Children and Adults Using CSFII Energy Intake and Layton's Equation

Age	Sample Size Nonweighted	Mean	SEM	50%-ile	90%-ile	95%-ile	SE of 95%-ile
Age (months)	**Infancy**						
0-2	182	839	42	725	1305	1614	290
3-5	294	709	24	669	1031	1232	170
6-8	261	727	16	684	1017	1136	73
9-11	283	760	20	710	1137	1283	96
0-11	1020	751	11	694	1122	1304	36
Age (years)	**Children**						
1	934	752	7	716	1077	1210	33
2	989	698	9	670	986	1107	31
3	1644	680	6	648	966	1082	18
4	1673	645	5	614	904	1011	19
5	790	602	7	587	823	922	25
6	525	550	10	535	765	849	28
7	270	508	9	495	682	788	39
8	253	458	11	439	657	727	37
9	271	466	11	445	673	766 [1]	21
10	234	438	12	425	661	754 [1]	38
11	233	378	9	350	566	616 [1]	32
12	170	373	13	356	545 [1]	588 [1]	46
13	194	311	12	289	459 [1]	588 [1]	55
14	193	313	12	298	443 [1]	572 [1]	92
15	185	299	10	285	461 [1]	524 [1]	25
16	201	278	10	258	434	505	46
17	159	276	15	251	453 [1]	538 [1]	**
18	135	277	10	244	410 [1]	451 [1]	42
0<2	1954	752	6	706	1094	1241	24
2<16	7624	481	3	451	764	869	6
	Adolescent Boys						
9-18	983	367	5	343	567	647	14
	Adolescent Girls						
9-18	992	315	6	288	507	580	24

[1] Value may be less statistically reliable than other estimates due to small cell size
** Unable to calculate

Ideally, breathing rates and other variates used in risk assessment should be as representative as possible of the exposed population. Population representative daily energy (caloric) intake can be estimated from national food consumption surveys, such as the CSFII and the National Health and Nutrition Examination Survey (NHANES). These surveys can be analyzed to provide results that are representative of the nation

and of several subpopulations, including narrow age groups. The sample sizes are large with these surveys and thus provide relatively robust results, which is of particular concern for the tails of probability distributions.

Limitations for the CSFII energy intake-derived breathing rates include the underreporting of food intakes discussed above. Underestimation of energy intake leads to underestimation of breathing rates. Another limitation is that only two days of food intake data had been collected. Although collection of two consecutive days of food intake is an improvement over earlier collections of one day of food intake, the repeated measures in the survey were still too limited to reduce the impact of daily variations in food intake and would tend to overestimate the upper and lower percentiles. Typical intake is not captured by the caloric intake of two days, and breathing rate and dietary intake on any given day are not tightly coupled.

3.~~3~~4.3.3. US EPA (2009) Metabolic Equivalent-Derived Daily Breathing Rate Estimates

Similar to one of the approaches Layton (1993) used to estimate the breathing rate, U.S. EPA employed a metabolic equivalent (METS) approach for estimating breathing rates. This method determines daily time-weighted averages of energy expenditure (expressed as multipliers of the basal metabolic rate) across different levels of physical activity. METs provide a scale for comparing the physical intensities of different activities. Recent energy expenditure data including the 1999-2002 NHANES and U.S EPA's Consolidated Human Activity Database (CHAD) were used that considers variability due to age, gender, and activities. NHANES (CDC, 2000; 2002) was used as the source of body weight data, and CHAD (U.S. EPA, 2002) was the central source of information on activity patterns and METS values for individuals. The 4-year sampling weights assigned to the individuals within NHANES 1999-2002 were used to weight each individual's data values in the calculations of these statistics.

Data were grouped into age categories and a simulated 24-hour activity pattern was generated by randomly sampling activity patterns from the set of participants with the same gender and age. Each activity was assigned a METS value based on statistical sampling of the distribution assigned by CHAD to each activity code. Using statistical software, equations for METS based on normal, lognormal, exponential, triangular and uniform distributions were generated as needed for the various activity codes. The METS values were then translated into energy expenditure (EE) by multiplying the METS by the basal metabolic rate (BMR), which was calculated as a linear function of body weight. The VO2 was calculated by multiplying EE by H, the volume of oxygen consumed per unit energy.

The inhalation rate for each activity within the 24-hour simulated activity pattern for each individual was then estimated as a function of VO2, body weight, age, and gender. Following this, the average inhalation rate was calculated for each individual for the entire 24-hour period, as well as for four separate classes of activities based on METS value (sedentary/passive [METS less than or equal to 1.5], light intensity [METS greater

than 1.5 and less than or equal to 3.0], moderate intensity [METS greater than 3.0 and less than or equal to 6.0], and high intensity [METS greater than 6.0]. Data for individuals were then used to generate summary tables with distributional data based on gender and age categories (Tables 3.~~10~~ 13a and 3.~~11~~13b). No parametric distributional assumptions were placed on the observed data distributions before these statistics were calculated.

Table 3.~~10~~13a. US EPA (2009) Metabolically-Derived Daily Breathing Rate (m^3/Day in Males and Females Unadjusted For Body Weight

Age Category (years)	Means and Percentiles in m^3/day							
	Males				Females			
	Mean	**50th**	**90th**	**95th**	**Mean**	**50th**	**90th**	**95th**
Birth to <1	8.76	8.70	11.93	12.69	8.53	8.41	11.65	12.66
1	13.49	13.11	17.03	17.89	13.31	13.03	17.45	18.62
2	13.23	13.19	16.27	17.71	12.74	12.60	15.58	16.37
3 to <6	12.65	12.58	14.63	15.41	12.16	12.02	14.03	14.93
6 to <11	13.42	13.09	16.56	17.72	12.41	11.95	15.13	16.34
11 to <16	15.32	14.79	19.54	21.21	13.44	13.08	16.25	17.41
16 to <21	17.22	16.63	21.94	23.38	13.59	13.20	17.12	18.29
21 to <31	18.82	18.18	24.57	27.14	14.57	14.10	19.32	21.14
31 to <41	20.29	19.83	26.77	28.90	14.98	14.68	18.51	20.45
41 to <51	20.93	20.60	26.71	28.37	16.20	15.88	19.91	21.35
51 to <61	20.91	20.41	27.01	29.09	16.18	15.90	19.93	21.22
61 to <71	17.94	17.60	21.78	23.50	12.99	12.92	15.40	16.15

Table 3.~~11~~13b. US EPA (2009) Metabolically-Derived Daily Breathing Rate (m^3/Kg-Day) in Males and Females Adjusted for Body Weight

Age Category (years)	Means and Percentiles in m^3/kg-day							
	Males				Females			
	Mean	**50th**	**90th**	**95th**	**Mean**	**50th**	**90th**	**95th**
Birth to <1	1.09	1.09	1.26	1.29	1.14	1.13	1.33	1.38
1	1.19	1.17	1.37	1.48	1.20	1.18	1.41	1.46
2	0.95	0.94	1.09	1.13	0.95	0.96	1.07	1.11
3 to <6	0.70	0.69	0.87	0.92	0.69	0.68	0.88	0.92
6 to <11	0.44	0.43	0.55	0.58	0.43	0.43	0.55	0.58
11 to <16	0.28	0.28	0.36	0.38	0.25	0.24	0.31	0.34
16 to <21	0.23	0.23	0.28	0.30	0.21	0.21	0.27	0.28
21 to <31	0.23	0.22	0.30	0.32	0.21	0.20	0.26	0.28
31 to <41	0.24	0.23	0.31	0.34	0.21	0.20	0.27	0.30
41 to <51	0.24	0.23	0.32	0.34	0.22	0.21	0.28	0.31
51 to <61	0.24	0.24	0.30	0.34	0.22	0.21	0.28	0.30
61 to <71	0.21	0.20	0.24	0.25	0.18	0.17	0.21	0.22

US EPA (2009) described the strengths and weaknesses of their approach. The strengths of this metabolically-derived method include nationally representative data sets with a large sample size, even within the age and gender categories. This approach also yields an estimate of ventilation rate that is a function of VO2 rather than an indirect measure of oxygen consumption such as VQ as other researchers have used.

Another strength is that the breathing rates included a BMR component which had been derived from NHANES body weights and to which NHANES sampling weights were linked. The BMR component of the breathing rates was representative of the population because of the sampling weights. That is, the degree of association between body weight and breathing rate was incorporated into the distribution of breathing rate distributions.

However, the degree of association between breathing rate and other characteristics (e.g., race, geographic region) was not incorporated into the distributions (US EPA, 2009). These non-body weight characteristics can be highly associated with variability in activity patterns. Although BMR may contribute the greatest percent to the quantitative breathing rate value, the variability in breathing rates is most likely driven by differing levels of physical activity by different persons. Because the activity data was collected over a 24-hour period, day-to-day variability is not well characterized (US EPA, 2009; US EPA, 2011). The outcome is that the simulated 24-hour activity pattern assigned to an NHANES participant is likely to contain a greater variety of different types of activities than one person may typically experience in a day.

Furthermore, because the simulated activity profiles did not consider possible limits on the “maximum possible METS value” that would account for previous activities, ventilation rates may be overestimated (US EPA, 2009). This happens, in part, because the MET approach does not take into consideration correlations that may exist between body weight and activity patterns. For example, high physical activity levels can be associated with individuals of high body weight, leading to unrealistically high inhalation rates at the upper percentiles levels (US EPA 2011). The result is that the central tendency of the MET breathing rates may be fairly representative of the population, but the breathing rates may not appropriately capture the variability within the population. This limitation was probably most evident in children <3 years of age where the data used to calculate BMR values may be less representative of the current population. (US EPA, 2009).

3.~~3~~4.4. Daily Breathing Rate Estimates from Doubly Labeled Water Measurements

In another method used to quantify human energy expenditure, published doubly-labeled water (DLW) energy expenditure data can be used in conjunction with Layton’s equation to convert metabolic energy to daily inhalation rates (Brochu et al., 2006a; 2006b; Stifelman, 2007). In the DLW method, isotopically labeled water containing $^{2}H_2 0$ (i.e., heavy water) and $H_2{}^{18}0$ is given orally to the study participant.

The isotopes then distribute in the body and disappear from body water pools by dilution from new unlabeled water into the body, by the excretion of the labeled isotope from the body, or by the production of CO_2. The difference in disappearance rates between the two isotopes represents CO_2 production over an optimal period of 1–3 half-lives (7 to 21 days in most human subjects) of the labeled water. CO_2 production is an indirect measure of metabolic rate and can be converted into units of energy using knowledge of the chemical composition of the foods consumed.

A major advantage of the DLW method is that it provides an index of total energy expenditure over a period of 1 to 3 weeks, which is a more biologically meaningful period of time compared to the other methods, and can reduce the impact of daily variations in physical activity or food intake (IOM, 2005). In addition, the DLW method is non-invasive, requiring only that the subject drink the stable isotopes and provide at least three urine samples over the study period. Thus, measurements can be made in subjects leading their normal daily lives (i.e., free-living individuals). The DLW method is considered to be the most accurate method for determining the breathing rate of an individual (IOM, 2005).

A disadvantage is that the DLW method is expensive to undertake, and that essentially all the available studies investigated different age ranges but the subjects were not randomly selected to be representative of populations. However, measurements are available in a substantial number of men, women and children whose ages, body weights, heights and physical activities varied over wide ranges.

DLW measurements of total daily energy expenditures (TDEE) include basal metabolism, physical activity level, thermogenesis, and the synthetic cost of growth (Butte et al., 2000). The synthetic cost of growth is the energy that is expended to synthesize the molecules that will be stored. This is different from the energy deposited for growth (ECD), which is the energy intake that is deposited in the body for new tissue. The ECD is an important factor in newborn infants and is not accounted for in DLW measurements. Thus, the derivation of breathing rates using Layton's equation does not require an adjustment to subtract out the ECD to determine TDEE, as was necessary for deriving the breathing rates of infants by the caloric intake approach (Section 3.~~4~~5.3.2).

3.~~3~~4.4.1. Brochu et al. (2006a,b)

Brochu et al. (2006a) calculated daily inhalation rates for 2210 individuals aged 3 weeks to 96 years using DLW energy expenditure data mainly from the IOM (2005). The IOM database is a compilation of DLW-derived energy expenditure results and other raw data from individuals collected from numerous studies. Breathing rates were estimated for different groups of individuals including healthy normal-weight males and females with normal active lifestyles (n=1252), overweight/obese individuals with normal active lifestyles (n=679), individuals from less affluent societies (n=59), underweight adults (n=34), and individuals during various extreme physical activities (n=170). Normal weight adults age 20 yrs and above were categorized as having BMIs between 18.5 and

25 kg/m^2. Overweight/obese adults had BMIs above 25 kg/m^2. For children and teenagers aged 4 to 19 yrs, BMIs corresponding to the 85th percentile or below were considered normal. The breathing rate data were presented as 5th, 10th, 25th, 50th, 75th, 90th, 95th, and 99th percentile values as well as mean and SEM values for the derived inhalation rates for narrow age groups ranging from 1 month to 96 years. A partial listing of the breathing rate percentiles for normal weight individuals by age group are shown in Tables 3.~~12~~ 14a and 3.~~13~~14b.

Table 3.~~12~~14a. Means and Percentiles of Daily Breathing Rates (in m^3/Day) for Free-Living Normal-Weight Males and Females Derived from DLW Measurements by Brochu et al. (2006a)

Age Category (years)	Means and Percentiles in m^3/day									
	Males[a]					Females[a]				
	N	Mean	50th	90th	95th	N	Mean	50th	90th	95th
0.22 to <0.5	32	3.38	3.38	4.30	4.57	53	3.26	3.26	4.11	4.36
0.5 to <1	40	4.22	4.22	5.23	5.51	63	3.96	3.96	4.88	5.14
1 to <2	35	5.12	5.12	6.25	6.56	66	4.78	4.78	6.01	6.36
2 to <5	25	7.60	7.60	9.25	9.71	36	7.06	7.06	8.54	8.97
5 to <7	96	8.64	8.64	10.21	10.66	102	8.22	8.22	9.90	10.38
7 to <11	38	10.59	10.59	13.14	13.87	161	9.84	9.84	12.00	12.61
11 to <23	30	17.23	17.23	21.93	23.26	87	13.28	13.28	16.61	17.56
23 to <30	34	17.48	17.48	21.08	22.11	68	13.67	13.67	16.59	17.42
30 to <40	41	16.88	16.88	20.09	21.00	59	13.68	13.68	15.94	16.58
40 to <65	33	16.24	16.24	19.67	20.64	58	12.31	12.31	14.96	15.71
65 to <96	50	12.96	12.96	16.13	17.03	45	9.80	9.80	12.58	13.37

[a] Percentiles based on a normal distribution assumption for all age groups

Table 3.~~13~~14b. Means and Percentiles of Daily Breathing Rates (in m^3/kg-Day) for Free-Living Normal-Weight Males and Females Derived from DLW Measurements by Brochu et al. (2006a)

Age Category (years)	Mean and Percentiles in m^3/kg-day									
	Males[a]					Females[a]				
	N	Mean	50th	90th	95th	N	Mean	50th	90th	95th
0.22 to <0.5	32	0.509	0.509	0.627	0.661	53	0.504	0.504	0.623	0.657
0.5 to <1	40	0.479	0.479	0.570	0.595	63	0.463	0.463	0.545	0.568
1 to <2	35	0.480	0.480	0.556	0.578	66	0.451	0.451	0.549	0.577
2 to <5	25	0.444	0.444	0.497	0.512	36	0.441	0.441	0.532	0.559
5 to <7	96	0.415	0.415	0.475	0.492	102	0.395	0.395	0.457	0.474
7 to <11	38	0.372	0.372	0.451	0.474	161	0.352	0.352	0.431	0.453
11 to <23	30	0.300	0.300	0.360	0.377	87	0.269	0.269	0.331	0.349
23 to <30	34	0.247	0.247	0.297	0.311	68	0.233	0.233	0.287	0.302
30 to <40	41	0.237	0.237	0.281	0.293	59	0.235	0.235	0.279	0.292
40 to <65	33	0.230	0.230	0.284	0.299	58	0.211	0.211	0.257	0.270
65 to <96	50	0.188	0.188	0.228	0.239	45	0.172	0.172	0.220	0.233

[a] Percentiles based on a normal distribution assumption for all age groups

Comparing the largest subgroups (i.e., overweight/obese individuals vs. normal-weight individuals), Brochu et al. observed that overweight/obese individuals inhaled between 0.8 to 3.0 m^3 more air per day than normal-weight individuals, but their physiological daily breathing rates are 6 to 21% lower than that of their leaner counterparts when expressed in m^3/kg-day. Also of interest is that the daily inhalation rates (in m^3/kg-day) of newborns and normal-weight infants aged 2.6 to less than 6 months are 2.1 to 5.1 times higher than those of normal-weight and overweight/obese adults aged 18 to 96 years with normal lifestyles.

Besides the lack of randomly selected individuals representative of a population for estimating energy expenditure, much of the DLW data used to derive the breathing rate percentiles relied heavily on adults with sedentary lifestyles (Black et al., 1996). Occupations of many participants included professionals, white collar workers or other sedentary occupations, and almost no participants were in manual labor occupations that are known to result in higher breathing rates. Although a small group of athletic individuals appear to be included in the DLW database by Brochu et al. (2006a), it was suggested by Black et al. (1996) that not enough participants involved in manual labor are represented in the DLW database. This may result in breathing rate percentiles that are lower than what might be obtained from a population-based study. Nevertheless, as noted above, the DLW method provides an index of total energy expenditure over a period of 1 to 3 weeks, which is a better determinant of long-term breathing rate than other methods described that rely on 1 to 2 days of energy intake or expenditure to estimate long-term breathing rates. Thus, the DLW method is considered to be the most accurate method for determining an average daily breathing rate of a free-living individual.

3.~~3~~4.4.2 Stifelman (2007)

Using energy expenditure data based on extensive DLW measurements from two sources (FAO, 2004a; 2004b; IOM, 2005), Stifelman (2007) calculated inhalation rates with Layton's equation for long-term physical activity levels categorized as active to very active individuals. The breathing rate data are presented in Table 3.~~14~~ 15 in one year age groupings for infants and children and in three age groupings for adults up to age 70.

TABLE 3.~~14~~15. Equivalent Breathing Rates Based on Institute of Medicine Energy Expenditure Recommendations for Active and Very Active People

Age (Years)	Inhalation rate – males active – very active (m^3/day)	Inhalation rate – females active – very active (m^3/day)
<1	3.4	3.4
1	4.9	4.9
2	5.9	5.5
3	8.4 – 9.5	7.9 – 9.3
4	8.8 – 10.1	8.3 – 9.9
5	9.4 – 10.7	8.8 – 10.5
6	9.8 – 11.3	9.3 – 11.1
7	10.4 – 11.9	9.7 – 11.6
8	10.9 – 12.6	10.2 – 12.3
9	11.5 – 13.3	10.7 – 12.8
10	12.1 – 14.0	11.1 – 13.4
11	12.9 – 14.9	11.7 – 14.1
12	13.7 – 15.9	12.3 – 14.9
13	14.8 – 17.2	12.9 – 15.6
14	16.0 – 18.5	13.2 – 16.0
15	17.0 – 19.8	13.3 – 16.2
16	17.8 – 20.7	13.4 – 16.3
17	18.2 – 21.2	13.3 – 16.2
18	18.6 – 21.5	13.2 – 16.1
19-30	17.0 – 19.7	13.4 – 15.2
31-50	16.2 – 18.9	12.8 – 14.5
51-70	15.1 – 17.8	12.0 – 13.8

Physical activity levels (PALs) were categorized into four levels of activity by the IOM, two of which were the active and very active levels. A PAL is the ratio of total energy expended (TEE) divided by the basal metabolic rate, defined as the minimum level of energy needed to support essential physiologic functions in free-living people. Stifelman (2007) also calculated the breathing rate associated with each level, as shown in Table 3.~~15~~16. It is believed unlikely that the PAL "very active" category (i.e., PAL range 1.9-2.5) would be exceeded over a duration of years. PALs exceeding the IOM and FAO ranges are generally not sustainable over long periods of time, but can be quite high for limited periods of time (Westerterp, 2001). For example, highly trained athletes during periods of high-intensity training competition, including cross-country skiers and Tour de France bicycle racers, can reach a PAL of 3.5-5.5.

The IOM and FAO PALs describe a range of 1.4-2.5 in accord with ranges of sustainable PALs described by others, including people actively engaged in non-mechanized agriculture, deployed military personnel, and long-distance runners (Stifleman, 2007; Westerterp, 2001; Westerterp, 1998; Black et a., 1996; Haggerty et al., 1994). Individuals among the general population exceeding PALs of 2-2.5 for long periods of time are expected to experience negative energy balance (i.e., weight loss) mainly because an important limit to sustainable metabolic rate is the energy intake (Westerterp 1998; Westerterp, 2001).

TABLE 3.~~15~~16. IOM Physical Activity Categories, Associated Breathing Rates and Equivalent Walking Distance

PAL Category	PAL midpoint value (range)	Breathing rate midpoint value	Equivalent walking distance (km /day)[a]
Sedentary	1.25 (1.0-1.39)	14.4 m^3/day	0
Low active	1.5 (1.4-1.59)	15.7 m^3/day	3.5
Active	1.75 (1.6-1.89)	17.3 m^3/day	11.7
Very active	2.2 (1.9-2.5)	19.4 m^3/day	26.9

[a] Equivalent walking distance in addition to energy expended during normal daily life, based on a 70 kg adult walking 5-6 km per hour. Adapted from Stifelman (2007) and Brooks et al. (2004)

Based on the DLW data, Stifelman's analysis indicates that human energy expenditure occurs within a fairly narrow range of activity levels (PAL in the range of 1.4-2.5), and that for breathing rates estimated by the DLW method, a breathing rate of 19.4 m^3/day (equivalent to a PAL of 2.2) is near the maximum energy expenditure that can be sustained for long periods of time in adults. This finding supports the idea that the traditional 20 m^3/day is an upper end breathing rate (Snyder et al. (1975).

The narrow range in breathing rates was found to be consistent with the daily energy expenditure estimated from the adult breathing rate distribution in Marty et al. (2002) where the range is slightly over 2-fold between the 5th and 95th percentile in Table 3.47. A roughly 2-fold range in between the 5th and 95th percentiles is also exhibited in the MET-derived breathing rates by US EPA (2009).

3.~~3~~4.4.3 Limits of Sustainable Breathing Rates Derived from PALs

As noted above, DLW studies have shown that a PAL of approximately 2 to 2.5 in the general population of adults is the limit of sustainable energy expenditure for long periods of time (Westerterp, 2001; IOM, 2005; Stifelman, 2007). The PAL of novice athletes training for endurance runs and soldiers during field training falls within this range (Westerterp, 1998; 2001). The PAL has been found to be twice the upper limit (PALs = 3.5 to 5.5) in professional endurance athletes in the most demanding sports (cross-country skiing and cycling) during training and competition. The PALs of these professional athletes are in the right tail of the breathing rate distribution of the general

population (Westerterp, 2001). However, the high PALs are not expected to be sustained at these high levels when averaged over years.

Knowing the average basal energy expenditure (BEE) for adults and the upper range of daily energy expenditure, the upper limit of long-term daily breathing rates for the general population can be estimated from Layton's equation (eq. 3.1). Marty et al. (2002) observed that the 95th percentile breathing rate should be found within this PAL range of 2 to 2.5. Thus, it might be reasonable to compare the 95th percentile adult breathing rate calculated by other methods to the breathing rates derived from an upper limit PAL range of 2 to 2.5.

Table 3.~~16~~ 17 show the expected breathing rates of adults in a PAL range of 2.0 to 2.5. The mean BEE in kcal/day for the adult age groups is obtained from Brooks et al. (2004). Mean weights for the adult age groups were also obtained from this reference in order to convert breathing rates in L/day to L/kg-day. The results from the DLW-derived energy expenditure data suggest that for normal weight adults (i.e., adults with BMIs within the healthy range of 18.5 to 25), the upper limit of breathing rates for males and females combined would be 16,629 to 20,787 L/day, or 256 to 320 L/kg-day.

Table 3.~~16~~17. Description of the Normative Adult DLW Data from Brooks et al. (2004) for Persons with a Healthy BMI, and the Resulting Calculations of Breathing Rate Within the Sustainable PAL Range of 2.0 to 2.5

	Age years	**n**	**Mean BEE kcal/d**	**TEE limits[a] kcal/d**	**Breathing rate L/d**	**Mean weight kg**	**Breathing rate L/kg-d**
Males	19-30	48	1769	3538 - 4423	20,060 - 25,078	71.0	283 - 353
	31-50	59	1675	3350 - 4188	18,995 - 23,746	71.4	266 - 333
	51-70	24	1524	3048 - 3810	17,282 - 21,603	70.0	247 - 309
	19-70[b]	-	-	-	18,582 - 23,229	-	263 - 328
Females	19-30	82	1361	2722 - 3403	15,434 - 19,295	59.3	260 - 325
	31-50	61	1322	2644 - 3305	14,991 - 18,739	58.6	256 - 320
	51-70	71	1226	2452 - 3065	13,903 - 17,379	59.1	235 - 294
	19-70[b]	-	-	-	14,675 - 18,344	-	249 - 311
Males/ females[c]	19-70	-	-	-	16,629 - 20,787	-	256 - 320

[a] Sustainable PAL range (2.0 to 2.5) multiplied by mean BEE equals the daily total energy expenditure (TEE) that can be sustained over long periods of time.
[b] 19-70 yr breathing rates calculated as a weighted average from the three smaller age groupings
[c] Average breathing rates of males and females combined, assuming each gender represents 50% of the population.

Although the PAL limits were estimated for adults, it might also be useful to estimate high-end sustainable breathing rates for adolescents using the same assumption that a PAL of 2 to 2.5 represents the limit of sustainable energy expenditure over a long-term

period. Some of the highest daily breathing rates in L/day were calculated for adolescents from the CSFII caloric intake data (Arcus-Arth and Blaisdell, 2007).

For deriving adolescent breathing rates from the mean BEE in Brooks et al. (2004) for 14-18 year olds, an upper limit of sustainable energy expenditure would be in the range of 3458-4323 kcal/d for males, and 2722-3403 kcal/d for females. Using Layton's equation to derive the breathing rates from these daily energy expenditures, sustainable upper limit breathing rates of 22,221-27,780 L/day for adolescent males, and 18,006-22,511 L/day for adolescent females were calculated. After normalizing for weight using the mean weights for the 14-18 year age groups in Brooks et al. (2004), upper range daily breathing rates of 378-472 L/kg-day for males and 332-513 L/kg-day for females were calculated.

3.~~3~~4.5. Compilations of Breathing Rate Data

In the US EPA (2011) Exposure Factors Handbook, ranges of measured breathing rate values were compiled for infants, children and adults by age and sex. Table 3.~~17~~ 18 presents the recommended breathing rate values for males and females combined for specific age groups up to age ≥81 yrs based on the average of the inhalation rate data from four recent key studies: Brochu et al. (2006a); U.S. EPA, (2009); Arcus-Arth and Blaisdell, (2007); and Stifelman (2007). The Table represents the unweighted means and 95th percentiles for each age group from the key studies. U.S. EPA noted that there is a high degree of uncertainty associated with the upper percentiles, including the 95th percentile shown in Table 3.~~17~~18, thus they should be used with caution. The upper percentiles represent unusually high inhalation rates for long-term exposures, but were included in the handbook to provide exposure assessors a sense of the possible range of inhalation rates for children.

Table 3.~~17~~18. US EPA (2011) Recommended Long-Term Exposure (More than 30 Days) Breathing Rate Values for Infants and Children (Males and Females Combined) Averaged From Four Key Studies

Age Group	Mean m^3/day	Sources Used for Means	95th Percentile m^3/day	Sources Used for 95th-ile
Birth to <1 month	3.6	a	7.1	a
1 to <3 months	3.5	a,b	5.8	a,b
3 to <6 months	4.1	a,b	6.1	a,b
6 to <12 months Birth to <1 year	5.4 5.4	a,b a,b,c,d	8.0 9.2	a,b a,b,c
1 to <2 years	8.0	a,b,c,d,	12.8	a,b,c
2 to <3 years	8.9	a,b,c,d	13.7	a,b,c
3 to <6 years	10.1	a,b,c,d	13.8	a,b,c
6 to <11 years	12.0	a,b,c,d	16.6	a,b,c
11 to <16 years	15.2	a,b,c,d	21.9	a,b,c
16 to <21 years	16.3	a,b,c,d	24.6	a,b,c
21 to <31 years	15.7	b,c,d	21.3	b,c
31 to <41 years	16.0	b,c,d	21.4	b,c
41 to <51 years	16.0	b,c,d	21.2	b,c
51 to <61 years	15.7	b,c,d	21.3	b,c
61 to <71 years	15.7	b,c,d	18.1	b,c
71 to <81 years	14.2	b,c	16.6	b,c
≥91 years	12.2	b,c	15.7	b,c

a Arcus-Arth and Blaisdell, 2007;
b Brochu et al. 2006a;
c U.S. EPA, (2009)
d Stifelman 2007

3.~~4~~5 OEHHA-Derived Breathing Rate Distributions for the Required Age Groupings Using Existing Data.

The summarized published reports provide breathing rate distributions by month/year of age or in specific age groups, but seldom in age groups applicable to OEHHA's age groupings for cancer risk assessment. However, individual data were obtainable from the CSFII food intake study and the DLW database in the IOM (2005) report, from which breathing rate distributions could be derived in the specific age groups of third trimester, 0<2, 2<9, 2<16, 16<30, and 16-70 years. In addition, The U.S. EPA's breathing rate distributions based on the MET approach, shown in Tables 3.~~10~~ 13a and 3.~~11~~13b, can be merged to obtain the necessary age group breathing rates.

3.~~4~~5.1 OEHHA-derived breathing rates based on CSFII energy intake data

In Tables 3.~~18a~~19a-e, non-normalized (L/day) and normalized (L/kg-day) breathing rates for the specific OEHHA age groups were derived for both children and adults from

the CSFII dataset using the Jacknife Replication statistical method (Arcus-Arth and Blaisdell, 2007). Breathing rates for pregnant women, for determination of third trimester breathing rates, are presented in Section 3.5.4.

In addition, each age group was also fit to a lognormal distribution using Crystal Ball® (Oracle Corp., Redwood Shores, CA, 2009). Crystal Ball® was also used to determine the best parametric model fit for the distribution of breathing rates for each age group. The Anderson-Darling test was chosen over other goodness-of-fit tests available in Crystal Ball® because this test specifically gives greater weight to the tails than to the center of the distribution. OEHHA is interested in the tails since the right tail represents the high-end (e.g., 95th percentile) breathing rates.

Tables 3.~~18a~~19a-e. Breathing Rate Distributions by Age Group (Males and Females Combined) Derived from CSFII Food Intake Data Using Jacknife Methodology and Parameter Estimates of Log-Normally and Best Fit Distributions

Table 3.~~18a~~19a. Breathing Rate Distributions for the 0<2 Year Age Group

	Jacknife Approach		**Lognormal Parametric Model**		**Best Fit Parametric Model**	
					Max Extreme	Lognormal
N (sample)	1954	1954	-	-	-	-
Skewness	na[a]	na	0.74	0.77	1.47	0.77
Kurtosis	na	na	3.96	4.34	7.81	4.34
%-ile or mean	**L/kg-day**	**L/day**	**L/kg-day**	**L/day**	**L/kg-day**	**L/day**
Sample Min	43	79	-	-	-	-
Mean (SE)[b]	752 (9)	7502 (91)	752 (1)	7568 (13)	752 (1)	7568 (13)
50%-ile (SE)	706 (7)	7193 (91)	720	7282	706	7282
75%-ile (SE)	870 (11)	9128 (91)	909	9201	871	9201
90%-ile (SE)	1094 (19)	11,502 (120)	1107	11,523	1094	11,523
95%-ile (SE)	1241 (24)	12,860 (170)	1241	12,895	1241	12,895
Sample Max	2584	24,411	-	-	-	-

[a] Not applicable
[b] SE = Standard error

Table 3.~~18b~~19b. Breathing Rate Distributions For the 2<9 Year Age Group

	Jacknife Approach		**Lognormal Parametric Model**		**Best Fit Parametric Model**	
					Log-normal	Lognormal
N (sample)	6144	6144	-	-	-	-
Skewness	na[a]	na	0.95	0.86	0.95	0.86
Kurtosis	na	na	4.63	4.96	4.63	4.96
%-ile or mean	**L/kg-day**	**L/day**	**L/kg-day**	**L/day**	**L/kg-day**	**L/day**
Sample Min	144	2661	-	-	-	-
Mean (SE)[b]	595 (4)	11,684 (82)	595 (1)	11,680 (16)	595 (1)	11,680 (16)
50%-ile (SE)	567 (5)	11,303 (70)	567	11,303	567	11,303
75%-ile (SE)	702 (5)	13,611 (110)	702	13,606	702	13,606
90%-ile (SE)	857 (7)	16,010 (170)	857	16,012	857	16,012
95%-ile (SE)	975 (9)	17,760 (229)	975	17,758	975	17,758
Sample Max	1713	31,739	-	-	-	-

[a] Not applicable
[b] SE = Standard error

Table 3.~~18c~~19c. Breathing Rate Distributions for the 2<16 Year Age Group

	Jacknife Approach		**Lognormal Parametric Model**		**Best Fit Parametric Model**	
					Gamma	Max Extreme
N (sample)	7624	7624	-	-	-	-
Skewness	na[a]	na	0.74	0.75	0.91	1.46
Kurtosis	na	na	3.97	4.02	4.38	7.26
%-ile or mean	**L/kg-day**	**L/day**	**L/kg-day**	**L/day**	**L/kg-day**	**L/day**
Sample Min	57	2661	-	-	-	-
Mean (SE)[b]	481 (5)	14,090 (135)	481 (1)	14,094 (24)	481 (1)	14,095 (24)
50%-ile (SE)	450 (5)	13,128 (110)	456	13,465	451	13,131
75%-ile (SE)	603 (4)	16,644 (189)	606	17,239	603	16,655
90%-ile (SE)	764 (6)	20,993 (361)	763	21,214	763	20,993
95%-ile (SE)	869 (6)	23,879 (498)	868	23,870	868	23,886
Sample Max	1713	53,295	-	-	-	-

[a] Not applicable
[b] SE = Standard error

Table 3.~~18d~~19d. Breathing Rate Distributions for the 16<30 Year Age Group

	Jacknife Approach		**Lognormal Parametric Model**		**Best Fit Parametric Model**	
					Max Extreme	Lognormal
N (sample)	2155	2155	-	-	-	-
Skewness	na[a]	na	0.69	1.90	1.69	1.90
Kurtosis	na	na	3.75	11.15	8.94	11.15
%-ile or mean	**L/kg-day**	**L/day**	**L/kg-day**	**L/day**	**L/kg-day**	**L/day**
Sample Min	23	1029	-	-	-	-
Mean (SE)[b]	197 (3)	13,759 (204)	200 (<1)	13,899 (31)	200 (<1)	13,899 (31)
50%-ile (SE)	180 (3)	12,473 (125)	190	12,494	182	12,494
75%-ile (SE)	238 (4)	16,975 (245)	259	17,192	242	17,192
90%-ile (SE)	320 (4)	21,749 (305)	331	22,136	323	22,136
95%-ile (SE)	373 (11)	26,014 (634)	378	26,481	377	26,481
Sample Max	976	75,392	-	-	-	-

[a] Not applicable
[b] SE = Standard error

Table 3.~~18e~~19e. Breathing Rate Distributions for the 16-70 Year Age Group

	Jacknife Approach		**Lognormal Parametric Model**		**Best Fit Parametric Model**	
					Max Extreme	Lognormal
N (sample)	8512	8512	-	-	-	-
Skewness	na[a]	na	0.67	2.05	1.87	2.05
Kurtosis	na	na	3.74	12.35	10.67	12.35
%-ile or mean	**L/kg-day**	**L/day**	**L/kg-day**	**L/day**	**L/kg-day**	**L/day**
Sample Min	13	740	-	-	-	-
Mean (SE)[b]	165 (2)	12,078 (134)	165 (<1)	12,074 (26)	165 (<1)	12,074 (26)
50%-ile (SE)	152 (1)	10,951 (86)	157	10,951	152	10,951
75%-ile (SE)	200 (1)	14,687 (141)	212	14,685	200	14,685
90%-ile (SE)	257 (3)	18,838 (173)	269	18,834	257	18,834
95%-ile (SE)	307 (4)	21,812 (371)	307	21,831	307	21,831
Sample Max	975	75,392	-	-		

[a] Not applicable
[b] SE = Standard error

3.~~4~~5.2 OEHHA-derived breathing rates based on the IOM DLW Database

The Institute of Medicine (IOM) 2005 dietary reference report includes an extensive database that is a compilation of DLW-derived energy expenditure results and other raw

data for individuals collected from numerous studies. An advantage of this dataset over the U.S. EPA MET approach and the TAV approaches is that individual data on energy expenditure are matched with the weight and age of the individuals. The disadvantage is that the data are not necessarily representative of a random sample of a population~~, with the possible exception of the infant energy expenditure data~~.

When breathing rates were calculated from the energy expenditure data, it became apparent that there were some extreme individual breathing rates that did not appear physically possible. Using the results from the PAL limits (Section 3.~~3~~4.4.3), breathing rates with a PAL greater than 2.5 were removed. Additionally, some breathing rates were below the expected BMR for an individual. Based on evidence that energy expenditure during sleep is 5 to 10% lower than the BMR, derived breathing rates that were 10% or more below the expected BMR were also removed (Brooks et al., 2004). However, relatively few individuals were removed due to an extreme breathing rate; <1 to 6% of the values were removed from any one age group.

Rather than assume a normal distribution for the age groupings as Brochu et al. (2006a) had done, OEHHA arranged the data to be more representative of a population by weighting the energy expenditure data by age and gender. The modeled populations were weighted towards an equal number of persons per year of age and the assumption was used that males and females in a population are at a ratio of 50:50. In addition, the IOM database separated individuals by weight, or more specifically, by body mass index (BMI). Children 3 to 18 years of age are considered at risk of overweight when their BMI is greater than the 85th percentile, and overweight when their BMI is greater than the 95th percentile (Kuczmarski et al., 2000). Thus, the IOM (2005) placed overweight/obese children in a separate dataset. For the modeled populations, an 85:15 weighting for normal:overweight children in the 2<9 and 2<16 age groups was used. Adults (>19 years of age) were placed in the overweight/obese dataset if they had BMIs of 25 kg/m^2 and higher by the IOM. The results from USDA's 1994-96 Diet and Health Knowledge Survey (Tippett and Clevelend, 2001) found that 54.6% of the U.S. population have a BMI of 25 kg/m^2 or greater (n=5530). Thus, for the adult age groups (16<30 and 16-70 yrs), 45:55 weighting for normal:overweight adults was used to model the populations.

For infants, the source of the raw data in the IOM (2005) database was from Butte et al. (2000), a DLW study conducted at the Children's Nutrition Research Center in Houston, TX. Butte et al. (2000) monitored energy expenditure in 76 healthy infants by the DLW method up to six times during the study, at 3, 6, 9, 12, 18, and 24 months of age, generating a total of 351 measurements that fell within the OEHHA-specified 0<2 year age group. Thus, many of the infants were tested more than once during the study period. Following each administration of DLW by mouth, urine samples were collected over 10 days and analyzed for the hydrogen and oxygen isotopes to calculate energy expenditure.

The percentage of breast-fed infants at ages 3, 6, 9, 12, 18, and 24 months were 100%, 80%, 58%, 38%, 15%, and 5%, respectively in the Butte et al. (2000) study. The racial

distribution by maternal lineage was 55 white, 7 African American, 11 Hispanic, and 3 Asian infants. The NCHS growth reference (Hamill et al., 1979) was used to evaluate the adequacy of growth in these infants. The growth performance of these infants was comparable with that of other breast-fed and formula-fed infant populations in whom socioeconomic and environmental constraints would not be expected to limit growth. Relative to the NCHS reference and compared with other breast-fed and formula-fed study populations, the growth of the children was considered satisfactory by the researchers.

Although the study did not choose subjects representative of any particular population, the range of activities that individuals of this age engage in is not as variable as the range of activities engaged in by older children and adults. In addition, even though many of the infants were tested more than once during the study period, repeated measures on the same individuals can reduce the amount of intraindividual variability in the distribution of measurements because a better estimate of typical energy expenditure is captured. Considering the limitations, the study results were judged by OEHHA to be similar enough to a randomly sampled population to calculate distributional statistics for breathing rate.

An additional observation from Butte et al. (2000) was that total energy expenditure measurements differed by age and by feeding group, but not by sex, when adjusted for weight. As expected, PAL increased significantly with age from 1.2 at 3 months to 1.4 at 24 months.

Breathing rates determined by the DLW method for women in their third trimester of pregnancy are presented separately in Section 3.5.4.

To obtain the daily breathing rate distributions for all age groups shown in Table 3.~~19a~~20a-e, OEHHA fit the data to a lognormal distribution using Crystal Ball® and sampled 250,000 times using Latin-Hypercube. The lognormal distribution is commonly used in stochastic risk assessment and has been found to be a reasonable parametric model for a variety of exposure parameters, including breathing rate. Latin-Hypercube analysis in Crystal Ball® was also used to determine the best parametric model fit for the distribution of breathing rates. The Anderson-Darling statistic was used for the goodness-of-fit test because it gives greater weight to the tails than to the center of the distribution.

Tables 3.~~19a~~20a-e. Breathing Rate Distributions by Age Group (Males and Females Combined) Derived from IOM (2005) DLW Database Using Parameter Estimates of Lognormal and Best Fit Distributions

Table 3.~~19a~~20a. 0<2 Year Age Group Breathing Rate Distribution

	Moments and Percentiles, Empirical Data		**Moments and Percentiles, Lognormal Parametric Model**		**Moments and Percentiles, Best Fit Parametric Model**	
N	281	281				
Skewness	-0.044	0.28	-0.001	0.44	-0.044	0.28
Kurtosis	2.10	2.59	3.00	3.35	2.10	2.59
	L/kg-day	**L/day**	**L/kg-day**	**L/day**	**L/kg-day**	**L/day**
					Beta	Beta
Sample Min	357	2228	-	-	-	-
Mean (SE)	567	5031	567	5031	567	5031
50%-ile	562	4967	567	4925	568	4943
80%-ile	657	6323	644	6232	655	6325
90%-ile	689	6889	685	6981	691	7042
95%-ile	713	7595	718	7638	714	7607
Sample Max	752	9210	-	-	-	-

Table 3.~~19b~~20b. 2<9 Year Age Group Breathing Rate Distribution

	Moments and Percentiles, Empirical Data		**Moments and Percentiles, Lognormal Parametric Model**		**Moments and Percentiles, Best Fit Parametric Model**	
N	810	810				
Skewness	0.0759	0.4676	0.0796	0.4763	0.0796	0.0290
Kurtosis	2.93	3.62	3.00	3.40	3.00	3.50
	L/kg-day	**L/day**	**L/kg-day**	**L/day**	**L/kg-day**	**L/day**
					Log-normal	Stu-dent's T
Sample Min	240	5085	-	-	-	-
Mean (SE)	482	9708	482	9708	482	9711
50%-ile	479	9637	481	9521	481	9708
80%-ile	551	11,478	555	11,650	555	11,641
90%-ile	597	12,629	595	12,880	595	12,704
95%-ile	631	13,626	628	13,962	628	13,632
Sample Max	703	21,152	-	-	-	-

Table 3.~~19c~~20c. 2<16 Year Age Group Breathing Rate Distribution

	Moments and Percentiles, Empirical Data		**Moments and Percentiles, Lognormal Parametric Model**		**Moments and Percentiles, Best Fit Parametric Model**	
N	1227	1237				
Skewness	0.2729	0.8705	0.4613	1.12	0.2729	1.14
Kurtosis	2.45	3.70	3.38	5.32	2.45	5.43
	L/kg-day	**L/day**	**L/kg-day**	**L/day**	**L/kg-day**	**L/day**
					Beta	Max Ext.
Sample Min	168	5328	-	-	-	-
Mean (SE)	423	12,695	423	12,700	423	12,695
50%-ile	411	11,829	414	12,000	416	11,988
80%-ile	529	16,184	517	15,833	527	15,788
90%-ile	580	18,944	576	18,328	583	18,303
95%-ile	623	20,630	628	20,694	626	20,716
Sample Max	737	27,803	-	-	-	-

Table 3.~~19d~~20d. 16<30 Year Age Group Breathing Rate Distribution

	Moments and Percentiles, Empirical Data		**Moments and Percentiles, Lognormal Parametric Model**		**Moments and Percentiles, Best Fit Parametric Model**	
N	245	245				
Skewness	0.3471	0.4786	0.4008	0.6962	0.4008	0.6962
Kurtosis	3.03	3.11	3.28	3.88	3.28	3.88
	L/kg-day	**L/day**	**L/kg-day**	**L/day**	**L/kg-day**	**L/day**
					Log-normal	Log-normal
Sample Min	135	7246	-	-	-	-
Mean (SE)	222	16,458	222	16,464	222	16,464
50%-ile	220	16,148	219	16,053	219	16,053
80%-ile	256	19,468	259	19,395	259	19,395
90%-ile	282	21,954	282	21,410	282	21,410
95%-ile	308	23,295	302	23,231	302	23,231
Sample Max	387	26,670	-	-	-	-

Table 3.~~19e~~20e. 16-70 Year Age Group Breathing Rate Distribution

	Moments and Percentiles, Empirical Data		**Moments and Percentiles, Lognormal Parametric Model**		**Moments and Percentiles, Best Fit Parametric Model**	
N	842	846				
Skewness	0.4264	0.6323	0.4506	0.7346	0.4506	0.7346
Kurtosis	3.18	3.32	3.36	3.98	3.36	3.98
	L/kg-day	**L/day**	**L/kg-day**	**L/day**	**L/kg-day**	**L/day**
					Log-normal	Log-normal
Sample Min	95	7235	-	-	-	-
Mean (SE)	206	15,713	206	15,715	206	15,715
50%-ile	204	15,313	203	15,282	203	15,282
80%-ile	241	18,773	243	18,664	243	18,664
90%-ile	268	20,612	266	20,687	266	20,687
95%-ile	286	22,889	286	22,541	286	22,541
Sample Max	387	29,136	-	-	-	-

3.~~4~~5.3 OEHHA Age Group Breathing Rate Distributions Derived From U.S. EPA (2009) MET Approach

In Tables 3.~~20a~~21a-e, non-normalized (L/day) and normalized (L/kg-day) breathing rates for the specific OEHHA age groups were derived for both children and adults from the data included in the U.S. EPA (2009) report and presented above. Values for males and females were combined by taking weighted averages for each age range provided, assuming that the numbers of males and females in the population are equal. Ages were combined by the same means to create the age ranges of toxicological interest to the "Hot Spots" program.

The breathing rates used in preparation of the U.S. EPA report were derived by selecting an activity pattern set from a compilation of daily activity pattern sets (CHAD) and assigning them to a person in NHANES of the same sex and age group, although the age groups are fairly narrow for the very young (i.e., 3-month or 1-year intervals), the older age groups consist of broad age categories (i.e., 3 to 5 year intervals). These broad age groups include periods, for example 3 to <6 years, when activity can vary greatly by year of age. In addition, NHANES calculates a "sampling weight" for each participant, which represents the number of individuals in the population with the same set of these characteristics. When an individual in CHAD is matched to an individual in NHANES only on sex and age group, the set of characteristics that belonged to the CHAD individual are ignored, which could result in significantly different weighting. Thus the derived breathing rates cannot be considered representative of the population.

For these reasons and other limitations of the EPA data, as stated in Section 3.3.3.3, OEHHA chose to fit a selected set of parametric distributions to the percentile data given by U.S. EPA, rather than attempting to use the raw data to determine the best fit parametric model. A gamma distribution was fit to each age group using Crystal Ball®, which is usually one of the better fitting distributions for the right-skewed distributions typical of intake variability. The gamma distribution is a three parameter distribution with fewer shape constraints than two parameter distributions such as a lognormal distribution.

Table 3.~~20a~~21a-e. Normalized and Non-Normalized Breathing Rate Distributions by Age Group (Males and Females Combined) Derived From U.S. EPA (2009) Breathing Rates Using a Gamma Parameter Estimate Distribution

Table 3.~~20a~~21a. 0<2 Year Age Group Breathing Rate Distribution

	Moments and Percentiles, Gamma Parametric Model	
N	1601	1601
	L/kg-day	**L/day**
Mean	1125	10,711
50%-ile	1104	10,489
75%-ile	1199	12,301
90%-ile	1302	14,104
95%-ile	1372	15,271

Table 3.~~20b~~21b. 2<9 Year Age Group Breathing Rate Distribution[a]

	Moments and Percentiles, Gamma Parametric Model	
N	4396	4396
	L/kg-day	**L/day**
Mean	597	12,758
50%-ile	591	12,518
75%-ile	662	13,911
90%-ile	732	15,375
95%-ile	776	16,176

[a] Breathing rate data for this age range were actually available for 2<11 years of age

Table 3.~~20c~~21c. 2<16 Year Age Group Breathing Rate Distribution

	Moments and Percentiles, Gamma Parametric Model	
N	7657	7657
	L/kg-day	**L/day**
Mean	449	13,365
50%-ile	440	13,106
75%-ile	496	14,694
90%-ile	555	16,426
95%-ile	595	17,609

Table 3.~~20d~~21d. 16<30 Year Age Group Breathing Rate Distribution[a]

	Moments and Percentiles, Gamma Parametric Model	
N	6111	6111
	L/kg-day	**L/day**
Mean	221	16,005
50%-ile	215	15,469
75%-ile	244	17,984
90%-ile	275	20,699
95%-ile	296	22,535

[a] Breathing rate data for this age range were actually available for 16<31 years of age

Table 3.~~20e~~21e. 16-70[a] Year Age Group Breathing Rate Distribution

	Moments and Percentiles, Gamma Parametric Model	
N	16,651	16,651
	L/kg-day	**L/day**
Mean	219	16,937
50%-ile	214	16,515
75%-ile	245	18,924
90%-ile	278	21,443
95%-ile	299	23,128

[a] Breathing rate data for this age range were given as 16<71 years of age

A limitation in calculating these breathing rates is that equal weighting by year of age was assumed when merging the U.S. EPA breathing rates into larger age groups used by OEHHA. However, this may not be a significant factor for the smaller age groups (i.e., 3rd trimester, 0<2, 2<9, 2<16, 16<30 yr old age groups), but could affect the

breathing rate estimate for the 16-70 year olds. This is because a random sample of the population would find proportionally fewer adults in the 61 to 70 year age range, for example, compared to 21 to 30 year age range.

Another limitation is that merging the U.S. EPA age groups into the OEHHA age groupings does not yield the precise age range for 2<9 and 16 to <30 year olds. The actual age range in the US EPA data used to get the 16 to <30 year olds is 16 to <31, which we do not consider a significant deviation. However, the actual age range in the US EPA data used to get the 2 to <9 year olds is 2 to <11 years. The addition of 9 and 10 year olds would slightly reduce the normalized breathing rate in L/kg-day because younger children (i.e., 2<9 year olds) have higher normalized breathing rates than older children (i.e., 9-10 year olds). Alternatively, addition of 9 and 10 year olds to the 2<9 year age group would slightly increase the absolute breathing rate in L/day due to higher volumes of air breathed per day by 9 and 10 year olds compared to younger children.

3.5.4 OEHHA-Derived Third Trimester Breathing Rates

For third trimester exposure, OEHHA calculated breathing rates using the assumption that the dose to the fetus during the third trimester was the same as that to the mother. Both the CSFII and DLW data sets included data from pregnant women that could be used to calculate breathing rates (Table 3.22). The DLW data included a code for trimester of pregnancy, while the CSFII data did not. Thus, breathing rates by the CSFII method was estimated using data for women in all stages of pregnancy with no means for separation by stage of pregnancy. OEHHA believes this would not underestimate the third trimester breathing rates, since the CSFII breathing rate data tend to overestimate the breathing rate in the upper (e.g., 95th percentile) and lower percentiles for the reasons cited in Section 3.4.3.2. Since breathing rate increases over the course of pregnancy, we felt that we could successfully combine these data with the DLW data and produce a reasonable set of point estimates for the third trimester.

In order to create a set of breathing rate data suitable for use in a stochastic risk assessment for third trimester pregnant women, we selected 1,000 observations from each set of data, normalized and non-normalized, using a Monte Carlo simulation in Crystal Ball®. Because the data sets from the two sources were similar in size, a relatively small set of simulated data was sufficient. We combined these data to create two sets of pooled data (see Section 3.2 above). We then fit a parametric distribution to each of the pooled samples, using Crystal Ball® and the Anderson-Darling goodness-of-fit test.

Table 3.22. Normalized and Non-Normalized Breathing Rate Distributions for Women in Their Third Trimester of Pregnancy: OEHHA-Derived Values from Doubly-Labeled Water (DLW) and Continuing Survey of Food Intake of Individuals (CSFII) Databases

	DLW L/kg BW-day	CSFII L/kg BW-day	DLW L/day	CSFII L/day
Distribution	Lognormal	Gamma	Lognormal	Gamma
Minimum	150	78	10,316	4,025
Maximum	348	491	23,932	29,041
Mean	220	232	15,610	14,830
Median	210	216	15,196	14,311
Std Dev	46	92	3,118	5,326
Skewness	1.19	0.5575	0.7744	0.4393
Kurtosis	4.04	2.57	3.57	3.02
Percentiles				
1%	150	84	10,316	4,025
5%	161	104	10,809	7,714
10%	174	127	11,846	8,201
25%	192	155	13,750	11,010
50%	210	216	15,196	14,311
75%	241	302	17,343	18,153
80%	246	323	17,832	19,114
90%	280	363	18,552	21,799
95%	322	392	22,763	24,349
99%	348	490	23,932	28,848

3.5.5 Summary of Long-Term Daily Breathing Rate Distributions

Table 3.23 presents a summary of the long-term daily mean and high end (i.e., 95th percentile) breathing rates derived by OEHHA from different sets of energy expenditure data. The breathing rate distributions for women in their third trimester of pregnancy are presented separately in Table 3.22 above. The MET- (non-normalized only), CSFII- and DLW-derived breathing rates in Table 3.22 are based on the best fit parametric models for each age group, although little variation in the breathing rate was observed between models within each breathing rate method. Also included are data from TAV studies that estimated breathing rates in age groupings reasonably similar to that used by OEHHA.

As noted in Table 3.23, some of the age groupings for the MET-derived breathing rates, and all age groups in the TAV-derived breathing rates do not precisely reflect the age ranges used in the "Hot Spots" program. This was primarily due to methodological differences in data collection which did not allow individual breathing rates matched with the age of the individual. However, the differences in the age ranges were small

enough in many cases to allow a rough comparison among the various breathing rate estimation methods, so they were included in the table.

TABLE 3.23. Summary of Breathing Rate by Study and Age Group

	0<2 yrs L/kg-day		**2<9 yrs L/kg-day**		**2<16 yrs L/kg-day**		**16<30 yrs L/kg-day**		**16-70 yrs L/kg-day**	
	mean	**95th**	**mean**	**95th**	**mean**	**95th**	**mean**	**95th**	**mean**	**95th**
MET[a]	1125	1372	597[b]	776[b]	449	595	221[c]	296[c]	219	299
CSFII[d]	752	1241	595	975	481	868	200	377	165	307
DLW[e]	567	713	482	628	423	626	222	302	206	286
TAV[f]										
Marty et al.	-	-	-	-	452[g]	580.5[g]	-	-	232[h]	381[h]
Allan et al.	-	-	-	-	-	-	-	-	201[e]	280[e]
	0<2 yrs L/day		**2<9 yrs L/day**		**2<16 yrs L/day**		**16<30 yrs L/day**		**16-70 yrs L/day**	
	mean	**95th**	**mean**	**95th**	**mean**	**95th**	**mean**	**95th**	**mean**	**95th**
MET[a]	10,711	15,271	12,758	16,176	13,365	17,609	16,005	22,535	16,937	23,128
CSFII[d]	7568	12,895	11,680	17,758	14,095	23,886	13,899	26,481	12,074	21,831
DLW[e]	5031	7595	9711	13,632	12,695	20,716	16,464	23,231	15,715	22,541
TAV[f]										
Marty et al.	-	-	-	-	8,100[g]	10,500[g]	-	-	14,600[h]	24,000[h]
Allan et al.	-	-	-	-	-	-	-	-	16,160[i]	22,480[i]

[a] U.S. EPA metabolic equivalent (MET) approach breathing rate point estimates shown were derived using the best fit parametric model from Tables 3.20a-e.
[b] All MET-derived breathing rates for the 2<9 yr age group actually represent 2<11 yr olds.
[c] All MET-derived breathing rates for the 16<30 yr age group actually represent 16<31 yr olds.
[d] CSFII food intake-derived breathing rate point estimates shown were derived using the best fit parametric model as presented in Tables 3.18a-e.
[e] Doubly-labeled water-derived (DLW) breathing rate point estimates shown were derived using the best fit parametric model as shown in Tables 3.19a-e.
[f] Time-activity-ventilation (TAV) breathing rate point estimates are from Table 3.3 (Marty et al. 2002) and Table 3.5 (Allan et al., 2008).
[g] The breathing rate point estimates from Table 3.3 actually represent an age range of about 3 to <12 yrs old. The non-normalized breathing rate point estimates in L/day is the equivalent for an 18 kg child.
[h] The breathing rate point estimates from Table 3.4 actually represent an age range of 12 to 70 years old. Non-normalized breathing rate point estimates in L/day are the equivalent for a 63 kg adult.
[i] Breathing rate point estimates were derived from Table 3.5 and represent an age range of 12 to 60+ years. The point estimates were calculated assuming equal weighting for each age group (12-19 yrs, 20-59 yrs, 60+ yrs) and combined. Breathing rates in Table 3.5 were available only in L/day, so the non normalized point estimates were both divided by the mean body weight for the 16-70 age group (80.3 kg) to generate breathing rates in L/kg-day.

The DLW energy expenditure data likely result in daily breathing rates that are slightly lower in some cases than what would be expected in a random population sample, particularly for adults (Black et al., 1996). On the other hand, U.S. EPA (2008) observed that the upper percentile breathing rates for the MET and CSFII approaches are unusually high for long-term daily exposures. Based on the limits of sustainable daily breathing rates for adolescents and adults discussed in Section 3.4.4.3, the 95th percentile breathing rates in Table 3.22 appear to be above sustainable limits for some age groups. For example, the CSFII-generated upper percentile breathing rates are

highest in the age groups containing older adolescents. The 16<30 year age group upper percentile breathing rate from the CSFII study is 377 L/kg-d. This breathing rate is above the sustainable breathing rate (based on PAL) of 283-353 L/kg-d for males 19-30 years of age shown in Table 3.16 (but is not above the sustainable breathing rates for the subgroup of males and females 14-18 yrs of age with a breathing rate of 332-513 L/kg-d).

A limitation of the estimated PALs for daily breathing rates determined in Tables 3.15 and 3.17 is that the participants used in the study may not reflect a random sample of the population. Nevertheless, the observed PAL of novice athletes training for endurance runs and soldiers during field training falls within this range of 2.0-2.5 (Westerterp, 1998; 2001). Thus, the breathing rates based on physical activity limits should be accurate for the general population, with the exception of professional endurance athletes in the most demanding sports (cross-country skiing and cycling) during training and competition.

With the advantages and disadvantages of the breathing rate datasets described in Section 3.2, OEHHA recommends using a daily breathing rate point estimates based on a mean of the DLW and CSFII approaches. The main benefit is the use of individual data from these two datasets, including individual body weights, which can be combined into one distribution. In order to create a set of breathing rate data suitable for use in a stochastic risk assessment of long-term daily average exposures, OEHHA combined data for each age range within the two sources of breathing rate data, CSFII and DLW. We selected an equal number of observations from each source for the five age ranges, normalized and non-normalized, using a Monte Carlo simulation in Crystal Ball® to create pooled data for each group. We then fit a parametric distribution to each of the pooled samples, using Crystal Ball® and the Anderson-Darling goodness-of-fit test.

For infants 0<2 yrs of age, OEHHA used the DLW data by Butte et al. (2000) for combining with CSFII study 0<2 yr data. This longitudinal study followed a group of about 40 infants collecting urine every 3 months after DLW administration from age 3 months to two years of age. The sample size was not considered large enough to use this data exclusively for determining the 0<2 yr breathing rates, so was combined with CSFII data of infants in the same age range.

3.~~5~~6 8-Hour Breathing Rates

Specialized exposure scenarios for estimating cancer risk to offsite workers, neighborhood residents, and school children may involve evaluating exposure in the 8-12 hour range~~, and emissions may occur at times when exposed off-site individuals are either largely sleeping (e.g., facility emissions occurring only at night) or awake (e.g., facility emissions occurring during the day)~~. Therefore, 8-hour breathing rates were estimated for exposed individuals engaged in activities that bracket the range of breathing rates including minimal inhalation exposure~~,~~ such as ~~during sleeping/napping~~reading a book and desk work, and high breathing rates such as farm work or yard work, that can be reasonably sustained for an 8-hour period.

As part of the development of average daily breathing rates, U.S. EPA (2009) used existing data on minute ventilation rates (in ml/min or ml/kg-min) for a range of activities and assigned MET values depending on the intensity level of activity:

- Sedentary/Passive Activities: Activities with MET values no higher than 1.5
- Light Intensity Activities: Activities with MET values exceeding 1.5 to ≤3.0
- Moderate Intensity Activities: Activities with MET values exceeding 3.0 to ≤6.0
- High Intensity Activities: Activities with MET values exceeding 6.0

An additional ventilation rate distribution was developed for sleeping/napping only, although the sedentary/passive activity category (MET values ≤1.5) also includes sleeping and napping. Table 3.~~21~~ 23 shows selected MET values for various workplace activities and activities in the home or neighborhood that were used to calculate daily breathing rates by U.S. EPA (2009).

Table 3.~~21~~23. METS Distributions for Workplace and Home Activities

Activity Description	Mean	Median	SD	Min	Max
Workplace Activities					
Administrative office work	1.7	1.7	0.3	1.4	2.7
Sales work	2.9	2.7	1.0	1.2	5.6
Professional	2.9	2.7	1.0	1.2	5.6
Precision/production/craft/repair	3.3	3.3	0.4	2.5	4.5
Technicians	3.3	3.3	0.4	2.5	4.5
Private household work	3.6	3.5	0.8	2.5	6.0
Service	5.2	5.3	1.4	1.6	8.4
Machinists	5.3	5.3	0.7	4.0	6.5
Farming activities	7.5	7.0	3.0	3.6	17.0
Work breaks	1.8	1.8	0.4	1.0	2.5
Household/Neighborhood Activities					
Sleep or nap	0.9	0.9	0.1	0.8	1.1
Watch TV	1.0	1.0	-	1.0	1.0
General reading	1.3	1.3	0.2	1.0	1.6
Eat	1.8	1.8	0.1	1.5	2.0
Do homework	1.8	1.8	-	1.8	1.8
General personal needs and care	2.0	2.0	0.6	1.0	3.0
Indoor chores	3.4	3.0	1.4	2.0	5.0
Care of plants	3.5	3.5	0.9	2.0	5.0
Clean house	4.1	3.5	1.9	2.2	5.0
Home repairs	4.7	4.5	0.7	4.0	6.0
General household chores	4.7	4.6	1.3	1.5	8.0
Outdoor chores	5.0	5.0	1.0	2.0	7.0
Walk/bike/jog (not in transit) age 20	5.8	5.5	1.8	1.8	11.3
Walk/bike/jog (not in transit) age 30	5.7	5.7	1.2	2.1	9.3
Walk/bike/jog (not in transit) age 40	4.7	4.7	1.8	2.3	7.1

MET values and hr/day spent at these various activities were used by U.S. EPA (2009) to calculate selected minute ventilation rates shown in Table 3.~~22a~~24a-b.

Table 3.~~22a~~24a. Descriptive Statistics for Minute Ventilation Rates (L/min-kg) While Performing Activities Within the Specified Activity Category (US EPA, 2009)

Age Category (years)	Males				Females			
	Mean	50th	90th	95th	Mean	50th	90th	95th
	Sedentary & Passive Activities[a] (METS ≤ 1.5)							
Birth to <1	0.40	0.39	0.47	0.50	0.40	0.40	0.48	0.52
1	0.41	0.40	0.49	0.52	0.43	0.42	0.51	0.54
2	0.34	0.34	0.41	0.45	0.36	0.35	0.42	0.44
3 to <6	0.25	0.25	0.33	0.35	0.25	0.25	0.33	0.36
6 to <11	0.16	0.16	0.21	0.22	0.16	0.16	0.21	0.23
11 to <16	0.10	0.10	0.13	0.14	0.10	0.09	0.12	0.13
16 to <21	0.08	0.08	0.09	0.10	0.07	0.07	0.10	0.10
21 to <31	0.06	0.06	0.08	0.08	0.06	0.06	0.07	0.08
31 to <41	0.07	0.07	0.08	0.09	0.06	0.06	0.08	0.08
41 to <51	0.07	0.07	0.09	0.09	0.06	0.06	0.08	0.09
51 to <61	0.07	0.07	0.09	0.09	0.07	0.07	0.08	0.09
61 to <71	0.08	0.08	0.09	0.09	0.07	0.07	0.08	0.08
	Light Intensity Activities (1.5 < METS ≤ 3.0)							
Birth to <1	0.99	0.97	1.17	1.20	0.98	0.96	1.18	1.23
1	1.02	1.01	1.22	1.30	1.05	1.04	1.25	1.27
2	0.84	0.83	1.00	1.03	0.90	0.89	1.04	1.10
3 to <6	0.63	0.63	0.79	0.87	0.62	0.60	0.78	0.83
6 to <11	0.38	0.38	0.49	0.53	0.38	0.38	0.50	0.54
11 to <16	0.25	0.24	0.31	0.33	0.23	0.22	0.28	0.31
16 to <21	0.18	0.18	0.22	0.23	0.17	0.17	0.21	0.22
21 to <31	0.16	0.15	0.19	0.21	0.15	0.15	0.18	0.19
31 to <41	0.16	0.16	0.20	0.21	0.15	0.15	0.19	0.20
41 to <51	0.17	0.16	0.20	0.21	0.16	0.16	0.20	0.22
51 to <61	0.17	0.16	0.20	0.22	0.16	0.16	0.20	0.21
61 to <71	0.16	0.16	0.19	0.20	0.15	0.14	0.17	0.18
	Moderate Intensity Activities (3.0 < METS ≤ 6.0)							
Birth to <1	1.80	1.78	2.18	2.28	1.87	1.85	2.25	2.40
1	1.88	1.82	2.33	2.53	1.90	1.87	2.24	2.37
2	1.55	1.54	1.84	2.02	1.60	1.58	1.92	2.02
3 to <6	1.17	1.12	1.56	1.68	1.14	1.11	1.45	1.56
6 to <11	0.74	0.71	0.96	1.04	0.72	0.71	0.94	1.01
11 to <16	0.49	0.47	0.64	0.68	0.44	0.43	0.55	0.61
16 to <21	0.39	0.38	0.49	0.52	0.36	0.35	0.46	0.49
21 to <31	0.36	0.34	0.47	0.51	0.33	0.32	0.42	0.45
31 to <41	0.36	0.34	0.47	0.52	0.32	0.30	0.41	0.46
41 to <51	0.37	0.35	0.47	0.52	0.33	0.32	0.44	0.49
51 to <61	0.38	0.37	0.48	0.55	0.34	0.33	0.44	0.49
61 to <71	0.34	0.34	0.40	0.42	0.29	0.28	0.35	0.37

[a] Sedentary and passive activities includes sleeping and napping

Table 3.~~22b~~24b. Descriptive Statistics for Minute Ventilation Rates (L/min) While Performing Activities Within the Specified Activity Category (US EPA, 2009)

Age Category (years)	Males				Females			
	Mean	50th	90th	95th	Mean	50th	90th	95th
	Sedentary & Passive Activities[a] (METS ≤ 1.5)							
Birth to <1	3.18	3.80	4.40	4.88	3.00	2.97	4.11	4.44
1	4.62	5.03	5.95	6.44	4.71	4.73	5.95	6.63
2	4.79	5.35	6.05	6.71	4.73	4.67	5.75	6.22
3 to <6	4.58	5.03	5.58	5.82	4.40	4.34	5.29	5.73
6 to <11	4.87	5.40	6.03	6.58	4.64	4.51	5.88	6.28
11 to <16	5.64	6.26	7.20	7.87	5.21	5.09	6.53	7.06
16 to <21	5.76	6.43	7.15	7.76	4.76	4.69	6.05	6.60
21 to <31	5.11	5.64	6.42	6.98	4.19	4.00	5.38	6.02
31 to <41	5.57	6.17	6.99	7.43	4.33	4.24	5.33	5.79
41 to <51	6.11	6.65	7.46	7.77	4.75	4.65	5.74	6.26
51 to <61	6.27	6.89	7.60	8.14	4.96	4.87	6.06	6.44
61 to <71	6.54	7.12	7.87	8.22	4.89	4.81	5.86	6.29
	Light Intensity Activities (1.5 < METS ≤ 3.0)							
Birth to <1	7.94	7.95	10.76	11.90	7.32	7.19	9.82	10.80
1	11.56	11.42	14.39	15.76	11.62	11.20	15.17	15.80
2	11.67	11.37	14.66	15.31	11.99	11.69	15.63	16.34
3 to <6	11.36	11.12	13.40	14.00	10.92	10.69	12.85	13.81
6 to <11	11.64	11.26	14.60	15.60	11.07	10.79	13.47	14.67
11 to <16	13.22	12.84	16.42	18.65	12.02	11.76	14.66	15.82
16 to <21	13.41	12.95	16.95	18.00	11.08	10.76	13.80	14.92
21 to <31	12.97	12.42	16.46	17.74	10.55	10.24	13.40	14.26
31 to <41	13.64	13.33	16.46	18.10	11.07	10.94	13.11	13.87
41 to <51	14.38	14.11	17.39	18.25	11.78	11.61	13.85	14.54
51 to <61	14.56	14.35	17.96	19.37	12.02	11.79	14.23	14.87
61 to <71	14.12	13.87	16.91	17.97	10.82	10.64	12.62	13.21
	Moderate Intensity Activities (3.0 < METS ≤ 6.0)							
Birth to <1	14.49	14.35	20.08	22.50	13.98	13.53	19.41	22.30
1	21.35	20.62	26.94	28.90	20.98	20.14	27.09	29.25
2	21.54	20.82	26.87	29.68	21.34	21.45	27.61	28.76
3 to <6	21.03	20.55	25.60	27.06	20.01	19.76	23.83	25.89
6 to <11	22.28	21.64	27.59	29.50	21.00	20.39	26.06	28.08
11 to <16	26.40	25.41	33.77	36.93	23.55	23.04	28.42	31.41
16 to <21	29.02	27.97	38.15	42.14	23.22	22.39	30.28	31.98
21 to <31	29.19	27.92	38.79	43.11	22.93	21.94	30.02	32.84
31 to <41	30.30	29.09	39.60	43.48	22.70	21.95	28.94	31.10
41 to <51	31.58	30.44	40.28	44.97	24.49	23.94	30.79	33.58
51 to <61	32.71	31.40	41.66	45.77	25.24	24.30	31.87	35.02
61 to <71	29.76	29.22	36.93	39.98	21.42	20.86	25.72	27.32

[a] Sedentary and passive activities includes sleeping and napping

In order to obtain minute ventilation rates that represent age ranges used in risk assessment for the "Hot Spots" program, age groups in Tables 3.~~23a~~25a-b were weighted equally by year of age and combined by OEHHA. The male and female data were also merged assuming 50:50 ratio in the California population. Two of the age groups combined from the U.S. EPA MET data do not exactly reflect the age ranges used by OEHHA, but they were judged reasonably close enough to use (i.e., combined MET ages 2 to <11 yrs represents OEHHA's 2<9 yr age group; combined MET ages 16 to <31 yrs represents OEHHA's 16<30 yr age group).

Table 3.~~23a~~25a. Minute Ventilation Rates for OEHHA Age Groups in L/kg-min (Males and Females Combined)

	0<2 years	**2<9 years**	**2<16 years**	**16<30 years**	**16-70 years**
	Sedentary & Passive Activities (METS ≤ 1.5)				
Mean	0.41	0.21	0.17	0.07	0.07
95th Percentile	0.52	0.29	0.24	0.09	0.09
	Light Intensity Activities (1.5 < METS ≤ 3.0)				
Mean	1.01	0.52	0.42	0.16	0.16
95th Percentile	1.25	0.70	0.56	0.21	0.21
	Moderate Intensity Activities (3.0 < METS ≤ 6.0)				
Mean	1.86	0.97	0.79	0.36	0.35
95th Percentile	2.40	1.33	1.09	0.49	0.48

Table 3.~~23b~~25b. Minute Ventilation Rates for OEHHA Age Groups in L/min (Males and Females Combined)

	0<2 years	**2<9 years**	**2<16 years**	**16<30 years**	**16-70 years**
	Sedentary & Passive Activities (METS ≤ 1.5)				
Mean	3.88	4.67	4.94	4.85	5.27
95th Percentile	5.60	6.22	6.66	6.73	6.96
	Light Intensity Activities (1.5 < METS ≤ 3.0)				
Mean	9.61	11.34	11.79	11.92	12.56
95th Percentile	13.57	14.80	15.67	16.15	16.24
	Moderate Intensity Activities (3.0 < METS ≤ 6.0)				
Mean	17.70	21.25	22.58	26.08	26.95
95th Percentile	25.74	28.07	30.25	37.67	37.65

From these tables, the 8-hour breathing rates were calculated by OEHHA based on age groupings used in the Hot Spots program and are presented in Section 3.2~~7 2 below~~. Eight-hour breathing rates based on high intensity activities (MET values >6.0) were not considered here because even at the 95th percentile, U.S. EPA (2009) showed that individuals spent only about 1 hour or less per day at this intensity. For moderate intensity activities, the 95th percentile was at or near 8 hours/day for some age groups.

For women in their third trimester of pregnancy, we are recommending using breathing rates based on moderate intensity activities.

3.~~6~~7 Short-term (1-Hour) Ventilation Rates

SB-352 mandates school districts to conduct a risk assessment for school sites located within 100 meters of a freeway or busy roadway, and also mandates that the AB-2588 risk assessment guidance be used in the risk assessment. Assessing cancer risks due to exposure at a school site requires less than 24 hour breathing rates. OEHHA recommends breathing rates derived from the USEPA (2009) age-specific ventilation rates for these purposes.

The U.S. EPA ventilation rates were developed for various levels of activities and can be used to estimate inhalation cancer risk from short-term maximal emissions from facilities. Breathing rates for children at school can range from sedentary in the classroom to active on the playground or sports field. OEHHA assumes that in some cases, a day care facility will be present on the school site where children may be as young as 0<2 years of age. The age ranges that U.S. EPA (2009) presents are useful for estimating the impact of early-in-life exposure for school-age children. Classroom instructors (i.e., adults) are also considered under SB-352. If the soil ingestion or dermal pathways need to be assessed, OEHHA recommends the exposure variates presented elsewhere in this document. The public health protective approach is to assume that all daily dermal and soil ingestion exposure occurs at school.

As discussed in Section 3.~~5~~ 6 above, U.S. EPA (2009) used existing data of ventilation rates (in ml/min or ml/kg-min) from a range of activities and assigned MET values depending on the intensity level of activity. Table 3.~~24~~ 26 shows MET values various school-related activities collected from the CHAD database (U.S. EPA, 2009).

~~(activities with METs values exceeding 3.0 to ≤ 6.0) were used to represent the typical range of children at play during recess.~~

Table 3.~~24~~26. METS Distributions for School-Related Activities

Activity Description	Mean	Median	SD	Min	Max
Passive sitting	1.5	1.5	0.2	1.2	1.8
Use of computers	1.6	1.6	0.2	1.2	2.0
Do homework	1.8	1.8	-	1.8	1.8
Use library	2.3	2.3	0.4	1.5	3.0
Attending day-care	2.3	2.3	0.4	1.5	3.0
Attending K-12 schools	2.1	2.1	0.4	1.4	2.8
Play indoors	2.8	2.8	0.1	2.5	3.0
Play outdoors	4.5	4.5	0.3	4.0	5.0
Recess and physical education	5.0	5.0	1.7	2.0	8.0

For OEHHA's purposes, the minute ventilation rates of males and females from Tables 3.~~22a~~24a-b were combined assuming a 50:50 proportional population distribution, and some age groups were combined assuming equal number of individuals in the population per year of age (Table 3.~~24a~~27a-b). For the SB-352, the child age groups were 0<2 years (infants), 2<6 years (preschool, kindergarten), 6<11 years (grade

school), 11<16 (junior high and high school). From these minute ventilation rates, 1-hour breathing rates are derived and presented in Section 3.~~7.1~~2.

Table 3.~~24a~~27a. Minute Ventilation Rates for SB352 School Sites in L/kg-min (Males and Females Combined)

	0<2 years	**2<6 years**	**6<11 years**	**11<16 years**	**16-70 years**
	Sedentary & Passive Activities (METS ≤ 1.5)				
Mean	0.41	0.28	0.16	0.10	0.07
95th Percentile	0.52	0.38	0.23	0.14	0.09
	Light Intensity Activities (1.5 < METS ≤ 3.0)				
Mean	1.01	0.69	0.38	0.24	0.16
95th Percentile	1.25	0.90	0.54	0.32	0.21
	Moderate Intensity Activities (3.0 < METS ≤ 6.0)				
Mean	1.86	1.26	0.73	0.47	0.35
95th Percentile	2.40	1.72	1.03	0.65	0.48
	High Intensity Activities (METS ≥ 6.0)				
Mean	-	2.27	1.37	0.92	0.64
95th Percentile	-	3.12	1.87	1.34	0.93

Table 3.~~24b~~25b. Minute Ventilation Rates for SB352 School Sites in L/min (Males and Females Combined)

	0<2 years	**2<6 years**	**6<11 years**	**11<16 years**	**16-70 years**
	Sedentary & Passive Activities (METS ≤ 1.5)				
Mean	3.88	4.56	4.76	5.43	5.27
95th Percentile	5.60	5.95	6.43	7.47	6.96
	Light Intensity Activities (1.5 < METS ≤ 3.0)				
Mean	9.61	11.31	11.36	12.62	12.56
95th Percentile	13.57	14.38	15.14	17.24	16.24
	Moderate Intensity Activities (3.0 < METS ≤ 6.0)				
Mean	17.70	20.75	21.64	24.98	26.95
95th Percentile	25.74	27.16	28.79	34.17	37.66
	High Intensity Activities (METS ≥ 6.0)				
Mean	-	37.34	41.51	48.69	50.10
95th Percentile	-	49.66	58.50	69.62	73.23

No high intensity minute ventilation rates are included in Tables 3.~~24a~~25a-b for infants age 0<2 yrs. The distributions generated by U.S. EPA (2009) for hrs/day spent at MET values ≥6.0 for infants (age 0<2 yrs) suggest that this level of activity for a 1-hr duration is unlikely for this age group.

SB-352 is also designed to protect adults working at the schools, including pregnant women. For women in their third trimester of pregnancy, OEHHA is recommending

using breathing rates of moderate intensity activities based on the same reasoning cited above in Section 3.6.

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4. SOIL INGESTION

4.1 Introduction

There is general consensus that hand-to-mouth activity results in incidental soil ingestion, and children ingest more soil than adults. Soil ingestion rates vary depending on the age of the individual, frequency of hand-to-mouth contact, seasonal climate, amount and type of outdoor activity, the surface on which that activity occurs, and personal hygiene practices. The specified age ranges of toxicological interest in the "Hot Spots" program are ages third trimester<2, 0<2, 2<9, 2<16, 16<30 and 16-70 years.

At present, the knowledge of soil ingestion patterns within the United States is limited. A few researchers in the U.S. have attempted to quantify soil ingestion patterns in children, and have performed studies in a few locales mainly in the northern parts of the United States. The limited information shows that children may ingest fairly substantial amounts of soil on a per-kilogram-body-weight basis, and their soil ingestion pattern is important in understanding and estimating their overall exposures to environmental toxicants from contaminated soil.

The Centers for Disease Control and Prevention's Agency for Toxic Substances and Disease Registry (ATSDR) has developed definitions for soil ingestion, soil-pica, and geophagy, to distinguish aspects of soil ingestion patterns that are important from a research perspective (ATSDR, 2001):

- ***Soil ingestion*** is defined as the intentional or unintentional consumption of soil. This may result from various behaviors including, but not limited to, mouthing, contacting dirty hands, eating dropped food, or consuming soil directly.

- ***Soil-pica*** is a form of intentional or unintentional soil ingestion of unusually high amounts of soil (i.e., on the order of 1,000 - 5,000 milligrams per day).

- ***Geophagy*** is a form of soil ingestion defined as the intentional ingestion of earths usually associated with cultural practices.

The "soil" ingested could be from outdoor soil, containerized soil for indoor plants, or a combination of both. ~~Children could ingest soil from outside as well as from soil in indoor potted plants.~~ The soil ingestion recommendations in this document represent ingestion of combined "soil" and outdoor settled dust. Outdoor settled dust is derived from particles that deposited or settled on outdoor objects and surfaces. It is not possible to differentiate between soil and outdoor settled dust. The "dust" found indoors includes soil tracked inside the building or blown indoors through opened windows and doors, particles from building

materials or consumer products, human and animal dander, and particles drawn in by the house's heating and air conditioning system.
The source of "dust" in indoor environments can be quite variable. Many studies provided dust or soil ingestion estimates on pollutants that have both indoor and outdoor sources. For some pollutants it is often difficult to determine the percentage which each of these sources contributed to the amount of soil or dust ingested. Many pollutants emitted from stationary outdoor sources can also come from important indoor sources. For example, lead from lead paint is probably the major source of lead found in indoor dust. The contribution of lead emitted from stationary sources to indoor dust is probably minor compared to that from lead paint but is difficult to pinpoint. Thus, pollutants found in indoor dust from many studies may ~~overestimate~~ misinterprete the amount contributed from stationary sources.

Soil ingestion has been documented in U.S. children and adults in several studies that use a "tracer element" methodology. The tracer element methodology attempts to quantify amounts of soil ingested by analyzing samples of soil from residences, and by analyzing samples of excreta (feces, and sometimes also urine). The soil, fecal, and urine samples are analyzed for the presence and quantity of tracer elements - typically, aluminum, silicon, titanium, and yttrium, and other elements. Because these metals/metalloids are not metabolized or absorbed to an appreciable extent in the gut, their presence in feces and urine can be used to estimate the quantity of soil ingested.

However, there is some evidence that tracer elements such as aluminum and silicon can be absorbed in small amounts from the digestive tract (Davis and Mirick, 2006). None of the studies using this methodology attempt to quantify amounts excreted in perspiration, tears, glandular secretions, shed skin, hair or nails. Entry into the body via the dermal and inhalation routes was not examined. Early studies usually did not account for the contribution of tracer elements from non-soil substances (food, medications, and non-food sources such as toothpaste) that children might swallow. Some studies adjusted the soil ingestion estimates to account for the potential contribution of tracer elements found in household dust as well as soil.

The amount of soil ingested is calculated from the quantity of the tracer element measured in the feces and urine minus that present in the food and medicine consumed. This number is then divided by the soil concentration of the tracer element to yield an estimate of ingested soil. Most of the studies assumed a lag time of 24 to 28 hours between ingestion and resulting fecal and urine output. Thus, the previous day's food, medications and non-food quantity of the tracer element is subtracted from that found in the current day's feces and urine excreted. An estimation of the amount of soil ingested daily can be obtained by dividing the total amount of soil ingested by the number of days in which the feces and urine were collected.

In the *Child-Specific Exposure Factors Handbook* (U.S. EPA, 2008), U.S. EPA includes the "biokinetic model comparison" and "survey response" methods in the document to assess soil and dust ingestion in children. The biokinetic model methodology is used mainly to estimate children's exposure to lead. This model compares lead exposure and uptake to predict children's blood lead levels with biomarker blood measurements.

The model predictions are made using assumptions about ingested soil and dust amounts that are based on the tracer element methodology. The survey response method uses the responses to survey questions regarding soil and dust ingestion. This method includes questions about children's soil and dust ingestion behaviors, frequency, and sometimes the quantity ingested. The respondents are the children themselves, or their caregivers.

4.2 Soil Ingestion Recommendations [This section was moved from the back of the chapter to the front of the chapter.]

4.2.1 Incidental Soil Ingestion

Before 1997, the U.S. EPA (1989, 1991) used 200 mg/day as a soil ingestion rate for children one through six years of age. In 1997, in the *Exposure Factors Handbook*, U.S. EPA recommends 100 mg/day as a mean for children under six, but indicates 200 mg could be used as a conservative estimate of the mean as it is consistent with the data.

U.S. EPA (2008) in the *Child-Specific Exposure Factors Handbook* recommended values (central tendency, mg/d) for soil, and soil and dust combined of 30, 60 (age 6 to <12 months), 50, 100 (age 1 to <6 years), and 50, 100 (age 6 to <21 years), respectively. The 90th and 95th percentile values from the key studies were used together with other data to derive a number for pica soil ingestion (above 1000 mg/d). We think that it is not appropriate to assume that the 90th and 95th percentile values in the children's studies are due to pica behavior as in any group of children there will be those that will consume more soil than the average.

OEHHA supports the U.S. EPA (2008) recommendations of 100 mg/day as the central tendency of the combined soil and dust ingestion rate for children aged 1 to <6 years. This number was rounded down from the actual number of 110 mg/d. Using 110 mg/day for soil and dust ingestion for the age group 1 to <6 years old (Table 4-13), and assuming this group has combined indoor and outdoor hand-to-mouth contacts of 14.8/hour (from Figure 4-17), soil and dust ingestion in other age groups are estimated (Table 4-18 and Table 4-19).

OEHHA calculated mean and 95th percentile soil and dust ingestions estimates (mg/kg BW-day) for the 3rd trimester < 2 by assuming that the soil and dust ingestions rate in mg/kg-day for the fetus was the same as for the mother (ages 16<30) and doing a time weighted average for the third trimester and ages 0 < 2.

OEHHA recommends the following point estimate soil and dust ingestion rates for children of various age groups and adults. Due to insufficient data, OEHHA has not developed distributions of soil ingestion data. Thus, this pathway is evaluated through the point estimate approach only.

Table 4.1 Recommended Soil Ingestion Estimates for Adults and Children (mg/kg-day)*

Age Groups (years)	Mean (mg/kg-day)	95th % (mg/kg-day)
3rd Trimester[a]	0.7	3
0 < 2	20	40
2<9	5	20
2<16	3	10
9<16[b]	2	7
16<30	0.7	3
16to70	0.6	3
PICA children[c]	200	-
PICA adult	NR	-

The mean weights for various age groups (with exceptions, see below) are from Chapter 10, Table 10.8

[a] Assumed to be the mother's soil ingestion rate (adult age 16 <30)

[b] Estimated mean body weight for this age group 55 kg

[c] Estimated mean body weight used for the PICA children 30 kg

* Soil includes outdoor settled dust

4.3 Algorithm for Dose from Soil Ingestion

4.3.1 Inadvertent Soil Ingestion by Adults and Children

The dose from inadvertent soil ingestion by adults can be estimated using the following general equation:

$$DOSEsoil = Csoil \times GRAF \times SIR \times EF \times (1 \times 10^{-9}) \quad \text{(Eq. 4-3~~1~~12)}$$

~~AT~~

where:

DOSEsoil = dose from soil ingestion (mg/kg body weight-day)

1×10^{-9} = conversion factor (μg to mg of contaminant, and kg to mg soil)
Csoil = concentration of contaminant in soil (μg/~~Kg~~ kg soil)
GRAF = gastrointestinal relative absorption fraction, unitless
SIR = soil ingestion rate (mg/kg BW-day)
EF = exposure frequency (days/year), EF = 350 d/yr (allows 2 weeks vacation away from residence)

~~ED = exposure duration (years)~~
~~AT = averaging time, period of time over which exposure is averaged (days); for noncancer endpoints, AT = ED × 365 d/yr; for cancer risk estimates, AT = 70 yr × 365 d/yr = 25,550 d~~

The annual average soil concentration in the Hot Spots model is determined by air dispersion models and the half life of the chemical in the soil. The term GRAF, or gastrointestinal relative absorption factor, is defined as the fraction of contaminant absorbed by the GI tract relative to the fraction of contaminant absorbed from the matrix (feed, water, other) used in the study(ies) that is the basis of either the cancer potency factor (CPF) or the reference exposure level (REL). If no data are available to distinguish absorption in the toxicity study from absorption from the environmental matrix in question, soil in this case, then the default assumption is that the GRAF = 1. The GRAF allows for adjustment for absorption from a soil matrix if it is known to be different from absorption across the GI tract in the study used to calculate the CPF or REL. At present that information is available only for polychlorinated dibenzo-p-dioxins and dibenzofurans. The GRAF for those compounds is 0.43. All others have a GRAF of 1.

The exposure frequency (EF) is the fraction of time spent at a residence or offsite work place, and is set at 350 days per year (i.e., per 365 days) to allow for two weeks per year away from home ~~following~~ (US EPA, ~~(~~1991).

For cancer risk, the risk is calculated for each age group using the appropriate age sensitivity factors (ASFs) and the chemical-specific cancer potency factor (POTENCY):

RISKsoil = DOSEsoil *POTENCY*ASF*ED/AT **(Eq. 4-2)**

Exposure duration (ED) is the number of years within the age groupings. In order to accommodate the use of the ASFs (see OEHHA, 2009), the exposure for each age grouping must be separately calculated. Thus, the DOSEsoil and ED are different for each age grouping. The ASF, as shown below, is 10 for the third trimester and infants 0<2 years of age, is 3 for children age 2<16 years of age, and is 1 for adults 16 to 70 years of age.

ED = exposure duration (yrs):
0.25 yrs for third trimester (ASF = 10)

	2 yrs for 0<2 age group	(ASF = 10)
	7 yrs for 2<9 age group	(ASF = 3)
	14 yrs for 2<16 age group	(ASF = 3)
	14 yrs for 16<30 age group	(ASF = 1)
	54 yrs for 16-70 age group	)ASF = 1)

AT, the averaging time for lifetime cancer risks, is 70 years in all cases. To determine lifetime cancer risks, the risks are then summed across the age groups:

$$RISKsoil_{(lifetime)} = RISKsoil_{(3rdtri)} + RISKsoil_{(0<2\ yr)} + RISKsoil_{(2<16\ yr)} + RISKsoil_{(16\text{-}70yr)} \quad \textbf{(Eq. 4-3)}$$

As explained in Chapter 1, we also need to accommodate cancer risk estimates for the average (9 years) and high-end (30 years) length of time at a single residence, as well as the traditional 70 year lifetime cancer risk estimate. For example, assessing risk in a 9 year residential exposure scenario assumes exposure during the most sensitive period, from the third trimester to 9 years of age and would be presented as such:

$$RISKsoil_{(9\text{-}yr\ residency)} = RISKsoil_{(3rdtri)} + RISKsoil_{(0<2\ yr)} + RISKsoil_{(2<9\ yr)} \quad \textbf{(Eq. 4-4)}$$

For 30-year residential exposure scenario, the 2<16 and 16<30 age group RISKsoil would be added to the risks for third trimester and age 0<2.~~.~~ For 70 year residential risk, Eq 4-3 would apply.

~~4.32.2 Inadvertent Soil Ingestion by Children~~

As described earlier, children have been divided into the following age groups with respect to soil ingestion rate: 0 to <2 years, 2 to <9 years, and 2 to <16 years of age. In addition, soil ingestion estimates are calculated for the adult age groups, 16 to < 30 years, and 16 to 70 years of age. In Section 4.7, OEHHA recommends soil ingestion rates for the 9, 30 and 70 year exposure duration scenarios.

The exposure duration scenarios evaluate the first 9, 30 and 70 years of an individual's life. The evaluation of the 9, 30 and 70 year exposure durations represent central tendency, 90th- 95th and lifetime of residency time. The evaluation of the 0 to <2 years, 2 to <9 years, 9 < 16 years, 16 to < 30 years, and 30 to 70 years age groupings are needed in order to properly estimate cancer risk for the age ranges as specified in *The Technical Support Document for Cancer Potency Factors: Methodologies for Derivation, Listing of Available Values, and Adjustments to Allow for Early Life Stage Exposures* (OEHHA, 2009).

For children, OEHHA is recommending that 9.7, 21.9, and 37.0 kg be used for the body weight for the 0 to <2, 2 to <9 and 2 to <16 year-old groups, respectively, for exposure duration determination of dose from soil ingestion (Chapter 10). For the 16 to <30 and 16 to70 year exposure duration scenarios, OEHHA recommends that 75.9 and 80.0 kg body weight, respectively, be used for the body weight term (Chapter 10). These body weights have been incorporated into the recommended soil consumption rates (mg/kg body weight-day). Care should be taken in using the appropriate ED and EF values for each sub-age grouping as well as the appropriate AT. Pica children are analyzed separately as described in Section 4.6.

4.3.~~3~~2 Inadvertent Soil Ingestion by Offsite Workers

The impact zone of a facility may include offsite workplaces. Risk estimates for those offsite workers include exposure from incidental soil ingestion for multi-pathway chemicals. Equation 4-3~~2~~ can be used, but the exposure is adjusted for the time at work by multiplying by 5/7 days, 50/52 weeks, and 46/70 years (a total adjustment of 0.15). This adjustment is meant to account for soil ingestion occurring while at work. The assumption inherent in the exposure adjustment is that one third of the daily soil ingestion occurs at work. For those who work outdoors this assumption may underestimate exposure, and could be an overestimation for those who work mainly indoors.

4.4~~3~~ SOIL INTAKE - KEY CHILDREN STUDIES

4.4~~3~~.1 Davis and Co-workers Studies

4.4~~3~~.1.1 Davis et al. (1990)

In this study, 104 toilet-trained children between the ages of 2 and 7 years were randomly recruited from a three-city area in southeastern Washington State. The study was conducted over a seven day period, primarily during the summer. A mass-balance/tracer technique was used to estimate soil ingestion. Daily soil ingestion was evaluated by analyzing soil and house dust, feces, urine, and duplicate food samples for aluminum, silicon, and titanium. In addition, information on dietary habits and demographics was collected in an attempt to identify behavioral and demographic characteristics that influence soil intake rates among children. The soil intake rates were corrected for the amount of tracer in vitamins and medications.
Soil ingestion rates were highly variable, especially those based on titanium. Mean daily soil ingestion estimates were 39 mg/day for aluminum, 82 mg/day for silicon and 246 mg/day for titanium (Table 4-~~1~~2). Median values were 25 mg/day for aluminum, 59 mg/day for silicon, and 81 mg/day for titanium. The differences in concentrations of the tracer elements in house dust and yard soil were adjusted to estimate soil ingestion rates.

Table 4.2~~1~~ Soil Ingestion Values From Davis et al. (1990)

Tracer Element[a]	Mean (mg/d)	Median (mg/d)	Standard Error of the Mean (mg/d)	Range (mg/d)[b]
Aluminum	38.9	25.3	14.4	279.0 to 904.5
Silicon	82.4	59.4	12.2	-404.0 to 534.6
Titanium	245.5	81.3	119.7	-5,820.8 to 6,182.2

a Excludes three children who did not provide any samples (n=101).
b Negative values occurred as a result of correction for non-soil sources of the tracer elements.

The adjusted mean soil/dust intake rates were 65 mg/day for aluminum, 160 mg/day for silicon, and 268 mg/day for titanium. Adjusted median soil/dust intake rates were: 52 mg/day for aluminum, 112 mg/day for silicon, and 117 mg/day for titanium.

The soil ingestion range includes negative numbers, which is indicative of a basic difficulty in estimating soil ingestion rates using the mass balance approach. If fecal output does not correspond to the food/medicines sampled due to factors such as the variation in transit time in the gut, then the calculated soil ingestion rate will be inaccurate. Overcorrecting for the presence of tracer elements in foods and medicines can bias the soil ingestion estimates downward, producing negative soil ingestion estimates which are obviously impossible. Likewise, if the food that was digested to produce the fecal sample contained more tracer elements than the food that was sampled, the soil ingestion rate can be biased in the positive.

In addition, the following demographic characteristics were found to be associated with high soil intake rates: male sex, racial groups other than white, low income, operator/laborer as the principal occupation of the parent, and city of residence. However, none of these factors were predictive of soil intake rates when tested using multiple linear regression.

Although a relatively large sample population was surveyed, these children were all from a single area of the U.S. and may not be representative of the U.S. population as a whole. The study was conducted over a one-week period during the summer and may not be representative of long term (i.e., annual) or seasonal patterns of soil intake.

4.4~~3~~.1.2 Davis and Mirick, 2006

The study used a subset of the 104 families who participated in the soil ingestion study by Davis *et al.* (1990). The data for this study were collected one year prior to the Davis *et al.* (1990) study. Nineteen families were selected in this study.

Each family consisted of one child participant between the age of 3 and 7, and one female and one male parent or guardian living in the same house. Samples were collected for 11 consecutive days of all food items consumed, all feces excreted, twice-daily urine, and soil/house dust. Tracer elements for this study included aluminum, silicon and titanium. In addition, parents completed a daily diary of the activities for 4 consecutive days for themselves and the participant child during the study period.

For children, the mean and median estimates for all three tracers ranged from 36.7 to 206.9 mg/day and 26.4 to 46.7 mg/day, respectively, and fall within the range of those reported by Davis *et al.* (1990). Adult soil ingestion estimates ranged from 23.2 to 624.9 mg/day for mean values and from 0 to 259.5 mg/day for median values, and were more variable than for the children in the study regardless of the tracer element used. The authors believed that this higher variability in adult soil ingestion rates may be attributed to occupational exposure in some, but not all, of the adults. Similar to the Davis *et al.* (1990) study, the soil ingestion estimates were the highest for titanium.

Various behaviors were found to be associated with increased soil ingestion in this study such as reported eating of dirt (for children), occupational contact with soil (for adults), and hand washing before meals (for both children and adults). Within the same family, a child's soil ingestion was not found to be associated with the parent's soil ingestion, nor did the mother and father's soil ingestion appear to be correlated. Although toothpaste is a known source of titanium, the titanium content of the toothpaste used by study participants was not determined.

An advantage of this study is that it examines soil ingestion among children and adults in the same family. However, the sample population was small and the families were a subset of those in a previous study, chosen for their high compliance to the study protocol. Thus, the uncertainties from the previous study still exist.

Table 4.3~~2~~ Soil Ingestion Values From Davis and Mirick (2006)

Participant	Tracer Element	Estimated Soil Ingestion (mg/day)			
		Mean	Median	Standard Deviation	Maximum
Child[b]	Aluminum	36.7	33.3	35.4	107.9
	Silicon	38.1	26.4	31.4	95.0
	Titanium	206.9	46.7	277.5	808.3
Mother[c]	Aluminum	92.1	0	218.3	813.6
	Silicon	23.2	5.2	37.0	138.1
	Titanium	359.0	259.5	421.5	1394.3
Father[d]	Aluminum	68.4	23.2	129.9	537.4
	Silicon	26.1	0.2	49.0	196.8
	Titanium	624.9	198.7	835.0	2899.1

[a] For some study participants, estimated soil ingestion resulted in a negative value. These estimates have been set to 0 mg/day for tabulation and analysis.
[b] Results based on 12 children with complete food, excreta, and soil data.
[c] Results based on 16 mothers with complete food, excreta, and soil data.
[d] Results based on 17 fathers with complete food, excreta, and soil data.

4.4~~3~~.2 Binder and Co-workers Study

4.4~~3~~.2.1 Binder et al. (1986)

Binder *et al.* (1986) used a tracer technique modified from a method previously used to measure soil ingestion among grazing animals to study the ingestion of soil among children. The children were studied during the summer of 1984 as part of a larger study of residents living near a lead smelter in East Helena, Montana.

Binder *et al.* (1986) measured tracer elements in feces to estimate soil ingestion by young children 1 to 3 years of age who wore diapers. Soiled diapers collected over a three day period from 65 children (42 males and 23 females), and composite samples of soil obtained from 59 of these children's yards were

analyzed for aluminum, silicon, and titanium. It was assumed that the soil ingested by these children originated largely from their own yards. The soil tracer elements were assumed to be minimally absorbed in the GI tract and minimally present in the children's diet. Soil ingestion by each child was estimated based on an assumed fecal dry weight of 15 g/day. Tracer elements were assumed to be neither lost nor introduced during sampling.

Daily soil ingestion rates based on aluminum, silicon and titanium are presented in Table 4.4~~3~~. The minimum soil ingestion presented in the table is based on the lowest of three estimates of soil ingestion in each subject. The minimum is presented because of the failure to account for the presence of the three tracers in ingested foods, medicines, and other sources such as toothpaste. Estimates from aluminum and silicon were comparable. However, much higher soil ingestion estimates were obtained using titanium as a tracer suggesting that there may be an unrecognized source of titanium that the children were ingesting or the tracer element was introduced during the laboratory processing of stool samples.

Table 4.4~~3~~ Soil Ingestion Rates (mg/day) From Binder et al. (1986)

Tracer:	Aluminum	Silicon	Titanium
Mean	181	184	1834
Standard deviation	203	175	3091
Range	25-1324	31-799	4-17,076
Median	121	136	618
95th percentile	584	578	9590
Geometric mean	128	130	401

The advantages of this study are that a relatively large number of children were studied and tracer elements were used to estimate soil ingestion. However, there were several methodological difficulties with the protocol pointed out by the investigators. The tracers ingested in foods and medicines were not accounted for which leads to overestimation of soil ingestion rates. Rather than using measured fecal weights, the investigators assumed a dry fecal weight of 15 g/day for each child. This may lead to either over- or underestimation of soil ingestion rates. Measuring fecal weights was difficult because the entire diaper (including urine) was collected, and as much stool as possible recovered from the diaper.

This was a short-term study and, as with all the studies on soil ingestion rates, the data may not be entirely representative of longer-term soil ingestion rates. Finally, the children may not be a representative sample of the U.S. population.

4.4.3 Calabrese and Co-workers Studies

a. Amherst, Massachusetts Studies

4.4~~3~~.3.1 Calabrese et al. (1989)

Sixty-four children between one and four years old in the Amherst, Massachusetts area were studied. Soil ingestion rate was based on measurements of eight tracer elements: aluminum, barium, manganese, silicon, titanium, vanadium, yttrium, and zirconium, and a method similar to Binder *et al.* (1986) but including a mass balance approach was used. Duplicate meal samples, including vitamins and medicines, were collected for all children from Monday through Wednesday of two consecutive weeks, while fecal and urine samples were collected over four 24-hour periods from noon Monday through noon Friday in the corresponding weeks.

Soil and dust samples were collected from each child's home and play areas. Children were given toothpaste, diaper rash ointment and other hygiene products that contained trace to no levels of the tracer elements. Blanks of diaper and commode specimens using distilled water were collected to control for introduced tracer. Waste samples from a single 24-hour period were pooled as were soil samples which represented composite samples from the three areas in which the child played the most.

In addition, these investigators also provided a validation study in six adult volunteers, age 25-41, for three consecutive days (Monday to Wednesday, breakfast and dinner) for three weeks. The volunteers ingested empty gelatin capsules in week one, gel capsules containing 50 mg sterilized soil in week two, and gel capsules containing 250 mg soil in week three. Duplicate food samples were collected as in the children's study and total excretion was collected Monday through Friday for the three study weeks. Soil was determined to be non-contaminated in terms of priority pollutants and contained enough of each tracer element to be detectable in the excreta.

The adult validation study indicated that study methodology could adequately detect soil ingestion at rates expected by children. The ingestion of soil in the second week was accompanied by a marked increase in fecal excretion of tracer that could not be accounted for by variability of tracer in food. Recovery data from the adult study indicated that aluminum, silicon, yttrium, and zirconium had the best recoveries (closest to 100%) while barium and manganese grossly exceeded 100% recovery. Both these elements were deemed unreliable due to their relatively higher concentrations in food relative to soil. Zirconium as a tracer was highly variable and titanium was not reliable in the adult studies. The investigators conclude that aluminum, silicon, and yttrium are the most reliable tracers for soil ingestion. Also see description of Calabrese *et al.* (1990).

The results of the soil ingestion calculations for children based on excretory tracer levels minus food tracer levels (Table 4.5~~4~~) indicate a median value between 9 mg/day for yttrium and 96 mg/day for vanadium. There was a large

degree of interindividual variation, with one or two extreme outliers. The mean estimates were considerably higher than the median in most cases.

Table 4.5~~4~~ Soil Ingestion Results (mg/day) For Children Aged 1 To 4 Years From Calabrese et al. (1989)

Tracer:	Aluminum	Silicon	Titanium	Vanadium	Yttrium	Zirconium
Mean	153	154	218	459	85	21
Median	29	40	55	96	9	16
SD	852	693	1150	1037	890	209
95th %	223	276	1432	1903	106	110
Max	6837	5549	6707	5676	6736	1391

One child in this study exhibited pica behavior. The high soil ingestion rates for this child may or may not be applicable to other soil pica children or, over time, even to this one child. However, it is interesting to note that this study did pick up a child with this behavior.

There are a number of methodological difficulties in attempting to quantify soil ingestion using the tracer methodology. Food (including vitamins and medicines), soil, and fecal material are analyzed for specific tracer elements in a mass balance approach to estimate soil ingestion. The assumption is that the tracer elements measured in the feces are exclusively from the food and medicines analyzed. However, transit time through the gut varies widely. The fecal sample may not represent the food/medicine sample input. This input-output misalignment can underestimate soil ingestion and could result in negative soil ingestion estimates.

The other main type of error in tracer studies for estimating soil ingestion is source error. Source error occurs when an unknown or unaccounted for source of the tracer element is ingested by the study subjects. The soil ingestion estimate can be inflated since it is assumed that soil is the source of tracer.

However, this study is useful in several ways. The mass balance approach attempts to correct for ingestion of tracer such as titanium in foods, medicines, and toothpaste. The validation regimen in adults points out the most reliable tracers and validates the overall methodology. The complete sample collection of urine and feces in this study obviates the need to assume a fecal weight for calculating soil ingestion estimates. A relatively large population was studied, but it may not be entirely representative of the U.S. population because it was selected from a single location. The results presented in this paper have been superseded by more refined analyses of the same data by the authors (Stanek and Calabrese, 1995a and 1995b).

4.4~~3~~.3.2 Calabrese and Stanek (1992)

This study estimated the amount of outdoor soil in indoor dust using statistical modeling. Data from 60 homes in the Calabrese *et al.* (1989) study were used to develop scatter plots of each tracer concentration in soil (outdoor) versus dust (indoor) for the subject population. The scatter plots show little evidence of a consistent relationship between outdoor soil and indoor dust concentrations.

The assumption is that 50% of excess fecal tracers were from indoor origin. Multiplying this by the model prediction that 31.3% of indoor dust came from outdoor soil resulted in an estimate that 15% of excess fecal tracers were from soil material present in indoor dust. These analyses indicate that approximately 65% of the total fecal tracer was of soil origin and the estimates of median outdoor soil ingestion presented in the earlier study should be reduced by 35%. The revised soil ingestion estimates are reduced from 29 to19 mg/d based on aluminum, 40 to 26 mg/d based on silicon, and 9 to 6 mg/d based on yttrium.

The model uses several simplifying assumptions: a) the amount of dust produced every day from both indoor and outdoor sources in a house is constant for all houses, b) the proportion of indoor dust due to outdoor soil is constant for all houses, and c) the concentration of the tracer element in dust produced from indoor sources is constant for all houses. The validity of these assumptions cannot be evaluated and subsequent papers by the authors did not make use of this adjustment.

4.4~~3~~.3.3 Stanek and Calabrese (1995a)

Stanek and Calabrese (1995a) reanalyzed the soil ingestion study by Calabrese *et al.* (1989). The individual daily soil ingestion estimates (64 subjects for 8 days) were used to develop distributions of values for 365 days for each subject using an assumed lognormal distribution. All soil ingested was assumed to come from outdoors and food intake was directly linked with fecal output. Daily soil ingestion estimates were made for each element and each study subject. The study links the food samples with the fecal samples in an attempt to more accurately estimate soil ingestion rates. In addition, the tracers were ranked according to their usefulness, and criteria for excluding certain soil ingestion estimates were incorporated into the reanalysis.

Negative estimates were replaced with a value of 1 mg/day. For each day and subject, medians, and lower and upper bounds of soil ingestion rate were calculated for the eight tracers. The lower and upper bounds functioned as exclusion criteria. If a soil ingestion rate estimate fell outside the bounds, it was assumed to be invalid and discarded. The investigators took estimates of the means and medians of the subjects' daily soil ingestion and constructed their cumulative distributions.

The results indicate that mean soil ingestion estimates over the study period of four to eight days were 45 mg/day or less for 50% of the children and

208 mg/day or less for 95% of the children. The median daily soil ingestion estimates were 13 mg/day or less for 50% of the children studied, and 138 mg/day or less for 95% of the children studied.

The median of the distribution of average daily soil ingestion extrapolated over 365 days is 75 mg, while the 95th percentile is 1751 mg/day. The median of the distribution of median soil ingestion estimates is 14 mg/day while the 95th percentile is 252 mg/day. The range of upper 95th percentiles of the median soil ingestion rate estimates for 63 kids (exclusive of the one pica child) is 1 to 5623 mg/day.

Stanek and Calabrese (1995a) also evaluated the presence of soil pica using their distribution methodology. They estimated that on 35-40 days of the year, 16% of children would ingest more than 1 gram/d of soil and 1.6% would ingest more than 10 grams/d.

Table 4.6~~5~~ Estimates of Children (%) Exceeding Certain Soil Ingestion Rates from Stanek and Calabrese (1995a)

Soil Ingestion Rate	Days per year of excessive soil ingestion		
	1-2	7-10	35-40
> 1 gram	63%	41%	16%
> 5 grams	42%	20%	1.6%
>10 grams	33%	9%	1.6%

There are many limitations to the study, one of which is the assumption of lognormal distributions to estimate daily soil ingestion over 365 days. There is little empirical evidence to support its use. The number of samples needed to capture typical intake over a year would be considerably more and seasonal variability would need to be taken into account. There are methodological difficulties in quantifying the distribution of soil ingestion rates such as assuming that the transit time in the gut was the same for all subjects and did not vary within subjects. The correction used is unlikely to be adequate to account for the input-output misalignment error, probably resulting in the negative soil ingestion estimates as obtained in Calabrese *et al.* (1989).

There are large discrepancies between trace elements estimates of soil ingestion for the same subject on the same day. The outlier criterion was used to correct for the likelihood that ingestion of some tracers occurred from other sources than food or soil. The exclusion methodology (using the median as a reference point rather than the mean) did not indicate how many data points were excluded or what those data points were. However, the effect of these exclusions is probably small as indicated by comparing the distributions of the mean estimates (where three or fewer elements are used following exclusion) with the distribution of the mean estimates (where no elements are excluded).

Short term studies are often all that are available to extrapolate to long term intakes needed for risk assessment. However, the limitations need to be acknowledged and the data available must be sufficient to perform the quantification.

4.4~~3~~.3.4 Stanek and Calabrese (1995b)

Stanek and Calabrese (1995b) reanalyzed the data from their 1989 study with data from Davis *et al.* (1990) using a different methodology from that used in Stanek and Calabrese (1995a). The Best Tracer Method (BTM), based on the food to soil ratio, is designed to overcome inter-tracer inconsistencies in the estimation of soil ingestion rates. It is assumed that tracers with a low food to soil ratio lead to more precise soil ingestion estimates because confounding from the tracer content of food is decreased.

The combined data from the two studies (Calabrese *et al.* 1989 and Davis *et al.* 1990) were used to construct estimates of the food to soil (F/S) ratio for each trace element for each subject/week. The F/S ratio was calculated by dividing the average daily amount of a trace element ingested from food by the soil trace element concentration per gram soil. For each subject/week, these ratios were ranked lowest to highest. The F/S ratio is small when the tracer concentration in food is almost zero compared to the tracer concentration in soil. A small F/S ratio is desirable because it lessens the impact of transit time error. This error occurs when fecal output does not reflect food ingestion, due to fluctuation in gastrointestinal transit time. Distributions of soil ingestion estimates are presented based on the various ranked tracers for both children (Calabrese *et al.* 1989; Davis *et al.* 1990) and adults (Calabrese *et al.* 1990).

In contrast to the Stanek and Calabrese (1995a) study, negative values for soil ingestion estimates were included in the distributions. This would shift the distribution towards lower ingestion estimates. While it is valuable to eliminate source error as much as possible by utilizing elements with low F/S ratios, the presence of negative soil ingestion estimates is indicative that there still is a problem with input-output misalignment. Negative soil ingestion estimates are biologically meaningless, and incorporating these values into a distribution is problematic. Distributions of soil ingestion estimates from the combined studies for children are presented in Table 4.~~6~~7.

Table 4.7~~6~~ Distributions of Soil Ingestion Estimates (mg/d) in Children from Stanek and Calabrese (1995b)

Studies	Percentiles						Mean ± SD	Min	Max
	10th	25th	50th	90th	95th	99th			
A[a]	-6	9	33	110	154	226	132 ± 1006	-97	11,415
B[b]	-52	-15	44	210	246	535	69 ± 146	-404	905
A and B	-12	10	37	156	217	535	104 ± 758	-404	11,415

Table based on element groupings formed by ranked food:soil ratios.
[a] Study A: data from Calabrese et al., 1989
[b] Study B: data from Davis et al., 1990

Based on the 64 children in the Calabrese *et al.* (1989) study and using the median soil ingestion estimates from the best four tracers, the mean soil ingestion rate was 132 mg/day and the median soil ingestion rate was 33 mg/day. The 95th percentile value was 154 mg/day. For the 101 children in the Davis *et al.* (1990) study, the mean soil ingestion rate was 69 mg/day and the median soil ingestion rate was 44 mg/day. The 95th percentile estimate was 246 mg/day. When the Calabrese *et al.* (1989) and Davis *et al.* (1990) studies were combined, soil ingestion rates for children were estimated to be 104 mg/day (mean), 37 mg/day (median) and 217 mg/day (95th percentile), using the BTM. When the adult data from the Calabrese *et al.* (1990) study were reevaluated, soil ingestion rates were estimated to be 64 mg/day (mean), 87 mg/day (median), and 142 mg/day (95th percentile), using the BTM.

This study combines data from two studies of children, one from southwestern Washington and one from Massachusetts, thus increasing the number of observations. It also corrects for some differences associated with tracer metabolism. The limitations associated with the data used in this study are the same as the limitations described earlier in the summaries of the Calabrese *et al.* (1989), Davis *et al.* (1990) and Calabrese *et al.* (1990) studies.

b. Anaconda, Montana Studies

4.4~~3~~.3.5 Calabrese et al. (1997)

Sixty-four children ages 1-3 years and predominantly from two-parent households living on a Superfund site in Anaconda, Montana were selected for this study. Thirty-six of the 64 children were male, and the children ranged in age from 1 to 3 years with approximately an equal number of children in each age group. The study was conducted for seven consecutive days during a two week period in the month of September.

Duplicate samples of meals, beverages, and over- the-counter medicines and vitamins were collected over the seven day period, along with fecal samples. In addition, soil and dust samples were collected from the children's home and play areas. Toothpaste containing non-detectable levels of the tracer elements, with the exception of silica, was provided to all of the children. Infants were provided with baby cornstarch, diaper rash cream, and soap which were found to contain low levels of the tracer elements. The mass-balance methodology similar to that in Calabrese *et al.* (1989) was used.

As in Calabrese *et al.* (1989), an additional study was conducted in which the mass-balance methodology was used on adults in order to validate that soil ingestion could be detected. Known amounts of soil were administered to ten adults (5 males, 5 females) from Western Massachusetts over a period of 28 days. Each adult ingested for 7 consecutive days: a) no soil during Week 1, b) 20 mg of sterilized soil during Week 2, c) 100 mg of sterilized soil during Week 3, and d) 500 mg of sterilized soil during Week 4. Duplicate food and fecal samples were collected every day during each study week and analyzed for the eight tracer elements (aluminum, silicon, titanium, cerium, lanthanum, neodymium, yttrium, and zirconium). The authors determined that a soil ingestion of 200 to 500 mg/day could be detected in a reliable manner.

Soil ingestion by each tracer element was estimated using the Best Tracer Method (BTM), which allows for the selection of the most recoverable tracer for a group of subjects (Stanek and Calabrese, 1995b). The median soil ingestion estimates for the four best trace elements based on food:soil ratios for the 64 children are presented in Table 4-8~~7~~. The best estimate was calculated by taking the median of these four trace elements. Based on the soil ingestion estimate for the best tracer, the mean soil ingestion rate was 66 mg/day and the median was 20 mg/day. The 95th percentile value was 283 mg/day. Using the median of the 4 tracers, the mean was 7 mg/day and the 95th percentile was 160 mg/day.

These results are lower than the soil ingestion estimates obtained by Stanek and Calabrese (1995a). The investigators believed that families, who participated in this study, were aware that they lived on an EPA Superfund site and this knowledge might have resulted in reduced exposure. There was no statistically significant difference found in soil ingestion estimates by gender or age, by housing or yard characteristics (i.e., porch, deck, door mat, etc.), or between children with or without pets.

The advantages of this study were a consecutive seven day study period rather than two periods of 3 and 4 days (Stanek and Calabrese, 1995a), the use of the BTM, and the use of a dietary education program to reduce food tracer input and variability.

Table 4.8~~7~~ Soil Ingestion Estimates for 64 Anaconda Children (mg/day) Based on Food:Soil Ratios for Aluminum, Silicon, Titanium, Yttrium, and Zirconium[b]

Tracer	Soil Ingestion (mg/day)[a]										
	Percentile							Min	Max	Mean	SD
	5th	10th	25th	50th	75th	90th	95th				
Median[b]	-91.0	-53.8	-38.0	-2.4	26.8	73.1	159.8	-101.3	380.2	6.8	74.5
Best	-24.4	-14.4	2.2	20.1	68.9	223.6	282.4	-53.4	609.9	65.5	120.3
2nd best	-62.1	-48.6	-26.6	1.5	38.4	119.5	262.3	-115.9	928.5	33.2	144.8
3rd best	-88.9	-67.0	-52.0	-18.8	25.6	154.7	376.1	-170.5	1293.5	31.2	199.6
4th best	-171.0	-131.9	-74.7	-29.3	0.2	74.8	116.8	-298.3	139.1	-34.6	79.7

[a] Negative values occurred as a result of calculating child-specific estimates for multiple days. For example, negative estimates of soil ingestion occurred when an individual child had low, but positive, soil ingestion, but the standard deviation was large.
[b] Median value of best four tracers

Table 4.9~~8~~ Dust Ingestion Estimates for 64 Anaconda Children (mg/day) Based on Food/Dust Ratios for Aluminum, Silicon, Titanium, Yttrium, and Zirconium[b]

Tracer	Dust Ingestion (mg/day)[a]										
	Percentile							Min	Max	Mean	SD
	5th	10th	25th	50th	75th	90th	95th				
Median[b]	-186.2	-152.7	-69.5	-5.5	62.8	209.2	353.0	-261.5	683.9	16.5	160.9
Best	-193.8	-91.0	-20.8	26.81	198.1	558.6	613.6	-377.0	1499.4	127.2	299.1
2nd best	-147.2	-137.1	-59.1	7.6	153.1	356.4	409.5	-239.8	1685.1	82.7	283.6
3rd best	-247.5	-203.1	-81.7	-14.4	49.4	406.5	500.5	-375.7	913.2	25.5	235.9
4th best	-365.6	-277.7	-161.5	-55.1	52.4	277.3	248.8	-542.7	6120.5	81.8	840.3

[a] Negative values occurred as a result of calculating child-specific estimates for multiple days. For example, negative estimates of dust ingestion occurred when an individual child had low, but positive, dust ingestion, but the standard deviation was large.
[b] Median value of best four tracers.

However, the data presented in this study are from a single seven-day period during September which may not reflect soil ingestion rates for longer time-periods or other seasonal months. The net residual negative error indicates probably an underestimation in the soil ingestion rates. The investigators estimated that this error is unlikely to affect the median value by more than 40 mg/day. Since the data from half of the distribution are negative, it is difficult to place a lot of confidence in the soil and dust ingestion estimates obtained.

4.4~~3~~.3.6 Calabrese et al. (1996)

In this study Calabrese *et al.*, (1996) examined the hypothesis that differences in soil tracer concentrations could be related to soil particle size. Soil that was used

by Calabrese *et al.* (1997) from Anaconda, Montana was reanalyzed for the tracer concentration after it had been sieved to a particle size of <250 µm in diameter (<2 mm soil particle size in the original study). The smaller particle size was examined based on the assumption that children and adults principally ingest soil of small particle size adhering to fingertips and under fingernails.

Soil concentration was not changed by particle size for five of the tracers used in the original study (aluminum, silicon, titanium, yttrium, and zirconium). However, the soil concentrations of three tracers (cerium, lanthanum and neodymium) were increased two- to four-fold at the smaller soil particle size. Soil ingestion estimates for these three tracers were decreased by approximately 60% at the 95th ~~95th~~ percentile, when the effect of particle size on tracer concentration is taken into account.

4.4~~3~~.3.7 Stanek et al. (1999)

Stanek *et al.* (1999) extended the findings from their earlier study (Calabrese *et al.* 1996) by quantifying trace element concentrations in soil of different particle sizes. The soil was sieved to particle sizes of 100 to 250 µm and to particle sizes of 53 to < 100 µm. This study used the data from soil concentrations from the Anaconda, Montana site reported by Calabrese *et al.* (1997).

Results of the study indicated that soil concentrations of aluminum, silicon, and titanium did not increase at the two finer particle size ranges measured. However, soil concentrations of cerium, lanthanum and neodymium increased by a factor of 2.5 to 4.0 in the 100-250 µm particle size range when compared with the 0 to 2 µm particle size range. There was not a significant increase in concentration in the 53 to 100 µm particle size range. The importance of this study and that published in 1996 is that they provide further insights regarding the selection of tracers for soil ingestion studies.

4.4~~3~~.3.8 Stanek and Calabrese (2000)

In this study the soil ingestion data from the Anaconda, Montana study were reanalyzed, assuming a lognormal distribution for the soil ingestion estimates. Average soil ingestion for children was predicted over time periods of 7 days, 30 days, 90 days, and 365 days. The 95th percentile soil ingestion values predicted were 133 mg/day over 7 days, 112 mg/day over 30 days, 108 mg/day over 90 days, and 106 mg/day over 365 days. Based on this analysis, estimates of the distribution of longer term average soil ingestion are expected to be narrower, with the 95th percentile estimates being as much as 25% lower. The limitations to this analysis were similar to that discussed in Stanek and Calabrese (1995a) in Section 4.4~~3~~.3.4~~3~~.

4.4~~3~~.4 Clausing and Co-workers Studies

4.4~~3~~.4.1 Clausing et al. (1987)

This soil ingestion study was conducted with Dutch children using the Limiting Tracer Method (LTM). Aluminum, titanium, and acid-insoluble residue (AIR) contents were determined for fecal samples from children aged 2 to 4 years attending a nursery school and for samples of playground dirt at that school.

Twenty seven daily fecal samples were obtained over a 5-day period for the 18 children examined. Using the average soil concentrations present at the school, and assuming a standard fecal dry weight of 10 g/day, soil ingestion was estimated for each tracer. Eight daily fecal samples were also collected from six hospitalized, bedridden children. These children served as a control group, representing children who had little access to soil. The average quantity of soil ingested by the school children in this study was 230 mg/day (range 23 to 979 mg/day) for aluminum; 129 mg/day (range 48 to 362 mg/day) for AIR; and 1,430 mg/day (range 64 to 11,620 mg/day) for titanium. As in the Binder et al. (1986) study, a fraction of the children (6/19) showed titanium values well above 1,000 mg/day.

Table 4.10~~9~~ Soil Ingestion Results (mg/day) From Clausing et al. (1987)

	School Children	Hospitalized Children	Difference
Mean	105	49	56
Standard Deviation	67	22	
Range	23-362	26-84	
Geometric Mean	90	45	

Mean soil intake for the school children was estimated to be 105 mg/day with a standard deviation of 67 mg/day (range 23 to 362 mg/day). Geometric mean soil intake was estimated to be 90 mg/day. The soil intake for this group of children was much higher when compared to the hospitalized children used as the control group (mean 49 mg/day, standard deviation 22 mg/day).

Mean (arithmetic) soil intake for the hospitalized children was estimated to be 56 mg/day based on aluminum. For titanium, three of these children had estimates well in excess of 1,000 mg/day, with the remaining three children in the range of 28 to 58 mg/day. The mean soil ingestion rate was estimated to be 49 mg/day with a population standard deviation of 22 mg/day (range 26 to 84 mg/day). The geometric mean soil intake rate was 45 mg/day (Table 4-10~~9~~).

The data on hospitalized children suggest a non-soil source of titanium and aluminum. However, conditions specific to hospitalization (e.g., medications) were not considered. Assuming that soil ingestion rates observed in hospitalized children actually represent background tracer intake from dietary and other non-soil sources, mean soil ingestion by nursery school children was estimated to be

56 mg/day (i.e., 105 mg/day for nursery school children minus 49 mg/day for hospitalized children).

The advantages of this study are that the investigators evaluated soil ingestion among children that had differences in access to soil and soil intake rates were corrected based on background estimates derived from the hospitalized group. However, the number of children used in this study was small. Tracer elements in foods or medicines were not evaluated. Also, the study was a short-term study and the intake rates may not be representative of soil intake over the long-term. The children's activities were not monitored. For example, hand washing frequency could impact soil ingestion.

4.4~~3~~.4.2 Van Wijnen et al. (1990)

In this study soil ingestion among Dutch children ranging in age from 1 to 5 years was evaluated using the tracer element methodology (LTM) used by Clausing *et al.* (1987). Three tracers (titanium, aluminum, and acid insoluble residue (AIR)) were measured in soil and feces and soil ingestion was estimated from the measurements. An average daily feces dry weight of 15 g was assumed. A total of 292 children attending daycare centers were sampled during the first sampling period and 187 children were sampled in the second. A total of 78 children were sampled at campgrounds. Samples taken from 15 hospitalized children were used as controls.

The mean soil ingestion values for these groups were: 162 mg/day for children in daycare centers, 213 mg/day for campers and 93 mg/day for hospitalized children. Geometric means were estimated to be 111 mg/day for children in daycare centers, 174 mg/day for children vacationing at campgrounds and 74 mg/day for hospitalized children (70-120 mg/day based on the 95th percent confidence limits of the mean) (Table 4-1~~0~~1). AIR was the limiting tracer in about 80 percent of the samples. Among children attending daycare centers, soil intake was also found to be higher when the weather was good.

The investigators used the mean value (93 mg/day) for hospitalized children as the background intake of tracers. Using the mean value to correct the soil intake rates, corrected soil intake rates were 69 mg/day for daycare children and 120 mg/day for campers. Corrected geometric mean soil intake was estimated to range from 0 to 90 mg/day with a 90th percentile value of 190 mg/day for the various age categories within the daycare group and 30 to 200 mg/day with a 90th percentile value of 300 mg/day for the various age categories within the camping group.

The major limitation of this study is that tracer concentrations in food and medicine were not evaluated. Although the population of children studied was relatively large, it may not be representative of the U.S. population. This study was conducted over a relatively short time period and estimated intake rates may

not reflect long-term patterns, especially at the high-end of the distribution. Another limitation of this study is that values were not reported element-by-element, and the children's daily activities such as hand washing frequency were not monitored.

Table 4.11~~0~~ Soil Ingestion Values Using the LTM Methodology for Children at Daycare Centers and Campgrounds

Age (Years)	Sex	Daycare centers			Campgrounds		
		N	Geometric Mean (mg/d)	Geometric Standard Deviation (mg/d)	N	Geometric Mean (mg/d)	Geometric Standard Deviation (mg/d)
birth to <1	**Girls** **Boys**	3 1	81 75	1.09 -	- -	- -	- -
1 to <2	**Girls** **Boys**	20 17	124 114	1.87 1.47	3 5	207 312	1.99 2.58
2 to <3	**Girls** **Boys**	34 17	118 96	1.74 1.53	4 8	367 232	2.44 2.15
3 to <4	**Girls** **Boys**	26 29	111 110	1.57 1.32	6 8	164 148	1.27 1.42
4 to <5	**Girls** **Boys**	1 4	180 99	- 1.62	19 18	164 136	1.48 1.30
Combined All ages	**Girls** **Boys**	86 72	117 104	1.70 1.46	36 42	179 169	1.67 1.79
Total		162[a]	111	1.60	78[b]	174	1.73

[a] Age and/or sex not registered for eight children.
[b] Age not registered for seven children.

4.4~~3~~.5 Other Relevant Studies and Analyses

4.4~~3~~.5.1 Thompson and Burmaster (1991)

Thompson and Burmaster (1991) developed parameterized distributions of soil ingestion rates for children based on a reanalysis of the key study data collected by Binder *et al.* (1986). In the original Binder *et al.* (1986) study, an assumed dry fecal weight of 15 g/day was used. Thompson and Burmaster re-estimated the soil ingestion rates from the Binder *et al.* (1986) study using the actual stool weights of the study participants instead of the assumed stool weights. Because the actual stool weights averaged only 7.5 g/day, the soil ingestion estimates presented by Thompson and Burmaster (1991) are approximately one-half of those reported by Binder *et al.* (1986).

The mean soil intake rates were 97 mg/day for aluminum, 85 mg/day for silicon, and 1,004 mg/day for titanium. The 90th percentile estimates were 197 mg/day for aluminum, 166 mg/day for silicon, and 2,105 mg/day for titanium. Based on the arithmetic average of aluminum and silicon for each child, mean soil intake was estimated to be 91 mg/day and 90th percentile intake was estimated to be 143 mg/day (Table 4-12~~1~~).

Table 4.12~~1~~ Distribution of Soil Ingestion Estimates For Children by Thompson and Burmaster (1991)

	Soil Intake (mg/d)			
	Aluminum	**Silicon**	**Titanium**	**Mean[a]**
Mean	97	85	1004	91
Median	45	60	293	59
90th %	197	166	2105	143

[a] Arithmetic average of soil ingestion based on aluminum and silicon

Thompson and Burmaster (1991) also adjusted Binder *et al.* (1986) data for aluminum, and silicon for lognormal distribution. No adjustment was made for titanium because titanium may be present in high concentrations in food and the Binder *et al.* (1986) study did not correct for food sources of titanium. Statistical tests indicated that only silicon and the average of the silicon and aluminum tracers were lognormally distributed.

The advantages of this study are that it provides percentile data and defines the shape of soil intake distributions. However, the number of data points used to fit the distribution was limited. This analysis is based on a study that did not correct for tracer intake from food or medicine and the methodological difficulties encountered in the original Binder *et al.* study still exist including difficulty in obtaining the entire fecal sample from a diaper.

4.4~~3~~.5.2 Sedman and Mahmood (1994)

The data of two previous studies, Calabrese *et al.* 1989 and Davis *et al.* 1990, were used to obtain estimates of the average daily soil ingestion in young children. The soil ingestion in these children was determined by dividing the excess tracer intake (the quantity of tracer recovered in the feces in excess of the measured intake) by the average concentration of tracer in soil samples from each child's dwelling.

The mean estimates of soil ingestion in children for each tracer were adjusted from both studies to reflect that of a 2-year old child. The mean of the adjusted levels of soil ingestion for a two year old child was 220 mg/kg for the Calabrese *et al.* (1989) study and 170 mg/kg for the Davis *et al.* (1990) study. Based on a normal distribution of means, the mean estimate for a 2-year old child was 195 mg/day. Based on uncertainties associated with the method employed, the authors recommended a conservative estimate of soil ingestion in young children

of 250 mg/day. Based on the 250 mg/day ingestion rate in a 2-year old child, a lifetime intake was estimated to be 70 mg/day.

4.4~~3~~.5.3 Calabrese and Stanek (1995)

Calabrese and Stanek (1995) examined the various sources and magnitude of positive and negative errors in soil ingestion estimates for children.
Possible sources of positive errors include:

a) ingestion of high levels of tracer elements before the start of the study and low ingestion during the study period, and
b) ingestion of tracer elements from a non-food or non-soil source during the study period.

Possible sources of negative bias include:

a) ingestion of tracer elements in food, but they are not captured in the fecal sample either due to slow lag time or not having a fecal sample available on the final study day, and
b) diminished detection of tracer element levels in fecal, but not in soil samples.

The data of Calabrese *et al.* (1989) were quantified to reduce the magnitude of error in the individual trace element ingestion estimates. A lag period of 28 hours was assumed for the passage of tracers ingested in food to the feces. A daily soil ingestion rate was estimated for each tracer for each 24-hr day fecal sample. Daily soil ingestion rates for tracers that fell beyond the upper and lower ranges were excluded from subsequent calculations, and the median soil ingestion rates of the remaining tracer elements were considered the best estimate for that particular day.

The positive and negative errors for six tracer elements from the 1989 Calabrese *et al.* study were estimated. The original mean soil ingestion rates ranged from a low of 21 mg/day based on zirconium to a high of 459 mg/day based on titanium. The adjusted mean soil ingestion rate after correcting for negative and positive errors ranged from 97 mg/day based on yttrium to 208 mg/day based on titanium.

The authors concluded that correcting for errors at the individual level for each tracer element provides more reliable estimates of soil ingestion. However, this approach is based on the hypothesis that the median tracer value is the most accurate estimate of soil ingestion, and the validity of this assumption depends on the specific set of tracers used in the study. The estimation of daily tracer intake is the same as in Stanek and Calabrese (1995a), and the same limitations mentioned earlier in Calabrese *et al.*(1989) still exist.

4.4~~3~~.5.5 Stanek et al. (2001)

The authors developed a simulation model to identify and evaluate biasing factors for soil ingestion estimates from data taken from Calabrese *et al.* (1989),

Davis *et al.* (1990), and Calabrese *et al.* (1997). Only the data from the aluminum and silicon trace element estimates were used.

Study duration has the most positive bias in all the biasing factors explored, with a bias of more than 100% for the 95th percentile estimates in the 4-day mass balance study. A smaller bias was observed for the impact of absorption of trace elements from food. Although the trace elements selected for use in the mass balance studies are believed to have low absorption, the amount unaccounted for will result in an underestimation of the soil ingestion distribution. In these simulations, the absorption of trace elements from food of up to 30% was shown to negatively bias the estimated soil ingestion distribution by less than 20 mg/day.

4.4~~3~~.5.6 Zartarian et al. (2005)

Zartarian *et al.* (2005) conducted an analysis of soil ingestion rates using data from several studies as input for the Stochastic Human Exposure and Dose Simulation (SHEDS) model for the U.S. EPA. Data from Calabrese's Amherst and Anaconda studies (Calabrese *et al.* 1989, 1997) were used to fit distributions of soil/dust ingestion rates. The statistical distributions relied upon two tracers only, aluminum and silicon, in estimating the parameters of the lognormal variability and uncertainty distributions.

Using a Monte-Carlo sampling method, values from the fitted distribution were separated into those values under 500 mg/day and values that exceeded 500 mg/day. Soil ingestion values that exceed 500 mg/day are assumed to represent pica behavior. Using the SHEDS model, the soil ingestion rate distribution for non-pica behavior children has a mean of 61, standard deviation of 81, median of 30, 95th percentile of 236, and 99th percentile of 402 (mg/day). For children exhibiting pica behavior, the mean is 962, standard deviation 758, median 735, 95th percentile 2130, and 99th percentile 3852 (mg/day).

A limitation of this analysis is that pica children and incidental ingestion were simulated separately. The distribution for incidental soil ingestion does not take into account that children may have days where they ingest unusually high levels of soil, which may not be indicative of long-term pica behavior.

4.4~~3~~.5.7 Hogan et al. (1998)

Hogan *et al.* (1998) published a paper that compares observed and predicted children's blood lead levels as applied to the Integrated Exposure and Uptake Biokinetic (IEUBK) model for lead in children. The IEUBK model is being used by the U.S. EPA and state regulatory agencies as a model for lead uptake from environmental media for risk assessments. The model functions primarily to estimate the risk and probability of children having blood lead concentrations exceeding a specific level of concern. It predicts children's blood levels by using

measurements of lead in house dust, soil, drinking water, food and air together with default inputs such as child-specific estimates of intake for each exposure medium.

One of the parameters that the IEUBK model uses to estimate child blood lead concentration is the ingestion of soil and household dust. Young children are primarily exposed to lead through fine particles of surface soil and household dust that adhere to their hands and are incidentally ingested during normal hand-to-mouth activities. The age-specific default soil and dust ingestion rates recommended for use in the IEUBK model (version 0.99d) are 50 and 60 mg/day (averaged over children ages 1 through 6), respectively. The combined soil and dust ingestion is 110 mg/day. The default soil ingestion values used in the IEUBK model are based on several observational studies by Binder *et al.* (1986), Clausing *et al.* (1987), Calabrese *et al.* (1989, 1991), van Wijnen *et al.* (1990) and Davis *et al.* (1990), utilizing the trace element methodology (U.S. EPA, 1994).

Hogan *et al*. (1998) applied an empirical comparisons exercise of the IEUBK method to evaluate three epidemiologic datasets consisting of blood lead levels of 478 children. These children were a subset of the entire population of children living in three historic lead smelting communities: Palmerton, Pennsylvania; Southern Kansas/southwestern Missouri; and Madison County, Illinois. The children's measured blood lead levels were compared with the IEUBK's blood lead predictions using measured lead levels in drinking water, soil and dust together with the model's default inputs such as soil/dust ingestion rates and lead bioavailability.

Results showed that there was reasonably close agreement between observed and IEUBK predicted blood lead distributions in the three studies. The geometric means for the observed and predicted blood lead levels were within 0.7 µg/dl. U.S. EPA (2008) used this study to do a back calculation on the soil and dust ingestion rates and concluded that the numbers (50 mg/d soil; 60 mg/d dust; and 110 mg/d combined) are "roughly accurate in representing the central tendency soil and dust ingestion rates" of children ages 1 to 6.

4.4~~3~~.6 U.S. EPA (2008)

The U.S. EPA (2008) *Child-Specific Exposure Factors Handbook* considered certain studies as "key" for developing recommendations for children's soil ingestion rates. Key tracer element methodology, biokinetic model comparison, and survey response studies were selected based on "judgment" about the study's design features, applicability, and utility of the data to U.S. children, clarity and completeness, and characterization of uncertainty and variability in ingestion estimates. Most of the key studies selected are similar to those described in this Section.

The soil ingestion recommendations represented ingestion of a combination of soil and outdoor settled dust. The dust ingestion recommendations included soil tracked into indoor environment, indoor settled dust and air-suspended particulate matter that is inhaled and swallowed. The recommended values for soil and dust are on a dry weight basis.

The recommended central tendency soil and dust ingestion for infants 6 months up to their first birthday is 60 mg/d (soil 30 mg/d, dust 30 mg/d), and for children ages 1 to <6 years is 100 mg/d (soil 50 mg/d, dust 60 mg/d, sum rounded to 100 mg/d). In the absence of data that can be used to develop specific central tendency soil and dust ingestion recommendations for children aged 6 to <11 years, 11 to <16 years and 16 to <21 years, U.S. EPA (2008) recommends using the central tendency soil and dust ingestion rate of 100 mg/d developed for children ages 1 to <6 years. An important factor is that the recommendations did not extend to issues regarding bioavailability of the contaminants present in the soil and dust.

Table 4.13~~2~~ Recommended Values for Daily Soil and Dust Ingestion From U.S. EPA (2008)

Age Group	Central Tendency Values, mg/day		
	Soil	Dust	Soil and Dust
6 to <12 m	30	30	60
1 to <6 y	50	60	100[a]
6 to <21 y	50	60	100[a]

[a] Sum of 110 mg/d rounded to one significant figure
Adapted from Child-Specific Exposure Factors Handbook, U.S. EPA (2008)

4.5Soil Ingestion Adult Studies

There are few studies that estimated adult soil ingestion. The three studies that provide data used in the estimation of soil ingestion in adults did not provide the ages of the individuals studied. They were not designed as adult soil ingestion studies but rather as a validation of the methodology used to study soil ingestion in children.

4.5~~4~~.1 Hawley (1985)

Hawley (1985) suggested a value of 480 mg/day for adults engaged in outdoor activities, a range of 0.6 to 110 mg/day of house dust during indoor activities, and an annual average of 60.5 mg/day. These estimates were derived from assumptions about soil/dust levels on hands, mouthing behavior, and frequencies of certain indoor and outdoor activities, without supporting measurements.

4.~~5~~4.2 Calabrese et al (1990)

This study was originally part of the study in children in Calabrese *et al.* (1989). The soil ingestion rates for the 6 volunteer adults were estimated by subtracting out the tracer quantities in food and soil capsules from the amounts excreted. The four most reliable tracers were aluminum, silicon, yttrium, and zirconium. Median soil ingestion rates were as follows: aluminum, 57 mg; silicon, 1 mg; yttrium, 65 mg; and zirconium, -4 mg. Mean values were: aluminum, 77 mg; silicon, 5 mg; yttrium, 53 mg, and zirconium, 22 mg. The average of the soil ingestion means based on the four tracers is 39 mg. The sample size is very small (n = 6) and the study was not designed to look at soil ingestion by the adults but rather as a validation of the overall soil ingestion tracer methodology.

4.~~5~~4.3 Stanek and Calabrese (1995b)

Stanek and Calabrese (1995b) reanalyzed the data from their 1989 study of children with data from Davis *et al.* (1990), and their adult study (Calabrese *et al.* 1990) using the Best Tracer Method (BTM). Distributions of soil ingestion estimates were based on the various ranked tracers for both children and adults. A description of this study is provided in Section 4.~~3~~4.3.~~5.~~ When the adult data from the Calabrese *et al.* (1990) study were reevaluated, soil ingestion rates were estimated to be 64 mg/day (mean), 87 mg/day (median), and 142 mg/day (95th percentile), using the BTM.

4.~~5~~4.4 Stanek et al. (1997)

Soil ingestion was evaluated in 10 adults as part of a larger study to evaluate soil ingestion in children. The average daily soil ingestion (taken over 4 weeks) was 6 mg/day. The estimation was based on four tracer elements aluminum, silicon, titanium, and zirconium, although 8 tracers were measured. The authors reported that “the broad range in estimates for different trace elements implies that a simple average estimate (over the eight trace elements) provides little insight into adult soil ingestion, since estimates based on different trace elements for the same adults and time periods are so highly variable”. To account for variability and bias, the authors decided to base the estimate of soil ingestion on trace elements whose concentrations in soil are relatively homogeneous across different particle sizes. Trace elements that satisfied this criterion include aluminum, silicon, titanium, yttrium and zirconium, and they were considered for estimating soil ingestion by the authors.

However, this study has some complications. One of the ten adults in the study had a high soil ingestion estimate (2 grams) on the first day. The subject also had 4 times higher freeze-dried fecal weight than on any day of the study suggesting that this may be due to days of fecal accumulation. The result is an inflated 95th percentile soil ingestion estimate.

Calabrese (2003) recommended that the upper 75th percentile estimate soil ingestion of 49 mg/day be used as an estimate of high-end soil ingestion by adults (letter to the General Electric Company concerning the U.S. EPA's Human Health Assessment for the Housatonic River) (Calabrese *et al.* 2003). Although the outlier subject in the study causes the 95% percentile soil ingestion estimate to be inflated, it should not be ignored as enhanced adult ingestion could occur among agricultural or utility workers. The study itself also shows that there are problems in the use of tracers and the results varied depending upon which set of tracers was used.

4.5~~4~~.5 Davis and Mirick (2006)

This study estimated soil ingestion in children aged 3 to 8 years and their parents (16 mothers and 17 fathers) for 11 consecutive days. Three trace elements (Al, Si, and Ti) were measured. The ages of the adults were not provided.

Since titanium exhibits much greater variability compared to other tracer elements due to its presence in various non-soil sources, only Al and Si were used to estimate the adult daily soil ingestion. The means of the mothers and fathers are calculated to be 58 and 47 mg/day, respectively. The weighed average for the combined adults is 53 mg/day.

Table 4.14~~3~~ Adult Soil Ingestion Estimates From Davis and Mirick (2006)

Tracer Element	Mean Adult Soil Ingestion (mg/day)	
	Mothers	Fathers
Al	92.1	68.4
Si	23.2	26.1
Mean	57.7	47.3
Mean of All Adults	52.5	

4.5~~4~~.6 Summary of Adult Soil Ingestion Estimates

The mean and 95th percentile adult soil ingestion rates are calculated from the studies as shown in Table 4-145. For soil ingestion in adults, the average of the mean and the 95th percentile are 41 and 213 mg/day, respectively.

Table 4.15~~4~~ Summary of Soil Ingestion Estimates (mg/day) in Adults

Study	Mean	P95
Calabrese et al (1990) and Stanek and Calabrese (1995b)	64	142

Stanek et al~~t~~ (1997)	6	331
Davis and Mirick (2006)	53	168[a]
Average	41	213

[a] The 95th percentile adult soil ingestion from Davis and Mirick (2006) was calculated from data in the paper assuming lognormal distribution.

4.6~~5~~ PICA

4.6~~5~~.1 General Pica

General pica is the repeated eating of non-nutritive substances including sand, clay, paint, plaster, hair, string, cloth, glass, matches, paper, feces, and various other items (Feldman, 1986). There are numerous reports on general pica among various populations and this behavior appears to occur in approximately half of all children between 1-3 years of age (Sayetta, 1986). Danford (1982) reported that the incidence of general pica was higher for black children (30%) than for white children (10-18%) between 1-6 years of age. There appears to be no sex differences in the incidence rates (Kaplan and Sadock, 1985).

However, general pica is reported to be higher among children in lower socioeconomic groups (50-60%) than in higher income families (about 30%) and is more common in rural areas (Lourie *et al.* 1963, Vermeer and Frate, 1979). A higher rate of general pica has also been reported in pregnant women, individuals with poor nutritional status, and mentally retarded children (Behrman and Vaughan 1983, Danford 1982, Illingworth 1983, Sayetta 1986).

General pica does not include the consumption of some condiments that contain clay or soil. Examples are the Hawaiian Red Alaea sea salt (containing the red volcanic clay called Alaea) and black sea salt found in many parts of the world (containing lava and other substances). These salts have characteristic taste and are used in cooking and food preservation.

4.6~~5~~.2 Soil Pica

ASTDR (2001) defines soil pica as the recurrent ingestion of unusually high amounts of soil of between 1,000 - 5,000 mg/day. Bruhn and Pangborn (1971) studied dirt ingestion in migrant agricultural workers among 91 non-black, low-income families in California. The incidence of pica was 19% in children, 14% in pregnant women, and 3% in non-pregnant women. However, in this study “dirt” was not clearly defined and may include non-soil substances.

Data from tracer studies (Binder *et al.*, 1986; Clausing *et al.,* 1987; Van Wïjnen *et al.*, 1990; Davis *et al.*, 1990; and Calabrese *et al.*, 1989) showed that only one child out of the more than 600 children studied ingested soil in significantly large amounts to indicate pica behavior. In addition, parental observations regarding

children who are likely to be high soil ingesters were reported to be often inaccurate (Calabrese *et al.*, 1997).

A study by Vermeer and Frate (1979) showed that the incidence of geophagia (i.e., intentional earth eating) was about 16% among children from a rural black community in Mississippi. In this study, the intentional earth eating was described as a cultural practice in the community surveyed and may not be representative of the general population. However, there are cultures in many parts of the world where soil eating is practiced in religious or sacred rituals.

4.6~~5~~.3 Soil Pica Behavior in Children

Information on the amount of soil ingested by children with pica behavior is very limited. There is no study on pica children and infrequent pica behavior is often observed in normal children in soil ingestion studies.

4.6~~5~~.3.1 Calabrese et al. (1991); Calabrese and Stanek (1992)

Calabrese *et al.* (1991) reported a pica child among the 64 children who participated in the soil ingestion study. One 3.5-year-old female child had extremely high soil ingestion, from 74-2200 mg/day during the first week and from 10.1-13.6 g/day during the second week of observation. The upper soil ingestion values for this pica child range from approximately 5 to 7 g/day.

Using a methodology that compared differential element ratios, Calabrese and Stanek (1992b) quantitatively attempt to distinguish outdoor soil ingestion from indoor dust ingestion in this pica child. Using tracer ratios of soil, dust, and residual fecal samples, an analysis was performed which indicates that from 71 to 99% of the tracer originated from soil. The authors concluded that the predominant proportion of the fecal tracers originated from outdoor soil and not from indoor dust.

4.6~~5~~.3.2 Wong (1988) as reviewed by Calabrese and Stanek (1993)

Wong (1988) in his doctoral thesis studied soil ingestion by 52 children in two government institutions in Jamaica. This study was reviewed by Calabrese and Stanek (1993). The younger group contained 24 children with an average age of 3.1 years (range of 0.3 to 7.6 years). The older group contained 28 children with an average age of 7.2 years (range of 1.8 to 14 years).

Fecal samples were obtained from the children and the amount of silicon in dry feces was measured to estimate soil ingestion. An unspecified number of daily fecal samples were collected from a control group consisting of 30 hospital children with an average age of 4.8 years (range of 0.3 to 12 years). Dry feces were observed to contain 1.45% silicon, or 14.5 mg Si per gram of dry feces. This quantity was used as a baseline representing the background level of silicon

ingestion from dietary sources. Observed quantities of silicon greater than 1.45% were interpreted as originating from soil ingestion.

For the 28 children in the older group, soil ingestion was estimated to be 58 mg/day, based on the mean minus one outlier, and 1520 mg/day, based on the mean of all the children. The outlier was a child with an estimated average soil ingestion of 41 g/day over the 4-month period. This child was stated to be "developmentally disabled", but no information was provided on the nature or severity of the disability. Of the 28 children in the group, 7 had average soil ingestion greater than 100 mg/day, 4 had average soil ingestion greater than 200 mg/day, and one had average soil ingestion greater than 300 mg/day. Eight children showed no indication of soil ingestion. The mean soil ingestion of all the children was 470 ± 370 mg/day.

Of the 24 children in the younger group, 14 had average soil ingestion of less than 100 mg/day, 10 had average soil ingestion greater than 100 mg/day, 5 had average soil ingestion greater than 600 mg/day, and 4 had average soil ingestion greater than 1000 mg/day. Five children showed no indication of soil ingestion. Of the 52 children studied, 6 displayed soil pica behavior.

The use of a single soil tracer in this study may introduce error in the sampling because there may be other sources of the tracer in the children's environment. For example, certain types of toothpastes have extremely high silica concentrations, and children may ingest significant quantities during brushing. Silica may also be found in indoor dust that children could ingest. Despite these uncertainties, the results indicate that soil pica is not a rare occurrence in younger children in this study population. Results from this Jamaica study may not be indicative of similar behavior in children in the United States.

4.6~~5~~.3.3 ATSDR (2001)

ATSDR (2001) held a workshop to discuss and review the state of the science on soil pica behavior. The review acknowledges that soil pica clearly exists, but there were insufficient data to determine the prevalence of this behavior in children and in adults. The present ATSDR assumption that soil pica children ingest 5 g of soil/day is supported by only a few subjects (i.e., two children in Massachusetts and six children in Jamaica). The ATSDR (2001) committee advises ATSDR to err on the side of being health protective and to continue using the 5 g/day pica ingestion number until more data become available.

4.6~~5~~.3.4 Zartarian et al. (2005)

Zartarian *et al.* (2005) conducted an analysis of soil ingestion rates from several studies in the literature using the Stochastic Human Exposure and Dose Simulation (SHEDS) model of the U.S. EPA. Data from Calabrese's Amherst and Anaconda studies were used to fit distributions of soil/dust ingestion rates. A soil

pica distribution was obtained by sampling from the fitted lognormal distribution and retaining values above 500 mg/day. The mean and 95th percentile values for this population were estimated to be 963 mg/day and 2170 mg/day, respectively (See Section 4.4~~3~~.5.6).

4.7~~5~~.3.5 U.S. EPA (1984)

In a risk assessment for 2,3,7,8-tetrachlorodibenzo-p-dioxin (TCDD), U.S. EPA (1984) used 5 g/day to represent the soil intake rate for pica children. The Centers for Disease Control (CDC) in an investigation on the exposure potential to 2,3,7,8-TCDD via soil ingestion used a value of 10 g/day to represent the amount of soil that a child with pica behavior might ingest (Kimbrough *et al.,* 1984). These values are based on only one pica child observed in the Calabrese *et al.* (1989) study where the intake ranged from 10-14 g/day during the second week of observation. The CDC suggests that an ingestion rate of 10 g/day is a reasonable value for use in acute exposure assessments, based on the available information.

4.6~~5~~.3.6 U.S. EPA (2008)

In the 2008 U.S. EPA's *Child-Specific Exposure Factors Handbook*, U.S. EPA redefined children's "soil-pica" as the quantity of soil ingested by children above 1000 mg/d. Using this definition, the upper 90th and 95th percentiles of soil ingestion from all the key primary studies were included in the assessment of children's pica soil ingestion. The soil-pica ingestion estimate for children up to age 14 ranged from 400 to 41,000 mg/d. The recommended value for soil pica in children was then set at 1000 mg/day. No data were available for children above 14-21 years. We believe this number is probably too low based on our calculations (see Table 4.16~~5~~).

4.6~~5~~.3.7 Summary of Pica Behavior Studies in Children

Soil ingestion in 8 children that exhibited pica behavior from two studies is given in Table 4-15~~6~~. It is important to note that soil pica behavior in children in the studies used was observed over a very short period of time and may not reflect long-term pica behavior. In the absence of data, the ATSDR panelists recommended in the *Summary Report for the ATSDR Soil-Pica Workshop* (2001) that "ATSDR should err on the side of being protective and should use 5000 mg until more data are collected". We concur with this recommendation. Our calculation on pica children in two studies shows that the amount ingested is about 5000 mg/day (Table 4-16~~5~~).

Table 4.16~~5~~ Pica Behavior in Children

Sample Size	Observation (days)	Age	Soil Ingestion (mg/day)	Source
1	2	2.5	20,000; 22,000	Calabrese et al. (1989, 1991)

1	4	-	1000-2000	
1 1 1 1 1	1 1 "different days" "different days" 1	3.1[a]	1447 7924 1016; 2690; 898 10343; 4222; 1404; 5341 5341	Wong (1988) doctoral thesis. Study reviewed and presented by Calabrese and Stanek (1993)
1[c]	"different days"	7.2[b]	48,300; 60,692; 51,422; 3782	Wong (1988) doctoral thesis. Study reviewed and presented by Calabrese and Stanek (1993)

Number of Children	Average Pica Soil Ingestion (mg/day)
8	10,600
7[d]	5500

[a] Average age of 24 children
[b] Average age of 28 children
[c] This child was stated to be "developmentally disabled" by the author
[d] Excluding last child

4.6.4 Soil Pica Behavior In Adults

The ASTDR report (2001) views adult soil pica to be an extremely rare behavior that has not been characterized. Deliberate consumption of clays or soil (geophagy) has been reported in many parts of the world and is particularly prevalent among certain cultural groups especially during certain rituals or religious ceremonies. However, the clay or soil is typically from known uncontaminated sources. Thus, surface soils are generally not the source of geophagical materials consumed. Very little data are available to establish an unintentional soil ingestion rate for adults with pica behavior.

4.7~~6~~ Hand-To-Mouth Transfer

The studies discussed earlier examined soil intake using a mass balance methodology that measures trace elements in feces and soil. These studies have various shortcomings one of which is the paucity of data for estimating soil ingestion to a broader age range in children and adults. Data are lacking for children less than 1 and above 7 years of age, and for adults where ages are often not given in the studies.

U.S. EPA (2005) provides guidance on the appropriate age groups to consider when assessing children's exposure and potential dose of environmental contaminants. The recommended childhood age groups for exposure and risk assessments are: birth to <1 month, 1 to < 3 months, 3 to < 6 months, 6 to < 12 months, 1 to < 2 years, 2 to < 3 years, 3 to < 6 years, 6 to < 11 years, 11 to < 16 years, 16 to < 18 years, and 18 to < 21 years. These age groupings take into consideration human developmental and physiological changes that impact exposure and potential dose intake. Hand-to-mouth activities may provide

information that may be useful in assessing the ingestion of soil in age groups that do not have direct soil ingestion data.

4.7~~6~~.1 Hand-to-Mouth Transfer Behavior in Children

Children often put their hands, toys, and other objects in their mouths during normal exploration of their environment, as a sucking reflex and as a habit. This hand-to-mouth behavior may result in the ingestion of soil and dust, from outside and/or indoors. Transfer from the hand to the mouth can occur directly by handling of contaminated soil and indirectly by using products, materials and equipment that come in contact with contaminated soil. This can happen in both occupational and non-occupational settings. Soil ingestion can occur by touching the mouth with the hand, nail biting, finger sucking, eating food (especially with bare hands), smoking cigarettes, and other hand-to-mouth activities.

Generally, children's mouthing behavior is studied using both direct observation and videotaping methodologies (Zartarian *et al.* 1998; Reed *et al.* 1999; Freeman *et al.* 2001, 2005; AuYeung *et al.* 2006, 2008; Black *et al.* 2005; Ferguson *et al.* 2005). Observations may be conducted by an instructed parent, or by a trained person. Videotaping the child's behavior is usually done by a trained technician, and information from these recordings is obtained by a trained person who watches the videotapes.

4.7~~6~~.2 Probabilistic Models of Hand-to-Mouth Transfer

Estimation of non-dietary ingestion of a chemical via hand-to-mouth contact includes information of the hand residue/soil loading (µg/cm² or µg/g), hand-to-mouth frequency (number of contacts/hr), area of hand surface mouthed (cm²), and exposure duration (hr/day). Probabilistic models have been developed to estimate non-dietary ingestion of a chemical via hand-to-mouth contact (e.g., Calendex™ by Exponent Inc.; CARES™ by International Life Science Institute; Lifeline™ by Lifeline Group; and Residential-SHEDS by U.S. EPA's Office of Research and Development).

These models have certain limitations as the calculations are based on data from the few studies available on non-dietary ingestion via hand-to-mouth contact. The studies used in the models have their own limitations such as the different methods of data collection, analysis and reporting, different age groupings of research subjects, and even different definition of "mouthing". Models such as SHEDS that deal with various microenvironments assume a strong relationship between the total dust ingested and indoor dust loading. Although the ratio of ingested outdoor soil to ingested indoor dust is important, factors influencing exposure and risk such as the types of exposures, chemical pollutants indoors and outdoors, amount of track-in, resuspension and particle size, seasonal effects, and fate and transport are some of the issues still largely uncharacterized.

4.7~~6~~.3 Relevant Hand-to-Mouth Transfer Studies (Summary)

Studies that provide estimates for a hand load transfer factor or transfer efficiency include the analyses of Dubé *et al.* (2004), Beyer *et al.* (2003), and the report from the Consumer Product Safety Commission (CPSC, 2003).

4.7~~6~~.3.1 Dubé et al. (2004)

Using data from Stanek and Calabrese (1995a), Dubé *et al.* (2004) estimated the fraction of "dislodgeable" residue on the hands of children that was incidentally ingested daily. The estimate was 25% hand load per day (range: 7 – 100%) for 2 to 6 year olds, and 13% hand load per day (range: 3.5 – 50%) for 7 to 31 year olds. This assumed that individuals 7 years old and up would ingest half the amount of soil as 2 to 6 year olds. Information was not provided for a direct hand-to-mouth transfer factor for soil, the fraction of material on the hand in contact with the mouth that is transferred, the number of hand to mouth contacts, and losses through intermediate contacts.

4.7~~6~~.3.2 Beyer et al. (2003)

Beyer *et al* (2003), in their assessment of incidental ingestion of metals from laundered shop towels in the workplace, used a value of 13% as the fraction dislodged from the hands that was incidentally ingested on a daily basis by adults.

4.7~~6~~.3.3 CPSC (2003)

The Consumer Product Safety Commission (CPSC, 2003) developed an estimate of the percent of residue dislodged on the hands that is ingested on a daily basis by children. The estimate was based on data on soil ingestion, soil–skin adherence, and contact surface area of the hand with soil from multiple studies. There are large uncertainties in the available data analyzed. The daily intake estimates for children ranged from 3% to 700% of the mass loaded on the hand (i.e., "handload"), with an average of 43% for both direct and indirect hand-to-mouth activities combined.

4.7~~6~~.3.4 Zartarian et al. (2000)

Zartarian *et al.* (2000) used the U.S. EPA's Residential Stochastic Human Exposure and Dose Simulation (Residential-SHEDS, 2000) model for pesticides to estimate children's exposure to chlorpyrifos. The primary purpose of the study is to demonstrate the capabilities of the model by simulating the exposures and doses of children who contacted chlorpyrifos residues inside treated residences and on turf-treated residential yards. The hand-to-mouth transfer efficiency of chlorpyrifos was estimated to range from 10% to 50%, based on the data of

Zartarian *et al.* (1997); Leckie *el al.* (1999); Kissel *et al.* (1998) and Camann *et al.* (2000). The 50% hand-to-mouth transfer efficiency has been used by the CPSC (1997) in estimating hand-to-mouth exposure to lead from polyvinyl chloride products, and by the U.S. EPA's Office of Pesticide Programs as a default value for hand-to-mouth exposure to pesticides (U.S. EPA, 2001).

4.7~~6~~.3.5 Zartarian et al. (2005)

Zartarian *et al.* (2005) working under a contract from the U.S. EPA derived a statistical distribution for hand-to-mouth transfer efficiency for arsenic from chromated copper arsenate (CCA)-treated wood. Hand-to-mouth transfer efficiency is defined as the fraction of chemical mass that enters the mouth and remains in the mouth as a result of one hand-to-mouth contact. The value of 50% was used as the lower bound on the transfer efficiency, with 100% assigned as the upper bound and the mode of distribution set to 75%. The resulting fitted beta distribution of the hand-to-mouth transfer efficiency for arsenic had a mean value of 78% and a 75th percentile value of 84.9% per hand-to-mouth contact.

4.7~~6~~.3.6 OEHHA (2008)

OEHHA (2008) published a lead exposure guideline for calculating the hand-to-mouth transfer of lead from the use of fishing tackle in recreational fishing. The guideline examined both direct and indirect hand-to-mouth activities. No data were available from the scientific literature on the amount of lead transferred from the hand to the mouth as a result of handling fishing tackle products, but data from two studies (Camann *et al*, 2000; Kissel *et al*, 1998) were found to be useful. The study by Camann *et al*. (2000) provides data on the removal of three pesticides from the hands of three adults. The study by Kissel *et al.* (1998) provides estimates on the total soil loading on the hand, and its transfer to the mouth from particular parts of the hand (i.e., thumb; two fingers; palm) in four adults. After reviewing the data from these and other studies, OEHHA (2008) selected a value of 50% as the direct, and 25% as the indirect hand-to-mouth transfer factors for lead in fishing tackle products for adults.

U.S. EPA (2002) concluded from the data of Reed *et al.* (1999) and Zartarian *et al.* (1998) that hand-to-mouth contacts of 9 contacts/hour was a reasonable estimate for children 2 to 6 years old. Since then other published studies (Black *et al*., 2005 and Ko *et al*., 2007) reported that the hand-to-mouth value of 9 contacts/hour probably underestimates the frequency of children's hand-to-mouth activity and the frequency could be over 20 contacts/hour. OEHHA (2008) selected 9 contacts/hour as the average estimate, and 20 as the upper bound estimate of direct hand-to-mouth contact frequency for adults during fishing in contact with lead fishing tackle products.

4.7~~6~~.3.7 Xue et al. (2007)

A meta-analysis was conducted by Xue and colleagues (2007) to examine hand-to-mouth frequency based on study, age groups, gender, and location (indoor vs. outdoor). Data were gathered from 9 studies (Zartarian *et al.* 1998; Reed *et al.* 1999; Leckie *et al.* 2000; Freeman *et al.* 2001; Greene, 2002; Tulve *et al.* 2002; Hore, 2003; Black *et al.* 2005; Beamer *et al.* 2008). The combined studies represent 429 subjects and more than 2,000 hours of behavior observations. To pool and analyze the data from these studies collectively, Xue *et al* (2007) contacted the authors of the 9 studies to obtain and clarify needed and missing data for the analysis.

Results of the analysis indicate that age and location are important for hand-to-mouth frequency, but not gender. As age increases, both indoor and outdoor hand-to-mouth frequencies decrease, and this behavior is higher indoors than outdoors. Average indoor hand-to-mouth frequency ranged from 6.7 to 28.0 contacts/hour, with the lowest value corresponding to the 6 years to <11 years age group and the highest value corresponding to the 3 months to <6 months group. Average outdoor hand-to-mouth frequency ranged from 2.9 to 14.5 contacts/hour, with the lowest value corresponding to the 6 years to <11 years age group and the highest value corresponding to the 6 months to <12 months group. For the 3 months to < 6 months age group, outdoor hand-to-mouth contact frequency data were not available.

The study is an important effort to provide data on hand-to-mouth contact frequency by indoor/outdoor location and age groups based on the recommendations by the U.S. EPA (2005) for assessing childhood exposures. However, it did not analyze or collect data on other mouthing behaviors such as object-to-mouth. Also, data for older children, ages 11 and above, are not included; they are likely to have very different behaviors from the younger children.

Table 4.17~~6~~ Hand-to-Mouth Frequency (contacts/hour) in Children

Age Group	No. of Observations	Mean	Std Dev	P25	P50	P75	P95
		INDOORS					
3m to < 6m	23	28	21.7	8.0	23.0	48.0	65.0
6m to < 12m	119	18.9	17.4	6.6	14.0	26.4	52.0
1y to < 6y[a]	575	16.2	-	4.5	11.1	22.1	53.1
6y to < 11y	14	6.7	5.5	2.4	5.7	10.2	20.6
		OUTDOORS					

3m to < 6m	0	-	-	-	-	-	-
6m to < 12m	10	14.5	12.3	7.6	11.6	16.0	46.7
1y to < 6y[a]	133	8.7	-	1.1	5.1	11.6	32.0
6 to < 11y	15	2.9	4.3	0.1	0.5	4.7	11.9
		COMBINED					
3m to < 6m	23	28	21.7	8.0	23.0	48.0	65.0
6m to < 12m	129	18.6	-	6.7	13.8	25.6	51.6
1y to < 6y[a]	708	14.8	-	3.8	10.0	20.2	49.1
6y to < 11y	29	4.7	-	1.2	3.0	7.4	16.1

Adapted from Xue *et al.*, 2007; results are from 9 studies using Weibull distributions.

[a] Three age groups, 1y to < 2 y, 2y to <3y, and 3y to <6y, combined.

4.7.4 Extrapolation of Soil Ingestion from Hand-to-Mouth Contacts

U.S. EPA (2008) in their *Child-Specific Exposure Factors Handbook* recommends 100 mg/d as the central tendency value for daily soil and dust ingestion in children 1 year to <6 years. The actual sum (soil and dust) is 110 mg/d but rounded to 100 mg/d (to one significant figure) (U.S. EPA, 2008). In the absence of data that can be used to develop soil and dust recommendations for children aged 6 to <11 years, 11 to <16 years and 16 to <21 years, U.S. EPA (2008) recommended using 100 mg/d as the central tendency value for children aged 6 to <21 years.

Using the mean weighed average value of 110 mg/day for soil and dust ingestion for the age group 1 to <6 years old (from Table 4.13~~2~~ derived from the 2008 U.S. EPA document), and assuming this age group has combined indoor and outdoor hand-to-mouth contacts of 14.8/hour (from Table 4.17~~6~~), soil ingestion in other age groups can be estimated (Table 4.18~~7~~).

OEHHA (2008) selects 9 and 20 as the average and upper bound estimates, respectively, of direct hand-to-mouth contact frequency for adults from the use of lead tackle in recreational fishing. Using the same extrapolation procedure above, the mean and the upper bound soil ingestion estimates were obtained. The combined soil and dust ingestion rate estimated from Xue *et. al.* (2007) data for children aged 6 months to < 12 months is higher than that provided by the U.S. EPA (2008) – 133 mg/d versus 60 mg/d, respectively. We believe that the value of 133 mg/d better reflects the soil and dust ingestion rate in children aged 6 months to < 12 months because children in this age group are known to have much higher hand-to-mouth contact behavior as they explore their environment (Xue *et al.* 2007).

Table 4.18~~7~~ Soil and Dust Ingestion Rates (mg/day) Extrapolated from Xue et al. (2007) Hand-to-Mouth Contact Data to Three Age Groups

Age Groups	Mean	P95
3m to < 6m	NC[a]	NC
6m to < 12m	133	370

1y to < 6y	106	352
6 to < 11y	34[b]	115[b]
Adult	64	143

[a] Not calculated as there is no hand-to-mouth contact in this group
[b] Low confidence level for this number due to low number of observations

OEHHA supports the U.S. EPA (2008) recommendations of 100 mg/day as the central tendency of the combined soil and dust ingestion rate for children aged 1 to <6 years. This number was rounded down from the actual number of 110 mg/d. Using 110 mg/day for soil and dust ingestion for the age group 1 to <6 years old (Table 4-13), and assuming this group has combined indoor and outdoor hand-to-mouth contacts of 14.8/hour (from Figure 4-17), soil and dust ingestion in other age groups are extrapolated from hand-to-mouth data (Table 4-18). The value for the 6 to <11 year old group is not used because of the low number of hand-to-mouth observations in this group. The soil ingestion values for adults and children (mg/day) estimated for the various age groups are shown in Table 4.19.

Table 4.19 Soil Ingestion Estimates for Adults and Children (mg/day)*

Age Groups (years)	**Mean (mg/day)**	**95th percentile (mg/day)**
3rd Trimester[a]	**50**	**200**
0 < 2	150	400
2<9	100	400
2<16	100	400
9<16	100	400
16<30	50	200
30>70	50	200
PICA children	5000	-
PICA adult	NR[b]	-

[a] Assumed to be the mother's soil ingestion rate (adult age 16 <30)

[b] No recommendation

* Soil includes outdoor settled dust

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5. Breast Milk Intake Rates

5.1 Terminology and Nomenclature

In this section, we review breast milk intake estimates reported in the published literature. In the prior version of these guidelines, published rates as well as unpublished rates derived by OEHHA were presented. The OEHHA derived rates have been updated and revised to reflect breastfeeding practices most likely to occur in the United States (U.S.) (i.e., following the American Academy of Pediatrics recommendations). The revised OEHHA derived rates have been published in a peer-reviewed journal (Arcus-Arth et al, 2005) and are presented along with other published rates in these guidelines.

Specific terms and definitions have been adopted for use throughout this chapter (Table 5.1), because different and sometimes contradictory terms for various breastfeeding patterns are used in the literature.

Table 5.1 Breastfeeding terminology[a]

Term	Definition
Fully breastfed	
Exclusively breastfed	Breast milk is sole source of calories.
Almost exclusively breastfed	Breast milk is primary if not sole milk source with no significant calories from other liquid or solid food sources.
Predominantly breastfed	Breast milk is the primary if not sole milk source with significant calories from other liquid or solid food sources.
Partially breastfed	Combined breast milk and other milk intake where non-breast milk (e.g., formula) is a significant milk source whether or not the infant is consuming significant calories from other liquid or solid food sources.
Token breastfeeding	Minimal, irregular or occasional breastfeeding contributing minimal nutrition and few calories.
Extended breastfeeding	Breastfeeding beyond 12 months of age.
Weaning	Discontinuation of breastfeeding.

[a] Adapted from Labbok and Krasovec (1990)

These terms are important for our discussion in this section because breastfeeding patterns are important determinants of breast milk intake rates.

Fully breastfed infants are those that receive breast milk as the primary, if not sole, source of milk. This category encompasses three specific patterns of breastfeeding. Thus, the term “fully breastfed” is probably most often applied to the entire lactation

period (0-12 months). For example, an infant who was exclusively breastfed for the first 6 months, then predominantly breastfed from 6 through 12 months, would be considered fully breastfed for the lactation period. We use the term "almost exclusively breastfed" particularly for the common practice of exclusive breastfeeding during the day with a small bottle of formula fed at night. Older infants who are breastfed and do not receive significant amounts of formula (or other non-breast milk) but do receive supplementary solid foods would fit into the category of "predominantly breastfed." Partially breastfed infants, like fully breastfed infants, receive some breast milk but unlike fully breastfed infants they also receive significant amounts of milk, or formula from non-breast milk sources.

A few words about units and nomenclature are provided to avoid confusion. In toxicology and pharmacology "dose" is typically expressed as the amount received over time divided by body weight (e.g., mg/kg-day). Analogously, breast milk intake rates can be expressed as the amount received by the infant over time divided by the infant's body weight~~-~~ Daily breast milk intake rate (e.g., g/kg BW-day) is the most commonly used unit of measure. If multiple days of breast milk intake rate for a single infant are averaged together, the result is the "average daily breast milk intake rate." This averaging is over time rather than over individuals. This term is useful for characterizing an average intake over time (e.g., over the first 6 months of life).

A final note is that the means and standard deviations (SDs) reported in these guidelines are arithmetic means and arithmetic SDs, unless otherwise indicated.

5.2 Recommendations [This section was moved from the back of the chapter to the front]

OEHHA recommends the following to estimate dose to the infant through breast milk.

5.2.1 Default Point Estimate for Daily Breast Milk Intake During the First Year

For the default point estimate approach to assess dose and risk from breast milk intake by breastfed infants during the first year, OEHHA recommends using the mean and high-end estimates presented in Table~~s~~ 5.2. The average and high end point estimates are 101 and 139 g/kg BW *day.

Table 5.2 Point Estimates of Breast Milk Intake for Breastfed Infants

Infant Group	***Intake (g/kg-day)***
Fully breastfed over the first year (i.e., fed in accordance with AAP recommendations)[1]	
Mean	101
90th percentile	130
95th percentile	139

Exclusively breastfed During first year[2]	
Mean	113
90th percentile	141
95th percentile	149
Fully breastfed over first 6 months (i.e., fed in accordance with AAP recommendations)[1]	
Mean	130
90th percentile	138
95th percentile	165

[1] AAP = dataset based on American Academy of Pediatrics (1997) infant feeding recommendations; [2] EBF = dataset of exclusively breastfed infants

As discussed in Section 5.1, fully breastfed infants are those that receive breast milk as the primary, if not sole, source of milk. Thus, the term "fully breastfed" is probably most often applied to the entire lactation period (0-12 months). An infant who was exclusively breastfed for the first 6 months, then predominantly breastfed from 6 through 12 months, would be considered fully breastfed for the lactation period. Exclusively breastfed infants are those in which breast milk is sole source of calories.

5.2.2 Stochastic Approach to Breast Milk Intake Among Individuals During the First Year of Life

For a stochastic analysis of exposure and dose through the breast milk intake pathway, a normal distribution with a mean of 101 g/kg-day and standard deviation 23 g/kg-day, is recommended as a distribution for breast milk intake (Table 5.3).

Table 5.3 Recommended Breast Milk Intake Rates Among Breastfed Infants (Averaged Over an Individual's First Year of Life)

	Mean (SD)	***Percentile***							
		5	*10*	*25*	*50*	*75*	*90*	*95*	*99*
Intake (g/kg-day)	101 (23)	62	71	85	101	116	130	139	154

The recommended values for average and high end breast milk consumption rates are the mean and 95th percentiles (101 and 139 g/kg BW ~~-~~*day) for fully breastfed infants.
The recommended parametric model for stochastic risk assessment is a normal distribution with a mean and standard deviation of 101 ± 23

5.2.3 Consideration of Variable Age of Breastfeeding Mothers

Because some environmental toxicants continue to accumulate, older primiparous mothers could excrete higher concentrations of the toxicant in breast milk than younger mothers could when daily intake is constant over time. For example, Hedley et al (2007) reported that breast milk concentrations of POPs increased in a population of Asian women ~~increased~~by 1.45 pg/g-fat/year. Incorporating a distribution or range of

age among breastfeeding mothers into the risk assessment is a refinement that could be considered in the future.

5.2.4 Analysis for Population-wide Impacts from Breast Milk Exposure

If the risk assessor is evaluating a population-wide risk (e.g., for the purpose of developing a range of cancer burden estimates from this pathway), it may be appropriate to incorporate information on the percent of the infant population that is breastfed at various ages. Information on the prevalence of breastfeeding by age of infant in California from the National Immunization Survey (NIS) specific to California in is available in ~~the~~ Appendix ~~to this chapter~~5A, Table 5A-11 ~~.~~for this purpose. Alternatively, values in Table 5A-17 could be used. This information should be re-evaluated periodically to take into account recent trends in breastfeeding and the outcome of the breastfeeding promotion policies of the last decade.

5.~~2~~3 Conceptual Framework for Variable Breast Milk Intake Rates

The Hot Spots program provides a tiered approach to risk assessment. ~~-~~Point estimate and stochastic approaches are available. ~~-~~The stochastic approach uses probability distributions for variates with sufficient data to estimate variability. The point estimate approach for the breast milk pathway uses average and high-end breast milk consumption values. ~~-~~Data on the distribution of breast milk intake rates allow selection of point estimates that represent average breast milk consumption and a specified percentile of high-end consumption. To incorporate the variability of breast milk intake into the infant dose of toxicant from breast milk, we use a stochastic approach to characterize parameters related to the breast milk pathway.

The data set that we use for breast milk intake rate distributions includes 130 infants for whom there are at least two measurement time points separated by at least 7 days during the lactation period. This is an unusually robust data set for evaluating variability in an important variate for risk assessment. The repeated measures help ensure that typical intake over time is captured thus reducing the effect of intraindividual variability on the distribution of values. Further, milk intake measurements and body weight for individual infants are included, and therefore breast milk intake can be normalized to body weight for each infant, ~~-~~Breast milk intake is correlated with infant body weight (e.g., large babies consume greater amounts of milk than small ones) and thus the variability simply due to body weight can be eliminated.

Interindividual variability is explicitly addressed through the distributional approach used in these guidelines. A distribution of intake rate quantifies the probability of the array of intake rate values in the population. This describes variability between individuals in the population.

Intraindividual variability is addressed by allowing intake to be a function of time (e.g., see Arcus-Arth et al., 2005; Burmaster and Maxwell, 1993), thus taking into account variability of an individual's intake over time. Intraindividual variability can also be

addressed by assessing the impact of different methods of averaging over time (e.g., Arcus-Arth et al., 2005).

The correlation of intake and body weight is taken into account by normalizing intake by body weight for each individual infant. That is, for each infant, their daily intake at that measurement is divided by his/her body weight at that measurement to give intake in units of g/kg-day. Because larger infants consume greater amounts of milk, normalizing to body weight reduces much of the variability due to differences in body weight among infants.

Exposure through mother's milk ingestion ($Dose_m$) is a function of the average substance concentration in mother's milk and the amount of mother's milk ingested. The minimum pathways that the nursing mother is exposed to include inhalation, soil ingestion and dermal, since the chemicals evaluated by the mother's milk pathway are multipathway chemicals. Other pathways may be appropriate depending on site conditions (e.g., presence of vegetable gardens or home grown chickens). The nursing mother in the mother's milk pathway is not herself subject to the mother's milk pathway. The summed average daily dose (mg/kg BW-day) from all pathways is calculated for the nursing mother using equations in the other chapters of this document.

The general algorithm for estimating dose to the infant via the mother's milk pathway is as follows:

$Dose_m = C_m * BMI_{bw} * EF * (1x10^{-3})$ ~~yr / 25,550~~ (~~EQ~~ Eq 5-1)

where:

$Dose_m$ = Dose to the infant through ingestion of mother's milk (mg/kg BW/day)

C_m = Concentration of contaminant in mother's milk is a function of the mother's exposure through all routes and the contaminant half-life in the body (mg/kg milk). Various equations for estimating Cm are presented in Appendix J

BMI_{bw} = Daily breast-milk ingestion rate (g-milk/kg BW/~~*~~day). See Table 5.2 for point estimates. See Table 5.3 for distribution for Tier 3 stochastic risk assessments.

EF = Frequency of exposure, unitless, (days/~~yr~~365 days)

~~yr = Breast-feeding period (yr)~~

~~25,550~~365 ~~= Exposure period (d)~~

$1x10^{-3}$ = Conversion factor~~s~~ (g to kg for milk, ~~µg to mg for contaminant~~)

The exposure frequency (EF) is the fraction of time the infant is exposed daily during the first year (i.e., 365 days) of breast-feeding. Thus, the EF is set at 1. For cancer risk in a screening level assessment, the risk via the mother's milk pathway ($RISKm_{(0<2\ yr)}$) occurs only during the first year in the 0<2 age group.

The risk is calculated for this age group using the appropriate, unitless, age sensitivity factor (ASF) of ~~-~~= 10, (see OEHHA, 2009) and the chemical-specific cancer potency factor (CPF), expressed in units of $(mg/kg\text{-}day)^{-1}$.

$$RISKm_{(0<2\ yr)} = Dose_m * CPF * ASF * ED * 0.5 \qquad \textbf{(Eq. 5-2)}$$

The cancer risk, $RISKm_{(0<2\ yr)}$ is the predicted number of expected cases of cancer over a lifetime as a result of the exposure (e.g., expressed as 1×10^{-6} or 1 case per million people exposed)

Exposure duration (ED) is the number of years within the age grouping, which is 2 years for the 0<2 year age group. Since risk for the mother's milk pathway is assessed only during the first year of the 0<2 year age group, a 0.5 adjustment factor is included in Eq. 5-2. The risk from other exposure pathways (e.g., the inhalation pathway) would not include this factor in the 0<2 age group.

To determine lifetime cancer risks (i.e., 70 years), the total risk for the 0<2 age group is then summed across the total risk of the other age groups:

$$RISK_{(lifetime)} = RISK_{(3rdtri)} + RISK_{(0<2\ yr)} + RISK_{(2<16\ yr)} + RISK_{(16\text{-}70yr)} \qquad \textbf{(Eq. 5-3)}$$

As explained in Chapter 1, different age groups for assessing risk are needed due to different ASFs for each group. We also need to accommodate cancer risk estimates for the average (9 years) and high-end (30 years) length of time at a single residence, as well as the traditional 70-year lifetime cancer risk estimate. For example, assessing risk in a 9-year residential exposure~~cy~~ scenario assumes exposure during the most sensitive period, from the third trimester to 9 years of age and would be presented as such:

$$RISK_{(9\text{-}yr\ residency)} = RISK_{(3rdtri)} + RISK_{(0<2\ yr)} + RISK_{(2<9\ yr)} \qquad \textbf{(Eq. 5-4)}$$

For the 30-year residential exposure scenario, the risk for 2<16 and 16<30 age groups would be added to the risks from third trimester and 0<2 exposures. For the 70-year residential exposure scenario risk, Eq 5-3 would apply.

~~**Recommended default values for EQ 5-1:**~~

~~BMI_{bw} = See Table 5.6 for point estimates. See Table 5.7 for distribution for Tier 3 stochastic risk assessments.~~
~~F = 365 (d)~~
~~yr = 1(yr)~~

~~For the residential MEI, the default assumptions are that the mother is exposed to facility emissions for 25 years, then her child receives milk for a year, and the child's exposure to facility emissions then continues for 9, 30, or 70 years. The dose of chemical (emitted from a given facility) from breast milk exposure for~~

~~each of the exposure durations is added into the dose of the chemical from other exposure pathways appropriate for the facility and the chemical. For all the exposure duration scenarios, the toxicant dose from the breast-feeding occurs in the first year and thus the ten-fold age sensitivity factor applies when determining cancer risk from the exposure to carcinogen during breast feeding.~~

The risk algorithm for the stochastic approach and for the point estimate approach is the same. In the stochastic approach, the distribution of mother's milk consumption is reflected as a distribution of dose to the infant.

The chemicals with human milk transfer coefficients (Tco_{hm}) to be analyzed in the breast milk exposure pathway are described in Appendix J.

5.~~2~~3.1 Transfer Coefficients for Chemicals From Mother into Milk

Tco_{hm} represent the transfer relationship between the chemical concentration found in milk and the mother's chronic daily dose (i.e. concentration (µg/kg-milk)/dose (µg/day) under steady state conditions. Transfer coefficients can be applied to the mother's chronic daily dose estimated by the Hot Spots exposure model to estimate a Cm for a specific chemical concentration in her milk by equation 5-~~3~~5. Appendix J has additional detail of the derivation of transfer coefficients for specific chemicals.

$$Cm = [DOSEair + DOSEwater + DOSEfood + DOSEsoil + DOSEdermal] \times Tco_{hm} \times BW \quad \text{(Eq. 5-~~2~~5)}$$

where: DOSEair = dose to the mother through inhalation (Eq 3-1) (mg/kg/day)
Dwi = dose though drinking water ingestion (mg/kg/day)
DOSEfood = dose through ingestion of food sources (Eq 7-1) (mg/kg/day)
DOSEsoil = dose through incidental ingestion of soil (Eq 4-1) (mg/kg/day)
DOSEdermal = dose from dermal absorption from contaminated soil (Eq 6-1) (mg/kg/day)
DOSEwater = dose through ingestion of surface water (Eq 8-2) (mg/kg/day)
Tco_{hm} = transfer coefficient (see Table 5-4) (day/kg-milk)
BW = body weight of the mother (default = 70.7 (kg)

However, if bio-transfer information is available for an individual exposure route, route-specific Tcos can be developed resulting in a modification of Eq. 5.~~2~~5:

$$Cm = [(DOSEair \times Tco_{mi}) + (DOSEwater \times Tco_{mw}) + DOSEfood \times Tco_{mf}) + (DOSEsoil \times Tco_{ms}) + (DOSEdermal \times Tco_{md}] \times BW \quad \text{(Eq. 5-~~3~~6)}$$

where: Tco_{mi} = biotransfer coefficient from inhalation to mother's milk (day/kg-milk)
Tco_{mw} = biotransfer coefficient from drinking water to mother's milk (day/kg-milk)
Tco_{mf} = biotransfer coefficient from food to mother's milk (day/kg-milk)

Tco_{ms} = biotransfer coefficient from incidental soil ingestion to mother's milk (day/kg-milk)
Tco_{md} = biotransfer coefficient from dermal absorption from contaminated soil (day/kg-milk)

Estimates of toxicant bio-transfer to breast milk are chemical-specific. Table 5.~~2~~ 4 shows the transfer coefficients for dioxin-like compounds, carcinogenic PAHs and lead that OEHHA has estimated from data found in the peer-reviewed literature. One key factor that plays a role in the difference between oral and inhalation transfer coefficient (e.g., for PAHs) is first pass metabolism which is lacking in dermal and inhalation exposures. Thus, for simplicity, OEHHA applies the transfer coefficients from inhalation to the dermal absorption pathway for lead and PAHs. For lead, we are using the inhalation Tco for all the other pathways of exposure to the mother. Likewise for PCDD/Fs and dioxin-like PCBs, we are using the oral Tco for the other pathways of exposure to the mother in Eq. 5-~~3~~7.

$$Cm = [(D\_inh \times Tco_{m\_inh}) + (D\_ing \times Tco_{m\_ing})] \times BW \qquad \text{Eq. 5-7}$$

where:

D_ing = the sum of DOSEfood + DOSEsoil + DOSEwater through ingestion (mg/kg-BW-day)
D_inh = the sum of DOSEair + DOSEdermal through inhalation and dermal absorption (mg/kg-BW-day)
Tco_{m_inh} = biotransfer coefficient from inhalation to mother's milk (d/kg-milk)
Tco_{m_ing} = biotransfer coefficient from ingestion to mother's milk (d/kg-milk)

Table 5.~~2~~ 4 Mother's Milk Transfer Coefficients (Tcos) (Taken from Appendix J)

Chemical/chem. group	**Tco (day/kg-milk)**
PCDDs - oral	3.7
PCDFs - oral	1.8
Dioxin-like PCBs - oral	1.7
PAHs – inhalation	1.55
PAHs – oral	0.401
Lead - inhalation	0.064

The chemicals evaluated in the mother's milk pathway are multipathway chemicals (Appendix E) for which sufficient data were available to estimate a Tco .

Each Tco estimate accounts for biological processes from intake to milk that affect the transfer of a toxicant in the mother's body. Appendix J further describes OEHHA's recommendations for estimating the concentration of chemicals in breast milk.

5.~~3~~4 Available Breast Milk Intake Rate Estimates

The literature contains several studies reporting measured breast milk intakes for infants at various ages and of different breastfeeding patterns. These studies typically have small sample sizes, are cross-sectional and do not represent the U.S. population of breastfeeding infants. However, the U.S. EPA (1997) Exposure Factors Handbook, the prior Hot Spots Exposure guidelines (OEHHA, 2000), and Arcus-Arth et al. (2005) compiled data from selected studies to derive summary intake rates for the population or certain subgroups of the infant population. Below we briefly summarize these reports.

5.~~3~~4.1 U.S. EPA Exposure Factors Handbook (1997) and Child Specific Exposure Factors Handbook (2008)

The U.S. EPA National Center for Environmental Assessment published an Exposure Factors Handbook in 1997 (U.S. EPA, 19997) that provides a review of the breast milk pathway intake rates, and recommends values for breast milk intake rate, lipid intake rate, and lipid content. The 1997 Exposure Factors Handbook recommended breast milk intake rate values based on data from five publications identified as “key studies” by the Agency: Butte *et al.* (1984a), Dewey and Lonnerdal (1983), Dewey *et al.* (1991a; 1991b), Neville *et al.* (1988), and Pao *et al.* (1980). The Handbook recommended mean time-weighted average milk intakes of 742 ml/day and 688 ml/day for infants 0-6 months and 0-12 months of age, respectively. The Handbook also recommends upper-percentiles for time-weighted average daily intakes of 980 ml/day and 1033 ml/day for 0-6 and 0-12 months of age, respectively. The upper percentiles were calculated as the “mean plus 2 standard deviations.” These estimates can be converted from ml to grams of breast milk by multiplying by 1.03. A disadvantage of these rates is that they are not normalized to infant body weight.

In September 2008, the U.S. EPA released the Child-specific Exposure Factors Handbook (CEFH). The CEFH reviewed relevant breast milk intake studies and provided recommended values (Table 5.3). In order to conform to the new standardized age groupings used in the CEFH, U.S. EPA used breast milk intake data from Pao et al. (1980), Dewey and Lönnerdal (1983), Butte et al. (1984), Neville et al. (1988), Dewey et al. (1991a), Dewey et al. (1991b), Butte et al. (2000) and Arcus-Arth et al. (2005). These data were compiled for each month of the first year of life.

Recommendations were converted to mL/day using a density of human milk of 1.03 g/mL rounded up to two significant figures. Only two studies (i.e., Butte et al., 1984 and Arcus-Arth et al., 2005) provided data on a body weight basis. For some months multiple studies were available; for others only one study was available. Weighted means were calculated for each age in months. When upper percentiles were not available from a study, these were estimated by adding two standard deviations to the mean value. Recommendations for upper percentiles,

when multiple studies were available, were calculated as the midpoint of the range of upper percentile values of the studies available for each age in months. These month-by-month intakes were composited to yield intake rates for the standardized age groups by calculating a weighted average.

U.S.EPA provides recommendations for the population of exclusively breastfed infants (Table 5.5) since this population may have higher exposures than partially breastfed infants. For U.S. EPA, exclusively breastfed refers to infants whose sole source of milk comes from human milk, with no other milk substitutes. Partially breastfed refers to infants whose source of milk comes from both human milk and milk substitutes (i.e., formula). Note that some studies define partially breastfed as infants whose dietary intake comes from not only human milk and formula, but also from other solid foods (e.g., strained fruits, vegetables, meats).

Table 5.~~3~~5. Recommended Values for Human Milk and Lipid Intake Rates for Exclusively Breastfed Infants by U.S. EPA Child-specific Exposure Factors Handbook (2008)

Age Group	Mean (mL/day)	Upper %tile (a) (mL/day)	Mean (mL/kg BW-day)	Upper %tile (a) (mL/kg BW-day)	Source
Human Milk Intake					
Birth to <1 month	510	950	150	220	b
1 to <3 months	690	980	140	190	b, c, d, e, f
3 to <6 months	770	1,000	110	150	b, c, d, e, f, g
6 to <12 months	620	1,000	83	130	b, c, e, g
Lipid Intake [h]					
Birth to <1 month	20	38	6.0	8.7	i
1 to <3 months	27	40	5.5	8.0	d, i
3 to <6 months	30	42	4.2	6.0	d, i
6 to <12 months	25	42	3.3	5.2	i

a Upper percentile is reported as mean plus 2 standard deviations
b. Neville et al., 1988.
c. Pao et al., 1980.
d. Butte et al., 1984.
e. Dewey and Lönnerdal, 1983.
f. Butte et al., 2000.
g. Dewey et al., 1991b.
h. The recommended value for the lipid content of human milk is 4.0 percent.
i. Arcus- Arth et al., 2005.

5.~~3~~4.2 OEHHA Hot Spots Exposure Assessment and Stochastic Analysis Guidelines (OEHHA, 2000)

In the prior version of this document (OEHHA, 2000), breast milk intake studies were identified using specified criteria (described in the prior guidelines). The studies are briefly described in the prior guidelines and are divided into two categories: those for which breast milk intake is reported as amount (e.g., ml or grams) per day and those for which intake is reported as amount per body weight per day. Mothers were described as healthy, well-nourished, and at or near normal body weight. Infants were described as healthy, near- or full-term, and single born.

In reviewing and evaluating studies, several factors potentially affecting the accuracy of breast milk intake estimates and their applicability to the general population of infants were considered. These are discussed in the prior guidelines and include (1) the methods for measuring the volume of breast milk consumed, (2) the correlation of breast milk intake with age and with body weight, (3) insensible water loss, and (4) the effect of maternal factors on breast milk intake.

In the prior version of this document (OEHHA, 2000), two datasets were selected with which to derive breast milk intake rates: Hofvander *et al.* (1982) and Dewey *et al.* (1991a; 1991b). These datasets were selected because the data were on a body weight and individual infant basis and the combined datasets provided data covering the 1-12 month age period (the majority of the typical breastfeeding period). For the Hofvander study, all infants were exclusively breast fed while infants in the Dewey et al. study were exclusively breastfed to about 4 months of age and many through 6 months of age. However, in Dewey et al., some infants (exactly who and how many were unspecified) were introduced to solid foods as early as 4 months of age (based on the age of food introduction of 5.3 $\pm$ 1.1 months reported in the published report). Therefore, the Dewey et al. infants did not fit the AAP recommendations at 6 months of age (i.e., exclusively breastfed). Nonetheless, the 3 (exclusive breastfeeding), 9 (fully breastfeeding), and 12 (fully breastfeeding) month ages were in accordance with AAP recommendations.

The normal distribution described the combined datasets fairly well and fit much better than the log normal distribution. The means at the 3-month age group were not statistically different between the Hofvander et al. and Dewey et al. studies. There was considerable variability in the intakes reported at any given age, with the range (60-120 g/kg-day) and standard deviation (18-25 g/kg-day) consistent among the different age groups.

There is an overall trend of decreasing consumption on a per kg basis with increasing age, with daily intake greatest at 30 days of age. A linear relationship fits the age versus consumption rate data fairly well. From this combined data set, an intake averaged across breastfeeding infants during the first year of life is estimated to be 102.4 g/kg-day. Assuming a normal distribution of intake among the infants in this population (with mean and standard deviation 102.4 and 21.82 g/kg-day, respectively),

the different levels of intake are derived and provided in Table 5.~~4~~6. Similarly, an estimate of average intake during the first 6 months of life is estimated to be 131.4 g/kg-day.

Table 5.~~4~~6 OEHHA (2000) - Distribution of daily breast milk intake (g/kg-day) for fully breastfed infants during their first 6 and 12 months of life*

Percentile	6 months	12 months
5	95.5	66.5
10	103	74.3
15	109	79.7
20	113	84.1
25	116	87.7
30	120	90.9
35	123	94.0
50	131	102
65	140	111
70	143	114
75	146	117
80	150	121
85	154	125
90	159	130
95	167	138
99	182	153

*Data from Hofvander et al. (1982) and Dewey et al. (1991a; 1991b), analysis conducted by OEHHA (2000).

5.~~3~~4.3 Arcus-Arth et al. (2005)

Arcus-Arth et al. (2005) extended the work presented in OEHHA (2000) and reported statistical distributions (i.e., percentiles and parameters) of breast milk intake rates for infants fed in accordance with the 1997 American Academy of Pediatrics recommendations (AAP, 1997). The AAP recommendations were for infants to be exclusively breast fed through 6 months of age, and then to receive breast milk as the sole source of milk through 12 months of age during which time solid foods and non-milk liquids are being introduced.

Arcus-Arth et al. also presented distributions of breast milk intake rates for infants exclusively breastfed for 0-12 months. The Arcus-Arth et al. rates are based on breast milk intakes normalized to body weight (g/kg-day) of individual infants seven days to one year of age, with many infants providing data at more than one age period but no infant providing intake measurements from early to late infancy (i.e., at periodic time points throughout the first year). The rates were found to be normally distributed at each measurement age (e.g., at 3 months) as well as over the one year age period (i.e., 7 days through 12 months).

Two methods were used to analyze the data. In the first method (Method 1), the daily intake per kg infant body weight was regressed on age. Intake was integrated over a 6 or 12 month period, and divided by 182.5 or 365 days, respectively. This resulted in a daily intake rate averaged over that period, i.e., an average daily intake. A pooled SD was calculated using the SD's at each measurement age. A distribution was then derived using an integrated average value calculated from the regression, the pooled SD, and an assumption of normality.

For the second method (Method 2), a dataset of breast milk intake over each of 6 or 12 months for 2500 hypothetical infants was created by randomly selecting values at each measurement age from the empirical distribution at that age and assuming normality. For each hypothetical infant, a line was fit using the generated "intake versus age" data, and an average daily intake for each infant was derived. The results are presented in Table 5.~~5~~ 7 below.

Table 5.~~5~~ 7 Daily Breast Milk Intake Rates Averaged Over 6 or 12 Months (g/kg-day)

Averaging Period	***Mean (SD)***	***Population Percentile***							
		5	***10***	***25***	***50***	***75***	***90***	***95***	***99***
AAP [1] ***0-6 Months*** **Method 1**	129.6 (21.3)	94.5	102.3	115.2	129.6	144.0	157.0	164.6	179.3
AAP [1] ***0-6 Months*** **Method 2**	126.3 (6.8)	115.2	117.7	121.8	126.3	130.9	135.0	137.5	142.1
AAP [1] ***0-12 Months*** **Method 1**	100.7 (22.7)	62.4	70.9	85.0	100.7	116.3	130.4	138.9	154.9
AAP [1] ***0-12 Months*** **Method 2**	101.6 (5.3)	92.8	94.8	98.0	101.6	105.2	108.4	110.3	113.4
EBF [2] ***0-12 Months***	113.0 (21.8)	77.1	85.0	98.3	113.0	127.7	140.9	148.8	163.8

[1] AAP = dataset based on American Academy of Pediatrics (1997) infant feeding recommendations
[2] EBF = dataset of exclusively breastfed infants

The variability, as measured by the SD and the range in values of the distribution, differ between Methods 1 and 2. Method 1 incorporated the correlation for an individual infant over time in their intake pattern (e.g., high-end consumers remained high-end consumers throughout the lactation period). Method 2 randomly selected intake values for a hypothetical infant at each age (measurement) point, and thus did not incorporate correlation between intakes. Because higher-end consumers tended to remain higher-end consumers while lower-end consumers remained lower-end, the range of values

from the 5th-percentile to the 99th-percentile is much greater for Method 1 than for Method 2.

In comparison to the breast milk intake rates derived for the prior Hot Spots Exposure guidelines (2000), the Arcus-Arth et al. (2005) rates are based on a larger sample size, include intake measurements as young as 7 days of age (the prior guidelines used data from infants only as young as 3 months), and are in accordance with AAP recommendations. Because pediatricians tend to refer to AAP guidance, it is likely that they would encourage mothers to follow AAP breastfeeding recommendations.

5.~~4~~5 Representativeness of Breast Milk Intake Estimates

The Exposure Factors Handbook (1997), prior Hot Spots Exposure and Stochastic Guidelines (2000), and Arcus-Arth et al. (2005) used data from mothers who were predominantly white, well-nourished and of relatively high socioeconomic (SES) and educational status, and therefore do not represent a cross-section of all California mothers. However, the literature indicates that SES does not affect the amount of breast milk produced by the mother or the amount of breast milk consumed by the infant, except when the mother is severely undernourished. This was the conclusion made by Ahn and MacLean (1980) who reported that studies generally agreed "that the milk output of mothers in [developing and industrialized countries are] comparable, except in populations of markedly undernourished women." Further, the World Health Organization (WHO, 1985) concluded that, for most mother-infant pairs, the volume of breast milk consumed by the infant is considerably less than the mother's potential supply. Thus, the breast milk intake rates reviewed in these guidelines are likely representative of the population of California infants.

5.6~~.0~~ Conclusion

Breastfeeding is an important indirect pathway of exposure for environmental toxicants, particularly persistent lipophilic chemicals, other substances that may accumulate in the body, and substances that are preferentially transferred into breast milk. Significantly larger quantities of some environmental toxicants stored in maternal tissue are delivered to breastfed infants compared to non-breastfed infants. Factors such as the duration of breastfeeding and maternal age at first breast feeding period can influence dose estimates. Breast milk intake should be considered when evaluating risks from environmental toxicants transferred to breast milk. This chapter provides a framework and the values needed for estimating the range of exposures to breast milk pollutants for breastfeeding infants.

The benefits of breastfeeding are widely recognized, and public health institutions promote and encourage breast feeding. In most situations, the benefits for the general infant population appear to outweigh the risks from exposure to toxicants in breast milk. It is a public health goal to minimize the risk and to understand the magnitude of the risk. Because the patterns of breastfeeding are changing, the duration of breastfeeding

and intake of breast milk at different ages should be re-evaluated periodically to ensure a sound basis for such calculations.

Appendix 5A

Appendix 5A includes some background information on the mother's milk exposure pathway that may be useful for some specialized risk assessment applications but is not currently used in the Hot Spots exposure assessment model.

5A-1 Breast Milk Lipid

5A-1.1 Breast Milk Lipid Content

Many chemicals of concern in breast milk are primarily found in the breast milk lipid. Thus information on the lipid content of breast milk may be useful for some risk assessment applications. The average lipid composition of breast milk is significantly different among women (Harmann, et al., 1998). Some researchers have reported monthly increases in breast milk lipid during the breastfeeding period (Ferris et al. 1988; Clark *et al.* 1982), while others have found that breast milk lipid does not change significantly over time (Butte *et al.* 1984b; Dewey and Lonnerdal, 1983). Mean reported values from various studies are provided in Table 5A-1.

Nommsen et al. (1991) measured lipid content in breast milk of 39 women at four measurement periods (3, 6, 9, and 12 months of infant age). The data were collected to be representative of a 24-hour nursing duration, thus accounting for within feeding and diurnal variation in lipid content. Examination of the subjects' lipid levels longitudinally reveals that a subject with high lipid levels in breast milk produced at three months will tend to have high levels at subsequent months. An analysis of variance (ANOVA) using the 39 subjects for which four lipid level measurements are available confirms that there is a highly significant subject effect. Some studies have reported that lipid levels increase over the lactation period (Allen et al., 1991). For the Nommsen et al. study, the average lipid levels among the 39 subjects increase from 3.63 g/100 ml at 3 months to 4.02 g/100 ml at 12 months. However, for 14 of the 39 individuals, the lipid level shows a downward trend (e.g., the 12-month lipid level is lower than the 3 month). There is increased variability in lipid content at later measurement periods relative to earlier periods.

Table 5A-1 Lipid Content of Breast Milk Reported by Various Researchers

Study	***Study Findings***
Butte *et al.* (1984c)	3.92 g lipid /dl - mean for preterm infants 4.31 g lipid /dl - mean for full term infants For infants aged 2 to 12 weeks. 13 full term and 8 preterm infants. Measurements taken at 2, 4, 6, 8, 10, 12 weeks postpartum. No significant changes in content noted over time. Standard deviations ranged from 0.78 to 1.57 g lipid /dl.
Clark *et al.* (1982)	Mean total lipid content in units g/100 ml increased between 2 and 16 weeks postpartum for 10 subjects: 3.9, 4.1, 4.6 and 5.2 at 2, 6, 12, and 16 weeks postpartum.
Ferris *et al.* (1988)	Mean lipid in g/100 ml were 3.98, 4.41, 4.87, and 5.50 at, respectively, 2, 6, 12, and 16 weeks postpartum in 12 subjects. Standard deviations ranged from 0.99 to 1.09 g/100 ml.
Dewey and Lonnerdal (1983)	Overall mean lipid content ranged from 4.3 to 4.9 g/100 ml 1-6 months postpartum, without significant differences at different months. Standard deviations ranged from 0.97 to 1.96 g/100 ml. Measurements taken at 1, 2, 3, 4, 5, and 6 months postpartum. Number of subjects at each month ranged from 13 to 18.
Dewey *et al.* (1991a; 1991b) – raw data provided by K. Dewey	Percent of Lipid in Breast Milk (mean +/- SD) (n=sample size) 3 Months age = 3.67 +/- 0.84 (n=72) 6 Months age = 3.92 +/- 1.04 (n=53) 9 Months age = 4.16 +/- 1.07 (n=46) 12 Months age = 4.02 +/- 1.55 (n=39) All ages = 3.9 +/- 1.1 (n=210)
Mitoulas et al. (2003)	3.55 g lipid/dl (mean for 1-12 months)

5A-1.2 *Breast Milk Lipid Intake Rates – Point Estimates*

The Exposure Factors Handbook (U.S. EPA, 1997) recommends values for breast milk lipid intake rates (Table 5A-2). Values for infants under one year were based on data of Butte *et al.* (1984a) and the Maxwell and Burmaster (1993) analysis of the Dewey *et al.* (1991a) study. A lipid intake rate of 26 ml/day (equivalent to 26.8 g/day) was recommended for risk assessment purposes, with an upper percentile value of 40.4 ml/day (equivalent to 41.6 g/day) ("based on the mean plus 2 standard deviations"). The high-end value is based on a statistical model but falls within the range of empirical values (maximum 51.2 g/day) from Dewey et al. (1991a). A disadvantage of these rates is that they are not normalized to infant body weight.

Table 5A-2. Recommended Values for Lipid Intake Rates for Exclusively Breastfed Infants by U.S. EPA Child-specific Exposure Factors Handbook[a] (2008)

Age Group	Mean (mL/day)	Upper %tile (a) (mL/day)	Mean (mL/kg BW-day)	Upper %tile (a) (mL/kg BW-day)	Source
Birth to <1 month	20	38	6.0	8.7	b
1 to <3 months	27	40	5.5	8.0	b,c
3 to <6 months	30	42	4.2	6.0	b,c,
6 to <12 months	25	42	3.3	5.2	b

a The recommended value for the lipid content of human milk is 4.0 percent.
b. Arcus- Arth et al., 2005
c. Butte et al., 1984.

Mitoulas et al. (2003) studied breast milk intake and lipid levels in 30 Australian mother-infant pairs. The infants were fully breastfed for at least 4 months, with complementary foods added between 4 and 6 months age. Measurements were made at 1, 2, 4, 6, 9, and 12 months of age. For the 0-6 and 0-12 month periods, the mean lipid intake was 13.50 and 12.96 g/day, respectively. For the period of exclusive breastfeeding (1-4 months age), mean lipid intake was 13.33 g/day.

5A-1.3 Breast Milk Lipid Intake Rates - Distributions

The Maxwell and Burmaster (1993) study presented a distribution of breast milk lipid intake by infants less than one year of age. They report that, at any given time, "approximately 22% of infants less than one year of age are being breastfed, the remaining 78% have no exposure to chemicals in their mother's breast milk." They found the mean lipid intake among nursing infants to be characterized by a normal distribution with mean 26.81 g/day and standard deviation 7.39 g/day. Their results are based on the fraction of infants at different ages being breastfed according to the reports of Ryan *et al.* (1991a, 1991b) and "on data for lipid intake from a sample of white, middle- to upper-income, highly educated women living near Davis, California" (Dewey *et al.*, 1991a).

Advantages of this study include the detailed analysis of the breast milk pathway, which addressed several of the key factors contributing to variable intakes among individual infants. However, some features of this study limit its usefulness for evaluation of acute and chronic exposure of breastfed infants to environmental toxicants. First, the study did not analyze data on breast milk intake during the first three months of life and instead extrapolated from the Davis study to predict intake during this period. Second, intake was expressed as amount per day, rather than amount per body weight per day;

the latter would facilitate more accurate dose calculations. Third, estimates of the breastfeeding population are made for the fraction of current feeders on any given day rather than the fraction of infants who breastfed at any time during their first year of life. For chronic exposure analyses it is important to consider prior intakes in addition to current intake of individual infants.

Arcus-Arth et al. (2005) presented lipid intake rates normalized to body weight by combining measured milk intake values with lipid content values. The first set of lipid intakes was derived using only Dewey et al. data (raw data provided by K. Dewey, and methodology described in Dewey et al. 1991a, b). The infants were exclusively breastfed through 3 months of age and fully breast fed thereafter. Milk intake and lipid content were measured at 3 (n=72), 6 (n=53), 9 (n=46), and 12 (n=39) months of age. The milk intake from each infant was multiplied by the corresponding measured lipid content value for that infant at that age to give lipid intake. These lipid intake rates were normally distributed at the 6-, 9-, and 12-month measurement ages.

The researchers also derived a second set of lipid intakes using the same milk intake values of Dewey et al. and a 4% lipid content value, which is the lipid content value commonly used as a default in risk assessment. The 4% lipid content derived rates differed by 2-10% from the measured lipid content derived rates, with probable overestimation at the mean and underestimation at the low- and high-end percentiles. Because the differences were not substantial, and because a dataset of lipid content values representing the population is not available, the 4% lipid content value was considered a reasonable default.

A third set of lipid intakes was derived to represent the subpopulation of infants fed in accordance with AAP recommendations (AAP, 1997). Because a few infants in the Dewey et al. study had consumed solid foods between 4 and 6 months of age, and because it is not known which infants these were, the 6-month data did not follow AAP recommendations and thus could not be used for this purpose. Therefore, Arcus-Arth et al. used the AAP dataset they had created and the default 4% lipid content value to derive a set of “AAP lipid intake rates.”

For each set of lipid intakes, the values were regressed by age to derive average daily lipid intake rates over the 0-6 and 0-12 month periods. While the 0-12 month derived lipid intake rates were available in the Arcus-Arth et al. journal article, the 0-6 month rates were not published but were obtained from the authors (Arcus-Arth, personal communication, 2008).

Arcus-Arth et al. derived lipid intakes and average daily lipid intake rates only for breastfed infants, not the entire infant population, resulting in intakes that are not directly comparable to those of Maxwell and Burmaster (1993). An advantage of the Arcus-Arth et al. derived rates is that they are normalized to infant body weight. A disadvantage is that lipid intake values for infants 0-3 months of age were derived using extrapolation because measured values for this age group were not available.

Inter- and intraindividual variation of lipid content over time should be considered when evaluating lipid intake for the infant population. We chose to use the average daily lipid intake rates of Arcus-Arth et al. because they have incorporated variability over time and have been normalized to body weight. The mean and selected percentiles of the average daily lipid intake rates are presented in Tables 5A-4, below.

Table 5A-3 suggests that assuming a 4% lipid content value tends to slightly overestimate the mean and slightly underestimate the high-end percentile of average daily lipid intake. Nonetheless, the values are similar, supporting the use of a 4% lipid content value as a reasonable default. Further, the Exposure Factors Handbook (U.S. EPA, 1997) recommends assigning a value of 4% (i.e., 4 g/dl) to breast milk lipid content based on data of the National Research Council (1991), Butte *et al.* (1984a), and Maxwell and Burmaster (1993).

Table 5A-3 Comparison of Lipid Content Assumptions: average daily lipid intake (g/kg day) of breastfed infants for the 0–12 month age period

		Population Percentiles							
	Mean	**5**	**10**	**25**	**50**	**75**	**90**	**95**	**99**
Measured lipid content [A]	3.70	2.01	2.38	3.00	3.70	4.39	5.01	5.38	6.08
4% lipid content [B]	4.03	2.53	2.85	3.37	3.96	4.54	5.07	5.38	5.98

[A] Lipid intake derived by multiplying the lipid content measurement by the milk intake measurement for each infant in the dataset provided by K. Dewey. Includes a few infants who may have received some solid foods between 4-6 months age.
[B] Lipid intake derived by multiplying a 4% lipid content value by the milk intake measurements provided by K. Dewey. Includes a few infants who may have received some solid foods between 4-6 months age.
* Data source: Arcus-Arth et al. (2005)

Assuming a 4% lipid content value, the distribution of average daily lipid intake rates for the AAP dataset is presented in Table 5A-4, below.

Table 5A-4 Distributions of Average Daily Lipid Intake (g/kg day) over the 0-6 and 0–12 month age periods for AAP infants and assuming 4% milk lipid content*

		Population Percentiles							
Age	**Mean**	**5**	**10**	**25**	**50**	**75**	**90**	**95**	**99**
0-6 months	5.18	3.78	4.09	4.61	5.18	5.76	6.28	6.58	7.17
0-12 [A] months	4.03	2.50	2.84	3.40	4.03	4.65	5.22	5.56	6.20

[A] includes infants exclusively breast fed through 6 months age and thereafter fully breast fed
* Data source: Arcus-Arth et al. (2005)

5A-2 Prevalence of Breastfeeding

Information on the prevalence of breastfeeding may be useful for assessing population impacts of pollutants. The majority of infants receive at least some breast milk during infancy. Of these infants, a significant number receive breast milk through at least 12 months of age. Using survey data, the prevalence of breastfeeding (i.e., percent of infants who are breastfed) can be estimated. The prevalence of in-hospital and early postpartum breastfeeding provides information regarding the initiation of breastfeeding and therefore the potential number of infants that may be exposed via the breast milk pathway. The prevalence of breastfeeding at later ages in the lactation period provides information on the duration of breastfeeding, which is a key determinant of the amount of breast milk, and therefore the total dose, to an infant over the lactation period.

Until recently, the only nationwide survey of breastfeeding prevalence was the Ross Mothers Survey (Ross Products Division, Abbott Laboratories). More recently, the National Immunization Survey and the National Survey of Children's Health have collected national data on breastfeeding prevalence, while the California Newborn Screening Program has collected data on infants in California (but only at an early postpartum (in-hospital) age). In addition, Hammer et al. (1999) provide prevalence data on a subpopulation of California infants (i.e., SF Bay area infants). These studies are briefly described below, and results are presented in Tables 5A-5 and 5A-6, below. The prevalence data can also be used in conjunction with breast milk intake rates to derive breast milk intake rates over the entire population of infants for the estimation of population cancer burden.

5A-2.1 The Ross Mothers Survey

The Ross Mothers Survey (RMS) is an annual nationwide mail survey conducted by Ross Products Division of Abbott Laboratories and is sent periodically sent to a probability sample of new mothers. Prior to January 1997, mothers received the survey at the time their babies turned six months of age. Since that time, surveys are sent to mothers at each month of age, from one through 12 months.

The survey asks mothers to recall the types of milk their babies received (1) in the hospital, (2) at one week of age, (3) in the last 30 days, and (4) most often in the last week. By using a multiple choice question, mothers select the kinds of milk fed to their infants from a listing that includes breast milk, commercially available infant formulas, and cow milk.

The weighting of the results reflects national demographics associated with the geography, race, age, and education of mothers throughout the United States. The 1998-2002 rates were weighted using U.S. Department of Health and Human Services 1997 natality data, while the 2002-2003 rates were weighted using year 2000 natality data. For 2002, the response rate was 21% (290,000 questionnaires returned out of 1,380,000 mailed) (Ryan, 2005).

The majority of infants in the U.S. receive breast milk at some time. The survey has consistently found that the percent of mothers breastfeeding in the U.S. varies considerably with geographic region. The highest rates of breastfeeding are in the Mountain and Pacific states (U.S. census regions). In the Pacific states in 2001, 82.9% of newborns were breastfed in-hospital, and 44.2% of infants were breastfed at 6 months (Ryan et al., 2002).

These rates are higher than the 1996 rates (75.1% and 30.9%, respectively for in-hospital and at 6 months age) reported in the prior guidelines.~~—~~ In addition to geographic differences, breastfeeding patterns vary considerably with maternal age and education, race/ethnicity, and economic status (National Research Council, 1991; Ross Products Division, Abbott Laboratories, 1996).

5A-2.2 The National Immunization Survey

The National Immunization Survey is conducted annually with approximately 35,600 questionnaires completed each year. Beginning July 2001 and continuing through December 2002, a sample of respondents was asked about breastfeeding using a set of breastfeeding questions. Starting January 2003, all respondents to the household telephone survey were asked these breastfeeding questions.

The NIS uses random-digit dialing to survey households about childhood immunization for children aged 19–35 months of age. The response rates for NIS years 2001–2006 ranged from 64.5% to 76.1%. Because children are 19–35 months of age at the time of the parent interview, each survey year represents children born sometime during a three calendar year period (Table A2 in NIS report). All analyses were conducted using statistical software that accounts for complex sample design. A more detailed description of the methods can be found at http://www.cdc.gov/nis.

Three modifications were made to the breastfeeding questions in 2004 and 2006. Only the change in January 2006 to Question 3, which consisted of asking the one question as two separate questions, resulted in significant effects on the prevalence rates (i.e., yielded significantly lower estimates of exclusive breastfeeding). Because of this large effect, the trends of exclusive breastfeeding by year of birth are shown separately for children whose caregivers were interviewed before and after January 2006.

Advantages of the NIS study include the relatively high response rates, California-specific data, and the inclusion in the survey of specific questions regarding the consumption by the infant of other foods or liquids in addition to breast milk. A disadvantage is the lengthy time interval between when the infant was breastfed and when the parent was asked questions pertinent to breastfeeding that infant, which may lead to inaccuracies in recall.

Table 5A-5 Prevalence of breastfeeding in the United States by birth year (percent ± ½ of confidence interval)

Age	Year					
	1999	**2000**	**2001**	**2002**	**2003**	**2004**
Early postpartum	68 ± 3	71 ± 2	71 ± 1	71 ± 1	73 ± 1	74 ± 1
At 6 months	33 ± 3	34 ± 2	37 ± 1	38 ± 1	39 ± 1	42 ± 1
At 12 months	15 ± 2	16 ± 2	18 ± 1	19 ± 1	20 ± 1	21 ± 1

* Exclusive breastfeeding information is from 2006 NIS survey data only and is defined as only breast milk — no solids, water, or other liquids.
* percent represents the proportion of infants
* Source: National Immunization Survey, Centers for Disease Control and Prevention, Department of Health and Human Services

Table 5A-6 Prevalence of Breastfeeding California Infants by Birth Year and Type of Breastfeeding (percent ± ½ of confidence interval)[1]

	N	**Ever Breast-fed**	**Breast-fed at 6 Months**	**Breast-fed at 12 Months**	**N**	**Exclusive Breast-fed[2] at 3 Months**	**Exclusive Breast-fed[2] at 6 Months**
Born in 2004	1702	83.8 ± 3.3	52.9 ± 4.3	30.4 ± 4.0	1438	38.7 ± 4.5	17.4 ± 3.5
Born in 2003	1688	83.8 ± 3.2	49.3 ± 4.0	26.6 ± 3.5			

[1] percent represents the proportion of infants
[2] Exclusive breastfeeding information is from 2006 NIS survey data only and is defined as only breast milk — no solids, water, and other liquids.
* Source: National Immunization Survey, Centers for Disease Control and Prevention, Department of Health and Human Services

5A-2.3 California Newborn Screening Program (MCAH, 2007)

In-hospital infant feeding practices in California are monitored using data collected by the Newborn Screening (NBS) Program. All non-military hospitals providing maternity services are required to complete the Newborn Screening Test Form prior to an infant's discharge. In addition to tracking genetic diseases and metabolic disorders, the NBS program gathers data on all infant feedings from birth to time of collecting the specimen for the genetic disease/metabolic disorder. The Maternal, Child and Adolescent Health (MCAH) Program staff, of the California Department of Public Health, analyze these data and publish the in-hospital breastfeeding rates (accessible at: http://www.cdph.ca.gov/data/statistics/Pages/BreastfeedingStatistics.aspx).

In September 2007, the MCAH published rates using 2006 Newborn Screening Program data. The prevalence rate for any breastfeeding in-hospital was 86.5% of mothers, while the rate of exclusive breastfeeding was 42.8%. The relatively low exclusive breastfeeding rate is only applicable to the in-hospital stay and not to the later period at home. This is because infants frequently receive some formula while in the hospital to prevent infant hypoglycemia which may result from an inability of the infant to properly nurse (e.g., latch on) initially or from the mother not producing sufficient milk for nursing yet.

5A-2.4 Hammer et al. (1999)

Hammer et al. (1999) prospectively studied the feeding patterns of 216 infants in the San Francisco Bay area from birth through weaning. Information on infant feeding practices was collected via an Infant Feeding Report form completed by the mother for a 3-day period at the end of every month. Parent-infant pairs were recruited from the well newborn nurseries at a university hospital, community hospital, and health maintenance organization (HMO). The parents' intention to feed the infant by a particular feeding pattern (e.g., bottle feeding) was not considered in selecting infants for the study.

Investigators or their staff in the laboratory did not give information or advice on feeding practices to parents, and all infants received routine health maintenance care from local physicians or clinics. Thus, the feeding patterns for these infants were not dictated by the study but instead are likely to have reflected prevalent feeding patterns in the general infant population of the SF Bay area. These patterns are likely to also be applicable to similar areas (e.g., urban) in California.

5A-2.5 Taylor (2006)

Taylor et al. (2006) analyzed data of singleton children of primiparous mothers from the 2002 National Survey of Family Growth. The data set included information on 3229 mother-child pairs when the child was 1-18 years of age. Women were asked if they had breastfed their child, and, if so, the number of completed weeks. A limitation of this study is the sometimes lengthy interval between infancy and when the mother was asked about infant feeding practices. An advantage of this study is the inclusion of only primiparous women, which is consistent with the assumption of the child being from a primiparous mother in these guidelines.

5A-2.6 Summary of Prevalence Data

Breastfeeding prevalence rates from the above studies are summarized in Table 5A-7, below. For the Ross Mothers Survey, rates for the Pacific region are presented because the Pacific region better represents California than the entire U.S.

Table 5A-7— Prevalence of Breastfeeding

Study	**NIS [1]**	**Ross Mothers Survey [2] (Pacific region)**	**New Born Screening Program [3]**	**Hammer et al. (1999) [4]**	**Taylor et al. (2006) [5]**
Study Background					
Sample Size	1702	39,600 (estimated 1999 sample size)	506,442	175	3229 primiparous, singleton
Geographic Region	U.S.	Pacific region	California	SF Bay Area, northern CA	U.S.
Year	2004	2001	2006	1997-1998 (presumed)	2002 (interview)1986-2001(birth year)
Percent of Infants Breastfeeding – Any Breastfeeding Pattern					
Ever breastfed	83.3%			90%	62%
In-hospital		82.9%	86.5%		
At 3 months					36%of all infants,58% of those who ever breastfed
At 6 months	52.9%	44.2%		48%	23% of all 38% of those who ever breastfed
At 12 months	30.4%			19%	6% of all,13% of those who ever breastfed

Table 5A-7— Prevalence of Breastfeeding (Cont.)

Study	**NIS [1]**	**Ross Mothers Survey [2] (Pacific region)**	**New Born Screening Program [3]**	**Hammer et al. (1999) [4]**	**Taylor et al. (2006) [5]**
Study Background					
Sample Size	1702	39,600 (estimated 1999 sample size)	506,442	175	3229 primiparous, singleton
Geographic Region	U.S.	Pacific region	California	SF Bay Area, northern CA	U.S.
Year	2004	2001	2006	1997-1998 (presumed)	2002 (interview)1986-2001(birth year)
Percent of Infants Breastfeeding - Exclusive Breastfeeding					
In-hospital		54.2%	42.8%		
At 2 months				31%	
At 3 months	38.7%				
At 6 months	17.4%	24.1%		14%	
At 12 months				7% (“sole breast-feeding”)	

[1] National Immunization Survey, Centers for Disease Control and Prevention, Department of Health and Human Services
[2] Ryan et al. (2002)
[3] MCAH of the California Department of Public Health
[4] fed directly from the breast, does not include feedings from a bottle of breast milk
[5] data from the National Survey of Family Growth (2002)

5A-2.7 Trends in Breastfeeding at Early-postpartum, 6 month, and 12 Month Ages

The Ross Mothers Survey, National Immunization Survey, National Survey of Children's Health, and Hammer et al. (1999) collected data on the prevalence of breastfeeding at various times of the lactation period, and thus provide information on the initiation and duration of breastfeeding. The California Newborn Screening Program only provides information on in-hospital infants (i.e., initiation of breastfeeding).

The Ross Mothers Survey showed increases in breastfeeding both for in-hospital and at 6 months age between 1993 and 2003 for California (Mothers Survey, Ross Products Division of Abbott (2004) (Table 5A-8). It is of note that the in-hospital rate stabilized at about 80% from 1999-2002 but then decreased to 73.9% in 2003. Upon examination of rates for the other states (not shown here), a similar decrease of in-hospital rates occurred for 47 of the other 49 states (the exceptions being Delaware and North Dakota, which were noted as having 'variable' data associated with low sample sizes). A systematic calculation in the rates or a change in hospital policy might be responsible for this decrease. A decrease from 2002 to 2003 is also seen in 6-month rates for California and a little over half of the other states, but the decrease is much less than for the in-hospital rates and possibly not statistically significant. Thus, there appears to be a sudden unexplained decrease in the initiation of breastfeeding but the duration of breastfeeding has not significantly changed.

Table 5A-8 California-specific Breastfeeding Rates from the Ross Mothers Survey*

	In-hospital	*At 6 months*
1993	69.5	25.8
1994	70.6	27.1
1995	73.2	29.8
1996	72.0	29.4
1997	75.2	35.0
1998	76.9	38.4
1999	79.1	39.1
2000	80.2	40.1
2001	81.7	43.6
2002	79.7	41.7
2003	73.9	39.8

* Source: Mothers Survey, Ross Products Division of Abbott, 2004

The prevalence of infants who are exclusively breastfed at 6 months has also increased according to the RMS data (Table 5A-9, below). However, in-hospital exclusive breastfeeding does not appear to have changed. This might be because the mother's milk has not yet come in or that the infant has not yet learned how to latch on during the short stay in the hospital. Hospital staff may be anxious to feed the infant formula due to concern over hypoglycemia, which can occur very quickly in neonates.

Table 5A-9 Prevalence (percent of infants) of Breastfeeding for the United States from the Ross Mothers' Survey[1]

	Breastfeeding		Exclusive Breastfeeding	
	In-hospital	**At 6 months**	**In-hospital**	**At 6 months**
1994	57.4	19.7	46.8	11.2
1995	58.9	20.8	47.6	11.9
1996	59.2	21.7	47.3	12.2
1997	62.4	26.0	46.1	12.7
1998	64.3	28.6	46.2	13.8
1999	67.2	30.7	46.3	15.8
2000	68.4	31.4	46.0	16.0
2001	69.5	32.5	46.3	17.2
2001 – *Pacific Region*			54.2	24.1

[1] source: Ryan et al. (2002)

The National Immunization Survey Study (NIS) provides data from 1999 to 2004 for the entire U.S, which is sufficient for the assessment of trend over time. The NIS U.S. data show that from 2001 to 2006 slight to moderate progressive increases in breastfeeding prevalence occurred at the early postpartum period and at 6 and 12 months of age (Table 5A-10). California-specific data are available, but only for 2003 and 2004, which is insufficient for evaluating statistical trends over time (Table 5A.11). However, the data do reveal an increase from 2003 to 2004 in 6- and 12-month prevalence rates for California.

Table 5A-10 Prevalence of Breastfeeding in the United States by Birth Year (percent ± ½ of confidence interval)[1,2]

Birth Year

	1999	**2000**	**2001**	**2002**	**2003**	**2004**
Early postpartum	68 ± 3	71 ± 2	71 ± 1	71 ± 1	73 ± 1	74 ± 1
At 6 months	33 ± 3	34 ± 2	37 ± 1	38 ± 1	39 ± 1	42 ± 1
At 12 months	15 ± 2	16 ± 2	18 ± 1	19 ± 1	20 ± 1	21 ± 1

1 Percent represents the proportion of infants

2 Source: National Immunization Survey, Centers for Disease Control and Prevention, Department of Health and Human Services

Table 5A-11 Prevalence of Breastfeeding for California Infants by Birth Year and Type of Breastfeeding (percent ± ½ of confidence interval)[1]

	N	Ever Breast-fed	Breast-fed at 6 Months	Breast-fed at 12 Months		N	Exclusive Breastfed [2] at 3 Months (2006)	Exclusive Breastfed[2] at 6 Months (2006)
Birth Year 2003	1688	83.8 ± 3.2	49.3 ± 4.0	26.6 ± 3.5				
Birth Year 2004	1702	83.8 ± 3.3	52.9 ± 4.3	30.4 ± 4.0		1438	38.7 ± 4.5	17.4 ± 3.5

[1] Percent represents the proportion of infants

[2] Exclusive breastfeeding information is from interviews in 2006 and is defined as consumption of only breast milk (i.e., no solids, water, or other liquids).

* Source: National Immunization Survey, Centers for Disease Control and Prevention, Department of Health and Human Services

Maternal education and age, and family socioeconomic status have been correlated with both initiation and duration of breastfeeding (NIS, National Research Council, 1991; Ross Products Division, Abbott Laboratories, 1996). The NIS data for infants born in 2004 shows that infants were more likely to have ever been breastfed, breastfed at 6 months, or exclusively breastfed if they were born to mothers 30 years of age or older, born to mothers who were college graduates, or born to families at the highest income level studied (i.e., the highest level over the poverty-to-income ratio).

Because the above data demonstrate continued trends towards increases in the initiation and duration of breastfeeding (including exclusive breastfeeding), these trends should be re-evaluated periodically. Factors affecting breastfeeding prevalence, such as maternal age and the promotion of breastfeeding (both discussed below), can help to assess breastfeeding trends.

5A-2.8 Age at Weaning

A few studies have examined the rate of breastfeeding cessation. Maxwell and Burmaster (1993) found that the fraction of infants breastfeeding (f) in the U.S. in 1989 was well described by a negative exponential distribution (e.g., $f = a\, e^{-c\, t}$) with a cessation rate of 0.5% per day for the 0-12 month period. Arcus-Arth et al. (2005) used Ross Mothers Survey data from the year 2000 and found a cessation rate of 0.2027% per day for the 0-6 month period and 0.07563% for the 6-12 month period.

We evaluated data from the National Survey of Children's Health (NSCH, CDC, 2003) to assess age of weaning data that are more recent and that are specific to California. The NSCH is a national survey funded by the Maternal and Child Health Bureau, U.S. Department of Health and Human Services, and administered by the National Center for

Health Statistics, Centers for Disease Control and Prevention. The survey collects data on national and state-level prevalence of a variety of physical, emotional, and behavioral child health indicators, including the age at which the child was completely weaned from breast milk.

The survey uses the State and Local Area Integrated Telephone Survey, which provides a consistent means to collect data across states. Phone numbers are selected randomly to identify households with one or more children less than 18 years of age. For these households, one child is randomly selected for inclusion in the study. Over 102,350 surveys were completed for children 0-17 years of age.

Survey results are weighted to represent the population of non-institutionalized children 0-17 years of age on both national and state levels. For the question on the age of weaning from breast milk, NSCH used only data from mothers whose children were 0-5 years of age at the time of interview. The reported age at weaning was reported as age intervals rather than age points.

These age intervals were <3, 3-6, 7-12, and over 12 months of age. Some women were still breastfeeding their child at the time of interview so it is unknown when these children were weaned. Data were available specific to California, with the most recent year being 2003. Results were based on those infants who were fed breast milk (versus based on all breastfed plus non-breastfed infants).

The NSCH Data Resource Center provides a website with an interactive data query feature for hands-on access to the survey data (http://www.nschdata.org/DataQuery/SurveyAreas.aspx). We used the website query system to assess age at weaning in California, by selecting "Survey Sections", then "California", "2003" and "Early Childhood", then "at what age did young children completely stop breastfeeding? (S6Q60 -- ages 0-5 who have been breastfed)." Results are presented in Table 5A-12, below.

Table 5A.12 Age interval when completely weaned from breast milk – California Infants[1]

	< 3 months	**3-6 months**	**7-12 months**	**> 12 months**	**Total**
Percent of breastfed infants[2]	19.9	30.2	31.3	18.6	100
Sample size	118	179	185	110	592

[1] data from the National Survey of Children's Health from 2003
[2] Excluding those still breastfeeding at time of interview

To evaluate the distribution of breast milk weaning age in California we used the data in Table 5A-13 and applied simulation and curve fitting functions in Crystal Ball version 7.2.1 (Decisioneering, 2007) to find the best-fit distribution and to identify distributional

parameters. We excluded infants (N=67) who were still breastfeeding at the time of interview, and adjusted the remaining data (i.e., percent weaned, N=592) to account for the exclusions. We found that the data best fit a gamma distribution with location = -0.17, scale = 3.60, and shape = 2.41464**.** The median age of weaning was 7.0 months and 75% of infants were weaned by 12 months, 90% by 16 months, and 95% by 18 months of age. It is noteworthy that a significant percentage of infants can be considered extended breast feeders (i.e., breastfed past 12 months of age). Our results are presented in Table 5.17.

Table 5A.13 -Mean and percentiles of the parametric model of age at weaning from breast milk for California infants in 2003 (in months) [1,2]

	mean	50%-ile	75%-ile	90%-ile	95%-ile
Weaning age (months)	8	8	12	16	18

[1] derived by OEHHA from the National Survey of Children's Health 2003 data
[2] excludes infants still breastfeeding at time of interview with mother

Other studies that provide information on the cessation of breastfeeding (weaning) include Hammer et al. (1999) (described above in Section 5A-2.~~8)~~4 and Rempel (2004). These two studies are summarized in Table 5A-14, below.

The Rempel (2004) study followed a cohort of Canadian mother-infant pairs from birth until 12 months of age. Of the 317 mothers who agreed to participate in the study, 289 initiated breastfeeding. The results are based on the 289 infants that breastfed. At 9 months of infant age, 27% of infants were still consuming some breast milk and 14% of the original 289 weaned between 9 and 12 months. Though the Rempel (2004) study involved Canadian mother-infant pairs, the results are likely similar to similar subpopulations in the U.S.

The mothers in the Rempel study were from Ontario (a fairly large cosmopolitan city), 16-42 years of age, had a mean +/- SD number years of education of 15 ± 2.8, 59% were employed full-time, 16% were employed part-time, 67% were married, 13% were born outside Canada. According to the authors "the participants represented a wide variety of cultural backgrounds." These demographics may be similar to some subpopulations of women in California cities.

Table 5A.14 -Age at Weaning

Study	N	Infants Studied	Infant Age at Weaning (month)	Year(s) of Study	Comments
Hammer et al. (1999)	175	General population	Median: 6.0 Range: 0.9-39.1	1996-1998 (approx)	SF Bay area
Rempel (2004)	312	General population	13% weaned between 9 &12	1999-2000	Canada

5A-3 Subpopulations of Special Concern

5A.3.1 Infants Breastfed for an Extended Period of Time

Documentation of extended breastfeeding is quite limited in this country both because there is little socio-cultural support for extended nursing (Stein et al., 2004) and because many health care practitioners do not consider asking about it (Sugarman and Kendall-Tackett, 1995). However, recent increases in the duration of breastfeeding (see Section 5~~.6~~A-2.7, above) as well as efforts by public agencies and the American Academy of Pediatrics to promote and support breastfeeding ~~(See Appendix E)~~ would suggest that the number (and proportion) of infants being breastfed beyond the first year of life may be increasing as well. Few studies have evaluated information on extended breastfeeding. These studies are described, and summarized in Table 5A-15, below.

Sugarman and Kendall-Tackett (1995) found that among a group of American women (n = 179) who breastfed past 6 months of infant age, the age of weaning averaged between 2.5 and 3.0 years, with a high end value of 7 years 4 months. Forty-three percent of children in this sample (i.e., breastfed past 6 months) were breastfed beyond their third birthday. The researchers also found in examining mothers who breastfed more than one child past 6 months of age, that in subsequent lactations the younger children were breastfed for longer periods of time than the older child(ren) had been.

Dettwyler (2004) reported results of an informal survey of children who were breastfed for periods greater than 3 years. The sample included 1280 children, most during the 1990s, but some in the 1980s and earlier. The average age at weaning was 4.24 years, with a median of 4.00, a mode of 3.50, and a standard deviation of 1.08 years. Close to half of the children weaned between 3.00 and 4.00 years of age.

Children whose weaning was characterized as “child led” weaned at an average age of 4.39 years, whereas those whose weaning was characterized as “mother led” were weaned at an average age of 3.83 years. The mothers were most often middle-class and upper-class, worked outside the home, and highly educated. More than 50% of the mothers were college graduates, and the sample included numerous women with advanced degrees. Of those who responded to the question on ethnicity of the mother, most said they were European-American. These characteristics mirror those found in previous studies of extended breastfeeding in the U.S. (Sugarman and Kendall-Tackett, 1995).

Although most infants in California are weaned during their first year (see Table 5A-14, above)), there is a subpopulation of infants who are breastfed for an extended period. The Hammer et al. (1999) study (see description in Section 5A-2.8, above), which did not seek to identify extended breastfeeding infants, demonstrates that extended breastfeeding may be more prevalent than is commonly thought. Of the 175 infants who were breastfed, the oldest age at complete weaning from the breast was 39.1 months (extended breastfeeding).

Table 5A.15 -Age at Weaning for Extended Breastfeeding Infants

Study	N	Infants Studied	Infant Age at Weaning	Year(s) of Study	Comments
Dettwyler (2004)	1280	Infants breastfed to at least 3 years	Mean: -4.24 yrs Median: -4.0 yrs SD: -1.08	1995-2000	U.S.
Hammer et al. (1999)	175	General population	Median: -6.0 mos Range: 0.9-39.1 mos	1996-1998 (presumed)	SF Bay area
Sugarman and Kendall-Tackett (1995)	134	Infants breastfed to at least 6 months	Mean: -2.5-3.0 yrs Range: 6 mo - 7 yrs 4 mos 43% breastfed past 3 yrs	1989-1991	U.S.

Immigrants to the U.S. may be more likely to practice extended breastfeeding, if they retain breast feeding practices from the home country. The 2003 joint WHO/UNICEF released a joint recommendation in 2003 that advocates exclusive breastfeeding for the first 6 months followed by breastfeeding with supplementation of complementary foods for at least the first two years of life (UNICEF/WHO, 1990). In the study by Buckley (2002), ten Hispanic mothers from Caribbean, South American or Central American countries, residing in the U.S. who breastfed their infant(s) beyond one year of age, stated that breastfeeding a child up to 4 years of age was common in their countries of origin.

In a “Challenging Case” of the Journal of Developmental Pediatrics, Dr. Boies reports personal communication with Anne Seshadri (2002) who states “mothers in India frequently breastfeed their infants until 3 or 4 years of age” (Stein et al., 2004). Immigration into the U.S. from locations, where extended breast feeding is practiced such as Hispanic countries and India, could cause an overall increase in the incidence of extended breastfeeding.

Currently there are little data on the composition of breast milk during extended breastfeeding. Studies have found that when milk volume decreases (e.g., near the time of weaning) that lipid content increases, while other studies have found the opposite result. It would be helpful to know the lipid content of breast milk during extended breastfeeding to better understand the importance of lipophillic chemical transfer to an extended breastfed infant.

Exposures to infants who are breastfed for an extended period should be further investigated and in some circumstances taken into account in non-default analyses. See Appendix ~~E~~ J for a more detailed discussion about the accumulation and transfer of chemicals in maternal body tissue and its potential impact on extended breastfed infants.

5A-3.2 Infants of Older Mothers

Older primiparous mothers have longer to accumulate toxicants with long body tissue half-lives (i.e., more than six years) and could therefore eliminate more toxicant to their breast milk than younger mothers would. Furthermore, older mothers tend to breastfeed for a longer duration than younger mothers do (Section 5A.3.1, above). Both conditions could lead to higher dosing of primiparous infants from the breast milk of older mothers than of infants from younger primiparous mothers' breast milk.

Many chemicals will reach a steady state in the mother's body before age 25. On the other hand, other substances do not reach steady state within 25 years. For example, lead continues to accumulate in cortical bone over the human lifetime (O'Flaherty 1998). Thus, women giving birth after 25 years of age will have accumulated greater amounts of lead that can be passed to the infant in breast milk relative to mothers 25 years of age and younger.

Older mothers tend to initiate breastfeeding of their infants and breastfeed for longer periods of time. Because substances such as lead can accumulate in maternal tissues past the default 25 years for exposure to facility emissions before birth of a child, it is important to consider maternal age in assessing infant exposure to such toxicants via breast milk.

5A-3.2.1 *Breastfeeding Practices of Older Mothers*

In Section 5A-2.1, we provide background on the Ross Mothers Survey and the NIS. These surveys have consistently found that both the initiation and duration of breastfeeding increased with maternal age. The Ross Mothers Survey data (Table 5A-16) show an increasing trend from 1996 to 2001 of older mothers to initiate breastfeeding and to continue to breastfeed for at least 6 months. The NIS data (Table 5A.17) show that older mothers are more likely to breastfeed and to exclusively breastfeed through 6 months in accordance with AAP recommendations (NSCH, 2007).

Table 5A-16 Prevalence (percent) of Breastfeeding by Maternal Age, Ross Mothers Survey

	Maternal Age				
	<20 years	**20-24 years**	**25-29 years**	**30-34 years**	**≥35 years**
In-hospital					
1996	43	53	62	68	69
2001	57	66	73	76	76
At 6 months					
1996	10	15	23	29	34
2001	20	26	35	42	44

* Source: Ryan et al. (2002)

Table 5A-17 Prevalence (percent) of Types of Breastfeeding by Maternal Age, Infants born in 2004

	Maternal Age		
	<20 years age	**20-29 years age**	**>=30 years age**
Ever Breastfeed	53	69	77
Breastfeed at 6 months	18	31	46
Breastfeed at 12 months	6	15	24
Exclusively breastfed at 3 months	17	26	35
Exclusively breastfed at 6 months	6	8	14

* Source: National Immunization Survey, Centers for Disease Control and Prevention, Department of Health and Human Services

5.3.2.2 *Prevalence of Older Women Giving Birth in California*

There is an increasing trend toward older women giving birth in California. Births to women 35 years of age and older showed a progressive increase from 1990 to 2006 (Table 5A-18, below) (CDPH, 2006).

Table 5A-18 California Births by Maternal Age and Year of Birth (percent of total births for that year)

	Maternal Age		
	35-39 years	**40-44 years**	**>=45 years**
1990	9	1.6	0.07
1995	11	2.3	0.12
2000	13	2.9	0.18
2006	14	3.3	0.25

Data source: California Department of Public Health, birth records

It should be noted that the above data are for maternal age at primiparous and multiparous births. Data on primiparous-only births are not readily available. For some lipophilic toxicants, primiparous birth is an important parity as this can be when the greatest amount of toxicant may be excreted in the mother's breast milk, and the mother's body burden is reduced, thus lowering the dose to subsequent children.

Increases in maternal age may continue due to the increasing use of in-vitro fertilization for older women, though such increases are likely to be very small relative to the population of women giving birth.

5.3.3 High-end Consumers

Under certain circumstances, information on individuals exposed at very high levels is of interest. For assessing high-end exposures, Table 5A-19 may be of use. It provides upper-end breast milk and lipid intake rate estimates for the breastfeeding population.

Table 5A-19 Intake estimates for the breastfeeding infant population

	Breast Milk Intake[1] (g/kg-day)		***Lipid Intake[2] (g/kg-day)***	
	6 month average	***1 year average***	***6 month average***	***1 year average***
99th percentile	179	155	7.1	6.2

[1]From Arcus-Arth et al. (2005)
[2] From correspondence with author (Arcus-Arth et al.) and based on lipid intakes at 3 and 6 months

Arcus-Arth et al. (2005) found that the rate of breast milk intake was highest during the second week of life. At this age, when susceptibility to certain toxicants is high, the mean intake is 160.6 g/kg-day and the 99th percentile is 257.8 g/kg-day.

5.11 References

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6. Dermal Exposure Assessment

6.1 Introduction

Semi-volatile and nonvolatile contaminants emitted into the air can be subsequently deposited onto soil or other surfaces. Exposure to chemicals can occur through skin contact with the contaminated soil. This exposure pathway is considered under the Air Toxics "Hot Spots" Act when evaluating chronic exposure. ~~Although dermal exposure to volatile chemicals can be significant with high air concentrations found in industrial settings, this pathway is not a significant exposure source for lower environmental air concentrations both relative to other exposure pathways and in terms of the magnitude of the dermal dose.~~

For semi-volatile organic compounds (SVOCs), OEHHA has not quantified exposure via the air-to-skin transdermal pathway for the Hot Spots Program. This pathway is inherently included in human and animal whole-body inhalation exposures to chemicals in toxicology and epidemiology studies for both VOCs and SVOCs. Whole-body inhalation studies almost always form the basis for determining Reference Exposure Levels (RELs) and Cancer Potency Factors (CPFs) where the metric of exposure is the airborne concentration. As such, exposure via the air-to-skin pathway is incorporated into the RELs and CPFs for individual chemicals.

The significance of the air-to-skin transdermal pathway for some Hot Spots SVOCs has been shown in a modeling study that utilized physical and chemical principles combined with empirical evidence to critically assess the significance of the dermal pathway as a contributor to total human exposure to SVOCs (Weschler and Nazaroff, 2012). In this study, it is proposed that intake by the air-to-skin transdermal pathway can exceed intake by inhalation for several SVOCs that humans can be exposed to. The air-to-skin pathway is of particular concern for the relatively more volatile SVOCs that both equilibrate rapidly with skin-surface lipids and also permeate the skin relatively quickly. Amphiphilic SVOCs (i.e., containing both hydrophilic and lipophilic properties) in particular are included this class. Hot Spots chemicals that fall into this class probably include the smaller molecular weight PCBs such as PCB77 and PCB81.

For a second group of SVOCs, direct air-to-skin transport can also contribute to total uptake, but perhaps not to the same fractional extent as the first group owing to slower equilibration with skin-surface lipids or slower migration through the stratum corneum (Weschler and Nazaroff, 2012). Hot Spots chemicals that fall into this group include many of the PAHs such as B(a)P and chrysene. In a third group of SVOCs, the equilibrium time is too long for air-to-skin transport to be important. Hot Spots chemicals in this third group include diethylhexylphthalate and probably the dioxins and furans (e.g., TCDD). However, skin contact with these SVOC-containing materials or surfaces (such as contaminated soil) may contribute to elevated levels in skin-surface lipids. Once sorbed at the skin surface, subsequent migration through the stratum corneum and viable epidermis can be relatively fast.

Although the air-to-skin transdermal pathway is generally taken into account in RELs and CPFs, the importance of this route should be discussed in the event RELs or CPFs are developed for some SVOCs based on studies that use other than whole-body inhalation (e.g., nose-only inhalation). Note that chronic inhalation exposures are always "whole body" for logistic reasons.

Likewise absorption of chemicals dissolved or deposited into water while swimming, bathing, or showering could be significant under certain exposure scenarios but usually not under the airborne release scenario considered in the "Hot Spots" program.

The significance of each of the above exposure pathways varies by type of chemical, but dermal uptake of chemicals from soil and other surfaces is considered the most relevant. This route applies to semivolatile organic chemicals such as PAHs, dioxins and PCBs, and some inorganic metals such as lead and lead compounds. Under the "Hot Spots" program, dermal exposure to soils contaminated with these chemicals is considered the principal dermal exposure pathway. The concentrations in soil around a specific facility due to long term deposition are estimated from facility emissions estimates, air modeling, estimates of soil half life and soil mixing depth.

As discussed in Section 6.5 below, OEHHA devised a new variate called the Annual Dermal Load, or ADL. This variate is a composite of the body surface area (BSA) per kg body weight, exposure frequency, and soil adherence variates, which simplifies the calculation for risk assessors. In addition, ADLs have been determined for California climate zones, expressed as warm, mixed and cold. These climate zones recognize the different amount of time one spends outside during the year (depending on the climate zone), and the amount of clothing one wears in these different climate zones. All of which influences the ADL value.

6.2 Recommended Dermal Exposure Values

[Note: this Section was moved from the back to the front]
For assessing dermal exposure, we are recommending point estimates using the ADL variates presented in Table 6.1. These point estimates are the mean and 95th percentile values from the stochastic distributions shown in Tables 6.2a-d. Using Eq. 6-8 (see below), the variables that are needed to assess dermal exposure include the climate-dependent ADL, the soil concentration of contaminant and the ABS (dermal absorption value from soil).

Table 6.1. Recommended Annual Dermal Load Point Estimates (in mg/kg-yr) for Dermal Exposure

	3rd Trimester	Children 0<2 yrs	Children 2<9 yrs	Children 2<16 yrs	Adults[a]	Off-Site Worker
Warm climate						
Mean	1.2×10^3	3.6×10^3	7.5×10^3	6.4×10^3	1.2×10^3	2.6×10^3
95th percentile	2.6×10^3	4.3×10^3	9.1×10^3	8.5×10^3	2.6×10^3	5.0×10^3
Mixed climate						

Mean 95 th percentile	1.1 x 10^3 2.4 x 10^3	2.2 x 10^3 2.9 x 10^3	6.6 x 10^3 8.7 x 10^3	5.7 x 10^3 8.1 x 10^3	1.1 x 10^3 2.4 x 10^3	2.6 x 10^3 5.0 x 10^3
Cold climate Mean 95 th percentile	 0.7 x 10^3 2.1 x 10^3	 1.2 x 10^3 1.9 x 10^3	 3.1 x 10^3 5.2 x 10^3	 2.8 x 10^3 5.1 x 10^3	 0.7 x 10^3 2.1 x 10^3	 2.6 x 10^3 5.0 x 10^3

[a] Residential adults includes 16<30 and 16-70 year age groups

ADL distributions in Tables 6.2a-d are by age group and climate, with the adult age groups (16-30 and 16-70 years of age) sharing the same values. The ADL for the third trimester of the fetus is based on the ADL of the mother; when normalized to body weight, we assume that exposure to the mother and the fetus will be the same. The mother's exposure is based on the adults age 16-30 years of age in Table 6.2d.

Tables 6.2a-d. Annual Dermal Load Distributions by Age Group and Climate

Table 6.2a. Annual Dermal Load (mg/kg-yr) Distributions for the 0<2 Year Age Group

Climate Type	**Warm climate**	**Mixed climate**	**Cold climate**
Distribution	Student's t	Logistic	Triangular
Minimum			0.2 x 10^3
Likeliest			0.7 x 10^3
Maximum			2.6 x 10^3
Scale	0.41	0.28	
Deg. freedom	3		
Midpoint	3.6 x 10^3		
Mean	3.6 x 10^3	2.2 x 10^3	1.2 x 10^3
50th percentile	3.6 x 10^3	2.2 x 10^3	0.9 x 10^3
90 th percentile	4.1 x 10^3	2.8 x 10^3	1.9 x 10^3
95 th percentile	4.3 x 10^3	2.9 x 10^3	1.9 x 10^3
99 th percentile	4.7 x 10^3	3.1 x 10^3	2.1 x 10^3

Table 6.2b. Annual Dermal Load (mg/kg-yr) Distributions for the 2<9 Year Age Group

Climate Type	**Warm climate**	**Mixed climate**	**Cold climate**
Distribution	Min extreme	Min extreme	Triangular
Minimum			0.4 x 10^3
Likeliest	8.0 x 10^3	7.3 x 10^3	1.9 x 10^3
Maximum			6.9 x 10^3
Scale	0.1	1.3	
Mean	7.5 x 10^3	6.6 x 10^3	3.1 x 10^3
50 th percentile	7.7 x 10^3	6.5 x 10^3	2.3 x 10^3
90 th percentile	8.7 x 10^3	8.4 x 10^3	5.1 x 10^3
95 th percentile	9.1 x 10^3	8.7 x 10^3	5.2 x 10^3

99th percentile	9.7 x 10^3	9.4 x 10^3	5.7 x 10^3

Table 6.2c. Annual Dermal Load (mg/kg-yr) Distributions for the 2<16 Year Age Group

Climate Type	Warm Climate	Mixed climate	Cold climate
Distribution	Min extreme	Logistic	Triangular
Minimum			0.3×10^3
Likeliest	7.2×10^3		1.6×10^3
Maximum			6.9×10^3
Scale	1.29	0.91	
Mean	6.4×10^3	5.7×10^3	2.8×10^3
50 th percentile	6.6×10^3	5.7×10^3	2.2×10^3
90 th percentile	8.1×10^3	7.7×10^3	4.8×10^3
95 th percentile	8.5×10^3	8.1×10^3	5.1×10^3
99 th percentile	9.3×10^3	8.9×10^3	5.6×10^3

Table 6.2d. Annual Dermal Load (mg/kg-yr) Distributions for Residential Adults (Age 16-30 and 16-70 Years) and Offsite Workers

Receptor	Residential Adult			Offsite Worker
Climate Type	**Warm**	**Mixed**	**Cold**	**All Climates[a]**
Distribution	Beta	Beta	Gamma	Lognormal
Minimum	0.2×10^3	0.02×10^3		
Maximum	3.3×10^3	0.3×10^3		
~~Location~~			~~0.01~~	
Scale			0.07	
~~Shape~~			~~0.94~~	
~~Alpha~~	~~1.3~~	~~1.01~~		
~~Beta~~	~~0.02~~	~~2.05~~		
Mean	1.2×10^3	1.1×10^3	0.7×10^3	2.6×10^3
~~Std. Dev.~~				~~1.3~~
50 th percentile	1.2×10^3	1.0×10^3	0.5×10^3	2.3×10^3
90 th percentile	2.4×10^3	2.1×10^3	1.6×10^3	4.5×10^3
95 th percentile	2.6×10^3	2.4×10^3	2.1×10^3	5.0×10^3
99 th percentile	2.9×10^3	2.6×10^3	2.3×10^3	6.4×10^3

[a] Face, hands and forearms are exposed only, regardless of climate

There are several advantages for stochastically combining the four variates from the original dermal dose equation (see Equation 6-1 below) into an annual dermal load variate. First, using one variate (annual dermal load) rather than four separate variates simplifies calculations for risk assessors. Also, distributional information that previously was separate is now integrated into one distribution. In addition, selecting a high-end value from the annual dermal load distribution reduces the possibility of over-conservatism that can occur when high-end values of the variates are multiplied together as was done with Equation 6-1 in the prior edition of the Stochastic guidelines (OEHHA, 2000).

6.~~2~~3 Dermal Uptake from Contaminated Soil Contact

Although the dermal exposure route is generally considered a minor exposure pathway, a screening study by Johnson and Kissel (1996) of over 200 risk assessments for Superfund sites resulted in identification of 37 sites at which projected lifetime excess cancer risks attributed to dermal contact with contaminated soil were greater than 1 in 10,000. Dermal exposure was the dominant exposure route at 9 sites. Thus it is possible for dermal exposure to reach a level of significance, although the soil concentrations resulting from airborne deposition tend to be lower than when more concentrated pollutants are present in hazardous waste sites. The primary soil contaminants in these dermal risk assessments included dioxins, PAHs, PCBs and arsenic. Johnson and Kissel (1996) highlighted early concern for the dermal pathway and the need for better information for dermal exposure variates, such as the chemical fractional skin absorption, surface area exposure and soil adherence, in order to better assess dermal absorption potential.

The potential for skin contact with soil near the home can be significant. In a national survey known as the Soil Contact Survey, almost half of households reported the presence of bare spots (44.7%) other than gardens in their yards (Wong et al., 2000a). A majority (63.7%) of respondents with homes also reported a vacant lot or field within walking distance of the home.

As discussed above, dermal absorption varies by exposure pathway and with the properties of the chemical. Other major factors which influence dermal absorption include the anatomical region exposed (Maibach et al., 1971; Wester and Maibach, 1985), the amount of skin exposed, soil or particle type and size, amount of soil adhering to skin (Duff and Kissel, 1996; Choate et al., 2006), type of surface contacted, chemical concentration (Nomeir et al., 1992; Sartorelli et al., 2003), duration of exposure, ambient temperature and humidity (Chang and Riviere, 1991), and activities which limit exposure (e.g., washing the skin).

The inherent variability in some of the exposure factors can be estimated, such as in total skin surface area of children and adults. In other cases, the actual variation is not as well known, such as soil loading on specific body parts in young children. Also, the factor involved may be well known but the net effect on dermal absorption of chemicals may not be readily described or quantified. For example, dermal absorption varies with skin temperature and blood flow, which tends to vary with ambient temperature and physical activity. However, the magnitude of this effect is insufficiently documented to support distribution modeling. Overall, there is generally not enough information to generate probability distributions for all of the key variates for estimating dermal absorption, although ranges are available for some variates.

This discussion of dermal exposure estimates includes the primary variates involved and can be reasonably quantified or estimated, based on the more common human

activities that result in soil skin contact (e.g., gardening). Dermal exposure is expressed as a variate called the dermal dose (Eq. 6-1). The dermal dose is defined as the amount of contaminant absorbed through the skin per unit of body weight per day (mg/kg-day). For the Air Toxics "Hot Spots" program, the dermal dose resulting from contact with contaminated soil can be estimated using the following equation:

$$DOSEdermal = (Cs \times SA \times SL \times EF \times ABS \cancel{\times ED}) \ / \ (BW \cancel{\times AT} \times 1x10^{6}) \qquad \text{(Eq. 6-1)}$$

where:

DOSEdermal	= exposure dose through dermal absorption (mg/kg-d)
Cs	= average concentration of chemical in soil (µg/kg)
SA	= surface area of exposed skin (m^2)
SL	= soil loading on skin (g/m^2-d)
EF	= exposure frequency (d/~~yr~~365 d)
ABS	= fraction of chemical absorbed across skin
BW	= body weight (kg)
$1x10^6$	= conversion factors for chemical and soil (µg to mg, g to kg)

The dermal absorption factor (ABS) is a chemical-specific, unitless factor that is discussed in Section 6.4.1 below. The exposure frequency (EF) is set at 350 days per year (i.e., per 365 days) to allow for a two-week vacation away from home each year (US EPA (1991).

[The following paragraph and associated equation were moved from Section 6.5 to here:]

Equation 6-1 requires multiplying values together, which could lead to overly conservative exposure estimates when high-end values for variates were used. By combining information from several variates into one composite distribution, over-conservatism may be avoided (see Section 6.5). To this end, OEHHA created a new variate, "annual dermal load", or ADL, which is a composite of the body surface area (BSA) per kg body weight, exposure frequency, and soil adherence variates:

$$ADL = (BSA / BW)^* [(SL_b)(SA_b\%_b)] * EF \qquad \textbf{(Eq. 6-2)}$$

Where :

ADL	= Annual dermal load (mg/kg BW-yr)
EF	= Exposure frequency (d /yr)

Thus, the dermal-dose equation (Eq. 6-1) can be reduced to the following:

$$\text{Dermal dose (mg/kg-d)} = ADL * Cs * ABS * (yr/365\ d) * 1x10^{-9} \qquad \textbf{(Eq. 6-3)}$$

Where

yr/365 d	= Conversion factor (years to days)
$1x10^{-9}$	= Conversion factor for chemical and soil (µg to mg, mg to kg)

For cancer risk, the risk is calculated for each age group using the appropriate age sensitivity factors (ASFs) and the chemical-specific cancer potency factor (CPF) expressed in units of $(mg/kg\text{-}day)^{-1}$:

$$RISKdermal = DOSEdermal * CPF * ASF * ED/AT \quad \textbf{(Eq. 6-4)}$$

RISK is the predicted risk of cancer (unitless) over a lifetime as a result of the exposure, and is usually expressed as chances per million persons exposed (e.g., 5×10^{-6} would be 5 chances per million persons exposed).

The dose-response phase of a cancer risk assessment aims to characterize the relationship between an applied dose of a carcinogen and the risk of tumor appearance in a human. This is usually expressed as a cancer potency factor, or CPF, in the above equation. The CPF is the slope of the extrapolated dose-response curve and is expressed as units of inverse dose $(mg/kg\text{-}d)^{-1}$, or inverse concentration $(\mu g/m^3)^{-1}$.

Exposure duration (ED) is the number of years within the age groupings. In order to accommodate the use of the ASFs (OEHHA, 2009), the exposure for each age grouping must be separately calculated. Because cancer risk has been shown to be greater in sensitive age groups, different ASFs are applied to different life stages used for cancer risk assessment (see below). DOSEdermal can vary depending on the type of outdoor activities that involve soil exposure. The type of outdoor activities may be specific for the age of the individual, such as general outdoor play on bare soil by young children, or gardening by adults. Thus, the DOSEdermal and ED are different for each age grouping.

ED = exposure duration (yrs):

0.25 yrs for third trimester	(ASF = 10)
2 yrs for 0<2 age group	(ASF = 10)
7 yrs for 2<9 age group	(ASF = 3)
14 yrs for 2<16 age group	(ASF = 3)
14 yrs for 16<30 age group	(ASF = 1)
54 yrs for 16-70 age group	(ASF = 1)

DOSEdermal includes indirect exposure to the fetus via direct exposure to the mother during the third trimester of pregnancy. Fetal exposure during the third trimester will be the same as that of the mother on a body weight-normalized basis, and is taken into account in the final determination of the annual dermal load presented in Section 6.2.

AT, the averaging time for lifetime cancer risks, is 70 years in all cases. To determine lifetime cancer risks, the risks are then summed across the age groups:

$$RISKdermal_{(lifetime)} = RISKdermal_{(3rdtri)} + RISKdermal_{(0<2\ yr)} + RISKdermal_{(2<16\ yr)} + RISKdermal_{(16\text{-}70yr)} \quad \textbf{(Eq. 6-5)}$$

As explained in Chapter 1, we also need to accommodate cancer risk estimates for the average (9 years) and high-end (30 years) length of time at a single residence, as well

as the traditional 70 year lifetime cancer risk estimate. For example, assessing risk in a 9 year residential scenario assumes exposure during the most sensitive period, from the third trimester to 9 years of age and would be presented as follows:

$$RISKdermal_{(9\text{-yr residency})} = RISKdermal_{(3rdtri)} + RISKdermal_{(0<2\ yr)} + RISKdermal_{(2<9\ yr)} \quad \textbf{(Eq. 6-6)}$$

For 30-year residential exposure scenario, the 2<16 and 16<30 age group RISKdermal would be added to the risk from the third trimester to 0<2 age group. For 70 year residency risk, Eq 6-5 would apply.

~~ED = exposure duration (yrs):~~

~~2.25 yrs for 0<2 age group~~
~~7 yrs for 2<9 age group~~
~~14 yrs for 2<16 age group~~
~~14 yrs for 16<30 age group~~
~~54 yrs for 16-70 age group~~

~~AT = averaging time days, to assess carcinogenic risk:~~
~~90 days for third trimester fetal stage~~
~~730 days for 0<2 yr age group~~
~~2554 days for 2<9 age group~~
~~5110 days for 2<16 yr age group~~
~~5110 days for 16<30 age group~~
~~19,711 days for 16-70 yr age group~~

~~The dermal dose can vary depending on the type of outdoor activities that involve soil exposure. The type of outdoor activities may be specific for the age of the individual, such as general outdoor play on bare soil by young children, or gardening by adults. Because cancer risk has been shown to be greater in sensitive age groups, dermal absorption variates in dermal dose Eq. 6-1 have been estimated from soil exposure studies based on life stages used for cancer risk assessment (i.e., third trimester, 0<2 yrs, 2<9 yrs, 2<16 yrs, 16<30 yrs and 16-70 yrs). Dermal exposure includes indirect exposure to the fetus via direct exposure to the mother during the third trimester of pregnancy. For the dermal exposure derivations presented below, only postpartum exposure (i.e., birth to 2 years of age, etc.) is determined. Fetal exposure during the third trimester will be the same as that of the mother on a body weight-normalized basis, and is taken into account in the final determination of the annual dermal load presented in Section 6.4.~~

~~The averaging times (AT) in Eq. 6-1 are based on the life stage of exposure. If the averaging time for dermal dose is estimated based on residence time, the default residence times are 9 years (3285 days), 30 years (10,950 days) and 70 years (25,550 days). Note that residence times may overlap the 0<2, 2<16, and 16-70 year age groupings used for estimating cancer risk.~~

Because distributional data are available for the total surface area, body weight and exposure frequency variates, a stochastic approach can be used to derive one distribution by combining these variates for the specified age groups. This stochastic approach provides an alternative means for estimating dermal exposure and is presented below in Section 6.~~5~~2.

The term Cs, concentration of the contaminant in soil, can be derived in the Hot Spots Analysis and Reporting Program (HARP) using air dispersion and deposition modeling (CARB, 2003). The concentration is a function of the deposition, accumulation period, chemical-specific soil half-life, mixing depth, and soil bulk density. The formula used is:

$$Cs = [Dep \times X)] \ / \ [K_s \times SD \times BD \times T_t] \qquad \textbf{(Eq. 6-~~2~~7)}$$

where:

Cs	= average soil concentration over the evaluation period (μg/kg)
Dep	= deposition on the affected soil area per day (μg/m^2-d)
X	= integral function accounting for soil half-life (d)
K_s	= soil elimination time constant = 0.693/$T_{1/2}$
SD	= soil mixing depth = 0.01 m for playground setting and 0.15 m for agricultural setting
BD	= bulk density of soil = 1333 kg/m^3
T_t	= 25,550 days (70 yrs), total averaging time for the chemical accumulation period (i.e., 70 yrs, the presumed life of the facility emitting chemicals)

The deposition on the affected soil area per day is expressed as:

$$Dep = GLC \times Dep\text{-}rate \times 86{,}400 \qquad \textbf{(Eq. 6-~~3~~8)}$$

where:

GLC	= ground level concentration from air dispersion modeling (μg/m^3)
Dep-rate	= vertical rate of deposition (m/sec) (see Chapter 2 for values)
86,400	= seconds per day conversion factor (sec/d)

The integral function, X, is as follows:

$$X = [\{Exp\ (-K_s \times T_f) - Exp\ (-K_s \times T_0)\} / K_s] + T_t \qquad \textbf{(Eq. 6-~~4~~9)}$$

where:

Exp	= exponent base e = 2.718
K_s	= soil elimination constant = 0.693/ $T_{1/2}$
$T_{1/2}$	= chemical-specific soil half-life (d)
T_f	= end of exposure period (d)
T_0	= beginning of exposure period (d) = 0 days
T_t	= total days of exposure period = Tf - T_0 (d)

Chemical-specific soil half-lives ($T_{1/2}$) are presented in Appendix G.
T_f = 25,500 d = 70 yrs. Identifies the total number of days of soil deposition.
T_f = 9,490 d = 25 yr for nursing mother in mother's milk pathway.

The assumptions in the soil concentration algorithm include:

1) Uniform mixing of pollutants in the soil and a constant concentration over the duration of the exposure.
2) The bulk density (BD) of soils is similar over a wide variety of soil types.
3) Substances are not leached or washed away, except where evidence exists to the contrary
4) For the mother's milk pathway, the mother is exposed for 25 years, the child receives milk for one year (from mother's 25th birthday to 26th birthday), and then is exposed to all other pathways.

6.~~3~~4 Derivation of Key Dermal Exposure Variates

Other than the soil concentration of a chemical, which is estimated from the emission, meteorological, terrain, and other data using HARP (or other software), the key variates in equation 6-1 are the chemical-specific fractional absorption factor (ABS), the surface area of exposed skin (SA), body weight, the soil loading or soil adherence of contaminated soil on skin (SL) in mg soil per cm^2 skin, and the exposure frequency (EF) in number of days exposed per year. The description of how point estimates or distributions were derived for each of these variates using existing literature sources are summarized below, and in Appendix F for the chemical ABS.

6.~~3~~4.1 Chemical-specific Absorption Factors

Skin permeability is related to the solubility or strength of binding of the chemical in the delivery matrix (soil or other particles) versus the receptor matrix, the skin's stratum corneum. This skin layer, which is the major skin permeability barrier, is essentially multiple lipophilic and hydrophilic layers comprised of flattened, dead, epidermal cells. The greatest rate of skin permeation occurs with small moderately lipophilic organic chemicals. However, such chemicals may not have the greatest total uptake, because they may evaporate off the skin. The highest penetration thus is expected from larger, moderately lipophilic chemicals with negligible vapor pressures. Organic chemicals which dissociate in solution, or metal salts that are more soluble in the aqueous phase of stratum corneum and insoluble in the lipid phase, will not penetrate the skin readily.

These principles of skin absorption are presented in US EPA (1992), and summarized in Appendix F of this document as it pertains to dermal absorption from contact with contaminated soil. Fractional dermal absorption point estimate values were derived by OEHHA from available literature sources for the semi-volatile and nonvolatile chemicals under the "Hot Spots" program (Table 6.~~1~~3). The rationale for the chemical-specific dermal absorption fraction values, and the use of default values in cases where sufficient data are lacking, can be found in Appendix F.

Table 6.~~1~~3. Dermal Absorption Fraction Factors (ABS) as Percent from Soil for Semi-Volatile and Solid Chemicals under the OEHHA "Hot Spots" Program

Chemical	ABS
Inorganic chemicals	
Arsenic	6
Beryllium	1
Cadmium	0.2
Chromium (VI)	2
Fluorides (soluble compounds)	1
Lead	3
Mercury	4
Nickel	2
Selenium	1
Organic chemicals	
Creosotes	13
Diethylhexylphthalate	9
Hexachlorobenzene	4
Hexachlorocyclohexanes	3
4,4'methylene dianiline	10
Polychlorinated biphenyls	14
Polychlorinated dibenzo-p-dioxins and dibenzofurans	3
Polycyclic aromatic hydrocarbons	13

Most exposure estimates have utilized a single value for presumed dermal uptake rate or percent without distinguishing between the specific skin regions that might be involved under different scenarios. However, it is known that the permeability of skin to chemicals may vary depending on the skin site of absorption. In general, hands are least permeable, and face and neck are most permeable (Maibach et al., 1971; Wester and Maibach, 1985). Other site-specific and scenario-specific factors are involved in dermal absorption, as discussed in Appendix F, which can result in significant differences in dermal uptake under different conditions. Data are inadequate to describe potential changes in fractional dermal absorption with changing scenarios. Thus, point estimate values are used for the ABS.

6.~~3~~4.2 Body Surface Area / Body Weight Distributional Variate

Total body surface area (BSA) and body weight are known to be highly correlated with a reported correlation coefficient (r) ranging from 0.88-0.96 (Durnin, 1959). Although there are distributional human body weight data, there are no directly measured data for BSA representative of the population. However, Gehan and George (1970) derived a BSA formula based on direct measurements of BSA from 401 individuals. Their formula accounted for over 99% of the variation in BSA and was derived using more BSA

measurements that were directly measured than other BSA formulae. The Gehan and George formula is shown as:

$$BSA\ (m^2) = (Wt^{0.51456}) \times (Ht^{0.42246}) \times 0.02350 \qquad \text{(Eq. 6-~~5~~10)}$$

where:

Wt = body weight (kg)
Ht = body height (cm)

For body weight and height data, OEHHA used the National Health and Nutrition Examination Survey (NHANES) 1999-2004 dataset (CDC, 2007). NHANES provides weights for each individual in the dataset and for the study design so that estimates using NHANES data can be weighted to be nationally representative. Total body surface estimates for each individual in the NHANES 1999-2004 dataset were derived using these individuals' body weight and height and equation 6-5. Means and specific percentiles are shown in Table 6.~~2~~ 4 and 6.~~3~~5. The sample size for NHANES, and for many subpopulations within NHANES (e.g., each year of age), is sufficiently large to provide information on interindividual variability and distributions. There are other sources of body weight and height data, but NHANES is the most recent national dataset, thus reflecting the current population, and has data on each individual for the assessment of interindividual variability.

Table 6.~~2~~4. Summary Distribution Estimates of Total Body Surface Area (in m^2) by Age Group[a]

	Children 0<2 years	**Children 2<9 years**	**Children 2<16 years**	**Adults >16 years**
Sample size	2106	3250	9007	16,718
Mean	0.459	0.884	1.177	1.942
SEM	0.003	0.005	0.006	0.003
50th percentile	0.470	0.824	1.124	1.923
90th percentile	0.564	1.107	1.730	2.302
95th percentile	0.583	1.212	1.880	2.414

[a] Derived using the equation 6.3 and the body height and weight data of the NHANES 1999-2004 study

Table 6.~~3~~5. Summary Estimates of Total Body Surface Area over Body Weight (m^2/kg) by Age Group[a]

	All ages	Children 0<2 years	Children 2<9 years	Children 2<16 years	Adults >16 years
Sample size	27831	2106	3250	9007	16718
Min	0.016	0.034	0.022	0.016	0.016
Max	0.077	0.077	0.054	0.054	0.040
Mean	0.028	0.049	0.039	0.035	0.025
SEM	0.000068	0.0001	0.000019	0.000097	0.000038
50th percentile	0.026	0.048	0.040	0.035	0.025
75th percentile	0.029	0.051	0.043	0.040	0.027
90th percentile	0.038	0.056	0.045	0.043	0.029
95th percentile	0.043	0.059	0.046	0.045	0.029
99th percentile	0.049	0.063	0.048	0.047	0.031

[a] Derived from NHANES 1999-2004 data

6.~~3~~4.3 Skin Surface Area Exposed

The amount of skin or body region that is exposed to soil contact is dependent on the type of clothing worn. Clothing is expected to significantly reduce exposure to the covered skin area from contaminated soil. Dermal risk assessment procedures used by U.S. EPA (2004) assumes no exposure of skin that is covered with clothing. The few studies that investigated this issue found that clothing had a protective effect for soil exposure, although some exposure may occur under clothing (Kissel et al., 1998; Dor et al., 2000). Considering Kissel et al. (1998) showed incomplete coverage of exposed body parts occurred in a soil exposure study, it appears unlikely that the limited soil exposure that occurs under clothing will underestimate total exposure. Consequently, the model OEHHA uses assumes no exposure to covered skin. Exposed skin is essentially limited to face, hands, forearms, lower legs, feet, or some combination thereof (U.S. EPA, 2004). However, the amount of skin exposed as a result of clothing choices is dependent on exposure activity, age group, and the climatic conditions. Because California has geographically diverse climatic regions, studies investigating clothing choices by children and adults during warm and cold weather outdoor activities were used to estimate skin exposure for different climate regions within the state.

6.~~3~~4.3.1Fractional Body Part Surface Area

U.S. EPA (2004) provides data on the percent of surface area for different body parts that may be exposed to soil. When the fractional surface area of a specific body part, such as hands, is multiplied by total surface area, the surface area of the specified body part in m^2 or cm^2 is determined. As mentioned above, normalized surface area can be derived for each individual in the NHANES dataset. Multiplying normalized surface area for each individual by the percent surface area of each body part gives an estimated normalized surface area of each body part for that individual. Individuals are then grouped by age to derive the surface area for each body part for each age group. Because the percent surface area is a constant, multiplying normalized total surface

area by the percent surface area maintains the same probability distribution of the NHANES normalized total body surface area. That is, the probability distribution of body surface area from the nationally representative NHANES data is preserved.

In the children's Soil Contact Survey by Wong et al. (2000b), the activity patterns of children (≤18 years) that would result in dermal soil contact were investigated. Of 680 households, 500 (73.5%) had children that were reported to play outdoors on bare dirt or mixed grass and dirt surfaces. An age breakdown of the children showed that those reporting little outdoor play were either very young (≤1 year) or relatively old (≥14 years for females; ≥16 years for males).

The Soil Contact Survey also asked about clothing choices during outdoor play in warm weather and determined estimated percentage skin surface area exposed (Table 6.~~4~~6). For children under 5 years of age, outdoor play was treated as a single activity. Information on outdoor activity of children aged 5 to 17 was categorized as gardening/yardwork and as organized team sports. The combination of short sleeves and short pants was a common clothing choice for outdoor activities. Skin exposure was lowest for participants in organized team sports because that group had the highest fraction wearing shoes and high socks.

The mean skin area exposed for children age 5-17 during gardening and yardwork (33.8%) is essentially the same as the default mean surface area value of 33.9% used by U.S. EPA (2004), based on soil adherence data, for children age 6 years and up. Together, the findings indicate that soil contact exposure in warm weather is primarily limited to face, hands, forearms, and lower legs, with feet exposure most common in young children up to about 6 years of age.

Table 6.~~4~~6. Estimated Skin Surface Area Exposed During Selected Warm Weather Outdoor Activities by Children[a]

	Skin area exposed (% of total) based on expressed clothing choices		
	Outdoor play (age <5 yrs)	Gardening/yardwork (age 5-17 yrs)	Organized team sports (age 5-17 yrs)
Mean	38.0	33.8	29.0
Median	36.5	33.0	30.0
SD	6.0	8.3	10.5

[a] Table adapted from data in Wong et al. (2000)

In the Soil Contact Survey of adults, Garlock et al. (1999) conducted a regional (Washington and Oregon state) and national telephone survey for four outdoor activities among 450 adults for each sample. The activities included gardening, other yard work, outdoor team sports and home construction or repair with digging. The reported participation rate for any activity was 89% for the regional survey and 79% for the national survey, with more than half of the respondents reporting participation in 2 or 3 of the activities. Table 6.~~5~~ 7 presents both the national and regional (in parentheses) percentage skin area exposed during warm and cold months among the outdoor

participants for these activities. Warm- and cold-weather months were defined by the respondent

Table 6.~~5~~7. Estimated Skin Surface Exposed During Outdoor Activities by Adults in the National and Regional (in parentheses) Surveys[a]

	Skin area exposed (% of total) based on expressed clothing choices			
	Gardening	Other yard work	Team sports	Repair/Digging
Warm months				
Median	33 (33)	33 (31)	33 (33)	28 (28)
95th %tile	69 (68)	68 (68)	43 (68)	67 (67)
Cold months				
Median	8 (3)	3 (3)	8 (8)	3 (3)
95th %tile	33 (14)	31 (12)	33 (30)	14 (14)

[a] Table adapted from data by Garlock et al. (1999).

In most activities, the median and 95th percentiles were remarkably similar between the two surveys. Current U.S. EPA guidelines (U.S. EPA, 2004; 2011) for skin area exposed to soil contact assumes roughly 25% exposure for adults, corresponding to head, forearms, lower legs and hands. These findings show that the median exposure during warm months exceeds 25%, suggesting some exposures occur with no shoes or no shirt (males) or with a halter (women).

Based on the results of the Soil Contact Surveys and the activity-dependent soil adherence data in U.S. EPA (2004), the anticipated exposed body parts for children and adults during cold and warm weather are shown in Table 6.6. In cold weather, the findings by Garlock et al. (1999) for adults suggest that the hands and face are most often exposed for some activities (e.g., gardening and team sports), but that only the face is most often exposed or partially exposed for other activities (e.g., other yard work and repair/digging), corresponding to wearing gloves. Given that the most common activities in this study, gardening and team sports, suggest both hands and face were exposed, our assessment will include both body parts for soil exposure of adults and children in a cold climate. Very limited data suggested body part exposure in young children during cold weather months was similar to findings in adults (Holmes et al., 1999). Accordingly, we will also use hands and faces as the exposed body parts for the cold climate assessments in children.

In warm weather, the adult fractional skin exposure during outdoor activities in the Soil Contact Study had a median ranging from 28-33% (Garlock et al., 1999). This finding is only slightly higher than the median fractional skin exposure of about 27% for face, hands, forearms and lower legs combined shown in Table 6.~~6~~8. Review of the U.S. EPA (2004) soil adherence data for adults shows that shoes are predominantly worn during outdoor activities, and that a halter (for women) or no shirt were choices of some participants as indicated by the Garlock et al. study. For the stochastic assessment, only face, forearms, hands and lower legs were considered “exposed” in warm weather.

For the offsite worker, fractional skin exposure is similar, but since full length pants are worn, assessments only included faces, hands and forearms.

For children in warm weather climates, the survey by Wong et al. (2000b) observed that in addition to the face, hands, forearms and lower legs, the feet were often exposed. For example, young daycare children ages 1 to 6.5 years with free access to both the indoors and outdoors were all found to go without shoes, exposing bare feet or socks, at least once during the day. No data were presented for children less than one year of age. Nevertheless, for the warm weather exposure assessment of the 0<2 age group, the body parts considered exposed include feet, face, hands, forearms and lower legs.

For older children, Wong et al. (2000b) noted that organized team sports are common activities in children ages 5<17 years which may result in soil contact with skin. However, shoes are likely worn during many of these activities. In another study that monitored children's microactivity patterns, it was observed among children ages 3-13 years that younger children were more likely to be barefoot both indoors and outdoors compared to older children (Freeman et al., 2001). The average age of the barefoot children was 5.8 years, and the average age of children that wore shoes was 8.2 years. To account for the greater tendency of younger children in the 2< 9 and 2<16 year age group to go barefoot during outdoor play, OEHHA designated that feet exposure will be given 2/3 and 1/3 weighting for the 2<9 and 2<16 year age groups, respectively, during warm weather activities. This feet exposure adjustment was assessed in the soil adherence section below, in which the soil adherence value for 2< 9 and 2<16 year-olds was reduced to 2/3 and 1/3, respectively, of the initial soil load.

Table 6.~~6~~8. Exposed Body Parts by Age Group and Weather Conditions, with the Corresponding Mean Values for the Percentage of Total Body Surface for each Body Part in Parenthesis.

	Children 0<2 yrs[a]	**Children 2<9 yrs[a]**	**Children 2<16 yrs[a]**	**Residential Adult[b]**	**Offsite Worker[b]**
Body Part Exposed	**Cold Weather**				
	Hands (5.5) Face (5.8)	Hands (5.3) Face (4.4)	Hands (5.4) Face (3.7)	Hands (5.2) Face (2.5)	Hands (5.2) Face (2.5)
	Warm Weather				
	Hands (5.5) Face (5.8) Forearms (6.0) Lower legs (8.7) Feet (6.4)	Hands (5.3) Face (4.4) Forearms (5.9) Lower legs (10.8) Feet (7.2)	Hands (5.4) Face (3.7) Forearms (6.0) Lower legs (11.8) Feet (7.2)	Hands (5.2) Face (2.5) Forearms (6.1) Lower legs (12.8)	Hands (5.2) Face (2.5) Forearms (6.1)

[a] The percentage of total body surface area for the specified body parts was estimated for each age group from data in Exhibit C-1 of U.S. EPA (2004). All values are averages for males and females combined.
[b] Body part percentage estimated from data in Table B-3 of U.S. EPA (1985).

OEHHA believes the surface area exposure estimates in Table 6.~~6~~ 8 are health protective, but not overly conservative. For example, soil exposure under clothing is not included in the algorithm, even though some studies have shown that a limited degree of exposure may occur under clothing (Kissel et al., 1998; Dor et al., 2000). Also, the neck is not included as an exposed skin region in this document, even though a field study by Dor et al. (2000) showed that soil contact on the exposed neck can occur. Future studies of soil contact to skin may need to include the neck as a potential skin region for soil contact.

6.~~3~~4.3.2 California Climate Regions and Skin Exposure

Climate will strongly influence people's choice of clothing. Due to California's varied climatic regions and existing data on clothing choices at different temperatures, three levels of climatic conditions, warm, mixed, and cold, are used to describe California's climate regions. The type of climate will, in turn, be used to assess the fraction of exposed skin for soil contact.

The "warm" climate is characteristic of Southern California areas such as Los Angeles, which can have warm to hot temperatures throughout the year. The "cold" climate is representative of San Francisco, Eureka, and other northern coastal communities, which have cool temperatures (daily highs of less than 65 degrees) for the majority of the year and can receive a considerable amount of fog and rainfall. The "mixed" climate is one that has warm-to-hot temperatures during much of the year (daily highs over 80 degrees are common), roughly from April to October, and cold temperatures (lows near or below freezing) during the remainder of the year. The mountains and central valley are examples of a mixed climate. Specifically, the mixed climate is described as seven months/year of warm temperatures, resulting in warm-temperature clothing choices, and the remaining five months a year as a cold climate with cold-temperature clothing choices. Thus, the average surface area exposed over a year is proportional to seven months of warm weather skin exposure and five months of cold weather skin exposure.

6.~~3~~4.4 Soil Adherence Factors

Assessing risk from dermal exposure with contaminated soil requires an estimate of the amount of soil that will stick to skin long enough for the chemical to transfer from the soil and into the skin. This estimate has been given the term soil loading, or soil adherence, and is expressed in mass of soil per area of skin (usually in mg/cm^2). Because some body parts may have substantially greater soil adherence rates relative to other body parts, we assigned body part-specific soil adherence values to the corresponding body part surface area. Soil adherence estimates utilized published studies that were body part-specific, measuring soil adherence to hands, forearms, face, lower legs, and feet resulting from specific outdoor activities. Knowledge of body-part specific soil adherence and surface area exposure can be applied in equation 6-6 below to determine a weighted soil adherence factor (U.S. EPA, 2004; 2011). The example equation presented here is based on potential skin exposure resulting from a choice of

clothing that allows soil contact with face, hands, forearms, lower legs and feet (e.g., children in a warm weather climate):

Weighted AF = Eq. 6-~~6~~9

$$\frac{(AF_{face})(SA_{face}) + (AF_{forearms})(SA_{forearms}) + (AF_{hands})(SA_{hands}) + (AF_{feet})(SA_{feet}) + (AF_{lower\ legs})(SA_{lower\ legs})}{SA_{face} + SA_{forearms} + SA_{hands} + SA_{lower\ legs} + SA_{feet}}$$

where:

Weighted AF = overall weighted adherence factor of soil to skin (mg/cm^2-event)
AF_i = adherence factor for specific body part (mg/cm^2-event)
SA_i = specific skin surface area exposed for soil contact (cm^2)

U.S. EPA (2004) provided individual data on body-part-specific soil adherence for numerous activities (e.g., playing in dry soil, gardening, etc.), which were derived from published work (Kissel et al., 1996b; Kissel et al., 1998; Holmes et al., 1999). Although soil load was measured for quite a few activities, the number of individuals measured was small for each activity and soil adherence data for some body parts were not available for certain activities and age groups. Thus, OEHHA chose to use the arithmetic average of the soil loading rate for each body part rather than attempt to define a distribution for soil adherence. Table 6.~~7~~ 9 presents the body part-specific soil adherence factors, in g/m^2, resulting from common outdoor activities in children and adults.

Lack of soil adherence data is particularly evident among children in the 0<2 year age group. Soil adherence data are essentially absent under one year of age. For children 1<2 yrs of age, soil adherence on specific body parts can be calculated from a small group of daycare children that had roamed freely indoors and outdoors and had access to outdoor soil (Holmes et al., 1999; U.S. EPA, 2004).

For infants less than 1 yr of age, Wong et al. (2000b) observed that these children remained mostly indoors and were likely given little opportunity for direct contact with soil when outdoors. In another children activity survey, parents reported that only 17% of infants age 7-12 months had contact with outdoor dirt the previous day, while 70% of children age 1 to 4 yrs had contact with outdoor soil the previous day (Black et al., 2005).

Notably, the outdoor soil contact findings by Black et al. (2005) contrast with their findings of time spent by children playing indoors on the floor, with considerably greater time spent on the floor among infants compared to older children. Although this chapter is focused on exposure to contaminated outdoor soil, there is much evidence that shows a significant amount of outdoor soil can be found in indoor house dust (Culbard and Johnson, 1984; Davies et al., 1985; Thornton et al., 1985; Culbard et al., 1988; Fergusson and Kim, 1991; Stanek and Calabrese, 1992). From these studies, an

average of about one-third of indoor house dust is composed of soil (range: 20-78%). Because infants <1 year old spend more time indoors and play on the floor more frequently than older children, soil exposure from indoor sources may be important source of dermal contact for this age group. However, lack of soil adherence data for infants and lack of soil adherence data due to indoor soil exposure prevent an estimation of the extent of the risk.

To avoid underestimating indoor soil exposure in infants of the 0<2 age group, the infants (i.e., 0≤1 yr olds) are assumed to have the same soil adherence levels on specified body parts as the 1<2 yr old children in a daycare facility (Holmes et al., 1999; U.S. EPA, 2004). Thus, the average soil adherence for the entire 0<2 age group is based on the 1<2 yr old daycare children and is presented in Table 6.~~7~~9.

A limitation of this data is the lack of soil adherence data for the faces of the young children. To avoid non-participation in the studies, the faces of the children were not examined for soil adherence. As a surrogate, soil adherence data on the faces of 8-12 yr old children playing in dry and wet soil were averaged and used to represent soil adherence on faces of the 0<2 yr age group (Kissel et al., 1998b; U.S. EPA, 2004).

For the 2<9 and 2<16 year-old child groups, equal weighting for soil adherence was given to three groups of children: those that played in dry soil, those that played in wet soil, and those that played team sports (Kissel et al., 1996b; Kissel et al., 1998; U.S. EPA, 2004). Team sports were included to account for the greater tendency of older children to play team sports as opposed to general play in dry or wet soil (Wong et al., 2000b).

The methodology for outdoor play by the children stipulated that shoes be worn. However, studies show that during unrestricted play by children <8 years of age many go barefoot during outdoor play (Freeman et al., 2001). To account for the tendency of younger children in the 2<9 and 2<16 age groups to be barefoot during outdoor play, the soil adherence data on feet of children with access indoors and outdoors at a daycare facility were used (Holmes et al., 1999; U.S. EPA, 2004). Although the ages of the daycare children ranged from 1 to 6.5 years, these data represent the best information currently available for soil adherence on feet of children. OEHHA decided feet exposure during warm weather activities will be given 2/3 weighting for the 2<9 year-olds and 1/3 weighting for the 2<16 year-olds, corresponding to frequent exposure of bare feet to soil primarily in younger children.

For residential adults, a number of outdoor activities that resulted in soil contact were investigated (U.S. EPA, 2004; 2011). Among these activities, gardeners were chosen to estimate body part-specific soil adherence for adults (Table 6.~~7~~9). Outdoor gardening represents not only one of the more common activities resulting in soil contact, but is also a high-end soil contact activity relative to some of the other outdoor activities examined.

In addition, a number of soil contact activities by adult workers have been examined for soil adherence (U.S. EPA, 2004). The calculated geometric mean weighted soil adherence factors from these data range from 0.02 (grounds keepers) to 0.6 mg/cm^2 (pipe layers in wet soil). Soil adherence values for adult workers in Table 6.~~7~~ 9 were based on utility workers, as soil adherence in this line of work appears to be near the median for soil-contact related jobs presented by the U.S. EPA report.

Table 6.~~7~~9. Body Part-Specific Soil Adherence Factors (in g/m^2) Resulting from Common Outdoor Activities in Children and Adults

	Children 0<2 years	**Children 2<9 years**	**Children 2<16 years**	**Residential Adults**	**Adult Workers**
Activity	General outdoor play	Sports, play in wet & dry soil	Sports, play in wet & dry soil	Gardening	Utility workers
Hands	1.334	5.919	5.919	3.179	3.487
Face	0.063[a]	0.082	0.082	0.574	1.102
Forearms	0.306	0.228	0.228	0.819	3.279
Lower legs	0.183	1.332	1.332	0.42	na[b]
Feet	0.744	1.23[c]	0.41[c]	na	na

[a] No soil adherence data for the face are available for young children. Soil adherence data for the face in 8-12 year old children playing in wet and dry soil were used as a surrogate.
[b] Not applicable
[c] Soil adherence to feet was reduced, corresponding to exposure of bare feet to soil primarily in the lower 2/3 of the 2<9 year age group and lower 1/3 of the 2<16 year age group.

There are a number of limitations in these types of soil adherence studies that may result in greater or lesser dermal absorption of contaminants in contact with skin. Equation 6-1 assumes uniform soil coverage over the specific body-parts exposed. Gardening studies in a greenhouse using soil amended with fluorescent marker shows that soil contact is uneven and occurs most predictably on those specific body parts, such as hands and knees, that routinely come in direct contact with surfaces (Kissel et al., 1998). This is potentially significant because contaminant absorption is likely reduced in absolute terms as contact area is reduced and as a percent of total contaminant available as soil loading increases beyond monolayer coverage (Duff and Kissel, 1996). As discussed in greater detail in Appendix F, increasing soil loading beyond monolayer coverage will likely reduce fractional absorption of a chemical in soil, as a portion of the soil-bound chemical will not be in direct contact with skin.

Alternatively, there are factors related to soil loading that may underestimate adherence or chemical absorption estimates. A potential underestimation of risk is that hands were washed before hand press studies to estimate pre-loading soil levels (Kissel et al., 1996; Kissel et al., 1998b). Choate et al. (2006) observed that nonwashed hands had considerably greater soil loading after exposure to soil when compared to soil loading on recently washed hands. The lower adhered mass on prewashed hands was probably due to the removal of oils from the skin that aid in the adherence of soil particles. In addition, Sheppard and Evenden (1992) observed a 30% increase in the concentration of a contaminant in soil adhering to the hands compared to the bulk soil

that the hands were pressed in. Sparingly soluble contaminants were observed to accumulate in the clay fraction of the bulk soil, characterized as the smallest particles in soil, which was the fraction adhering to hands in greatest abundance.

6.~~3~~4.5 Duration and Frequency of Exposure to Contaminated Soil

Frequencies (in days/year) and durations (in hours/day) of soil exposures have not been well characterized in past studies. Recent surveys of adult and child activity patterns in relation to soil contact behavior are now available to help reduce the uncertainty associated with these variates. Regarding soil contact duration, the ABS of a particular chemical is dependent on duration of exposure. Thus, dermal absorption studies that most closely reflect the expected duration of soil contact are the most useful for estimating a chemical-specific ABS.

6.3.5.1 Exposure Duration

US EPA (2004) recommends a soil exposure time of 24 hrs and one soil exposure event per day. The exposure duration of 24 hrs assumes soil adhered to skin for 24-hrs starting from the time of first soil contact with skin to soil removal by hand washing and bathing.

One event per day can be defined as one period of exposure to soil per day. Algorithms have also been developed to assess multiple exposure events per day, which can be thought of as replenishment or replacement with a fresh layer of soil on skin (Bunge and Parks, 1997). If soil replacement is frequent enough, the soil concentration is not depleted before the next exposure, and the concentration remains essentially constant for the entire exposure period. Notably, activities involving multiple soil contacts may be better represented by a single contact scenario, if soil from the initial contact interferes with direct exposure to subsequent soil encounters. For the purposes of simplicity, one exposure event per day will be synonymous to a daily exposure, with the assumption that soil depletion of the chemical does not occur before removal from the skin with washing.

For children, exposure durations of 24 hrs are supported by national survey data reported in Wong et al. (2000b) which showed a median child bathing of one time per day. Similarly, regional data from Washington and Oregon reported median child bathing of 7 times per week. The 5th percentile for bathing was 2 and 3 times/week for cold and warm weather, respectively. However, Shoaf et al. (2005) reported a median value of two times per week for child bathing. The deviance from the national survey results was considered to be due to parents being more relaxed in interviews and less inclined to report conservative estimates.

Hand washings were more frequent than bathing among children. Wong et al. (2000b) reported median hand washing of 3 to 5 times per day in the national survey and a median hand washing of 4 times per day in the regional survey. The 5th percentile for hand washing was 2 times/day. Again, Shoaf et al. (2005) reported a less frequent

median value of one time per day for hand washings. Videotaping of children's microactivity patterns by Freeman et al. (2001) also tends to support fewer hand washings per day than the national and regional surveys reported by Wong et al. (2000b).

Considering that hands tend to have higher soil loadings than other parts of the body, except perhaps the feet, but are washed more frequently than other body parts, 24 hr exposure to contaminated soil is supported by OEHHA as a reasonable estimate for an overall default assumption for exposure duration. This health protective approach is not considered overly conservative given that some studies show bathing behaviors in children may be as few as 2 times per week.

National and regional bathing and hand washing patterns in adults were reported by Garlock et al. (1999). Nearly all respondents in both surveys (72 to 99%) reported washing hands right away after soil contact activities including gardening, yard work, team sports and home repair and digging. Bathing was reported to occur mainly within 1 hr or later that day after an activity. Only 1 to 8% did not bathe until the next day. Similar to the child bathing/hand washing survey data, the authors cautioned that the washing/bathing findings may be biased towards more socially desirable responses and should be interpreted with caution. Accordingly, the health protective assumption is to also use a soil contact duration of 24 hrs for adults, as recommended by U.S. EPA (2004).

The duration of the activity does not appear to be a good predictor of soil loading. Kissel et al. (1998) noted that initial soil contact involves a substantial portion of key body parts and is followed by continual gain and loss of soil during activity due to abrasion of skin surfaces. Soil amended with fluorescent marker does suggest increasing involvement of skin surfaces with time, but this outcome was not clearly reflected in the gravimetric results.

6.~~3~~4.5.2 Exposure Frequency

Soil exposure frequency is the final parameter of significance in these exposure estimates. Prior research by Hawley (1985) based estimates for frequency of contact with soils largely on professional judgment. The U.S. EPA (1992) used Hawley's estimate in arriving at a default value for frequency of contact with soil of 40 events (days) per year as typical for adults, with a high-end estimate of 350 events per year. Hawley also estimated soil contact in young (<2-5 years of age) and older children at 130 events per year. In the revised U.S. EPA dermal risk assessment guidelines (U.S. EPA, 2004), a reasonable maximum exposure (RME) frequency for a residential scenario is 350 days/year for both adults and children.

The Soil Contact Surveys in adults (Garlock et al., 1999) and children (Wong et al., 2000b) provided more specific estimates of time or days spent involved in outdoor activities that may result in soil contact. For the child Soil Contact Survey, adult participants with children recorded outdoor play activities of their children in both warm

and cold weather. The play participation rate was 73.5% of all children surveyed. The term "play" or "player" referred specifically to participation in outdoor play on bare soil or mixed grass and soil. Of the 500 children reported to play outdoors, 407 were reported to play outdoors during warm weather months and 390 were reported to play outdoors in cold months. Child players in both seasons were 57.4%.

The child frequency in days/week and hours/day for participants of outdoor play activities is shown in Table 6.~~8~~10. Among child players, the median play frequency was 7 days/week in warm weather (April-October) and 3 days/week in cold weather (November-March). Arithmetic or geometric means were not reported in the study.

Table 6.~~8~~10. Frequency of Outdoor Activities with Soil Contact Among Child* Participants in Warm and Cold Climates

Percentile	Cold Months (November-March)		Warm Months (April-October)	
	days/week	hours/day	days/week	hours/day
5	1	1	2	1
50	3	1	7	3
95	7	4	7	8

* Data from Wong et al. (2000b) for children <18 years of age

The exposure frequencies of outdoor play activities in days/week were multiplied by 50 weeks/year (assumes a two-week vacation per year away from the contaminated environment) to arrive at exposure frequencies in days/year (Table 6.~~9~~11). For a mixed climate, outdoor play activity in days/year was calculated as 7 months of warm climate (e.g., April-October) and 5 months of cold climate (e.g., November-March), with the assumption of one week vacation away from the contaminated environment during each of the cold and warm climate periods.

Table 6.~~9~~11. Estimated Frequency of Outdoor Activities with Soil Contact in Days/Year for Children <18 Years of Age*

Percentile	Cold	Mixed	Warm
5	50	60	100
50	150	267	350
95	350	350	350

* Extrapolated from data of Wong et al. (2000b)

For adults, outdoor activities in the Soil Contact Survey by Garlock et al. (1999) were categorized as (1) gardening, (2) other yardwork, (3) team sports, and (4) home repair involving digging. The reported participation rate for the first three activities ranged from 79 to 89% while that for the last activity was 30 and 18% for regional and national surveys, respectively. The report presented activity frequency for warm and cold climates, with climate defined by the survey respondents. Results were presented for "doers", or participants, of the activity as well as all survey respondents. The survey was conducted on a national basis and for a regional area around Hanford, Washington. Because the Hanford area does not get the extreme weather conditions that some

areas of the nation outside of California do, the Hanford area data were considered more likely representative of California than the national data. For three of the activities, gardening, other yardwork, and team sports, the results were presented in hours/month. These soil contact frequency data are not directly applicable to the Hot Spots dermal exposure algorithm because the algorithm requires a different unit of measure (days/year). The frequency of each of these three activities was combined and the results are presented in Table 6.~~10~~12.

Table 6.~~10~~12. Total Reported Activity Duration (hrs/mo) Among Adult Participants of Three Activities: Gardening, Other Yard Work, and Team Sports[a]

Hanford (regional) Survey[b]		
Percentile	Cold	Warm
5	1	4
50	6	27
95	31	126
National Survey		
Percentile	Cold	Warm
5	2	4
50	9	22
95	130	108

[a] Data from Garlock et al. (1999)
[b] Participants of regional survey were from counties in Oregon and Washington surrounding the Hanford Nuclear Reservation.

The fourth activity surveyed by Garlock et al. (1999), home repair involving digging, was reported in event days per season. No statistical difference was found between the two survey regions in terms of event days/season among participants for this activity. OEHHA chose not to use the "home repair involving digging" activity data because these data add uncertainty (significant bias may exist in the "digging" data due to the low participation rate) with only small gain in sample size. Table 6.~~11~~ 13 presents the results for the home repair involving digging activity.

Table 6.~~11~~13. Frequency of Home Repair Involving Digging in Events/Season (Days/Season)

	Cold	Warm
	Hanford	
50th percentile	3	4
95th percentile	24	28
	National	
50th percentile	4	6
95th percentile	35	31

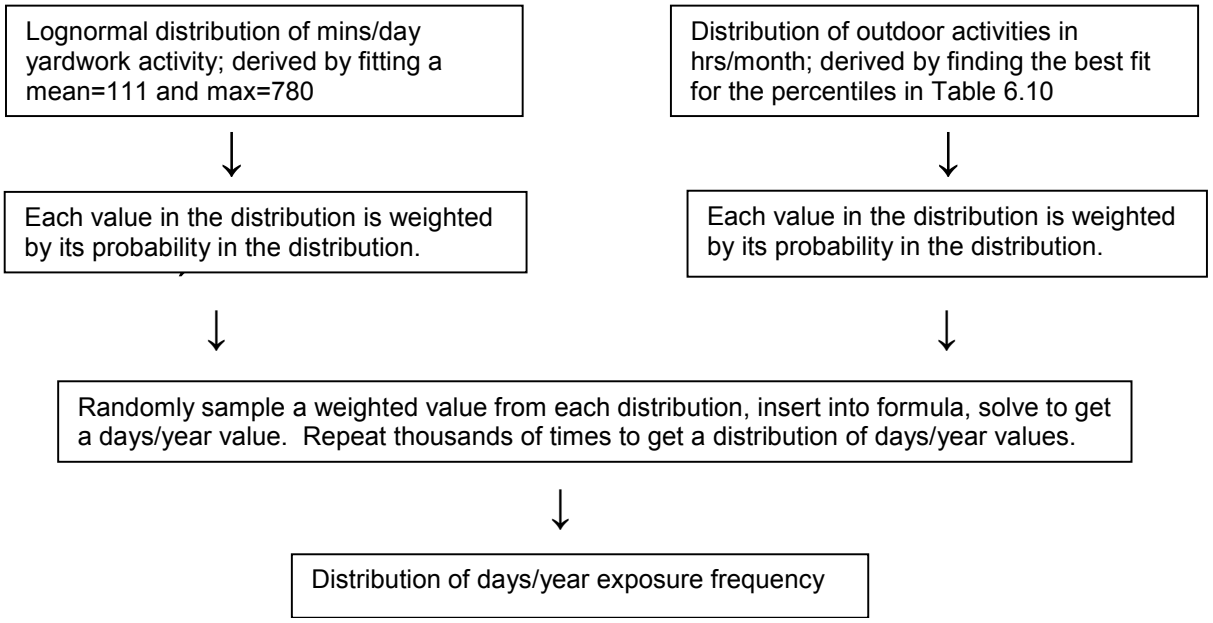
OEHHA chose to use the first three of the Garlock et al. activities (gardening, other yardwork, and team sports) for estimating soil contact frequency of adults. Using Monte Carlo simulation in Crystal Ball (Decisioneering, 2008), OEHHA calculated the best fit distribution for exposure frequency in hours/month for each climate (Table 6.~~10~~12). In

order to use these distributions for the exposure variate in these guidelines, the units need to be converted from hours/month to days/year. To do so, a similar activity survey by Jenkins et al. (1992) was employed. The Jenkins et al. study was a statewide survey of Californians' activity patterns, including "yard work/outdoor chores." Results were reported in minutes/day and were given for both participants of the activity as well as extrapolated to the population. OEHHA used only the participant results to convert the Garlock et al. study's hours/month data to estimates of days/year. The following formula was used for the conversion:

Days/year = (hrs/mo * 60 mins/hr *12 mos/yr) / (mins/day)

For the time spent by California participants in the "yardwork" activities, Jenkins et al. reported a mean and maximum of 111 and 780 minutes/day, respectively. We fit a lognormal distribution to the mean and maximum values using Monte Carlo simulation (Decisioneering, 2008). For this fit, we considered the maximum to be the 99th percentile. We applied Monte Carlo methods to solve the above formula using the minutes/day and hours/month distributions. We repeated the Monte Carlo analysis of the formula for each climate. As was done for the child exposure frequencies, a mixed climate was considered to have seven months of warm climate (e.g., April-October) and five months of cold climate (e.g., November-March). Diagram 1 outlines the derivation of the distribution of days per year.

Diagram 1. Derivation of distribution of days/year using Monte Carlo methods



In order to perform a Monte Carlo analysis, we assumed a correlation exists between the number of minutes per day and the number of hours per month spent in outdoor activities. We also assumed a maximum exposure frequency of 350 days/year in the

analyses. The analyses resulted in distributions of days/year for each climate (Table 6.~~12~~14).

Table 6.~~12~~14. Days/Year of Soil Contact Activities by Adults*

Climate		Cold	Mixed	Warm
Mean		97	150	168
Percentiles	5th	11	25	31
	50th	70	135	161
	75th	140	220	241
	90th	227	290	302
	95th	276	318	326
	99th	331	343	345

* Derived from data of Garlock et al. (1999) and Jenkins et al. (1992)

Several potential limitations exist for using an unrelated activity survey to estimate exposure frequency in days/year from the Soil Contact Survey. The category yard work/outdoor chores in the California survey may include activities not involving soil contact, and the two survey populations (i.e., Jenkins' California survey and Garlock's regional/national survey) were mainly from different states. The Jenkins study included participants age >11 years, whereas the adult Soil Contact Survey was conducted with adults 18 years and older. However, these survey data together provide the best available estimate for daily exposure to soil in California resulting from common outdoor activities.

Although specific soil exposure frequency of adult workers was not part of the Soil Contact Survey, a reasonable estimate would assume exposure five d/wk with roughly two weeks off per year, regardless of the California climate region, resulting in an exposure frequency of 250 d/yr. U.S. EPA (2004) uses 350 d/yr as a Reasonably Maximally Exposed individual for industrial workers, and an exposure frequency of 219 d/yr as a central tendency for this variate.

Soil exposure frequency estimates in d/yr for use in Hot Spots programs are summarized below in Table 6.~~13~~15. The exposure frequency percentiles from the child Soil Contact Survey are most representative for children in the 2<9 and 2<16 year age group. Only about 10% of the children in the Survey were under 2 yrs of age. For the 0<2 year age group, as noted above, Wong et al. (2000b) observed that most newborns (20% or less) up to the first year after birth generally stay indoors and are not exposed to outdoor surfaces with bare dirt. However, most children age 1<2 years participate in outdoor play activities, similar to older children.

As discussed above in Section 6.3.3, about 30% of indoor dust is composed of soil that is brought in from outside. The tendency of infants to play on the floor and be exposed to soil in the dust is much greater when compared to older children. Although infants spend significantly less time outdoors than older children, they may be exposed to contaminated soil via indoor dust as often as older children are exposed to soil

outdoors. To address this issue, which involves a sensitive age group, OEHHA used a health-protective approach by assuming that the same exposure frequency occurred for the 0<2 age group as the older child age groups (Table 6.~~13~~15).

Table 6.~~13~~15. Cumulative Probability Distributions of Soil Exposure Frequency for Children and Adults in Days/Year

Age Group	Cumulative Probability	Warm Climate	Mixed Climate	Cold Climate
0<2 years	5% 50% 95%	100 350 350	79 267 350	50 150 350
2< 9 and 2<16 years	5% 50% 95%	100 350 350	79 267 350	50 150 350
Adult – residential	5th 50th 95th	31 165 326	25 137 318	11 70 276
Adult – offsite worker	central tendency	250	250	250

6.~~4~~5 Point Estimates and Stochastic Approach for Dermal Dose Assessment

The dermal exposure pathway generally contributes only a small portion of the risk of airborne substances under the typical facility operation and exposure scenarios in the Air Toxics "Hot Spots" program. In the previous edition of this exposure guidelines document (OEHHA, 2000), OEHHA recommended using specified average and high-end point estimate values for four of the variates in equation 6-1:

- body weight (Table 6.5)
- exposed surface area of skin (SA) (Table 6.5)
- soil load on skin (SL) (Table 6.9)
- frequency of exposure (EF) (Table 6.15)

~~Equation 6-1 requires multiplying values together, which could lead to overly conservative exposure estimates when high-end values were used in the equation 6-1. By combining information from the four variates into one composite distribution, over-conservatism may be avoided. To this end,~~ As explained in Section 6.3, OEHHA created a new variate, "annual dermal load", or ADL, which is a composite of the body surface area (BSA) per kg body weight, exposure frequency, and soil adherence variates. Point estimates from the composite "annual dermal load" can be used for point estimate assessments while parameters and information on the type of distribution (e.g., lognormal) can be used for stochastic assessments.

Distributional data are available for the body surface area per kg of body weight (BSA/BW) and exposure frequency variates. Thus, a stochastic approach could be used to derive a distribution by combining these variates. On the other hand, only point estimates for soil loading and percent of surface area for specific body parts for

activities that result in soil contact are available. These constant values (means) can be used in the stochastic derivation of a composite distribution because they will not affect the distributional type or shape of the combined BSA/KG and exposure frequency distribution. Using a Monte Carlo simulation in Crystal Ball (Decisioneering, 2008) a distribution for the ADL was derived combining these variates. The ADL is in units of mg of soil loaded onto skin per kg body weight per year (mg / kg-yr~~) and expressed as:~~

~~ADL = (BSA / BW)* [(SL_b)(SA_b%$_b$)] * EF (Eq. 6-7)~~

~~Where :~~

~~BSA/BW = total body surface area / body weight (cm^2/kg)~~
~~SL_b = daily soil loading on a specific body part (mg/cm^2-d)~~
~~SA%$_b$ = percent surface area of the exposed specific body part~~
~~EF = exposure frequency (d /yr)~~

~~Thus, the dermal dose equation (Eq. 6-1) can be reduced to the following:~~

~~Dermal dose (mg/kg-d) = ADL*Cs *ABS * ED / AT * $1x10^9$ (Eq. 6-8)~~

To derive a distribution of ADL values that can be used to stochastically derive dermal dose, nationally representative values of “BSA per kg body weight” and “exposure frequency” distribution data are used together with mean values of “soil adherence” and “%BSA-exposed”. For each age group and climate, a value is sampled from each of the “BSA/BW” and “Exposure Frequency” distributions based on its probability in the distribution. These values are multiplied by the mean “soil adherence” and “%BSA-exposed” values for a given body part (and age group and climate). This product gives an ADL for that body part ($ADL_{bodypart}$). This process is repeated for up to four more times using the same “BSA/kg” and “Exposure Frequency” values but with “soil adherence” and “%BSA-exposed” values for a different body part each time. This results in five $ADL_{bodypart}$ values, one for each of face, hands, feet, forearms, and lower legs. The five $ADL_{bodypart}$’s are summed to give an ADL for a hypothetical person for a specific age group and climate.

This process of deriving an ADL for a hypothetical person is repeated thousands of times to give a distribution of ADL values (for that age group and climate). This distribution of ADL values has incorporated the population distribution information from the “body surface area normalized to body weight” and “exposure frequency” variates. Diagram 2 outlines the procedure of stochastically estimating a probability distribution of ADL values and Table 6.~~14~~ 2 in Section 6.2 above ~~presents~~present the stochastically-derived ADL distributions for each of the five age groupings.

Diagram 2. Derivation of Annual Dermal Load (ADL) using Monte Carlo methodology

Distribution of BSA/bodywt for each individual in NHANES.

Distribution of exposure frequency in days/year (see Diagram 1).

↓

Each value in the distribution is weighted by its probability in the distribution.

Each value in the distribution is weighted by its probability in the distribution.

↓

List of mean values of soil adherence for each body part.

Mean values of %BSA-exposed for each body part.

↓

1. Calculate $ADL_{bodypart}$
   1) Randomly sample a weighted value from the "BSA/kg" and "Exposure Frequency" distributions above
   2) Choose one body part (face, forearms, lower legs, feet, hands). Use mean value of soil adherence and %BSA-exposed for that specific body part
   3) Insert values from 1) and 2) into the formula below

   $ADL_{bodypart}$ = (BSA/kg * Exposure Frequency * soil-adherence$_{bodypart}$ * %BSA$_{bodypart}$)

2. Repeat above using the same values from 1) but for each body part in 2) until the $ADL_{bodypart}$ for each body part has been solved.

3. Sum the five $ADL_{bodypart}$'s to get a value for ADL for a hypothetical person.

4. Repeat the above procedure thousands of times to obtain a population distribution of ADL values.

↓

Distribution of Annual Dermal Load for each climate and age group.

↓

Repeat the above to derive a distribution of ADL for each climate and age group.

6.~~5~~6 Dermal Uptake Equations by Other Agencies

6.~~5~~6.1 U.S. EPA Exposure Estimates

The U.S. EPA (2004) suggested using the following equation for estimating dermal exposure to chemicals from soil:

$$DAD = \frac{DA_{event} \times EV \times ED \times EF \times SA}{BW \times AT} \qquad \text{(Eq. 6-~~9~~12)}$$

where:

DAD = dermal absorbed dose (mg/kg-d)
DA_{event} = absorbed dose per event (mg/cm^2-event)
EV = event frequency (events/d)
EF = exposure frequency (d/yr)
ED = exposure duration (yrs)
SA = skin surface area available for contact (cm^2)
BW = body weight (kg)
AT = averaging time (d); for noncarcinogenic effects, AT = ED x 365 d/yr, for carcinogenic effects, AT = 70 yrs or 25,550 d

The absorbed dose per event, DA_{event}, uses a percent absorption calculation which considers chemical-specific absorption estimates and the soil type and skin adherence factor:

$$DA_{event} = C_{soil} \times CF \times AF \times ABS_d \qquad \text{Eq. 6-~~10~~13}$$

where:

DA_{event} = absorbed dose per event (mg/cm^2-event)
C_{soil} = chemical concentration in soil (mg/kg)
CF = conversion factor (10^{-6}/mg)
AF = adherence factor of soil to skin (mg/cm^2-event)
ABS_d = dermal absorption fraction

US EPA (2004) recommends an age-adjusted dermal exposure factor (SFS_{adj}) when dermal exposure is expected throughout childhood and into the adult years. This accounts for changes in surface area, body weight and adherence factors over time. The SFS_{adj} is calculated using the US EPA age groupings of 1-6 years (children) and 7-31 years (adult):

$$SFS_{adj} = \frac{(SA_{1\text{-}6})(AF_{1\text{-}6})(ED_{1\text{-}6})}{(BW_{1\text{-}6})} + \frac{(SA_{7\text{-}31})(AF_{7\text{-}31})(ED_{7\text{-}31})}{(BW_{7\text{-}31})} \qquad \text{Eq. 6-~~11~~14}$$

where:

SFS_{adj} = age-adjusted dermal exposure factor (mg-yrs/kg-events)
AF_{1-6} = adherence factor of soil to skin for a child 1-6 yrs (mg/cm^2-event)
AF_{7-31} = adherence factor of soil to skin for an adult 7-31 yrs (mg/cm^2-event)
SA_{1-6} = skin surface area available for contact during ages 1-6 yrs (cm^2)
SA_{7-31} = skin surface area available for contact during ages 7-31 yrs (cm^2)
ED_{1-6} = exposure duration during ages 1-6 (yrs)
ED_{7-31} = exposure duration during ages 7-31 (yrs)
BW_{1-6} = average body weight during ages 1-6 yrs (kg)
BW_{7-31} = average body weight during ages 7-31 yrs (kg)

6.~~5~~6.2 Cal/EPA Department of Pesticide Regulation Guidance for the Preparation of Human Pesticide Exposure Assessment Documents

The Department of Pesticide Regulation (DPR) has developed guidelines for exposure assessment that include a dermal absorption component for occupational exposure to pesticides. The guidelines are currently under revision and have not been posted as of this writing (DPR, 2007). Previously, the DPR dermal absorption estimate procedure used a default uptake value of 100% unless a pesticide registrant chooses to collect specific data. However, DPR has revised the dermal absorption default for pesticides to 50% absorption on the basis of a survey of previous pesticide absorption studies, and the finding that 100% absorption in humans has not been observed for any pesticide (DPR, 1996). Experimental absorption values prior to the current revision process were calculated from in vivo data as follows:

$$\text{Percent dermal absorption} = \frac{\text{Applied dose} - \text{Unabsorbed dose}}{\text{Applied dose}} \times 100 \qquad \text{Eq. 6-}\cancel{12}15$$

The absorbed portion may also be calculated from the sum of all residues found in excreta, expired air, blood, carcass, and skin at the site of application (after washing), or estimated from the asymptotic plot of all (radioactively-labelled) residues excreted in feces, urine, and air. Absorption rate in an animal experiment in vivo is assumed to be applicable to humans, unless it can be corrected with the ratio of in vitro uptake in animal vs. human skin.

6.~~5~~6.3 CalTOX

The Department of Toxic Substances Control (DTSC) developed the CalTOX computer program to estimate potential exposure to chemicals at hazardous waste sites (DTSC, 1993; 1994). The program incorporates variable parameters in each exposure pathway to estimate multimedia uptake of a chemical by all exposure routes, with the uncertainty assumptions explicitly presented. The program provides a mechanism for screening health risks at hazardous waste sites. CalTOX incorporates explicit assumptions for distributions of all exposure parameters, but with regard to dermal exposure, is focused

on dermal uptake of contaminants poured directly onto soil, and at concentrations higher than one would anticipate from airborne deposition. The basic uptake model is:

$$ADD = AR_s \times SA_b \times 0.3 \times 15 \times EF_{sl}/365 \times C_g \qquad \text{(Eq.6-~~13~~16)}$$

where:

ADD = average daily dose in mg/kg-day, for one exposure event/d
AR_s = ratio of the absorbed dose to the soil concentration, e.g., uptake per unit area of skin per unit concentration in soil in mg/cm^2 per mg/cm^3
SA_b = body surface area per kg, in m^2/kg
0.3 = fraction of total body exposed to soil, default value; coefficient of variation (CV) assumed = 0.04
15 = conversion factor for soil density, in kg/cm-m^2, based on a soil bulk density of 1500 kg/m^3
$EF_{sl}/365$ = exposure frequency in days/year, divided by the days in a year; mean assumed = 137, CV = 0.6
C_g = chemical concentration in soil (mg chemical/kg soil).

The absorbed dose for each event is calculated with the following equation:

$$AR_s = T_s \times \left\{ 1 - \exp\left[\frac{-K^s_p \times ET_{sl}}{T_s} \right] \right\} \qquad \text{(Eq. 6-~~14~~17)}$$

where:

AR_s = skin uptake as defined above
T_s = thickness of soil layer on skin, in cm
$-K^s_p$ = permeability factor for chemical movement from soil into skin, in cm/hr
ET_{sl} = soil exposure time, in hrs/d

The thickness of the soil layer on skin, T_s, depends on the soil loading factor, which was assumed to be 0.5 mg/cm^2, with CV = 0.4. The permeability factor, K^s_p, is derived from permeability values, K_p, from water, with a correction for decreased skin hydration. ET_{sl} is set equal to half the total exposure time at home.

6.~~6~~ 7 References

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7. Home Produced Food Exposure Assessment

7.1 Introduction

Semivolatile organic toxicants and toxic heavy metals emitted into the air by California facilities (e.g., dioxin and lead) are subject to deposition onto vegetation, soil, and surface water bodies. Homegrown produce can become contaminated through the deposition of the toxicant onto the surface of edible leaves, exposed edible portions of vegetables, and fruit, or, in the case of metals, may be taken up from the soil into the roots of the plant. Food animals may become contaminated from consuming contaminated vegetation (e.g., pasture, grains), water, or soil, or from inhaling the airborne toxicants. Humans may then be exposed by consuming the contaminated produce (leafy greens, fruits, vegetables), or animal products (meat, milk, and eggs).

Commercially grown produce or commercially raised beef, chicken, pork, cow's milk, and eggs come from diverse sources, so that the potential public health impacts from a single Hot Spots facility impacting a commercial operation are minimal. Therefore, only the risks from Hot Spots facility contamination of homegrown produce and home-raised beef, chicken, pork, eggs, and milk are assessed.

In order to quantify risks (cancer and chronic noncancer) from homegrown, or home raised food exposures the dose must be determined. Dose is proportional to the consumption rate of the homegrown food items and the concentration of the toxicant in the homegrown products (i.e., produce, meat, eggs, and milk). In this chapter, we discuss and present consumption rates (both probability distributions and point estimate values) and methods to determine toxicant concentration levels for homegrown foods. The equation for determining the dose from home grown foods is shown in Equation 7.1.

7.2 Home Produced Food Exposure Recommendations[Sections 7.2.X were moved from the back of the chapter to the front]

OEHHA has used the National Health and Nutrition Examination Survey (NHANES) 1999-2004 survey data to generate per capita consumption distributions for produce (exposed, leafy, protected, and root categories), meat (beef, chicken, and pork), dairy products, and eggs. The NHANES data are the most recent data available with which to estimate consumption rates for the food categories discussed and that are relatively representative of the California population. The variability in food consumption that may be associated with interindividual variability in body weight was accounted for by presenting the rates on a body weight basis.

There is uncertainty in the estimations of produce, meat, dairy products, and eggs. The consumption rates are based on a single day of surveyed food intake. One day of survey data per individual is not adequate for capturing typical intake which means that the lower and upper percentiles are likely to be overestimated. Unfortunately these data are the best representative data for the United States population.

7.2.1 Point Estimates

OEHHA is recommending that the default values presented in Table 7.1 be used, as needed, for the point estimate approach (Tier 1). These default values represent the mean and 95th percentiles of the empirical distributions presented in Tables 7.8 through 7.13 . When the food pathway is a dominant pathway, and multiple homegrown produce, home raised meat, milk, and eggs categories all are assessed, the 95th percentiles default consumption rate for the highest risk category (e.g. leafy produce) should be used. OEHHA recommends the mean consumption values for the remaining categories. This procedure will help avoid overly conservative estimation of risk that would arise from assuming that a single receptor would be a high consumer of all homegrown categories.

Table 7.1 Recommended Average and High End Point Estimate Values for Home Produced Food Consumption (g/kg-day)

Food Category	**Third Trimester**		**Ages 0<2**		**Ages 2<9**	
Produce	Avg.	High End	Avg.	High End	Avg.	High End
Exposed	1.9	5.9	11.7	30.2	7.4	21.7
Leafy	0.9	3.2	3.8	10.8	2.5	7.9
Protected	1.7	5.8	5.9	17.5	4.7	13.3
Root	1.7	4.6	5.7	15.3	3.9	10.8
Meat						
Beef	2.0	4.8	3.9	11.3	3.5	8.6
Poultry	0.9	2.9	2.9	10.5	2.2	7.8
Pork	1.8	4.7	4.5	11.4	3.7	9.0
Milk	5.4	15.9	50.9	116	23.3	61.4
Eggs	1.6	4.2	6.1	15.0	3.9	9.4
	Ages 2>16		**Ages 16<30**		**Ages 16-70**	
Produce	Avg.	High End	Avg.	High End	Avg.	High End
Exposed	1.9	5.9	1.9	5.9	1.8	5.6
Leafy	0.9	3.2	0.9	3.2	1.1	3.4
Protected	1.7	5.8	1.7	5.8	1.6	5.2
Root	1.7	4.6	1.7	4.6	1.5	4.2
Meat						
Beef	2.0	4.8	2.0	4.8	1.7	4.4
Poultry	0.9	2.9	0.9	2.9	0.9	2.8
Pork	1.8	4.7	1.8	4.7	1.5	3.8

Food Category	Third Trimester		Ages 0<2		Ages 2<9	
Milk	5.4	15.9	5.4	15.9	4.3	13.2
Eggs	1.6	4.2	1.6	4.2	1.3	3.4

[a] Food consumption values for 3rd trimester calculated by assuming that the fetus receives the same amount of contaminated food on a per kg BW basis as the mother (adult age 16 to less than 30).

7.2.2 Stochastic Approach

OEHHA is recommending that the parametric models for food consumption distributions presented in Tables 7.2 through 7.7 be used as needed in Tier III stochastic risk assessments. The methods leading to these distributions are described in Section 7.4.1.

Table 7.2 Parametric Models of Per Capita Food Consumption (g/kg-day) for All Ages

Food Category	Distribution Type	Anderson -Darling Statistic	Mean	Std. Dev	Location	Scale	Shape
Produce							
Exposed	LogN	62	11.8	11.9			
Leafy	Gamma	88			0.0	1.26	0.9664
Protected	Gamma	95			0.0	2.49	0.8076
Root	Gamma	70			0.0	1.77	1.0592
Meat							
Beef	LogN	16	1.97	1.73			
Poultry	LogN	19	1.84	1.64			
Pork	LogN	144	1.08	1.76			
Dairy	LogN	358	8.74	21			
Eggs	LogN	114	1.62	1.55			

Table 7.3 Parametric Models of Per Capita Food Consumption (g/kg-day) for 0 <2 Years.

Food Category	Distrib. Type	Anderson-Darling Statistic	Mean	Std. Dev	Location	Scale	Shape	Like-liest
Produce								
Exposed	Gamma	60			0.01	6.56	0.830	

Food Category	Distrib. Type	Anderson-Darling Statistic	Mean	Std. Dev	Location	Scale	Shape	Like-liest
Leafy	Gamma	167			0.01	3.30	1.161	
Protected	LogN	67	6.03	7.31				
Root	Gamma	83			0.06	4.44	1.28	
Meat								
Beef	LogN	16	1.97	1.73				
Poultry	LogN	58	4.5	4.08				
Pork	LogN	230	3.00	4.46				
Dairy	Max Ext.	169				27.82		33.79
Eggs	LogN	172	6.11	4.21				

Table 7.4 Parametric Models of Food Consumption (g/kg-day) for Ages 2<9

Food Category	Distribution Type	Anderson-Darling Statistic	Mean	Std. Dev	Location	Scale	Shape	Rate
Produce								
Exposed	Exponential	206						0.14
Leafy	LogN	127	2.64	3.89				
Protected	Weibull	68			0.02	4.76	1.063	
Root	LogN	60	3.95	3.85				
Meat								
Beef	LogN	35	3.55	2.79				
Poultry	LogN	17	3.71	2.67				
Pork	LogN	66	2.25	2.84				
Milk	LogN	12	23.4	20.78				
Eggs	LogN	38	3.93	3.00				

Table 7.5 Parametric Models of Food Consumption (g/kg-day) for Ages 2<16

Food Category	Distribution Type	Anderson-Darling Statistic	Mean	Std. Dev	Location	Scale	Shape
Produce							
Exposed	Gamma	60			0.01	6.54	0.8325
Leafy	LogN	68	1.83	2.91			
Protected	Gamma	47			0.00	3.69	0.9729
Root	LogN	51	3.10	3.44			
Meat							
Beef	LogN	10	2.96	2.49			
Poultry	LogN	27	2.98	2.52			
Pork	LogN	48	1.84	2.79			
Milk	LogN	35	16.8	19.2			
Eggs	LogN	71	3.16	2.95			

***Table 7.6 Parametric Models of Food Consumption (g/kg-day) for Ages* 16< 30[a]**

Food Category	Distribution Type	Anderson-Darling Statistic	Mean	Std. Dev	Location	Scale	Shape
Produce							
Exposed	Gamma	70			0.01	2.05	0.9220
Leafy	Weibull	191			0.00	0.88	0.8732
Protected	LogN	93	1.81	3.31			
Root	LogN	43	1.69	1.69			
Meat							
Beef	LogN	26	1.98	1.54			
Poultry	LogN	26	1.80	1.42			
Pork	LogN	242	1.01	1.74			
Milk	Gamma	22			0.02	5.66	0.9421
Eggs	LogN	29	1.55	1.36			

[a] These distributions are also recommended for the third trimester.

***Table 7.7 Parametric Models of Food Consumption (g/kg-day) for Ages* 16-70**

Food Category	Distribution Type	Anderson-Darling Statistic	Mean	Std. Dev	Location	Scale	Shape
Produce							
Exposed	Gamma	148			0.01	2.07	0.8628
Leafy	Gamma	83			0.00	1.15	0.9713
Protected	Gamma	78			0.01	1.90	0.8325
Root	Gamma	14			0.00	1.28	1.166
Meat							
Beef	LogN	20	1.75	1.40			
Poultry	LogN	18	1.53	1.18			
Pork	LogN	190	0.97	1.59			
Milk	Gamma	20			0.00	4.50	0.9627
Eggs	LogN	30	1.3	1.01			

7.~~2~~3 Home Grown Food Intake Dose

7.~~2~~3.1 Point Estimate (Deterministic) Algorithm

The general algorithm for estimating dose via the food pathway is as follows:

DOSEfood = (Cf * IF * GRAF * L)* EF* (1 × 10^{-6})- (Eq. 7-1)
AT

where: DOSEfood = (mg/kg-day)
Cf = concentration of toxicant in food type F (μg/kg)
IF = consumption for food type F (g/kg body weight per day)
GRAF = gastrointestinal relative absorption factor (unitless)
L = fraction of food type consumed from contaminated source (unitless)
1 × 10^{-6} = conversion factor (μg/kg to mg/g) for Cf term
EF = exposure frequency (days/365 days)

~~ED = exposure duration (years)~~
~~AT = averaging time, period over which exposure is averaged (days).~~

The gastrointestinal relative absorption factor (GRAF) is currently only available for dioxins and furans. In most cases, a GRAF factor of one is used because it assumed that absorption would be similar in the animal oral studies as it would for humans consuming the contaminated food. In addition, data for estimating a GRAF are almost never available. The exposure frequency (EF) is set at 350 days per year (i.e., per 365 days) following US EPA (1991).

For cancer risk, the risk is calculated for each age group using the appropriate age sensitivity factors (ASFs) and the chemical-specific cancer potency factor (POTENCY):

RISKfood = DOSEfood *POTENCY*ASF*ED/AT **(Eq. 7-2)**

Exposure duration (ED) is the number of years within the age groupings. In order to accommodate the use of the ASFs (see OEHHA, 2009), the exposure for each age grouping must be separately calculated. Thus, the DOSEfood and ED are different for each age grouping. The ASF, as shown below, is 10 for the third trimester and infants 0<2 years of age, is 3 for children age 2<16 years of age, and is 1 for adults 16 to 70 years of age.

ED = exposure duration (yrs):

0.25 yrs for third trimester	(ASF = 10)
2 yrs for 0<2 age group	(ASF = 10)
7 yrs for 2<9 age group	(ASF = 3)
14 yrs for 2<16 age group	(ASF = 3)
14 yrs for 16<30 age group	(ASF = 1)
54 yrs for 16-70 age group	(ASF = 1)

AT, the averaging time for lifetime cancer risks, is 70 years in all cases. To determine lifetime cancer risks, the risks are then summed across the age groups:

$$RISKfood_{(lifetime)} = RISKfood_{(3rdtri)} + RISKfood_{(0<2\ yr)} + RISKfood_{(2<16\ yr)} + RISKfood_{(16\text{-}70yr)} \quad \textbf{(Eq. 7-3)}$$

As explained in Chapter 1, we also need to accommodate cancer risk estimates for the average (9 years) and high-end (30 years) length of time at a single residence, as well as the traditional 70 year lifetime cancer risk estimate. For example, assessing risk in a 9 year residential exposure scenario assumes exposure during the most sensitive period, from the third trimester to 9 years of age and would be presented as such:

$$RISKfood_{(9\text{-}yr\ residency)} = RISKfood_{(3rdtri)} + RISKfood_{(0<2\ yr)} + RISKfood_{(2<9\ yr)} \quad \textbf{(Eq. 7-4)}$$

For the 30-year residential exposure scenario, the risk for the 2<16 and 16<30 age group would be added in to the risk from exposures in the third trimester and from age 0<2 yr. For 70 year residency risk, Eq 7-3 would apply.

7.~~2~~3.2 Stochastic Algorithm

The algorithm for the stochastic method is the same as the point estimate algorithm. Recommended distributions, as parametric model of empirical data on variability, are available to substitute for single values, where data permit.

7.~~3~~4 Food Consumption Variates for the Hot Spots Exposure Model

The homegrown produce and home-raised meat, eggs, and milk pathways in the Hot Spots program are used to assess chronic noncancer risks and cancer risks. Separate consumption estimates are needed for the third trimester, 0 to <2 years, 2<16 years, 16<30 years and 30 to 70 years in g/kg body weight per day, in order to account for the greater exposure of children and the differential impact of early in life exposure.

The ideal data for such long-term exposure determinations would be recent, representative of the California population, and have repeated measures on the same individuals to characterize typical intake over time. The amount of homegrown produce, and home-raised meat, eggs and milk would be addressed. Such data are not available. The available data while not perfect are nonetheless useful for the purposes of chronic exposure assessment. In the next Section, we review the currently available data and discuss the reasons for our recommendations.

7.4.1 Derivation of Consumption Rates

7.~~3~~4.1.1 Data

Several survey methods have been used to estimate consumption of various foods or food items by a population. These include market basket, food frequency, diary, and consumption recall methods. The USDA has conducted market basket surveys in which the amount of food that enters into the wholesale and retail markets was

measured (Putnam and Allshouse, 1992). These amounts are then divided by the U.S. population to give per capita consumption. This methodology does not allow determination of food consumption rates for individuals in the age ranges that are needed. It provides data on the amount bought at the market, not the amount consumed, which differ due to trimming, water and fat loss during processing and cooking (Putnam and Allshouse, 1992). The USDA market basket studies are thus not useful for assessing chronic exposure in our model because of these limitations.

The food frequency method asks subjects to recall the frequency with which they consumed certain food items over a previous period of time. Typically, information is collected on specific food items (e.g., green tea) or food groups (e.g., grilled red meat) that are being evaluated for their relationship to a certain disease (e.g., cancer). These surveys are conducted on relatively small groups of individuals or on large groups of a certain subpopulation (e.g., nurses in the Nurses Health Study). The food frequency method could provide very helpful information for estimating 'usual' consumption of foods that are typically consumed on a less than daily basis (e.g., berries), and for assessing intraindividual variability (Block, 1992). However, food frequency data from current studies are not representative of the general population and thus not ideal for assessing chronic exposure in the Hot Spots model.

The U.S. Department of Agriculture (USDA) conducted seven Nationwide Food Consumption Surveys (NFCS) beginning in 1935 and ending in 1987-88 that collected data on household food consumption (http://www.ars.usda.gov/Services/docs.htm). The two most recent NFCS studies (1977-78 and 1987-88) included data on individuals. Because one of our objectives for food consumption rates was that the rates reflect current dietary patterns, the NFCS were considered too old to meet our needs. The USDA also conducted a series of food consumption surveys called the Continuing Survey of Food Intake of Individuals (CSFII) (1985, 1986, 1987, 1989, 1990, 1991, 1994-96, and 1998). OEHHA used the 1989-91 CSFII data to determine distributions of food consumption rates for the previous version of the Hot Spots Exposure Assessment and Stochastic Analysis Guidelines (OEHHA, 2000).

The three days of consumption data per individual in the CSFII 1989-1991 capture typical intake better than the fewer days in more recent surveys but are still not considered a sufficient number of repeated measures for a good determination of intraindividual variability (Andersen, 2006). The CSFII 1994-96, 1998 and the National Health and Nutrition Examination Survey (NHANES) 1999-2004, with more recent data, have become available. We therefore chose to consider the more recent datasets because the advantages of the more recent data outweighed the greater number of individual measures on the same individual in the older surveys.

The CSFII 1994-1996, 1998 survey (hereafter referred to as CSFII) collected data on two non-consecutive days of consumption, 3-10 days apart, by over 20,000 individuals, while the NHANES 1999-2004 (hereafter referred to as NHANES) dataset provided only one day of consumption (with the exception of the 2004 year) on over 30,000 individuals. OEHHA considered that the two days of intake of the CSFII did not provide

sufficient additional information on typical intake to outweigh the advantage of the more recent NHANES data.

Further, the number of days between data collection for each individual in the CSFII was not available in the dataset and CSFII reported that there was no standard procedure used to determine the second day of food consumption. This likely resulted in the interval between the first and second days of data collection to be widely variable among individuals.

California specific food consumption data are not available. The CSFII data are available for the Pacific region, but not for California alone. Neither California-specific nor Pacific region-specific data are available for NHANES. Therefore, OEHHA chose to use the NHANES dataset since the need for the most recent data was considered more important than having data specific to California.

7.~~3~~4.1.2 The NHANES Data

The NHANES uses a multistage sampling design to select individuals for the survey. Some of these stages do not use simple random sampling to select units to be surveyed (i.e., “sampled”) resulting in uneven probability and non-independent selection. Therefore, statisticians also created weights to account for these issues. These weights allow for proper estimation of variance, the standard error of the mean (SEM), and confidence intervals (CIs). These parameters (variance, SEM, CIs) estimate confidence that the value of a statistic (e.g., the mean) is the true population value. Therefore, accounting for a multistage survey design is important for estimating confidence in the numerical value of the results. This differs from the sampling weights that provided results that best represent the targeted population.

It is common that some individuals selected to participate in a survey end up either voluntarily or for other reasons, such as incomplete responses, not participating or contributing to the survey. This may result in a surveyed sample of individuals that do not reflect the targeted demographics of the survey. In NHANES, the statisticians created “sample weights” that account for non-participation. Using these weights in statistical analyses provides results that are more representative of the population.

NHANES is designed to collect the most accurate information possible. Participants are interviewed in a private setting, the mobile examination center (MEC), which consists of several mobile units specially designed and equipped for the survey. The MEC is used by NHANES to collect dietary information as well as body measurements (e.g., height, X-rays) and body specimens (e.g., urine) that are also part of the total survey for some participants. The privacy and professional setting of the MEC is thought to encourage greater accuracy in food consumption reporting. The dietary interview room of the MEC contains measuring devices (e.g., cups, spoons, photos) to help participants better estimate the amounts of various foods consumed. In 2002, NHANES implemented the automated multiple pass method, a method intended to solicit greater and more accurate recall of food consumption.

The NHANES survey is quite comprehensive in the range of prepared and non-prepared foods for which data are collected. These foods include beverages, sweets, and condiments, as well as items more commonly considered foods. Further, some food entries contain very detailed information about the food (e.g., peaches, sliced, canned, in light syrup).

We chose to use NHANES data for the derivation of consumption rates because the data are the most recent available, have a larger sample size than CSFII, use detailed procedures to best estimate consumption (e.g., automated pass), and provide weights (sampling and multistage) with which to generate results that are the most representative of the population. Further, because NHANES is now considered a continuous survey (a complete nationwide survey is completed every two years), past results can be compared with future ones due to consistent operating procedures and study design, and future data can be added to past data to provide a more statistically sound sample size.

The disadvantage of the NHANES data is that the single day of data will tend to exaggerate the higher percentiles of the distribution. For example, if chicken consumption were investigated for 2 separate days, and the individual indicates consumption on one day but not on the second survey day, then chicken consumption would be the average of the two survey days. The average of the two days is probably closer to typical intake for the individual than the one day of chicken consumption that is captured by the NHANES survey.

7.~~3~~4.1.3 Methodology for the Derivation of Food Consumption Rates

Since 1999, NHANES has been conducted in two-year increments on a continuous basis. The two-year increment is needed to collect data on the full national sample of selected participants. Thus, the NHANES data are composed of datasets from the 1999-2000, 2001-2002, and 2003-2004 periods and the survey is sometimes called the "Continuous NHANES."

The NHANES collected two days of intake for some individuals in the 1999-2004 period. In 2002, a pilot test of collecting two days of intake was conducted on 10 percent of the participants. The pilot study results were not publicly released because of confidentiality issues. In 2003-2004, two days of intake were collected. However, the 2003-2004 dataset has a much smaller sample size relative to the 1999-2004 dataset. We decided that the increased interindividual information available from the larger sample size of one-day intake from the 1999-2000 dataset was advantageous to the two-day intake from a smaller sample size of the 2003-2004 dataset.

7.~~3~~4.1.4 Categorization of Produce

For the risk assessment of home produced foods, food items can be grouped into food categories to simplify calculations. For produce (i.e., fruits and vegetables), we

reviewed the study of Baes et al. (1984) who considered exposure to radionuclides from produce consumption. The physical processes by which plants can be contaminated by airborne radionuclides are analogous to the processes by which airborne low volatility chemical contamination may occur. In the Baes et al. study, produce is divided into three categories based on the manner in which contamination from air deposition could occur.

The first category, leafy produce, consists of broad-leafed vegetables in which the leaf is the edible part with a large surface area and can be contaminated by deposition of the toxicant onto its surface (e.g., spinach). The next category, exposed produce, includes produce with a small surface area subject to air deposition (e.g., strawberries, green peppers). The third category, protected produce, includes produce in which the edible part is not exposed to air deposition (e.g., oranges, peas).

OEHHA has chosen to use an additional category, root produce, which includes produce for which root translocation could be a source of contamination (e.g., potatoes). In Baes et al., root produce had been placed into one of the other three categories. For the semi-volatile organic and heavy metal toxicants addressed in the AB-2588 program, the produce items from NHANES are classified into the four categories of leafy, exposed, protected, and root produce.

7.~~3~~4.1.5 Categorization of Meat, Eggs, and Dairy

In addition to homegrown produce, animals are sometimes raised at home, depending on space and zoning regulations, for meat, egg, and milk consumption. Animal derived food items such as lamb, goat meat, or goat milk where consumption rates are small are not included in our risk assessment model.

Cattle, pigs, and poultry differ in the types (e.g., pasture vs. grain) and quantities (g/kg-body weight) of feed consumed and thus food products from these animals are likely to differ in contaminant concentrations. The transfer of contaminant into meat differs from that into eggs and milk. Therefore, we categorized animal derived foods into beef, pork, poultry, eggs, and milk product groups. These groups include the main food item (e.g., milk) as well as products from that item (e.g., cheese).

7.~~3~~4.1.6 Estimating and Analyzing Consumption Rate Distributions

We used the NHANES 1999-2004 data to estimate consumption rates for the third trimester, 0 to<2 years, 2<9 years, 9<16 years, 16 <30 years, 30 to 70 years, and 0-70 years age groups. The NHANES dataset contained data on food items as eaten (e.g., grams of raw apple or grams of cheeseburger), which resulted in two issues for data analysis. In order to estimate the dose of toxicant from the beef component of the hamburger, we need to estimate the grams of beef in hamburger. Toxicant concentration is calculated based on grams of raw or harvested food. Therefore, for foods composed of multiple food items (e.g., ground beef, cheese, tomato, lettuce), the weight of each food item in the food was estimated based on the food item's typical

proportion in that type of food. For example, ground beef is considered to be 50 percent of the weight of the cheeseburger while tomatoes in a lettuce and tomato salad are estimated at 50 percent of the reported weight of salad.

The second issue was that ideally we would use the weight of the raw food (rather than the food as eaten) because the concentration of toxicant in a food group (e.g., exposed produce) is based on the raw food at the time of produce harvesting, meat butchering, milking, or egg laying. In particular, the gram weight of food consumed was adjusted for food items such as jams, jellies, juices, and cheese (a complete list of adjustments, including adjustments to the grams consumed for other reasons, is presented in Appendix D). This is because it takes one part fruit to make 2/3 part juice while one needs 1.5 parts milk to make 1 part cheese. OEHHA did not adjust meats for the amount of moisture lost during cooking. This is because the percent moisture can be highly variable but the majority of the time it is less than 10 percent of initial raw weight, and a default adjustment would have introduced significant uncertainty due to highly variable methods of cooking.

For each participant in the survey, the grams of each food item eaten at each eating occasion was divided by that participant's body weight in kg to give g/kg for each food item-occasion. For food items (e.g., cheeseburger) with multiple components (e.g., ground beef, cheese, lettuce, tomato) the proportional g/kg of each food component was determined (e.g., g/kg ground beef, g/kg cheese). For some food item components the consumption amounts were adjusted, as described above, to account for differences in "as eaten" weights and raw/harvested weights.

We then summed the g/kg of the food item components across eating occasions during the day (e.g., ground beef in cheeseburger at lunch and in meatballs at dinner) to give g/kg-day for each food item component. The sum of the g/kg-day of each food item component was then assigned to its appropriate food group category (an example of this is described in the paragraph following this one). The g/kg-day of all food item components in a food group category were summed to give g/kg-day of the food group category for that participant (e.g., g/kg-day exposed produce).

As an example of assigning food item components to food group categories, we can use a study participant who consumed the following foods: strawberries on cereal at breakfast;~~:~~ a tomato, lettuce and cheese salad and strawberry shake for lunch;~~:~~ chicken, a baked potato, and broccoli, and a slice of apple pie for dinner.

In this example, the g/kg of strawberries at breakfast and at lunch would be added together and then added to the g/kg of the summed g/kg tomatoes, and apples to give the g/kg daily intake for the exposed produce group. Likewise, the g/kg of lettuce at lunch, and broccoli at dinner would be added together for the leafy produce group, the g/kg of onion (in the salad) and potato would be added together for the root produce group. For the poultry food group, the g/kg of chicken at lunch would have been the daily intake for the poultry food group. Beverages were also included as food items so that the g/kg of milk on cereal and in the shake would be added together. These intake

rates of milk would then be added to the g/kg of cheese on the salad for the milk products food group for that survey participant. In this manner we obtain the g/kg-day values for each participant for each food group.

Foods that could not be grown in California (e.g., bananas, pineapple) or are only available commercially (e.g., canned milk) were excluded from our analyses. Some food items were not easily identified as to whether they were commercial or home produced (e.g., frozen berries). In these cases, the assumption was made that they were home produced. Canned produce was also included because the product of home canning is sometimes referred to as canned (e.g., "canned peaches"). The list of foods eligible to be used in deriving the food consumption rates for these guidelines is in Appendix D.

Resultant g/kg-day values for each food group category were analyzed across all ages and the third trimester to <2 years, 2<9 years, 9<16 years, 16<30 years, 16<70 years age groups. It was assumed that during the third trimester that food consumption (and exposure to food borne contaminants) was the same as during ages 0<2 years. This is clearly a simplification but the third trimester is a short time period and the error introduced by this assumption is likely to be small. The "Proc Surveymeans" procedure in SAS 9.1 (SAS Institute, 2007) was used to derive mean, SEM, and 50th-, 90th-, 95th-, and 99th-percentile values. The "Proc Surveymeans" procedure incorporates information from each stage of the sampling, which is needed to provide non-biased variance estimates (e.g., the SEM), as well as incorporating information from the sampling weights to provide results that are the most representative of the population.

7.~~3~~4.1.7 Produce, Meat, Dairy and Egg Consumption Distributions

Produce, meat, dairy and egg consumption empirical distributions are presented for 0-70, 0<2 years, 2<9 years, 2<16 years, 16<30 years, and 16-70 years (Tables 7.8, 7.9, 7.10, 7.11, 7.12, and 7.13 respectively). The empirical distribution for 16<30 is also recommended for the third trimester because the fetus is assumed to receive the same dose (mg/kg BW) as the mother, and this age category is most representative of the child-bearing years. Consumption is expressed in terms of grams of food per kilogram body weight per day in these tables. The average and high end point estimate recommendations are presented above in Table 7.4.1. These point estimates are the mean and 95th percentiles from the distributions.

The parametric model that best fit each distribution was estimated using the fitting function in Crystal Ball® version 7.2.1 (Oracle, 2007) and presented in Tables 7.2, through 7.7. Of the three goodness-of-fit tests available in Crystal Ball, the Anderson-Darling test was chosen to identify the best-fit distribution since this test is more sensitive to the tails of the distributions than the other two goodness-of-fit tests (the Chi-Square and the Kolmogorov-Smirnov). For an individual dataset and distribution, the better the distribution fits the data set, the smaller the Anderson-Darling statistic will be.

There are 20 distributions that Crystal Ball can test for distributional fit to the dataset of interest, including the Lognormal, Beta, Gamma, Logistic, Beta, and Pareto. For a few consumption rate stratifications (i.e., for a specific age group and food category), the best fit was determined to be Pareto. However, the mean and percentiles estimated for the Pareto distribution were significantly different from the empirically derived mean and percentiles. For these consumption rate strata, we chose to use the second best fit rather than the Pareto, which more clearly fit the empirically derived mean. Tables 7.2 – 7.7 present the best fit distribution for the consumption rates (noted in the column labeled "distribution type").

Table 7.~~34.~~18 Empirical Distributions of Food Consumption (g/kg-day) for All Ages (0-70 years)

Food Category	N	Mean	SEM	Min	Max	50th-%ile	75th-%ile	80th-%ile	90th-%ile	95th-%ile	99th-%ile
Produce											
Exposed	9683	3.1	0.05	0.0	84.3	1.7	3.5	4.3	7.2	10.8	23.5
Leafy	7049	1.2	0.03	0.0	19.9	0.8	1.6	1.8	2.7	3.8	7.0
Protected	7033	2.0	0.04	0.0	49.8	1.2	2.5	3.0	4.8	6.8	13.3
Root	11,467	1.9	0.01	0.0	39.5	1.3	2.4	2.8	4.0	5.6	10.8
Meat											
Beef	9043	2.0	0.03	0.0	26.8	1.5	2.5	2.9	4.0	5.2	8.5
Pork	3585	1.1	0.03	0.0	21.4	0.6	1.4	1.6	2.4	3.5	6.8
Poultry	8813	1.9	0.02	0.0	22.5	1.4	2.3	2.6	3.8	5.1	8.7
Milk	17,635	8.4	0.14	0.0	285.3	4.2	9.1	11.3	19.5	31.3	70.6
Eggs	5056	1.7	0.03	0.0	27.1	1.2	2.0	2.3	3.6	5.1	9.3

7.~~34.29~~ Empirical Distributions of Food Consumption (g/kg-day) for Ages 0<2 Yrs

Food Category	N	Mean	SEM	Min	Max	50th-%ile	75th-%ile	80th-%ile	90th-%ile	95th-%ile	99th-%ile
Produce											
Exposed	941	11.7	0.05	0.1	84.3	8.9	15.4	17.6	23.9	30.2	55.3
Leafy	169	3.8	0.04	0.0	19.9	2.8	5.3	6.6	9.2	10.8	14.5
Protected	464	5.9	0.04	0.1	49.8	3.9	7.5	9.1	12.8	17.5	28.8
Root	783	5.7	0.02	0.1	51.4	4.2	8.2	9.2	12.3	15.3	24.0
Meat											

Beef	301	3.9	0.03	0.1	17.7	3.1	5.6	6.4	8.4	11.3	15.6
Pork	91	2.9	0.37	0.0	14.0	1.7	3.8	4.9	6.8	10.5	14.0
Poultry	472	4.5	0.02	0.0	21.8	3.5	5.9	6.7	9.3	11.4	19.6
Milk	924	50.9	1.9	0.0	285.3	44.1	72.3	80.4	100.1	116.1	167.6
Eggs	330	6.1	0.03	0.1	27.1	4.9	7.7	8.5	13.4	15.0	18.8

Table 7.~~34.3~~10 Empirical Distributions of Food Consumption (g/kg-day) for Ages 2<9 Years

Food Category	N	Mean	SEM	Min	Max	50th-%ile	75th-%ile	80th-%ile	90th-%ile	95th-%ile	99th-%ile
Produce											
Exposed	1944	7.4	0.26	0.0	74.2	5.6	9.9	11.0	15.6	21.7	35.2
Leafy	689	2.5	0.15	0.0	14.0	1.6	3.3	3.9	6.0	7.9	12.3
Protected	970	4.7	0.17	0.0	33.9	3.5	6.3	7.3	10.2	13.3	19.3
Root	643	3.9	0.12	0.0	34.9	3.1	5.0	5.7	8.0	10.8	17.7
Meat											
Beef	1288	3.5	0.10	0.0	26.8	2.9	4.6	5.0	6.8	8.6	13.6
Pork	434	2.2	0.17	0.0	21.4	1.4	2.7	3.4	4.6	7.8	10.6
Poultry	1430	3.7	0.10	0.0	22.5	3.1	4.7	5.2	7.0	9.0	14.1
Milk	3294	23.3	0.59	0.0	181.8	18.0	30.6	35.2	47.4	61.4	91.2
Eggs	782	3.9	0.15	0.1	19.7	3.4	5.0	5.7	7.4	9.4	15.2

***Table 7.~~34.4~~11 Empirical Distributions of Food Consumption (g/kg-day) for Ages* 2<16 Years**

Food Category	N	Mean	SEM	Min	Max	50th-%ile	75th-%ile	80th-%ile	90th-%ile	95th-%ile	99th-%ile
Produce											
Exposed	3764	5.5	0.15	0.0	74.2	3.5	7.3	8.4	12.4	16.6	32.1
Leafy	1833	1.7	0.09	0.0	14.5	1.0	2.3	2.6	4.0	5.8	11.3
Protected	2128	3.6	0.11	0.0	34.7	2.5	4.9	5.6	8.5	10.6	17.5
Root	3599	3.0	0.06	0.0	34.9	2.2	3.9	4.5	6.4	8.7	15.5
Meat											
Beef	3119	3.0	0.07	0.0	26.8	2.3	3.9	4.3	5.7	7.6	11.8
Pork	1018	1.8	0.10	0.0	21.4	1.1	2.2	2.7	4.0	5.7	10.4
Poultry	3093	3.0	0.06	0.0	22.5	2.4	3.9	4.4	5.9	7.5	11.4
Milk	7082	16.5	0.34	0.0	181.8	11.6	21.8	25.2	36.7	48.4	78.6
Eggs	1500	3.1	0.09	0.0	19.7	2.4	4.2	4.6	6.4	8.1	13.5

Table 7.~~34.5~~12 ***Empirical Distributions of Food Consumption (g/kg-day) for Ages 16<30 Years***

Food Category	N	Mean	SEM	Min	Max	50th-%ile	75th-%ile	80th-%ile	90th-%ile	95th-%ile	99th-%ile
Produce											
Exposed	1757	1.9	0.06	0.0	20.6	1.4	2.6	3.2	4.3	5.9	9.1
Leafy	1774	0.9	0.04	0.0	11.4	0.6	1.3	1.6	2.2	3.2	5.2
Protected	1523	1.7	0.09	0.0	22.7	1.0	2.1	2.5	3.9	5.8	10.7
Root	2703	1.7	0.05	0.0	13.0	1.2	2.2	2.5	3.6	4.6	7.5
Meat											
Beef	2462	2.0	0.05	0.0	19.4	1.6	2.6	2.9	3.9	4.8	7.4
Pork	843	0.9	0.04	0.0	9.0	0.5	1.4	1.6	2.3	2.9	4.9
Poultry	2208	1.8	0.04	0.0	12.1	1.4	2.3	2.5	3.5	4.7	7.5
Milk	3806	5.4	0.16	0.0	116.3	3.6	7.1	8.4	12.4	15.9	27.6
Eggs	1053	1.6	0.06	0.0	11.6	1.2	1.9	2.3	3.2	4.2	5.8

Table 7.~~34.6~~13 *Empirical Distributions of Food Consumption (g/kg-day) for Ages 16-70 Years*

Food Category	N	Mean	SEM	Min	Max	50th-%ile	75th-%ile	80th-%ile	90th-%ile	95th-%ile	99th-%ile
Produce											
Exposed	4978	1.8	0.06	0.0	23.2	1.3	2.4	2.8	4.1	5.6	8.8
Leafy	5047	1.1	0.03	0.0	15.6	0.8	1.5	1.7	2.5	3.4	5.8
Protected	4441	1.6	0.05	0.0	30.6	1.0	2.1	2.4	3.7	5.2	9.7
Root	6852	1.5	0.02	0.0	13.0	1.1	2.1	2.3	3.2	4.2	6.6
Meat											
Beef	5623	1.7	0.03	0.0	19.4	1.4	2.3	2.5	3.4	4.4	6.8
Pork	2476	0.9	0.03	0.0	14.6	0.5	1.3	1.5	2.2	2.8	4.8
Poultry	5248	1.5	0.02	0.0	12.1	1.3	2.0	2.2	2.9	3.8	6.1
Milk	9629	4.3	0.08	0.0	116.3	3.0	5.8	6.6	9.9	13.2	22.6
Eggs	3226	1.3	0.03	0.0	11.6	1.0	1.6	1.8	2.5	3.4	5.4

*Min = 0 (zero) is due to amounts consumed <0.05 that were rounded to 0.0 (zero)

7.~~4~~5 Calculating Contaminant Concentrations in Food

The previous sections focused on consumption rates for a variety of foods, and included development of means and distributions for those consumption rates. Consumption rates represent one exposure variate in the algorithm for calculating human exposure to contaminants through the food chain. As in Eq. 7-1, concentrations of contaminants in food products, Cf, must also be estimated. The following sections describe the algorithms and default values for exposure variates used in estimating concentrations in foods.

7.~~4~~5.1 Algorithms used to Estimate Concentration in Vegetation (Food and Feed)

Vegetation that is consumed directly by humans will be referred to as 'food', while that consumed by animals is termed 'feed'. Humans can be exposed to contaminants from vegetation either directly through food consumption or indirectly through the consumption of animal products derived from animals that have consumed contaminated feed.

The concentration of contaminants in plants is a function of both direct deposition and root uptake. These two processes are estimated through the following equations:

$$Cf = (Cdep)*(GRAF) + Ctrans \qquad \text{(Eq. 7-2)}$$

where:
- Cf = concentration in the food (μg/kg)
- Cdep = concentration due to direct deposition (μg/kg)
- GRAF = gastrointestinal relative absorption fraction
- Ctrans = concentration due to translocation from the roots (μg/kg)

7.~~4~~5.1.1 GRAF

A gastrointestinal relative absorption fraction (GRAF) is included in the calculation of concentration via deposition to account for decreased absorption in the GI tract of materials bound to fly ash or fly ash-like particulate matter relative to absorption of a contaminant added to the diet in animal feeding studies (i.e., laboratory animal studies used to determine oral chronic Reference Exposure Levels). At the present time, GRAF data are only available for polychlorinated dibenzo-p-dioxins and dibenzofurans (PCDD/F), based on the 2,3,7,8-TCDD congener. The GRAF for those compounds is 0.43. All other compounds have a GRAF of 1.0. There are no data available to describe differential absorption onto feed from fly ash particles as compared to other compounds. Consequently, the factor comes into play only in calculating dose of PCDD/F through this pathway. Note that the factor is not applied to the material translocated through the roots, as toxicants taken up by the roots are assumed to be absorbed to the same extent as that in the feed of the experimental animals in the study, which is the basis for both the cancer potency factor and reference exposure level.

7.~~4~~5.1.2 Deposition onto Crops

The factor Cdep is calculated by the following equation:

$$Cdep = [(Dep)\ (IF)/(k)\ (Y)] \times (1-e^{-kT}) \qquad \text{(Eq. 7-3)}$$

where:
- Cdep = amount of toxicant depositing on the vegetation per kg crop (μg-toxicant / kg-crop)
- Dep = deposition rate on impacted vegetation (μg/m^{2}day)
- IF = interception fraction
- k = weathering constant (d^{-1})
- Y = crop yield (kg/m^2)
- e = base of natural logarithm (~2.718)
- T = growth period (days)

The variate, Dep, is a function of the modeled (or measured) ground level concentration, and the vertical rate of deposition of emitted materials, and is calculated as follows:

$$Dep = GLC \times Dep\text{-}rate \times 86{,}400 \qquad \text{(Eq. 7-4)}$$

where: GLC = ground level concentration of contaminant in air ($\mu g/m^3$)
Dep-rate = vertical deposition rate (m/sec)
86,400 = seconds per day (sec/day)

The ground level concentration is calculated in the air dispersion modeling (see Chapter 2). The deposition rate is assumed to be 0.02 meters per second for a controlled source and 0.05 meters/second for an uncontrolled source (see Chapter 2).

The interception fraction in Eq. 7-3 above is crop specific. The work of Baes et al. (1984), examining the transport of radionuclides through agriculture, describes interception fraction as a factor which accounts for the fact that not all airborne material depositing in a given area initially deposits on edible vegetation surfaces. That fraction will be somewhere between zero and one.

There are no data on interception fraction for leafy and exposed produce but interception fractions for these produce categories were modeled by Baes et al. (1984). Baes et al. used assumptions based on typical methods of cultivating leafy and exposed produce in the U.S., and on the following equations:

$$If_e = 1 - e^{(-0.0324Y_e)}$$
$$If_l = 1 - e^{(-0.0846Y_l)}$$

where:
If_e = interception fraction for exposed produce
If_l = interception fraction for leafy produce
Y = yield of exposed produce (kg/m^2, dry)
Y = yield of leafy produce (kg/m^2, dry).

Baes et al. calculated an average interception fraction of 0.15 for leafy produce and 0.052 for exposed produce. For these guidelines, the interception fractions were rounded off to 0.2 and 0.1 for leafy and exposed produce, respectively.

Some information is available from studies of radioactive isotopes for pasture grasses. The empirical relationship for grasses is given by:

$$IFpg = 1\text{-}e^{-2.88\,Y} \qquad \text{(Eq. 7-5)}$$

where: IFpg = interception fraction for pasture grasses
Y = yield in kg/m^2 (dry)

Assuming that the wet yield is 2 kg/m^2, and 80 percent of the wet weight is water, then the IFpg is approximately 0.7 (Baes et al., 1984). This value compares well with the Baes modeled interception fractions for leafy and exposed produce since grasses are

more densely packed into a given area relative to home grown leafy and exposed produce.

For protected and root produce, there are no known interception fractions (modeled or empirical) and it is difficult to arrive at a wet yield value. OEHHA recommends that the 2 kg/m^2 wet yield value be used for the protected and root categories of produce.

Additional default values for variates in Eq. 7-3 are obtained from *Multi-pathway Health Risk Assessment Parameters Guidance Document* prepared for South Coast Air Quality Management District (Clement Associates, 1988). The weathering constant, k, is based on experimental observations from studies of particulate radionuclides on plant surfaces. This weathering constant does not include volatilization from the leaf surface since the radionuclides used were not volatile, nor does it include biotransformation or chemical transformation on the leaf surface. Baes et al. (1984) describe particulate half-lives ranging from 2.8 to 34 days with a geometric mean of 10 days for radionuclides depositing on plants. OEHHA proposes using a weathering constant of 10 days based on Baes et al. (1984).

The growth period, T, in Equation 7-3 above is based on the time from planting to harvest. OEHHA recommends a value of 45 days for leafy and root crops and 90 days for exposed and protected produce (time from fruit set to harvest). The assumptions in the interception fraction include the issue of increasing surface area with growth. Therefore, no additional adjustment is necessary.

7.~~4~~5.1.3 Translocation from the Roots

The variate, Ctrans, in Equation 7-6, represents the amount of contaminant that is translocated, or absorbed, from the soil into the roots of homegrown crops that are food sources for humans. Once absorbed, the contaminant may accumulate in edible roots (e.g., carrots) and be translocated to other parts of the plant that are consumed including the leaves and fruit. The equation for calculating concentration in the plant from root uptake is as follows:

$$Ctrans = Cs \times UF \qquad \text{(Eq. 7-6)}$$

Where: Cs = concentration in the soil (see Chapter 6)
UF = soil-to-plant uptake factor

The soil-to-plant uptake factor (UF) is the ratio of the fresh weight contaminant concentration in the edible plant or plant part over the total concentration of the contaminant in soil wet weight. The UFs (Eq. 7-6) recommended by OEHHA are from the scientific literature. Due to the large volume of studies investigating metal concentrations in edible plants grown in contaminated soils, OEHHA created a database to assemble the data and calculate UFs. The database and methods used to estimate the UFs are described in Appendix H.

The concentration in the soil (Cs) is calculated as described in Chapter 6 using air dispersion and deposition modeling. The UF for specified metals can then be applied in Eq. 7-6 in order to estimate Ctrans.

Due to lack of root absorption and translocation, the soil-to-plant uptake of organic compounds under the "Hot Spots" program (e.g., dioxins and PCBs) is considered not to be a pathway of contamination. Therefore, the soil-to-plant UFs are currently limited to the inorganic metals and metalloids.

The soil-to-plant UFs of edible plants, shown in Table 7.14~~45.1~~, are divided into four types: leafy, root, protected, and exposed. The foods in each of these produce categories are presented in Appendix D. The classification of edible plants into these four groups reflects the potential differences in contaminant concentrations that may occur in the plant parts resulting not only from soil-to-plant uptake, but also from airborne deposition.

Table 7.~~45.1~~14 Soil-to-plant uptake factors for inorganic metals and metalloids in edible crops[a]

Element	Leafy	Exposed	Protected	Root
Arsenic	1×10^{-2}	2×10^{-2}	7×10^{-2}	8×10^{-3}
Beryllium	2×10^{-4}	8×10^{-3}	3×10^{-4}	5×10^{-3}
Cadmium	1×10^{-1}	2×10^{-2}	1×10^{-2}	8×10^{-2}
Chromium (VI)	3×10^{-1}	2×10^{-2}	7×10^{-2}	3×10^{0}
Fluoride	4×10^{-2}	4×10^{-3}	4×10^{-3}	9×10^{-3}
Lead	8×10^{-3}	7×10^{-3}	3×10^{-3}	4×10^{-3}
Mercury	2×10^{-2}	9×10^{-3}	1×10^{-2}	2×10^{-2}
Nickel	1×10^{-2}	3×10^{-3}	3×10^{-2}	6×10^{-3}
Selenium	6×10^{-2}	4×10^{-2}	3×10^{-1}	7×10^{-2}

[a] Soil-to-plant UFs represent the fresh weight concentration of a contaminant in the plant part over the wet weight concentration of contaminant in the soil.

7.~~4~~5.2 Algorithms used to Estimate Dose to the Food Animal

The general formula for estimating concentrations of contaminants in animal products is as follows:

$$Cfa = [Dinh + Dwi + Dfeed + Dpast + Dsi] \times Tco \qquad \text{(Eq. 7-7)}$$

where:
- Dinh = dose through inhalation (μg/day)
- Dwi = dose through water intake (μg/day)
- Dfeed = dose through feed consumption (μg/day)
- Dpast = dose through pasturing/grazing (μg/day)
- Dsi = dose through soil ingestion (μg/day)
- Tco = transfer coefficient from consumed media to meat/milk products

Ideally, the Tco values would be evaluated separately for the inhalation and oral routes but the data do not exist to separately evaluate the inhalation route. The Tco values are based on oral studies, and are presented in Appendix K, and summarized in Table 7.16 and 7.17~~45.2 and 7.45.3~~.

7.~~4~~5.2.1 Dose via Inhalation

The dose via inhalation is proportional to the concentration of the contaminant in the air and the amount of air breathed by the animal in a single day. It is assumed that 100 percent of the chemical is absorbed. The dose via inhalation is calculated as follows:

$$Dinh = BR \times GLC \qquad \text{(Eq.7-8)}$$

where: Dinh = dose to the animal via inhalation (μg/day)
BR = daily breathing rate of the animal (m^3/day)
GLC = ground level concentration (μg/m^3)

7.4~~5~~.2.2 Dose via Water Consumption

Airborne contaminants depositing in surface water sources of drinking water for food animals can end up in the human food chain. The dose to the food animal from water consumption is proportional to the concentration of the contaminant in the drinking water and the amount of water consumed by the animal daily. In addition, the fraction of the water consumed daily that comes from a contaminated body of water is used to adjust the dose to the food animal. That fraction is a site-specific value that must be estimated for the site. The dose via water consumption can be calculated as follows:

$$Dwi = WI \times Cw \times Fr \qquad \text{(Eq. 7-9)}$$

where: Dwi = dose to the food animal through water intake (μg/day)
WI = water intake rate (L/day)
Cw = concentration of contaminant in water (μg/L)
Fr = fraction of animal's water intake from the impacted source

Cw is calculated as in Chapter 8. Water consumption rates for food animals are shown in Table 7.15~~45.2~~. The fraction of the animals' water intake that comes from the source impacted by emissions is a site-specific variable.

7.4.2.3 Dose from Feed Consumption, Pasturing and Grazing

Airborne contaminants may deposit on pastureland and on fields growing feed for animals. The default assumption is that the feed is not contaminated because most feed would be purchased from offsite sources. However, if feed is produced onsite, the dose from contaminated feed should be determined. Deposited contaminant contributes to the total burden of contaminants in the meat and milk. The dose to the animal from feed and pasture/grazing can be calculated as follows:

$$Dfeed = (1 - G) \times FI \times L \times Cf \qquad \text{(Eq. 7-10)}$$

where: Dfeed = dose through feed intake (μg/day)
G = fraction of diet provided by grazing
FI = feed consumption rate (kg/d)
L = fraction of feed that is locally grown and impacted by facility emissions
Cf = concentration of contaminant in feed (μg/kg) (calculated in Eq. 7-2)

$$Dpast = G \times Cf \times FI \qquad \text{(Eq. 7-11)}$$

where:
- Dpast = dose from pasture grazing (μg/day)
- G = fraction of diet provided by grazing
- FI = pasture consumption rate (kg/day)
- Cf = concentration of contaminant in pasture (μg/kg)

DMI, kg dry matter intake (feed), is given for food animals in Table 7.15~~45.2~~. The percent of the diet that comes from pasture and feed, and the fraction of feed that is locally grown and impacted by emissions are site-specific variables and values for these variables need to be assessed by surveying farmers in the impacted area. Concentration in the feed and pasture are calculated as in Equations 7-10 and 7-11 above. It is considered likely that feed will come from sources not subject to contamination from the stationary source under evaluation.

Table 7.15~~45.2~~ Point Estimates for Animal Pathway

Parameter	Beef Cattle	Lactating Dairy Cattle	Pigs	Meat Poultry	Egg-laying Poultry
BW (body weight in kg)	533	575	55	1.7	1.6
BR (inhalation rate in m^3/d)	107	115	7	0.4	0.4
WI (water consumption in kg/d)	45	110	6.6	0.16	0.23
DMI (kg/d)[1]	9	22			
Feed Intake			2.4	0.13	0.12
%Sf (soil fraction of feed)	0.01	0.01	NA	NA	NA
%Sp (soil fraction of pasture)	0.05	0.05	0.04	0.02	0.02

[1] Dry matter intake

7.4.2.4 Transfer Coefficients from Feed to Animal Products

The derivation and use of transfer coefficients for specific chemicals is explained in Appendix K. Tables 7.16~~45.3~~ and 7.17~~45.4~~ contain the recommended values for persistent organic chemicals and metals, respectively.

Table 7.~~45.3~~16 Food Animal Transfer Coefficients for Persistent Organic Chemicals

Organic Chemical	**Tcos (d/kg)[a]**				
	Cow's Milk	**Chicken Egg**	**Chicken Meat**	**Cattle Meat**	**Pig Meat**
Diethylhexylphthalate	9×10^{-5}	0.04	0.002	6×10^{-4}	5×10^{-4}
Hexachlorobenzene	0.02	20	10	0.2	0.08
Hexachlorocyclohexanes	0.01	7	5	0.2	0.09
PAHs	0.01	0.003	0.003	0.07	0.06
Polychlorinated biphenyls					
Congener 77	0.001	6	4	0.07	0.4
81	0.004	10	7	0.2	0.4
105	0.01	10	7	0.6	0.7
114	0.02	10	7	0.9	0.7
118	0.03	10	7	1	0.7
123	0.004	10	7	0.2	0.7
126	0.04	10	7	2.	0.7
156	0.02	10	8	0.9	2
157	0.01	10	8	0.5	2
167	0.02	10	8	1	2
169	0.04	10	8	2	2
189	0.005	10	8	0.2	1
Unspeciated	0.01	10	7	0.2	0.5
~~Unspeciated (TEQ-adjusted)~~	~~0.01~~	~~20~~	~~10~~	~~0.7~~	~~0.3~~
PCDD/Fs					
Congener 2378-TCDD	0.02	10	9	0.7	0.1
12378-PeCDD	0.01	10	9	0.3	0.09
123478-HxCDD	0.009	10	6	0.3	0.2
123678-HxCDD	0.01	10	6	0.4	0.1
123789-HxCDD	0.007	7	3	0.06	0.02
1234678-HpCDD	0.001	5	2	0.05	0.2
OCDD	0.0006	3	1	0.02	0.1
2378-TCDF	0.004	10	6	0.1	0.02
12378-PeCDF	0.004	30	10	0.1	0.01
23478-PeCDF	0.02	10	8	0.7	0.09
123478-HxCDF	0.009	10	5	0.3	0.1
123678-HxCDF	0.009	10	6	0.3	0.09
234678-HxCDF	0.008	5	3	0.3	0.06
123789-HxCDF	0.009	3	3	0.3	0.03
1234678-HpCDF	0.002	3	1	0.07	0.06
1234789-HpCDF	0.003	3	1	0.1	0.02
OCDF	0.002	1	0.6	0.02	0.03
Unspeciated	0.001	6	5	0.03	0.09
~~Unspeciated (TEQ-adjusted)~~	~~0.005~~	~~10~~	~~7~~	~~0.2~~	~~0.09~~

[a] All Tco values were rounded to the nearest whole number.
[b] NA – no data available or not applicable

Table 7.~~45~~.~~4~~17 Food Animal Transfer Coefficients for Inorganic and Organic Metals

Inorganic and Organic Metals	Tcos (d/kg)[a]				
	Cow's Milk	Chicken Egg	Chicken Meat	Cattle Meat	Pig Meat
Arsenic	5×10^{-5}	0.07	0.03	2×10^{-3}	0.01[b]
Beryllium	9×10^{-7}	0.09	0.2	3×10^{-4}	0.001
Cadmium	5×10^{-6}	0.01	0.5	2×10^{-4}	0.005
Chromium (VI)	9×10^{-6}	NA[c]	NA	NA	NA
Fluoride	3×10^{-4}	0.008	0.03	8×10^{-4}	0.004[b]
Lead	6×10^{-5}	0.04	0.4	3×10^{-4}	0.001[b]
Mercury ~~Hg(II) only in diet:~~ ~~Inorganic mercury~~ ~~Methyl mercury (MeHg)~~ ~~MeHg only in diet:~~ ~~Inorganic mercury~~ ~~Methyl mercury~~	 7×10^{-5} ~~NA~~ ~~NA~~ ~~7×10^{-4}~~	 0.~~3~~8 ~~0.5~~ ~~NA~~ ~~10~~	 0.~~02~~1 ~~0.09~~ ~~NA~~ ~~10~~	 4×10^{-4} ~~NA~~ ~~NA~~ ~~NA~~	 0.002[b] ~~NA~~ ~~NA~~ ~~NA~~
Nickel	3×10^{-5}	0.02	0.02	3×10^{-4}	0.001
Selenium	0.009	3	0.9	0.04	0.5

[a] All Tco values were rounded to the nearest whole number.
[b] The meat Tco was estimated using the metabolic weight adjustment ratio of 4.8 from cattle to pig
[c] NA – no data available or was not applicable

7.~~5~~6 Default Values for Calculation of Contaminant Concentration in Animal Products

7.~~5~~6.1 Body Weight Defaults

Cows used for milk production will be adults (i.e., full body weight) and females, so only adult female weights should be used for the home produced milk pathway. OEHHA recommends the central tendency weight of 575 kg for the home raised milk cow (midpoint of the adult cow range). A cow or bull raised for home produced beef may be of any age, gender or strain. We recommend 533 kg (midpoint of the beef cattle range) for the home produced beef pathways (National Research Council, 2000). Beef cattle are growing while being raised and thus transitioning through lower body weights to reach the mature body weight. We therefore propose a default central tendency value. Mean pig body weights of 30.9-80 kg at age 13-23 weeks have been reported (Agricultural Research Council, London, 1967). The 4H club encourages children to participate in the home raising of pigs. The 4H club recommends that the pigs weigh between 200 and 240 pounds (90.9 and 109 kg) at the end of the project (http://www.goats4h.com/Pigs.html#weight). OEHHA recommends half of 240 pounds, 120 pounds or 55 kg, as the average weight of the pig while being raised.

The National Research Council (1994) in Table 2.5 lists the weight of broiler chickens by week up to 9 weeks. The weight for the males is 3.5 kg after 9 weeks. The average weight over the 9-week period is 1.7 kg, which is the OEHHA's recommendation for a default body weight for chickens raised for meat. The OEHHA recommends the average weight of white and brown egg laying chickens at 18 weeks to first egg laying (1.5 kg) in Table 2-1 National Research Council (1994) .

7.~~5~~6.2 Breathing Rate Defaults

Animal breathing rate defaults were calculated based upon a relationship of tidal volume to body weight. Each pound of body weight has been reported to correspond to approximately 2.76 ml of tidal volume (2.76 ml/lb ≅ 6.07 ml/kg body weight) (Breazile, 1971). Using this relationship, the default animal body weight, and breathing cycle frequencies provided in Breazile (1971), we generated breathing rates. Reported breathing frequencies for cattle, pigs, and poultry were 18-28, 8-18, and 15-30 respirations per minute, respectively. The body weight defaults described above were used in the calculations. Use of these values generated a range of breathing rates and the default value was derived as the average of the range limits. Default breathing rates for dairy cattle, beef cattle, pigs, and poultry are 116, 107, 6.2, and 0.33 m^3/day, respectively. The default value for cattle falls within the range of that reported by Altman et al. (1958).

7.~~5~~6.3 Feed Consumption Defaults

Backyard farmers could raise cattle, swine, and chickens from birth to early adulthood for meat. There is a large change in body weight that correlates with feed-consumption rates during that period of the animal's life. For meat animals, the OEHHA attempted to identify the consumption rate at the mid-point of the meat animals' pre-slaughter life span. In contrast, the adult cows and chicken that produce milk and eggs have relatively constant feed-consumption rates and body weights. For these cows and chickens, OEHHA attempted to identify the consumption rate of the fully-grown adult.

OEHHA's risk assessment model assumes that the source contaminates the pasture or hay from that pasture. A regulated source could contaminate a pasture that provides a cow with 100 percent of its nutrition. In contrast, homeowners usually procure feed for backyard swine and chicken that is produced off-site. Therefore, the default assumptions are that the regulated source contaminates 0 percent of the swine or chicken feed, and 100 percent of cows' feed. Site-specific conditions may require that different percent contamination be used.

7.~~5~~6.3.1 Bovine Feed Ingestion

Most published literature on bovine feed ingestion is on commercial production. While the backyard and commercial animals are the same breeds, the feeding patterns can be different. It is likely that home raised cattle will be fed a higher percentage of forage, for example. DMI is the feed consumption rate with the units of kilograms feed per day

(kg/d). Feed is dried before it is weighed to obtain a DMI because water content varies. The NRC identifies several factors that affect DMI (NRC, 2001). These include fiber content of the forage, initial size of the animal, and time preceding parturition. Two types of feed are reported in the literature: forage (grass, hay, alfalfa, etc.) and concentrate (high-energy feeds like corn, soybean or oats). As concentrate increases, consumption of forage decreases.

As the animal gets larger, it eats more food; therefore, DMI is correlated with body weight. Body weight does not change greatly during the majority of the milk producing years of dairy cows. Therefore, we assume the backyard dairy cow consumes the same amount as those in the studies described below. In contrast, the body weight of beef cattle varies greatly as they grow from calves to adults. Papers often report the starting body weight for beef cattle. OEHHA selected peer-reviewed papers in which DMI was reported with adequate description of the methods. DMI was measured in these studies but was not necessarily the objective of the study.

Cows eat about as much pasture as they do hay or silage. Holden et al. (1994) compared DMIs of pasture, hay, and silage in three non-lactating, non-pregnant dairy cows. The pasture was identical to that used for the hay and silage. The cows ate pasture, hay, and silage in sequential 19-day exposures. Chromium oxide, an indigestible component of vegetation, was used to estimate consumption. This study showed that fecal chromium oxide accurately predicts DMI of hay and silage. More importantly, intake rates (kg/d) showed no difference among pasture, silage or hay using fecal chromium oxide estimates. Therefore, OEHHA selected studies that measured silage or hay consumptions assuming they are the same as pasture consumption.

Britt et al. (2003) measured DMI in 13 herds of lactating Holstein dairy cows in Kentucky, Tennessee, and Mexico at different times throughout the year. The mean ± standard deviation of 34 measurements is 21.8 ±1.6 kg/day with a range of 16.8 to 24.5. Holcomb et al. (2001) reported an average DMI for 40 Holsteins of 21.6 kg/day. Rastani et al. (2005) measured DMI for 20 weeks around birth. Ten weeks prior to birth, the DMI was 20 kg/day and gradually decreased to 10 kg/day at birth, and then it gradually increased to 23 kg/day ten weeks post-partum. The OEHHA recommendation for DMI for dairy cows is 22 kg/day, the mean of these three reports.

As described in the Bovine section above, a number of factors influence the uncertainty and variability of pasture DMI of backyard dairy cows. As Rastani et al. (2005) show, lactating cows consume about twice as much as cows not lactating. We did not consider non-lactating cows since milk is the vehicle of human exposure. Cows fed supplements such as corn, soybean, or oats would eat less pasture.

The NRC (2000) has developed an equation predicting DMI based on the energy content in mega-calories per kg of dry matter of the forage (Mcal/kg). A graph of DMI vs. energy content using this equation peaks at about 9 kg/d with cows fed medium energy content forage. The DMI gradually decreases to about 7.6 kg/day with both high

and low energy content forages. A second graph in the NRC report shows DMI plotted against initial body weight. The smallest steers (200 kg) ate the least (4 kg/d) and larger animals ate the most (12 kg/d for 350 kg steers). Burns et al. (2000) reported DMI in six Angus steers (initial mean BW = 334 kg) fed with an average DMI of 9.7 kg/d. Stanley et al. (1993) measured DMI in four Hereford x Angus cows at seven time points. The total duration was 83 days during which there was a linear increase in DMI from 8.8 to 14.9 kg/day. Unfortunately, the authors did not report body weights at the seven time points. OEHHA recommends a default DMI of 9 kg/day for cattle home raised for beef to estimate average food consumption during the home raising period.

The uncertainties described for dairy cows apply to beef cattle. In addition, DMI correlates with body weight and the body weight varies greatly in beef cattle grown from calves to young adults for slaughter. The OEHHA value is an average over this period. It could over-estimate intake if calves are slaughtered for veal or under-estimate intake of cattle slaughtered long after reaching maturity.

7.~~5~~6.3.2 Swine Feed Ingestion

Since it is likely that most backyard swine would eat feed produced off-site, this exposure pathway to the swine should be included only when feed is grown on-site. OEHHA assumes people obtain backyard swine as weanlings and slaughter them at early adulthood when they weigh about 110 kg. The food consumption varies with body weight and calorie density of the feed. The NRC has developed a mathematical model from simultaneous observations of body weight and feed intake of a nutritionally adequate corn/soybean mix to over 8,000 swine. The model (NRC, 1998) predicts the digestible energy requirement (in kcal/day) as a function of body weight (from 10 to 120 kg). The equation predicts that swine at the average body weight of 55 kg would require about 8000 kcal/d. Corn has a digestible energy content of about 3,300 kcal/kg (Feoli et al.(2007). Thus, a 55 kg swine would consume about 2.4 kg/d.

Generally, backyard swine consume restaurant waste or other feed not produced on-site. Therefore, risk assessors should assume the amount of contaminated feed consumed by backyard swine is zero, as the default. If the dry weight digestible energy content of this feed is known, it can be used to convert 8,000 kcal into kg of feed consumed per day. When swine eat supplements not raised on-site, the risk assessor will need to determine the fraction of feed raised on-site.

7.~~5~~6.3.3 Chicken Feed Ingestion

Since most backyard chickens would eat feed produced off-site, this exposure pathway for chickens should be included only when chickens' feed is known to be grown on-site. Chicken feed consumption from onsite could contaminate the meat and/or eggs.

7.~~5~~6.3.4 Feed Ingestion by Chickens Raised for Meat

Ingestion of homegrown feed by chickens, which are home-raised for meat, is only an exposure pathway if the feed is also grown on site, which is unlikely. If the feed is grown on site then the following feed consumption value is provided. The National Research Council (1994) report in Table 2.5 of their document shows data on chicken food consumption for broilers from one to nine weeks of age. Males, the most likely to be eaten by homeowners, weigh 3.5 kg at 9 weeks and consume 0.23 kg/d of feed. Males at the midpoint, 4 weeks, weigh 1 kg and consume 0.132 kg/d. If only a fraction of the feed at a particular site is grown on site, this fraction should be used to reduce the consumption rate.

7.~~5~~6.3.5 Laying Hen Feed Ingestion

Ingestion of homegrown feed by chickens home raised for eggs is only an exposure pathway if the feed is grown on site, which is unlikely. If the feed is grown on site, then the following feed consumption value is provided. Table 2.2 of the NRC report (1994) shows consumption rates for laying hens from 2 to 20 weeks of age. At 20 weeks, the average weight of strains laying brown eggs and strains laying white eggs is 1.6 kg and the average food consumption at 20 weeks is 0.12 kg/d, which is recommended as the default for egg laying chickens. If only a fraction of the feed which chickens at a particular site ingest is grown on site, this fraction should be used to reduce the consumption rate.

7.~~5~~6.4 Water Consumption Defaults

Water consumption for home raised beef cattle, dairy cattle, pigs, and chickens would be an exposure pathway for these animals only if surface waters are used as a water source (e.g., a farm pond). If municipal or well water were used, the water supply would not be contaminated by the facility under evaluation under the assumptions of the Hot Spots risk assessment model.

7.~~5~~6.4.1 Bovine Water Consumption

Literature reported bovine water intake rates are generally expressed in relation to dry matter consumption on a weight basis. Water intake also generally increases with increasing temperature. Water intakes for cattle of 3.1-5.9 kg/kg dry matter at temperatures ranging from 12°C to 29.4°C have been reported (Winchester and Morris, 1956, as summarized by the Agricultural Research Council, London, 1965).

Water intakes of 6.6-10.2 kg/kg dry matter consumed for shorthorn cows at 27°C and 3.2-3.8 kg/kg dry matter consumed at 10°C have been reported (Johnson et al., 1958). Water intake for shorthorn cows at 18-21°C of 4.2-5.0 kg/kg dry matter consumed have also been reported (Balch et al., 1953). Water intake at lower temperatures (-18 to 4°C) of 3.5 kg/kg dry matter consumed has also been reported (MacDonald and Bell, 1958).

Friesian cattle water intake was estimated at 3.3-4.3 kg/kg dry matter consumed (Atkeson et al., 1934).

The National Research Council (2001) has several equations for calculating water intake of dairy cows that take into account ambient temperature, sodium intake, DMI, and milk production to produce a refined estimate of water intake. Given the feed intake for both non-lactating and lactating cattle as described above, a reasonable default estimate of water consumption is approximately 5-fold the dry matter consumption. If this exposure pathway to beef cattle or dairy cows is applicable, the resulting default water consumption rates for beef cattle and lactating dairy cattle are 45 and 110 kg/day, respectively.

7.~~5~~6.4.2 Swine Water Consumption Rates

Water consumption has been estimated for pigs at 1 kg/day for 15 kg pigs, increasing to 5 kg/day at 90 kg body weight (Agricultural Research Council, London, 1967). Non-pregnant sow water consumption was estimated at 5 kg/day, pregnant sows at 5-8 kg/day, and lactating sows at 15-20 kg/day. The National Research Council (1998) estimates 120 mL water/kg BW day for growing (30 to 40 kg) nonlactating pigs and 80 mL water/kg BW-day for nonlactating adult pigs (157 kg). A default value of 6.6 L/day is recommended based on the 120 mL/kg BW day figure in the National Research Council (1998).

7.~~5~~6.4.3 Water Consumption Rates by Chickens

The water consumption exposure pathway would only be applicable as an exposure pathway for chickens if surface water were used as a drinking water source (e.g., a farm pond). If municipal water or well water is used as the water supply for home raised chicken, the water is assumed uncontaminated from airborne emissions of a facility. Water consumption by chickens has been reported to fall in the range of 1-3 times the food consumption on a weight basis (Agricultural Research Council, London, 1975). They established a 2:1 ratio of water to feed consumption as the default value. Given a daily feed consumption rate of 0.1 kg/day, the resulting daily water consumption rate for chickens is 0.2 kg/day.

The National Research Council (1994) estimated water consumption over an eight-week period for broilers and brown egg layers. The average water consumption rate is 0.16 L/day for broilers. The daily water consumption rate is 0.23 L/day for brown egg layers at 20 weeks (National Research Council, 1994). A default water consumption rate of 0.16 L/day is recommended for broilers and 0.23 L/day is recommended for egg laying chickens, if the water exposure pathway is applicable to chickens.

7.~~5~~6.5 Soil Ingestion Defaults

Soil ingestion was estimated for dairy cattle based upon fecal titanium content (Fries et al., 1982). Among yearling heifers and non-lactating cattle receiving feed (vs. pasture),

soil ranged from 0.25 to 3.77 percent of dry matter ingested, depending on the management system used, with those cattle with access to pasture having the greatest soil ingestion. For cattle on feed, a reasonable estimate of 1 percent soil ingestion was made. For cattle grazing pasture, soil intake estimates of 4-8 percent dry matter ingestion have been made for cattle receiving no supplemental feed (Healy, 1968).

Soil ingestion varies seasonally, with the greatest soil ingestion during times of poor plant growth (14 percent) and the least soil ingestion during lush growth (2 percent). In a study of several farms in England, beef and dairy cattle were found to have soil ingestion rates ranging from 0.2 to 17.9 percent of dry matter consumed, depending both on the location and the time of year (Thornton and Abrahams, 1983). The two largest sets of data evaluated showed a range of soil ingestion of 1.1-4.4 percent dry matter consumed. Thus, a reasonable estimate of soil ingestion by beef and dairy cattle as percent of pasture consumed is 5 percent.

Soil ingestion estimates have been made for pigs (Healy and Drew, 1970). A mean weekly soil ingestion estimate of 1 kg soil/week was made for pigs grazing swedes (rutabaga), corresponding to 0.014 kg soil/day. Other estimates for animals grazing swedes, swedes with hay, and pasture only were 0.084, 0.048, and 0.030 kg soil/day, respectively. Assuming total feed ingestion of 2 kg/day, the soil ingestion as percent of grazed feed (pasture) ranged from 1.5 to 7 percent, with a best estimate of 4 percent. In the absence of information concerning soil content of feed for pigs, no estimate has been made for soil ingestion from feed. For risk assessment purposes, pigs are assumed to consume 4 percent soil from pasture ingestion.

As a digestive aid, chickens normally consume approximately 2 percent grit in their diet (McKone, 1993). This value was used as an estimate of the fraction of soil ingestion for chickens with access to pasture. Chickens were assumed to have access to pasture/soil and therefore, no estimate was made for soil ingestion strictly from feed.

7.~~6~~7 Fraction of Food Intake that is Home-Produced

The Child-Specific Exposure Factors Handbook (USEPA, 2008) has information on the fraction of food intake that is home produced (Table 13.6). This information is from a U.S. EPA analysis of the 1987-1988 National Food Consumption Survey. The Table contains information on a number of specific home produced items as well as broad categories such as total vegetables and fruits.

Table 7.18~~67.1~~ Fraction of Food Intake that is Home-Produced

	All Households	Households that Garden	Households that Farm
Total Fruits	0.04	0.101	0.161
Total Vegetables	0.068	0.173	0.308
Avg. Total Veg & Fruits	0.054	0.137	0.235
	All Households	Households that Raise Animals/Hunt	Households that Farm
Beef	0.038	0.485	0.478
Pork	0.013	0.242	0.239
Poultry	0.011	0.156	0.151
Eggs	0.014	0.146	0.214
Total Dairy	0.012	0.207	0.254

The data on the fraction of food intake that is home produced are older than would be considered optimal and there is no data on variability in percent consumption in the populations of concern. There are many factors that could affect the percent of home-produced fruits and vegetables. These may include lot size, employment status, avidity and income. As a default for home-produced leafy, exposed, protected and root produce, OEHHA recommends 0.137 as the fraction of produce that is home raised (Table 7.18~~67.1~~). The households that grow their own vegetables and fruits are the population of concern. In rural situations where the receptor is engaged in farming, OEHHA recommends 0.235 as the default value for fraction of leafy, exposed, protected and root produce that is home produced.

OEHHA recommends the fraction home-raised under “Households that raise animals/hunt” (Table 7.18~~67.1~~) for beef, pork, poultry (chicken), eggs and dairy (milk), with the exception of rural household receptors engaged in farming. OEHHA recommends that the fractions listed under “Households that farm” be used for the rural household receptors.

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8. Water Intake Exposure Pathway

8.1 Introduction

Surface water can serve as a source of domestic water in some locations, particularly rural areas. Airborne contaminants from facilities can deposit directly on surface water bodies, thus exposing humans to contaminants through water consumption. Hot Spots facilities having non-municipal surface bodies of water, which are within the facility's zone of impact and which are used as a source of drinking water, need to include the water pathway in their risk assessments. Note that this pathway is rarely invoked for typical facilities in the Air Toxics Hot Spots program. Hot Spots risk assessments do not include municipal or commercial water sources. Municipal water is excluded because surface reservoirs are generally so large that contaminants from a single source become highly diluted once they enter the surface water body. Further, the level of some contaminants in municipal water may be reduced by water treatment processes typically used for municipal water supplies.

OEHHA does not recommend water pathway algorithms for municipal water source evaluation because the simple model used in the Hot Spots program is not adequate for this purpose. In these guidelines, the algorithm for calculating the water concentration of contaminants only includes that amount of chemical that directly deposits onto the surface of the water and not amounts that deposit in the soil and then enter the water body via runoff. It is assumed that contaminants initially deposited onto the water body surface remain suspended in the water column.

Water can be consumed by individuals through various forms of foods and beverages. For Hot Spots program risk assessments we will only consider plain drinking water, water added for reconstituting foods and beverages, and water absorbed by food during cooking. This is because these foods and beverages could be made with water from a non-municipal surface water body. We will not consider water from commercial food or drink, or water that occurs naturally in fresh foods (e.g., water in an apple). The reasons for these exclusions are given in the paragraph above.

8.2 Recommendations [This section was moved from the back of the chapter to the front.]

8.2.1 Point Estimate Approach

Currently there are no water intake distributions specific for California residents. However, OEHHA's derived water intake rate distributions provide a reasonable basis for exposure assessments of the California population. Chemical specific properties such as volatility may influence alternate route exposures via tap water, e.g., by bathing, showering, flushing toilets, etc. In the Air Toxics "Hot Spots" program, these exposure routes are currently not considered. However, they are treated in Superfund risk assessments where ground water contamination is a larger issue. The following recommendations are based on currently available data. Depending on the nature of

the analysis one or more of the recommendations may apply.

For ages involving infants, OEHHA recommends using intake rates based on reconstituted formula intake. This is to protect the sizable subpopulation of infants who typically receive significant amounts of water through reconstituted formula. Breastfed infants, particularly during the first 6 months of age, are essentially non-consumers of water, and should not be included in the derivation of water intake rates designed to protect exposed infants.

For cancer risk assessment, the cancer risk estimates for exposures in the third trimester and from 0<2 years are weighted by an age sensitivity factor of 10 and exposures for the 2<16 year age groups are weighted by an age sensitivity factor of 3 (OEHHA, 2009). These age groups do not completely fit the 0-9, 0-30, and 0-70 year exposure duration scenario age groups. In order to properly weight for these periods and evaluate risk over each of the exposure duration scenarios, water intake rates specific for the third trimester, 0<2, 2<9, 2<16, 16-30, and 16-70 year age groups are needed. For example, for the 0-9 year scenario, intake rates are needed for the third trimester and the period from 0<2 year (for which the cancer risk will be weighted 10X), and intake rates are needed for the 2-9 year period (for which the cancer risk will be weighted 3X). Likewise, for the 0-30 year scenario, rates are needed for the third trimester, and 0<2 year, 2<16 year, and 16-30 year periods, while for the 0-70 year scenario, rates are needed for the 0<2, 2<16, and 16-70 year periods. OEHHA has derived water intake rates for these additional age groups using the steps and methods outlined in Section 8.2.9 ("OEHHA Derived Water Intake Rates") below.

Table 8.1 presents recommended point estimate water intake rates for Air Toxics Hot Spots risk assessments. The derivation is described below in section 8.4.13.

Table 8.1 Recommended Point Estimate Tap Water Intake Rates (ml/kg-day)

Point Estimates				
Using Mean Values	**For the Age Period**	**9-year scenario**	**30-year scenario**	**70-year scenario**
	3rd trimester	18	18	18
	0<2 years	113	113	113
	2<9 years	26	-	-
	2<16 years	-	24	24
	16-30 years	-	18	-
	16-70 years	-	-	18
Using 95th-percentile values	**For the Age Period**	**9-year scenario**	**30-year scenario**	**70-year scenario**
	3rd trimester	47	47	47
	0<2 years	196	196	196
	2<9 years	66	-	-
	2<16 years	-	61	61
	16-30 years	-	47	-
	16-70 years	-	-	45

8.2.2 The Stochastic Approach

When using distributions it is appropriate to truncate them to avoid impossibly large or small values. For drinking water ingestion, the minimum should be set to zero while the maximum should be set to the maximum value listed in Table 8.11.

Recommended water intake rates for stochastic analyses are presented in Table 8.2.

Table 8.2 Recommended Distributions of Tap Water Intake Rates (ml/kg-day) for Stochastic Risk Assessment

	9-year scenario	30-year scenario	70-year scenario
0<2 years	**Max Extreme** Likeliest = 93 Scale = 35	**Max Extreme** Likeliest = 93 Scale = 35	**Max Extreme** Likeliest = 93 Scale = 35
2<9 years	**Weibull** Location = 0.02 Scale = 29 Shape = 1.3		
2<16 years		**Gamma** Location = 0.19 Scale = 15.0 Shape = 1.6	**Gamma** Location = 0.19 Scale = 15.0 Shape = 1.6
16-30 years		**Gamma** location=0.49 scale=13.6 shape=1.26	
16-70 years			**Beta** min=0.17 max=178 alpha=1.5 beta= 12.9

8.2.3 Recommended Water Intake Rates for ~~Pregnant and~~ Lactating Subpopulations

OEHHA also recommends water intake rates specific ~~for pregnant and~~ for lactating subpopulations. These recommendations are presented in Table 8.18 in Section 8.5.2. In the point estimate approach, the mean and 95th percentile intake rate for lactating women should be used for the drinking water exposure of a mother when evaluating contaminant concentrations in breast milk. For stochastic analyses, OEHHA recommends using the percentile data for ~~the pregnant and~~ the lactating subpopulations in Table 8.18 and fitting each to distributional models using the procedure outlined in Sections 8.4.13 and 8.4.14. Although the same study derived water intake rates for pregnant women, we utilized the water intake rates for adults ages for the third trimester as they were slightly more health protective than the values derived for pregnant women by U.S. EPA (2004) and presented in Section 8.5.2 below.

8.2.4 Recommended Water Intake Rates for High Activity Levels / Hot Climates

For groups who may be highly physically active or who may live or work in hot climates, OEHHA recommends using the 95th percentile value in Table 8.1 for the age group for which the sensitive endpoint has been identified. For stochastic analyses, OEHHA recommends using the distributions for 9-year or 30-year scenarios in Table 8.2.

8.3 Water Intake Algorithm

The equation to calculate contaminant concentration in surface water for the Air Toxics "Hot Spots" risk assessment model is:

$$Cw = GLC * Dep\text{-}rate * 86{,}400 * SA * 365 / (WV * VC) \qquad \textbf{(Eq. 8-1)}$$

where: Cw = Average concentration in water (µg/kg)
GLC = Ground-level concentration of the pollutant (µg/m^3)
Dep-rate = Vertical rate of deposition (m/sec) (0.02 meters/second for controlled, or 0.05 meters/second for uncontrolled, sources.)
86,400 = Seconds per day conversion factor (sec/d)
SA = Water surface area (m^2)
365 = Days per year (d/yr)
WV = Water volume (kg) (1L = 1 kg)
VC = Number of volume changes per year

Site-specific values for SA, WV, and VC are needed for evaluating the surface water exposure pathway and can be estimated from data collected on-site or public data sources. The equation assumes that all material deposited into the water remains in the water column and that the deposition rate remains constant for a 9, 30 or 70-year exposure duration.

Estimating the daily oral dose of contaminants via the water intake pathway requires information on typical daily water intake of individuals. Typical water intake varies among individuals. Characterizing this inter-individual variability allows more accurate estimates of average and high end intake as well as characterizing a range of exposures to the population.

Water intake can be classified as tap water or total water. Tap water is water consumed directly from the tap (i.e., plain drinking water) as well as water used to reconstitute beverages (e.g., coffee, OJ) or foods (e.g., baby cereal), and water absorbed during cooking of foods (e.g., cooked oatmeal) in the home or at a food service establishment (e.g., school, restaurant). "Total water" consists of tap water, plus water found naturally in foods (e.g., in a fresh apple), and water that is in commercial beverages (e.g., soft drinks) and foods (e.g., canned spaghetti). The term "direct" is used by the USEPA (2008) to describe tap water consumed from the tap. The term "indirect" is used to describe tap water used to make foods or beverages. Water in purchased items such as canned soup and intrinsic water in items such as lettuce were not included in the indirect category.

For the Hot Spots program, we are interested in tap water intake rates of consumers. We use tap water intake rates because tap water does not include water from commercial sources and from fresh foods. Commercial food and beverages are excluded because they are almost certainly prepared using water from municipal sources and because commercial food and drink are typically from diverse sources

resulting in minimization of the likelihood of a person being exposed from a single source (i.e., facility). Water in fresh foods is excluded because it does not come from a local water source. We use consumer-only data because consumers are the population being exposed. Thus, for example, data from non-consumers, such as individuals who exclusively drink bottled water, would be excluded from the data we use to quantify water intake rates.

The sources for tap water are municipal (public) water, household wells or cisterns, and household or public springs. The Hot Spots program water pathway risk assessments apply to water obtained from non-municipal surface water sources. Because non-municipal surface water is delivered via the tap (faucet) to consumers, and because most studies that have measured water consumption do not specify non-municipal surface water sources, we will use "tap" water data for the estimation of intake rates. For stochastic evaluation of exposures from the water pathway, probability distributions reflecting variability within the population are needed, where data permit. There are intake data that are available in ml/kg-day. By normalizing water intake by body weight, the variability associated with the correlation between water intake and body weight is reduced.

Historically, when estimating exposures via drinking water, risk assessors assumed that children ingest 1 liter/day of water, while adults ingest 2 liters/day (NAS, 1977). These values have been used in guidance documents and regulations issued by the U.S. Environmental Protection Agency (U.S. EPA). The purpose of this section is to briefly assess data on water intake rates for use in stochastic types of exposure assessments that employ distributions of water intake. In addition, point estimates of intake can be identified from the distribution and used in the point estimate approach of Tier 1 and 2.

The algorithm for determining dose from surface drinking water sources is:

$$DOSEwater = 1 \times 10^{-6} * Cw * WIR * ABS * Fdw * EF \cancel{* ED/AT} \qquad \textbf{(Eq. 8-2)}$$

where:
DOSEwater = daily oral dose of contaminant, mg/kg-d
1×10^{-6} = conversion factor (1 mg/1000 µg) (1L/1000 ml)
Cw = Concentration of contaminant in drinking water, µg/L
WIR = Water intake rate for receptor of concern in ml/kg BW-day
ABS = GI tract absorption factor (default = 100%)
Fdw = Fraction of drinking water from contaminated source (default = 100%)
EF = Exposure frequency (days/year)

In practice, the GI tract absorption factor (ABS) is only used if the cancer potency factor itself includes a correction for absorption across the GI tract. It is inappropriate to adjust a dose for absorption if the cancer potency factor is based on applied rather than absorbed dose. The Fdw variate is always 1 (i.e., 100%) for Tier 1 screening risk assessments. This variate may only be adjusted under Tier 2-4 risk assessments. The exposure frequency (EF) is set at 350 days per year (i.e., per 365 days) following US EPA (1991).

For cancer risk, the risk is calculated for each age group using the appropriate age sensitivity factors (ASF) and the chemical-specific cancer potency factor (POTENCY):

RISKwater = DOSEwater *POTENCY*ASF*ED/AT **(Eq. 8-3)**

Exposure duration (ED) is the number of years within the age groupings. In order to accommodate the use of the ASFs (see OEHHA, 2009), the exposure for each age grouping must be separately calculated. Thus, the DOSEwater and ED are different for each age grouping. The ASF, as shown below, is 10 for the third trimester and infants 0<2 years of age, is 3 for children age 2<16 years of age, and is 1 for adults 16 to 70 years of age.

ED = Exposure duration (years):

0.25 yrs for third trimester (ASF = 10)
2 yrs for 0<2 age group (ASF = 10)
7 yrs for 2<9 age group (ASF = 3)
14 yrs for 2<16 age group (ASF = 3)
14 yrs for 16<30 age group (ASF = 1)
54 yrs for 16-70 age group (ASF = 1)

AT, the averaging time for lifetime cancer risks, is 70 years in all cases. To determine lifetime cancer risks, the risks are then summed across the age groups:

$$RISKwater_{(lifetime)} = RISKwater_{(3rdtri)} + RISKwater_{(0<2\ yr)} + RISKwater_{(2<16\ yr)} + RISKwater_{(16\ yr\ onward)} \quad \textbf{(Eq. 8-4)}$$

As explained in Chapter 1, we also need to accommodate cancer risk estimates for the average (9 years) and high-end (30 years) length of time at a single residence, as well as the traditional 70 year lifetime cancer risk estimate. For example, assessing risk for a 9 year residential exposure scenario assumes exposure during the most sensitive period, from the third trimester to 9 years of age and would be presented as such:

$$RISKwater_{(9\text{-}yr\ residency)} = RISKwater_{(3rdtri)} + RISKwater_{(0<2\ yr)} + RISKwater_{(2<9\ yr)} \quad \textbf{(Eq. 8-5)}$$

For the 30-year residential exposure scenario, risk for the 2<16 and 16<30 age groups would be added to risks for exposures in the third trimester and ages 0<2 years.. For the 70 year lifetime risk, Eq 8-4 would apply.

~~BW = body weight (kg)~~
~~AT = averaging time (days), to assess carcinogenic risk:~~
~~90 days for third trimester~~
~~730 days for 0<2 yr age group~~
~~2554 days for 2<9 age group~~
~~5110 days for 2<16 yr age group~~
~~5110 days for 16<30 age group~~
~~19,711 days for 16-70 yr age group~~

8.~~2~~ 4 Water Intake Rate Studies

Water intake rates have been estimated through the collection of empirical (measured or self-reported) intake data. Some studies have modeled these data by fitting them to distributions. Both U.S. EPA and Cal/EPA (OEHHA) have reviewed and made recommendations for water intake rates in their exposure guidelines. In this section (8.~~2~~4) we will present background on the major studies that have collected or modeled water intake rate data as well as summarize U.S. EPA (Exposure Factors Handbooks) and OEHHA (Air Toxics "Hot Spots" Program Exposure and Stochastic guidelines) exposure guidelines. We review and present water intake values in ml/kg-day because these rates are needed for Equation 8.2 (above). The studies and guidelines are presented chronologically, below. We also describe and present the estimates derived by OEHHA for the current guidelines.

It is important to note that currently available water intake data were collected over short-term periods (one to three days). These data do not reflect long-term typical water intake rates because repeated measures are not available on the same individual over long periods. Therefore, the variability of currently available estimates includes both intra- and inter-individual variability. These two types of variability cannot be separately evaluated with the current data. The average long term intake is better estimated by such data than high end intake.

8.~~2~~4.1 Canadian Ministry of National Health and Welfare (1981)

The Canadian Ministry of National Health and Welfare (1981) study was conducted in the summer of 1977, the winter of 1978, and involved 970 individuals in 295 households. Interview and questionnaire techniques were used to determine per capita intake of tap water in all beverages (water, tea, coffee, reconstituted milk, soft drinks, homemade alcoholic beverages, etc.). Patterns of water intake were analyzed with respect to age, sex, season, geographical location, and physical activity. Average daily intake rates by age group are presented in Table 8.~~1~~ 3 (below). OEHHA did not use data from the Canadian study because the overall climate of Canada tends to be colder than California, the estimates are not likely representative of the current demographics of the U.S. population, and the raw data necessary to determine distributional characteristics were not available.

Table 8.3 Average Daily Water Intake (ml/kg-day) from the Canadian Ministry of National Health and Welfare (1981)

Age	Females	Males	Both sexes
<3 years	53	35	45
3-5 years	49	48	48
6-17 years	24	27	26
18-34 years	23	19	21
35-54 years	25	19	22
55+ years	24	21	22
All Ages	24	21	22

8.~~2~~4.2 Ershow and Cantor (1989), Ershow et al. (1991)

The Ershow and Cantor (1989) and Ershow et al. (1991) studies analyzed drinking water intake rates using the 1977-1978 Nationwide Food Consumption Survey (NFCS) data. Tap water intakes include tap water consumed as plain water and tap water added, while at home or at restaurants, in the preparation of food and beverages. There were approximately 20,000 study participants. Data were analyzed by age group, sex, season, and geographic region (including the Western Region), and separately for pregnant women, lactating women, and breast-fed children. Intakes were normalized to body weight using self-reported body weights. Because the Western Region estimates of the NFCS most closely reflect intake patterns of California, the Western Region estimates were recommended in the prior version of the Air Toxics Hot Spots Program Stochastic and Exposure guidelines (OEHHA, 2000).

The Western Region estimates are presented by age group in Table 8.~~2~~4. These estimates are based on about 16 percent of the total data set. Note that the traditional assumption of 2 liters daily water intake for a 70 kg body weight person corresponds to approximately the 75th percentile on Ershow and Cantor's distribution (28 ml/kg-day, see Table 8.~~2~~4). Table 8.~~3~~ 5 summarizes the intake estimates for pregnant women, lactating women, and breast-fed children of the Ershow and Cantor study. Though the Ershow and Cantor (1989) and Ershow et al. (1991) studies presented extensive analyses of the NFCS data, more recent intake data that more closely reflect current water intake patterns are now available.

Table 8.~~2~~ 4 Tap Water Intake Rates (ml/kg-day) of the Western Region, from Ershow and Cantor (1989) [1]

	Mean (SD)	50%	75%-ile	90%-ile	95%-ile
All Ages	24 (17)	21	30	43	54
< 1 year	53 (51)	39	67	106	141
1-10 years	39 (24)	34	49	70	88
11-19 years	18 (11)	17	24	32	39
20-64 years	21 (12)	19	27	37	44
65+ years	23 (10)	21	28	37	42

[1] Pregnant and lactating women, and breast-fed children excluded

Table 8.~~3~~ 5 Tap Water Intake Rates (ml/kg-day) for Control, Pregnant and Lactating Women, and Breast-fed Children, from Ershow et al. (1991) [1]

	Mean (SD)	50%	75%-ile	90%-ile	95%-ile
Control [1]	19 (11)	17	24	33	29
Pregnant	18 (10)	16	24	35	40
Lactating	21 (10)	21	27	35	37
Breast-fed	22 (25)	12	38	56	60

[1]Control = women 15-49 years age who were not pregnant or lactating

8.~~2~~4.3 Roseberry and Burmaster (1992)

Roseberry and Burmaster fit lognormal distributions to the datasets of Ershow and Cantor (1989) (discussed above). In tabulating the data they adjusted the data that were originally collected in 1977-78 to better represent the U.S. age group distribution of 1988. Although this study provided distributions of water intake, which is an essential component of stochastic analyses, OEHHA chose to not use these estimates because more recent water intake data are available. Further, the estimates are not normalized to body weight so they cannot be used or compared to the water estimates recommended in this document.

8.4.4 Levy et al. (1995)

Levy et al. (1995) evaluated fluoride intake of infants at 6 weeks, and 3, 6, and 9 months of age. At 6 weeks age, the sample size was 124, while at 9 months of age it was 77. Mothers were asked to record the average number of ounces of water per day over the past week that the infant consumed as plain water or that were used to make formula, juices and other beverages, baby food, cereal, and other foods consumed by the infant. These amounts were used to determine water intake. However, we did not use data from this study because only the mean and range were reported and because results were given as ounces per day (i.e., intake rates were not normalized to body weight).

8.~~2~~4.5 Exposure Factors Handbook (U.S. EPA, 1997)

The U.S. EPA's Exposure Factors Handbook (EFH) (U.S. EPA, 1997) reviewed water intake studies conducted before 1997 and made recommendations for water intake rate values in U.S. EPA risk assessments. The EFH (1997) used three key studies as the basis for their water intake recommendations: Canadian Ministry of National Health and Welfare (1981), Ershow and Cantor (1989), and Roseberry and Burmaster (1992) (see above). These studies were selected based on the applicability of their survey designs to exposure assessment of the entire United States population. U.S. EPA recommended 21 ml/kg-day as the average tap water intake rate for adults. This value is the population-weighted mean of the data from the Canadian Ministry of National Health and Welfare (1981) and Ershow and Cantor (1989). For the high-end adult value, U.S. EPA averaged the 90th percentile values from the same two studies to obtain a value of 34.2 ml/kg-day. The U.S. EPA recommended using the estimates of Roseberry and Burmaster (1992) for a characterization of the lognormal distribution of water intake estimates. However, U.S. EPA cautioned against using Roseberry and Burmaster (1992) for post-1997 estimates since these distributions reflect 1978 data adjusted to the U.S. age distribution of 1988. In addition to intake rates for adults, U.S. EPA also provided a table of intake rates for children, by age category, also from Ershow and Cantor (1989) and the Canadian Ministry of National Health and Welfare (1981).

OEHHA chose to not use the U.S. EPA (1997) estimates for current Hot Spots Stochastic and Exposure Guidelines (the current document) because more recent data are available and different age groupings are needed for OEHHA's current guidelines.

It should be noted that the USEPA released an external review draft of an updated Exposure Factors Handbook in 2009. The final version of the Exposure Factors Handbook was released in October, 2011 (USEPA, 2011).

8.~~2~~4.6 OEHHA (2000) Exposure Assessment and Stochastic Analysis Guidance

The previous version of the Hot Spots Exposure and Stochastic guidance (2000) recommended the "Western Region" water intake values of Ershow and Cantor (1989), which are presented in Table 8.~~2~~ 4 (above). The Western Region was considered more applicable to California than the entire U.S. due to climate and lifestyle (e.g., physical activity) factors.

OEHHA (2000) provided point and distributional recommendations for the 9-, 30-, and 70-year exposure durations used with that guidance. For the 9-year scenario, OEHHA simulated a distribution using the tap water distributions presented by Ershow and Cantor (1989) for children <1 year of age and for children 1 to 10 years of age using Crystal Ball®. This distribution is presented below in Table 8.~~4~~6. The distribution was fit to a lognormal parametric model with an arithmetic mean and standard deviation of 40.3 ±□21.6, μ ± is exp(3.57 ±0.50). The Anderson Darling Statistic is 0.65.

Table 8.6 OEHHA (2000) Tap Water Intake Rates Fit to a Lognormal Model for the 9-year Scenario (ml/kg-day) [1]

mean	SD	Percentiles										
		5	10	20	30	40	50	60	70	80	90	95
40	22	16	19	23	27	31	35	40	46	54	68	81

[1]Derived by OEHHA from data of ages 0-10 years from Ershow and Cantor (1989) fit to a lognormal distribution. Results presented in OEHHA Exposure Assessment and Stochastic Analysis Guidelines (2000)

For the 30- and 70-year scenarios, OEHHA used data for all ages of females from Ershow and Cantor (1989) to fit to a lognormal distribution with a mean of 24.0 and standard deviation (SD) of 17.2. The female mean was chosen because it is slightly higher than the male mean. Estimates of the fit to a lognormal model distribution are presented in Table 8.~~5~~7, below.

Table 8.~~5~~ 7 OEHHA (2000) Tap Water Intake Rates Fit to a Lognormal Distribution for the 30- and 70-year Scenarios (ml/kg-day) [1]

mean	SD	Percentiles										
		5	10	20	30	40	50	60	70	80	90	95
24	17	7	9	12	14	17	20	23	31	34	45	56

[1]Derived by OEHHA using data of females of all ages from Ershow and Cantor (1989) fit to a lognormal distribution. Results presented in OEHHA Exposure Assessment and Stochastic Analysis Guidelines (2000)

The OEHHA (2000) Exposure and Stochastic Guidance recommended using the mean and 95th percent-ile values from Table 8.6 and 8.7 (above) for each of the 9-, 30-, and

70-year scenarios. These recommended point values are presented in Table 8.~~6~~8, below.

Table 8.~~6~~ 8 Previously Recommended Point-Value Estimates for Daily Water Intake Rates (ml/kg-day) for the Exposure and Stochastic Guidelines of OEHHA (2000)

	9-year scenario (children)	**30- and 70-year scenario**
Average	40	24
High-end	81	54

For stochastic analyses using the OEHHA (2000) Exposure and Stochastic Guidance, the distributional values presented in Tables 8.~~4~~ 6 and 8.~~5~~ 7 (above) and fit to a lognormal distribution were recommended.

8.~~2~~4.7 U.S. EPA Office of Water (2004)

The Office of Water, U.S. EPA, derived estimated water intakes using data from the Continuing Survey of Food Intake of Individuals (CSFII) 1994-1996, 1998 dataset. The CSFII 1994-1996, 1998 (hereafter referred to as CSFII) is a nationwide survey that collected data on food and beverage intakes for two 24-hour non-consecutive periods, 3-10 days apart, on approximately 20,000 individuals during the years 1994-1996 and 1998. The Office of Water estimated the amount of water consumed by each individual, including both direct and indirect water intake. Direct water intake is water consumed as plain water from the tap, while indirect water intake is water used to prepare beverages and foods, either at home or at a food service establishment.

Two-day average water intakes for each participant were used in the analyses. Results are presented by water source (tap, bottled, other sources, or all water sources), type of water (direct, indirect or both), consumption type (consumer-only or combined consumer plus non-consumer ("per capita")), and in units of L/day or L/kg-day. Fine and broad age groups were analyzed. This report provides the most recent published analysis of water intake rates that are representative of the U.S. population. The report includes results for both combined and separate analyses of direct and indirect water intakes. However, the Office of Water (2004) intake estimates are from data that is the average of two non-consecutive days of intake and thus do not reflect a person's long-term typical intake. The combined direct plus indirect, community water intake rates by age group from the Office of Water (2004) report are presented in Table 8.~~7~~9, below. For all ages, the mean and 95th percentile water intake rates were 17 and 44 ml/kg-d.

Table 8.~~7~~ 9 Direct + Indirect, Community Water Intake Rates From U.S. EPA (2004) Table IV-8 (ml/kg-day)

			Percentiles							
Age in Years	**Sample Size**	**Mean**	**5**	**10**	**25**	**50**	**75**	**90**	**95**	**99**
0<0.5	414	95	5	7	37	91	133	184	221	294
0.5<0.9	534	53	3	5	12	47	81	112	129	186
0<2	1828	44	2	4	11	28	62	109	137	215
1-3	3230	26	2	4	9	20	35	53	68	110
4-6	2715	22	1	3	8	18	31	47	63	91
0<6	6410	30	2	4	9	21	38	67	93	162
7-10	956	16	1	3	6	13	22	33	40	59
11-14	736	13	1	2	5	10	17	27	36	54
15-19	771	12	1	1	4	9	16	26	32	62
20+	8459	16	1	3	7	13	22	32	39	62
20-24	637	15	1	2	5	11	18	31	39	80
25-54	4512	16	1	3	7	13	21	32	40	65
55-64	1383	17	1	3	8	14	23	32	38	58
65+	1927	18	2	5	10	16	24	32	37	53
All Ages	17,815	17	1	3	7	13	22	33	44	77

8.~~2~~4.8 U.S. EPA Child-Specific Exposure Factors Handbook (2008)

The U.S. EPA Child-Specific Exposure Factors Handbook (CEFH) provides statistical exposure factor recommendations, including recommended water intake rate values for exposure assessments that are specific for infants and children.

The CEFH (2008) undertook an analysis of the CSFII 1994-1996, 1998 dataset to derive water intake rates specific for the CEFH age groups. CEFH (2008) defined direct water as water consumed as a beverage. They defined indirect as water used to make beverages or foods. In their analysis, the CEFH did not differentiate between direct and indirect water resulting in intake estimates for combined direct plus indirect water.

The CEFH (2008) presented separate analyses of water intake by water source (i.e.,

community, bottled, other sources, and all sources). The U.S. EPA CEFH (2008) presented both ml/day and ml/kg-day intake rate values, and mean, minimum, maximum, and eleven percentile bins of intake estimates. No recommendations for fitted distributions for water intake rates were made in the CEFH (2008). Both per capita and consumer only water consumption rates were presented.

8.~~2~~4.9 CEFH Table 3-19

Of the tables in CEFH (2008), Table 3-19 provides water intake estimates that were of the most relevance to OEHHA because these rates are for combined direct plus indirect community water intake. The table includes percentile values for consumer-only rates. Table 3-19 is presented in Table 8.~~8~~10, below. OEHHA chose to use the estimates for some of these age groups in deriving OEHHA-specific age group water intake rates (see Section 8.~~2~~4.13, below). This information is also published in Kahn and Stralka (2009).

Table 8.~~8~~ 10 Table 3-19 U.S. EPA CEFH (2008). Consumer-only, Direct plus Indirect, Community Water, Intake Rates By Age Group for U.S. Infants and Children (ml/kg-day)

	Sample Size	Mean	50th	90th	95th	99th
0<1 month	37	137	138	235	238	263
1<3 months	108	119	107	228	285	345
3<6 months	269	80	77	148	173	222
6<12 months	534	53	47	112	129	186
1<2 years	880	27	20	56	75	109
2<3 years	879	26	21	52	62	121
3<6 years	3703	24	19	49	65	97
6<11 years	1439	17	13	35	45	72
11<16 years	911	13	10	26	34	54
16>18 years	339	12	9	24	32	58
18<21 years	361	13	10	29	35	63

* Source of Data: USDA Continuing Survey of Food Intakes by Individuals (CSFII), 1994-96, 1998

8.~~2~~4.10 Michaud et al. (2007)

Michaud et al. (2007) investigated the relationship between total fluid intake and bladder cancer. Participants were asked via questionnaire about the volume and frequency of specific beverages during the 5 years prior to the study interview. The researchers calculated total fluid intake by multiplying the volume and frequency of each beverage and summing the result. Because the fluid intake included fluids from commercial beverages, and because water absorbed into foods during cooking was not included, we did not use these intakes. Further, intakes were only given as ml/day and results were reported as quintiles so only intervals of intake were reported (e.g., 29 ml/day, 29-40 ml/day, 41-55 ml/day, etc.).

8.4.11 Barraj et al. (2008)

Barraj et al. (2008) collected drinking water consumption data over a 7-day period on a nationwide sample of persons of all ages during two 'waves' (survey periods meant to represent winter and summer seasons). Diaries were used to record frequency and amounts of plain drinking water consumed. The final dataset contained data from 4198 individuals from 2154 households. The response rate was 33 percent and 36 percent for wave 1 and wave 2, respectively. The proportion of study participants by age-sex groups and U.S. region was comparable to those of the U.S. 2000 census, with the exception of women over 50 years of age. The proportion of whites in the study was greater than the U.S. census. Results included 24-hour drinking water consumption rates, number of occasions of drinking water, amount per occasion, and inter- and intra-individual variability in water consumption patterns. Because this study was restricted to plain drinking water, while we are interested in water used for reconstituting food and beverages and water absorbed during cooking, in addition to plain drinking water, we cannot use these data to quantify water intake rates. Nonetheless, the study did evaluate inter- and intra-individual variability in daily water intake (ounces per day) and found that inter-individual variability was greater than intra-individual variability. There were significant day-to-day differences in water intake (ounces per day) in "wave 1" (summer) for women 13-49 years of age and men 20-49 years of age, and in "wave 2" (winter/early spring) for children 0-5 and boys 13-19 years of age. There was also a significant weekend effect.

8.~~2~~4.12 Kahn and Stralka (2009)

Kahn and Stralka (2009) published in a peer-reviewed journal the water intake rates that they had derived for the U.S. EPA, Office of Drinking Water (2004) report. This publication will not be discussed here because the methodology and results are presented in Section 8.~~2~~4.7, above. However, we make note of this publication and that it has been reviewed for these guidelines.

8.~~2~~4.13 OEHHA Derived Water Intake Rates for Hot Spots Program Age Groups and Exposure Duration Scenarios

OEHHA chose to use water intake estimates from the Office of Water, U.S. EPA (2004) and U.S. EPA CEFH (2008) Table 3-19 as the basis for OEHHA's water intake rate recommendations (with the exception of the infant age group, see below). Both the Office of Water (2007) and U.S. EPA CEFH (2008) Table 3.19 intake estimates are representative of demographics (e.g., age, sex, income, etc.) of the U.S. population because they have been weighted using the data-specific sample and variance weights. The rates are in ml/kg-day, which is the unit of measure specified for the current Hot Spots program guidance (see Equation 8.1, above). The Office of Water report and U.S. EPA CEFH (2008) Table 3.19 include consumer-only tap (community) water intake rates, which are of particular relevance for OEHHA because water consumed from local surface water bodies is likely to be made available to consumers via the tap available at home. Though more recent water intake data are now available (NHANES 1999-2004), the NHANES water intake data are limited because information on whether the water was from the tap or not was not collected, the water source (e.g., municipal, bottled, etc.) is not specified for several of the years, and intake data were collected on two days per individual. Further, although direct intake rates are in the NHANES dataset, to obtain the indirect intake rates that OEHHA needs would require calculations using recipe code books and other data manipulation. Thus, the Office of Water and U.S. EPA CEFH (2008) Table 3.19 rates, which are based on 1994-1996 and 1998 data, are the most recent derivation of direct and indirect water intake rates that are representative of the population.

It should be noted, though, that the Office of Water (2004) and U.S. EPA CEFH (2008) Table 3.19 intake rates are not available on a state-by-state basis. Thus, the rates used by OEHHA are not specific to California and therefore may differ from those of the California population due to different climate and lifestyle factors. However, it is likely that the rates would not be substantially different overall since there are other areas of the U.S. with climate and lifestyle patterns similar to those of California. Further, the California population represents a significant fraction (over 10%) of the national population and thus would have contributed a substantial weight to the CSFII survey.

Because the age groups in the Office of Water report (2004) and U.S. EPA CEFH (2008) Table 3.19 differ from the age groups and exposure duration scenarios to be used for the current Hot Spots risk assessments, OEHHA derived water intake rates specific for the Hot Spots program ages. Table 8.~~9~~11, below, lists the data sources used to derive water intake rates for the Hot Spots program.

Table 8.11 Data Used to Derive Water Intake Rates for Hot Spots Program Age Groups and Exposure Duration Scenarios

Hot Spots Age Group	Derived by OEHHA [1]	CEFH Revised Table 3-19 (2008)	Office of Water (2004)
0<2 years	0<1 year [1]	1<2 years	
2-9 years		2<3 years 3<6 years 6<11 years	
2<16 years		2<3 years 3<6 years 6<11 years 11<16 years	
16-30 years		16<21 years	20-24 years 25-54 years [2]
16-70 years		16<21 years	20-24 years 25-54 years 55-64 years [3]
>=16 years		16<21 years	20-24 years 25-54 years 55-64 years 65+ years
Hot Spots Exposure Duration	**Derived by OEHHA [1]**	**CEFH Table 3-19 (2008)**	**Office of Water (2004)**
9-year	0<1 year [1]	1<2 years 2<3 years 3<6 years 6<11 years	
30-year	0<1 year [1]	1<2 years 2<3 years 3<6 years 6<11 years 11<16 years 16<21 years	20-24 years 25-54 years [2]
70-year	0<1 year [1]	1<2 years 2<3 years 3<6 years 6<11 years 11<16 years 16<21 years	20-24 years 25-54 years 55-64 years [3]

[1]Using intakes of water in reconstituted formula consumed by infants in CSFII 1994-1996, 1998
[2]Because intake rates are relatively stable after 16 years of age, the 25-54 year age group was used to represent the 25-30 year age group but with population size adjusted to the 25-30 year age group
[3]Because intake rates are relatively stable between the 55-64 year and 65+ year age groups (mean of 17 vs. 18 and 95%-ile of 38 vs. 37, for the 55-64 and 65+ year age groups, respectively), OEHHA chose to use the 55-64 year age group to represent the 65-70 year age group and adjust for the additional 65-70 years of age population.

For the derivation of Hot Spots program age groups and exposure duration scenarios, OEHHA used Crystal Ball version 7.2 (Oracle, 2008) to find the best fit for distributions, to simulate values of distributions, and to identify distributional parameters (mean, scale, location, etc.). Crystal Ball was also used to derive percentiles and summary statistics. In identifying the best fit for a distribution, the Anderson-Darling test, one of three goodness-of-fit tests available in Crystal Ball, was used because it gives extra weight to the tails of the distribution, which the other goodness-of-fit tests do not. The tails of the distribution are of particular interest to OEHHA because the right tail defines high-end intake rates.

OEHHA did not use the Office of Water (2004) or U.S. EPA CEFH (2008) Table 3.19 water intake estimates for infant (0<1 year of age) intake rates. Instead, OEHHA derived water intake rates of infants consuming reconstituted formula. The reasons for this are described below in Section 8.~~3~~5.1, "Infants." OEHHA used data from the CSFII 1994-1996, 1998 dataset to derive infant water intake rates. To identify infants who received reconstituted formula, the food description provided for the formula consumed by each infant was reviewed. Breast-fed infants were excluded from analysis. To calculate the amount of water consumed by each infant, the amount of reconstituted formula consumed was multiplied by the percent of indirect water in each type of reconstituted formula (these values were obtained from Appendix-D of the U.S. EPA Office of Drinking Water report (2004)). Two outliers were identified and excluded from analyses. Sample weights were available in the dataset in order to weight each individual's intake according to the number of infants in the population that he/she represented (see USDA, 2000 for a more detailed description). Each infant's water intake was paired with her/his sample weight in Crystal Ball (version 7.2) to derive a distribution of intakes representative of the population. The Anderson-Darling goodness-of-fit test was used to find the best fit distribution for the weighted data. This weighting and best fit procedure was conducted for each infant age group (0<1, 1<2, 0<3, 3<6, and 0<12 months of age).

The OEHHA–derived water intake rates for these infant age groups will be used in conjunction with other data to derive Hot Spots program age group and exposure duration scenario water intake rates (as outlined in Table 8.~~9~~11, above). By doing so, the Hot Spots program water intake rates will reflect intake rates of the truly exposed infants (those receiving reconstituted formula). The results are presented in Table 8.~~10~~12, below, along with the Office of Water (2004) or U.S. EPA CEFH (2008) Table 3.19 estimates (direct plus indirect consumer-only community water intake rates) for comparison.

Table 8.~~10~~ 12 Water Intake Rates of Infants by Age Group (ml/kg-day) – Derived by OEHHA (2008) or U.S. EPA (2004 or 2008)

Study	Age in Months	Sample Size	Mean	50%-ile	90%-ile	95%-ile	99%-ile
OEHHA CSFII [2]	0<1	45	184	171	253	300	466
U.S. EPA Table 3-19 [3]	0<1	37	137	155	236	269	269
OEHHA CSFII [2]	1<2	61	134	113	294	301	375
OEHHA CSFII [2]	0<3	137	122	113	206	294	375
U.S. EPA Table 3-19 [3]	0<3	108	119	107	247	289	375
OEHHA CSFII [2]	0<6	467	127	123	200	237	333
U.S. EPA (2004) [3]	0<6	414	95	91	184	221	294
OEHHA CSFII [2]	0<12	906	142	148	213	228	276
U.S. EPA (2004) [3]	0<12	948	71	62	145	185	261

[1]N = sample size. However, results have been weighted to adjust sample to the population.
[2]OEHHA analyses include water intake only from reconstituted formula
[3]U.S. EPA (2008) includes any direct or indirect intake of community water by consumers-only

A limitation of using intake data from infants receiving reconstituted formula is that the intakes do not include water added to food and non-formula drink, which results in possible underestimation of water intake. This limitation is likely only applicable to the second half of infancy when infants typically receive supplemental food and drink in addition to formula. A second limitation to the OEHHA derived infant intake rates are that the source of water (e.g., tap) used to reconstitute the formula is unknown. However, it is probable that a large fraction of infants are fed reconstituted formula prepared with tap water (see Section 8.~~3~~5.1, below, for results of Levallois et al. 2007).

The Office of Water (2004) mean estimates are lower than the OEHHA mean estimates because they include data from infants who may have been almost exclusively (i.e., received an insignificant amount of calories from other non-milk food or drink), or exclusively, breast-fed but received a small amount of water. The 90th-, 95th-, and 99th-percentile estimates are similar among the analyses because these values likely represent infants who are exclusively fed formula reconstituted

with water. These values support the consistency of results among analyses, and that some infants consuming reconstituted formula may have very high water intake rates.

To estimate intake rates for the Hot Spots 0<2 year age group, the percentiles of the distribution and associated intake values for the 0<1 year age group (OEHHA derived, see Table 8.~~10~~12, above) were entered into Crystal Ball and used to characterize the probability distribution of the intake rates. The best fit for the distribution was identified using the Anderson Darling goodness-of-fit test. The parameters for the modeled distribution were then derived using the empirical minimum and maximum to truncate unrealistically low and high values. This process (characterizing the probability distribution) was repeated for the water intake values of the 1<2 year age group of the CEFH Table 3-19 (2008). Table IV-8 of the Office of Water (2004) provided data on the population size of each age group (0<1 year and 1<2 years) relative to the full age group (0<2 years).

The population proportion was multiplied by 60,000 to give the number of infants for each age group in a hypothetical population of 60,000 infants. The Latin Hypercube method of Monte Carlo simulation in Crystal Ball was then used to generate simulated values for the 0<1 year age group based on the calculated number of infants in the hypothetical population. The same simulation procedure was applied to the 1<2 year age group distribution. The simulated values were then combined into one dataset. The best fit for the distribution of the combined values was characterized using the empirical minimum and maximum values for truncation to eliminate potentially unrealistic extreme values. The parameters of the combined (0<2 year age group) distribution were identified and summary statistics calculated.

To derive distributions for the other Hot Spots age groups and exposure duration scenarios, the above described procedure was also used. That is, using the data outlined in Table 8.~~9~~ 11 for each Hot Spots program age group and exposure duration scenario, the probability distribution was characterized, population proportions were calculated (using Office of Water Table IV-8), and values proportional to population size were simulated. The simulated values were then combined, the best fit for the resultant distribution was identified, and parameters and summary statistics for the distribution were found. It may be noted that when calculating population proportions, the age groups of Table IV-8 of the Office of Water (2004) did not always fit the CEFH Table 3-19 age groups. In these cases, some approximations were required.

Values for the OEHHA derived Hot Spots age groups and exposure duration scenarios are presented in Table 8.~~11~~13, below.

Table 8.13 OEHHA Derived Consumer-only Water Intake Rates (ml/kg-day) for Hot Spots Program Age Groups and Exposure Duration Scenarios[1]

Age	Mean	50th	Variance	90th	95th	99th	Max
Third Trimester	18	14	218	38	47	67	117
0<1 year [2]	143	149	3240	213	228	276	491 [5]
0<2 years [2]	113	106	1915	172	196	247	491 [4]
2-9 years [3]	26	22	414	54	66	92	190 [5]
2<16 years [3]	24	19	362	49	61	88	152
>=16 years [3]	19	16	208	38	47	67	135 [5]
16-30 years [3]	18	14	218	38	47	67	117
16-70 years [3]	18	15	191	37	45	62	116
Duration							
0-9 year [2]	45	25	3052	102	152	288	491
0-30 year [2]	28	15	1219	59	87	177	450
0-70 year [2]	23	14	886	51	73	141	442

[1]OEHHA recommends the mean and 95th percentiles as the average and high end point estimate values.
[2]Includes the OEHHA derived 0<1 year of age group water intake rates derived from the water in reconstituted formula for infants in CSFII
[2]OEHHA derived – data sources are **c**onsumer-only, direct + indirect, community water intake rates from Office of Water (2004) and U.S. EPA CEFH (2008) Table 3.19.
[4]Right tail outliers deleted
[5]fit distribution has maximum of infinity

8.~~2~~4.14 Fitted Distributions of OEHHA Derived Water Intake Rates

The steps involved in deriving water intake rates specific for the Hot Spots program age group and exposure duration scenarios are described above, and briefly discussed here. OEHHA characterized the probability distributions for certain age group datasets from the Office of Water (2004) or Table 3-19 (2008) using Crystal Ball version 7.2 (Oracle, 2008). The best fit distributional type (e.g., gamma) was then found using the Anderson-Darling goodness-of-fit test. The parameters of the best fit distribution were then determined. Distributions were combined as listed in Table 8.~~9~~ 11 to provide age groups matching the age groups needed for the Air Toxics Hot Spots program. The distributions were combined proportionate to population size which was approximated using the population numbers in U.S. EPA (2004). The mean and percentiles were calculated for the combined age group distributions using Crystal Ball 7.2 (Oracle, 2008) and the results are presented in Table 8.~~11~~13, above. The combined age group distributions were characterized using Crystal Ball to find the best fit distribution, the Anderson-Darling statistic for that fit, and the parameters that fit that distribution. The distributional characteristics and values are presented in Table 8.~~12~~14, below.

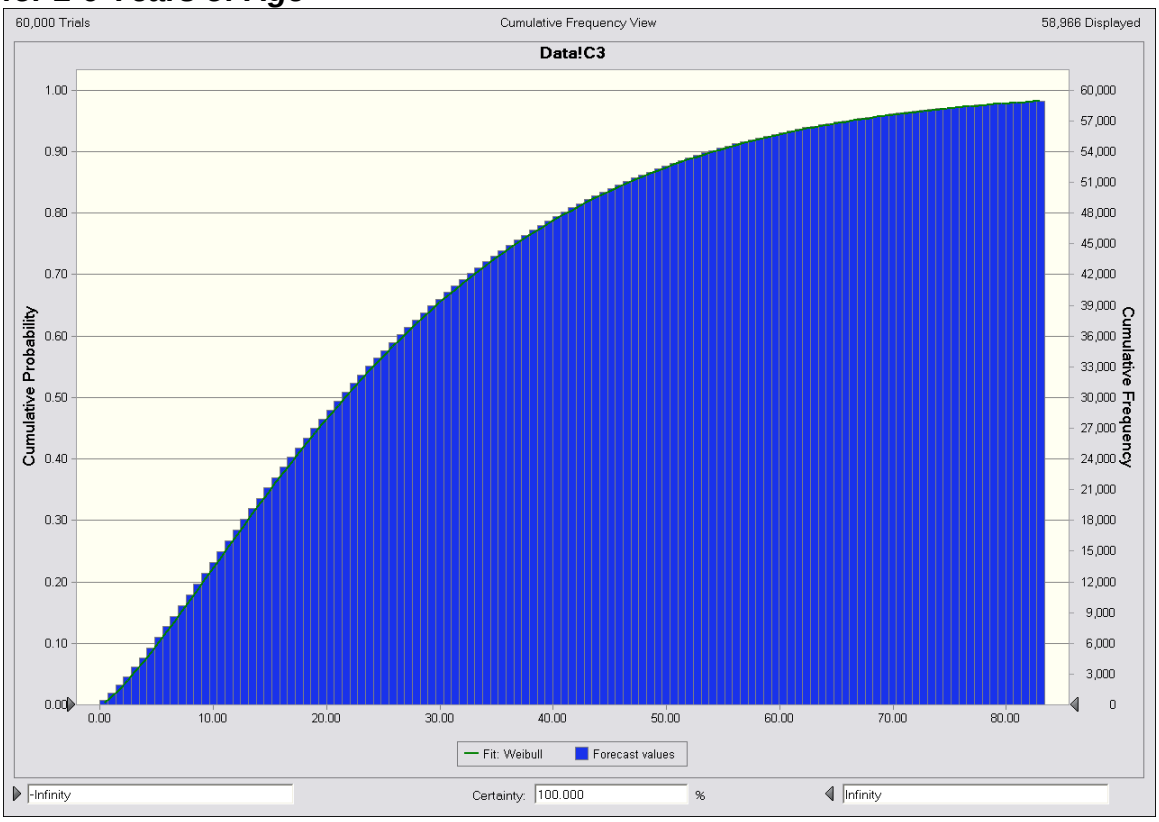
Table 8.~~12~~ 14 Recommended Distributions of OEHHA Derived Water Intake Rates for Stochastic Analysis (ml/kg-day)

Age	Best Fit [1]	A-D statistic [2]	Parameters of Distribution [3]
0<1 year	Beta	23.2	Min = 60 Max = 264 Alpha = 4.1 Beta = 2.5
0<2 years [5]	Max Extreme	1.06	Likeliest = 93 Scale = 35
2<9 years	Weibull	0.01	Location = 0.02 Scale = 29 Shape = 1.3
2<16 years [6]	Gamma	0.11	Location = 0.19 Scale = 15.0 Shape = 1.6
≥16 years [6]	Gamma	0.52	Location = 0.17 Scale = 10.7 Shape = 1.8
16-30 year[7]	Gamma	10.6	location=0.49, scale=13.6, shape=1.26
16-70 year	Beta	1.09	min=0.17, max=178, alpha=1.5beta= 12.9
Duration			
0-9 year scenario	Lognormal	2.7	Mean = 45 SD = 70
0-30 year scenario	Lognormal	0.31	Mean = 26 SD = 39
0-70 year scenario	Lognormal	0.04	Mean = 23 SD = 29

[1]Best Fit refers to the distribution found to best fit the empirical data according to the Anderson-Darling goodness-of-fit test
[2]A-D statistic = Anderson-Darling statistic
[3]Parameters of Distribution refers to the parameters of the best fit distribution
[4]Taken directly from U.S. EPA CEFH (2008) Table 3.19.
[5]0<2 year age group derived by combining water in reconstituted formula only for 0<12 month ages from CSFII and the 1<2 year age group from U.S. EPA CEFH (2008) Table 3.19
[6]OEHHA analyses that derived alternate age groups using U.S. EPA (2004) and U.S. EPA CEFH (2008) Table 3.19.
[7]This distribution is recommended for the third trimester also.

To give a graphical example of the OEHHA derived distributions, the cumulative probability of the 2-9 year of age distribution (best fit) is shown below, in Figure 8.1.

Figure 8.1. Cumulative Probability Distribution for Water Intake Rates (ml/kg-day) for 2-9 Years of Age



8.~~3~~ 5 Special Subpopulations of Concern

8.~~3~~5.1 Infants

Infants may be more sensitive and exposed (on a body weight basis) to some toxicants than non-infant children and adults. Further, infants have unique nutritional needs, necessitating the feeding of milk or milk substitutes through at least three, and more commonly through four to six months of age. For the first 4-6 months, infants who are fed breast milk typically receive little, if any, other fluid. This is primarily because continued lactation is dependent on continued nursing. If nursing is reduced or discontinued for any length of time, the milk production quickly ceases. Thus, breast-fed infants tend to receive breast milk as their sole source of fluid and nutrition during the first half of infancy.

On the other hand, infants who are not breast-fed receive formula. The Ross Mothers Survey (Ross Products Division, Abbott, 2003) reported that in 2003, 44 percent, 18 percent, and 10 percent of infants were exclusively breastfed (no other liquids) in the hospital (i.e., soon after birth), at 6 months of age, and at 12 months of age, respectively. This suggests that the percent of infants who receive formula may be up to 56 percent soon after birth and 82 percent at 6 months of age.

Formula can be bought ready-to-feed or in a form requiring the addition of water before it can be fed to the infant (i.e., powder or concentrated liquid). OEHHA analyzed the CSFII 1994-1996, 1998 and NHANES (National Health and Nutrition Examination Survey) 1999-2004 dataset to assess the proportion of infants who received reconstituted formula, relative to all types of formula. The food code descriptions were reviewed to identify the type of formula each infant received, including reconstituted formula. The results are presented in Table 8.~~13~~15, below. These results provide evidence that a large fraction of formula-fed infants receive reconstituted formula, especially so for the youngest ages. These results also suggest that there may be a trend over time toward greater consumption of reconstituted formula relative to ready-to-feed formula.

Table 8.~~13~~ 15 Percent of formula-fed infants consuming reconstituted formula

Age	CSFII	NHANES
0 < 1 month	82% (45 / 55) [1]	94% (31 / 32)
0<6 months	71% (467 / 658)	87% (398 / 457)
0<12 months	75% (906 / 1201)	87% (886 / 1013)

[1] ( ) = # receiving reconstituted formula / # receiving any type formula

Additionally, a study of 2-month old infants in rural Canada (with a sample size of approximately 300) found that 91 percent of formula-fed infants received formula reconstituted with water (Levallois et al., 2007). This is consistent with the results in Table 8.~~13~~15, above. Because OEHHA is particularly interested in tap water intake rates, it is important to note that, of the Canadian infants receiving reconstituted formula, 60 percent received formula reconstituted with tap water.

Because the majority of formula-fed infants receive formula that has been reconstituted with water, which is often tap water (60 percent per Levallois et al., 2007), during the first half of infancy, the infant population is dichotomized into infants who receive little, or no, tap water (breast-fed infants) and infants who receive significant amounts of tap water every day (reconstituted formula fed infants).

While the infant's diet during first half of infancy typically consists almost exclusively of breast milk or formula, infant diet during the second half is much more varied and includes the gradual introduction of food and non-milk beverages. (The term 'second half of infancy' is used loosely here because the age at which food and non-milk drink is introduced varies but is typically between 4-6 months of age). Nonetheless, during this second half of infancy, the dichotomization of infants into two groups based on water intake rates continues, though the difference between the groups may be somewhat less pronounced.

The American Academy of Pediatrics (AAP, 1997) recommends that infants be exclusively breast-fed through 6 months of age and continue to receive breast milk as their sole source of milk while being introduced to solid food through 12 months. Thus, breast-fed infants may begin to receive some food and drink prepared with water but often not until at least 6 months of age. Further, breast-fed infants

frequently continue to receive breast milk as a significant source of fluid and nutrition for several months past the introduction of supplemental food and drink. For formula-fed infants, because the accepted medical recommendation is to not feed cow's milk until at least 12 months of age, formula-fed infants typically continue to receive formula as their sole milk source. Like breast-fed infants, formula-fed infants may increase their intake of food and non-formula drink prepared with water during this period. Both breast-fed and formula-fed infants tend to decrease their consumption of breast milk or formula, respectively, while their consumption of food and drink prepared with water is likely to increase. Thus, during the second half of infancy, overall water intake of breast-fed infants likely increases, though probably not dramatically, while intake of formula-fed infants likely varies considerably between infants but with the potential for some infants to have even greater intake rates than during the first half of infancy.

The above information supports the existence of a sizable subpopulation of infants who are exclusively (or almost exclusively) fed formula reconstituted with water, which is often tap water, for the first 4-6 months and thereafter receive significant quantities of tap water through 12 months of age. These infants could receive significant tap water intake over the first year of life. In the past few years, there has been heightened awareness of the probable increased susceptibility of infants and children to some environmental toxicants. Therefore, it is prudent to identify subpopulations of infants who may be the most highly exposed. For the water pathway, reconstituted formula-fed infants can have a very high rate of tap water intake over the first year of life. Thus, water intake rates representative of this subpopulation (reconstituted formula fed infants) should be used for assessments of infants to exposures via the water pathway.

In risk assessment, we are interested in the dose to those who are exposed; in the case of the water pathway, those who consume water. With water intake, some individuals may not consume water on one or more days, or consume insignificant amounts of water (e.g., breast-fed infants). For the 'consumer-only' groups of infants in the Office of Water report, (U.S. EPA, 2004), only mean (average) values were given and these were only for the 0<6 and 0<12 month ages (i.e., relatively broad age groups for infants). In Table 3-19, consumer-only rates include percentiles of the distribution and the ages are stratified into narrower age groups (i.e., 0<1, 1<3, 3<6, and 6<12 months of age).

Of interest to OEHHA are rates of direct plus indirect community water intakes for narrow age groups of consumer-only infants. With such rates, both central tendency plus high-end rates of potentially more susceptible and exposed infants can be identified. U.S. EPA CEFH (2008) Table 3.19 provides these estimates. The U.S. EPA CEFH (2008) Table 3.19 infant estimates are presented in Table 8.~~14~~16, below. However, the data used to derive these estimates included infants who were breast-fed. Therefore, these values do not represent the high-end exposure subpopulation of formula-fed infants.

Table 8.~~14~~ 16 Infants Only -- U.S. EPA (2008), Child-Specific Exposure Factors Handbook Table 3-19. Estimates of Direct + Indirect, Consumer-only, Community Water Intake By Age Group (ml/kg-day)

Age (years)			Percentiles (ml/kg-day)								
	Mean	**Min**	**5**	**10**	**25**	**50**	**75**	**90**	**95**	**99**	**Max**
0<1 month	137	5	11	11	67	155	198	236	269	269	269
1<3 months	119	3	9	12	72	107	153	247	289	375	375
3<6 months	80	1	3	7	28	77	118	149	174	224	288
6<12 months	53	0	3	5	12	48	81	112	130	186	254

8.~~3~~5.2 Pregnant and Lactating Women

Pregnant and lactating women have greater water requirements than non-pregnant or non-lactating women. A pregnant woman requires increased water intake in order to support fetal circulation, amniotic fluid, and a higher maternal blood volume, while a lactating woman requires increased water to replace the water excreted in breast milk. Values from the literature support this hypothesis. OEHHA (2000) Exposure Assessment and Stochastic Analysis Guidelines presented a table based on Ershow and Cantor (1989) that compared water intake rates of pregnant and lactating women with 'control' (not lactating, not pregnant) women of the same ages (see Table 8.~~15~~17, below). These estimates demonstrate that lactating women consume significantly more water than non-lactating, and even pregnant, women. More recent data are available than the values in Table 8.~~15~~17. Therefore the values from Table 8.~~15~~ 17 will not be used for Hot Spots guidance values.

Table 8.~~15~~ 17 Water Intake Estimates For Pregnant and Lactating Women from Ershow and Cantor (1989*) (ml/kg-day) – *Tap Water

Group	**N**	**Mean**	**50th**	**75th**	**90th**	**95th**
Control	6201	19	17	24	33	39
Pregnant	188	18	16	24	35	40
Lactating	77	21	21	27	35	37

*Data from Ershow et al. 1991 based on data from the USDA Nationwide Food Consumption Survey (NFCS 1977-78)

The Office of Water, U.S. EPA (2004) report presented estimates of water intake rates for pregnant and lactating women. These rates are derived from CSFII 1994-1996, 1998 data. The consumer-only intake rates of direct plus indirect community water intakes are presented in Table 8.~~16~~ 18 below.

Table 8.~~16~~ 18 Water Intake Rates of Direct + Indirect Community Water for Consumers-only (ml/kg-day) for Pregnant, Lactating, and Non-pregnant / Non-lactating Women 15-40 Years of Age

Group	Sample size	mean	Percentiles				
			50th	75th	90th	95th	99th
Pregnant	65	14	9	22	33	43	47
Lactating	33	26	20	41	54	55	57
Non-pregnant, non-lactating, aged 15-44 yrs	2028	15	12	21	32	38	68

- From Part IV Table A3 of U.S. EPA (2004)
- Data used were from CSFII 1994-1996, 1998

8.~~3~~5.3 High Activity Levels / Hot Climates

In the Exposure Factors handbook (1997), the U.S. EPA also addresses the issue of water consumption for those individuals performing strenuous activities under various environmental conditions, including desert climates (U.S. EPA, 1997). Data on these intake rates are very limited, and since the populations in the available studies are not considered representative of the general U.S. population, U.S. EPA did not use these data as the basis of their recommendations. Instead, they used the data from two studies to provide bounding intake values for those individuals engaged in strenuous activities in hot climates (McNall and Schlegel, 1968; U.S. Army, 1983).

McNall and Schlegel (1968) measured water intake of adult males working under varying degrees of physical activity, and varying temperatures. The results of this study indicate that hourly intake can range from 0.21 to 0.65 L/hour depending on the temperature and activity level.

U.S. EPA notes that these intake rates cannot be multiplied by 24 hours/day to convert to daily intake rates because they are only representative of water intakes during the 8-hour study periods of the test protocol. Intakes of the subjects for the rest of the day are not known.

The U.S. Army has developed water consumption planning factors to enable them to transport an adequate amount of water to soldiers in the field under various conditions (U.S. Army, 1983 and 1999). According to their estimates, intake among physically active individuals can range from 6 L/day in temperate climates to 11 L/day in hot climates. The Army's water consumption planning factors are based on military operations and may over-estimate civilian water consumption.

8.~~5~~ 6 References

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9. Fish Consumption

9.1 Introduction

The "Hot Spots" (AB-2588) risk assessment process addresses contamination of bodies of water near facilities emitting air pollutants. The consumption of fish from contaminated bodies of water can be a significant exposure pathway for persistent bioaccumulative organic compounds and some heavy metals. Sport fishing in freshwater lakes and ponds is the primary concern for this exposure pathway, as deposited contaminants have the greatest potential to concentrate in these types of water bodies. Although regional air contaminants depositing into the ocean, bays and estuaries are a significant problem, the risks predicted from a single source are expected to be relatively insignificant due to tidal flows and dilution. Possible exceptions could be estuaries, salt marshes or sloughs with very low tidal flow that lead to accumulation of pollutants from nearby emission sources.

Commercial store-bought fish generally come from a number of sources. Consequently, the health risks of concern are due to noncommercial, or sport, fishing. The sport fish consumption rate is a critical variate in the assessment of potential health risks to individuals consuming fish from waters impacted by facility emissions. Other synonymous terms used for sport fishing include "self-caught fish" and "wild-caught fish". The term "angler" or "sport fisher" refers to persons who catch sport fish or shellfish. These groups may include subsistence fishers.

Estimates of sport fish consumption by fishers tend to be greater than estimates of commercial fish consumption rates for the general population (Puffer et al., 1982a; Puffer et al., 1982b; SCCWRP and MBC, 1994; OEHHA, 2001). The higher intake rate of sport fish consumption by fishers creates a sensitive subpopulation relative to the general population when a facility's emissions impact a fishable body of water. For this reason, consumption rates that apply to the general sport fisher population, rather than per capita estimates of fish consumption, are used here to characterize fish consumption by the subpopulation that is at risk from consuming fish contaminated by air emissions from stationary sources.

Sport fish consumption rates may also vary by geographic location and for specific subpopulations. The U.S. EPA recommends using data on local consumption patterns and population characteristics whenever possible (U.S. EPA, 2000). For instance, subsistence fishers, as well as certain cultural groups, can have particularly high consumption rates relative to the general population (Harnly et al., 1997; SFEI, 2000; U.S. EPA, 2000). Use of national averages can seriously underestimate risks to these subpopulations.

Because freshwater bodies ~~including~~ such as lakes and~~,~~ ponds ~~and reservoirs~~ have the greatest potential for concentrating deposited contaminants, the ideal fish consumption study to use for the Hot Spots program would be a study of California freshwater sport fish consumption. Unfortunately, there are no such studies available. However,

comprehensive studies have been conducted in California surveying consumption rates of saltwater or Central Valley Delta fishers (Puffer et al., 1982a; Puffer et al., 1982b; SCCWRP and MBC, 1994; Wong, 1997; SFEI, 2000; Shilling et al., 2010). One strength of the California marine surveys is that the survey population is ethnically diverse, which may better approximate the consumption patterns for the California population, relative to studies that surveyed more homogeneous populations.

The application of the results of an ideal single fish consumption study conducted elsewhere to an impacted water body will always be uncertain because factors such as individual water body productivity, size, and local angler water body preferences will influence fish consumption. Conducting a site-specific sport fish consumption survey, in most cases, would not be a cost-effective alternative to use of the values presented in this chapter. Thus, OEHHA encourages the description of factors in the risk assessment which might significantly reduce or increase the estimated quantity of sport fish consumed for the consideration of the risk managers.

9.2 Recommendations for Angler-Caught Fish Consumption Rates

[note: this section moved (and slightly reworded) from the back to the front]

Recommended point estimates for angler-caught fish consumption rates are shown in Table 9.1. The fish consumption estimates are used to calculate individual cancer risk and noncancer chronic risk to those who eat sport (angler-caught) fish. Under the "Hot Spots" program, these values apply principally for risks to the general freshwater fishing population from consumption of all sport fish species at a given location.

The risks should be presented using the high-end estimate in Tier 1 risk assessments, if the fish ingestion pathway is a dominant pathway. As noted in Chapter 1, dominant pathways are defined as the two pathways contributing the most to cancer risk when high-end estimates of intake are used in the risk calculation. The risks estimated from the average value would be used where fish ingestion is not a dominant pathway and may also be presented for comparison in assessments where fish ingestion is a dominant pathway.

However, if high fish-consuming groups including ethnic groups and/or subsistence fishers are known to be present, OEHHA recommends that the intake rate at the 95th percentile be used to reflect the upper bound estimate of consumption rates for these subpopulations, and when characterizing and aiming to protect the target population as a whole.

Table 9.1 Point Estimate Values for Sport Fish Consumption by Age Group

	Third Trimester	0 <2 Years	2<9 Years	2<16 Years	16<30 Years	16-70 Years
	Consumption rates in g/day					

Average	-	2.1	7.9	13.3	28.8	28.8
High End[a]	-	6.6	25.4	42.9	92.4	92.4
	Consumption rates normalized by body weight, in g/kg-day					
Average	0.38	0.18	0.36	0.36	0.38	0.36
High-End[a]	1.22	0.58	1.16	1.16	1.22	1.16

[a] High end fish consumption values are the 95th percentiles. OEHHA recommends using the g/kg-day values.

Distributional analysis rather than single point estimates of fish consumption rates may be used to describe exposure within a population. Using a stochastic analysis will allow a more complete characterization of the variability in consumption in a population.

OEHHA is recommending the avidity-bias corrected distribution derived from the San Francisco Bay study (see Section 9.5) be used in Tier 3 and 4 risk assessments. The data in Table 9.2, expressed in g/kg-d, were obtained by dividing the adult fish consumption lognormal distribution data (in g/day) in Table 9.6 by the mean body weight of 80.0 kg derived in Section 10 for adults age 16-70 years. This was necessary because individual body weights were not collected in the fish consumption surveys.

Table 9.2. Empirical Distribution for Avidity Bias Adjusted Sport-Caught Fish Consumption Expressed in g/kg-day

Mean	p10	p20	p30	p40	p50	p60	p70	p80	p90	p95
Third trimester, 2<9, 2<16, 16<30 and 16-70-year age groups										
0.36	0.06	0.09	0.12	0.16	0.21	0.28	0.36	0.50	0.79	1.16
0<2-year age group										
0.18	0.03	0.05	0.06	0.08	0.11	0.14	0.18	0.25	0.40	0.58

As discussed below, there were no data available to clearly ascertain sport fish consumption rates of children. Estimates from studies for children in households of anglers indicate both potentially higher consumption rates than the anglers themselves (Mayfield et al., 2007; Shilling et al., 2010), and lower consumption rates than the anglers themselves (US EPA, 2002). We therefore assumed that sport fish consumption rate for adults 16-70 years of age would be proportional to body weight for the child age groupings of 2<9 and 2<16-year olds. Multiplying the adult consumption rate point estimates in g/kg-day by the time-weighted average body weight of 21.9 kg from Section 10 for the 2<9 year olds yields a mean and high-end fish consumption rate of 7.9 and 25.4 g/day, respectively. Performing the same calculation for the 2<16 age group with an average body weight of 37.0 kg results in a mean and high-end fish consumption rate of 13.3 and 42.9 g/day, respectively.

For the 0<2 age group, no fish consumption is expected in the first year, and fish consumption during the second year was assumed proportional on a gram per kg body weight basis to that of older children and adults. Thus, the fish consumption rate is

based on the mean body weight of children during the second year (11.4 kg for 1<2 year age group) and divided by two to represent the first 2 years after birth. The resulting mean and high-end fish consumption rates are 2.1 and 6.6 g/day, respectively (See Table 9.1 above).

Fetal exposure via the mother's consumption of fish during the third trimester is represented in g/kg-day only; no estimate was determined based on g/day. To account for the third trimester of fetal exposure we assumed sport fish consumption for both the fetus and the mother will be the same during this three-month period using the sport fish consumption rate of 0.38 g/kg-day for adults age 16<30 years.

9.~~2~~3 List of "Hot Spots" Chemicals for Which Evaluation of the Fish Pathway Is Recommended

The subset of organic and metal compounds that exhibit multipathway exposure are semi-volatile or nonvolatile, and are therefore partially or wholly in the solid or liquid phase and subject to deposition on water bodies. Fate and transport of the deposited chemical are estimated in order to assess the impact on fish that humans may catch and consume. The basis for the selection of these compounds as Hot Spots multipathway substances can be found in Appendix E. If the chemical has a long half-life and accumulates in fish, the multipathway analysis becomes more important. Below are the compounds on the Air Toxics "Hot Spots" list for which evaluation of the fish pathway is recommended:

Organic Compounds

Diethylhexylphthalate
Hexachlorobenzene
Hexachlorocyclohexanes
Polychlorinated biphenyls
Polychlorinated dibenzo-p-dioxins and dibenzofurans
Polycyclic aromatic hydrocarbons

Inorganic and Organic Metals

Arsenic & arsenic compounds
Beryllium & beryllium compounds
Cadmium & cadmium compounds
Soluble compounds of hexavalent chromium
Lead & inorganic lead compounds
Inorganic mercury and methylmercury
Nickel & nickel compounds
Selenium & selenium compounds

9.~~3~~4 Algorithm for Dose via Fish Ingestion

In the Air Toxics "Hot Spots" program, the concentration of a chemical in fish, Cf, is a product of the modeled concentration in water, Cw, and the bioaccumulation factor (BAF) for the chemical of concern.

$$Cf = Cw \times BAF \qquad \text{(Eq. 9-1)}$$

where: Cf = concentration in fish (μg/kg)
Cw = concentration in water (μg/kg)
BAF = chemical-specific bioaccumulation factor for fish

Bioaccumulation refers to the uptake and retention of a chemical by an aquatic organism such as fish from all surrounding media (e.g., water, food, sediment). A BAF is the ratio of the chemical concentration in the fish tissue to the concentration in water, taking into account uptake through contaminated food, sediment and water. There are a number of factors that can affect the BAF of a chemical in fish. Appendix I summarizes the concepts for BAFs in the "Hot Spots" program and presents the derivation of the BAF for each chemical. A brief discussion of the various factors influencing the BAF in fish is also presented.

Airborne contaminants can deposit directly into a body of water or be carried there by runoff. The current Air Toxics "Hot Spots" algorithm only considers direct deposition onto the surface of the water body. OEHHA has not currently endorsed a modeling approach for runoff. If runoff into a water body is thought to significantly impact risk from a particular facility, the risk assessor should include discussion of this problem. The concentration in the water in the model below is a function of what is directly deposited into the body of water. This is calculated as follows:

$$Cw = Dep\ (SA)\ (365) / (WV)\ (VC) \qquad \text{(Eq. 9-2)}$$

and

$$Dep = GLC \times \text{dep-rate} \times 86{,}400 \qquad \text{(Eq. 9.2a)}$$

where: Cw = concentration in water due to direct deposition (μg/kg)
Dep = amount deposited/day (μg/m^2/day) = GLC x dep-rate x 86,400
GLC = modeled ground level concentration (μg/m^3)
dep-rate = vertical rate of deposition (m/sec)
86,400 = seconds/day
SA = surface area of water body (m^2)
365 = days per year
WV = water volume (L = kg)
VC = number of volume changes per year

The deposition rate is assumed to be 0.02 m/sec for a controlled source and 0.05 m/sec for an uncontrolled source (see Chapter 2). The terms SA, WV, and VC are site-specific factors; values for these terms need to be ascertained by the risk assessor.

Calculating dose of contaminant via fish ingestion requires an estimate of the fish concentration and the amount of fish an individual consumes. The following equation can be used to calculate dose via ingestion of contaminated fish:

$$DOSEfish = (Cf \times I_{fish} \times GI \times Fsf \times EF \times \cancel{ED \times} (1 \times 10^{-6}) \cancel{/ (AT)} \qquad \text{(Eq. 9-3)}$$

where: DOSEfish = dose of contaminant via ingestion of fish (mg/kg BW-day)
Cf = concentration in fish (μg/kg)
I_{fish} = sport fish ingestion rate (g/kg BW-day)
GI = gastrointestinal absorption fraction, unitless
Fsf = fraction of sport fish caught at contaminated site, unitless
EF = exposure frequency (days/~~year~~365 days)
~~ED = exposure duration (years)~~
1×10^{-6} = conversion factor (μg/mg) (kg/gm)
~~AT = averaging time; time period over which exposure is averaged in days e.g., for carcinogenic risk calculations,~~
~~90 days for third trimester fetal stage~~
~~730 days for the 0<2 year age group~~
~~5110 days for the 2<16 year age group~~
~~19,711 days for the 16-70 year age group~~
~~25,550 days for the 0-70 year age group~~

The value of Cf is calculated using equations 9-1 and 9-2. The default gastrointestinal absorption fraction is 1. There are currently no data to support a value different from 1 for any of the chemicals that are evaluated for this pathway. The factor, Fsf, is a site-specific factor; the risk assessor must evaluate site-specific data to ascertain what fraction of the sport fish consumed by an individual comes from the impacted body of water. If such data are unobtainable, then Fsf should be set to 1. We provide both point estimates and a distribution of sport fish consumption rates normalized to body weight in this chapter. The exposure frequency (EF) is set at 350 days per year (i.e., per 365 days) to allow for a two week period of time away from home (US EPA (1991).

For cancer risk, the risk is calculated for each age group using the appropriate age sensitivity factors (ASFs) and the chemical-specific cancer potency factor (CPF) expressed in units of $(mg/kg\text{-}day)^{-1}$.

$$RISKfish = DOSEfish * CPF * ASF * ED/AT \qquad \textbf{(Eq. 9-4)}$$

RISK is the predicted risk of cancer (unitless) over a lifetime as a result of the exposure, and is usually expressed as chances per million persons exposed (e.g., 5×10^{-6} would be 5 chances per million persons exposed).

The dose-response phase of a cancer risk assessment aims to characterize the relationship between an applied dose of a carcinogen and the risk of tumor appearance in a human. This is usually expressed as a cancer potency factor, or CPF, in the above

equation. The CPF is the slope of the extrapolated dose-response curve and is expressed as units of inverse dose $(mg/kg\text{-}d)^{-1}$.

Exposure duration (ED) is the number of years within the age groupings. In order to accommodate the use of the ASFs (OEHHA, 2009), the exposure for each age grouping must be separately calculated. Thus, the ED is different for each age grouping. The ASF, as shown below, is 10 for the third trimester and infants 0<2 years of age, is 3 for children age 2<16 years of age, and is 1 for adults 16 to 70 years of age.

ED = exposure duration (yrs):

0.25 yrs for third trimester	(ASF = 10)
2 yrs for 0<2 age group	(ASF = 10)
7 yrs for 2<9 age group	(ASF = 3)
14 yrs for 2<16 age group	(ASF = 3)
14 yrs for 16<30 age group	(ASF = 1)
54 yrs for 16-70 age group	(ASF = 1)

AT, the averaging time for lifetime cancer risks, is 70 years in all cases. To determine lifetime cancer risks, the risks are then summed across the age groups:

$$RISKfish_{(lifetime)} = RISKfish_{(3rdtri)} + RISKfish_{(0<2\ yr)} + RISKfish_{(2<16\ yr)} + RISKfish_{(16\text{-}70yr)} \quad \textbf{(Eq. 9-5)}$$

As explained in Chapter 1, we also need to accommodate cancer risk estimates for the average (9 years) and high-end (30 years) length of time at a single residence, as well as the traditional 70 year lifetime cancer risk estimate. For example, assessing risk in a 9 year residential exposure scenario assumes exposure during the most sensitive period, from the third trimester to 9 years of age and would be presented as such:

$$RISKfish_{(9\text{-}yr\ residency)} = RISKfish_{(3rdtri)} + RISKfish_{(0<2\ yr)} + RISKfish_{(2<9\ yr)} \quad \textbf{(Eq. 9-6)}$$

For the 30-year residential exposure scenario, the risk for the 2<16 and 16<30 age groups would be added to the risks from exposure during the third trimester and from ages 0<2 yr. For 70 year residency risk, Eq 9-5 would apply.

The fetus can be exposed via the mother's consumption of fish during the third trimester of pregnancy. Fetal exposure during the third trimester via fish consumption by the mother is taken into account in the final determination of the point estimate values presented in Section 9.2. For the 0<2 yr age group, no fish consumption by the infant is expected from birth to one year of age.

9.~~4~~5 Studies Evaluated for Sport Fish Consumption Rate

In order to determine the dose of a contaminant via ingestion of fish, reasonable point estimates and distributions for the rate of California sport fish ingestion are required.

The most comprehensive studies of noncommercial fish consumption in California are the Santa Monica Bay Seafood Consumption Study (SCCWRP and MBC, 1994) and the San Francisco Bay Seafood Consumption Study (SFEI, 2000). These studies were undertaken to describe the demographic characteristics of anglers that fish the Santa Monica Bay and San Francisco Bay, to assess their sport seafood consumption rates, and to identify ethnic subgroups that may have high rates of seafood consumption. Other California fish consumption studies that provide estimates of fish consumption rates are also reviewed here. Since comprehensive freshwater fish consumption rate studies in California are lacking, the best freshwater fish studies performed elsewhere in the U.S. are also summarized. Studies that discussed consumption of sport fish by household members are also summarized. Household members may represent a more sensitive subgroup of people consuming contaminated sport fish brought home by anglers. Sensitive household members include children and pregnant and breastfeeding women.

9.~~4~~5.1 Marine and Delta Fish Consumption Studies

9.~~4~~5.1.1 1998-1999 San Francisco Bay Seafood Consumption Study

Between July 1998 and June 1999, the California Department of Health Services conducted over 150 fishing site visits and approached over 1700 San Francisco Bay (SF Bay) anglers (SFEI, 2000). The sites chosen for interviews included public piers and adjacent beaches or banks, public boat launches, and party boats. Anglers were asked how many times they ate Bay fish in the four weeks prior to being interviewed - a time period within which anglers were assumed to have reasonably accurate recall. Anglers were also asked the portion size of the meal compared to a plastic model of an eight-ounce fish fillet. The portion size question was asked only once and was used to calculate all fish consumption rates. Angler fish-consumption rates were determined by multiplying the two variables, meal frequency and portion size, and converted to grams per day (g/d). Consumption rates are described primarily for two populations, consumers and recent consumers. Consumers are anglers who reported eating Bay fish. Recent consumers are a subset of consumers who reported consuming Bay fish in the last four weeks.

Of 1738 eligible (i.e., not previously interviewed) anglers interviewed, 501 individuals identified as recent consumers provided adequate information for deriving a consumption rate. The researchers had determined a sample size of 500 recent consumers would be needed to derive a reasonably precise mean consumption rate (i.e., 95% confidence interval of +/- 10% around the geometric mean consumption rate and 95% confidence interval of +/- 15% around the upper percentiles). The mean and 95th percentile for fish consumption rate among recent consumers based on 4-week recall was 28 and 108 g/d, respectively.

The SF Bay report also included a distribution of consumption rates for recent consumers adjusted for avidity bias (See section 9.~~7~~8.2.1 for discussion on avidity bias). In on-site surveys such as the SF Bay study, avid anglers may be over-represented in

the sample and infrequent anglers will be under-represented, resulting in avidity bias. This bias occurs because an individual who fishes frequently has a greater chance of being interviewed than a person who fishes infrequently. Thus the distribution will over-represent the consumption of frequent fishers. Further information about avidity bias is discussed below. The mean and 95th percentile for the avidity adjusted fish consumption rate among recent consumers based on 4-week recall was 23 and 80 g/d, respectively.

Although less reliable than the four week recall, consumers (n=1019) were asked to report the number of times they ate Bay fish in the past 12 months. The unadjusted mean and 95th percentile for fish consumption rate based on 12-month recall was 11 and 44 g/d, respectively. Consumption rates for the 12-month period prior to the interview could not be adjusted for avidity bias due to insufficient fishing frequency data over the same time period.

Due to historic mercury contamination in the region, the SF Bay report also surveyed angler households for pregnant or breastfeeding women. The developing fetus and infants are particularly sensitive to mercury contamination. The SF Bay report found that only 2% of anglers reported that pregnant or breastfeeding women in their household ate SF Bay sport-caught fish. However, 46% of anglers reported that women of childbearing age (18-45 years) in their household ate SF Bay sport-caught fish, and 13% reported that children younger than six years of age ate SF Bay sport-caught fish.

9.~~4~~5.1.2 1991-1992 Santa Monica Bay Seafood Consumption Study

For the Santa Monica Bay study, surveys were conducted at 29 sites on 99 days, from September 1991 to August 1992 (SCCWRP and MBC, 1994; Allen et al., 1996). Fishers on piers and jetties, private boats, party boats, and beaches were interviewed using a questionnaire. The fish consumption estimates applied only to consumption of Santa Monica Bay sport fish, and did not include consumption of fish from all sport and commercial sources. Anglers were questioned about consumption of eight commonly consumed species of fish as well as about fish they had in hand. Anglers were also asked to estimate how much fish he/she consumed per meal, compared to a wood model representing a 150 gram (0.33 pound) portion of a fish fillet. Similar to the SF Bay study, fishers were asked the number of times they had consumed sport fish in the 4 weeks prior to the interview, but unlike the SF Bay study, the frequency of fish consumption was increased by one meal to account for consumption of catch present at the time of the interview. Fishers who had eaten any of the 8 species in the survey in the 4 weeks prior to the interview were included in consumption rate estimates. Of the 1,243 fishers interviewed, 554 provided information that could be used for calculating consumption rates. Average daily sport fish consumption rates (g/day) were calculated by multiplying the fisher's estimate of the typical meal size relative to the model, by the frequency of consumption in the four weeks prior to the interview, divided by 28 days. The mean and 95th percentile consumption rates for the overall surveyed population were 49.6 and 161 g/d, respectively.

OEHHA utilized a basic inverse-weighting scheme to adjust the fish consumption rate data for avidity bias, resulting in a mean of 29.4 g/d (OEHHA, 2000). Additionally, the analysis adjusted for four separate factors producing potential bias in the sampling procedure (i.e., number of times fished, frequency of site selection, proportion of successful interviews, and week days versus weekend days sampled). The four-factor corrected mean was 30.5 g/d, and differed from the avidity-corrected mean by only 3%. The four-factor adjusted high end (95th percentile) fish consumption rate estimate was 85.2 g/d.

9.~~4~~5.1.3 1980 Los Angeles Metropolitan Area Survey

In 1980, an intercept survey was conducted in the Los Angeles metropolitan area (including Santa Monica Bay) to assess noncommercial fish and shellfish consumption rates by local fishers, and to identify subgroups that have significantly larger consumption rates (Puffer et al., 1982a; Puffer et al., 1982b). The intercept survey method surveys fishers at a fishing site or sites about fish consumption, catch or other questions of interest. During the one-year study period, a total of 1,059 fishers were interviewed at 12 sites, including piers, jetties, and party boats. Average daily consumption rates were estimated based on the number of fish in the catch, the average weight of the fish in the catch, the edible portion of the species, the number of fish eaters in the family and the frequency of fishing per year. The fish consumption rate data were presented as a cumulative percentile distribution, with a median of 37 g/d and 90th and 95th percentiles of 225 and 339 g/d, respectively. Mean estimates of fish consumption were not presented.

While this study was quite extensive, there were several limitations. Consumption data were collected from over 1,000 individuals representing various ethnic groups in the survey population (i.e., Caucasian, Black, Mexican-American, and Oriental/Samoan), but only English speaking fishers were included in the study. The Santa Monica and SF Bay Seafood Consumption Studies interviewed a number of different ethnic groups in their native languages. In addition, the survey did not ask fishers for direct estimates of the amount of fish they consumed, correction for avidity bias was not performed, and no recall was included of sport fish consumption over a previous period of time.
Price et al. (1994) attempted to correct for avidity bias using the general assumption that sampling probability is proportional to the inverse of fishing frequency. The adjusted consumption rate distribution was considerably lower than that obtained by Puffer et al. studies; the median and 90th percentile were estimated at 2.9 and 35 g/d, respectively. U.S. EPA (1997) notes that an avidity-correction assumption is not completely valid, as interviewers visited sites numerous times and anglers were not interviewed more than once. However, U.S. EPA (1997) does state that the estimates of Price et al. (1994) are probably better estimates of the fish consumption of the entire population that fishes the area than the nonadjusted survey results.

9.~~4~~5.1.4 1988-1989 San Diego Bay Health Risk Study

The San Diego Department of Health Services conducted a survey of fishers fishing the San Diego Bay (SDCDHS, 1990) to identify the demographics of this fisher population and to characterize their noncommercial fish consumption patterns. The authors derived an overall bay-wide fishing population mean of 31.2 g/d. Only 59 fishers provided all of the necessary data for calculating individual noncommercial fish consumption rates and subsets of the 59 interviews were used to calculate species and ethnic-specific rates. ~~The statistical power of the study was limited~~Thus, there is more uncertainty about the fish consumption values because of the small number of subjects in the study population, particularly for the subsets for specific species and influence of ethnicity. In addition, the consumption rate overestimates consumption in the general fishing population because the rate only includes fishers who were known to catch and consume fish year-round.

9.~~4~~5.1.5 1993 San Francisco Bay Seafood Consumption and Information Project

In an earlier study of fish consumption habits of people fishing in San Francisco Bay, Wong (1997) conducted personal interviews with approximately 200 people fishing or crabbing from ten public piers during September to November 1996. A fish fillet model, representing 150 grams, was used to assist with estimating the amount of fish consumed per meal. Sixty-two respondents (29 percent) reported consumption of SF Bay fish in the 7-day period preceding the interview. A calculated median consumption rate of 32 g/d was determined for anglers that ate fish and/or shellfish from SF Bay. This study was not corrected for avidity bias.

9.~~4~~5.1.6 2010 California Central Valley Delta Fish Consumption Study

A fish consumption survey was conducted in the California Central Valley Delta (including the Sacramento-San Joaquin Rivers Delta) where a high rate of subsistence fishing of potentially mercury-contaminated fish occurs (Shilling et al., 2010). This study reflects a region where both freshwater and anadromous fish are caught. Anglers were chosen for interviews as they were encountered along the riverbank by surveyors. Shore anglers (n=373) were interviewed during biweekly to monthly site visits between September 2005 and June 2008. Anyone reporting that they had been previously interviewed was not interviewed again. Fish consumption rates (g/d) were calculated for each individual based on 30-day recall of how much and how often individual types of fish were eaten. Fish fillet models were used representing 1.5, 4.5, and 7.5 oz cooked weights of fish fillet for the estimate of actual fish consumption rates.

The arithmetic mean and median consumption rates of locally caught fish were 27.4 and 19.7 g/day, respectively, for anglers. There were no statistically significant differences in consumption rates among age groups (18-34, 35-49, and >49 years of age). The 95th percentile rate of locally caught fish (126.6 g/d) was also determined to represent the majority of the fish consuming population. Note that this distribution is not normally distributed. The arithmetic mean and median consumption rates of locally caught fish for children (n=174, age unspecified) in households of anglers were 35.3 and 22.2 g/day, respectively. This study was not corrected for avidity bias.

In addition to interviewing shore anglers, interviews were conducted with selected members of the local South East Asian community in which it was known that a member of their extended family fished. The mean corresponding consumption rate for locally-caught fish from the community member survey was 55.2 g/day, which was higher than the corresponding rate for anglers in the field. Because this portion of the study was a community-based, rather than ~~an~~ angler-based, survey of an ethnic group known for high consumption of locally-caught fish, it does not represent an overall California fish consumption rate.

9.~~4~~5.2 Freshwater Fish Consumption Studies

9.~~4~~5.2.1 Washington King County Lakes Study

A survey was conducted at three Washington state freshwater lakes from June 2002 to May 2003 (Mayfield et al., 2007). A total of 212 anglers were interviewed and asked to estimate their typical meal size from a visual aid (6, 8, 10, and 12 oz. fillets) and how often they had consumed fish they caught from the lakes in the previous month. Surveyors also asked the anglers to provide the same information for any children (i.e., <18 years) who also consumed their catch. Forty-six percent of anglers reported sharing their catch with children. The mean consumption rate was 10 and 7 g/d for anglers and their children, respectively. The 95th percentiles were 42 and 29 g/d for anglers and the children of anglers, respectively. Although many anglers reported consuming fish from King County Lakes, many had not consumed any fish in the previous month. Therefore, the median consumption rate was zero.

9.~~4~~5.2.2 Michigan Freshwater Fish Consumption Studies

The University of Michigan conducted a stratified random mail survey of 2600 Michigan residents with annual fishing licenses during the period of January to June 1988 (West et al., 1989a; 1989b; 1989c). Those with one day fishing licenses from both in state and out of state were excluded thus eliminating some infrequent fishers. Fish meals included self-caught, market, restaurant, and gift fish. Fish consumption information was gathered from all members of the household for a 7-day recall period and included only those individuals who responded that they ate fish. However, all responses were tabulated in one of only three meal sizes, 5, 8, and 10 oz. Because the overall response rate was only 47.3 percent, the authors adjusted the population mean value of 18.3 g/d downward by 2.2 g/d to account for nonresponse bias, thus deriving a mean rate of 16.1 g/d. Derivation of the adjustment factor was based on a follow-up telephone survey of respondents and nonrespondents (West et al., 1989b). The researchers did not generate a distribution. The probability of being contacted in this study was not dependent on the frequency of fishing; therefore, the avidity bias found in intercept surveys is not present in the data. However, the authors noted that the sampled population may not have represented subsistence fishers because it was selected from licensed anglers only.

Murray and Burmaster (1994) used the raw data of West et al. studies to generate a distribution for total fish and self-caught fish among adults only, providing 12 empirical distributions for eight population subgroups. Fish consumption rate estimates were derived for persons who consumed self-caught fish during the recall period, resulting in a consumption rate based on a population that more frequently consumes fish. This study represents the most comprehensive analysis of freshwater sport fish consumption by anglers. Table 9.~~1~~ 3 includes empirical distribution data for average daily fish consumption rate in the four adult subgroups that are most relevant for the California "Hot Spots" program. The Great Lakes fish population groups refer to anglers and family members who only ate self-caught fish from the Great Lakes. These groups may be analogous to sport fishers in California that fish only from one or a few lakes in a defined area that are impacted by pollutants. The self-caught fish population groups refer to groups that caught and consumed fish caught anywhere in Michigan.

Table 9.~~1~~3. Average Daily Fish Consumption Rates in g/day of Adults for Four Subgroups from Murray and Burmaster (1994)

Population group[a]	Distribution for fish consumption type	N	Fraction as % of adults[b]	Mean	SD	P50[c]	P95[d]
Anglers/ate self-caught fish	Self-caught fish	191	0.08	45.0	23.7	32.7	98.0
All/ate self-caught fish	Self-caught fish	418	0.18	42.3	22.3	32.7	98.0
Anglers/ate Great Lakes fish	Great Lakes fish	89	0.04	40.9	19.9	32.7	81.6
All/ate Great Lakes fish	Great Lakes fish	188	0.08	38.5	19.0	32.7	81.6

[a] The first two rows refer only to fish consumption of self-caught fish for anglers only (anglers) or the anglers plus adult family members (all). The last two rows refer to fish consumption of only self-caught fish from the Great Lakes for anglers only (anglers) or the anglers plus adult family members (all).
[b] This column represents the percentage of general population (i.e., Michigan adults) that ate self-caught fish.
[c] 50th percentile
[d] 95th percentile

Murray and Burmaster (1994) found that a lognormal model fit the empirical data well and provided parametric compound distributions for use in Monte Carlo simulations.

9.~~4~~5.2.3 1992-1993 Freshwater Fish Consumption by Alabama Anglers

A statewide survey was conducted from August 1992 to July 1993 to estimate daily fish consumption of freshwater fish harvested by anglers fishing from 29 locations throughout Alabama, including tailwater sites, reservoirs, and river drainages (Meredith and Malvestuto, 1996). A total of 1,586 anglers were interviewed at the completion of fishing activity. Of the total anglers interviewed, 1,303 anglers reported consumption of fish from the study areas. Serving size was estimated by equating the entire surface

(palm side) of the flat open hand to a single 113 g (4 ounce) serving. To estimate fish consumption rates, anglers were asked to estimate the number of fish meals eaten in the past month consisting of fish caught at the study sites ("site meals") and those caught at all lakes and rivers in Alabama, including study sites ("all meals"). Only anglers indicating they consumed fish from the study sites were included in the analysis. The mean annual consumption rate estimated by this method was 30.3 g/d for site meals and 45.8 g/d for all meals.

9.~~4~~5.3 Studies of Household Members Who Eat Sport-Caught Fish

Determining the consumption rate of sport fish eaten by others in angler households was beyond the scope of most studies summarized above. Some studies have shown that people who do not go fishing eat sport-caught fish given to them by friends and family, but possibly at reduced rates compared to the anglers themselves (Toth and Brown, 1997; Burger, 2000; Nadon et al., 2002; Mayfield et al., 2007). The household members of anglers are of particular interest because the anglers are predominantly male, and may bring home fish to household members that are at higher risk from consuming contaminated sport-caught fish (i.e., pregnant and breastfeeding women, women who are of childbearing age, and children). Table 9.~~2~~ 4 below presents the data from studies that did estimate consumption rates for household members that eat freshwater sport-caught fish.

Table 9.~~2~~4. Freshwater Sport Fish Consumption Rates by Household Members of Anglers

Group	N	Consumption rate (g/day)	Consumption rate (g/kg-day)	Reference
Children		Arithmetic Means	Arithmetic Means	U.S. EPA (2002) [a]
1-5 yrs	121	5.63	0.369	
6-10 yrs	151	7.94	0.276	
11-20 yrs	249	7.27	0.123	
<18 yrs	81	7	0.19	Mayfield et al. (2007)
[b]	174	35.3	0.95[c]	Shilling et al. (2010)
Women				
All ages (<17-50+)	80	10.5 [d]	0.14 [d]	Silver et al. (2007)
<17 yrs	5	13.9		
Pregnant	6	12.8		
Breastfeeding	11	10.2		
18-49 yrs	217	33.0	0.44	Shilling et al. (2010)

[a] U.S. EPA values are based on treatment of data from West et al. (1989a)
[b] Child age range not specified, but can be inferred from the study to mean <18 years of age.
[c] Based on average body weight of 37.0 kg for children 2<16 years of age from Table 10.~~8~~?

[d] Only geometric mean consumption rates were available for women in the Silver et al. study .

9.~~4~~5.3.1 U.S. EPA analysis of West et al. (1989a) child fish consumption data subset

The U.S. EPA (2002) child fish consumption rates presented in Table 9.~~2~~ 4 were obtained from the raw data by West et al. (1989a) to estimate freshwater recreational fish consumption rates for household members of anglers, based on the 7-day recall data. The household members were divided into three age groups, age 1-5, 6-10, and 11-20 years. The analysis was restricted to individuals who ate fish and who resided in households reporting some recreational fish consumption during the previous year. Since the study was a stratified random mail survey of Michigan residents with annual fishing licenses, the study was not dependent on the frequency of fishing and did not need to be corrected for avidity bias.

Using an average adult body weight of 80.0 kg from Table 10.~~8~~ 1of this document, the average adult angler consumption rate on a per kg body weight basis is 0.56 g/kg-day (45.0 g/day from Table 9.1 ÷ 80.0 kg). Comparing the child consumption rates in Table 9.~~2~~ 4 to that of adult anglers who ate self-caught fish, this study suggests that the children in households of anglers eat less on a per body weight basis than the adult anglers.

9.~~4~~5.3.2 Child sport fish consumption rate for the Washington King County Lakes Study

The Washington state freshwater fish consumption study recorded a mean consumption rate of 7 g/day for children (<18 years) of anglers interviewed (Mayfield et al., 2007). However, this study was not corrected for avidity bias, and included persons who did not consume sport fish during the 30-day recall period. Not accounting for avidity may overestimate consumption, while including anglers and their children who did not consume sport fish in the last month may underestimate the consumption rate of persons who frequently consume sport fish.

Using a mean body weight of 37.0 kg for children age 2<16 years, and 80.0 kg (age 18<75) for the mean body weight of adults, the sport fish consumption rates on a per kg body weight basis are 0.19 g/kg-day for children (7 g/d ÷ 37.0 kg) and 0.13 g/kg-day for adults (10 g/d ÷ 80.0 kg). The Washington state freshwater fish consumption data suggest that, if corrected for differences in body weight, children of anglers may consume as much fish, or more, on a per kg body weight basis as the anglers themselves. However, when compared to avidity-adjusted average adult angler consumption rates corrected for body weight from the S.F. Bay study (0.36 g/kg-day, see Table 9.~~5~~1), the child consumption rate from the Washington study is only about half that of the adult S.F. Bay anglers.

9.~~4~~5.3.3 California sport fish consumption survey among low-income women

The only study that investigated sport-caught fish consumption rates among a California population at increased risk (and presumably household members of an angler) was a survey of low-income women at a Special Supplemental Nutrition Program for Women, Infants and Children (WIC) clinic in the California Sacramento-San Joaquin Delta region (Silver et al., 2007). Of 500 eligible women participating in the survey, 80 (16%) reported eating sport fish in the last 30 days. These participants were asked about consumption frequency, portion size of cooked meals, and source of the fish. To assist with recall of portion size, fish fillet "portion models" were shown corresponding to 1.5, 3.0, 4.5, and 7.5 oz weight. The geometric mean sport fish consumption rate among this group was 10.5 g/d. Hmong and Cambodian women consumption rates showed a higher consumption trend but were not statistically significantly different.

Comparison of this geometric mean sport fish consumption rate for women in angler households with the geometric mean sport fish consumption rate among anglers in the SF Bay and Santa Monica Bay studies suggests household members eat less sport-caught fish than the anglers themselves. The unadjusted geometric mean sport fish consumption rate for the SF Bay study and Santa Monica Bay study were 16.5 and 23.6 g/d, respectively. However, these consumption rates did not account for gender body weight differences and the predominance of male anglers in surveys (e.g., 92% of interviewed anglers in the SF Bay study were male), which would bring sport fish consumption rates among anglers and women household members closer together. Using mean body weight data by gender summarized in Table 10.2, the SF Bay and Santa Monica Bay mean consumption rates were divided by the average body weight of adult males (88.3 kg, age 20 yrs and above) and the WIC mean consumption rate divided by the average body weight for adult females (74.7 kg, age 20 yrs and above). Consumption rates on a per body weight basis yields values of 0.19, 0.27 and 0.14 g/kg-day for the SF Bay, Santa Monica Bay and WIC fish consumption studies, respectively.

9.~~4~~5.3.4 California Central Valley Delta study of household fish consumption

The household consumption rates of women and children in the study by Shilling et al. (2010) are considerably higher compared to the household members in other studies. This may be due to the high number of subsistence fishers in this study, and that a majority of the anglers reported catching fish in order to feed their families. This study did not correct the consumption rate for avidity bias, so consumption rate may be overestimated.

Comparing the anglers with their family members, the consumption rates of children and women in households of anglers were not statistically significantly greater than the anglers themselves ($P < 0.05$, *t*-test). The study reported average consumption rates of 26.4, 33.0, and 35.1 g/day for male anglers, women in households of anglers, and children in households of anglers, respectively. However, when OEHHA divided the consumption rates by average body weights for men (88.3 kg), women (74.7 kg) and children (37 kg for 2 to <16 yrs), the fish consumption on a per body weight basis was 0.30, 0.44, and 0.95 g/kg-day, respectively. The results from this study suggest that

household members of anglers, many of which are subsistence fisherman that fish mainly to feed their families, have a greater fish consumption rate than the anglers themselves.

9.~~4~~5.3.5 Household sport fish consumption frequency surveys

A nationwide telephone survey of fish consumption patterns found that the presence of a fishing license in the home was a significant predictor of sport-caught fish ingestion by family members, including children and their mothers (Imm et al., 2007). Families with a fishing license in the home were more likely to eat sport-caught fish than families without a fishing license in the home. Forty-seven percent of children (2-17 years of age) who lived with a licensed angler ate sport-caught fish, with an average of 16 sport-caught fish meals (median = 8 meals; maximum = 240 meals) per year. A nationwide survey of 3015 women of childbearing age (ages 18-45) reported that 29% of participants had consumed sport fish in the previous 12 months (Anderson et al., 2004). Among those reporting sport fish consumption, the median and mean number of sport-caught fish meals for the past 12 months were 6 and 16, respectively. Neither study collected data on portion sizes of fish meals to estimate consumption rate.

9.~~5~~6 Comparison of Marine Fish Consumption Rates among California Studies

Fish consumption rates for four California fish consumption studies, the SF Bay study, the Santa Monica Bay study, the Save the Bay Study (Wong, 1997), and the Central Valley Delta study (Shilling et al., 2010) are shown in Table 9.~~3~~ 5 for comparison. The data from the SF Bay and Santa Monica Bay studies are presented both adjusted and unadjusted for avidity bias as discussed under section 9.~~7~~8.2.1. Differences among the consumption rates could be explained by the different study methodologies used by the studies.

For example, the unadjusted geometric mean consumption rate from the Santa Monica Bay study is about 50 percent higher than the unadjusted rate derived from the SF Bay study, and the difference was found to be statistically significant. In the Santa Monica study, the frequency of consumption was increased by one to account for consumption of any fish in hand at the time of the interview. Fish in hand at the time of interview was not included in the SF Bay consumption rate estimates. This factor was thought to explain the higher consumption rates of the Santa Monica Bay study (SFEI, 2000). Another difference between the two studies was that the Santa Monica Bay study used a 5.3 ounce (150 g) portion model while the SF Bay study used an 8 ounce (227 g) portion model. The model size appears to have influenced the responses in both studies. Whether the different model sizes would widen or narrow the consumption rate difference between the two studies is not known.

In the Save the Bay study, the median consumption rate (32 g/d) was considerably higher than the unadjusted consumption rates of the other two California studies. However, only 7-day recall of fish consumption was surveyed among interviewed anglers. This short recall period creates an even smaller subset of all anglers

compared to the 4-week recall used in the California studies, and also selectively includes anglers with the highest consumption rates.

Other factors unrelated to methodologies that may contribute to consumption rate differences among studies include differences in climate, fishery production, year of study, and demographic characteristics. As noted in Section 9.~~4~~5.3.4, the California Central Valley Delta study by Shilling et al. (2010) contained a high number of subsistence anglers that reported catching fish in order to feed their families. This study also did not correct the consumption rate for avidity bias. Even so, consumption rates among the Central Valley Delta anglers are similar to avidity-adjusted rates in Table 9.3. This study suggests that a greater proportion of this population of subsistence anglers gives the fish they catch to their families, and this may account for the high consumption rate of household family members shown in Table 9.~~2~~4.

Table 9.~~3~~ 5 Comparison of Consumption Rates (in g/day) for the San Francisco Bay Seafood Consumption Study, Santa Monica Bay Study, Save the Bay Study and the Central Valley Delta Study[a]

	Adjusted SF Bay Study[b]	**Adjusted Santa Monica Study[c]**	**Unadjust-ed SF Bay Study[b]**	**Unadjust-ed Santa Monica Study[c]**	**Save the Bay Study[d]**	**Central Valley Study[e]**
Respondents	n=1152	[f]	n=1331	n=1244	n=222	[f]
Population used to derive consumption rate (% of respondents)	n=465 (40%)	[f]	n=501 (38%)	n=555 (45%)	n=62 (27%)	n=373 ([f])
	4-week recall	4-week recall	4-week recall	4-week recall	7-day recall	4-week recall
Mean (Standard Deviation)	23.0 (32.1)	30.5 (45)	28.0 (39.5)	49.6 (111.1)	[f]	27.4 ([f])
Geometric Mean	14.0	[f]	16.5	23.6	[f]	[f]
50th Percentile	16.0	15.0	16.0	21.4	32	19.7
90th Percentile	48.0	62.4	56.0	107.1	[f]	[f]
95th Percentile	80.0	85.2	108.0	161	[f]	126.6

[a] Table modified from SFEI (2000)
[b] SFEI, 2000; [c] Allen et al. (1996); [d] Wong, 1997; [e] Shilling et al. (2010)
[f] Not reported

9.~~6~~7 Comparison of Freshwater and Marine Fish Consumption Rate Studies

Although the California fish consumption rate studies are derived from a population fishing from marine water bodies, a similar distribution of consumption rates also

occurred from data obtained of populations fishing from freshwater bodies. For example, Murray and Burmaster (1994) calculated mean rates for non-avidity-biased consumption of Michigan sport-caught freshwater fish by anglers as 45.0 g/d for self-caught fish in general, and 40.9 g/d for anglers consuming fish from the Great Lakes, in particular. Meredith and Malvestuto (1996) reported an avidity-biased consumption rate of 30.3 g/d for specific study sites in Alabama, and 45.8 g/d for all sport-caught meals caught in the state. These mean values fall between the adjusted mean for the SF Bay study (23.0 g/d) and the unadjusted mean for the Santa Monica Bay study (49.6 g/d) shown in Table 9.~~1~~5. These saltwater and freshwater studies were comparable in many study parameters and in analytical evaluation and, thus, can be reasonably used to support angler-caught freshwater fish consumption estimates in California.

The Washington King County Lakes study (Mayfield et al., 2007) exhibited a lower mean angler consumption rate of 10 g/day for freshwater fish compared to the Alabama and Michigan studies. The lower consumption rate in the Washington study is likely due to differences in methodology. Anglers that had not eaten sport fish in the previous month were included in the consumption rate analysis, whereas the Alabama and Michigan studies excluded anglers who had not eaten sport fish in the previous month. Thus, the Alabama and Michigan studies target the angler population that are the most frequent consumers of sport fish.

A more analogous comparison to the Washington King County Lakes study might be made with the unadjusted mean fish consumption rate based on 12-month recall in the SF Bay study. A lower mean consumption rate of 11.0 g/d was recorded for this group, which includes frequent (i.e., consumed sport fish in the last 4 weeks) and infrequent (i.e., consumed sport fish in the previous year, but not in the previous 4 weeks) anglers. The Washington King County Lakes mean consumption rate of 10 g/d is similar, using the assumption that this consumption rate includes both frequent and infrequent anglers that probably consumed sport fish in the previous year.

9.~~7~~8 Determination of Fish Consumption Distribution

9.~~7~~8.1 Choice of Study

The data from the San Francisco Bay ~~Sea~~ Seafood Consumption Study (SFEI, 2000) were determined to be the most comprehensive and appropriate report for our estimation of average daily sport fish consumption in California. The SF Bay study was chosen over the other major California fish consumption studies in Table 9.~~3~~ 5 because it represents the most recent well-conducted study of a California population. The SF Bay study applies to salt water sport-caught fish, whereas the “Hot Spots” program primarily applies to consumption of contaminated fresh water sport fish. However, as discussed above, comparable fish consumption rates have been observed for both marine and fresh water angler populations. If comprehensive and reliable data become available which describe consumption of freshwater sport fish in California, the current consumption rate values will be revised

The Central Valley Delta fish consumption study by Shilling et al. (2010) was ~~also~~ considered. This study contained a high number of subsistence anglers and did not correct for avidity bias. However, the consumption rate of 27.4 g/day for all anglers, and the body weight adjusted value of 0.33 g/kg-day compared well to the SF Bay study avidity-corrected average consumption rates of 28.8 g/day and 0.36 g/kg-day, respectively, for adults (see Table 9.~~5~~ 1).

9.~~7~~8.2 Statistical Correction for Unequal Sampling Probabilities

Samples obtained from on-site surveys, such as the SF Bay and Santa Monica Bay fish consumption rate studies, can provide estimates of the distribution of fish consumption rates for the total angler population being sampled. In order to obtain unbiased estimates for the total angler population in the SF Bay study, the estimates were (1) adjusted for sources of unequal sampling probabilities in fishing frequency, leading to avidity bias, and (2) examined for the effect of interview decliners on the consumption rate estimate.

9.~~7~~8.2.1 Avidity Bias

How frequently anglers go fishing (i.e., their avidity) can vary widely among anglers. Some may fish daily while others may fish only once per year. In on-site surveys, how often an angler goes fishing determines how likely he or she will be included in the survey. Generally, avid anglers will be over represented in the sample and infrequent anglers will be under represented, resulting in avidity bias (Price et al., 1994; U.S. EPA, 1997; OEHHA, 2001).

Avidity bias presents a concern when an angler's avidity is correlated with important parameters that are being studied, such as consumption rate. If no correlation exists, there is no bias and data adjustments will not change the results. However, if correlation exists, the sample will not accurately reflect the overall angler population. Adjusting for avidity bias allows for the results to more closely reflect general exposure of the target population of the study (i.e., San Francisco Bay anglers), and to determine a point estimate for the California fish consumption rate.

In the SF Bay study, sample data were adjusted for avidity bias by weighting the respondents in proportion to the inverse of their sampling probability during the four weeks prior to the interview. The algorithm for the statistical adjustment for avidity bias can be found in the report. For cases where the target population is the general fishing population and fish is not a major exposure pathway, as can be expected in most cases under the "Hot Spots" program, the adjusted (weighted) results that correct for avidity bias are recommended. However, if the target fishing population are fishers that consume sport fish on a regular and frequent basis (i.e., at least once per month), the unadjusted values are considered most relevant (OEHHA, 2001). For risks associated with a single fish species from a water body (i.e., single pathway exposures where fish consumption is a major pathway), it has been recommended that the unadjusted values

representing the median and the 90th percentile be used to characterize the population at risk (SCCWRP and MBC, 1994; OEHHA, 2001)

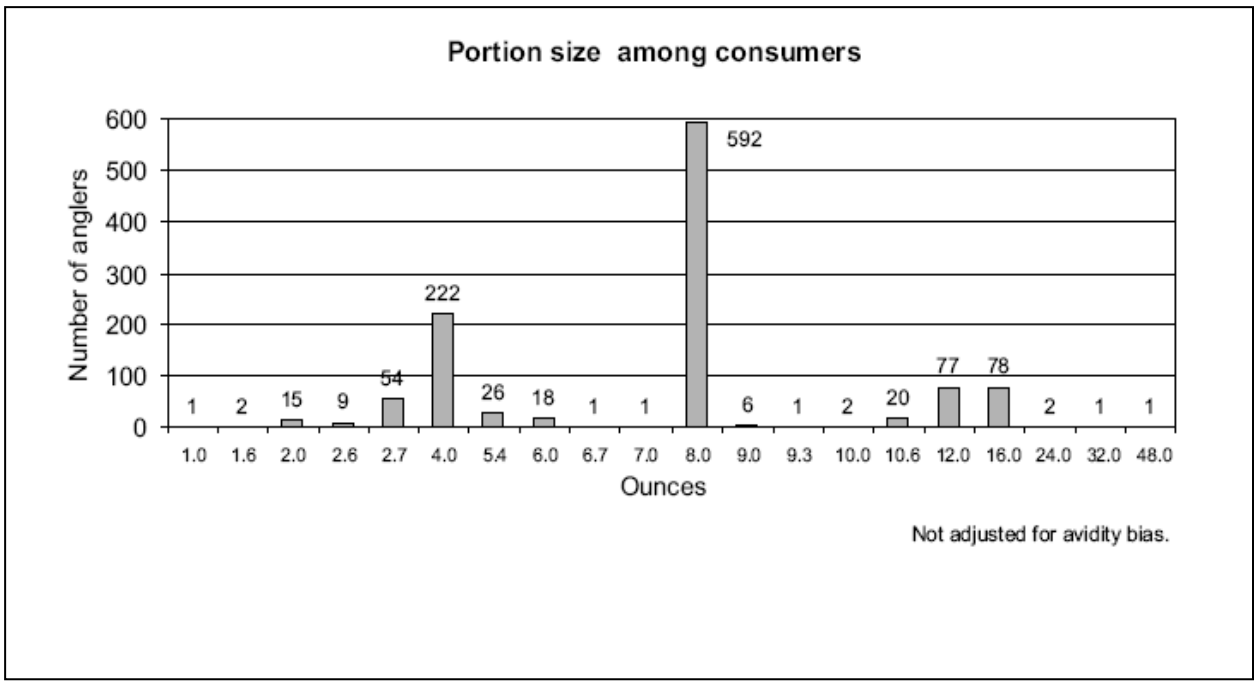
9.~~7~~8.2.2 Influence of Interview Decliners on the Fish Consumption Rate

Anglers who declined to be interviewed for the SF Bay study represented 23% (n=407) of the net attempted interviews. Lacking data on nearly one fourth of the sample may have introduced some bias. As a worst-case scenario, it was assumed that all decliners had recent consumption (in the last four weeks) of Bay fish, to ensure that the influence of decliners did not result in an underestimation of overall consumption rates of recent consumers. Because ethnicity was the only demographic variable that showed a significant influence on consumption rate, the sample was adjusted to account for ethnic differences between the decliners and interviewed anglers. This was done by assuming that decliners of a certain ethnic group had the same consumption rate as recent consumers interviewed in the same ethnic group. Although any bias associated with anglers who declined to be interviewed is not quantifiable, the analysis using reasonable assumptions about this group revealed that the 23% of anglers from whom the researchers could not directly obtain consumption data were unlikely to influence the overall derived consumption estimates.

9.~~7~~8.3 Graphical and Statistical Presentation of Consumption Rate Distributions

Figure 9-1 shows the portion size responses among consumers from the SF Bay study (SFEI, 2000) as a distribution. Portion size responses for consumers and recent consumers (i.e., anglers who reported consuming SF Bay fish in the last four weeks) were similar. In general, anglers gave portion size responses in multiples or fractions of the 8-ounce fish fillet model they were shown during the interview. Just over half of consumers reported that the 8-ounce model was equal to the amount they eat at one time, and the overall mean portion size for consumers was 7.7 ounces.

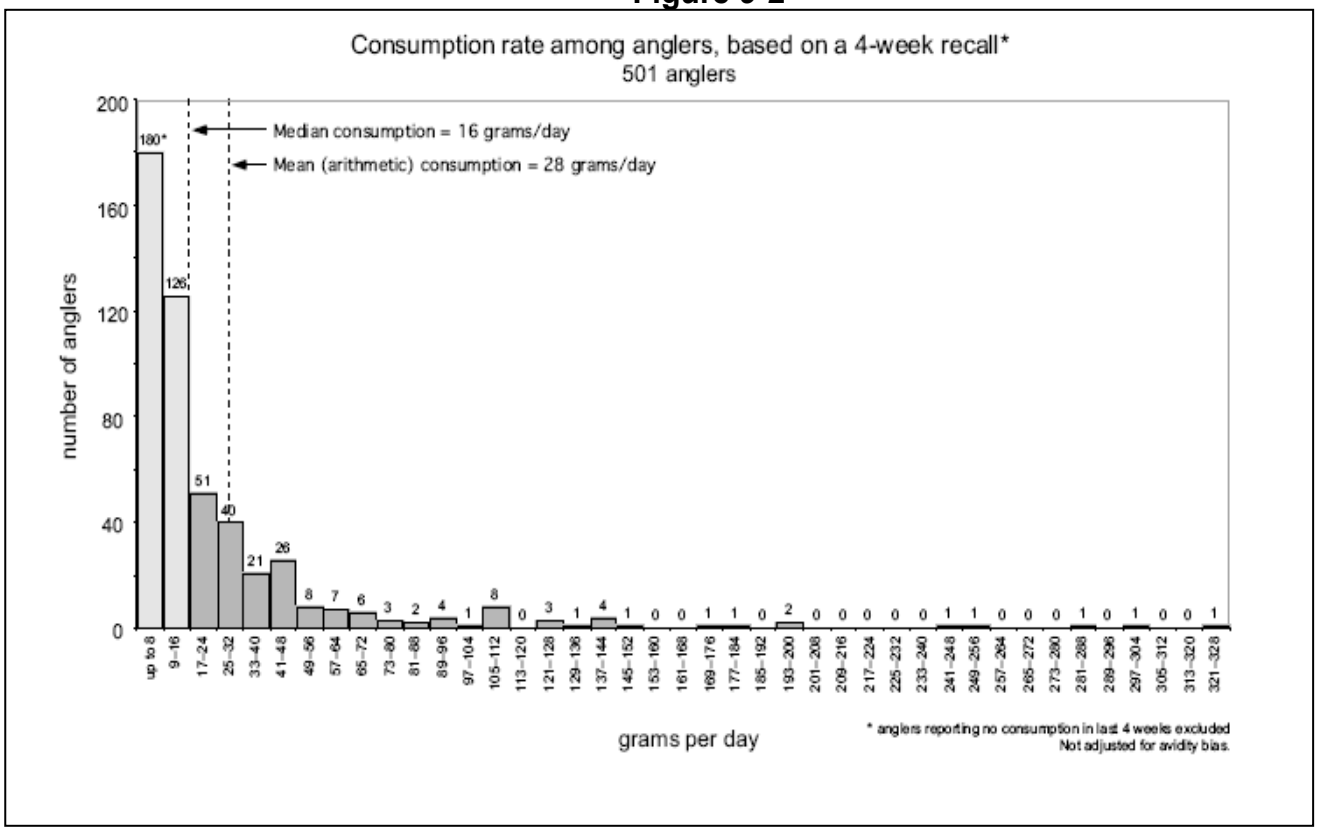
Figure 9-1



(Reprinted from SFEI, 2000))

Multiplying portion size by meal frequency responses provided by the anglers during the interview gives the consumption rate. Figure 9-2 shows the raw (untransformed) data for consumption rate distribution for recent consumers.

Figure 9-2



(Reprinted from SFEI, 2000)

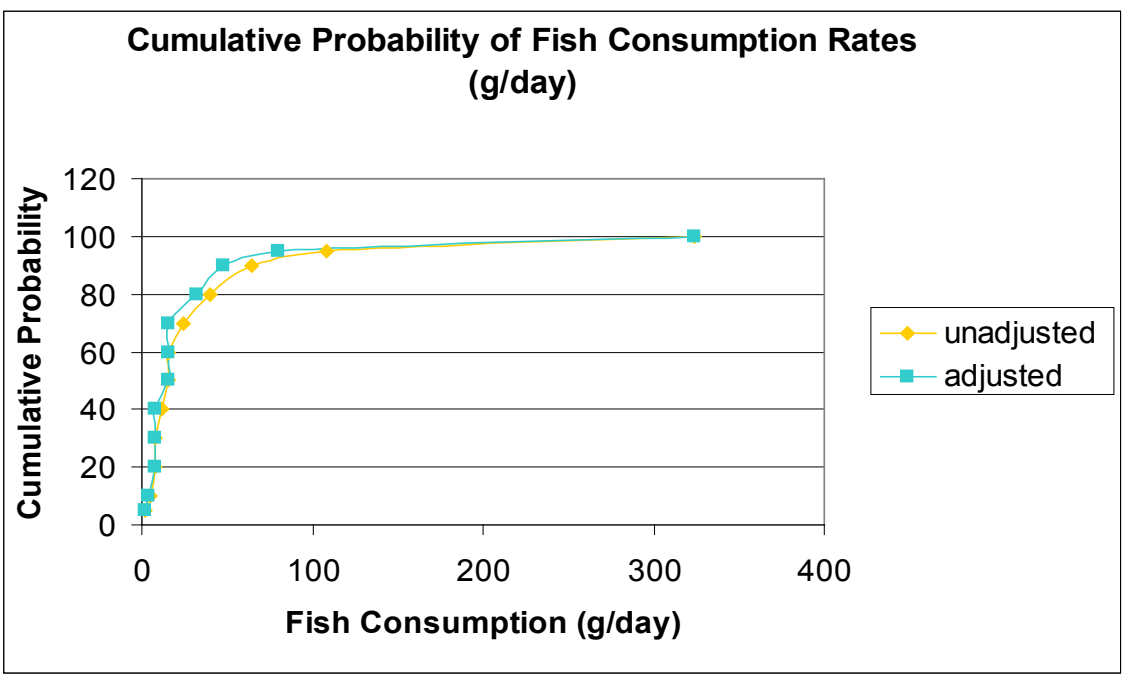
The cumulative empirical distribution curves for the rate of fish consumption for all anglers who caught Bay fish in the SF Bay survey, both unadjusted and adjusted for avidity bias, are shown in Fig. 9-3. The fish consumption rate distribution is highly skewed to the right with a long upper tail, characteristic of a lognormal distribution. The skewness and kurtosis, shown in Table 9.~~4~~6, are positive. A positive skewness indicates a distribution with a tail to the right. In other words, skewness is an indicator of the lack of symmetry of the distribution. The kurtosis indicates heaviness of the tails. Kurtosis is a measure of whether the data are peaked or flat relative to a normal distribution. That is, data sets with high kurtosis tend to have a distinct peak near the mean, decline rather rapidly, and have heavy tails. Data sets with low kurtosis tend to have a flat top near the mean rather than a sharp peak.

The best fit for the empirical distribution of avidity adjusted fish consumption rates was checked using Crystal Ball (Decisioneering, 2008). The best fit was the lognormal distribution based on the Anderson-Darling, Chi-square, and Kolgomorov-Smirnov goodness of fit tests. The Anderson-Darling test was the most important for our

purposes because it gave greater weight to the tails of the distribution. The right tail represents the most highly exposed in the population so it is important to properly characterize this region of the distribution. Because the lognormal distribution was found to be the best fit, Crystal Ball was also used to fit a lognormal parametric model to the avidity-adjusted data.

Moments and percentiles of the empirical distributions (unadjusted and adjusted for avidity) and of the lognormal fitted avidity adjusted fish consumption rates are presented in Table 9.~~4~~6. Figure 9-4 depicts the cumulative probability distribution of the lognormal fitted data. The lognormally fit distribution is slightly more skewed to the right than the original empirical distribution. Nonetheless, the empirical avidity adjusted distribution was non-continuous, as evidenced by the somewhat staircase appearance of its graphs (Figs 9-2 and 9-3). The 20th, 30th, and 40th cumulative percentiles all had the same consumption rate value (i.e., 8 g/day) (Table 9.~~4~~6). Likewise, the 50th, 60th, and 70th percentiles had a 16 g/day value. Fitting a lognormal distribution to the empirical data smoothes the choppy empirical distribution. Though the empirical distribution was appropriate for the sample, the lognormally fit distribution is likely more realistic for the population. For the empirical data, the unadjusted values are higher than the adjusted values because the correction for avidity bias is crucial to compensate for the increase of fish consumption rates with increased frequency (i.e., avidity) of fishing.

Figure 9-3



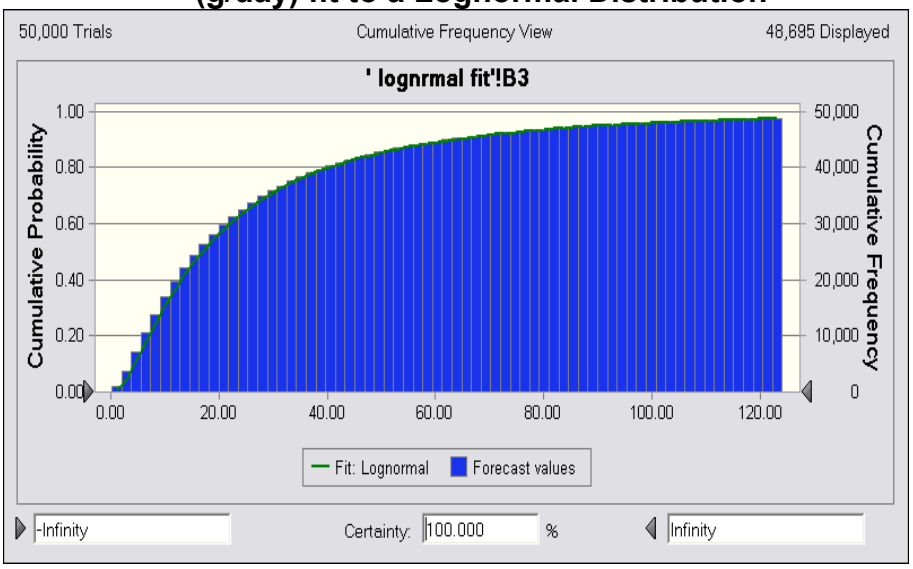
Data source: SFEI (2000)

Table 9.~~4~~6. Comparison of Empirical Distributions and the Recommended Lognormal Model of Fish Consumption Rates for Stochastic Analysis

	Moments and Percentiles (g/day)		
	Empirical Distribution Unadjusted[a]	**Empirical Distribution Avidity-Bias Adjusted[a]**	**Lognormal Parametric Model Fit to Avidity-Bias Adjusted Data**
Geometric Mean	16.55	13.97	[b]
Arithmetic Mean	28.08	23.02	28.8
Standard Deviation	39.63	32.05	39.6
Skewness	3.9	[b]	6.7
Kurtosis	19.9	[b]	140.3
PERCENTILES			
Sample Minimum	2.00	2.00	0.0
10	5.33	4.00	4.5
20	8.00	8.00	7.1
30	8.00	8.00	9.9
40	12.00	8.00	13.0
50	16.00	16.00	16.9
60	16.00	16.00	22.0
70	24.00	16.00	29.0
80	36.00	32.00	40.3
90	56.00	48.00	63.4
95	108.00	80.00	92.4
99	[b]	[b]	177.0
Sample Maximum	324.00	324.00	[c]

[a] Data from SFEI (2000), Appendix K, Table K29
[b] Not Reported
[c] Not Applicable

Figure 9-4 Cumulative Probability of Avidity Adjusted Fish Consumption Rates (g/day) fit to a Lognormal Distribution



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10. Body Weight

10.1 Introduction

Body weight is an important variate in risk assessment that is used in calculating dose (mg/kg body wt). ~~Some~~ Many of the point estimates and distributions of exposure variates are based on studies that ~~OEHHA used to generate distributions and point estimates for variates~~ collected body weight data on individual subjects. For example, the food consumption rate data for each subject collected in the Continuing Survey of Food Intake Among Individuals (USDA, 2000) was divided by the body weight of that subject, and distributions of consumption per unit body weight per day were generated. However, a few of variates (i.e., fish consumption and soil ingestion)~~the studies used by OEHHA, such as the one used to determine fish consumption rate distributions and point estimates,~~ are based on studies that did not collect body weight information on the individual subjects. Therefore a review of the body weight literature was conducted and appropriate body weight defaults were selected to use to calculate the dose in mg/kg body weight in risk assessments for exposure via fish consumption and soil ingestion. Note that the fish consumption pathway has been very rarely invoked in the Hot Spots program.

10.2 Recommended Point Estimates for Body Weights

[Note: This section was moved from the back to the front]
Recommended body weight point estimates in Table 10.1 for specific age groupings are based on raw data for age-specific body weights of U.S. residents collected in the National Health and Nutrition Examination Surveys (NHANES) discussed below in Section 10.3. The measured NHANES-derived body weight data likely represent most accurate estimates of body weight for Californians and U.S. citizens.

In the interest of simplicity males and females are averaged. Little gender-based data is available for the two variates in which these body weight information is used, namely soil ingestion and angler-caught fish consumption. OEHHA concluded that the additional level of refinement by gender for body weight to use in these two exposure pathways does not add enough useful information to a risk assessment to warrant the increased complexity of the assessment. If a toxicant affects only one or predominantly one gender, the assessor may want to adjust point estimates and distributions of intake parameters to reflect body weight of the gender in question. However, such an adjustment will not result in a significant change in the results of the risk assessment.

Table 10.1. Mean Point Estimates for Body Weight (Kg)

Age Range (years)	Mean
0<2	9.7
2<9	21.9
2<16	37.0
16<30	75.9

16-70	80.0

Although body weight data of Californians are available, the data are self-reported (See Section 10.4, The California Health Interview Survey). Comparison of the NHANES and California Health Interview Survey datasets presented in Tables 10.4 and 10.7, respectively, shows that California body weight values are similar to the NHANES body weights, but consistently lower in most age groups by <1 to 12%. These generally small differences could mean that self-reported body weights are often underestimated by the CHIS participants. Another possibility is that Californians have body weights that are lower compared to the rest of the U.S. Obesity trends in the U.S. show a lower prevalence for obesity in California compared to many other states (CDC, 2009). However, because the California body weight data was self-reported and NHANES body weight data was not, we chose to utilize the NHANES data.

OEHHA is not recommending body weight distributions for a stochastic approach because most of the consumption rate distributions that we derive from raw data, or recommend from the literature already incorporate subject body weight. It may be appropriate to use body weight distributions when the correlation between body weight and the consumption rate of interest is known. For the fish consumption distribution we have chosen to divide the consumption distribution by a point estimate of body weight because the correlation is not known. If body weight distributions are used without the appropriate correlation, broad distributions are generated that may overestimate the variability in the parameter of interest. We do not have enough information to derive appropriate soil ingestion distributions; thus, use of a point estimate for body weight is appropriate.

10.~~2~~3 Body Weights Derived from the National Health and Nutrition Examination Surveys (NHANES)

The data collected by NHANES includes detailed anthropometric measurements such as body weight for assessments on the health and nutrition status of U.S. residents (CDC, 2006). The most comprehensive surveys (NHANES II, and III) for body weight were conducted periodically by the National Center for Health Statistics (NCHS) since the 1970s. However, NHANES became a continuous survey in 1999. As anthropometric reference data collection for children and adults is ongoing, 2-year data sets are released as more data become available. The survey samples are nationally representative, from birth to 80+ years of age, from the civilian, non-institutionalized population of the United States. Body weights were recorded for individuals wearing disposable gowns and socks to the nearest 0.1 kg. Some subpopulation subgroups (low income, preschool children, elderly) were oversampled to ensure that sufficient numbers of subjects are available to support estimation to the specified level of precision.

NHANES body weight data represent the most current information on body weight of the U.S. population. NHANES has a large sample size and provides raw data from which interindividual variability can be assessed and categorized by specific age

groupings. The body weights recorded for the NHANES reports also have the advantage of being directly measured rather than self-reported.

The most current information on body weights is preferred and summarized in this document because of the rapid increase in obesity incidence in U.S. residents over the last 30 years (Portier et al., 2007). Thus, earlier studies of body weight distributions derived from the NHANES II, including Brainard and Burmaster (1992), Burmaster and Hull (1997), Burmaster and Crouch (1997), and Finley et al. (1994), are not summarized here but can be found in the first edition of this document (OEHHA, 2000).

10.~~2~~3.1 NCHS Analysis of NHANES 2003-2006 body weight data

The most recently published study by the NCHS that presented NHANES-generated body weight distributions used a combined 4-year dataset based on 2003-2004 and 2005-2006 data (McDowell et al., 2008). A 4-year dataset improves the stability and reliability of the statistical estimates for subgroup analysis. Adolescents 12-19 years of age, persons 60 years of age or older, Mexican Americans, black persons, and low-income persons were oversampled to improve the precision of the statistical estimates for these groups. The 2003-2006 analytic sample was based on 19,593 persons and excluded pregnant females from body weight tabulations. Mean, standard error, and selected percentiles by age group and sex are shown in Table 10.~~1~~2.

Table 10.~~1~~2. Body Weight in Kg for Children and Adults Derived by NCHS From NHANES 2003-2006

Age Category	Body Weight Means and Percentiles in Kg									
	Males [a]					Females [b]				
	Mean	SE	50th	90th	95th	Mean	SE	50th	90th	95th
0-2 mo	5.2	0.12	5.2	[c]	[c]	4.9	0.10	4.9	[c]	[c]
3-5 mo	7.3	0.08	7.2	8.2	[c]	6.8	0.10	6.6	[c]	[c]
6-8 mo	8.4	0.13	8.4	9.9	[c]	8.1	0.13	8.0	[c]	[c]
9-11 mo	9.7	0.15	9.7	[c]	[c]	9.2	0.11	9.0	[c]	[c]
1 yr	11.6	0.12	11.5	13.8	14.4	10.9	0.11	10.9	13.0	13.4
2 yr	14.1	0.14	13.9	16.4	16.9	13.4	0.13	13.1	16.1	16.8
3 yr	15.8	0.16	15.3	18.7	[c]	15.8	0.20	15.5	18.5	[c]
4 yr	18.6	0.31	18.1	22.7	[c]	17.9	0.21	17.5	20.8	[c]
5 yr	22.1	0.49	21.0	26.9	[c]	20.5	0.37	19.6	25.5	[c]
6 yr	24.2	0.33	23.7	29.5	[c]	23.4	0.49	22.1	29.7	[c]
7 yr	26.6	0.58	25.6	33.9	[c]	27.3	0.62	25.7	35.5	[c]
8 yr	31.4	0.90	29.0	41.9	[c]	30.7	0.94	28.2	42.1	[c]
9 yr	34.6	0.71	32.3	44.1	[c]	36.7	0.99	34.0	50.7	[c]
10 yr	40.1	0.86	37.3	56.8	[c]	42.4	1.07	40.5	58.5	[c]
11 yr	46.8	1.62	44.2	67.0	[c]	49.2	1.31	47.3	68.2	[c]
12 yr	50.8	1.23	46.9	72.8	82.9	52.9	1.31	49.5	76.2	[c]
13 yr	57.8	1.37	55.6	81.0	90.9	57.4	0.98	54.4	76.0	88.5
14 yr	63.1	1.73	59.8	84.3	99.1	58.8	1.75	54.4	81.0	[c]
15 yr	70.2	1.36	66.3	89.9	100.4	60.9	0.76	57.6	81.0	[c]
16 yr	76.1	1.50	70.7	101.9	116.1	61.5	0.95	58.8	79.6	[c]
17 yr	75.0	1.30	70.6	101.3	111.0	66.0	1.66	60.6	87.3	[c]
18 yr	77.2	1.67	72.7	105.8	110.4	67.6	2.15	63.0	92.1	[c]
19 yr	80.2	1.69	76.5	107.3	117.3	67.4	1.79	63.0	92.7	[c]
20-29 yr	85.4	1.06	81.1	111.5	122.6	70.7	1.03	65.3	98.6	110.7
30-39 yr	88.1	0.80	85.9	109.6	120.8	74.7	1.06	70.2	101.7	114.2
40-49 yr	91.8	0.83	88.9	114.0	124.7	77.7	1.03	72.9	106.6	116.9
50-59 yr	90.2	0.95	88.7	113.1	124.4	78.0	1.15	73.7	106.3	117.8
60-69 yr	90.0	0.98	88.0	112.9	121.3	77.3	0.91	74.0	102.0	112.9
70-79 yr	85.0	0.92	83.8	104.5	116.7	70.6	1.07	68.3	91.2	98.9
20 yrs and over	88.3	0.46	85.6	111.5	122.6	74.7	0.53	70.7	101.8	113.6

[a] For male children age groups, n ranged from 101 to 360; for male adult 10-year age groups, n ranged from 555 to 811.
[b] For female children age groups, n ranged from 81 to 335; for female adult 10-year age groups, n ranged from 468 to 779.
[c] Figure does not meet standards of reliability or precision.

In Table 10.~~1~~2, estimation of some of the higher percentiles (90th and 95th) did not meet standards of reliability or precision. The reliability of the estimates was evaluated using the relative standard error (RSE), which is calculated by dividing the standard error by

the estimate, and the minimum sample size criterion. NCHS recommends that an estimate with an RSE greater than 30 percent be considered unreliable.

10.~~2~~3.2 U.S. EPA Analysis of NHANES 1999-2006 body weight data

The U.S. EPA analyzed data from the 1999-2006 NHANES to generate distributions of body weight for various age ranges of children in their Child-Specific Exposure Factors Handbook (U.S. EPA, 2008). Because four NHANES datasets were utilized in the analysis (NHANES 1999-2000, 2001-2002, 2003-2004, and 2005-2006) containing approximately 20,000 children, sample weights were developed for the combined dataset in accordance with CDC guidance. Mean and selected percentile body weights for specified age groups derived from NHANES are presented in Table 10.~~2~~ 3 for males and females combined.

Table 10.~~2~~3. Body Weight For Children in Kg Derived by U.S. EPA (2008) From NHANES 1999-2006, Males and Females Combined

Age Group	N	Body Weight Means and Percentiles in Kg				
		Mean	50th	75th	90th	95th
Birth to < 1 mo	158	4.8	4.8	5.1	5.8	6.2
1 to <3 mo	284	5.9	5.9	6.6	7.1	7.3
3 to <6 mo	489	7.4	7.3	8.0	8.7	9.1
6 to <12 mo	927	9.2	9.1	10.1	10.8	11.3
1 to <2 yr	1176	11.4	11.3	12.4	13.4	14.0
2 to <3 yr	1144	13.8	13.6	14.9	16.3	17.1
3 to <6 yr	2318	18.6	17.8	20.3	23.6	26.2
6 to <11 yr	3593	31.8	29.3	36.8	45.6	52.5
11 to <16 yr	5297	56.8	54.2	65.0	79.3	88.8
16 to <21 yr	4851	71.6	67.6	80.6	97.7	108.0

For our objectives, the OEHHA stochastic risk assessment approach is focused on chronic exposure and on deriving parameter distributions for use in assessing cancer risk weighted by age-at-exposure. Thus, we need age groupings that represent 0<2, 2<9, 2<16, 16<30, and 16-70 yrs. The U.S. EPA's body weight data for specified age groups would be useful for assessing hazard for acute and subchronic exposures.

10.~~2~~3.3 OEHHA Analysis of NHANES 1999-2006 body weight data

The body weight estimates derived by OEHHA in this document consist of a combined 8-year NHANES dataset from 1999 to 2006, each one spanning 2 years (1999-2000, 2001-2002, 2003-2004, and 2005-2006) (NCHS, 2005; 2006; 2007). As of this writing, the 2007-2008 NHANES dataset results had not been finalized. The NHANES body weight data represent the most current information on body weight. NHANES has a large sample size and provides raw data from which OEHHA can assess interindividual variability and categorize by specific age groupings for the purposes of the "Hot Spots" program. Since the survey was meant to be representative of the U.S. population, the

raw data were weighted to reflect the age structure, sex and race of the population at the time of the survey.

The NHANES data included the body weight and age for each participant, so participants were placed into the age groupings consistent with OEHHA's "Hot Spots" program. The body weights for each age group were fit to a lognormal distribution using Crystal Ball® (Decisioneering, 2009). Crystal Ball® was also used to determine the best parametric model fit for the distribution of body weights for each age group. The Anderson-Darling goodness-of-fit test was chosen to determine the best fit distribution because this test specifically gives greater weight to the tails than to the center of the distribution. OEHHA is interested in the tails since the right tail represents the high-end (e.g., 95th percentile) body weights.

For each age group, males and females combined, the mean, and percentiles (50th, 75th, 90th, and 95th) of the body weight distributions are presented in Table 10.~~3~~4.

Table 10.~~3~~4. OEHHA-Derived Body Weight Distributional Results Based on the NHANES IV 1999-2006 Surveys, Males and Females Combined

Age Range (years)	N	Body Weight Mean and Percentiles (in kg)				
		Mean	50th	75th	90th	95th
0<2	3034	9.7	9.9	11.5	12.7	13.4
2<9	5626	21.9	20.3	25.5	32.7	36.8
2<16	12,352	37.0	32.1	50.1	64.3	74.8
16<30	8083	75.9	72.1	85.9	102.8	114.9
16-70	32,012	80.0	77.4	91.5	106.6	116.8

Directly measured body weights that are representative of the U.S. population and the large sample sizes are clear advantages for using these body weight distributions. The limitation for using NHANES body weight data is that it is not California-specific; the body weights collected from California participants could not be removed from the report and analyzed separately.

10.2.4 Analysis of NHANES data for body weight changes over time

Distributional changes in body weight over a 24-year period were investigated by Portier et al. (2007) based on NHANES data from three different surveys (II, 1976-1980; III, 1988-1994; IV 1999-2002). For each of the three body weight data sets, the weighted mean and standard deviation of natural log-transformed body weights were computed for single-year age groups and population-specific weight patterns further described using piece-wise polynomial spline functions and nonparametric age-smoothed trend lines.

The analysis demonstrated that there were changes in body weight as well as changes in age-specific distributions over the 24-year time period (Table 10.~~4~~5). However, the

changes were not constant for all ages. For the most part, mean body weights of children (1-6 yrs) did not change for males, and there was only about a 1 kg change in females from NHANES III to IV. Similarly, there was no change for adolescent males (7-16 years), but there was an upward change in female adolescent average body weight of about 4 kg from the NHANES II to IV surveys. The major differences occurred among adults, where mean body weight for males (18-65 yrs) showed an upward trend of about 3.5 to 4 kg between each survey with about a 4 to 5 kg increase for females (18-65 yrs). Percentile distributions by age group were not provided. This study demonstrates the changing nature of body weights in the U.S. population and the value of using the most recent data for risk assessment purposes.

Table 10.~~4~~5. Comparison of Body Weights in Kg for Selected Age Groupings from NHANES II, III AND IV Surveys

Age Range (years)	NHANES	Male		Female		Overall Male and Female	
		Mean	Std Dev	Mean	Std Dev	Mean	Std Dev
1-6	II	17.04	4.58	16.34	4.70	16.66	4.47
	III	16.88	4.70	16.52	4.91	16.75	4.98
	IV	17.10	4.86	17.46	5.02	17.27	4.97
7-16	II	45.15	17.64	43.93	15.91	44.75	17.49
	III	49.34	20.94	46.77	18.02	47.76	18.40
	IV	47.86	20.10	47.87	19.19	47.73	19.13
18-65	II	78.65	13.23	65.47	13.77	71.23	11.97
	III	82.19	16.18	69.45	16.55	75.61	18.02
	IV	85.47	19.03	74.55	19.32	79.96	20.73
65+	II	74.45	13.05	66.26	13.25	69.56	12.20
	III	79.42	14.66	66.76	14.52	72.25	15.71
	IV	83.50	16.35	69.59	14.63	75.54	15.88

10.~~2~~3.5 Child Growth Charts Derived from NHANES data

Child growth charts, including weight-for-age data, were published by the Centers for Disease Control (Kuczmarski et al., 2002) using improved statistical smoothing procedures in conjunction with several national surveys (NHANES II and III, NHANES I, II and III). Growth charts and percentile distributions for weight by sex and age were presented in two sets of data: Birth to 36 months (infants) and 2 to 20 years (children and adolescents). The surveys were pooled because no single survey in the NHANES series had enough observations to construct growth charts. Sample sizes from 400 to 500 were required to achieve precision of the empirical percentiles at the specific ages for the curve fitting. The weight-for-age curves were smoothed using a 3-parameter linear model and locally weighted regression.

The evaluation of the growth charts found no large or systematic differences between the smoothed percentiles and the empirical data. Very low birth weight (VLBW) infants were excluded from the infant percentiles, but included in the older child percentile

where the effect of VLBW is diminished. The observed mean, standard deviation, and selected percentiles were presented in one month age intervals for infants (birth to 36 months), and 0.5-year intervals for children and adolescents ages 2-20 years.

More recent children body weight results derived from NHANES data have been published and presented above (McDowell et al., 2008; U.S. EPA, 2008), so the CDC growth charts are not reprinted here in this document. However, the growth charts can be downloaded from the website in the listed citation by Kuczmarski et al. (2002) below. The report did not address the upward trend in weight of female children over time noted by Portier et al. (2007), possibly because the later release of NHANES IV survey data (1999-2002) strengthened the observed trend that was not yet firmly established by the earlier surveys used in the CDC report.

10.~~3~~4 California Health Interview Survey

The California Health Interview Survey (CHIS) is conducted by the California Department of Health Services every two years, with the most recent published survey data collected in 2005 (CHIS, 2006). CHIS is the largest population-based state health survey including individual health information such as health conditions and limitations, health behaviors, and health care access and health insurance coverage information. The report used the same method to adjust for non-response as that used by NHANES, correcting for several factors (e.g., race, ethnicity, household income, etc.) in order to make the body weights more representative of the California population. The individual self-reported body weight information is available to researchers in a statistical program format.

Because body weight and age information was collected for each participant, OEHHA combined the data into the specified age groups and fit a lognormal distribution to their body weights using Crystal Ball® (Decisioneering, 2009), same as that performed for the NHANES body weight data. The best parametric model fit for the distribution of body weights was determined for each age group and the Anderson-Darling test was used for goodness-of-fit. For each age group, males and females combined, minimum and maximum values, mean, standard error of the mean, and percentiles of the body weight distributions are presented in Table 10.6.

Table 10.6. Body Weight Distributional Data from the California Health Interview Survey, Males and Females Combined

Age Group (years)	N	Body Weight Mean and Percentiles (in kg)						
		Min	Max	Mean	SEM	50%	90%	95%
0<2	1,927	3	32	9.4	0.07	10	13	14
2<9	6,022	9	79	21.4	0.095	20	31	36
2<16	11,719	9	145	36.6	0.176	32	62	71
16<30	6,367	41	150	72.1	0.22	68	95	107
16<70	37,108	41	150	76.0	0.095	73	100	109

Although the state-wide body weight database is specific for Californians, it is self-reported. Self-reported body weights are often underestimated by the participants. The survey, which was conducted by phone, reported a relatively low response rate of 29.2%. However, the report noted that this nonresponse rate was similar to the rate for other phone surveys, and the sampling weights used in the analysis would be expected to adjust much of the bias associated with the high nonresponse rate.

10.~~4~~5 Analysis of CSFII body weight data

The U. S. Department of Agriculture (USDA) conducts a continuing survey of the food intakes by individuals. Self-reported body weight data were collected during the USDA's 1994-1996 and 1998 Continuing Survey of Food Intake by Individuals (CSFII), which was a multistage probability sample survey of individuals within U.S. households. Distributions of body weights by different age categories from this survey were calculated by Kahn and Stralka (2009) and shown in Table 10.7.

Table 10.7. Body Weight Distrib~~t~~utions from the CSFII, Males and Females Combined

Age Group	N	Body Weight Mean and Percentiles (in kg)				
		Mean	50th	75th	90th	95th
<1 mo	88	4	3	4	4[a]	5[a]
1 to <3 mo	245	5	5	6	6	7[a]
3 to <6 mo	411	7	7	8	9	10
6 to <12 mo	678	9	9	10	11	12
1 to <2 yr	1002	12	11	13	14	15
2 to <3 yr	994	14	14	16	18	19
3 to <6 yr	4112	18	18	20	23	25
6 to <11 yr	1553	30	27	35	41	45
11 to <16 yr	975	54	52	61	72	82
16 to <18 yr	360	67	63	73	86	100[a]
18 to <21 yr	383	69	66	77	89	100[a]
≥21 yr	9049	76	74	86	99	107
≥65 yr	2139	72	71	81	93	100

[a] The sample size did not meet minimum reporting requirements

The CSFII body weight results have the same limitation as the CHIS body weight data, in that self-reported body weights are often underestimated by the participants. Also, more recent and comprehensive national body weight data are collected by NHANES.

10.~~5~~6 International Commission on Radiological Protection

The International Commission on Radiological Protection (ICRP) reviewed and compiled extensive data on anatomical measurements, elemental composition, and physiological values for the human body (ICRP, 2003). Weight (W), length (L), and surface area (SA) during prenatal life are presented as means +/- standard deviation (SD) as a function of gestational age. From the data, a number of allometric relations were derived which

relate gestational age to average length, and length to surface area and weight. Postnatal life data from a number of sources were reviewed. Charts presented in the report show mean body weight ± one SD from 0 to 15 years and adults by sex. However, the bulk of the body weight information is based on Western European data, and it was noted that in some age groupings, differences exist in body weight between North Americans and Europeans.

10.7 References

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11. Residential and Worker Exposure Duration, Individual vs. Population Cancer Risk, and Evaluation of Short Term Projects

11.1 Introduction

This chapter covers topics related to estimating cancer risk for facility-specific emissions under the Air Toxics Hot Spots program. The Hot spots statute mandates the assessment of cancer risks from airborne emissions of stationary sources to people living or working near a specific facility. The duration of exposure for residential and offsite worker receptors influences the estimate of cancer risk from a specific facility. In the past, cancer risk was estimated for the maximally exposed individual resident who was assumed to be at the point of highest exposure to emitted carcinogens 24 hours per day, 7 days per week for a lifetime. This is a health protective but not particularly realistic assumption. To address this problem, ARB and OEHHA evaluated information available on length of residence at a specific address to develop guidance on the duration of exposure for the residential exposure scenario.

Past risk assessments assumed a 40 year exposure duration for offsite workers based on little data. For the offsite worker exposure scenario, ARB and OEHHA evaluated information available on the length of time people work at the same location. Information on the percentage of time people are at home was also evaluated to provide an adjustment based on activity patterns for time away from home.

This chapter also discusses reporting and more explicitly considering population wide cancer risks separately from the traditional maximally exposed individual cancer risk estimate.

Finally, the chapter presents guidance to the Air Districts for evaluating cancer risks from short-term projects in their purview that are not Hot Spots facilities.

11.1.1 Residential Exposure Duration for Cancer Risk Assessment

An assumption of lifetime exposure duration (70 years) for the calculation of cancer risk is incorporated into the unit risk factors, inhalation cancer potency factors and oral cancer potency factors. The cancer potency factors and unit risk factors are estimated from data from long-term worker epidemiological studies or lifetime rodent studies. A lifetime cancer risk of 5×10^{-5} means that in a population of a million chronically exposed individuals ~~for 70 years~~, ~~it would be expected that~~ 50 excess cancer cases would ~~occur~~be predicted. Since the cancer potency factors and unit risk factors are based on lifetime or very long-term studies, there are uncertainties in calculating less than lifetime risk.

A complicating factor in estimating cancer risk is the greater impact of early-in-life exposure. ~~Over the last few years, an increasing number of studies~~Analyses of available data on the influence of age-at-exposure on potency of carcinogens by

OEHHA (OEHHA, 2009) and U.S.EPA (U.S.EPA, 2005, Barton et al., 2005) indicate that early in life exposures to carcinogens are more potent than later in life exposures. ~~There are a variety of reasons why this may occur. Cell division in the younger organism is much more rapid, thus, mutations become fixed before they can be repaired. Metabolism can be less or more efficient and occur through different pathways. Early-in-life cellular damage has a longer amount of time to progress through various stages to cancer. Epigenetic mechanisms may also play a role.~~This is discussed in detail in OEHHA (2009).

In order to address the issue of early-in life exposures, OEHHA has adopted a policy, based on the available scientific data, of weighting cancer risk from exposures from the third trimester to <2 yrs of age by a factor of ten, and exposures from age two to less than sixteen years by a factor of three (OEHHA, 2009). In addition to innate sensitivities to some carcinogens, c~~C~~hildren have greater exposures due to physiological and behavioral factors. As a result, a greater proportion of total lifetime risk is accrued by age 16 with lifetime exposure to a constant air concentration than was previously recognized.

Accumulation of risk over a lifetime is thus no longer assumed linear with increasing length of exposure to a constant dose, but depends on the age at exposure. To further complicate estimation of risk, exposure to a constant air contaminant concentration or soil contaminant concentration over time is also not linear. There are physiological and behavioral differences between adults and children, which results in children's doses (mg/kg body weight) being greater than adults at the same environmental contaminant concentration.

When estimating cancer risk from individual stationary facilities to nearby residents ~~from a stationary facility~~, exposure duration is an important determinant of cancer risk. Cancer risk for residents is also influenced by activity patterns. Exposure duration for the resident near a facility amounts to the time that resident lives in his or her house. Another important factor is the number of hours that the resident spends at his or her residence. This factor varies with age. Section 11.5 discusses available information to use in estimating exposure duration for residential exposure scenarios.

11.1.2 Offsite Worker Exposure Duration for Cancer Risk Assessment

Offsite workers near a stationary source of airborne emissions are treated as members of the public in the Hot Spots program. The length of time that a worker is on the job at a specific location determines the exposure duration and is directly proportional to the cancer risks estimated from a specific stationary source. In the past, OEHHA recommended a default of 40 years for employment tenure. OEHHA has examined the data on job tenure in the United States in order to develop a new data-derived high-end estimate of job tenure that would be public health protective without being unnecessarily conservative. These data are not perfect for this purpose but provide a useful basis for our new recommendation. Section 11.6 discusses available information to use in estimating exposure duration for offsite worker exposure scenarios.

The point estimate risk assessment approach (Tier 1 and 2) can be used with more than one estimate of resident chronic exposure duration to give multiple point estimates of cancer risk. For stochastic risk assessment (Tier 3 and 4), OEHHA recommends calculating separate cancer risk distributions for each fixed chronic exposure duration.~~there are two possible approaches to incorporating duration of exposure.~~ An alternative approach would be to express the variability in exposure duration as a distribution of residency times and equate residency time to exposure duration. The variance in residency times would be propagated through the model and contribute to the variance in the cancer risk. ~~The second approach would be to calculate separate cancer risk distributions for each fixed chronic exposure duration.~~

OEHHA does not recommend a distribution of residence times for our model (Tier ~~I~~II). Since each individual knows the length of time that he or she has resided near the facility, if the 9, 30 and 70-year cancer risks are presented the residents should have a better idea of his or her risk.

11.2 Recommendations *[This section has been moved to the front of the chapter from the back of the chapter; additional recommendations that were scattered in the chapter have been brought forward here]*

11.2.1 Exposure Duration for Estimating Cancer Risk in the Residential and Offsite Worker Exposure Scenarios

OEHHA is recommending that an exposure duration (residency time) of 30 years be used for individual cancer risk determination for the maximally exposed individual resident (MEIR) (Table 11.1). This should provide adequate public health protection against individual risk. Note that the 30 year exposure duration starts in the third trimester to accommodate the increased susceptibility of exposures in early life (OEHHA, 2009), and would apply to both the point estimate and stochastic approaches. Reducing the residency time assumption from 70 years to 30 years will however reduce the protection for the population. Thus, we have recommendations below (Section 11.1.3) for specifically evaluating population cancer risk from facility emissions.

As supplemental information in the risk assessment for the MEIR scenario, OEHHA is recommending that point estimate and stochastic risk estimates also be presented for 9 and 70-year exposure durations, both starting in the third trimester. This will help convey the message to the public that cancer risk is proportional to the duration of exposure (i.e., length of residency near the facility). Different communities may have different patterns of residency duration and the pattern within the community may need to be considered by the risk manager.

Although the data for determining residency duration is less than perfect, it is likely that 30 years is a reasonable estimate of the 90th or 95th percentile of residency duration in a population. Thus, a 30-year residency time is consistent with recommendations for other risk assessment variates in our model. In addition, it should be noted that

accounting for the greater potency of early-in-life exposure using the Age Sensitivity Factors (OEHHA, 2009) means that a smaller fraction of lifetime risk is incurred after age 30.

Note that there is an assumption that after the person moves, he or she is no longer significantly exposed to the emissions from the facility in question. However the larger the isopleths of cancer risks, the greater the probability that the person could be moving into a residence still impacted by the facility. As the size of the cancer risk isopleths increases, the probability that population risk will be more important in terms of public health increases (see discussion in Section 11.7).

OEHHA recommends, based on the available data, that 25 years be used as a reasonable estimate of the 95th percentile of employment duration for the Hot Spots program. Thus, for estimating cancer risk for the offsite worker scenario, a 25 year exposure duration should be used.

The time that a person is away from his or her residence can mean either no exposure to a small facility's emissions, or in the case of a facility with a large isopleth footprint, continuing significant exposure. The available California data do not determine distance from residence during time away from residence (Appendix L). This makes it difficult to come up with a general recommendation, protective of public health, for evaluating risk to the residential MEI during the time that a person is away from the residence. However, OEHHA notes it is appropriate to consider the fraction of time people spend at home as an adjustment for exposure to carcinogens (Table 11.2)

A large fraction of lifetime (70-year) cancer risk and an even larger fraction of the cancer risk for the first 30 years in life is incurred during the first 16 years of life because of the higher risk of early in life exposure. A good fraction of the time away from residence will be spent at school for the first sixteen years of life. Many California schoolchildren attend a local neighborhood school. Therefore, OEHHA is recommending that time away from residence be considered as away from facility emissions (no facility cancer risk) for facilities that do not have a school within the 1 X 10^{-6} or greater cancer risk isopleth. We recommend no adjustment for time away from residence when there are schools inside the 1 X 10^{-6} (or greater) cancer risk isopleth. The larger facilities with multiple emissions sources are most likely to have schools within the 1 X 10^{-6} isopleth and are more likely to cause significant exposure to people while they are away from their residences.

11.2.2 Activity Patterns and Time Spent at Home

OEHHA and ARB evaluated information from activity patterns databases to estimate the percentage of the day that people are home (discussed in Appendix L). This information can be used to adjust exposure duration and risk from a specific facility's emissions, based on the assumption that exposure to the facility's emissions are not occurring away from home. Table L.6 in Appendix L shows the number of minutes spent at home, statewide in California, and the percentage of total time spent at home as well. Ages 0 to 2 spend 85% of their time at home, ages 2 through 15 spend 72% of the their time at home, and ages greater than 15 spend 73% of their time at home (Table 11.2). The data used to determine these percentages were collected by the California Department of Transportation in 2000 and 2001 (Cal Trans, 2001). The time away from the home includes vacations.

11.2.3 Recommendations for Presenting Population Risks

Clear separation of individual risk and population risk and their separate evaluation will be helpful in risk communication and could result in better public health protection and more equitable risk management decisions (further discussed in Section 11.7). The cancer risk estimate based on a 70-year residential exposure does not account for an important aspect of population risk. In particular, large facilities with multiple stacks can dilute emissions over a large area that impact thousands of individuals and theoretically cause a large number of cancer cases, but because of the dilution, the cancer risk estimate for the maximally exposed individual resident, which is what most risk management decisions are based upon, is below a level of concern. A small facility with a single stack, impacting very few individuals due to more concentrated emissions can exceed individual risk limits set by the air districts, thus triggering notification and other measures. The large facility may in fact have a much greater public health impact (greater number of cancer cases) when population risk is considered. There are different methods that can be used as measure of population burden, based on a lifetime (70 year) cancer risk estimate. Calculating cancer burden as described ~~above~~ below is one method. The number of individuals residing within a 1 X 10^{-6}, 1 X 10^{-5}, and/or 1 X 10^{-4} isopleth is another potential measure of population burden (OEHHA, 2003). OEHHA recommends this latter approach for the Hot Spots risk assessments to more explicitly consider population-wide cancer risks from facility emissions. This metric is more easily understood, and provides a metric for population-wide cancer risks that can inform risk management decisions. Cancer burden can also be presented, based on a 70 year lifetime risk estimate.

11.3.3 Recommendations for Exposure Duration for Short-term projects

We recommend that exposure from projects less than 6 months be assumed to last 6 months (e.g., a 2-month project would be evaluated as if it lasted 6 months). Exposure from projects lasting less than two months would not be evaluated for cancer risk. We recommend that exposure from projects lasting more than 6 months be evaluated for the duration of the project. In all cases the exposure should be assumed to start in the

third trimester to allow for the use of the Age Sensitivity Factors (OEHHA, 2009). Thus, if the District is evaluating a proposed 5-year mitigation project at a hazardous waste site, the exposure duration for the residents would be from the third trimester through the first five years of life. The exposure duration for the offsite worker scenario would be five years in this case.

Table 11.1 Summary of Recommendations for Exposure Duration

Receptor	***Recommendation***
Resident	30 years[a]
Resident (supplemental Information)	9 years for central tendency; 70 years for maximum
Worker	25 years

a All durations start with exposure in the third trimester to accomodate use of the Age Sensitivity Factors for early life exposure to carcinogens

Table 11.2 Recommendations for Time Away from Residence for Evaluating Cancer Risk for Facilities Without A School Within the 1 X 10^{-6} (or greater) Cancer Risk Isopleth[1]

Age Range	Fraction of Time at Residence
3rd Trimester<2	0.85
2<16	0.72
16-30	0.73

1Facilities with a school within the 1 X10^{-6} (or greater) cancer risk isopleth should use 1 as the fraction of time at the residence for ages 3rd trimester to less than age 16.

11.4 Cancer Risk Algorithm and Exposure Duration

The following equations for ~~inhalation dose~~cancer risk can accommodate different exposure durations:

~~$DOSE = (C_{air} \times BR \times ED \times FAH \times EF \times 1 \times 10^{-6}) / [AT]$~~

9-year exposure duration - Calculation of Cancer Risk from the Third Trimester to Age Nine:

$$\text{Cancer Risk} = [(ADD_{\text{third trimester}} \times CPF \times 10) \times 0.3\ \text{yrs}/70\ \text{yrs}] + [(ADD_{0\ \text{to}\ <2\text{yrs}} \times CPF \times 10) \times 2\ \text{yrs}/70\ \text{yrs}] + [(ADD_{2 < 9\text{yrs}} \times CPF \times 3) \times 7\ \text{yrs}/70\ \text{yrs}] \times FAH$$

30-year exposure duration - Calculation of Cancer Risk from Third Trimester to Age 30:

$$\text{Cancer Risk} = [(ADD_{\text{third trimester}} \times CPF \times 10) \times 0.3\ \text{yrs}/70\ \text{yrs}] + [(ADD_{0\ \text{to}\ <2\text{yrs}} \times CPF \times 10) \times 2\ \text{yrs}/70\ \text{yrs}] + [(ADD_{2 < 16\text{yrs}} \times CPF \times 3) \times 14\ \text{yrs}/70\ \text{yrs}] +$$

[(ADD$_{16 < 30yrs}$ X CPF X 1) X 14yrs/70 yrs X FAH

Lifetime (70 year) exposure duration - Calculation of Cancer Risk from Third Trimester to Age 70:

Cancer Risk = [(ADD$_{third\ trimester}$ X CPF X 10) X 0.3 yrs/70 yrs] + [(ADD$_{0\ to\ <2yrs}$ X CPF X 10) X 2 yrs/70 yrs] + [(ADD$_{2 < 16yrs}$ X CPF X 3) X 14 yrs/70 yrs]+ [(ADD$_{16 < 70yrs}$ X CPF X 1) X 54 yrs/70 yrs X FAH

where:

ADD = Average Daily Dose, mg/kg-d, for the specified time period (estimated using the exposure variates presented in the TSD)
CPF = Cancer Potency Factor $(mg/kg\text{-}d)^{-1}$
Age Sensitivity Factor third trimester to less than 2 years = 10
Age Sensitivity Factor age 2 to less than 16 years = 3
Age Sensitivity Factor age 16 to less than 70 years = 1
FAH=Fraction of time at home
ED =Exposure duration, in years
1×10^{-6} =Conversion factor ($\mu g/m^3$) to (mg/L)
AT =Averaging time (period over which exposure is averaged, in years); for carcinogenic effects, the averaging time is 70 years = 25,500 days

~~where:~~

~~DOSE = Inhalation dose [(mg/kg body weight)/day]~~
~~C_{air} = Average annual air concentration of contaminant ($\mu g/m^3$)~~
~~BR = Average daily breathing rate (L/day*kg body weight)~~
~~EF = Exposure frequency, days/year~~
~~FAH= Fraction of time at home~~
~~ED = Exposure duration, in years~~
~~1×10^{-6} = Conversion factor ($\mu g/m^3$) to (mg/L)~~
~~AT = Averaging time (period over which exposure is averaged, in years); for carcinogenic effects, the averaging time is 70 years = 25,500 days~~

Adjustment for exposure less than 365 days/year (e.g., 350 out of 365 days a year to allow for a two week period away from home each year for the residential exposure scenario, or worker exposures of eight hours per day, 5 d/week for the offsite worker exposure scenario) can be factored into the equation using the EF term.

11.5 Available Studies for Evaluating Residency Time and Exposure Duration for the Residential Exposure Scenario

11.5.1 National Studies

Israeli and Nelson (1992) used information from the American Housing Survey (AHS) for the United States for 1985 and 1987 (Bureau of the Census, 1987; 1989) to develop a distribution of average total residence time for all U.S. residents. Finley et al. (1994) calculated more of the percentiles for the data presented by Israeli and Nelson (1992). The mean of the distribution presented by Israeli and Nelson (1992) is 4.6 years. In addition, distributions are presented for subpopulations such as renters and owners, and for regions of the country. The study clearly shows that homeowners have a much greater average residency time than renters and therefore may be a more at risk population from exposure to emissions of a nearby facility. The average residency time for the Western region was lower than for the entire U.S. population.

The authors note that with the methodology they used, there could be repeated sampling or over-sampling of a population of frequent movers. This methodology would also tend to overemphasize the more frequent short duration residency periods that have been found to occur from approximately age twenty to thirty by the Bureau of Census (1988). The Israeli and Nelson (1992) study has information on various categories such as renters, homeowners, farm, urban and rural populations, and large geographic regions such as the West. OEHHA staff did not consider the Israeli and Nelson (1992) study to be appropriate for determining an appropriate residency time to use in less-than-lifetime exposure scenarios in the Air Toxics "Hot Spots" program.

The Israeli and Nelson (1992) study does not examine the effect of socio-economic status on residency times. Many facilities in the Air Toxics "Hot Spots" program are located in areas surrounded by low socioeconomic status populations. OEHHA has published a framework for assessing cumulative impacts, *Cumulative Impacts - Building a Scientific Foundation* (2010), which established the need to take into account socioeconomic factors in risk assessment. As the methodology for doing so evolves, OEHHA will update the Exposure Assessment and Stochastic Analysis Technical Support Document as appropriate.

Johnson and Capel (1992) used a Monte Carlo approach for determining residency occupancy periods. Their methodology can incorporate population information about location, gender, age, and race to develop a mobility table based on US Census data. The mobility table contains the probability that a person with the demographic characteristics considered would not move. A mortality table is also used which determines the probability that a person with the demographic characteristics considered would die. Some of the results from this study are presented in Table 11.3.

Although the published methodology can be used to determine mobility for different income groups, the published tables are for the entire U.S. population. In addition, as is pointed out in the study, the Monte Carlo methodology employed in the study uses the same probability of moving for persons who have resided in their current residence for extended periods as for those who have recently moved in. The data collected by the U.S. Census does not indicate where the individuals queried move to, other than broad descriptions such as "in county", "out of county", "within metropolitan area", and so forth. This problem is common to all of the studies discussed. As a result, it is difficult to

define residence time within a zone of impact for those who do not move very far (e.g., within the same apartment complex, neighborhood, or town). The conclusions of this study are similar to the results that the U.S. EPA (1997) reached using the AHS study (Bureau of the Census, 1993) (Table 11.3).

The U.S. EPA (1997) has reviewed the studies presented above. In addition, the U.S. EPA (1997) reviewed the results of the 1991 AHS (Bureau of the Census, 1993). The U.S. Bureau of the Census (1993) conducted a survey using 55,000 interviews, which covered homeowners and renters. Black, white and Hispanic ethnic groups were represented in this study. The U.S. EPA used the information available in this study to determine a distribution of the percent of households who have lived at their current address for several ranges of years. The median and 90th percentiles of this distribution are 9.1 and 32.7 years, respectively. The methodology used to derive the distribution was not specified in the report (U.S. EPA, 1995). Based on the studies by Israeli and Nelson (1992), Johnson and Capel (1992), and their analysis of the U.S. Bureau of the Census (1993), U.S. EPA recommends a central tendency estimate of 9 years, and a high-end estimate of 30 years for residency time.

11.~~6~~5.2 California-Specific Data on Residency Time

Appendix L used data from The Integrated Public Use Microdata Series (IPUMS-USA) to evaluate residency time. IPUMS-USA consists of more than fifty samples of the American population drawn from fifteen federal censuses and from the American Community Surveys (ACS). ACS is a nationwide survey that collects and produces population and housing information every year from about three million selected housing unit addresses across every county in the nation (ACS). IPUMS-USA samples, which draw on every surviving census from 1850-2000 and the 2000-2009 ACS samples, collectively constitute the quantitative information on long-term changes in the American population. These records for the period since 1940 only identify geographic areas with equal or larger than 100,000 residents (250,000 in 1960 and 1970) (IPUMS-USA).The IPUMS-USA identifies the date moved into the residence and therefore a cumulative distribution of length of time that population has lived in the current residence can be constructed from these data. Figure L2 shows that 91% of the population has lived in their current residence for 29 years or less. This means that only 9% of the population has lived more than 29 years in his or her current residence.

Table 11.3 Summary of Studies of United States Residency Times (in Years)

Israeli and Nelson (1992)	1.4, 23.1 (50th and 95th %tile)
Johnson and Capel (1992)	2.0, 9.0, 33 (5th, 50th and 95th %tile)
U.S. EPA (1997); evaluation of BOC (1993) data	9.1, 32.7 (50th, 90th %tile)
CARB Analysis of IPUMS data (Appendix L)	29 (91st percentile)

11.6 Available Studies for Assessing Job Tenure and Exposure Duration for the Offsite Worker Exposure Scenario

11.6.1 Key National Studies on Job Tenure

The data with respect to job tenure in the United States are mainly cross sectional for determining a Tier 1 default. However, there are some longitudinal data. The purpose of the Census Bureau's Survey of Income and Program Participation (SIPP) is to collect information on source and amount of income, labor force participation, program participation and eligibility, and general demographic characteristics, to measure the effectiveness of existing federal, state, and local programs. The data were collected to estimate future costs and coverage for government programs, such as food stamps, to provide improved statistics on the distribution of income and measures of economic well-being; and to evaluate the effectiveness of federal, state, and local programs.

Like NHANES, the SIPP sample is a multistage-stratified sample of the U.S. civilian non-institutionalized population. Individuals selected for the survey, along with others who live with them, are interviewed once every 4 months over a 48-month period. To spread the work evenly over the 4-month reference period for the interviewers, the Census Bureau randomly divides each panel into four rotation groups. Each rotation group is interviewed in a separate month. Four rotation groups constitute one cycle, or wave, of interviewing, for the entire panel.

The first SIPP panel began interviews in 1983. During the period 1984-1993, a new panel of households was introduced each year in February. In 1990, the Committee on National Statistics (CNSTAT) at the National Research Council reviewed SIPP protocols and made recommendations, many of which were implemented in 1996 and continue to be followed today. In the current version, SIPP is a longitudinal survey that consists of 12 waves of 4 months (4 rotations) each, resulting in a 4-year non-overlapping, continuous cycle, with sample size ranging from approximately 14,000 to 36,700 interviewed households. Included in the SIPP database is information about employment, such as number of concurrent jobs, starting and ending dates of jobs, types of employment, employment income and unemployment compensation, and reasons for leaving a job.

OEHHA analyzed the most recent set of SIPP job data from Wave 1 of the 2008 SIPP survey to evaluate the distribution of employment tenure among employed people in a nationally representative sample. SIPP participants were asked when they started working for a current or most recent past employer, and when they stopped working for that same employer. We disregarded data pertaining to second jobs for individuals who had more than one job at a time. We calculated job duration using job start and end dates, and used an end date of December 31, 2008 for those who were still employed at the same job. We ran frequency distributions of years on the job and years on the job by age using the FREQUENCY and SURVEYFREQ procedures in SAS version 9.1.3 (Table 11.4).

Table 11.4 Employment Tenure by Years on the Job from the Survey of Income and Program Participation (SIPP), 1996-2008

Years on the Job	**Percent of Total**					
	1996-2008	**1996-2008 Summary**	**2008 Only**	**2008 Summary**	**2008 Cumulative Total 0 to 100%**	**2008 Cumulative Total 100 to 0%**
N	**150,017**	**150,017**	**45,363**	**45,363**	**-**	**-**
0	12.67		19.42			100
1	17.87		13.15			
2	10.34		9.87			
3	7.86		7.53			
4	6.06	54.79	5.41	55.38	55.38	44.62
5	5.09		4.58			
6	4.34		3.62			
7	3.48		3.72			
8	3.30		3.87			
9	2.47	18.67	2.59	18.39	73.77	26.23
10	2.82		3.20			
11	2.08		1.93			
12	1.84		1.75			
13	1.59		1.70			
14	1.52	9.84	1.33	9.91	83.68	16.32
15	1.59		1.40			
16	1.45		1.12			
17	1.22		0.94			
18	1.30		1.27			
19	1.05	6.61	1.05	5.78	89.46	10.54
20	1.23		1.34			
21	0.86		0.90			
22	0.82		0.91			
23	0.83		0.84			

Table 11.4 Employment Tenure by Years on the Job from the Survey of Income and Program Participation (SIPP), 1996-2008

Years on the Job	Percent of Total					
	1996-2008	**1996-2008 Summary**	**2008 Only**	**2008 Summary**	**2008 Cumulative Total 0 to 100%**	**2008 Cumulative Total 100 to 0%**
24	0.75	4.48	0.63	4.62	94.08	5.92
25	0.70		0.62			
26	0.64		0.47			
27	0.53		0.50			
28	0.57		0.72			
29	0.43	2.87	0.45	2.75	96.83	3.17
30	0.51		0.62			
31	0.37		0.38			
32	0.30		0.30			
33	0.23		0.26			
34	0.23	1.65	0.30	1.87	98.7	1.3
35	0.22		0.26			
36	0.17		0.17			
37	0.13		0.16			
38	0.11		0.17			
39	0.09	0.72	0.12	0.88	99.58	0.42
40	0.08		0.12			
41	0.07		0.06			
42	0.04		0.05			
43	0.04		0.06			
44	0.03	0.25	0.02	0.31	99.89	0.11
45	0.02		0.03			
46	0.01		0.01			
47	0.01		0.01			
48	0.02		0.03			
49	0.01	0.08	0.01	0.09	99.98	0.02
50	0.01		0.01			
51-70	0.044	0.044	0.02	0.02	100	

11.6.2 Supporting Studies

11.6.2.1 Current Population Survey

The Bureau of Labor Statistics (BLS) collects extensive information on the U.S. labor force through the ongoing Current Population Survey (CPS). The CPS is a monthly survey of about 60,000 households that provides data on the labor force status,

demographics, and other characteristics of the civilian noninstitutional population ≥16 years of age. One part of the survey includes questions about employee tenure, which is a measure of how long workers had been with their current employer at the time of the survey (BLS, 2008a). Information on employee tenure has been obtained from supplemental questions to the current CPS every two years since 1996. The percent distribution by tenure with current employer is shown in Table 11.5. The data refer to the sole or principal job of full- and part-time workers. All data exclude the incorporated and unincorporated self-employed.

Table 11.5 Distribution of Employed Wage and Salary Workers by Tenure with Current Employer and Age, Males and Females Combined, January 2008 From BLS CPS

Age Group (yrs)	**Number employed (in thousands)**	**Percent Distribution by Tenure with Current Employer**							
		≤12 mo	13 to 23 mo	2 yrs	3 to 4 yrs	5 to 9 yrs	10 to 14 yrs	15 to 19 yrs	≥20 yrs
≥16	129,276	22.9	7.4	5.6	16.9	20.2	10.6	6.2	10.3
16-19	5,200	73.8	11.5	7.5	7.0	0.3	- [a]	-	-
≥20	124,076	20.8	7.2	5.5	17.3	21.0	11.0	6.4	10.7
20 - 24	13,139	49.9	13.2	10.2	20.4	6.4	<0.05	-	-
25 - 34	29,097	28.2	10.4	8.5	23.4	23.5	5.4	0.6	<0.05
35 - 44	30,150	17.1	6.6	4.8	18.1	25.5	15.3	8.2	4.5
45 - 54	30,151	12.9	4.4	3.5	13.7	21.6	14.4	9.9	19.4
55 - 64	17,242	9.4	4.3	2.6	11.2	19.7	14.1	10.9	27.8
≥65	4,297	8.9	2.5	2.8	10.6	18.9	16.6	10.4	29.2

[a] Dash represents zero or rounds to zero.

The tenure question in the CPS was designed specifically as a gauge of employment security. Tenure durations beyond 20 years were not computed for Table 11.5, possibly due to the definition of a “lifetime” job lasting at least 20 years by Hall (1982). Thus, longer tenure employment statistical analysis was not considered necessary.

The BLS also presented longitudinal data for median employee tenure by age over the years 1996 to 2008 (Table 11.6). Other distributional percentiles for this tenure data were not presented in the report.

Table 11.6 Median (50th Percentile) Years of Tenure with Current Employer for Employed Wage and Salary Workers by Age 1996 to 2008, Males and Females Combined, from BLS

Age Group (yrs)	1996	1998	2000	2002	2004	2006	2008
≥16	3.8	3.6	3.5	3.7	4.0	4.0	4.1
16 - 17	0.7	0.6	0.6	0.7	0.7	0.6	0.7
18 - 19	0.7	0.7	0.7	0.8	0.8	0.7	0.8
20 - 24	1.2	1.1	1.1	1.2	1.3	1.3	1.3
≥25	5.0	4.7	4.7	4.7	4.9	4.9	5.1
25 - 34	2.8	2.7	2.6	2.7	2.9	2.9	2.7
35 - 44	5.3	5.0	4.8	4.6	4.9	4.9	4.9
45 - 54	8.3	8.1	8.2	7.6	7.7	7.3	7.6
55 - 64	10.2	10.1	10.0	9.9	9.6	9.3	9.9
≥65	8.4	7.8	9.4	8.6	9.0	8.8	10.2

A number of factors can affect employee tenure, including the age profile among workers, type of occupation, and changes in the number of hires and separations with time. The most apparent effect on employee tenure is the age of the worker. As expected, length of tenure to one's employer is strongly related to the age of the worker. For example, in Table 11.6 the median tenure for employees age 55 to 64 in 2008 was 9.9 years, almost four times the tenure (2.7 years) for workers age 25 to 34. Younger working age participants tend to be a more mobile work force. Younger participants also have not accumulated enough working years with any one employer to be considered long-term tenured workers. As workers age, both job stability increases and the number of years since the worker initially began working increases resulting in more workers with jobs that will last 20 years or more.

An earlier study by Farber (1995) used the raw data from the CPS to calculate a distribution of employment-based job duration. Table 11.7 presents the median (50th percentile) and 0.9 quantile (90th percentile) results based on the 1993 CPS findings for tenure with current employer. Although the quantile job tenure results were generated in 1993, the longitudinal median tenure findings in Table 11.6 suggest there has been little change in the numbers since the 1990s.

Table 11.7 Median (50th Percentile) and 0.9 Quantile Job Tenure (in Years) with Current Employer in 1993, Males and Females Combined

Job Tenure Quantiles	Age Category (Years)			
	25-34	35-44	45-54	55-64
Median	3.2	5.8	9.5	12.4
0.9	9.7	17.5	25.2	31.5

The main limitation using the CPS to estimate occupational duration at a single location is that the job tenure question asks for years spent with current employer (i.e., the job is

still in progress), rather than completed job duration where there is a start and end date. However, the survey covers the entire span of working years from age 16 to 70+ years. In particular, the oldest groups of participants represent those workers at or near retirement age with a full work history. In addition, Nardone et al. (1997) observed that similar job tenure percentiles were obtained when comparing young workers from both the CPS and NLSY79 surveys (see below).

Comparison of this survey with the SIPP shows that for the first 20 years of employment beginning at age 15 or 16 years, the tenure percentages are almost identical. The CPS shows that 10.3 percent of participants beginning at age 16 are still with their current employer after 20 years. The SIPP (Table 11.4) estimates 10.54 percent of participants are still with their current employer after 20 years.

11.6.2.2 National Survey of Youth 1979

The BLS also collects employment duration data from a separate survey called the National Survey of Youth 1979 (NLSY79). A unique feature of this survey is that it collects the beginning and ending dates of all jobs held by a respondent so that a longitudinal history can be constructed of each respondent's work experience. The NLSY79 is a nationally representative sample of 12,686 young men and women who were 14 to 22 years of age when first surveyed in 1979. The estimates in the current release of data for 2006-2007 contain the first 22 rounds of the survey since 1979 (BLS, 2008b).

The respondents in the NLSY79 are still relatively young, ages 41 to 50 in 2006-07. As the cohort continues to age, information that is more complete will become available. Thus, the current release covers only the period while the respondents were ages 18 to 42; older participants in the study are not included because sample sizes were still too small to provide statistically reliable estimates for age groups >42.

As part of the NLSY79, the duration of employment with a single employer for all jobs started from age 18 to 42 in 1978-2006 is estimated. A job is defined in the survey as an uninterrupted period of work with a particular employer. Jobs are therefore employer-based, not position-based. However, if a respondent indicates that he or she left a job but in a subsequent survey returned to the same job, it is counted as a new job.

Individuals were surveyed annually from 1979 to 1994 and biennially since 1994. In 2006-07, 7,654 individuals responded to the survey, for a retention rate of 77 percent. Only these individuals are included in the estimates in this release. All results are weighted using the 2006-07 survey weights that correct for the oversampling, interview nonresponse, and permanent attrition from the survey. When weighted, the estimates represent all persons born in the years 1957 to 1964 and living in the U.S. when the survey began in 1979 (Table 11.8). Not represented are U.S. immigrants who were born from 1957 to 1964 and moved to the United States after 1979.

Table 11.8 Duration of Employment Relationships with a Single Employer for All Jobs Started from Age 18 to Age 42 in 1978-2006 by Age at Start of Job

Age Group (yrs)	Cumulative Percent Distribution of Duration of Completed Employment Relationships					Percent of jobs ongoing in 2006
	<1 yr	<2 yrs	<5 yrs	<10 yrs	<15 yrs	
18 - 22	72.3	85.2	94.1	97.1	98.0	1.3
23 - 27	59.2	75.9	88.8	94.0	95.7	3.5
28 - 32	52.5	69.7	85.5	91.6	93.6	6.2
33 - 37	42.8	60.7	80.6	88.2	88.9	11.1
38 - 42	30.5	46.6	65.1	ND	ND	30.2

ND - No data. Estimates are not presented for these categories because most sample members were not yet old enough at the time of the 2006-07 survey to have completed jobs of these durations.

Unlike the CPS results, the job duration data in the NLSY79 report are based on starting and ending dates for jobs with a single employer. A limitation of the data is that the survey is still ongoing. Hence, some of the numbers in Table 11.8 will change as the survey is periodically updated, particularly for the most recent findings. Presumably, additional information will also be available for long-term employment in future surveys (i.e., duration of completed employment 15 to <20 yrs).

11.6.2.3 Comparison of the CPS and the NLSY79

Job durations the CPS report were compared by Nardone *et al.* (1997) with a similar cohort of individuals from the NLSY79 data as a yardstick to examine the quality of the CPS data. Specifically, the most recent job tenure data from the NLSY79 28- to 36-year old workers collected in 1993 were compared to the CPS findings for the same age group. Despite the differences in data collection methods between the CPS and NLSY79, the differences in the job tenure distributions were quite small (Table 11.9). Little difference is found at the 90th percentile, with CPS job tenure registering 11.22 years and that of the NLSY79 11.13 years. Overall, Nardone et al. (1997) concluded that the CPS data appear to provide an adequate approximation of the tenure distribution among young workers.

Table 11.9 Distribution of Years of Tenure Among 28- to 35-year old Workers, Current Population Survey (CPS) and National Longitudinal Survey of Youth 1979 (NLSY79), Males and Females Combined

Job Tenure Quantiles	Percentile				
	10th	25th	50th	75th	90th
CPS	0.04	1.04	3.34	7.00	11.22
NLSY79	0.37	1.13	3.46	7.03	11.13

11.7 Individual Resident Cancer Risk vs. Residential Population Risk

A threshold dose for cancer risk for almost all carcinogens cannot be established. Therefore, risk managers must establish a cancer risk that is considered acceptable or de minimus through the political process. Most risk assessments estimate cancer risk at the worker point of maximum exposure (Maximum Exposed Individual Worker or MEIW) and the residential point of maximum exposure (MEIR). This ensures that individual risk is measured at the point with the estimated highest air concentrations of cancer-causing chemicals. ~~This~~ The acceptable risk level for individual cancer risk varies in different Federal and State programs from 1 X 10^{-6} to 1 X 10^{-4}. In the Hot Spots program, a 1 X 10^{-5} level for notification is a common standard for the Air Districts. The District may have different levels for permitting, or requiring additional pollution control devices for existing facilities. ~~The individual cancer risk is measured at the worker point of maximum exposure (worker Maximum Exposed Individual or MEI) and the residential point of maximum exposure (residential MEI). This ensures that individual risk is measured at the point with the estimated highest air concentrations of cancer-causing chemicals. Since individual risk is proportional to exposure duration, the length of time that the residential or worker MEI resides at his or her job, or lives at his or her residence is a critical parameter.~~

The previous OEHHA recommendation of estimating cancer risk for a 70-year residency as a default is health protective for individual risk and provides a degree of population risk public health protection as well. Basing risk management on the cancer risk estimated for a 70 year exposure duration helps reduce the chances a person will experience a cancer risk greater than the acceptable limit (e.g., 10^{-5}) if he or she moves within the isopleths of another similar-risk facility. However, a 70-year residency default also confuses the two concepts of individual risk and population risk. The cancer potency factors are based on the risk to a population, either the population of workers in an occupational study or a population of animals. Yet it is applied to a person or a few people living at the estimated point of maximum impact (the MEI). On the other hand, whether or not a single person is residing at the MEI location over 70 years, there is an assumption in considering population risk that someone will always be living at the MEI location. Thus, in terms of population risk it is irrelevant that the risk at that location is spread over different individuals over time (see discussion below of population versus maximally exposed individual risk).

The individual cancer risk approach has some inherent limitations in terms of protecting public health. A small facility with a single stack can impact a few individuals with an individual cancer risk that is unacceptable, whereas a large facility may have an individual cancer risk that is below the acceptable limit for individual risk but exposes many more people. This large facility can cause more potential cancer cases than the smaller facility and thus have a greater public health impact.

For large facilities with multiple sources such as refineries, ports or rail yards, the population impacts are the primary public health concern. A population risk metric is a better measure of the public health impact and efficacy of proposed control measures.

For example, dispersal of repair operations with high diesel emissions in a rail yard will lower individual risk but will not impact population risk. Such a dispersal of operations would not affect the number of cancer cases that would be ~~expected~~predicted, but would spread the risk over a larger number of people. Individual risk is a poor metric for progress in public health protection in this example.

To evaluate population risk, regulatory agencies have used the cancer burden as a method to account for the number of excess cancer cases that ~~would~~ could occur in a population. The population burden can be calculated by multiplying the cancer risk at a census block centroid times the number of people who live in the census block, and adding up the cancer cases across the zone of impact. A census block is defined as the smallest entity for which the Census Bureau collects and tabulates decennial census information; it is bounded on all sides by visible and nonvisible features shown on Census Bureau maps. The centroid is defined as the central location within a specified geographic area (U.S. Department of Commerce, 1994).

The cancer burden is calculated on the basis of lifetime (70 year) risks. It is independent of how many people move in or out of the vicinity of an individual facility. The number of cancer cases is considered independent of the number of people exposed, within some lower limits of exposed population size, and the length of exposure (within reason). If 10,000 people are exposed to a carcinogen at a concentration with a $1X10^{-5}$ cancer risk for a lifetime the cancer burden is 0.1, and if 100,000 people are exposed to a $1 X 10^{-5}$ risk the cancer burden is 1.

There are different methods that can be used as measure of population burden. The number of individuals residing within a $1 X 10^{-6}$, $1 X 10^{-5}$, and/or $1 X 10^{-4}$ isopleth is another potential measure of population burden (OEHHA, 2003).

11.8 Factors That Can Impact Population Risk – Cumulative Impacts

Although the Hot Spots program is designed to address the impacts of single facilities and not aggregate or cumulative impacts, there are a number of known factors that influence the susceptibility of the exposed population and thus may influence population risk. Socioeconomic status influences access to health care, nutrition, and outcome after cancer diagnosis. Community unemployment can affect exposure and residency time near a facility. Factors that affect the vulnerability of the population are discussed in the report *Cumulative Impacts Building a Scientific Foundation* (OEHHA, 2010). Information on many of these factors is relatively easy to obtain on a census tract level. The OEHHA recommends that these types of factors be considered by the risk manager, along with the quantitative measures of population risk. OEHHA is in the process of developing guidance on quantification of the impact of these factors.

11.9 Cancer Risk Evaluation of Short Term Projects

The local air pollution control districts sometimes use the risk assessment guidelines for the Hot Spots program in permitting decisions. Frequently, the issue of how to address cancer risks from short term projects arises.

Cancer potency factors are based on animal lifetime studies or worker studies where there is long-term exposure to the carcinogenic agent. There is considerable uncertainty in trying to evaluate the cancer risk from projects that will only last a small fraction of a lifetime. There are some studies indicating that dose rate changes the potency of a given dose of a carcinogenic chemical. In others words, a dose delivered over a short time period ~~has~~ may have a different potency than the same dose delivered over a lifetime.

The OEHHA's evaluation of the impact of early-in-life exposure has likely reduced some of the uncertainty in evaluating the cancer risk to the general population for shorter-term exposures, as it helps account for susceptibility to carcinogens by age at exposure (OEHHA, 2009). Thus, we have recommended for short term exposures that the risk assessment start at the third trimester for cancer risk calculation.

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EXHIBIT C

South Coast
Air Quality Management District
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SCAQMD Air Quality Significance Thresholds

Mass Daily Thresholds [a]		
Pollutant	**Construction [b]**	**Operation [c]**
NOx	100 lbs/day	55 lbs/day
VOC	75 lbs/day	55 lbs/day
PM10	150 lbs/day	150 lbs/day
PM2.5	55 lbs/day	55 lbs/day
SOx	150 lbs/day	150 lbs/day
CO	550 lbs/day	550 lbs/day
Lead	3 lbs/day	3 lbs/day

Toxic Air Contaminants (TACs), Odor, and GHG Thresholds	
TACs (including carcinogens and non-carcinogens)	Maximum Incremental Cancer Risk ≥ 10 in 1 million Cancer Burden > 0.5 excess cancer cases (in areas ≥ 1 in 1 million) Chronic & Acute Hazard Index ≥ 1.0 (project increment)
Odor	Project creates an odor nuisance pursuant to SCAQMD Rule 402
GHG	10,000 MT/yr CO2eq for industrial facilities

Ambient Air Quality Standards for Criteria Pollutants [d]	
NO2 1-hour average annual arithmetic mean	SCAQMD is in attainment; project is significant if it causes or contributes to an exceedance of the following attainment standards: 0.18 ppm (state) 0.03 ppm (state) and 0.0534 ppm (federal)
PM10 24-hour average annual average	10.4 μg/m^3 (construction)[e] & 2.5 μg/m^3 (operation) 1.0 μg/m^3
PM2.5 24-hour average	10.4 μg/m^3 (construction)[e] & 2.5 μg/m^3 (operation)
SO2 1-hour average 24-hour average	0.25 ppm (state) & 0.075 ppm (federal – 99th percentile) 0.04 ppm (state)
Sulfate 24-hour average	25 μg/m^3 (state)
CO 1-hour average 8-hour average	SCAQMD is in attainment; project is significant if it causes or contributes to an exceedance of the following attainment standards: 20 ppm (state) and 35 ppm (federal) 9.0 ppm (state/federal)
Lead 30-day Average Rolling 3-month average Quarterly average	1.5 μg/m^3 (state) 0.15 μg/m^3 (federal) 1.5 μg/m^3 (federal)

[a] Source: SCAQMD CEQA Handbook (SCAQMD, 1993)
[b] Construction thresholds apply to both the South Coast Air Basin and Coachella Valley (Salton Sea and Mojave Desert Air Basins).
[c] For Coachella Valley, the mass daily thresholds for operation are the same as the construction thresholds.
[d] Ambient air quality thresholds for criteria pollutants based on SCAQMD Rule 1303, Table A-2 unless otherwise stated.
[e] Ambient air quality threshold based on SCAQMD Rule 403.

KEY: lbs/day = pounds per day ppm = parts per million μg/m^3 = microgram per cubic meter ≥ = greater than or equal to
MT/yr CO2eq = metric tons per year of CO2 equivalents > = greater than

Revision: March 2011

South Coast Air Quality Management District

RISK ASSESSMENT PROCEDURES for Rules 1401 and 212

Version 7.0

July 1, 2005

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effective July 1, 2005

INTRODUCTION

Risk assessment procedures, including procedures for a simple risk screening, were developed by South Coast Air Quality Management District (AQMD) staff for the adoption of Rule 1401 - New Source Review of Toxic Air Contaminants, in June 1990.

The purpose of this document is to:

- assist applicants and engineers to help evaluate Rule 1401 compliance;
- provide explanations and sample calculations; and
- provide industry worksheets.

This document describes the procedures for preparing risk assessments under Rule 1401 and Rule 212 – Standards for Approving Permits and Issuing Public Notice. It is intended to be a "living" document. That is, as new toxic air contaminants (TACs) are added, risk values changed, or procedures revised, the document will be updated. This version of "Risk Assessment Procedures for Rules 1401 and 212" is based on "The Air Toxics Hot Spots Program Guidance Manual for Preparation of Health Risk Assessments" ("Guidance Manual") finalized by the state Office of Environmental Health Hazard Assessment (OEHHA) in August 2003 and the "(California) Air Resources Board (CARB) Recommended Interim Risk Management Policy for Inhalation-Based Residential Cancer Risk" ("Interim Policy") issued on October 9, 2003. The Guidance Manual may be found at: http://www.oehha.org/air/hot_spots/HRAguidefinal.html. The Interim Policy may be found at: http://www.arb.ca.gov/toxics/harp/docs/rmpolicy.PDF. The Guidance Manual and Interim Policy supercede the risk assessment methods presented in "The California Air Pollution Control Officer's Association (CAPCOA) Air Toxics Hot Spot Program; Revised 1992; Risk Assessment Guidelines", which was completed in October 1993. Past procedures will be archived and TAC listings have been separated by the time period of significant Rule 1401 changes (see attachments).

Background

Rule 1401, adopted June 1, 1990 and amended December 7, 1990, specified limits for maximum individual cancer risk (MICR) and excess cancer cases for new, relocated, or modified equipment which emits carcinogenic air contaminants. The rule was amended July 10, 1998 to include non-carcinogenic compounds. The rule was amended on March 17, 2000 to remove the requirement to assess cumulative risk from emissions from units permitted after 1990 located within 100 meters of the new equipment under evaluation for permit. And, the rule has been amended several times to change the list of regulated compounds (both additions and deletions) and their corresponding risk values (cancer potency factors and reference exposure levels).

Requirements

This document describes the procedures for determining cancer and non-cancer health effects.

Rule 1401 applies to applications deemed complete on or after June 1, 1990. In general, it applies only if there is an increase in TAC emissions from new, relocated, or modified equipment. However, equipment installed without a required permit to construct is also included. It applies to equipment previously exempt by Rule 219 only if the applicant fails to apply for a permit within one year following loss of exempt status. There are a few exemptions listed at the end of the rule.

Rule 1401 requires risk assessments only for TACs listed in the rule at the time the application is deemed complete. Copies of all tables for risk analysis are included at the end of this document as attachments.

The following requirements must be met before a permit is granted for affected equipment.

- The cumulative increase in maximum individual cancer risk (MICR) shall not exceed:
  one in one million (1×10^{-6}) if Best Available Control Technology for Toxics (T-BACT) is not used; or,
  ten in one million (10×10^{-6}) if T-BACT is used;

- The cumulative cancer burden (increase in cancer cases in the population) shall not exceed 0.5; and,

- For target organ systems, neither the cumulative increase in either the total chronic hazard index (HIC) nor the total acute hazard index (HIA) due to total emissions from the affected permit unit shall exceed 1.0 for any target organ system, or an alternate hazard index level deemed to be safe.

Rule 212 (c)(3) requires public notification if the MICR, based on Rule 1401, exceeds one in one million (1×10^{-6}), due to a project's proposed construction, modification, or relocation for facilities with more than one permitted equipment unless the applicant can show the total facility-wide MICR is below ten in a million (10×10^{-6}). For facilities with a single permitted equipment, the MICR level must not exceed ten in a million (10×10^{-6}). The circulation and distribution of the notifications must meet the criteria in Rule 212.

The current version of AQMD rules may be obtained on the website http://www.aqmd.gov.

Revisions

The major revisions to this document include the following:

- The use of cancer potency factors (instead of unit risk factors) to allow for daily breathing rate and body weight variation;
- The accommodation of the OEHHA "tier" approach (facility data and stochastic calculations), "derived" risk calculations (two dominant pathways), and "adjusted" assumptions (most significantly, the residential breathing rate established by CARB's Interim Policy);
- The revised multipathway profiles for the resident and worker; and
- The multipathway factors for the resident and worker.

These terms are described in greater detail in the following chapters. The first three come from the recent revisions to the state Guidance Manual. The last one is unique to the AQMD and these procedures.

The following tables summarize important information regarding Rule 1401 and risk assessment requirements.

RULE 1401

New Source Review of Toxic Air Contaminants

Applicability:

- Increase in Toxic Air Contaminants (TACs) from new, relocated, or modified equipment
- Equipment installed without required permit to construct
- Equipment previously exempt by Rule 219 if applicant fails to apply for a permit within one year from loss of exempt status
- Non-carcinogenic compounds also included for applications deemed complete on or after 9/8/98 (chronic) and 2/10/99 (acute)

Requirements for health risk assessment:

- Risk assessments only for TACs that are listed in the rule when the application is deemed complete
- MICR shall not exceed one in one million if T-BACT is not installed
- MICR shall not exceed ten in one million if T-BACT is installed
- Cancer burden shall not exceed 0.5
- Chronic Hazard Index and Acute Hazard Index shall not exceed 1.0 for any target organ system

OVERVIEW

This document provides several tiers for preparing a risk assessment, from a quick look-up table to a detailed risk assessment involving air quality modeling analysis. Permit applicants may use any of these tiers to demonstrate compliance with the risk limits of Rule 1401. The applicant should include a copy of the risk assessment with the permit application.

The tiers are designed to be used in order of increasing complexity. If compliance cannot be demonstrated using one tier, the permit applicant may proceed to the next tier. A permit applicant who can show compliance by using a lower tier does not need to perform an analysis for the higher tiers. In general, for most permits, a detailed analysis is not required. The tiers are:

- Tier 1: Screening Emission Levels
- Tier 2: Screening Risk Assessment
- Tier 3: Screening Dispersion Modeling
- Tier 4: Detailed Risk Assessment

Please note that the OEHHA Guidance Manual "Tier" approach differs from these AQMD Risk Procedures "Tier" compliance. The OEHHA Tiers refer to the incorporation of facility data and stochastic modeling; however, regulatory compliance may only be demonstrated with an OEHHA Tier-1 calculation. In contrast, the AQMD Tiers refer to increasing complexity and regulatory compliance may be demonstrated with any AQMD Tier.

In addition, this document briefly discusses the Best Available Control Technology for Toxics (T-BACT) identification process for Rule 1401.

PRELIMINARY TASKS

Before conducting any of these risk assessment tiers, three preliminary tasks must be performed:

1. **Identify the toxic air contaminants (TAC) emitted by the permit unit**. The risk assessment must include those TACs emitted by the permit unit which were listed in the rule when the permit application was deemed complete by AQMD staff. Sets of tables corresponding to each rule revision are included at the end of this document as attachments. Determine the date on which the application was deemed complete and refer to the appropriate set of tables. Table 1A lists the TACs subject to Rule 1401 and Rule 212.

   For guidance, California Air Resources Board (CARB) has prepared a table listing devices and processes as they relate to the types of emissions and the specific contaminants emitted. This table is available on the CARB webpage at: www.arb.ca.gov/ab2588/ab2588.htm. Click on "Inventory Guidelines", and then on "Appendix C - Facility Guideline Index." Please note that this table is not an exhaustive list. Facilities are, therefore, advised to use this table for guidance only.

If no TACs listed in the applicable version of Rule 1401 are emitted by the equipment, no further risk assessment is required.

2. **Determine if the permitting action or equipment is exempt from the provisions of Rule 1401.** Exemptions are granted for:

   √ permit renewal or change of ownership;
   √ modifications with no increase in risk;
   √ functionally identical equipment replacement;
   √ equipment previously exempt under Rule 219 and filing for a permit to operate within one year of removing the Rule 219 exemption;
   √ modifications to terminate research projects;
   √ emergency ICEs exempt under Rule 1304.

   An additional exemption is granted for demonstrations of contemporaneous emission reductions such that no receptor experiences a total increase in MICR of greater than one in one million and the contemporaneous reduction occurs within 100 meters of the equipment.

   If the equipment falls under one of these exemptions, no further risk assessment is required.

3. **Estimate the quantity of emissions from the permit unit.** The appropriate emission estimation technique depends on the type of source. Techniques include emission testing, a mass balance or other engineering calculation, or emission factors for specific types of processes. The emissions used for the risk calculation should be post-control emissions (that is, reductions in emissions due to enforceable controls and permit conditions should be taken into account). AQMD permitting staff should be consulted regarding approved techniques for identifying contaminants and estimating emissions for specific sources.

   The AQMD also has a broader mandate to ensure that permits are not granted to facilities which may endanger public health (California Health and Safety Code Section 41700). In addition, under Rule 212, the applicant may be required to evaluate other compounds that are determined to be potentially toxic. Therefore, an applicant may be required to evaluate risks from compounds not listed in Table I as part of the permitting process if they are a concern for a specific source. These may include substances with irritant effects or other adverse health effects.

Tier 1: Screening Emission Levels

OVERVIEW OF TIER 1

Tier 1 involves a simple look-up table (Table 1A) in which the equipment's emissions or source-specific units (Table 1B) are compared to Screening Levels. The Screening Levels are pollutant emission thresholds which are not expected to produce a MICR greater than one in one million nor a hazard index greater than one.

Tier 1 can be used by applicants to determine whether or not detailed risk analysis will be required when filing for a permit. It can also be used by applicants and AQMD staff to determine whether a permit is required based on paragraph (s)(2) in Rule 219 – Equipment not Requiring a Written Permit Pursuant to Regulation II.

Tier 1 may be used only for a single emission source and a single toxic air contaminant. However, it can be used for multiple pollutants if the Multiple Pollutant Screening Level Procedure (described below) is followed.

INSTRUCTIONS FOR TIER 1

The Tier 1 analysis is performed as follows:

1. Determine the maximum annual emissions (for cancer and non-cancer chronic TACs) or determine the maximum hourly emissions (for non-cancer acute TACs). For perchloroethylene dry cleaners, determine the average monthly perchloroethylene usage (in gallons).
2. Compare the emissions to the Screening Levels for that contaminant in Table 1A. For perchloroethylene dry cleaners, compare the monthly usage rate to the limits in Tables 1B. Columns are labeled with the distance to the nearest receptor.
3. If the maximum annual emissions or the maximum hourly emissions do not exceed the Screening Levels, the equipment will comply with Rule 1401 and not require notice under Rule 212 for toxics. For perchloroethylene dry cleaners, the monthly usage must be less than the limits in Tables 1B.
4. If the maximum annual emissions or the maximum hourly emissions exceed the Screening Levels, proceed to Tier 2.

The Screening Levels in Tables 1A or 1B were determined by back calculation, using the highest concentration values (X/Q) established in Tables 2A, 3A, 4A, 5A, 6, and 7 that would not exceed a cancer risk of one in one million or a chronic or acute hazard index of 1.

MULTIPLE POLLUTANT SCREENING LEVEL PROCEDURE

1. Calculate the Pollutant Screening Index for each pollutant (PSI_p). For each carcinogenic and/or chronic compound, divide the maximum annual emissions (in pounds per year) of each pollutant (Qyr) by the Pollutant Screening Level (PSL_p) in pounds per year, as contained in Table 1A. For

each acute compound, divide the maximum hourly emission (Qhr) of each pollutant by the Pollutant Screening Level (PSL_p) as contained in Table 1A.

$$PSI_{cancer\ and/or\ chronic} = Qyr / PSL_p$$

$$PSI_{acute} = Qhr / PSL_p$$

2. Calculate the Application Screening Index (ASI). Sum up the individual Pollutant Screening Indices for all chronic and carcinogenic pollutants (PSI_p) and, separately, for all acute pollutants.

$$ASI_{cancer\ and/or\ chronic} = \Sigma\ PSI_p$$

$$ASI_{acute} = \Sigma\ PSI_p$$

3. Neither the cumulative cancer/chronic hazard nor acute hazard index can exceed 1.

Refer to Example 1 (starting on page 24) for multiple pollutant screening.

If step 3 cannot be met, proceed to Tier 2.

Tier 2: Screening Risk Assessment

OVERVIEW OF TIER 2

Tier 2 is a screening risk assessment, which includes procedures for determining the level of risk from a source for MICR, Cancer Burden, and Acute and Chronic Hazard Indices. If the estimated risk from Tier 2 screening is below Rule 1401 limits, then a more detailed evaluation is not necessary. Examples of calculations are provided at the end of the description of Tier 4 risk assessment. (See page 24.)

If the screening risk assessment results in a risk estimate that exceeds the risk limits or the permit applicant feels that a more detailed evaluation would result in a lower risk estimate, the applicant has the option of conducting a more detailed analysis using Tier 3 or 4.

To perform a Tier 2 screening risk assessment, the following information is needed:

- Maximum annual **emissions** of each carcinogen and non-cancer chronic TAC, and the maximum hourly emissions of each non-cancer acute TAC;
- The **distance** from the permit unit to the nearest off-site receptor(s);*
- Certain source characteristics, such as **stack height** and/or **building dimensions**;
- **Operating schedule**: whether the permit unit will operate more or less than 12 hr/day; and
- **Geographic location** of the permit unit (i.e., city).

* In order to perform a screening risk assessment, it is necessary to identify the nearest receptor location. For the purpose of calculating the MICR and chronic HI, a receptor is any location outside the boundaries of the facility at which a person could experience chronic exposure. For the purpose of calculating the acute HI, a receptor is any location outside the boundaries of the facility at which a person could experience acute exposure. Receptor locations include residential, commercial and industrial areas, and other locations where sensitive populations may be located. Residential receptor locations include current residential land uses and areas which may be developed for residential uses in the future, given land use trends in the general area. Commercial/industrial receptor locations include areas zoned for manufacturing, light or heavy industry, or retail activity. Sensitive receptor locations include schools, hospitals, convalescent homes, day-care centers, and other locations where children, chronically ill individuals or other sensitive persons could be exposed to TACs.

When identifying receptor locations in order to calculate MICR or chronic hazard index, the potential for chronic (long-term) exposure should be considered. Land uses at which it is not possible for individuals to be exposed on a long-term basis, should not be considered receptor locations for purposes of calculating MICR or chronic hazard index. Examples of such locations include permanent bodies of water, flood channels, or roadways. When identifying receptor locations to calculate acute hazard index, all off-site locations where there is the potential for acute exposure should be considered.

This information is used to determine inputs into the equation for calculating MICR. The cancer burden must also be estimated. Methods for calculating MICR, cancer burden, chronic hazard index (HIC), and acute hazard index (HIA) are provided.

Tier 2 is designed for a single emission source. If this worst-case approach does not demonstrate compliance with the risk limits, proceed to Tier 3.

INSTRUCTIONS FOR CALCULATING MAXIMUM INDIVIDUAL CANCER RISK (MICR)

The MICR Calculation Worksheet in Appendix I can be used to help with the calculation. This worksheet can be included in the permit application as documentation of the MICR calculation.

MICR is calculated as follows:

MICR = Cancer Potency (CP) x Dose-Inhalation (DI) x Multipathway Factor (MP)

Where:

$$DI = x\ C_{air}\ x\ DBR\ x\ EVF\ 10^{-6}\text{; and}$$
$$C_{air} = Q_{tons}\ x\ X/Q\ x\ AF_{ann}\ x\ MET$$

Therefore, the equation for calculating MICR is:

$$MICR = CP\ x\ Q_{tons}\ x\ X/Q\ x\ AF_{ann}\ x\ MET\ x\ DBR\ x\ EVF\ x\ 10^{-6}\ x\ MP$$

Term	Description	Where to Find
CP	Cancer Potency $(mg/kg\text{-}day)^{-1}$	Table 8A
DI	Dose through inhalation (mg/kg/day)	Calculated value
MP	Multi-pathway factor (if applicable)	Table 8A
10^{-6}	Micrograms to milligrams conversion, liters to cubic meters conversion	not applicable
C_{air}	Annual average 24 hour per day concentration in air ($\mu g/m^3$)	Calculated value
DBR	Daily breathing rate (L/kg body weight-day)	Table 9A
EVF	Exposure Value Factor (unitless)	Table 9B
Q_{tons}	Maximum emission rate (tons/yr)	Emission estimate specific to permit unit
X/Q	Dispersion factor [$(\mu g/m^3)/(tons/yr)$]	Table 2A, 3A, 4A or 5A
AF_{ann}	Annual concentration adjustment factor (unitless)	Table 2C or 3C
MET	Meteorological correction factor (unitless)	Table 2B, 3B, 4B or 5B

Step 1: Determine Appropriate Risk Tables

The first step is to determine when the application was deemed complete. Find the risk tables in the attachments corresponding to the date when the application was deemed complete. Only that set of tables should be used to calculate the risk for this equipment.

Step 2: Estimate Emission Rate (Q_{tons})

As the second step, the maximum annual emissions of the TAC in tons/year (Q_{tons}) must be estimated. The emission rate must be expressed in tons/year because the dispersion factors (X/Q) are expressed in tons/year.

Step 3: Determine Release Type

Determine whether the permit unit is best characterized as a point source or a volume source:

- A **point source** is one that releases its emissions through a stack (designed with acceptable stack height).
- A **volume source** is otherwise assumed, especially when the emissions are released unrestricted by any physical means (pipes or vents and/or vacuum or fan), including releases inside of a building or as fugitive emissions.

For permit units that have both point and volume releases, use the table that will result in the highest X/Q value, or apportion the emissions between the point and volume sources.

Step 4: Determine Release Height

For a **point source**, determine the **stack height**, which is the distance from ground level to the top of the stack.

For a **volume source**, determine the **building height**, which is the distance from ground level to the top of the building in which the permit unit is located, and the **floor area**, which is the dimensions (length x width) of the building in which the permit unit is located. If the stack or building height falls between two entries in the tables, use the lower of the two heights.

Acceptable Stack Height. Although a taller stack provides better dispersion, there are limits to the degree to which this factor can be incorporated into the risk assessment. Rule 1401 specifies that the stack height used to determine risk shall not exceed the "Acceptable Stack Height" for the permit unit. Acceptable stack height is defined as 2.5 times the height of the equipment or 2.5 times the height of the building housing the equipment, and may not exceed 65 meters (213 feet), unless the applicant demonstrates to the satisfaction of AQMD staff that a greater height is necessary. For example, for a building that is 14 feet high, the acceptable stack height is 35 feet, measured from ground level. If the physical stack height exceeds 35

feet, the risk must be calculated using the 35-foot value unless the applicant demonstrates that the greater height is necessary.

An **area source** is similar to a volume source in that the emissions take place over an area (as opposed to a point such as from a stack). However, in an area source, the pollutants are released at a uniform height. Examples of area sources are storage piles, slag dumps, lagoons or ponds, and liquid spills. Toxic hydrocarbon emissions from open top and floating roof storage tanks are also often treated as elevated area sources. Use Tier 3 or 4 for area sources.

Step 5: Determine Operating Schedule

Determine whether the equipment will operate:

- 12 hr/day or less; or
- more than 12 hr/day

Step 6: Identify Tables for Dispersion Factor (X/Q), Meteorological Correction Factor (MET), and Annual Concentration Adjustment Factor (AF_{ann})

Several tables are provided for X/Q, MET, and AF_{ann} factors. The selection of the appropriate table is discussed below:

Release Type	Operating Schedule of Equipment	Table for X/Q	Table for MET	Table for AF_{ann}
Point	≤ 12 hr/day	Table 2A	Table 2B	Table 2C
	> 12 hr/day	Table 3A	Table 3B	Table 3C
Volume	≤ 12 hr/day	Table 4A	Table 4B	Table 2C
	> 12 hr/day	Table 5A	Table 5B	Table 3C

Step 7: Identify Type of Receptor and Distance from Receptor

Identify the nearest receptor locations. Receptor locations are off-site locations where persons may be exposed to emission of a TAC from the equipment. Receptor locations include residential, commercial, and industrial land use areas, and other locations where sensitive populations may be located.

Residential receptor locations include current residential land uses and areas that may be developed for residential uses in the future, given land use trends in general areas.

Worker receptor locations include areas zoned for manufacturing, light or heavy industry, retail activity, or other locations that are regular work sites.

Sensitive receptor locations include schools, hospitals, convalescent homes, day-care centers, and other locations where children, chronically ill individuals, or other sensitive persons could be exposed.

When identifying receptor locations to calculate MICR, the potential for chronic (long-term) exposure should be considered. Land uses at which it is not possible for individuals to be exposed on a long-term basis, either presently or in the future, should not be considered receptor locations for purposes of calculating MICR. Examples of such locations include permanent bodies of water, flood channels, or roadways.

For a point source, the receptor distance is the distance from the center of the stack to the nearest receptor location.

For a volume source, the receptor distance is the distance from the center of the building to the nearest receptor location.

Experience shows that in most cases, the receptor distance will be 50 meters or more. However, the table also provides X/Q values for a 25-meter distance. The 25-meter distance should be used for circumstances in which there is a receptor located very close to the permit unit, for example, a residence located with a business, another business adjacent to the facility, or a sensitive receptor located less than 50 meters from the permit unit.

If the closest receptor location is a worker receptor, then the MICR must also be calculated for the closest residential or sensitive receptor. The greater of the two MICR values is used to determine compliance with the risk limits in the rule.

Care should be taken when estimating these distances since concentrations decrease rapidly with increasing distance. It is acceptable to linearly interpolate to estimate dispersion factors between the downwind distances given in the tables. If the receptor lies over 1,000 meters from the permit unit, use the listing for 1,000 meters.

Step 8: Select X/Q Value

Select the appropriate X/Q value from the table based on the **source characteristics** (i.e., stack height for point sources and building height and building area for volume sources) and the **receptor distance.**

What is a Dispersion Factor (X/Q)?

The concentration of a contaminant decreases as it travels away from the site of release and spreads out or "disperses." Dispersion factors (X/Q) are numerical estimates of the amount of dispersion that occurs under specific conditions.

The amount of dispersion depends on the distance traveled, the height of release and meteorological conditions such as wind speed and atmospheric stability.

The dispersion factors for the screening risk assessment procedure give the estimated annual average ground-level concentration (ug/m^3) resulting from a source emitting one ton/year of a contaminant.

An Alternative Set of Dispersion Factors (X/Q)
for Tier 2 Analysis Only
for Combustion Sources (Boilers and Internal Combustion Engines) Only

The Southern California Gas Company (working with AQMD staff) has developed a Health Risk Assessment Program for boilers and internal combustion engines fired by natural gas. This program is titled: Southern California Gas Company: Dispersion Modeling and Health Risk Assessment, External and Internal Combustion Equipment, Version 1.5. This file contains an Excel program to conduct a risk assessment (according to the previous AQMD Risk Assessment Procedures, Version 6.0) and the documentation on how to use the program. The program can be downloaded from:

http://www.socalgas.com/business/resource_center/aq_health_risk_tools.shtml.

For a **Tier 2 analysis only**, the AQMD will allow the use of the **dispersion factors** [X/Q in (ug/m$^{3)}$)/(gm/sec)] **from the tables** in this file. The tables are **for Boilers with an hourly rating between 2 MMBTU/hr to 75 MMBTU/hr and Internal Combustion Engines that are rated between 50 to 550 HP**. There tables are separated by the hours of operation of the engine or boiler (less than 12 hours a day and greater than 12 hours a day)

The selection of the engine or boiler size has to meet the criteria listed in the documentation provided for this program. The X/Q values are selected based on the closest receptor distances and the closest city to the source location of the emissions for the selected engine or boiler type.

Note: The Gas Company's Health Risk Assessment Program, Version 1.5, cannot be used to prepare a health risk assessment pursuant to these revised AQMD Risk Assessment Procedures, Version 7.0, as this program has not been updated to reflect the use of cancer potency values, daily breathing rates, multi-pathway adjustment factors for workers, and other changes from Version 6.0.

For guidance on the applicability or limitations of this alternative set of dispersion factors, contact Mohan Balagopalan, (909) 396 - 2704.

Step 9: Select Meteorological Correction Factor (MET)

Figure 1, at the end of the tables, provides the locations of meteorological stations in the air basin used for these calculations. Determine the station appearing in this figure that is closest to the facility and select the MET factor from the appropriate table (Table 2B, 3B, 4B or 5B).

What is a Meteorological Correction Factor (MET)?

Because local meteorology varies from location to location, the amount of dispersion will also vary with location of the source. Meteorological correction factors (MET) adjust for differences due to the geographic location of sources.

In order to derive the MET factors, dispersion modeling was performed at all the AQMD meteorological stations (see Figure 1). It should be noted that West Los Angeles generally yielded the highest concentrations at every downwind distance and was used as the basis of the dispersion factors. Correction factors were developed for the other 34 meteorological stations by dividing their predicted concentrations with those predicted at West Los Angeles with the highest factor chosen from the receptors at 50, 75, and 100 meters for each station.

The MET factors are different for point and volume sources and for different operating schedules (> or ≤ 12 hr/day). See the table under Step 6 - Identify Tables for Dispersion Factor (X/Q) and Meteorological Correction Factor (MET).

Step 10: Identify Cancer Potency Factor (CP)

Using Table 8A, identify the cancer potency factor (CP) for the TAC.

What is a Cancer Potency Factor (CP)?

The cancer potency factor is a measure of the cancer potency of a carcinogen. It is the estimated probability that a person will contract cancer as a result of inhalation of a concentration of 1 milligram of the TAC per kilogram of body weight continuously over a period of 70 years.

The cancer potency factors in these procedures were approved by the Scientific Review Panel and prepared by the state Office of Environmental Health Hazard Assessment (OEHHA).

Step 11: Identify Multi-pathway Factor (MP)

Using Table 8A, identify the multi-pathway adjustment (MP) factor for the TAC, if applicable. If no MP factor is listed, use a MP factor of 1.

What is a Multi-pathway Adjustment Factor (MP)?

The multi-pathway adjustment factor (MP) is used for substances that may contribute to risk from exposure pathways other than inhalation. These substances deposit on the ground in particulate form and contribute to risk through ingestion of soil or backyard garden vegetables or through other routes. The MP factor estimates the total risk associated with a given inhalation risk. MP factors are provided in Table 8A.

These factors allow permit units that emit multi-pathway pollutants to use the risk screening procedure rather than proceeding directly to preparing a detailed risk assessment.

The MP factors are to be used only in urban residential or worker exposure situations. Note that there are separate MP factors for workers and residents (see Table 8A) since their potential routes of exposure varies. If the facility is in the vicinity of other potential routes of population exposure such as agricultural areas, drinking water reservoirs, lakes or ponds used for fishing, or areas used for livestock grazing, then these MP screening assumptions are not appropriate and a more detailed multi-pathway assessment (Tier 4) must be performed.

For a more detailed description of the derivation of the multi-pathway factors, please see Appendix II.

Step 12: Select Exposure Value Factor (EVF)

Using Table 9B, select the appropriate EVF.

What is Exposure Value Factor (EVF)?

In order to protect public health, and in accordance with the recommendations of OEHHA, a 70-year lifetime exposure is assumed for all receptor locations except for off-site workers (i.e., receptor locations in commercial or industrial areas), for which a 40-year lifetime exposure is assumed. In addition to the 70- and 40-year exposure duration (ED) values described above, exposure values used to calculate cancer risk are exposure frequency (EF), which is the number of days per year of exposure, and the averaging time period in days over which exposure is averaged (AT). For EF, OEHHA recommends use of 350 days/year for residential exposure and 245 days/year for worker exposure. For AT, OEHHA recommends the use of 25,550 days (70 years x 365 days/year).

OEHHA recommends calculation of EVF using the equation:

$$EVF = (EF \times ED) / AT$$

For residential/sensitive receptors, EVF = (350 days/yr x 70 years) / 25,550 days = 0.96
For worker receptors, EVF = (245 days/yr x 40 years) / 25,550 days = 0.38

EVF values are summarized in Table 9B.

Only the EVF values in Table 9B should be used in a Tier 2 calculation. No further prorating of the published EVF values or consideration of other operating schedules is allowed.

If the residential or sensitive receptor is closer than the worker receptor, only the MICR for the residential or sensitive receptor need be calculated. (An equal or more distant worker receptor would have a lower MICR (because of the lower EVF) than a comparable residential or sensitive receptor.) Otherwise, the screening risk calculations for both the commercial/industrial MICR and the residential MICR should be shown and the greater of the two values is used to determine compliance with Rule 1401.

Step 13: Select Daily Breathing Rate (DBR)

Using Table 9A, select the appropriate daily breathing rate value.

What are Daily Breathing Rate (DBR) Values?

Exposure to airborne chemicals occurs through inhalation and subsequent absorption into the body, potentially resulting in adverse health effects depending on toxicological properties of the chemical and concentration in air. The dose of a substance through inhalation is a function of the concentration of the substance and the amount of air inhaled. DBR values used in these procedures, expressed in liters per kilogram-day (L/kg-day), are recommended by OEHHA and were developed based on results from several breathing rate studies.

Step 14: Select Annual Concentration Adjustment Factor (AF_{ann})

Using Table 2C or 3C, select the appropriate annual concentration adjustment factor. Table 2C is used for exposures of 12 hours per day or less, while Table 3C is used for exposures of more than 12 hours per day.

AF_{ann} is calculated using the following equation:

AF_{ann} = (maximum number of hours of exposure per day / actual number of hours of exposure per day*) x (maximum number of days of operation per week / actual number of days of operation per week**)

For all residents, sensitive receptors, and workers at facilities operating continuously:

AF_{ann} = (24 hours of exposure per day / 24 hours per day) x (7 days of operation per week / 7 days per week) = 1

Assuming workers at a facility operating 8 hours per day, 5 days per week, AF_{ann} would be calculated as follows:

AF_{ann} = (24 hours of exposure per day / 8 hours per day) x (7 days of operation per week / 5 days per week) = 4.2

* If actual number of hours of exposure per day is ≤ 8, a value of 8 is to be used.
** If actual number of days of operation per week is ≤ 5, a value of 5 is to be used.

What is Annual Concentration Adjustment Factor (AF_{ann})?

AF_{ann} adjusts dispersion factors (X/Q), which are 24 hours per day and 7 days per week averages, to an average for the off-site worker exposure period (i.e., 8 hours per day and 5 days per week). This is necessary because the worker breathing rate of 149 l/kg-day is only applicable to the work-day and work-week exposure. It is assumed that the worker is only exposed while at work.

MICRs for Multiple Toxic Air Contaminants

If the equipment emits more than one TAC, the total MICR must be calculated. The total MICR is the sum of the MICRs for each of the TACs emitted by the permit unit.

INSTRUCTIONS FOR CALCULATING CANCER BURDEN

The cancer burden is the estimated increase in the occurrence of cancer cases in a population as a result of exposures to TAC emissions from the equipment. The cancer burden for a population unit (city, census tract, sub-area or grid) is the product of the number of persons in the population and the estimated individual risk from TACs. The cancer burden only needs to be calculated if the MICR is greater than one (1) in one million.

The following procedure may be used to perform an acceptable screening analysis for cancer burden due to a single source of TAC:

- Calculate MICR as previously outlined.

- Estimate the distance at which the MICR falls below one in one million. This distance can be estimated by back-calculating the distance that would result in a MICR of one in one million, using the X/Q values in Table 2A, 3A, 4A, and 5A.

- Define a zone of impact in the shape of a circle. The radius (r) of this circle is the distance between the permit unit and the point at which the risk falls below one in one million. The area of this circle is calculated using the equation for the area of a circle, which is $3.14 \times r^2$.

- Estimate the residential population within this zone of impact based on census data or a worst-case estimate. Generally, the residential population in the Basin is less than 4,000 persons/ km^2, but some areas are as high as 7,000 persons/ km^2. Additionally, the worker population within the commercial/industrial areas of the zone of impact should be estimated and included.

  For areas where census data is available, it should be used. Where there is no census data, 7,000 persons/km^2 should be used for the areas with high population densities and 4,000 persons/km^2 should be used for areas with low population densities. Where the population densities are unknown, use 7,000 persons/km^2.

- Calculate cancer burden by multiplying the total population (residential and worker) in the zone of impact by the maximum individual cancer risk. The screening cancer burden estimate is the sum of the excess cancer burden calculated for residential and worker populations.

If the dispersion factors in Tables 2A, 3A, 4A, and 5A are not able to estimate the distance at which MICR falls below one in one million, then a more refined risk assessment is warranted.

INSTRUCTIONS FOR CALCULATING ACUTE AND CHRONIC HAZARD INDEX (HIA AND HIC)

Some TACs increase non-cancer health risk due to short term (acute) or long term (chronic) exposures. The screening risk assessment for those TACs must estimate acute and/or chronic hazard index as applicable. Like the calculation procedure for MICR, one must first identify when the application was deemed complete and select the appropriate set of risk tables found in the attachments.

Reference Exposure Level (REL) is used as an indicator of potential adverse non-cancer health effects. An REL is a concentration level (ug/m^3) or dose (mg/kg-day) at which no adverse health effects are anticipated. RELs are provided in Table 8A.

When only one TAC is considered, the hazard index calculated is referred to as the **individual substance hazard index**. When several TACs affect the same organ system in the body (e.g., respiratory system, nervous system, reproductive system), there can be a cumulative effect on the target organ. In these cases, the **total hazard index** is evaluated. This is the summation of the individual HIs for all TACs that affect the same target organ (see Tables 10A and 10B).

Detailed procedures for calculating total hazard index are provided in the 2003 OEHHA Guidance Manual. The equations used to calculate the chronic and acute Hazard Index (HIC & HIA) per target organ are as follows:

$$\text{Total HIC}_{\text{target organ}} = \Sigma \{[\text{Qyr}_{\text{TAC}} \mathbf{x} (\text{X/Q}) \mathbf{x} \text{ MET } \mathbf{x} \text{ MP}]/\text{Chronic REL}_{\text{TAC}}\}_{\text{target organ}}$$

$$\text{Total HIA}_{\text{target organ}} = \Sigma \{[\text{Qhr}_{\text{TAC}} \mathbf{x} (\text{X/Q})_{\text{hr}}]/\text{Acute REL}_{\text{TAC}}\}_{\text{target organ}}$$

Note that the chronic HI is based upon an annual average emission per year whereas the acute HI is based upon a maximum one-hour emission level (except for a few compounds) and the acute HI does not use a meteorological correction factor (MET) or a multi-pathway adjustment factor (MP).

ACUTE HAZARD INDICES FOR COMPOUNDS HAVING RELS AVERAGED OVER 4, 6, OR 7 HOURS

Currently, there are only eight acute compounds, as specified in the table below, which have RELs developed over average 4, 6, or 7 hours exposure times. All other acute compounds have RELs developed over maximum one-hour exposures.

Compounds with Acute RELs Averaged Over 4, 6, or 7 Hours

Chemical Name	CAS #	Acute REL	Avg. Time (hours)
Arsenic and arsenic compounds, inorganic	7440-38-2	1.90E-01	4
Benzene (including benzene from gasoline)	71-43-2	1.30E+03	6
Carbon disulfide	75-15-0	6.20E+03	6
Carbon tetrachloride	56-23-5	1.90E+03	7
Chloroform	67-66-3	1.50E+02	7
Ethylene glycol ethyl ether (EGEE)	110-80-5	3.70E+02	6
Ethylene glycol monoethyl ether acetate	111-15-9	1.40E+02	6
Ethylene glycol monomethyl ether	109-86-4	9.30E+01	6

For acute compounds with RELs based on maximum one-hour exposure, the equation to estimate the acute hazard indices for these compounds is:

$$HIA= [Q_{hr} \times (X/Q)_{hr}]/REL$$

For the eight compounds having RELs averaged over 4, 6, or 7 hours, adjustment factors (AF) have been developed, using air quality models for point and volume type sources, to reflect the risk based on the averaging times. These adjustment factors are listed in Tables 8B and 8C, based on the specified averaging times and source proximity to the nearest meteorological station. The acute hazard indices for these compounds are estimated using the following equation:

$$HIA= [(Q_{hr} \times (X/Q)_{hr})/REL] \times AF$$

Where, AF is the adjustment factor developed for compounds with RELs averaged over 4, 6, and 7 hours.

PROCEDURE FOR ALTERNATE HAZARD INDEX LEVEL EXEMPTION

Rule 1401 provides an exemption from the hazard index limit of 1.0 in cases in which a higher exposure level is deemed to be safe. This exemption has never been used. Under this exemption, the HIC and/or HIA limit of 1.0 does not apply if the applicant substantiates to the satisfaction of AQMD staff that at all receptor locations and for every target organ system, the total chronic and acute HI levels resulting from emissions from the equipment will not exceed alternate HI levels determined by OEHHA to be protective against adverse health effects. This applies only to TACs listed in Rule 1401 at the time the application was deemed complete. Refer to the attachments for the appropriate list of TACs.

Applicants should indicate in their permit application that they wish to apply for an exemption under the alternative hazard index provisions of the rule. The permit application should include both a risk assessment estimating the HIA and HIC levels and relevant information supporting the exemption. Depending on the particular health risks in question, additional information such as characterization of the surrounding population, the location of sensitive receptors, or other data may be required.

AQMD staff will consult with OEHHA staff regarding the request for the alternative HI level. If OEHHA staff finds that the levels of exposure to the public will not exceed levels that are protective against adverse health effects, the application will be eligible for the exemption.

In some cases, OEHHA staff may establish a general policy recommending different acceptable exposure levels for different exposed populations. For example, if exposure to a certain compound is particularly harmful to children but less of a concern for adults, OEHHA staff may determine as a general policy that higher exposure levels are acceptable in locations where children would not be exposed. OEHHA policy in these cases would be a basis for eligibility for the alternate hazard index exemption.

Tier 3: Screening Dispersion Modeling

Tier 3 uses a screening dispersion modeling computer program to estimate risk. This tier requires more expertise than Tiers 1 and 2. Applicants should consult AQMD modeling staff before conducting a Tier 3 analysis. For guidance on performing a Tier 3 analysis contact:

Staff	E-mail address	Telephone number
Yi-Hui Huang	yhuang@aqmd.gov	(909) 396-3176
Tom Chico	tchico@aqmd.gov	(909) 396-3149

Tier 3 screening modeling should only be used for a permit unit with a single emission or release point. If there are multiple emission or release points, Tier 4 must be used. In addition, Tier 3 should only be beneficial for applications involving a combustion process since plume rise is more appropriately addressed with a dispersion model. (Tiers 1 and 2 do not address the dispersion effects from plume rise of buoyant plumes.)

To perform a Tier 3 analysis, the following is needed:

- Air dispersion modeling expertise;
- An EPA-approved dispersion model program such as T-SCREEN or SCREEN3, which can be downloaded from www.epa.gov/scram001; and
- Additional equipment information such as stack gas temperature, stack gas exit velocity or flow rate, and stack inside diameter.

It should be noted that TSCREEN and SCREEN3 estimate peak one-hour concentrations for HIA calculations. These concentrations must be multiplied by 0.08 to estimate annual average concentrations for the MICR and HIC calculations.

In a Tier 3 approach, the Tier 2 equations for MICR, HIC, and HIA continue to be used except that a dispersion model is used to estimate each pollutant concentration. In addition, it is not appropriate to use the meteorological correction factor (i.e., MET) contained in the Tier 2 equations. Thus, the Tier 3 equations follows:

$$\mathbf{MICR = CP \times AveConc \times AF_{annual} \times DBR \times EVF \times 10^{-6} \times MP}$$

$$\mathbf{Total\ HIC_{target\ organ} = \Sigma\ \{[AveConc_{TAC} \times MP]/Chronic\ REL_{TAC}\}_{target\ organ}}$$

$$\mathbf{Total\ HIA_{target\ organ} = \Sigma\ \{[PeakConc_{TAC}]/Acute\ REL_{TAC}\}_{target\ organ}}$$

PeakConc is the peak one-hour pollutant concentration estimated by TSCREEN or SCREEN3 and AveConc is the annual average concentration or 0.08 times PeakConc. Refer to the section on Tier 2, Screening Risk Assessment for explanation of the other variables in the equations.

If the MICR, HIC, and HIA do not exceed the rule limits, then the equipment complies with Rule 1401 and no further analysis is required. If any risk value exceeds the rule limits, then proceed to Tier 4.

Tier 4: Detailed Risk Assessment

Tier 4 is a detailed risk assessment using ARB's Hotspots Analysis and Reporting Program (HARP). The HARP software and documentation can be obtained at http://www.arb.ca.gov/toxics/harp/harp.htm. The U.S. EPA air quality dispersion model called ISCST3 (Industrial Source Complex – Short Term, Version 3) is used by HARP for the exposure assessment. ISCST3 documentation is available at www.epa.gov/scram001. Meteorological data for use in HARP and ISCST3 can be downloaded at http://www.aqmd.gov/smog/metdata/MeteorologicalData.html.

Tier 4 is an option if neither Tier 2 nor Tier 3 can demonstrate compliance, or if the applicant wishes to obtain a more refined estimate of the cancer and non-cancer risk. Since Tier 4 involves detailed modeling using actual meteorological data from the closest air monitoring station, it will often result in a less conservative estimate of the risk than either Tiers 2 or 3.

A detailed risk assessment should be performed by individuals with experience and training in air quality modeling and risk assessment. In addition, AQMD modeling staff should be consulted before performing a detailed risk assessment. For guidance on performing a detailed risk assessment contact:

Staff	**E-mail address**	**Telephone number**
Yi-Hui Huang	yhuang@aqmd.gov	(909) 396-3176
Tom Chico	tchico@aqmd.gov	(909) 396-3149

Written guidance on preparing a detailed risk assessment is contained in an Office of Environmental Health Hazard Assessment document titled, "Air Toxics Hot Spots Program Risk Assessment Guidelines (August 2003)" which may be obtained at http://www.oehha.org/air/hot_spots/HRAguidefinal.html.

AQMD modeling staff has prepared supplemental risk assessment guidance which must be followed by all applicants submitting Tier 4 assessments. AQMD's supplemental guidance is available at http://www.aqmd.gov/prdas/AB2588/AB2588_B3.html.

EXAMPLE 1: MICR, CANCER BURDEN, HIA, & HIC CALCULATION

The equipment is a spray booth, operating 8 hr/day, located in an industrial and residential area. There are multiple TACs emitted from this booth. Some of the TACs are carcinogenic and some have chronic and acute non-cancer risks.

The application was deemed complete on July 30, 2005.
The nearest receptor distances:
Worker (Industrial) = 328 ft (100 meters)
Residential = 492 ft (150 meters)
Operating Schedule: 8 hr/day, 5 days/wk
Stack height = 28 ft
Plant location: Ontario, CA
Pollutants: Hexavalent chromium, Xylene, Cadmium, Toluene-2,4-diisocyanate, and Perchloroethylene

Emission rates for the TACs are listed in Table A below.
Note: The maximum hourly emissions should be estimated based on the maximum gallons of paint that could be sprayed in any hour.

Table A

Toxic Air Contaminant	Emission Rate		
	Qhr(Max.) (lbs/hr)	**Qyr (lbs/yr)**	**QYR (tons/yr)**
Cadmium	2.7×10^{-6}	0.0189	9.46×10^{-6}
Hexavalent chromium	2.5×10^{-6}	0.0175	8.76×10^{-6}
Perchloroethylene	3.8×10^{-4}	2.628	1.31×10^{-3}
Toluene-2,4-diisocyanate	1.1×10^{-3}	78.84	3.94×10^{-2}
Xylene	0.04	262.80	1.31×10^{-1}

(The list of TACs and their corresponding emission rates are for illustration purposes only. They may not reflect actual conditions.)

First, identify the appropriate risk assessment tables (included in the appendices) based upon when the application was deemed complete. In this case, the tables for applications deemed complete on or after July 1, 2005 (i.e., Permit Application Package "L") are used.

Second, calculate MICR for those TACs that have Inhalation Cancer Potency Values from Table 8A. Table B below identifies the TACs and their corresponding inhalation cancer potency values for MICR calculations.

Table B

Toxic Air Contaminant (TAC)	**Inhalation Cancer Potency** $(mg/kg\text{-}day)^{-1}$
Cadmium	1.50×10^{1}
Hexavalent Chromium	5.10×10^{2}
Perchloroethylene	2.10×10^{-2}
Toluene-2,4-diisocyanate	3.90×10^{-2}
Xylene	None

Based on the above table, MICR will be evaluated for residential and worker receptors for cadmium, hexavalent chromium, perchloroethylene and toluene-2,4-diisocyanate. Xylene does not have a cancer potency value and so this compound will not be included in the MICR calculations.

From Table 8A, we can also determine which of the substances is carcinogenic, chronic, and/or acute. The results are as follows:

TAC	**MICR (cancer)**	**HIC (chronic)**	**HIA (Acute)**
Cadmium	√	√ (MP)	
Hexavalent chromium	√	√	
Perchloroethylene	√	√	√
Toluene-2,4-diisocyanate	√	√	
Xylene		√	√

MP indicates that the multi-pathway adjustment factor will be different than 1.0.

Next, for chronic and acute substances, review Tables 10A and 10B to determine the target organs affected by these TACs due to chronic and/or acute toxicity. Table C below indicates the target organs affected by the chronic TACs with chronic toxicity. In the table, check marks (√) indicate the affected target organs.

Table C (Chronic Toxicity)

TAC	NS	AL	KIDNEY	RESP
Cadmium			√	√
Hexavalent Chromium				√
Perchloroethylene		√	√	√
Toluene-2,4-diisocyanate				√
Xylene	√			√

NS: Nervous System
AL: Alimentary System (Liver)
KIDNEY: Kidneys
RESP: Respiratory System

Similarly, after reviewing Table 10B for acute exposure, we find the target organs affected by the acute TACs. In Table D check marks (√) indicate the target organs.

Table D (Acute Toxicity)

TAC	NS	EYE	RESP
Perchloroethylene	√	√	√
Xylene		√	√

NS: Nervous System
EYE: Eye
RESP: Respiratory System

Tier I: Screening Emission Levels

The nearest receptor location should be used, in this case the worker location of 100m should be used. Since there are several pollutants, the Multiple Pollutant Screening Level Procedure should be used.

Please note that this step is used to approximate the equipment potential risk.

For Tier 1, the equipment's TACs emissions (annual and/or maximum hourly) should be compared with the Screening Levels for the contaminant in Tables 1A or 1B as appropriate. Since this

example has multiple pollutants, the Pollutant Screening Index should be calculated for each pollutant per procedure specified on pages 6 and 7.

For Carcinogenic and/or Chronic Compounds:

Calculate the Pollutant Screening Index for each pollutant (PSI_p).

$$PSI_p = Qyr_p / PSL_p$$

The Qyr is based upon the annual emissions of each TAC (lbs/yr). The PSLs are found in Table 1A and are expressed in lb/yr. Use the PSLs for a distance of 100 meters.

Sum up the individual Pollutant Screening Indices for each pollutant ($\sum PSI_p$).

TAC	Qyr_p	PSL_p	PSI_p
Cadmium	0.0189	0.0595	0.32
Hexavalent chromium	0.0175	0.00175	10.00
Perchloroethylene	2.628	42.5	0.06
Toluene-2,4-diisocyanate	78.84	18.1	4.36
Xylene	262.80	181,000	0.0014
		$\sum PSI_p =$	14.74

Calculate the Application Screening Index (ASI).

$$ASI_{cancer\ and/or\ chronic} = \Sigma\ PSI_p = 14.74$$

For Acute Compounds:

Calculate the Pollutant Screening Index for each pollutant (PSI_p).

$$PSI_p = Qhr_p / PSL_p$$

The Qhr is based upon the maximum hourly emissions (lb/hr). The PSLs for acute compounds are found in Table 1A and are expressed in lb/hr. Use the PSLs for a distance of 100 meters.

Sum up the individual Pollutant Screening Indices for each acute pollutant ($\sum PSI_p$).

TAC	Qhr_p	PSL_p	PSI_p
Perchloroethylene	3.8×10^{-4}	53.5	0.000007
Xylene	0.04	58.9	0.000679
		$\sum PSI_p =$	0.000686

Calculate the Application Screening Index (ASI).

$$ASI_{acute} = \Sigma\ PSI_p$$

Please note that the cumulative cancer/chronic risk cannot exceed 1. In this example, this facility did not pass Tier I since the ASI exceeds 1 for cancer/chronic, even though, the ASI for acute is below 1. If this Tier I screening were calculated to be less than 1, the applicant would not have to proceed with further risk screening assessment procedures.

Tier II: Screening Risk Assessment

CP, REL and MP values are taken from Table 8A in Permit Application Package "L".
(X/Q) values for cancer and chronic exposures are taken from Table 2A. This table is for a point source operating ≤ 12 hr/day, for a stack height of 28 feet, and a receptor distance of 100 meters for worker, and 150 meters for residential.
The value for the $(X/Q)_{hr}$ for acute exposures is taken from Table 6, which is for point source. If it were a volume source Table 7 would be used.
Exposure values are taken from Table 9B.
MET = 0.86 for Pomona (closest to Ontario) - from Table 2B.

These values are summarized below:
(1) Worker:

TAC	CP $(mg/kg\text{-}d)^{-1}$	REL ug/m^3 Acute	REL ug/m^3 Chronic	X/Q (chronic & carcinogenic) $(ug/m^3)/(tons/yr)$	$(X/Q)_{hr}$ for acute $(ug/m^3)/(lbs/hr)$	MPw for MICR	MPw for HIC
Cadmium	1.50×10^{1}	n/a	2.00×10^{-2}	4.19	n/a	1	1.12
Hexavalent chromium	5.10×10^{2}	n/a	2.00×10^{-1}	4.19	n/a	1	1
Perchloro-ethylene	2.10×10^{-2}	20,000	35	4.19	295.2	1	1
Toluene-2,4-diisocyanate	3.90×10^{-2}	n/a	7.00×10^{-2}	4.19	n/a	1	1
Xylene	n/a	22,000	700	4.19	295.2	n/a	1

n/a - not applicable

(2) Resident: This example uses a 150m distance to the closest receptor. Using Tables 2A and 6, an interpolation between the downwind distance of 100 and 200m must be done to determine the carcinogenic, acute, and chronic X/Q.

TAC	CP $(mg/kg\text{-}d)^{-1}$	REL ug/m^3 Acute	REL ug/m^3 Chronic	X/Q (chronic & carcinogenic) $(ug/m^3)/(tons/yr)$	$(X/Q)_{hr}$ for acute $(ug/m^3)/(lbs/hr)$	MPr for MICR	MPr for HIC
Cadmium	1.50×10^{1}	n/a	2.00×10^{-2}	2.66	n/a	1	1.50
Hexavalent chromium	5.10×10^{2}	n/a	2.00×10^{-1}	2.66	n/a	1	1
Perchloro-ethylene	2.10×10^{-2}	20,000	35	2.66	202.4	1	1
Toluene-2,4-diisocyanate	3.90×10^{-2}	n/a	7.00×10^{-2}	2.66	n/a	1	1
Xylene	n/a	22,000	700	2.66	202.4	n/a	1

n/a - not applicable

MICR Calculation

$$MICR = \Sigma\,(CP \times Qyr \times (X/Q) \times AF_{ann} \times MET \times DBR \times EVF \times 10^{-6} \times MP)$$

(1) Worker:

TAC	CP	Qyr (tons/yr)	X/Q	AF_{ann}	MET	DBR	EVF	MP_w	MICR
Cadmium	1.50×10^{1}	9.46×10^{-6}	4.19	4.2	0.86	149	0.38	1	1.22×10^{-7}
Hexavalent Chromium	5.10×10^{2}	8.76×10^{-6}	4.19	4.2	0.86	149	0.38	1	3.83×10^{-6}
Perchloro-ethylene	2.10×10^{-2}	1.31×10^{-3}	4.19	4.2	0.86	149	0.38	1	2.36×10^{-8}
Toluene-2,4-diisocyanate	3.90×10^{-2}	3.94×10^{-2}	4.19	4.2	0.86	149	0.38	1	1.32×10^{-6}
Total									**5.29×10^{-6}**

(2) Resident:

TAC	CP	Qyr (tons/yr)	X/Q	AF_{ann}	MET	DBR	EVF	MPr	MICR
Cadmium	1.50×10^{1}	9.46×10^{-6}	2.66	1	0.86	302	0.96	1	9.41×10^{-8}
Hexavalent Chromium	5.10×10^{2}	8.76×10^{-6}	2.66	1	0.86	302	0.96	1	2.96×10^{-6}
Perchloro-ethylene	2.10×10^{-2}	1.31×10^{-3}	2.66	1	0.86	302	0.96	1	1.82×10^{-8}
Toluene-2,4-diisocyanate	3.90×10^{-2}	3.94×10^{-2}	2.66	1	0.86	302	0.96	1	1.02×10^{-6}
Total									**4.09×10^{-6}**

Please note that the higher of the worker and residential cancer risks needs to be selected. This value will be entered in MICR field in the NSR, 1401 section. In this example, the maximum cancer risk is at the worker receptor.

Cancer Burden Calculation

Cancer burden should always be calculated if the MICR exceeds 1 in a million, regardless of the type of receptor.

It is necessary to determine a cancer burden for risk at the worker receptor since the worker risk was determined to be higher than the residential risk. MICR for worker receptors was calculated to be **5.29×10^{-6}**.

Estimate of distance at which MICR falls below one in one million.
The distance at which the MICR falls below one in one million requires you to take the reciprocal of the calculated MICR multiplied by 1.0×10^{-6}. This factor (F) will be the multiplier to the X/Q value used in determining the MICR.

$$F = (1 / MICR) \times 1.0 \times 10^{-6}$$

$$F = (1 / 5.29 \times 10^{-6}) \times 1.0 \times 10^{-6}$$

$$F = 0.19$$

Determination of the new downwind distance will be based upon a X/Q value calculated from the originally used X/Q value multiplied by F.

Therefore,

New X/Q = 4.19 x 0.19

New X/Q = 0.80

Using Table 2A, the New X/Q lies between downwind distances of 200 to 300 m. Interpolating for the new downwind distance gives,

$$\text{New downwind distance} = \frac{[300\text{ m} - 200\text{ m}] \times [1.12 - 0.80]}{[1.12 - 0.50]} + 200\text{ m}$$

New downwind distance = 251.6 m = 0.2516 km

This new Downwind Distance is where the MICR will fall below one in one million.

Define Zone of Impact
The zone of impact (ZI) is calculated using the New Downwind Distance as the radius of a circle and calculating the area of that circle.

Therefore,

$ZI = 3.14\ r^2$

$ZI = 3.14\ (0.2516\text{ km})^2$

$ZI = 0.20\text{ km}^2$

Estimate the population within the ZI
ZI should include both worker and residential populations.

For areas where census data is available, it should be used. Where there is no census data, 7,000 persons/km^2 should be used for the areas with high population densities and 4,000 persons/km^2 should be used for areas with low population densities. Where the population densities are unknown, use 7,000 persons/km^2.

In this example we have no information on census data or population density, therefore,

Zone of Impact Population = ZI x Population Density

Zone of Impact Population = 0.20 km^2 x 7,000 persons/ km^2

Zone of Impact Population = 1,400 persons

Calculate Cancer Burden
Cancer Burden (CB) is the zone of impact population multiplied by the calculated MICR.

Therefore,

$$CB = 1{,}400 \text{ persons} \times 5.29 \times 10^{-6}$$

CB = 0.0074

Hazard Index Calculations

Acute and Chronic Hazard Indices should be calculated for each target organ.

Acute Hazard Index:

$$HIA = [Q_{hr} \times (X/Q)_{hr}]/REL$$

Based on Table 10B, the target organs for the TACs have been listed.

Note: The X/Q values in Table 6 are based upon the maximum hourly emission rates. It should also be noted that the X/Q for residential receptor (150 m) is estimated using interpolation between the downwind distance of 100 and 200 m.
Resident X/Q (150 m) = 202.4 (ug/m^3)/(lbs/hr)
Worker X/Q (100 m) = 295.2 (ug/m^3)/(lbs/hr)

Perchloroethylene:
Affects nervous system, eye, and respiratory organs.

The Acute Hazard Index for Perchloroethylene is calculated as follows:

Worker: HIA = [3.8 x10^{-4} x 295.2] / 20,000 **= 5.6 x 10^{-6}**
Nervous, eye, and respiratory systems: 5.6 x 10^{-6}

Resident: HIA = [3.8 x10^{-4} x 202.4] / 20,000 **= 3.8 x 10^{-6}**
Nervous, eye, and respiratory systems: 3.8 x 10^{-6}

Xylene:
Affects eye and respiratory organs.

The Acute Hazard Index for Xylene is calculated as follows:

Worker: HIA = [0.04 x 295.2]/22,000 **= 5.4 x 10^{-4}**
Eye and respiratory systems: 5.4 x 10^{-4}

Resident: HIA = [0.04 x 202.4]/22,000 **= 3.7 x 10^{-4}**

Eye and respiratory systems: 3.7×10^{-4}

Chronic Hazard Index:

HIC = Σ [(QYR) **x** (X/Q)chronic **x** MET **x** MP]/(Chronic REL)]

Based on Table 10A, the target organs for the TACs for chronic have been listed. The Chronic Hazard Index for the TACs in this example are calculated as follows:

Cadmium:
Affects kidneys and respiratory organs.

The residential chronic hazard index for cadmium is:

Resident: HIC = $[9.46 \times 10^{-6} \times 2.66 \times 0.86 \times 1.50] / [2.00 \times 10^{-2}]$ **= 1.62×10^{-3}**
Kidney and respiratory systems: 1.62×10^{-3}

Worker: HIC = $[9.46 \times 10^{-6} \times 4.19 \times 0.86 \times 1.12] / [2.00 \times 10^{-2}]$ **= 1.91×10^{-3}**
Kidney and respiratory systems: 1.91×10^{-3}

Hexavalent Chromium:
Affects respiratory organs.

The chronic hazard index for hexavalent chromium is:

Resident: HIC = $[8.76 \times 10^{-6} \times 2.66 \times 0.86 \times 1] / [2.00 \times 10^{-1}]$ **= 1.00×10^{-4}**
Respiratory system: 1.00×10^{-4}

Worker: HIC = $[8.76 \times 10^{-6} \times 4.19 \times 0.86 \times 1] / [2.00 \times 10^{-1}]$ **= 1.58×10^{-4}**
Respiratory system: 1.58×10^{-4}

Perchloroethylene:
Affects kidneys, alimentary system (liver), and respiratory organs.

The chronic hazard index for perchloroethylene is:

Resident: HIC = $[1.31 \times 10^{-3} \times 2.66 \times 0.86 \times 1]/35$ **= 8.56×10^{-5}**
Kidney, alimentary, and respiratory systems: 8.56×10^{-5}

Worker: HIC = $[1.31 \times 10^{-3} \times 4.19 \times 0.86 \times 1]/35$ **= 1.35×10^{-4}**
Kidney, alimentary, and respiratory systems: 1.35×10^{-4}

Toluene 2,4-diisocyanate
Affects respiratory organs.

The chronic hazard index for toluene 2,4-diisocyanate is:

Resident: HIC = [3.94 x 10^{-2} x 2.66 x 0.86 x 1] / [7.00 x 10^{-2}] **= 1.29**
Respiratory system: 1.29

Worker: HIC = [3.94 x 10^{-2} x 4.19 x 0.86 x 1] / [7.00 x 10^{-2}] **= 2.03**
Respiratory system: 2.03

Xylene
Affects nervous system and respiratory organs.

The chronic hazard index for xylene is:

Resident: HIC = [1.31 x 10^{-1} x 2.66 x 0.86 x 1] / [7.00 x 10^{2}] **= 4.28 x 10^{-4}**
Nervous and respiratory systems: 4.28 x 10^{-4}

Worker: HIC = [1.31 x 10^{-1} x 4.19 x 0.86 x 1] / [7.00 x 10^{2}] **= 6.74 x 10^{-4}**
Nervous and respiratory systems: 6.74 x 10^{-4}

In summary:

I. **MICR:**

Worker:

TAC	MICR
Cadmium	1.22×10^{-7}
Hexavalent Chromium	3.83×10^{-6}
Perchloroethylene	2.36×10^{-8}
Toluene-2,4-diisocyanate	1.32×10^{-6}
Xylene	n/a
Total	**5.29×10^{-6}**

Resident:

TAC	MICR
Cadmium	9.41×10^{-8}
Hexavalent Chromium	2.96×10^{-6}
Perchloroethylene	1.82×10^{-8}
Toluene-2,4-diisocyanate	1.02×10^{-6}
Xylene	n/a
Total	**4.09×10^{-6}**

II. **Cancer Burden:**

CB = 0.0074

III. **Acute Hazard Index (HIA) and Chronic Hazard Index (HIC):**
By Target Organs for Acute:

(1) Worker:

TAC	HIA		
	NS	EYE	RESP
Perchloroethylene	5.6×10^{-6}	5.6×10^{-6}	5.6×10^{-6}
Xylene		5.4×10^{-4}	5.4×10^{-4}
Total	**5.6×10^{-6}**	**5.5×10^{-4}**	**5.5×10^{-4}**

(2) Resident:

TAC	HIA		
	NS	EYE	RESP
Perchloroethylene	3.8×10^{-6}	3.8×10^{-6}	3.8×10^{-6}
Xylene		3.7×10^{-4}	3.7×10^{-4}
Total	**3.8×10^{-6}**	**3.7×10^{-4}**	**3.7×10^{-4}**

By Target Organs for Chronic:

(1) Worker:

TAC	HIC			
	NS	KIDNEYS	AL	RESP
Cadmium		1.91×10^{-3}		1.91×10^{-3}
Hexavalent Chromium				1.58×10^{-4}
Perchloroethylene		1.35×10^{-4}	1.35×10^{-4}	1.35×10^{-4}
Toluene-2,4-diisocyanate				2.03
Xylene	6.74×10^{-4}			6.74×10^{-4}
Total	**6.74×10^{-4}**	**2.05×10^{-3}**	**1.35×10^{-4}**	**2.03**

(2) Resident:

TAC	HIC			
	NS	KIDNEYS	AL	RESP
Cadmium		1.62×10^{-3}		1.62×10^{-3}
Hexavalent Chromium				1.00×10^{-4}
Perchloroethylene		8.56×10^{-5}	8.56×10^{-5}	8.56×10^{-5}
Toluene-2,4-diisocyanate				1.29
Xylene	4.28×10^{-4}			4.28×10^{-4}
Total	**4.28×10^{-4}**	**1.71×10^{-3}**	**8.56×10^{-5}**	**1.29**

RESULT:

The spray booth in this example does not contain T-BACT, fails the Rule 1401 MICR limit, and would not be granted a permit. However, if the spray booth was equipped with T-BACT, it would pass the Rule 1401 MICR limit. Notwithstanding, the spray booth in this example also fails the Rule 1401 HIC limit and would not be granted a permit based on this criteria alone. A Tier 3 or 4 analysis should be conducted.

- ***MICRs for residential and commercial receptors exceed 1×10^{-6} (one in one million) but are below 10×10^{-6} (ten in one million).***
- ***Cancer burden is less than 0.5.***
- ***HIAs for residential and commercial receptors do not exceed 1.0 for each target organ.***
- ***HICs for residential and commercial receptors exceed 1.0 for respiratory organs.***

EXAMPLE 2: MICR, HIA, HIC, & CANCER BURDEN CALCULATION FOR PLATING OPERATIONS

A metal finishing shop operates a nickel plating operation. Prior to the actual plating process, component parts are first cleaned and/or etched. The cleaning is conducted in an electro-cleaner tank containing a sodium hydroxide (NaOH) solution. Parts requiring etching are immersed in a tank containing hydrochloric acid (HCl). Finally, the parts are placed in a plating tank containing a nickel solution where the nickel metal (Ni) is deposited on the parts.

The application was deemed complete on July 30, 2005.
Volume source: Building dimensions 40'(W) x 70'(L) x 17'(H)
The nearest receptor distances are:
Worker (Industrial) = 100 meters
Residential = 500 meters
Operating Schedule: 8 hr /day, 3 days/wk, 50 wks/yr = 1200 hrs/yr
Plant location: Azusa, CA

Note: Emissions from metal finishing operations can be determined from source test data or from emission factors and correlations, as appropriate. Operational data used in developing emission factors and correlations currently used by AQMD permitting engineers include the concentration of chemicals in the process tank, the quantity of ampere-hours applied to a tank, the plating efficiency, the tank temperature, parameters affecting air-sparging emissions, and control efficiencies for air pollution control equipment or other emissions reduction techniques that are employed.

Emission rates for the TACs are listed in Table A below.

Table A

Toxic Air Contaminant	**Emission Rate**		
	Qhr(Max.) (lbs/hr)	**Qyr (lbs/yr)**	**Qyr (tons/yr)**
Nickel	3.8×10^{-4}	0.227	1.14×10^{-4}
Sodium hydroxide	2.15×10^{-6}	0.0021	1.05×10^{-6}
Hydrogen chloride	1.2×10^{-4}	0.841	4.2×10^{-4}

(The list of TACs and their corresponding emission rates are for illustration purposes only. They may not reflect actual conditions.)

First, Identify the appropriate risk assessment tables (included in the Attachments) based upon when the application was deemed complete. In this case, the tables for applications deemed complete on July 1, 2005 are included in Permit Application Package "L" in the Attachments to this document.

Second, The MICR is calculated for those TACs that have appropriate Cancer Potency Values from Table 8A. Table B below identifies the TACs for MICR calculations.

Table B

Toxic Air Contaminant (TAC)	Cancer Potency Value	Chronic REL	Acute REL
Nickel	9.1×10^{-1}	5.0×10^{-2}	6.00
Sodium hydroxide	None	None	8.00
Hydrogen chloride	None	9.00	2.10×10^{3}

Based on the above table, MICR will be evaluated for residential and worker receptors for nickel.

From Table 8A, determine which of the substances is carcinogen, chronic, and/or acute. The results are as follows:

TAC	MICR (cancer)	HIC (chronic)	HIA (Acute)
Nickel	√	√	√
Sodium hydroxide			√
Hydrogen chloride		√	√

Next, for chronic and acute substances, Table 10A and 10B need to be reviewed to determine the target organs affected by these TACs due to chronic and/or acute toxicity.

Tables C and D below indicate the target organs affected by the TACs with chronic and acute toxicity, respectively. In the table, check marks (√) indicate the affected target organs.

Table C (Chronic Toxicity)

TAC	HEM	RESP
Nickel	√	√
Hydrogen chloride		√

HEM: Hematologic System
RESP: Respiratory System

Table D (Acute Toxicity)

TAC	SKIN	IMMUN	EYE	RESP
Nickel		√		√
Sodium hydroxide	√		√	√
Hydrogen chloride			√	√

SKIN: Skin IMMUN: Immune system
EYE: Eye RESP: Respiratory System

Tier I: Screening Emission Levels

For Carcinogenic and/or Chronic Compounds:

Calculate the Pollutant Screening Index for each pollutant (PSI_p).

$$PSI_p = Qyr_p / PSL_p$$

The Qyr is based upon the annual emissions of each TAC (lbs/yr). The PSLs are found in Table 1A and are expressed in lb/yr.

Sum up the individual Pollutant Screening Indices for each pollutant ($\sum PSI_p$).

TAC	**Qyr_p**	**PSL_p**	**PSI_p**
Nickel	0.227	0.981	0.23
Hydrogen Chloride	0.841	2330	3.6×10^{-4}
		$\sum PSI_p =$	0.23

Calculate the Application Screening Index (ASI).

$$ASI_{cancer\ and/or\ chronic} = \Sigma\ PSI_p = 0.23$$

For Acute Compounds:

Calculate the Pollutant Screening Index for each pollutant (PSI_p).

$$PSI_p = Qhr_p / PSL_p$$

The Qhr is based upon the maximum hourly emissions (lb/hr). The PSLs for acute compounds are found in Table 1A and are expressed in lb/hr.

Sum up the individual Pollutant Screening Indices for each acute pollutant ($\sum PSI_p$).

TAC	Qhr_p	PSL_p	PSI_p
Nickel	3.8×10^{-4}	0.016	0.024
Sodium hydroxide	2.15×10^{-6}	0.0214	1.00×10^{-4}
Hydrogen chloride	1.2×10^{-4}	5.62	2.14×10^{-5}
		$\sum PSIp =$	0.024

Calculate the Application Screening Index (ASI).

$$ASI_{acute} = \Sigma\ PSI_p = 0.024$$

Please note that the cumulative cancer/chronic risk did not exceed 1 and the cumulative acute hazard index did not exceed 1. In this example, this facility did pass Tier I since the ASI did not exceed 1

for cancer/chronic and 1 for acute. Since this Tier I screening was calculated to be less than 1, the applicant would not have to proceed with further risk screening assessment procedures.

Tier II: Screening Risk Assessment

CP, REL and MP values are taken from Table 8A in Permit Application Package "L".
(X/Q) values for cancer and chronic exposures are taken from Table 4A. This table is for a volume source operating • 12 hr/day, for an area of less than 3000 ft^2, and a receptor distance of 100 meters for worker, and 500 meters for residential.
The value for the $(X/Q)_{hr}$ for acute exposures is taken from Table 7 because this is a volume source.
Exposure values, daily breathing rate values and annual concentration adjustment factors are taken from Tables 9B, 9A, and 2C, respectively.

MET = 0.8 for Azusa - from Table 4B.

These values are summarized below:

(3) Worker: Using 100m receptor

TAC	CP $(mg/kg\text{-}d)^{-1}$	REL (ug/m^3) Acute	REL (ug/m^3) Chronic	X/Q (chronic & carcinogenic) $(ug/m^3)/(tons/yr)$	$(X/Q)_{hr}$ for acute $(ug/m^3)/(lbs/hr)$	MP_w for MICR	MP_w for HIC
Nickel	9.1×10^{-1}	6.00	5.00×10^{-2}	3.95	309	1	1
NaOH	n/a	8.00	n/a	n/a	309	n/a	n/a
HCl	n/a	2.1×10^3	9.00	3.95	309	n/a	1

n/a – not applicable

(4) Resident: Using 500m distance to the closest receptor.

TAC	CP $(mg/kg\text{-}d)^{-1}$	REL (ug/m^3) Acute	REL (ug/m^3) Chronic	X/Q (chronic & carcinogenic) $(ug/m^3)/(tons/yr)$	$(X/Q)_{hr}$ for acute $(ug/m^3)/(lbs/hr)$	MPr for MICR	MPr for HIC
Nickel	9.1×10^{-1}	6.00	5.00×10^{-2}	0.17	24.1	1	1
NaOH	n/a	8.00	n/a	n/a	24.1	n/a	n/a
HCl	n/a	2.1×10^3	9.00	0.17	24.1	n/a	1

n/a – not applicable

MICR CALCULATION

$$MICR = \Sigma\,(CP \times Qyr \times (X/Q) \times AF_{ann} \times MET \times DBR \times EVF \times 10^{-6} \times MP)$$

(1) Worker:

TAC	CP	Qyr (tons/yr)	X/Q	AF_{ann}	MET	DBR	EVF	MP_w	MICR
Nickel	9.1×10^{-1}	1.14×10^{-4}	3.95	4.2	0.80	149	0.38	1	7.8×10^{-8}
Total									**7.8×10^{-8}**

(2) Resident:

TAC	CP	Qyr (tons/yr)	X/Q	AF_{ann}	MET	DBR	EVF	MPr	MICR
Nickel	9.1×10^{-1}	1.14×10^{-4}	0.17	1	0.80	302	0.96	1	4.09×10^{-9}
Total									**4.09×10^{-9}**

Please note that a comparison between the worker and residential cancer risks needs to be made and the higher value will be entered in MICR field in the NSR, 1401 section. In this example, the maximum cancer risk is at the worker receptor.

Cancer Burden Calculation

Cancer burden should always be calculated if the MICR exceeds 1 in a million, regardless of the type of receptor. For this example, cancer burden was not calculated because neither worker nor residential risk exceeded 1 in a million.

Hazard Index Calculations

Acute and Chronic Hazard Indices should be calculated for each target organ.

Acute Hazard Index:

For all acute compounds with RELs developed over 1 hour average, the acute hazard indices are estimated using the equation below:

$$HIA = [Q_{hr} \times (X/Q)_{hr}]/REL$$

Based on Table 10B, the target organs for the TACs have been listed.

Nickel:
Affects immune and respiratory systems.

Note: The X/Q values in Table 7 are based upon the maximum hourly emission rates.

The Acute Hazard Index for Nickel is calculated as follows:

Worker: HIA = $(3.8 \times 10^{-4} \times 309) / 6$ = $\mathbf{2.0 \times 10^{-2}}$
Immune and respiratory systems: 2.0×10^{-2}

Resident: HIA = $(3.8 \times 10^{-4} \times 24.1) / 6$ = $\mathbf{1.5 \times 10^{-3}}$
Immune and respiratory systems: 1.5×10^{-3}

Sodium Hydroxide:
Affects skin, eye, and respiratory systems.

Note: The X/Q values in Table 7 are based upon the maximum hourly emission rates.

The Acute Hazard Index for sodium hydroxide is calculated as follows:

Worker: HIA = $(2.15 \times 10^{-6} \times 309) / 8$ = $\mathbf{8.3 \times 10^{-5}}$
Skin, eye, and respiratory systems: 8.3×10^{-5}

Resident: HIA = $(2.15 \times 10^{-6} \times 24.1) / 8$ = $\mathbf{6.5 \times 10^{-6}}$
Skin, eye, and respiratory systems: 6.5×10^{-6}

Hydrogen chloride:
Affects eye, and respiratory systems.

Note: The X/Q values in Table 7 are based upon the maximum hourly emission rates.

The Acute Hazard Index for hydrogen chloride is calculated as follows:

Worker: HIA = $(1.2 \times 10^{-4} \times 309) / 2100$ = $\mathbf{1.8 \times 10^{-5}}$
Eye and respiratory systems: 1.8×10^{-5}

Resident: HIA = $(1.2 \times 10^{-4} \times 24.1) / 2100$ = $\mathbf{1.4 \times 10^{-6}}$
Eye and respiratory systems: 1.4×10^{-6}

Chronic Hazard Index:

HIC = Σ [(QYR) **x** (X/Q)chronic **x** MET **x** MP]/(Chronic REL)]

Based on Table 10A, the target organs for the TACs with chronic RELs have been listed. The Chronic Hazard Index for the TACs in this example are calculated as follows:

Nickel
Affects hematologic systems and respiratory organs.

The chronic hazard index for nickel is:

Resident: HIC = [1.14 x 10^{-4} x 0.17 x 0.80 x 1] / [5.00 x 10^{-2}] = **3.1 x 10^{-4}**
Hematologic and respiratory systems: 3.1 x 10^{-4}

Worker: HIC = [1.14 x 10^{-4} x 3.95 x 0.80 x 1] / [5.00 x 10^{-2}] = **7.2 x 10^{-3}**
Hematologic and respiratory systems: 7.2 x 10^{-3}

Hydrogen Chloride
Affects respiratory organs.

The chronic hazard index for hydrogen chloride is:

Resident: HIC = [4.20 x 10^{-4} x 0.17 x 0.80 x 1] / [9.00] = **6.3 x 10^{-6}**
Respiratory system: 6.3 x 10^{-6}

Worker: HIC = [4.20 x 10^{-4} x 3.95 x 0.80 x 1] / [9.00] = **1.5 x 10^{-4}**
Respiratory system: 1.5 x 10^{-4}

In summary:

I. **MICR:**

(1) Worker:

TAC	MICR
Nickel	7.8 x 10^{-8}

(2) Resident:

TAC	MICR
Nickel	4.09 x 10^{-9}

II. **Acute Hazard Index (HIA) and Chronic Hazard Index (HIC):**

By Target Organs for Acute:

(1) Worker:

TAC	HIA			
	SKIN	IMMUNE	EYE	RESP
Nickel		2.0×10^{-2}		2.0×10^{-2}
Sodium hydroxide	8.3×10^{-5}		8.3×10^{-5}	8.3×10^{-5}
Hydrogen chloride			1.8×10^{-5}	1.8×10^{-5}
Total	8.3×10^{-5}	2.0×10^{-2}	1.0×10^{-4}	2.0×10^{-2}

(2) Resident:

TAC	HIA			
	SKIN	IMMUNE	EYE	RESP
Nickel		1.5×10^{-3}		1.5×10^{-3}
Sodium hydroxide	6.5×10^{-6}		6.5×10^{-6}	6.5×10^{-6}
Hydrogen chloride			1.4×10^{-6}	1.4×10^{-6}
Total	6.5×10^{-6}	1.5×10^{-3}	7.9×10^{-6}	1.5×10^{-3}

By Target Organs for Chronic:

(1) Worker:

TAC	HIC	
	HEM	RESP
Nickel	7.2×10^{-3}	7.2×10^{-3}
Hydrogen chloride		1.5×10^{-4}
Total	$\mathbf{7.2 \times 10^{-3}}$	$\mathbf{7.4 \times 10^{-3}}$

(2) Resident:

TAC	HIC	
	HEM	RESP
Nickel	3.1×10^{-4}	3.1×10^{-4}
Hydrogen chloride		6.3×10^{-6}
Total	$\mathbf{3.1 \times 10^{-4}}$	$\mathbf{3.2 \times 10^{-4}}$

RESULT:
For this example, the evaluations indicate that MICR for residential and commercial, HIA, and HIC are all below the risk limits of Rule 1401.

Cancer Burden Calculation

For this example, an analysis is not required to determine a cancer burden because the total MICR is below 1×10^{-6}.

EXAMPLE 3: HIA CALCULATION FOR COMPOUNDS WITH RELS AVERAGED OVER 4, 6, OR 7 HRS

***Note**: Presently there are eight acute compounds (see table below) which have RELs averaged over 4, 6, or 7 hours. For these compounds the acute hazard indices are estimated using the adjustment factors that are developed for these averaging times. The acute hazard indices for these compounds are estimated using the equation listed below:*

$HIA = [(Q_{hr} \times (X/Q)_{hr})/REL] \times AF$

Where,

AF is the adjustment factor developed for compounds with RELs averaged over 4, 6, or 7 hours and listed below based on the source types (point or volume) and locations.

Compounds with Acute RELs Averaged Over 4, 6, or 7 Hours

Chemical Name	CAS #	Acute REL	Avg. Time (hours)
Arsenic and arsenic compounds, inorganic	7440-38-2	1.90E-01	4
Benzene (including benzene from gasoline)	71-43-2	1.30E+03	6
Carbon disulfide	75-15-0	6.20E+03	6
Carbon tetrachloride	56-23-5	1.90E+03	7
Chloroform	67-66-3	1.50E+02	7
Ethylene glycol ethyl ether (EGEE)	110-80-5	3.70E+02	6
Ethylene glycol monoethyl ether acetate	111-15-9	1.40E+02	6
Ethylene glycol monomethyl ether	109-86-4	9.30E+01	6

Ethylene glycol ethyl ether (EGEE) with its REL averaged over 6 hours is used in the following example.

The equipment is a spray booth, operating 8 hr/day, located in an industrial and residential area. There are multiple TACs emitted from this booth. The TACs have carcinogenic and acute non-cancer risks.

Assumptions:

The application was deemed complete on July 30, 2005
The nearest receptor distances are:
Worker (Industrial) = 500 meters
Residential = 1000 meters
Operating Schedule: 8 hr /day, 1 day/wk
Stack height = 28 ft
Plant location: West Los Angeles, CA
The coating material contains lead chromate and EGEE.
The transfer efficiency is 65%.

Maximum annual coating sprayed: 25.0 gal/yr
Maximum hourly coating sprayed: 0.5 gal/hr

From MSDS sheets:
Lead chromate: 5 wt%
EGEE: 6 wt%
Coating density: 10 lb/gal

Percent by weight of lead and hexavalent chromium in lead chromate are estimated as follows:

Lead = (MW of Pb / MW of PbCrO4) x wt% of lead chromate in paint
= (207 lb Pb/323 lb PbCrO4) x 0.05 = 0.032 = 3.2 wt%

Hexavalent chromium = (MW of Cr^{+6} / MW of PbCrO4) x wt% of lead chromate in paint
= (52 lb Cr^{+6}/323 lb of PbCrO4) x 0.05 = 0.008 = 0.8 wt%

The maximum yearly and hourly emissions are estimated as follows:

Lead:
Qyr (lb/yr) = 25 gal/yr x 10 lb/gal x 0.032 x (1 - 0.65) = 2.8
Qhr (lb/hr) = 0.5 gal/hr x 10 lb/gal x 0.032 x (1 - 0.65) = 0.056

Hexavalent Chromium:
Qyr (lb/yr) = 25 gal/yr x 10 lb/gal x 0.008 x (1 - 0.65) = 0.7
Qhr (lb/hr) = 0.5 gal/hr x 10 lb/gal x 0.008 x (1 - 0.65) = 0.014

EGEE:
Qyr (lb/yr) = 25 gal/yr x 10 lb/gal x 0.06 = 15
Qhr (lb/hr) = 0.5 gal/hr x 10 lb/gal x 0.06 = 0.3

Emission rates for the TACs are listed in Table A below.

Table A

Toxic Air Contaminant	**Emission Rate**		
	Qhr(Max.) (lbs/hr)	**Qyr (lbs/yr)**	**QYR (tons/yr)**
Lead	0.056	2.8	0.0014
Hexavalent chromium	0.014	0.7	0.00035
EGEE	0.3	15	0.0075

(The list of TACs and their corresponding emission rates are for illustration purposes only. They may not reflect actual conditions.)

Calculate the MICR and Cancer Burden using the same method as in the previous example. The results of the calculations are:

MICR:

Worker:

TAC	MICR
Lead	7.40×10^{-9}
Hexavalent Chromium	7.64×10^{-6}
Total	$\mathbf{7.65 \times 10^{-6}}$

Resident:

TAC	MICR
Lead	3.57×10^{-9}
Hexavalent Chromium	2.59×10^{-6}
Total	$\mathbf{2.59 \times 10^{-6}}$

Cancer Burden:

CB = 0.20

Hazard Index Calculations

Acute and Chronic Hazard Indices should be calculated for each target organ. The calculation of the acute hazard index for compounds with RELs developed based on 4, 6, or 7 averaging hours is slightly different than the calculation for compounds with RELs developed based on 1 hour average.

Acute Hazard Index:

For all acute compounds with RELs developed based on a 1 hour average, the acute hazard indices are estimated using the equation below:

$$HIA = [Q_{hr} \times (X/Q)_{hr}] / REL$$

For acute compounds with RELs developed based on 4, 6, or 7 hours average, the acute hazard indices are estimated as follows:

$HIA = [(Q_{hr} \times (X/Q)_{hr}) / REL] \times AF$
Where,
AF is REL adjustment factor developed for compounds with REL averaged over 4, 6, or 7 hours and listed in Table 8B or 8C based on the source types (point or volume) and location of the source.

Based on Table 10B, the target organs for the TACs have been listed.

EGEE:
Affects Developmental and Reproductive Systems.
The REL for EGEE is averaged over 6 hours. From Table 8B, the AF for EGEE is 0.83 since it is a point source in West Los Angeles.

Note: The X/Q values in Table 6 are based on the maximum hourly emission rates.
Resident X/Q (1000 m) = 8.3 (ug/m^3)/(lbs/hr)
Worker X/Q (500 m) = 24.8 (ug/m^3)/(lbs/hr)

Note: The acute REL is taken from Table 8A.
Acute REL = 370 ug/m^3

The Acute Hazard Index for EGEE is calculated as follows:

Worker: HIA = [(0.3 x 24.8) / 370] x 0.83 **= 0.017**
Developmental and reproductive systems: 0.017

Resident: HIA = [(0.3 x 8.3) / 370] x 0.83 **= 0.006**
Developmental and reproductive systems: 0.006

Chronic Hazard Index:

HIC = Σ [(QYR) **x** (X/Q)chronic **x** MET **x** MP] / (Chronic REL)]

Based on Table 10A, the target organs for the TACs for chronic have been listed. The Chronic Hazard Indices for the TACs in this example are calculated as follows:

Note: The X/Q values are taken from Table 2A.
Resident X/Q (1000 m) = 0.05 (ug/m^3)/(lbs/hr)
Worker X/Q (500 m) = 0.18 (ug/m^3)/(lbs/hr)

Note: The MET is taken from Table 2B.
MET = 1.00

Hexavalent Chromium
Affects respiratory organs.

Note: The MPs and chronic RELs are taken from Table 8A.
MPr = 1.00; MPw = 1.00
Chronic REL = 2.00 x 10^{-1} ug/m^3

The chronic hazard index for hexavalent chromium is:

Resident: HIC = [0.00035 x 0.05 x 1.00 x 1.00] / [2.00 x 10^{-1}] **= 8.75 x 10^{-5}**
Respiratory system: 8.75 x 10^{-5}

Worker: HIC = [0.00035 x 0.18 x 1.00 x 1.00] / [2.00 x 10^{-1}] **= 3.15 x 10^{-4}**
Respiratory system: 3.15 x 10^{-4}

Ethylene Glycol Ethyl Ether (EGEE)
Affects hematologic systems and reproductive organs.

Note: The MPs and chronic RELs are taken from Table 8A.
MPr = 1.00; MPw = 1.00
Chronic REL = 7.00 x 10^{1} ug/m^3

The chronic hazard index for EGEE is:

Resident: HIC = [0.0075 x 0.05 x 1.00 x 1.00] / [7.00 x 10^{1}] **= 5.36 x 10^{-6}**
Hematologic and reproductive systems: 5.36 x 10^{-6}

Worker: HIC = [0.0075 x 0.18 x 1.00 x 1.00] / [7.00 x 10^{1}] **= 1.93 x 10^{-5}**
Hematologic and reproductive systems: 1.93 x 10^{-5}

In summary:

Acute Hazard Index (HIA) and Chronic Hazard Index (HIC):

By Target Organs for Acute:

(1) Worker:

TAC	HIA	
	REPR	DEV
EGEE	0.017	0.017
Total	**0.017**	**0.017**

(2) Resident:

TAC	HIA	
	REPR	DEV
EGEE	0.006	0.006
Total	**0.006**	**0.006**

By Target Organs for Chronic:

(1) Worker:

TAC	HIC		
	RESP	HEM	REPR
Hexavalent Chromium	3.15×10^{-4}		
EGEE		1.93×10^{-5}	1.93×10^{-5}
Total	$\mathbf{3.15 \times 10^{-4}}$	$\mathbf{1.93 \times 10^{-5}}$	$\mathbf{1.93 \times 10^{-5}}$

(2) Resident:

TAC	HIC		
	RESP	HEM	REPR
Hexavalent Chromium	8.75×10^{-5}		
EGEE		5.36×10^{-6}	5.36×10^{-6}
Total	$\mathbf{8.75 \times 10^{-5}}$	$\mathbf{5.36 \times 10^{-6}}$	$\mathbf{5.36 \times 10^{-6}}$

RESULT:
The spray booth in this example does not contain T-BACT, fails the Rule 1401 MICR limit, and would not be granted a permit. However, if the spray booth was equipped with T-BACT, it would pass the Rule 1401 MICR limit and be granted a permit.

- ***MICRs for residential and commercial receptors exceed 1×10^{-6} (one in one million) but are below 10×10^{-6} (ten in one million).***
- ***Cancer burden is less than 0.5.***
- ***HIAs for residential and commercial receptors do not exceed 1.0 for each target organ.***
- ***HICs for residential and commercial receptors do not exceed 1.0 for each target organ.***

EXAMPLE 4: CONTEMPORANEOUS RISK REDUCTION

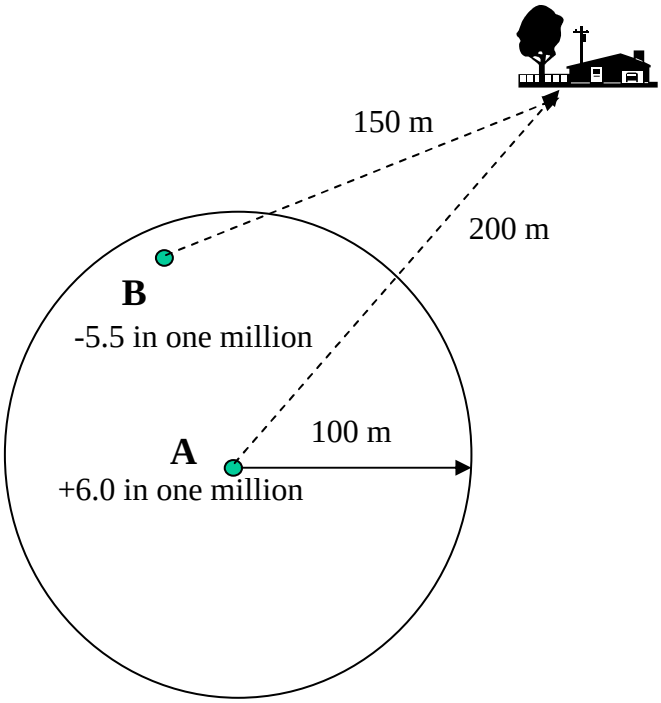
Rule 1401(g)(2)(A): The requirements of paragraph (d)(1) and (d)(4) shall not apply if the applicant demonstrates that a contemporaneous risk reduction resulting in a decrease in emissions will occur such that both of the following conditions are met:

(i) no receptor location will experience a total increase in MICR of greater than one in one million due to the cumulative impact of both the permit unit and the contemporaneous risk reduction, and

(ii) the contemporaneous risk reduction occurs within 100 meters of the permit unit.

T-BACT shall be used on permit units exempted under this subparagraph if the MICR from the permit unit exceeds one in one million (1 x 10^{-6}).

Note: All permit applications associated with the increases and decreases in risk for contemporaneous risk reduction must be submitted together and the reduction in risk must occur before the start of operation of the equipment that will have an increase in risk.



Assumptions:

Units A and B: Only have cancer impacts.

Unit A: New equipment, installed with T-BACT, MICR = 6.0 in one million

Unit B: Existing equipment with decreased MICR of 5.5 in one million due to change in operating conditions or process. Unit B emissions, prior to modification, resulted in an 8 in a million risk for the nearest receptor. After modification, Unit B risk is 2.5 in a million which is a decrease of 5.5 in a million.

Receptor R1: The increased risk for Receptor R1 is the MICR for Unit A less the decrease in risk for Unit B.

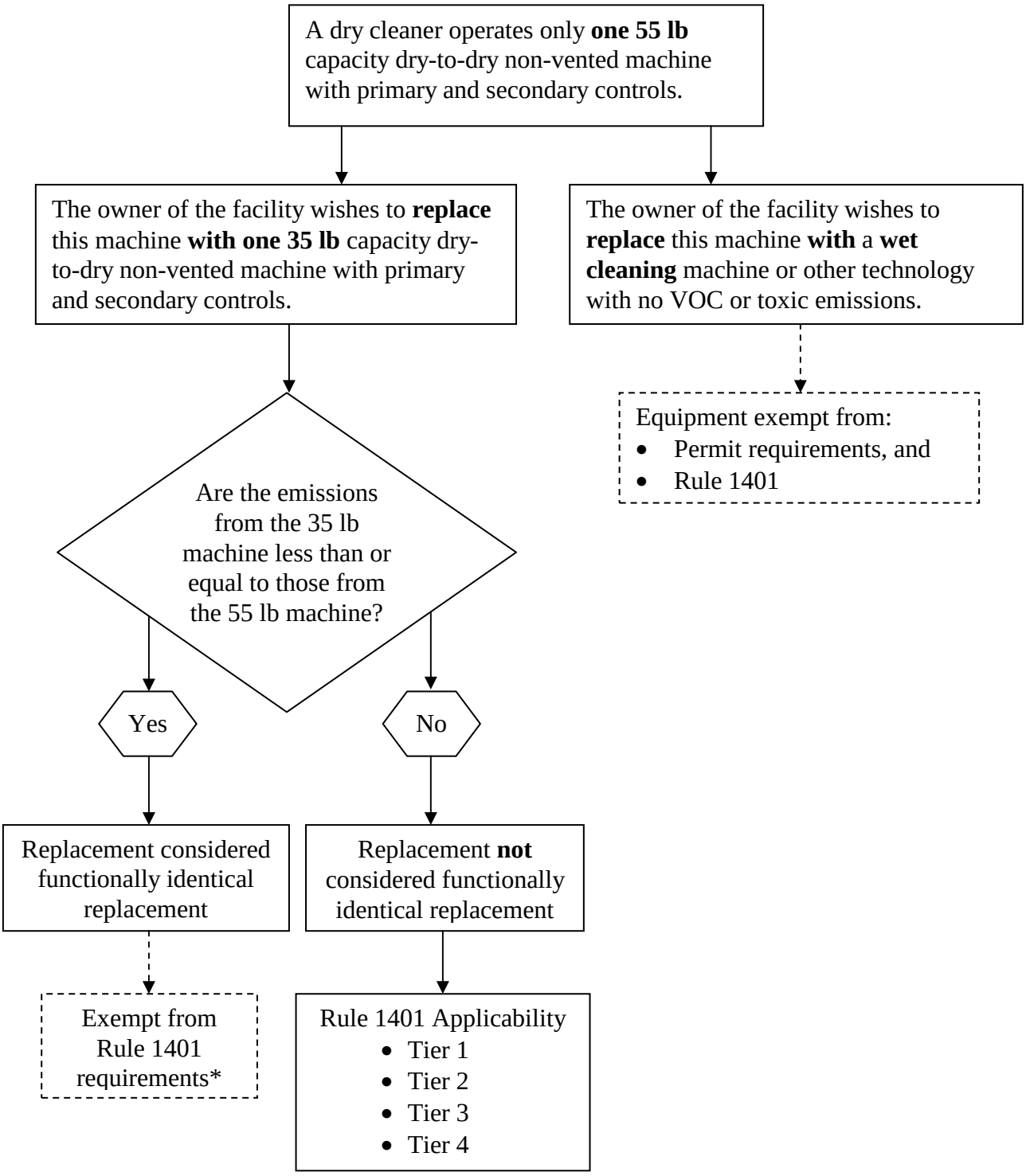
6.0 – 5.5 = **0.5 in one million**.

Note: This demonstaration is best achieved with a Tier 4 analysis (detailed air dispersion modeling) and must be performed for all possible receptors.

RESULT:

- ***Equipment was installed using T-BACT.***
- ***No receptor experiences an increase in risk greater than one in*** *one* ***million.***
- ***The contemporaneous risk reduction occurs within 100 meters of the new equipment.***
- ***If all other rule requirements are met, a permit would be issued.***

EXAMPLE 5: FUNCTIONALLY IDENTICAL EQUIPMENT REPLACEMENT



* Rule 1421(d)(1)(F) allows for the functionally identical equipment replacement of **only one** machine. Please note that all perchloroethylene machines must comply with Rule 1402 as well.

BEST AVAILABLE CONTROL TECHNOLOGY FOR TOXICS

Best Available Control Technology for Toxics (T-BACT) is not required if the MICR is less than or equal to one in one million. If cancer risk is greater than one in one million, T-BACT is required and must reduce risk to less than or equal to 10 in a million.

SIC Codes, which describe industry types or classifications, or SCC Codes, which describe emitting processes or equipment, can be used to help identify T-BACT. If no standard is available, AQMD staff works with the applicant to identify T-BACT when required.

AQMD staff is continually examining and updating control technologies that comply with the definition presented in Rule 1401(c)(2). However, in many situations T-BACT is equivalent to BACT. The applicant is encouraged to contact the AQMD permit processing division for current T-BACT information.

T-BACT EXAMPLES

Type of Industry:	*Petroleum*
Type of Emitting Process:	***Sulfur Recovery Unit***
Specific TAC Emissions:	***Benzene, Formaldehyde***
Applicable BACT:	*Thermal Oxidizer*
T-BACT:	*Thermal Oxidizer*

BACT = T-BACT

With T-BACT, risk is 10 in one million or less

T-BACT is acceptable

Type of Industry:	*Metal Plating*
Type of Emitting Process:	***Nickel Plating, Chromium Plating***
Specific TAC Emissions:	***Nickel, Hexavalent Chromium***
Applicable BACT:	*Wet Scrubber*
T-BACT:	*HEPA*

With T-BACT, risk is 10 in one million or less

T-BACT is acceptable

REFERENCES

Blaisdell, Robert, et. al. 2003. *Air Toxics Hot Spots Program Risk Assessment Guidelines: The Air Toxics Hot Spots Program Guidance Manual for Preparation of Health Risk Assessments.* California Environmental Protection Agency, Office of Environmental Health Hazard Assessment.

Chico, Thomas. 1994. *Development of Modeling and Screening Risk Assessment Procedures for Dry Cleaning Facilities.* South Coast AQMD.

Chico, Thomas. 1994. *Development of Modeling and Screening Risk Assessment Procedures for Volume-Type Sources.* South Coast AQMD.

APPENDIX I

Calculation Worksheets

Maximum Individual Cancer Risk (MICR) Calculation Worksheet
Acute Hazard Index (HIA) Calculation Worksheet
Chronic Hazard Index (HIC) Calculation Worksheet

Maximum Individual Cancer Risk (MICR) CALCULATION WORKSHEET

Facility Name: _____

Facility Address: _____

Description of Equipment: _____

Equipment is (circle one): **Point Source** or **Volume Source**

Toxic Air Contaminants Emitted by Equipment	Maximum Annual Emissions in lb/yr	Maximum Annual Emissions in tons/yr(Qtons)	CP (Table 8A)	MP MICR (Table 8A)	
				Resident	Worker
1.					
2.					
3.					

Equipment operates (circle one) ≤ **12 hr/day** or > **12 hr/day**

If equipment is a **point source**, enter **Stack Height:** _____ ft

If equipment is a **volume source**, enter **Building Height:** _____ ft & **Floor Area:** _____ ft^2

Distance **to nearest residential or sensitive receptor:**_____ m & **off-site worker receptor:** _____ m

Nearest **AQMD meteorological station:** _____ (Table 11 & Fig 1)

Select **X/Q, MET, and AF_{ann} Tables** as follows (circle tables selected)

	Point Source	Volume Source
≤ 12 hr/day	Tables 2A, 2B, 2C	Tables 4A, 4B, 2C
> 12 hr/day	Tables 3A, 3B, 3C	Tables 5A, 5B, 3C

X/Q value for nearest residential/sensitive receptor: _____ for nearest off-site worker receptor: _____

AF_{ann} value for nearest residential/sensitive receptor: 1.0 for nearest off-site worker receptor: _____

MET value _____

DBR value for nearest residential/sensitive receptor: 302 (Table 9A)

DBR value for nearest off-site worker receptor: 149 (Table 9A)

EVF value for nearest residential/sensitive receptor: 0.96 (Table 9B)

EVF value for nearest off-site worker receptor: 0.38 (Table 9B)

MICR CALCULATION

TACs	CP		Q_{tons}		X/Q		AF_{ann}		MET		DBR		EVF		10^{-6}		MP		MICR
1.		x		x		x		x		x		x		x	10^{-6}	x		=	
2.		x		x		x		x		x		x		x	10^{-6}	x		=	
3.		x		x		x		x		x		x		x	10^{-6}	x		=	
4.		x		x		x		x		x		x		x	10^{-6}	x		=	

MICR =_____

Acute Hazard Index (HIA) CALCULATION WORKSHEET

Target Organ: _____

Facility Name: _____

Facility Address: _____

Description of Equipment: _____

Equipment is (circle one): **Point Source** or **Volume Source**

If equipment is a **point source**, enter:

Stack Height: _____ ft

If equipment is a **volume source**, enter

Building Height: _____ ft & **Floor Area**: _____ ft^2

Distance **to nearest residential or sensitive receptor:** _____ meters

Distance to **nearest off-site worker receptor**: _____ meters

Nearest **AQMD meteorological station:** _____

Select **X/Q_{hr}:** _____

Select **AF** for compounds with 4, 6, or 7 hour averaging times: _____

Select **X/Q_{hr}** from Table 6 if Point Source or from Table 7 if Volume Source

Select **Acute REL** from Table 8A

Select **AF** from Table 8B if Point Source or from Table 8C if Volume Source

Toxic Air Contaminants Emitted by Equipment	Maximum Hourly Emissions in lb/hr	Peak Hourly Dispersion Factor X/Q-hr	Acute Reference Exposure Level (REL)	Adjustment Factor (AF)
1.				
2.				
3.				

ACUTE HAZARD INDEX (HIA) CALCULATION:

$[Qhr \times (X/Q)_{hr}] / (Acute\ REL) \times AF$

Contaminants	Q_{hr}		X/Q-hr		REL		AF		HIA
1.		**x**		/		**x**		=	
2.		**x**		/		**x**		=	
3.		**x**		/		**x**		=	

Chronic Hazard Index (HIC) CALCULATION WORKSHEET

Target Organ: _____

Facility Name: _____

Facility Address: _____

Description of Equipment: _____

Equipment operates (circle one) ≤ **12 hr/day** or > **12 hr/day**

Equipment is (circle one): **Point Source** or **Volume Source**

If equipment is a **point source**, enter:

Stack Height: _____ ft

If equipment is a **volume source**, enter

Building Height: _____ ft & **Floor Area**: _____ ft^2

Distance **to nearest residential or sensitive receptor:** _____ meters

Distance to **nearest off-site worker receptor**: _____ meters

Nearest **AQMD meteorological station:** _____

Select **X/Qyr and MET Tables** as follows (circle tables selected)

	Point Source	Volume Source
≤ 12 hr/day	Tables 2A and 2B	Tables 4A and 4B
> 12 hr/day	Tables 3A and 3B	Tables 5A and 5B

Select **Chronic REL** and **MP Chronic** from Table 8A

Toxic Air Contaminants Emitted by Equipment	Maximum Annual Emissions in lb/yr	Maximum Annual Emissions in tons/yr (Qyr)	Dispersion Factor (X/Q)	Chronic Reference Exposure Level (REL)	Meteorological Correction Factor (MET)	Multi-pathway Factor Chronic (MP Chr)
1.						
2.						
3.						

CHRONIC HAZARD INDEX (HIC) CALCULATION:

Σ [(Qyr) x (X/Q) x MET x MP] / (Chronic REL) for each TAC

Contaminants	Qyr		X/Q		MET		MP		REL		TAC
1.		**x**		**x**		**x**		/		=	
2.		**x**		**x**		**x**		/		=	
3.		**x**		**x**		**x**		/		=	

APPENDIX II

Derivation of Tier 2 Multi-pathway Adjustment Factors (MP) and Meteorological Correction Factors (MET)

DERIVATION OF TIER 2 MULTI-PATHWAY ADJUSTMENT FACTORS (MP)
AND METEOROLOGICAL CORRECTION FACTORS (MET)

MULTI-PATHWAY FACTORS (MP)

Toxic air contaminants enter the body through a number of routes: inhalation; absorption through the skin; and ingestion from contaminated food, water, milk and soil. To account for uptake of toxics through routes of exposure other than inhalation, risk assessments often include a "multi-pathway" exposure analysis.

To simplify the screening risk assessment, multi-pathway adjustment (MP) factors were developed. The inhalation risk is multiplied by the MP factors to account for the additional health risk due to other pathways of exposure.

AQMD staff has previously developed multi-pathway factors in its risk assessment and screening procedures. For this update of the risk assessment procedures, the methodology has been updated and multi-pathway factors have been developed for additional compounds.

The MP factors were developed using the Hotspots Analysis and Reporting Program (HARP), version 1.0 (build 21.09.03), a computer software package combining the tools of emission inventory database, facility prioritization, air dispersion modeling, and risk assessment analysis. Assumptions and parameters used to develop the MP factors are listed below:

Dispersion model options:

- Use Regulatory Default – No
- Rural or Urban – Urban
- Gradual Plume Rise – Yes
- Stack Top Downwash – Yes
- Buoyancy Induced Dispersion – Yes
- Calms Processing – No
- Emission rate = 1 pound per year

Risk assessment options:

- Deposition velocity – 0.02 m/sec
- Fraction of homegrown fruits and vegetables consumed – 5.2%
- For noncancer chronic risk estimates, the "Derived (OEHHA)" risk analysis method is used. In this approach, the two dominant (driving) exposure pathways use the high-end point-estimates of exposure, while the remaining exposure pathways use average point estimates.
- For cancer risk estimates, the "Derived (Adjusted)" risk analysis method is used. This method is identical to the "Derived (OEHHA)" method discussed above with one

exception. The "Derived (Adjusted)" method uses the breathing rate at the 80th percentile of exposure rather than the high-end point-estimate when the inhalation pathway is one of the dominant exposure pathways.

- The cancer risk estimates, including the Derived equations (both OEHHA and Adjustsed), are based on 70-year exposures.
- Pathways considered for residential exposure include inhalation, soil ingestion, dermal absorption, homegrown produce, and mother's milk.
- Pathways considered for worker exposure include inhalation, soil ingestion, and dermal absorption.
- The chronic multipathway factors (resident and worker) for the group listing of polychlorinated biphenyls (CAS number 1336-36-3) has been assigned those of its individual subspecies (18.08 and 10.27, respectively). (The group listing of PCBs does not include the Toxicity Equivalency Factors as developed by the World Health Organization 1997 and as adopted by the Office of Environmental Health Hazards Assessment in 2003.)

METEOROLOGICAL CORRECTION FACTORS (MET)

In order to derive the meteorological correction (MET) factors, detailed air dispersion modeling was performed for all 35 AQMD meteorological stations. It was noted that West Los Angeles (Figure 1) generally yielded the highest concentrations at every downwind distance. MET correction factors were developed for the other 34 meteorological stations by dividing their predicted concentrations by those for West Los Angeles, with the highest factor chosen among the receptors at 50, 75, and 100 meters for each station.

APPENDIX III

PROCEDURES FOR ADDRESSING NON-DETECTED COMPOUNDS AND BLANKS IN RISK ASSESSMENT

Procedures for Addressing Non-detected Toxic Air Contaminants and Blanks in Risk Assessment

INTRODUCTION

This appendix describes guidelines for estimating emissions of non-detected toxic air contaminants (TACs) and using blanks in emissions estimations for purposes of preparing health risk assessments for Rules 1401, 1402 and the Air Toxics "Hot Spots" program (AB 2588). Procedures are the same for preparing risk assessments for Rules 1401, 1402 and AB2588, however the lists of compounds are different. Rule 1401 uses only cancer potency factors (CPc) and reference exposure levels (RELs) approved by the Scientific Review Panel and prepared by the state Office of Environmental Health Hazard Assessment (OEHHA), whereas Rule 1402 and AB2588 use different sources for CPs and RELs, including draft numbers.

Under previous policy, the AQMD required that if a TAC could be present in emissions from a source but not detected during air testing, it must be assumed to be present below the limit of detection (LOD). This approach has been applied to stack testing, to measurements such as laboratory analysis of materials, and other monitoring and measurement methods. The concentration of non-detected TACs were to be reported as one-half (1/2) of the LOD.

Concerns were raised that this policy of carrying undetected TACs through a health risk assessment at half of the LOD could inflate risk estimates and might require facilities to install control equipment for emissions that may not be present. In addition, it would not be possible to detect the TAC after its emissions had been controlled and reduced.

Also, in the past, the AQMD did not allow any adjustments in the measured values of samples based on the results of reagent blanks. Concerns were raised that in certain cases the concentration of TACs measured in reagent blanks should be deducted from the actual measured samples.

To address these concerns, AQMD staff worked closely with affected facilities such as publicly owned treatment works (POTWs) and others during previous rulemaking efforts for Rules 1401 and 1402 to develop guidelines for addressing non-detected TACs and blanks in risk assessment.

OVERVIEW

The new approach begins with an initial level of screening to determine whether or not a TAC is likely to be present and therefore should be tested for. If the conditions in the screening guidelines are met, no further testing or analysis is required. If a TAC does not pass the screening guidelines, the facility must quantify and report the emissions of the compound through testing or other methods as approved by AQMD staff. The reported emission levels are calculated based on the number of test runs or analyses that are below the LOD.

SCREENING GUIDELINES

For a TAC to be excluded from testing or analysis and hence quantification for health risk assessment, it must meet either condition A, B, or C listed below.

Proof for exclusion of any TAC based on literature studies on physical nature or chemistry of the compounds to substantiate the findings, and any prior analysis or testing shall be deemed complete for AQMD approval. Any prior testing must have been conducted according to AQMD's approved test methods or other recognized standards, as approved by AQMD staff.

If a list of TACs to be tested for is agreed upon but is subsequently discovered by the facility or the AQMD that additional compounds may be present, AQMD staff may require that the facility test for the presence of the additional TACs.

The screening criteria to be used for determining the presence of TACs are the following.

Condition A: No likelihood of the presence of a TAC

A facility may choose to demonstrate that there is no likelihood of a TAC being present in the raw materials, process streams or materials introduced into the equipment or process. The methodology or documentation to show proof of the non-existence of the TAC must be deemed complete with the source test protocol or test method analysis protocol for AQMD approval. If the evidence to substantiate the absence of a TAC is insufficient, or AQMD staff has reason to believe that the TAC may be present, it must be tested for and quantified (see Cases 1, 2, and 3).

For example, a facility operator can demonstrate the absence of cadmium in emissions from the melting of lead ingots in a pot furnace by presenting the following documentation:

- Certified analysis of the lead ingots showing that cadmium is not a constituent of the ingot.
- Description of the process substantiating that no other material is added to the furnace that will contribute to cadmium emissions. The operator must also provide analysis for the fuel used in the process to demonstrate that it does not contain cadmium.
- Documentation substantiating that melting lead ingots without cadmium present in the ingot in a pot furnace will not result in the emissions of cadmium when the firebricks or pot liner are heated during the melting operations.

In addition, the facility operator may submit test results based on tests performed within the last two years, or a longer period if the facility can demonstrate that no significant changes have occurred to the AQMD-approved test method, process equipment or process materials, that indicate cadmium was reported as below LOD.

Condition B: Absence of a TAC or its precursors in the process

If there is any evidence that precursors, which could lead to formation of a TAC during a process or reaction, may be present, then a facility may have to test for the TAC. To be excluded from testing and quantification requirements, the facility must provide documentation to demonstrate, based on test results, that none of the essential precursors are present in the material or process. This is similar to the previous criteria and differs only in that precursor compounds that could contribute to the formation of the subject TAC must also be identified as not being present.

An example is emission of dioxins from a waste incinerator. In this case, test data may be available to show that there are no dioxins present in the waste stream being incinerated. However, the presence of chlorine and hydrocarbons in the combustion process could result in the formation of products of incomplete combustion (PICs) such as dioxins or other toxic compounds. Testing for these compounds would be required unless the facility operator demonstrates that none of the essential precursors are present in the waste stream or the process itself.

Condition C: Special TAC list for POTWs

Unlike other industrial sources whose potential toxic air emissions are relatively well defined and which contain limited species, proving the absence of TACs from emissions from POTWs is more difficult. This is because the instantaneous discharge of wastewater from various residential, commercial and industrial system users could potentially result in the presence of different toxic contaminants in the influent sewage. Therefore, it is recommended that a special TAC list be developed for POTWs to select appropriate TACs for testing and determination of health risk associated with air emissions from liquid phase and sludge treatment processes.

The special TAC list for POTWs will be approved by AQMD staff with consideration given to information including but not limited to the following:

1. The Pooled Emission Estimating Program (PEEP) identified and selected compounds under the AB 2588 emissions inventory program, as approved by AQMD staff.

2. The Joint Emissions Inventory Program (JEIP) identified and selected compounds under AQMD Rule 1179 inventory requirements, as approved by AQMD staff.

3. TACs that have a reasonable likelihood of being present in the air emissions of POTWs, based on other test results or information sources, as approved by AQMD staff.

Additionally, based on the specific sources of sewage for certain POTWs, specific TACs in addition to the ones identified through the above steps could be added or deleted from the list on a case-by-case basis.

Based on the special TAC list for POTWs as developed from the above procedure and subject to approval by AQMD staff, facilities will be required to quantify the listed compounds through testing or other methods approved by AQMD staff for inclusion in the health risk assessment. The facility will not have to test for compounds not included in the special TAC list for POTWs, and the inclusion of non-listed TACs in the health risk assessment is not required. However, if after the industry-specific list is developed and approved, the facility or the AQMD later discovers information that additional TACs may be present, AQMD staff may revise the industry-specific list and may require the facility to quantify emissions of such TACs that were previously excluded from quantification.

QUANTIFICATION OF EMISSIONS BASED ON SOURCE TEST RESULTS

The cases listed below explain the process for quantification of emissions based on the source test results.

Treatment of Test Runs Below LOD

If some test runs are below LOD, quantification of the TAC depends on the percent of the test runs and analyses that are below LOD. Three possible scenarios are discussed below. In all of these cases, all of the following three conditions must be met:

1. All tests should be performed using AQMD-approved test methods, triplicate sample runs and AQMD-approved detection limits. When non-detected values are reported, the actual analytical limit of detection for all runs and the number of sample runs shall be reported; and

2. The data from the analyses or tests were obtained within a period of two (2) years prior to the time the data is to be used by AQMD staff, unless the facility demonstrates to the AQMD's satisfaction that earlier test data remain valid due to lack of significant changes in test methods, process equipment or process materials; and

3. For cyclic operations or variations in feedstock, the tests or analyses conducted should be representative of the variations in loads, feed rates and seasons, if applicable. In such cases, an adequate number of test runs should be conducted for all cyclic or seasonal operations.

Case #1: TAC is not detected in any test runs or analyses

In situations in which all test runs and analyses consistently indicate levels below the LOD, the compound can be identified as "not detected" and its inclusion in the health risk assessment will not be required, provided all three conditions listed above are met.

Case #2: TAC is detected in less than 10% of the test runs or analyses

In situations in which a compound has been detected and the percentage of samples in which it is detected is less than ten percent, and provided that all three conditions listed above are met, the following procedure shall be used to average the results:

1. For those runs or analyses that were below LOD, assign zero.
2. Average the measured values obtained for the runs that were above LOD with zero values for the runs below LOD and report the final average result for use in the risk estimation.

Case #3: TAC is detected in 10% or more of the test runs or analyses

In cases in which ten or more percent of the test runs and analyses show measured values of a TAC above the LOD, and provided that all three condition listed above are met, the following procedure shall be used to average the results:

1. For those runs or analysis that were below LOD, assign one half (1/2) of the corresponding LOD for each run.
2. Average the measured values obtained for the runs that were above LOD with 1/2 LOD values for the runs below LOD and report the final average result for use in the risk estimation.

In cases in which there are fewer than ten samples (for example, two triplicate samples have been taken) and a TAC has been detected in one or more samples, the following procedures shall be used.

- If the TAC is detected in one sample, use Case #2.
- If the TAC is detected in two or more samples, use Case #3.

Use of Reagent Blanks

Reagent blank values may be subtracted from sample values under the conditions specified below. In order to use these procedures, it will be necessary to obtain from AQMD staff, prior to the test or analyses, a determination as to the maximum allowable value for the blank.

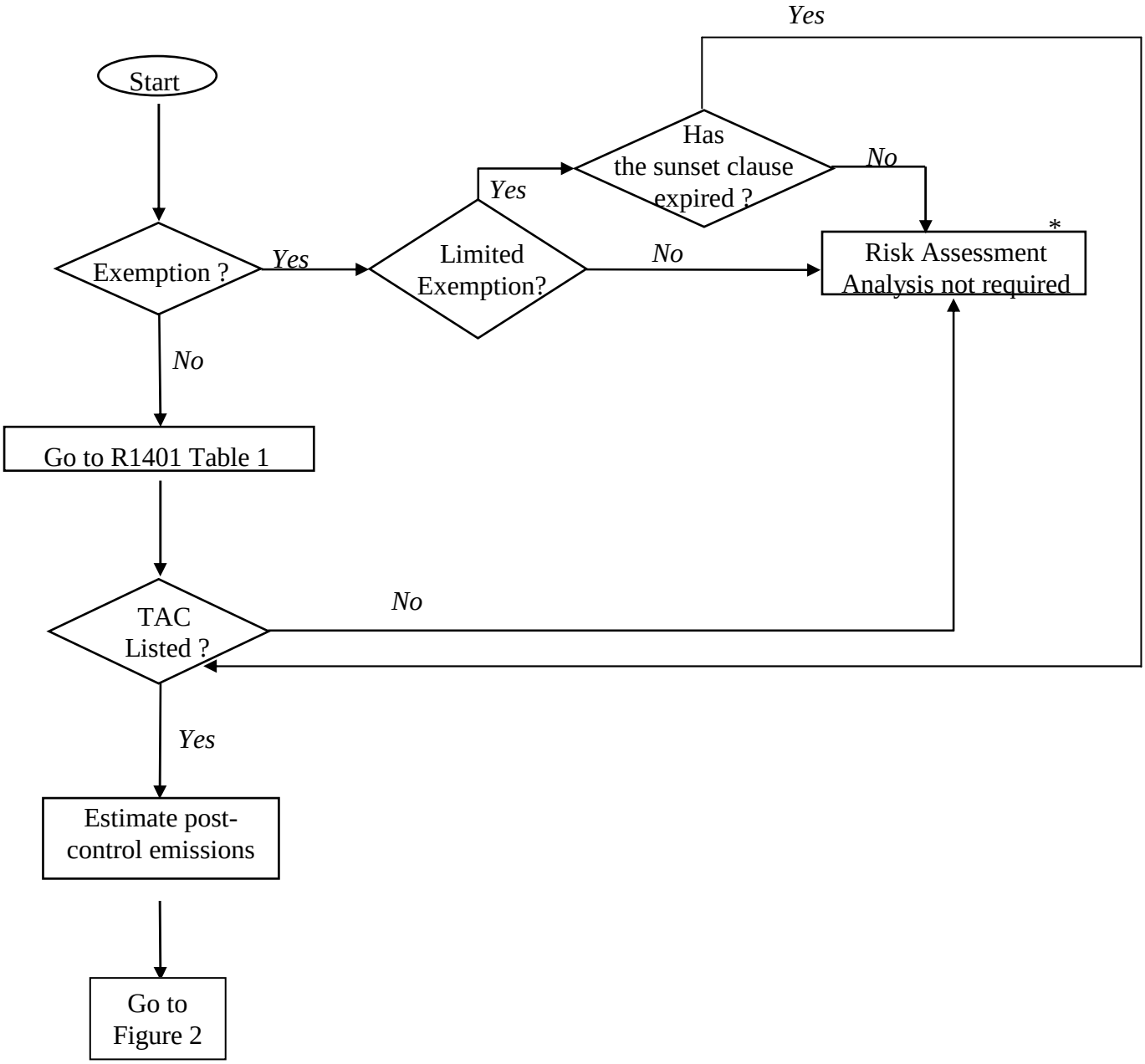
If the level of the TAC in the reagent blank is less than or equal to the maximum allowable blank, the reagent blank may be subtracted. The data must be reported with and without the correction. If the level of the TAC in the reagent blank is greater than the maximum allowable blank and the concentration of the sample is greater than 3 times the reagent blank value, then the maximum allowable reagent blank value can be subtracted. The data must be reported with and without correction.

APPENDIX IV

FLOW CHARTS AND DIAGRAMS

Note: The reader needs to ascertain the date in which the subject equipment's permit application was deemed complete. This date is used to identify the correct set of permitting tables (see Attachments) to be used for permit processing.

Figure 1
Preliminary Tasks



* Consult with AQMD staff for other TACs not listed in Table 1, which potentially endanger public health or may require a Rule 212 evaluation.

Figure 2
Tier 1 - Screening Levels

Tier 1 involves comparing emissions or source specific units from a piece of equipment to Screening Levels

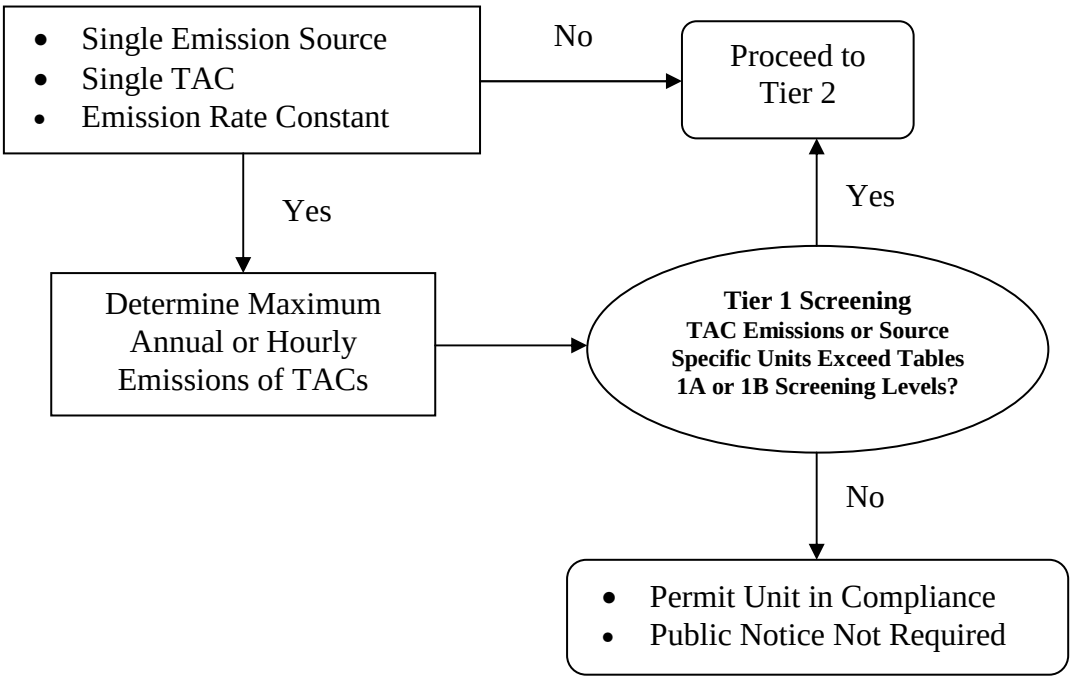
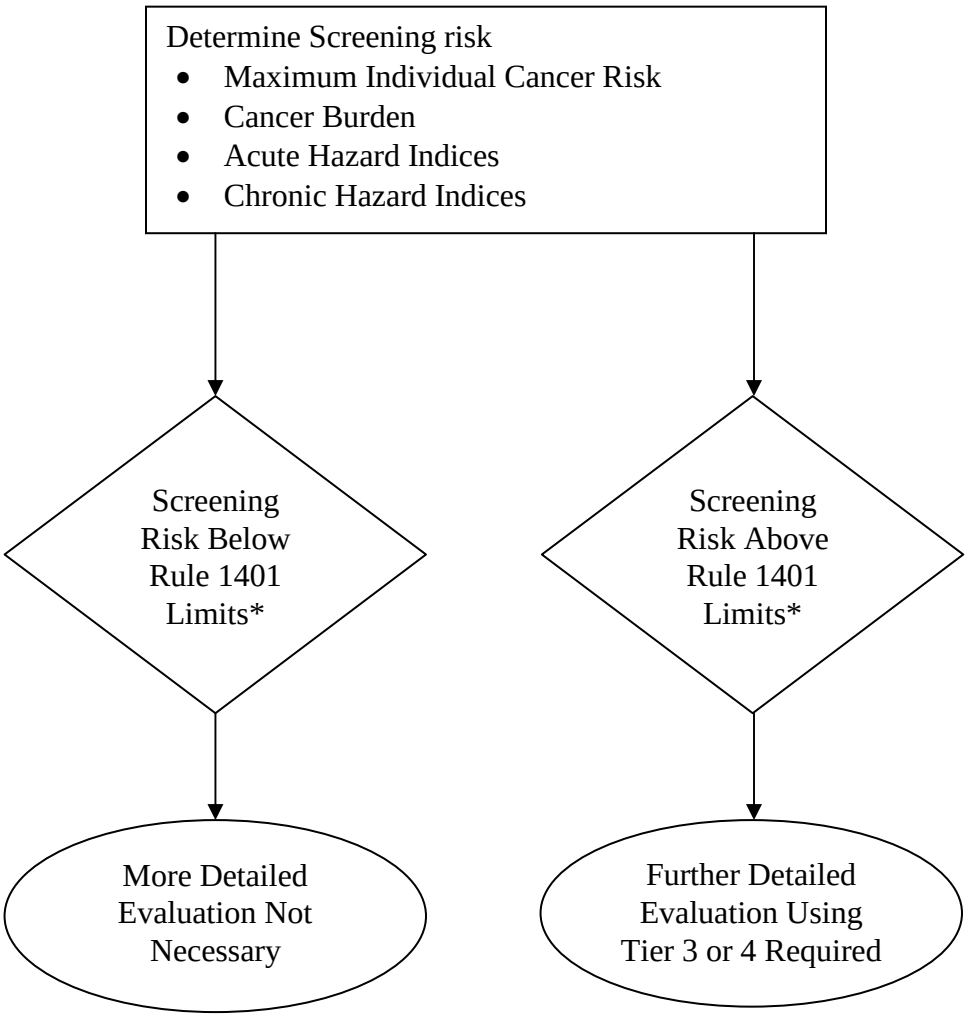


Figure 3A
Tier 2 - Screening Levels

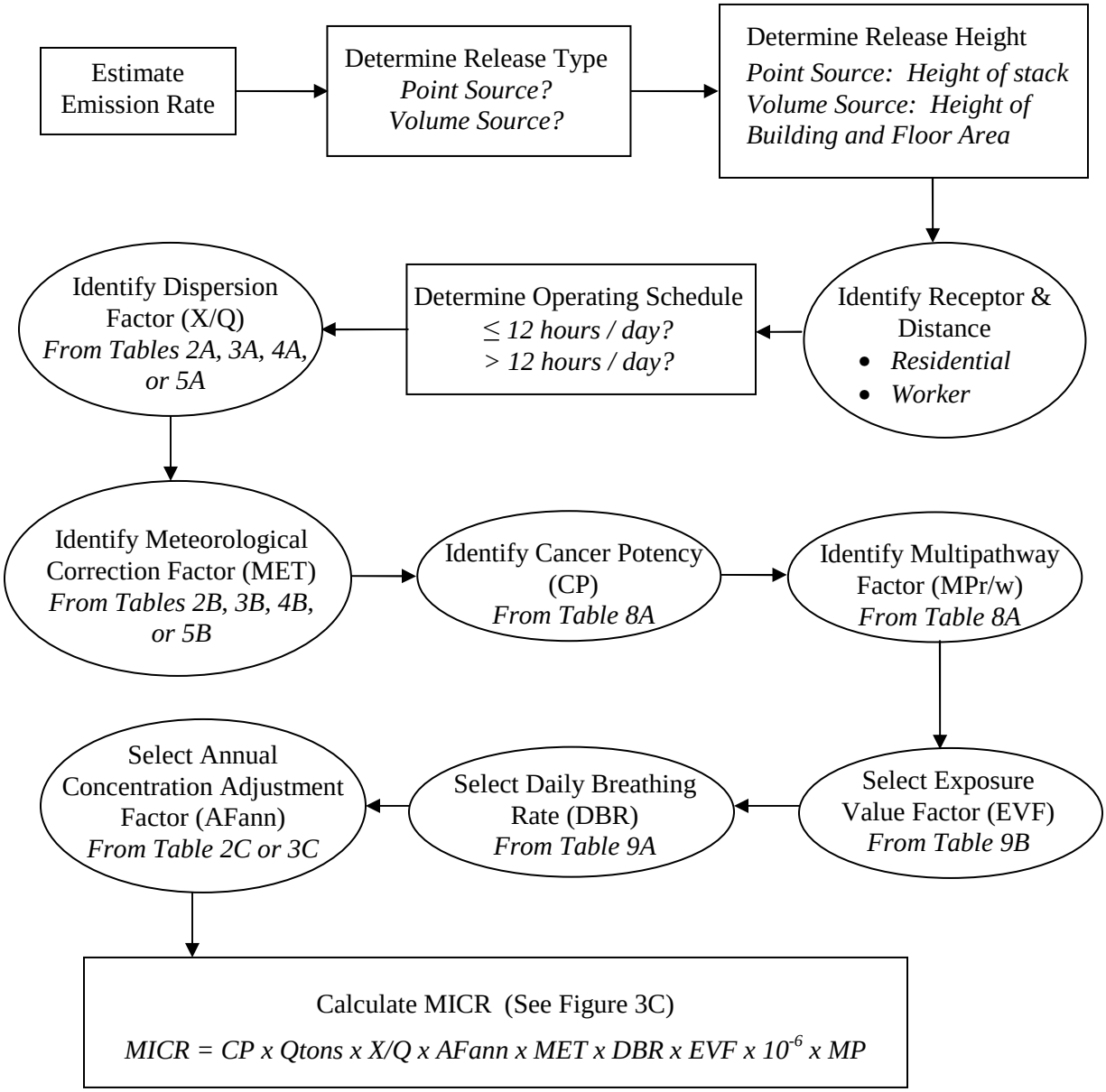
Tier 2 is a screening risk assessment, which includes procedures for determining level of risk from MICR, Cancer Burden, and Acute & Chronic Hazard Indices



* *Level of Concern:*

- *MICR exceeds one in one million with no T-BACT*
- *MICR exceeds 10 in one million with T-BACT*
- *Cancer burden exceeds 0.5*
- *HIA or HIC exceeds 1 for any target organ system*

Figure 3B
Tier 2 - Maximum Individual Cancer Risk (MICR) Calculation



If MICR exceeds one in one million, cancer burden must also be estimated.
(See Figure 4.)

Figure 3C
Tier 2 - Maximum Individual Cancer Risk (MICR) Equation

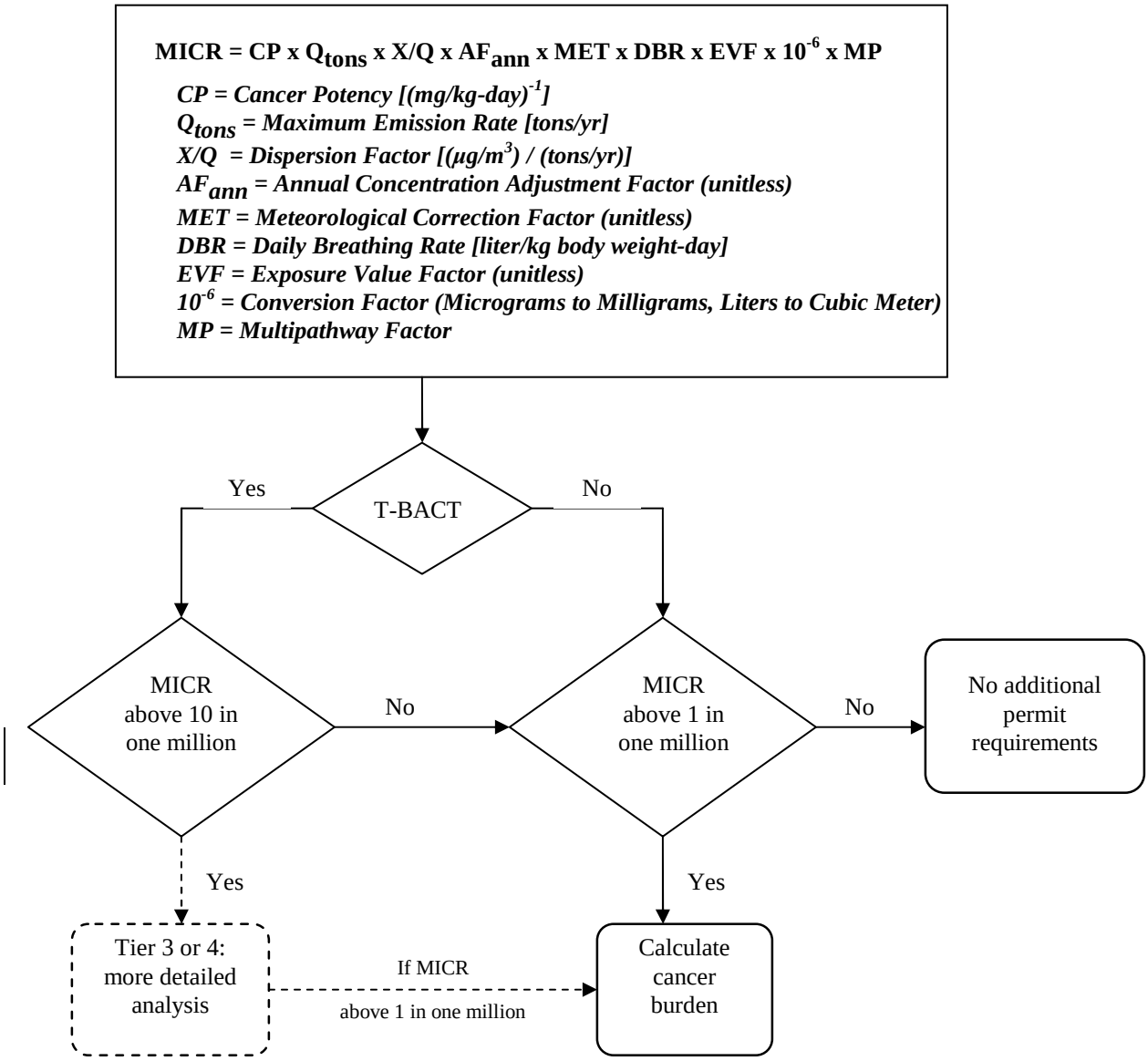


Figure 3D
Tier 2 - Dispersion Factor

Dispersion Factor (X/Q): Numerical estimates of the amount of decrease in concentration of a contaminant as it travels away from the site of release.

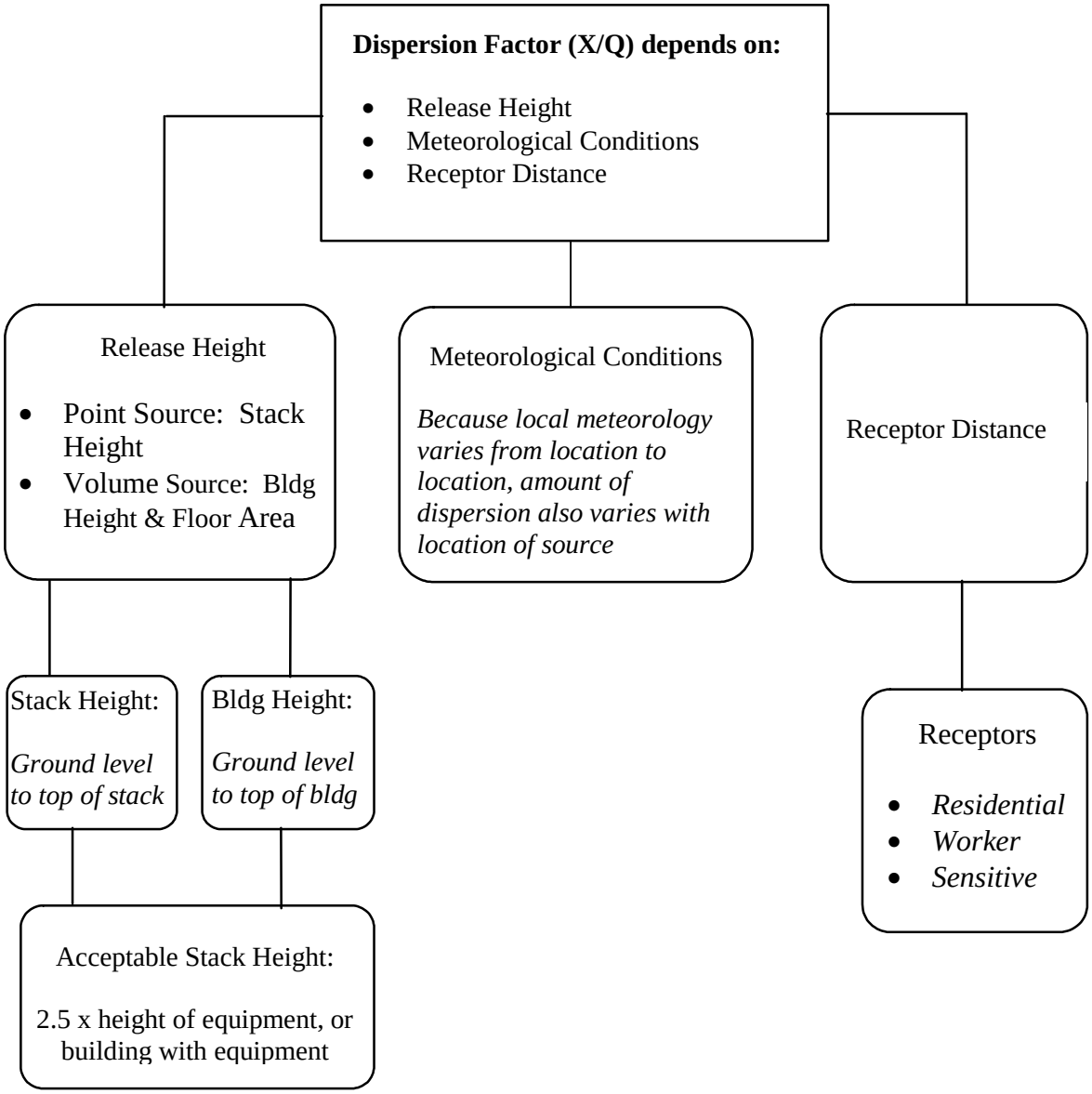


Figure 3E
Tier 2 - Cancer Potency Factor

Cancer Potency Factor (CP)

Cancer Potency Factor (CP)

- *Measure of the cancer potency of a carcinogen*

- *Estimated probability that a person will contract cancer due to inhalation of 1 milligram per kilogram of body weight of TAC continuously over period of 70 years*

Figure 3F
Tier 2 - Multi-pathway Adjustment Factor

Multi-pathway Adjustment Factor (MP)

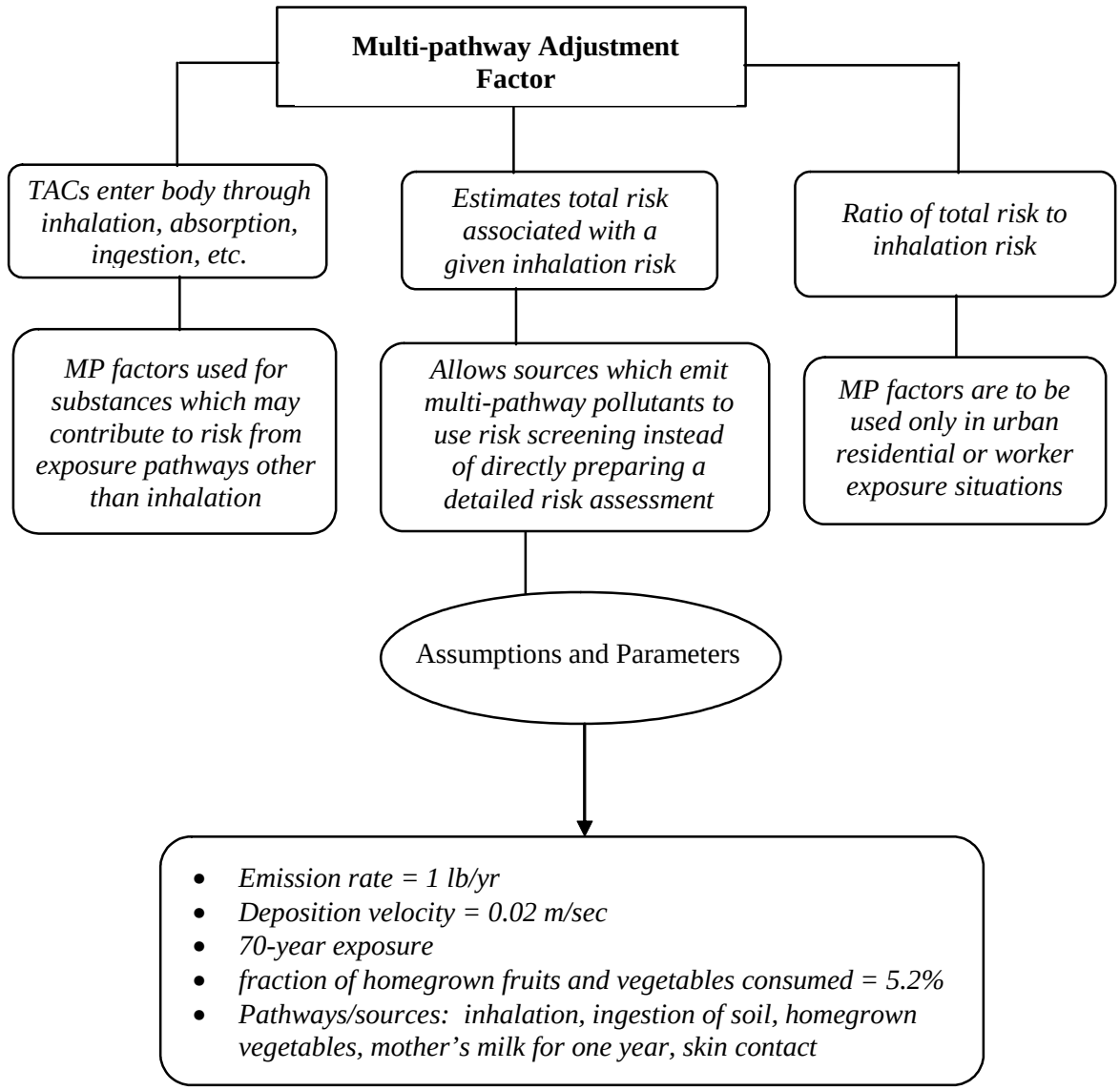


Figure 3G
Tier 2 - Exposure Value Factor

Exposure Value Factor (EVF)

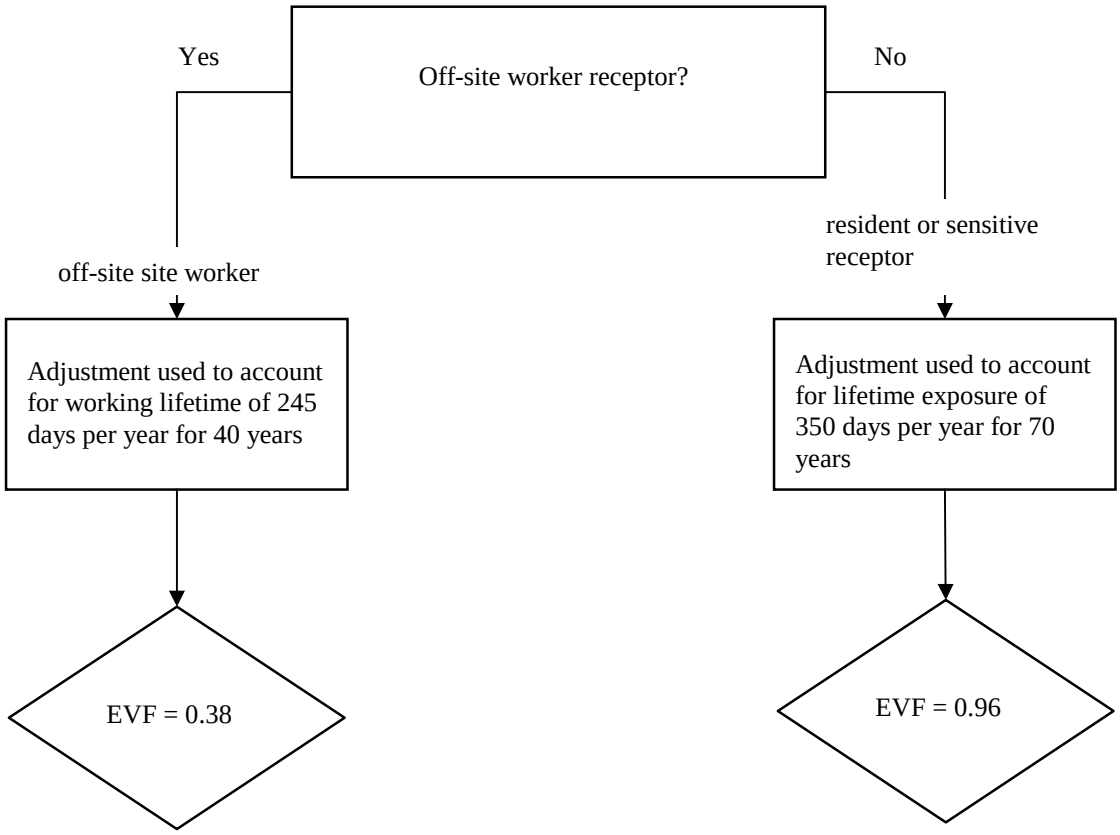


Figure 3H
Tier 2 - Daily Breathing Rate

Daily Breathing Rate (DBR)

Daily Breathing Rate (DBR)

- *Amount of air inhaled*
- *Used to determine the dose of a substance inhaled*

Figure 3I
Tier 2 - Annual Concentration Adjustment Factor

Annual Concentration Adjustment Factor (AF_{ann})

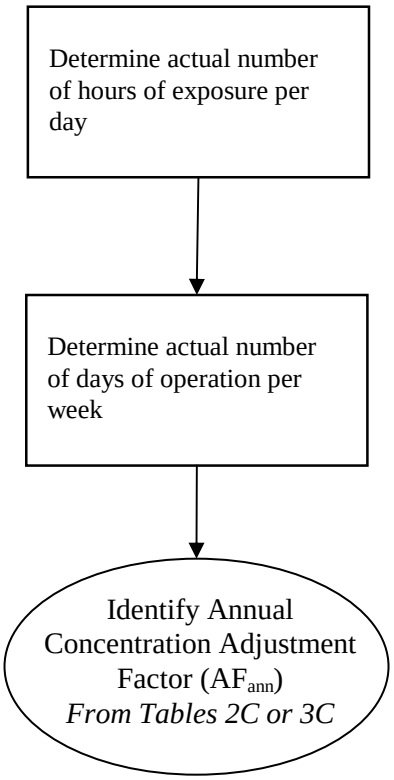


Figure 4
Cancer Burden

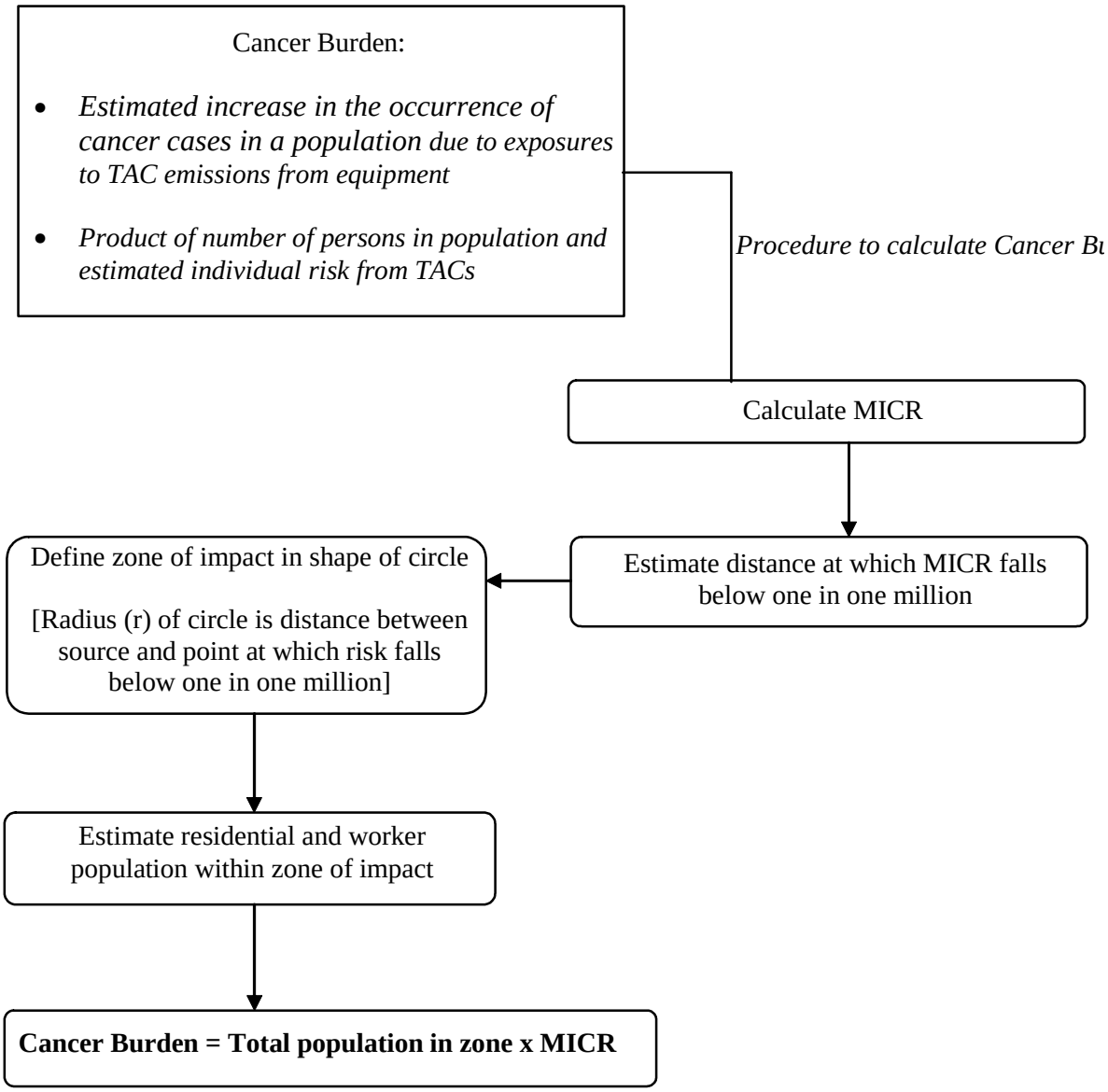
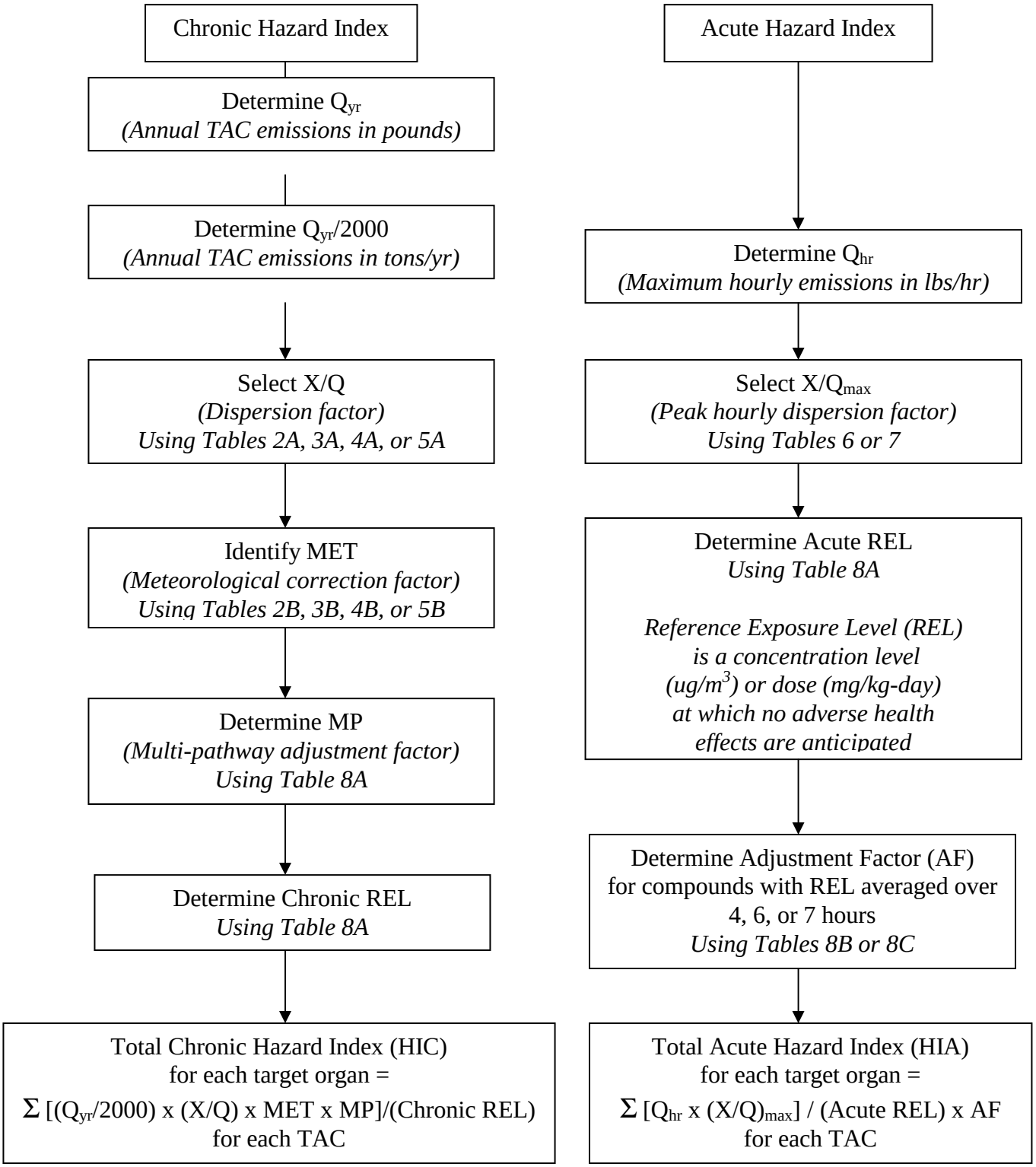


Figure 5
Chronic and Acute Hazard Index (HIC and HIA)



APPENDIX V

RULE 1401 EXEMPTION PROVISIONS

Exemption Provisions

Rule 1401 (g)(1)(A): Permit Renewal or Change of Ownership

Any equipment which is in continuous operation, without modification or change in operating conditions, for which a new permit to operate is required solely because of permit renewal or change of ownership.

Rule 1401 (g)(1)(B): Modification with No Increase in Risk

A modification of a permit unit that causes a reduction or no increase in the cancer burden, MICR or acute or chronic HI at any receptor location.

Rule 1401 (g)(1)(C): Functionally Identical Replacement

A permit unit replacing a functionally identical permit unit, provided there is no increase in maximum rating or increase in emissions of any toxic air contaminants. For replacement of dry cleaning permit units only, provided there is no increase in any toxic air contaminants.

Rule 1401 (g)(1)(D): Equipment Previously Exempt Under Rule 219

Equipment which previously did not require a written permit pursuant to Rule 219 that is no longer exempt, provided that the equipment was installed prior to the Rule 219 amendment eliminating the exemption and a complete application for the permit is received within one (1) year after the Rule 219 amendment removing the exemption.

Rule 1401 (g)(1)(E): Modifications to Terminate Research Projects

Modifications restoring the previous permit conditions of a permit unit, provided that: the applicant demonstrates that the previous permit conditions were modified solely for the purpose of installing innovative control equipment as part of a demonstration or investigation designed to advance the state of the art with regard to controlling emissions of toxic air contaminants; the emission reductions achieved by the demonstration project are not used for permitting any equipment with emission increases under the contemporaneous emission reduction exemption as specified in paragraph (g)(2); the demonstration project is completed within two (2) years; and a complete application is submitted no later than two (2) years after the date of issuance of the permit which modified the conditions of the previous permit for the purpose of the demonstration or investigation.

Rule 1401 (g)(1)(F): Emergency Internal Combustion Engines

Emergency internal combustion engines that are exempted under Rule 1304.

Rule 1401 (g)(1)(G): Wood Product Stripping

Wood product stripping permit units, provided that the risk increases due to emissions from the permit unit owned or operated by the applicant for which complete applications were submitted on or after July 10, 1998 will not exceed a MICR of 100 in one million (1.0×10^{-4}) or a total acute or chronic hazard index of five (5) at any receptor location. This exemption shall not apply to permit applications received after January 10, 2000, or sooner if the Executive Officer makes a determination that T-BACT is available to enable compliance with the requirements of paragraphs (d)(1), (d)(2) and (d)(3).

Rule 1401 (g)(1)(H): Gasoline Transfer and Dispensing Facilities (Expired)

For gasoline transfer and dispensing facilities, as defined in Rule 461 – Gasoline Transfer and Dispensing, the Executive Officer shall not, for the purposes of paragraphs (d)(1) through (d)(5), consider the risk contribution of methyl tert-butyl ether for any gasoline transfer and dispensing permit applications deemed complete on or before December 31, 2003. If the state of California extends the phase-out requirement for methyl tert-butyl ether as an oxygenate in gasoline, the limited time exemption shall be extended to that expiration date or December 31, 2004, whichever is sooner.

Rule 1401 (g)(2): Contemporaneous Risk Reduction

Simultaneous risk reduction such that an increase in MICR or HI from a equipment will be mitigated by a risk reduction from another equipment within 100 meters and the net impact on any receptor will be less than or equal to an increased MICR of 1 in 1 million or an HI of 1, provided that both applications for the increase and decrease are deemed complete together, the risk reduction occurs first, and the reduction is enforceable.

ATTACHMENTS

PERMIT APPLICATION PACKAGES
INCLUDING TABLES

**(Note: Attachment L,
EFFECTIVE FOR APPLICATIONS DEEMED COMPLETE
ON OR AFTER July 1, 2005)**

EXHIBIT D

Recommended Methods for Screening and Modeling Local Risks and Hazards

Bay Area Air Quality Management District
939 Ellis Street
San Francisco, CA 94109

May 2011

Version 2.0

EXECUTIVE SUMMARY

The purpose of the "Recommended Methods for Screening and Modeling Local Risks and Hazards" (document) is to assist lead agencies in conducting a risk and hazard analysis as part of their CEQA environmental review for proposed land use projects. The Report provides detailed guidance on how to screen projects for potential risk and hazards impacts and, if necessary, how to conduct site-specific computer modeling.

This document compliments and helps implement the Bay Area Air Quality Management District's (BAAQMD or District) 2010 CEQA Guidelines (Guidelines) and thresholds of significance for particulate matter and toxic air contaminants (TACs). The thresholds were developed to encourage focused infill development in the region, reduce vehicle emissions, and protect public health by raising awareness regarding the effects of siting people near existing and/or new sources of toxic air containments. The Guidelines also outline a methodology for analyzing potential risk and hazard impacts to sensitive receptors from proposed land use developments. This document, used in conjunction with the Guidelines, provides greater detail on how to perform preliminary screening, and if needed, detailed computer modeling of potential risk and hazard impacts from a new source of toxic emissions on existing receptors, or from existing sources of toxic emissions to new receptors.

When applying the methods presented in this document, the user should first apply the recommended screening process to their proposed project to determine whether air quality modeling is necessary. The screening tools are described in Section 3.0. For new receptor projects, lead agencies should review the risks from nearby roadways, freeways, and stationary sources. This document describes in detail how to screen for potential risk and hazards from TAC sources using the following tools:

- **Surface Street Screening Tables:** Through the use of computer models, the District estimated particulate matter equal to or less than 2.5 microns in diameter ($PM_{2.5}$) concentration and cancer risk values for roadways based on annual average daily traffic (AADT) for each of the nine Bay Area counties. The county specific tables provide estimated $PM_{2.5}$ concentration and cancer risk by distance away from the roadway. The hazard index was found to be minimal for all surface streets and is therefore not included in the tables. Local planners can use these tables to determine if a project may be adversely impacted from local roadways and decide if further modeling is needed.

- **Freeway Screening Analysis Tool:** The District developed a Google Earth™ application that maps each State highway link in the Bay Area, where highway links are defined by Caltrans mileposts. For each link, District modeled $PM_{2.5}$ concentration, cancer risk, and hazard index, values at various distances from the edge of each side of the highway. This information is available at elevations of six feet and 20 feet to represent sensitive receptors on the first and second floors of buildings. Local planners can use this application to determine if a project may be adversely impacted from freeways and determine if further modeling is needed.

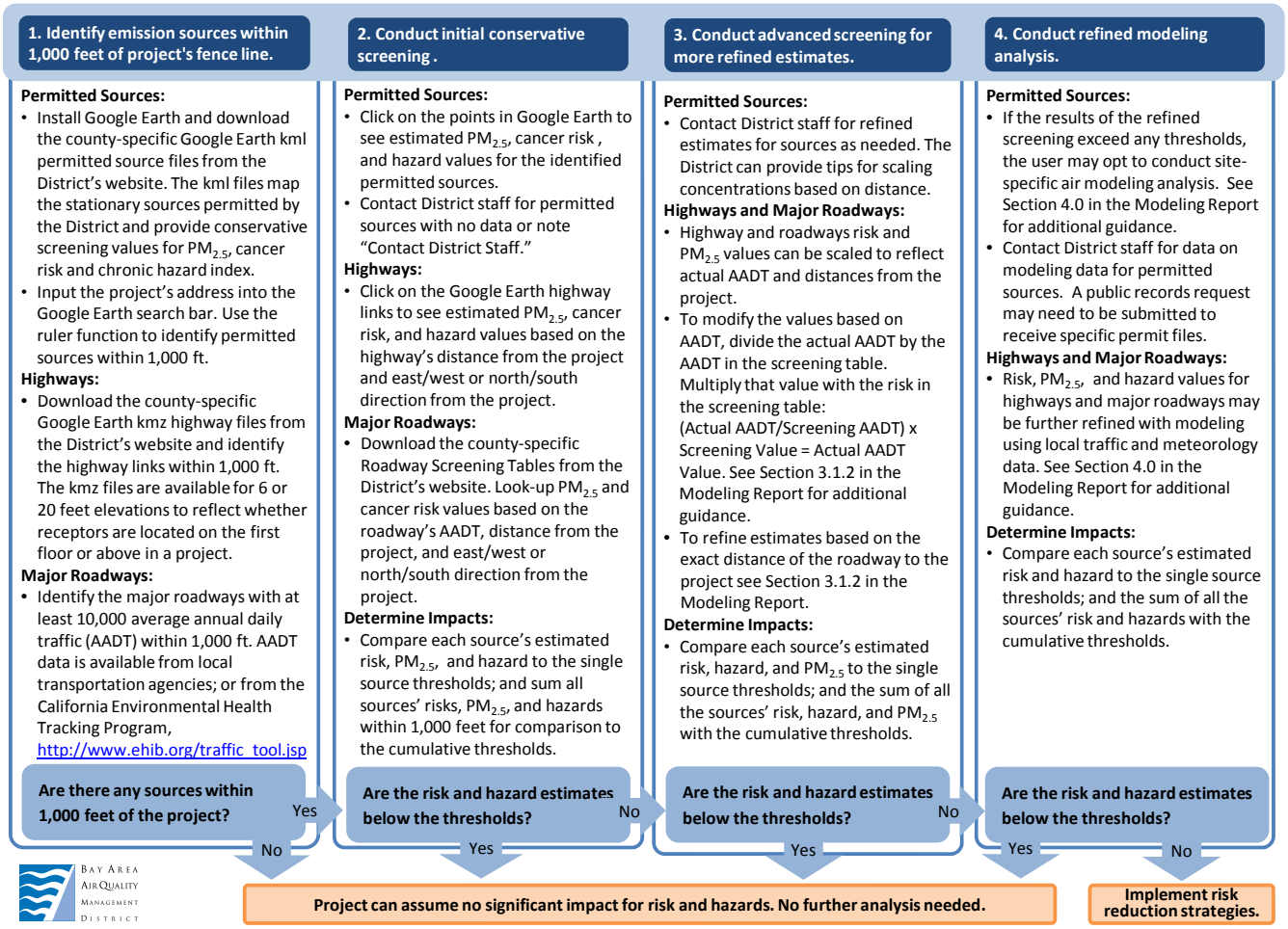
- **Stationary Source Risk and Hazard Screening Analysis Tool:** The District developed a Google Earth™ application that maps the locations of all the stationary sources in the region that the District permits, such as back-up generators, gas stations, dry cleaners, and auto body shops. For each source, the application lists the name of the source and conservative screening level cancer risk and $PM_{2.5}$ concentration values. Users can use this application to estimate the potential risks from stationary sources to particular project sites and determine if proposed projects may be adversely impacted and if further modeling is needed.

The assumptions and modeling parameters used for these screening tools are detailed in this Report in Section 3.0. These tools reflect the most current data available as of May 1, 2011. For a detailed step-by-step reference guide outlining the screening process, see Figure ES-1 below, the "BAAQMD Risk and Hazard Screening Analysis Process Flow Chart".

If after the screening process, a project is found to have potential risk and hazard impacts that exceed the District's recommended thresholds of significance, the user may choose to conduct site specific modeling for the proposed project. In this case, the user should apply the recommended modeling approach described in Section 4.0 of this document. The District provides a step-by-step approach to selecting the appropriate modeling tools, modeling parameters, and responding to project-specific conditions. These modeling guidelines are based on standard procedures developed by the California Office of Environmental Health Hazard Assessment (OEHHA) for toxicity values and age sensitivity, and are consistent with the most current risk assessment methodology and toxicity factors used in the District's Regulation 2, Rule 5: New Source Review of Toxic Air Contaminant. Users may deviate from the methods described in the document as found necessary, for example, to factor in the amount of time that receptors spend indoors verses out-of-doors, provided such deviations are justified with scientific documentation.

Figure ES-1: Risk and Hazard Screening Analysis Process Flow Chart

BAAQMD Risk and Hazard Screening Analysis Process Flow Chart:



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1.0 INTRODUCTION

This document is a companion document to the Bay Area Air Quality Management District's (BAAQMD; District) *California Environmental Quality Act (CEQA) Air Quality Guidelines* (BAAQMD 2010a) and to the *California Environmental Quality Act Thresholds of Significance* (BAAQMD 2010b). The purpose of this document is to provide a recommended methodology for assessing risks and hazards at a local, or community, scale from air pollutants emitted from common urban source types to nearby receptors. The methodology can be used to assess single-source impacts from either an individual new source or impacts on new receptors (such as new residents in a housing project) from existing sources of toxic emissions.

The methodology follows a tiered approach. The level of effort and requirements for more site specific information generally increases as the user progressively moves through each tier. Each tier provides concentrations and risks that are directly comparable to the applicable Thresholds of Significance, although it is important to note that the use of more site specific modeling input data produces more accurate results. Also, progression from one tier to the next in a sequential fashion is not necessary and a refined modeling analysis can be conducted at any time.

The following sections describe:

- **Screening Tables** provide an easy-to-use initial comparison to determine if nearby sources or roadways may have a significant impact to a receptor. The section describes how to use the screening tables to determine if a site specific modeling analysis and risk assessment are warranted. The section also identifies sources that are likely to have low emissions such that their health impacts are below the thresholds.

- **Refined Modeling Approach** describes the recommended methodology for performing dispersion modeling and estimating emission factors if the project exceeds the thresholds based on the screening analysis.

- **Cancer Risks** describes methodology for estimating the incremental lifetime cancer risk using age-sensitivity factors.

- **Chronic Hazard Health Impacts and Acute Hazard Health Impacts** describes the methodology for estimating short term one hour acute exposures and long term chronic noncancer health impacts.

The modeling methodology presented in this document are based on the California Air Pollution Control Officers Association (CAPCOA)'s Health Risk Assessments for Proposed Land Use Projects (July, 2009 – available through www.CAPCOA.org). While the District has relied heavily on the CAPCOA report for much of the detailed modeling methodology, they have been modified in certain instances as noted in each section to address specific Bay Area air quality modeling issues.

The Exposure Assessment components are based on the procedures developed by the California Office of Environmental Health Hazard Assessment (OEHHA). These calculation methodologies may change over time as OEHHA further refines its exposure guidelines. **It is important that the user apply the most current risk assessment methodology and toxicity factors from OEHHA's health risk assessment guidelines.**

1.1 Health Concerns

The focus of this guidance is to provide a methodology for evaluating local community risk and hazard impacts associated with toxic air contaminants (TACs) and particulate matters with diameters equal to or less than 2.5 microns ($PM_{2.5}$). TACs are a defined set of airborne pollutants that may pose a potential hazard to human health. Sources of TACs include industrial and mobile sources and similar to $PM_{2.5}$, can be emitted directly to the atmosphere or through reactions with different pollutants. This report presents methods for assessing the potential health impacts from direct $PM_{2.5}$ and TACs emissions, not those formed through secondary reactions in the atmosphere.

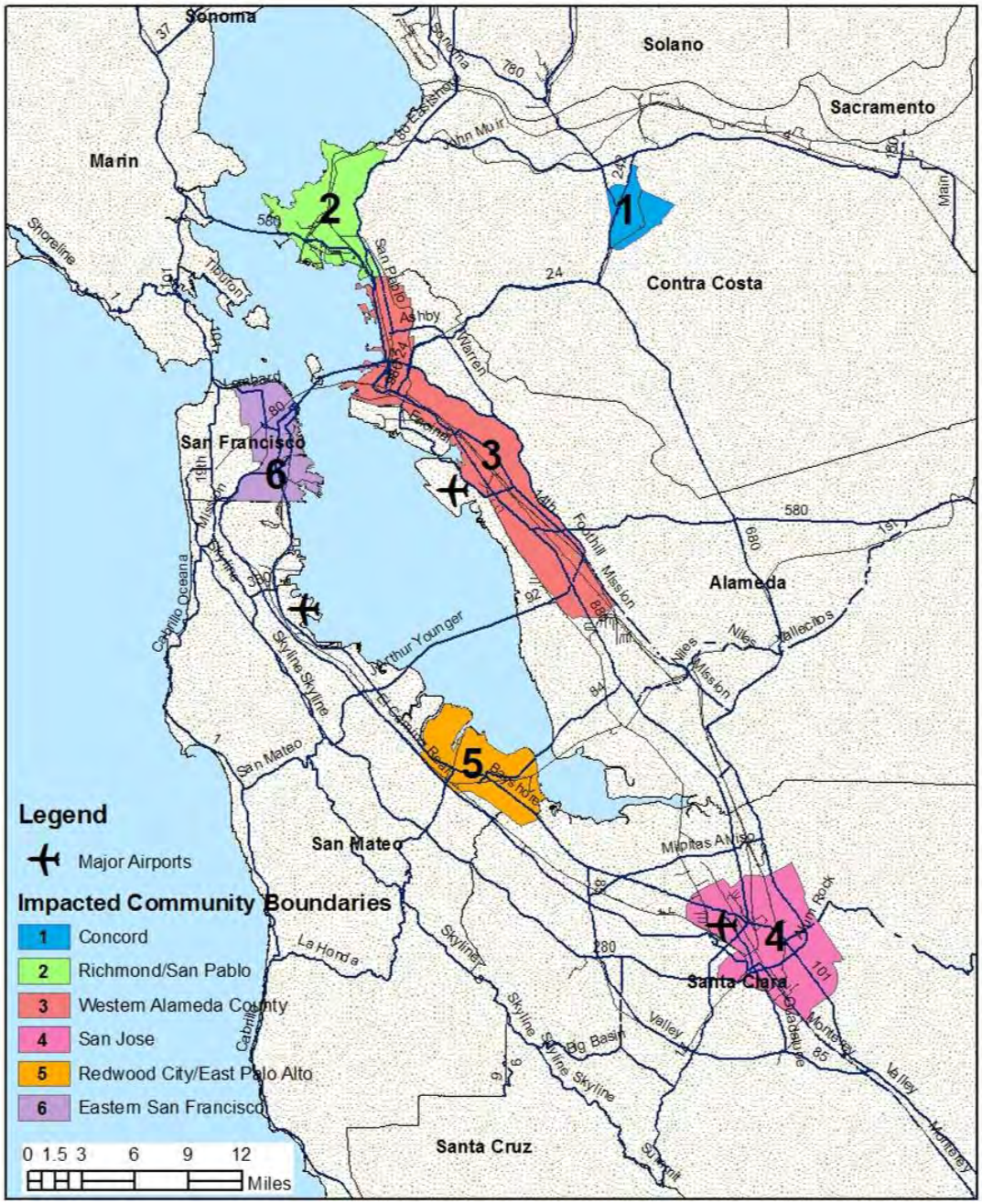
The potential health effects associated with TACs include both long term health impacts including cancer, birth defects, neurological damage, asthma, bronchitis or genetic damage and short term effects such as eye watering, persistent cough, running nose, throat pain, and headaches. Many scientific studies have linked fine particulate matter and traffic-related air pollution to respiratory illness and premature mortality. In the Bay Area, there are number of urban and industrialized communities where the exposure to TACs is relatively high in comparison to others. These same communities are often faced with other environmental and socio-economic hardships that further stress their residents and results in poor health outcomes. To address community risk from air toxics, the District initiated the Community Air Risk Evaluation (CARE) program in 2004 to identify locations with high levels of risks from TACs co-located with sensitive populations. Using year 2005 emission inventory combined with demographic and health statistics, the CARE program identified impacted communities based on a combination of high TAC concentrations, presence of significant sources, and proximity to low-income, sensitive populations. Figure 1 shows the impacted communities (December 2009), which include Western Alameda County, Concord, eastern San Francisco, Redwood City/East Palo Alto, Richmond/San Pablo, and San Jose.

The air quality conditions in the impacted communities are partially the result of past decisions related to land use and transportation planning. The District has developed this document to help identify and avoid land use conflicts by providing a methodology for assessing the potential health impacts to new residents from existing sources and from new sources on existing residents within a community. The objective is to ensure that future growth in a community is health protective and effective mitigations are implemented to reduce potential adverse impacts.

In addition to the guidance provided herein, local jurisdictions also have the option of developing Community Risk Reduction Plans (CRRPs) as a means of reducing the overall exposure to TAC and PM2.5 emissions and concentrations in an entire community from new and existing sources. The goal of a CRRP is to bring TAC and $PM_{2.5}$ concentrations for the entire community covered by the Plan down to acceptable levels as identified by the local jurisdiction and approved by the

Air District. This approach provides local agencies a proactive alternative to addressing communities with high levels of risk on a project-by-project approach. This proactive approach is encouraged for all communities, and especially those within a CARE impacted community.

Figure 1 – CARE Impacted Communities (December, 2009)



1.2 CEQA Thresholds

Under the CEQA guidance, the District developed thresholds of significance for air pollutants emitted from a new project and for cumulative exposures that includes emissions from a new project in combination with existing sources. The goal of the thresholds is to ensure that no source creates, or receptor endures, a significant adverse impact from any individual project, and that the total exposure from all nearby sources does not result in a significant adverse impact. If a project exceeds the identified significance thresholds, its emissions in concert with contributions from all nearby sources may result in significant adverse air quality impacts.

The thresholds for local risks and hazards from TAC and $PM_{2.5}$ are intended to apply to all sources of emissions, including both permitted stationary sources and on- and off-road mobile sources, such as sources related to construction, busy roadways, or freight movements. The thresholds of significance for TAC and $PM_{2.5}$ are listed in Table 1.

Table 1. Threshold of Significance for Local Community Risk and Hazard Impacts

Analysis	New Source	New Receptor
Individual Project	Compliance with qualified community risk reduction plan OR To the nearest receptor (resident) regardless of distance: Increased Cancer Risk > 10 in a million Increased Chronic and Acute Hazard Index > 1.0 Ambient $PM_{2.5}$ concentration increase > 0.3 ug/m^3	Compliance with qualified community risk reduction plan OR From the source with the highest cancer risk, $PM_{2.5}$ concentration, or hazard in comparison to other sources within the 1,000 foot radius of the receptor: Increased Cancer Risk > 10 in a million Increased Chronic and Acute Hazard Index > 1.0 Ambient $PM_{2.5}$ concentration increase > 0.3 ug/m^3
Cumulative Impacts	Compliance with qualified community risk reduction plan OR Common sources within 1,000 foot radius of the individual project modeled to the maximum likely exposed individual (resident) based on the individual source analysis: Cancer Risk > 100 in a million Chronic Hazard Index > 10.0 $PM_{2.5}$ concentration > 0.8 ug/m^3	Compliance with qualified community risk reduction plan OR Major sources within 1,000 foot radius of the receptor: Cancer Risk > 100 in a million Chronic Hazard Index > 10.0 $PM_{2.5}$ concentration > 0.8 ug/m^3

1.3 Overview Process

The District recommends a tiered approach where at each successive step, the project's $PM_{2.5}$ and TAC cancer risk and hazards are compared to the CEQA thresholds. A tiered approach addresses health impacts from two of the most common types of projects: (1) a new source of TAC or $PM_{2.5}$ is proposed for a community (see Figure 2) and (2) a new residential development is proposed that may be impacted from existing sources (see Figure 3).

Examples of new sources of TAC emissions include gasoline dispensing facilities (i.e., gasoline stations), dry cleaners, and autobody shops. Less obvious sources of TAC include diesel back-up generators that are housed in the basement of hospitals, governmental agencies, and fire stations, in case of power outages. Examples of projects that may be impacted from existing nearby TAC sources such as roadways, stationary sources, railyards, airports, and ports include residential developments, mixed use commercial-residential developments, commercial buildings, and daycare centers.

The flow charts (Figures 2 and 3) show how to proceed with the CEQA process to determine if a project is impacting or being impacted by sources of TAC. The initial step is to determine whether the project is categorically exempt from CEQA. For some cases, a project may not be exempt because the health risk may trigger an exception (CEQA §15300.2).

For projects that are not exempted and considered significant, the project site-specific characteristics and surrounding conditions are used to evaluate the potential cancer risk, hazard, and $PM_{2.5}$ concentrations posed by the project or to a new receptor. For these projects, the project sponsors must determine the project radius and identify significant sources and receptors within the project radius. The project sponsor can initially screen the project by comparing the screening values based on distances to the nearest major roadway and/or emissions from significant sources to the CEQA thresholds. The District provides screening tables for California designated highways and certain existing permitted, stationary sources as an initial screen to determine if nearby sources or roadways may have a significant impact on a project. The District is recommending that in additional to evaluating the individual impact from a single source, the project sponsor should also evaluate the cumulative impacts from all TAC and $PM_{2.5}$ sources. The cumulative impacts are the summation of the cancer risks, hazards, and $PM_{2.5}$ concentrations from all significant sources identified within 1,000 foot radius of the project.

If the screening values from the project exceed the single source or cumulative thresholds, the project sponsor can conduct more refined modeling analysis by incorporating additional site-specific information. Project sponsors can also implement all feasible measures to mitigate the potential health impacts. This document discusses several tiers of refined modeling analysis that may be performed with each successive tier requiring more site-specific information. For the first tier, a screening model is recommended that requires minimal site-specific data. More complex modeling analysis can be conducted based on the available source specific data.

Figure 2 – Tiered Approach for Estimating Community Risks and Hazards from New Sources

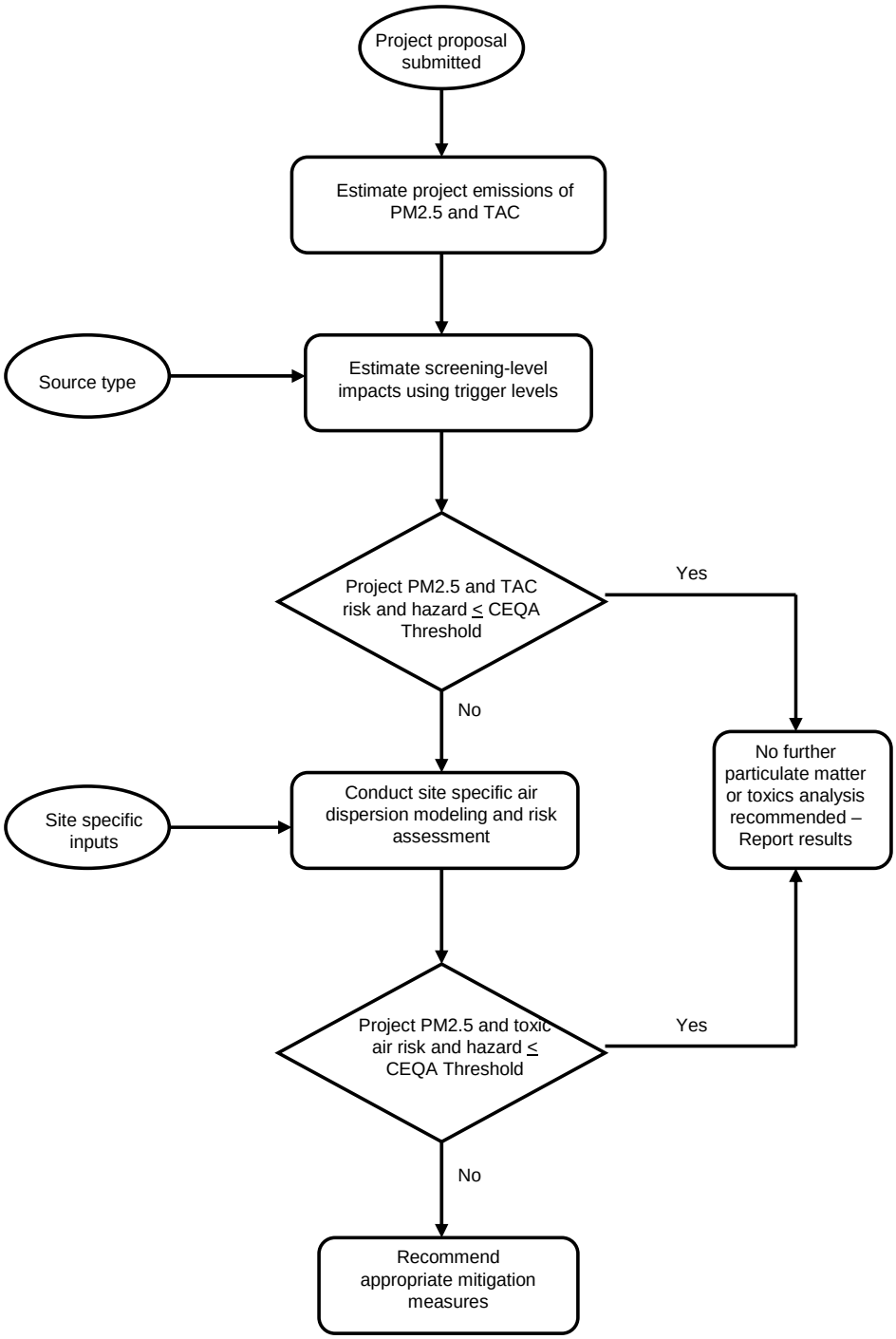
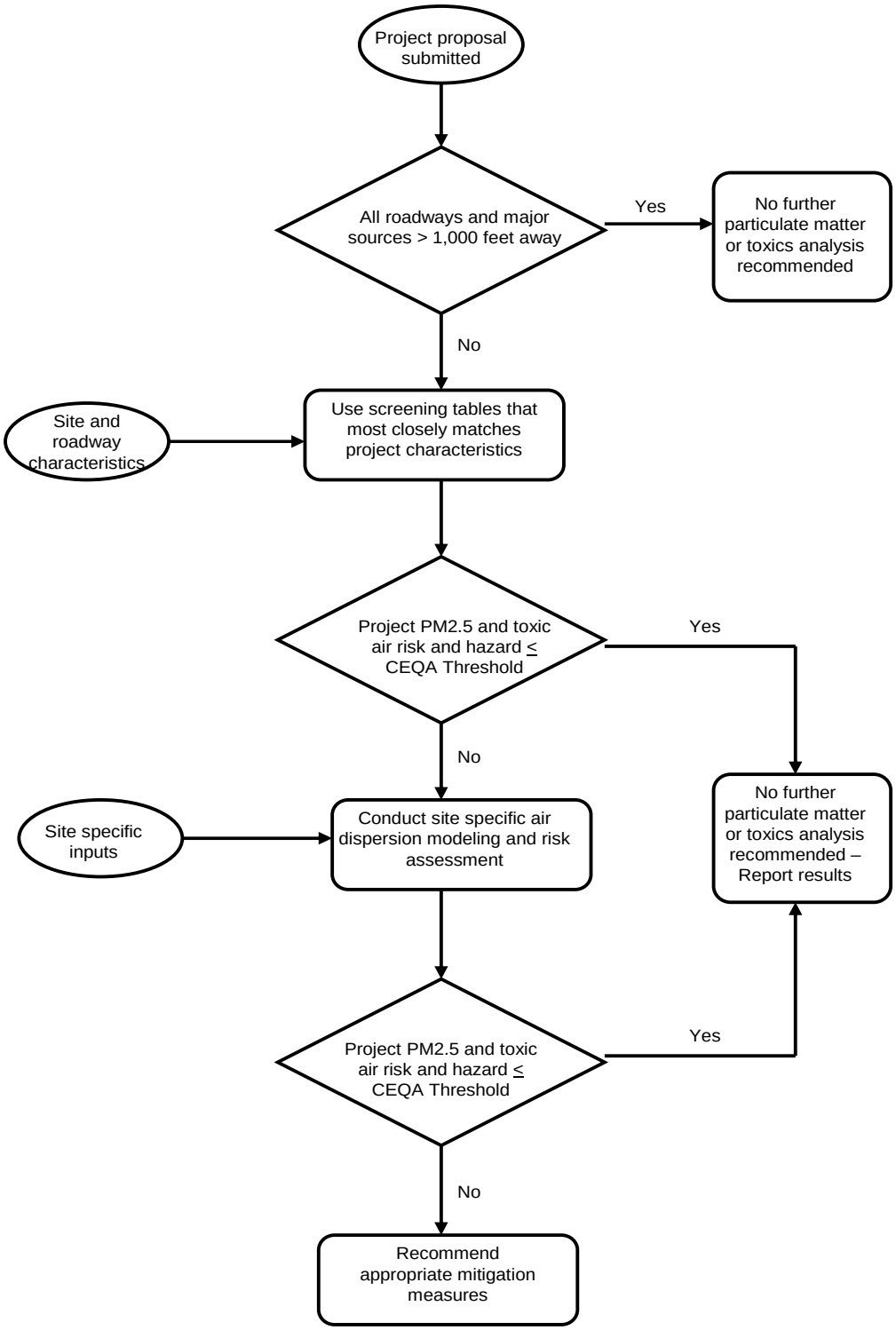


Figure 3 – Tiered Approach for Estimating Community Risks and Hazards from New Receptors



1.4 Starting Point

The most current documentation (including this document), datasets for screening and modeling, and District staff contact information are available on-line at http://www.baaqmd.gov/Divisions/Planning-and-Research/CEQA-GUIDELINES/Tools-and-Methodology.aspx. This URL serves as the starting point for all CEQA tools, methodology documentation, and data related to District recommended screening and modeling of local risks and hazards. For questions on data availability and screening and modeling methods, please contact the District's Planning, Rules, and Research Division at (415) 749-4995.

2.0 IDENTIFYING SOURCES, RECEPTORS, AND IMPACT AREA

The screening methods for local risks and hazards recommended in this document rely upon several key definitions to identify the pollution sources and the receptors of potential concern and to establish the area where potential impacts are evaluated.

- What emissions sources should be analyzed?
- What receptors should be considered?
- How should cumulative impacts of toxic air contaminants and particulate matter be determined and over what area?

This section provides some key definitions and recommended methods for making these preliminary determinations.

2.1 Identifying Sources

For the purposes of this methodology document, the District defines three types of sources:

- *Common sources* whose emissions of TACs or $PM_{2.5}$ are significant enough to warrant consideration when siting new receptors or when determining cumulative impacts but simple enough as to lend themselves to simplified risk screening tools;

- *Complex sources* whose emissions may pose significant risks but that are complex, or otherwise unique in nature, such that they do not lend themselves to simplified screening tools or even modeling analysis that can be easily generalized; and

- *Minor, low-impact sources* that are unlikely to pose a significant risk.

Each of these three types is defined in this section. Focus is given to the common sources because they generally pose the greatest risks in the Bay Area. Complex sources are important to consider if the proposed project is sited nearby; but they will require specific and specialized analysis. A detailed methodology for assessing risk from complex sources is beyond the scope of this document. Minor, low-impact sources can be neglected from risk and hazard assessments for new projects.

2.1.1 Common Sources

Common sources may be significant sources of local risk and hazards from TAC or $PM_{2.5}$ and, for the purposes of this document are defined to include the following:

- Freeways and major roadways;
- Gas stations;
- Stationary diesel engines, such as stand-by back up generators;
- Dry cleaners;
- Crematories;
- Spray-booths;
- Construction projects; and
- Railroad tracks for trains with diesel engines.

Risk screening tables or risk screening tools are provided for some of these common sources. This risk may expand as screening tools are developed in the future.

2.1.2 Complex Sources

The District regulates and permits stationary sources of air pollution and administers incentive funds to reduce pollution from mobile sources. The mobile sources are not directly regulated or permitted by the District; however, they may contribute a significant portion of the emissions attributed to non-permitted facilities. Quantification of emissions from these types of sources is complex and requires comprehensive knowledge on the sources of emissions (i.e., trucks, locomotives, construction equipment, airplanes, etc.), number of sources, and the types of pollutants emitted. In addition, District has permitted several single facilities that have numerous permits such as in the case of oil refineries which make TAC and $PM_{2.5}$ quantification difficult. Examples of complex sources that generate significant pollution include:

- Major ports, including the Port of Oakland;
- Railyards;
- Distribution centers and truck-related businesses;
- Airports;
- Oil refineries;
- Power plants;
- Metal melting facilities; and
- Cement plants.

The modeling approach for these types of sources are beyond the scope of this document and it is recommend that the project sponsor contact their lead agency for further information on how to address emissions from these sources if they are located within the project radius.

2.1.3 Minor, Low-Impact Sources

The District has identified several sources that do not pose a significant health impact even in combination with other nearby sources. These determinations were made through extensive modeling, source tests, and evaluation of their TAC emissions. The minor, low-impact sources include:

- Roads with less than 10,000 total vehicles per day and less than 1,000 trucks per day;
- Non-diesel boilers;
- Soil-vapor extraction wells; and
- Cooking (excluding under-fired charbroilers) and space-heating equipment.

Sources that meet these criteria can be excluded from the CEQA process.

2.2 Identifying Receptors

For the purpose of this document, receptors are defined as people—children, adults, and seniors—occupying or residing in:

- Residential dwellings, including apartments, houses, condominiums;
- Schools, colleges, and universities;
- Daycares;
- Hospitals; and
- Senior-care facilities.

Modeling should assume that these dwellings and facilities shelter receptors. At this time, the methodology does not include significant thresholds for on-site and off-site worker exposures. The Occupation Safety and Health Administration (OSHA) is the main federal agency that adopts laws and regulations for ensuring safe and healthful work environment to prevent injuries and protect the health of workers. All employers must follow OSHA regulations to ensure the health and well being of their employees. As part of the District's permitting process, exposures to off-site workers and residents are evaluated prior to issuing any permits.

2.3 Determining the Project Radius

For assessing community risks and hazards, the District recommends that a region around the proposed project be defined by a *project radius* for assessing potential impacts on new receptors and cumulative impacts of new sources. More specifically, a 1,000 foot radius is generally recommended around the project property boundary to identify existing sources that may individually or cumulatively impact new receptors and to identify existing sources that may contribute to the cumulative impact of new sources. The following section provides details on the purpose of and methods for setting the project radius.

2.3.1 New Receptors

For any proposed project that includes the siting of new receptors, assess impacts from sources of toxic air contaminants and $PM_{2.5}$ within 1,000 feet of the proposed project. The 1,000 foot radius is recommended for assessing risks and hazards from both individual sources and the cumulative effects of multiple nearby sources (i.e., proposed project plus existing and foreseeable future projects).

For large, complex sources, such as those listed in Section 2.1 above, a larger radius may be appropriate, but the specifics should be determined on a case-by-case basis.

2.3.2 New Sources

For assessing the project alone impacts of a new source or new sources, no project radius is recommended. In this case, the location of maximum risk, hazard, and $PM_{2.5}$ concentration affecting a receptor should be identified.

For assessing the *cumulative* impacts of a new source or sources in combination with existing sources, a project radius is recommended. Assessment of impacts from existing sources within 1,000 feet of the new source(s) in combination with risks and hazards from the new source(s) is recommended. Once the location of the maximally impacted receptor is identified for the new source(s), additional cumulative impacts are assessed at that location from other sources within the radius of the project (i.e. not the receptor). Assessments should sum individual hazards or risks to find the cumulative impact at the location of the maximally impacted receptor from the new source(s).

2.3.3 Constructing the Project Radius

To construct the project radius, a polygon should be formed that is 1,000 feet from the property boundary of the new development. GIS programs provide a proximity feature for constructing such polygons based on linear distance. The polygon may be constructed by hand following the steps below (see Figure 4):

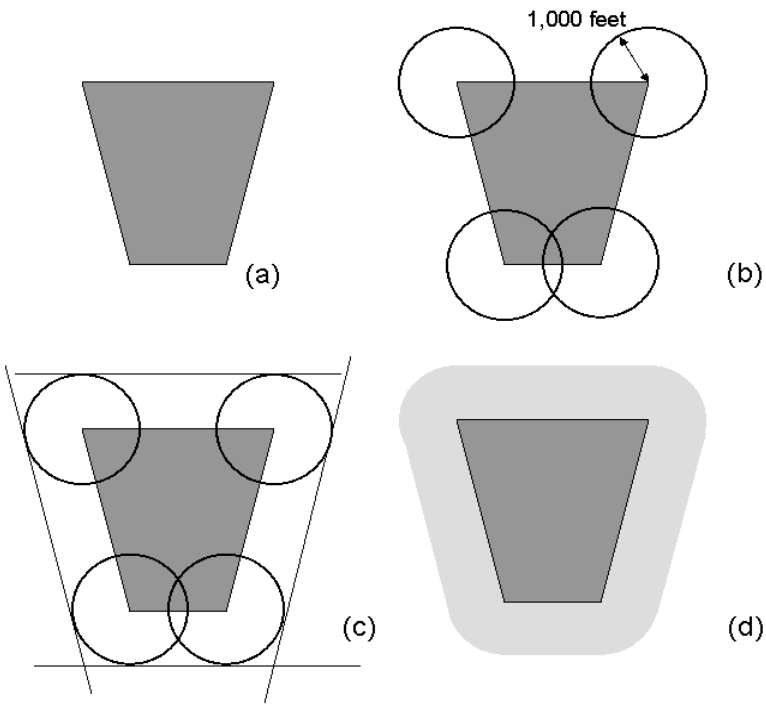
1. Create a map to scale representing the property boundary of the proposed project.
2. On the map, construct circles centered on the corners of the property boundary.
3. Form a polygon by drawing straight lines that are tangent to adjacent circles.

2.3.4 Selecting an Approach

As outlined in Section 1.0, the recommended methodology follows a tiered sequence of analysis, with the level of effort and requisite site-specific information increasing as the user progresses from screening to site specific modeling. Since the data requirements and screening or modeling tools differ with the approach, the user is encouraged to plot his or her approach in advance and select the appropriate tools as needed. The following list provides an outline of the data,

screening tools, or models necessary for each of the tiered approaches. Subsequent sections describe the data, screening tools, and models—as well as where to find them—in more detail.

Figure 4. Constructing the project radius. The shaded polygon (a) represents the property boundary. Circles of 1,000 foot radius (b) are constructed with centers at the polygon corners. Line segments (c) are drawn tangent to the circles. Line segments are truncated at the points of tangency to create the project radius (d).



Approach: Check source locations relative to the 1,000 foot project radius
Data:

- 1,000 foot project radius
- Source locations

Approach: Project Screening
Data/Tools:

- 1,000 foot project radius
- Source locations
- Screening tables (stationary, roadway, railroad tracks)
- Screening tool (construction)
- Receptor locations (for new sources)

Approach: Detailed Modeling
Data/Models:

- 1,000 foot project radius
- Stationary source: locations, emissions, release parameters
- On-road mobile: Roadway locations, traffic counts for cars and trucks, emission factors
- Off-road mobile: location data, activity estimates, load factors, emission factors
- Meteorological data
- Receptor locations (for new sources)
- One or more of the following models: SCREEN3, ISC, AERMOD, CAL3QHCR

3.0 SCREENING TABLES

The methodology outlined here provides a stepwise process that indicates the need for and approach for conducting a more detailed risk analysis. In the first step, project characteristics and distances from common sources are used to screen projects using District-provided screening tables for surface streets, highways, and permitted sources. This section describes how to use the screening tables and the methodology used to develop the tables.

3.1 Roadways

The District developed roadway screening tables for all California highways and surface streets. Surface street screening tables are based on annual average daily traffic (AADT) counts. In order to use the tables, project sponsors must first gather vehicle count information for all major roadways within 1,000 foot radius of the proposed project. Only roadways that have over 10,000 vehicles per day should be included in the evaluation.

3.1.1 Traffic Counts

The Traffic Data Branch of the California Department of Transportation (Caltrans) collects and disseminates on-line (http://traffic-counts.dot.ca.gov/) traffic counts in various formats for freeways and roadways that are part of the State Highway System. State Highways are signed Interstate, California, and US, as shown in the examples in Figure 5 below. Caltrans does not collect traffic count information on locally maintained surface streets. Count information for locally maintained streets is available from the City or County Public Works Department, Traffic Engineers office, in the area where the street is located or from the County-specific Congestion Management Authority.

Caltrans makes available the following data sets:

- **Traffic Volumes** (Annual Average Daily Traffic; AADT) for all vehicles on California State highways. Searches by route of these data sets are available on-line (http://traffic-counts.dot.ca.gov/). Data sets include traffic count estimate for highway segments relative to milepost markers or major cross streets. For projects south or west of the nearest milepost location, select counts designated as “back”. For projects north or east of the nearest milepost location, select “ahead”.

- **Truck Traffic** (Annual Average Daily Truck Traffic) on California State highways. Annual average daily truck traffic is estimated as the total truck traffic for the year divided by 365 days. Counts are provided relative to the post mile markers. For projects south or west of the nearest milepost, select counts designed as "B" for back leg. Projects north or east of a mile post, select "A" for ahead. The "O" designation is used for cases in which the counts along the back and ahead legs are equal.

Figure 5. Caltrans collects and disseminates traffic counts for State Highways, which are signed as Interstate, California, and US.

Annual average daily traffic is the total volume for the year divided by 365 days. The traffic count year is from October 1st through September 30th. Only a few locations in California are actually counted continuously, but most counts are verified periodically. Traffic counting is generally performed by electronic counting instruments moved from location throughout the State in a program of continuous traffic count sampling. The resulting counts are adjusted to an estimate of annual average daily traffic by compensating for seasonal influence, weekly variation and other variables. Each count location is identified by the post mile which corresponds to a point on a highway. The post mile increases from the beginning of a route within a county to the next county line generally increasing from south to north and west to east directions. The post miles are reset at each county line. All traffic volume figures listed include traffic in both directions unless otherwise indicated. Included in the data is an estimate of the "peak hour" traffic at all points on the State highway system. This value is intended for use in estimating the amount of congestion experienced and indicates how near to capacity the highway is operating. Peak hour traffic normally occurs on the roadway every weekday and on a few rare occasions, the peak hour counts are exceeded a few hours each year.

In addition to the highway counts, California Environmental Health Tracking Program (CEHTP) has developed a traffic volume linkage tool that allows user to obtain traffic volumes near specific locations. The CEHTP is a program within the California Department of Public Health and is funded by the Centers for Disease Control and Prevention. The traffic counts are estimated using the Caltrans Highway Performance Monitoring System (HPMS) data for California based on the year 2004. The web connection to the site can be found at: http://www.ehib.org/page.jsp?page_key=136. The tool can be used to determine the number of vehicles that travel daily near a proposed project. The user enters the latitude and longitude of a site location and the radius of influence for which roadway traffic are needed. The tool includes a program that geocodes individual street address to a latitude and longitude coordinate system or the coordinates may be determined through Google Earth™ as well. The tool provides AADT along each roadway and a summation of all traffic within the radius of influence. The advantage of this program is that it provides surface street counts for most major surface streets in the Bay Area. However, the data are from 2004 and may not be reflective of current site conditions. The

data are appropriate for screening purposes, but the District recommends contacting the County Public Works Department or Congestion Management Authority for site-specific modeling analysis. For projects in San Francisco, the San Francisco Transportation Agency maintains a program called SFCHAMPS that contains the projected traffic volume for all surface streets in San Francisco.

3.1.2 Surface Streets

Surface streets are defined as any road in the Bay Area that is not designated a California highway. Surface streets include both roads on rural and urban lands that have been incorporated into a city's jurisdiction or are un-incorporated and are part of the county. Proximity to the roadway and the vehicle traffic on that roadway are key factors in determining whether the impact from a local surface street is significant under CEQA. To determine the impact from local surface streets, the District developed county specific surface street screening tables based on the AADT on a roadway.

The tables were developed using the following methodology:

- $PM_{2.5}$ concentrations were estimated using the base year 2014. For the 70 year cancer risk analysis, annual average emissions were estimated using the latest version of California Air Resources Board's (CARB) EMission FACtors (EMFAC2007) for 2014 through 2040. Because EMFAC2007 does not estimate emissions beyond 2040, the emissions from year 2040 where then applied to remaining years (2041 through 2084).

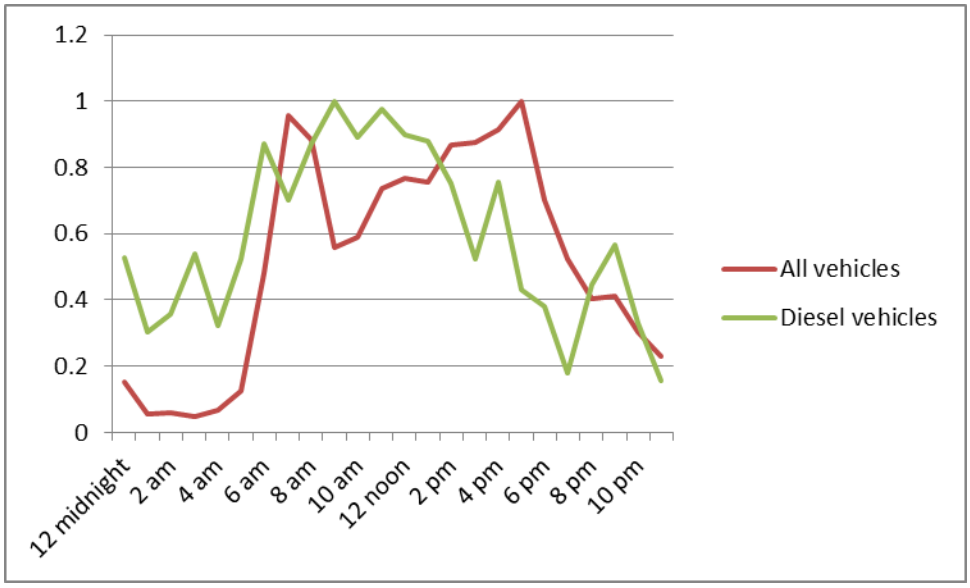
- Modeling was completed for AADT ranging from 10,000 to 100,000 vehicles per day. The AADT and annual emissions were scaled by the hourly diurnal factor derived using the VMT for $PM_{2.5}$ and diesel particulate matter (see Section 4.3.3.1). The diurnal scaling factor was developed by dividing each hourly VMT by the total VMT estimated for the day. The AADT and emissions were then multiplied by the scaling factor for each hour to develop hourly vehicle volumes and emissions. Figure 6 presents the diurnal scaling factors for Alameda County as an example of what was used in the model. The two different diurnal factors were derived depending on whether the model was estimating concentrations from all vehicles versus diesel trucks alone. As illustrated in the figure, there are two peak emissions point corresponding to the morning and evening commute times. For the diesel exhaust, the peak appears to occur at 9 am. All of the nine Bay Area counties have similar diurnal patterns.

- The District averaged the county-specific emissions from EMFAC2007 for speeds of 0 mph to 35 mph based on a temperature of 60 degrees Fahrenheit and humidity of 60%.

- Hourly vehicle volume and emissions were input into roadway model CAL3QHCR to estimate annual average concentrations. All roadways were assumed to be at ground level and receptors were set at six feet (1.8 meters). The model was run for to estimate $PM_{2.5}$, total organic gases, and diesel exhaust concentrations. The percentage of trucks traveling on surface streets was estimated using the California Motor Vehicle's Stock Travel and Fuel Forecast (MVSTAFF) report (http://www.dot.ca.gov/hq/tsip/tab/mvstaff.html) for 2006. This annual report estimates,

and forecasts the annual statewide and countywide number of vehicles, vehicle miles of travel, vehicle fuel consumption, and vehicle fuel economy. The fraction of trucks traveling on surface streets was estimated by weighing the truck VMT by the total VMT for all vehicles on non-State highways per county (see Table 2). MVSTAFF defines trucks as vehicles with at least two axles and six tires. EMFAC2007 county total diesel emission factors (which include all diesel vehicles) were adjusted to match the MVSTAFF definition of truck counts.

Figure 6. Example Diurnal Scaling Factor for Alameda County (relative to peak-hour traffic)



- Meteorological data collected from the District's monitoring stations were input to the CAL3QHCR model. The meteorological station and year the data were collected are noted in the screening tables. Each roadway was modeled assuming a link length of one kilometer.

- Age sensitivity factors (ASF) were applied in estimating the cancer risk to yearly emissions starting in 2014 through 2030. ASFs are used to account for the increased susceptibility of infants and children to carcinogens, as compared to adults. A factor of 10 was applied for exposures that occur from the third trimester of pregnancy to two years of age, and by a factor of three for exposures that occur from two years through 15 years of age (see Section 4.3.3.1 for how these age sensitivity values were applied).

Table 2. Truck Percentage on Non-State Highways using MVSTAFF 2006

County	Estimated Truck % along non-state highways
Alameda	4.09
Contra Costa	3.59
Marin	2.84
Napa	3.91
San Francisco	2.85
San Mateo	3.13
Santa Clara	3.51
Solano	3.63
Sonoma	4.32

- The screening tables were further refined to account for anticipated diesel reductions from CARB's On-road Heavy Duty Diesel Vehicles (In-Use) Regulation[1]. The District estimated a percentage of diesel reduction anticipated per year based on phased in compliance dates specified in the diesel regulations adopted by CARB. Table 3 presents a summary of the diesel reduction anticipated per year for all diesel vehicles.

Table 3. Percent Reduction Anticipated per Year Based on CARB's Diesel Regulations

Year	Emission Reduction % based on CARB diesel regulations
2014	0.22
2015	0.37
2016	0.39
2017	0.41
2018	0.41
2019	0.4
2020	0.38
2021	0.38
2022	0.38
2023	0.36
2024	0.34
2025	0.31
2026	0.29
2027	0.267
2028	0.244
2029	0.221
2030	0.198
2031	0.175
2032	0.152
2033	0.129
2034	0.106
2035	0.083
2036	0.06
2037	0.037
2038	0.014
≥ 2039	0

The screening tables present the $PM_{2.5}$ concentrations and cancer risks for roads with 10,000 to 100,000 vehicles per day at specified distances away from the edge of the nearest travel lane of a road to the project. Each table presents concentrations for north/south or east/west roadway configurations. These sets of tables correspond to projects located upwind or downwind of the roadway with respect to the prevailing wind direction. Concentrations were estimated 10 feet, 50 feet, 100 feet, 200 feet, 500 feet, 700 feet, and 1,000 feet from the edge of the roadway (farthest lane) closest to the project. Roadways with less than 10,000 vehicles per day are consider minor, low-impact sources and inclusion of these roads in CEQA evaluation is not warranted. In addition, the tables do not include acute or chronic noncancer hazards since the maximum hazards estimated from the highest AADT were significantly below the thresholds.

The first step in using the tables is to download the county specific tables in which the project will be located. The screening surface street tables are located at the District web site: http://www.baaqmd.gov/Divisions/Planning-and-Research/CEQA-GUIDELINES/Tools-and-Methodology.aspx. Prior to using the tables, the user must know: (1) which roads exceed 10,000 AADT within 1,000 foot radius of the project and their associated AADT and (2) the distance from the project to the roadway.

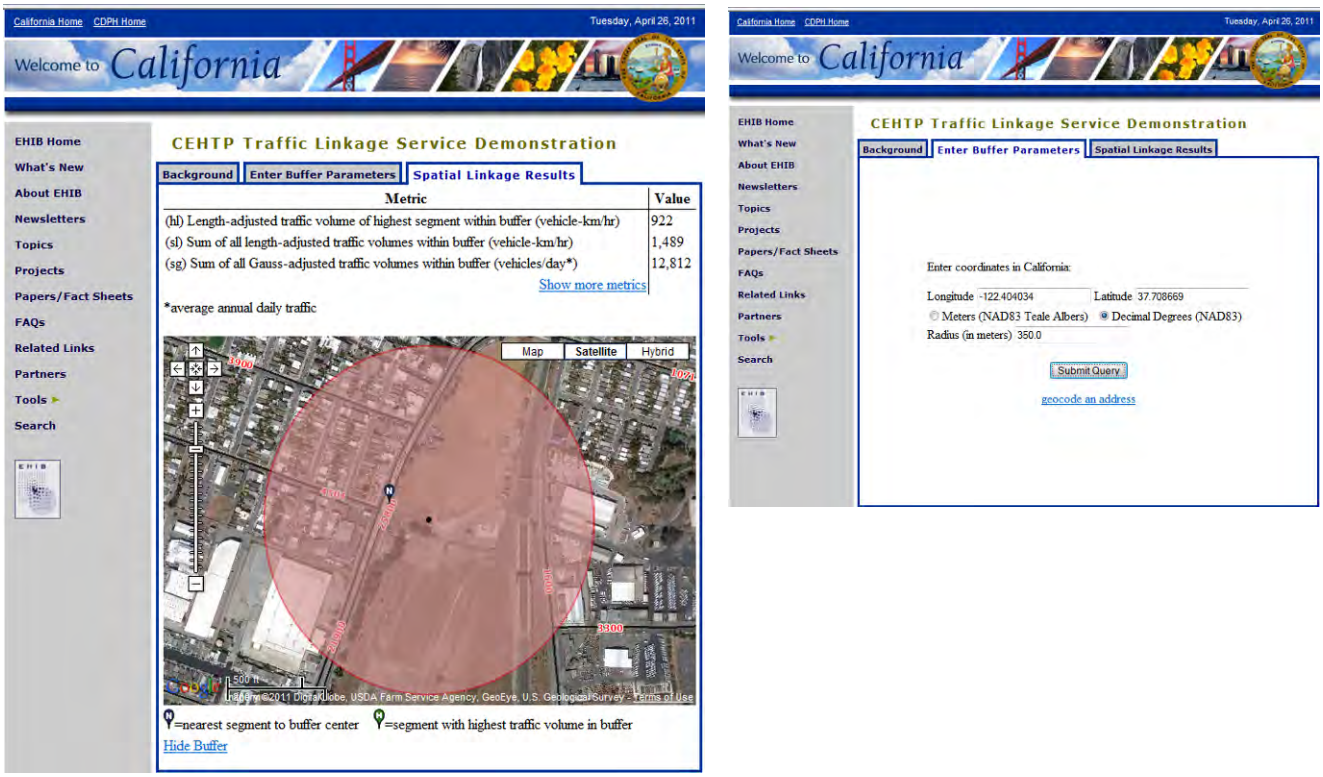
To identify roads with greater than 10,000 AADT near a project site, the District recommends using CEHTP's traffic volume tool (see Section 3.1.1 for further discussion). The web connection to the site can be found at: http://www.ehib.org/page.jsp?page_key=136. The tool can be used to determine the number of vehicles that travel daily near a proposed project. The user enters the latitude and longitude (in degrees) of a project location and the radius of influence for which roadway traffic are needed. The tool includes a program that geocodes individual street address to a latitude and longitude coordinate system or the coordinates may be determined through Google Earth™ by selecting "option" in the "tools" bar and clicking on "show lat/long in decimal degrees". The tool then provides an aerial map of the project site with the AADT along all roadways within a user defined radius around the project. An example is shown below in Figure 7 for a hypothetic

[1] Information available online at http://www.arb.ca.gov/msprog/onrdiesel/onrdiesel.htm

project in San Francisco. The latitude and longitude coordinates were taken from Google Earth™. In this example, only the main road going through the center of the circle has AADT greater than 10,000 vehicles (i.e., 25,800).

To determine the distance from the project to the roadway, the project sponsor can use the ruler tool in any mapping program. District routinely uses the ruler tool in Google Earth™ to measure the distance from the edge of the project to the nearest traffic lane. Continuing with the example in Figure 7, Plant Number 3520 is located approximately 276 feet west of the roadway that has 25,800 vehicles per day (see Figure 8).

Figure 7. Example of the CEHTP's Traffic Count



The user then opens the county-specific surface street screening table in which the project is located. Based on the predominant direction of the roadway, the user selects either the north-south or east-west directional tables. For the example in Figure 8, the roadway is located in San Francisco in a north-south direction, has 25,800 vehicles per day, and is approximately 276 feet from the source. To estimate the risks and hazards, the user matches the AADT in the row header with the distance from the project to the roadway in the column header. For cases in which the exact AADT or distances are not estimated in the table, the user should select the more conservative value between the two estimated values. In Table 4, the estimated cancer risk for the example is 2.31 cases per million and the $PM_{2.5}$ concentration is 0.092 ug/m^3.

Figure 8. Example of Google Earth™ Ruler Tool

The cancer risk and $PM_{2.5}$ concentrations can be further refined by linearly interpolating the AADT and the distance between the project and the roadway. For example, the user can average the values between 20,000 and 30,000 AADT to estimate the values for a roadway has an AADT of 25,800. In the example, the $PM_{2.5}$ concentration for 25,000 AADT at 200 feet would be 0.077 ug/m^3 (the average between 0.061 ug/m^3 at 20,000 AADT and 0.092 ug/m^3 at 30,000 AADT). To further refine the estimate, the user can also linearly interpolate based on the distance. In the example above, the project is located approximately 300 feet west of the roadway with an AADT of about 25,000. The first step is to determine the $PM_{2.5}$ concentrations at 200 and 500 feet for an AADT of 25,000 by averaging the values at 20,000 and 30,000 AADT (see Table 5). The next step is to then ratio the $PM_{2.5}$ concentrations for 25,000 AADT by the difference between the values at 200 feet and 500 feet as shown in the calculation below.

$$PM_{2.5\ 300\ feet} = PM_{2.5\ 200\ ft} - (PM_{2.5\ 200\ ft} - PM_{2.5\ 300\ ft}) \times (200\ ft - 300\ ft) / (200\ ft - 500\ ft)$$
$$= 0.077 - (0.077 - 0.027) \times (-100\ ft)/(-300\ ft)$$
$$= 0.060\ ug/m^3$$

Another way to interpolate the concentration between distances is to determine the incremental change in concentrations over even distances. In the example above, the user can estimate the $PM_{2.5}$ concentrations for every 100 feet increments from 200 to 500 feet. The user subtracts the difference between the two distances in the table (in this example, it would be 0.077 ug/m^3 – 0.027 ug/m^3 = 0.050 ug/m^3) and divides by the number of 100s between the distances (i.e, three). The incremental difference for each progression of 100 feet is 0.017 ug/m^3. This implies that for every 100 feet that a project moves further away from that roadway, the $PM_{2.5}$ concentration decreases by 0.017 ug/m^3. In this example, the $PM_{2.5}$ concentration at 300 feet is then 0.060 ug/m^3 ($PM_{2.5}$ concentration of 0.080 at 200 feet subtracted by the increment of 0.017 ug/m^3) and is 0.043 ug/m^3 at 400 feet.

Table 4. Example Cancer Risk and $PM_{2.5}$ Estimation for Surface Street

NORTH-SOUTH DIRECTIONAL ROADWAY							
Annual Average Daily Traffic	Distance East or West of Surface Street - Cancer Risk (per million)						
	10 feet	50 feet	100 feet	200 feet	500 feet	700 feet	1,000 feet
1,000	No analysis required						
5,000							
10,000	2.13	2.10	1.49	0.65	0.36	0.27	0.22
20,000	2.22	2.49	2.22	1.55	0.62	0.51	0.38
30,000	3.37	3.56	3.28	2.31	0.97	0.75	0.55
40,000	4.26	4.46	4.27	3.10	1.33	1.06	0.79
50,000	5.79	6.49	5.78	4.00	1.68	1.33	0.96
60,000	7.81	8.55	7.34	4.76	1.95	1.55	1.15
70,000	9.82	10.60	8.90	5.52	2.22	1.77	1.33
80,000	11.22	12.12	10.17	6.31	2.53	2.02	1.52
90,000	12.63	13.63	11.44	7.10	2.85	2.27	1.71
100,000	14.03	15.15	12.71	7.88	3.17	2.53	1.90

NORTH-SOUTH DIRECTIONAL ROADWAY							
Annual Average Daily Traffic	Distance East or West of Surface Street - PM2.5 Concentration (ug/m^3)						
	10 feet	50 feet	100 feet	200 feet	500 feet	700 feet	1,000 feet
1,000	No analysis required						
5,000							
10,000	0.080	0.063	0.044	0.016	0.012	0.000	0.000
20,000	0.092	0.101	0.092	0.061	0.021	0.016	0.012
30,000	0.129	0.147	0.129	0.092	0.032	0.022	0.017
40,000	0.166	0.193	0.175	0.120	0.051	0.037	0.024
50,000	0.249	0.267	0.239	0.166	0.064	0.050	0.029
60,000	0.341	0.359	0.304	0.198	0.076	0.057	0.039
70,000	0.433	0.451	0.368	0.230	0.087	0.064	0.050
80,000	0.495	0.516	0.421	0.263	0.099	0.074	0.057
90,000	0.557	0.580	0.474	0.296	0.111	0.083	0.064
100,000	0.618	0.645	0.526	0.329	0.124	0.092	0.071

Table 5. Linearly Interpolated $PM_{2.5}$ Concentrations Based on Distance and AADT

AADT	200 feet	300 feet	500 feet
20,000	0.061	NA	0.021
25,000	0.077	0.060	0.027
30,000	0.092	NA	0.032

A similar methodology can be applied to cancer risk. In this example, the project in San Francisco did not exceed the $PM_{2.5}$ threshold or cancer risk. However, if the thresholds for either cancer risk or $PM_{2.5}$ were exceeded, the user can determine whether additional modeling is warranted or implementation of mitigation measures is appropriate. It should be noted that these screening tables are conservative because they are based on selecting meteorology from a single station as being representative for the entire county. If the user chooses to conduct a more refined modeling analysis by including more site-specific meteorology and truck fractions, the District recommends the following general procedures outlined in Section 4.0.

3.1.3 California Highways

This two part section describes a set of on-line tables that are available for estimating local, air quality-related, risks and hazards in the San Francisco Bay Area generated by motor vehicles traveling on the California State highway network. The first part of this section briefly discusses the data sources and technical approach used to produce the tables, including assumptions made in the technical approach. The second part of this section includes the location of the tables, presents recommended methods for applying the on-line tables, and provides an example application for a Bay Area location.

Data Sources and Technical Approach

To assess the air pollution from on-road motor vehicles on the State highways, an air quality modeling system was developed. This section describes the data sources and technical approach used within the modeling system. The main data sources and model inputs include the roadway network, the emissions, meteorological inputs, receptor locations, and risk factors and reference exposure levels for the emitted pollutants. Each of these elements is briefly described below.

Modeling Period

- The on-line tables for risks and hazards from motor vehicles on California freeways and highways in the Bay Area used emissions from year 2014. All $PM_{2.5}$ concentrations and hazard indices were calculated for year 2014. Cancer risk values were calculated for a seventy year period using emissions starting in year 2014 and continuing to year 2084.

- Meteorological data used were the latest year available for each of 64 stations in the Bay Area. Most of the observed meteorological data were from the period 2000 to 2008, but earlier years were used to maximize spatial coverage. The earliest data set used was from 1970. These years were all assumed to be representative of current meteorological conditions.

Freeway and Highway Network

- A representation of the State roadway network in the Air District boundaries (Figure 9) was developed by reconciling the National Highway Planning Network (NHPN) spatial database with the 2008 Topographically Integrated Geographic Encoding and Referencing (TIGER) Line spatial database. Both these data sources were available as geographical information system (GIS) shapefiles. The NHPN shapefile was adopted as

the primary data source. Road links missing from the NHPN data were filled in using data from the TIGER shapefile. The highway network was divided into segments, *links*, based on the availability of traffic counts on each roadway. There are 1236 links (numbered 0 through 1235) in the Bay Area network for which emissions were calculated and risks and hazards were estimated.

The number of lanes of traffic were developed starting with the number of lanes in the NHPN database. However, NHPN data did not include lane numbers for all highway links. For those links without assigned lane numbers, data were manually collected from Google Earth™ maps.

Emissions

To estimate emissions from on-road motor vehicles, vehicle activity (vehicle miles travelled) was first estimated on each roadway link, then activity-based emission factors were applied to estimate daily average emission totals on each link. Developing these emissions required a variety of data, including traffic volumes (activity), vehicle speeds, fleet mixes, emission factors, diurnal profiles, and growth and control factors (for projecting baseline traffic volumes and emission factors to future years). Sources of data used to estimate emissions are described below[2].

- Traffic activity on the State highway system was represented using 2009 Annual Daily Traffic (AADT) counts from the California Department of Transportation (Caltrans). AADT values represent the total traffic volume for the year divided by 365 days, and these counts are reported for state highway segments defined using milepost values. Caltrans provides AADT data for total traffic and for trucks only, with trucks classified by axle number (the two-axle class excludes pickups and vans with only four tires).

- Year 2009 traffic volumes were forecast to 2012 using county-level growth factors from the EMFAC2007 mobile source emissions model. EMFAC2007 was run for all Bay Area counties for 2009 and 2012, and vehicle miles of travel (VMT) output data were used to calculate the growth factors needed to project 2009 traffic volumes to 2012. Year 2012 activity data was assumed for all subsequent years.

- Vehicle speeds by highway segment were based on 2010 and 2015 outputs from the Metropolitan Transportation Commission's (MTC) BAYCAST-90 travel demand model.

- Link-level composite emission factors for trucks and light-duty vehicles were derived from EMFAC2007's Impact Rate Detail output (*.rtl files). EMFAC2007 was run for each year from 2012 to 2040, and details on calculating composite emission factors are provided in the section that follows. (Emissions past year 2040 were assumed to be constant at year 2040 levels.)

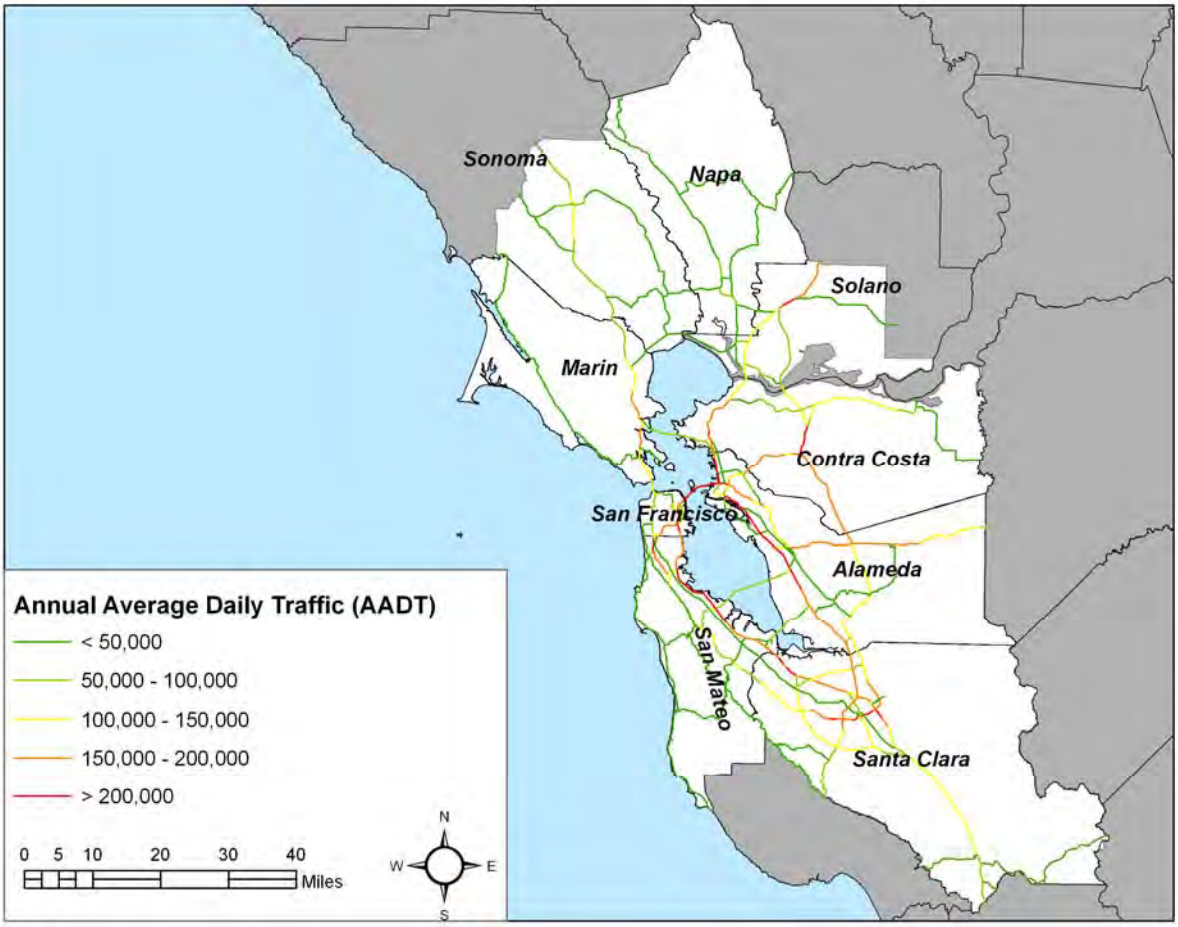
- County-specific diurnal profiles for trucks and light-duty vehicles were derived from EMFAC2007 (see Figure 6; Section 3.1.2).

[2] D. Yuan and S. Reid.Sonoma Technology, Inc., Technical Memorandum, Emissions estimates for State highways. April 27, 2011. STI-910044-TM, under contract to the Bay Area Air Quality Management District.

- Growth and control factors from CARB, including the impacts of the On-Road truck rule, were applied to estimates of emissions from on-road heavy duty trucks (see Table 4; Section 3.1.2).

The activity and speed data described above were linked to the GIS shapefile for the highway network. The base year AADT and truck percentages for each highway segment were joined as attributes to the State highway shapefile based on milepost values and roadway descriptions. Figure 9 shows a map of AADT-derived traffic volumes for the State highways in the Bay Area.

Figure 9. State highway network in the Bay Area Air Quality Management District, showing annual average daily traffic (AADT) on each highway link.



Once traffic volume and speed data were prepared, composite emission factors were developed for each highway link based on the associated truck percentage and average speed. Emission factors were generated for running exhaust and running losses only, as emissions for other modes (e.g., vehicle starts) are not relevant to the state highway system or are negligible compared to exhaust and running loss emissions. This general approach is consistent with the CT-EMFAC model, which is used by Caltrans to estimate transportation project emissions.

However, composite emission factors from CT-EMFAC could not be used directly because CT-EMFAC's truck emission factors include medium-duty vehicles (weight class of 5751 to 8500 lbs), while analysis of MVSTAFF[4] data for the state highway system indicated that Caltrans' AADT truck counts reflect heavy-duty truck (>8500 lbs) activity primarily. As a result, new composite emission factors for NOx, CO, TOG, SO2, CO2, PM, PM10, and PM2.5 were developed directly from EMFAC2007 runs for 2012 through 2040.

Meteorological information

Observed meteorological data from 64 sites in the Bay Area were used to supply wind speed and direction, mixing heights, and stability type information for dispersion modeling. These 64 sites provide reasonable approximations of common meteorological conditions for the 1236 roadway links. Most of the meteorological data are from the period 2000 to 2008, but some of the data were from the 1980's and 1990's. One site located near Moffet Field provided data from 1970. Recent wind measurements are available on-line, in a model-ready format at http://hank.baaqmd.gov/tec/data.

Receptor locations

Receptor locations were defined for locations at right angles to the center of each roadway link at distances of 10, 25, 50, 75, 100, 200, 300, 400, 500, 750, and 1,000 feet from the edge of the roadway (see Figure 10). Two sets of receptor heights were defined: 6 feet, which corresponding to typical breathing heights, and 20 feet, corresponding to a typical second-story height.

Dispersion Model

Emissions estimates, meteorological observations, and receptor locations were input to an air quality dispersion model to estimate near-roadway pollution concentrations. For modeling the State highway network, the model Rcaline[5] was applied. Rcaline is run within the statistical analysis and programming language R[6]. Rcaline provides an interface to the CALINE3[7] model developed by the California Department of Transportation (CalTrans). Given the same inputs, Rcaline has been tested to produce identical outputs CALINE.

Rcaline removes significant limitations found in previous implementations of CALINE. For example, it can be used to model large number of roadway links and a large number of receptors, limited only by available memory and CPU resources. By providing access to CALINE within the R environment, Rcaline facilitates running CALINE using contemporary data sources, such as GIS shapefiles, as input. Rcaline also provides full machine-precision access to CALINE model results in a convenient format. Rcaline facilitates the use basic R commands or third-party

[4] California Motor Vehicle Stock Travel and Fuel Forecast (see http://www.dot.ca.gov/hq/tsip/smb/mvstaff.html).
[5] D. Holstius. Rcaline: Modeling traffic-related pollution with R and the CALINE3 dispersion model. January 24, 2011. (Available on-line at http://169.229.208.128/groups/rcaline/).
[6] The R statistical analysis and programming language and documentation are freely available on-line at http://cran.r-project.org/.
[7] P.E. Benson. A review of the development and application of the CALINE3 and 4 models. *Atmospheric Environment*. Part B. Urban Atmosphere, 26(3):379-390, 1992.

R packages to visualize, compare, and export model results, for example producing shapefiles or Keyhole Markup Language (".kml") files as output.

Figure 10. Receptor locations (shown as white circles) to the west and east of a roadway link (shown as a red line). Receptor distances were taken from the edge of the roadway.

Estimating Risks and Hazards

- Unit risk factors and reference exposure levels for estimating cancer risk and hazard indices from diesel particulate matter and from gasoline exhaust and evaporative running losses were applied (see Sections 4 and 6).
- Age sensitivity factors (ASF) were applied in estimating the cancer risk to yearly emissions starting in 2014 through 2030 (see Table 11 in Section 4).

Output Format

The output from Rcaline used for the highway network is a compressed ".kml" file (".kmz"). A file was produced for each county and for each of the two sets of receptor heights (six feet and 20 feet). For example, two ".kmz" files are available for Alameda County, one at a typical receptor height (Alameda-6ft.kmz) and one at a typical 2nd story receptor height (Alameda-20ft.kmz). These files can be viewed using the Google Earth™ mapping software freely available online at http://www.google.com/earth/index.html. Each file shows a map of the highway network for the county. Selecting a link on the map will bring up a table with $PM_{2.5}$ concentrations in, units of micrograms per cubic meter; cancer risk, in units of expected risk per million; chronic hazard index, a unitless ratio; and acute hazard index, also a unitless ratio, at distances on either side of the highway.

Application of the Tables

The purpose of the highway screening tables is to provide an easy-to-use initial analysis to determine if nearby highway impacts to a new receptor are below the thresholds of significance. The outcome of the screening may be used to assess a determination of no further action or it may indicate that a more refined analysis is warranted.

The highway screening analysis tool present $PM_{2.5}$ concentrations, cancer risks, and chronic and acute hazard index for all State highway segments in the Bay Area at specified distances away from the edge of each highway link within a county. Each highway link includes a table with concentrations for north/south or east/west roadway configurations. Concentrations, risks, and hazards in the tables are provided at 10 feet, 25 feet, 50 feet, 75 feet, 100 feet, 200 feet, 300 feet, 400 feet, 500 feet, 750 feet, and 1,000 feet from the edge of the roadway closest to the project. Concentrations were estimated at two different heights, six feet and 20 feet. The six feet height estimates represent concentration levels when receptors are located on the ground floor of a building; and the 20 feet height estimates concentration levels, risks, and hazards at a eight typical of the second floor of a building. To apply these tables, the following steps are recommended:

1. Download the county-specific ".kmz" files in which the project will be located. The Google Earth™ ".kmz" tables are located at the District web site: http://www.baaqmd.gov/Divisions/Planning-and-Research/CEQA-GUIDELINES/Tools-and-Methodology.aspx. Prior to using the tables, the user must know the distance from the project to the highway. To determine the distance from the project to the roadway, the users can use the ruler tool in any mapping program. The District routinely uses the ruler tool in Google Earth™ to measure the distance from the edge of the project to the nearest traffic lane, see example in Figure 8 (Section 3.1.2) above. For new residential developments, the receptor should be placed at the edge of the property boundary.

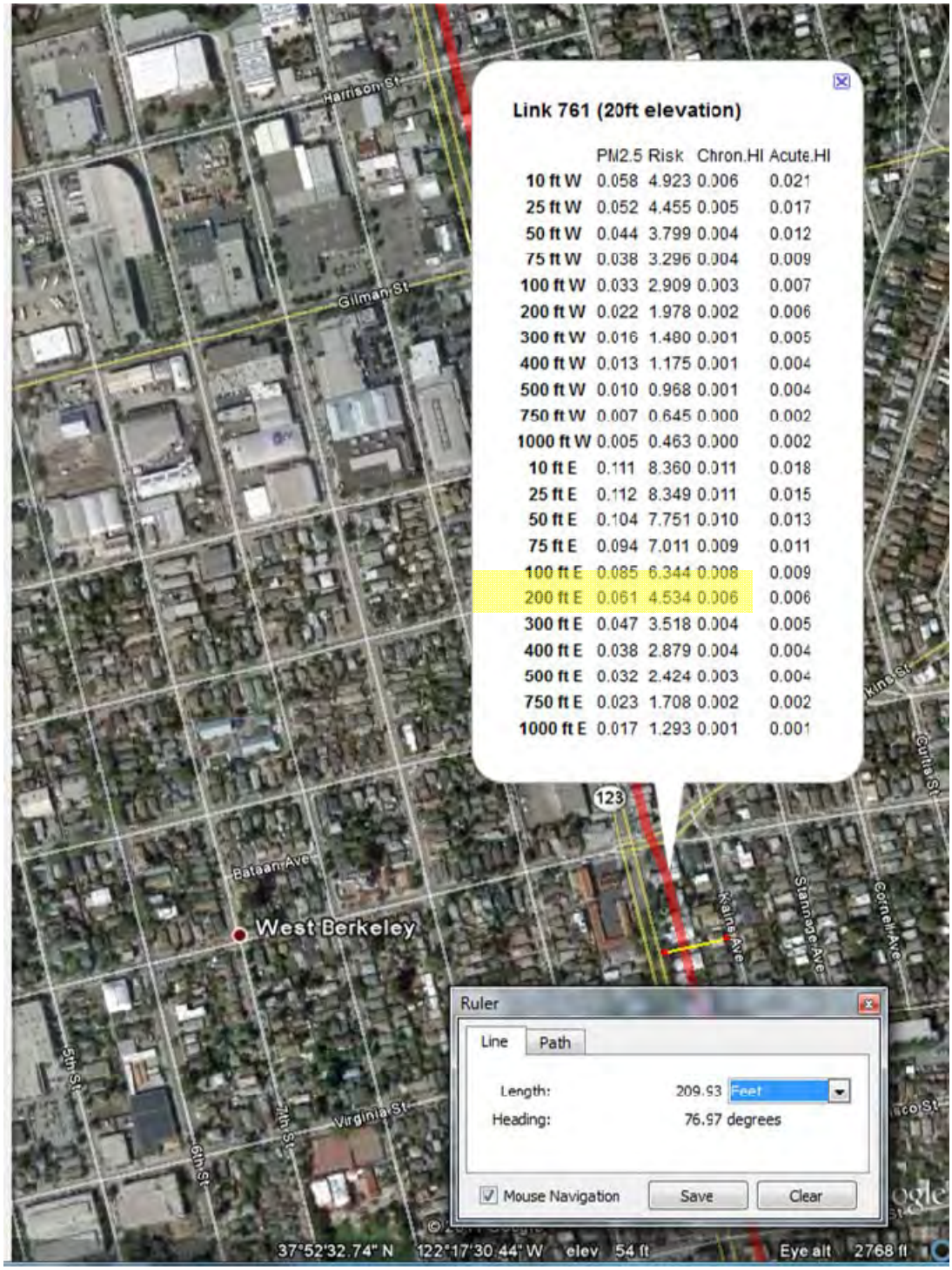
2. If the receptor does not have any significant highway sources within 1,000 foot radius, then the proposed project meets the distance requirements and no further single-source roadway-related air quality evaluation is recommended.

3. If there are highway segments within 1,000 feet of the roadway, the user then clicks on the highway segments within a 1,000 foot radius of the project. As an example, if a proposed project is located 200 feet east of San Pablo Avenue (Highway 123) in Berkeley, and it is known that the ground floor of the project will not house any receptors, the Alameda county ".kmz" file for 20 feet should be downloaded from the BAAQMD website.

4. Once opened in Google Earth™, the closest Highway 123 link to the project should be clicked on for a summary of the estimated risk and hazard impacts at that highway segment. A user would then use the risk and hazard impacts listed at 200 feet east of the freeway in its project analysis. In this case, the highway link table indicates that at 200 feet east of the highway, the $PM_{2.5}$ concentration is estimated at 0.061 ug/m^3, the cancer risk at 4.524 per million, the chronic hazard index at 0.006, and the acute hazard index at 0.006. Figure 11 below illustrates this example using a snapshot from Google Earth™.

5. If a project is located between two highway links for the same roadway, the higher values between the two highway links or distance points should be used.

Figure 11. Example of Applying the Highway Screening Tables



6. If the project is between two distances, tabulated values may be further refined by linearly interpolating between values in the table. The same linear interpolating

methodology outlined for roadways in Section 3.1.2 (see Table 5) may be used for highways.

7. If the user chooses to conduct a more refined modeling analysis by including more site-specific meteorology and truck fractions, the District recommends the following general procedures outlined in Section 4.0.

3.2 Permitted Sources

The District has developed a geographical database of cancer risks, hazards, and $PM_{2.5}$ concentrations for most stationary sources permitted by the District in the year 2008. This database is in the form of a set of compressed Keyhole Markup Language (kml) files that can be viewed with the Google Earth™ software package. The values represent concentrations near the fence-line of the plant.

Note that the screening-level impacts for health risk and $PM_{2.5}$ concentration in the permitted source geographical database are upper-bound estimates. **These values do not represent the true risk values from a plant.** Rather, because the estimates are conservative by design, if a plant passes screening, it can be assumed that it would pass a more site-specific, detailed modeling analysis.

For a few sources, the District modeled the emissions from all sources at the plant as part of its permit and has included the site-specific cancer risk, $PM_{2.5}$ concentrations, and hazards estimated from the health risk assessment in the database. These plants are noted in the database with an "*" at the end of their plant names.

The permitted source screening table contains all the plants in the Bay Area that have permits to operate and that emit one or more toxic air contaminants. The types of permitted sources include, but are not limited to: refinery sources, gasoline dispensing facilities, dry cleaners, diesel internal combustion engines, natural gas turbines, crematories, landfills, waste water treatment facilities, hospitals and coffee roasters. The screening table contains the following information:

- Unique Plant Number used by the District to identify them (Plant Number starting with "G" are gasoline dispensing facilities that be retail or non-retail)
- Plant name
- Geocoded location for the Plant (Universal Transverse Mercador (UTM) coordinates)
- Conservatively estimated health risk impacts due to emissions from the plant that are to be used for screening purposes only: Cancer risk (in millions) and chronic hazard index impacts unless an "*" has been added to the end of the plant name, in which case, the values were derived from a site-specific health risk assessment. Please note that the screening values do not include acute hazard index since the maximum values are significantly below the thresholds.
- Conservatively estimated $PM_{2.5}$ concentrations (in units of micrograms per cubic meters)

The screening-level health risk impacts in the permitted source screening table are calculated using health effect values adopted by the Office of Environmental Health Hazard Assessment

(OEHHA); health-protective assumptions relating to the extent of an individual's exposure, including age sensitivity factors; and a conservative modeling procedure to establish the extent to which a TAC is dispersed in the atmosphere after its release from the source.

For permitted source categories other than gasoline dispensing facilities, the screening-level impacts for health risk and $PM_{2.5}$ concentrations in the permitted source screening table are based on the same screening-level dispersion modeling procedure that was used to develop the trigger levels in District Regulation 2, Rule 5, Table 2-5-1, Toxic Air Contaminant Trigger Levels (http://www.baaqmd.gov/Divisions/Planning-and-Research/Rules-and-Regulations.aspx). This modeling uses a cavity effects screening procedure where dispersion is affected by aerodynamic downwash from a nearby building and relates emission rate to one-hour average ambient air concentrations. The cavity region occurs immediately adjacent to the lee side of the building and is often the "worst-case" dispersion scenario where receptor areas are in close proximity to the source being evaluated. The cavity effects equation is provided in EPA's Screening Procedures for Estimating the Air Quality Impact of Stationary Sources (EPA, 1992), and is incorporated into the EPA SCREEN3 model (EPA, 1995).
The cavity equation is as follows:

$$\text{Conc}_{\text{1 Hour Max}} = Q / (1.5 \times A \times u)$$

Where:
Conc = One hour maximum exposure concentration at the fenceline of the plant (ug/m^3);
Q = Emission rate (g/sec);
A = Cross section area of the building normal to the wind (m^2); and
u = Wind speed (m/sec).

The cavity effects equation requires the selection of the crosswind building area and the average wind speed. A value of 92.7 square meters was used for the crosswind building area (e.g., a building approximately 25 feet high x 40 feet wide). The average wind speed was taken to be two meters per second, based on EPA screening modeling guidelines. The cavity equation was used to estimate maximum one hour concentration. In order to estimate the annual average concentration for chronic exposure, a multiplying factor representing the ratio between annual average and one-hour maximum concentrations of 0.1 was used. This is the high-end value of the range of multiplying factors provided in EPA screening modeling guidelines (EPA, 1982).

Evaluating gasoline dispensing facilities (GDFs) are more complex because emissions come from spills, vents, and the dispensing pumps. For this source categories, the screening health risk calculations were further refined. EPA's AERMOD atmospheric dispersion model was used to develop worst-case ground-level concentrations and to develop distance adjustment multipliers. AERMET processed meteorological data sets used in the matrix of modeling runs include those for Concord, Hunters Point, Oakland Airport, Petaluma Airport, UC Richmond and San Jose Airport. Over two dozen different building dimensions were modeled to include downwash effects. GDF were conservatively modeled as a point source for the storage tank vent with a 10-feet high two inch diameter stack, 0.00035 m/s exhaust gas velocity and $294^{o}K$ exhaust gas temperature; and a single volume source for the refueling and spillage at the dispenser with

an initial lateral dimension of 2.3 feet. The fraction of emissions out the vent and at the dispenser was estimated at 0.073 and 0.927, respectively.

The screening health risk values calculated for GDFs are based on the worst-case concentrations determined through the AERMOD modeling results. Distance adjustment multipliers were developed to adjust (lower) the screening health risk values for GDF when the distance from the receptor location to the source is greater than 60 feet. The District followed the same methodology to estimate downwind multipliers for diesel engines since they are ubiquitous throughout the Bay Area. These distance adjustment multipliers are to be used only in conjunction with the screening health risk values for diesel engines and GDFs and may not be used for other source types. The user should contact the District Planning Division to receive copies of the downwind multipliers for these sources.

The screening-level impacts for health risk and $PM_{2.5}$ concentrations in the permitted source screening table do not represent actual impacts. Rather, the values are upper-bound estimates used as a screening tool to determine whether or not a refined modeling analysis is required and to identify those plants that may warrant further analysis to determine actual risk. The calculations used to determine the screening table impacts do not include source specific exhaust information such as stack height, exhaust gas exit velocity, exhaust gas temperature, nor do they account for the distances to actual receptors. A more refined analysis using source specific exhaust parameters, site specific meteorological data, site specific building dimensions and locations, and actual location of source and receptors is expected to result in significantly lower and more accurate values than those found in the permitted source screening table.

The permitted source screening table may be used to determine which plants to include in a refined modeling analysis for a project. The impacts for the plants identified can then be summed and compared to the trigger levels in the CEQA guidance document to determine if further analysis is required. Note that the UTM coordinates represent only a single point at a plant, which may not be the point closest to the project. Also, the reference points (North American Datum, NAD) for the UTM coordinates in the screening table may not be the same for all plants. UTM coordinates for some facilities may be reference to NAD27, while others are reference to NAD83. Potential distance offsets may be as great as 220 meters. In order to ensure that all relevant plants are included, the distance used to identify facilities from the permitted source screening table should extend a reasonable distance beyond the distance specified in the CEQA guidance document and actual locations should be verified.

All plant information within each of the nine Bay Area county were then converted to kml file format (format compatible with Google Earth™) that retained site-specific plant information and geocoded the plant coordinates. Each of the county files can be found at: http://www.baaqmd.gov/Divisions/Planning-and-Research/CEQA-GUIDELINES.aspx.

The Google Earth™ application is a free mapping software package that can be downloaded at: http://earth.google.com/. To use the application, a user should complete the following steps:

- Install Google Earth™ on user's computer;

- Download the county-specific permitted source data in kml file format from the District web site (see link above) onto a user's hard drive;
- Double click on the kmz file on the user's hard drive and it will automatically open Google Earth™ and plot the permitted sources as colored dots on a map; and
- Point to any source and a dialog box will open containing the plant number, GDF number, facility name, and estimates of risk, hazards, and $PM_{2.5}$ concentrations.

The user then uses the "polygon" tool in Google Earth™ to plot the 1,000 foot radius around the plant or the receptor to determine which sources should be included in the single source and cumulative analysis. As previously discussed, the estimates shown in these screening tables are conservative and do not account for dilution of the concentrations further downwind of the source. The District recommends initially summing the values for cancer risk, hazards, and $PM_{2.5}$ from all sources within 1,000 foot radius of the project to estimate cumulative impacts. In the example shown in Figure 12, a rough 1,000 radius (highlighted in yellow) is shown for Plant 10927. For the cumulative analysis, the District recommends summing the values for the two other sources found within 1000 foot radius, namely values for plants G9452 and 15416.

Figure 12. Example Stationary Source Inventory and Boundary

For plants that have "Contact District Staff" in the values, the user should download the "Stationary Source Inquiry Form" located at: http://www.baaqmd.gov/Divisions/Planning-and-Research/CEQA-GUIDELINES/Tools-and-Methodology.aspx. Instructions are provided in the form as to how to fill out and send the form to the District. If any single source exceeds the single source impact thresholds or the sum of all sources exceeds the cumulative impact thresholds then the user should consider possible mitigations that can reduce the potential air quality impacts.

4.0 REFINED MODELING APPROACH

If the screening analysis shows that a proposed project or new development may exceed the $PM_{2.5}$, risk, or hazard threshold, then a more refined modeling analysis may be prepared. A refined analysis is generally more accurate since it incorporates site-specific conditions that are not accounted for the screening approach.

There are several air dispersion models available that can be used in the refined analysis. The choice of model will vary depending on the modelers experience and the available site-specific information. The first tiers of models are screening models that are available through free downloads from US EPA web site. These models are easy to use and require limited site specific information including the types of source (point, area, or volume), dimensions of source, and emissions. These models simulate one source at a time and include default worst case meteorological data to predict the maximum one hour concentrations at a specific distance downwind of the source.

More sophisticated models are highlighted in the next tier of analysis where multiple sources and site-specific meteorological data can be used. The models require some familiarity with air dispersion modeling concepts and site conditions and emission release characteristics of the sources to be modeled. Note that the user is not required to conduct the analysis following this tiered approach; at any time, he or she can skip ahead to perform a more refined analysis.

4.1 General Air Dispersion Modeling Concepts

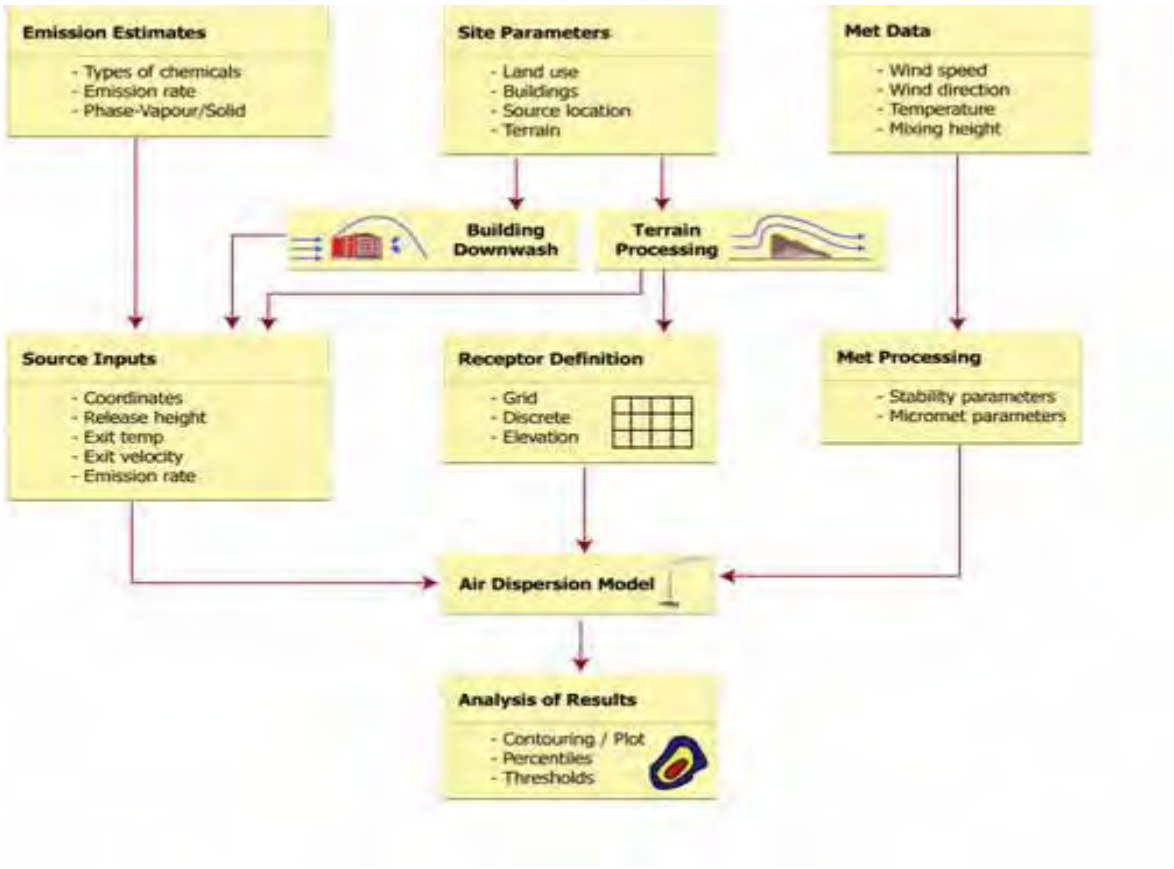
Air dispersion modeling is the mathematical estimation of pollutant impacts from emissions sources within a project radius. Several factors impact the fate and transport of pollutants in the atmosphere including, but not limited to meteorological conditions, site configuration, emission release characteristics, and surrounding terrain. Figure 13[11] presents a general overview of the process typically followed for performing an air dispersion modeling assessment. Highlighted in the figure are some key concepts that need to be defined prior to conducting an air dispersion modeling analysis.

4.1.1 Coordinate System

Any modeling assessment requires a coordinate system of the project radius to be defined in order to assess the relative distances from sources to receptors and, where necessary, to consider other geographical features. Using a standard coordinate system for a project increases the efficiency of the review process while providing real-world information about the site location. For screening purposes, a simple straight line of receptors that are spaced equal distances from the source may suffice. More refined models places receptors along a Cartesian grid or on radial distances from a center point.

[11] CAPCOA, 2009. Health Risk Assessments for Proposed Land Use Projects. Prepared by CAPCOA Planning Managers. Released July 2009.

Figure 13. Generalized Process for Performing a Refined Air Dispersion Modeling Analysis



Source: CAPCOA, 2009.

Most air models use the UTM coordinates. The UTM system uses meters as its basic unit of measurement and allows for more precise definition of specific locations than latitude/longitude. The project sponsor should ensure that the same horizontal datum is used throughout the project to define all objects (sources, buildings, and receptors). Defining some objects based on a NAD27 (North American datum of 1927) while defining others within a NAD83 (North American datum of 1983) can lead to significant errors in relative locations of up to 220 meters. The Google Earth™ mapping application can be used to determine UTM or latitude/longitude coordinates for the project area.

For a localized assessment, the user may use local coordinates that are relative to local set datum and not based on a geographic standard. For example, a facility may reference the northwest corner of the perimeter of the property boundary as the origin (0,0) of the coordinate system and have all other locations identified based on its location relative to this defined local datum. All plant buildings and sources are then related spatially to this origin as well as all site measurements are estimated relative to the local coordinate system.

The only caveat to using the local coordinate system is that it cannot be compared or spatially mapped to other sources or receptors in the actual world. For this reason, it is advantageous to

consider a geographic coordinate system that can specify the location of any object anywhere in the world with precision.

4.1.2 Receptor Grid

A receptor is defined as a point where an actual person (residential) may be located for a given period of time and may include:

- Residential dwellings, including apartments, houses, condominiums;
- Schools, colleges, and universities;
- Daycares;
- Hospitals; and
- Senior-care facilities.

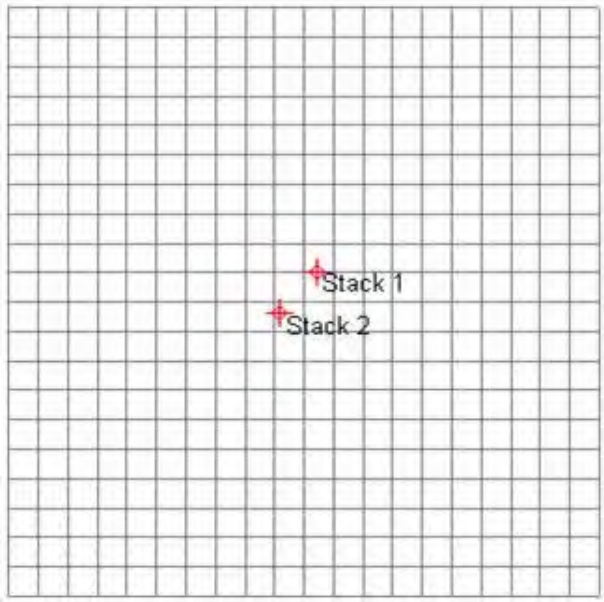
For CEQA evaluations, the length of time can vary from one hour for acute hazard evaluation, one year for $PM_{2.5}$ exposures, and 70 years for chronic cancer risk and hazard assessments. For each of these evaluations, the District is recommending that all sensitive receptors be identified within the project radius. Motels, trailer parks, residential camp grounds, and other places where people reside for long periods should also be considered sensitive, residential receptors.

The receptor grid identifies a series of receptor locations in which the model will estimate air concentrations. The grid does not necessary corresponds to actual home locations, but is a means of developing isopleths that illustrate the dispersion pattern of the source emissions and anticipated downwind concentration in the community or project radius. Discrete receptors that represent actual individualized locations (discrete receptors) where people reside can be added to the model. Fenceline receptors, which correspond to the placement of receptors along the perimeter of the project's property, should only be employed if there are existing or reasonably anticipated future sensitive receptors who will be residing in this area. Receptor grids do not always cover precise locations that may be of interest in modeling projects.

There are several techniques that can be used in air dispersion modeling for defining a receptor grid. The most commonly used receptor grid is the Cartesian grid, which is defined by an origin with receptor points evenly (uniform) or unevenly (non-uniform) spaced around the origin. Figure 14 illustrates a sample uniform Cartesian receptor grid. The grid should encompass the entire area of the project radius and be spaced appropriately to identify the most impacted receptor. For cases with emissions from short stacks or vents and a close property line, a receptor spacing of 10 meters may be sufficient. For taller stacks and greater distances to the property boundary, a receptor spacing greater than 25 meter, but less than 50 meters may be appropriate to ensure adequate coverage of the project area.

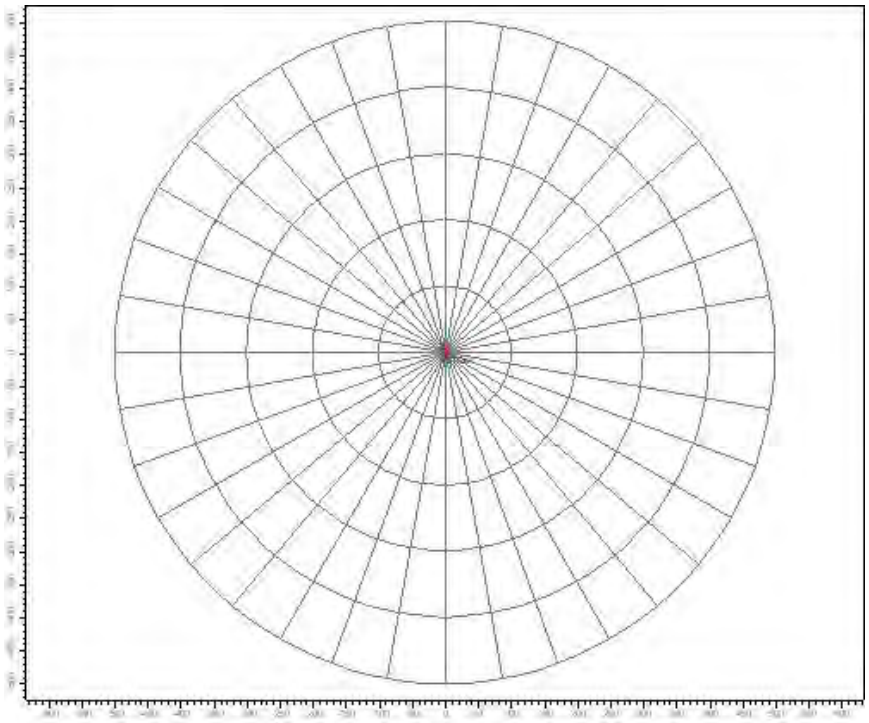
Another less commonly used receptor grid is polar grid system, which are characterized by an origin with receptor points defined by the intersection of concentric rings, which have defined distances in meters from the origin, with direction radials that are separated by specified degree spacing. Figure 15 illustrates a sample uniform polar receptor grid.

Figure 14. Example of a Cartesian Grid



Source: CAPCOA, 2009

Figure 15. Example of a Polar Grid



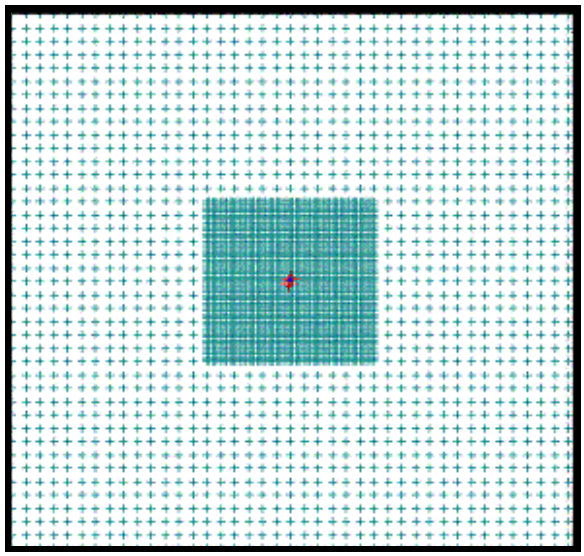
Source: CAPCOA, 2009

Polar grids are used when only one source or one dominant source is being modeled. However, for facilities with a number of significant emissions sources, receptor spacing can become too

coarse (receptor points are too far apart) when using polar grids such that the maximum impacted area is not clearly identified. As a result, polar grids should generally be used in conjunction with Cartesian grid to ensure adequate spacing.

The model estimates a concentration for each point of a grid which requires extensive computational time. For large modeling domains, project sponsors can use a combination of coarse and fine grids in one modeling run to encompass the project area. As illustrated in Figure 16, a fine grid receptor of tightly spaced receptors is defined near the source and larger grid spacing is defined for the area outside of the fine grid. The advantage of this approach is that it reduces the number of receptors, but maintains sufficient resolution such that the maximum impact area is well defined. Receptors should also be placed along the property boundaries. The spacing of these receptors depends on the distance from the emission sources to the facility boundaries. It is the responsibility of the user to demonstrate that adequate receptor grid spacing has been used and that the modeling results have captured all areas that may potentially be impacted from the project where the toxic thresholds may be exceeded.

Figure 16. Sample Combination Grid System with Two Types of Receptor Spacing



Source: CAPCOA, 2009

4.1.3 Averaging Times

A key advantage of the refined modeling analysis is the ability to select the appropriate averaging time with which to compare to the CEQA thresholds. The District has defined different thresholds depending on the health effects and time of exposure. For example, cancer risks and chronic noncancer hazard are assessed for long term exposures over 70 years. Acute noncancer health effects are usually based on a maximum one hour exposure. $PM_{2.5}$ concentrations are based on annual average exposures. The ability to assess air quality using the most appropriate effects-based averaging time means the refined air dispersion models provide a more representative assessment of health and environmental impacts of air emissions from a plant.

In addition to enabling the use of appropriate model averaging times, refined models allow the input of project-specific conditions such as variable source emission rates and hours of operation, to more accurately assess the concentrations over different averaging times. That is, a source that operates only during certain hours of the day can be modeled using only those hours of meteorological data. The averaging time should also reflect the time during which a receptor would be exposed. For example, suppose a construction project that is anticipated to start in 2010 and complete at the end of 2012 is projected to house new residents in 2013. The construction analysis should be performed for two years and compared to the appropriate thresholds. For the residential evaluation, the anticipated air concentrations from roads should be reflective of 2013 for $PM_{2.5}$, diesel exhaust, and acute hazard while the long term cancer exposures should be averaged over 2013 to 2083 (70 year exposure period).

4.1.4 Terrain

Terrain elevation is defined as the elevation relative to the facility base elevation. Terrain elevations can have a large impact on the air dispersion and deposition modeling results and therefore on the estimates of potential risk and hazard to human health and the environment. The terrain type is based on the project area and can be characterized as either being simple or complex described as follows:

- Complex Terrain: the terrain elevations within 50 kilometers of the stack are above the top of the source stack being evaluated in the air modeling analysis (see Figure 17).

- Simple Terrain: the terrain elevations within 50 kilometers of the stack are below the top of the source stack being evaluated in the air modeling analysis. The “Simple” terrain can be divided further into two categories:

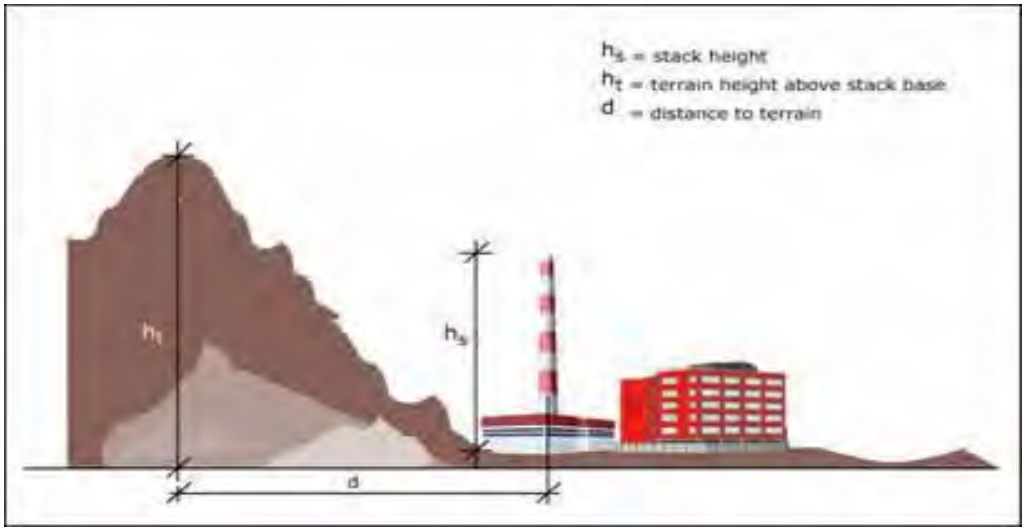
    - Simple Flat Terrain is used where terrain elevations are assumed not to exceed stack base elevation. If this option is used, then terrain height is considered to be zero meters (0.0 m).
    - Simple Elevated Terrain, as illustrated in Figure 18 is used where terrain elevations exceed stack base but are below stack height.

The identification of accurate terrain conditions is the responsibility of the user. It should be remembered that complex terrain is any terrain within the study area that is above the source release height. The appropriate terrain environment can be determined through the use of digital elevation data or other geographic data sources. Digital elevation terrain data is available from a variety of vendors in several different formats. Digital elevation model (DEM) data are available for free from Lakes Environmental's Web GIS web page http://www.webgis.com and USGS DEM files are available from CARB at http://www.arb.ca.gov/toxics/harp/maps.htm. USGS DEMs are in 7.5-minute format for use in the CARB’s HARP program and from Lakes Environmental in either 7.5 minute or 1 degree formats.

The District recommends using 7.5-minute data in air dispersion modeling rather than the coarse resolution 1 degree data. The project sponsor should also be mindful that the USGS DEMs are available in two horizontal datums. Older DEMs were commonly in NAD27 (North American

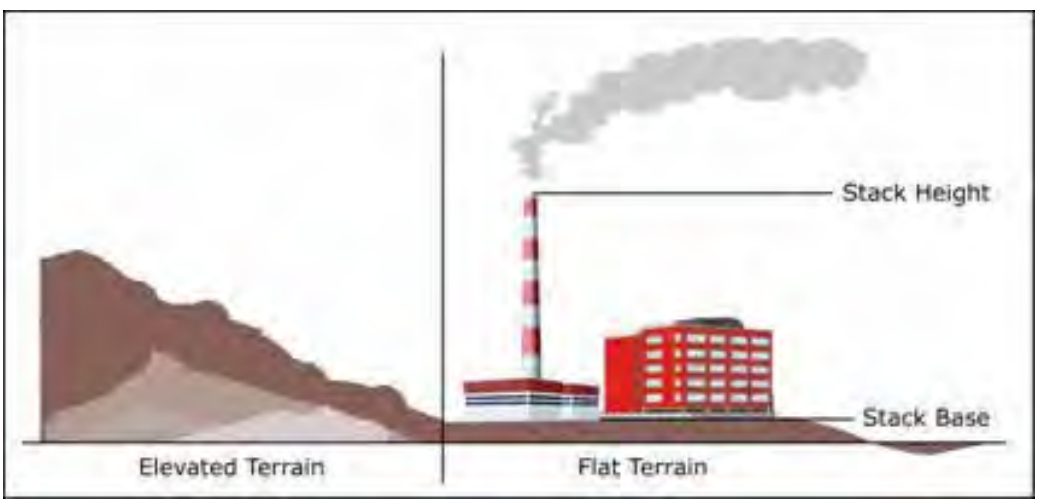
Datum of 1927) while many of the latest versions are in NAD83 (North American Datum of 1983).

Figure 17. Complex Terrain Conditions



Source: CAPCOA, 2009

Figure 18. Two Types of Simple Terrain Conditions



Source: CAPCOA, 2009

There are different requirements for importing DEMs file into refined air models. The user should review the air model's User's Manual to determine if the format is compatible or if files need to exported to another program for preprocessing (i.e., AERMAP must be used to pre-process the digital terrain data to make it compatible for AERMOD).

4.1.5 Urban or Rural Conditions

Refined modeling takes into account different types of land use categories: rural or urban. The classification of a site as urban or rural can be based on the Auer method specified in the EPA document *Guideline on Air Quality Models (40 CFR Part 51, Appendix W)*[12]. From the Auer's method, areas typically defined as Rural include:

- Residences with grass lawns and trees
- Large estates
- Metropolitan parks and golf courses
- Agricultural areas
- Undeveloped land
- Water surfaces

Auer suggests that an area can be classified as urban if it has less than 35% vegetation coverage or the area falls into one of the following use types:

Table 6. Urban Land Use

Type	Use and Structures	Vegetation
I1	Heavy industrial	Less than 5%
I2	Light/moderate industrial	Less than 5%
C1	Commercial	Less than 15%
R2	Dense single / multi-family	Less than 30%
R3	Multi-family, two-story	Less than 35%

Follow the Auer's method, explained below, for the selection of either urban or rural dispersion coefficients:

Step 1: Draw a circle with a radius of three kilometers from the center of the stack or centroid of the polygon formed by the facility stacks. Overlay a grid on top of the circle as illustrated in Figure 18.

Step 2: Identify each square as primarily being urban or rural under the land use classifications in Table 4. If over 50% of all the squares within the circle are I1, I2, C1, R2, and R3, then the area is classified as urban, otherwise the area is classified as rural.

Another approach to selecting the urban versus rural classification is to use the Population Density Procedure where the average population density, p, per square kilometer is determined.

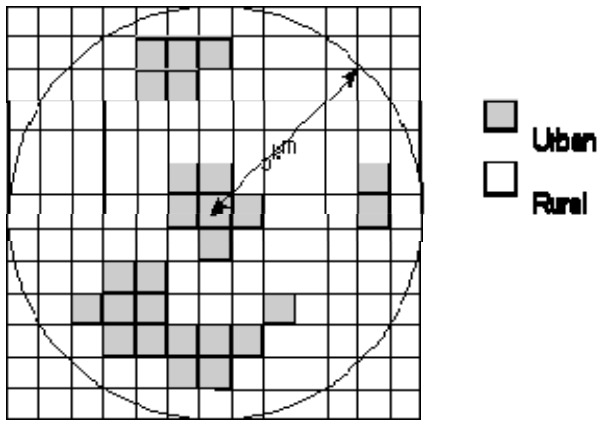
- If $p > 750$ people/km^2, select the Urban option,

[12] U.S. Environmental Protection Agency, 2001. Appendix W to Part 51 Guideline on Air Quality Models, 40 CFR Part 51. U. S. Environmental Protection Agency, Research Triangle Park, NC.

- If p <= 750 people/km^2, select the Rural option.

Of the two methods above, the land use procedure is considered a more definitive criterion. The population density procedure should be used with caution and should not be applied to highly industrialized areas where the population density may be low and thus a rural classification would be indicated, but the area is sufficiently built-up so that the urban land use criteria would be satisfied. In this case, the classification should be urban and urban dispersion parameters should be used. For simplicity, the project sponsor can model both urban and rural land uses and use the most conservative concentrations predicted from the two analyses. In most cases, the rural conditions will produce the highest downwind concentrations.

Figure 18. Example of How to Determine Land Use Designation



Source: CAPCOA, 2009

4.1.6 Building Impacts

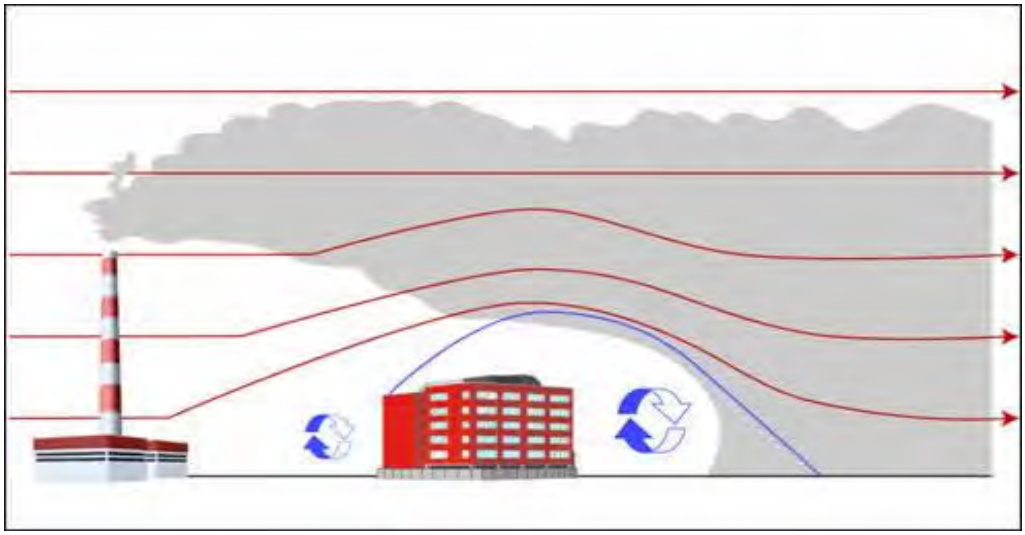
Buildings and other structures near a relatively short stack can have a substantial effect on plume transport and dispersion, and on the resulting ground-level concentrations that are observed. When the airflow meets a building (or other obstruction), it is forced up and over the building. On the lee side of the building, the flow separates, leaving a closed circulation containing lower wind speeds. Farther downwind, the air flows downward again. In addition, building increases the amount of *wind shear* and, as a result, more turbulence, such *as turbulent wake zone* (see Figure 19).

If a plume gets caught in the *cavity* caused by buildings, very high concentrations can result. If the plume escapes the cavity, but remains in the turbulent wake, it may be carried downward and dispersed more rapidly by the turbulence. This can result in either higher (reduced mixing) or lower concentrations (enhanced mixing) than would occur without the building, depending on whether the reduced height or increased turbulent diffusion has the greater effect.

There has long been a “rule of thumb” that a stack should be at least 2.5 times the height of adjacent buildings. This is called the “good engineering practice” (GEP) stack height. The US

EPA[13] states that "If stacks for new or existing major sources are found to be less than the height defined by the US EPA's refined formula for determining GEP height, then air quality impacts associated with cavity or wake effects due to the nearby building structures should be determined."

Figure 19. Dispersion Pattern due to Building Downwash



Source: CAPCOA, 2009

The US EPA's refined formula for determining GEP stack height is:

GEP Stack Height = H + 1.5L

where,

GEP = Good Engineering Practice

H = Building/Tier Height measured from ground to the highest point

L = Lesser of the Building Height (PB) or Projected Building Width (PBW)

US EPA recommends evaluating building downwash only when the building is considered sufficiently close to a stack to cause wake effects. Building effects should only be considered when the distance between the stack and the nearest part of the building is less than or equal to five (5) times the lesser of the building height or the projected width of the building.

$$\text{Distance}_{\text{stack-bldg}} <= 5L$$

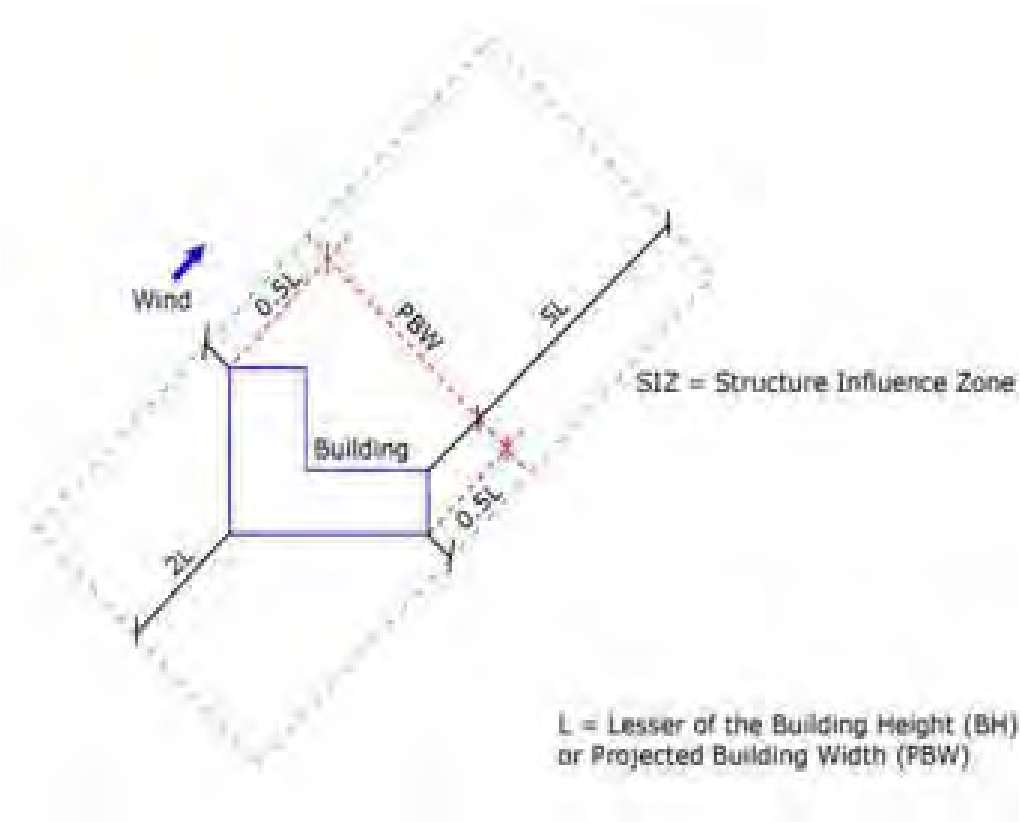
The user can use algorithms in US EPA's Building Profile Input Program – Plume Rise Model Enhancements (BPIP-PRIME) to estimate the directional-specific building heights and widths. For downwash analyses with direction-specific building dimensions, wake effects are assumed to occur if the stack is within a rectangle composed of two lines perpendicular to the wind

[13] U.S. Environmental Protection Agency, 1990. Stack Heights, Section 123, Clean Air Act, 40 CFR Part 51. U. S. Environmental Protection Agency, Research Triangle Park, NC.

direction, one at 5L downwind of the building and the other at 2L upwind of the building, and by two lines parallel to the wind direction, each at 0.5L away from each side of the building, as shown below. L is the lesser of the height or projected width. This rectangular area has been termed a Structure Influence Zone (SIZ). Any stack within the SIZ for any wind direction is potentially affected by GEP wake effects for some wind direction, or range of wind directions (see Figures 20 and 21).

It is the responsibility of the user to identify whether any building in the vicinity of the project meet the GEP requirements and building downwash effects should be considered. The recommended refined models incorporate algorithms to handle building downwash. The screening model, SCREEN3, considers the effects of a single building and the user is prompted to enter the building height, minimum horizontal building dimension, and maximum horizontal building dimension in meters. If using automated distances or discrete distances option in the SCREEN3 model, wake effects are included in the calculations. Cavity calculations are made for two building orientations, first with the minimum horizontal building dimension along wind, and second with the maximum horizontal dimension along wind. For more information regarding the cavity calculations, the user is referred to Section 3.6 of the SCREEN3 User's Guide[15] Section 3.6 (or see Section 3.2).

Figure 20. GEP 5L and Structure Influence Zone (SIZ) Areas of Influence



Source: CAPCOA, 2009.

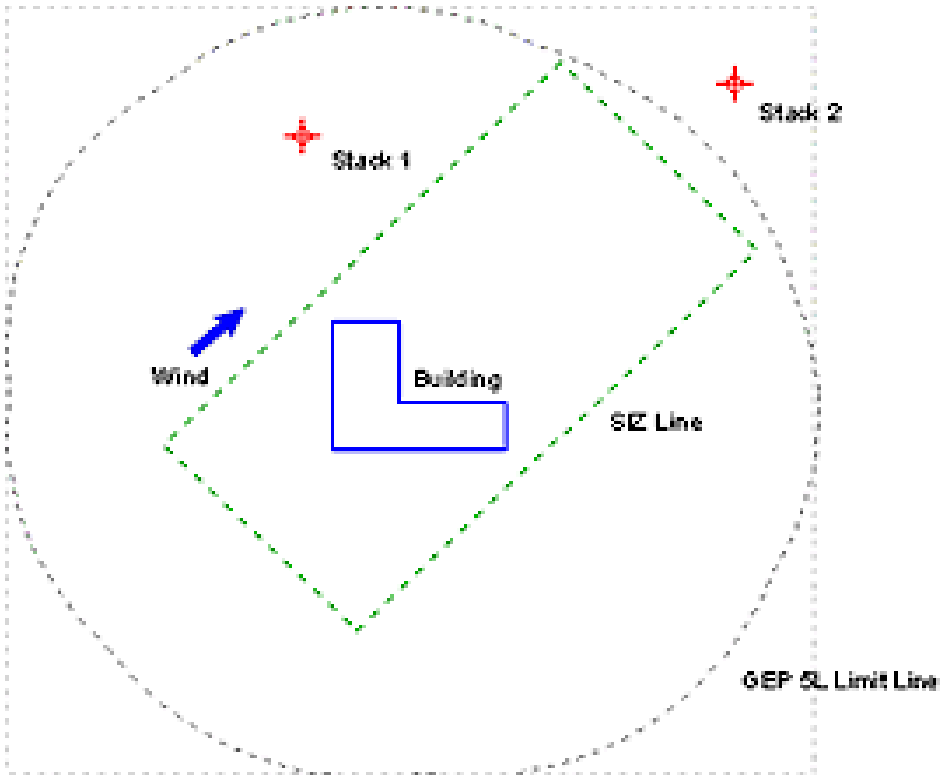
[15] U.S. Environmental Protection Agency, 1995. SCREEN3 Model User's Guide. EPA-454/B-95-004. Office of Air Quality Planning and Standards, Research Triangle Park, NC.

The more refined models (such as AERMOD and ISCST3/ISC-PRIME) can model the effects of complicated sites consisting of up to hundreds of buildings. The inclusion of the PRIME (Plume Rise Model Enhancements) algorithm[16] to compute building downwash produces more accurate results. The following information is required to perform building downwash analysis within BPIP:

- X and Y location for all stacks and building corners.
- Height for all stacks and buildings (meters). For building with more than one height or roofline, identify each height (tier).
- Base elevations for all stacks and buildings.

For a more detailed technical description of the EPA BPIP-PRIME model see the Addendum to ISC3 User's Guide[17]. The BPIP User's Guide[18] provides details on how to input building and stack data to the program.

Figure 21. GEP 360° 5L and Structure Influence Zone (SIZ) Areas of Influence



Source: CAPCOA, 2009

[16] Schulman, L.L., D.G. Strimaitis and J.S. Scire, 2000: Development and evaluation of the PRIME plume rise and building downwash model. Journal of the Air & Waste Management Association, 50:378-390.

[17] Schulman, et al., 1997. Addendum - User's Guide for the Industrial Source Complex (ISC3) Dispersion Models, Volume 1. Office of Air Quality Planning and Standards, Research Triangle Park, NC.

[18] U.S. Environmental Protection Agency, 1995. User's Guide to the Building Profile Input Program, EPA-454/R-93-038, Office of Air Quality Planning and Standards, Research Triangle Park, N.C.

4.1.7 Multiple Sources

In a proposed project, multiple sources may be present, especially when modeling to evaluate cumulative impacts from all nearby sources to a receptor. When the plumes from multiple sources emerge, the plume rise can be enhanced, due to combined wake effects, and the downwind concentrations can be somewhat modified compared to summing individual simulations of the same sources. Source groups in refined models (i.e, AERMOD and ISC) enable the creation of source groups "ALL" that considered all the sources at the same time. Analysis of individual groups of sources in either model can be performed by using the SRCGROUP option. One example may be assigning each source to a separate source group to determine the maximum concentration generated by each individual source.

For screening models, only one source can be simulated at a time. For a screening model analysis, the District recommends summing the concentrations estimated from each source run to assess cumulative impacts from the proposed project.

4.2 Tier 1 SCREEN3

The District recommends the use of SCREEN3 as a first step in the screening analysis. The SCREEN3 model[19] was developed to provide an easy-to-use method of obtaining pollutant concentration estimates. The model is a single source Gaussian plume model which provides maximum ground-level concentrations from point, area, flare, and volume sources as well as concentrations in the cavity zone, and concentrations due to inversion break-up and shoreline fumigation. The SCREEN3 model is designed as a screening version of the Industrial Source Complex (ISC) model described in Tier 2. Worst-case default meteorological data is provided in the model which incorporates the full combinations of wind speeds and stability classes.

The main limitation of the model is that it only estimates concentrations from one source at a time and, consequently, the output from multiple runs must be summed if more than one source is impacting a project or receptor (i.e., sum the maximum concentration from individual source runs to determine impacts from multiple sources). The concentrations are estimated following the procedures outlined in EPA's document "Screening Procedures for Estimating the Air Quality Impact of Stationary Sources"[20].

The SCREEN3 model can be downloaded from the US EPA web site at http://www.epa.gov/scram001/dispersion_screening.htm. A user-friendly interface is also available for SCREEN3 as a free download from Lakes Environmental web site at http://www.weblakes.com/download/us_epa.html.

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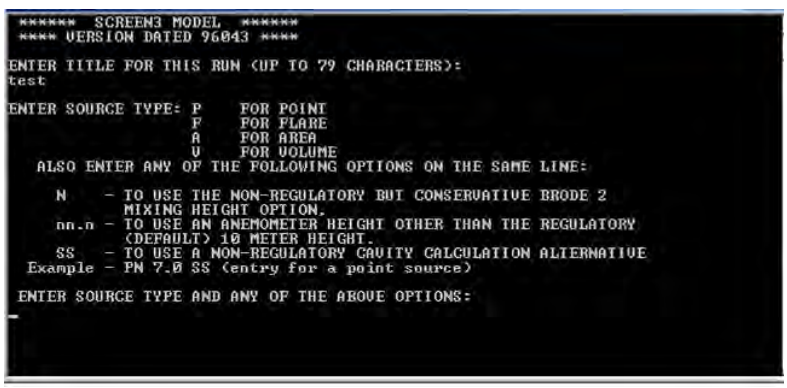
[19] U.S. Environmental Protection Agency, 1995. SCREEN3 Model User's Guide. EPA-454/B-95-004. Office of Air Quality Planning and Standards, Research Triangle Park, NC.

[20] U.S. Environmental Protection Agency, 1992: Screening Procedures for Estimating the Air Quality Impact of Stationary Sources, Revised, October 1992 (EPA-450/R-92-019), User's Guide for the Industrial Source Complex (ISC2) Dispersion Models: Volume II—Description of Model Algorithms. U.S. Environmental Protection Agency, OAQPS, Research Triangle Park, NC 27711. Publication No. EPA-450/4-92-008b.

The input requirements of SCREEN3 are minimal for a screening analysis. Refined models such as ISC, AERMOD, and CAL3QHCR discussed in the Section 4.3, require much more site-specific information allowing for greater characterization and more representative results. To perform a modeling study using SCREEN3, the user must first identified the type of sources to be modeled. As shown in Figure 22, the SCREEN3 can model a point, flare, area, or volume source. For modeling flare sources, the District recommends consulting CAPCOA's Health Risk Assessments for Proposed Land Use Projects (July 2009). Based on the type of source selected, the user will enter the physical and emissions characteristics that includes the emissions rates, stack heights, etc. The model also allows for inputs on meteorological conditions, building downwash, terrain, and fumigations. The most commonly used options are discussed in further detail below.

The District is in the processes of developing a database that contains modeling parameters for some permitted gasoline dispensing facilities, crematoriums, dry cleaners, and prime and back-up diesel generators. Until this information becomes available via the District web site, users should contact the District's Planning Division to obtain such parameters for permitted sources.

Figure 22. Source Types Modeled in SCREEN3



4.2.1 Point Sources

A point source is a single, identifiable source of air emissions. Point sources are typically used when modeling releases from sources like stacks and isolated vents. Typically, vents from gas dispensers at gasoline stations, vent stack from dry cleaner using perchloroethylene, diesel prime and backup generators, boilers, coffee roasters, cremetariums, paint strippers, tanks, and soil extraction units are modeled as point emissions. Each of these sources are a single point where emissions are released into the atmosphere and in some cases, the outlet may be located on the roof of the building while the source itself is located at ground level, such is the case for most diesel back-up generators. Input requirements for point sources in SCREEN3 include:

- **Emission Rate** [g/sec]: The emission rate of the pollutant.
- **Stack Height** [m]: The stack height above ground.
- **Stack Inside Diameter** [m]: The inner diameter of the stack.

- **Stack Gas Exit Velocity** [m/s] or Stack Gas Exit Flow Rate [m3/s]: Either the stack gas exit velocity or the stack gas exit flow rate should be given. The exit velocity can be determined from the following formula:

  $Vs = 4*V/(\pi*(d_s\text{^}2))$

  Where,

  V_s = Exit Velocity
  V = Flow Rate
  d_s = Stack Inside Diameter

- **Stack Gas Temperature** [K]: The temperature of the released gas in degrees Kelvin.
- **Ambient Air Temperature** [K]: The average atmospheric temperature (K) in the vicinity of the source. If no ambient temperature data are available, assume a default value of 293 degrees Kelvin (K). For non-buoyant releases, the user should input the same value for the stack temperature and ambient temperature.

4.2.2 Area Source

An area source is a two-dimensional source of diffused air pollutant emissions such as a landfill, storage pile, slag dump, and lagoon. SCREEN3 allows definition of a rectangular area, aligned with the north-south axes while area sources selected in the more complex models have the ability to handle other shapes and can be rotated relative to the north-south axis. The District typically models emissions from landfills as an area source.

- **Emission Rate** [g/(s-m^2)]: The emission rate of the pollutant. The emission rate for area sources is input as an emission rate per unit area (g/(s-m^2)).
- **Source Release Height** [m]: The source release height above ground.
- **Longer Side Length of Rectangular Area** [m]: The longer side of the rectangular source in meters.
- **Shorter Side Length of Rectangular Area** [m]: The shorter side of the rectangular source in meters.
- **Receptor Height Above Ground** [m or ft]: This may be used to model impacts at “flagpole” receptors where the receptor is located above ground level, e.g., to represent the roof or second story of a building. The default value is assumed to be 0.0 m (i.e., ground-level receptors), but the user may enter 1.5 meter to represent the height of an average adult.
- **Wind Direction Search Option**: Since the concentration at a particular distance downwind from a rectangular area is dependent on the orientation of the area relative to the wind direction, the SCREEN model provides the user with two options for treating wind direction. The regulatory default option is “yes” which results in a search of a range of wind directions (see Section 4.2.4 for more details).

4.2.3 Volume Source

A volume source is a three-dimensional source of diffuse air pollutant emissions that is used to model releases from a variety of industrial sources, such as building roof monitors, fugitive leaks

from an industrial facility, multiple vents, conveyor belts, and roads. Another example would be the emissions from an automobile paint shop with multiple roof vents or multiple open windows. Typically, the District uses the volume source option to model emissions from gas dispensers at gasoline stations, vehicle emissions from roadways, and fugitive emissions from dry cleaners that use perchloroethylene. Default parameters for gasoline stations are described in Section 4.3.2. Parameters required to model volume source include:

- **Emission Rate** [g/sec]: The emission rate of the pollutant in grams per second (g/s).
- **Source Release Height** [m]: The source release height above ground surface at the center of the volume.
- **Initial Lateral Dimension** [m]: See Table 5 for guidance on determining initial dimensions. Units are meters.
- **Initial Vertical Dimension** [m]: See Table 5 below for guidance on determining initial dimensions. Units are meters.
- **Receptor Height Above Ground** [m or ft]: This may be used to model impacts at "flagpole" receptors where the receptor is located above ground level, e.g., to represent the roof or second story of a building. The default value is assumed to be 0.0 m (i.e., ground-level receptors), but the user may enter 1.5 meter to represent the height of an average adult.

Table 7. Recommended Procedures for Estimating Dimensions of Volume Sources

Type of Source	Procedure for Obtaining Initial Dimension
Initial Lateral Dimension ($_{yo}$)	
Single Volume Source	S_{yo} = (side length)/4.3
Line Source (Represented by Adjacent Volume Sources)	S_{yo} = (side length)/2.15
Line Source (Represented by Separated Volume Sources)	S_{yo} = (center to center distance)/2.15
Initial Vertical Dimension ($_{zo}$)	
Surface-Based Source ($h_e \sim 0$)	S_{zo} = (vertical dimension of source)/2.15
Elevated Source ($h_e > 0$) on or Adjacent to a Building	S_{zo} = (building height)/2.15
Elevated Source ($h_e > 0$) not on or Adjacent to a Building	S_{zo} = (vertical dimension of source)/4.3

4.2.4 Meteorology

Meteorology plays an important role in determining the downwind concentration. Not only does the meteorology (i.e, prevailing wind direction) determine the location of the highest impacted receptor, it also determines the concentration. The amount of turbulence in the atmosphere increases the entrainment and mixing of unpolluted air into the plume and thereby acts to reduce the concentration of pollutants in the plume (i.e, enhances the plume dispersion). The amount of atmospheric turbulence is categorized into six stability classes: A, B, C, D, E and F. Class A is the most unstable, or most turbulent, class, and class F the most stable, or least turbulent, class. Table 8 lists the six classes and Table 9 provides the meteorological conditions that define each class.

Table 8. Stability Classes

Stability class	Definition	Stability class	Definition
A	very unstable	D	Neutral
B	Unstable	E	slightly stable
C	Slightly unstable	F	Stable

Table 9. Meteorological Conditions that Define Each Stability Class

Surface windspeed		Daytime incoming solar radiation			Nighttime cloud cover	
m/s	mi/h	Strong	Moderate	Slight	> 50%	< 50%
< 2	< 5	A	A – B	B	E	F
2 – 3	5 – 7	A – B	B	C	E	F
3 – 5	7 – 11	B	B – C	C	D	E
5 – 6	11 – 13	C	C – D	D	D	D
> 6	> 13	C	D	D	D	D

SCREEN3 allows the user to either select a combination of stability class and wind speeds or input a single stability class and wind speed combination. Each option is described as:

- *Full Meteorology (All Stability Classes and Wind Speeds):* uses a combination of all six stability classes (five for urban sources) and their associated wind speeds to identify the "worst case" meteorological conditions, i.e., the combination of wind speed and stability that results in the maximum ground level concentrations.

- *Single Stability Class:* uses a selected stability class to be used (A through F) with a range of wind speeds to determine ground level concentrations.

- *Single Stability Class and Wind Speed:* uses a selected stability class and wind speed to estimate the ground level concentrations.

The District recommends running the SCREEN3 model using the full meteorological data. The user should be aware that SCREEN3 provides the maximum one hour concentrations at each receptor locations. The one hour concentrations are then multiplied by 0.1 to convert to annual concentrations for comparison to the thresholds. For using the annual average conversion factor, SCREEN3 must be run using the full meteorological dataset.

4.2.5 Additional Parameters

SCREEN3 model also considers building downwash, terrain heights, and fumigation effects. The building downwash option is only applicable to point and flare source types. Downwash occurs when the aerodynamic turbulence induced by nearby buildings cause a pollutant emitted from an elevated source to be mixed rapidly toward the ground (downwash), resulting in higher ground-level concentrations. The user must input the building dimensions (height, length, and width) to use this option.

SCREEN3 supports flat, elevated and complex terrain (see Section 4.1.4 for more information). If the simple flat terrain is selecting, the terrain heights must not exceed stack base elevation. In most cases, the terrain height is considered at ground level (0 meters). In a simple elevated terrain where the terrain heights exceed the stack base but are below stack height, the terrain height above stack base should be entered. If elevated or complex terrain is used, distance and terrain heights must be provided.

The last option available through SCREEN3 is fumigation. Fumigation occurs when a plume that was originally emitted into a stable layer is mixed rapidly to ground level when unstable air below the plume reaches plume level. The fumigation option is only available for point and flare source types if:

- The rural dispersion coefficient was selected (for rural inland sites), and
- The stack height >= 10 meters

The fumigation option can also be used to model shoreline fumigation effects by entering the distance to the shoreline.

4.3 Tier 2 Complex Model Input Data

More refined modeling is recommended for projects in which the screening analysis exceeds the thresholds or a more site specific characterization is required because it is complex with multiple sources. Refined models such as ISC, AERMOD, and CAL3QHCR require much more site-specific information, but yields greater characterization of the project and more representative results.

4.3.1 Recommended Models

The recommended models for use in refined modeling analysis include:

Refined Models:
- ISCST3 and
- AERMOD

Roadway Model:
- CAL3QHCR

Both ISC and AERMOD follow similar modeling methodologies for conducting air dispersion analysis. The primary differences are the preprocessors used to develop the meteorological data and the terrain elevations. The District already processes meteorological data from numerous stations throughout the Bay Area in ISC-compatible format (available on-line at http://hank.baaqmd.gov/tec/data/). At this time, only a limited number of stations have AERMET processed data; though such data can be requested from the District through a public records request. (Public records requests for AERMET-processed data can be made online at http://www.baaqmd.gov/Divisions/Legal/Public-Records-Request.aspx.) Both ISC and AERMOD include non-regulatory options; however, at this time, the District is recommending that all regulatory options be selected for conducting CEQA evaluations.

Alternative models may be used; however, the user should consult with the lead agency to ensure that conditions warrant their use. A brief overview of each of the recommended models is provided below.

Industrial Source Complex (ISC)

The Industrial Source Complex – Short Term (ISCST3) dispersion model is a steady-state Gaussian plume model, which can be used to assess pollutant concentrations and/or deposition fluxes from a wide variety of sources including volume, point, and area sources. The ISCST3 dispersion model from the U.S. EPA was designed to support the EPA's regulatory modeling options, as specified in the Guidelines on Air Quality Models (Revised)[21]. The model also accepts pre-processed site-specific meteorological data that is available through the District web site at: http://hank.baaqmd.gov/tec/data/.

The ISC models requirements include:

- Meteorological Data Processing - PCRAMMET or District provided preprocessed data
- Obtain Digital Terrain Elevation Data (If terrain is being considered)
- Building Downwash Analysis (BPIP-PRIME) – Project requires source and building information

[21] U.S. Environmental Protection Agency, 1986. Guidelines on Air Quality Models (Revised) and Supplement A. EPA-450/2-78-027R. U.S. Environmental Protection Agency, Research Triangle Park, NC.

- Final site characterization – complete source and receptor information
- ISC – Run the ISC model.
- Visualize and analyze results.

Unlike AERMOD (described in below), the ISC models do not contain a terrain pre-processor. As a result, receptor elevation data must be obtained through alternative means. The use of an inverse distance algorithm for interpolating representative receptor elevations is an effective method. The ISC model can be downloaded from US EPA web site at http://www.epa.gov/scram001/dispersion_alt.htm.

AERMOD

The American Meteorological Society/EPA Regulatory Model Improvement Committee (AERMIC) Regulatory Model, AERMOD[22,23,24] was specially designed to support the U.S. EPA's regulatory modeling programs. AERMOD is the next-generation air dispersion model that incorporates concepts such as planetary boundary layer theory and advanced methods for handling complex terrain. AERMOD was developed to replace the Industrial Source Complex Model-Short Term (ISCST3) as U.S. EPA's preferred model for most small-scale regulatory applications.[25,26] AERMOD can be downloaded from the US EPA web site at http://www.epa.gov/scram001/dispersion_prefrec.htm.

The AERMOD program is comprised of three programs: (1) AERMET – preprocessor for making compatible meteorological data sets, (2) AERMAP - preprocessor for digital terrain data, and (3) AERMOD – air dispersion model. Files generated from AERMET and AERMAP are then read by AERMOD in estimating downwind concentrations. Steps for using AERMOD are as follows:

- Meteorological Data Processing (AERMET is used for this)
- Obtain Digital Terrain Elevation Data (If terrain is being considered)

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[22] U.S. Environmental Protection Agency, 1998. Revised Draft - User's Guide for the AMS/EPA Regulatory Model – AERMOD. Office of Air Quality Planning and Standards, Research Triangle Park, NC.

[23] Paine, R.J., R.W. Brode, R.B. Wilson, A.J. Cimorelli, S.G. Perry, J.C. Weil, A. Venkatram, W.D. Peters and R.F. Lee, 2003. AERMOD: The Latest Features and Evaluation Results. Paper # 69878 presented at the Air and Waste Management Association 96th Annual Conference and Exhibition, June 22-26, 2003. Air and Waste Management Association, Pittsburgh, PA 15222.

[24] Cimorelli, A.J., S.G. Perry, A. Venkatram, J.C. Weil, R.J. Paine, R.B. Wilson, R.F. Lee, W.D. Peters, R.W. Brode, J.O. Paumier, 2002: AERMOD: Description of Model Formulation. U.S. Environmental Protection Agency, EPA-454/R-02-002d (draft dated October 31, 2002). Available from http://www.epa.gov/scram001.

[25] U.S. Environmental Protection Agency, 1995. User's Guide for the Industrial Source Complex (ISC3) Dispersion Models (Revised), Volume 1. EPA-454/B-95-003a. Office of Air Quality Planning and Standards, Research Triangle Park, NC.

[26] U.S. Environmental Protection Agency, 1995. User's Guide for the Industrial Source Complex (ISC3) Dispersion Models, Volume II – Description of Algorithms. U.S. Environmental Protection Agency, Research Triangle Park, NC 27711. Available from website http://www.epa.gov/scram001 as of January 2003.

- Building Downwash Analysis (BPIP-PRIME is used for this) – Project requires source and building information
- Final site characterization – complete source and receptor information
- AERMAP – Perform terrain data pre-processing for AERMOD air dispersion model if required.
- AERMOD – Run the model.
- Visualize and analyze results.

Overall, AERMOD was designed to be the next generation model that builds on the formats already established in the ISC models. ISC and AERMOD are both steady state plume models and the input and output files are similar.

CAL3QHCR

CAL3QHCR is a refined version of the original CALINE (California Line Source Dispersion Model) that was developed as a modeling tool to predict roadside PM or CO concentrations. The model is designed to estimate total air pollutant concentrations from highways from both moving and idling vehicles. The model can process a full year of hourly meteorological data and incorporate emissions, traffic, and signalization data for each hour of a week. The model can be obtained from EPA at http://www.epa.gov/scram001/dispersion_prefrec.htm.

Refined models such as ISC, AERMOD, and CAL3QHCR have many input options, and are described further throughout this document as well as in their respective technical documents[27,28,29,30]. Both ISC and AERMOD support a variety of source options similar to SCREEN3. For each type of sources, the requirements are identical for ISC and AERMOD regardless of the model being used. The following section outlines the inputs required for each source type. Detailed descriptions on the input fields for these models can be found in supporting documents for ISC[31,32] and for AERMOD[33]. The CAL3QHCR model is a roadway

[27] Cimorelli, A.J., S.G. Perry, A. Venkatram, J.C. Weil, R.J. Paine, R.B. Wilson, R.F. Lee, W.D. Peters, R.W. Brode, J.O. Paumier, 2002: AERMOD: Description of Model Formulation. U.S. Environmental Protection Agency, EPA-454/R-02-002d (draft dated October 31, 2002). Available from http://www.epa.gov/scram001.

[28] U.S. Environmental Protection Agency, 1995. User's Guide for the Industrial Source Complex (ISC3) Dispersion Models (Revised), Volume 1. EPA-454/B-95-003a. Office of Air Quality Planning and Standards, Research Triangle Park, NC.

[29] U.S. Environmental Protection Agency, 1995. User's Guide for the Industrial Source Complex (ISC3) Dispersion Models, Volume II – Description of Algorithms. U.S. Environmental Protection Agency, Research Triangle Park, NC 27711. Available from website http://www.epa.gov/scram001 as of January 2003.

[30] U.S. Environmental Protection Agency, 1997. Addendum to ISC3 User's Guide – The Prime Plume Rise and Building Downwash Model. Submitted by Electric Power Research Institute. Prepared by Earth Tech, Inc., Concord, MA.

[31] U.S. Environmental Protection Agency, 1995. User's Guide for the Industrial Source Complex (ISC3) Dispersion Models (Revised), Volume 1. EPA-454/B-95-003a. Office of Air Quality Planning and Standards, Research Triangle Park, NC.

[32] U.S. Environmental Protection Agency, 1997. Addendum to ISC3 User's Guide – The Prime Plume Rise and Building Downwash Model. Submitted by Electric Power Research Institute. Prepared by Earth Tech, Inc., Concord, MA.

model and is not designed to model other types of sources such as point and volumes sources typically used in AERMOD and ISC. However, the other models can model roadways in additional to various other types of sources. For this reason, discussions on the CAL3QHCR input are presented in the roadway modeling section 4.3.3.

The user is not required to complete the screening tables or SCREEN3 analysis prior to conducting a refined analysis. An overview of the modeling approach and general steps for using each refined model are provided below.

4.3.2 Stationary Source Types

POINT SOURCES

Point sources are generally used to model emissions from stacks or vents. Typically, vents from gas dispensers at gasoline stations, vent stack from dry cleaner using perchloroethylene, diesel prime and backup generators, boilers, coffee roasters, cremetariums, paint strippers, tanks, and soil extraction units are modeled as point emissions. Each of these sources are a single point where emissions are released into the atmosphere and in some cases, the outlet may be located on the roof of the building while the source itself is located at ground level, such is the case for most diesel back-up generators. The data required to model point source include:

- **Source ID**: An identification name for the source being defined, up to 8 characters in length.
- **X Coordinate**: The x (east-west) coordinate for the source location in meters (center of the point source).
- **Y Coordinate**: Enter here the y (north-south) coordinate for the source location in meters (center of the point source).
- **Base Elevation** [m]: The source base elevation. The model only uses the source base elevation if elevated terrain is being used.
- **Release Height above Ground** [m]: The source release height above the ground in meters.
- **Emission Rate** [g/sec]: The emission rate of the pollutant in grams per second.
- **Stack Gas Exit Temperature** [K]: The temperature of the released gas in degrees Kelvin.
- **Stack Gas Exit Velocity** [g/sec]: The stack gas exit velocity in meters per second or the stack gas flow rate. The exit velocity can be determined from the following formula:

  $$\mathbf{Vs = 4*V/(\pi*(d_s\text{^}2))}$$

  Where,

  V_s = Exit Velocity
  V = Flow Rate
  d_s = Stack Inside Diameter

- **Stack Inside Diameter** [m]: The inner diameter of the stack.

[33] Cimorelli, A.J., S.G. Perry, A. Venkatram, J.C. Weil, R.J. Paine, R.B. Wilson, R.F. Lee, W.D. Peters, R.W. Brode, J.O. Paumier, 2002: AERMOD: Description of Model Formulation. U.S. Environmental Protection Agency, EPA-454/R-02-002d (draft dated October 31, 2002). Available from http://www.epa.gov/scram001.

The District is developing a database containing some of the modeling parameters for gasoline dispensing facilities, dry cleaners, and prime and back-up diesel generators. Until the data becomes available through the District web site, users can contact the District's Planning Division for more information.

AREA SOURCES

An area source is a two-dimensional source of air pollutant emissions, used for modeling sources such as a landfill, storage pile, slag dump, or lagoon. The District typically models emissions from landfills as an area source. Area source modeling can also be used to simulate emissions from roadways although they are more commonly modeled as volume sources. Discussion on how to address roadway emissions using ISC or AERMOD is presented in Section 4.3.4. The parameters required to model area sources include:

- **Source ID**: An identification name for the source being defined, up to 8 characters in length.
- **X Coordinate**: The x (east-west) coordinate for the vertex (corner) of the area source that occurs in the southwest quadrant of the source. Units are in meters.
- **Y Coordinate**: The y (north-south) coordinate for the vertex (corner) of the area source that occurs in the southwest quadrant of the source. Units are in meters.
- **Base Elevation** [m]: The source base elevation. The model only uses the source base elevation if elevated terrain is being used. The default unit is meters.
- **Release Height above Ground** [m]: The release height above ground in meters. The ISC and AERMOD models can estimate concentrations from receptors located within the area source by integrate only the portion of area that is upwind of the receptor. However, the District does not recommend placement of receptors within the area source since concentrations may be underestimated by not accounting for emissions emitted directly beneath the receptor.
- **Emission Rate** [g/(s-m^2)]: Enter the emission rate of the pollutant. The emission rate for area sources is input as an emission rate per unit area. The same emission rate is used for both concentration and deposition calculations.
- Options for Defining Area: In ISC, the shape of the area source must be a rectangle or square. The maximum length/width aspect ratio for area sources is 10 to 1. If this is exceeded, then the area should be divided to achieve a 10 to 1 aspect ratio (or less) for all sub-areas. See ISC Documentation[34] for more details on inputting area data. In addition to the rectangular area, AERMOD can have circular or polygon areas defined (see AERMOD documentation[35] for details).

[34] U.S. Environmental Protection Agency, 1995. User's Guide for the Industrial Source Complex (ISC3) Dispersion Models (Revised), Volume 1. EPA-454/B-95-003a. Office of Air Quality Planning and Standards, Research Triangle Park, NC.

[35] Cimorelli, A.J., S.G. Perry, A. Venkatram, J.C. Weil, R.J. Paine, R.B. Wilson, R.F. Lee, W.D. Peters, R.W. Brode, J.O. Paumier, 2002: AERMOD: Description of Model Formulation. U.S. Environmental Protection Agency, EPA-454/R-02-002d (draft dated October 31, 2002). Available from http://www.epa.gov/scram001.

The District recommends submitting a public records request to receive emissions estimates and modeling parameters for permitted landfills.

VOLUME SOURCES

A volume source is a three-dimensional source of diffuse air pollutant emissions that is used to model releases from a variety of industrial sources. The District uses the volume source option to model emissions from gas dispensers at gasoline stations, vehicle emissions from roadways, and fugitive emissions from dry cleaners that use perchloroethylene. Parameters required to model volume source include:

- **Source ID**: An identification name for the source being defined, up to 8 characters in length.
- **X Coordinate**: The x (east-west) coordinate for the source location in meters. This location is the center of the volume source.
- **Y Coordinate**: The y (north-south) coordinate for the source location in meters. This location is the center of the volume source.
- **Base Elevation** [m]: The source base elevation. The model only uses the source base elevation if elevated terrain is being used. The default unit is meters.
- **Release Height above Ground** [m]: The release height above ground surface in meters (center of volume).
- **Emission Rate** [g/s]: The emission rate of the pollutant in grams per second. The same emission rate is used for both concentration and deposition calculations.
- **Length of Side** [m]: The length of the side of the volume source in meters. The volume source cannot be rotated and has the X side equal to the Y side (square).
- **Building Height** (If On or Adjacent to a Building) [m]: If the volume source is elevated and is on or adjacent to a building, then specify the building height. The building height can be used to calculate the Initial Vertical Dimension of the source. Note that if the source is surface-based, then this is not applicable.
- **Initial Lateral Dimension** [m]: This parameter is calculated by choosing the appropriate condition in Table 5 in Section 4.3.3. This table provides guidance on determining initial dimensions. Units are in meters.
- **Initial Vertical Dimension** [m]: This parameter is calculated by choosing the appropriate condition in Table 5 in Section 4.3.3. This table provides guidance on determining initial dimensions. Units are in meters.

Refueling emission and spillage from gas dispensing stations at gas stations and fugitive emissions from dry cleaning machines are modeled as volume sources by the District. For gas dispensing stations, the horizontal and vertical dimensions represent the actual shape of the dispenser. The release height when modeling emissions from refueling is the height of the hose nozzle. For emissions related to spillage, the horizontal and vertical dimensions are the same as when modeling refueling emissions except that the release height is set as zero (ground floor release). To simply the method, the District also collected information from over 450 stations and have consolidated the data to provide general default parameters for modeling in cases where only the number of dispensers are known. The average height of dispenser is approximately 7.3 feet and the initial vertical dimension is 3.4 feet (7.3 feet divided by model factor 2.15). The

lateral dimension is related to the number of dispensers at the gas station. Based on the survey responses sent out by the District, the lateral dimension (L) is equal to:

$$L = -0.0129 \times n^2 + 1.0845 \times n + 2.3943$$

Where:
L = lateral dimension (feet)
n = number of gasoline dispensers

For example, for a station that has five dispensers, the initial lateral dimension is 7.5 feet.

For the dry cleaner, most of the emissions are released through the vent stack; however, a small fraction of emissions are released from the dry cleaning machine as fugitive emissions. To model these fugitive emissions, the District recommends using the dimensions of the room that houses the machine. For more information regarding modeling parameters, contact the District's Planning Division.

4.3.3 Roadway Sources

There are a number of air dispersion models that can be used to predict concentrations from roadway emissions. CAL3QHCR is a preferred/recommended US EPA model for roadway modeling that relies on local meteorology. Both ISC and AERMOD models can be used to model roadways as a line of volume sources (see Section 4.3.3.3) for more details). When all three models (ISC, AERMOD, and CAL3QHCR) were modeled for the same scenario[36], the concentrations predicted from all three models were consistent and consequently, any of the three models could be used effectively to predict pollutant concentrations from roadway emissions.

The first section discusses how to estimate emission rates for roads that can then be used in the refined models. The methodology for running the CAL3QHCR is presented in Section 4.3.3.2 and the following Section 4.3.3.3 presents the approach to modeling roadways using ISC and AERMOD. The step by step guidance demonstrates how to use the CAL3QHCR model to estimate $PM_{2.5}$ emissions and cancer risks from total organic gases and diesel particular matter. The example calculations are taken from CAPCOA's Health Risk Assessments for Proposed Land Use Projects. For additional guidance, consult the User's Guide to CAL3QHCR, Version 2.0 [37].

4.3.3.1 EMFAC Emissions Data

In order to model roadway impacts, the emissions and number of vehicles must be estimated on an hourly basis as input into CAL3QHCR. Caltrans does not provide hourly traffic counts. To

[36] CAPCOA. 2009. Health Risk Assessments for Proposed Land Use Projects. Prepared by CAPCOA Planning Managers. Released July 2009. Available at: http://www.capcoa.org/.
[37] User's Guide to CAL3QHC Version 2.0, EPA-454/R-92-006 (Revised, with CAL3QHCR addendum), September 1995.

obtain hourly estimates of traffic volumes used for modeling, the hourly profiles from CARB's EMFAC model can be used. The current version of EMFAC is 2007 version 2.30; however, the user is recommended to check the CARB web site at: http://www.arb.ca.gov/msei/onroad/latest_version.htm to ensure that the latest version is downloaded. The web site also contains a detailed user's manual that illustrates how to use the program. The model combines information on the type of vehicle class, number of vehicles, and distance traveled by the vehicle to estimate emissions factors for variety of pollutants including total organic gases (TOG), reactive organic gases (ROG), and $PM_{2.5}$. The vehicle fleet currently modeled is categorized into 13 classes (ranging from passenger cars to heavy duty trucks) that represent type of vehicle, weight class, and fuel types (i.e, gas, diesel, and electric) that operate on highways, freeways, and local roads in California. The number of vehicles in each class is based on an analysis of the Department of Motor Vehicles (DMV) registration data. The vehicle fleet is specific to the year and county selected.

The CAL3QHCR requires that for every roadway link the user enters hourly data on the number of vehicles per hour and the emissions per vehicle mile traveled. The user can also assume a constant value for both inputs, but the resulting $PM_{2.5}$ concentrations would be overly conservative. EMFAC provides, for each California County, an hourly profile of vehicle miles travelled (VMT) by vehicle class (cars and trucks). The total daily VMT can be used to normalize the hourly VMT by dividing each hourly value by the total VMT, which creates a diurnal scaling factor (also commonly referred to as normalization factor) for estimating hourly traffic volumes. The diurnal scaling factor is then multiplied by the AADT (from the Caltrans counts for highways or CEHTP's traffic volume spatial linkage tool for local streets) to obtain an estimate of the hourly traffic counts. Hourly emissions per vehicle mile traveled are estimated by dividing the hourly emissions from EMFAC by the corresponding hourly VMT. This process can be followed for both cars and trucks. Details for estimating each of these emissions from the EMFAC output files are provided below.

Input parameters to the EMFAC model include:

- Year: first year of project build out or when residents are living in the development. The model can estimate emissions between 1970 to 2040,
- Season: Select annual average,
- Geographic Area: select use average, San Francisco for Air Basin, and Bay Area for Air District.
- Model Years: The model years of vehicles to be used in developing the emissions for the year. Select all.
- Vehicle Class: Types of vehicle classes to be included in the emission estimates. Select all.
- I/M Program Schedule: select default.
- Mode and Output: these options allow the user to select the output format for the emissions data. The District recommends select Burden: Area planning inventory because it provides emissions data in units of tons per day.
- BURDEN inventory files: Select Detailed Planning Inventories (CSV), which will produce an emission file that is Microsoft Excel comma separated values (csv) file compatible to any spreadsheet program.
- Output Frequency: select hourly

- Output Particulate as: select $PM_{2.5}$ for comparison to applicable thresholds
- Output Hydrocarbons as: select TOG

Selecting these parameters, the EMFAC model produces an output file that contains:

- VMT/1000 for each hour,
- $PM_{2.5}$ emissions for each hour
- Total organic gas emissions for each hour

Figure 22 is a screen shot of the first page of the EMFAC Burden output file, which shows the first hour of emissions applicable to 12:00 midnight. The boxed hourly data is the data that will be used in to develop the input data for CAL3QHCR.

In this first example, the methodology is shown to estimate the $PM_{2.5}$ concentrations from all vehicles traveling on roadways. The following section shows a similar methodology for estimating cancer risk and hazard associated with diesel trucks and gasoline vehicles. It should be noted that the District recommends setting up two modeling runs to fully characterize roadway impacts: one file for $PM_{2.5}$ and organic gas emissions from all vehicles and a second file for diesel alone. The reason is that the diurnal scaling factors shown in Figure 6 for the two source groups are significantly different and will produce different results when coupled with the hourly meteorological data.

PREPARING HOURLY DATA FOR $PM_{2.5}$ ESTIMATIONS

Step 1. To develop hourly traffic count values needed by CAL3QHCR, the first step is to estimate a diurnal scaling factor that will be used to determine the number of vehicles per hour. The user must first enter the total VMT/1000 corresponding to each hour from the EMFAC output file. By reviewing the list of hourly VMT, select the highest hourly VMT count reported by EMFAC. Figure 23 shows an example. In this example, the highest hourly VMT count is 2,618,000 miles, which falls on Hour 17, 5:00 pm. Next, divide each hourly VMT value from EMFAC by the highest hourly VMT count (2,618,000 miles), resulting in a diurnal hourly scaling factors.

Step 2. The next step is to estimate the number of vehicles that travel on the roadway on hourly basis. This is accomplished by multiplying each diurnal scaling factor times the road's peak hour traffic count. The peak hour represents the highest number of vehicles that normally occurs on a weekday. The peak hour traffic count nearest to the proposed receptors should be used. The peak hour traffic count is available on Caltrans's website at http://www.dot.ca.gov/hq/traffops/saferesr/trafdata/index.htm. The user should select *back peak* hour for projects south or west of the nearest milepost location. For projects north or east of the nearest milepost location, select *ahead peak* hour. Table 8 provides an example calculation where the diurnal scaling factors from Figure 18 are multiplied by the peak hour of 11,900 vehicles per hour. It should be noted that peak hour of traffic should match the exact time in which the highest VMT occurs (for this example, it is hour 17 at 5:00 pm). In addition, the sum of all the hourly counts should approximately equal the AADT for the roadway.

Figure 22. Example Scenario EMFAC Output for Estimating $PM_{2.5}$ Emissions

Title : San Francisco County Subarea Annual CYr 2012 Default Title - BUR
Version : Emfac2007 V2.3 Nov 1 2006
Run Date : 2010/04/16 09:06:50
Scen Year: 2012 -- All model years in the range 1968 to 2012 selected
Season : Annual
Area : San Francisco County
I/M Stat : Enhanced Interim (2005)
Emissions: Tons Per Hr00

	Light Duty Passenger Cars				Light Duty Trucks				Medium Duty Trucks				Heavy Duty Trucks: Gasoline Trucks			Heavy Duty Trucks: Diesel Trucks	Total HD Trucks	Urban Buses	Motor-cycles	All Vehicles
	Non-cat	Cat	Diesel	Total	Non-cat	Cat	Diesel	Total	Non-cat	Cat	Diesel	Total	Non-cat	Cat	Total					
Vehicles	1667	269502	700	271869	521	115500	822	116843	61	22048	1366	23474	150	2422	2572	6035	8606	1116	14663	436572.
VMT/1000	0.	84.	0.	85.	0.	37.	0.	38.	0.	8.	3.	11.	0.	0.	0.	13.	14.	2.	1.	149.
Trips	55.	14204.	32.	14291.	17.	6076.	41.	6134.	4.	1489.	460.	1953.	37.	679.	716.	197.	913.	49.	246.	23586.
Total Organic Gas Emissions																				
Run Exh	0.00	0.01	0.00	0.01	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.03
Idle Exh	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00
Start Ex	0.00	0.01	0.00	0.01	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.02
Total Ex	0.00	0.01	0.00	0.02	0.00	0.01	0.00	0.01	0.00	0.00	0.00	0.00	0.00	0.00	0.01	0.00	0.01	0.00	0.01	0.05
Diurnal	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00
Hot Soak	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00
Running	0.00	0.01	0.00	0.01	0.00	0.01	0.00	0.01	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.02
Resting	0.00	0.01	0.00	0.01	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.01
Total	0.00	0.03	0.00	0.03	0.00	0.02	0.00	0.02	0.00	0.01	0.00	0.01	0.00	0.00	0.01	0.00	0.01	0.00	0.01	0.08
Carbon Monoxide Emissions																				
Run Exh	0.02	0.17	0.00	0.19	0.01	0.11	0.00	0.12	0.00	0.02	0.00	0.03	0.00	0.00	0.01	0.02	0.03	0.02	0.05	0.43
Idle Exh	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00
Start Ex	0.00	0.09	0.00	0.09	0.00	0.05	0.00	0.05	0.00	0.02	0.00	0.02	0.01	0.07	0.07	0.00	0.07	0.00	0.00	0.24
Total Ex	0.03	0.25	0.00	0.28	0.01	0.15	0.00	0.16	0.00	0.05	0.00	0.05	0.01	0.07	0.08	0.02	0.10	0.02	0.05	0.67
Oxides of Nitrogen Emissions																				
Run Exh	0.00	0.02	0.00	0.02	0.00	0.01	0.00	0.01	0.00	0.00	0.01	0.02	0.00	0.00	0.00	0.11	0.11	0.04	0.00	0.21
Idle Exh	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00
Start Ex	0.00	0.01	0.00	0.01	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.02
Total Ex	0.00	0.02	0.00	0.02	0.00	0.02	0.00	0.02	0.00	0.01	0.01	0.02	0.00	0.01	0.01	0.11	0.12	0.04	0.00	0.22
Carbon Dioxide Emissions (000)																				
Run Exh	0.00	0.04	0.00	0.04	0.00	0.02	0.00	0.02	0.00	0.01	0.00	0.01	0.00	0.00	0.00	0.02	0.02	0.00	0.00	0.09
Idle Exh	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00
Start Ex	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00
Total Ex	0.00	0.04	0.00	0.04	0.00	0.02	0.00	0.02	0.00	0.01	0.00	0.01	0.00	0.00	0.00	0.02	0.02	0.00	0.00	0.10
PM2.5 Emissions																				
Run Exh	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.01
Idle Exh	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00
Start Ex	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00
Total Ex	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.01
TireWear	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00
BrakeWr	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00
Total	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.01
Lead	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00
SOx	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00
Fuel Consumption (000 gallons)																				
Gasoline	0.02	3.97	0.00	3.99	0.01	2.20	0.00	2.20	0.00	0.63	0.00	0.63	0.00	0.05	0.05	0.00	0.05	0.01	0.03	6.92
Diesel	0.00	0.00	0.01	0.01	0.00	0.00	0.01	0.01	0.00	0.00	0.15	0.15	0.00	0.00	0.00	2.03	2.03	0.44	0.00	2.62

Title : San Francisco County Subarea Annual CYr 2012 Default Title - BUR
Version : Emfac2007 V2.3 Nov 1 2006
Run Date : 2010/04/16 09:06:50
Scen Year: 2012 -- All model years in the range 1968 to 2012 selected
Season : Annual
Area : San Francisco County
I/M Stat : Enhanced Interim (2005)

Step 3. The next step is to estimate the hourly emission rates in grams per vehicle miles traveled. $PM_{2.5}$ emissions data are reported by EMFAC in tons/hour and need to be converted to grams/hour. The grams/hour values are then divided by hourly VMT (as reported by EMFAC), to obtain grams per vehicle mile per hour for input into CAL3QHCR.

For the $PM_{2.5}$ analysis, the annual average concentrations predicted from the model are directly compared to the thresholds. The $PM_{2.5}$ analysis does not use toxicity factors, exposure pathway, or exposure duration common in risk assessments. Instead, the annual average $PM_{2.5}$ concentrations predicted from the model are compared to the thresholds.

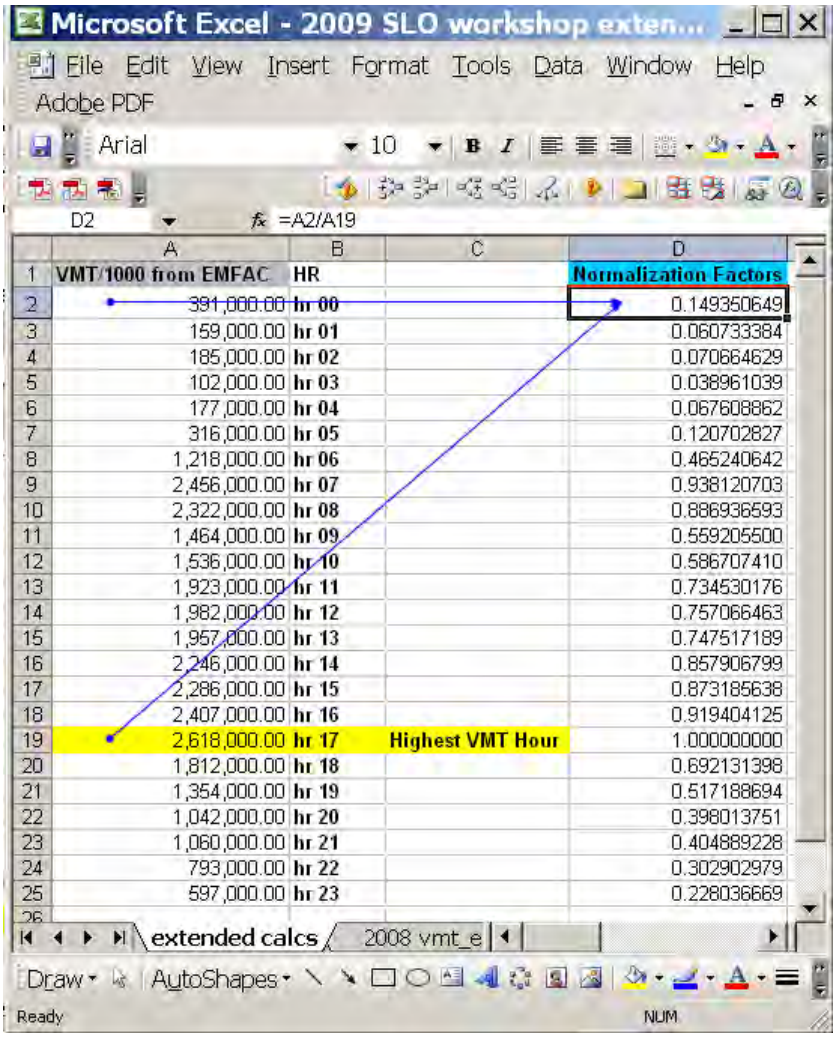
PREPARING HOURLY DATA FOR CANCER RISK AND HAZARD ESTIMATIONS

In estimating cancer risks and hazards associated with roadway emissions, the District considered:

- Diesel $PM_{2.5}$ emissions from all diesel vehicles (passenger cars, trucks, and buses);

- Total organic gas (TOG) emissions from tailpipes of non-diesel vehicles; and
- TOG emissions from evaporative running losses from non-diesel vehicles.

Figure 23. Calculating the Diurnal Scaling Factor (i.e, Normalization Factor)



	A	B	C	D
1	VMT/1000 from EMFAC	HR		Normalization Factors
2	391,000.00	hr 00		0.149350649
3	159,000.00	hr 01		0.060733384
4	185,000.00	hr 02		0.070664629
5	102,000.00	hr 03		0.038961039
6	177,000.00	hr 04		0.067608862
7	316,000.00	hr 05		0.120702827
8	1,218,000.00	hr 06		0.465240642
9	2,456,000.00	hr 07		0.938120703
10	2,322,000.00	hr 08		0.886936593
11	1,464,000.00	hr 09		0.559205500
12	1,536,000.00	hr 10		0.586707410
13	1,923,000.00	hr 11		0.734530176
14	1,982,000.00	hr 12		0.757066463
15	1,957,000.00	hr 13		0.747517189
16	2,246,000.00	hr 14		0.857906799
17	2,286,000.00	hr 15		0.873185638
18	2,407,000.00	hr 16		0.919404125
19	2,618,000.00	hr 17	Highest VMT Hour	1.000000000
20	1,812,000.00	hr 18		0.692131398
21	1,354,000.00	hr 19		0.517188694
22	1,042,000.00	hr 20		0.398013751
23	1,060,000.00	hr 21		0.404889228
24	793,000.00	hr 22		0.302902979
25	597,000.00	hr 23		0.228036669

Source: CAPCOA, 2009

VMT and emissions from these sources are quantified in the detailed summary provided by EMFAC. The user must select the appropriate data from EMFAC output (csv file) in order to quantify emissions from these sources. The procedures for developing the emission files follow steps similar to those for $PM_{2.5}$ emissions except that two separate emissions files will be developed–one for TOG from non-diesel vehicles and one for diesel vehicles to account for the differences in VMT and emissions from diesel versus gasoline vehicles.

Table 8. Example Calculation for Estimating Hourly Traffic Count

Time of day	Traffic Count (vehicles/hour)
Hr 00	1777
Hr 01	723
Hr 02	841
Hr 03	464
Hr 04	805
Hr 05	1436
Hr 06	5536
Hr 07	11164
Hr 08	10555
Hr 09	6655
Hr 10	6982
Hr 11	8741
Hr 12	9009
Hr 13	8895
Hr 14	10209
Hr 15	10391
Hr 16	10941
Hr 17	**11900**
Hr 18	8236
Hr 19	6155
Hr 20	4736
Hr 21	4818
Hr 22	3605
Hr 23	2714

Source: CAPCOA, 2009

Step 1. The first step is to develop hourly traffic counts for vehicles reflective of non-diesel TOG and diesel $PM_{2.5}$ emissions. Similar to the PM estimation, the user must first develop diurnal scaling factors to order to estimate the hourly traffic counts. The user first runs the EMFAC model to generate Burden inventory files. The base year in which the EMFAC model is run should be projected to the year in which residents are anticipated to occupy the development. The user creates two files: one for diesel $PM_{2.5}$ and the other for non-diesel TOG. For the TOG file, the user enters the total VMT/1000 and emissions from total exhaust ("Total Ex") from tailpipe emissions and running evaporative losses ("Running"). Figure 24 has the corresponding categories highlighted in red squares with the corresponding values circled in blue. For diesel $PM_{2.5}$ emissions, the user must sum the individual diesel contributions from each diesel vehicle category (i.e., light duty passenger cars, light duty trucks, medium duty trucks, and heavy duty trucks). The easiest method for summing each of the individual diesel contributions is to use a spreadsheet program that adds user defined cells containing emissions and VMT data. The user

can then copy the formula to the next hour of emissions. Figure 25 shows an example of the TOG and diesel emissions for each hour based on emissions in 2009 for San Francisco County.

To develop the diurnal scaling factor for TOG and diesel $PM_{2.5}$ emissions, the user normalizes each hourly VMT by the highest VMT (Table 9). For TOG, the highest VMT is at Hour 17, 5:00 pm of 1,038,000. The scaling factor for each hour is estimated by dividing each hour VMT per hour by 1,038,000. At hour 17, the scaling factor will be one. Next, the user follows the same procedures for diesel emissions. In the example provided, the highest VMT occurs at 9:00 am (Hour 9) of 44,000. Each hour VMT is then divided by 44,000 to produce the scaling factors for diesel exhaust.

Step 2. The next step is to estimate the number of vehicles that travel on the roadway each hour by multiplying each normalization factor times the road's peak hour traffic count. For TOG emissions, the peak hour of traffic represents the highest number of vehicles that normally occurs on a weekday. The data are available through Caltrans's website (http://www.dot.ca.gov/hq/traffops/saferesr/trafdata/index.htm). The peak hour traffic count nearest to the proposed receptors should be used. The user should select back peak hour for projects south or west of the nearest milepost location. For projects north or east of the nearest milepost location, select ahead peak hour.

For diesel emissions, the process is more complex since the numbers of diesel trucks traveling on the roadway are not readily available. The District recommends estimating the number of diesel trucks by determining the percentage of vehicles on the road that are trucks. Caltran's web site reports the annual average daily truck traffic on California State Highway System. If the percentage of trucks is not available through Caltrans, the user may use a conservative default of 10% to represent the highest percentage of diesel trucks on the roadway.

In this example, approximately 1.7% of the vehicles on Highway 280 at the intersection of Highway 101 in San Francisco are trucks. The peak one hour of vehicles at the same location is 14,400 vehicles. Assuming 1.7% of the vehicles are trucks, the peak hour of trucks is 245 trucks. The number of vehicles that travel each hour on the road is then estimated by multiplying the hourly diurnal scaling factor by the peak hour of vehicles or trucks.

The sum of all the hourly counts should approximately equal the AADT (vehicles or trucks) for the roadway.

Step 3. The last step is to develop the hourly emission rates in grams per vehicle miles traveled for TOG and diesel. The hourly emissions for TOG and diesel were taken from the EMFAC output files as described in Step 1. For TOG, the emissions from tailpipe and evaporative losses are summed to produce a combined TOG emission per hour. Both emissions estimates from EMFAC are reported in tons per hour and needs to be converted to gram/hour. The grams/hour emissions are then divided by the VMT per hour for each hour (as reported by EMFAC), to obtain grams per vehicle mile per hour for input into CAL3QHCR.

Figure 24. Example EMFAC Output File for Estimating TOG Emissions

Title   : San Francisco County Subarea Annual CYr 2012 Default Title - BUR
Version   : Emfac2007 V2.3 Nov 1 2006
Run Date : 2010/04/16 09:06:50
Scen Year: 2012 -- All model years in the range 1968 to 2012 selected
Season   : Annual
Area   : San Francisco County
I/M Stat : Enhanced Interim (2005)
Emissions: Tons Per Hr00

	Light Duty Passenger Cars				Light Duty Trucks				Medium Duty Trucks				Heavy Duty Trucks: Gasoline Trucks			Diesel Trucks	Total HD Trucks	Urban Buses	Motor-cycles	All Vehicles
	Non-cat	Cat	Diesel	Total	Non-cat	Cat	Diesel	Total	Non-cat	Cat	Diesel	Total	Non-cat	Cat	Total					
Vehicles	1667.	269502.	700.	271869.	521.	115500.	822.	116843.	61.	22048.	1366.	23474.	150.	2422.	2572.	6035.	8606.	1116.	14663.	[illegible]
VMT/1000	0.	84.	0.	85.	0.	37.	0.	38.	0.	8.	3.	11.	0.	0.	0.	13.	14.	2.	1.	149.
Trips	55.	14204.	32.	14291.	17.	6076.	41.	6134.	4.	1489.	460.	1953.	37.	679.	716.	197.	913.	49.	246.	[illegible]
Total Organic Gas Emissions																				
Run Exh	0.00	0.01	0.00	0.01	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.03
Idle Exh	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00
Start Ex	0.00	0.01	0.00	0.01	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.02
Total Ex	0.00	0.01	0.00	0.02	0.00	0.01	0.00	0.01	0.00	0.00	0.00	0.00	0.00	0.00	0.01	0.00	0.01	0.00	0.01	0.05
Diurnal	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00
Hot Soak	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	[illegible]
Running	0.00	0.01	0.00	0.01	0.00	0.01	0.00	0.01	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.02
Resting	0.00	0.01	0.00	0.01	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.01
Total	0.00	0.03	0.00	0.03	0.00	0.02	0.00	0.02	0.00	0.01	0.00	0.01	0.00	0.00	0.01	0.00	0.01	0.00	0.01	0.08
Carbon Monoxide Emissions																				
Run Exh	0.02	0.17	0.00	0.19	0.01	0.11	0.00	0.12	0.00	0.02	0.00	0.03	0.00	0.00	0.01	0.02	0.03	0.02	0.05	0.43
Idle Exh	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00
Start Ex	0.00	0.09	0.00	0.09	0.00	0.05	0.00	0.05	0.00	0.02	0.00	0.02	0.01	0.07	0.07	0.00	0.07	0.00	0.00	0.24
Total Ex	0.03	0.25	0.00	0.28	0.01	0.15	0.00	0.16	0.00	0.05	0.00	0.05	0.01	0.07	0.08	0.02	0.10	0.02	0.05	0.67
Oxides of Nitrogen Emissions																				
Run Exh	0.00	0.02	0.00	0.02	0.00	0.01	0.00	0.01	0.00	0.00	0.01	0.02	0.00	0.00	0.00	0.11	0.11	0.04	0.00	0.21
Idle Exh	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00
Start Ex	0.00	0.01	0.00	0.01	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.02
Total Ex	0.00	0.02	0.00	0.02	0.00	0.02	0.00	0.02	0.00	0.01	0.01	0.02	0.00	0.01	0.01	0.11	0.12	0.04	0.00	0.22
Carbon Dioxide Emissions (000)																				
Run Exh	0.00	0.04	0.00	0.04	0.00	0.02	0.00	0.02	0.00	0.01	0.00	0.01	0.00	0.00	0.00	0.02	0.02	0.00	0.00	0.09
Idle Exh	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00
Start Ex	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00
Total Ex	0.00	0.04	0.00	0.04	0.00	0.02	0.00	0.02	0.00	0.01	0.00	0.01	0.00	0.00	0.00	0.02	0.02	0.00	0.00	0.10
PM2.5 Emissions																				
Run Exh	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.01
Idle Exh	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00
Start Ex	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00
Total Ex	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.01
TireWear	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00
BrakeWr	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00
Total	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.01
Lead	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00
SOx	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00
Fuel Consumption (000 gallons)																				
Gasoline	0.02	3.97	0.00	3.99	0.01	2.20	0.00	2.20	0.00	0.63	0.00	0.63	0.00	0.05	0.05	0.00	0.05	0.01	0.03	6.92
Diesel	0.00	0.00	0.01	0.01	0.00	0.00	0.01	0.01	0.00	0.00	0.15	0.15	0.00	0.00	0.00	2.03	2.03	0.44	0.00	2.62

Title   : San Francisco County Subarea Annual CYr 2012 Default Title - BUR
Version   : Emfac2007 V2.3 Nov 1 2006
Run Date : 2010/04/16 09:06:50
Scen Year: 2012 -- All model years in the range 1968 to 2012 selected
Season   : Annual
Area   : San Francisco County
I/M Stat : Enhanced Interim (2005)

The above discussion presents the methodology for estimating annual average concentrations for a particular year, but for cancer risk where the threshold is based on 70-year exposure period, additional refinements are necessary to translate the single year exposure to 70-year average lifespan exposure. The user will run the CAL3QHCR model using the inputs specified above, but additional spreadsheet calculations are required to weight the annual average concentration over a 70-year exposure duration.

An added complication in the analysis is that not only do the VMT and emissions vary per year, but in addition, the District has adopted OEHHA's age sensitivity factors (ASF) (see the District's Regulation 2, Rule 5). ASFs are used to account for the increased susceptibility of infants and children to carcinogens, as compared to adults. The ASF calculation procedure includes the use of age-specific weighting factors in calculating cancer risks from exposures of infants, children and adolescents, to reflect their anticipated special sensitivity to carcinogens. OEHHA recommends weighting cancer risk by a factor of 10 for exposures that occur from the third trimester of pregnancy to two years of age, and by a factor of three for exposures that occur

from two years through 15 years of age. These weighting factors are applied equally to all carcinogens.

Figure 25. Example EMFAC Output File for Estimating Diesel Emissions

Title : San Francisco County Subarea Annual CYr 2012 Default Title - BUR
Version : Emfac2007 V2.3 Nov 1 2006
Run Date : 2010/04/16 09:06:50
Scen Year: 2012 -- All model years in the range 1968 to 2012 selected
Season : Annual
Area : San Francisco County
I/M Stat : Enhanced Interim (2005)
Emissions: Tons Per Hr00

	Light Duty Passenger Cars Non-cat	Cat	Diesel	Total	Light Duty Trucks Non-cat	Cat	Diesel	Total	Medium Duty Trucks Non-cat	Cat	Diesel	Total	Heavy Duty Gasoline Trucks Non-cat	Cat	Total	Diesel Trucks	Total HD Trucks
Vehicles	1667.	269502.	[illegible]	271869.	521.	115500.	[illegible]	116843.	61.	22048.	[illegible]	23474.	150.	2422.	2572.	[illegible]	[illegible]
VMT/1000	0.	84.	0.	85.	0.	37.	0.	38.	0.	8.	3.	11.	0.	0.	0	13.	14.
Trips	55.	14204.	[illegible]	14291.	17.	6076.	[illegible]	6134.	4.	1489.	[illegible]	1953.	37.	679.	716.	[illegible]	913.
Total Organic Gas Emissions																	
Run Exh	0.00	0.01	0.00	0.01	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00
Idle Exh	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00
Start Ex	0.00	0.01	0.00	0.01	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00
Total Ex	0.00	0.01	0.00	0.02	0.00	0.01	0.00	0.01	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.01	0.00
Diurnal	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00
Hot Soak	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00
Running	0.00	0.01	0.00	0.01	0.00	0.01	0.00	0.01	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00
Resting	0.00	0.01	0.00	0.01	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00
Total	0.00	0.03	0.00	0.03	0.00	0.02	0.00	0.02	0.00	0.01	0.00	0.01	0.00	0.00	0.00	0.01	0.00
Carbon Monoxide Emissions																	
Run Exh	0.02	0.17	0.00	0.19	0.01	0.11	0.00	0.12	0.00	0.02	0.00	0.03	0.00	0.00	0.00	0.03	0.02
Idle Exh	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00
Start Ex	0.00	0.09	0.00	0.09	0.00	0.05	0.00	0.05	0.00	0.02	0.00	0.02	0.01	0.07	0.07	0.00	0.07
Total Ex	0.03	0.25	0.00	0.28	0.01	0.15	0.00	0.16	0.00	0.05	0.00	0.05	0.01	0.07	0.08	0.02	0.10
Oxides of Nitrogen Emissions																	
Run Exh	0.00	0.02	0.00	0.02	0.00	0.01	0.00	0.01	0.00	0.00	0.01	0.02	0.00	0.00	0.00	0.11	0.11
Idle Exh	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00
Start Ex	0.00	0.01	0.00	0.01	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	[illegible]
Total Ex	0.00	0.02	0.00	0.02	0.00	0.02	0.00	0.02	0.00	0.01	0.01	0.02	0.00	0.01	0.02	0.11	[illegible]
Carbon Dioxide Emissions (000)																	
Run Exh	0.00	0.04	0.00	0.04	0.00	0.02	0.00	0.02	0.00	0.01	0.00	0.01	0.00	0.00	0.00	0.02	[illegible]
Idle Exh	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	[illegible]
Start Ex	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	[illegible]
Total Ex	0.00	0.04	0.00	0.04	0.00	0.02	0.00	0.02	0.00	0.01	0.00	0.01	0.00	0.00	0.00	0.02	[illegible]
PM2.5 Emissions																	
Run Exh	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00
Idle Exh	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00
Start Ex	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00
Total Ex	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00
TireWear	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00
BrakeWr	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00
Total	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00
Lead	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00
SOx	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00
Fuel Consumption (000 gallons)																	
Gasoline	0.02	3.97	0.00	3.99	0.01	2.20	0.00	2.20	0.00	0.63	0.00	0.63	0.00	0.05	0.05	0.00	0.05
Diesel	0.00	0.00	0.01	0.01	0.00	0.00	0.01	0.01	0.00	0.00	0.15	0.15	0.00	0.00	0.00	2.03	2.03

Title : San Francisco County Subarea Annual CYr 2012 Default Title - BUR
Version : Emfac2007 V2.3 Nov 1 2006
Run Date : 2010/04/16 09:06:50
Scen Year: 2012 -- All model years in the range 1968 to 2012 selected
Season : Annual
Area : San Francisco County
I/M Stat : Enhanced Interim (2005)

Sum individual VMT contribution from each diesel truck category

Sum individual contribution from each $PM_{2.5}$ diesel truck category

The first step in developing the 70-year average concentration is to run the EMFAC model to produce annual VMT and emissions of TOG and diesel $PM_{2.5}$ for every year from the start date of occupancy of the development or when new source is operational to 2040, the last year of emissions forecast by EMFAC. In the EMFAC model under Input 1, the user can select Step 2 – Calendar Years where the list of available years for which the emissions will be estimated can be included in the analysis (see Figure 26).

Each year of emissions of TOG and diesel PM2.5 and VMT should then be extracted from the EMFAC output file using the methodology described in Step 1 above. Table 10 presents an example table generated for San Francisco County that includes emissions and VMT from EMFAC for the years 2010 through 2080. Note: the EMFAC model only estimates emissions to 2040 and the user must then apply 2040 emissions for the remaining years.

Table 9. Example TOG and Diesel Emissions and Diurnal Scaling Factor

SAN FRANCISCO COUNTY 2009							
	TOG Emissions				Diesel Only		
Hours	VMT/1000	Total Ex (tons/hour)	Running (tons/hr)	Diurnal Scaling Factor	VMT/1000	PM2.5 (tons/hour)	Diurnal Scaling Factor
0	145	0.06	0.02	0.14	17	0	0.39
1	55	0.03	0.01	0.05	12	0	0.27
2	45	0.03	0.01	0.04	7	0	0.16
3	22	0.01	0	0.02	3	0	0.07
4	57	0.02	0.01	0.05	4	0	0.09
5	110	0.05	0.02	0.11	11	0	0.25
6	477	0.18	0.07	0.46	27	0	0.61
7	976	0.4	0.18	0.94	23	0	0.52
8	904	0.42	0.17	0.87	40	0.01	0.91
9	564	0.31	0.12	0.54	44	0.01	1.00
10	592	0.28	0.12	0.57	35	0.01	0.80
11	751	0.35	0.16	0.72	41	0.01	0.93
12	784	0.34	0.18	0.76	39	0.01	0.89
13	768	0.32	0.15	0.74	37	0.01	0.84
14	895	0.35	0.18	0.86	36	0.01	0.82
15	907	0.37	0.18	0.87	30	0	0.68
16	940	0.38	0.19	0.91	40	0.01	0.91
17	1038	0.43	0.2	1.00	25	0	0.57
18	720	0.29	0.14	0.69	14	0	0.32
19	541	0.23	0.11	0.52	7	0	0.16
20	412	0.17	0.07	0.40	17	0	0.39
21	423	0.16	0.07	0.41	28	0	0.64
22	316	0.12	0.05	0.30	18	0	0.41
23	235	0.1	0.04	0.23	4	0	0.09

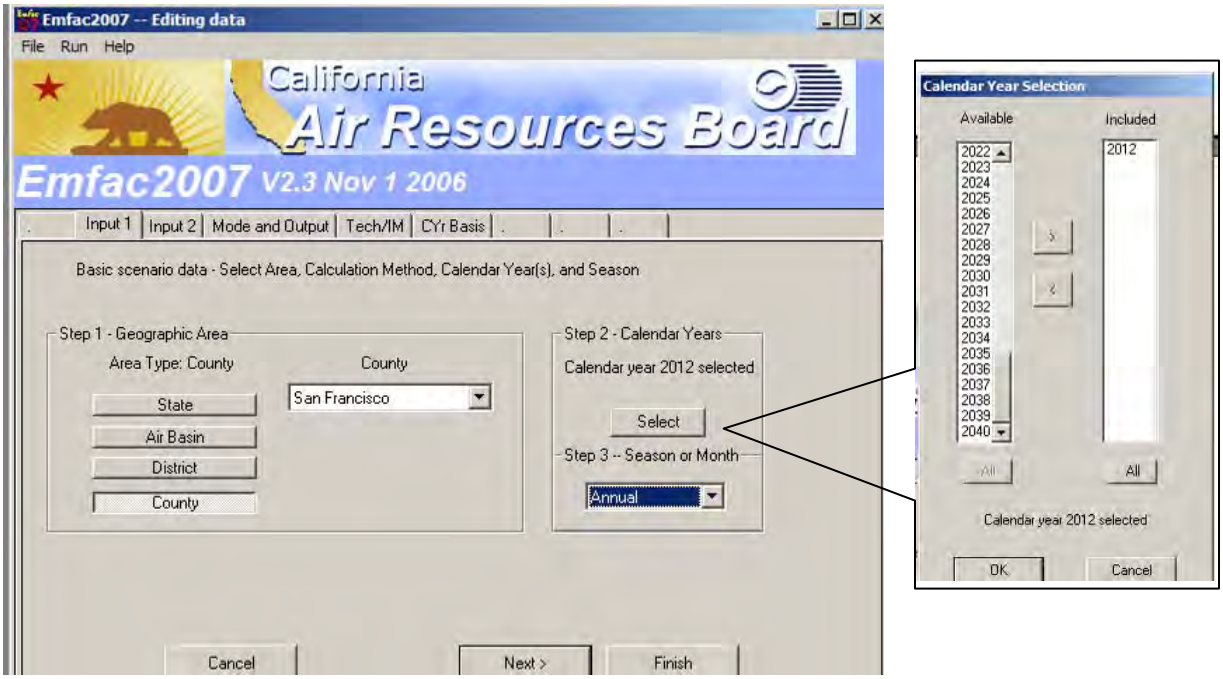
To estimate the 70-year average emissions, the user would generally average the emissions extracted from the EMFAC model. However, because of the age sensitivity factors (ASFs) for cancer risk estimates, more calculation is required. Because both the emissions and ASFs vary per year, the method for estimating 70-year average concentrations must account for variations in both. For estimating cancer risk where the emissions do not vary by year, concentrations can simply be multiplied by a cumulative ASF of 1.7 that incorporates the overall variations in ASFs.

Step 1. The first step is to develop sensitivity weighting factors (SWF) that are the age sensitivity values multiplied by the duration of the exposure by the lifetime of the exposure. This is expressed as:

Sensitivity Weighing Factor = ASF x Length of Exposure (year) / 70 year lifespan

Table 11 summarizes the SWF for every year of exposure up to 70 years.

Figure 26. Example EMFAC 70 Year Emissions and VMT



Step 2. The user then estimates 70-year average emission rates by multiplying each SWF by the corresponding emissions (grams/vehicle mile) for that year. Table 12 presents an example calculation for diesel $PM_{2.5}$ for San Francisco County using the values presented in Tables 10 and 11.

The 70-average emission rate is then the sum of the individual sensitivity weighted emission rates. In this example presented in Table 12, the 70-year average emission rate is 0.262 grams/vehicle mile.

Step 3. To predict the 70-year average concentrations at downwind receptor locations, the user must scale the emissions used in the base year run using CAL3QHCR by the 70-year average emissions. For example, suppose the diesel $PM_{2.5}$ emissions for San Francisco County in 2014 were 0.22 grams/vehicle miles along Highway 101. Using this emission rate in the CAL3QHCR model, the annual average downwind concentration 100 feet east of the freeway is estimated as 10 ug/m^3. To estimate the 70-year average concentration of diesel PM2.5 at this receptor location, the user must ratio the predicted concentration at the receptor by the base emissions from 2014 and the 70-year emissions as follows:

70 yr Avg Conc (ug/m^3) = Annual Avg Conc (ug/m^3) x [70-year SWF Emission (g/mile) / Base Yr Emissions (g/mile)]

Or

$$11.8 \text{ ug/m}^3 = 10 \text{ ug/m}^3 \times [0.262 \text{ ug/m}^3 / 0.22 \text{ ug/m}^3]$$

Table 10. Example VMT and Emissions for 70 Year Exposure

	SAN FRANCISCO COUNTY				
	Emissions from Total Organic Gases			Diesel Only	
Year	VMT/1000	Total Exhaust (tons/day)	Evaporative Losses (tons/day)	VMT/1000	Diesel PM2.5 (tons/day)
2014	13343	3.65	1.92	570	0.11
2015	13500	3.41	1.85	572	0.11
2016	13634	3.23	1.79	576	0.11
2017	13778	3.03	1.73	577	0.11
2018	13928	2.85	1.67	580	0.1
2019	14081	2.7	1.62	585	0.1
2020	14235	2.52	1.57	593	0.1
2021	14392	2.41	1.53	597	0.1
2022	14550	2.31	1.49	600	0.11
2023	14711	2.23	1.45	604	0.11
2024	14875	2.16	1.41	610	0.11
2025	15039	2.1	1.38	613	0.1
2026	15244	2.07	1.35	619	0.09
2027	15448	2.02	1.32	625	0.09
2028	15656	1.98	1.3	629	0.1
2029	15869	1.77	1.27	641	0.09
2030	16086	1.73	1.24	647	0.09
2031	16303	1.69	1.22	655	0.1
2032	16524	1.66	1.19	663	0.1
2033	16749	1.63	1.17	669	0.1
2034	16979	1.61	1.15	676	0.09
2035	17212	1.59	1.14	683	0.09
2036	17448	1.57	1.13	691	0.09
2037	17683	1.56	1.12	696	0.09
2038	17921	1.56	1.12	704	0.09
2039	18160	1.55	1.11	712	0.08
2040-2084	18405	1.55	1.11	721	0.08

As noted above, the age sensitivity values increased the predicted 70-year average concentrations predicted by the model to account for the anticipated special sensitivity experienced by infants and children to carcinogens. The methodology presented above would also be applied to estimating 70-year concentrations from tailpipe exhausts and evaporative losses. For the cancer risk estimates alone, the user can further reduce the diesel exhaust concentrations by accounting for the expected reductions based on CARB's on-road regulations. Table 3 presents the percent reductions expected from all diesel vehicles based on the on-road regulations. These percentages can be directly applied to the respective concentrations estimated through modeling. The risk calculations to account for the toxic components in TOG are further detailed in Section 5.2.

Table 11. Sensitivity Weighting Factors

Risk Year	Year Used in Roadway Modeling	Period (years)	Age Sensitivity Factor	Sensitivity Weighting Factor
1	2014	1	10	0.143
2	2015	1	10	0.143
3*	2016	1	4.75	0.068
4	2017	1	3	0.043
5	2018	1	3	0.043
6	2019	1	3	0.043
7	2020	1	3	0.043
8	2021	1	3	0.043
9	2022	1	3	0.043
10	2023	1	3	0.043
11	2024	1	3	0.043
12	2025	1	3	0.043
13	2026	1	3	0.043
14	2027	1	3	0.043
15	2028	1	3	0.043
16	2029	1	3	0.043
17**	2030	1	1.5	0.021
18	2031	1	1	0.014
19	2032	1	1	0.014
20	2033	1	1	0.014
21	2034	1	1	0.014
22	2035	1	1	0.014
23	2036	1	1	0.014
24	2037	1	1	0.014
25	2038	1	1	0.014
26	2039	1	1	0.014
27	2040 – 2084	44.25	1	0.632

Note: at age 2*, the factors are weighted for 0.25 years by 10 and 0.75 years by 3; at age 16**, the factor is weighted by 0.25 years at 3 and 0.75 by 1.

Table 12. Example 70 Year Average Emissions for Diesel $PM_{2.5}$ in San Francisco County

Emission Year	Sensitivity Weighting Factor	VMT (miles) /1000	Diesel PM2.5 (tons/day)	Emission Rate (g/vehicle-mile)	Sensitivity Weighted Emission Rate (g/vehicle-mile)
2014	0.14	567	0.14	0.224	0.032
2015	0.14	567	0.12	0.192	0.027
2016	0.068	569	0.12	0.191	0.013
2017	0.043	572	0.12	0.19	0.008
2018	0.043	572	0.12	0.19	0.008
2019	0.043	570	0.11	0.175	0.008
2020	0.043	572	0.11	0.174	0.007
2021	0.043	576	0.11	0.173	0.007
2022	0.043	577	0.11	0.173	0.007
2023	0.043	580	0.1	0.156	0.007
2024	0.043	585	0.1	0.155	0.007
2025	0.043	593	0.1	0.153	0.007
2026	0.043	597	0.1	0.152	0.007
2027	0.043	600	0.11	0.166	0.007
2028	0.043	604	0.11	0.165	0.007
2029	0.043	610	0.11	0.164	0.007
2030	0.021	613	0.1	0.148	0.003
2031	0.014	619	0.09	0.132	0.002
2032	0.014	625	0.09	0.131	0.002
2033	0.014	629	0.1	0.144	0.002
2034	0.014	641	0.09	0.127	0.002
2035	0.014	647	0.09	0.126	0.002
2036	0.014	655	0.1	0.139	0.002
2037	0.014	663	0.1	0.137	0.002
2038	0.014	669	0.1	0.136	0.002
2039	0.014	676	0.09	0.121	0.002
2040 - 2084	0.632	683	0.09	0.12	0.076

4.3.3.2 CAL3QHCR Data Files

The US EPA's CAL3QHCR model is an air dispersion model for predicting air quality impacts of pollutants near roadways. The CAL3QHCR is a refined version of the original California Line Source Dispersion Model (CALINE) that was developed as a modeling tool to predict

roadside carbon monoxide (CO) concentrations. The CAL3QHCR model not only predicts CO concentrations, but also can be used to estimate ambient $PM_{2.5}$ concentrations from idling or moving motor vehicles. The model processes up to one year of hourly meteorological data and vehicular emissions and traffic volumes can be specified for every hour.

The CAL3QHCR model requires the following inputs:

- **One year of meteorological data** – the model can be run using ISC compatible meteorological data if the filename extension is changed to ".asc",
- **Hourly traffic volumes** (in units of vehicles per hour) that can be derived using Caltrans data and normalization factors,
- **Hourly vehicle emissions** (in units of grams per vehicle mile) are derived from EMFAC,
- **Receptor locations** - location to the nearest sensitive receptor from the edge of the travel lane, in addition to the generic receptor grid (for example, 1,000 meters by 1,000 meters grid with 50 meter grid spacing) in X-Y coordinates, and
- **Surface roughness -** depending on the land use can range from 3 cm to 400 cm,
- **Roadway orientation** in terms of its X-Y coordinates (arbitrary origin/0,0), including length and width.

An example scenario is described below to illustrate how to develop the input files necessary for running CAL3QHCR model. Further details regarding the model can be found in CAPCOA's Health Risk Assessments for Proposed Land Use Projects (where this example was presented) and in US EPA's User's Manual for CAL3QHCR.

The CAL3QHCR input file requires data be defined in the calculational domain such that the X-Y coordinates at the beginning and at the end of the roadway section are defined. These have an arbitrary origin, with the positive y axis aligned toward north. For the example presented in this section, nine potential receptors are assumed to lie directly south of an east-west free-flow freeway with a peak hour traffic count of 11,900 vehicles. The freeway is assumed to be 120 feet wide, with an additional 10 feet on each side to account for the wake of moving vehicles[38], making for a total link width of 140 feet. If modeling diesel emissions from trucks, the District recommends using a source height of 2.3 meters (10 feet).

This example scenario relies on basic information needed to complete the modeling using CAL3QHCR model. The width (mixing zone) of the roadway is defined as the width of the freeway including all of the lanes of traffic and the shoulders. If the road does not have a shoulder, then it is recommended that an additional 10 feet be added to the edge of the nearest travel lane to the receptor to account for the wake of moving vehicles. The length of the roadway to be modeled should be at a minimum of one kilometer. The District does not recommend modeling more than five kilometers of a roadway for estimating local-scale impacts, unless the proposed project itself exceeds five kilometers in length.

CAL3QHCR requires that the elevation of the roadway in comparison to the surrounding area be specified in the input files. For most projects, the elevation of the roadway is at grade and consequently, the height of the road is set at zero. For elevated roadways such as an overpass,

[38] The mixing zone is an area where dispersion results are considered to be inaccurate.

the relative height is positive; and for depressed roadways such as an underpass, the relative height is negative.

The z-coordinate (receptor breathing height) for the receptor grid must be specified. In most cases, the default recommendation is 1.5 meters or 6 feet, which approximates an average receptor height. There are special instances where the residents are living on the second floor with commercial/retail areas on the ground level. Even in these instances, the District recommends using the default height of 1.5 meters.

Figure 27 illustrates the example scenario described in this section. The freeway is 120 feet wide, and after accounting for the wake of 10 feet on each side of the freeway, the total link width to be used in the model is 140 feet. The length of the roadway modeled is three kilometers, or 1.5 kilometers on each side from the center point. The roadway is at grade. A receptor has been placed at the edge of the roadway to define the roadway dimensions; however the dispersion results for this receptor should be discarded as they are not accurate at roadway edges. The District recommends using a receptor grid that encompasses the length of the roadway and has receptors spaced every 50 to 100 meters. Other parameters and recommended defaults required by the model are listed in Table 13.

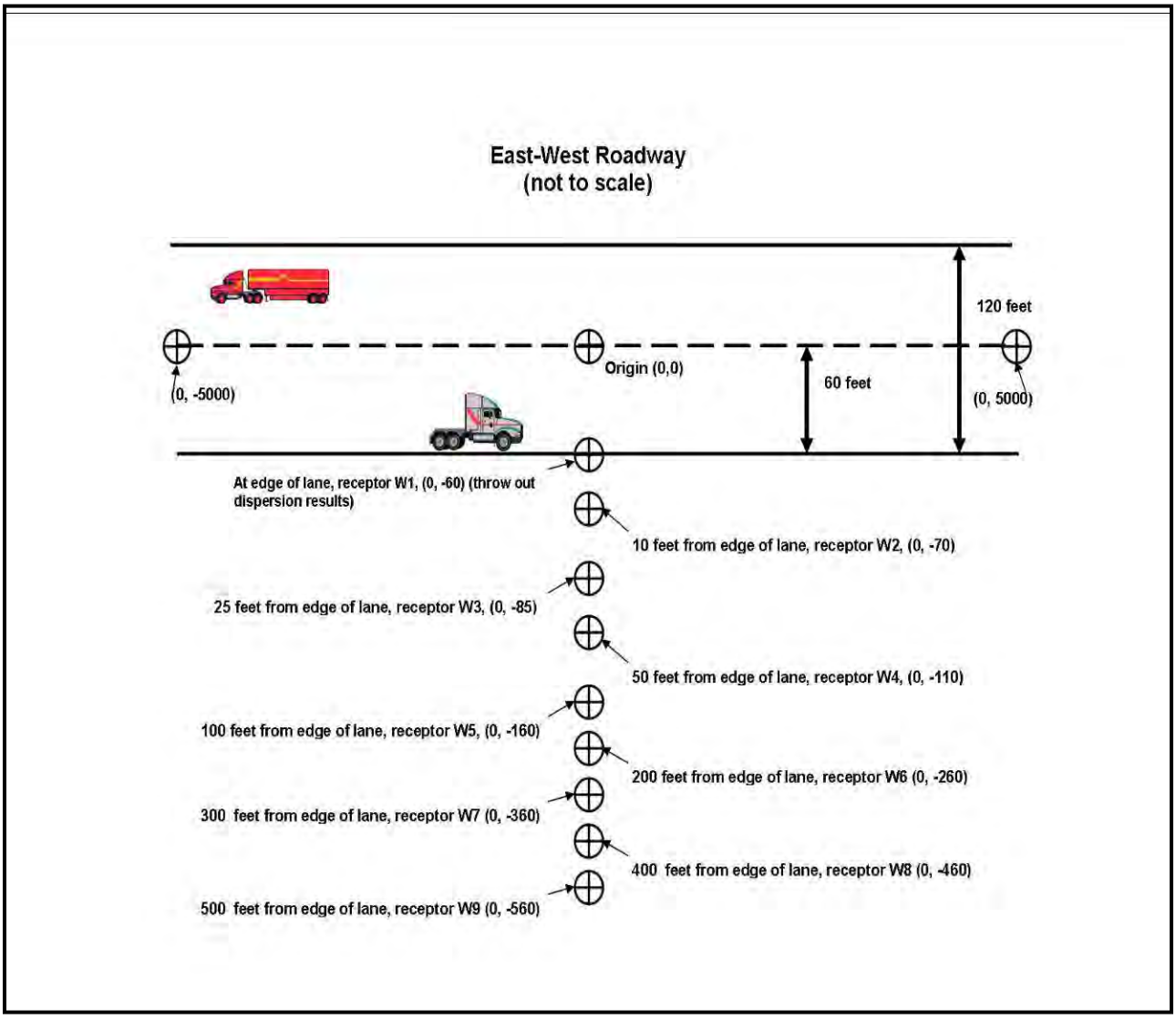
Downloading CAL3QHCR Model:

The CAL3QHCR model can be downloaded from EPA's Preferred/Recommended Dispersion Models website (http://www.epa.gov/scram001/dispersion_prefrec.htm). There are five files needed to run the program:

- input file (.inp),
- batch file (.bat),
- control file (.ctl),
- meteorological data file (.met), and
- executable file (.exe).

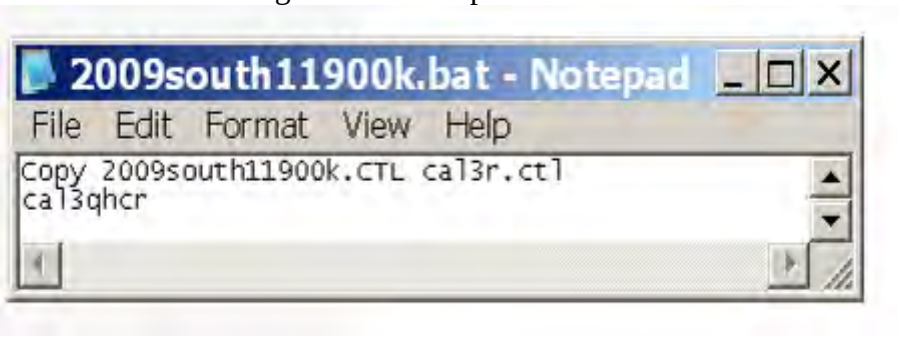
The first step is to select a name for the model run. For the example above, the name of the example scenario run is "2009south11900k". The simplest method for creating the control file is to copy the existing file with a new name. This is done by preparing a batch file (.bat) that is a DOS file batch command. To prepare the file, the user has to right click on the file to open it for editing. (Note that opening or double clicking on the file will cause the program to run. If this happens, simply delete the files the program creates and start again.) Once the file is open, the user types in the filename of the run after the word "Copy". Figure 28 shows an example of how a batch file is created.

Figure 27. Example Scenario East-West Roadway and Receptors Placements for CAL3QHCR



Source: CAPCOA, 2009

Figure 28. Example Batch File



Source: CAPCOA, 2009

Table 13. Other Recommended Parameters for Input into CAL3QHCR

Parameter	Default	
Calculation averaging time (min)	60	
Surface roughness (cm, from 3 to 400). For mixed uses and others not listed here, the modeler should make a reasonable assumption.	single family	108
	offices	170
	apartments	370
Settling velocity (cm/s)	0	
Deposition velocity (cm/s)	0	
Site setting (U=urban, R=rural)	U	
Form of traffic volume, emission rate data (1=one hour's data, 2=one week of hourly data)	2	
Pollutant (P for PM to give output in $\mu g/m^3$)	P	
Hourly ambient background concentration ($\mu g/m^3$)	0	
Roadway height indicator (AG=at grade, FL=elevated and filled, BR=bridge, DP=depressed)	AG	
Roadway height (ft, 0 if AG, relative height if FL, BR, or DP)	0	

Preparing Control File:

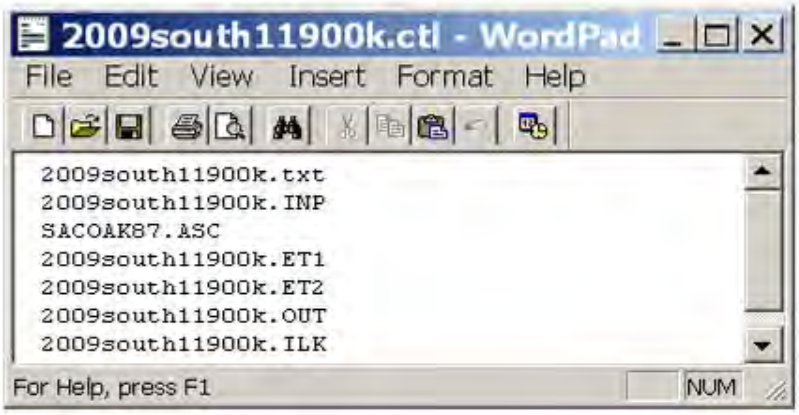
CAL3QHCR looks to the control file to find the file names that are read into the program and outputted by the program. The control file identifies all of the files that the CAL3QHCR will need to complete the run. The user will type the filename of the run in front of each file extension, except the .ASC file (meteorological file), where the user will type in the meteorological data file name. The control file should also be given the same filename with the ctl extension. Figure 29 presents example control file.

The meteorological file can be downloaded from the District web site at http://hank.baaqmd.gov/tec/data/. The user should select a meteorological station that is closest to their proposed project. Once the file is downloaded, the user should change the extension on the file to ".met".

Preparing Input File:

The input file contains the scenario parameters including the emissions and traffic volumes on roadways. The variables to be included in the file have been discussed above. To develop the file, it is recommended that the user edit an existing file (i.e., example file) such as the file provided with the model download, or by editing over a file that was previously used for another project. The user should remember to rename the file prior to editing. An example of the input file is presented in Figure 30 along with detailed explanations of the inputs.

Figure 29. Example Control File



Source: CAPCOA, 2009

Executing the Model Run:

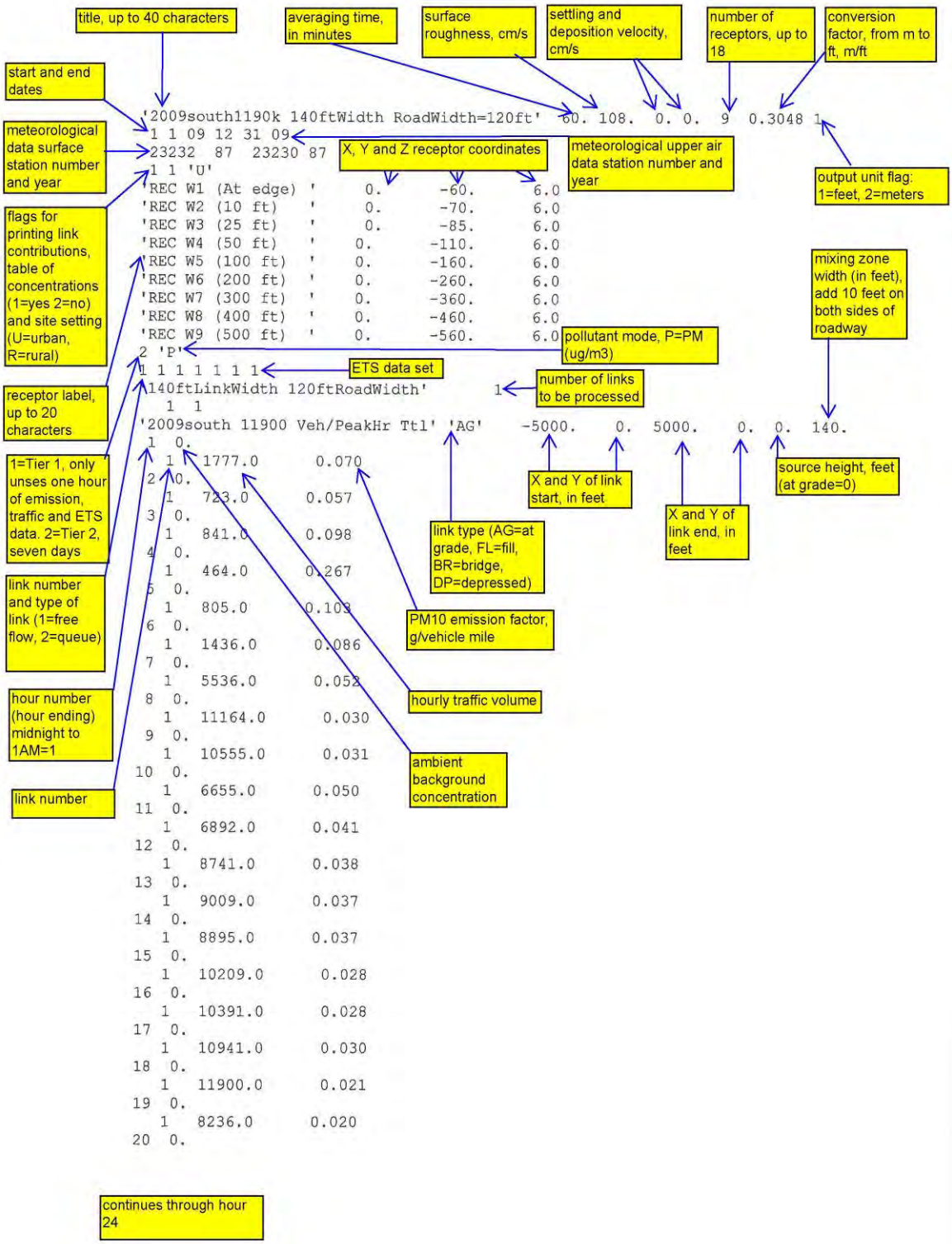
To run the file, the user will double click on the batch file (.bat). The model will produce a series of files with extensions .ET1, .ET2, .ILK, .OUT, .txt, and .ctl. The user should review the file with the extension ".txt" to ensure that no errors were encountered during the run.

The output file (.OUT) will show, among other information, the highest annual average concentrations. Figure 31 presents an example of the relevant output data from the model run.

This example estimates the annual average concentration of PM for a particular roadway at specified receptor locations. However, to translate the concentration to represent a 70-year average concentration, the user must take into account the changes in travel demand over the next 70 years. Discussion is provided in Section 6.0 on modifying the annual average concentration predicted from the model to a 70-year average concentration in which cancer risk can be predicted for comparison to the CEQA thresholds. The user should review the output files and ensure that air concentrations were predicted for each receptor. In cases where the values are zero, the user may consider rerunning the model, but increasing the emissions by a standard factor (i.e., multiplying the emissions by 1000 times). The user then divides the modeled air concentration by the same factor that was used to increase the emissions to yield the actual predicted concentration at each receptor.

In addition, this example provides a general overview of modeling the most common roadway scenarios; however, the model is also designed to model the effects at traffic intersections, traffic signaling, and traffic queuing. These features are site-specific and the user's manual for the model should be consulted.

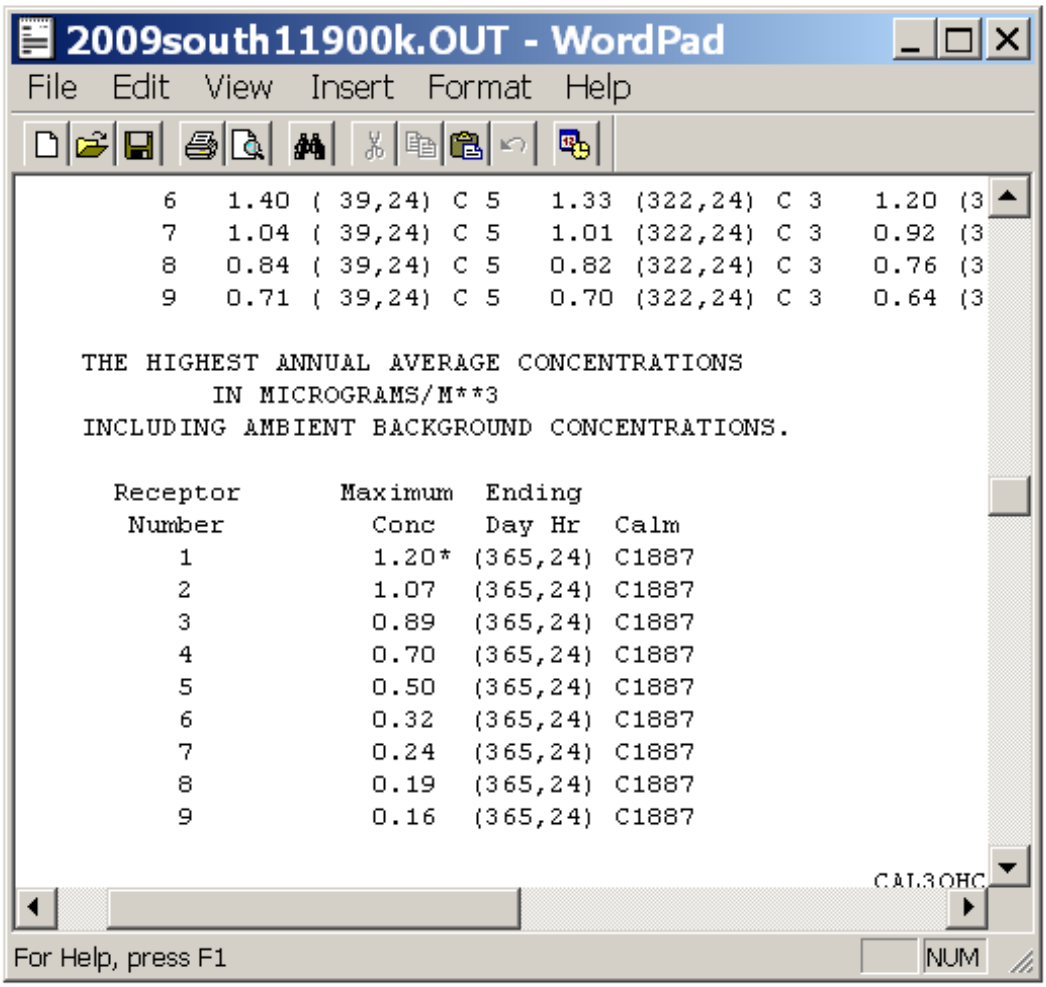
Figure 30. Example Input File




```
'2009south1190k 140ftWidth RoadWidth=120ft'  60. 108.  0. 0.  9  0.3048 1
1 1 09 12 31 09
23232  87  23230 87
1 1 'U'
'REC W1 (At edge) '     0.      -60.      6.0
'REC W2 (10 ft)   '     0.      -70.      6.0
'REC W3 (25 ft)   '     0.      -85.      6.0
'REC W4 (50 ft)   '     0.     -110.      6.0
'REC W5 (100 ft)  '     0.     -160.      6.0
'REC W6 (200 ft)  '     0.     -260.      6.0
'REC W7 (300 ft)  '     0.     -360.      6.0
'REC W8 (400 ft)  '     0.     -460.      6.0
'REC W9 (500 ft)  '     0.     -560.      6.0
2 'P'
1 1 1 1 1 1 1
1
140ftLinkWidth 120ftRoadWidth'
  1  1
'2009south 11900 Veh/PeakHr Ttl' 'AG'    -5000.    0.  5000.    0.  0.  140.
1  0.
  1   1777.0      0.070
2  0.
  1    723.0      0.057
3  0.
  1    841.0      0.098
4  0.
  1    464.0      0.267
5  0.
  1    805.0      0.103
6  0.
  1   1436.0      0.086
7  0.
  1   5536.0      0.052
8  0.
  1   11164.0      0.030
9  0.
  1   10555.0      0.031
10  0.
  1   6655.0      0.050
11  0.
  1   6892.0      0.041
12  0.
  1   8741.0      0.038
13  0.
  1   9009.0      0.037
14  0.
  1   8895.0      0.037
15  0.
  1   10209.0      0.028
16  0.
  1   10391.0      0.028
17  0.
  1   10941.0      0.030
18  0.
  1   11900.0      0.021
19  0.
  1   8236.0      0.020
20  0.
```

Source: CAPCOA, 2009

Figure 31. Example Output File



```
2009south11900k.OUT - WordPad
File  Edit  View  Insert  Format  Help

        6   1.40 ( 39,24) C 5   1.33 (322,24) C 3   1.20 (3
        7   1.04 ( 39,24) C 5   1.01 (322,24) C 3   0.92 (3
        8   0.84 ( 39,24) C 5   0.82 (322,24) C 3   0.76 (3
        9   0.71 ( 39,24) C 5   0.70 (322,24) C 3   0.64 (3

   THE HIGHEST ANNUAL AVERAGE CONCENTRATIONS
           IN MICROGRAMS/M**3
   INCLUDING AMBIENT BACKGROUND CONCENTRATIONS.

     Receptor       Maximum  Ending
      Number          Conc   Day Hr  Calm
         1            1.20*  (365,24) C1887
         2            1.07   (365,24) C1887
         3            0.89   (365,24) C1887
         4            0.70   (365,24) C1887
         5            0.50   (365,24) C1887
         6            0.32   (365,24) C1887
         7            0.24   (365,24) C1887
         8            0.19   (365,24) C1887
         9            0.16   (365,24) C1887

                                                CAL3QHC
For Help, press F1                                NUM
```

4.3.3.3 Roadway Modeling using ISC or AERMOD

Roadway impacts can also be modeled using ISC or AERMOD. The advantage of using these models over CAL3QHCR is that most projects including impacts from numerous stationary sources as well as roadways. The CAL3QHCR model is limited to only roadway modeling while ISC and AERMOD can model the impacts from both roadways and stationary sources. For example, a commercial development may have toxic emissions from truck transportation, gasoline dispensing facility, dry cleaners, and standby diesel generators. The user can choose to model these additional sources using ISC or AERMOD and then superimpose the concentrations with those predicted by CAL3QHCR. The simpler option is to model the sources and roadways together using either ISC or AERMOD; results of roadway modeling using ISC and AERMOD are consistent with those from using CAL3QHCR. Procedures for using ISCST3 and AERMOD to model emissions from roadways are discussed below.

The data that are required to model roadway emissions using ISC and AERMOD are similar to those required for using CAL3QHCR. They include the following:

- **Meteorological data** – preprocessed meteorological files for ISC are available though the District web site at http://hank.baaqmd.gov/tec/data/.
- **Traffic data and vehicle emissions** – The same data as discussed above for the CAL3QCHR model are used.
- **Roadway configuration** – The entire width of the roadway including the shoulder is the lateral dimension of the area source. Receptors should be located the same as with the CAL3QCHR model. The initial vertical dimension is the height of the vehicle (i.e., passenger car or truck) to account for the turbulent mixing that is created from vehicle traffic.
- **Terrain data** – For ISC, elevation data must be entered manually. AERMAP is used to generate the elevations and hill slopes for receptors and sources for input to the AERMOD model. Digital Elevation Model (DEM) files for use in AERMAP are available from a variety of sources.

The ISC and AERMOD model emissions from four basic types of sources: point, area, and volume. Emissions from idling vehicles located at a loading dock can be modeled as point sources. Area sources have been used in the past to model emissions from parking lots. The District recommends modeling emissions from travelling vehicles as area sources.

The parameters required to model area sources include:

- **Source ID**: An identification name for the source being defined, up to 8 characters in length.
- **X Coordinate**: The x (east-west) coordinate for the vertex (corner) of the area source that occurs in the southwest quadrant of the source. Units are in meters.
- **Y Coordinate**: The y (north-south) coordinate for the vertex (corner) of the area source that occurs in the southwest quadrant of the source. Units are in meters.
- **Base Elevation** [m]: The source base elevation. The model only uses the source base elevation if elevated terrain is being used. The default unit is meters.
- **Release Height above Ground** [m]: The release height above ground in meters. The release height of the passenger vehicle and/or truck should be used. The District recommends using a height of 10 feet for trucks and height of 1.5 feet for passenger cars.
- **Emission Rate** [g/(s-m^2)]: Enter the emission rate of the pollutant. The emission rate for area sources is input as an emission rate per unit area. The same emission rate is used for both concentration and deposition calculations.
- **Defining Area**: In ISC, the shape of the area source must be a rectangle or square. The maximum length/width aspect ratio for area sources is 10 to 1. If this is exceeded, then the area should be divided to achieve a 10 to 1 aspect ratio (or less) for all sub-areas. The lateral dimension is the entire width of the roadway including all lanes of traffic and the shoulders. If the road does not have a shoulder, then it is recommended that an additional 10 feet be added to the edge of the nearest travel lane to the receptor to account for the wake of moving vehicles. The length of the roadway to be modeled should be at a minimum of one kilometer. The District cautions users to not model roadways beyond five kilometers in length unless the side of the proposed project nearest to the roadway exceeds five kilometers.

A receptor grid similar to CAL3QHCR modeling should be used of at least one kilometer by one kilometer with receptors spaced every 50 to 100 meters. For each receptor and each specified

source group, the output file will contain the highest predicted annual average concentrations for the specified averaging time. Multiple files can be created for multiple source groups (which can be single sources or multiple sources depending upon those specified by the user) and for each averaging time modeled. The user can specify specific plotfiles to be generated as *.XOQ file that can be read through third party packages such as the Hot Spots Analysis and Reporting Program (HARP). They also can be used by graphics programs incorporated into the model interface programs or software such as SURFER to generate isopleths of concentration for a visual display of the results.

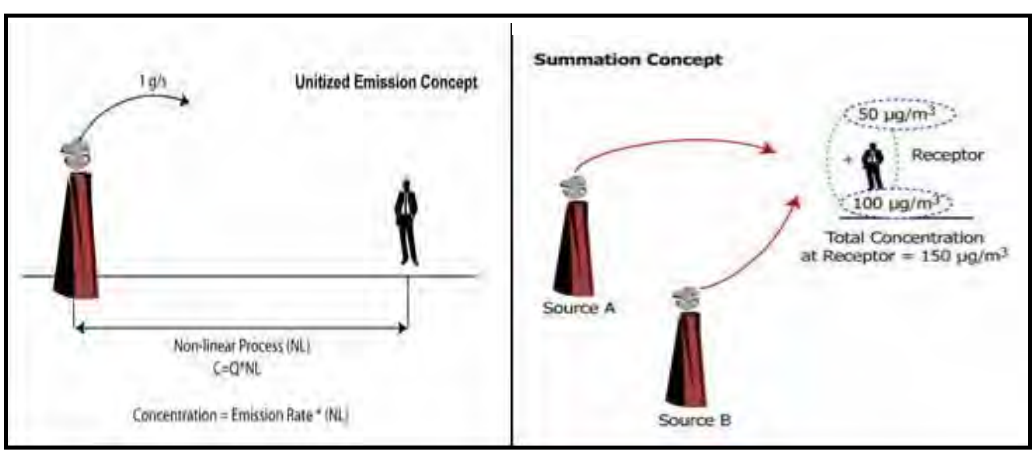
4.3.3.4 Multi-Pollutants Concentrations

Many industrial sources emit multiple pollutants. Models are not equipped to automatically perform modeling of different pollutants that may share the same emission source, but have pollutant-specific emission rates or pollutant-specific variations in emission rates (emissions change per year). One approach to address this issue is to model each scenario in separate model runs for each specific pollutant type and/or year of meteorological data. This requires extensive modeling times and organizational effort to track the results of each separate run.

A simpler solution is to apply unitized, or normalized, emission rates in which the results from the model can be scaled by the actual chemical-specific emissions rate. Then individual pollutant concentrations may be summed. For determining the multi-year averages for estimating cancer risk, the procedure becomes more complex. Discussions on how to perform each of these methods is provided below.

Most air dispersion models produce a Gaussian (bell-shaped) dispersion pattern. The model incorporates the hourly meteorological conditions, terrain elevations, and site characteristics to estimate the downwind concentration. Although the dispersion is non-linear, predicted concentrations scale linearly with emissions. This relationship allows the user to input a unit concentration of one gram/sec to be emitted at the source that can then be multiplied by the actual emission factors for each chemical to predict the downwind concentration of that pollutant at that specific receptor location. Figure 32 helps visualize this concept, by describing an emission rate of 1 g/s (left).

Figure 32. Unitized Emission Rate (left) and Summation (right) Concepts



The Unitized Emission Rate Concept only applies to single sources. For assessments with multiple sources the user can model each source independently by using a unitized emission rate of one gram per sec. For area sources, the unitized emission rate is one gram per second per square meter (1 g/sec/m^2). The concentration at the receptor can then be multiplied by the actual chemical emission rate, and the final result from all the sources will be summed. This is called the Summation Concept, where the concentration and deposition fluxes at a receptor are the linear addition of the resulting values from each source. Figure 27 (right) depicts the Summation concept. The user can use a post-processor such as CARB's HARP program (http://www.arb.ca.gov/toxics/harp/harp.htm) to automatically process model results that have been predicted using a unitized emission rate.

The user should be aware that separate dispersion runs should be performed for estimating acute hazard index, chronic hazard index, cancer risk, and PM2.5 concentrations.

4.4 Tier 3 Model Refinements

The models described above can be further refined to increase the accuracy of the predicted downwind concentrations. The refinements are site-specific and should be determined in conjunction with the lead agency to ensure the changes are appropriate and accurate. The following section provides some available refinements to improve the accuracy of the models.

4.4.1 Variable or Seasonal Emissions

The ISCST3 and AERMOD models both contain support for variable emission rates. This allows for modeling of source emissions that may fluctuate over time since some sources may emit only during certain periods of time. Industrial processes often fluctuate depending on supply and demand requirements. This affects some sectors seasonally, particularly facilities involved in food processing. For example, soup production makes use of agricultural produce which is at its highest in the late summer. Production schedules for soup production typically ramp up resulting in different emissions during the late summer and early fall than at mid to late winter.

Emissions can be varied within the ISCS and AERMOD models by applying scaling factors to different time periods. These emission differences can be accounted for by the application of variable emission factors, with control over the following time periods:

- By Season and hour-of-day
- By Season, hour-of-day, and day-of-week
- By Season, hour, week

For example, for a source that is non-continuous, a factor of 0 is entered for the periods when the source is not operating or is inactive. Model inputs for variable emissions rates can include the following time periods:

- Seasonally

- Monthly
- Hourly
- By Season and hour-of-day
- By Season, hour-of-day, and day-of-week
- By Season, hour, and week

4.4.2 Receptors Located Above Ground Level

In numerous new development projects in the Bay Area, residential units are situated above ground floor commercial/retail areas. The user should work closely with the lead agency to determine the most realistic and long term scenario in which residents would be exposed to toxic air contaminants. If it is determined that residents in their homes will be exposed for the longest duration (up to 12 hours per day) and at the highest concentrations, then receptor heights should be representative of each floor in which residents are living. For example, if a standby generator is located across the street from a four story apartment building with commercial/retail space on the ground floor. The release height of the stack from the generator is approximately 25 feet above ground level. In this case, it may be more conservative and realistic to model concentrations to the second story apartments rather than ground level receptors where the residents would spend significantly less time. In the freeway screening tables, the District has provided estimated cancer risk, $PM_{2.5}$ concentrations, and hazards for second story residential occupancy (20 feet) with commercial uses assumed on the first floor.

4.4.3 On-Site Meteorology

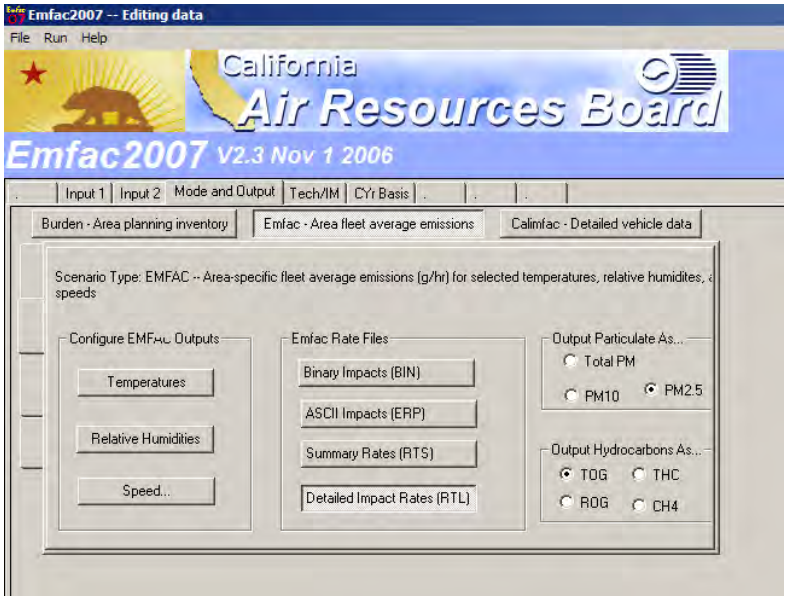
The District receives and collects meteorological data from over 30 stations in the Bay Area. Not every proposed project is in close proximity to one of these stations and a project sponsor may choose to collect their own meteorological data for one year prior to development of the site. There are numerous siting requirements that have to be met in selecting an appropriate location for a meteorological tower. As a general rule, meteorological sensors should be sited at a distance beyond the influence of obstructions, such as buildings and trees. The measurements should also be representative of the project area and be located in a secure and accessible area so that the operator can make any necessary repairs. EPA's Quality Assurance Handbook for Air Pollution Measurement Systems, Volume IV, Meteorological Measurements, version 2.0 (Final) (dated January 20, 2008) is a complete reference guide for siting, construction, and collecting meteorological data that adheres District's modeling and accuracy criteria. Approval for the placement of meteorological tower should be obtained from the District prior to any site preparation activities or installation of any equipment.

4.4.4 Constant Vehicle Speed on Local Roadways

In the roadway modeling, the District recommends using the full range of variable vehicle speeds in the EMFAC model to predict roadway emissions. This is a conservative method of accounting for variable vehicle speeds experienced on many of the major highways in the Bay Area. However on local surface streets, a more constant vehicle speeds may be experienced. In this case, surveyed vehicle speeds using automatic counters over a defined study period (over

one week) may result in a more representative speed that can be used in EMFAC. The user can input a specific speed, temperature, and relative humidity under "Mode and Output" in the EMFAC model. Instead of selecting Burden – Area Planning category, the user will select the second option entitled Emfac – Area Fleet Average Emissions. Figure 33 presents a screen shot of the Emfac Area Fleet screen. The District does not recommend setting a single speed for highway travel. The Emfac output was used to estimate annual emissions for speeds of 0 to 35 mph on surface streets.

Figure 33. Example of Emfac-Area Fleet Average Emissions Screen



5.0 CUMULATIVE ANALYSIS

The District is recommending that users examine toxic and $PM_{2.5}$ sources that are located within 1,000 feet of a proposed project site for comparisons to cumulative thresholds of significance. The sources may include, but are not limited to, highways and high volume roadways, truck distribution centers, ports, rail yards, refineries, airports, chrome plating facilities, crematoriums, dry cleaners using perchloroethylene, airports, standby and prime generators, and gasoline dispensing facilities. The user should include all past, present, and foreseeable future sources within a 1,000 foot radius (or beyond where appropriate) from the fenceline of the sources, or from the location of a receptor, plus the contribution from the project. To gather this information, the District recommends:

- Conducting a site walk of the area to determine the locations of significant sources that are not permitted by the District,
- Use District's county-specific kml file created for Google Earth™ that contains information of most permitted sources near the proposed project area
- Contact county-specific congestion management agency to identify local surface streets within the 1,000 foot radius that have over 10,000 vehicles per day

The project sponsor initially evaluates the cumulative impacts by utilizing the screening tables and kml files provided by the District. The cumulative impacts are the summation of the cancer risks, hazards, and $PM_{2.5}$ concentrations from all significant sources identified within 1,000 foot radius of the project. For new sources, the project sponsor should first identify the location of the maximum exposed receptor from the single source screening analysis. In the cumulative analysis, the user evaluates the risks and hazards from all sources within 1,000 foot radius of the new source to the maximally exposed receptor that was identified through the single source analysis. The risks, hazards, and $PM_{2.5}$ concentrations at the maximally exposed receptor locations are then compared against the thresholds of significance. For new receptors, the cumulative analysis evaluates the risks and hazards from all sources within 1,000 foot radius of the receptor.

In some cases, proposed projects may be substantially large where both new receptors and new sources will be added to a community in phases. Sufficient number of new receptors may generate air pollution impacts from their added vehicle trips and support services such as bus and truck deliveries. The District is recommending that new receptors not be evaluated as a new source unless the project sponsor anticipates an additional 10,000 vehicles per day on local streets that are attributable to the new residential development. If the development is anticipated to have more than 10,000 additional vehicles per day on the roads, the District recommends evaluating the sum of the existing traffic with the additional new traffic volume for comparison to the screening tables. If the user conducts a refined modeling analysis, the roadway impacts based on the combined traffic volumes (existing and new traffic) should be compared to the single source thresholds. For the cumulative analysis, the District recommends including all sources within 1000 feet of the roadway be evaluated to estimate the impact to the maximally exposed receptor (i.e., in most cases, this will be the new residential development).

6.0 ESTIMATING HEALTH RISK AND HAZARD

Generally, a health risk assessment for CEQA purposes must include all sources of emissions that will emanate from a project. This includes existing and proposed plant-wide emissions. This includes all sources of potential emissions whether or not they are subject to the District permitting requirements. Additionally, all sources that emit for which OEHHA has identified as having toxicity values must be included in the health risk assessment.

It is not permissible to omit permitted sources under CEQA, even if these sources will be evaluated during the permit process. The permitting process does not evaluate the cumulative risk associated with the entire plant, only the individual permit unit. A challenge to the completeness of the risk assessments can be made if these sources are not included in the analysis.

It is also not permissible to omit pollutants in the plant risk assessment, assuming that these emissions will be evaluated separately. Pollutants that have OEHHA approved toxicity values must be included in the chronic and acute hazard estimates. Again, a challenge to the completeness of the risk assessments can be made if these substances are omitted.

Health risks and hazards shall be assessed by following the procedures described in OEHHA's Health Risk Assessment Guidelines for the Air Toxics Hot Spots Program (August 2003), and any State risk assessment and risk management policies and guidelines, such as CAPCOA's Guidance Document for Health Risk Assessments for Proposed Land Use Projects (July 2009 - http://www.capcoa.org/rokdownloads/HRA/CAPCOA_HRA_LU_Guidelines_8-6-09.pdf). The OEHHA Health Risk Assessment Guidelines contain several sections which identify (a) the overall methodology, (b) the exposure assessment assumptions and procedures, and (c) the health effects data (cancer potency factors, chronic reference exposure levels, and acute reference exposure levels).

A summary of OEHHA's Health Risk Assessment Guidelines and an index of the relevant documents are located at: http://www.oehha.ca.gov/air/hot_spots/index.html

OEHHA's risk assessment methodology (August 2003) is located at:
http://www.oehha.ca.gov/air/risk_assess/index.html

The exposure assessment and stochastic technical support document (September 2000) is located at: http://www.oehha.ca.gov/air/exposure_assess/index.html

The Technical Support Document for Cancer Potency Factors: Methodologies for Derivation, Listing of Available Values, and Adjustments to Allow for Early Life Stage Exposures (May 2009) is located at: http://www.oehha.ca.gov/air/hot_spots/tsd052909.html

The Technical Support Document for the Derivation of Noncancer Reference Exposure Levels (RELs) (June 2008) is located at: http://www.oehha.ca.gov/air/hot_spots/rels_dec2008.html

OEHHA is currently working on revising the risk assessment methodology, as well as the exposure assessment and stochastic technical support documents (TSDs). Upon adoption, these revisions will be incorporated into the CEQA guidelines.

6.1 Exposures

Most of the toxicants assessed are volatile organic compounds that remain as gases when emitted into the air. These chemicals are not subject to appreciable deposition to soil, surface waters, or plants. Therefore, human exposure does not occur to any appreciable extent via ingestion or dermal exposure. Significant exposure to these volatile organic toxicants emitted into the air only occurs through the inhalation pathway. If the emissions consist of only substances that enter the body through the inhalation pathway, the risk assessment methodologies cited under the Air Toxics "Hot Spots" Emissions Inventory and Risk Assessment Program can be used.

However, a small subset of compounds, semi-volatile organic and metal toxicants, are emitted partially or totally as particles subject to deposition. Ingestion and dermal pathways as well as the inhalation pathway must be evaluated for these chemicals for all potential receptor populations. An exception to this is diesel particulate, which is modeled only through the inhalation pathway. A software program, the Hot Spots Analysis and Reporting Program (HARP), is the recommended model for calculating and presenting HRA results. The latest

version of HARP can be downloaded at http://www.arb.ca.gov/toxics/harp/harp.htm. The intent in developing the HARP software is to provide consistent risk assessment procedures. In addition, HARP is designed to assess potential health impacts posed by substances that must be analyzed by a multipathway (e.g., inhalation and non-inhalation) approach.

The District recognizes that the assumptions used in the risk methodology may be overly conservative especially in cases where residents are assumed to spend 24 hours every day for 70 years in outside activity near their homes. The user can deviate from the prescribed inputs in this section if they can provide scientific documentation regarding actual receptor behaviors and activity patterns. For example, the user may consider reducing the exposure duration from 70 years to a shorter time period if the housing is temporary (i.e., shelters, hostel, temporary housing). User may also consider reduced exposures by accounting for the time residents spend indoors. It is recommended that prior to making any adjustments to the exposure duration that the user first analyzes the project's risk and hazards using the standard assumptions. Only in cases where the project exceeds the threshold should additional modifications be considered. The user should keep in mind that the activity patterns of the most vulnerable populations (i.e., infants and seniors) may prove to be the most conservative receptor.

6.2 Cancer Risk

Cancer risk assessment as currently practiced involves estimating exposure to carcinogenic chemicals and multiplying the dose times the cancer potency factor. The toxicity values that are used must be those that the California Office of Environmental Health Hazard Assessment (OEHHA) has identified. These toxicity values can be found at (http://www.arb.ca.gov/toxics/healthval/healthval.htm). If a substance is emitted and toxicity values have not been identified by OEHHA, other sources of data can be applied.

In accordance with OEHHA's revised health risk assessment guidelines (specifically, OEHHA's Technical Support Document (TSD) for Cancer Potency Factors, May 2009), calculation of cancer risk estimates should also incorporate age sensitivity factors (ASFs). The revised TSD for Cancer Potency Factors provides updated calculation procedures used to consider the increased susceptibility of infants and children to carcinogens, as compared to adults. The updated calculation procedure includes the use of age-specific weighting factors in calculating cancer risks from exposures of infants, children and adolescents, to reflect their anticipated special sensitivity to carcinogens. OEHHA recommends weighting cancer risk by a factor of 10 for exposures that occur from the third trimester of pregnancy to 2 years of age, and by a factor of 3 for exposures that occur from 2 years through 15 years of age. These weighting factors should be applied to all carcinogens. For estimating cancer risk for residential receptors, the incorporation of the ASFs results in a cancer risk adjustment factor (CRAF) of 1.7. For estimating cancer risk for student receptors, a CRAF of 3 should be applied. For estimating cancer risk for worker receptors, a CRAF of 1 should be applied.

The procedures for estimating the cancer risk is as follows:

- **Step 1.** Model the emissions to determine both the annual average ground-level concentrations and the maximum one hour concentration (or other period depending on the acutely toxic substance).

- **Step 2.** Create a separate plot file for the annual average and one hour maximum ground level concentrations produced from the air dispersion model.

- **Step 3.** Open the plot file in any spreadsheet application and ensure that the data are parsed into individual cells.

- **Step 4.** Prior to estimating the cancer risk, the first step is to estimate the dose by applying the following formula to each ground-level concentration:

$$\text{Dose} = (C_{air} * \text{DBR} * \text{EF} * \text{ED} * \text{CF}) / \text{AT}$$

  where:

  Dose = dose through inhalation (mg/kg-day)
  C_{air} = air concentration ($\mu g/m^3$) from air dispersion model
  DBR = daily breathing rate (302 L\kg body weight-day for adult and 581 L/kg-day for child)
  EF = exposure frequency (350 days/year)
  ED = exposure duration (70 years)
  CF = conversion factor (10^{-6} ([mg/µg] * [m^3/L])
  AT = averaging time (25,550 days or 70 years)

- **Step 5.** To estimate the cancer risk, the dose is multiplied by the cancer potency factor and the CRAF:

$$\text{Cancer Risk} = (\text{Dose} * \text{CRAF} * \text{Cancer Potency Factor})$$

  where:

  Cancer Risk = risk (potential chances per million)
  Dose = dose through inhalation (mg/kg-day)
  CRAF = 1.7 (residential receptors with constant concentrations over 70 years)
  Cancer Potency Factor = toxicity factor (mg/kg-day^{-1})

Cancer risk adjustment factors should be used to calculate cancer risk estimates for all applicable exposure pathways and potential receptor populations. Please note that these ASFs represent default values. In cases where there are adequate data for specific carcinogen potency by age, OEHHA will recommend chemical-specific adjustments to cancer risk estimates. In addition, OEHHA is currently revising the TSD for Exposure Assessment. When the revised TSD for Exposure Assessment is finalized and adopted, the Guidelines will be revised accordingly.

The potential cancer risk shall be calculated using standard risk assessment methodology. For residents, they include the assumptions that potential exposures occur 24 hours per day, 350 days per year for a 70-year lifetime.

The methods presented above are applicable to most scenarios except in the case of estimating cancer risks from roadway impacts specifically from tailpipe and evaporative losses from non-diesel vehicles due to the mixture of individual compounds that make up TOG. For cancer risks from diesel particulate matter, cancer potency values are available and the methodology provided above should be used. It should be noted that the age sensitivity values were incorporated into the emissions estimates for roadway in Section 4.3.3.2, so CRAF should not be included in the risk calculations due to TOG and diesel PM emissions.

The District presented an approach in Section 4.3.3.2 for estimating the 70-year average concentrations at downwind receptor location. To estimate the cancer risk from TOG, the user must first speciate the different compounds that make up the toxic portions of TOG. A weighted toxicity value is then developed that incorporates the individual toxicity of each compound that make up TOG. The District uses the following breakdown in Tables 14 and 15 of the toxic portion of TOG for tailpipe and evaporative losses.

Table 14. Toxic Speciation of TOG due to Tailpipe Emissions

Toxic Compounds	**EMFAC Gasoline TOG Speciation (% TOG)**	**Unit Factor**	**(HARP) Residential Cancer Risk Factors $(ug/m^3)^{-1}$**	**Unit Cancer Risk Weighted Factor $(ug/m^3)^{-1}$**	**Chronic Noncancer Reference Dose (ug/m^3)**	**Unit Chronic Noncancer Risk Weighted Factor (ug/m^3)**	**Acute Noncancer Reference Dose (ug/m^3)**	**Unit ACUTE Noncancer Risk Weighted Factor (ug/m^3)**
Acetaldehyde	0.28%	0.0028	0.0000027	7.537E-09	140	0.39	470	1.31
Acrolein	0.13%	0.0013	0	0	0.35	0.00046	2.5	0.0033
Benzene	2.47%	0.0247	0.000029	7.169E-07	60	1.48	1300	32.14
1,3-Butadiene	0.55%	0.0055	0.000174	9.487E-07	20	0.11	0	0
Ethylbenzene	1.05%	0.0105	2.52E-06	2.643E-08	2000	20.97	0	0
Formaldehyde	1.58%	0.0158	6.08E-06	9.602E-08	9	0.14	55	0.87
Hexane	1.60%	0.0160	0	0	7000	111.92	0	0
Methanol	0.12%	0.0012	0	0	4000	4.89	28000	34.22
Methyl Ethyl Ketone	0.02%	0.0002	0	0	0	0	13000	2.37
Naphthalene	0.05%	0.0005	0.000035	1.641E-08	9	0.0042	0	0
Propylene	3.06%	0.0306	0	0	3000	91.86	0	0
Styrene	0.12%	0.0012	0	0	900	1.11	21000	25.79
Toluene	5.76%	0.0576	0	0	300	17.27	37000	2129.65
Xylenes	4.80%	0.0480	0	0	700	33.61	22000	1056.22
Toxicity Weighted Factor				**1.81E-06**		**283.77**		**3282.58**

Table 15. Toxic Speciation of TOG due to Evaporative Losses

Toxic Compounds	EMFAC Gasoline TOG Speciation (% TOG)	Unit Factor	(HARP) Residential Cancer Risk Factors $(ug/m^3)^{-1}$	Unit Cancer Risk Weighted Factor $(ug/m^3)^{-1}$	Chronic Noncancer Reference Dose (ug/m^3)	Unit Chronic Noncancer Risk Weighted Factor (ug/m^3)	Acute Noncancer Reference Dose (ug/m^3)	Unit ACUTE Noncancer Risk Weighted Factor (ug/m^3)
Benzene	0.36%	3.60E-03	2.90E-05	1.04E-07	6.00E+01	2.16E-01	1.30E+03	4.68E+00
Ethylbenzene	0.12%	1.18E-03	2.52E-06	2.97E-09	2000	2.36E+00	0	0
Hexane	1.54%	1.54E-02	0	0	7000	1.08E+02	0	0
Toluene	1.70%	1.70E-02	0	0	300	5.11E+00	3.70E+04	6.30E+02
Xylenes	0.58%	5.78E-03	0	0	700	4.05E+00	2.20E+04	1.27E+02
Toxicity Weighted Factor				**1.07E-07**		**120**		**762**

The weighted toxicity values are then developed for each emission source by multiplying the TOG speciated percentage of each individual compound by its corresponding toxicity value. The summation of all of the individual weighted toxicity values is then cumulative weighted toxicity that should be applied in the risk and hazard calculations.

6.3 Chronic Noncancer Hazard

The potential for chronic non-cancer hazards is evaluated by comparing the long-term exposure level to a chronic Reference Exposure Level (REL). A REL is a concentration level at or below which no adverse health effects are anticipated. RELs are designed to protect sensitive individuals within the population. Noncancer chronic hazard are calculated by dividing the annual average concentration by the REL (Reference Exposure Level) for that substance. The equation for estimating the hazard quotient is:

$$\text{Hazard Quotient} = C_i/REL_i$$

Where:
C_i = Concentration in the air of substance i (annual average concentration in $\mu g/m^3$)
REL_i = Chronic noncancer Reference Exposure Level for substance i ($\mu g/m^3$)

The hazard index (HI) is the sum of the individual HQs for TACs identified as affecting the same target organ or organ systems. HQs for different organ systems are not added, for example, do not sum respiratory irritation HQs with cardiovascular effects. The following equation is used to calculate the Hazard Index for the eye irritation endpoint:

$$\text{Hazard Index } (HI_{eye}) = HQ_{\text{substance 1(eye)}} + HQ_{\text{substance 2(eye)}}$$

In accordance with OEHHA's risk assessment guidelines, chronic non-cancer hazards should be assessed for inhalation and non-inhalation (e.g., ingestion and dermal contact) chronic exposures.

6.4 Acute Noncancer Hazard

The potential for acute non-cancer hazards is evaluated by comparing the maximum short-term exposure level to an acute Reference Exposure Level (REL). A REL is a concentration level at or below which no adverse health effects are anticipated. RELs are designed to protect sensitive individuals within the population. The calculation of acute noncancer impacts is similar to the procedure for chronic noncancer impacts. The equation is as follows:

$$\text{Acute HQ} = \text{Maximum Hourly Air Concentration } (\mu g/m^3) \text{ / Acute REL } (\mu g/m^3)$$

In most cases for a single substance, the acute Hazard Quotient is the highest one hour air concentration divided by the acute REL for that substance. There are a few substances that have acute RELs for exposure periods other than 1 hour. In those cases, the maximum air concentration for the appropriate exposure period (e.g., 8 hours) is divided by the acute REL. As with the chronic noncancer calculation, for multiple substances that impact the same organ system, the individual substance HQs are summed to determine the HI. In accordance with OEHHA's risk assessment guidelines, acute non-cancer hazards should only be assessed for the inhalation exposure pathway. No exposure period adjustments are necessary for acute health impact calculations.

EXHIBIT E

SECTION 3: SIGNIFICANCE THRESHOLDS

Appendix A to this report establishes two levels of significance thresholds for health risk that were applied to determine whether the project has a project-level health risk impact and a cumulatively considerable health risk impact on the environment. These thresholds are consistent with CEQA requirements and supported by substantial evidence. The thresholds applied in the assessment are as follows and are discussed in Appendix A.

3.1 - Project-Level Health Risk Significance Thresholds

In accordance with the thresholds contained within the SJVAPCD GAMAQI, the following project-level significance health risk thresholds were applied:

- A cancer risk level of 10 new cases in a population of one million
- A non-cancer hazard index of 1.0

A project that contributes a cancer risk in excess of 10 new cases in a population of million persons or a non-cancer hazard index of greater than 1.0 would be considered to have a significant project-level impact.

3.2 - Cumulative Health Risk Significance Thresholds

The Cumulative Thresholds Analysis attached as Appendix A to this report has established a cumulative toxics thresholds through independent analysis of information regarding the impacts of these pollutants, among other things. Appendix A describes the cumulative analysis approaches used by the SJVAPCD, San Luis Obispo County Air Pollution Control District, and BAAQMD and provides supporting documentation for their(??) thresholds and the geographic analysis radius for examining sources of TAC emissions.

The cumulative toxic threshold used in this HRA to evaluate cumulative TAC impacts is applied to the total of the impacts of existing sources that capture the emissions from “past projects” developed and currently emitting TACs, the project, and planned and probable future projects. Appendix A also defines what constitutes a cumulatively considerable contribution to toxic impacts for projects proposed in areas where the impact from existing sources already exceeds the cumulative threshold without the project. The cumulative thresholds applied in the assessment address two potential health risks and hazards: cancer risk and non-cancer hazards, the latter dealing the effects of TACs on the respiratory, reproductive, blood, developmental, and vision systems of the body. The cumulative thresholds are as follows:

- **Cancer Risk to Maximally Exposed Receptor –** Cumulative sources (including the project, existing sources and planned and probable future sources) within 1,000 feet analysis radius of the project would be subject to a significance threshold of 100 in one million.
- **Cancer Risk to Maximally Exposed Receptor from cumulative sources that total over 90 in one million without the project –** When cumulative TAC sources located within 1,000 feet analysis radius from the location of the project exceed a cancer risk of 90 new cases in a population of one million, a project contribution of 10 in one million will be considered a significant cumulative contribution.
- **Non-Cancer Risk to Maximum Exposed Receptor –** Cumulative sources of non-cancer hazards resulting from the same TAC emissions would be subject to a significance threshold of a chronic or acute Hazard Index of greater than 10.0 within 1,000 feet analysis radius from the location of the new source being evaluated.

SECTION 4: ASSESSING HEALTH RISK IMPACTS

The cumulative TAC assessment prepared for the Walmart Project followed a two-step process. The first step of the cumulative assessment was to estimate the maximum project-level health risk impacts and the location of the maximum exposed sensitive receptor, which is the receptor most affected by the project's TAC emissions. This maximum exposed sensitive receptor then served as the receptor location from which the contribution from all existing, planned and probable future TAC sources located within a 1,000-foot analysis radius from the project were measured. The cumulative impacts were then compared with the significance thresholds adopted for this assessment.

This health risk assessment replaces the previous HRA prepared by Illingworth and Rodkin (Illingworth and Rodkin 2010) that was included in the 2011 EIR within the project Draft EIR as Appendix I. This present assessment reflects the following updates to the previous HRA:

- The present assessment developed mobile source emissions using data from the most current version of the ARB EMFAC2011 mobile source emission model; the SJVAPCD recommends the use of most current version of EMFAC for CEQA assessments.
- The present assessment assumed that the 2 axle delivery trucks would be medium heavy duty trucks rather than light heavy duty trucks assumed in the previous assessment to ensure a more conservative estimate of emissions from these vehicles.[1]
- Applied a higher diesel particulate matter emission rate for the transport refrigeration units that operate on refrigerated trucks to reflect SJVAPCD emission factor guidance.

4.1 - Assessment of the Project-Level Health Risk Impacts

This section discusses the methods and quantifies the results of the assessment of the project-level impacts. The project involves the expansion of the existing Walmart store by up to 54,857 square feet, increasing the total store area to 181,640 square feet. Therefore, the assessment of project impacts evaluates those resulting from the addition of the 54,857 square feet of facility expansion.

4.1.1 - Estimation of Project TAC Emissions

The primary TAC emissions from the project result from the travel and idling of diesel-fueled vehicles and the operation of transport refrigeration units (TRU) used to transport perishable products.[2] The Walmart expansion project would involve the addition of three large 4+axle[3] diesel

[1] Was done in response to one of the late technical comments submitted by counsel for the petitioner in the Tulare County Superior Court CEQA lawsuit.
[2] A transport refrigeration unit or TRU is a small diesel engine that is used to refrigerate perishable products while in transit to their delivery destination.
[3] A 4+axle heavy duty truck or HHDT is more familiarly known as an "18 wheeler" truck or "big rig" truck. The smaller 2-axle trucks are used for vendor deliveries.

fueled delivery trucks and four 2-axle diesel fueled delivery trucks. Other TAC emissions result from the operation of customer and worker vehicles that travel to and from the project.

Table 1 identifies the vehicular traffic associated with the project while Exhibit 7 displays the location of the project's onsite emission sources. Exhibit 7 also provides the locations of the onsite emission sources for the existing Walmart store for comparison purposes. Note the differences in the onsite truck delivery routes between the existing Walmart store and after development of the project. The onsite truck delivery route associated with the existing Walmart store follows a straight north to source route while the truck route after the development of the project follows the outlines of the project fence line. These differences affect the impacts of the emissions from the existing Walmart store after the implementation of the project by moving the delivery truck routes closer to the adjacent residences resulting in a higher relative impact compared to the impacts from the existing Walmart truck route.

Table 1: Inventory of Project Walmart Vehicle Trips During Operations

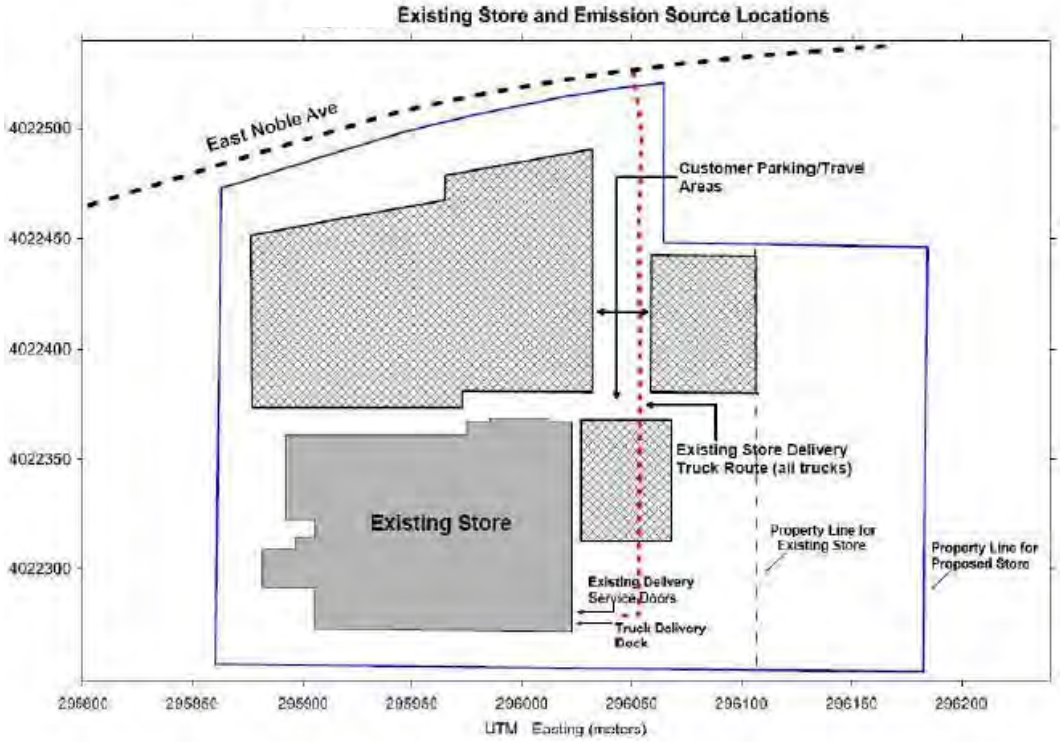
Vehicle Class[(1)]	Project Truck Deliveries and Vehicles (vehicles per day)	Project Truck Delivery and Vehicle Trips (trips per day)
2 axle heavy duty truck	4	8
4+ axle heavy duty truck (with TRU)	2	4
4+ axle heavy duty truck (without TRU)	1	2
Customer and Worker Vehicles (DSL and GAS)	463	925

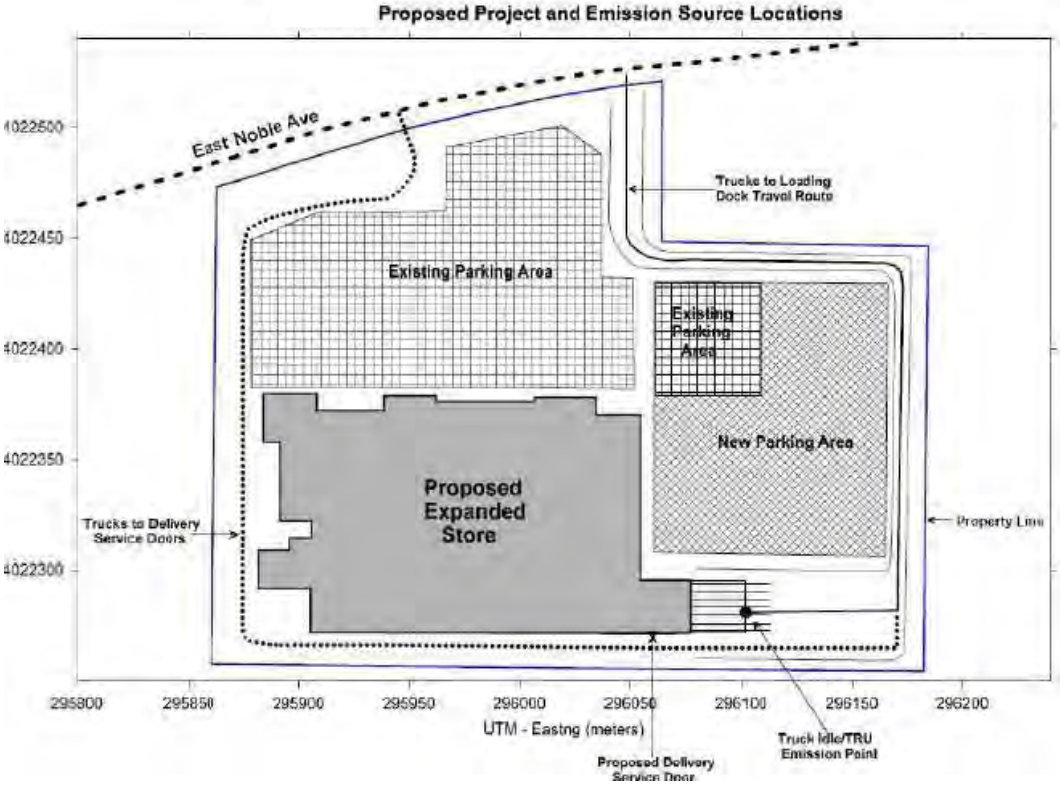
Notes:
(1) 2 axle vehicles are represented by the EMFAC medium heavy duty vehicle class; 4+ axle vehicles are represented by the EMFAC heavy-heavy duty vehicle class; all heavy duty vehicles are assumed to be diesel-fueled.
TRU = transport refrigeration unit
Source: see Appendix B for the emission calculations

The project operations assumed 24-hour store operations and customer access and with truck deliveries occurring from 6 am to 10 p.m. daily, based upon a previously imposed condition of approval Onsite vehicle travel assumed a speed of 15 mph. All delivery trucks were assumed to idle for 5 minutes per day. The rates of emissions from project operations were derived from the vehicle emission data provided by the ARB in its EMFAC2011 mobile source emission model[4].

In calculating emissions with the EMFAC2011 model for the heavy duty 4-axle trucks (HHDT), only model year trucks 2006 or newer were used since Walmart's truck fleet servicing this store is made up of trucks 2006 or newer. DPM emissions in the near future (5 to 10 years) from these types of heavy-duty diesel trucks will be substantially reduced from the emission levels used for this evaluation due to regulatory requirements for on-road heavy-duty diesel trucks. The DPM emission factors used to estimate the project's emissions are provided in Table 2.

[4] The EMFAC2011 model can predict emissions for any year from 1990 to 2035. The EMFAC2011 model is an update to a previous model EMFAC2007 and incorporates current information on vehicle usage and population, and emission rates. ARB released the EMFAC2011 model for use on September 30, 2011 and was not available for use at the time the 2010 DEIR was prepared (ARB 2011).





Michael Brandman Associates

Exhibit 7
Location of Walmart Onsite Emission Sources

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Table 2: DPM Emission Factors for Mobile Sources

Vehicle Speed (mph)	Diesel Vehicle Running Emission Factors (g/mi)[1]							
	LDA	LDT1	LDT2	MDT	LHDT1	LHDT2	MHDT	HHDT[2]
15 mph	0.192	0.265	0.227	0.113	0.085	0.081	0.656	0.816/0.205
25 mph	0.129	0.178	0.153	0.076	0.057	0.055	0.347	0.475/0.176
35 mph	0.095	0.131	0.112	0.056	0.042	0.040	0.264	0.392/0.180
45 mph	0.076	0.105	0.090	0.045	0.034	0.032	0.245	0.395/0.198
55 mph	0.067	0.092	0.079	0.040	0.030	0.028	0.289	0.483/0.276
	Diesel Vehicle Idling Emission Factor (g/hr)[1]							
	LDA	LDT1	LDT2	MDT	LHDT1	LHDT2	MHDT	HHDT[2]
Vehicle Idle	1.367	1.890	1.619	0.806	0.609	0.561	1.547	0.981/0.407
TRU Emission Factor (g/hp-hr)[3]								
TRU Exhaust + Idle	**0.28**	—						

Notes:
LDA = light duty automobile LDT1 and LDT2 = light duty trucks MDT = medium duty truck
LHDT1 and LHDT2 = light heavy duty trucks MHDT = medium heavy duty trucks
HHDT = heavy heavy duty trucks TRU = transportation refrigeration unit
(1) Derived from ARB EMFAC2011 for Tulare County in 2010
(2) Two emission factors are shown for the HHDT vehicle class. The value on the left applies to all non-Walmart HHDT while the value of the right applies to all Walmart HHDT
(3) Derived from ARB OFFROAD2007 fleet average for Tulare County in 2010

The burning of gasoline by gasoline-powered vehicles also results in the emissions of total organic gas (TOG) emissions,[5] which contain several toxic components including benzene and 1.3-butadiene that have identified carcinogenic and non-carcinogenic impacts. The potential health impacts from TOG emissions resulting from gasoline-powered motor vehicle traffic along the local roadway network were also accounted for in the HRA. Table 3 shows the TOG emission factors for mobile sources.

Table 3: TOG Emission Factors for Gasoline Mobile Sources

Vehicle Speed (mph)	Gasoline Vehicle Running Emission Factors (g/mi)[1]							
	LDA	LDT1	LDT2	MDT	LHDT1	LHDT2	MHDT	HHDT
15 mph	0.477	1.251	0.696	0.547	1.021	1.269	4.923	7.836
25 mph	0.332	0.902	0.491	0.364	0.702	0.865	3.335	4.461
35 mph	0.274	0.757	0.407	0.291	0.571	0.698	2.681	3.061
45 mph	0.252	0.702	0.376	0.264	0.515	0.624	2.394	2.456
55 mph	0.253	0.704	0.376	0.262	0.409	0.596	2.283	2.208

Notes:
LDA = light duty automobile LDT1 and LDT2 = light duty trucks MDT = medium duty truck
LHDT1 and LHDT2 = light heavy duty trucks MHDT = medium heavy duty trucks
HHDT = heavy heavy duty trucks
(1) Derived from ARB EMFAC2011 for Tulare County in 2010 and includes running exhaust emissions and running loss emissions

[5] TOG is defined by the California Air Resources Board (ARB) as compounds of carbon, excluding carbon monoxide, carbon dioxide, carbonic acid, metallic carbides or carbonates, and ammonium carbonate. TOG includes all organic gas compounds emitted to the atmosphere, including the low reactivity compounds.

In addition to the emissions generated from traffic within the project location, the project's vehicle traffic was also distributed within the local roadway network as identified in the project's traffic impact report (Kimley-Horn and Associates 2010).

4.1.2 - Air Dispersion Model

In accordance with guidance from the SJVAPCD (SJVAPCD 2010), the assessment of health risk impacts from TAC emissions applied the EPA's AERMOD Model. AERMOD represents a major scientific improvement over the ISC model that was previously recommended by the EPA for air quality assessments. AERMOD predicts pollutant concentrations from point, area, volume, line, and flare sources with variable emissions in terrain from flat to complex with the inclusion of building downwash effects from buildings on pollutant dispersion. It captures the essential atmospheric physical processes and provides reasonable estimates over a wide range of meteorological conditions and modeling scenarios.

General Model Assumptions

The basic options used in the dispersion modeling are summarized in Table 4.

Table 4: General Modeling Assumptions

Feature	Option Selected
Terrain processing	Flat terrain
Emission source configuration	See Table 5 below
Regulatory dispersion options	Fast processing
Land use	Urban
Coordinate system	UTM
Building downwash	Included in calculations
Receptor height	0 meters

As indicated in Table 4, the effects of building downwash on the dispersion of emissions from the project buildings were accounted for. Building downwash occurs when the aerodynamic turbulence, induced by nearby buildings, causes pollutants emitted from an elevated source to be mixed rapidly toward the ground (referred to as downwash). This results in potentially higher ground-level concentrations than if the buildings were not present owing to the downward mixing of emissions resulting from wind turbulence in the leeward side of the building. The AERMOD dispersion model contains algorithms to account for building downwash effects. The required information includes the location of the emission source; location of adjacent buildings; and the building geometry in terms of length, width, and height. For purposes of this analysis, the emission source and building locations and geometries were taken from the project site plan and from aerial photographs. Building heights varied from 25 feet to 40 feet depending on the particular building.

Meteorological Data

Hourly meteorological data are also required to operate the AERMOD model to determine the direction and rate of dispersion of emissions released into the atmosphere. The SJVAPCD has prepared meteorological data sets covering the period 2005-2009 for several locations within the SJVAPCD that can be used as input to the AERMOD model. These data sets include items such as wind direction and speed, air temperature, surface roughness, albedo, Bowen Ratio, and vertical temperature structure of the lower atmosphere. The SJVAPCD meteorological data set closest to the project site is from the Visalia Airport located approximately 6.5 miles west of the project site. These meteorological data are considered representative of the project site and were used in this assessment. Valid meteorological data are available from the Visalia Airport for the 4-year time period from 2006 to 2009.

4.1.3 - Receptor Network

The assessment also requires the specification of a network of receptors such that the impacts can be computed at the various locations within the network. The locations of the receptors use in the modeling analysis were shown earlier in Exhibit 6 and include the sensitive receptors located adjacent to the project.

4.1.4 - Emission Source Characterization

Each of the emission source types described above also requires geometrical and emission release specifications for use in the air dispersion model. Table 5 provides a summary of the assumptions used to configure the various emissions. The following definitions are used in defining the emission source geometrical configurations referred to in Table 5:

- *Point source*: a single identifiable local source of emissions; it is approximated in the air dispersion model as a mathematical point in the modeling region with a location and emission characteristics such as height of release, temperature, etc.; for example, a stack or vent.
- *Line source*: a series of volume sources along a path (Example: vehicular traffic along a street or within the project).
- *Area source*: a large area over which emissions are uniformly distributed (example: a parking lot).

Table 5: Summary of Existing Store and Project Emission Source Configurations

Emission Source Type	Configuration	Relevant Assumptions
Onsite Diesel Truck Traffic	Line Sources	• Emission release height: 6 feet • Vehicle Speed: 15 mph • Length of the line source (distance from the facility entrances to the loading area/docks • Vehicle types: MHDT and HHDT diesel delivery trucks • Emission factors: ARB EMFAC2011 • Loading dock activity is restricted to the hours of 6 am and 10 pm daily based upon a previously imposed condition of approval for the project.
Onsite Diesel Truck Idling	Point Sources located at the loading docks	• Emission release height: 10 feet above grade[1] • Emission release characteristics > Stack diameter: 0.3 feet > Stack velocity: 170 feet/sec > Stack temperature: 200° F • Idle time: 5 minutes in accordance with State law. Previously imposed conditions of project approval included this restriction as well. • Vehicle types: MHDT and HHDT diesel delivery trucks • Emission factors: ARB EMFAC2011 • Loading dock activity is restricted to the hours of 6 am and 10 pm daily based upon a previously imposed condition of approval for the project.
Trucks with Diesel TRUs	Point Source at the loading area/dock; line source while traveling onsite	• Stack release height of TRU 7 feet above grade[1] based on measurements from Walmart fleet trucks. • TRU Size: 34 horsepower (typical size) • Load factor: 53% • Emission factors: TRU emission factors based fleet average for Tulare County in 2010 from ARB OFFROAD2007 model
Offsite Vehicle Traffic	Line Sources along the local roadway network	• Offsite travel based on trip distribution as derived from the 2011 EIR traffic impact study • Vehicle speeds dependent on vehicle class and roadway and ranged from 25 mph to 45 mph • Emission factors: ARB EMFAC2011 • Loading dock activity is restricted to the hours of 6 am and 10 pm daily based upon a previously imposed condition of approval for the project.
Walmart Parking Lot	Area Sources located at the Walmart building	• Vehicle speed: 15 mph • Idle time of 1 minute per vehicle per day • Vehicles: diesel LDA, LDT, and MDT • Emission factors: ARB EMFAC2011

Note:
[1] The Walmart loading dock is below grade resulting in a release height 2 feet less than the SJVAPCD recommended default. This applies to the release height for truck idling and TRU operation for Walmart trucks at the loading dock.
Source: see Appendix C for the emission source details.

4.1.5 - Health Risk Assessment Methodology

The health risk assessment of toxic air contaminants involves the application of a risk characterization model to the results from the air dispersion model to estimate potential health risks at each sensitive receptor location. The estimation of health risks are calculated directly from the emissions of DPM and TOG using the AERMOD air dispersion model for the types of emission sources considered in this assessment (roadways and idling sources).

Methodology for Estimating Lifetime Cancer Risk

The methodology basically assumes that a person is exposed continuously to a project's TAC emissions for a period of 350 days per year, 24 hours per day over a 70-year lifetime period. Clearly, this methodology provides a very conservative estimate of health risks, since an individual would not typically reside in any one location for a 70-year period and be continuously exposed over that period 350 days per year, 24 hour per day.

Diesel Particulate Matter Cancer Risk Assessment Methodology for Mobile Sources

The cancer risk from mobile source-related DPM is calculated by multiplying the average DPM concentrations calculated using the AERMOD air dispersion model and an inhalation exposure factor as in Equation 1 below (OEHHA 2003).

Cancer Risk = Inhalation cancer potency factor x Dose-inhalation (EQ-1)

Where:

Cancer Risk = Total individual lifetime excess cancer risk defined as the cancer risk a hypothetical individual faces if exposed to carcinogenic emissions from a particular facility continuously, 24 hours/day, for a 70-year lifetime; this risk is defined as an excess risk because it is above and beyond the background cancer risk to the population contributed by emission sources not related to the project; cancer risk is expressed in terms of risk per million exposed individuals.

Inhalation cancer potency factor (CPF) = 1.1 (milligrams per kilogram per day)$^{-1}$ for DPM; inhalation is the principal exposure pathway for cancer impacts for DPM

Dose-inhalation = C_{air} x (DBR x A x EF x ED x 10^{-6} /AT) (EQ-2)

Where:

C_{air} = Average DPM concentrations calculated from the AERMOD model in $\mu g/m^3$
DBR = Daily breathing rate
A = Inhalation absorption factor
EF = Exposure frequency
ED = Exposure duration
AT = Averaging time period over which the exposure is averaged

Values for the components of the Inhalation Exposure Factor were provided by the SJVAPCD for sensitive receptors and are shown in Table 6.

Table 6: Values of the Inhalation Exposure Factor for DPM

Receptor	CP – DPM $(mg/kg/day)^{-1}$	DBR (liters/kg-day)	EF (days/year)	ED (years)	AT (days)
Sensitive/Residential	1.1	393	350	70	25,550

After applying Equations 1 and 2 with the values for the various factors shown in Table 6, the Cancer Risk for DPM is then calculated as:

$$\text{Cancer Risk}_{DPM} = C_{DPM} \times 414.5 \text{ (risk per million for sensitive receptors)} \quad \text{(EQ-3)}$$

Where:

Cancer Risk_{DPM} = lifetime cancer risk to sensitive receptors from DPM emissions at each receptor
C_{DPM} = Average DPM concentrations calculated from the AERMOD model in $\mu g/m^3$ at each receptor location

TOG Cancer Risk Assessment Methodology for Mobile Sources

As noted earlier, DPM comprises at least 80 percent of the estimated total airborne cancer risk from TACs. Another source of TACs results from the tailpipe emissions from gasoline vehicles and includes several important toxic compounds including benzene, ethylbenzene, formaldehyde, acrolein, 1-3,butadiene and others, individual compounds that make up TOG emissions from tailpipes. To estimate cancer risks from gasoline vehicle tailpipe emissions, the TOG emissions must first be speciated into the different compounds that make up the toxic portions of TOG. A weighted toxicity value is then developed for use in the cancer risk impact calculations that incorporates the individual toxicity of each compound that makes up the TOG emissions (BAAQMD 2011a). The following speciated profile for gasoline tailpipe TOG emissions is shown in Table 7. This profile was used to describe the toxic portion of tailpipe gasoline TOG emissions.

The cancer risk from the gasoline tailpipe emissions is estimated as follows:

$$\text{Cancer Risk}_{TOG} = C_{TOG} \times 2.5 \quad \text{(EQ-4)}$$

Where:

Cancer RiskTOG = estimated cancer risk attributable to TACs from TOG in risk per million at each receptor
C_{TOG} = average concentration of TOG concentration from the AERMOD model at each receptor location ($\mu g/m^3$)

The total cancer risk at each sensitive receptor is then the sum of the cancer risk from all sources of TACs.

$$\text{Total Cancer Risk} = \text{Cancer Risk}_{DPM} + \text{Cancer Risk}_{TOG} \quad \text{(EQ-5)}$$

Table 7: Toxic Speciation Profile of TOG Due To Tailpipe Emissions

TOG Compound	EMFAC Gasoline TOG Speciation (%TOG)	Unit Factor	Residential Cancer Risk Factors $(\mu g/m^3)^{-1}$	Unit Cancer Risk Weighted Factor $(\mu g/m^3)^{-1}$	Chronic Non-Cancer REL $(\mu g/m^3)$	Unit Chronic Non-Cancer Risk Weighted Factor $(\mu g/m^3)$	Acute Non-Cancer REL $(\mu g/m^3)$	Unit Acute Non-Cancer Risk Weighted Factor $(\mu g/m^3)$
Acetaldehyde	0.28	0.0028	0.0000027	7.537E-09	140	0.39	470	1.31
Acrolein	0.13	0.0013	0	0	0.55	0.00046	2.5	0.0035
Benzene	2.47	0.0247	0.000029	7.169E-07	60	1.48	1300	32.14
1,3-Butadiene	0.55	0.0055	0.000174	9.487E-07	20	0.11	0	0
Ethylbenzene	1.05	0.105	0.0000025	2.643E-08	2000	20.97	0	0
Formaldehyde	1.58	0.0158	0.0000061	9.602E-08	9	0.14	55	0.87
Hexane	1.60	0.0160	0	0	7000	111.92	0	0
Methanol	0.12	0.0012	0	0	4000	4.89	28000	34.22
Methyl ethyl ketone	0.02	0.0002	0	0	0	0	13000	2.37
Naphthalene	0.05	0.0005	0.000035	1.641E-08	9	0.0042	0	0
Propylene	3.06	0.0306	0	0	3000	91.86	0	0
Styrene	0.12	0.0012	0	0	900	1.11	21000	25.79
Toluene	5.76	0.0576	0	0	300	17.27	37000	2129.65
Xylenes	3.80	0.0480	0	0	700	33.61	22000	1056.22
Total Weighted Factor				**1.8E-06**[(1)]		**120**		**3282.58**

Note:
The Unit Cancer Risk Weighted Factor was increased to 2.5E-06 to account for the SJVAPCD's use of the 95th percentile daily breathing rate in the calculation of lifetime cancer risk.
Source: BAAQMD 2011a

Non-cancer Hazards

Exposures to certain TACs can also result in chronic (long-term) or acute (short-term) non-cancer health effects. Such effects could include respiratory, eye, dermal, reproductive, birth, and developmental problems. Non-cancer health risks are conveyed in terms of the hazard index (HI), a ratio of the predicted concentration of the facility's reported TAC emissions to a concentration considered acceptable to public health professionals. A significant risk is defined as an HI of 1 or greater. An HI of less than 1 indicates that no significant health risks are expected from the facility's TAC emissions.

The relationship for the non-cancer risks of TACs, is given by the following equation:

$$HI = C/_{REL} \qquad \text{(EQ-6)}$$

Where:

HI = Hazard Index, A unit-less number indicating the estimated potential for relative adverse health impacts from acute (short-term exposures lasting seconds to hours) and chronic non-cancer (long term exposures lasting months to years) exposures to air emissions of toxic substances.
C = Average air pollutant TAC concentration ($\mu g/m^3$) estimated through monitoring or air dispersion modeling
REL = Reference Exposure Level, defined as a concentration or dose of a toxic compound below which non-cancer health effects are not anticipated in the most sensitive receptor

Chronic Non-Cancer Hazard from Diesel Particulate Matter Mobile Source Emissions

Chronic or long-term exposures to DPM can result is non-cancer health effects. Equation 6 is used to estimate the chronic non-cancer hazard index, HI, from DPM with the following definitions:

C = annual average concentration of DPM at a receptor as calculated from an air dispersion model in units of $\mu g/m^3$
REL = reference exposure level of 5 $\mu g/m^3$

Therefore, an annual average DPM concentration exceeding 5 $\mu g/m^3$ would be necessary result in an exceedance of the SJVAPCD project-level non-cancer health risk index of 1.0

Chronic Non-Cancer Hazard from TOG Emissions

A weighted toxicity profile is used to estimate the chronic non-cancer hazard index from mobile source TOG gasoline emissions. The chronic non-cancer toxicity-weighted reference exposure level was shown earlier in Table 7 above. Equation 6 is used to estimate chronic non-cancer hazard index from the tailpipe TOG emissions with the following definitions:

C = annual average concentration of TOG at a receptor as calculated from an air dispersion model in units of $\mu g/m^3$
REL = reference exposure level of 120 $\mu g/m^3$

Acute Non-Cancer Risk from Diesel Particulate Matter Emissions

Exposures to toxic air contaminants can also result in acute (short-term) impacts. In a manner similar to assessment of chronic hazard impacts, acute hazard impacts are calculated using a hazard index.

Acute Non-Cancer Hazard from Diesel Particulate Matter Mobile Source Emissions

Currently, the California Office of Environmental Health Hazards Assessment (OEHHA) has not set an acute reference exposure level for DPM.

Acute Non-Cancer Hazard from TOG Emissions

Equation 6 is applied in estimating an acute non-cancer hazard index for tailgas TOG emissions with the following assumptions:

> C = maximum on-hour average concentration of TOG at a receptor as calculated from an air dispersion model in units of $\mu g/m^3$
> REL = reference exposure level of 3,283 $\mu g/m^3$ as per the toxicity-weighted acute reference exposure level provided in Table 7.

4.1.6 - Results of the Project Health Risk Assessment

This section summarizes the results of the project's health risk assessment.

Cancer Risk

Table 8 summarizes the project-level cancer risk. As noted therein, the highest cancer risk from the project at any receptor is 3.3 in one million, which occurs at the residences located at the southeast corner of the Walmart property near the intersection of East College Avenue and South Tracy Street. The reason this location is determined to be the site of the MER is that it is located the closest to the project's new TAC emissions, which come primarily from the truck access route and the new loading dock area. The modeling results are provided in Appendix C. A graphic plot of the project's cancer risk impacts is provided in Exhibit 8.

Table 8: Project-Level Cancer Risk at the Maximum Exposed Sensitive Receptor

Receptor Location	Project Cancer Risk (risk/million)	SJVAPCD Significance Threshold (risk/million)	Significant Impact?
Residences located at the southeast corner of the Walmart property near the intersection of East College Avenue and South Tracy Street	3.3	10.0	No
Source: Appendix C			

The estimated project risk largely reflects the incremental increase in truck trips and use of TRUs required to serve the expansion of the existing Walmart and relocation of the truck access route for the entire site.

Significance of Project-Level Emissions of TACs on Cancer Risk

On a project-level basis, the TAC emissions from the project would not exceed the project-level cancer risk significance threshold of 10 in one million established by the SJVAPCD.

4.1.7 - Non-Cancer Hazards

The highest non-cancer hazard index at any receptor within the area modeled was 0.002.

Significance of Project-Level Emissions of TACs on Non-Cancer Hazards

On a project-level basis, the TAC emissions from the project would not exceed the project-level non-cancer hazard index significance threshold of 1.0 established by the SJVAPCD.

4.2 - Assessment of the Cumulative Health Risk Impacts

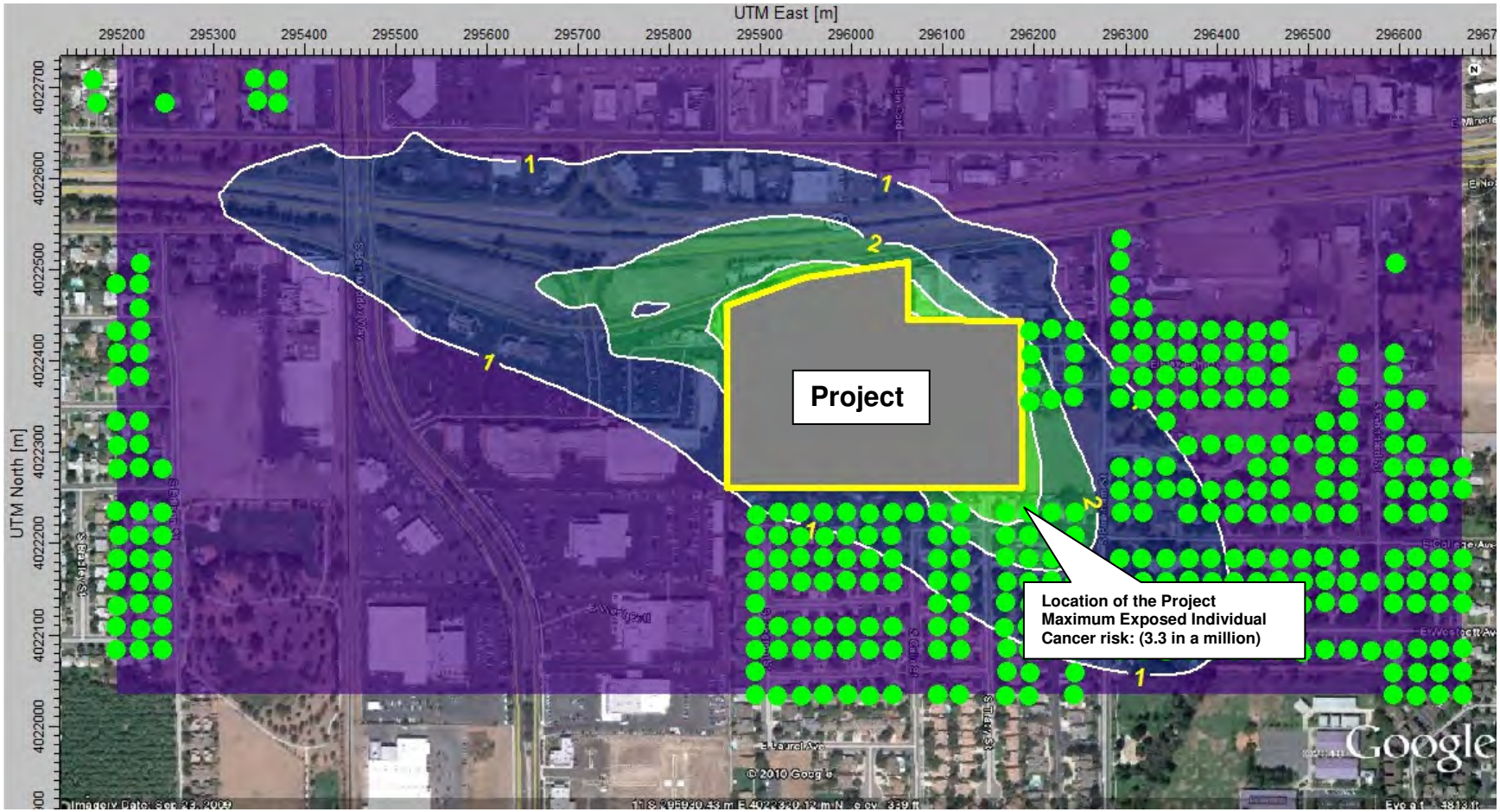
After identifying the magnitude and location of the maximum exposed sensitive receptor from the project, the next step of the assessment is to estimate emissions and risk from existing and reasonably foreseeable sources of TACs on the maximum exposed project sensitive receptor.

Various existing and reasonably foreseeable future sources of toxic air contaminants were identified within the 1000-foot analysis radius of the project. The BAAQMD also recommends including sources located beyond 1,000 feet on a case-by-case basis. In this case, review of the project area beyond the 1,000-foot radius identified a number of sources with the potential to contribute to the cumulative impact.[6] The source farthest from the project site was a food processing facility located approximately 1,450 feet west of the project site. The sources assessed were in existence in the year 2010 or were reasonably foreseeable for development, based on information provided by the City of Visalia.

4.2.1 - Estimating Existing Sources of TAC Emissions

The first requirement when preparing the cumulative analysis involves the process of identifying and quantifying the types and sources of TAC air emissions from a myriad of different existing, planned, and probable future emission sources within the 1,000-foot analysis radius of the project also termed an “emission inventory.” The existing emissions represent the level of emissions that occur on an everyday basis upon which the emissions from the project are superimposed to determine if a significant cumulative impact exists.

[6] In some cases, large emission sources located just outside of the 1000-foot analysis radius were also included in the assessment; these sources included the food processing facility, a restaurant, a auto dealership, a gasoline service station, the rail line, and portions of the local roadway network. See Appendix B for emission source details.



Contours: cancer risk in units of risk per million

Location of Sensitive Receptor

Michael Brandman Associates

Exhibit 8
Graphic Plot of Project Cancer Risks

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Identification of the TACs of Concern

The following TACs, shown in Table 9, were identified as TACs of concern, based on a review of the types of emission sources within the 1,000-foot analysis radius of the project. Exposures to these pollutants can potentially lead to increased incidences in cancer- and non-cancer-related health effects such as eye irritations, respiratory problems, reproductive problems, blood-related problems, and developmental problems.

Table 9: Toxic Air Contaminant Emissions of Concern

TAC of Concern	Sources	Type of Toxic Effects		
		Carcinogenic	Non-carcinogenic	
			Chronic (long-term)	Acute (short-term)
DPM (Diesel Particulate Matter)	Diesel truck exhaust from truck travel and idling; truck transportation refrigeration units (TRUs) and rail locomotives	Yes	Yes	No
1,3-Butadiene	Motor vehicle exhaust	Yes	No	No
Acetaldehyde	Food processing, motor vehicle exhaust	Yes	Yes	No
Acrolein	Food processing, motor vehicle exhaust	No	Yes	Yes
Ammonia	Food processing	No	Yes	Yes
Benzene	Food processing, evaporation from gasoline service stations, motor vehicle exhaust	Yes	Yes	Yes
Benzo(a)Pyrene	Restaurant cooking	Yes	No	No
Di(2-Ethylexyl) phthalate	Food processing	Yes	No	No
Ethyl benzene	Food processing, spray paint, motor vehicle exhaust	Yes	Yes	No
Ethylene glycol	Food processing and spray paint	No	Yes	No
Ethylene glycol monobutyl ether	Food processing	No	No	Yes
Formaldehyde	Food processing, motor vehicle exhaust	Yes	Yes	Yes

Table 9 (cont.): Toxic Air Contaminant Emissions of Concern

TAC of Concern	Sources	Type of Toxic Effects		
		Carcinogenic	Non-carcinogenic	
			Chronic (long-term)	Acute (short-term)
Hexane	Food processing, motor vehicle exhaust	No	Yes	No
Isopropyl alcohol	Food processing	No	No	Yes
Methanol	Food processing, motor vehicle exhaust	No	Yes	Yes
Methyl ethyl ketone	Food processing, motor vehicle exhaust	No	No	Yes
Methylene chloride	Food processing	Yes	Yes	Yes
Napthalene	Food processing, restaurant cooking, motor vehicle exhaust	Yes	Yes	No
PAHs-w/o components	Food processing	Yes	No	No
Phosphoric acid	Food processing	No	Yes	No
Propylene	Food processing, motor vehicle exhaust	No	Yes	No
Sodium hydroxide	Food processing	No	No	Yes
Styrene	Motor vehicle exhaust	No	Yes	Yes
Toluene	Food processing, motor vehicle exhaust	No	Yee	Yes
Xylenes	Food processing, motor vehicle exhaust	No	Yes	Yes
Source: OEHHA Toxicity Criteria Database 2012.				

Table 10 summarizes the health effects of the TACs shown in Table 9.

Table 10: TAC Health Effects

TAC	Health Effects
Acetaldehyde	Acetaldehyde is a carcinogen that also causes chronic non-cancer toxicity in the respiratory system. Symptoms of chronic intoxication of acetaldehyde in humans resemble those of alcoholism. The primary acute effect of inhalation exposure to acetaldehyde is irritation of the eyes, skin, and respiratory tract in humans. At higher exposure levels, erythema, coughing, pulmonary edema, and necrosis may also occur. Acute inhalation of acetaldehyde resulted in a depressed respiratory rate and elevated blood pressure in experimental animals.
Acrolein	Acutely acrolein acts primarily as an irritant to the eyes and respiratory tract.
Ammonia	Ammonia vapors cause irritation of the eyes and respiratory tract. Higher concentrations cause conjunctivitis, laryngitis, and pulmonary edema, possibly accompanied by a feeling of suffocation. Contact with the skin causes burns and blistering. The eye is especially sensitive to alkali burns.
Benzene	Benzene is highly carcinogenic and occurs throughout California. Benzene also has non-cancer health effects. Brief inhalation exposure to high concentrations can cause central nervous system depression. Acute effects include central nervous system symptoms of nausea, tremors, drowsiness, dizziness, headache, intoxication, and unconsciousness. Neurological symptoms of inhalation exposure to benzene include drowsiness, dizziness, headaches, and unconsciousness in humans. Ingestion of large amounts of benzene may result in vomiting, dizziness, and convulsions in humans. Exposure to liquid and vapor may irritate the skin, eyes, and upper respiratory tract in humans. Redness and blisters may result from dermal exposure to benzene. Chronic inhalation of certain levels of benzene causes disorders in the blood in humans. Benzene specifically affects bone marrow (the tissues that produce blood cells). Aplastic anemia, excessive bleeding, and damage to the immune system (by changes in blood levels of antibodies and loss of white blood cells) may develop. Increased incidence of leukemia (cancer of the tissues that form white blood cells) has been observed in humans occupationally exposed to benzene.
Benzo(a)Pyrene	B(a)P is a carcinogen and is readily absorbed following inhalation, oral, and dermal routes of administration.
1,3-Butadiene	An early occupational study reported complaints of irritation of eyes, nasal passages, throat, and lungs in rubber manufacturing workers following acute exposure to unknown levels of 1,3-butadiene. Additional symptoms reported included coughing, fatigue, and drowsiness; however, all symptoms ceased on removal from the exposure.
Di(2-Ethylexyl) phthalate	DEHP, at the levels found in the environment, is not expected to cause adverse health effects in humans. Most of what we know about the health effects of DEHP comes from studies of rats and mice that were given DEHP in their food, or the DEHP was placed in their stomach with the aid of a tube through their mouth. In most of these studies, the amounts of DEHP given to the animals were much higher than the amounts found in the environment. Rats and mice appear to be particularly sensitive to some of the effects of DEHP. Thus, because certain animal models may not apply to humans, it is more difficult to predict some of the health effects of DEHP in humans using information from these studies.
Ethyl Benzene	Acute (short-term) exposure to ethylbenzene in humans results in respiratory effects, such as throat irritation and chest constriction, irritation of the eyes, and neurological effects such as dizziness. Chronic (long-term) exposure to ethylbenzene by inhalation in humans has shown conflicting results regarding its effects on the blood. Animal studies have reported effects on the blood, liver, and kidneys from chronic inhalation exposure to ethylbenzene. Limited information is available on the carcinogenic effects of ethylbenzene in humans.

Table 10 (cont.): TAC Health Effects

TAC	Health Effects
Ethylene glycol	Acute (short-term) exposure of humans to ethylene glycol by ingesting large quantities causes three stages of health effects: central nervous system (CNS) depression, followed by cardiopulmonary effects, and later renal damage.
Ethylene glycol monobutyl ether	Eye, nose and throat irritation, taste disturbances, and headache and nausea have been reported.
Formaldehyde	The major toxic effects caused by acute formaldehyde exposure via inhalation are eye, nose, and throat irritation and effects on the nasal cavity. Other effects seen from exposure to high levels of formaldehyde in humans are coughing, wheezing, chest pains, and bronchitis. Chronic exposure to formaldehyde by inhalation in humans has been associated with respiratory symptoms and eye, nose, and throat irritation. Animal studies have reported effects on the nasal respiratory epithelium and lesions in the respiratory system from chronic inhalation exposure to formaldehyde. Occupational studies have noted statistically significant associations between exposure to formaldehyde and increased incidence of lung and nasopharyngeal cancer. This evidence is considered to be "limited" rather than "sufficient" due to possible exposure to other agents that may have contributed to the excess cancers. EPA considers formaldehyde to be a probable human carcinogen (cancer-causing agent) and has ranked it in EPA's Group B1. In California, formaldehyde has been identified as a carcinogen.
Hexane	The acute toxicity of n-hexane is low, although it is a mild anesthetic. Inhalation of high concentrations produces first a state of mild euphoria, followed by somnolence with headaches and nausea. The toxicity of n-hexane has been extensively discussed by the Agency for Toxic Substances and Disease Registry. The long-term toxicity of n-hexane in humans is well known. Extensive peripheral nervous system failure is known to occur in humans chronically exposed to levels of n-hexane ranging from 400 to 600 parts per million (ppm), with occasional exposures up to 2,500 ppm. The initial symptoms are tingling and cramps in the arms and legs, followed by general muscular weakness. In severe cases, atrophy of the skeletal muscles is observed, along with a loss of coordination and problems of vision.
Isopropyl alcohol	Symptoms of acute poisoning include dizziness, loss of coordination, headache, and confusion. Vomiting, hematemesis, diarrhea, and hypotension may occur following ingestion of large quantities of isopropyl alcohol. Late manifestations include aspiration pneumonia and kidney and liver dysfunction.
Methanol	Methanol is easily absorbed following ingestion, inhalation, or dermal exposure and is metabolized by the liver to formaldehyde, then formate. The latter metabolite is responsible for the metabolic acidosis and ocular effects characteristic of acute methanol poisoning. Odor and irritation are not adequate warnings of overexposure to methanol. The visual disturbances vary from spots or cloudiness of vision to complete blindness. Methanol toxicity can result in coma and death by respiratory or cardiac arrest.
Methyl ethyl ketone	Symptoms of acute MEK exposure include irritation of the eyes, nose, and throat. In human case studies, inhalation of MEK for its euphoric effect has also resulted in slight excitement, followed by somnolence or unconsciousness at higher concentrations. Humans occupationally exposed to MEK have also complained of mild neurologic effects including headaches, dizziness, and nausea.
Methylene Chloride	Frequently reported effects following acute inhalation exposure to MC include CNS depression at concentrations of 1,000 ppm (3,500 mg/m^3) or more and increased blood carboxyhemoglobin (COHb) content at lower concentrations due to metabolism of MC to carbon monoxide.
Napthalene	Naphthalene has been identified as a carcinogenic substance.

Table 10 (cont.): TAC Health Effects

TAC	Health Effects
PAHs-w/o components	Several studies in animals and humans indicate that prenatal exposure to PAHs results in serious or irreversible effects in the fetus, including cancer, teratogenesis, and low birth weight. As discussed in the introductory section of this report, fetal damage sustained as a result of exposure to environmental toxicants is a source of adverse postnatal health impacts.
Phosphoric acid	Phosphoric acid has low vapor pressures at room temperature and is not expected to present an inhalation hazard unless a mist is generated. Mists can probably cause irritation of the nose, throat, and respiratory tract.
Propylene	Studies show that propylene has low acute toxicity from inhalation. Inhalation of propylene gas can cause anesthetic effects and at very high concentrations, unconsciousness. However, the asphyxiation limit for humans is about 10 times higher (236,000 ppm) than the lower flammability level for propylene.
Sodium hydroxide	Sodium hydroxide is a strong irritant and has a marked corrosive action on all body tissues regardless of the route of exposure. It is also more irritating than equivalent amounts of strong acid.
Styrene	Styrene may irritate the eyes and mucous membranes and may be toxic to the central nervous system. Immediate eye and throat irritation, increased nasal mucus secretion, listlessness, impairment of balance, and drowsiness followed by unsteadiness, muscle weakness, and depression have also been reported.
Toluene	Dysfunction of the central nervous system and narcosis are the major effects of acute exposure to toluene. Irritation of the skin, eye, and respiratory tract can also result. Inhalational abuse of toluene with high-level exposure for long periods of time has produced progressive and irreversible changes in brain structure and function.
Diesel Particulate Matter (DPM)	In its comprehensive assessment of diesel exhaust, OEHHA analyzed more than 30 studies of people who worked around diesel equipment, including truck drivers, railroad workers, and equipment operators. The studies showed these workers were more likely to develop lung cancer than workers who were not exposed to diesel emissions. These studies provide strong evidence that long-term occupational exposure to diesel exhaust increases the risk of lung cancer. Exposure to diesel exhaust can have immediate health effects. Diesel exhaust can irritate the eyes, nose, throat, and lungs, and it can cause coughs, headaches, lightheadedness, and nausea. In studies with human volunteers, diesel exhaust particles made people with allergies more susceptible to the materials to which they are allergic, such as dust and pollen. Exposure to diesel exhaust also causes inflammation in the lungs, which may aggravate chronic respiratory symptoms and increase the frequency or intensity of asthma attacks.
Source: Various OEHHA toxicity summaries.	

Estimation of the Existing Toxic Air Contaminant Emissions

The levels of existing TAC emissions were derived from identified sources of TAC that either were in existence in 2010 or were planned or were probable future projects based on projections provided by the City of Visalia within the 1,000-foot analysis radius, which the City has confirmed remain accurate.[7] The emissions from these various sources were estimated using a variety of data sources, including:

- Stationary source emission inventory summaries requested from the SJVAPCD (food processing, gasoline service station, and auto paint sources)
- Project traffic data and estimates of non-Walmart traffic from the project traffic impact report (Kimley-Horn and Associates 2010) from the previous HRA (Illingworth and Rodkin 2010) and estimates of non-Walmart traffic from the City of Visalia and California Department of Transportation for the local roadway network
- Rail locomotive traffic data from the project traffic impact report (Kimley-Horn and Associates 2010) for the rail line
- Restaurant cooking emissions from the methodologies recommended by the SJVAPCD
- Mobile source and rail locomotive emission rate information available from the ARB

The TAC emissions analyzed in this report include those that have been identified by the ARB as carcinogenic in nature or as causing non-cancer chronic (from long-term exposures) or acute (from short-term exposures) health impacts such as eye irritation, respiratory problems, reproductive problems, blood problems, and neurological development problems. Of particular importance are emissions of DPM from diesel-fueled motor vehicles, which the ARB has estimated as comprising about 80 percent of the airborne cancer risk from TACs in California.

The types of emission sources accounted for in this HRA included the operations at the existing Walmart site, local restaurants, car dealerships, a food processing facility, a food market, auto paint shop, gasoline service stations, the San Joaquin Valley Railroad freight line, SR-198, and the traffic along the local roadway network. The analysis includes sources beyond the 1,000-foot analysis radius to provide assurance that all sources with the potential to contribute cumulative impacts were assessed. The San Joaquin Valley Railroad and the food processing facility were up to 1,500 feet from the project site.

Stationary Emission Source Identification

Table 11 identifies the existing TAC stationary emission sources considered in this HRA along with their location and relevant TAC emissions. Exhibit 9 shows the locations of the identified stationary emission sources.

[7] The City of Visalia has identified a proposed new carwash/fast food use located across the street from the Walmart store at 2321 E. Noble Avenue. This HRA has included this foreseeable new emission source in the emissions inventory.

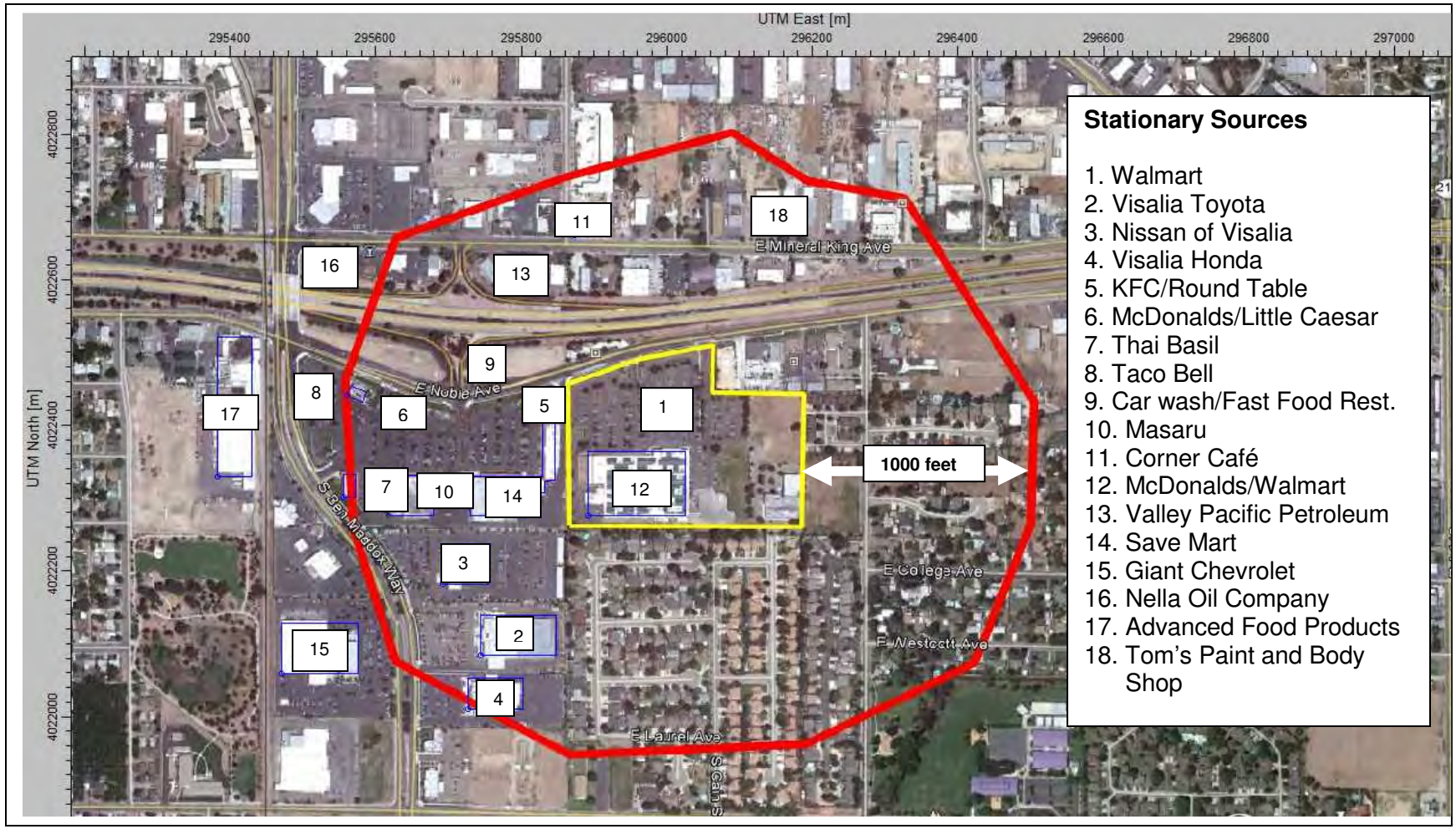

Exhibit 9

Locations of Existing, Planned and Probable Future Stationary Sources of TAC Emissions

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Table 11: Stationary TAC Emission Sources Included in the Cumulative HRA

Facility	Business	Visalia Address	TAC Emission
Existing Walmart	Retail	1819 E. Noble Avenue	Diesel particulate emissions
Visalia Toyota	Auto Dealership	922 S. Ben Maddox Way	Diesel particulate emissions
Nissan of Visalia	Auto Dealership	830 S. Ben Maddox Way	Diesel particulate emissions
Visalia Honda	Auto Dealership	1016 S. Ben Maddox Way	Diesel particulate emissions
Giant Chevrolet	Auto Dealership	1001 S. Ben Maddox Way	Diesel particulate emissions
KFC	Restaurant	1699 E. Noble Avenue	Diesel particulates Emissions Cooking Emissions
Round Table Pizza	Restaurant	1691 E. Noble Avenue	Diesel particulates Emissions Cooking Emissions
McDonalds	Restaurant	1401 E. Noble Avenue	Diesel particulates Emissions Cooking Emissions
Little Caesars	Restaurant	1439 E. Noble Avenue	Diesel particulates Emissions Cooking Emissions
Thai Basil	Restaurant	1423 E. Noble Avenue	Diesel particulates Emissions Cooking Emissions
Taco Bell	Restaurant	1377 E. Noble Avenue	Diesel particulates Emissions Cooking Emissions
Carwash/Fast Food	Carwash/Restaurant	2321 E. Noble Avenue	Diesel particulates Emissions Cooking Emissions
Masaru Japanese Restaurant	Restaurant	1509 E. Noble Avenue	Diesel particulates Emissions Cooking Emissions
Corner Café	Restaurant	1719 E. Mineral King Avenue	Diesel particulates Emissions Cooking Emissions
McDonalds/Walmart	Restaurant	1819 E. Noble Avenue	Diesel particulates Emissions Cooking Emissions
Valley Pacific Petroleum Services	Gasoline Station	1633 E. Mineral King Avenue	VOC Evaporative Emissions
Save Mart	Food Service	1591 E. Noble Avenue	Diesel particulate emissions
Nella Oil	Gasoline Service	1375 E. Mineral King Avenue	VOC Evaporative Emissions
Advanced Food Products	Food Processing	1211 E. Noble Avenue	Various carcinogenic substances
Toms Auto Body and Paint	Automotive Painting	2000 E. Mineral King Avenue	Ethyl Benzene
Source: See Appendix D			

The Court ruling identified the Social Security Building to the east of the project as a possible cumulative source. Office buildings do not generate substantial TAC emissions. Offices generate very few diesel truck trips and do not typically include uses with processes that emit other toxics.

Existing Walmart Store Emissions

TAC emissions consist principally of DPM from the operation of the existing Walmart facility and result from the operation of diesel-powered vehicles that travel to and from the site as well as emissions from diesel vehicles as they travel and idle within the confines of the facility either within the parking lot or at the loading docks. The existing Walmart store was assumed to operate 12 hours per day. Table 12 provides an inventory of the operational vehicle trips for the existing Walmart store. Exhibit 7 shown above provides a view of the existing onsite Walmart truck route.

Table 12: Inventory of Existing Walmart Store Vehicle Trips During Operations

Vehicle Class[1]	Existing Store Truck Deliveries and Vehicles per day	Existing Store Truck Delivery and Vehicle Trips per day
2-axle heavy duty truck	8	16
4+ axle heavy duty truck (with TRU)	0	0
4+ axle heavy duty truck (without TRU)	8	16
Customer and Worker Vehicles (DSL and GAS)	3,629	7,258

Vehicle travel speeds while traveling onsite were assumed to be 15 miles per hour for both trucks and customer vehicles. Project-related vehicle travel speeds for offsite roadway segments were assumed to vary between 25 mph and 45 mph depending on the vehicle class, roadway segment and posted speed limit. The Walmart delivery trucks were assumed to idle for 5 minutes per day. Customer and worker vehicles were assumed to idle for 1 minute while idling within the parking lots of the Walmart store.

Auto Dealership Emissions

Three automobile dealerships were identified within the 1,000-foot analysis radius: Visalia Toyota, Nissan of Visalia, and Visalia Honda. A fourth dealership, Giant Chevrolet is located just outside of the 1,000-foot zone of influence and was included in the assessment. All dealerships are located along Ben Maddox Way south of Noble Avenue, as shown in Exhibit 9. For purposes of this assessment, it was assumed that each dealer would be served by one 4+axle automobile delivery truck each day. Onsite travel would be at 15 mph and each truck would idle for 15 minutes a day. The auto dealerships were assumed to be open 12 hours each day.

Restaurant Emissions

Eight existing restaurants were identified within the 1,000-foot zone of influence. A ninth restaurant, a Taco Bell restaurant, was located just outside of the zone but was included in this assessment. A tenth restaurant, car wash/fast food restaurant, is in the planning stages and its estimated TAC emissions were also included in the assessment. All restaurants are shown in Exhibit 9. The TAC emissions associated with the operation of the restaurants include DPM from delivery truck travel and idling and from the operation of the TRUs. Each restaurant was assumed to be served by one 4+axle truck with an attached TRU each day. Onsite vehicle speed was assumed to be 15 mph and each truck was assumed to idle for 15 minutes per day.

In addition, the SJVAPCD has determined that the cooking of meat would also result in the emission of certain TACs. The two main TACs from the cooking operations are polycyclic organic hydrocarbons (represented as benz(o)pyrene) and naphthalene. The estimation of TACs from restaurant cooking applied the emission methodology contained in the SJVAPCD Guidance on Air Dispersion Modeling (SJVAPCD 2010). The restaurants were assumed to be open 12 hours each day.

Gasoline Service Station Emissions

One gasoline service station, Valley Pacific Petroleum Services, is currently in operation within the 1,000-foot zone of influence. A second service station, Nella Oil—located just outside of the zone at the intersection of Ben Maddox Way and Mineral King Avenue—was also included in the assessment. Both gas stations are shown in Exhibit 9. The TAC emissions of concern are DPM emissions from the onsite travel and idling of fuel delivery trucks at the gas station and evaporative emissions of benzene from the storage and dispensing of gasoline. Benzene has also been identified by the ARB as a carcinogenic substance. Estimates of benzene from the evaporation of gasoline were derived from emission inventory reports provided by the SJVAPCD for the reporting years 2008 and 2010 and are provided in Appendix B. Onsite vehicle speed was assumed to be 15 mph and each truck was assumed to idle for 15 minutes per day. The gasoline service stations were assumed to be open 24 hours each day.

Food Service Emissions

A large food market, Save Mart Supermarket, was also identified within the 1,000-foot zone of influence and is shown in Exhibit 9. The TAC emissions from this facility consist of DPM emissions from the delivery trucks that transport goods to the store. The emissions from this facility were based on the daily truck traffic assumed to have one additional vehicle compared to the Walmart Expansion Project, namely four 2-axle heavy duty trucks, two 4+axle trucks with a TRU, and two 4+axle heavy duty trucks without a TRU as a conservative assumption in the absence of other data. Onsite vehicle speed was assumed to be 15 mph. However, each truck was assumed to idle for 15 minutes per day. This is due to the fact that compliance with the State law 5-minute limitation on truck idling is conservatively not assumed for this store as information as to the store's compliance with this rule, either voluntarily or as a condition of approval, is unavailable. The Save Mart was assumed to operate 18 hours per day.

Food Processing Emissions

A large food processing facility, Advanced Food Products, is located on the west side of Ben Maddox Way. Although located just outside of the 1,000-foot zone of influence, the TAC emissions from this facility were also included in the assessment. The location of this emission source is shown in Exhibit 9. The facility produces a wide variety of food products and includes emission-generating equipment such as natural gas-fired boilers and various process operations. Communication with the plant manager (Dave Surfus 2012) indicates that the facility received on average about 16 large, 4+axle trucks per day for product deliveries and process materials. During its operation, the facility emits a variety of TACs, some of which are carcinogenic. A listing of the TACs as derived from the

SJVAPCD emission inventory facility report is provided in Appendix B. The food processing facility operates 24 hours per day.

Mobile Source Emissions

The mobile source emissions included in this assessment derive from vehicular traffic along the local roadway network of city streets and along SR-198. Estimates of daily traffic along these local roadways were derived from traffic data contained in the previous HRA prepared by Illingworth and Rodkin (Illingworth and Rodkin 2010). This data source provided traffic trips from the existing Walmart store along with traffic trips from the project. Traffic data for not associated with either the existing Walmart store or the project were derived from traffic data provided by the City of Visalia based on traffic counts data up to the year 2010 (City of Visalia 2011) and traffic data for 2010 from the California Department of Transportation (CDOT 2010). The local roadway network included in this assessment is shown in Exhibit 10. As noted in this exhibit, roadway segments beyond the 1,000-foot analysis radius were included in the assessment to ensure that the full extent of the roadway impacts was accounted for.

Several steps are necessary to quantify the motor vehicle emissions from the local roadway network. The first step is to establish the mix of vehicles by segregating the daily traffic into the various vehicle classes since the emissions from motor vehicles depend on the class or type of vehicle. Information provided by the City of Visalia Traffic Safety Division recommended assuming that 2 percent of the non-SR-198 traffic consists of 3 axle and 4+ axle heavy duty trucks; of this total, 50 percent are 3-axle trucks and the remaining 50 percent are 4+ axle trucks. Ninety-eight percent of the traffic consists of the remaining vehicle classes, including autos, light- and medium-duty trucks, and 2-axle heavy-duty trucks.

Traffic data available from the California Department of Transportation was consulted to establish the vehicle mix for the SR-198 roadway segments included in this assessment. Approximately 9 percent of the traffic along the SR-198 segments consists of trucks. The truck traffic data is also broken down further by number of truck axles with 2-axle trucks comprising an average of 5 percent of the total traffic, 3-axle trucks comprising 0.6 percent of the total traffic, and 4+ axle trucks comprising 3.5 percent of the total traffic. In addition, to identify the number of diesel-fueled vehicles from which the estimate of DPM emissions can be derived, vehicle estimates were used from the ARB EMFAC2011 mobile source emission that provides a breakdown of vehicle class by fuel type, either gas-fueled or diesel-fueled.

The next step in the mobile source emission estimation process is to establish a vehicle profile that distributes the daily traffic total by hour of the day along each roadway segment identified in Table 13. For this purpose, estimates of vehicle miles traveled (VMT) by hour of the day within Tulare County in 2010 were used, as estimated by the ARB EMFAC2007 mobile source emission model.

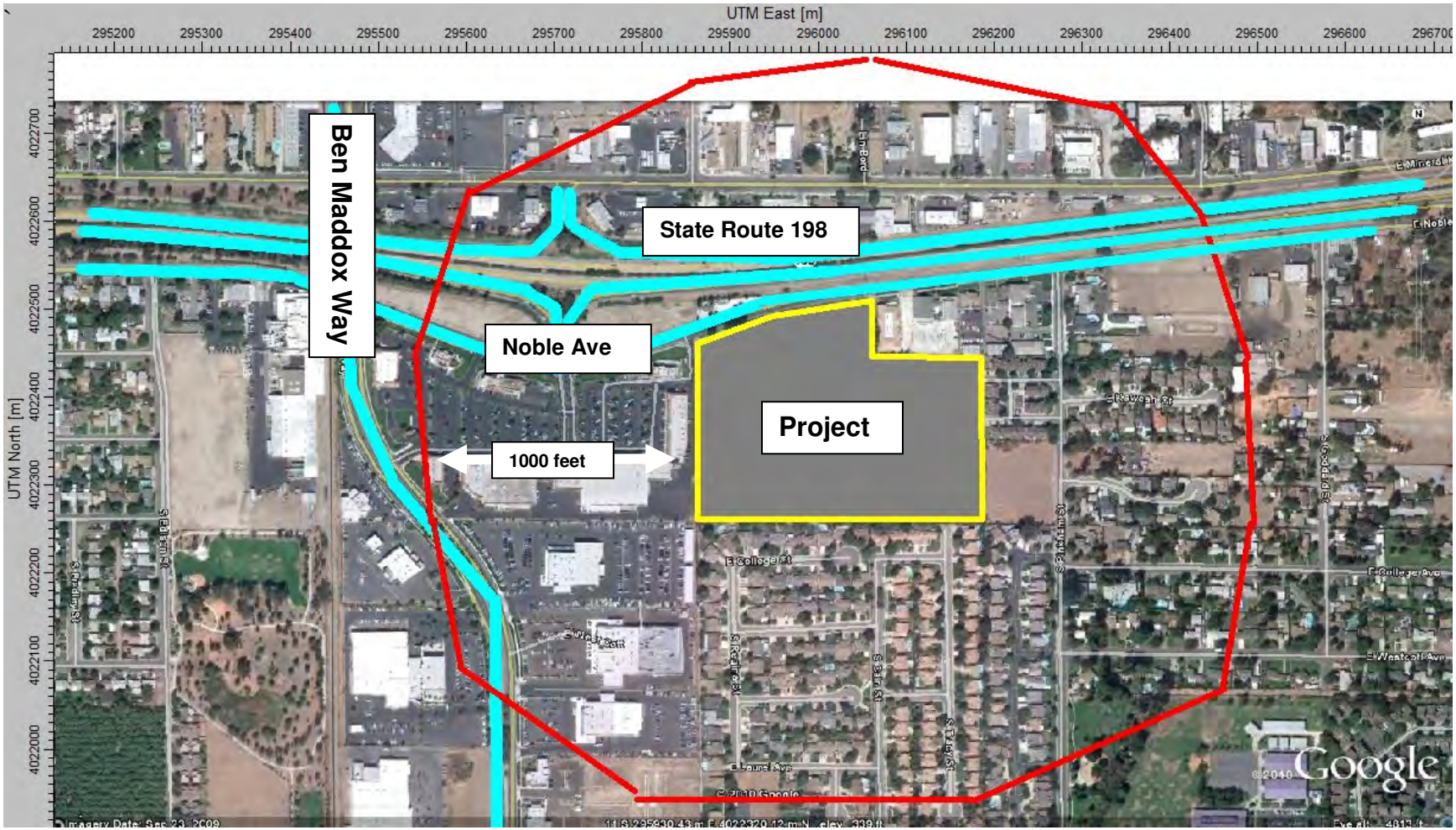

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Exhibit 10
Existing Roadway Network

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To estimate hourly traffic profile for the roadway segments, total VMT for each hour of the day as well as the daily total for vehicle are within Tulare County were noted from the EMFAC2007 model estimations. Each hourly VMT total was then divided by the daily total to establish the portion of the daily VMT contributed by each hour. The resulting number for each hour is known as a "VMT scaling factor." Exhibit 11 displays the VMT scaling factors for each hour, which basically describes the distribution of traffic during the day. As shown in this exhibit, there are two traffic peaks as represented by the scaling factors, a morning peak at around 7 a.m., and an afternoon peak at about 5 p.m. These VMT scaling factors are then input into the air dispersion model to characterize the manner in which roadway emissions vary from hour to hour each day. The VMT scaling factors calculated above were used to characterize the vehicle profile for all roadway segments.

Table 13 provides an example of the VMT scaling calculation method described above for the Noble Avenue roadway segment from Ben Maddox Way to Pinkham Street.

Table 13: Vehicle Profile for Roadway Segment, Noble Avenue—Ben Maddox Way to Pinkham Street

Time	VMT in Tulare County (2010) (VMT/1000)(1)	Hourly VMT to Daily Average Scaling Factor(2)	Roadway Segment VMT (VMT/hr)(3)
Hr 00	154	0.33	176
Hr 01	62	0.13	71
Hr 02	82	0.17	94
Hr 03	75	0.16	86
Hr 04	81	0.17	93
Hr 05	136	0.29	156
Hr 06	451	0.95	517
Hr 07	855	1.81	980
Hr 08	802	1.70	919
Hr 09	520	1.10	596
Hr 10	547	1.16	627
Hr 11	673	1.42	771
Hr 12	690	1.46	791
Hr 13	682	1.44	782
Hr 14	769	1.63	881
Hr 15	776	1.64	889
Hr 16	823	1.74	943
Hr 17	881	1.86	1010
Hr 18	617	1.31	707

Table 13 (cont.): Vehicle Profile for Roadway Segment, Noble Avenue—Ben Maddox Way to Pinkham Street

Time	VMT in Tulare County (2010) (VMT/1000)[1]	Hourly VMT to Daily Average Scaling Factor[2]	Roadway Segment VMT (VMT/hr)[3]
Hr 19	456	0.96	523
Hr 20	365	0.77	418
Hr 21	369	0.78	423
Hr 22	271	0.57	311
Hr 23	207	0.44	237
Daily Average	473	—	Total: 13,000 VMT per day

Notes:
(1) Hourly VMT were derived from the ARB EMFAC2007 mobile source emission model for Tulare County in 2010.
(2) Scaling Factors were derived by dividing the hourly VMT by the daily average VMT.
(3) Daily VMT total of 13,000 vehicles per day for the indicated roadway segment
Source: see Appendix D

Rail Line Emissions

The San Joaquin Valley Railroad operates a rail line that runs in a north-south direction along the western side of Ben Maddox Way. Although outside of the 1,000-foot zone of influence, the emissions from the locomotives that use the rail line were also included in this assessment. The location of the rail line is shown in Exhibit 12. According to the information contained in the project traffic impact study (Kimley and Horn and Associates 2010), there are three trains that cross the Noble Avenue crossing each day. Therefore, the assessment modeling assumed three trains per day with each train having one locomotive. The train speed as derived from the grade crossing data is 15 mph (notch setting 2). The locomotives were assumed to be an EMG GP-38 model with 1,800 horsepower, consistent with the published inventory of locomotives for the railroad (D. Bowen 2012).

Mobile Emission Factors

To estimate the emissions from mobile sources, emission factors were used that relate the amount of pollutant emission as a function of vehicle speed or idling time and vehicle class. The appropriate emission factors for DPM were obtained from use of the ARB mobile source Emission Factor Model (EMFAC2011) for the year 2010 and Tulare County and were shown earlier in Table 2. Emissions of DPM were also estimated for those facilities that involve the use of a transport refrigeration unit (TRU) using the ARB OFFROAD2007 emission model. Rail locomotive emission factors were taken from the ARB railyard health risk assessment for the Oakland Railyard (ARB 2008). The estimated locomotive emission factor was 110 grams/hour.

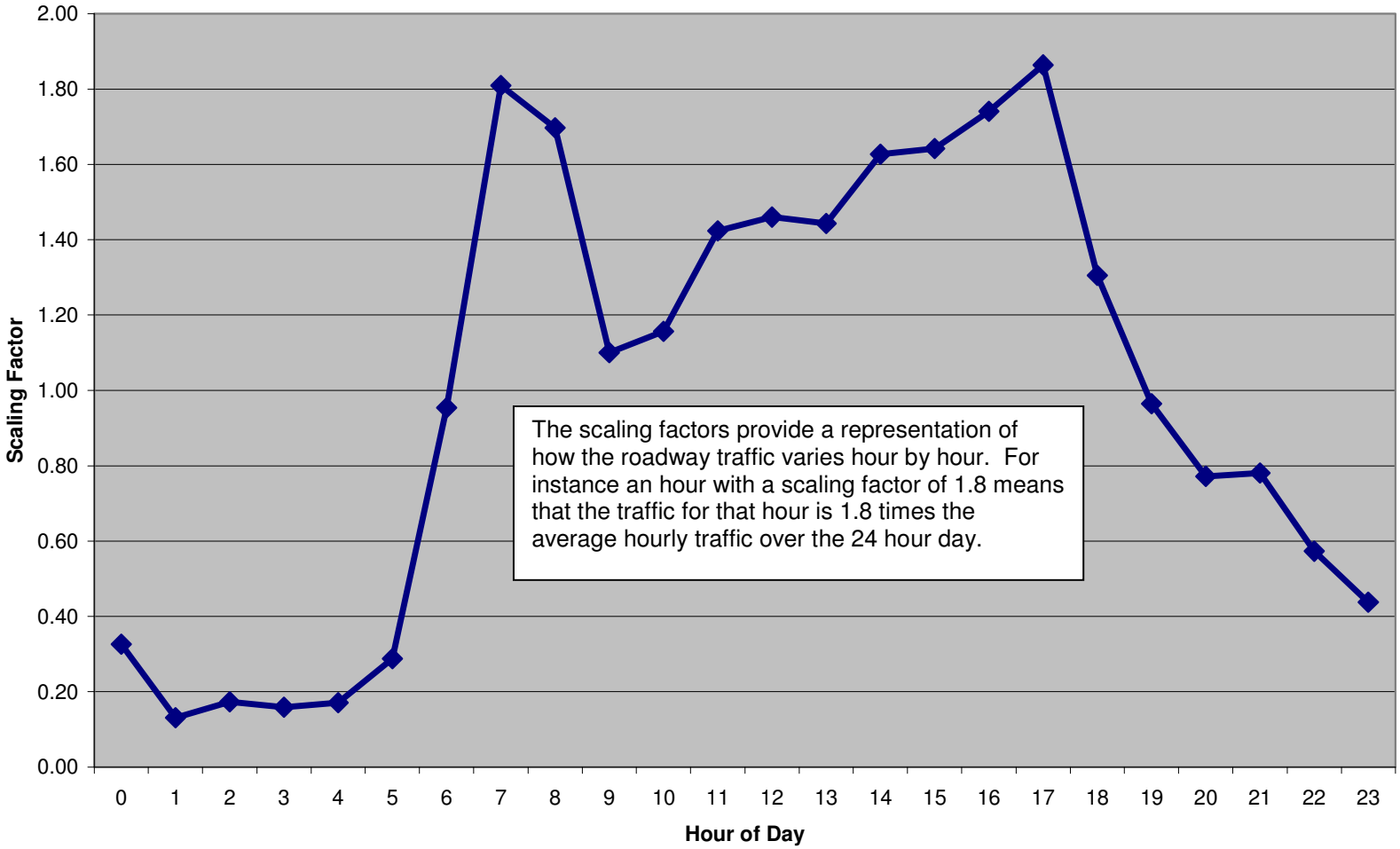

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Exhibit 11
Roadway Traffic VMT Scaling Factors

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NORTH

Exhibit 12
Location of the San Joaquin Valley Railroad Line

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The burning of gasoline by gasoline-powered vehicles also results in the emissions of total organic emissions (TOG), which contains several components including benzene and 1.3-butadiene which have been identified as causing carcinogenic and non-carcinogenic impacts. The potential health impacts from TOG emissions resulting from gasoline-powered motor vehicle traffic along the local roadway network were also accounted for in the HRA. The TOG emission factors for gasoline mobile sources were shown previously in Table 3.

Air Dispersion Model and Health Risk Methodologies

The air dispersion model, meteorological data, receptor network and health risk methods were used to estimate the project's TAC emission impacts. The project's incremental emissions were added to the emissions inventory, which represents existing, planned, and probable future TAC emissions. The various emission assumptions are summarized in Table 14. Estimates of cancer risk from several of the TAC emission sources identified in Table 11 required the use of an additional health risk model called the ARB HARP model. This model was used to assess the health risks from the gasoline station evaporative emissions, restaurant cooking emissions, auto spray paint emissions, and food processing emissions.

Table 14: All Cumulative Emission Source Assumptions

Emission Source Type	Configuration	Relevant Assumptions
Onsite Diesel Truck Traffic	Line Sources	• Stack release height: 6 feet • Vehicle speed: 15 mph • Length of the line source (distance from the facility entrances to the loading area/docks at the various stationary sources (restaurants, service stations, etc.) • Vehicle types: MHDT and HHDT diesel delivery trucks • Emission factors: ARB EMFAC2011
Onsite Diesel Truck Idling	Point Sources located at the loading docks	• Stack release height:[1] > Walmart heavy duty trucks: 10 feet above grade > All other heavy duty trucks vehicles: 12 feet • Stack release characteristics > Stack diameter: 0.3 feet > Stack velocity: 170 feet/sec > Stack temperature: 200° F • Idle time: 15 minutes per truck per day for all trucks except the Walmart trucks which idle for 5 minutes per day • Vehicle types: MHDT and HHDT diesel delivery trucks • Emission factors: ARB EMFAC2011
Trucks with Diesel TRUs	Point Source at the loading area/dock; line source while traveling onsite	• Stack release height:[1] > Walmart trucks with TRUs: 7 feet above grade > All other heavy duty trucks with TRUs: 12 feet • TRU Size: 34 horsepower (typical size) • Load factor: 53% • Emission factors: TRU emission factors based fleet average for Tulare County in 2010 from ARB OFFROAD2007 model

Table 14 (cont.): Cumulative Emission Source Assumptions

Emission Source Type	Configuration	Relevant Assumptions
Offsite Vehicle Traffic	Line Sources along the local roadway network	• Offsite travel based on trip distribution as derived from the traffic impact study, the California Department of Transportation, and the City of Visalia. • Vehicle speeds dependent on vehicle class and roadway and ranged from 25 mph to 45 mph • Emission factors: ARB EMFAC2011
Walmart Parking Lot	Area Sources located at the Walmart building	• Vehicle speed: 15 mph • Idle time of 1 minute per vehicle per day • Vehicles: diesel LDA, LDT, and MDT • Emission factors: ARB EMFAC2011
Rail Line	Line Source	• Train speed: 15 mph • Notch setting: 2 • 1 locomotive per train • 3 trains per day • Emissions based on ARB Oakland Railyard study for a GP-3x locomotive
Gasoline Service Station	Point and volume sources	• Source configuration follows the CAPCOA Industry-Wide recommendations for gasoline service stations (CAPCOA 1997) • 24 hour per day operation
Food Processing Facility	Volume Source	• 24 hour per day operation • Volume source emission height: 20 feet
Restaurants	Point Sources	• Emission height: 5 feet above the top of the building • Emission released at ambient temperature • 12-hour per day operation • Save Mart: 18 hours/day operation

Note:
[1] The Walmart loading dock is below grade resulting in a release height 2 feet less than the SJVAPCD recommended default. This applies to the release height for truck idling and TRU operation for Walmart trucks that occurs at the loading dock. The loading dock configurations for other cumulative sources is not known, so SJVAPCD default release heights were used for those facilities.
Source: see Appendix B for the emission details

4.2.2 - Results of the Cumulative Health Risk Assessment

Cumulative Cancer Risks from the Project and Existing Sources of TAC Emissions

Table 15 summarizes the results of the cumulative health risk assessment for the project and existing, planned, and probable future TAC emission sources in the year 2010 in terms of lifetime cancer risks. Shown therein are the impacts at the maximum exposed receptor project receptor. Also shown is a comparison with the cumulative health risk significance threshold adopted for this assessment.

Table 15: Cumulative Cancer Risk at the Maximum Exposed Project Receptor

Receptor Location	Emission Source Category	Cancer Risk (risk per million)
Residents located at the southeast corner of the Walmart property near the intersection of East College Avenue and South Tracy Street	Existing Walmart Diesel PM (after project development) State Route 198 Diesel PM Local Street Diesel PM Rail Line Diesel PM Restaurants, Auto Dealers Gas Station, Food Related Diesel PM *Subtotal of All Existing and Planned Probable Future Diesel PM*	1.7 12.0 2.9 0.4 2.1 *19.1*
	Mobile Source Total Organic Compounds	2.5
	Existing and reasonably foreseeable future Restaurant Cooking, Gas Station Evaporation, and Auto Body Spray Painting TAC Emissions	2.3
	Total for All Existing and Planned Probable Future Sources	**23.9**
	Project Diesel PM Emissions	3.3
	Total for Project, Existing, and Planned Probable Future TAC Emissions	27.2
	Cumulative Significance Threshold	100
	Cumulatively Considerable Impact?	No

Notes:
Diesel PM = diesel particulate matter
TAC = toxic air contaminants
Source: Appendix E.

The cumulative risk is 27.2 in a million at the maximally exposed project receptor, which is located approximately 980 feet from the SR-198 freeway. It is important to note that most of the estimated cancer risk at the maximally exposed project is due to the SR-198 freeway and the major roads near the project site. These mobile sources comprise about 55 percent of the total cumulative risk. By comparison, the emissions from the project contribute roughly 12 percent to the total cumulative cancer risk. The importance of distance from these sources and the associated risk can be seen in Exhibit 13.

Significance of Cumulative Emissions of TACs on Cancer Risks[8]

On a cumulative basis, the TAC emissions from existing sources, the project, and planned probable future TAC emission sources would not exceed the cumulative cancer hazard index significance

[8] For residential projects (and other project types) that would place a sensitive receptor near existing TAC sources, the focus of the cumulative TAC analysis is the environment's impact on the proposed new receptor. Thus, the receptor site (residence) within the project's analysis area most impacted by the cumulative TAC sources would be the location used to determine if a significant cumulative impact would result from exposing residents to TAC emissions. This location may differ from the location used to estimate TAC impacts of a commercial project where the focus is the project's impact on the environment—i.e., an existing sensitive receptor.

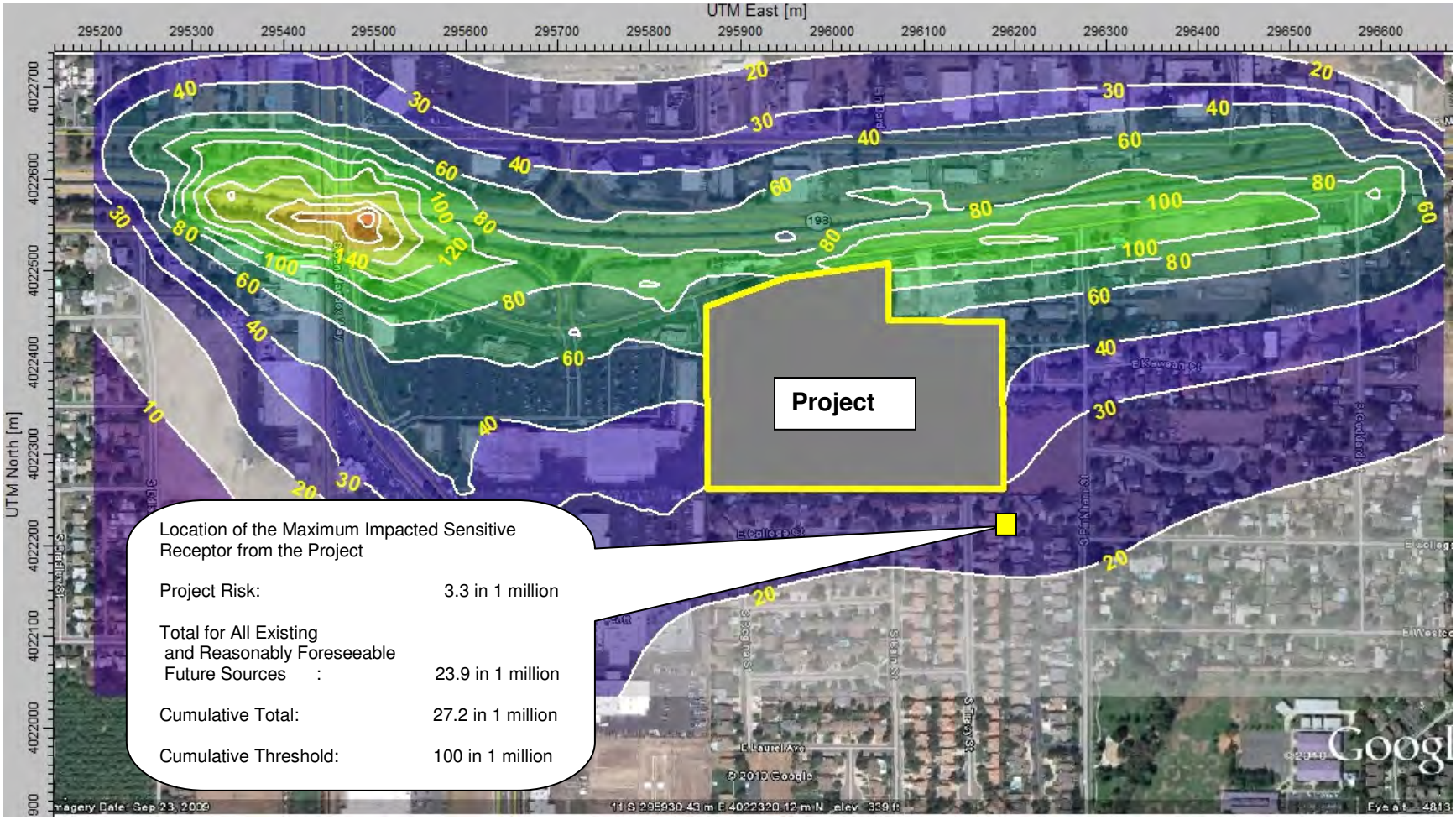
threshold of 100 established for this assessment and therefore not result in a cumulatively considerable health risk impact.

Significance of Cumulative Emissions of TAC on Non-Cancer Hazard

The maximum non-cancer hazard index calculated at the location of the maximum impacted receptor from the existing sources, the project and planned probable future TAC emissions any receptor was 0.03.

Significance of Cumulative Emissions of TACs on Non-Cancer Hazards

On a cumulative basis, the TAC emissions from the project, existing and reasonably foreseeable future TAC emission sources would not exceed the cumulative non-cancer hazard index significance threshold of 10.0 established for this assessment and, therefore, not result in a cumulatively considerable health risk impact.



Contours represent cumulative cancer risk for the project and existing, planned and probable future TAC emissions.

Contours are in units of cancer risk per million population.

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Exhibit 13
Graphic Plot of Cumulative Cancer Risks

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SECTION 5: INHERENT UNCERTAINTY IN HEALTH RISK ASSESSMENT

There are substantial uncertainties involved in assessing the health risk of air pollutants. There are uncertainties in dispersion modeling, emission estimation, toxicological factors, and exposure assessment. The methodology described above for assessing health risks involving emission estimations, dispersion modeling, and toxicity risk factors have been developed to provide conservative results (in terms of over-predicting impacts). Given this, this HRA presents a picture of health risks that are somewhat greater than in reality would be the case. Some of the factors that result in the report's conservative results are discussed below.

5.1.1 - Exposures Over 70-years

The OEHHA (OEHHA 2003) recommends using the 70-year exposure duration for determining residential cancer risks. Although it is unlikely that people will reside at a single residence for 70 years, it is common that people will spend their entire lives in a major urban area. While residing in urban areas, it is very possible to be exposed to the emissions from other facilities. In order to help ensure that people do not accumulate an excess unacceptable cancer risk from cumulative exposure to stationary facilities at multiple residences, OEHHA recommends the 70-year exposure duration for risk management decisions. However, it is important to note that a person who has resided in his or her current residence for less than 70 years will have a cancer risk less than what is calculated for a 70-year risk. Nonetheless, this assessment uses the recommended 70-year exposure duration, which provides a worst-case, conservative scenario for TAC exposures.

5.1.2 - Estimates of DPM Emissions from Diesel Trucks and TRUs

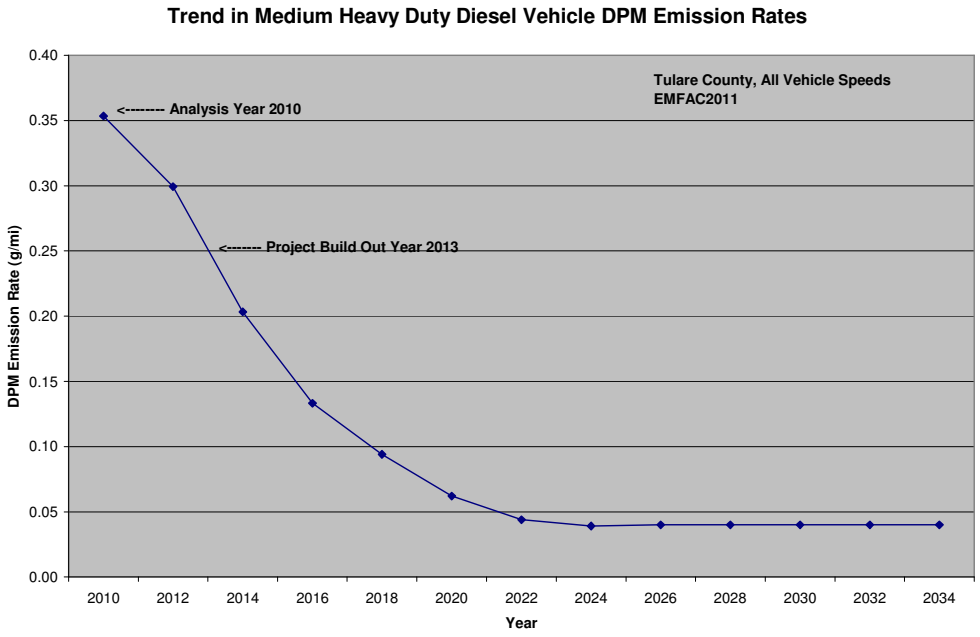
One very important assumption that the SJVAPCD-recommended methodology for calculating cancer risks omits is that emissions from mobile sources, particularly from heavy-duty diesel trucks are expected to decline sharply in the future. The SJVAPCD assumes that the emissions, whether from a proposed project or from the surrounding emission sources, remain unchanged for the entire 70-year exposure period over which cancer risk is estimated. This assumption results in substantially over-estimating future impacts and does not represent what is estimated to occur in the future as a result of mandated emission regulations.

Based on current emission rules already adopted by the ARB that specifically address DPM emissions from heavy-duty diesel trucks, heavy-duty diesel truck DPM emissions are expected to decline by up to 80 percent over the next 10 years from levels in 2010 on a gram per mile basis. Even during the time period from 2010 to the actual buildout year of the project in 2013, DPM emissions from heavy-duty trucks are expected to decline by 30 to 40 percent from the levels in 2010. Such rules are already included in estimating future levels of emissions as part of the emission inventories employed in the San Joaquin Valley Air Basin attainment plans for attaining ozone and particulate matter air quality standards. Exhibit 14 shows the future trends of DPM emission rates from the analysis year of 2010 used in this assessment from the types of heavy-duty truck vehicles analyzed in this

assessment. These emission rates were taken from the EMFAC2011 mobile source emission model and reflect all emission control regulations currently adopted by the ARB. The ARB has also adopted emission standards that will reduce DPM emissions from transportation refrigeration units by 80 to 90 percent over the next 10 years. Finally, the EPA has also adopted emission control regulations for diesel locomotives that will result in cleaner locomotives in the future.

5.1.3 - Application of Breathing Rates in the Estimation of Cancer Risk

One of the parameters that is required to estimate cancer risk is the daily breathing rate (DBR) shown in Equation 2 above. The DBR is an estimate of the volume of air breathed by exposed populations and varies by the weight and level of physical activity of a person. The assumption required by the SJVAPCD is to use the 95th percentile of the DBR, which has been established by the OEHHA as having a value of 392 liters/kilogram-day. In 2003, the ARB provided recommendations for a DBR of the 80th percentile or 302 liters/kilogram-day for determining inhalation-based cancer risk (ARB 2003). Since cancer risk is directly proportional the DBR, the use of the 95th percentile rather than the ARB-recommended 80th percentile DBR results in a higher and extremely conservative estimate of cancer risk that is overstated by about 30 percent.



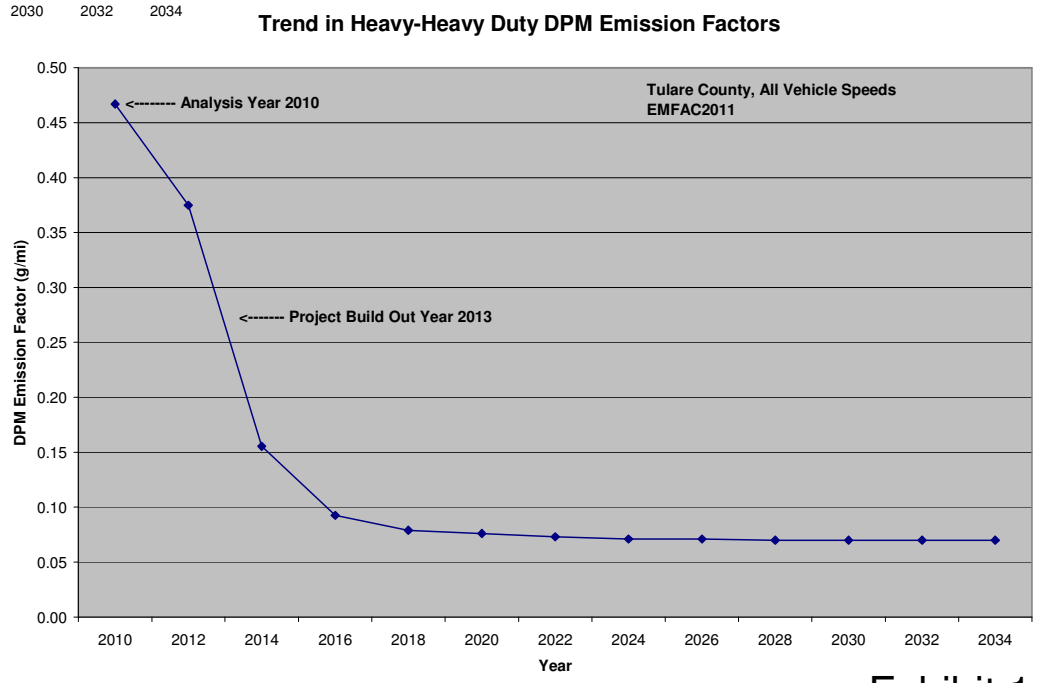


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Exhibit 14

Future Trends in DPM Emission Rates for Heavy Duty Diesel Trucks

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SECTION 6: REFERENCES

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EXHIBIT F

Toxic Air Contaminant- Limited Health Risk Assessment

Ponte Vista, San Pedro Development

Prepared by:

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Executive Summary

Ponte Vista Development proposes to construct a residential complex (Development) on the eastern side of Western Avenue approximately 0.5 miles south of Palos Verdes Drive, San Pedro, California. The proposed project would be situated immediately southwest of the Defense Fuel Support Point (DFSP), San Pedro facility and west of the ConocoPhillips refinery. This Limited Health Risk Assessment (LHRA) considered potential health impacts to the Development from toxic chemical emissions associated with storage of jet fuel and movement of diesels trucks at the neighboring DFSP facility. The LHRA also considered potential health impacts from operations at the ConocoPhillips refinery. Due to the relative proximity (1.5-2 miles) of the Ports of Long Beach and Los Angeles, this document provides a cursory summary of ambient health risk associated with emissions from Port and Port related activities.

This effort was conducted in support of a project Environmental Impact Report (EIR) effort by the Ponte Vista Development.

The findings of this limited Health Risk Assessment are as follows:

<u>DFSP and ConocoPhillips</u>

- 70 Year Cancer Risk: 3.29 in one million (Significance Threshold: 10 in one million);
- Chronic Non-Cancer Hazard Index: 0.396 (Significance Threshold: 1.0); and
- Acute Hazard Index: 0.117 (Significance Threshold: 1.0).

<u>Ambient Cancer Risk</u>

- Population Weighted Cancer Risk for the Ports Area: 1,415 in one million[1].
- Cancer Risk near the development due to Vicinity Activities (sources include Ports, freeways, other sources): approximately 800 in one million[2].

The cancer risk as well as the non-cancer chronic and acute hazard indices estimated to result from exposure at the planned Development to chemical emissions generated by operations at DFSP and ConocoPhillips do not exceed CEQA significance thresholds, and no significant impact would result.

[1] SCAQMD, MATES III Final Report, September 2008, Chapter 4: Table 4-4.
[2] SCAQMD, MATES III Final Report, September 2008, Chapter 4: Figure 4-10.

1.0 Introduction

This document describes the methods and results of an LHRA that evaluates potential public health effects to the proposed Development from Toxic Air Contaminants (TACs) emitted at the DFSP facility and the ConocoPhillips refinery located directly east and northeast from the proposed Development. The LHRA also summarizes health risks, estimated by the South Coast Air Quality Management District (SCAQMD), in the vicinity of the proposed Development from toxic emissions associated with activities at neighboring Ports of Los Angeles and Long Beach (Ports), located 1.5 to 2 miles southeast of the Development. The Development is proposed by Ponte Vista Development and is to be located on the eastern side of Western Avenue approximately 0.5 miles south of Palos Verdes Drive in San Pedro.

1.1 Emission Sources

The DFSP facility, located directly to the north of the proposed Development, is a government-owned, contractor-operated, fuel storage and distribution facility. The primary function of the DFSP is to receive, store, distribute, and maintain inventory control of bulk jet fuel (JP-5 and JP-8). The facility consists of eleven aboveground storage tanks (ASTs); three tanks are bulk storage tanks for Marine Diesel Fuel. Of the remaining eight smaller tanks, two tanks are used for collection of waste fuel and slop, three tanks provide storage of fuel additives for limited use, and three tanks store film forming foam for the fire suppression systems. Of the twenty-nine underground storage tanks (UST) at the DFSP, twenty-six are large bulk storage tanks used for receipt, storage, and issue of JP-5 and JP-8 (eleven of these tanks are currently out of service); the remaining three USTs are small tanks used for collection of waste fuel and slop. The majority of filling and issue operations are conducted via pipeline, although some tank trucks are also used.

In the South Coast Air Basin (SCAB), facilities emitting more than four tons of volatile organic compounds (VOC)s annually must submit an annual emissions report summarizing emissions to the SCAQMD. Due to the low vapor pressure associated with the storage of JP-5 and JP-8, the DFSP has historically emitted less than four tons of VOC per year and has not been required to submit annual emission reports to the SCAQMD. For this same reason, the DFSP has not been required to prepare air toxic inventories. Lacking reported emissions inventories, this LHRA relied on MSDS information provided by the DFSP for JP-5 and JP-8, throughput provided by DFSP, and USEPA emission quantification tools. These MSDS identify ethylbenzene, naphthalene, and ethylene glycol monomethyl ether, all components of jet fuel (Appendix A).

Although most of DFSP loading/unloading operations are conducted via distribution pipeline, Diesel Particulate Matter (DPM) emissions from DFSP's limited diesel trucking operations are quantified based on information provided by DFSP. DPM is also emitted from the ConocoPhillips refinery. DPM is considered by CARB to be the primary carcinogen associated with combustion of diesel fuel.

TAC emissions information from the ConocoPhillips refinery, located northeast of the planned Development, was obtained from SCAQMD's FIND database. The FIND database presents TACs required for ConocoPhillips annual emissions reporting in recent years and a more complete listing of TACs in past years. Therefore, maximum emissions values for all TACs presented in the FIND database dating back to 2004 were used in this analysis to capture all emittants and to represent maximum exposure at the Development. Emissions from the Ports have historically been major contributors to cancer risk in the Port vicinity[3].

1.2 Toxic Air Contaminants

TACs are defined by California Health and Safety Code Section 39655 (a) as air pollutants, which may cause or contribute to an increase in mortality, serious illness, or which may pose a present or potential hazard to human health. TACs do not have established ambient standards, but are known or suspected to cause short-term (acute) and/or long-term (chronic non-carcinogenic or carcinogenic) adverse health effects.

Table-1 and Table-2 identify pollutants from the DFSP facility and the ConocoPhillips refinery.

Table-1: TACs from DFSP

Pollutants Associated with DFSP Operations	Chemical Abstract Service (CAS) Number
Ethyl benzene – storage of jet fuel	100414
Naphthalene - storage of jet fuel	91203
Ethylene glycol monomethyl Ether – storage of jet fuel	109864
Diesel Particulate Matter (DPM) - combustion of diesel fuels in trucks	9901
Xylene- storage of marine diesel fuel	1330207
Naphthalene- storage of marine diesel fuel	91203

[3] SCAQMD, MATES III Final Report, September 2008, Chapter 4.

Table-2 TACs from ConocoPhillips

Pollutants Associated with ConocoPhillips Operations	Chemical Abstracts Service (CAS) Number
1,2,4- Trimethylbenzene	95636
1,3-Butadiene	106990
Acetaldehyde	75070
Acrolein	107028
Ammonia	7664417
Arsenic	7664417
Asbestos	7440382
Benzene	71432
Berylium	7440417
Cadmium	7440439
Carbon Tetrachloride	56235
Carbonyl Sulfide	463581
Chlorine	7782505
Chromium (VI)	18540299
Chrysene	218019
Copper	7440508
DPM	9901
Diethylene glycol monobutyl ether	112345
Diethylene glycol monomethyl ether	111773
Ethyl Benzene	100414
Ethylene glycol monobutyl ether	111762
Ethylene glycol monomethyl ether	109864
Ethylene Dibromide	106934
Ethylene Dichloride	107062
Formaldehyde	50000
Glycol Ethers	1115
Hexane	110543

Hydrochloric Acid	7647010
Hydrogen Sulfide	7783064
Lead (inorganic)	7439921
Methyl Chloroform	71556
Methyl Tertiary Butyl Ether	1634044
Manganese	7439965
Mercury	7439976
Methanol	67561
Methyl Ethyl Ketone	78933
Methyl Isobutyl Ketone (Hexone)	108101
Methylene Chloride	75092
Naphthalene	91203
Nickel	7440020
PAHs	1151
Perchloroethylene	127184
Propylene glycol monomethyl ether	107982
Propylene glycol monomethyl ether (acetate)	108656
Selenium	7782492
Styrene	100425
Sulfuric Acid	7664939
Toluene	108883
Trichloroethylene	79016
Vinyl Chloride	75014
Xylene	1330207
M-Xylene	108383
O-Xylene	95476

Potential health risks and hazards primarily associated with DPM emissions from the neighboring Ports were not quantified specifically for the proposed Development, but are summarized from studies conducted by the SCAQMD (MATES III)[4].

1.3 Model Selection and Assumptions

This LHRA uses methods that are consistent with current guidance contained in documents prepared by the Office of Environmental Health Hazard Assessment (OEHHA) and the SCAQMD, i.e., The Air Toxics Hot Spots Program Guidance Manual for Preparation of Health Risk Assessment (OEHHA 2003) and the Risk Assessment Procedures for Rules 1401, 1402, and 212 (SCAQMD 2005). The methods in these guidance documents are incorporated into the Hot Spots Analysis and Reporting Program (HARP 1.4d) model from the CARB.

The HARP model incorporates use of unity concentrations provided by the U.S. Environmental Protection Agency's (EPA)'s AERMOD air dispersion model, version 11103. The selection of the AERMOD model is widely accepted by the modeling community and regulatory agencies on its ability to provide reasonable results for large industrial complexes with multiple emission sources, the availability of annual sets of hourly meteorological data from the SCAQMD for the model, and the model's ability to handle the various physical characteristics of emission sources, including point, area, and volume source types. AERMOD is an EPA-approved Gaussian-plume dispersion model that was designated as a U.S. EPA guideline model in December 2006. The LHRA included the following analyses to estimate health impact results:

- Identification of emission sources and quantification of emissions,
- Selection of TACs through evaluation of toxicity and release quantities,
- Analysis of exposure pathways for the identified TACs,
- Identification of ground-level receptor locations that may be affected by the emissions,
- Air dispersion modeling analysis to determine the pollutant concentration at each receptor location, and
- Risk modeling to determine the potential health risk at each receptor location.

2.0 Emissions Sources and Quantification

2.1 Sources of Emissions and Emission Quantification

Sources of emissions at the DFSP were identified based on information provided by DFSP personnel (DFSP 2010) as follows:

- Jet fuel can be stored at the facility in twenty-six USTs and marine diesel fuel in three ASTs. At the time of this LHRA, fifteen USTs and three ASTs were in operation. The remaining eleven USTs were designated as being out of service. However, DFSP

[4] SCAQMD, MATESIII Final Report, September 2008, Chapter 4: Figure 4-10.

personnel indicated the possibility that in the next several years all USTs and ASTs capable of storing jet fuel will be in operation. Therefore, this LHRA was prepared with the conservative assumption that all USTs and ASTs were in operation. Appendix B presents TAC emissions from DFSP storage tanks considered in this LHRA.

- USTs and ASTs capable of storing jet fuel and marine diesel fuel at DFSP have individual storage capacities of over 2 million gallons. Several smaller DFSP tanks with capacities ranging from 100 to 12,100 gallons were not considered in this evaluation, because TAC emissions from storage of slop, additives, and fire extinguishing materials would be minimal compared to jet fuel storage.
- DPM emissions from on-site trucking operations were based on a maximum of 60 truck trips per day[5] and are presented in Appendix B.

Since emission inventories were not available from regulatory agencies for the reasons described in Section 1.1, DFSP emissions were estimated based on source information provided by DFSP personnel as follows:

- Throughput of jet fuel at DFSP was provided by DFSP personnel. Throughput for each tank was determined by prorating the total DFSP throughput by individual tank capacity. Based on DFSP records, USTs 1-20 have a design capacity of 2.1 million gallons, USTs 42-47 have a design capacity of 2.2 million gallons, and ASTs 48-50 have a design capacity of 3.4 million gallons. Therefore, VOC and TAC emissions were calculated to be the same for each tank type.
- Annualized VOC emissions were determined by USEPA's TANKS 4.0.9d emissions program (TANKS). TANKS uses ingredient, specific vapor pressure, molecular weight, boiling point, specific gravity, weight percents, and other physical property data to calculate ingredient specific working loss and breathing loss emissions. Only working losses were considered for USTs.
- DPM emissions from the DFSP were estimated based on trucking frequency information provided by DFSP personnel and CARB's EMFAC, 2007 Emission factors, for the quantification of pollutants from on-road sources.
- Fugitive emissions from DFSP operations were not available from regulatory inventory databases or from interviews with DFSP personnel and therefore not included in this assessment.

TAC emissions information from the ConocoPhillips refinery was obtained from SCAQMD's FIND database. The FIND database presents TACs required for ConocoPhillips annual emissions reporting in recent years, and a more complete listing of TACs in past years. Maximum emissions values for all TACs presented in the FIND database dating back to 2004

[5] DFSP, 2005 Response to data request, page 24 of 36, AER Form B8.

were used in this analysis to capture all emittants and to represent maximum exposure at the Development. Appendix B presents calculation basis and assumptions.

DPM emissions from Port activities were not estimated as part of this effort, but the associated risks were summarized based on SCAQMD's MATES III study. Potential health risks and hazards associated with DPM emissions from the neighboring Ports were not quantified specifically for the proposed Development, but are qualitatively discussed.

2.2 TAC Selection and Emissions

This LHRA followed risk assessment procedures developed by the SCAQMD and OEHHA. Not all of the chemicals possibly released from storage operations at the DFSP facility and the ConocoPhillips refinery pose an equal hazard to the Development. Ethyl benzene, naphthalene, and ethylene glycol monomethyl ether, from DFSP operations, were all identified as TACs of concern for this LHRA based on their inclusion on OEHHA's consolidated table of health values, emissions estimates, and human toxicity information.

Jet fuel, stored at the DFSP facility, is a low vapor pressure, complex blend consisting mostly of kerosene with varying amounts of additives and other components. The MSDS provided by DFSP (Appendix A) identified the following composition:

- 95-100 weight percent kerosene;
- 0.5 weight percent ethyl benzene;
- 0.8 weight percent naphthalene; and
- 0.3 weight percent ethylene glycol monomethyl ether.

Kerosene itself is a complex mixture of hydrocarbons blended to meet standardized product specifications. Kerosene composition can vary greatly, includes C6 to C16 hydrocarbons, and has a flash point between 100 and 150 degrees Fahrenheit. Speciated components of Kerosene are not included in this LHRA.

TAC emissions and detailed calculations from DFSP are presented in Appendix B. TAC emissions identified in SCAQMD's FIND database for ConocoPhillips are also presented in Appendix B.

The Ports are located adjacent to each other on San Pedro Bay, about 20 miles south of downtown Los Angeles and approximately 1.5-2 miles southeast of the proposed Development site. Port activities involve a wide variety of sources that contribute to DPM emissions such as the ocean-going ships that participate in international trade. Other sources include trucks, locomotives, cargo handling equipment, and harbor craft such as tug boats, crew boats, and fishing vessels. Though various TAC emissions other than DPM are associated with Port activities, DPM emissions were assumed to drive health risk in the Port vicinity (MATES III).

Direct quantification of DPM and other TAC emissions from Port operations was outside of the scope of this effort however, port emissions are characterized in the MATES III study.

3.0 Exposure Pathway Analysis and Exposed Populations

This section identifies both the potential pathways of exposure to predicted TACs and potentially exposed populations. The following defines the exposure pathways evaluated in this LHRA, and presents the rationale for the inclusion or elimination from consideration.

An exposure pathway is considered complete if all of the following components are present:

- A chemical source,
- A release and transport mechanism,
- A receptor (a potentially exposed person),
- An exposure point at a receptor location (chemicals are present where receptors are located), and
- An exposure route through which a receptor may be exposed (a chemical uptake route such as ingestion, inhalation or dermal contact).

Each of these components and interactions that may result in complete, incomplete or insignificant exposure pathways are discussed below.

3.1 Chemical Sources

Chemical sources and emissions are discussed in Section 1 of this document.

3.2 Chemical Release and Transport Mechanism

Air, soil, and groundwater can all serve as potential transport media for chemicals to migrate from a site to potential human receptors. However, the movement of chemicals through these media will not necessarily result in actual human exposure. The rate of chemical movement and the resulting concentration at a potential exposure point are dependent upon the characteristics of the chemical and the environmental media through which it passes.

3.3 Exposure Route

Based on OEHHA's approved risk assessment health values, the TACs of concern are considered to contribute to health risk primarily from the inhalation exposure pathway. The proposed Development site usage is for residential purposes; therefore exposure to soil is not expected from the DFSP or ConocoPhillips sites. Groundwater is also not expected to result in a complete exposure pathway, since potable water will be provided from municipal sources. Therefore, the inhalation exposure pathway was determined to be the only exposure pathway that links the potential sources with the receptors at the site.

3.4 Potentially Exposed Receptors

In general, children, the elderly, and individuals with respiratory conditions could be more sensitive to TACs released from the DFSP and ConocoPhillips sites than the average resident. Toxicity information used to assess risks and hazards to people potentially living in the proposed Development incorporated conservative assumptions designed to protect these more sensitive individuals (sensitive receptors). Therefore, sensitive receptor groups were not specifically evaluated in the analysis. Instead, potential cancer and non-cancer chronic risks were evaluated for residents living from childhood through adulthood. These receptors are anticipated to represent the highest possible exposures, risks, and hazards to human health that might exist at the Development.

This LHRA was conducted with the specific focus on impacts to potential residents of the proposed Development from the DFSP, ConocoPhillips, and activities associated with Port operations. Due to the limited nature of this LHRA, only potential residents living at the proposed Development were considered in this LHRA. Locations of sensitive receptors, including schools, hospitals, and nursing homes were outside of the scope of this evaluation and are not included in this LHRA. Coordinate information and elevation of the Development receptors were determined from United States Geological Survey topographic data.

4.0 Dispersion Model Selection and Inputs

The AERMOD dispersion model was applied to this study to assess unity concentration (dispersion) field impacts from the DFSP and ConocoPhillips emission sources. Port activities are not specifically modeled as part of this effort, but cancer risk is summarized as presented in the MATES III study and therefore considered in this LHRA.

4.1 Model Inputs

The AERMOD modeling analysis evaluated the dispersion and resulting unity concentrations for the DFSP and ConocoPhillips emissions sources. Specifically, jet fuel storage tanks, marine diesel fuel storage tanks, and movement of diesel trucks were modeled for the DFSP. The analysis simulated these emission sources, taking into consideration source physical parameterizations and operational locations. Since source-specific information was unavailable for the ConocoPhillips refinery, the site was modeled as a single area source with the exception of metals and PAHs modeled as a representative combustion point source centered at a row of combustion sources identified using Google Earth. DPM was modeled as a representative combustion point source emitted from portable internal combustion engines (ICE)s.

The following assumptions were made in the modeling analysis:

- Receptors were located at discrete locations with spacing of 100 meters or less.
- DFSP USTs were characterized as point emission sources.

- DFSP ASTs were characterized as volume sources and simulated by AERMOD as being released and mixed within a volume of air prior to being dispersed downwind.
- DFSP Diesel trucks at the facility were modeled as point emission sources and were conservatively assumed to all be located at Tank 4, the tank site closest to the proposed Development site.
- Emissions associated with ConocoPhillips were modeled as a single area source with the approximate dimensions of most fugitive source locations at the ConocoPhillips site, and two combustion sources for PAHs and metals, and DPM.

Detailed model input assumptions and parameters are presented in Appendix C.

4.2 Meteorological Data

For dispersion modeling purposes, the SCAQMD has developed annual sets of hourly meteorological data (365 days x 24 hours/day = 8,760 hours of wind speed, wind direction, temperature, stability, and mixing height data) for various locations within the SCAB. CARB's Long Beach monitoring station meteorological data from 2005 through 2007 was used for dispersion modeling in this LHRA. The Long Beach monitoring station is located approximately 7.5 miles east by northeast of the proposed Development. While background air quality and emissions levels may change with time, basic meteorological conditions do not change with time and this data set is appropriate for use in modeling.

4.3 Model Options

This modeling analysis used the EPA regulatory default options for all modeling runs and urban dispersion parameters. Modeling options used for this LHRA represent conservative assumptions.

5.0 Exposure Identification

The AERMOD dispersion modeling analysis provides ground level TAC unity concentrations at the Development receptors. This unity concentration represents an intermediate product in the LHRA process and characterizes the dispersion field for all point and volume sources emitting at one gram per second and area sources emitting at one gram per second for each square meter occupied. Actual source emissions are input to the HARP model and HARP calculated the actual dispersion field concentrations at each receptor. HARP incorporates and uses the latest TAC toxicity parameters established by OEHHA to analyze the probability of contracting cancer and to compare estimated ambient TAC concentrations to concentrations with no significant health hazards. Unit risk factors (URF)s represent the estimated probability of a person contracting cancer as a result of constant exposure to an ambient concentration of one microgram per cubic meter of a substance over a 70-year lifetime. The acute and chronic relative exposure levels (REL)s represent potential adverse acute and chronic non-cancer health effects. An REL is

a concentration level (micrograms per cubic meter) or dose (milligrams per kilogram per day) at which no adverse health effects are anticipated.

For this project the HARP model estimates of public health impacts due to selected TAC emissions were based on the breathing rate described in the CARB Recommended Interim Risk Management Policy for Inhalation-Based Residential Risk. For carcinogenic risk assessments based on the inhalation pathway only, where a single cancer risk value is required for a risk management decision, the CARB policy recommends that the potential cancer risk be based on the breathing rate representing the 80th percentile for a 70-year exposure period. The 80th percentile lifetime breathing rate is equal to 302 liters per kilogram of body weight per day. Therefore, the LHRA determined maximum residential area health impacts by using HARP's built-in 80th percentile point estimate analysis method and an exposure duration of 24 hours per day, 365 days per year, and 70 years. All exposure parameters are presented in HARP input and output files (Appendix C).

6.0 Predicted Health Impacts

The SCAQMD has established a threshold to determine the significance of health impacts from existing facilities. Based on the SCAQMD air quality assessment guidelines, a facility produces less than significant cancer impacts if the estimated probability of contracting cancer due to emissions from the facility is less than 10 chances in one million.

For chronic non-cancer exposure, maximum annual TAC concentrations are compared with OEHHA's long-term REL. A Hazard Index is the sum of hazard quotients across all exposure endpoints affected by each TAC. A hazard quotient, in turn represents the ratio of estimated site-specific exposure to a single chemical from a site over a specified period to the estimated daily exposure level, at which no adverse health effects are likely to occur. A Hazard Index of 1.0 or less indicates that the exposure would not present adverse health effects. This guidance is consistent with the non-cancer significance threshold recommended by the SCAQMD.

Table-3 presents a summary of the maximum health impacts that would potentially occur at the Development receptor with maximum impact from the DFSP and ConocoPhillips TAC emissions. The data shows that the maximum cancer risk would be below 10 chances in one million. The data also shows that the non-cancer chronic risk and the acute risk would remain below the SCAQMD hazard index threshold value of 1.0. Emissions from the Ports have historically been major contributors to cancer risk in the Port vicinity (MATES III). While Port activities are associated with various air pollutants with varying cancer risk contributions, DPM is the greatest contributor to cancer risk in the ports area as well most of the SCAB (MATES III). For this reason, cancer risk estimated by the SCAQMD due to DPM emissions from neighboring Ports operations is also presented.

Table-3: Maximum Health Impacts

Health Impact	Maximum Impact	Significance Threshold
Impacts Attributed to DFSP & ConocoPhillips Operations		
Cancer Risk	3.29 in one million	10 in one million
Chronic Hazard Index	0.396	1.0
Acute Hazard Index	0.117	1.0
Impacts Attributed to Port Activities		
Population-Weighted Cancer Risk for the Ports Area	1,415 in one million[6]	
Cancer Risk near the Development due to Vicinity Activities (sources included Ports, freeways, other sources)	800 in one million[7]	

7.0 Uncertainties and Limitations

This LHRA was based on product and throughput information provided by DFSP. DFSP has not been required to prepare and submit annual emissions inventories to the local air quality authority, SCAQMD. For this same reason, the DFSP has not been required to prepare air toxic inventories. Lacking reported emissions inventories, this LHRA relied on MSDS information provided by the DFSP for JP-5 and JP-8, throughput provided by DFSP, and TANKS 4.0.9d emissions modeling. The hazardous components identified in the MSDS were used to estimate health hazards to the Development from the DFSP facility. It should be noted, however that kerosene, a major component of jet fuel, is not included in OEHHA's Consolidated Table and therefore was not included in this LHRA.

Inherent uncertainties exist in risk assessment procedures. For instance, it is common practice to use conservative assumptions with respect to uncertain parameters. These uncertainties and conservative assumptions must be noted when evaluating the results of risk assessments.

Since the potential health effects of contaminants are commonly identified based on animal studies, there is uncertainty in the application of these findings to humans. In addition, for many

[6] SCAQMD, MATES III Final Report, September 2008, Chapter 4: Table 4-4.
[7] SCAQMD, MATESIII Final Report, September 2008, Chapter 4: Figure 4-10.

compounds it is uncertain whether the health effects observed at higher exposure levels in the laboratory or in occupational settings will occur at lower environmental exposure levels. In order to ensure that potential health impacts are not underestimated, it is commonly assumed that effects seen in animals or at high exposure levels could potentially occur in humans following low-level environmental exposure at lower rates, unless there is specific evidence to the contrary.

The estimation of cancer potencies and RELs is another major area of uncertainty. Estimates of potencies and RELs are derived from experimental animal studies or from epidemiological studies of exposed workers or other populations. Uncertainty arises from the application of potency or REL values derived from this data to the general human population. With regard to cancer potencies, if the potency estimate is derived from animal studies, it is common practice by regulatory agencies to use an upper bound estimate of the potency of a compound in order to ensure that risks to humans from a given exposure are not understated. Similarly, the RELs developed by regulatory agencies commonly incorporate safety factors to ensure that they are health protective.

Uncertainty also exists in exposure estimates that are used to estimate risks. The procedures used in this LHRA assess exposures as though individuals residing in the vicinity of the Development remain in this location for a lifetime of 70 years. A different set of exposure assumptions may lead to lower exposure estimates and consequently lower risk estimates.

The risk contributions from Port activities carry further limitations; specifically, the appropriate levels of risk ascribed to diesel particulates. CalEPA recommended diesel particulates cancer risk level of 300 in a million per microgram per cubic meter (ug/m3), considered evidence which suggested diesel risks as low as 150 in a million to as high as 2,400 in a million per ug/m3. Thus, the selection of a risk factor for diesel particulates can have a substantial effect in assessing overall risks; however, even using the lowest bound of the CalEPA recommended risk factor (150 in a million) does not change diesel's domination in the overall risks. The CARB study used the CalEPA recommended value of 300 in a million per ug/m3.

In conclusion, the lack of data causes a great deal of uncertainty associated with the process of risk assessment, requiring the use of assumptions. The assumptions used in this LHRA are designed to err on the side of health protection to avoid underestimation of risk. Sources of uncertainty, which may overestimate or underestimate risk, include extrapolation of toxicity data in animals to humans, uncertainty in the estimation of emissions, uncertainty in the air dispersion models, and uncertainty in the exposure estimates. Thus, risk estimates generated by an LHRA should not be interpreted as the expected rates of disease in the exposed population but rather as estimates of potential risk, based on current knowledge and assumptions. Additionally, the uncertainty factors integrated within the estimates of non-cancer RELs are meant to err on the side of public health protection to avoid underestimation of risk. Risk assessment is best used as a ruler to compare one source with another and to prioritize concerns.

8.0 References

California Air Resources Board, *EMFAC 2007, Version 2.3, Emission Factors for On-Road Heavy-Heavy Duty Diesel Trucks, August 2003.*

California Air Resources Board, *Air Toxics Hot Spots Program Risk Assessment Guidelines, August 2003.*

California Air Resources Board, *Recommended Interim Risk Management Policy for Inhalation-Based Residential Risk, October 2003.*

California Air Resources Board, *Hotspots Analysis and Reporting Program, Version 1.4d.*

OEHHA 2003, Office of Environmental Health and Hazard Assessment, *The Air Toxics Hot Spots Program Guidance Manual for Preparation of Health Risk Assessment, 2003.*

South Coast Air Quality Management District, *Risk Assessment Procedures for Rules 1401, 1402, 212, Version 7.0- 2005.*

South Coast Air Quality Management District, *Multiple Air Toxics Exposure Study (MATES) III, September 2008.*

U.S. Environmental Protection Agency, *AERMOD Dispersion Model, Version 11103, 2006.*

U.S. Environmental Protection Agency, *TANKS Emissions Estimation Software, Version 4.09D, 2006.*

Appendix A- MSDSs

- Jet Fuel (JP-5)
- Jet Fuel (JP-8)
- Marine Diesel Fuel (F-76)

ExxonMobil

120303-00 JP-5 (NATO F-44)
MATERIAL SAFETY DATA BULLETIN

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1. PRODUCT AND COMPANY IDENTIFICATION

PRODUCT NAME: JP-5 (NATO F-44)
SUPPLIER: EXXONMOBIL OIL CORPORATION
3225 GALLOWS RD.
FAIRFAX, VA 22037

24 - Hour Health and Safety Emergency (call collect): 609-737-4411

24 - Hour Transportation Emergency:
CHEMTREC: 800-424-9300 202-483-7616
LUBES AND FUELS: 281-834-3296

Product and Technical Information:
Lubricants and Specialties: 800-662-4525 800-443-9966
Fuels Products: 800-947-9147
MSDS Fax on Demand: 713-613-3661
MSDS Internet Website: http://www.exxon.com, http://www.mobil.com

2. COMPOSITION/INFORMATION ON INGREDIENTS

CHEMICAL NAMES AND SYNONYMS: HYDROCARBONS AND ADDITIVES

GLOBALLY REPORTABLE MSDS INGREDIENTS:

Substance Name	Approx. Wt%
KEROSENE (8008-20-6)	95-100

COMPONENT(S) OF PRODUCT INGREDIENTS INCLUDE:

NAPHTHALENE (91-20-3)	0.8
ETHYL BENZENE (100-41-4)	0.5

NOTE: Composition may contain up to 0.3% glycol ethers (DGME, EGME) and proprietary additives.

See Section 8 for exposure limits (if applicable).

3. HAZARDS IDENTIFICATION

This product is considered hazardous according to regulatory guidelines (See Section 15).

EMERGENCY OVERVIEW: Colorless to Pale Straw Liquid. Material is combustible. Liquid can release vapors that readily form flammable mixtures at or above the flash point. Product can accumulate a static charge which may cause a fire or explosion. DOT ERG No. : 128

POTENTIAL HEALTH EFFECTS: This product can irritate and defat the skin. Prolonged and/or repeated skin contact may cause dermatitis. High concentrations of vapors may be irritating to the eyes and respiratory system and act as an anesthetic. Low viscosity material-if swallowed may enter the lungs and cause lung damage.

POTENTIAL ENVIRONMENTAL EFFECTS: Toxic to aquatic organisms; may cause long-term adverse effects in the aquatic environment.

For further health effects/toxicological data, see Section 11.

4. FIRST AID MEASURES

EYE CONTACT: Flush thoroughly with water. If irritation occurs, call a physician.

SKIN CONTACT: Wash contact areas with soap and water. Immediately remove contaminated clothing. Launder contaminated clothing before reuse. (See Section 16 - Injection Injury)

INHALATION: Remove from further exposure. If respiratory irritation, dizziness, nausea, or unconsciousness occurs, seek immediate medical assistance. If breathing has stopped, assist ventilation with mechanical device or use mouth-to-mouth resuscitation.

INGESTION: Seek immediate medical attention. Do not induce vomiting.

NOTE TO PHYSICIANS: Material if aspirated into the lungs may cause chemical pneumonitis. PRE-EXISTING MEDICAL CONDITIONS WHICH MAY BE AGGRAVATED BY EXPOSURE: Hydrocarbon Solvents/Petroleum Hydrocarbons- Skin contact may aggravate an existing dermatitis.

5. FIRE-FIGHTING MEASURES

EXTINGUISHING MEDIA: Carbon dioxide, foam, dry chemical and water fog.

SPECIAL FIRE FIGHTING PROCEDURES: Water should be used to keep fire-exposed containers cool. Prevent runoff from fire control or dilution from entering streams, sewers, or drinking water supply.

SPECIAL PROTECTIVE EQUIPMENT: For fires in enclosed areas, fire fighters must use self-contained breathing apparatus.

UNUSUAL FIRE AND EXPLOSION HAZARDS: Material is combustible. Liquid can release vapors that readily form flammable mixtures at or above the flash point. Product can accumulate a static charge which may cause a fire or explosion.

COMBUSTION PRODUCTS: Fumes, smoke, carbon monoxide, sulfur oxides, aldehydes and other decomposition products, in the case of

incomplete combustion.
Flash Point C(F): 60(140) (ASTM D-93).
Flammable Limits (approx.% vol.in air) - LEL: 0.7%, UEL: 5.0%
NFPA HAZARD ID: Health: 1, Flammability: 2, Reactivity: 0

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6. ACCIDENTAL RELEASE MEASURES

NOTIFICATION PROCEDURES: Report spills/releases as required to appropriate authorities. U.S. Coast Guard and EPA regulations require immediate reporting of spills/releases that could reach any waterway including intermittent dry creeks. Report spill/release to Coast Guard National Response Center toll free number (800)424-8802. In case of accident or road spill notify CHEMTREC (800) 424-9300.

PROCEDURES IF MATERIAL IS RELEASED OR SPILLED:

LAND SPILL: Eliminate sources of ignition. Shut off source taking normal safety precautions. Take measures to minimize the effects on ground water. Recover by pumping using explosion-proof equipment or contain spilled liquid with sand or other suitable absorbent and remove mechanically into containers. If necessary, dispose of adsorbed residues as directed in Section 13.

WATER SPILL: Eliminate sources of ignition and warn other ships in the vicinity to stay clear. Notify port and other relevant authorities. Confine with booms if skimming equipment is available to recover the spill. Otherwise disperse in unconfined waters, if permitted by local authorities and environmental agencies. If permitted by regulatory authorities the use of suitable dispersants should be considered where recommended in local oil spill procedures.

ENVIRONMENTAL PRECAUTIONS: Prevent material from entering sewers, water sources or low lying areas; advise the relevant authorities if it has, or if it contaminates soil/vegetation.

PERSONAL PRECAUTIONS: See Section 8

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7. HANDLING AND STORAGE

HANDLING: Keep product away from high energy ignition sources, heat, sparks, pilot lights, static electricity, and open flame. Harmful in contact with or if absorbed through the skin. Avoid inhalation of vapors or mists. Use in well ventilated area away from all ignition sources. Do not fill container in or on a vehicle. Static electricity may ignite vapors and cause fire. Place container on ground when filling and keep nozzle in contact with container. See Section 8 for additional personal protection advice when handling this product.

STORAGE: Store in a cool area. Small containers of approved design, properly sealed and labeled, should be stored in well ventilated surroundings and kept out of reach of children. Eliminate all sources of ignition from the storage and handling area.

SPECIAL PRECAUTIONS: To prevent and minimize fire or explosion risk from static accumulation and discharge, effectively bond and/or ground product transfer system. Do not use electronic devices (including but not limited to cellular phones, computers, calculators, pagers, etc.) in or around any fueling operation or storage area unless the devices are certified intrinsically safe by an approved national testing agency and to the safety

standards required by national and/or local laws and regulations. Electrical equipment and fittings must comply with local fire prevention regulations for this class of product. Use the correct grounding procedures. Refer to national or local regulations covering safety at petroleum handling and storage areas for this product.

EMPTY CONTAINER WARNING: Empty containers retain residue (liquid and/or vapor) and can be dangerous. DO NOT PRESSURIZE, CUT, WELD, BRAZE, SOLDER, DRILL, GRIND OR EXPOSE SUCH CONTAINERS TO HEAT, FLAME, SPARKS, STATIC ELECTRICITY, OR OTHER SOURCES OF IGNITION; THEY MAY EXPLODE AND CAUSE INJURY OR DEATH. Do not attempt to refill or clean container since residue is difficult to remove. Empty drums should be completely drained, properly bunged and promptly returned to a drum reconditioner. All containers should be disposed of in an environmentally safe manner and in accordance with governmental regulations.

8. EXPOSURE CONTROLS/PERSONAL PROTECTION

OCCUPATIONAL EXPOSURE LIMITS:

ExxonMobil recommends an 8-hour time-weighted average (TWA) exposure of 500 mg/m3 total vapor (approx. 100 ppm) or 5 mg/m3 stable aerosols.

Substance Name (CAS-No.)	Source	---TWA--- ppm	mg/m3	----STEL--- ppm	mg/m3	NOTE
KEROSENE (8008-20-6)						
as Petroleum Distillate	OSHA	400	1600			
Total HC Vapor Skin	ACGIH		200			
NAPHTHALENE (91-20-3)						
	OSHA	10	50	15	75	
	ACGIH	10	52	15	79	
ETHYL BENZENE (100-41-4)						
	OSHA	100	435	125	545	
	ACGIH	100	434	125	543	

NOTE: Limits shown for guidance only. Follow applicable regulations.

VENTILATION: Use in well ventilated area with local exhaust ventilation. Ventilation equipment must be explosion proof.

RESPIRATORY PROTECTION: Use supplied-air respiratory protection in confined or enclosed spaces, if needed.

EYE PROTECTION: If splash with liquid is possible, chemical type goggles should be worn.

SKIN PROTECTION: Impervious gloves should be worn. Good personal hygiene practices should always be followed.

9. PHYSICAL AND CHEMICAL PROPERTIES

Typical physical properties are given below. Consult Product Data Sheet for specific details.

APPEARANCE: Liquid
COLOR: Colorless to Pale Straw
ODOR: Mild
ODOR THRESHOLD-ppm: NE
pH: NA
BOILING POINT C(F): > 93(200)
MELTING POINT C(F): NA
FLASH POINT C(F): 60(140) (ASTM D-93)
FLAMMABILITY (solids): NE
AUTO FLAMMABILITY C(F): 250(482)
EXPLOSIVE PROPERTIES: NA
OXIDIZING PROPERTIES: NA
VAPOR PRESSURE-mmHg 20 C: < 1.0
VAPOR DENSITY: NE
EVAPORATION RATE: NE
RELATIVE DENSITY, 15/4 C: 0.775-0.83
SOLUBILITY IN WATER: Negligible
PARTITION COEFFICIENT: > 3.5
VISCOSITY AT 40 C, cSt: 1.1
VISCOSITY AT 100 C, cSt: NE
POUR POINT C(F): -47(-53)
FREEZING POINT C(F): NE
VOLATILE ORGANIC COMPOUND: NE
DMSO EXTRACT, IP-346 (WT.%): NA
NA=NOT APPLICABLE NE=NOT ESTABLISHED D=DECOMPOSES

FOR FURTHER TECHNICAL INFORMATION, CONTACT YOUR MARKETING REPRESENTATIVE

10. STABILITY AND REACTIVITY

STABILITY (THERMAL, LIGHT, ETC.): Stable.
CONDITIONS TO AVOID: Heat, sparks, flame and build up of static electricity.
INCOMPATIBILITY (MATERIALS TO AVOID): Halogens, strong acids, alkalies, and oxidizers.
HAZARDOUS DECOMPOSITION PRODUCTS: Product does not decompose at ambient temperatures.
HAZARDOUS POLYMERIZATION: Will not occur.

11. TOXICOLOGICAL DATA

---ACUTE TOXICOLOGY---

ORAL TOXICITY (RATS): Practically non-toxic (LD50: greater than 2000 mg/kg). ---Based on testing of similar products and/or the components.
DERMAL TOXICITY (RABBITS): Practically non-toxic (LD50: greater than 2000 mg/kg). ---Based on testing of similar products and/or the components.

INHALATION TOXICITY (RATS): Practically non-toxic (LC50: greater than 5 mg/l). ---Based on testing of similar products and/or the components.
EYE IRRITATION (RABBITS): Practically non-irritating. (Draize score: greater than 6 but 15 or less). ---Based on testing of similar products and/or the components.
SKIN IRRITATION (RABBITS): Irritant.

---REPRODUCTIVE TOXICOLOGY (SUMMARY)---

A review of the literature indicates that inhalation of kerosene vapors does not cause reproductive or developmental effects in laboratory animals. There is no evidence of effects on humans.

---CHRONIC TOXICOLOGY (SUMMARY)---

Certain straight-run middle distillates have been found to produce skin tumors in laboratory mouse skin-painting tests, but these have usually been associated with a high level of skin irritation. ExxonMobil has conducted tests that determined that the irritation produces the tumors. Therefore, if the precautions outlined in this MSDS are followed to minimize repeated or prolonged skin contact which could cause irritation, these oils should pose no carcinogenic hazard to humans. Prolonged repeated skin contact with low viscosity materials may defat the skin resulting in possible irritation and dermatitis. Some jet fuel has potential in mice to suppress indicators of immune system functionality. The relevance of these effects to humans is uncertain.

---OTHER TOXICOLOGY DATA---

This product contains ethylbenzene. The International Agency for Research on Cancer (IARC) has evaluated ethylbenzene and classified it as possibly carcinogenic to humans (Group 2B) based on sufficient evidence for carcinogenicity in experimental animals, but inadequate evidence for cancer in exposed humans.

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12. ECOLOGICAL INFORMATION

ENVIRONMENTAL FATE AND EFFECTS:

In the absence of specific environmental data for this product, this assessment is based on information for representative substances.

ECOTOXICITY: Based on test results for similar products, this substance may be harmful to aquatic organisms such as fish (LL =10-100 mg/L), and toxic to algae and daphnia (EL50/IrL50 =1-10 mg/L.)

MOBILITY: Dissolution of the higher molecular weight hydrocarbon components in water will be limited, but losses through sediment adsorption may be significant.

PERSISTENCE AND DEGRADABILITY: When released into the environment, most of the constituents of kerosene fuels will volatilize and be photodegraded in the atmosphere. The less volatile, more water-soluble components which are aromatic hydrocarbons will also undergo aqueous photodegradation. The majority of the

components in this product are expected to be inherently biodegradable.

BIOACCUMULATIVE POTENTIAL: Not established.

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13. DISPOSAL CONSIDERATIONS

WASTE DISPOSAL: Product is suitable for burning for fuel value in compliance with applicable laws and regulations and consideration of product characteristics at time of disposal.

RCRA INFORMATION: The unused product, in our opinion, is not specifically listed by the EPA as a hazardous waste (40 CFR, Part 261D), nor is it formulated to contain materials which are listed hazardous wastes. It does not exhibit the hazardous characteristics of ignitability, corrosivity, or reactivity. The unused product is not formulated with substances covered by the Toxicity Characteristic Leaching Procedure (TCLP). However, used product may be regulated.

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14. TRANSPORT INFORMATION

NOTE: The flash point of this material is 140F. Regulatory classifications vary as follows:

DOT:	Flammable Liquid OR Combustible Liquid - (49CFR 173.120(b)(2))
OSHA:	Combustible Liquid
IATA/IMO:	Flammable Liquid

USA DOT:

SHIPPING NAME:	Fuel, Aviation, Turbine Engine
HAZARD CLASS & DIV:	COMBUSTIBLE LIQUID
ID NUMBER:	UN1863
ERG NUMBER:	128
PACKING GROUP:	PG III
STCC:	NE
DANGEROUS WHEN WET:	No
POISON:	No
LABEL(s):	NA
PLACARD(s):	Combustible
PRODUCT RQ:	NA
MARPOL III STATUS:	NA

RID/ADR:

HAZARD CLASS:	3
PACKING GROUP:	III
LABEL:	3
DANGER NUMBER:	30
UN NUMBER:	1863
SHIPPING NAME:	Fuel, Aviation, Turbine Engine
REMARKS:	NA

IMO:

HAZARD CLASS & DIV:	3
UN NUMBER:	1863
PACKING GROUP:	PG III
SHIPPING NAME:	Fuel, Aviation, Turbine Engine
LABEL(s):	Flammable Liquid
MARPOL III STATUS:	NA

ICAO/IATA:

HAZARD CLASS & DIV:	3
ID/UN Number:	1863
PACKING GROUP:	PG III
SHIPPING NAME:	Fuel, Aviation, Turbine Engine
SUBSIDIARY RISK:	NA
LABEL(s):	Flammable Liquid

STATIC ACCUMULATOR (50 picosiemens or less): YES

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15. REGULATORY INFORMATION

US OSHA HAZARD COMMUNICATION STANDARD: Product assessed in accordance with OSHA 29 CFR 1910.1200 and determined to be hazardous.

EU Labeling: Product is dangerous as defined by the European Union Dangerous Substances/Preparations Directives.

Symbol: Xn N Harmful, Dangerous for the environment.

Risk Phrase(s): R10-65-38-67-51/53.
Flammable. Harmful: may cause lung damage if swallowed. Irritating to skin. Vapors may cause drowsiness and dizziness. Toxic to aquatic organisms, may cause long-term adverse effects in the aquatic environment.

Safety Phrase(s): S16-43-24-62.
Keep away from sources of ignition - No smoking. In case of fire use foam/drypowder/CO2. Avoid contact with skin. If swallowed, do not induce vomiting: seek medical advice immediately and show this container or label.

Contains: Aviation Jet Fuel.

Governmental Inventory Status: All components comply with TSCA, EINECS/ELINCS, AICS, METI, DSL, KOREA, and PHILIPPINES.

U.S. Superfund Amendments and Reauthorization Act (SARA) Title III:
This product contains no "EXTREMELY HAZARDOUS SUBSTANCES".

SARA (311/312) REPORTABLE HAZARD CATEGORIES:
FIRE CHRONIC ACUTE

This product contains the following SARA (313) Toxic Release Chemicals:

CHEMICAL NAME	CAS NUMBER	CONC.
ETHYL BENZENE(COMPONENT ANALYSIS)	100-41-4	0.5%

The following product ingredients are cited on the lists below:

CHEMICAL NAME	CAS NUMBER	LIST CITATIONS *
NAPHTHALENE (COMPONENT ANALYSIS) (0.80%)	91-20-3	16, 22
ETHYL BENZENE (COMPONENT ANALYSIS)	100-41-4	1, 8, 24
KEROSENE	8008-20-6	19, 21, 25, 26

--- REGULATORY LISTS SEARCHED ---

1=ACGIH ALL	6=IARC 1	11=TSCA 4	16=CA P65 CARC	21=LA RTK
2=ACGIH A1	7=IARC 2A	12=TSCA 5a2	17=CA P65 REPRO	22=MI 293
3=ACGIH A2	8=IARC 2B	13=TSCA 5e	18=CA RTK	23=MN RTK
4=NTP CARC	9=OSHA CARC	14=TSCA 6	19=FL RTK	24=NJ RTK
5=NTP SUS	10=OSHA Z	15=TSCA 12b	20=IL RTK	25=PA RTK
				26=RI RTK

* EPA recently added new chemical substances to its TSCA Section 4 test rules. Please contact the supplier to confirm whether the ingredients in this product currently appear on a TSCA 4 or TSCA 12b list.
Code key:CARC=Carcinogen; SUS=Suspected Carcinogen; REPRO=Reproductive

16. OTHER INFORMATION

USE: AVIATION FUEL

NOTE: PRODUCTS OF EXXON MOBIL CORPORATION AND ITS AFFILIATED COMPANIES ARE NOT FORMULATED TO CONTAIN PCBS.

Health studies have shown that many hydrocarbons pose potential human health risks which may vary from person to person. Information provided on this MSDS reflects intended use. This product should not be used for other applications. In any case, the following advice should be considered:

INJECTION INJURY WARNING: If product is injected into or under the skin, or into any part of the body, regardless of the appearance of the wound or its size, the individual should be evaluated immediately by a physician as a surgical emergency. Even though initial symptoms from high pressure injection may be minimal or absent, early surgical treatment within the first few hours may significantly reduce the ultimate extent of injury.

Precautionary Label Text:

CONTAINS KEROSENE

CAUTION!

COMBUSTIBLE LIQUID AND VAPOR. CAUSES SKIN IRRITATION. MAY CAUSE NOSE, THROAT AND LUNG IRRITATION, DIZZINESS, NAUSEA, LOSS OF CONSCIOUSNESS. LOW VISCOSITY MATERIAL-IF SWALLOWED, MAY BE ASPIRATED AND CAN CAUSE SERIOUS OR FATAL LUNG DAMAGE.

Keep away from heat, sparks, and flame. Avoid breathing vapor. Avoid contact with skin or clothing. Keep container closed. Use with adequate ventilation.

In case of contact, wash skin with soap and water. Remove contaminated clothing. Destroy or wash clothing before reuse. If swallowed, seek immediate medical attention. Do not induce vomiting. Only induce vomiting at the instruction of a physician.

For industrial use only. Not intended or suitable for use in or around a household or dwelling.

This warning is given to comply with California Health and Safety Code 25249.6 and does not constitute an admission or a waiver of rights. Chemicals known to the State of California to cause cancer, birth defects, or other reproductive harm are created by the combustion of this product. Refer to product Material Safety Data Sheet for further safety and health information.

****
For Internal Use Only: MHC: 1* 1* 1* 1* 2, MPPEC: C, TRN: 120303-00,
ELIS: 012030, CMCS97: 977973, REQ: MIAMI, SAFE USE: C
EHS Approval Date: 14OCT2003
****

Information given herein is offered in good faith as accurate, but without guarantee. Conditions of use and suitability of the product for particular uses are beyond our control; all risks of use of the product are therefore assumed by the user and WE EXPRESSLY DISCLAIM ALL WARRANTIES OF EVERY KIND AND NATURE, INCLUDING WARRANTIES OF MERCHANTABILITY AND FITNESS FOR A PARTICULAR PURPOSE IN RESPECT TO THE USE OR SUITABILITY OF THE PRODUCT. Nothing is intended as a recommendation for uses which infringe valid patents or as extending license under valid patents. Appropriate warnings and safe handling procedures should be provided to handlers and users. Alteration of this document is strictly prohibited. Except to the extent required by law, republication or retransmission of this document, in whole or in part, is not permitted. Exxon Mobil Corporation and its affiliated companies assume no responsibility for accuracy of information unless the document is the most current available from an official ExxonMobil distribution system. Exxon Mobil Corporation and its affiliated companies neither represent nor warrant that the format, content or product formulas contained in this document comply with the laws of any other country except the United States of America.

Prepared by: ExxonMobil Oil Corporation
Environmental Health and Safety Department, Clinton, USA

ExxonMobil

123059-00 JP-8 (NATO F-34)
MATERIAL SAFETY DATA BULLETIN

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1. PRODUCT AND COMPANY IDENTIFICATION

PRODUCT NAME: JP-8 (NATO F-34)
SUPPLIER: EXXONMOBIL OIL CORPORATION
3225 GALLOWS RD.
FAIRFAX, VA 22037

24 - Hour Health and Safety Emergency (call collect): 609-737-4411

24 - Hour Transportation Emergency:
CHEMTREC: 800-424-9300 202-483-7616
LUBES AND FUELS: 281-834-3296

Product and Technical Information:
Lubricants and Specialties: 800-662-4525 800-443-9966
Fuels Products: 800-947-9147
MSDS Fax on Demand: 713-613-3661
MSDS Internet Website: http://www.exxon.com, http://www.mobil.com

2. COMPOSITION/INFORMATION ON INGREDIENTS

CHEMICAL NAMES AND SYNONYMS: KEROSENE

GLOBALLY REPORTABLE MSDS INGREDIENTS:

Substance Name	Approx. Wt%
KEROSENE (8008-20-6)	95-100

COMPONENT(S) OF PRODUCT INGREDIENTS INCLUDE:

NAPHTHALENE (91-20-3)	0.8
ETHYL BENZENE (100-41-4)	0.5

NOTE: Composition may contain up to 0.3% glycol ethers (DGME, EGME) and proprietary additives.

See Section 8 for exposure limits (if applicable).

3. HAZARDS IDENTIFICATION

This product is considered hazardous according to regulatory guidelines (See Section 15).

EMERGENCY OVERVIEW: Colorless to Pale Straw Liquid. Material is combustible. Liquid can release vapors that readily form flammable mixtures at or above the flash point. Product can accumulate a static charge which may cause a fire or explosion. DOT ERG No. : 128

POTENTIAL HEALTH EFFECTS: This product can irritate and defat the skin. Prolonged and/or repeated skin contact may cause dermatitis. High concentrations of vapors may be irritating to the eyes and respiratory system and act as an anesthetic. Low viscosity material-if swallowed may enter the lungs and cause lung damage.

POTENTIAL ENVIRONMENTAL EFFECTS: Toxic to aquatic organisms; may cause long-term adverse effects in the aquatic environment.

For further health effects/toxicological data, see Section 11.

4. FIRST AID MEASURES

EYE CONTACT: Flush thoroughly with water. If irritation occurs, call a physician.

SKIN CONTACT: Wash contact areas with soap and water. Immediately remove contaminated clothing. Launder contaminated clothing before reuse. (See Section 16 - Injection Injury)

INHALATION: Remove from further exposure. If respiratory irritation, dizziness, nausea, or unconsciousness occurs, seek immediate medical assistance. If breathing has stopped, assist ventilation with mechanical device or use mouth-to-mouth resuscitation.

INGESTION: Seek immediate medical attention. Do not induce vomiting.

NOTE TO PHYSICIANS: Material if aspirated into the lungs may cause chemical pneumonitis. PRE-EXISTING MEDICAL CONDITIONS WHICH MAY BE AGGRAVATED BY EXPOSURE: Hydrocarbon Solvents/Petroleum Hydrocarbons- Skin contact may aggravate an existing dermatitis.

5. FIRE-FIGHTING MEASURES

EXTINGUISHING MEDIA: Carbon dioxide, foam, dry chemical and water fog.

SPECIAL FIRE FIGHTING PROCEDURES: Water should be used to keep fire-exposed containers cool. Prevent runoff from fire control or dilution from entering streams, sewers, or drinking water supply.

SPECIAL PROTECTIVE EQUIPMENT: For fires in enclosed areas, fire fighters must use self-contained breathing apparatus.

UNUSUAL FIRE AND EXPLOSION HAZARDS: Material is combustible. Liquid can release vapors that readily form flammable mixtures at or above the flash point. Product can accumulate a static charge which may cause a fire or explosion.

COMBUSTION PRODUCTS: Fumes, smoke, carbon monoxide, sulfur oxides, aldehydes and other decomposition products, in the case of incomplete combustion.
Flash Point C(F): > 38(100) (ASTM D-93).
Flammable Limits (approx.% vol.in air) - LEL: 0.7%, UEL: 5.0%
NFPA HAZARD ID: Health: 1, Flammability: 2, Reactivity: 0

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6. ACCIDENTAL RELEASE MEASURES

NOTIFICATION PROCEDURES: Report spills/releases as required to appropriate authorities. U.S. Coast Guard and EPA regulations require immediate reporting of spills/releases that could reach any waterway including intermittent dry creeks. Report spill/release to Coast Guard National Response Center toll free number (800)424-8802. In case of accident or road spill notify CHEMTREC (800) 424-9300.

PROCEDURES IF MATERIAL IS RELEASED OR SPILLED:

LAND SPILL: Eliminate sources of ignition. Shut off source taking normal safety precautions. Take measures to minimize the effects on ground water. Recover by pumping using explosion-proof equipment or contain spilled liquid with sand or other suitable absorbent and remove mechanically into containers. If necessary, dispose of adsorbed residues as directed in Section 13.

WATER SPILL: Eliminate sources of ignition and warn other ships in the vicinity to stay clear. Notify port and other relevant authorities. Confine with booms if skimming equipment is available to recover the spill. Otherwise disperse in unconfined waters, if permitted by local authorities and environmental agencies. If permitted by regulatory authorities the use of suitable dispersants should be considered where recommended in local oil spill procedures.

ENVIRONMENTAL PRECAUTIONS: Prevent material from entering sewers, water sources or low lying areas; advise the relevant authorities if it has, or if it contaminates soil/vegetation.

PERSONAL PRECAUTIONS: See Section 8

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7. HANDLING AND STORAGE

HANDLING: Keep product away from high energy ignition sources, heat, sparks, pilot lights, static electricity, and open flame. Harmful in contact with or if absorbed through the skin. Avoid inhalation of vapors or mists. Use in well ventilated area away from all ignition sources. Do not fill container in or on a vehicle. Static electricity may ignite vapors and cause fire. Place container on ground when filling and keep nozzle in contact with container. See Section 8 for additional personal protection advice when handling this product.

STORAGE: Store in a cool area. Small containers of approved design, properly sealed and labeled, should be stored in well ventilated surroundings and kept out of reach of children. Eliminate all sources of ignition from the storage and handling area.

SPECIAL PRECAUTIONS: To prevent and minimize fire or explosion risk from static accumulation and discharge, effectively bond and/or ground product transfer system. Do not use electronic devices (including but not limited to cellular phones, computers, calculators, pagers, etc.) in or around any fueling operation or

storage area unless the devices are certified intrinsically safe by an approved national testing agency and to the safety standards required by national and/or local laws and regulations. Electrical equipment and fittings must comply with local fire prevention regulations for this class of product. Use the correct grounding procedures. Refer to national or local regulations covering safety at petroleum handling and storage areas for this product.

EMPTY CONTAINER WARNING: Empty containers retain residue (liquid and/or vapor) and can be dangerous. DO NOT PRESSURIZE, CUT, WELD, BRAZE, SOLDER, DRILL, GRIND OR EXPOSE SUCH CONTAINERS TO HEAT, FLAME, SPARKS, STATIC ELECTRICITY, OR OTHER SOURCES OF IGNITION; THEY MAY EXPLODE AND CAUSE INJURY OR DEATH. Do not attempt to refill or clean container since residue is difficult to remove. Empty drums should be completely drained, properly bunged and promptly returned to a drum reconditioner. All containers should be disposed of in an environmentally safe manner and in accordance with governmental regulations.

8. EXPOSURE CONTROLS/PERSONAL PROTECTION

OCCUPATIONAL EXPOSURE LIMITS:

ExxonMobil recommends an 8-hour time-weighted average (TWA) exposure of 500 mg/m3 total vapor (approx. 100 ppm) or 5 mg/m3 stable aerosols.

Substance Name (CAS-No.)	Source	TWA ppm	TWA mg/m3	STEL ppm	STEL mg/m3	NOTE
KEROSENE (8008-20-6)						
as Petroleum Distillate	OSHA	400	1600			
Total HC Vapor Skin	ACGIH		200			
NAPHTHALENE (91-20-3)						
	OSHA	10	50	15	75	
	ACGIH	10	52	15	79	
ETHYL BENZENE (100-41-4)						
	OSHA	100	435	125	545	
	ACGIH	100	434	125	543	

NOTE: Limits shown for guidance only. Follow applicable regulations.

VENTILATION: Use in well ventilated area with local exhaust ventilation. Ventilation equipment must be explosion proof.

RESPIRATORY PROTECTION: Use supplied-air respiratory protection in confined or enclosed spaces, if needed.

EYE PROTECTION: If splash with liquid is possible, chemical type goggles should be worn.

SKIN PROTECTION: Impervious gloves should be worn. Good personal hygiene practices should always be followed.

9. PHYSICAL AND CHEMICAL PROPERTIES

Typical physical properties are given below. Consult Product Data Sheet for specific details.

APPEARANCE: Liquid
COLOR: Colorless to Pale Straw
ODOR: Mild
ODOR THRESHOLD-ppm: NE
pH: NA
BOILING POINT C(F): > 93(200)
MELTING POINT C(F): NA
FLASH POINT C(F): > 38(100) (ASTM D-93)
FLAMMABILITY (solids): NE
AUTO FLAMMABILITY C(F): 250(482)
EXPLOSIVE PROPERTIES: NA
OXIDIZING PROPERTIES: NA
VAPOR PRESSURE-mmHg 20 C: < 1.0
VAPOR DENSITY: NE
EVAPORATION RATE: NE
RELATIVE DENSITY, 15/4 C: 0.775-0.83
SOLUBILITY IN WATER: Negligible
PARTITION COEFFICIENT: > 3.5
VISCOSITY AT 40 C, cSt: 1.1
VISCOSITY AT 100 C, cSt: NE
POUR POINT C(F): -47(-53)
FREEZING POINT C(F): NE
VOLATILE ORGANIC COMPOUND: NE
DMSO EXTRACT, IP-346 (WT.%): NA
NA=NOT APPLICABLE NE=NOT ESTABLISHED D=DECOMPOSES

FOR FURTHER TECHNICAL INFORMATION, CONTACT YOUR MARKETING REPRESENTATIVE

10. STABILITY AND REACTIVITY

STABILITY (THERMAL, LIGHT, ETC.): Stable.
CONDITIONS TO AVOID: Heat, sparks, flame and build up of static electricity.
INCOMPATIBILITY (MATERIALS TO AVOID): Halogens, strong acids, alkalies, and oxidizers.
HAZARDOUS DECOMPOSITION PRODUCTS: Product does not decompose at ambient temperatures.
HAZARDOUS POLYMERIZATION: Will not occur.

11. TOXICOLOGICAL DATA

---ACUTE TOXICOLOGY---

ORAL TOXICITY (RATS): Practically non-toxic (LD50: greater than 2000 mg/kg). ---Based on testing of similar products and/or the components.
DERMAL TOXICITY (RABBITS): Practically non-toxic (LD50: greater than 2000 mg/kg). ---Based on testing of similar products and/or the components.

INHALATION TOXICITY (RATS): Practically non-toxic (LC50: greater than 5 mg/l). ---Based on testing of similar products and/or the components.
EYE IRRITATION (RABBITS): Practically non-irritating. (Draize score: greater than 6 but 15 or less). ---Based on testing of similar products and/or the components.
SKIN IRRITATION (RABBITS): Irritant.

---REPRODUCTIVE TOXICOLOGY (SUMMARY)---

A review of the literature indicates that inhalation of kerosene vapors does not cause reproductive or developmental effects in laboratory animals. There is no evidence of effects on humans.

---CHRONIC TOXICOLOGY (SUMMARY)---

Certain straight-run middle distillates have been found to produce skin tumors in laboratory mouse skin-painting tests, but these have usually been associated with a high level of skin irritation. ExxonMobil has conducted tests that determined that the irritation produces the tumors. Therefore, if the precautions outlined in this MSDS are followed to minimize repeated or prolonged skin contact which could cause irritation, these oils should pose no carcinogenic hazard to humans. Prolonged repeated skin contact with low viscosity materials may defat the skin resulting in possible irritation and dermatitis. Some jet fuel has potential in mice to suppress indicators of immune system functionality. The relevance of these effects to humans is uncertain.

---OTHER TOXICOLOGY DATA---

This product contains ethylbenzene. The International Agency for Research on Cancer (IARC) has evaluated ethylbenzene and classified it as possibly carcinogenic to humans (Group 2B) based on sufficient evidence for carcinogenicity in experimental animals, but inadequate evidence for cancer in exposed humans.

---

12. ECOLOGICAL INFORMATION

ENVIRONMENTAL FATE AND EFFECTS:

In the absence of specific environmental data for this product, this assessment is based on information for representative substances.

ECOTOXICITY: Based on test results for similar products, this substance may be harmful to aquatic organisms such as fish (LL =10-100 mg/L), and toxic to algae and daphnia (EL50/IrL50 =1-10 mg/L.)

MOBILITY: Dissolution of the higher molecular weight hydrocarbon components in water will be limited, but losses through sediment adsorption may be significant.

PERSISTENCE AND DEGRADABILITY: When released into the environment, most of the constituents of kerosene fuels will volatilize and be photodegraded in the atmosphere. The less volatile, more water-soluble components which are aromatic hydrocarbons will also undergo aqueous photodegradation. The majority of the

components in this product are expected to be inherently biodegradable.

BIOACCUMULATIVE POTENTIAL: Not established.

---

13. DISPOSAL CONSIDERATIONS

WASTE DISPOSAL: Product is suitable for burning for fuel value in compliance with applicable laws and regulations and consideration of product characteristics at time of disposal.

RCRA INFORMATION: Disposal of unused product may be subject to RCRA regulations (40 CFR 261). Disposal of the used product may also be regulated due to ignitability, corrosivity, reactivity, or toxicity as determined by the Toxicity Characteristic Leaching Procedure (TCLP).

FLASH: > 38(100) C(F)

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14. TRANSPORT INFORMATION

NOTE: The flash point of this material is > 100F. Regulatory classifications vary as follows:

DOT:	Flammable Liquid OR Combustible Liquid - (49CFR 173.120(b)(2))
OSHA:	Combustible Liquid
IATA/IMO:	Flammable Liquid

USA DOT:

SHIPPING NAME:	Fuel, Aviation, Turbine Engine
HAZARD CLASS & DIV:	COMBUSTIBLE LIQUID
ID NUMBER:	UN1863
ERG NUMBER:	128
PACKING GROUP:	PG III
STCC:	NE
DANGEROUS WHEN WET:	No
POISON:	No
LABEL(s):	NA
PLACARD(s):	Combustible
PRODUCT RQ:	NA
MARPOL III STATUS:	NA

RID/ADR:

HAZARD CLASS:	3
PACKING GROUP:	III
LABEL:	3
DANGER NUMBER:	30
UN NUMBER:	1863
SHIPPING NAME:	Fuel, Aviation, Turbine Engine
REMARKS:	NA

IMO:

HAZARD CLASS & DIV:	3
UN NUMBER:	1863
PACKING GROUP:	PG III

SHIPPING NAME:	Fuel, Aviation, Turbine Engine
LABEL(s):	Flammable Liquid
MARPOL III STATUS:	NA

ICAO/IATA:

HAZARD CLASS & DIV:	3
ID/UN Number:	1863
PACKING GROUP:	PG III
SHIPPING NAME:	Fuel, Aviation, Turbine Engine
SUBSIDIARY RISK:	NA
LABEL(s):	Flammable Liquid

STATIC ACCUMULATOR (50 picosiemens or less): YES

---

15. REGULATORY INFORMATION

US OSHA HAZARD COMMUNICATION STANDARD: Product assessed in accordance with OSHA 29 CFR 1910.1200 and determined to be hazardous.

EU Labeling: Product is dangerous as defined by the European Union Dangerous Substances/Preparations Directives.

Symbol: Xn N Harmful, Dangerous for the environment.

Risk Phrase(s): R10-65-38-67-51/53.
Flammable. Harmful: may cause lung damage if swallowed. Irritating to skin. Vapors may cause drowsiness and dizziness. Toxic to aquatic organisms, may cause long-term adverse effects in the aquatic environment.

Safety Phrase(s): S16-43-24-62.
Keep away from sources of ignition - No smoking. In case of fire use foam/drypowder/CO2. Avoid contact with skin. If swallowed, do not induce vomiting: seek medical advice immediately and show this container or label.

Contains: Aviation Jet Fuel.

Governmental Inventory Status: All components comply with TSCA, EINECS/ELINCS, AICS, METI, DSL, KOREA, and PHILIPPINES.

U.S. Superfund Amendments and Reauthorization Act (SARA) Title III:
This product contains no "EXTREMELY HAZARDOUS SUBSTANCES".

SARA (311/312) REPORTABLE HAZARD CATEGORIES:
FIRE CHRONIC ACUTE

This product contains the following SARA (313) Toxic Release Chemicals:

CHEMICAL NAME	CAS NUMBER	CONC.
ETHYL BENZENE(COMPONENT ANALYSIS)	100-41-4	0.5%

The following product ingredients are cited on the lists below:

CHEMICAL NAME	CAS NUMBER	LIST CITATIONS *
NAPHTHALENE (COMPONENT ANALYSIS) (0.80%)	91-20-3	16, 22
ETHYL BENZENE (COMPONENT ANALYSIS)	100-41-4	1, 8, 24
KEROSENE	8008-20-6	19, 21, 25, 26

--- REGULATORY LISTS SEARCHED ---

1=ACGIH ALL	6=IARC 1	11=TSCA 4	16=CA P65 CARC	21=LA RTK
2=ACGIH A1	7=IARC 2A	12=TSCA 5a2	17=CA P65 REPRO	22=MI 293
3=ACGIH A2	8=IARC 2B	13=TSCA 5e	18=CA RTK	23=MN RTK
4=NTP CARC	9=OSHA CARC	14=TSCA 6	19=FL RTK	24=NJ RTK
5=NTP SUS	10=OSHA Z	15=TSCA 12b	20=IL RTK	25=PA RTK
				26=RI RTK

* EPA recently added new chemical substances to its TSCA Section 4 test rules. Please contact the supplier to confirm whether the ingredients in this product currently appear on a TSCA 4 or TSCA 12b list.
Code key:CARC=Carcinogen; SUS=Suspected Carcinogen; REPRO=Reproductive

16. OTHER INFORMATION

USE: AVIATION FUEL

NOTE: PRODUCTS OF EXXON MOBIL CORPORATION AND ITS AFFILIATED COMPANIES ARE NOT FORMULATED TO CONTAIN PCBS.

Health studies have shown that many hydrocarbons pose potential human health risks which may vary from person to person. Information provided on this MSDS reflects intended use. This product should not be used for other applications. In any case, the following advice should be considered:

INJECTION INJURY WARNING: If product is injected into or under the skin, or into any part of the body, regardless of the appearance of the wound or its size, the individual should be evaluated immediately by a physician as a surgical emergency. Even though initial symptoms from high pressure injection may be minimal or absent, early surgical treatment within the first few hours may significantly reduce the ultimate extent of injury.

Precautionary Label Text:

CONTAINS KEROSENE

CAUTION!

COMBUSTIBLE LIQUID AND VAPOR. CAUSES SKIN IRRITATION. MAY CAUSE NOSE, THROAT AND LUNG IRRITATION, DIZZINESS, NAUSEA, LOSS OF CONSCIOUSNESS. LOW VISCOSITY MATERIAL-IF SWALLOWED, MAY BE ASPIRATED AND CAN CAUSE SERIOUS OR FATAL LUNG DAMAGE.

Keep away from heat, sparks, and flame. Avoid breathing vapor. Avoid contact with skin or clothing. Keep container closed. Use with adequate ventilation.

In case of contact, wash skin with soap and water. Remove contaminated clothing. Destroy or wash clothing before reuse. If swallowed, seek immediate medical attention. Do not induce vomiting. Only induce vomiting at the instruction of a physician.

For industrial use only. Not intended or suitable for use in or around a household or dwelling.

This warning is given to comply with California Health and Safety Code 25249.6 and does not constitute an admission or a waiver of rights. Chemicals known to the State of California to cause cancer, birth defects, or other reproductive harm are created by the combustion of this product. Refer to product Material Safety Data Sheet for further safety and health information.

****
For Internal Use Only: MHC: 1* 1* 1* 1* 2, MPPEC: C, TRN: 123059-00,
ELIS: 012305, CMCS97: 978653, REQ: MIAMI, SAFE USE: C
EHS Approval Date: 14OCT2003
****

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Prepared by: ExxonMobil Oil Corporation
Environmental Health and Safety Department, Clinton, USA

MATERIAL SAFETY DATA SHEET

SECTION 1 - PRODUCT AND COMPANY IDENTIFICATION

PRODUCT NAME: Diesel Fuel; SYNONYMS: Diesel Fuel #1 - LS Dyed; Diesel Fuel #2 - DSL2, Off-Road, On-Road, HS-Dyed, LS-Dyed, LS-Undyed, LS Diesel; Winter Blend; Fuel Oil #2 - Diesel Fuel Oil, No. 2 Diesel Fuel Oil, Non-Hwy Dyed; Diesel Fuel - Premium, Super, Supreme, Powerblend, Non-Taxed LS Dyed; Additized; Russian Summer; Arctic; -10 and -35 F pour point depressed diesel; Lago; Burner Oil; Aleyska Turbine Fuel; Distillate - Mid; No. 2; Marine - Marine Gas Oil, MGO, DFM; Navy Fuel; F76; Marine Diesel Fuel (MDO); Intermediate Marine Fuel IF-30 to IF-460; IMF; RR Diesel Fuel - No. 40, No. 35, RR Power Fuel HS Off-Road; CARB Diesel Fuel - On-Road, Off-Road, Tax Exempt Blends, TF3, 10%; EPA - LS Diesel Fuel Dyed, Undyed, Off-Road HS Dyed - Ultra Low Sulfur Diesel

GENERAL USE: Fuel

PRODUCT DESCRIPTION: Liquid. Color varies, clear, yellow (pale to straw), red, blue, blue-green color. Petroleum odor.

MANUFACTURER'S NAME Tesoro Petroleum Companies, Inc.	DATE PREPARED: September 16, 2004 SUPERSEDES: May 23, 2002	Page 1 of 5
ADDRESS (NUMBER, STREET, P.O. BOX) 300 Concord Plaza Drive	TELEPHONE NUMBER FOR INFORMATION Tesoro Call Center (877) 783-7676	
(CITY, STATE AND ZIP CODE) COUNTRY San Antonio, TX 78216-6999 USA	EMERGENCY TELEPHONE NUMBER Chemtrec (800) 424-9300	
DISTRIBUTOR'S NAME Same		
ADDRESS (NUMBER, STREET, P.O. BOX)	TELEPHONE NUMBER FOR INFORMATION	
(CITY, STATE AND ZIP CODE) COUNTRY	EMERGENCY TELEPHONE NUMBER	

SECTION 2 - HAZARDOUS INGREDIENTS

HAZARDOUS COMPONENTS	CAS #	% (by volume)	OSHA PEL PPM	OSHA PEL MG/M3	ACGIH TWA PPM	ACGIH TWA MG/M3	SARA TITLE III	RQ LBS
Contains or May Contain:								
Diesel Fuel #2	68476-34-6	0 - 100	not established					
Fuel Oil #2	68476-30-2	0 - 100	not established					
Tower Residues, atmospheric	64741-45-3	0 - 100	not established					
Residues (petroleum), Vacuum	64741-56-6	0 - 100	not established					
Heavy catalytically cracked distillate (e,f,g)	64741-61-3	0 - 100		0.2		0.2		
Light thermally cracked distillate (h)	64741-59-9	0 - 100	not established					
Catalytically cracked clarified oil (e,g)	64741-62-4	0 - 100		0.2		0.2		
Xylene (mixed) (a,b,c)	1330-20-7	0 - 1.1	100	435	100		Yes	1000
Trimethylbenzene 1,2,4 (a)	95-63-6	0 - 1.2	25	125			Yes	
Nonane	111-84-2	0 - 1.1	200	1050	200			
Sulfur, precipitated	7704-34-9	0 - 5.0		15				
Naphthalene (a,b,c,d)	91-20-3	0 - 1	10	50	10		Yes	100
Red Dye	not specified	Trace						

(a,c) See Section 15

(b) Indicates that the Resource Conservation and Recovery Act (RCRA) has determined the waste for this chemical is listed as hazardous and must be handled according to regulations in 40 CFR 260-281.

(d) Product is listed or defined as a marine pollutant in IMDG Code or 49 CFR 172.101 Appendix B, List of Marine Pollutants and must be classified as an Environmentally Hazardous Substance, Class 9, in addition to any other defined hazards for this product.

(e) California Prop 65, Safe Drinking Water and Toxic Enforcement Act of 1986, chemicals known to the state to cause cancer or reproductive toxicity. A person in the course of doing business must warn others who may consume, come into contact with, or otherwise be exposed to this chemical.

(f) IARC has determined that residual fuels are possibly carcinogenic to humans. Handling procedures and safety precautions in the MSDS should be followed to minimize employee's exposure.

(g) IARC has determined there is sufficient evidence for the carcinogenicity of catalytically cracked oils.

(h) Kidney damage may result following aspiration pneumonitis. The results of animal bioassays on middle distillate fuels show that prolonged dermal contact produces a weak to moderate carcinogenic activity.

SECTION 3 - HAZARDS IDENTIFICATION

EMERGENCY OVERVIEW

Various colored liquid, potentially hazardous vapors. Flammable as defined by DOT and TDG. May be classified by DOT as Combustible. Classified as Combustible by OSHA. Can cause eye and skin irritation upon contact. Inhalation of vapors can cause anesthetic effect leading to death in poorly ventilated areas. Hazard symbols for this product - Xn Risk Phrases - R10 20 36/38

POTENTIAL HEALTH EFFECTS

INHALATION: High concentrations are irritating to the respiratory tract; may cause headache, dizziness, nausea, vomiting and malaise.

SKIN: Brief contact may cause slight irritation; prolonged contact may cause moderate irritation or dermatitis.

EYES: High vapor concentration or contact may cause irritation and discomfort.

INGESTION: May result in vomiting; aspiration of vomitus into the lungs must be avoided; DO NOT induce vomiting. Minute amounts aspirated into the lungs can produce severe lung injury, chemical pneumonitis, pulmonary edema or death.

CARCINOGENICITY NTP? No IARC MONOGRAPHS? No OSHA REGULATED? No

This product contains a mixture of petroleum hydrocarbons called middle distillates. Because of this broad description, many products are considered middle distillates yet they are produced by a variety of different petroleum refining processes. Toxicology data developed on some middle distillates found that they caused positive responses in some mutagenicity tests and caused skin cancer when repeatedly applied to mice over their lifetime.

SECTION 4 - FIRST AID MEASURES

INHALATION: Remove affected person to fresh air; provide oxygen if breathing is difficult; if affected person is not breathing, administer CPR and seek emergency medical attention.

SKIN: Remove contaminated clothing; wash affected area with soap and water; launder contaminated clothing before reuse; if irritation persists, seek medical attention.

EYES: Remove contact lenses. Flush eyes with clear running water for 15 minutes while holding eyelids open; if irritation persists, seek medical attention.

INGESTION: DO NOT induce vomiting; if vomiting occurs spontaneously, keep head below hips to prevent aspiration of liquid into lungs; seek immediate medical attention. Vomiting may be induced only under the supervision of a physician.

SECTION 5 - FIRE FIGHTING MEASURES

FLASH POINT (METHOD USED)	FLAMMABLE LIMITS LEL: 0.3%	UEL: 10.0%
100° - 199° F (38° - 93° C) TCC	AUTOIGNITION TEMPERATURE: 350° - 625° F	NFPA CLASS: II

GENERAL HAZARDS: Product is considered combustible. Products of combustion include compounds of carbon, hydrogen and oxygen, including carbon monoxide.

EXTINGUISHING MEDIA

Carbon dioxide, water fog, dry chemical, chemical foam

FIRE FIGHTING PROCEDURES

Firefighters must wear full facepiece self - contained breathing apparatus in positive pressure mode. Do not use solid stream of water since stream will scatter and spread fire. Fine water spray can be used to keep fire - exposed containers cool.

UNUSUAL FIRE AND EXPLOSION HAZARDS

Closed containers can explode due to buildup of pressure when exposed to extreme heat. Do not use direct stream of water on pool fires as product may reignite on water surface. Caution - Material is combustible!

HAZARDOUS COMBUSTION PRODUCTS

Smoke, fumes, oxides of carbon

SECTION 6 - ENVIRONMENTAL RELEASE MEASURES

STEPS TO BE TAKEN IN CASE MATERIAL IS RELEASED OR SPILLED: COMBUSTIBLE. Evacuate and ventilate area; confine and absorb into absorbent; place material into approved containers for disposal; for spills in excess of allowable limits (RQ) notify the National Response Center (800) 424 - 8802; refer to CERCLA 40 CFR 302 and SARA Title III, Section 313 40 CFR 372 for detailed instructions concerning reporting requirements. Do not discharge into lakes, ponds, streams or public waters.

SECTION 7 - HANDLING AND STORAGE

PRECAUTIONS TO BE TAKEN IN HANDLING AND STORAGE: This material is combustible. It should be stored in tightly closed containers in a cool, well ventilated area. Vapor may form explosive mixtures in air. All sources of ignition should be controlled. This material may be classified as COMBUSTIBLE by DOT unless transported by vessel or aircraft. Refer to 49 CFR 173.120. Keep this and other chemicals out of reach of children. Avoid inhaling concentrated fumes or vapors.

SECTION 8 - EXPOSURE CONTROLS / PERSONAL PROTECTION

ENGINEERING CONTROLS

The use of local exhaust ventilation is recommended to control emissions near the source. Provide mechanical ventilation of confined spaces. Use explosion-proof ventilation equipment. See Section 2 for Component Exposure Guidelines.

PERSONAL PROTECTION:

RESPIRATORY PROTECTION (SPECIFY TYPE): None required while threshold limits (Section 2) are kept below maximum allowable concentrations; if TWA exceeds limits, NIOSH approved respirator must be worn. Refer to 29 CFR 1910.134 or European Standard EN 149 for complete regulations.

PROTECTIVE GLOVES: Neoprene or rubber gloves with cuffs.

EYE PROTECTION: Protective eyeglasses or chemical safety goggles. Refer to 29 CFR 1910.133 or European Standard EN166.

OTHER PROTECTIVE CLOTHING OR EQUIPMENT: Safety eyebath nearby

WORK / HYGIENIC PRACTICES: Practice safe workplace habits. Minimize body contact with this, as well as all chemicals in general.

SECTION 9 - PHYSICAL AND CHEMICAL PROPERTIES

VAPOR PRESSURE (PSIA) < 0.5 PSIA @ 100° F	VAPOR DENSITY (AIR = 1) > 1
SPECIFIC GRAVITY @ 60° F (WATER = 1) 0.78 - 0.955	EVAPORATION RATE (WATER = 1) < 1
SOLUBILITY IN WATER Negligible, below 1.0%	FREEZING POINT - 51° F (- 46° C)
pH Not determined	APPEARANCE AND ODOR Liquid, clear, yellow (pale to straw), red, blue, blue-green, petroleum odor.
BOILING RANGE 30 - 806° F (1.1 - 430° C)	PHYSICAL STATE Liquid
VISCOSITY 1.7 - 40.0 cS @ 100°F	VOLATILE ORGANIC COMPOUNDS (Total VOC's) 6.75 lbs / gallon

SECTION 10 - STABILITY AND REACTIVITY

STABILITY UNSTABLE: STABLE: XXX	CONDITIONS TO AVOID: Extreme temperatures, open flames

INCOMPATIBILITY (MATERIALS TO AVOID): Strong oxidizers, strong acids

HAZARDOUS DECOMPOSITION OR BYPRODUCTS: Decomposition will not occur if handled and stored properly. In case of a fire, oxides of carbon, hydrocarbons, fumes, and smoke may be produced.

HAZARDOUS POLYMERIZATION MAY OCCUR: WILL NOT OCCUR: XXX	CONDITIONS TO AVOID: None

SECTION 11 - TOXICOLOGICAL INFORMATION

Hazardous Ingredients (All products may not be listed if information is not available)	CAS #	EINECS #	LD50 of Ingredient (Species and Route)	LC50 of Ingredient (Species)
Contains or May Contain:				
Diesel Fuel #2	68476-34-6	270-676-1	Not established	Not established
Fuel Oil #2	68476-30-2	270-671-4	Not determined	Not determined
Tower Residues, atmospheric	64741-45-3	265-045-2	Not established	Not established
Residues (petroleum), Vacuum	64741-56-6	265-057-8	Not established	Not established
Heavy catalytically cracked distillate (e,f,g)	64741-61-3	265-063-0	Not established	Not established
Light thermally cracked distillate (h)	64741-59-9	265-060-4	Not established	Not established
Catalytically cracked clarified oil (e,g)	64741-62-4	265-064-6	Not established	Not established
Xylene (mixed) (a,b,c)	1330-20-7	215-535-7	4300 mg / kg Oral - rat	5000 ppm / 4H Inhalation - rat
Trimethylbenzene 1,2,4 (a)	95-63-6	202-436-9	5 gm / kg Oral - mouse	18 gm / m3 / 4H Inhalation - rat
Nonane	111-84-2	203-913-4	218 mg / kg Oral - mouse	3200 ppm / 4H Inhalation - rat
Sulfur, precipitated	7704-34-9	231-722-6	Not available	Not available
Naphthalene (a,b,c,d)	91-20-3	202-049-5	1780 mg / kg Oral - rat	Not established
Red Dye	not specified	not specified	Not determined	Not determined

SECTION 12 - ECOLOGICAL INFORMATION

No data are available on the adverse effects of this material on the environment. Neither COD nor BOD data are available. Release of this product should be prevented from contaminating soil and water and from entering drainage and sewer systems. U.S.A. regulations require reporting spills of this material that could reach any surface waters. The toll free number for the U.S. Coast Guard National Response Center is (800) 424-8802. Naphthalene (91-20-3) one of the ingredients in this mixture is classified as a Marine Pollutant.

SECTION 13 - DISPOSAL CONSIDERATIONS

WASTE DISPOSAL METHOD: Dispose of in accordance with Local, State, and Federal Regulations. This product may produce hazardous vapors or fumes in a closed disposal container creating a dangerous environment. Refer to "40 CFR Protection of Environment Parts 260 - 299" for complete waste disposal regulations. Consult your local, state, or Federal Environmental Protection Agency before disposing of any chemicals. Do not flush to sanitary sewer or waterway.

SECTION 14 - TRANSPORT INFORMATION

PROPER SHIPPING NAME: Diesel Fuel

DOT HAZARD CLASS / Pack Group: 3 / III
REFERENCE: 49 CFR 173.150, .203, .242
UN / NA IDENTIFICATION NUMBER: NA 1993
LABEL: Flammable
HAZARD SYMBOLS: F

IATA HAZARD CLASS / Pack Group: Not applicable
IMDG HAZARD CLASS: Not applicable
RID/ADR Dangerous Goods Code: Not applicable
UN TDG Class / Pack Group: Not applicable

Note: Transportation information provided is for reference only. Client is urged to consult CFR 49 parts 100 - 177, IMDG, IATA, EC, United Nations TDG, and WHMIS (Canada) TDG information manuals for detailed regulations and exceptions covering specific container sizes, packaging materials and methods of shipping.

SECTION 15 - REGULATORY INFORMATION

TSCA (Toxic substance Control Act)

All components of this product are listed on the U.S. Toxic Substances Control Act Chemical Inventory (TSCA Inventory) or are exempted from listing because a Low Volume Exemption has been granted in accordance with 40 CFR 723.50.

SARA TITLE III (Superfund Amendments and Reauthorization Act)

311/312 Hazard Categories

Acute health, flammable

313 Reportable Ingredients:

(a) A "Yes" in the SARA TITLE III column in Section 2 indicates a toxic chemical subject to annual reporting requirements of Section 313 of the Emergency Planning and Community Right-To-Know Act of 1986 and of 40 CFR 372.

CERCLA (Comprehensive Response Compensation and Liability Act)

(c) The Comprehensive Environmental Response, Compensation, and Liability Act (CERCLA) has notification requirements for releases or spills to the environment of the Reportable Quantity (RQ for this mixture > 24,000 lbs) or greater amounts, according to 40 CFR 302.

CPR (Canadian Controlled Products Regulations)

This product has been classified in accordance with the hazard criteria of the Controlled Products Regulations and the MSDS contains all the information required by the Controlled Products Regulations.

IDL (Canadian Ingredient Disclosure List)

Components of this product identified by CAS number are listed on the Canadian Ingredient Disclosure List are shown in Section 2.

DSL / NDSL (Canadian Domestic Substances List / Non-Domestic Substances List)

Components of this product identified by CAS number are listed on the DSL or NDSL and may or may not be listed in Section 2 of this document. Only ingredients classified as "hazardous" are listed in Section 2 unless otherwise indicated.

EINECS (European Inventory of Existing Commercial Chemical Substances)

Components of this product identified by CAS numbers are on the European Inventory of Existing Commercial Chemical Substances.

EC Risk Phrases	SYMBOL(S) REQUIRED FOR LABEL	EC Safety Phrases
R10 Flammable R20 Harmful by inhalation R36/38 Irritating to eyes and skin. R51 Toxic to aquatic organisms. R65 Damaging to lungs when swallowed	Harmful	S23 Do not breathe vapor S25 Avoid contact with eyes S28 After contact with skin, wash immediately with plenty of soap and water. S29 Do not empty into drains S62 If swallowed, do not induce vomiting; seek medical advice immediately and show this label.

SECTION 16 - OTHER INFORMATION

Values do not reflect absolute minimums and maximums; these values are typical which may vary from time to time.

HMIS HAZARD RATINGS				
	HEALTH	1	0 = INSIGNIFICANT	3 = HIGH
	FLAMMABILITY	2	1 = SLIGHT	4 = EXTREME
	PHYSICAL HAZARD	0	2 = MODERATE	
	PERSONAL PROTECTIVE EQUIPMENT	B	Safety Glasses, Gloves	

REVISION SUMMARY:

This MSDS has been revised in the following sections: Section 1, add name; Section 3, Hazard Symbols; Section 11, add EINECS #; Section 15, TSCA text, add symbol; Section 16, HMIS Text

MSDS Prepared by: Chem-Tel, Inc.
1305 N. Florida Ave.
Tampa, Florida USA 33602
(800) 255-3924 Outside USA (813) 248-0573

DISCLAIMER: The information supplied in this data sheet is obtained from currently available sources, which are believed to be reliable. HOWEVER, THE INFORMATION IS PROVIDED WITHOUT ANY WARRANTY, EXPRESSED OR IMPLIED, REGARDING THE ACCURACY OF THE INFORMATION OR THE RESULTS TO BE OBTAINED FROM ITS USE.
Handling, storage, use or disposal of the above-referenced product is beyond our control and may occur under conditions with which we are unfamiliar. FOR THESE AND OTHER REASONS, WE DO NOT ASSUME RESPONSIBILITY AND EXPRESSLY DISCLAIM ANY LIABILITY FOR DAMAGE, INJURY AND COST ARISING FROM OR RELATED TO THE USE OF THE PRODUCT.

PRODUCT NUMBER (s): BHPP-1052, BHPP-1054, MSDS-1054, 2, 3, 27, 28, 29, 30, 31, 32, 33, 34, 35, 36, 37, 39, 46, 75, 88, 89, 90, 94, 97, 98, 99, 100, 101, 102, 103, 104, 105, 106, 108, 109, 111, 116, 117, 118, 282, 290, 291, 294, 304, 319, 351, 352, 1000, 1001, 1071,1076

MATERIAL SAFETY DATA SHEET

Manufacturer:	Schaeffer Mfg. Company	**Emergency Response Number:**
Address:	102 Barton Street	**314-865-4105 (24hr emergency number) or**
Address	St. Louis, MO 63104	**800-325-9962**

SECTION 1 – PRODUCT INFORMATION

Chemical Family: Petroleum Hydrocarbons | **Trade Name:** **#137B Diesel Treat 2000**

Formula: Proprietary Mixture.

SECTION 2 – HAZARDOUS INGREDIENTS

COMPONENTS-CHEMICAL NAMES AND COMMON NAMES	CAS Number	%	Exposure Limits			
			TVL		PEL	
			ppm	mg/m^3	ppm	mg/m^3
Heavy Aromatic Naphtha	64742-95-6	2.8-4.2			50	
1,2,4-Trimethylbenzene	95-63-6	2.46	25		25	
Aromatic Solvent Naphtha	64742-94-5	14-15	100			
Heavy Aromatic Distillate	64742-48-9	38-40	NE		NE	
Avetic Acid Ethynel Ester	24937-78-8	14-15	NE		NE	
2-Butoxyethanol	111-76-2	7-9	25	121	50	240
Benzene	71-43-6	0.039	10	32	10	
Diethylene Glycol Monoethyl Ether	111-77-3	0.425	NE			
Tall Oil Fatty Acids	61790-12-3	3-4	NE			
Cumene	98-82-6	0.154	50	246	50	246
Ethylbenzene	100-41-4	3-4	100	434	100	435
2-Ethylhexyl Nitrate	27247-96-7	4-6	8			
Amines, polyethylene poly-reaction products with succinic anhydride isobutylene derivatives	84605-20-9	9-12	NE		NE	
Xylene	1330-20-7	2-3	100	434	100	
Naphthalene	91-20-3	0.1521	100	434	100	435

Section 3 – PHYSICAL DATA

Boiling Point:	300°F/148.8°C	**Specific Gravity:**	.8641
Vapor Pressure (mm, Hg):	Not Determined	**% Volatile:**	>75%
Vapor Density (Air = 1):	Not Determined	**Evaporation Rate: (=1)**	Not Determined
Solubility in Water:	Negligible	**pH:**	Not Applicable

Appearance and Odor: Tan Color, aromatic odor.

SECTION 4 – FIRE AND EXPLOSION HAZARD DATA

Flash Point (Method) °F/°C: 129°F/54°C PMCC | **Flammability Limits UEL & LEL** ----Not Determined

Extinguishing Media: Carbon dioxide foam, dry chemical foam, sand, earth, waterfog.

Special Fire Fighting Procedures: For fires involving this material, do not enter any enclosed or confined space without protective equipment including self-contained breathing apparatus. Cool exposed containers with waterspray. Avoid breathing fumes.

Unusual Fire & Explosion Hazards: Toxic fumes, gases or vapors may evolve on burning. Vapors may be heavier than air and may travel along the ground to distant ignition source and flash back. Container may rupture on heating. The 2 Ethylhexyl Nitrate contained in this product may undergo a self accelerating exothermic reaction if heated above 212°F (100°C).

SECTION 5 - REACTIVITY HAZARD DATA

STABILITY [**X**] STABLE [ ]UNSTABLE | **Hazardous Decomposition** [ ] WILL [**X**] WILL NOT OCCUR

Conditions to Avoid: High heat, high energy ignition sources

Incompatibility (Mat. to avoid): Strong oxidizing agents, amines, phenols, halogen compounds.

Hazardous Decomposition Products: Oxides of carbon and nitrogen.

Conditions to Avoid: None.

SECTION 6 - HEALTH HAZARD DATA

Threshold Limit Value and Sources: None established.

Acute Effects of Overexposure:

Ingestion: Irritation of the gastrointestinal lining, nausea, vomiting, diarrhea and abdominal pain. This material if ingested can directly enter the lungs or if subsequently swallowed. Once in the lungs it is very difficult to remove and can cause severe injury or death.

Eye Contact: Liquid contact produces irritation and redness to the eyes.

Skin Contact: Prolonged and repeated contact with the skin can cause redness or severe irritation.

Inhalation: Inhalation of vapors can cause headache, dizziness, nausea, or decreased blood pressure.

CHRONIC EFFECTS OF OVEREXPOSURE: Repeated overexposure may cause destruction of red blood cells with anemia, fever, jaundice and kidney and liver damage.

Emergency and First Aid Procedures:

Swallowing: If a large amount of this material is swallowed give a large amount of water to drink. Do not induce vomiting. Seek medical attention immediately.

Skin: Wash skin thoroughly with soap and water. Launder contaminated clothing.

Inhalation: Remove victim to fresh air. If breathing is labored, administer oxygen. If breathing has stopped start artificial respiration immediately.

Eyes: Flush eyes with clear, cool, clean water for 15 minutes. Seek medical attention immediately

Date Prepared: 10/13/04 **OF-1049 Rev. (1999)**

SECTION 7 – SPILL OR LEAK PROCEDURES
Environmental Impact: This material is not expected to present any environmental problems other than those associated with oil spills. If spilled into a watercourse, call the Coast Guard Toll Free No. 800-424-8802.
Procedures To Be Taken If Material Is Released or Spilled: Eliminate all sources of ignition. Absorb spills with absorbent clay. Ventilate confined spaces. Keep out of sewers and watercourses.
Waste Disposal Method: Dispose of at an approved waste or disposal site facility in accordance with all applicable federal, state and local laws and regulations. This product is considered to be an RCRA hazardous waste due to the presence of Benzene CAS#71-43-2 DO18 and its flammability D001.

SECTION 8 – SPECIAL PROTECTION INFORMATION	
Respiratory Protection:	Use NIOSH/MSHA approved fullface respirator with an organic vapor cartridge if the recommended exposure limits are exceeded.
Ventilation:	Use local exhaust ventilation to control mists or vapors.
Eye Protection:	Goggles of face shield.
Protective Clothing:	Long sleeve shirt is recommended. Wear either a chemical protective suit or apron when potential for contact with material exists. Use neoprene and nitrile rubber boots when necessary to avoid contaminating shoes. Wear nitrile or neoprene gloves.

SECTION 9 – SPECIAL PRECAUTIONS
Precautions To Be Taken In Handling and Storage: Do not store near heat, spark, flame or strong oxidizers. Keep containers closed when not in use. Adequate ventilation required. Electrostatic charge may accumulate and create a hazardous condition when handling this material. To minimize this hazard, bonding and grounding may be necessary but may not, by themselves, be sufficient. Review all operations which have the potential of generating an accumulation of electrostatic charge and/or a flammable atmosphere (including tank and container filling, splash filling, tank cleaning, sampling, gauging, switch loading, filtering, mixing and vacuum truck operations) and use appropriate mitigating procedures.
Special Comments: This product is a DOT Class 3 flammable liquid. Avoid breathing vapors. Avoid prolonged or repeated skin contact. Remove contaminated shoes and clothing. Throw away shoes. Launder clothing before reuse. Wash thoroughly with soap and water after use and before eating, drinking, smoking, and using toilet facilities.

SECTION 10 – ADDITIONAL HEALTH AND TOXICOLOGICAL DATA

HMIS & NFPA Ratings: Health = 2 Fire = 2 Reactivity = 1

Contaminated clothing should be disposed of properly and/or decontaminated before reuse. Under no circumstance should vomiting be induced. Vomiting can cause aspiration of the product into the lungs. If aspirated into the lungs, chemical pneumonia, which may cause death in spite of treatment with oxygen and antibiotics, may result.

Probable mucosal damage may contraindicate the use of gastric lavage. Measures against circulatory shock, respiratory depression and convulsion may be needed.

This product contains 0.039% of Benzene which is listed as potential cancer causing agents as determined by the National Toxicology Programs Annual Reports, OSHA's Subpart Z list, the International Agency for Cancer Research's Monographs.

Proposition 65 State of California Warning: This product contains .0039% of Benzene CAS#71-43-2 which has been found by the State of California to be a potential reproductive toxin and/or cancer-causing agent.

This product is an IRC (ignitable, reactive, corrosive) substance under CERCLA. If 2,779 gallons of the material is spilled which will release 100lbs of 2-Ethylhexyl Nitrate into the environment and unless the material is cleaned up immediately for reprocessing, recycling or reuse this may trigger the reporting requirements of CERCLA Section 103.

For SARA Title III Information, see last page

The materials in this product are listed on the US TSCA Inventory and are in compliance with the Canadian Environmental Protection Act.

DOT Non Bulk Description: Flammable liquids, N.O.S., (Heavy Aromatic Naphtha,2-Butoxyethanol , Hydrotreated Heavy Naphtha),3, UN1993, PGIII

Bulk: Flammable Liquids: N.O.S., (Heavy Aromatic Naphtha,2-Butoxyethanol, Hydrotreated Heavy Naphtha),3, UN1993, PG III

SARA TITLE III INFORMATION

I. **Section 302/304 Extremely Hazardous**

Component	CAS#	%	RQ (lbs.)	RQ (gal.)*
Benzene	71-43-2	.0039	10	35,638

II. Section 102(a) CERCLA Hazardous Substance

Component	CAS#	%	RQ (lbs.)	RQ (gals.)
Cumene	98-82-6	0.154	5000	42,3621
Xylene	1330-20-7	2-3	100	6,352
Benzene	71-43-2	.0039	10	35,638
Ethylbenzene	100-41-4	3.7	1000	3,775
Naphthalene	91-20-3	0.1521	100	9,138

*Product RQ for Stationary Sources in case of spill in order to release Regulatory Requirements RQ as specified by CERCLA

III. Title Section 311 Hazardous Categorization

Acute	Chronic	Fire	Pressure	Reactivity
X	X	X	X	

IV. Section 313 Toxic Chemical

Component	CAS#	%
Xylene	1330-20-7	32-34
Benzene	71-43-2	.000385
Vinyl Acetate	108-05-4	0.14
2-Butoxyethanol	104-76-7	9-11
Ethylbenzene	100-41-4	0.91
Cumene	98-82-6	0.77
Diethylene Glycol Monoethyl Ether	111-77-3	0.425

Although the information and recommendations set forth herein (hereafter referred to as information) are presented in good faith and believed to be accurate and factual as of the date hereof, Schaeffer Mfg. Company makes no representation as to the completeness or accuracy thereof. Information is supplied upon the condition that the person receiving the same will make their own determination as to its safety and suitability for their purposes prior to use. In no event will Schaeffer Mfg. Company be responsible for damages of any natures whatsoever resulting from the use or reliance upon information. **No representation or warranty, either expressed or implied, of merchantability or fitness for a particular purpose is made with respect to information of the product to which the information refers.**

Appendix B- TAC Emissions

- TANKS Modeling
- DFSP Emissions Calculations
- ConocoPhillips Emissions Calculations

TANKS 4.0.9d
Emissions Report - Detail Format
Tank Indentification and Physical Characteristics

Identification

User Identification:	Jet Fuel USTs 1-20
City:	Los Angeles AP
State:	California
Company:	Ponte Vista
Type of Tank:	Vertical Fixed Roof Tank
Description:	Ponte Vista Development DFSP Emissions

Tank Dimensions

Shell Height (ft):	20.00
Diameter (ft):	135.00
Liquid Height (ft) :	17.63
Avg. Liquid Height (ft):	10.00
Volume (gallons):	1,887,303.74
Turnovers:	2.21
Net Throughput(gal/yr):	4,164,141.00
Is Tank Heated (y/n):	N

Paint Characteristics

Shell Color/Shade:	White/White
Shell Condition	Good
Roof Color/Shade:	White/White
Roof Condition:	Good

Roof Characteristics

Type:	Dome
Height (ft)	0.00
Radius (ft) (Dome Roof)	0.00

Breather Vent Settings

Vacuum Settings (psig):	-0.03
Pressure Settings (psig)	0.03

Meterological Data used in Emissions Calculations: Los Angeles AP, California (Avg Atmospheric Pressure = 14.67 psia)

TANKS 4.0.9d
Emissions Report - Detail Format
Liquid Contents of Storage Tank

Jet Fuel USTs 1-20 - Vertical Fixed Roof Tank
Los Angeles AP, California

Mixture/Component	Month	Daily Liquid Surf. Temperature (deg F) Avg.	Min.	Max.	Liquid Bulk Temp (deg F)	Vapor Pressure (psia) Avg.	Min.	Max.	Vapor Mol. Weight.	Liquid Mass Fract.	Vapor Mass Fract.	Mol. Weight	Basis for Vapor Pressure Calculations
Jet Fuel	All	65.10	60.53	69.67	62.97	0.0105	0.0093	0.0118	127.7021			160.47	
.Ethylene Glycol						0.0017	0.0014	0.0021	62.1000	0.0030	0.0006	62.10	Option 3: A=57476, B=9.24
Ethylbenzene						0.1293	0.1106	0.1508	106.1700	0.0050	0.0770	106.17	Option 2: A=6.975, B=1424.255, C=213.21
Jet kerosene						0.0098	0.0086	0.0109	130.0000	0.9840	0.9194	162.00	Option 1: VP60 = .0085 VP70 = .011
Naphthalene						0.0031	0.0025	0.0038	128.2000	0.0080	0.0030	128.20	Option 2: A=7.3729, B=1968.36, C=222.61

TANKS 4.0.9d
Emissions Report - Detail Format
Detail Calculations (AP-42)

Jet Fuel USTs 1-20 - Vertical Fixed Roof Tank
Los Angeles AP, California

Annual Emission Calcaulations

Standing Losses (lb):	736.2822
Vapor Space Volume (cu ft):	275,681.2279
Vapor Density (lb/cu ft):	0.0002
Vapor Space Expansion Factor:	0.0309
Vented Vapor Saturation Factor:	0.9893
Tank Vapor Space Volume:	
Vapor Space Volume (cu ft):	275,681.2279
Tank Diameter (ft):	135.0000
Vapor Space Outage (ft):	19.2597
Tank Shell Height (ft):	20.0000
Average Liquid Height (ft):	10.0000
Roof Outage (ft):	9.2597
Roof Outage (Dome Roof)	
Roof Outage (ft):	9.2597
Dome Radius (ft):	135.0000
Shell Radius (ft):	67.5000
Vapor Density	
Vapor Density (lb/cu ft):	0.0002
Vapor Molecular Weight (lb/lb-mole):	127.7021
Vapor Pressure at Daily Average Liquid Surface Temperature (psia):	0.0105
Daily Avg. Liquid Surface Temp. (deg. R):	524.7719
Daily Average Ambient Temp. (deg. F):	62.9500
Ideal Gas Constant R (psia cuft / (lb-mol-deg R)):	10.731
Liquid Bulk Temperature (deg. R):	522.6400
Tank Paint Solar Absorptance (Shell):	0.1700
Tank Paint Solar Absorptance (Roof):	0.1700
Daily Total Solar Insulation Factor (Btu/sqft day):	1,594.0000
Vapor Space Expansion Factor	
Vapor Space Expansion Factor:	0.0309
Daily Vapor Temperature Range (deg. R):	18.2794
Daily Vapor Pressure Range (psia):	0.0025
Breather Vent Press. Setting Range(psia):	0.0600
Vapor Pressure at Daily Average Liquid Surface Temperature (psia):	0.0105
Vapor Pressure at Daily Minimum Liquid Surface Temperature (psia):	0.0093
Vapor Pressure at Daily Maximum Liquid Surface Temperature (psia):	0.0118
Daily Avg. Liquid Surface Temp. (deg R):	524.7719
Daily Min. Liquid Surface Temp. (deg R):	520.2021
Daily Max. Liquid Surface Temp. (deg R):	529.3418
Daily Ambient Temp. Range (deg. R):	14.8500
Vented Vapor Saturation Factor	
Vented Vapor Saturation Factor:	0.9893
Vapor Pressure at Daily Average Liquid: Surface Temperature (psia):	0.0105
Vapor Space Outage (ft):	19.2597
Working Losses (lb):	133.5708
Vapor Molecular Weight (lb/lb-mole):	127.7021
Vapor Pressure at Daily Average Liquid Surface Temperature (psia):	0.0105
Annual Net Throughput (gal/yr.):	4,164,141.0000
Annual Turnovers:	2.2064
Turnover Factor:	1.0000
Maximum Liquid Volume (gal):	1,887,303.7427
Maximum Liquid Height (ft):	17.6259
Tank Diameter (ft):	135.0000
Working Loss Product Factor:	1.0000
Total Losses (lb):	869.8530

TANKS 4.0.9d
Emissions Report - Detail Format
Individual Tank Emission Totals

Emissions Report for: Annual

Jet Fuel USTs 1-20 - Vertical Fixed Roof Tank
Los Angeles AP, California

	Losses(lbs)		
Components	Working Loss	Breathing Loss	Total Emissions
Jet Fuel	133.57	736.28	869.85
Jet kerosene	122.81	676.94	799.75
Ethylbenzene	10.29	56.72	67.01
Naphthalene	0.39	2.18	2.57
.Ethylene Glycol	0.08	0.45	0.53

TANKS 4.0.9d
Emissions Report - Detail Format
Tank Indentification and Physical Characteristics

Identification

User Identification:	Jet Fuel USTs 42-47
City:	Los Angeles AP
State:	California
Company:	Ponte Vista
Type of Tank:	Vertical Fixed Roof Tank
Description:	Ponte Vista Development DFSP Emissions

Tank Dimensions

Shell Height (ft):	25.00
Diameter (ft):	122.50
Liquid Height (ft) :	21.41
Avg. Liquid Height (ft):	10.00
Volume (gallons):	1,887,303.74
Turnovers:	2.21
Net Throughput(gal/yr):	4,164,141.00
Is Tank Heated (y/n):	N

Paint Characteristics

Shell Color/Shade:	White/White
Shell Condition	Good
Roof Color/Shade:	White/White
Roof Condition:	Good

Roof Characteristics

Type:	Dome
Height (ft)	0.00
Radius (ft) (Dome Roof)	0.00

Breather Vent Settings

Vacuum Settings (psig):	-0.03
Pressure Settings (psig)	0.03

Meterological Data used in Emissions Calculations: Los Angeles AP, California (Avg Atmospheric Pressure = 14.67 psia)

TANKS 4.0.9d
Emissions Report - Detail Format
Liquid Contents of Storage Tank

Jet Fuel USTs 42-47 - Vertical Fixed Roof Tank
Los Angeles AP, California

Mixture/Component	Month	Daily Liquid Surf. Temperature (deg F) Avg.	Min.	Max.	Liquid Bulk Temp (deg F)	Vapor Pressure (psia) Avg.	Min.	Max.	Vapor Mol. Weight.	Liquid Mass Fract.	Vapor Mass Fract.	Mol. Weight	Basis for Vapor Pressure Calculations
Jet Fuel	All	65.10	60.53	69.67	62.97	0.0105	0.0093	0.0118	127.7021			160.47	
.Ethylene Glycol						0.0017	0.0014	0.0021	62.1000	0.0030	0.0006	62.10	Option 3: A=57476, B=9.24
Ethylbenzene						0.1293	0.1106	0.1508	106.1700	0.0050	0.0770	106.17	Option 2: A=6.975, B=1424.255, C=213.21
Jet kerosene						0.0098	0.0086	0.0109	130.0000	0.9840	0.9194	162.00	Option 1: VP60 = .0085 VP70 = .011
Naphthalene						0.0031	0.0025	0.0038	128.2000	0.0080	0.0030	128.20	Option 2: A=7.3729, B=1968.36, C=222.61

TANKS 4.0.9d
Emissions Report - Detail Format
Detail Calculations (AP-42)

Jet Fuel USTs 42-47 - Vertical Fixed Roof Tank
Los Angeles AP, California

Annual Emission Calcaulations

Standing Losses (lb):	734.9608
Vapor Space Volume (cu ft):	275,817.0898
Vapor Density (lb/cu ft):	0.0002
Vapor Space Expansion Factor:	0.0309
Vented Vapor Saturation Factor:	0.9871
Tank Vapor Space Volume:	
Vapor Space Volume (cu ft):	275,817.0898
Tank Diameter (ft):	122.5000
Vapor Space Outage (ft):	23.4023
Tank Shell Height (ft):	25.0000
Average Liquid Height (ft):	10.0000
Roof Outage (ft):	8.4023
Roof Outage (Dome Roof)	
Roof Outage (ft):	8.4023
Dome Radius (ft):	122.5000
Shell Radius (ft):	61.2500
Vapor Density	
Vapor Density (lb/cu ft):	0.0002
Vapor Molecular Weight (lb/lb-mole):	127.7021
Vapor Pressure at Daily Average Liquid Surface Temperature (psia):	0.0105
Daily Avg. Liquid Surface Temp. (deg. R):	524.7719
Daily Average Ambient Temp. (deg. F):	62.9500
Ideal Gas Constant R (psia cuft / (lb-mol-deg R)):	10.731
Liquid Bulk Temperature (deg. R):	522.6400
Tank Paint Solar Absorptance (Shell):	0.1700
Tank Paint Solar Absorptance (Roof):	0.1700
Daily Total Solar Insulation Factor (Btu/sqft day):	1,594.0000
Vapor Space Expansion Factor	
Vapor Space Expansion Factor:	0.0309
Daily Vapor Temperature Range (deg. R):	18.2794
Daily Vapor Pressure Range (psia):	0.0025
Breather Vent Press. Setting Range(psia):	0.0600
Vapor Pressure at Daily Average Liquid Surface Temperature (psia):	0.0105
Vapor Pressure at Daily Minimum Liquid Surface Temperature (psia):	0.0093
Vapor Pressure at Daily Maximum Liquid Surface Temperature (psia):	0.0118
Daily Avg. Liquid Surface Temp. (deg R):	524.7719
Daily Min. Liquid Surface Temp. (deg R):	520.2021
Daily Max. Liquid Surface Temp. (deg R):	529.3418
Daily Ambient Temp. Range (deg. R):	14.8500
Vented Vapor Saturation Factor	
Vented Vapor Saturation Factor:	0.9871
Vapor Pressure at Daily Average Liquid: Surface Temperature (psia):	0.0105
Vapor Space Outage (ft):	23.4023
Working Losses (lb):	133.5708
Vapor Molecular Weight (lb/lb-mole):	127.7021
Vapor Pressure at Daily Average Liquid Surface Temperature (psia):	0.0105
Annual Net Throughput (gal/yr.):	4,164,141.0000
Annual Turnovers:	2.2064
Turnover Factor:	1.0000
Maximum Liquid Volume (gal):	1,887,303.7427
Maximum Liquid Height (ft):	21.4066
Tank Diameter (ft):	122.5000
Working Loss Product Factor:	1.0000
Total Losses (lb):	868.5316

TANKS 4.0.9d
Emissions Report - Detail Format
Individual Tank Emission Totals

Emissions Report for: Annual

Jet Fuel USTs 42-47 - Vertical Fixed Roof Tank
Los Angeles AP, California

	Losses(lbs)		
Components	Working Loss	Breathing Loss	Total Emissions
Jet Fuel	133.57	734.96	868.53
Jet kerosene	122.81	675.73	798.53
Ethylbenzene	10.29	56.61	66.90
Naphthalene	0.39	2.17	2.57
.Ethylene Glycol	0.08	0.45	0.53

TANKS 4.0.9d
Emissions Report - Detail Format
Tank Indentification and Physical Characteristics

Identification

User Identification:	Marine Diesel Fuel F76- Tanks 48, 49, & 50
City:	Los Angeles AP
State:	California
Company:	Ponte Vista
Type of Tank:	Vertical Fixed Roof Tank
Description:	Ponte Vista Development DFSP Emissions

Tank Dimensions

Shell Height (ft):	40.00
Diameter (ft):	120.00
Liquid Height (ft) :	22.31
Avg. Liquid Height (ft):	20.00
Volume (gallons):	1,887,304.27
Turnovers:	0.07
Net Throughput(gal/yr):	135,000.00
Is Tank Heated (y/n):	N

Paint Characteristics

Shell Color/Shade:	White/White
Shell Condition	Good
Roof Color/Shade:	White/White
Roof Condition:	Good

Roof Characteristics

Type:	Dome
Height (ft)	0.00
Radius (ft) (Dome Roof)	0.00

Breather Vent Settings

Vacuum Settings (psig):	-0.03
Pressure Settings (psig)	0.03

Meterological Data used in Emissions Calculations: Los Angeles AP, California (Avg Atmospheric Pressure = 14.67 psia)

TANKS 4.0.9d
Emissions Report - Detail Format
Liquid Contents of Storage Tank

Marine Diesel Fuel F76- Tanks 48, 49, & 50 - Vertical Fixed Roof Tank
Los Angeles AP, California

Mixture/Component	Month	Daily Liquid Surf. Temperature (deg F) Avg.	Min.	Max.	Liquid Bulk Temp (deg F)	Vapor Pressure (psia) Avg.	Min.	Max.	Vapor Mol. Weight.	Liquid Mass Fract.	Vapor Mass Fract.	Mol. Weight	Basis for Vapor Pressure Calculations
Marine Diesel Fuel F76	All	65.10	60.53	69.67	62.97	0.0116	0.0101	0.0130	125.9690			159.98	
1,2,4-Trimethylbenzene						0.0250	0.0209	0.0298	120.1900	0.0120	0.0330	120.19	Option 2: A=7.04383, B=1573.267, C=208.56
Jet kerosene						0.0098	0.0086	0.0109	130.0000	0.9670	0.8333	162.00	Option 1: VP60 = .0085 VP70 = .011
Naphthalene						0.0031	0.0025	0.0038	128.2000	0.0100	0.0034	128.20	Option 2: A=7.3729, B=1968.36, C=222.61
Xylenes (mixed isomers)						0.1079	0.0921	0.1260	106.1700	0.0110	0.1304	106.17	Option 2: A=7.009, B=1462.266, C=215.11

TANKS 4.0.9d
Emissions Report - Detail Format
Detail Calculations (AP-42)

Marine Diesel Fuel F76- Tanks 48, 49, & 50 - Vertical Fixed Roof Tank
Los Angeles AP, California

Annual Emission Calcaulations

Standing Losses (lb):	916.6577
Vapor Space Volume (cu ft):	319,283.4436
Vapor Density (lb/cu ft):	0.0003
Vapor Space Expansion Factor:	0.0309
Vented Vapor Saturation Factor:	0.9830
Tank Vapor Space Volume:	
Vapor Space Volume (cu ft):	319,283.4436
Tank Diameter (ft):	120.0000
Vapor Space Outage (ft):	28.2309
Tank Shell Height (ft):	40.0000
Average Liquid Height (ft):	20.0000
Roof Outage (ft):	8.2309
Roof Outage (Dome Roof)	
Roof Outage (ft):	8.2309
Dome Radius (ft):	120.0000
Shell Radius (ft):	60.0000
Vapor Density	
Vapor Density (lb/cu ft):	0.0003
Vapor Molecular Weight (lb/lb-mole):	125.9690
Vapor Pressure at Daily Average Liquid Surface Temperature (psia):	0.0116
Daily Avg. Liquid Surface Temp. (deg. R):	524.7719
Daily Average Ambient Temp. (deg. F):	62.9500
Ideal Gas Constant R (psia cuft / (lb-mol-deg R)):	10.731
Liquid Bulk Temperature (deg. R):	522.6400
Tank Paint Solar Absorptance (Shell):	0.1700
Tank Paint Solar Absorptance (Roof):	0.1700
Daily Total Solar Insulation Factor (Btu/sqft day):	1,594.0000
Vapor Space Expansion Factor	
Vapor Space Expansion Factor:	0.0309
Daily Vapor Temperature Range (deg. R):	18.2794
Daily Vapor Pressure Range (psia):	0.0029
Breather Vent Press. Setting Range(psia):	0.0600
Vapor Pressure at Daily Average Liquid Surface Temperature (psia):	0.0116
Vapor Pressure at Daily Minimum Liquid Surface Temperature (psia):	0.0101
Vapor Pressure at Daily Maximum Liquid Surface Temperature (psia):	0.0130
Daily Avg. Liquid Surface Temp. (deg R):	524.7719
Daily Min. Liquid Surface Temp. (deg R):	520.2021
Daily Max. Liquid Surface Temp. (deg R):	529.3418
Daily Ambient Temp. Range (deg. R):	14.8500
Vented Vapor Saturation Factor	
Vented Vapor Saturation Factor:	0.9830
Vapor Pressure at Daily Average Liquid: Surface Temperature (psia):	0.0116
Vapor Space Outage (ft):	28.2309
Working Losses (lb):	4.6814
Vapor Molecular Weight (lb/lb-mole):	125.9690
Vapor Pressure at Daily Average Liquid Surface Temperature (psia):	0.0116
Annual Net Throughput (gal/yr.):	135,000.0000
Annual Turnovers:	0.0715
Turnover Factor:	1.0000
Maximum Liquid Volume (gal):	1,887,304.2703
Maximum Liquid Height (ft):	22.3078
Tank Diameter (ft):	120.0000
Working Loss Product Factor:	1.0000
Total Losses (lb):	921.3391

TANKS 4.0.9d
Emissions Report - Detail Format
Individual Tank Emission Totals

Emissions Report for: Annual

Marine Diesel Fuel F76- Tanks 48, 49, & 50 - Vertical Fixed Roof Tank
Los Angeles AP, California

	Losses(lbs)		
Components	Working Loss	Breathing Loss	Total Emissions
Marine Diesel Fuel F76	4.68	916.66	921.34
Jet kerosene	3.90	763.82	767.72
Xylenes (mixed isomers)	0.61	119.51	120.12
1,2,4-Trimethylbenzene	0.15	30.21	30.37
Naphthalene	0.02	3.12	3.14

Ponte Vista LHRA
Appendix B- DFSP TAC Emissions

Underground Storage Tanks (1-20)	CAS	lb/yr	lb/hr	Cancer	Chronic	Acute
Ethyl Benzene	100414	10.29		X	X	
Naphthalene	91203	0.39		X	X	
Ethylene glycol monomethyl ether	109864	0.08	0.00		X	X

Underground Storage Tanks (42-47)	CAS	lb/yr	lb/hr	Cancer	Chronic	Acute
Ethyl Benzene	100414	10.29		X	X	
Naphthalene	91203	0.40		X	X	
Ethylene glycol monomethyl ether	109864	0.08	0.00		X	X

Above Ground Storage Tanks (48-50)	CAS	lb/yr	lb/hr	Cancer	Chronic	Acute
Xylene	1330207	120.12	0.01		X	X
Naphthalene	91203	3.14		X	X	

Truck Idling	CAS	lb/yr	lb/hr	Cancer	Chronic	Acute
DPM	9901	6.15	0.01	X	X	

Truck DPM Emissions Data	
Max truck trips/day [1]	60
Max truck trips/hour	5
Truck trips/year [2]	3960
Truck distance traveled [1]	0.5
Emfac2007 emissions factor [3]	0.003106

[1] LHRA 2006
[2] Email from Tim Hutson, February 9, 2007.
[3] On road Heavy-Heavy Duty Diesel Trucks (33,001-60,000 lbs) for 2011.

Ponte Vista LHRA
Appendix B- ConocoPhillips TAC Emissions

Toxic Air Contaminant		Fugitive		Combustion		Health Risk/Effect		
	CAS	lb/yr	lb/hr	lb/yr	lb/hr	Cancer	Chronic	Acute
1,3-Butadiene	106990			2262.882	0.25831986	X	X	
Acetaldehyde	75070	2926.424	0.33406667			X	X	X
Acrolein	107028	732.67	0.08363813				X	X
Ammonia	7664417	192607.452	21.9871521				X	X
Arsenic	7664417			8.352	0.00095342	X	X	X
Asbestos	7440382	0.829	9.4635E-05			X		
Benzene	71432	853.959	0.0974839			X	X	X
Berylium	7440417	2.44	0.00027854			X	X	
Cadmium	7440439			11.082	0.00126507	X	X	
Carbon Tetrachloride	56235	0.228	2.6027E-05			X	X	X
Chlorine	7782505	4.909	0.00056039				X	X
Chromium (VI)	18540299			1.995	0.00022774	X	X	
Chrysene	218019			0.04	4.5662E-06	X		
Copper	7440508			88.172	0.0100653			X
DPM	9901	700.716	0.07999041			X	X	
Ethyl Benzene	100414	1530.784	0.17474703			X	X	
Ethylene glycol monobutyl ether	111762	21.678	0.00247466					X
Ethylene glycol monomethyl ether	109864	8.61	0.00098288				X	X
Ethylene Dibromide	106934	0.273	3.1164E-05			X	X	
Ethylene Dichloride	107062	0.144	1.6438E-05			X	X	
Formaldehyde	50000			2876.362	0.32835183	X	X	X
Hexane	110543	5730.624	0.65418082				X	
Hydrochloric Acid	7647010	11.513	0.00131427				X	X
Hydrogen Sulfide	7783064	2298.999	0.26244281				X	X
Lead (inorganic)	7439921			25.328	0.00289132	X		
Methyl Chloroform	71556	0.832	9.4977E-05				X	X
Metyl Tertiary Butyl Ether	1634044	1.238	0.00014132			X	X	
Manganese	7439965			468.816	0.05351781		X	
Mercury	7439976			3.957	0.00045171		X	X
Methanol	67561	28520.098	3.25571895				X	X
Methyl Ethyl Ketone	78933	862.205	0.09842523					X
Methylene Chloride	75092	0.529	6.0388E-05			X	X	X
Naphthalene	91203			552.836	0.06310913	X	X	
Nickel	7440020			123.022	0.01404361	X	X	X
PAHs	1151			14.525	0.00165811	X		
Perchloroethylene	127184	276.604	0.0315758			X	X	X
Propylene glycol monomethyl ether	107982	100.83	0.01151027				X	
Selenium	7782492			11.876	0.00135571		X	
Styrene	100425	17.737	0.00202477				X	X
Sulfuric Acid	7664939	37422.934	4.27202443				X	X

Ponte Vista LHRA
Appendix B- ConocoPhillips TAC Emissions

Toxic Air Contaminant		Fugitive		Combustion		Health Risk/Effect		
	CAS	lb/yr	lb/hr	lb/yr	lb/hr	Cancer	Chronic	Acute
Toluene	108883	5705.298	0.65128973				X	X
Trichloroethylene	79016	2537.98	0.28972374			X	X	
Vinyl Chloride	75014	0.092	1.0502E-05			X		
Xylene	1330207	7203.805	0.82235217				X	X
M-Xylene	108383	2.331	0.0002661				X	X
O-Xylene	95476	0.809	9.2352E-05				X	X

Appendix C- Dispersion & Chemical Exposure Modeling

- AERMOD Input Output
- HARP- Cancer Risk Output
- HARP- Chronic Hazard Index Output
- HARP- Acute Hazard Index Output

```
**
****************************************
**
** AERMOD Input Produced by:
** AERMOD View Ver. 7.1.0
** Lakes Environmental Software Inc.
** Date: 6/16/2011
** File: C:\Users\dwaymire\Documents\lakes\aermod view\PVHRA
\PVHRA.ADI
**
****************************************
**
**
****************************************
** AERMOD Control Pathway
****************************************
**
**
CO STARTING
   TITLEONE C:\Documents and Settings\HP_Administrator\My
Documents\Lakes\AERMOD
   MODELOPT DFAULT CONC NODRYDPLT NOWETDPLT
   AVERTIME 1 PERIOD
   URBANOPT 9862049 Urban_Group_1
   POLLUTID XOQ
   RUNORNOT RUN
CO FINISHED
**
****************************************
** AERMOD Source Pathway
****************************************
**
**
SO STARTING
** Source Location **
** Source ID - Type - X Coord. - Y Coord. **
   LOCATION STCK1        POINT      379083.000  3737607.000
75.950
** DESCRSRC Tank 1
   LOCATION STCK2        POINT      379032.000  3737472.000
75.350
** DESCRSRC Tank 2
   LOCATION STCK3        POINT      379236.000  3737636.000
69.960
** DESCRSRC Tank 3
   LOCATION STCK4        POINT      379099.000  3737330.000
67.360
** DESCRSRC Tank 4
   LOCATION STCK5        POINT      379345.000  3737477.000
73.760
** DESCRSRC Tank 5
   LOCATION STCK6        POINT      379265.000  3737279.000
```

```
66.230
** DESCRSRC Tank 6
   LOCATION STCK7        POINT      379684.000  3737474.000
62.610
** DESCRSRC Tank 7
   LOCATION STCK8        POINT      379317.000  3737152.000
60.670
** DESCRSRC Tank 8
   LOCATION STCK9        POINT      379434.000  3737331.000
63.000
** DESCRSRC Tank 9
   LOCATION STCK10       POINT      379462.000  3737106.000
51.020
** DESCRSRC Tank 10
   LOCATION STCK11       POINT      379718.000  3739682.000
13.730
** DESCRSRC Tank 11
   LOCATION STCK12       POINT      379672.000  3737303.000
61.900
** DESCRSRC Tank 12
   LOCATION STCK13       POINT      379647.000  3737158.000
57.490
** DESCRSRC Tank 13
   LOCATION STCK14       POINT      379869.000  3737471.000
49.040
** DESCRSRC Tank 14
   LOCATION STCK15       POINT      379780.000  3737243.000
55.870
** DESCRSRC Tank 15
   LOCATION STCK16       POINT      379736.000  3737020.000
44.810
** DESCRSRC Tank 16
   LOCATION STCK17       POINT      380016.000  3737292.000
44.420
** DESCRSRC Tank 17
   LOCATION STCK18       POINT      379934.000  3737165.000
46.210
** DESCRSRC Tank 18
   LOCATION STCK19       POINT      380063.000  3737094.000
38.950
** DESCRSRC Tank 19
   LOCATION STCK20       POINT      379926.000  3736942.000
43.490
** DESCRSRC Tank 20
   LOCATION STCK21       POINT      379132.000  3737788.000
76.440
** DESCRSRC Tank 42
   LOCATION STCK22       POINT      379144.000  3737866.000
75.290
** DESCRSRC Tank 43
   LOCATION STCK23       POINT      379194.000  3737808.000
74.300
```

```
** DESCRSRC Tank 44
   LOCATION STCK24       POINT      379292.000  3737850.000
63.700
** DESCRSRC Tank 45
   LOCATION STCK25       POINT      379230.000  3737905.000
69.340
** DESCRSRC Tank 46
   LOCATION STCK26       POINT      379310.000  3737925.000
62.030
** DESCRSRC Tank 47
   LOCATION PAREA1       AREAPOLY   380147.591  3738353.064
11.600
** DESCRSRC ConocoPhilips
   LOCATION VOL1         VOLUME     378888.000  3738152.000
74.660
** DESCRSRC Tank 48
   LOCATION VOL2         VOLUME     378910.000  3738104.000
75.770
** DESCRSRC Tank 49
   LOCATION VOL3         VOLUME     378965.000  3738116.000
75.260
** DESCRSRC Tank 50
   LOCATION STCK27       POINT      379099.000  3737330.000
67.360
** DESCRSRC Truck Idling
   LOCATION STCK32       POINT      381179.000  3737539.000
11.010
** DESCRSRC ConocoPhilips Stack
   LOCATION STCK33       POINT      380820.000  3737760.000
27.740
** DESCRSRC Portable ICEs
** Source Parameters **
   SRCPARAM STCK1             1.0     3.350     0.000   0.01600
0.200
   SRCPARAM STCK2             1.0     3.350   293.150   0.01600
0.200
   SRCPARAM STCK3             1.0     3.350   293.150   0.01600
0.200
   SRCPARAM STCK4             1.0     3.350   293.150   0.01600
0.200
   SRCPARAM STCK5             1.0     3.350   293.150   0.01600
0.200
   SRCPARAM STCK6             1.0     3.350   293.150   0.01600
0.200
   SRCPARAM STCK7             1.0     3.350   293.150   0.01600
0.200
   SRCPARAM STCK8             1.0     3.350   293.150   0.01600
0.200
   SRCPARAM STCK9             1.0     3.350   293.150   0.01600
0.200
   SRCPARAM STCK10            1.0     3.350   293.150   0.01600
0.200
```

```
   SRCPARAM STCK11             1.0     3.350   293.150   0.01600
0.200
   SRCPARAM STCK12             1.0     3.350   293.150   0.01600
0.200
   SRCPARAM STCK13             1.0     3.350   293.150   0.01600
0.200
   SRCPARAM STCK14             1.0     3.350   293.150   0.01600
0.200
   SRCPARAM STCK15             1.0     3.350   293.150   0.01600
0.200
   SRCPARAM STCK16             1.0     3.350   293.150   0.01600
0.200
   SRCPARAM STCK17             1.0     3.350   293.150   0.01600
0.200
   SRCPARAM STCK18             1.0     3.350   293.150   0.01600
0.200
   SRCPARAM STCK19             1.0     3.350   293.150   0.01600
0.200
   SRCPARAM STCK20             1.0     3.350   293.150   0.01600
0.200
   SRCPARAM STCK21             1.0     3.350   293.150   0.01600
0.200
   SRCPARAM STCK22             1.0     3.350   293.150   0.01600
0.200
   SRCPARAM STCK23             1.0     3.350   293.150   0.01600
0.200
   SRCPARAM STCK24             1.0     3.350   293.150   0.01600
0.200
   SRCPARAM STCK25             1.0     3.350   293.150   0.01600
0.200
   SRCPARAM STCK26             1.0     3.350   293.150   0.01600
0.200
   SRCPARAM PAREA1       7.8742E-07    30.480         5     7.088
   AREAVERT PAREA1       380147.591 3738353.064 380127.248
3737819.060
   AREAVERT PAREA1       380513.766 3736552.706 381174.914
3736552.706
   AREAVERT PAREA1       381444.459 3737168.083
   SRCPARAM VOL1               1.0    12.200    27.910     5.670
   SRCPARAM VOL2               1.0    12.200    27.910     5.670
   SRCPARAM VOL3               1.0    12.200    27.910     5.670
   SRCPARAM STCK27             1.0     3.000   739.000  45.40000
0.204
   SRCPARAM STCK32             1.0    50.292   435.594   5.92840
2.438
   SRCPARAM STCK33             1.0     2.438   849.483 151.45500
0.101
   URBANSRC STCK1
   URBANSRC STCK2
   URBANSRC STCK3
   URBANSRC STCK4
   URBANSRC STCK5
```

```
URBANSRC STCK6
URBANSRC STCK7
URBANSRC STCK8
URBANSRC STCK9
URBANSRC STCK10
URBANSRC STCK11
URBANSRC STCK12
URBANSRC STCK13
URBANSRC STCK14
URBANSRC STCK15
URBANSRC STCK16
URBANSRC STCK17
URBANSRC STCK18
URBANSRC STCK19
URBANSRC STCK20
URBANSRC STCK21
URBANSRC STCK22
URBANSRC STCK23
URBANSRC STCK24
URBANSRC STCK25
URBANSRC STCK26
URBANSRC PAREA1
URBANSRC VOL1
URBANSRC VOL2
URBANSRC VOL3
URBANSRC STCK27
URBANSRC STCK32
URBANSRC STCK33
SRCGROUP SRCGP1   STCK1
SRCGROUP SRCGP2   STCK2
SRCGROUP SRCGP3   STCK3
SRCGROUP SRCGP4   STCK4
SRCGROUP SRCGP5   STCK5
SRCGROUP SRCGP6   STCK6
SRCGROUP SRCGP7   STCK7
SRCGROUP SRCGP8   STCK8
SRCGROUP SRCGP9   STCK9
SRCGROUP SRCGP10  STCK10
SRCGROUP SRCGP11  STCK11
SRCGROUP SRCGP12  STCK12
SRCGROUP SRCGP13  STCK13
SRCGROUP SRCGP14  STCK14
SRCGROUP SRCGP15  STCK15
SRCGROUP SRCGP16  STCK16
SRCGROUP SRCGP17  STCK17
SRCGROUP SRCGP18  STCK18
SRCGROUP SRCGP19  STCK19
SRCGROUP SRCGP20  STCK20
SRCGROUP SRCGP21  STCK21
SRCGROUP SRCGP22  STCK22
SRCGROUP SRCGP23  STCK23
SRCGROUP SRCGP24  STCK24
```

```
   SRCGROUP SRCGP25  STCK25
   SRCGROUP SRCGP26  STCK26
   SRCGROUP SRCGP27  VOL1
   SRCGROUP SRCGP28  VOL2
   SRCGROUP SRCGP29  VOL3
   SRCGROUP SRCGP30  PAREA1
   SRCGROUP SRCGP31  STCK27
   SRCGROUP SRCGP32  STCK32
   SRCGROUP SRCGP33  STCK33
   SRCGROUP ALL
SO FINISHED
**
****************************************
** AERMOD Receptor Pathway
****************************************
**
**
RE STARTING
   INCLUDED PVHRA.rou
RE FINISHED
**
****************************************
** AERMOD Meteorology Pathway
****************************************
**
**
ME STARTING
   SURFFILE "..\..\..\Bluescape\Projects\Ponte Vista\Modeling\Met
Data\lghb.SFC"
   PROFFILE "..\..\..\Bluescape\Projects\Ponte Vista\Modeling\Met
Data\lghb.PFL"
   SURFDATA 0 2005 Long_Beach 389990.00 3743040.00
   UAIRDATA 3190 2005
   PROFBASE 30.0 METERS
ME FINISHED
**
****************************************
** AERMOD Output Pathway
****************************************
**
**
OU STARTING
   RECTABLE ALLAVE 1ST
   RECTABLE 1 1ST
** Auto-Generated Plotfiles
   PLOTFILE 1 ALL 1ST PVHRA.AD\01H1GALL.PLT 31
   PLOTFILE 1 SRCGP1 1ST PVHRA.AD\01H1G001.PLT 32
   PLOTFILE 1 SRCGP2 1ST PVHRA.AD\01H1G002.PLT 33
   PLOTFILE 1 SRCGP3 1ST PVHRA.AD\01H1G003.PLT 34
   PLOTFILE 1 SRCGP4 1ST PVHRA.AD\01H1G004.PLT 35
   PLOTFILE 1 SRCGP5 1ST PVHRA.AD\01H1G005.PLT 36
   PLOTFILE 1 SRCGP6 1ST PVHRA.AD\01H1G006.PLT 37
```

```
PLOTFILE 1 SRCGP7 1ST PVHRA.AD\01H1G007.PLT 38
PLOTFILE 1 SRCGP8 1ST PVHRA.AD\01H1G008.PLT 39
PLOTFILE 1 SRCGP9 1ST PVHRA.AD\01H1G009.PLT 40
PLOTFILE 1 SRCGP10 1ST PVHRA.AD\01H1G010.PLT 41
PLOTFILE 1 SRCGP11 1ST PVHRA.AD\01H1G011.PLT 42
PLOTFILE 1 SRCGP12 1ST PVHRA.AD\01H1G012.PLT 43
PLOTFILE 1 SRCGP13 1ST PVHRA.AD\01H1G013.PLT 44
PLOTFILE 1 SRCGP14 1ST PVHRA.AD\01H1G014.PLT 45
PLOTFILE 1 SRCGP15 1ST PVHRA.AD\01H1G015.PLT 46
PLOTFILE 1 SRCGP16 1ST PVHRA.AD\01H1G016.PLT 47
PLOTFILE 1 SRCGP17 1ST PVHRA.AD\01H1G017.PLT 48
PLOTFILE 1 SRCGP18 1ST PVHRA.AD\01H1G018.PLT 49
PLOTFILE 1 SRCGP19 1ST PVHRA.AD\01H1G019.PLT 50
PLOTFILE 1 SRCGP20 1ST PVHRA.AD\01H1G020.PLT 51
PLOTFILE 1 SRCGP21 1ST PVHRA.AD\01H1G021.PLT 52
PLOTFILE 1 SRCGP22 1ST PVHRA.AD\01H1G022.PLT 53
PLOTFILE 1 SRCGP23 1ST PVHRA.AD\01H1G023.PLT 54
PLOTFILE 1 SRCGP24 1ST PVHRA.AD\01H1G024.PLT 55
PLOTFILE 1 SRCGP25 1ST PVHRA.AD\01H1G025.PLT 56
PLOTFILE 1 SRCGP26 1ST PVHRA.AD\01H1G026.PLT 57
PLOTFILE 1 SRCGP27 1ST PVHRA.AD\01H1G027.PLT 58
PLOTFILE 1 SRCGP28 1ST PVHRA.AD\01H1G028.PLT 59
PLOTFILE 1 SRCGP29 1ST PVHRA.AD\01H1G029.PLT 60
PLOTFILE 1 SRCGP30 1ST PVHRA.AD\01H1G030.PLT 61
PLOTFILE 1 SRCGP31 1ST PVHRA.AD\01H1G031.PLT 62
PLOTFILE 1 SRCGP32 1ST PVHRA.AD\01H1G032.PLT 63
PLOTFILE 1 SRCGP33 1ST PVHRA.AD\01H1G033.PLT 64
PLOTFILE PERIOD ALL PVHRA.AD\PE00GALL.PLT 65
PLOTFILE PERIOD SRCGP1 PVHRA.AD\PE00G001.PLT 66
PLOTFILE PERIOD SRCGP2 PVHRA.AD\PE00G002.PLT 67
PLOTFILE PERIOD SRCGP3 PVHRA.AD\PE00G003.PLT 68
PLOTFILE PERIOD SRCGP4 PVHRA.AD\PE00G004.PLT 69
PLOTFILE PERIOD SRCGP5 PVHRA.AD\PE00G005.PLT 70
PLOTFILE PERIOD SRCGP6 PVHRA.AD\PE00G006.PLT 71
PLOTFILE PERIOD SRCGP7 PVHRA.AD\PE00G007.PLT 72
PLOTFILE PERIOD SRCGP8 PVHRA.AD\PE00G008.PLT 73
PLOTFILE PERIOD SRCGP9 PVHRA.AD\PE00G009.PLT 74
PLOTFILE PERIOD SRCGP10 PVHRA.AD\PE00G010.PLT 75
PLOTFILE PERIOD SRCGP11 PVHRA.AD\PE00G011.PLT 76
PLOTFILE PERIOD SRCGP12 PVHRA.AD\PE00G012.PLT 77
PLOTFILE PERIOD SRCGP13 PVHRA.AD\PE00G013.PLT 78
PLOTFILE PERIOD SRCGP14 PVHRA.AD\PE00G014.PLT 79
PLOTFILE PERIOD SRCGP15 PVHRA.AD\PE00G015.PLT 80
PLOTFILE PERIOD SRCGP16 PVHRA.AD\PE00G016.PLT 81
PLOTFILE PERIOD SRCGP17 PVHRA.AD\PE00G017.PLT 82
PLOTFILE PERIOD SRCGP18 PVHRA.AD\PE00G018.PLT 83
PLOTFILE PERIOD SRCGP19 PVHRA.AD\PE00G019.PLT 84
PLOTFILE PERIOD SRCGP20 PVHRA.AD\PE00G020.PLT 85
PLOTFILE PERIOD SRCGP21 PVHRA.AD\PE00G021.PLT 86
PLOTFILE PERIOD SRCGP22 PVHRA.AD\PE00G022.PLT 87
PLOTFILE PERIOD SRCGP23 PVHRA.AD\PE00G023.PLT 88
PLOTFILE PERIOD SRCGP24 PVHRA.AD\PE00G024.PLT 89
```

```
   PLOTFILE PERIOD SRCGP25 PVHRA.AD\PE00G025.PLT 90
   PLOTFILE PERIOD SRCGP26 PVHRA.AD\PE00G026.PLT 91
   PLOTFILE PERIOD SRCGP27 PVHRA.AD\PE00G027.PLT 92
   PLOTFILE PERIOD SRCGP28 PVHRA.AD\PE00G028.PLT 93
   PLOTFILE PERIOD SRCGP29 PVHRA.AD\PE00G029.PLT 94
   PLOTFILE PERIOD SRCGP30 PVHRA.AD\PE00G030.PLT 95
   PLOTFILE PERIOD SRCGP31 PVHRA.AD\PE00G031.PLT 96
   PLOTFILE PERIOD SRCGP32 PVHRA.AD\PE00G032.PLT 97
   PLOTFILE PERIOD SRCGP33 PVHRA.AD\PE00G033.PLT 98
OU FINISHED


  *** Message Summary For AERMOD Model Setup ***

  --------- Summary of Total Messages --------

 A Total of            0 Fatal Error Message(s)
 A Total of            2 Warning Message(s)
 A Total of            0 Informational Message(s)


    ******** FATAL ERROR MESSAGES ********
               ***  NONE  ***


    ********   WARNING MESSAGES   ********
 SO W320     137  PPARM:Input Parameter May Be Out-of-Range for
Parameter            VS
 ME W396     227 MEOPEN:Met data from outdated version of AERMET,
version:        06341

 ************************************
 *** SETUP Finishes Successfully ***
 ************************************
```

```
 *** AERMOD - VERSION  11103 ***   *** C:\Documents and Settings
\HP_Administrator\My Documents\Lakes\AERMOD ***        06/16/11
                                        ***
***        18:52:09

PAGE   1
 **MODELOPTs:  RegDFAULT CONC
ELEV
                                                          NODRYDPLT
NOWETDPLT

                                              ***     MODEL SETUP
OPTIONS SUMMARY       ***
 - - - - - - - - - - - - - - - - - - - - - - - - - - - - - - - - - - - -
- - - - - - - - - - - - - - - - - - - - - - - - - - - - - - - - - - - -

 **Model Is Setup For Calculation of Average CONCentration
Values.

   --  DEPOSITION LOGIC  --
 **NO GAS DEPOSITION Data Provided.
 **NO PARTICLE DEPOSITION Data Provided.
 **Model Uses NO DRY DEPLETION.  DRYDPLT  =  F
 **Model Uses NO WET DEPLETION.  WETDPLT  =  F

 **Model Uses URBAN Dispersion Algorithm for the SBL for    33
Source(s),
   for Total of    1 Urban Area(s):
   Urban Population =   9862049.0 ;  Urban Roughness Length =
1.000 m

 **Model Uses Regulatory DEFAULT Options:
         1. Stack-tip Downwash.
         2. Model Accounts for ELEVated Terrain Effects.
         3. Use Calms Processing Routine.
         4. Use Missing Data Processing Routine.
         5. No Exponential Decay for URBAN/Non-SO2.
         6. Urban Roughness Length of 1.0 Meter Assumed.

 **Model Assumes No FLAGPOLE Receptor Heights.

 **Model Calculates  1 Short Term Average(s) of:   1-HR
     and Calculates PERIOD Averages

 **This Run Includes:     33 Source(s);      34 Source Group(s);
and      54 Receptor(s)

 **The Model Assumes A Pollutant Type of:  XOQ

 **Model Set To Continue RUNning After the Setup Testing.

 **Output Options Selected:
```

```
          Model Outputs Tables of PERIOD Averages by Receptor
          Model Outputs Tables of Highest Short Term Values by
Receptor (RECTABLE Keyword)
          Model Outputs External File(s) of High Values for
Plotting (PLOTFILE Keyword)

 **NOTE:  The Following Flags May Appear Following CONC Values:
c for Calm Hours

m for Missing Hours

b for Both Calm and Missing Hours

 **Misc. Inputs:  Base Elev. for Pot. Temp. Profile (m MSL) =
30.00 ;  Decay Coef. =    0.000     ;  Rot. Angle =     0.0
                  Emission Units = GRAMS/SEC
;  Emission Rate Unit Factor =   0.10000E+07
                  Output Units   = MICROGRAMS/M**3

 **Approximate Storage Requirements of Model =      3.6 MB of
RAM.
```

**MODELOPTs: RegDFAULT CONC ELEV NODRYDPLT NOWETDPLT

*** POINT SOURCE DATA ***

STACK ID	STACK HEIGHT (METERS)	STACK TEMP. (DEG.K)	NUMBER PART. CATS.	EMISSION RATE (GRAMS/SEC)	STACK EXIT VEL. (M/SEC)	STACK DIAMETER (METERS)	BLDG EXISTS	URBAN SOURCE	CAP/ HOR	BASE ELEV. (METERS)	EMIS RATE SCALAR VARY BY
STCK1	3.35	0.00	0	0.10000E+01	0.02	0.20	379083.0	3737607.0	NO	YES	NO	76.0
STCK2	3.35	293.15	0	0.10000E+01	0.02	0.20	379032.0	3737472.0	NO	YES	NO	75.3
STCK3	3.35	293.15	0	0.10000E+01	0.02	0.20	379236.0	3737636.0	NO	YES	NO	70.0
STCK4	3.35	293.15	0	0.10000E+01	0.02	0.20	379099.0	3737330.0	NO	YES	NO	67.4
STCK5	3.35	293.15	0	0.10000E+01	0.02	0.20	379345.0	3737477.0	NO	YES	NO	73.8
STCK6	3.35	293.15	0	0.10000E+01	0.02	0.20	379265.0	3737279.0	NO	YES	NO	66.2
STCK7	3.35	293.15	0	0.10000E+01	0.02	0.20	379684.0	3737474.0	NO	YES	NO	62.6
STCK8	3.35	293.15	0	0.10000E+01	0.02	0.20	379317.0	3737152.0	NO	YES	NO	60.7
STCK9	3.35	293.15	0	0.10000E+01	0.02	0.20	379434.0	3737331.0	NO	YES	NO	63.0
STCK10	3.35	293.15	0	0.10000E+01	0.02	0.20	379462.0	3737106.0	NO	YES	NO	51.0
STCK11	3.35	293.15	0	0.10000E+01	0.02	0.20	379718.0	3739682.0	NO	YES	NO	13.7
STCK12	3.35	293.15	0	0.10000E+01	0.02	0.20	379672.0	3737303.0	NO	YES	NO	61.9
STCK13	3.35	293.15	0	0.10000E+01	0.02	0.20	379647.0	3737158.0	NO	YES	NO	57.5
STCK14	3.35	293.15	0	0.10000E+01	0.02	0.20	379869.0	3737471.0	NO	YES	NO	49.0

```
 STCK15            0   0.10000E+01  379780.0 3737243.0    55.9
3.35   293.15     0.02     0.20    NO      YES   NO
 STCK16            0   0.10000E+01  379736.0 3737020.0    44.8
3.35   293.15     0.02     0.20    NO      YES   NO
 STCK17            0   0.10000E+01  380016.0 3737292.0    44.4
3.35   293.15     0.02     0.20    NO      YES   NO
 STCK18            0   0.10000E+01  379934.0 3737165.0    46.2
3.35   293.15     0.02     0.20    NO      YES   NO
 STCK19            0   0.10000E+01  380063.0 3737094.0    38.9
3.35   293.15     0.02     0.20    NO      YES   NO
 STCK20            0   0.10000E+01  379926.0 3736942.0    43.5
3.35   293.15     0.02     0.20    NO      YES   NO
 STCK21            0   0.10000E+01  379132.0 3737788.0    76.4
3.35   293.15     0.02     0.20    NO      YES   NO
 STCK22            0   0.10000E+01  379144.0 3737866.0    75.3
3.35   293.15     0.02     0.20    NO      YES   NO
 STCK23            0   0.10000E+01  379194.0 3737808.0    74.3
3.35   293.15     0.02     0.20    NO      YES   NO
 STCK24            0   0.10000E+01  379292.0 3737850.0    63.7
3.35   293.15     0.02     0.20    NO      YES   NO
 STCK25            0   0.10000E+01  379230.0 3737905.0    69.3
3.35   293.15     0.02     0.20    NO      YES   NO
 STCK26            0   0.10000E+01  379310.0 3737925.0    62.0
3.35   293.15     0.02     0.20    NO      YES   NO
 STCK27            0   0.10000E+01  379099.0 3737330.0    67.4
3.00   739.00    45.40     0.20    NO      YES   NO
 STCK32            0   0.10000E+01  381179.0 3737539.0    11.0
50.29   435.59     5.93     2.44    NO      YES   NO
 STCK33            0   0.10000E+01  380820.0 3737760.0    27.7
2.44   849.48   151.46     0.10    NO      YES   NO
```

**MODELOPTs: RegDFAULT CONC ELEV NODRYDPLT NOWETDPLT

*** VOLUME SOURCE DATA ***

SOURCE ID	NUMBER PART. CATS.	EMISSION RATE (GRAMS/SEC)	X (METERS)	Y (METERS)	ELEV. (METERS)	HEIGHT (METERS)	SY (METERS)	SZ (METERS)	BASE SOURCE SCALAR VARY BY	RELEASE INIT. URBAN
VOL1	0	0.10000E+01	378888.0	3738152.0	74.7	12.20	27.91	5.67	YES	
VOL2	0	0.10000E+01	378910.0	3738104.0	75.8	12.20	27.91	5.67	YES	
VOL3	0	0.10000E+01	378965.0	3738116.0	75.3	12.20	27.91	5.67	YES	

**MODELOPTs: RegDFAULT CONC
ELEV
NODRYDPLT
NOWETDPLT

*** AREAPOLY
SOURCE DATA ***

SOURCE ID	NUMBER PART. CATS.	EMISSION RATE (GRAMS/SEC /METER**2)	LOCATION OF AREA X (METERS)	Y (METERS)	BASE ELEV. (METERS)	RELEASE HEIGHT (METERS)	NUMBER OF VERTS.	INIT. SZ (METERS)	URBAN SOURCE BY	EMISSION RATE SCALAR VARY
PAREA1	0	0.78742E-06	380147.6	3738353.1	11.6	30.48	5	7.09	YES	

**MODELOPTs: RegDFAULT CONC
ELEV
NODRYDPLT
NOWETDPLT

*** SOURCE IDs
DEFINING SOURCE GROUPS ***

GROUP ID SOURCE
IDs

SRCGP1 STCK1 ,

SRCGP2 STCK2 ,

SRCGP3 STCK3 ,

SRCGP4 STCK4 ,

SRCGP5 STCK5 ,

SRCGP6 STCK6 ,

SRCGP7 STCK7 ,

SRCGP8 STCK8 ,

SRCGP9 STCK9 ,

SRCGP10 STCK10 ,

SRCGP11 STCK11 ,

```
SRCGP12   STCK12      ,

SRCGP13   STCK13      ,

SRCGP14   STCK14      ,

SRCGP15   STCK15      ,

SRCGP16   STCK16      ,

SRCGP17   STCK17      ,

SRCGP18   STCK18      ,

SRCGP19   STCK19      ,

SRCGP20   STCK20      ,
```

**MODELOPTs: RegDFAULT CONC ELEV NODRYDPLT NOWETDPLT

*** SOURCE IDs DEFINING SOURCE GROUPS ***

GROUP ID	SOURCE IDs
SRCGP21	STCK21 ,
SRCGP22	STCK22 ,
SRCGP23	STCK23 ,
SRCGP24	STCK24 ,
SRCGP25	STCK25 ,
SRCGP26	STCK26 ,
SRCGP27	VOL1 ,
SRCGP28	VOL2 ,
SRCGP29	VOL3 ,
SRCGP30	PAREA1 ,
SRCGP31	STCK27 ,

```
  SRCGP32   STCK32      ,

  SRCGP33   STCK33      ,

  ALL       STCK1       , STCK2       , STCK3       , STCK4
, STCK5       , STCK6       , STCK7       , STCK8       ,

            STCK9       , STCK10      , STCK11      , STCK12
, STCK13      , STCK14      , STCK15      , STCK16      ,

            STCK17      , STCK18      , STCK19      , STCK20
, STCK21      , STCK22      , STCK23      , STCK24      ,

            STCK25      , STCK26      , PAREA1      , VOL1
, VOL2        , VOL3        , STCK27      , STCK32      ,

            STCK33      ,
```

**MODELOPTs: RegDFAULT CONC ELEV NODRYDPLT NOWETDPLT

*** DISCRETE CARTESIAN RECEPTORS ***
(X-COORD, Y-COORD, ZELEV, ZHILL, ZFLAG)

(METERS)

```
     ( 378877.7, 3737400.4,      63.2,      98.1,       0.0);
( 378926.6, 3737406.2,      60.1,      99.4,       0.0);
     ( 378978.4, 3737414.8,      64.5,      75.9,       0.0);
( 379007.2, 3737384.6,      60.8,      76.2,       0.0);
     ( 379021.6, 3737354.4,      59.2,      75.9,       0.0);
( 379036.0, 3737322.7,      59.3,      75.9,       0.0);
     ( 379047.5, 3737286.8,      58.9,      73.8,       0.0);
( 379077.7, 3737266.6,      58.6,      69.2,       0.0);
     ( 379105.0, 3737250.8,      57.2,      69.5,       0.0);
( 379132.4, 3737230.7,      53.0,      73.5,       0.0);
     ( 379161.1, 3737209.1,      55.1,      67.7,       0.0);
( 379187.0, 3737190.4,      58.5,      60.3,       0.0);
     ( 379221.6, 3737167.4,      58.2,      61.6,       0.0);
( 379250.3, 3737147.2,      53.5,      65.8,       0.0);
     ( 379280.5, 3737127.1,      52.0,      63.4,       0.0);
( 379286.3, 3737076.7,      46.7,      64.3,       0.0);
     ( 379296.4, 3737039.3,      41.4,      67.1,       0.0);
( 379306.5, 3736994.7,      38.8,      62.8,       0.0);
     ( 379316.5, 3736953.0,      37.4,      62.2,       0.0);
( 379328.0, 3736908.4,      35.3,      61.6,       0.0);
     ( 379342.4, 3736865.3,      31.3,      61.3,       0.0);
( 379345.3, 3736829.3,      30.0,      30.0,       0.0);
     ( 378886.4, 3737242.2,      52.9,      94.8,       0.0);
( 378910.8, 3737340.0,      57.6,      97.5,       0.0);
     ( 378982.8, 3737327.1,      55.6,      93.0,       0.0);
( 378981.3, 3737220.6,      51.8,      74.4,       0.0);
     ( 379057.6, 3737190.4,      48.4,      74.7,       0.0);
( 379120.9, 3737151.5,      47.3,      69.5,       0.0);
     ( 379172.6, 3737118.5,      47.2,      67.7,       0.0);
( 379224.4, 3737076.7,      42.3,      68.3,       0.0);
     ( 379260.4, 3737022.1,      40.4,      66.5,       0.0);
( 379290.6, 3736973.2,      38.3,      62.5,       0.0);
     ( 379287.7, 3736884.0,      34.5,      60.3,       0.0);
( 379197.1, 3736869.6,      35.9,      35.9,       0.0);
```

```
     ( 379191.4, 3736964.5,      38.8,      38.8,       0.0);
( 379149.6, 3737023.5,      41.7,      61.9,       0.0);
     ( 379089.2, 3737071.0,      44.2,      44.2,       0.0);
( 379018.7, 3737108.4,      46.8,      46.8,       0.0);
     ( 378946.8, 3737131.4,      48.6,      48.6,       0.0);
( 378866.2, 3737155.9,      51.3,      51.3,       0.0);
     ( 378840.3, 3737065.2,      47.9,      47.9,       0.0);
( 378932.4, 3737033.6,      45.2,      45.2,       0.0);
     ( 379007.2, 3736999.0,      41.9,      41.9,       0.0);
( 379067.6, 3736951.6,      39.1,      39.1,       0.0);
     ( 379113.7, 3736869.6,      35.8,      35.8,       0.0);
( 379020.2, 3736876.8,      35.2,      35.2,       0.0);
     ( 378945.3, 3736937.2,      36.3,      44.2,       0.0);
( 378886.4, 3736971.7,      41.6,      41.6,       0.0);
     ( 378820.2, 3736990.4,      44.5,      44.5,       0.0);
( 378856.2, 3737332.8,      58.0,      98.5,       0.0);
     ( 378836.0, 3737247.9,      55.1,      95.4,       0.0);
( 378814.4, 3737163.1,      52.1,      92.0,       0.0);
     ( 378798.6, 3737076.7,      48.7,      48.7,       0.0);
( 378772.7, 3736996.2,      45.4,      45.4,       0.0);
```

**MODELOPTs: RegDFAULT CONC ELEV NODRYDPLT NOWETDPLT

*** METEOROLOGICAL DAYS SELECTED FOR PROCESSING *** (1 =YES; 0=NO)

```
           1 1 1 1 1 1 1 1 1 1   1 1 1 1 1 1 1 1 1 1   1 1 1 1 1
1 1 1 1 1  1 1 1 1 1 1 1 1 1 1   1 1 1 1 1 1 1 1 1 1
           1 1 1 1 1 1 1 1 1 1   1 1 1 1 1 1 1 1 1 1   1 1 1 1 1
1 1 1 1 1  1 1 1 1 1 1 1 1 1 1   1 1 1 1 1 1 1 1 1 1
           1 1 1 1 1 1 1 1 1 1   1 1 1 1 1 1 1 1 1 1   1 1 1 1 1
1 1 1 1 1  1 1 1 1 1 1 1 1 1 1   1 1 1 1 1 1 1 1 1 1
           1 1 1 1 1 1 1 1 1 1   1 1 1 1 1 1 1 1 1 1   1 1 1 1 1
1 1 1 1 1  1 1 1 1 1 1 1 1 1 1   1 1 1 1 1 1 1 1 1 1
           1 1 1 1 1 1 1 1 1 1   1 1 1 1 1 1 1 1 1 1   1 1 1 1 1
1 1 1 1 1  1 1 1 1 1 1 1 1 1 1   1 1 1 1 1 1 1 1 1 1
           1 1 1 1 1 1 1 1 1 1   1 1 1 1 1 1 1 1 1 1   1 1 1 1 1
1 1 1 1 1  1 1 1 1 1 1 1 1 1 1   1 1 1 1 1 1 1 1 1 1
           1 1 1 1 1 1 1 1 1 1   1 1 1 1 1 1 1 1 1 1   1 1 1 1 1
1 1 1 1 1  1 1 1 1 1 1 1 1 1 1   1 1 1 1 1 1 1 1 1 1
           1 1 1 1 1 1 1 1 1 1   1 1 1 1 1 1
```

NOTE: METEOROLOGICAL DATA ACTUALLY PROCESSED WILL ALSO DEPEND ON WHAT IS INCLUDED IN THE DATA FILE.

*** UPPER BOUND OF FIRST THROUGH FIFTH WIND SPEED CATEGORIES ***

(METERS/SEC)

1.54, 3.09, 5.14, 8.23, 10.80,

```
 **MODELOPTs:  RegDFAULT CONC
ELEV
                                                          NODRYDPLT
NOWETDPLT

                                     *** UP TO THE FIRST 24 HOURS
OF METEOROLOGICAL DATA ***

   Surface file:   ..\..\..\Bluescape\Projects\Ponte Vista
\Modeling\Met Data\lghb.SFC                 Met Version:  06341
   Profile file:   ..\..\..\Bluescape\Projects\Ponte Vista
\Modeling\Met Data\lghb.PFL
   Surface format: FREE
   Profile format: FREE
   Surface station no.:        0                  Upper air
station no.:     3190
                  Name: LONG_BEACH
Name: UNKNOWN
                  Year:   2005
Year:   2005

 First 24 hours of scalar data
 YR MO DY JDY HR     H0     U*     W*  DT/DZ ZICNV ZIMCH  M-O LEN
Z0  BOWEN ALBEDO  REF WS   WD     HT  REF TA     HT
- - - - - - - - - - - - - - - - - - - - - - - - - - - - - - - - - - - - -
- - - - - - - - - - - - - - - - - - - - - - - - - - - - - - - - - - - -
 05 01 01   1 01   -1.5  0.046 -9.000 -9.000 -999.   23.      6.1
0.60   1.00   1.00    0.70   80.   12.2  281.4    8.5
 05 01 01   1 02   -3.0  0.066 -9.000 -9.000 -999.   39.      8.8
0.60   1.00   1.00    1.00   53.   12.2  281.4    8.5
 05 01 01   1 03   -6.6  0.106 -9.000 -9.000 -999.   79.     16.3
0.60   1.00   1.00    1.60   44.   12.2  280.9    8.5
 05 01 01   1 04   -6.1  0.093 -9.000 -9.000 -999.   65.     11.7
0.60   1.00   1.00    1.40   43.   12.2  280.4    8.5
 05 01 01   1 05   -2.5  0.060 -9.000 -9.000 -999.   34.      7.5
0.60   1.00   1.00    0.90   51.   12.2  279.9    8.5
 05 01 01   1 06   -5.3  0.086 -9.000 -9.000 -999.   58.     10.9
0.60   1.00   1.00    1.30   60.   12.2  279.9    8.5
 05 01 01   1 07   -6.2  0.093 -9.000 -9.000 -999.   65.     11.7
0.60   1.00   1.00    1.40   51.   12.2  279.2    8.5
 05 01 01   1 08   -5.5  0.093 -9.000 -9.000 -999.   65.     13.2
0.60   1.00   0.54    1.40   52.   12.2  279.9    8.5
 05 01 01   1 09   43.2  0.285  0.491  0.005   99.  349.    -48.2
0.60   1.00   0.31    1.80   41.   12.2  282.5    8.5
 05 01 01   1 10  111.0  0.323  1.377  0.005  851.  423.    -27.5
0.60   1.00   0.24    1.90   69.   12.2  285.4    8.5
```

```
 05 01 01   1 11  135.9  0.330  1.656  0.010 1210.  435.    -23.8
0.60   1.00   0.21    1.90   84.   12.2  287.5    8.5
 05 01 01   1 12   14.0  0.227  0.778  0.010 1212.  253.    -75.0
0.60   1.00   0.20    1.50  113.   12.2  285.9    8.5
 05 01 01   1 13   27.0  0.155  0.969  0.010 1218.  141.    -12.4
0.60   1.00   0.20    0.80  132.   12.2  286.4    8.5
 05 01 01   1 14   17.0  0.194  0.832  0.009 1222.  197.    -39.0
0.60   1.00   0.21    1.20  223.   12.2  286.4    8.5
 05 01 01   1 15    3.8  0.150  0.504  0.009 1223.  134.    -80.8
0.60   1.00   0.24    1.00  208.   12.2  286.4    8.5
 05 01 01   1 16    0.1  0.212  0.150  0.009 1223.  225.  -8659.6
0.60   1.00   0.33    1.60  172.   12.2  285.9    8.5
 05 01 01   1 17   -2.9  0.066 -9.000 -9.000 -999.   62.      9.0
0.60   1.00   0.59    1.00  211.   12.2  285.9    8.5
 05 01 01   1 18   -1.6  0.053 -9.000 -9.000 -999.   28.      8.2
0.60   1.00   1.00    0.80  233.   12.2  285.4    8.5
 05 01 01   1 19   -0.7  0.033 -9.000 -9.000 -999.   14.      4.4
0.60   1.00   1.00    0.50  245.   12.2  284.9    8.5
 05 01 01   1 20   -1.1  0.040 -9.000 -9.000 -999.   18.      5.3
0.60   1.00   1.00    0.60  314.   12.2  284.2    8.5
 05 01 01   1 21   -1.1  0.040 -9.000 -9.000 -999.   18.      5.3
0.60   1.00   1.00    0.60  354.   12.2  283.8    8.5
 05 01 01   1 22   -1.1  0.040 -9.000 -9.000 -999.   18.      5.3
0.60   1.00   1.00    0.60  188.   12.2  283.1    8.5
 05 01 01   1 23   -0.7  0.033 -9.000 -9.000 -999.   14.      4.4
0.60   1.00   1.00    0.50  329.   12.2  283.1    8.5
 05 01 01   1 24   -3.1  0.066 -9.000 -9.000 -999.   39.      8.4
0.60   1.00   1.00    1.00   35.   12.2  282.0    8.5


 First hour of profile data
 YR MO DY HR HEIGHT F  WDIR    WSPD AMB_TMP sigmaA  sigmaW
sigmaV
 05 01 01 01    8.5 0 -999.  -99.00   281.5   99.0  -99.00  -
99.00
 05 01 01 01   12.2 1   80.    0.70  -999.0   99.0  -99.00  -
99.00

 F indicates top of profile (=1) or below (=0)
```

**MODELOPTs: RegDFAULT CONC ELEV NODRYDPLT NOWETDPLT

*** THE PERIOD (26280 HRS) AVERAGE CONCENTRATION VALUES FOR SOURCE GROUP: SRCGP1 ***
INCLUDING SOURCE(S): STCK1 ,

*** DISCRETE CARTESIAN RECEPTOR POINTS ***

** CONC OF XOQ IN MICROGRAMS/M**3 **

X-COORD (M)	Y-COORD (M)	CONC
378877.74	3737400.43	12.19331
378926.65	3737406.18	14.65307
378978.44	3737414.82	19.79161
379007.21	3737384.60	16.40046
379021.60	3737354.39	13.43103
379035.98	3737322.74	11.18692
379047.49	3737286.78	9.18174
379077.70	3737266.64	8.12853
379105.04	3737250.81	7.24073
379132.37	3737230.67	6.18938
379161.14	3737209.09	5.56913
379187.04	3737190.39	5.19942
379221.57	3737167.37	4.57775
379250.34	3737147.23	3.95120
379280.55	3737127.09	3.53687
379286.30	3737076.74	2.96143
379296.38	3737039.33	2.59388
379306.45	3736994.74	2.28839
379316.52	3736953.02	2.05909
379328.02	3736908.42	1.84589
379342.41	3736865.26	1.65493
379345.29	3736829.30	1.54031
378886.37	3737242.18	6.37684
378910.82	3737340.01	10.09469
378982.75	3737327.06	10.76553
378981.32	3737220.60	6.41189

379057.56 3737190.39 5.50568
379120.86 3737151.55 4.50470
379172.65 3737118.46 3.82125
379224.44 3737076.74 3.11224
379260.41 3737022.07 2.57863
379290.62 3736973.16 2.21414
379287.74 3736883.96 1.81897
379197.11 3736869.58 1.91325
379191.36 3736964.53 2.39092
379149.64 3737023.51 2.90588
379089.21 3737070.98 3.52460
379018.72 3737108.39 4.15231
378946.79 3737131.41 4.50771
378866.23 3737155.86 4.67434
378840.33 3737065.23 3.48427
378932.40 3737033.58 3.30091
379007.21 3736999.05 2.95484
379067.63 3736951.58 2.53194
379113.67 3736869.58 2.02385
379020.16 3736876.77 2.13404
378945.35 3736937.19 2.48532
378886.37 3736971.72 2.73668
378820.19 3736990.42 2.81551
378856.16 3737332.81 8.41479
378836.02 3737247.94 5.99923
378814.44 3737163.06 4.46918
378798.61 3737076.74 3.45853
378772.72 3736996.18 2.76225

**MODELOPTs: RegDFAULT CONC ELEV NODRYDPLT NOWETDPLT

*** THE PERIOD (26280 HRS) AVERAGE CONCENTRATION VALUES FOR SOURCE GROUP: SRCGP2 ***
INCLUDING SOURCE(S): STCK2 ,

*** DISCRETE CARTESIAN RECEPTOR POINTS ***

** CONC OF XOQ IN MICROGRAMS/M**3 **

X-COORD (M)	Y-COORD (M)	CONC
378877.74	3737400.43	28.34053
378926.65	3737406.18	46.41586
378978.44	3737414.82	104.31422
379007.21	3737384.60	77.28617
379021.60	3737354.39	47.13622
379035.98	3737322.74	30.72058
379047.49	3737286.78	20.95548
379077.70	3737266.64	16.45377
379105.04	3737250.81	13.49552
379132.37	3737230.67	10.75142
379161.14	3737209.09	8.99165
379187.04	3737190.39	7.98865
379221.57	3737167.37	6.68235
379250.34	3737147.23	5.55712
379280.55	3737127.09	4.82119
379286.30	3737076.74	3.95154
379296.38	3737039.33	3.40946
379306.45	3736994.74	2.95698
379316.52	3736953.02	2.62072
379328.02	3736908.42	2.31614
379342.41	3736865.26	2.05134
379345.29	3736829.30	1.89455
378886.37	3737242.18	12.51482
378910.82	3737340.01	25.24948
378982.75	3737327.06	31.95113
378981.32	3737220.60	12.93573

379057.56 3737190.39 9.91278
379120.86 3737151.55 7.18587
379172.65 3737118.46 5.64865
379224.44 3737076.74 4.33895
379260.41 3737022.07 3.43702
379290.62 3736973.16 2.86376
379287.74 3736883.96 2.29877
379197.11 3736869.58 2.46769
379191.36 3736964.53 3.20741
379149.64 3737023.51 4.09119
379089.21 3737070.98 5.31068
379018.72 3737108.39 6.78409
378946.79 3737131.41 7.73697
378866.23 3737155.86 8.00074
378840.33 3737065.23 5.41151
378932.40 3737033.58 5.07994
379007.21 3736999.05 4.36158
379067.63 3736951.58 3.54180
379113.67 3736869.58 2.67499
379020.16 3736876.77 2.91447
378945.35 3736937.19 3.57262
378886.37 3736971.72 4.01700
378820.19 3736990.42 4.13064
378856.16 3737332.81 17.34856
378836.02 3737247.94 10.88179
378814.44 3737163.06 7.34501
378798.61 3737076.74 5.29701
378772.72 3736996.18 3.99793

**MODELOPTs: RegDFAULT CONC ELEV NODRYDPLT NOWETDPLT

*** THE PERIOD (26280 HRS) AVERAGE CONCENTRATION VALUES FOR SOURCE GROUP: SRCGP3 ***
INCLUDING SOURCE(S): STCK3 ,

*** DISCRETE CARTESIAN RECEPTOR POINTS ***

** CONC OF XOQ IN MICROGRAMS/M**3 **

X-COORD (M)	Y-COORD (M)	CONC
378877.74	3737400.43	6.87546
378926.65	3737406.18	7.97335
378978.44	3737414.82	10.35442
379007.21	3737384.60	10.03024
379021.60	3737354.39	9.29630
379035.98	3737322.74	8.65386
379047.49	3737286.78	7.74961
379077.70	3737266.64	7.49451
379105.04	3737250.81	7.11741
379132.37	3737230.67	6.36527
379161.14	3737209.09	6.02228
379187.04	3737190.39	5.80305
379221.57	3737167.37	5.24305
379250.34	3737147.23	4.57152
379280.55	3737127.09	4.12135
379286.30	3737076.74	3.38045
379296.38	3737039.33	2.91866
379306.45	3736994.74	2.55218
379316.52	3736953.02	2.28442
379328.02	3736908.42	2.03578
379342.41	3736865.26	1.81178
379345.29	3736829.30	1.67906
378886.37	3737242.18	4.56371
378910.82	3737340.01	6.30574
378982.75	3737327.06	7.30597
378981.32	3737220.60	5.19168

379057.56 3737190.39 5.06642
379120.86 3737151.55 4.56475
379172.65 3737118.46 4.09885
379224.44 3737076.74 3.41574
379260.41 3737022.07 2.85141
379290.62 3736973.16 2.44985
379287.74 3736883.96 1.98208
379197.11 3736869.58 2.02695
379191.36 3736964.53 2.54346
379149.64 3737023.51 3.02850
379089.21 3737070.98 3.49725
379018.72 3737108.39 3.82924
378946.79 3737131.41 3.82680
378866.23 3737155.86 3.63785
378840.33 3737065.23 2.87185
378932.40 3737033.58 2.94773
379007.21 3736999.05 2.80113
379067.63 3736951.58 2.50841
379113.67 3736869.58 2.06376
379020.16 3736876.77 2.07679
378945.35 3736937.19 2.29791
378886.37 3736971.72 2.43773
378820.19 3736990.42 2.40157
378856.16 3737332.81 5.35759
378836.02 3737247.94 4.21609
378814.44 3737163.06 3.37912
378798.61 3737076.74 2.77214
378772.72 3736996.18 2.29972

**MODELOPTs: RegDFAULT CONC ELEV NODRYDPLT NOWETDPLT

*** THE PERIOD (26280 HRS) AVERAGE CONCENTRATION VALUES FOR SOURCE GROUP: SRCGP4 ***
INCLUDING SOURCE(S): STCK4 ,

*** DISCRETE CARTESIAN RECEPTOR POINTS ***

** CONC OF XOQ IN MICROGRAMS/M**3 **

X-COORD (M)	Y-COORD (M)	CONC
378877.74	3737400.43	17.60487
378926.65	3737406.18	23.81301
378978.44	3737414.82	40.04069
379007.21	3737384.60	61.64257
379021.60	3737354.39	91.53756
379035.98	3737322.74	142.04618
379047.49	3737286.78	136.48906
379077.70	3737266.64	134.03369
379105.04	3737250.81	90.72055
379132.37	3737230.67	52.66687
379161.14	3737209.09	34.07361
379187.04	3737190.39	26.29054
379221.57	3737167.37	18.76119
379250.34	3737147.23	13.69964
379280.55	3737127.09	10.87134
379286.30	3737076.74	7.97885
379296.38	3737039.33	6.42759
379306.45	3736994.74	5.25075
379316.52	3736953.02	4.44532
379328.02	3736908.42	3.76564
379342.41	3736865.26	3.21102
379345.29	3736829.30	2.89796
378886.37	3737242.18	16.93170
378910.82	3737340.01	23.16230
378982.75	3737327.06	49.61854
378981.32	3737220.60	30.51969

379057.56 3737190.39 34.54084
379120.86 3737151.55 21.47544
379172.65 3737118.46 14.16251
379224.44 3737076.74 9.26671
379260.41 3737022.07 6.51553
379290.62 3736973.16 5.02486
379287.74 3736883.96 3.72920
379197.11 3736869.58 4.07426
379191.36 3736964.53 5.86525
379149.64 3737023.51 8.33347
379089.21 3737070.98 12.10817
379018.72 3737108.39 15.63842
378946.79 3737131.41 14.63409
378866.23 3737155.86 11.58472
378840.33 3737065.23 7.71137
378932.40 3737033.58 8.76789
379007.21 3736999.05 8.12314
379067.63 3736951.58 6.43547
379113.67 3736869.58 4.46360
379020.16 3736876.77 4.77841
378945.35 3736937.19 5.82488
378886.37 3736971.72 6.20591
378820.19 3736990.42 5.76935
378856.16 3737332.81 15.64098
378836.02 3737247.94 12.98396
378814.44 3737163.06 9.53463
378798.61 3737076.74 7.01453
378772.72 3736996.18 5.23134

**MODELOPTs: RegDFAULT CONC ELEV NODRYDPLT NOWETDPLT

*** THE PERIOD (26280 HRS) AVERAGE CONCENTRATION VALUES FOR SOURCE GROUP: SRCGP5 ***
INCLUDING SOURCE(S): STCK5 ,

*** DISCRETE CARTESIAN RECEPTOR POINTS ***

** CONC OF XOQ IN MICROGRAMS/M**3 **

X-COORD (M)	Y-COORD (M)	CONC
378877.74	3737400.43	5.41544
378926.65	3737406.18	6.26584
378978.44	3737414.82	8.14889
379007.21	3737384.60	8.74329
379021.60	3737354.39	8.86444
379035.98	3737322.74	8.94946
379047.49	3737286.78	8.61122
379077.70	3737266.64	9.13997
379105.04	3737250.81	9.50631
379132.37	3737230.67	9.40838
379161.14	3737209.09	9.69928
379187.04	3737190.39	9.97389
379221.57	3737167.37	9.52499
379250.34	3737147.23	8.46119
379280.55	3737127.09	7.67547
379286.30	3737076.74	5.96727
379296.38	3737039.33	5.02511
379306.45	3736994.74	4.23060
379316.52	3736953.02	3.66003
379328.02	3736908.42	3.16422
379342.41	3736865.26	2.75692
379345.29	3736829.30	2.50074
378886.37	3737242.18	4.45690
378910.82	3737340.01	5.60081
378982.75	3737327.06	7.00015
378981.32	3737220.60	5.55657

379057.56 3737190.39 6.34237
379120.86 3737151.55 6.70269
379172.65 3737118.46 6.61084
379224.44 3737076.74 5.79211
379260.41 3737022.07 4.72968
379290.62 3736973.16 3.95511
379287.74 3736883.96 2.99752
379197.11 3736869.58 2.91806
379191.36 3736964.53 3.84094
379149.64 3737023.51 4.53306
379089.21 3737070.98 4.85103
379018.72 3737108.39 4.65733
378946.79 3737131.41 4.17112
378866.23 3737155.86 3.68143
378840.33 3737065.23 2.97005
378932.40 3737033.58 3.31436
379007.21 3736999.05 3.48968
379067.63 3736951.58 3.37354
379113.67 3736869.58 2.83523
379020.16 3736876.77 2.66727
378945.35 3736937.19 2.72665
378886.37 3736971.72 2.69356
378820.19 3736990.42 2.51808
378856.16 3737332.81 4.69353
378836.02 3737247.94 4.01103
378814.44 3737163.06 3.33733
378798.61 3737076.74 2.80331
378772.72 3736996.18 2.35567

**MODELOPTs: RegDFAULT CONC ELEV NODRYDPLT NOWETDPLT

*** THE PERIOD (26280 HRS) AVERAGE CONCENTRATION VALUES FOR SOURCE GROUP: SRCGP6 ***
INCLUDING SOURCE(S): STCK6 ,

*** DISCRETE CARTESIAN RECEPTOR POINTS ***

** CONC OF XOQ IN MICROGRAMS/M**3 **

X-COORD (M)	Y-COORD (M)	CONC
378877.74	3737400.43	6.85025
378926.65	3737406.18	8.15036
378978.44	3737414.82	10.59174
379007.21	3737384.60	12.74847
379021.60	3737354.39	14.47498
379035.98	3737322.74	16.91571
379047.49	3737286.78	19.24139
379077.70	3737266.64	24.79120
379105.04	3737250.81	31.01862
379132.37	3737230.67	37.45814
379161.14	3737209.09	47.53386
379187.04	3737190.39	56.29516
379221.57	3737167.37	53.78465
379250.34	3737147.23	39.93221
379280.55	3737127.09	29.35083
379286.30	3737076.74	17.59036
379296.38	3737039.33	12.81629
379306.45	3736994.74	9.48204
379316.52	3736953.02	7.46795
379328.02	3736908.42	5.96106
379342.41	3736865.26	4.86746
379345.29	3736829.30	4.24805
378886.37	3737242.18	7.36996
378910.82	3737340.01	8.10240
378982.75	3737327.06	11.44043
378981.32	3737220.60	11.44474

379057.56 3737190.39 16.88583
379120.86 3737151.55 22.13790
379172.65 3737118.46 23.88052
379224.44 3737076.74 18.56486
379260.41 3737022.07 12.08698
379290.62 3736973.16 8.64137
379287.74 3736883.96 5.66195
379197.11 3736869.58 5.67321
379191.36 3736964.53 8.80250
379149.64 3737023.51 11.70574
379089.21 3737070.98 12.42814
379018.72 3737108.39 10.64704
378946.79 3737131.41 8.40725
378866.23 3737155.86 6.50710
378840.33 3737065.23 5.17748
378932.40 3737033.58 6.29833
379007.21 3736999.05 7.11180
379067.63 3736951.58 7.05757
379113.67 3736869.58 5.50638
379020.16 3736876.77 4.96250
378945.35 3736937.19 4.93928
378886.37 3736971.72 4.72238
378820.19 3736990.42 4.22396
378856.16 3737332.81 6.52692
378836.02 3737247.94 6.17038
378814.44 3737163.06 5.47756
378798.61 3737076.74 4.69502
378772.72 3736996.18 3.82634

**MODELOPTs: RegDFAULT CONC ELEV NODRYDPLT NOWETDPLT

*** THE PERIOD (26280 HRS) AVERAGE CONCENTRATION VALUES FOR SOURCE GROUP: SRCGP7 ***
INCLUDING SOURCE(S): STCK7 ,

*** DISCRETE CARTESIAN RECEPTOR POINTS ***

** CONC OF XOQ IN MICROGRAMS/M**3 **

X-COORD (M)	Y-COORD (M)	CONC
378877.74	3737400.43	2.28779
378926.65	3737406.18	2.53391
378978.44	3737414.82	2.86247
379007.21	3737384.60	3.07220
379021.60	3737354.39	3.16752
379035.98	3737322.74	3.26704
379047.49	3737286.78	3.31765
379077.70	3737266.64	3.53857
379105.04	3737250.81	3.72947
379132.37	3737230.67	3.82874
379161.14	3737209.09	4.06706
379187.04	3737190.39	4.30544
379221.57	3737167.37	4.52822
379250.34	3737147.23	4.56974
379280.55	3737127.09	4.69265
379286.30	3737076.74	4.12588
379296.38	3737039.33	3.74669
379306.45	3736994.74	3.43653
379316.52	3736953.02	3.19618
379328.02	3736908.42	2.93797
379342.41	3736865.26	2.67621
379345.29	3736829.30	2.48362
378886.37	3737242.18	2.22504
378910.82	3737340.01	2.43192
378982.75	3737327.06	2.83148
378981.32	3737220.60	2.66090

379057.56 3737190.39 2.99070
379120.86 3737151.55 3.24856
379172.65 3737118.46 3.46486
379224.44 3737076.74 3.47719
379260.41 3737022.07 3.35973
379290.62 3736973.16 3.20335
379287.74 3736883.96 2.65102
379197.11 3736869.58 2.30960
379191.36 3736964.53 2.68162
379149.64 3737023.51 2.76952
379089.21 3737070.98 2.69041
379018.72 3737108.39 2.51694
378946.79 3737131.41 2.28509
378866.23 3737155.86 2.04338
378840.33 3737065.23 1.80426
378932.40 3737033.58 1.99133
379007.21 3736999.05 2.11444
379067.63 3736951.58 2.16079
379113.67 3736869.58 2.04854
379020.16 3736876.77 1.80189
378945.35 3736937.19 1.73935
378886.37 3736971.72 1.71289
378820.19 3736990.42 1.61582
378856.16 3737332.81 2.17205
378836.02 3737247.94 2.04078
378814.44 3737163.06 1.88042
378798.61 3737076.74 1.71432
378772.72 3736996.18 1.52847

**MODELOPTs: RegDFAULT CONC ELEV NODRYDPLT NOWETDPLT

*** THE PERIOD (26280 HRS) AVERAGE CONCENTRATION VALUES FOR SOURCE GROUP: SRCGP8 ***
INCLUDING SOURCE(S): STCK8 ,

*** DISCRETE CARTESIAN RECEPTOR POINTS ***

** CONC OF XOQ IN MICROGRAMS/M**3 **

X-COORD (M)	Y-COORD (M)	CONC
378877.74	3737400.43	4.81242
378926.65	3737406.18	5.60021
378978.44	3737414.82	6.55463
379007.21	3737384.60	7.81444
379021.60	3737354.39	8.82291
379035.98	3737322.74	10.11289
379047.49	3737286.78	11.59178
379077.70	3737266.64	14.38441
379105.04	3737250.81	17.61958
379132.37	3737230.67	21.27715
379161.14	3737209.09	30.23806
379187.04	3737190.39	45.57961
379221.57	3737167.37	81.16891
379250.34	3737147.23	131.45734
379280.55	3737127.09	270.33279
379286.30	3737076.74	95.20104
379296.38	3737039.33	50.53796
379306.45	3736994.74	28.28760
379316.52	3736953.02	18.61376
379328.02	3736908.42	12.94566
379342.41	3736865.26	9.57082
379345.29	3736829.30	7.83189
378886.37	3737242.18	5.81904
378910.82	3737340.01	5.81222
378982.75	3737327.06	7.71969
378981.32	3737220.60	8.71083

379057.56 3737190.39 12.90658
379120.86 3737151.55 20.73390
379172.65 3737118.46 33.91474
379224.44 3737076.74 49.57784
379260.41 3737022.07 36.85206
379290.62 3736973.16 22.93344
379287.74 3736883.96 11.48162
379197.11 3736869.58 10.06588
379191.36 3736964.53 17.03650
379149.64 3737023.51 18.91139
379089.21 3737070.98 15.21153
379018.72 3737108.39 10.70216
378946.79 3737131.41 7.72929
378866.23 3737155.86 5.71624
378840.33 3737065.23 5.12519
378932.40 3737033.58 6.84663
379007.21 3736999.05 8.51174
379067.63 3736951.58 9.44895
379113.67 3736869.58 8.27979
379020.16 3736876.77 6.33964
378945.35 3736937.19 5.75793
378886.37 3736971.72 5.28073
378820.19 3736990.42 4.51509
378856.16 3737332.81 4.88392
378836.02 3737247.94 4.93543
378814.44 3737163.06 4.79571
378798.61 3737076.74 4.51985
378772.72 3736996.18 3.98366

**MODELOPTs: RegDFAULT CONC ELEV NODRYDPLT NOWETDPLT

*** THE PERIOD (26280 HRS) AVERAGE CONCENTRATION VALUES FOR SOURCE GROUP: SRCGP9 ***
INCLUDING SOURCE(S): STCK9 ,

*** DISCRETE CARTESIAN RECEPTOR POINTS ***

** CONC OF XOQ IN MICROGRAMS/M**3 **

X-COORD (M)	Y-COORD (M)	CONC
378877.74	3737400.43	4.06145
378926.65	3737406.18	4.67357
378978.44	3737414.82	5.56791
379007.21	3737384.60	6.34893
379021.60	3737354.39	6.84139
379035.98	3737322.74	7.41053
379047.49	3737286.78	7.84063
379077.70	3737266.64	8.94967
379105.04	3737250.81	10.00703
379132.37	3737230.67	10.70297
379161.14	3737209.09	12.27901
379187.04	3737190.39	13.96115
379221.57	3737167.37	15.43992
379250.34	3737147.23	15.35271
379280.55	3737127.09	15.62014
379286.30	3737076.74	11.65410
379296.38	3737039.33	9.52545
379306.45	3736994.74	7.76604
379316.52	3736953.02	6.51873
379328.02	3736908.42	5.44485
379342.41	3736865.26	4.58427
379345.29	3736829.30	4.04551
378886.37	3737242.18	4.19746
378910.82	3737340.01	4.58857
378982.75	3737327.06	5.82748
378981.32	3737220.60	5.61705

379057.56 3737190.39 6.98878
379120.86 3737151.55 8.22821
379172.65 3737118.46 9.21886
379224.44 3737076.74 9.24696
379260.41 3737022.07 8.18623
379290.62 3736973.16 6.95981
379287.74 3736883.96 4.89336
379197.11 3736869.58 4.35453
379191.36 3736964.53 5.76257
379149.64 3737023.51 6.25862
379089.21 3737070.98 6.01344
379018.72 3737108.39 5.37185
378946.79 3737131.41 4.57532
378866.23 3737155.86 3.81483
378840.33 3737065.23 3.24628
378932.40 3737033.58 3.76857
379007.21 3736999.05 4.13163
379067.63 3736951.58 4.25218
379113.67 3736869.58 3.83696
379020.16 3736876.77 3.26220
378945.35 3736937.19 3.12735
378886.37 3736971.72 3.03975
378820.19 3736990.42 2.79412
378856.16 3737332.81 3.90601
378836.02 3737247.94 3.68868
378814.44 3737163.06 3.36152
378798.61 3737076.74 3.00627
378772.72 3736996.18 2.58365

**MODELOPTs: RegDFAULT CONC ELEV NODRYDPLT NOWETDPLT

*** THE PERIOD (26280 HRS) AVERAGE CONCENTRATION VALUES FOR SOURCE GROUP: SRCGP10 ***
INCLUDING SOURCE(S): STCK10 ,

*** DISCRETE CARTESIAN RECEPTOR POINTS ***

** CONC OF XOQ IN MICROGRAMS/M**3 **

X-COORD (M)	Y-COORD (M)	CONC
378877.74	3737400.43	2.46302
378926.65	3737406.18	2.97301
378978.44	3737414.82	3.10840
379007.21	3737384.60	3.77485
379021.60	3737354.39	4.21548
379035.98	3737322.74	4.56305
379047.49	3737286.78	5.01120
379077.70	3737266.64	5.80421
379105.04	3737250.81	6.87518
379132.37	3737230.67	8.81043
379161.14	3737209.09	10.44574
379187.04	3737190.39	10.95268
379221.57	3737167.37	14.27390
379250.34	3737147.23	20.74095
379280.55	3737127.09	28.10149
379286.30	3737076.74	29.31996
379296.38	3737039.33	27.24621
379306.45	3736994.74	23.69785
379316.52	3736953.02	20.10693
379328.02	3736908.42	16.28127
379342.41	3736865.26	12.93809
379345.29	3736829.30	10.65135
378886.37	3737242.18	3.63990
378910.82	3737340.01	3.20671
378982.75	3737327.06	4.39054
378981.32	3737220.60	4.95638

379057.56 3737190.39 6.70792
379120.86 3737151.55 9.19397
379172.65 3737118.46 12.51313
379224.44 3737076.74 16.60023
379260.41 3737022.07 19.45310
379290.62 3736973.16 19.30633
379287.74 3736883.96 12.34204
379197.11 3736869.58 8.59152
379191.36 3736964.53 11.21072
379149.64 3737023.51 10.40997
379089.21 3737070.98 8.13809
379018.72 3737108.39 6.12594
378946.79 3737131.41 4.73068
378866.23 3737155.86 3.67100
378840.33 3737065.23 3.52055
378932.40 3737033.58 4.57175
379007.21 3736999.05 5.69341
379067.63 3736951.58 6.63713
379113.67 3736869.58 6.49473
379020.16 3736876.77 4.93973
378945.35 3736937.19 4.29980
378886.37 3736971.72 3.85976
378820.19 3736990.42 3.29929
378856.16 3737332.81 2.77837
378836.02 3737247.94 3.16066
378814.44 3737163.06 3.17945
378798.61 3737076.74 3.15312
378772.72 3736996.18 2.94355

**MODELOPTs: RegDFAULT CONC ELEV NODRYDPLT NOWETDPLT

*** THE PERIOD (26280 HRS) AVERAGE CONCENTRATION VALUES FOR SOURCE GROUP: SRCGP11 ***
INCLUDING SOURCE(S): STCK11 ,

*** DISCRETE CARTESIAN RECEPTOR POINTS ***

** CONC OF XOQ IN MICROGRAMS/M**3 **

X-COORD (M)	Y-COORD (M)	CONC
378877.74	3737400.43	0.38382
378926.65	3737406.18	0.38992
378978.44	3737414.82	0.36551
379007.21	3737384.60	0.36869
379021.60	3737354.39	0.36540
379035.98	3737322.74	0.35548
379047.49	3737286.78	0.34745
379077.70	3737266.64	0.34156
379105.04	3737250.81	0.34100
379132.37	3737230.67	0.34844
379161.14	3737209.09	0.33449
379187.04	3737190.39	0.31705
379221.57	3737167.37	0.30960
379250.34	3737147.23	0.31674
379280.55	3737127.09	0.31268
379286.30	3737076.74	0.31523
379296.38	3737039.33	0.31649
379306.45	3736994.74	0.30995
379316.52	3736953.02	0.30211
379328.02	3736908.42	0.29445
379342.41	3736865.26	0.28799
379345.29	3736829.30	0.28203
378886.37	3737242.18	0.37669
378910.82	3737340.01	0.38354
378982.75	3737327.06	0.37732
378981.32	3737220.60	0.36284

379057.56 3737190.39 0.35869
379120.86 3737151.55 0.34765
379172.65 3737118.46 0.33621
379224.44 3737076.74 0.33178
379260.41 3737022.07 0.31893
379290.62 3736973.16 0.30808
379287.74 3736883.96 0.29471
379197.11 3736869.58 0.29954
379191.36 3736964.53 0.31608
379149.64 3737023.51 0.32829
379089.21 3737070.98 0.33868
379018.72 3737108.39 0.34643
378946.79 3737131.41 0.35354
378866.23 3737155.86 0.36130
378840.33 3737065.23 0.35060
378932.40 3737033.58 0.33982
379007.21 3736999.05 0.33246
379067.63 3736951.58 0.32228
379113.67 3736869.58 0.30578
379020.16 3736876.77 0.31287
378945.35 3736937.19 0.32888
378886.37 3736971.72 0.33561
378820.19 3736990.42 0.34153
378856.16 3737332.81 0.38856
378836.02 3737247.94 0.37823
378814.44 3737163.06 0.36771
378798.61 3737076.74 0.35639
378772.72 3736996.18 0.34634

**MODELOPTs: RegDFAULT CONC ELEV NODRYDPLT NOWETDPLT

*** THE PERIOD (26280 HRS) AVERAGE CONCENTRATION VALUES FOR SOURCE GROUP: SRCGP12 ***
INCLUDING SOURCE(S): STCK12 ,

*** DISCRETE CARTESIAN RECEPTOR POINTS ***

** CONC OF XOQ IN MICROGRAMS/M**3 **

X-COORD (M)	Y-COORD (M)	CONC
378877.74	3737400.43	2.21725
378926.65	3737406.18	2.44891
378978.44	3737414.82	2.74182
379007.21	3737384.60	2.99647
379021.60	3737354.39	3.15270
379035.98	3737322.74	3.32715
379047.49	3737286.78	3.47451
379077.70	3737266.64	3.79439
379105.04	3737250.81	4.09611
379132.37	3737230.67	4.34214
379161.14	3737209.09	4.81475
379187.04	3737190.39	5.32125
379221.57	3737167.37	5.92126
379250.34	3737147.23	6.23010
379280.55	3737127.09	6.66059
379286.30	3737076.74	5.89369
379296.38	3737039.33	5.36420
379306.45	3736994.74	4.93603
379316.52	3736953.02	4.60245
379328.02	3736908.42	4.24156
379342.41	3736865.26	3.88448
379345.29	3736829.30	3.58680
378886.37	3737242.18	2.32657
378910.82	3737340.01	2.43205
378982.75	3737327.06	2.86387
378981.32	3737220.60	2.86824

379057.56 3737190.39 3.38377
379120.86 3737151.55 3.93927
379172.65 3737118.46 4.46639
379224.44 3737076.74 4.70332
379260.41 3737022.07 4.66574
379290.62 3736973.16 4.52857
379287.74 3736883.96 3.69422
379197.11 3736869.58 3.04570
379191.36 3736964.53 3.55415
379149.64 3737023.51 3.60069
379089.21 3737070.98 3.36031
379018.72 3737108.39 2.97205
378946.79 3737131.41 2.57602
378866.23 3737155.86 2.21618
378840.33 3737065.23 2.03259
378932.40 3737033.58 2.35294
379007.21 3736999.05 2.59460
379067.63 3736951.58 2.71504
379113.67 3736869.58 2.60634
379020.16 3736876.77 2.22301
378945.35 3736937.19 2.10232
378886.37 3736971.72 2.02891
378820.19 3736990.42 1.86614
378856.16 3737332.81 2.17526
378836.02 3737247.94 2.11517
378814.44 3737163.06 2.00963
378798.61 3737076.74 1.89679
378772.72 3736996.18 1.73678

**MODELOPTs: RegDFAULT CONC ELEV NODRYDPLT NOWETDPLT

*** THE PERIOD (26280 HRS) AVERAGE CONCENTRATION VALUES FOR SOURCE GROUP: SRCGP13 ***
INCLUDING SOURCE(S): STCK13 ,

*** DISCRETE CARTESIAN RECEPTOR POINTS ***

** CONC OF XOQ IN MICROGRAMS/M**3 **

X-COORD (M)	Y-COORD (M)	CONC
378877.74	3737400.43	1.97383
378926.65	3737406.18	2.34674
378978.44	3737414.82	2.33647
379007.21	3737384.60	2.85460
379021.60	3737354.39	3.03806
379035.98	3737322.74	3.23435
379047.49	3737286.78	3.43297
379077.70	3737266.64	3.79265
379105.04	3737250.81	4.16193
379132.37	3737230.67	4.54276
379161.14	3737209.09	5.12627
379187.04	3737190.39	5.73111
379221.57	3737167.37	6.64522
379250.34	3737147.23	7.44648
379280.55	3737127.09	8.47301
379286.30	3737076.74	8.16439
379296.38	3737039.33	7.78737
379306.45	3736994.74	7.39957
379316.52	3736953.02	6.97922
379328.02	3736908.42	6.44831
379342.41	3736865.26	5.90661
379345.29	3736829.30	5.40903
378886.37	3737242.18	2.37787
378910.82	3737340.01	2.38329
378982.75	3737327.06	2.82142
378981.32	3737220.60	2.98338

379057.56 3737190.39 3.63535
379120.86 3737151.55 4.42439
379172.65 3737118.46 5.28947
379224.44 3737076.74 6.04910
379260.41 3737022.07 6.57171
379290.62 3736973.16 6.69469
379287.74 3736883.96 5.38692
379197.11 3736869.58 4.17879
379191.36 3736964.53 4.83957
379149.64 3737023.51 4.58990
379089.21 3737070.98 3.96819
379018.72 3737108.39 3.33062
378946.79 3737131.41 2.80210
378866.23 3737155.86 2.34993
378840.33 3737065.23 2.22562
378932.40 3737033.58 2.67258
379007.21 3736999.05 3.09347
379067.63 3736951.58 3.43244
379113.67 3736869.58 3.42936
379020.16 3736876.77 2.80698
378945.35 3736937.19 2.51726
378886.37 3736971.72 2.34006
378820.19 3736990.42 2.09338
378856.16 3737332.81 2.13706
378836.02 3737247.94 2.14522
378814.44 3737163.06 2.11154
378798.61 3737076.74 2.05346
378772.72 3736996.18 1.92276

**MODELOPTs: RegDFAULT CONC ELEV NODRYDPLT NOWETDPLT

*** THE PERIOD (26280 HRS) AVERAGE CONCENTRATION VALUES FOR SOURCE GROUP: SRCGP14 ***
INCLUDING SOURCE(S): STCK14 ,

*** DISCRETE CARTESIAN RECEPTOR POINTS ***

** CONC OF XOQ IN MICROGRAMS/M**3 **

X-COORD (M)	Y-COORD (M)	CONC
378877.74	3737400.43	1.55644
378926.65	3737406.18	1.71447
378978.44	3737414.82	1.82466
379007.21	3737384.60	2.01894
379021.60	3737354.39	2.12401
379035.98	3737322.74	2.22114
379047.49	3737286.78	2.30564
379077.70	3737266.64	2.46859
379105.04	3737250.81	2.60148
379132.37	3737230.67	2.57922
379161.14	3737209.09	2.84856
379187.04	3737190.39	3.08977
379221.57	3737167.37	3.25415
379250.34	3737147.23	3.09661
379280.55	3737127.09	3.22676
379286.30	3737076.74	3.05053
379296.38	3737039.33	2.90383
379306.45	3736994.74	2.74650
379316.52	3736953.02	2.61960
379328.02	3736908.42	2.47855
379342.41	3736865.26	2.32450
379345.29	3736829.30	2.20188
378886.37	3737242.18	1.62634
378910.82	3737340.01	1.73115
378982.75	3737327.06	1.97970
378981.32	3737220.60	1.91209

379057.56 3737190.39 2.18057
379120.86 3737151.55 2.39921
379172.65 3737118.46 2.57072
379224.44 3737076.74 2.66773
379260.41 3737022.07 2.64255
379290.62 3736973.16 2.58844
379287.74 3736883.96 2.24400
379197.11 3736869.58 1.94509
379191.36 3736964.53 2.17759
379149.64 3737023.51 2.19741
379089.21 3737070.98 2.10161
379018.72 3737108.39 1.93446
378946.79 3737131.41 1.74258
378866.23 3737155.86 1.54465
378840.33 3737065.23 1.43206
378932.40 3737033.58 1.59968
379007.21 3736999.05 1.72156
379067.63 3736951.58 1.78096
379113.67 3736869.58 1.72815
379020.16 3736876.77 1.52937
378945.35 3736937.19 1.46876
378886.37 3736971.72 1.42326
378820.19 3736990.42 1.33008
378856.16 3737332.81 1.57846
378836.02 3737247.94 1.54078
378814.44 3737163.06 1.42804
378798.61 3737076.74 1.35736
378772.72 3736996.18 1.25663

**MODELOPTs: RegDFAULT CONC ELEV NODRYDPLT NOWETDPLT

*** THE PERIOD (26280 HRS) AVERAGE CONCENTRATION VALUES FOR SOURCE GROUP: SRCGP15 ***
INCLUDING SOURCE(S): STCK15 ,

*** DISCRETE CARTESIAN RECEPTOR POINTS ***

** CONC OF XOQ IN MICROGRAMS/M**3 **

X-COORD (M)	Y-COORD (M)	CONC
378877.74	3737400.43	1.60038
378926.65	3737406.18	1.89947
378978.44	3737414.82	1.85545
379007.21	3737384.60	2.25306
379021.60	3737354.39	2.36900
379035.98	3737322.74	2.48811
379047.49	3737286.78	2.60177
379077.70	3737266.64	2.81852
379105.04	3737250.81	3.03685
379132.37	3737230.67	3.26443
379161.14	3737209.09	3.56235
379187.04	3737190.39	3.84044
379221.57	3737167.37	4.25903
379250.34	3737147.23	4.63326
379280.55	3737127.09	5.05471
379286.30	3737076.74	4.84233
379296.38	3737039.33	4.59845
379306.45	3736994.74	4.35614
379316.52	3736953.02	4.14669
379328.02	3736908.42	3.89692
379342.41	3736865.26	3.62596
379345.29	3736829.30	3.40224
378886.37	3737242.18	1.88950
378910.82	3737340.01	1.91174
378982.75	3737327.06	2.21931
378981.32	3737220.60	2.29001

379057.56 3737190.39 2.69246
379120.86 3737151.55 3.12703
379172.65 3737118.46 3.56356
379224.44 3737076.74 3.89948
379260.41 3737022.07 4.05359
379290.62 3736973.16 4.04284
379287.74 3736883.96 3.41158
379197.11 3736869.58 2.81934
379191.36 3736964.53 3.19134
379149.64 3737023.51 3.11703
379089.21 3737070.98 2.81251
379018.72 3737108.39 2.45449
378946.79 3737131.41 2.13214
378866.23 3737155.86 1.84030
378840.33 3737065.23 1.73674
378932.40 3737033.58 2.02232
379007.21 3736999.05 2.27209
379067.63 3736951.58 2.44656
379113.67 3736869.58 2.41441
379020.16 3736876.77 2.05819
378945.35 3736937.19 1.90141
378886.37 3736971.72 1.79811
378820.19 3736990.42 1.63823
378856.16 3737332.81 1.73422
378836.02 3737247.94 1.72534
378814.44 3737163.06 1.67910
378798.61 3737076.74 1.62225
378772.72 3736996.18 1.52349

**MODELOPTs: RegDFAULT CONC ELEV NODRYDPLT NOWETDPLT

*** THE PERIOD (26280 HRS) AVERAGE CONCENTRATION VALUES FOR SOURCE GROUP: SRCGP16 ***
INCLUDING SOURCE(S): STCK16 ,

*** DISCRETE CARTESIAN RECEPTOR POINTS ***

** CONC OF XOQ IN MICROGRAMS/M**3 **

X-COORD (M)	Y-COORD (M)	CONC
378877.74	3737400.43	1.18572
378926.65	3737406.18	1.36266
378978.44	3737414.82	1.36342
379007.21	3737384.60	1.58038
379021.60	3737354.39	1.71021
379035.98	3737322.74	1.79436
379047.49	3737286.78	1.90600
379077.70	3737266.64	2.08265
379105.04	3737250.81	2.31731
379132.37	3737230.67	2.76206
379161.14	3737209.09	2.90143
379187.04	3737190.39	2.93581
379221.57	3737167.37	3.34281
379250.34	3737147.23	4.17443
379280.55	3737127.09	4.89249
379286.30	3737076.74	5.82969
379296.38	3737039.33	6.17571
379306.45	3736994.74	6.44868
379316.52	3736953.02	6.65607
379328.02	3736908.42	6.71925
379342.41	3736865.26	6.53587
379345.29	3736829.30	6.18852
378886.37	3737242.18	1.64243
378910.82	3737340.01	1.45113
378982.75	3737327.06	1.73947
378981.32	3737220.60	2.04555

379057.56 3737190.39 2.72562
379120.86 3737151.55 3.28339
379172.65 3737118.46 3.88402
379224.44 3737076.74 4.68363
379260.41 3737022.07 5.43358
379290.62 3736973.16 6.07252
379287.74 3736883.96 5.67744
379197.11 3736869.58 4.27889
379191.36 3736964.53 4.35636
379149.64 3737023.51 3.83637
379089.21 3737070.98 3.19598
379018.72 3737108.39 2.63375
378946.79 3737131.41 2.21879
378866.23 3737155.86 1.74644
378840.33 3737065.23 1.85822
378932.40 3737033.58 2.25829
379007.21 3736999.05 2.67973
379067.63 3736951.58 3.09730
379113.67 3736869.58 3.39980
379020.16 3736876.77 2.70308
378945.35 3736937.19 2.31210
378886.37 3736971.72 2.07782
378820.19 3736990.42 1.83145
378856.16 3737332.81 1.31829
378836.02 3737247.94 1.44124
378814.44 3737163.06 1.56631
378798.61 3737076.74 1.71367
378772.72 3736996.18 1.67978

**MODELOPTs: RegDFAULT CONC ELEV NODRYDPLT NOWETDPLT

*** THE PERIOD (26280 HRS) AVERAGE CONCENTRATION VALUES FOR SOURCE GROUP: SRCGP17 ***
INCLUDING SOURCE(S): STCK17 ,

*** DISCRETE CARTESIAN RECEPTOR POINTS ***

** CONC OF XOQ IN MICROGRAMS/M**3 **

X-COORD (M)	Y-COORD (M)	CONC
378877.74	3737400.43	1.01550
378926.65	3737406.18	1.11801
378978.44	3737414.82	1.12624
379007.21	3737384.60	1.27498
379021.60	3737354.39	1.36982
379035.98	3737322.74	1.44531
379047.49	3737286.78	1.53015
379077.70	3737266.64	1.64564
379105.04	3737250.81	1.76945
379132.37	3737230.67	1.92566
379161.14	3737209.09	2.05053
379187.04	3737190.39	2.15674
379221.57	3737167.37	2.36080
379250.34	3737147.23	2.56200
379280.55	3737127.09	2.74864
379286.30	3737076.74	2.65104
379296.38	3737039.33	2.65257
379306.45	3736994.74	2.60785
379316.52	3736953.02	2.55107
379328.02	3736908.42	2.46621
379342.41	3736865.26	2.35954
379345.29	3736829.30	2.25902
378886.37	3737242.18	1.26226
378910.82	3737340.01	1.19232
378982.75	3737327.06	1.36653
378981.32	3737220.60	1.48339

379057.56 3737190.39 1.70734
379120.86 3737151.55 1.91754
379172.65 3737118.46 2.11255
379224.44 3737076.74 2.32152
379260.41 3737022.07 2.43182
379290.62 3736973.16 2.47978
379287.74 3736883.96 2.23183
379197.11 3736869.58 1.90990
379191.36 3736964.53 2.05380
379149.64 3737023.51 1.97259
379089.21 3737070.98 1.79609
379018.72 3737108.39 1.59680
378946.79 3737131.41 1.42118
378866.23 3737155.86 1.26680
378840.33 3737065.23 1.20977
378932.40 3737033.58 1.38111
379007.21 3736999.05 1.53728
379067.63 3736951.58 1.65686
379113.67 3736869.58 1.67969
379020.16 3736876.77 1.46827
378945.35 3736937.19 1.35841
378886.37 3736971.72 1.27369
378820.19 3736990.42 1.16813
378856.16 3737332.81 1.10553
378836.02 3737247.94 1.16006
378814.44 3737163.06 1.17335
378798.61 3737076.74 1.14189
378772.72 3736996.18 1.09684

**MODELOPTs: RegDFAULT CONC ELEV NODRYDPLT NOWETDPLT

*** THE PERIOD (26280 HRS) AVERAGE CONCENTRATION VALUES FOR SOURCE GROUP: SRCGP18 ***
INCLUDING SOURCE(S): STCK18 ,

*** DISCRETE CARTESIAN RECEPTOR POINTS ***

** CONC OF XOQ IN MICROGRAMS/M**3 **

X-COORD (M)	Y-COORD (M)	CONC
378877.74	3737400.43	1.01750
378926.65	3737406.18	1.13621
378978.44	3737414.82	1.12713
379007.21	3737384.60	1.29273
379021.60	3737354.39	1.39857
379035.98	3737322.74	1.47700
379047.49	3737286.78	1.57496
379077.70	3737266.64	1.70559
379105.04	3737250.81	1.85816
379132.37	3737230.67	2.09907
379161.14	3737209.09	2.22135
379187.04	3737190.39	2.31228
379221.57	3737167.37	2.56966
379250.34	3737147.23	2.91065
379280.55	3737127.09	3.20589
379286.30	3737076.74	3.31767
379296.38	3737039.33	3.35584
379306.45	3736994.74	3.36227
379316.52	3736953.02	3.35226
379328.02	3736908.42	3.28576
379342.41	3736865.26	3.15186
379345.29	3736829.30	3.00816
378886.37	3737242.18	1.34725
378910.82	3737340.01	1.22419
378982.75	3737327.06	1.42319
378981.32	3737220.60	1.61273

379057.56 3737190.39 1.94204
379120.86 3737151.55 2.23121
379172.65 3737118.46 2.51246
379224.44 3737076.74 2.82170
379260.41 3737022.07 3.04311
379290.62 3736973.16 3.19612
379287.74 3736883.96 2.92473
379197.11 3736869.58 2.42304
379191.36 3736964.53 2.54407
379149.64 3737023.51 2.37651
379089.21 3737070.98 2.11233
379018.72 3737108.39 1.84184
378946.79 3737131.41 1.61333
378866.23 3737155.86 1.38210
378840.33 3737065.23 1.36858
378932.40 3737033.58 1.58850
379007.21 3736999.05 1.79772
379067.63 3736951.58 1.98003
379113.67 3736869.58 2.06893
379020.16 3736876.77 1.75511
378945.35 3736937.19 1.57812
378886.37 3736971.72 1.46264
378820.19 3736990.42 1.32765
378856.16 3737332.81 1.13187
378836.02 3737247.94 1.21734
378814.44 3737163.06 1.26725
378798.61 3737076.74 1.28325
378772.72 3736996.18 1.23915

**MODELOPTs: RegDFAULT CONC ELEV NODRYDPLT NOWETDPLT

*** THE PERIOD (26280 HRS) AVERAGE CONCENTRATION VALUES FOR SOURCE GROUP: SRCGP19 ***
INCLUDING SOURCE(S): STCK19 ,

*** DISCRETE CARTESIAN RECEPTOR POINTS ***

** CONC OF XOQ IN MICROGRAMS/M**3 **

X-COORD (M)	Y-COORD (M)	CONC
378877.74	3737400.43	0.72452
378926.65	3737406.18	0.80144
378978.44	3737414.82	0.78318
379007.21	3737384.60	0.89027
379021.60	3737354.39	0.95902
379035.98	3737322.74	1.00790
379047.49	3737286.78	1.07284
379077.70	3737266.64	1.15106
379105.04	3737250.81	1.24734
379132.37	3737230.67	1.41380
379161.14	3737209.09	1.47570
379187.04	3737190.39	1.49901
379221.57	3737167.37	1.64576
379250.34	3737147.23	1.90474
379280.55	3737127.09	2.10776
379286.30	3737076.74	2.33967
379296.38	3737039.33	2.48389
379306.45	3736994.74	2.55084
379316.52	3736953.02	2.59848
379328.02	3736908.42	2.63192
379342.41	3736865.26	2.63683
379345.29	3736829.30	2.58665
378886.37	3737242.18	0.98276
378910.82	3737340.01	0.87028
378982.75	3737327.06	0.99344
378981.32	3737220.60	1.15367

379057.56 3737190.39 1.37876
379120.86 3737151.55 1.59790
379172.65 3737118.46 1.80065
379224.44 3737076.74 2.11671
379260.41 3737022.07 2.30434
379290.62 3736973.16 2.46105
379287.74 3736883.96 2.39242
379197.11 3736869.58 1.99902
379191.36 3736964.53 2.00840
379149.64 3737023.51 1.84956
379089.21 3737070.98 1.62172
379018.72 3737108.39 1.39474
378946.79 3737131.41 1.21584
378866.23 3737155.86 1.04457
378840.33 3737065.23 1.09170
378932.40 3737033.58 1.27385
379007.21 3736999.05 1.45092
379067.63 3736951.58 1.60630
379113.67 3736869.58 1.71973
379020.16 3736876.77 1.47289
378945.35 3736937.19 1.31910
378886.37 3736971.72 1.21096
378820.19 3736990.42 1.09998
378856.16 3737332.81 0.81662
378836.02 3737247.94 0.89590
378814.44 3737163.06 0.96435
378798.61 3737076.74 1.02215
378772.72 3736996.18 1.03012

**MODELOPTs: RegDFAULT CONC ELEV NODRYDPLT NOWETDPLT

*** THE PERIOD (26280 HRS) AVERAGE CONCENTRATION VALUES FOR SOURCE GROUP: SRCGP20 ***
INCLUDING SOURCE(S): STCK20 ,

*** DISCRETE CARTESIAN RECEPTOR POINTS ***

** CONC OF XOQ IN MICROGRAMS/M**3 **

X-COORD (M)	Y-COORD (M)	CONC
378877.74	3737400.43	0.84189
378926.65	3737406.18	0.94731
378978.44	3737414.82	0.93982
379007.21	3737384.60	1.06535
379021.60	3737354.39	1.13805
379035.98	3737322.74	1.18179
379047.49	3737286.78	1.23963
379077.70	3737266.64	1.32863
379105.04	3737250.81	1.44761
379132.37	3737230.67	1.67581
379161.14	3737209.09	1.72612
379187.04	3737190.39	1.71955
379221.57	3737167.37	1.89071
379250.34	3737147.23	2.26137
379280.55	3737127.09	2.54584
379286.30	3737076.74	3.07353
379296.38	3737039.33	3.23635
379306.45	3736994.74	3.39112
379316.52	3736953.02	3.53879
379328.02	3736908.42	3.66320
379342.41	3736865.26	3.72275
379345.29	3736829.30	3.70302
378886.37	3737242.18	1.11880
378910.82	3737340.01	1.00122
378982.75	3737327.06	1.16341
378981.32	3737220.60	1.33662

379057.56 3737190.39 1.75844
379120.86 3737151.55 2.02819
379172.65 3737118.46 2.30019
379224.44 3737076.74 2.65225
379260.41 3737022.07 2.98022
379290.62 3736973.16 3.28440
379287.74 3736883.96 3.28523
379197.11 3736869.58 2.65774
379191.36 3736964.53 2.59347
379149.64 3737023.51 2.31744
379089.21 3737070.98 2.00263
379018.72 3737108.39 1.72018
378946.79 3737131.41 1.42733
378866.23 3737155.86 1.18649
378840.33 3737065.23 1.30993
378932.40 3737033.58 1.53724
379007.21 3736999.05 1.77289
379067.63 3736951.58 2.00924
379113.67 3736869.58 2.21671
379020.16 3736876.77 1.84144
378945.35 3736937.19 1.60146
378886.37 3736971.72 1.45549
378820.19 3736990.42 1.30737
378856.16 3737332.81 0.92488
378836.02 3737247.94 1.00091
378814.44 3737163.06 1.08340
378798.61 3737076.74 1.17651
378772.72 3736996.18 1.21649

**MODELOPTs: RegDFAULT CONC ELEV NODRYDPLT NOWETDPLT

*** THE PERIOD (26280 HRS) AVERAGE CONCENTRATION VALUES FOR SOURCE GROUP: SRCGP21 ***
INCLUDING SOURCE(S): STCK21 ,

*** DISCRETE CARTESIAN RECEPTOR POINTS ***

** CONC OF XOQ IN MICROGRAMS/M**3 **

X-COORD (M)	Y-COORD (M)	CONC
378877.74	3737400.43	5.90137
378926.65	3737406.18	6.34708
378978.44	3737414.82	7.37927
379007.21	3737384.60	6.45140
379021.60	3737354.39	5.71177
379035.98	3737322.74	5.13603
379047.49	3737286.78	4.54729
379077.70	3737266.64	4.23055
379105.04	3737250.81	3.93517
379132.37	3737230.67	3.52327
379161.14	3737209.09	3.31564
379187.04	3737190.39	3.19056
379221.57	3737167.37	2.91917
379250.34	3737147.23	2.60672
379280.55	3737127.09	2.39851
379286.30	3737076.74	2.06617
379296.38	3737039.33	1.84377
379306.45	3736994.74	1.66056
379316.52	3736953.02	1.52142
379328.02	3736908.42	1.38726
379342.41	3736865.26	1.26154
379345.29	3736829.30	1.18605
378886.37	3737242.18	3.56322
378910.82	3737340.01	4.94157
378982.75	3737327.06	4.94856
378981.32	3737220.60	3.50249

379057.56 3737190.39 3.14620
379120.86 3737151.55 2.76176
379172.65 3737118.46 2.47415
379224.44 3737076.74 2.11123
379260.41 3737022.07 1.82315
379290.62 3736973.16 1.61240
379287.74 3736883.96 1.36451
379197.11 3736869.58 1.41445
379191.36 3736964.53 1.69892
379149.64 3737023.51 1.97741
379089.21 3737070.98 2.27733
379018.72 3737108.39 2.55924
378946.79 3737131.41 2.72037
378866.23 3737155.86 2.83822
378840.33 3737065.23 2.26415
378932.40 3737033.58 2.14785
379007.21 3736999.05 1.96797
379067.63 3736951.58 1.74905
379113.67 3736869.58 1.46575
379020.16 3736876.77 1.51431
378945.35 3736937.19 1.70234
378886.37 3736971.72 1.85148
378820.19 3736990.42 1.91066
378856.16 3737332.81 4.51219
378836.02 3737247.94 3.49909
378814.44 3737163.06 2.78829
378798.61 3737076.74 2.27235
378772.72 3736996.18 1.89672

**MODELOPTs: RegDFAULT CONC ELEV NODRYDPLT NOWETDPLT

*** THE PERIOD (26280 HRS) AVERAGE CONCENTRATION VALUES FOR SOURCE GROUP: SRCGP22 ***
INCLUDING SOURCE(S): STCK22 ,

*** DISCRETE CARTESIAN RECEPTOR POINTS ***

** CONC OF XOQ IN MICROGRAMS/M**3 **

X-COORD (M)	Y-COORD (M)	CONC
378877.74	3737400.43	4.73417
378926.65	3737406.18	4.97721
378978.44	3737414.82	5.59997
379007.21	3737384.60	4.96410
379021.60	3737354.39	4.46201
379035.98	3737322.74	4.06905
379047.49	3737286.78	3.65893
379077.70	3737266.64	3.43544
379105.04	3737250.81	3.22453
379132.37	3737230.67	2.91955
379161.14	3737209.09	2.77526
379187.04	3737190.39	2.68809
379221.57	3737167.37	2.48526
379250.34	3737147.23	2.24302
379280.55	3737127.09	2.08012
379286.30	3737076.74	1.80931
379296.38	3737039.33	1.62370
379306.45	3736994.74	1.47219
379316.52	3736953.02	1.35710
379328.02	3736908.42	1.24450
379342.41	3736865.26	1.13667
379345.29	3736829.30	1.07250
378886.37	3737242.18	2.96987
378910.82	3737340.01	3.98643
378982.75	3737327.06	3.94016
378981.32	3737220.60	2.89816

379057.56 3737190.39 2.62320
379120.86 3737151.55 2.33745
379172.65 3737118.46 2.12264
379224.44 3737076.74 1.83442
379260.41 3737022.07 1.60421
379290.62 3736973.16 1.43194
379287.74 3736883.96 1.22416
379197.11 3736869.58 1.26422
379191.36 3736964.53 1.49902
379149.64 3737023.51 1.72311
379089.21 3737070.98 1.95908
379018.72 3737108.39 2.17964
378946.79 3737131.41 2.30927
378866.23 3737155.86 2.41643
378840.33 3737065.23 1.96370
378932.40 3737033.58 1.86046
379007.21 3736999.05 1.71232
379067.63 3736951.58 1.53516
379113.67 3736869.58 1.30363
379020.16 3736876.77 1.34114
378945.35 3736937.19 1.49433
378886.37 3736971.72 1.62225
378820.19 3736990.42 1.67753
378856.16 3737332.81 3.72021
378836.02 3737247.94 2.94835
378814.44 3737163.06 2.39246
378798.61 3737076.74 1.97796
378772.72 3736996.18 1.67203

**MODELOPTs: RegDFAULT CONC ELEV NODRYDPLT NOWETDPLT

*** THE PERIOD (26280 HRS) AVERAGE CONCENTRATION VALUES FOR SOURCE GROUP: SRCGP23 ***
INCLUDING SOURCE(S): STCK23 ,

*** DISCRETE CARTESIAN RECEPTOR POINTS ***

** CONC OF XOQ IN MICROGRAMS/M**3 **

X-COORD (M)	Y-COORD (M)	CONC
378877.74	3737400.43	5.03576
378926.65	3737406.18	5.48017
378978.44	3737414.82	6.45522
379007.21	3737384.60	5.85704
379021.60	3737354.39	5.29335
379035.98	3737322.74	4.83828
379047.49	3737286.78	4.33987
379077.70	3737266.64	4.09959
379105.04	3737250.81	3.86161
379132.37	3737230.67	3.49399
379161.14	3737209.09	3.32367
379187.04	3737190.39	3.22144
379221.57	3737167.37	2.97093
379250.34	3737147.23	2.66583
379280.55	3737127.09	2.46025
379286.30	3737076.74	2.11362
379296.38	3737039.33	1.88164
379306.45	3736994.74	1.69272
379316.52	3736953.02	1.55021
379328.02	3736908.42	1.41253
379342.41	3736865.26	1.28280
379345.29	3736829.30	1.20527
378886.37	3737242.18	3.26275
378910.82	3737340.01	4.39370
378982.75	3737327.06	4.54968
378981.32	3737220.60	3.31367

379057.56 3737190.39 3.05066
379120.86 3737151.55 2.73398
379172.65 3737118.46 2.48405
379224.44 3737076.74 2.13691
379260.41 3737022.07 1.85249
379290.62 3736973.16 1.64084
379287.74 3736883.96 1.38497
379197.11 3736869.58 1.42231
379191.36 3736964.53 1.70779
379149.64 3737023.51 1.97418
379089.21 3737070.98 2.24513
379018.72 3737108.39 2.48081
378946.79 3737131.41 2.59223
378866.23 3737155.86 2.64590
378840.33 3737065.23 2.13706
378932.40 3737033.58 2.06681
379007.21 3736999.05 1.91924
379067.63 3736951.58 1.72510
379113.67 3736869.58 1.45764
379020.16 3736876.77 1.48708
378945.35 3736937.19 1.65026
378886.37 3736971.72 1.78011
378820.19 3736990.42 1.81737
378856.16 3737332.81 3.96904
378836.02 3737247.94 3.16009
378814.44 3737163.06 2.56718
378798.61 3737076.74 2.12510
378772.72 3736996.18 1.79049

**MODELOPTs: RegDFAULT CONC ELEV NODRYDPLT NOWETDPLT

*** THE PERIOD (26280 HRS) AVERAGE CONCENTRATION VALUES FOR SOURCE GROUP: SRCGP24 ***
INCLUDING SOURCE(S): STCK24 ,

*** DISCRETE CARTESIAN RECEPTOR POINTS ***

** CONC OF XOQ IN MICROGRAMS/M**3 **

X-COORD (M)	Y-COORD (M)	CONC
378877.74	3737400.43	3.96737
378926.65	3737406.18	4.40468
378978.44	3737414.82	5.03743
379007.21	3737384.60	4.88961
379021.60	3737354.39	4.58856
379035.98	3737322.74	4.29767
379047.49	3737286.78	3.94668
379077.70	3737266.64	3.81779
379105.04	3737250.81	3.68337
379132.37	3737230.67	3.43160
379161.14	3737209.09	3.30133
379187.04	3737190.39	3.20042
379221.57	3737167.37	3.00084
379250.34	3737147.23	2.76493
379280.55	3737127.09	2.58343
379286.30	3737076.74	2.22632
379296.38	3737039.33	1.97798
379306.45	3736994.74	1.77670
379316.52	3736953.02	1.62724
379328.02	3736908.42	1.48126
379342.41	3736865.26	1.34007
379345.29	3736829.30	1.25742
378886.37	3737242.18	2.88685
378910.82	3737340.01	3.69512
378982.75	3737327.06	3.98479
378981.32	3737220.60	3.06160

379057.56 3737190.39 2.93660
379120.86 3737151.55 2.71191
379172.65 3737118.46 2.51920
379224.44 3737076.74 2.20105
379260.41 3737022.07 1.92625
379290.62 3736973.16 1.71500
379287.74 3736883.96 1.43996
379197.11 3736869.58 1.45525
379191.36 3736964.53 1.74430
379149.64 3737023.51 1.99424
379089.21 3737070.98 2.22442
379018.72 3737108.39 2.39798
378946.79 3737131.41 2.43742
378866.23 3737155.86 2.40375
378840.33 3737065.23 1.98558
378932.40 3737033.58 1.98063
379007.21 3736999.05 1.87941
379067.63 3736951.58 1.71574
379113.67 3736869.58 1.46768
379020.16 3736876.77 1.47119
378945.35 3736937.19 1.60285
378886.37 3736971.72 1.70723
378820.19 3736990.42 1.71276
378856.16 3737332.81 3.31833
378836.02 3737247.94 2.74643
378814.44 3737163.06 2.29816
378798.61 3737076.74 1.94998
378772.72 3736996.18 1.66939

**MODELOPTs: RegDFAULT CONC ELEV NODRYDPLT NOWETDPLT

*** THE PERIOD (26280 HRS) AVERAGE CONCENTRATION VALUES FOR SOURCE GROUP: SRCGP25 ***
INCLUDING SOURCE(S): STCK25 ,

*** DISCRETE CARTESIAN RECEPTOR POINTS ***

** CONC OF XOQ IN MICROGRAMS/M**3 **

X-COORD (M)	Y-COORD (M)	CONC
378877.74	3737400.43	3.92557
378926.65	3737406.18	4.22215
378978.44	3737414.82	4.76446
379007.21	3737384.60	4.41575
379021.60	3737354.39	4.06000
379035.98	3737322.74	3.76012
379047.49	3737286.78	3.42824
379077.70	3737266.64	3.27116
379105.04	3737250.81	3.11801
379132.37	3737230.67	2.86941
379161.14	3737209.09	2.75530
379187.04	3737190.39	2.67990
379221.57	3737167.37	2.50488
379250.34	3737147.23	2.28986
379280.55	3737127.09	2.13726
379286.30	3737076.74	1.85843
379296.38	3737039.33	1.66412
379306.45	3736994.74	1.50722
379316.52	3736953.02	1.38940
379328.02	3736908.42	1.27336
379342.41	3736865.26	1.16045
379345.29	3736829.30	1.09419
378886.37	3737242.18	2.68903
378910.82	3737340.01	3.49114
378982.75	3737327.06	3.57884
378981.32	3737220.60	2.71529

379057.56 3737190.39 2.52507
379120.86 3737151.55 2.30156
379172.65 3737118.46 2.12442
379224.44 3737076.74 1.85559
379260.41 3737022.07 1.63322
379290.62 3736973.16 1.46249
379287.74 3736883.96 1.24636
379197.11 3736869.58 1.27118
379191.36 3736964.53 1.50544
379149.64 3737023.51 1.71610
379089.21 3737070.98 1.92276
379018.72 3737108.39 2.09943
378946.79 3737131.41 2.18286
378866.23 3737155.86 2.22902
378840.33 3737065.23 1.83755
378932.40 3737033.58 1.77883
379007.21 3736999.05 1.66193
379067.63 3736951.58 1.50888
379113.67 3736869.58 1.29393
379020.16 3736876.77 1.31176
378945.35 3736937.19 1.44033
378886.37 3736971.72 1.55048
378820.19 3736990.42 1.58412
378856.16 3737332.81 3.21163
378836.02 3737247.94 2.62319
378814.44 3737163.06 2.17608
378798.61 3737076.74 1.83187
378772.72 3736996.18 1.56556

**MODELOPTs: RegDFAULT CONC ELEV NODRYDPLT NOWETDPLT

*** THE PERIOD (26280 HRS) AVERAGE CONCENTRATION VALUES FOR SOURCE GROUP: SRCGP26 ***
INCLUDING SOURCE(S): STCK26 ,

*** DISCRETE CARTESIAN RECEPTOR POINTS ***

** CONC OF XOQ IN MICROGRAMS/M**3 **

X-COORD (M)	Y-COORD (M)	CONC
378877.74	3737400.43	3.34362
378926.65	3737406.18	3.67182
378978.44	3737414.82	4.08390
379007.21	3737384.60	3.96971
379021.60	3737354.39	3.74246
379035.98	3737322.74	3.51757
379047.49	3737286.78	3.25376
379077.70	3737266.64	3.15212
379105.04	3737250.81	3.05352
379132.37	3737230.67	2.87506
379161.14	3737209.09	2.77184
379187.04	3737190.39	2.68785
379221.57	3737167.37	2.53938
379250.34	3737147.23	2.37014
379280.55	3737127.09	2.23322
379286.30	3737076.74	1.95358
379296.38	3737039.33	1.75352
379306.45	3736994.74	1.58757
379316.52	3736953.02	1.46304
379328.02	3736908.42	1.34002
379342.41	3736865.26	1.21921
379345.29	3736829.30	1.14803
378886.37	3737242.18	2.49927
378910.82	3737340.01	3.13102
378982.75	3737327.06	3.32407
378981.32	3737220.60	2.61212

379057.56 3737190.39 2.50687
379120.86 3737151.55 2.32989
379172.65 3737118.46 2.17942
379224.44 3737076.74 1.92989
379260.41 3737022.07 1.70835
379290.62 3736973.16 1.53506
379287.74 3736883.96 1.30283
379197.11 3736869.58 1.31302
379191.36 3736964.53 1.55485
379149.64 3737023.51 1.75898
379089.21 3737070.98 1.94423
379018.72 3737108.39 2.08454
378946.79 3737131.41 2.12248
378866.23 3737155.86 2.10731
378840.33 3737065.23 1.76439
378932.40 3737033.58 1.75134
379007.21 3736999.05 1.66504
379067.63 3736951.58 1.52915
379113.67 3736869.58 1.32186
379020.16 3736876.77 1.32440
378945.35 3736937.19 1.43671
378886.37 3736971.72 1.52731
378820.19 3736990.42 1.53666
378856.16 3737332.81 2.85231
378836.02 3737247.94 2.39515
378814.44 3737163.06 2.02947
378798.61 3737076.74 1.73989
378772.72 3736996.18 1.50413

**MODELOPTs: RegDFAULT CONC ELEV NODRYDPLT NOWETDPLT

*** THE PERIOD (26280 HRS) AVERAGE CONCENTRATION VALUES FOR SOURCE GROUP: SRCGP27 ***
INCLUDING SOURCE(S): VOL1 ,

*** DISCRETE CARTESIAN RECEPTOR POINTS ***

** CONC OF XOQ IN MICROGRAMS/M**3 **

X-COORD (M)	Y-COORD (M)	CONC
378877.74	3737400.43	2.07506
378926.65	3737406.18	1.93163
378978.44	3737414.82	1.92511
379007.21	3737384.60	1.69611
379021.60	3737354.39	1.55952
379035.98	3737322.74	1.45701
379047.49	3737286.78	1.35382
379077.70	3737266.64	1.26734
379105.04	3737250.81	1.18926
379132.37	3737230.67	1.08825
379161.14	3737209.09	1.04412
379187.04	3737190.39	1.02085
379221.57	3737167.37	0.95871
379250.34	3737147.23	0.88039
379280.55	3737127.09	0.82969
379286.30	3737076.74	0.75238
379296.38	3737039.33	0.69504
379306.45	3736994.74	0.64905
379316.52	3736953.02	0.61323
379328.02	3736908.42	0.57640
379342.41	3736865.26	0.53875
379345.29	3736829.30	0.51730
378886.37	3737242.18	1.41337
378910.82	3737340.01	1.69673
378982.75	3737327.06	1.50850
378981.32	3737220.60	1.23898

379057.56 3737190.39 1.07375
379120.86 3737151.55 0.95219
379172.65 3737118.46 0.87070
379224.44 3737076.74 0.77058
379260.41 3737022.07 0.69738
379290.62 3736973.16 0.64058
379287.74 3736883.96 0.57689
379197.11 3736869.58 0.61106
379191.36 3736964.53 0.68656
379149.64 3737023.51 0.76920
379089.21 3737070.98 0.86959
379018.72 3737108.39 0.98727
378946.79 3737131.41 1.09907
378866.23 3737155.86 1.24026
378840.33 3737065.23 1.08205
378932.40 3737033.58 0.95325
379007.21 3736999.05 0.84374
379067.63 3736951.58 0.74888
379113.67 3736869.58 0.65065
379020.16 3736876.77 0.70209
378945.35 3736937.19 0.79988
378886.37 3736971.72 0.89270
378820.19 3736990.42 0.97010
378856.16 3737332.81 1.77218
378836.02 3737247.94 1.51330
378814.44 3737163.06 1.30954
378798.61 3737076.74 1.13595
378772.72 3736996.18 1.00977

**MODELOPTs: RegDFAULT CONC ELEV NODRYDPLT NOWETDPLT

*** THE PERIOD (26280 HRS) AVERAGE CONCENTRATION VALUES FOR SOURCE GROUP: SRCGP28 ***
INCLUDING SOURCE(S): VOL2 ,

*** DISCRETE CARTESIAN RECEPTOR POINTS ***

** CONC OF XOQ IN MICROGRAMS/M**3 **

X-COORD (M)	Y-COORD (M)	CONC
378877.74	3737400.43	2.31891
378926.65	3737406.18	2.15853
378978.44	3737414.82	2.15331
379007.21	3737384.60	1.88366
379021.60	3737354.39	1.72380
379035.98	3737322.74	1.60363
379047.49	3737286.78	1.48371
379077.70	3737266.64	1.38401
379105.04	3737250.81	1.29476
379132.37	3737230.67	1.18122
379161.14	3737209.09	1.12956
379187.04	3737190.39	1.10208
379221.57	3737167.37	1.03182
379250.34	3737147.23	0.94461
379280.55	3737127.09	0.88810
379286.30	3737076.74	0.80352
379296.38	3737039.33	0.74154
379306.45	3736994.74	0.69117
379316.52	3736953.02	0.65173
379328.02	3736908.42	0.61146
379342.41	3736865.26	0.57086
379345.29	3736829.30	0.54746
378886.37	3737242.18	1.54910
378910.82	3737340.01	1.87943
378982.75	3737327.06	1.66568
378981.32	3737220.60	1.35365

379057.56 3737190.39 1.16759
379120.86 3737151.55 1.02934
379172.65 3737118.46 0.93673
379224.44 3737076.74 0.82615
379260.41 3737022.07 0.74464
379290.62 3736973.16 0.68190
379287.74 3736883.96 0.61226
379197.11 3736869.58 0.64976
379191.36 3736964.53 0.73312
379149.64 3737023.51 0.82478
379089.21 3737070.98 0.93682
379018.72 3737108.39 1.06835
378946.79 3737131.41 1.19289
378866.23 3737155.86 1.34829
378840.33 3737065.23 1.16814
378932.40 3737033.58 1.02773
379007.21 3736999.05 0.90738
379067.63 3736951.58 0.80239
379113.67 3736869.58 0.69368
379020.16 3736876.77 0.75065
378945.35 3736937.19 0.85901
378886.37 3736971.72 0.95933
378820.19 3736990.42 1.04230
378856.16 3737332.81 1.96016
378836.02 3737247.94 1.65759
378814.44 3737163.06 1.42289
378798.61 3737076.74 1.22614
378772.72 3736996.18 1.08403

**MODELOPTs: RegDFAULT CONC ELEV NODRYDPLT NOWETDPLT

*** THE PERIOD (26280 HRS) AVERAGE CONCENTRATION VALUES FOR SOURCE GROUP: SRCGP29 ***
INCLUDING SOURCE(S): VOL3 ,

*** DISCRETE CARTESIAN RECEPTOR POINTS ***

** CONC OF XOQ IN MICROGRAMS/M**3 **

X-COORD (M)	Y-COORD (M)	CONC
378877.74	3737400.43	2.38527
378926.65	3737406.18	2.24434
378978.44	3737414.82	2.25991
379007.21	3737384.60	1.97956
379021.60	3737354.39	1.81011
379035.98	3737322.74	1.68243
379047.49	3737286.78	1.55446
379077.70	3737266.64	1.44993
379105.04	3737250.81	1.35563
379132.37	3737230.67	1.23490
379161.14	3737209.09	1.17954
379187.04	3737190.39	1.14960
379221.57	3737167.37	1.07424
379250.34	3737147.23	0.98146
379280.55	3737127.09	0.92111
379286.30	3737076.74	0.83202
379296.38	3737039.33	0.76673
379306.45	3736994.74	0.71378
379316.52	3736953.02	0.67237
379328.02	3736908.42	0.63015
379342.41	3736865.26	0.58762
379345.29	3736829.30	0.56322
378886.37	3737242.18	1.59118
378910.82	3737340.01	1.94341
378982.75	3737327.06	1.73926
378981.32	3737220.60	1.40594

379057.56 3737190.39 1.21692
379120.86 3737151.55 1.07243
379172.65 3737118.46 0.97441
379224.44 3737076.74 0.85693
379260.41 3737022.07 0.77058
379290.62 3736973.16 0.70432
379287.74 3736883.96 0.63145
379197.11 3736869.58 0.67115
379191.36 3736964.53 0.75893
379149.64 3737023.51 0.85551
379089.21 3737070.98 0.97275
379018.72 3737108.39 1.10770
378946.79 3737131.41 1.23071
378866.23 3737155.86 1.37935
378840.33 3737065.23 1.19022
378932.40 3737033.58 1.05606
379007.21 3736999.05 0.93655
379067.63 3736951.58 0.82933
379113.67 3736869.58 0.71621
379020.16 3736876.77 0.77255
378945.35 3736937.19 0.88103
378886.37 3736971.72 0.98038
378820.19 3736990.42 1.05920
378856.16 3737332.81 2.00587
378836.02 3737247.94 1.68966
378814.44 3737163.06 1.44578
378798.61 3737076.74 1.24354
378772.72 3736996.18 1.09655

**MODELOPTs: RegDFAULT CONC ELEV NODRYDPLT NOWETDPLT

*** THE PERIOD (26280 HRS) AVERAGE CONCENTRATION VALUES FOR SOURCE GROUP: SRCGP30 ***
INCLUDING SOURCE(S): PAREA1 ,

*** DISCRETE CARTESIAN RECEPTOR POINTS ***

** CONC OF XOQ IN MICROGRAMS/M**3 **

X-COORD (M)	Y-COORD (M)	CONC
378877.74	3737400.43	0.27861
378926.65	3737406.18	0.29638
378978.44	3737414.82	0.29112
379007.21	3737384.60	0.31557
379021.60	3737354.39	0.33021
379035.98	3737322.74	0.33937
379047.49	3737286.78	0.35064
379077.70	3737266.64	0.36358
379105.04	3737250.81	0.37969
379132.37	3737230.67	0.40810
379161.14	3737209.09	0.41320
379187.04	3737190.39	0.41016
379221.57	3737167.37	0.42675
379250.34	3737147.23	0.46319
379280.55	3737127.09	0.48569
379286.30	3737076.74	0.52164
379296.38	3737039.33	0.55327
379306.45	3736994.74	0.57782
379316.52	3736953.02	0.59588
379328.02	3736908.42	0.61804
379342.41	3736865.26	0.64981
379345.29	3736829.30	0.66221
378886.37	3737242.18	0.33885
378910.82	3737340.01	0.31304
378982.75	3737327.06	0.33837
378981.32	3737220.60	0.37011

379057.56 3737190.39 0.40899
379120.86 3737151.55 0.44079
379172.65 3737118.46 0.46601
379224.44 3737076.74 0.51155
379260.41 3737022.07 0.54440
379290.62 3736973.16 0.57592
379287.74 3736883.96 0.60469
379197.11 3736869.58 0.55866
379191.36 3736964.53 0.53055
379149.64 3737023.51 0.49293
379089.21 3737070.98 0.45462
379018.72 3737108.39 0.41679
378946.79 3737131.41 0.38633
378866.23 3737155.86 0.35329
378840.33 3737065.23 0.37070
378932.40 3737033.58 0.40796
379007.21 3736999.05 0.44563
379067.63 3736951.58 0.48327
379113.67 3736869.58 0.52441
379020.16 3736876.77 0.49092
378945.35 3736937.19 0.45356
378886.37 3736971.72 0.41333
378820.19 3736990.42 0.38504
378856.16 3737332.81 0.30147
378836.02 3737247.94 0.32018
378814.44 3737163.06 0.33754
378798.61 3737076.74 0.35639
378772.72 3736996.18 0.36993

**MODELOPTs: RegDFAULT CONC ELEV NODRYDPLT NOWETDPLT

*** THE PERIOD (26280 HRS) AVERAGE CONCENTRATION VALUES FOR SOURCE GROUP: SRCGP31 ***
INCLUDING SOURCE(S): STCK27 ,

*** DISCRETE CARTESIAN RECEPTOR POINTS ***

** CONC OF XOQ IN MICROGRAMS/M**3 **

X-COORD (M)	Y-COORD (M)	CONC
378877.74	3737400.43	1.12675
378926.65	3737406.18	1.43281
378978.44	3737414.82	2.30697
379007.21	3737384.60	3.00619
379021.60	3737354.39	3.52596
379035.98	3737322.74	4.14345
379047.49	3737286.78	3.88489
379077.70	3737266.64	3.61037
379105.04	3737250.81	2.73265
379132.37	3737230.67	1.84663
379161.14	3737209.09	1.35474
379187.04	3737190.39	1.11157
379221.57	3737167.37	0.88098
379250.34	3737147.23	0.73602
379280.55	3737127.09	0.66201
379286.30	3737076.74	0.52296
379296.38	3737039.33	0.47308
379306.45	3736994.74	0.44331
379316.52	3736953.02	0.42824
379328.02	3736908.42	0.41771
379342.41	3736865.26	0.40905
379345.29	3736829.30	0.40603
378886.37	3737242.18	1.11676
378910.82	3737340.01	1.35238
378982.75	3737327.06	2.31076
378981.32	3737220.60	1.52175

379057.56 3737190.39 1.51633
379120.86 3737151.55 0.99900
379172.65 3737118.46 0.70787
379224.44 3737076.74 0.53753
379260.41 3737022.07 0.46742
379290.62 3736973.16 0.43858
379287.74 3736883.96 0.43203
379197.11 3736869.58 0.51507
379191.36 3736964.53 0.51705
379149.64 3737023.51 0.59837
379089.21 3737070.98 0.77493
379018.72 3737108.39 0.97528
378946.79 3737131.41 1.00446
378866.23 3737155.86 0.95003
378840.33 3737065.23 0.91152
378932.40 3737033.58 0.90824
379007.21 3736999.05 0.82402
379067.63 3736951.58 0.71234
379113.67 3736869.58 0.63217
379020.16 3736876.77 0.77818
378945.35 3736937.19 0.88411
378886.37 3736971.72 0.92833
378820.19 3736990.42 0.93470
378856.16 3737332.81 1.05116
378836.02 3737247.94 0.99617
378814.44 3737163.06 0.92198
378798.61 3737076.74 0.90751
378772.72 3736996.18 0.92994

**MODELOPTs: RegDFAULT CONC ELEV NODRYDPLT NOWETDPLT

*** THE PERIOD (26280 HRS) AVERAGE CONCENTRATION VALUES FOR SOURCE GROUP: SRCGP32 ***
INCLUDING SOURCE(S): STCK32 ,

*** DISCRETE CARTESIAN RECEPTOR POINTS ***

** CONC OF XOQ IN MICROGRAMS/M**3 **

X-COORD (M)	Y-COORD (M)	CONC
378877.74	3737400.43	0.04077
378926.65	3737406.18	0.04055
378978.44	3737414.82	0.04184
379007.21	3737384.60	0.04191
379021.60	3737354.39	0.04229
379035.98	3737322.74	0.04305
379047.49	3737286.78	0.04373
379077.70	3737266.64	0.04435
379105.04	3737250.81	0.04461
379132.37	3737230.67	0.04433
379161.14	3737209.09	0.04548
379187.04	3737190.39	0.04696
379221.57	3737167.37	0.04771
379250.34	3737147.23	0.04716
379280.55	3737127.09	0.04748
379286.30	3737076.74	0.04712
379296.38	3737039.33	0.04678
379306.45	3736994.74	0.04706
379316.52	3736953.02	0.04746
379328.02	3736908.42	0.04778
379342.41	3736865.26	0.04791
379345.29	3736829.30	0.04813
378886.37	3737242.18	0.04163
378910.82	3737340.01	0.04109
378982.75	3737327.06	0.04164
378981.32	3737220.60	0.04272

379057.56 3737190.39 0.04335
379120.86 3737151.55 0.04440
379172.65 3737118.46 0.04541
379224.44 3737076.74 0.04571
379260.41 3737022.07 0.04652
379290.62 3736973.16 0.04712
379287.74 3736883.96 0.04763
379197.11 3736869.58 0.04719
379191.36 3736964.53 0.04643
379149.64 3737023.51 0.04567
379089.21 3737070.98 0.04480
379018.72 3737108.39 0.04397
378946.79 3737131.41 0.04321
378866.23 3737155.86 0.04248
378840.33 3737065.23 0.04298
378932.40 3737033.58 0.04393
379007.21 3736999.05 0.04468
379067.63 3736951.58 0.04551
379113.67 3736869.58 0.04650
379020.16 3736876.77 0.04559
378945.35 3736937.19 0.04436
378886.37 3736971.72 0.04386
378820.19 3736990.42 0.04332
378856.16 3737332.81 0.04075
378836.02 3737247.94 0.04142
378814.44 3737163.06 0.04199
378798.61 3737076.74 0.04253
378772.72 3736996.18 0.04289

**MODELOPTs: RegDFAULT CONC ELEV NODRYDPLT NOWETDPLT

*** THE PERIOD (26280 HRS) AVERAGE CONCENTRATION VALUES FOR SOURCE GROUP: SRCGP33 ***
INCLUDING SOURCE(S): STCK33 ,

*** DISCRETE CARTESIAN RECEPTOR POINTS ***

** CONC OF XOQ IN MICROGRAMS/M**3 **

X-COORD (M)	Y-COORD (M)	CONC
378877.74	3737400.43	0.30847
378926.65	3737406.18	0.32361
378978.44	3737414.82	0.32610
379007.21	3737384.60	0.34458
379021.60	3737354.39	0.35548
379035.98	3737322.74	0.36332
379047.49	3737286.78	0.37157
379077.70	3737266.64	0.38256
379105.04	3737250.81	0.39441
379132.37	3737230.67	0.41266
379161.14	3737209.09	0.41810
379187.04	3737190.39	0.41991
379221.57	3737167.37	0.43133
379250.34	3737147.23	0.44988
379280.55	3737127.09	0.46183
379286.30	3737076.74	0.47403
379296.38	3737039.33	0.48984
379306.45	3736994.74	0.49699
379316.52	3736953.02	0.49906
379328.02	3736908.42	0.50357
379342.41	3736865.26	0.51873
379345.29	3736829.30	0.51982
378886.37	3737242.18	0.34803
378910.82	3737340.01	0.33362
378982.75	3737327.06	0.35619
378981.32	3737220.60	0.37520

379057.56 3737190.39 0.40498
379120.86 3737151.55 0.42685
379172.65 3737118.46 0.44206
379224.44 3737076.74 0.46944
379260.41 3737022.07 0.48146
379290.62 3736973.16 0.49139
379287.74 3736883.96 0.49180
379197.11 3736869.58 0.46114
379191.36 3736964.53 0.46199
379149.64 3737023.51 0.44745
379089.21 3737070.98 0.42647
379018.72 3737108.39 0.40174
378946.79 3737131.41 0.37925
378866.23 3737155.86 0.35358
378840.33 3737065.23 0.35880
378932.40 3737033.58 0.38536
379007.21 3736999.05 0.41003
379067.63 3736951.58 0.42928
379113.67 3736869.58 0.44174
379020.16 3736876.77 0.42328
378945.35 3736937.19 0.40780
378886.37 3736971.72 0.38245
378820.19 3736990.42 0.36223
378856.16 3737332.81 0.32165
378836.02 3737247.94 0.33200
378814.44 3737163.06 0.34014
378798.61 3737076.74 0.34789
378772.72 3736996.18 0.35071

**MODELOPTs: RegDFAULT CONC ELEV NODRYDPLT NOWETDPLT

*** THE PERIOD (26280 HRS) AVERAGE CONCENTRATION VALUES FOR SOURCE GROUP: ALL ***
INCLUDING SOURCE(S): STCK1 , STCK2 , STCK3 , STCK4 , STCK5 , STCK6 , STCK7 , STCK8 , STCK9 , STCK10 , STCK11 , STCK12 , STCK13 , STCK14 , STCK15 , STCK16 , STCK17 , STCK18 , STCK19 , STCK20 , STCK21 , STCK22 , STCK23 , STCK24 , STCK25 , STCK26 , PAREA1 , VOL1 , . . . ,

*** DISCRETE CARTESIAN RECEPTOR POINTS ***

** CONC OF XOQ IN MICROGRAMS/M**3 **

X-COORD (M)	Y-COORD (M)	CONC
378877.74	3737400.43	138.86310
378926.65	3737406.18	174.74828
378978.44	3737414.82	268.42329
379007.21	3737384.60	264.27228
379021.60	3737354.39	262.61819
379035.98	3737322.74	297.60980
379047.49	3737286.78	281.69326
379077.70	3737266.64	284.35663
379105.04	3737250.81	248.47484
379132.37	3737230.67	217.74115
379161.14	3737209.09	219.80901
379187.04	3737190.39	238.20199
379221.57	3737167.37	267.45593
379250.34	3737147.23	303.27323
379280.55	3737127.09	436.54120
379286.30	3737076.74	237.58976
379296.38	3737039.33	177.63299
379306.45	3736994.74	141.37405
379316.52	3736953.02	120.73625
379328.02	3736908.42	104.36864

379342.41 3736865.26 91.28269
379345.29 3736829.30 82.62804
378886.37 3737242.18 107.31575
378910.82 3737340.01 140.33443
378982.75 3737327.06 188.08508
378981.32 3737220.60 136.46561
379057.56 3737190.39 152.23144
379120.86 3737151.55 153.41332
379172.65 3737118.46 164.51751
379224.44 3737076.74 171.72702
379260.41 3737022.07 148.79605
379290.62 3736973.16 126.18604
379287.74 3736883.96 92.75915
379197.11 3736869.58 81.60647
379191.36 3736964.53 104.42168
379149.64 3737023.51 114.31104
379089.21 3737070.98 114.13633
379018.72 3737108.39 109.45344
378946.79 3737131.41 99.80772
378866.23 3737155.86 88.57829
378840.33 3737065.23 73.01546
378932.40 3737033.58 80.28219
379007.21 3736999.05 83.76406
379067.63 3736951.58 82.80886
379113.67 3736869.58 73.81256
379020.16 3736876.77 66.46129
378945.35 3736937.19 66.91550
378886.37 3736971.72 66.75218
378820.19 3736990.42 63.12336
378856.16 3737332.81 114.07042
378836.02 3737247.94 95.63084
378814.44 3737163.06 80.48211
378798.61 3737076.74 69.21493
378772.72 3736996.18 59.54313

**MODELOPTs: RegDFAULT CONC ELEV NODRYDPLT NOWETDPLT

*** THE 1ST HIGHEST 1-HR AVERAGE CONCENTRATION VALUES FOR SOURCE GROUP: SRCGP1 ***
INCLUDING SOURCE(S): STCK1 ,

*** DISCRETE CARTESIAN RECEPTOR POINTS ***

** CONC OF XOQ IN MICROGRAMS/M**3 **

X-COORD (M)	Y-COORD (M)	CONC	(YYMMDDHH)	X-COORD (M)	Y-COORD (M)	CONC	(YYMMDDHH)
378877.74	3737400.43	261.78806	(07102604)	378926.65	3737406.18	300.08159	(05091505)
378978.44	3737414.82	385.31622	(07030804)	379007.21	3737384.60	376.63728	(05041606)
379021.60	3737354.39	285.43711	(07101404)	379035.98	3737322.74	256.64005	(05102824)
379047.49	3737286.78	263.91302	(05102824)	379077.70	3737266.64	196.55937	(06101101)
379105.04	3737250.81	184.55287	(06110101)	379132.37	3737230.67	144.51181	(05060624)
379161.14	3737209.09	160.00308	(05060624)	379187.04	3737190.39	166.41044	(05091702)
379221.57	3737167.37	156.54643	(05091702)	379250.34	3737147.23	122.36497	(05091704)
379280.55	3737127.09	113.96770	(07090703)	379286.30	3737076.74	97.54608	(05043002)
379296.38	3737039.33	87.09609	(05043002)	379306.45	3736994.74	77.43057	(05091704)
379316.52	3736953.02	71.83816	(05091704)	379328.02	3736908.42	66.02334	(05091704)
379342.41	3736865.26	60.39933	(05091704)	379345.29	3736829.30	56.76723	(05091704)
378886.37	3737242.18	150.08922	(07030804)	378910.82	3737340.01	184.68720	(07030804)
378982.75	3737327.06	275.67136	(05041606)				

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378981.32   3737220.60      157.88365  (07101404)
        379057.56   3737190.39      155.21969  (05102824)
379120.86   3737151.55      115.21942  (06110101)
        379172.65   3737118.46      116.22717  (05060624)
379224.44   3737076.74      113.54344  (05091702)
        379260.41   3737022.07       98.62072  (05091702)
379290.62   3736973.16       79.22594  (05091702)
        379287.74   3736883.96       75.06077  (05091702)
379197.11   3736869.58       59.43992  (05060624)
        379191.36   3736964.53       76.26070  (05060624)
379149.64   3737023.51       64.14042  (05060624)
        379089.21   3737070.98      103.74840  (06101101)
379018.72   3737108.39      131.21043  (05102824)
        378946.79   3737131.41      115.91919  (07101404)
378866.23   3737155.86      117.77543  (05041603)
        378840.33   3737065.23       87.77444  (05041606)
378932.40   3737033.58       91.40517  (07101404)
        379007.21   3736999.05      100.14427  (05102824)
379067.63   3736951.58       70.52552  (06101101)
        379113.67   3736869.58       65.97208  (06110101)
379020.16   3736876.77       77.15354  (05102824)
        378945.35   3736937.19       69.59169  (05041201)
378886.37   3736971.72       70.66893  (07101404)
        378820.19   3736990.42       83.15313  (05041606)
378856.16   3737332.81      177.19637  (05091505)
        378836.02   3737247.94      132.95729  (05091505)
378814.44   3737163.06      104.49335  (07030804)
        378798.61   3737076.74       90.29178  (07030804)
378772.72   3736996.18       74.88052  (05041603)
```

**MODELOPTs: RegDFAULT CONC
ELEV
NODRYDPLT
NOWETDPLT

*** THE 1ST HIGHEST 1-HR AVERAGE
CONCENTRATION VALUES FOR SOURCE GROUP: SRCGP2 ***
INCLUDING SOURCE(S): STCK2
,

*** DISCRETE
CARTESIAN RECEPTOR POINTS ***

** CONC OF XOQ IN
MICROGRAMS/M**3 **

X-COORD (M)	Y-COORD (M)	CONC	(YYMMDDHH)	X-COORD (M)	Y-COORD (M)	CONC	(YYMMDDHH)
378877.74	3737400.43	536.06901	(06110720)	378926.65	3737406.18	706.47846	(05092206)
378978.44	3737414.82	1429.42730	(07102604)	379007.21	3737384.60	1204.48543	(07101404)
379021.60	3737354.39	992.04674	(05102824)	379035.98	3737322.74	607.12991	(06101101)
379047.49	3737286.78	421.18199	(06110101)	379077.70	3737266.64	385.11558	(05091702)
379105.04	3737250.81	360.92755	(05091702)	379132.37	3737230.67	280.90721	(07090703)
379161.14	3737209.09	237.42276	(06032401)	379187.04	3737190.39	222.07606	(05093002)
379221.57	3737167.37	187.10437	(05093002)	379250.34	3737147.23	135.58150	(05093002)
379280.55	3737127.09	91.86136	(05093002)	379286.30	3737076.74	112.83201	(05093002)
379296.38	3737039.33	109.05248	(05093002)	379306.45	3736994.74	100.31941	(05093002)
379316.52	3736953.02	88.76713	(05090704)	379328.02	3736908.42	80.79244	(05090704)
379342.41	3736865.26	72.08559	(05090704)	379345.29	3736829.30	66.55646	(06032401)
378886.37	3737242.18	231.42629	(07030804)	378910.82	3737340.01	426.70400	(07102604)
378982.75	3737327.06	658.34220	(05041606)				

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378981.32   3737220.60      278.39210  (05041201)
        379057.56   3737190.39      220.37740  (06110101)
379120.86   3737151.55      229.56585  (05091702)
        379172.65   3737118.46      163.91788  (05043002)
379224.44   3737076.74      131.97108  (06032401)
        379260.41   3737022.07      109.61433  (05090704)
379290.62   3736973.16       95.68139  (05090704)
        379287.74   3736883.96       79.97279  (07090703)
379197.11   3736869.58       95.16030  (05091702)
        379191.36   3736964.53      114.75593  (05091702)
379149.64   3737023.51      140.40843  (05091702)
        379089.21   3737070.98      134.68694  (05060624)
379018.72   3737108.39      159.88876  (05102824)
        378946.79   3737131.41      182.43269  (07101404)
378866.23   3737155.86      177.40705  (07030804)
        378840.33   3737065.23      131.40853  (05041603)
378932.40   3737033.58      122.02300  (07101404)
        379007.21   3736999.05      120.17991  (05102824)
379067.63   3736951.58       99.46017  (06110101)
        379113.67   3736869.58       70.84822  (05060624)
379020.16   3736876.77       81.09058  (06101101)
        378945.35   3736937.19       98.81365  (05041201)
378886.37   3736971.72      104.07154  (07101404)
        378820.19   3736990.42      107.55457  (05041606)
378856.16   3737332.81      345.66700  (06021701)
        378836.02   3737247.94      193.85143  (05091505)
378814.44   3737163.06      163.23421  (05091505)
        378798.61   3737076.74      124.38049  (07030804)
378772.72   3736996.18      102.06361  (07030804)
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**MODELOPTs: RegDFAULT CONC ELEV NODRYDPLT NOWETDPLT

*** THE 1ST HIGHEST 1-HR AVERAGE CONCENTRATION VALUES FOR SOURCE GROUP: SRCGP3 ***
INCLUDING SOURCE(S): STCK3 ,

*** DISCRETE CARTESIAN RECEPTOR POINTS ***

** CONC OF XOQ IN MICROGRAMS/M**3 **

X-COORD (M)	Y-COORD (M)	CONC	(YYMMDDHH)	X-COORD (M)	Y-COORD (M)	CONC	(YYMMDDHH)
378877.74	3737400.43	158.51447	(05092206)	378926.65	3737406.18	194.18937	(05092206)
378978.44	3737414.82	239.49412	(06092703)	379007.21	3737384.60	194.39716	(07102604)
379021.60	3737354.39	214.33648	(05091505)	379035.98	3737322.74	168.92430	(07030804)
379047.49	3737286.78	181.77138	(07030804)	379077.70	3737266.64	196.19354	(05041606)
379105.04	3737250.81	188.99124	(05041606)	379132.37	3737230.67	158.13914	(07101404)
379161.14	3737209.09	155.98789	(05041201)	379187.04	3737190.39	186.48402	(05102824)
379221.57	3737167.37	130.89561	(06101101)	379250.34	3737147.23	131.25132	(06110101)
379280.55	3737127.09	105.64717	(06110101)	379286.30	3737076.74	86.91849	(06110101)
379296.38	3737039.33	70.48658	(06110101)	379306.45	3736994.74	58.03600	(06110101)
379316.52	3736953.02	52.67061	(05060624)	379328.02	3736908.42	51.19201	(05060624)
379342.41	3736865.26	50.70384	(05060624)	379345.29	3736829.30	46.35162	(05060624)
378886.37	3737242.18	86.54844	(07102604)	378910.82	3737340.01	159.24764	(06092703)
378982.75	3737327.06	161.77510	(05091505)				

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378981.32   3737220.60      116.66740  (07030804)
        379057.56   3737190.39      150.06274  (05041606)
379120.86   3737151.55      115.57120  (07101404)
        379172.65   3737118.46      133.20893  (05102824)
379224.44   3737076.74       92.42398  (06101101)
        379260.41   3737022.07       87.64140  (06110101)
379290.62   3736973.16       68.06253  (06110101)
        379287.74   3736883.96       60.59544  (06110101)
379197.11   3736869.58       59.19218  (05102824)
        379191.36   3736964.53       81.94184  (05102824)
379149.64   3737023.51       95.07945  (05102824)
        379089.21   3737070.98       95.98245  (07101404)
379018.72   3737108.39      115.59352  (05041606)
        378946.79   3737131.41       98.78325  (07030804)
378866.23   3737155.86       97.75417  (05091505)
        378840.33   3737065.23       72.41859  (05091505)
378932.40   3737033.58       80.00201  (05041603)
        379007.21   3736999.05       90.08284  (05041606)
379067.63   3736951.58       71.28265  (07101404)
        379113.67   3736869.58       62.39952  (05041201)
379020.16   3736876.77       61.06712  (07101404)
        378945.35   3736937.19       73.26335  (05041606)
378886.37   3736971.72       66.32101  (07030804)
        378820.19   3736990.42       50.46770  (07030804)
378856.16   3737332.81      137.77473  (06021701)
        378836.02   3737247.94      113.72906  (07102604)
378814.44   3737163.06       66.55742  (07102604)
        378798.61   3737076.74       76.94786  (05091505)
378772.72   3736996.18       65.09523  (05091505)
```

**MODELOPTs: RegDFAULT CONC ELEV NODRYDPLT NOWETDPLT

*** THE 1ST HIGHEST 1-HR AVERAGE CONCENTRATION VALUES FOR SOURCE GROUP: SRCGP4 ***
INCLUDING SOURCE(S): STCK4 ,

*** DISCRETE CARTESIAN RECEPTOR POINTS ***

** CONC OF XOQ IN MICROGRAMS/M**3 **

X-COORD (M)	Y-COORD (M)	CONC	(YYMMDDHH)	X-COORD (M)	Y-COORD (M)	CONC	(YYMMDDHH)
378877.74	3737400.43	410.07325	(07033104)	378926.65	3737406.18	509.07349	(06103124)
378978.44	3737414.82	318.05193	(06103124)	379007.21	3737384.60	798.11637	(06103124)
379021.60	3737354.39	1432.05434	(07033104)	379035.98	3737322.74	2006.91323	(05090703)
379047.49	3737286.78	1820.74821	(06092703)	379077.70	3737266.64	2128.05310	(05041606)
379105.04	3737250.81	1420.15104	(06110101)	379132.37	3737230.67	1096.93130	(05091702)
379161.14	3737209.09	704.33621	(05090704)	379187.04	3737190.39	566.42610	(05093002)
379221.57	3737167.37	316.53241	(05102723)	379250.34	3737147.23	282.24657	(05102723)
379280.55	3737127.09	245.40217	(05102723)	379286.30	3737076.74	137.52790	(05102723)
379296.38	3737039.33	150.20777	(05093002)	379306.45	3736994.74	153.50470	(05093002)
379316.52	3736953.02	139.84711	(05093002)	379328.02	3736908.42	119.97851	(05090704)
379342.41	3736865.26	105.55940	(05090704)	379345.29	3736829.30	93.85427	(06032401)
378886.37	3737242.18	348.08947	(06110720)	378910.82	3737340.01	478.98685	(05051905)
378982.75	3737327.06	856.58632	(07042501)				

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378981.32   3737220.60      550.83628  (06092703)
        379057.56   3737190.39      614.81111  (07101404)
379120.86   3737151.55      409.39066  (05060624)
        379172.65   3737118.46      353.24406  (05091702)
379224.44   3737076.74      242.74472  (06032401)
        379260.41   3737022.07      187.84362  (05090704)
379290.62   3736973.16      152.25079  (05090704)
        379287.74   3736883.96      119.22235  (07090703)
379197.11   3736869.58      121.78768  (05060624)
        379191.36   3736964.53      183.46227  (05091702)
379149.64   3737023.51      212.91776  (05060624)
        379089.21   3737070.98      271.90811  (05102824)
379018.72   3737108.39      377.00211  (05041606)
        378946.79   3737131.41      300.38307  (05091505)
378866.23   3737155.86      253.15936  (05092206)
        378840.33   3737065.23      174.07875  (07102604)
378932.40   3737033.58      195.25998  (07030804)
        379007.21   3736999.05      190.34136  (07101404)
379067.63   3736951.58      191.75823  (05102824)
        379113.67   3736869.58      126.31036  (06110101)
379020.16   3736876.77      126.30206  (05041201)
        378945.35   3736937.19      169.10616  (05041606)
378886.37   3736971.72      141.16696  (07030804)
        378820.19   3736990.42      129.90304  (05091505)
378856.16   3737332.81      351.84826  (07042501)
        378836.02   3737247.94      281.69626  (05102722)
378814.44   3737163.06      171.68555  (05121121)
        378798.61   3737076.74      161.89382  (06092703)
378772.72   3736996.18      126.38574  (07102604)
```

**MODELOPTs: RegDFAULT CONC ELEV NODRYDPLT NOWETDPLT

*** THE 1ST HIGHEST 1-HR AVERAGE CONCENTRATION VALUES FOR SOURCE GROUP: SRCGP5 ***
INCLUDING SOURCE(S): STCK5 ,

*** DISCRETE CARTESIAN RECEPTOR POINTS ***

** CONC OF XOQ IN MICROGRAMS/M**3 **

X-COORD (M)	Y-COORD (M)	CONC	(YYMMDDHH)	X-COORD (M)	Y-COORD (M)	CONC	(YYMMDDHH)
378877.74	3737400.43	125.09149	(05090703)	378926.65	3737406.18	135.95136	(05090703)
378978.44	3737414.82	173.28926	(05090703)	379007.21	3737384.60	198.97928	(05102722)
379021.60	3737354.39	208.13192	(05101823)	379035.98	3737322.74	207.64887	(05121121)
379047.49	3737286.78	174.59370	(05092206)	379077.70	3737266.64	208.47365	(06021701)
379105.04	3737250.81	214.31739	(07102604)	379132.37	3737230.67	176.51292	(05091505)
379161.14	3737209.09	198.58555	(05091505)	379187.04	3737190.39	219.58430	(07030804)
379221.57	3737167.37	254.53021	(05041606)	379250.34	3737147.23	194.66478	(07101404)
379280.55	3737127.09	185.42453	(05041201)	379286.30	3737076.74	164.55378	(05102824)
379296.38	3737039.33	159.56294	(05102824)	379306.45	3736994.74	134.17076	(05102824)
379316.52	3736953.02	104.21857	(05102824)	379328.02	3736908.42	82.62007	(06101101)
379342.41	3736865.26	82.18723	(06101101)	379345.29	3736829.30	76.70656	(06101101)
378886.37	3737242.18	114.88089	(05121121)	378910.82	3737340.01	141.71264	(05102722)
378982.75	3737327.06	168.92721	(06110720)				

```
378981.32   3737220.60      139.07176  (05092206)
        379057.56   3737190.39      151.82683  (07102604)
379120.86   3737151.55      145.78400  (05091505)
        379172.65   3737118.46      156.05222  (05041603)
379224.44   3737076.74      137.79400  (07101404)
        379260.41   3737022.07      124.41915  (05041201)
379290.62   3736973.16      131.39070  (05102824)
        379287.74   3736883.96      104.35287  (05102824)
379197.11   3736869.58       80.21252  (07101404)
        379191.36   3736964.53       97.86185  (07101404)
379149.64   3737023.51      122.50202  (05041606)
        379089.21   3737070.98      102.18246  (07030804)
379018.72   3737108.39       86.23705  (07102604)
        378946.79   3737131.41      108.69786  (06092703)
378866.23   3737155.86       93.17448  (05092206)
        378840.33   3737065.23       80.66836  (06021701)
378932.40   3737033.58       76.10911  (07102604)
        379007.21   3736999.05       87.72552  (05091505)
379067.63   3736951.58       86.79440  (07030804)
        379113.67   3736869.58       93.57259  (05041606)
379020.16   3736876.77       72.69094  (07030804)
        378945.35   3736937.19       75.35500  (05091505)
378886.37   3736971.72       57.52839  (07102604)
        378820.19   3736990.42       72.11988  (06092703)
378856.16   3737332.81      123.41983  (05102722)
        378836.02   3737247.94      111.43964  (06110720)
378814.44   3737163.06       63.08878  (05121121)
        378798.61   3737076.74       80.69287  (05092206)
378772.72   3736996.18       64.35114  (06092703)
```

**MODELOPTs: RegDFAULT CONC ELEV NODRYDPLT NOWETDPLT

*** THE 1ST HIGHEST 1-HR AVERAGE CONCENTRATION VALUES FOR SOURCE GROUP: SRCGP6 ***
INCLUDING SOURCE(S): STCK6 ,

*** DISCRETE CARTESIAN RECEPTOR POINTS ***

** CONC OF XOQ IN MICROGRAMS/M**3 **

X-COORD (M)	Y-COORD (M)	CONC	(YYMMDDHH)	X-COORD (M)	Y-COORD (M)	CONC	(YYMMDDHH)
378877.74	3737400.43	192.99950	(07033104)	378926.65	3737406.18	201.89773	(07033104)
378978.44	3737414.82	271.06303	(06103124)	379007.21	3737384.60	306.92835	(06103124)
379021.60	3737354.39	343.08026	(07033104)	379035.98	3737322.74	368.99826	(06040802)
379047.49	3737286.78	423.73317	(05102923)	379077.70	3737266.64	504.04578	(07112121)
379105.04	3737250.81	521.47203	(05090703)	379132.37	3737230.67	659.29318	(05101823)
379161.14	3737209.09	772.80906	(05092206)	379187.04	3737190.39	800.29213	(05091505)
379221.57	3737167.37	1050.49984	(05041606)	379250.34	3737147.23	863.10883	(05102824)
379280.55	3737127.09	529.76307	(06110101)	379286.30	3737076.74	339.83255	(06110101)
379296.38	3737039.33	272.66465	(05060624)	379306.45	3736994.74	224.05366	(05060624)
379316.52	3736953.02	191.01682	(05060624)	379328.02	3736908.42	163.61557	(05060624)
379342.41	3736865.26	142.50480	(05060624)	379345.29	3736829.30	126.02024	(05060624)
378886.37	3737242.18	188.93848	(05090703)	378910.82	3737340.01	187.04793	(06040802)
378982.75	3737327.06	244.83120	(06040802)				

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378981.32   3737220.60      185.27394  (05102722)
        379057.56   3737190.39      352.20827  (06110720)
379120.86   3737151.55      427.91619  (06092703)
        379172.65   3737118.46      442.79678  (07030804)
379224.44   3737076.74      377.10963  (05041201)
        379260.41   3737022.07      271.08638  (06101101)
379290.62   3736973.16      201.05506  (06110101)
        379287.74   3736883.96      151.35136  (06110101)
379197.11   3736869.58      145.06216  (05041201)
        379191.36   3736964.53      197.97034  (07101404)
379149.64   3737023.51      254.38332  (05041606)
        379089.21   3737070.98      236.25172  (05091505)
379018.72   3737108.39      232.91231  (05092206)
        378946.79   3737131.41      199.84121  (06110720)
378866.23   3737155.86      161.16990  (05102722)
        378840.33   3737065.23      131.98935  (05121121)
378932.40   3737033.58      155.00043  (05092206)
        379007.21   3736999.05      144.13703  (07102604)
379067.63   3736951.58      154.18567  (07030804)
        379113.67   3736869.58      160.71515  (05041606)
379020.16   3736876.77      112.47517  (07030804)
        378945.35   3736937.19      109.42914  (07102604)
378886.37   3736971.72      118.43328  (06021701)
        378820.19   3736990.42       96.94775  (05092206)
378856.16   3737332.81      152.94739  (05051905)
        378836.02   3737247.94      162.46548  (07112121)
378814.44   3737163.06      128.34275  (05102722)
        378798.61   3737076.74      126.37586  (06110720)
378772.72   3736996.18       80.00543  (05121121)
```

**MODELOPTs: RegDFAULT CONC ELEV NODRYDPLT NOWETDPLT

*** THE 1ST HIGHEST 1-HR AVERAGE CONCENTRATION VALUES FOR SOURCE GROUP: SRCGP7 ***
INCLUDING SOURCE(S): STCK7 ,

*** DISCRETE CARTESIAN RECEPTOR POINTS ***

** CONC OF XOQ IN MICROGRAMS/M**3 **

X-COORD (M)	Y-COORD (M)	CONC	(YYMMDDHH)
378877.74	3737400.43	74.87315	(05090703)
378926.65	3737406.18	81.15295	(05090703)
378978.44	3737414.82	88.86321	(05090703)
379007.21	3737384.60	91.75071	(05090703)
379021.60	3737354.39	68.91807	(05090703)
379035.98	3737322.74	72.82474	(05102722)
379047.49	3737286.78	96.18877	(05102722)
379077.70	3737266.64	101.17414	(06103001)
379105.04	3737250.81	107.12009	(05101823)
379132.37	3737230.67	110.77525	(06110720)
379161.14	3737209.09	112.31525	(05121121)
379187.04	3737190.39	94.61374	(05121121)
379221.57	3737167.37	113.90972	(05092206)
379250.34	3737147.23	123.27778	(05092206)
379280.55	3737127.09	123.58367	(06092703)
379286.30	3737076.74	109.44677	(07102604)
379296.38	3737039.33	72.94410	(07102604)
379306.45	3736994.74	90.29669	(05091505)
379316.52	3736953.02	81.70842	(05091505)
379328.02	3736908.42	65.66159	(07030804)
379342.41	3736865.26	73.40360	(07030804)
379345.29	3736829.30	66.87304	(07030804)
378886.37	3737242.18	68.04412	(05102722)
378910.82	3737340.01	57.30229	(05090703)
378982.75	3737327.06	50.64305	(05102722)

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378981.32   3737220.60       78.11366  (05101823)
        379057.56   3737190.39       89.19267  (06110720)
379120.86   3737151.55       70.68667  (05121121)
        379172.65   3737118.46       95.83182  (05092206)
379224.44   3737076.74       94.45205  (06092703)
        379260.41   3737022.07       79.45364  (07102604)
379290.62   3736973.16       85.49223  (05091505)
        379287.74   3736883.96       61.04165  (05091505)
379197.11   3736869.58       62.41395  (05091505)
        379191.36   3736964.53       71.22040  (07102604)
379149.64   3737023.51       75.27618  (06092703)
        379089.21   3737070.98       74.14317  (05092206)
379018.72   3737108.39       64.08698  (05121121)
        378946.79   3737131.41       70.98298  (07090702)
378866.23   3737155.86       64.40622  (05101823)
        378840.33   3737065.23       57.53319  (05121121)
378932.40   3737033.58       40.43866  (05121121)
        379007.21   3736999.05       63.95794  (05092206)
379067.63   3736951.58       61.63837  (06092703)
        379113.67   3736869.58       52.58791  (07102604)
379020.16   3736876.77       56.17359  (06092703)
        378945.35   3736937.19       54.98716  (05092206)
378886.37   3736971.72       39.02447  (05092206)
        378820.19   3736990.42       40.47671  (05121121)
378856.16   3737332.81       52.88121  (05090703)
        378836.02   3737247.94       58.74624  (05102722)
378814.44   3737163.06       58.65984  (06103001)
        378798.61   3737076.74       56.84411  (06110720)
378772.72   3736996.18       46.66661  (05121121)
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 *** AERMOD - VERSION  11103 ***   *** C:\Documents and Settings
\HP_Administrator\My Documents\Lakes\AERMOD ***        06/16/11
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PAGE  51
 **MODELOPTs:  RegDFAULT CONC
ELEV
                                                          NODRYDPLT
NOWETDPLT

                               *** THE   1ST HIGHEST  1-HR AVERAGE
CONCENTRATION   VALUES FOR SOURCE GROUP:  SRCGP8   ***
                                  INCLUDING SOURCE(S):     STCK8
,

                                              *** DISCRETE
CARTESIAN RECEPTOR POINTS ***

                                          ** CONC OF XOQ      IN
MICROGRAMS/M**3                            **

      X-COORD (M)  Y-COORD (M)        CONC     (YYMMDDHH)
X-COORD (M)  Y-COORD (M)        CONC     (YYMMDDHH)
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-
        378877.74   3737400.43       89.81565  (06103124)
378926.65   3737406.18       48.55387  (06103124)
        378978.44   3737414.82       44.99210  (07090423)
379007.21   3737384.60       52.39070  (07090423)
        379021.60   3737354.39       61.48880  (06103124)
379035.98   3737322.74      138.46802  (06103124)
        379047.49   3737286.78      275.29865  (06103124)
379077.70   3737266.64      344.19513  (06103124)
        379105.04   3737250.81      409.39401  (06103124)
379132.37   3737230.67      461.85786  (06103124)
        379161.14   3737209.09      597.06637  (07033104)
379187.04   3737190.39      867.06375  (07033104)
        379221.57   3737167.37     1256.87446  (06040802)
379250.34   3737147.23     1866.56542  (07112121)
        379280.55   3737127.09     3188.96170  (05092206)
379286.30   3737076.74     1658.98253  (05041606)
        379296.38   3737039.33      885.78739  (05102824)
379306.45   3736994.74      634.53660  (05102824)
        379316.52   3736953.02      399.86193  (06101101)
379328.02   3736908.42      302.60799  (06110101)
        379342.41   3736865.26      216.03376  (06110101)
379345.29   3736829.30      182.53252  (06110101)
        378886.37   3737242.18      162.59321  (06040802)
378910.82   3737340.01      168.63103  (06103124)
        378982.75   3737327.06      177.14590  (06103124)
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378981.32   3737220.60      221.36361  (06040802)
        379057.56   3737190.39      247.60578  (05051905)
379120.86   3737151.55      431.85826  (07042501)
        379172.65   3737118.46      545.62405  (05102722)
379224.44   3737076.74      811.08890  (06021701)
        379260.41   3737022.07      724.39145  (05041606)
379290.62   3736973.16      515.56584  (05102824)
        379287.74   3736883.96      314.92748  (05102824)
379197.11   3736869.58      248.56448  (05041606)
        379191.36   3736964.53      309.19311  (05091505)
379149.64   3737023.51      371.10360  (06021701)
        379089.21   3737070.98      313.04584  (05101823)
379018.72   3737108.39      236.28187  (05090703)
        378946.79   3737131.41      197.70077  (07112121)
378866.23   3737155.86      158.68621  (07042501)
        378840.33   3737065.23      104.50408  (05090703)
378932.40   3737033.58      167.50930  (05102722)
        379007.21   3736999.05      197.48870  (05121121)
379067.63   3736951.58      209.89440  (06021701)
        379113.67   3736869.58      184.96929  (05091505)
379020.16   3736876.77      153.29612  (06092703)
        378945.35   3736937.19      113.01005  (05121121)
378886.37   3736971.72      135.37646  (06110720)
        378820.19   3736990.42      117.63169  (05102722)
378856.16   3737332.81      133.58849  (06103124)
        378836.02   3737247.94      139.58750  (06040802)
378814.44   3737163.06      138.05532  (05102923)
        378798.61   3737076.74      117.59722  (05090703)
378772.72   3736996.18      107.13257  (05102722)
```

**MODELOPTs: RegDFAULT CONC ELEV NODRYDPLT NOWETDPLT

*** THE 1ST HIGHEST 1-HR AVERAGE CONCENTRATION VALUES FOR SOURCE GROUP: SRCGP9 ***
INCLUDING SOURCE(S): STCK9 ,

*** DISCRETE CARTESIAN RECEPTOR POINTS ***

** CONC OF XOQ IN MICROGRAMS/M**3 **

X-COORD (M)	Y-COORD (M)	CONC	(YYMMDDHH)	X-COORD (M)	Y-COORD (M)	CONC	(YYMMDDHH)
378877.74	3737400.43	106.82751	(05051905)	378926.65	3737406.18	102.96427	(05051905)
378978.44	3737414.82	147.11224	(06040802)	379007.21	3737384.60	156.82642	(05051905)
379021.60	3737354.39	188.52088	(05051905)	379035.98	3737322.74	195.59458	(07042501)
379047.49	3737286.78	206.02640	(05090703)	379077.70	3737266.64	179.50223	(05090703)
379105.04	3737250.81	208.78168	(05102722)	379132.37	3737230.67	242.60813	(06103001)
379161.14	3737209.09	285.09728	(06110720)	379187.04	3737190.39	268.46062	(05121121)
379221.57	3737167.37	333.19280	(06021701)	379250.34	3737147.23	320.40254	(07102604)
379280.55	3737127.09	323.19159	(05091505)	379286.30	3737076.74	244.18856	(07030804)
379296.38	3737039.33	209.81738	(05041603)	379306.45	3736994.74	214.96869	(05041606)
379316.52	3736953.02	147.34127	(07101404)	379328.02	3736908.42	136.48077	(07101404)
379342.41	3736865.26	118.99091	(05041201)	379345.29	3736829.30	110.03292	(05041201)
378886.37	3737242.18	101.38627	(05090703)	378910.82	3737340.01	133.28487	(05102923)
378982.75	3737327.06	161.87262	(07042501)				

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378981.32   3737220.60      124.46447  (05102722)
        379057.56   3737190.39      171.82020  (05101823)
379120.86   3737151.55      160.18225  (05121121)
        379172.65   3737118.46      206.06549  (06021701)
379224.44   3737076.74      192.11312  (05091505)
        379260.41   3737022.07      184.55527  (07030804)
379290.62   3736973.16      193.61165  (05041606)
        379287.74   3736883.96      125.15785  (05041606)
379197.11   3736869.58      108.13120  (05041603)
        379191.36   3736964.53      116.76211  (05091505)
379149.64   3737023.51      130.64816  (07102604)
        379089.21   3737070.98      148.20121  (05092206)
379018.72   3737108.39      128.12958  (05121121)
        378946.79   3737131.41      119.82617  (06110720)
378866.23   3737155.86      106.28945  (05102722)
        378840.33   3737065.23       95.23156  (06110720)
378932.40   3737033.58       70.63376  (05121121)
        379007.21   3736999.05      109.21181  (06021701)
379067.63   3736951.58      104.02099  (07102604)
        379113.67   3736869.58       92.04880  (05091505)
379020.16   3736876.77       69.67204  (07102604)
        378945.35   3736937.19       85.16465  (06021701)
378886.37   3736971.72       75.46587  (05092206)
        378820.19   3736990.42       67.84021  (05121121)
378856.16   3737332.81      118.41239  (07042501)
        378836.02   3737247.94      103.16591  (05090703)
378814.44   3737163.06       90.81248  (05102722)
        378798.61   3737076.74       86.52323  (05101823)
378772.72   3736996.18       75.35121  (05121121)
```

**MODELOPTs: RegDFAULT CONC ELEV NODRYDPLT NOWETDPLT

*** THE 1ST HIGHEST 1-HR AVERAGE CONCENTRATION VALUES FOR SOURCE GROUP: SRCGP10 ***
INCLUDING SOURCE(S): STCK10 ,

*** DISCRETE CARTESIAN RECEPTOR POINTS ***

** CONC OF XOQ IN MICROGRAMS/M**3 **

X-COORD (M)	Y-COORD (M)	CONC	(YYMMDDHH)	X-COORD (M)	Y-COORD (M)	CONC	(YYMMDDHH)
378877.74	3737400.43	114.73017	(06103124)	378926.65	3737406.18	81.37331	(06103124)
378978.44	3737414.82	78.24005	(05100806)	379007.21	3737384.60	72.48900	(06050222)
379021.60	3737354.39	107.70727	(06103124)	379035.98	3737322.74	173.36881	(06103124)
379047.49	3737286.78	213.38603	(06103124)	379077.70	3737266.64	227.41456	(06103124)
379105.04	3737250.81	222.24958	(06103124)	379132.37	3737230.67	217.45917	(07033104)
379161.14	3737209.09	271.51671	(07033104)	379187.04	3737190.39	376.67064	(07033104)
379221.57	3737167.37	446.59616	(06040802)	379250.34	3737147.23	455.85914	(06040802)
379280.55	3737127.09	572.22101	(05051905)	379286.30	3737076.74	533.75572	(05090703)
379296.38	3737039.33	513.03090	(05101823)	379306.45	3736994.74	454.01188	(05092206)
379316.52	3736953.02	371.17446	(07102604)	379328.02	3736908.42	301.87918	(05091505)
379342.41	3736865.26	270.62121	(05041603)	379345.29	3736829.30	262.73513	(05041606)
378886.37	3737242.18	115.42352	(06040802)	378910.82	3737340.01	129.42838	(06103124)
378982.75	3737327.06	134.92306	(06103124)				

378981.32 3737220.60 148.41277 (06040802)
379057.56 3737190.39 185.23457 (06040802)
379120.86 3737151.55 206.93908 (05051905)
379172.65 3737118.46 307.56099 (05102923)
379224.44 3737076.74 362.95431 (05090703)
379260.41 3737022.07 396.14132 (06110720)
379290.62 3736973.16 379.48065 (06021701)
379287.74 3736883.96 259.24011 (05091505)
379197.11 3736869.58 201.25757 (06092703)
379191.36 3736964.53 243.93533 (05121121)
379149.64 3737023.51 227.94701 (05102722)
379089.21 3737070.98 210.51868 (05090703)
379018.72 3737108.39 171.20498 (07042501)
378946.79 3737131.41 139.15900 (05102923)
378866.23 3737155.86 114.17175 (05051905)
378840.33 3737065.23 106.61844 (07112121)
378932.40 3737033.58 125.17804 (05090703)
379007.21 3736999.05 120.72770 (05102722)
379067.63 3736951.58 166.89183 (05101823)
379113.67 3736869.58 154.46232 (05092206)
379020.16 3736876.77 125.16147 (05121121)
378945.35 3736937.19 113.69415 (06103001)
378886.37 3736971.72 83.95791 (05102722)
378820.19 3736990.42 71.65683 (05090703)
378856.16 3737332.81 106.93377 (07033104)
378836.02 3737247.94 102.76090 (06040802)
378814.44 3737163.06 100.58699 (05051905)
378798.61 3737076.74 98.46050 (07112121)
378772.72 3736996.18 76.28488 (05090703)

**MODELOPTs: RegDFAULT CONC ELEV NODRYDPLT NOWETDPLT

*** THE 1ST HIGHEST 1-HR AVERAGE CONCENTRATION VALUES FOR SOURCE GROUP: SRCGP11 ***
INCLUDING SOURCE(S): STCK11 ,

*** DISCRETE CARTESIAN RECEPTOR POINTS ***

** CONC OF XOQ IN MICROGRAMS/M**3 **

X-COORD (M)	Y-COORD (M)	CONC	(YYMMDDHH)
378877.74	3737400.43	18.87420	(05081104)
378926.65	3737406.18	18.88955	(06082501)
378978.44	3737414.82	19.16902	(05092107)
379007.21	3737384.60	19.15176	(05081806)
379021.60	3737354.39	18.90000	(05081806)
379035.98	3737322.74	18.88776	(05071806)
379047.49	3737286.78	18.51749	(05071806)
379077.70	3737266.64	18.18323	(07052505)
379105.04	3737250.81	18.10169	(06112406)
379132.37	3737230.67	17.80484	(05061003)
379161.14	3737209.09	17.86250	(05061003)
379187.04	3737190.39	17.99460	(06060602)
379221.57	3737167.37	17.79337	(07080304)
379250.34	3737147.23	17.67128	(06080205)
379280.55	3737127.09	17.54483	(06080205)
379286.30	3737076.74	16.33350	(06080205)
379296.38	3737039.33	14.98131	(06082602)
379306.45	3736994.74	14.03167	(05041201)
379316.52	3736953.02	13.27612	(05041201)
379328.02	3736908.42	12.43954	(05041201)
379342.41	3736865.26	11.72616	(05041201)
379345.29	3736829.30	11.30022	(05041201)
378886.37	3737242.18	17.34507	(06082501)
378910.82	3737340.01	18.35703	(06082501)
378982.75	3737327.06	18.56032	(05081806)

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378981.32   3737220.60       17.47955  (05081806)
        379057.56   3737190.39       16.88251  (07052505)
379120.86   3737151.55       16.56854  (05061003)
        379172.65   3737118.46       16.67331  (06060602)
379224.44   3737076.74       15.28646  (06072705)
        379260.41   3737022.07       15.08788  (05041201)
379290.62   3736973.16       14.33761  (05041201)
        379287.74   3736883.96       13.95698  (05041201)
379197.11   3736869.58       14.45624  (05041201)
        379191.36   3736964.53       14.15962  (05041201)
379149.64   3737023.51       14.75117  (06060602)
        379089.21   3737070.98       15.26032  (05090422)
379018.72   3737108.39       15.92404  (05071806)
        378946.79   3737131.41       16.43998  (05081806)
378866.23   3737155.86       16.44955  (07080924)
        378840.33   3737065.23       15.43336  (07080924)
378932.40   3737033.58       15.13518  (05071806)
        379007.21   3736999.05       14.35615  (07101404)
379067.63   3736951.58       13.24972  (05061003)
        379113.67   3736869.58       12.01685  (06072802)
379020.16   3736876.77       13.81271  (07101404)
        378945.35   3736937.19       14.27386  (07101404)
378886.37   3736971.72       13.88684  (05081806)
        378820.19   3736990.42       14.39490  (05092107)
378856.16   3737332.81       18.46417  (05081104)
        378836.02   3737247.94       17.69666  (05081104)
378814.44   3737163.06       16.77544  (05081104)
        378798.61   3737076.74       15.61594  (05081104)
378772.72   3736996.18       14.48517  (05081104)
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**MODELOPTs: RegDFAULT CONC ELEV NODRYDPLT NOWETDPLT

*** THE 1ST HIGHEST 1-HR AVERAGE CONCENTRATION VALUES FOR SOURCE GROUP: SRCGP12 ***
INCLUDING SOURCE(S): STCK12 ,

*** DISCRETE CARTESIAN RECEPTOR POINTS ***

** CONC OF XOQ IN MICROGRAMS/M**3 **

X-COORD (M)	Y-COORD (M)	CONC	(YYMMDDHH)	X-COORD (M)	Y-COORD (M)	CONC	(YYMMDDHH)
378877.74	3737400.43	63.28376	(05051905)	378926.65	3737406.18	61.11546	(05051905)
378978.44	3737414.82	67.90945	(06040802)	379007.21	3737384.60	82.65499	(05051905)
379021.60	3737354.39	101.02520	(05051905)	379035.98	3737322.74	104.92737	(05102923)
379047.49	3737286.78	103.08760	(07042501)	379077.70	3737266.64	114.13569	(07112121)
379105.04	3737250.81	120.86945	(05090703)	379132.37	3737230.67	119.98774	(05090703)
379161.14	3737209.09	98.86525	(05090703)	379187.04	3737190.39	113.05874	(05102722)
379221.57	3737167.37	155.79873	(05102722)	379250.34	3737147.23	160.33321	(05101823)
379280.55	3737127.09	173.07658	(06110720)	379286.30	3737076.74	111.71824	(05121121)
379296.38	3737039.33	135.18363	(05092206)	379306.45	3736994.74	120.48206	(06092703)
379316.52	3736953.02	118.11485	(07102604)	379328.02	3736908.42	83.62532	(05091505)
379342.41	3736865.26	101.48897	(05091505)	379345.29	3736829.30	85.49233	(05091505)
378886.37	3737242.18	72.45657	(07112121)	378910.82	3737340.01	80.20528	(05102923)
378982.75	3737327.06	92.36063	(05102923)				

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378981.32   3737220.60       88.44244  (05090703)
        379057.56   3737190.39       70.29495  (05090703)
379120.86   3737151.55      103.62071  (05102722)
        379172.65   3737118.46      119.57745  (05101823)
379224.44   3737076.74      121.46947  (05121121)
        379260.41   3737022.07      116.85936  (05092206)
379290.62   3736973.16      116.04685  (06092703)
        379287.74   3736883.96       79.80578  (07102604)
379197.11   3736869.58       85.50121  (06092703)
        379191.36   3736964.53       96.85667  (05092206)
379149.64   3737023.51       91.20693  (05121121)
        379089.21   3737070.98       93.97620  (05101823)
379018.72   3737108.39       85.79950  (05102722)
        378946.79   3737131.41       58.97099  (05102722)
378866.23   3737155.86       47.47059  (05090703)
        378840.33   3737065.23       61.95472  (05102722)
378932.40   3737033.58       70.05747  (05101823)
        379007.21   3736999.05       77.82537  (06110720)
379067.63   3736951.58       55.71944  (05121121)
        379113.67   3736869.58       74.74439  (06021701)
379020.16   3736876.77       56.51753  (05092206)
        378945.35   3736937.19       62.73651  (05121121)
378886.37   3736971.72       62.38441  (06110720)
        378820.19   3736990.42       58.14552  (05101823)
378856.16   3737332.81       73.94535  (05102923)
        378836.02   3737247.94       69.49676  (07112121)
378814.44   3737163.06       52.17709  (05090703)
        378798.61   3737076.74       52.43856  (05102722)
378772.72   3736996.18       54.90745  (06103001)
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**MODELOPTs: RegDFAULT CONC ELEV NODRYDPLT NOWETDPLT

*** THE 1ST HIGHEST 1-HR AVERAGE CONCENTRATION VALUES FOR SOURCE GROUP: SRCGP13 ***
INCLUDING SOURCE(S): STCK13 ,

*** DISCRETE CARTESIAN RECEPTOR POINTS ***

** CONC OF XOQ IN MICROGRAMS/M**3 **

X-COORD (M)	Y-COORD (M)	CONC	(YYMMDDHH)	X-COORD (M)	Y-COORD (M)	CONC	(YYMMDDHH)
378877.74	3737400.43	80.49034	(07033104)	378926.65	3737406.18	79.64629	(07033104)
378978.44	3737414.82	87.62992	(06103124)	379007.21	3737384.60	91.44960	(07033104)
379021.60	3737354.39	99.86864	(07033104)	379035.98	3737322.74	101.90385	(05121122)
379047.49	3737286.78	108.45712	(06040802)	379077.70	3737266.64	109.35208	(06040802)
379105.04	3737250.81	106.67578	(06040802)	379132.37	3737230.67	105.45988	(05051905)
379161.14	3737209.09	142.56390	(05051905)	379187.04	3737190.39	165.99176	(05051905)
379221.57	3737167.37	184.02219	(05102923)	379250.34	3737147.23	194.12154	(07112121)
379280.55	3737127.09	216.22317	(05090703)	379286.30	3737076.74	155.85209	(05102722)
379296.38	3737039.33	183.83864	(06103001)	379306.45	3736994.74	178.51934	(07090702)
379316.52	3736953.02	132.92912	(05092206)	379328.02	3736908.42	155.46219	(06021701)
379342.41	3736865.26	145.17429	(07102604)	379345.29	3736829.30	112.35956	(07102604)
378886.37	3737242.18	72.20965	(05051905)	378910.82	3737340.01	80.40786	(06040802)
378982.75	3737327.06	90.87316	(06040802)				

378981.32 3737220.60 93.39568 (05051905)
379057.56 3737190.39 110.53767 (05051905)
379120.86 3737151.55 127.67961 (07042501)
379172.65 3737118.46 144.28774 (05090703)
379224.44 3737076.74 111.53557 (05090703)
379260.41 3737022.07 159.70338 (06103001)
379290.62 3736973.16 158.41176 (05121121)
379287.74 3736883.96 133.63252 (06021701)
379197.11 3736869.58 92.96478 (05092206)
379191.36 3736964.53 127.63587 (06110720)
379149.64 3737023.51 115.48108 (05102722)
379089.21 3737070.98 99.28096 (05090703)
379018.72 3737108.39 97.62657 (05090703)
378946.79 3737131.41 87.60473 (07112121)
378866.23 3737155.86 77.77565 (07042501)
378840.33 3737065.23 72.44970 (05090703)
378932.40 3737033.58 61.39434 (05090703)
379007.21 3736999.05 75.01006 (05102722)
379067.63 3736951.58 94.11484 (06103001)
379113.67 3736869.58 85.46844 (05121121)
379020.16 3736876.77 82.88794 (06110720)
378945.35 3736937.19 73.46977 (05102722)
378886.37 3736971.72 57.22004 (05102722)
378820.19 3736990.42 35.17591 (05090703)
378856.16 3737332.81 74.07731 (06040802)
378836.02 3737247.94 66.11205 (05051905)
378814.44 3737163.06 71.26949 (07042501)
378798.61 3737076.74 68.21053 (05090703)
378772.72 3736996.18 40.10000 (05090703)

**MODELOPTs: RegDFAULT CONC ELEV NODRYDPLT NOWETDPLT

*** THE 1ST HIGHEST 1-HR AVERAGE CONCENTRATION VALUES FOR SOURCE GROUP: SRCGP14 ***
INCLUDING SOURCE(S): STCK14 ,

*** DISCRETE CARTESIAN RECEPTOR POINTS ***

** CONC OF XOQ IN MICROGRAMS/M**3 **

X-COORD (M)	Y-COORD (M)	CONC	(YYMMDDHH)	X-COORD (M)	Y-COORD (M)	CONC	(YYMMDDHH)
378877.74	3737400.43	71.26201	(07112121)	378926.65	3737406.18	82.20441	(07112121)
378978.44	3737414.82	81.17394	(07112121)	379007.21	3737384.60	94.66721	(05090703)
379021.60	3737354.39	88.84272	(05090703)	379035.98	3737322.74	62.79074	(05090703)
379047.49	3737286.78	58.65005	(05102722)	379077.70	3737266.64	85.43932	(05102722)
379105.04	3737250.81	97.01262	(05102722)	379132.37	3737230.67	76.85481	(06103001)
379161.14	3737209.09	90.83782	(05101823)	379187.04	3737190.39	112.50472	(06110720)
379221.57	3737167.37	123.27377	(07090702)	379250.34	3737147.23	87.31593	(05121121)
379280.55	3737127.09	66.61341	(05121121)	379286.30	3737076.74	85.18455	(05092206)
379296.38	3737039.33	85.38549	(05092206)	379306.45	3736994.74	77.62855	(06092703)
379316.52	3736953.02	77.35799	(07102604)	379328.02	3736908.42	67.46104	(07102604)
379342.41	3736865.26	49.14730	(05091505)	379345.29	3736829.30	59.09448	(05091505)
378886.37	3737242.18	37.46481	(05102722)	378910.82	3737340.01	72.29671	(05090703)
378982.75	3737327.06	58.36145	(05090703)				

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378981.32   3737220.60       59.40785  (05102722)
        379057.56   3737190.39       67.90862  (06103001)
379120.86   3737151.55       75.28479  (06110720)
        379172.65   3737118.46       77.59561  (05121121)
379224.44   3737076.74       53.18569  (05092206)
        379260.41   3737022.07       80.27684  (05092206)
379290.62   3736973.16       75.97762  (06092703)
        379287.74   3736883.96       66.03390  (07102604)
379197.11   3736869.58       61.84693  (06092703)
        379191.36   3736964.53       67.64393  (05092206)
379149.64   3737023.51       47.69390  (05092206)
        379089.21   3737070.98       64.51156  (05121121)
379018.72   3737108.39       62.77065  (06110720)
        378946.79   3737131.41       56.51952  (05101823)
378866.23   3737155.86       51.05541  (05102722)
        378840.33   3737065.23       48.24724  (05101823)
378932.40   3737033.58       53.84653  (07090702)
        379007.21   3736999.05       47.08263  (05121121)
379067.63   3736951.58       46.57900  (05092206)
        379113.67   3736869.58       55.07493  (06021701)
379020.16   3736876.77       49.73519  (05092206)
        378945.35   3736937.19       32.40442  (05121121)
378886.37   3736971.72       46.89950  (05121121)
        378820.19   3736990.42       46.26722  (06110720)
378856.16   3737332.81       68.01867  (05090703)
        378836.02   3737247.94       30.62663  (05102722)
378814.44   3737163.06       47.56265  (05102722)
        378798.61   3737076.74       45.81213  (05101823)
378772.72   3736996.18       44.19051  (06110720)
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**MODELOPTs: RegDFAULT CONC ELEV NODRYDPLT NOWETDPLT

*** THE 1ST HIGHEST 1-HR AVERAGE CONCENTRATION VALUES FOR SOURCE GROUP: SRCGP15 ***
INCLUDING SOURCE(S): STCK15 ,

*** DISCRETE CARTESIAN RECEPTOR POINTS ***

** CONC OF XOQ IN MICROGRAMS/M**3 **

X-COORD (M)	Y-COORD (M)	CONC	(YYMMDDHH)	X-COORD (M)	Y-COORD (M)	CONC	(YYMMDDHH)
378877.74	3737400.43	59.97366	(06040802)	378926.65	3737406.18	60.56479	(06040802)
378978.44	3737414.82	96.27046	(06040802)	379007.21	3737384.60	67.00556	(06040802)
379021.60	3737354.39	54.78180	(05051905)	379035.98	3737322.74	76.69682	(05051905)
379047.49	3737286.78	85.93115	(05051905)	379077.70	3737266.64	91.81816	(05102923)
379105.04	3737250.81	96.25347	(07042501)	379132.37	3737230.67	99.90059	(07042501)
379161.14	3737209.09	109.25052	(07112121)	379187.04	3737190.39	114.71253	(05090703)
379221.57	3737167.37	119.55925	(05090703)	379250.34	3737147.23	98.50278	(05090703)
379280.55	3737127.09	107.72141	(05102722)	379286.30	3737076.74	128.95614	(06103001)
379296.38	3737039.33	123.54097	(06110720)	379306.45	3736994.74	111.14009	(05121121)
379316.52	3736953.02	85.98809	(05092206)	379328.02	3736908.42	105.67248	(05092206)
379342.41	3736865.26	96.57594	(06092703)	379345.29	3736829.30	92.78049	(07102604)
378886.37	3737242.18	65.26327	(07042501)	378910.82	3737340.01	59.63419	(05051905)
378982.75	3737327.06	70.10109	(05051905)				

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378981.32   3737220.60       72.90931  (07112121)
        379057.56   3737190.39       83.32795  (07112121)
379120.86   3737151.55       89.69974  (05090703)
        379172.65   3737118.46       60.84114  (05102722)
379224.44   3737076.74      107.45031  (05102722)
        379260.41   3737022.07      111.93396  (06110720)
379290.62   3736973.16       95.05686  (05121121)
        379287.74   3736883.96       95.30843  (05092206)
379197.11   3736869.58       65.92248  (05092206)
        379191.36   3736964.53       91.99228  (07090702)
379149.64   3737023.51       88.82611  (06103001)
        379089.21   3737070.98       69.91494  (05102722)
379018.72   3737108.39       55.62744  (05090703)
        378946.79   3737131.41       66.45280  (05090703)
378866.23   3737155.86       62.64985  (05090703)
        378840.33   3737065.23       34.62711  (05090703)
378932.40   3737033.58       51.49048  (05102722)
        379007.21   3736999.05       68.85497  (05102722)
379067.63   3736951.58       71.22868  (05101823)
        379113.67   3736869.58       57.64463  (05121121)
379020.16   3736876.77       63.30122  (07090702)
        378945.35   3736937.19       58.66145  (05101823)
378886.37   3736971.72       57.23790  (05102722)
        378820.19   3736990.42       47.41500  (05102722)
378856.16   3737332.81       58.87788  (05051905)
        378836.02   3737247.94       60.55064  (07042501)
378814.44   3737163.06       56.41412  (05090703)
        378798.61   3737076.74       40.51873  (05090703)
378772.72   3736996.18       39.13260  (05102722)
```

**MODELOPTs: RegDFAULT CONC ELEV NODRYDPLT NOWETDPLT

*** THE 1ST HIGHEST 1-HR AVERAGE CONCENTRATION VALUES FOR SOURCE GROUP: SRCGP16 ***
INCLUDING SOURCE(S): STCK16 ,

*** DISCRETE CARTESIAN RECEPTOR POINTS ***

** CONC OF XOQ IN MICROGRAMS/M**3 **

X-COORD (M)	Y-COORD (M)	CONC	(YYMMDDHH)	X-COORD (M)	Y-COORD (M)	CONC	(YYMMDDHH)
378877.74	3737400.43	71.49861	(06103124)	378926.65	3737406.18	76.94952	(06103124)
378978.44	3737414.82	58.04385	(06103124)	379007.21	3737384.60	77.36723	(06103124)
379021.60	3737354.39	96.87370	(06103124)	379035.98	3737322.74	103.05164	(06103124)
379047.49	3737286.78	90.82941	(06103124)	379077.70	3737266.64	101.48789	(07033104)
379105.04	3737250.81	117.76095	(07033104)	379132.37	3737230.67	130.94643	(07033104)
379161.14	3737209.09	153.78915	(07033104)	379187.04	3737190.39	152.94482	(07033104)
379221.57	3737167.37	169.18599	(05121122)	379250.34	3737147.23	183.51984	(05121122)
379280.55	3737127.09	193.05736	(06040802)	379286.30	3737076.74	145.58423	(05051905)
379296.38	3737039.33	173.72877	(05102923)	379306.45	3736994.74	175.30818	(07112121)
379316.52	3736953.02	154.69336	(05090703)	379328.02	3736908.42	163.08723	(05102722)
379342.41	3736865.26	163.53145	(05101823)	379345.29	3736829.30	155.31358	(05121121)
378886.37	3737242.18	81.56933	(05121122)	378910.82	3737340.01	72.17391	(06103124)
378982.75	3737327.06	94.85256	(06103124)				

378981.32 3737220.60 89.78702 (05121122)
379057.56 3737190.39 89.13799 (06040802)
379120.86 3737151.55 104.34877 (06040802)
379172.65 3737118.46 102.62851 (06040802)
379224.44 3737076.74 129.21979 (05051905)
379260.41 3737022.07 155.20612 (07042501)
379290.62 3736973.16 166.97843 (05090703)
379287.74 3736883.96 147.42204 (05102722)
379197.11 3736869.58 114.31535 (05102722)
379191.36 3736964.53 127.67537 (05090703)
379149.64 3737023.51 116.95712 (07042501)
379089.21 3737070.98 102.38043 (05051905)
379018.72 3737108.39 73.52352 (05051905)
378946.79 3737131.41 54.36078 (05051905)
378866.23 3737155.86 50.38761 (06040802)
378840.33 3737065.23 64.08473 (05102923)
378932.40 3737033.58 74.53727 (07042501)
379007.21 3736999.05 83.49012 (07112121)
379067.63 3736951.58 96.62309 (05090703)
379113.67 3736869.58 79.42449 (05102722)
379020.16 3736876.77 47.62740 (05090703)
378945.35 3736937.19 75.58261 (05090703)
378886.37 3736971.72 69.72588 (07112121)
378820.19 3736990.42 61.36200 (07112121)
378856.16 3737332.81 76.37930 (07033104)
378836.02 3737247.94 82.21798 (06040802)
378814.44 3737163.06 47.47753 (06040802)
378798.61 3737076.74 60.82163 (05051905)
378772.72 3736996.18 56.20431 (07042501)

**MODELOPTs: RegDFAULT CONC ELEV NODRYDPLT NOWETDPLT

*** THE 1ST HIGHEST 1-HR AVERAGE CONCENTRATION VALUES FOR SOURCE GROUP: SRCGP17 ***
INCLUDING SOURCE(S): STCK17 ,

*** DISCRETE CARTESIAN RECEPTOR POINTS ***

** CONC OF XOQ IN MICROGRAMS/M**3 **

X-COORD (M)	Y-COORD (M)	CONC	(YYMMDDHH)	X-COORD (M)	Y-COORD (M)	CONC	(YYMMDDHH)
378877.74	3737400.43	51.35966	(05051905)	378926.65	3737406.18	55.04522	(05051905)
378978.44	3737414.82	48.71925	(05051905)	379007.21	3737384.60	64.81397	(05051905)
379021.60	3737354.39	71.84886	(05051905)	379035.98	3737322.74	73.36481	(05102923)
379047.49	3737286.78	75.27721	(07042501)	379077.70	3737266.64	74.99275	(07112121)
379105.04	3737250.81	85.70818	(07112121)	379132.37	3737230.67	86.68074	(07112121)
379161.14	3737209.09	96.38382	(05090703)	379187.04	3737190.39	91.74300	(05090703)
379221.57	3737167.37	80.24473	(05090703)	379250.34	3737147.23	61.96948	(05090703)
379280.55	3737127.09	65.96540	(05102722)	379286.30	3737076.74	80.15282	(05102722)
379296.38	3737039.33	79.55581	(06103001)	379306.45	3736994.74	78.94279	(06110720)
379316.52	3736953.02	77.73360	(07090702)	379328.02	3736908.42	61.14710	(05121121)
379342.41	3736865.26	54.69465	(05092206)	379345.29	3736829.30	67.04586	(05092206)
378886.37	3737242.18	62.76539	(07112121)	378910.82	3737340.01	65.13452	(05102923)
378982.75	3737327.06	74.59929	(05102923)				

378981.32 3737220.60 64.24195 (07112121)
379057.56 3737190.39 59.33318 (05090703)
379120.86 3737151.55 53.10978 (05090703)
379172.65 3737118.46 35.92675 (05102722)
379224.44 3737076.74 67.58724 (05102722)
379260.41 3737022.07 73.39760 (06103001)
379290.62 3736973.16 78.14973 (06110720)
379287.74 3736883.96 54.90203 (05121121)
379197.11 3736869.58 58.80514 (05121121)
379191.36 3736964.53 64.74578 (05101823)
379149.64 3737023.51 62.80642 (05102722)
379089.21 3737070.98 43.44378 (05102722)
379018.72 3737108.39 34.00221 (05090703)
378946.79 3737131.41 42.70649 (05090703)
378866.23 3737155.86 53.83869 (05090703)
378840.33 3737065.23 22.62629 (05090703)
378932.40 3737033.58 33.84578 (05102722)
379007.21 3736999.05 50.40099 (05102722)
379067.63 3736951.58 53.04552 (06103001)
379113.67 3736869.58 55.75507 (07090702)
379020.16 3736876.77 48.09430 (06110720)
378945.35 3736937.19 45.04584 (06103001)
378886.37 3736971.72 42.23194 (05102722)
378820.19 3736990.42 32.75693 (05102722)
378856.16 3737332.81 60.71290 (05102923)
378836.02 3737247.94 60.68828 (07112121)
378814.44 3737163.06 54.91527 (05090703)
378798.61 3737076.74 26.56801 (05090703)
378772.72 3736996.18 26.94122 (05102722)

**MODELOPTs: RegDFAULT CONC ELEV NODRYDPLT NOWETDPLT

*** THE 1ST HIGHEST 1-HR AVERAGE CONCENTRATION VALUES FOR SOURCE GROUP: SRCGP18 ***
INCLUDING SOURCE(S): STCK18 ,

*** DISCRETE CARTESIAN RECEPTOR POINTS ***

** CONC OF XOQ IN MICROGRAMS/M**3 **

X-COORD (M)	Y-COORD (M)	CONC	(YYMMDDHH)	X-COORD (M)	Y-COORD (M)	CONC	(YYMMDDHH)
378877.74	3737400.43	60.03493	(06040802)	378926.65	3737406.18	69.06232	(06040802)
378978.44	3737414.82	62.70226	(05121122)	379007.21	3737384.60	76.08914	(06040802)
379021.60	3737354.39	78.65291	(06040802)	379035.98	3737322.74	65.44642	(06040802)
379047.49	3737286.78	59.16463	(05051905)	379077.70	3737266.64	76.21468	(05051905)
379105.04	3737250.81	91.00236	(05051905)	379132.37	3737230.67	88.65652	(05051905)
379161.14	3737209.09	107.07852	(05051905)	379187.04	3737190.39	114.06141	(05102923)
379221.57	3737167.37	121.95767	(07042501)	379250.34	3737147.23	110.68447	(07042501)
379280.55	3737127.09	109.86276	(07112121)	379286.30	3737076.74	96.49872	(05090703)
379296.38	3737039.33	61.73797	(05090703)	379306.45	3736994.74	91.69138	(05102722)
379316.52	3736953.02	95.81741	(06103001)	379328.02	3736908.42	95.47415	(06110720)
379342.41	3736865.26	89.20908	(05121121)	379345.29	3736829.30	66.74943	(05121121)
378886.37	3737242.18	61.36675	(05051905)	378910.82	3737340.01	52.58706	(06040802)
378982.75	3737327.06	58.29431	(06040802)				

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378981.32   3737220.60       63.48887  (05051905)
        379057.56   3737190.39       67.23039  (05102923)
379120.86   3737151.55       73.35660  (07042501)
        379172.65   3737118.46       81.40527  (07112121)
379224.44   3737076.74       87.30893  (05090703)
        379260.41   3737022.07       56.06942  (05102722)
379290.62   3736973.16       92.86602  (05102722)
        379287.74   3736883.96       88.06665  (06110720)
379197.11   3736869.58       73.18110  (05101823)
        379191.36   3736964.53       72.03950  (05102722)
379149.64   3737023.51       52.36537  (05090703)
        379089.21   3737070.98       70.50184  (05090703)
379018.72   3737108.39       62.80632  (07112121)
        378946.79   3737131.41       55.42124  (07112121)
378866.23   3737155.86       52.26872  (07042501)
        378840.33   3737065.23       48.69879  (05090703)
378932.40   3737033.58       52.67245  (05090703)
        379007.21   3736999.05       40.49460  (05090703)
379067.63   3736951.58       50.49365  (05102722)
        379113.67   3736869.58       63.34259  (05101823)
379020.16   3736876.77       56.05645  (05102722)
        378945.35   3736937.19       35.26259  (05102722)
378886.37   3736971.72       30.90936  (05090703)
        378820.19   3736990.42       38.04082  (05090703)
378856.16   3737332.81       39.66879  (06040802)
        378836.02   3737247.94       66.65976  (05051905)
378814.44   3737163.06       52.42684  (07042501)
        378798.61   3737076.74       44.11395  (07112121)
378772.72   3736996.18       39.15890  (05090703)
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**MODELOPTs: RegDFAULT CONC ELEV NODRYDPLT NOWETDPLT

*** THE 1ST HIGHEST 1-HR AVERAGE CONCENTRATION VALUES FOR SOURCE GROUP: SRCGP19 ***
INCLUDING SOURCE(S): STCK19 ,

*** DISCRETE CARTESIAN RECEPTOR POINTS ***

** CONC OF XOQ IN MICROGRAMS/M**3 **

X-COORD (M)	Y-COORD (M)	CONC	(YYMMDDHH)
378877.74	3737400.43	42.25385	(06040802)
378926.65	3737406.18	48.83761	(05121122)
378978.44	3737414.82	48.78552	(05121122)
379007.21	3737384.60	53.40015	(05121122)
379021.60	3737354.39	55.44995	(06040802)
379035.98	3737322.74	58.27864	(06040802)
379047.49	3737286.78	52.55137	(06040802)
379077.70	3737266.64	49.27433	(06040802)
379105.04	3737250.81	47.02197	(06040802)
379132.37	3737230.67	47.00681	(05051905)
379161.14	3737209.09	59.27614	(05051905)
379187.04	3737190.39	66.82776	(05051905)
379221.57	3737167.37	79.06700	(05051905)
379250.34	3737147.23	95.32084	(05051905)
379280.55	3737127.09	104.55259	(05102923)
379286.30	3737076.74	97.05706	(07042501)
379296.38	3737039.33	78.93866	(07112121)
379306.45	3736994.74	78.75661	(05090703)
379316.52	3736953.02	52.39141	(05090703)
379328.02	3736908.42	68.26506	(05102722)
379342.41	3736865.26	78.75542	(05102722)
379345.29	3736829.30	77.86162	(05101823)
378886.37	3737242.18	42.14522	(05051905)
378910.82	3737340.01	50.59366	(06040802)
378982.75	3737327.06	57.96825	(06040802)

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378981.32   3737220.60       54.07233  (05051905)
        379057.56   3737190.39       71.71949  (05051905)
379120.86   3737151.55       80.17388  (05051905)
        379172.65   3737118.46       86.26114  (05102923)
379224.44   3737076.74       69.36353  (07042501)
        379260.41   3737022.07       75.09934  (05090703)
379290.62   3736973.16       66.66215  (05090703)
        379287.74   3736883.96       68.92412  (05102722)
379197.11   3736869.58       55.72886  (05102722)
        379191.36   3736964.53       58.74174  (05090703)
379149.64   3737023.51       60.37497  (07112121)
        379089.21   3737070.98       57.91853  (07042501)
379018.72   3737108.39       66.67386  (07042501)
        378946.79   3737131.41       66.84143  (05102923)
378866.23   3737155.86       58.08805  (05102923)
        378840.33   3737065.23       54.35052  (07042501)
378932.40   3737033.58       53.09324  (07112121)
        379007.21   3736999.05       50.99863  (05090703)
379067.63   3736951.58       49.98006  (05090703)
        379113.67   3736869.58       40.86106  (05102722)
379020.16   3736876.77       25.21808  (05102722)
        378945.35   3736937.19       42.76186  (05090703)
378886.37   3736971.72       44.57688  (05090703)
        378820.19   3736990.42       42.29947  (05090703)
378856.16   3737332.81       43.94616  (06040802)
        378836.02   3737247.94       37.79950  (05051905)
378814.44   3737163.06       54.28179  (05051905)
        378798.61   3737076.74       55.12291  (07042501)
378772.72   3736996.18       42.45717  (07112121)
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**MODELOPTs: RegDFAULT CONC ELEV NODRYDPLT NOWETDPLT

*** THE 1ST HIGHEST 1-HR AVERAGE CONCENTRATION VALUES FOR SOURCE GROUP: SRCGP20 ***
INCLUDING SOURCE(S): STCK20 ,

*** DISCRETE CARTESIAN RECEPTOR POINTS ***

** CONC OF XOQ IN MICROGRAMS/M**3 **

X-COORD (M)	Y-COORD (M)	CONC	(YYMMDDHH)	X-COORD (M)	Y-COORD (M)	CONC	(YYMMDDHH)
378877.74	3737400.43	53.28407	(06103124)	378926.65	3737406.18	58.42356	(06103124)
378978.44	3737414.82	48.57532	(06103124)	379007.21	3737384.60	60.24674	(06103124)
379021.60	3737354.39	69.88552	(06103124)	379035.98	3737322.74	71.34404	(06103124)
379047.49	3737286.78	63.47148	(06103124)	379077.70	3737266.64	63.71899	(07033104)
379105.04	3737250.81	73.19649	(07033104)	379132.37	3737230.67	87.35886	(07033104)
379161.14	3737209.09	98.62140	(07033104)	379187.04	3737190.39	98.18302	(07033104)
379221.57	3737167.37	106.79628	(07033104)	379250.34	3737147.23	121.13398	(07033104)
379280.55	3737127.09	126.94324	(05121122)	379286.30	3737076.74	98.09047	(06040802)
379296.38	3737039.33	74.72595	(06040802)	379306.45	3736994.74	106.09835	(05051905)
379316.52	3736953.02	107.67010	(05102923)	379328.02	3736908.42	110.20441	(07112121)
379342.41	3736865.26	105.42951	(05090703)	379345.29	3736829.30	69.16140	(05090703)
378886.37	3737242.18	67.82501	(05121122)	378910.82	3737340.01	52.94339	(06103124)
378982.75	3737327.06	68.10425	(06103124)				

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378981.32   3737220.60       73.66120  (05121122)
        379057.56   3737190.39       62.71393  (05121122)
379120.86   3737151.55       67.76547  (06040802)
        379172.65   3737118.46       79.23459  (06040802)
379224.44   3737076.74       81.00848  (06040802)
        379260.41   3737022.07       83.36401  (05051905)
379290.62   3736973.16      102.58523  (05102923)
        379287.74   3736883.96       99.65648  (05090703)
379197.11   3736869.58       84.80456  (05090703)
        379191.36   3736964.53       85.20862  (05102923)
379149.64   3737023.51       72.84231  (05051905)
        379089.21   3737070.98       47.11881  (06040802)
379018.72   3737108.39       52.90746  (06040802)
        378946.79   3737131.41       51.74132  (06040802)
378866.23   3737155.86       59.14674  (06040802)
        378840.33   3737065.23       42.20275  (05051905)
378932.40   3737033.58       54.15162  (05051905)
        379007.21   3736999.05       62.68674  (05051905)
379067.63   3736951.58       68.11579  (07042501)
        379113.67   3736869.58       72.03763  (05090703)
379020.16   3736876.77       60.78140  (07112121)
        378945.35   3736937.19       56.49052  (07042501)
378886.37   3736971.72       52.82484  (05102923)
        378820.19   3736990.42       48.33240  (05102923)
378856.16   3737332.81       52.61747  (07033104)
        378836.02   3737247.94       63.90323  (05121122)
378814.44   3737163.06       57.03087  (06040802)
        378798.61   3737076.74       39.37087  (05051905)
378772.72   3736996.18       45.26857  (05102923)
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**MODELOPTs: RegDFAULT CONC ELEV NODRYDPLT NOWETDPLT

*** THE 1ST HIGHEST 1-HR AVERAGE CONCENTRATION VALUES FOR SOURCE GROUP: SRCGP21 ***
INCLUDING SOURCE(S): STCK21 ,

*** DISCRETE CARTESIAN RECEPTOR POINTS ***

** CONC OF XOQ IN MICROGRAMS/M**3 **

X-COORD (M)	Y-COORD (M)	CONC	(YYMMDDHH)
378877.74	3737400.43	118.59099	(05091505)
378926.65	3737406.18	151.29385	(07030804)
378978.44	3737414.82	204.70805	(05041606)
379007.21	3737384.60	149.10875	(07101404)
379021.60	3737354.39	144.73472	(07101404)
379035.98	3737322.74	129.59232	(05041201)
379047.49	3737286.78	123.33349	(05041201)
379077.70	3737266.64	142.00590	(05102824)
379105.04	3737250.81	108.89621	(05102824)
379132.37	3737230.67	102.54266	(06101101)
379161.14	3737209.09	99.44081	(06110101)
379187.04	3737190.39	82.46774	(06110101)
379221.57	3737167.37	82.23905	(05060624)
379250.34	3737147.23	86.02609	(05060624)
379280.55	3737127.09	77.05709	(05060624)
379286.30	3737076.74	69.16351	(05060624)
379296.38	3737039.33	62.20635	(05060624)
379306.45	3736994.74	56.88104	(05060624)
379316.52	3736953.02	52.65564	(05060624)
379328.02	3736908.42	48.37042	(05060624)
379342.41	3736865.26	43.64674	(05060624)
379345.29	3736829.30	42.39598	(05060624)
378886.37	3737242.18	89.71533	(05041603)
378910.82	3737340.01	124.40633	(05041603)
378982.75	3737327.06	124.55107	(05041606)

```
378981.32   3737220.60       96.45652  (07101404)
        379057.56   3737190.39      105.76269  (05102824)
379120.86   3737151.55       78.29987  (06101101)
        379172.65   3737118.46       75.46927  (06110101)
379224.44   3737076.74       54.57761  (05060624)
        379260.41   3737022.07       60.47042  (05060624)
379290.62   3736973.16       57.62478  (05060624)
        379287.74   3736883.96       48.16222  (05060624)
379197.11   3736869.58       44.87520  (06110101)
        379191.36   3736964.53       52.27233  (06110101)
379149.64   3737023.51       64.58965  (06101101)
        379089.21   3737070.98       70.98003  (05102824)
379018.72   3737108.39       75.50868  (05041201)
        378946.79   3737131.41       77.10422  (07101404)
378866.23   3737155.86       86.71158  (05041606)
        378840.33   3737065.23       76.17227  (05041606)
378932.40   3737033.58       64.26036  (07101404)
        379007.21   3736999.05       59.80398  (05041201)
379067.63   3736951.58       62.84431  (05102824)
        379113.67   3736869.58       44.73580  (06101101)
379020.16   3736876.77       57.49346  (05102824)
        378945.35   3736937.19       46.88655  (05041201)
378886.37   3736971.72       52.57347  (07101404)
        378820.19   3736990.42       67.68276  (05041606)
378856.16   3737332.81      106.01938  (07030804)
        378836.02   3737247.94       92.90004  (07030804)
378814.44   3737163.06       76.02983  (05041603)
        378798.61   3737076.74       64.21188  (05041603)
378772.72   3736996.18       53.00384  (05041603)
```

**MODELOPTs: RegDFAULT CONC ELEV NODRYDPLT NOWETDPLT

*** THE 1ST HIGHEST 1-HR AVERAGE CONCENTRATION VALUES FOR SOURCE GROUP: SRCGP22 ***
INCLUDING SOURCE(S): STCK22 ,

*** DISCRETE CARTESIAN RECEPTOR POINTS ***

** CONC OF XOQ IN MICROGRAMS/M**3 **

X-COORD (M)	Y-COORD (M)	CONC	(YYMMDDHH)
378877.74	3737400.43	121.06170	(07030804)
378926.65	3737406.18	126.01096	(05041603)
378978.44	3737414.82	168.94318	(05041606)
379007.21	3737384.60	129.28181	(07101404)
379021.60	3737354.39	115.90365	(07101404)
379035.98	3737322.74	109.98109	(05041201)
379047.49	3737286.78	103.85771	(05041201)
379077.70	3737266.64	120.09841	(05102824)
379105.04	3737250.81	100.59519	(05102824)
379132.37	3737230.67	82.60459	(06101101)
379161.14	3737209.09	86.95675	(06101101)
379187.04	3737190.39	82.23221	(06110101)
379221.57	3737167.37	56.83395	(06110101)
379250.34	3737147.23	66.54368	(05060624)
379280.55	3737127.09	71.73602	(05060624)
379286.30	3737076.74	62.88289	(05060624)
379296.38	3737039.33	57.60240	(05060624)
379306.45	3736994.74	53.21503	(05060624)
379316.52	3736953.02	49.88735	(05060624)
379328.02	3736908.42	46.52594	(05060624)
379342.41	3736865.26	43.13122	(05060624)
379345.29	3736829.30	41.10249	(05060624)
378886.37	3737242.18	93.44744	(05041606)
378910.82	3737340.01	103.60678	(05041606)
378982.75	3737327.06	101.58459	(07101404)

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378981.32   3737220.60       82.12700  (07101404)
        379057.56   3737190.39       90.11347  (05102824)
379120.86   3737151.55       62.43661  (06101101)
        379172.65   3737118.46       69.15374  (06110101)
379224.44   3737076.74       45.56650  (06110101)
        379260.41   3737022.07       45.40567  (05060624)
379290.62   3736973.16       48.65434  (05060624)
        379287.74   3736883.96       38.02645  (05060624)
379197.11   3736869.58       43.77862  (06110101)
        379191.36   3736964.53       50.62834  (06110101)
379149.64   3737023.51       57.15319  (06101101)
        379089.21   3737070.98       66.47001  (05102824)
379018.72   3737108.39       66.30027  (05041201)
        378946.79   3737131.41       68.64077  (07101404)
378866.23   3737155.86       83.08299  (05041606)
        378840.33   3737065.23       70.01134  (05041606)
378932.40   3737033.58       56.76899  (07101404)
        379007.21   3736999.05       53.34432  (05041201)
379067.63   3736951.58       58.08614  (05102824)
        379113.67   3736869.58       37.50588  (06101101)
379020.16   3736876.77       51.46816  (05102824)
        378945.35   3736937.19       43.28084  (05041201)
378886.37   3736971.72       49.40407  (07101404)
        378820.19   3736990.42       60.48952  (05041606)
378856.16   3737332.81       98.20461  (07030804)
        378836.02   3737247.94       81.44636  (05041603)
378814.44   3737163.06       67.61787  (05041603)
        378798.61   3737076.74       56.95687  (05041606)
378772.72   3736996.18       52.79727  (05041606)
```

**MODELOPTs: RegDFAULT CONC ELEV NODRYDPLT NOWETDPLT

*** THE 1ST HIGHEST 1-HR AVERAGE CONCENTRATION VALUES FOR SOURCE GROUP: SRCGP23 ***
INCLUDING SOURCE(S): STCK23 ,

*** DISCRETE CARTESIAN RECEPTOR POINTS ***

** CONC OF XOQ IN MICROGRAMS/M**3 **

X-COORD (M)	Y-COORD (M)	CONC	(YYMMDDHH)	X-COORD (M)	Y-COORD (M)	CONC	(YYMMDDHH)
378877.74	3737400.43	129.80146	(05091505)	378926.65	3737406.18	115.45997	(05091505)
378978.44	3737414.82	158.42358	(07030804)	379007.21	3737384.60	148.61186	(05041606)
379021.60	3737354.39	160.98185	(05041606)	379035.98	3737322.74	125.19679	(05041606)
379047.49	3737286.78	116.20464	(07101404)	379077.70	3737266.64	104.85082	(05041201)
379105.04	3737250.81	107.30293	(05041201)	379132.37	3737230.67	120.56403	(05102824)
379161.14	3737209.09	97.19607	(05102824)	379187.04	3737190.39	93.94551	(06101101)
379221.57	3737167.37	93.22846	(06110101)	379250.34	3737147.23	73.08531	(06110101)
379280.55	3737127.09	61.85744	(05060624)	379286.30	3737076.74	53.03707	(05060624)
379296.38	3737039.33	50.48482	(05060624)	379306.45	3736994.74	47.77404	(05060624)
379316.52	3736953.02	45.89094	(05060624)	379328.02	3736908.42	44.00384	(05060624)
379342.41	3736865.26	42.65641	(05060624)	379345.29	3736829.30	39.70989	(05060624)
378886.37	3737242.18	87.56713	(07030804)	378910.82	3737340.01	104.48939	(07030804)
378982.75	3737327.06	119.01566	(05041606)				

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378981.32   3737220.60      105.34184  (05041606)
        379057.56   3737190.39       77.61923  (05041201)
379120.86   3737151.55       97.37318  (05102824)
        379172.65   3737118.46       66.53131  (06101101)
379224.44   3737076.74       69.07501  (06110101)
        379260.41   3737022.07       52.54557  (06110101)
379290.62   3736973.16       37.37468  (05060624)
        379287.74   3736883.96       35.06640  (06110101)
379197.11   3736869.58       48.25359  (06101101)
        379191.36   3736964.53       55.21449  (06101101)
379149.64   3737023.51       60.92923  (05102824)
        379089.21   3737070.98       72.96394  (05102824)
379018.72   3737108.39       71.63443  (07101404)
        378946.79   3737131.41       86.30120  (05041606)
378866.23   3737155.86       73.70894  (05041603)
        378840.33   3737065.23       61.84669  (05041603)
378932.40   3737033.58       62.72283  (05041606)
        379007.21   3736999.05       54.07666  (07101404)
379067.63   3736951.58       55.48247  (05102824)
        379113.67   3736869.58       55.96794  (05102824)
379020.16   3736876.77       47.71882  (05041201)
        378945.35   3736937.19       50.24316  (07101404)
378886.37   3736971.72       63.05768  (05041606)
        378820.19   3736990.42       51.81284  (05041603)
378856.16   3737332.81      101.28859  (05091505)
        378836.02   3737247.94       67.46693  (07030804)
378814.44   3737163.06       69.08544  (07030804)
        378798.61   3737076.74       61.06781  (07030804)
378772.72   3736996.18       51.01330  (05041603)
```

**MODELOPTs: RegDFAULT CONC ELEV NODRYDPLT NOWETDPLT

*** THE 1ST HIGHEST 1-HR AVERAGE CONCENTRATION VALUES FOR SOURCE GROUP: SRCGP24 ***
INCLUDING SOURCE(S): STCK24 ,

*** DISCRETE CARTESIAN RECEPTOR POINTS ***

** CONC OF XOQ IN MICROGRAMS/M**3 **

X-COORD (M)	Y-COORD (M)	CONC	(YYMMDDHH)	X-COORD (M)	Y-COORD (M)	CONC	(YYMMDDHH)
378877.74	3737400.43	91.11703	(07102604)	378926.65	3737406.18	108.42457	(05091505)
378978.44	3737414.82	130.98689	(05091505)	379007.21	3737384.60	116.23824	(07030804)
379021.60	3737354.39	121.60483	(07030804)	379035.98	3737322.74	116.38823	(05041603)
379047.49	3737286.78	111.80655	(05041606)	379077.70	3737266.64	125.06904	(05041606)
379105.04	3737250.81	94.72360	(07101404)	379132.37	3737230.67	98.38284	(07101404)
379161.14	3737209.09	93.16719	(05041201)	379187.04	3737190.39	95.09589	(05041201)
379221.57	3737167.37	111.04068	(05102824)	379250.34	3737147.23	87.09488	(05102824)
379280.55	3737127.09	77.58739	(06101101)	379286.30	3737076.74	70.06567	(06101101)
379296.38	3737039.33	65.10662	(06101101)	379306.45	3736994.74	60.15025	(06101101)
379316.52	3736953.02	55.62081	(06110101)	379328.02	3736908.42	51.67674	(06110101)
379342.41	3736865.26	46.53953	(06110101)	379345.29	3736829.30	43.97587	(06110101)
378886.37	3737242.18	66.66767	(05091505)	378910.82	3737340.01	103.22159	(05091505)
378982.75	3737327.06	102.70919	(07030804)				

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378981.32   3737220.60       86.32425  (05041603)
        379057.56   3737190.39       95.11909  (05041606)
379120.86   3737151.55       78.18565  (07101404)
        379172.65   3737118.46       76.48080  (05041201)
379224.44   3737076.74       81.20592  (05102824)
        379260.41   3737022.07       50.75809  (06101101)
379290.62   3736973.16       56.53485  (06101101)
        379287.74   3736883.96       48.14531  (06101101)
379197.11   3736869.58       58.40265  (05102824)
        379191.36   3736964.53       67.72666  (05102824)
379149.64   3737023.51       62.89139  (05041201)
        379089.21   3737070.98       67.63403  (07101404)
379018.72   3737108.39       83.19425  (05041606)
        378946.79   3737131.41       71.04005  (05041603)
378866.23   3737155.86       61.24895  (07030804)
        378840.33   3737065.23       58.44099  (07030804)
378932.40   3737033.58       56.46812  (05041606)
        379007.21   3736999.05       57.06530  (05041606)
379067.63   3736951.58       53.26480  (07101404)
        379113.67   3736869.58       48.29066  (05041201)
379020.16   3736876.77       46.96303  (07101404)
        378945.35   3736937.19       59.38057  (05041606)
378886.37   3736971.72       50.61914  (05041603)
        378820.19   3736990.42       52.34303  (07030804)
378856.16   3737332.81       78.91941  (05091505)
        378836.02   3737247.94       80.56860  (05091505)
378814.44   3737163.06       61.88483  (05091505)
        378798.61   3737076.74       44.02031  (07030804)
378772.72   3736996.18       45.12769  (07030804)
```

**MODELOPTs: RegDFAULT CONC ELEV NODRYDPLT NOWETDPLT

*** THE 1ST HIGHEST 1-HR AVERAGE CONCENTRATION VALUES FOR SOURCE GROUP: SRCGP25 ***
INCLUDING SOURCE(S): STCK25 ,

*** DISCRETE CARTESIAN RECEPTOR POINTS ***

** CONC OF XOQ IN MICROGRAMS/M**3 **

X-COORD (M)	Y-COORD (M)	CONC	(YYMMDDHH)
378877.74	3737400.43	99.96590	(05091505)
378926.65	3737406.18	102.39359	(07030804)
378978.44	3737414.82	123.51164	(05041603)
379007.21	3737384.60	126.49065	(05041606)
379021.60	3737354.39	131.83780	(05041606)
379035.98	3737322.74	106.57161	(05041606)
379047.49	3737286.78	94.32952	(07101404)
379077.70	3737266.64	91.09793	(07101404)
379105.04	3737250.81	91.26234	(05041201)
379132.37	3737230.67	90.74224	(05102824)
379161.14	3737209.09	101.41023	(05102824)
379187.04	3737190.39	85.15148	(05102824)
379221.57	3737167.37	77.20498	(06101101)
379250.34	3737147.23	75.33927	(06101101)
379280.55	3737127.09	67.59873	(06110101)
379286.30	3737076.74	58.65062	(06110101)
379296.38	3737039.33	50.56427	(06110101)
379306.45	3736994.74	44.08927	(06110101)
379316.52	3736953.02	38.81392	(06110101)
379328.02	3736908.42	33.42354	(06110101)
379342.41	3736865.26	27.52928	(06110101)
379345.29	3736829.30	26.24969	(06110101)
378886.37	3737242.18	73.61855	(05041603)
378910.82	3737340.01	95.17697	(07030804)
378982.75	3737327.06	104.41556	(05041606)

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378981.32   3737220.60       90.88658  (05041606)
        379057.56   3737190.39       72.11287  (07101404)
379120.86   3737151.55       74.11168  (05102824)
        379172.65   3737118.46       74.01096  (05102824)
379224.44   3737076.74       59.04716  (06101101)
        379260.41   3737022.07       55.85113  (06110101)
379290.62   3736973.16       47.86236  (06110101)
        379287.74   3736883.96       43.04934  (06110101)
379197.11   3736869.58       36.43647  (06101101)
        379191.36   3736964.53       40.26773  (05102824)
379149.64   3737023.51       66.07504  (05102824)
        379089.21   3737070.98       60.50934  (05041201)
379018.72   3737108.39       64.18456  (07101404)
        378946.79   3737131.41       75.91631  (05041606)
378866.23   3737155.86       65.66207  (05041603)
        378840.33   3737065.23       54.16112  (05041603)
378932.40   3737033.58       56.85786  (05041606)
        379007.21   3736999.05       51.09206  (07101404)
379067.63   3736951.58       49.28642  (05041201)
        379113.67   3736869.58       52.43695  (05102824)
379020.16   3736876.77       40.94057  (05041201)
        378945.35   3736937.19       43.90834  (07101404)
378886.37   3736971.72       56.79905  (05041606)
        378820.19   3736990.42       45.07509  (05041603)
378856.16   3737332.81       67.79024  (05091505)
        378836.02   3737247.94       69.42771  (07030804)
378814.44   3737163.06       63.93243  (07030804)
        378798.61   3737076.74       52.56496  (05041603)
378772.72   3736996.18       47.90065  (05041603)
```

**MODELOPTs: RegDFAULT CONC ELEV NODRYDPLT NOWETDPLT

*** THE 1ST HIGHEST 1-HR AVERAGE CONCENTRATION VALUES FOR SOURCE GROUP: SRCGP26 ***
INCLUDING SOURCE(S): STCK26 ,

*** DISCRETE CARTESIAN RECEPTOR POINTS ***

** CONC OF XOQ IN MICROGRAMS/M**3 **

X-COORD (M)	Y-COORD (M)	CONC	(YYMMDDHH)	X-COORD (M)	Y-COORD (M)	CONC	(YYMMDDHH)
378877.74	3737400.43	85.46760	(05091505)	378926.65	3737406.18	102.83576	(05091505)
378978.44	3737414.82	84.39467	(05091505)	379007.21	3737384.60	108.44763	(07030804)
379021.60	3737354.39	102.63931	(05041603)	379035.98	3737322.74	94.73811	(05041603)
379047.49	3737286.78	105.74902	(05041606)	379077.70	3737266.64	102.27418	(05041606)
379105.04	3737250.81	83.85954	(07101404)	379132.37	3737230.67	85.30323	(07101404)
379161.14	3737209.09	79.57676	(05041201)	379187.04	3737190.39	83.40867	(05041201)
379221.57	3737167.37	95.45168	(05102824)	379250.34	3737147.23	85.18477	(05102824)
379280.55	3737127.09	60.07888	(06101101)	379286.30	3737076.74	56.46211	(06101101)
379296.38	3737039.33	54.92875	(06101101)	379306.45	3736994.74	52.91165	(06101101)
379316.52	3736953.02	50.82517	(06101101)	379328.02	3736908.42	47.71102	(06101101)
379342.41	3736865.26	43.81718	(06110101)	379345.29	3736829.30	41.69343	(06110101)
378886.37	3737242.18	61.69320	(07030804)	378910.82	3737340.01	77.87060	(05091505)
378982.75	3737327.06	92.87211	(07030804)				

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378981.32   3737220.60       74.81693  (05041603)
        379057.56   3737190.39       79.08020  (05041606)
379120.86   3737151.55       69.22522  (07101404)
        379172.65   3737118.46       68.77952  (05041201)
379224.44   3737076.74       75.00816  (05102824)
        379260.41   3737022.07       53.41870  (05102824)
379290.62   3736973.16       47.37742  (06101101)
        379287.74   3736883.96       40.61319  (06101101)
379197.11   3736869.58       54.11518  (05102824)
        379191.36   3736964.53       60.06338  (05102824)
379149.64   3737023.51       57.03195  (05041201)
        379089.21   3737070.98       60.79802  (07101404)
379018.72   3737108.39       71.75980  (05041606)
        378946.79   3737131.41       61.16526  (05041603)
378866.23   3737155.86       61.91364  (07030804)
        378840.33   3737065.23       54.14188  (07030804)
378932.40   3737033.58       57.36233  (05041606)
        379007.21   3736999.05       48.07066  (05041606)
379067.63   3736951.58       48.56371  (07101404)
        379113.67   3736869.58       44.24577  (05041201)
379020.16   3736876.77       43.46108  (07101404)
        378945.35   3736937.19       53.66950  (05041606)
378886.37   3736971.72       43.34080  (05041603)
        378820.19   3736990.42       46.00192  (07030804)
378856.16   3737332.81       83.51039  (05091505)
        378836.02   3737247.94       65.82297  (05091505)
378814.44   3737163.06       43.21656  (05091505)
        378798.61   3737076.74       48.35720  (07030804)
378772.72   3736996.18       46.05186  (07030804)
```

**MODELOPTs: RegDFAULT CONC ELEV NODRYDPLT NOWETDPLT

*** THE 1ST HIGHEST 1-HR AVERAGE CONCENTRATION VALUES FOR SOURCE GROUP: SRCGP27 ***
INCLUDING SOURCE(S): VOL1 ,

*** DISCRETE CARTESIAN RECEPTOR POINTS ***

** CONC OF XOQ IN MICROGRAMS/M**3 **

X-COORD (M)	Y-COORD (M)	CONC	(YYMMDDHH)	X-COORD (M)	Y-COORD (M)	CONC	(YYMMDDHH)
378877.74	3737400.43	56.74528	(06101101)	378926.65	3737406.18	56.38851	(06110101)
378978.44	3737414.82	52.29179	(05060624)	379007.21	3737384.60	52.81862	(05060624)
379021.60	3737354.39	50.78458	(05060624)	379035.98	3737322.74	49.18179	(05060624)
379047.49	3737286.78	46.81017	(05060624)	379077.70	3737266.64	44.73635	(05060624)
379105.04	3737250.81	40.70753	(05060624)	379132.37	3737230.67	34.78969	(05060624)
379161.14	3737209.09	36.60918	(05091704)	379187.04	3737190.39	38.60119	(05091704)
379221.57	3737167.37	38.29723	(05091704)	379250.34	3737147.23	35.47113	(05091704)
379280.55	3737127.09	34.11347	(05043002)	379286.30	3737076.74	31.03271	(05043002)
379296.38	3737039.33	28.80719	(05043002)	379306.45	3736994.74	27.25552	(05091704)
379316.52	3736953.02	26.10342	(05091704)	379328.02	3736908.42	24.84521	(05091704)
379342.41	3736865.26	23.46703	(05091704)	379345.29	3736829.30	22.70923	(05091704)
378886.37	3737242.18	42.18109	(06101101)	378910.82	3737340.01	50.41129	(06101101)
378982.75	3737327.06	40.27140	(05060624)				

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378981.32   3737220.60       35.39701  (06110101)
        379057.56   3737190.39       37.82655  (05060624)
379120.86   3737151.55       34.07660  (05060624)
        379172.65   3737118.46       29.29425  (05091704)
379224.44   3737076.74       30.15285  (05091704)
        379260.41   3737022.07       28.68040  (05091704)
379290.62   3736973.16       27.05827  (05091704)
        379287.74   3736883.96       23.87988  (05091704)
379197.11   3736869.58       22.97590  (05060624)
        379191.36   3736964.53       24.10843  (05060624)
379149.64   3737023.51       28.56935  (05060624)
        379089.21   3737070.98       32.35613  (05060624)
379018.72   3737108.39       29.34250  (05060624)
        378946.79   3737131.41       35.41639  (06110101)
378866.23   3737155.86       35.96423  (06101101)
        378840.33   3737065.23       29.03778  (06101101)
378932.40   3737033.58       31.71387  (06110101)
        379007.21   3736999.05       24.86469  (06110101)
379067.63   3736951.58       25.97949  (05060624)
        379113.67   3736869.58       25.07567  (05060624)
379020.16   3736876.77       21.03007  (06110101)
        378945.35   3736937.19       27.27026  (06110101)
378886.37   3736971.72       28.86449  (06101101)
        378820.19   3736990.42       24.11698  (06101101)
378856.16   3737332.81       45.56158  (06101101)
        378836.02   3737247.94       36.26967  (06101101)
378814.44   3737163.06       30.77245  (05102824)
        378798.61   3737076.74       27.61894  (05102824)
378772.72   3736996.18       25.19723  (05102824)
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**MODELOPTs: RegDFAULT CONC ELEV NODRYDPLT NOWETDPLT

*** THE 1ST HIGHEST 1-HR AVERAGE CONCENTRATION VALUES FOR SOURCE GROUP: SRCGP28 ***
INCLUDING SOURCE(S): VOL2 ,

*** DISCRETE CARTESIAN RECEPTOR POINTS ***

** CONC OF XOQ IN MICROGRAMS/M**3 **

X-COORD (M)	Y-COORD (M)	CONC	(YYMMDDHH)	X-COORD (M)	Y-COORD (M)	CONC	(YYMMDDHH)
378877.74	3737400.43	55.57192	(06101101)	378926.65	3737406.18	60.67010	(06101101)
378978.44	3737414.82	57.22080	(06110101)	379007.21	3737384.60	53.49657	(05060624)
379021.60	3737354.39	52.10540	(05060624)	379035.98	3737322.74	51.01391	(05060624)
379047.49	3737286.78	48.77674	(05060624)	379077.70	3737266.64	47.90124	(05060624)
379105.04	3737250.81	44.45251	(05060624)	379132.37	3737230.67	38.53775	(05060624)
379161.14	3737209.09	37.58715	(05091704)	379187.04	3737190.39	40.09551	(05091704)
379221.57	3737167.37	40.22079	(05091704)	379250.34	3737147.23	37.44808	(05091704)
379280.55	3737127.09	35.80340	(05043002)	379286.30	3737076.74	32.42464	(05043002)
379296.38	3737039.33	30.26704	(05091704)	379306.45	3736994.74	28.66826	(05091704)
379316.52	3736953.02	27.38833	(05091704)	379328.02	3736908.42	26.01262	(05091704)
379342.41	3736865.26	24.55612	(05091704)	379345.29	3736829.30	23.68991	(05091704)
378886.37	3737242.18	42.15916	(06101101)	378910.82	3737340.01	53.19369	(06101101)
378982.75	3737327.06	46.30306	(06110101)				

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378981.32   3737220.60       40.26924  (06110101)
        379057.56   3737190.39       38.97677  (05060624)
379120.86   3737151.55       36.82823  (05060624)
        379172.65   3737118.46       30.19062  (05060624)
379224.44   3737076.74       31.25199  (05091704)
        379260.41   3737022.07       29.88415  (05091704)
379290.62   3736973.16       28.27405  (05091704)
        379287.74   3736883.96       24.64849  (05091704)
379197.11   3736869.58       24.70176  (05060624)
        379191.36   3736964.53       26.23561  (05060624)
379149.64   3737023.51       30.69970  (05060624)
        379089.21   3737070.98       33.54288  (05060624)
379018.72   3737108.39       29.81033  (06110101)
        378946.79   3737131.41       37.87287  (06110101)
378866.23   3737155.86       34.65666  (06101101)
        378840.33   3737065.23       27.43691  (05102824)
378932.40   3737033.58       33.26692  (06101101)
        379007.21   3736999.05       28.08427  (06110101)
379067.63   3736951.58       25.90698  (05060624)
        379113.67   3736869.58       25.64432  (05060624)
379020.16   3736876.77       23.65367  (06110101)
        378945.35   3736937.19       28.64854  (06110101)
378886.37   3736971.72       28.84403  (06101101)
        378820.19   3736990.42       25.49206  (05102824)
378856.16   3737332.81       42.69187  (05102824)
        378836.02   3737247.94       37.83649  (05102824)
378814.44   3737163.06       33.42310  (05102824)
        378798.61   3737076.74       30.09773  (05041201)
378772.72   3736996.18       28.61099  (05041201)
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**MODELOPTs: RegDFAULT CONC ELEV NODRYDPLT NOWETDPLT

*** THE 1ST HIGHEST 1-HR AVERAGE CONCENTRATION VALUES FOR SOURCE GROUP: SRCGP29 ***
INCLUDING SOURCE(S): VOL3 ,

*** DISCRETE CARTESIAN RECEPTOR POINTS ***

** CONC OF XOQ IN MICROGRAMS/M**3 **

X-COORD (M)	Y-COORD (M)	CONC	(YYMMDDHH)	X-COORD (M)	Y-COORD (M)	CONC	(YYMMDDHH)
378877.74	3737400.43	56.01842	(05041201)	378926.65	3737406.18	51.89578	(06101101)
378978.44	3737414.82	63.63192	(06101101)	379007.21	3737384.60	57.27188	(06110101)
379021.60	3737354.39	52.19200	(06110101)	379035.98	3737322.74	47.68530	(06110101)
379047.49	3737286.78	43.35732	(06110101)	379077.70	3737266.64	42.74191	(05060624)
379105.04	3737250.81	44.69607	(05060624)	379132.37	3737230.67	43.14734	(05060624)
379161.14	3737209.09	41.84927	(05060624)	379187.04	3737190.39	39.77814	(05060624)
379221.57	3737167.37	34.70115	(05091704)	379250.34	3737147.23	35.28234	(05091704)
379280.55	3737127.09	35.69453	(05091704)	379286.30	3737076.74	31.92768	(05091704)
379296.38	3737039.33	29.58424	(05091704)	379306.45	3736994.74	27.59570	(05091704)
379316.52	3736953.02	26.07781	(05091704)	379328.02	3736908.42	24.55794	(05091704)
379342.41	3736865.26	23.21245	(05091704)	379345.29	3736829.30	21.88918	(05091704)
378886.37	3737242.18	36.59827	(05102824)	378910.82	3737340.01	42.39922	(05102824)
378982.75	3737327.06	50.97695	(06101101)				

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378981.32   3737220.60       42.89558  (06101101)
        379057.56   3737190.39       34.66572  (06110101)
379120.86   3737151.55       36.44767  (05060624)
        379172.65   3737118.46       35.72753  (05060624)
379224.44   3737076.74       29.68528  (05060624)
        379260.41   3737022.07       25.47434  (05091704)
379290.62   3736973.16       25.36009  (05091704)
        379287.74   3736883.96       21.73895  (05060624)
379197.11   3736869.58       26.11331  (05060624)
        379191.36   3736964.53       29.08207  (05060624)
379149.64   3737023.51       30.84485  (05060624)
        379089.21   3737070.98       27.80257  (05060624)
379018.72   3737108.39       35.60472  (06110101)
        378946.79   3737131.41       35.92252  (06101101)
378866.23   3737155.86       32.66361  (05041201)
        378840.33   3737065.23       30.50769  (05041201)
378932.40   3737033.58       30.24259  (06101101)
        379007.21   3736999.05       31.06322  (06110101)
379067.63   3736951.58       25.97992  (06110101)
        379113.67   3736869.58       21.15272  (05060624)
379020.16   3736876.77       26.49593  (06110101)
        378945.35   3736937.19       27.17103  (06101101)
378886.37   3736971.72       23.63961  (05102824)
        378820.19   3736990.42       28.47049  (05041201)
378856.16   3737332.81       49.89070  (05041201)
        378836.02   3737247.94       43.90646  (05041201)
378814.44   3737163.06       38.96043  (05041201)
        378798.61   3737076.74       34.44260  (05041201)
378772.72   3736996.18       31.09292  (05041201)
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**MODELOPTs: RegDFAULT CONC ELEV NODRYDPLT NOWETDPLT

*** THE 1ST HIGHEST 1-HR AVERAGE CONCENTRATION VALUES FOR SOURCE GROUP: SRCGP30 ***
INCLUDING SOURCE(S): PAREA1 ,

*** DISCRETE CARTESIAN RECEPTOR POINTS ***

** CONC OF XOQ IN MICROGRAMS/M**3 **

X-COORD (M)	Y-COORD (M)	CONC	(YYMMDDHH)	X-COORD (M)	Y-COORD (M)	CONC	(YYMMDDHH)
378877.74	3737400.43	10.18134	(05051905)	378926.65	3737406.18	10.44002	(05051905)
378978.44	3737414.82	10.42482	(05051905)	379007.21	3737384.60	10.68545	(05051905)
379021.60	3737354.39	10.79561	(05051905)	379035.98	3737322.74	10.81722	(05051905)
379047.49	3737286.78	10.81781	(05051905)	379077.70	3737266.64	10.89512	(05051905)
379105.04	3737250.81	11.02376	(05102923)	379132.37	3737230.67	11.26453	(05102923)
379161.14	3737209.09	11.25321	(05102923)	379187.04	3737190.39	11.16711	(05102923)
379221.57	3737167.37	11.26487	(07042501)	379250.34	3737147.23	11.55068	(07042501)
379280.55	3737127.09	11.69068	(07042501)	379286.30	3737076.74	11.83612	(07112121)
379296.38	3737039.33	12.00897	(07112121)	379306.45	3736994.74	12.07917	(05090703)
379316.52	3736953.02	12.11197	(05090703)	379328.02	3736908.42	12.10907	(05090703)
379342.41	3736865.26	12.10107	(05090703)	379345.29	3736829.30	11.94487	(05090703)
378886.37	3737242.18	10.40486	(05102923)	378910.82	3737340.01	10.47247	(05051905)
378982.75	3737327.06	10.77639	(05051905)				

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378981.32   3737220.60       10.73129  (05102923)
        379057.56   3737190.39       11.05812  (07042501)
379120.86   3737151.55       11.28667  (07042501)
        379172.65   3737118.46       11.42116  (07042501)
379224.44   3737076.74       11.73562  (07112121)
        379260.41   3737022.07       11.84747  (07112121)
379290.62   3736973.16       12.00279  (05090703)
        379287.74   3736883.96       11.86908  (05090703)
379197.11   3736869.58       11.41062  (05090703)
        379191.36   3736964.53       11.55821  (05090703)
379149.64   3737023.51       11.35873  (07112121)
        379089.21   3737070.98       11.13025  (07112121)
379018.72   3737108.39       10.81405  (07042501)
        378946.79   3737131.41       10.56380  (07042501)
378866.23   3737155.86       10.26118  (07042501)
        378840.33   3737065.23       10.15705  (07112121)
378932.40   3737033.58       10.48865  (07112121)
        379007.21   3736999.05       10.78518  (05090703)
379067.63   3736951.58       11.05299  (05090703)
        379113.67   3736869.58       11.09879  (05090703)
379020.16   3736876.77       10.80505  (05090703)
        378945.35   3736937.19       10.65912  (05090703)
378886.37   3736971.72       10.36488  (05090703)
        378820.19   3736990.42       10.07987  (05090703)
378856.16   3737332.81       10.27085  (05051905)
        378836.02   3737247.94       10.18018  (05102923)
378814.44   3737163.06       10.08292  (07042501)
        378798.61   3737076.74       10.01207  (07112121)
378772.72   3736996.18        9.90683  (05090703)
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**MODELOPTs: RegDFAULT CONC ELEV NODRYDPLT NOWETDPLT

*** THE 1ST HIGHEST 1-HR AVERAGE CONCENTRATION VALUES FOR SOURCE GROUP: SRCGP31 ***
INCLUDING SOURCE(S): STCK27 ,

*** DISCRETE CARTESIAN RECEPTOR POINTS ***

** CONC OF XOQ IN MICROGRAMS/M**3 **

X-COORD (M)	Y-COORD (M)	CONC	(YYMMDDHH)	X-COORD (M)	Y-COORD (M)	CONC	(YYMMDDHH)
378877.74	3737400.43	37.62761	(05021119)	378926.65	3737406.18	44.13669	(05021806)
378978.44	3737414.82	64.93834	(05022021)	379007.21	3737384.60	81.19313	(05021118)
379021.60	3737354.39	104.50841	(05111517)	379035.98	3737322.74	128.64539	(07123117)
379047.49	3737286.78	127.23229	(06012307)	379077.70	3737266.64	118.81477	(07122621)
379105.04	3737250.81	94.69915	(07122619)	379132.37	3737230.67	65.80929	(07122619)
379161.14	3737209.09	38.40126	(07122619)	379187.04	3737190.39	25.29687	(06010508)
379221.57	3737167.37	19.70008	(06110214)	379250.34	3737147.23	16.00166	(06110214)
379280.55	3737127.09	15.44694	(07010502)	379286.30	3737076.74	13.00188	(07010508)
379296.38	3737039.33	12.81534	(07111307)	379306.45	3736994.74	13.00472	(05112619)
379316.52	3736953.02	13.05872	(05112619)	379328.02	3736908.42	12.79303	(05112619)
379342.41	3736865.26	12.28963	(05112619)	379345.29	3736829.30	12.00808	(05112619)
378886.37	3737242.18	33.07318	(05021101)	378910.82	3737340.01	42.53604	(05021121)
378982.75	3737327.06	70.43243	(05111518)				

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378981.32   3737220.60       45.35171  (06012307)
        379057.56   3737190.39       55.43383  (07122620)
379120.86   3737151.55       43.24485  (07122619)
        379172.65   3737118.46       29.33967  (06010508)
379224.44   3737076.74       20.39100  (06010501)
        379260.41   3737022.07       16.08862  (06010501)
379290.62   3736973.16       13.91859  (05112619)
        379287.74   3736883.96       13.36291  (05112619)
379197.11   3736869.58       15.83539  (06010501)
        379191.36   3736964.53       19.96422  (06010501)
379149.64   3737023.51       24.52257  (06120406)
        379089.21   3737070.98       28.48165  (06120405)
379018.72   3737108.39       32.60852  (07122620)
        378946.79   3737131.41       29.19327  (07011308)
378866.23   3737155.86       25.63481  (07101304)
        378840.33   3737065.23       19.38826  (05022302)
378932.40   3737033.58       20.80084  (05120908)
        379007.21   3736999.05       21.42894  (07122622)
379067.63   3736951.58       19.40193  (06120407)
        379113.67   3736869.58       16.10152  (06120404)
379020.16   3736876.77       14.63304  (06120407)
        378945.35   3736937.19       16.08204  (06020608)
378886.37   3736971.72       16.80502  (05120907)
        378820.19   3736990.42       15.54881  (05120907)
378856.16   3737332.81       32.49884  (05021121)
        378836.02   3737247.94       28.47997  (07123118)
378814.44   3737163.06       22.30462  (05021104)
        378798.61   3737076.74       17.93988  (05022302)
378772.72   3736996.18       14.70811  (05022302)
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**MODELOPTs: RegDFAULT CONC ELEV NODRYDPLT NOWETDPLT

*** THE 1ST HIGHEST 1-HR AVERAGE CONCENTRATION VALUES FOR SOURCE GROUP: SRCGP32 ***
INCLUDING SOURCE(S): STCK32 ,

*** DISCRETE CARTESIAN RECEPTOR POINTS ***

** CONC OF XOQ IN MICROGRAMS/M**3 **

X-COORD (M)	Y-COORD (M)	CONC	(YYMMDDHH)	X-COORD (M)	Y-COORD (M)	CONC	(YYMMDDHH)
378877.74	3737400.43	0.86420	(05083002)	378926.65	3737406.18	0.85940	(05083002)
378978.44	3737414.82	0.87059	(05083002)	379007.21	3737384.60	0.85827	(06090604)
379021.60	3737354.39	0.86309	(05081506)	379035.98	3737322.74	0.86814	(05081506)
379047.49	3737286.78	0.86482	(05081506)	379077.70	3737266.64	0.85784	(05081506)
379105.04	3737250.81	0.86177	(06110519)	379132.37	3737230.67	0.86401	(06110519)
379161.14	3737209.09	0.87272	(06110519)	379187.04	3737190.39	0.88025	(06110519)
379221.57	3737167.37	0.87862	(06110519)	379250.34	3737147.23	0.86560	(06110519)
379280.55	3737127.09	0.85412	(06110519)	379286.30	3737076.74	0.84193	(06062803)
379296.38	3737039.33	0.84267	(07080603)	379306.45	3736994.74	0.84246	(07080603)
379316.52	3736953.02	0.83400	(07080603)	379328.02	3736908.42	0.82266	(06100203)
379342.41	3736865.26	0.82092	(07090305)	379345.29	3736829.30	0.82565	(07090305)
378886.37	3737242.18	0.84595	(05081506)	378910.82	3737340.01	0.86026	(05081506)
378982.75	3737327.06	0.85851	(05081506)				

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378981.32   3737220.60        0.85303  (06110519)
        379057.56   3737190.39        0.86058  (06110519)
379120.86   3737151.55        0.86057  (06110519)
        379172.65   3737118.46        0.85155  (06110519)
379224.44   3737076.74        0.83405  (06081504)
        379260.41   3737022.07        0.84364  (07080603)
379290.62   3736973.16        0.84127  (07080603)
        379287.74   3736883.96        0.82144  (06100203)
379197.11   3736869.58        0.82626  (05082405)
        379191.36   3736964.53        0.84544  (07080603)
379149.64   3737023.51        0.83946  (07080603)
        379089.21   3737070.98        0.84032  (06081504)
379018.72   3737108.39        0.85274  (06110519)
        378946.79   3737131.41        0.85656  (06110519)
378866.23   3737155.86        0.85391  (06110519)
        378840.33   3737065.23        0.84152  (06110519)
378932.40   3737033.58        0.84452  (07031120)
        379007.21   3736999.05        0.83417  (07031120)
379067.63   3736951.58        0.84399  (07080603)
        379113.67   3736869.58        0.82899  (07080603)
379020.16   3736876.77        0.83502  (07080603)
        378945.35   3736937.19        0.83481  (07080603)
378886.37   3736971.72        0.83584  (07031120)
        378820.19   3736990.42        0.84329  (07031120)
378856.16   3737332.81        0.86098  (05081506)
        378836.02   3737247.94        0.85298  (05081506)
378814.44   3737163.06        0.84900  (06110519)
        378798.61   3737076.74        0.84324  (06110519)
378772.72   3736996.18        0.84354  (07031120)
```

**MODELOPTs: RegDFAULT CONC ELEV NODRYDPLT NOWETDPLT

*** THE 1ST HIGHEST 1-HR AVERAGE CONCENTRATION VALUES FOR SOURCE GROUP: SRCGP33 ***
INCLUDING SOURCE(S): STCK33 ,

*** DISCRETE CARTESIAN RECEPTOR POINTS ***

** CONC OF XOQ IN MICROGRAMS/M**3 **

X-COORD (M)	Y-COORD (M)	CONC	(YYMMDDHH)	X-COORD (M)	Y-COORD (M)	CONC	(YYMMDDHH)
378877.74	3737400.43	8.64636	(05091904)	378926.65	3737406.18	8.85336	(05091904)
378978.44	3737414.82	9.03745	(05091904)	379007.21	3737384.60	9.17600	(06100307)
379021.60	3737354.39	9.17932	(06100307)	379035.98	3737322.74	9.24280	(05071106)
379047.49	3737286.78	9.21423	(07101503)	379077.70	3737266.64	9.30341	(07081903)
379105.04	3737250.81	9.36994	(07081903)	379132.37	3737230.67	9.42288	(06080501)
379161.14	3737209.09	9.55812	(05053105)	379187.04	3737190.39	9.67125	(05053105)
379221.57	3737167.37	9.75107	(07070223)	379250.34	3737147.23	9.81915	(07061305)
379280.55	3737127.09	9.95717	(05081303)	379286.30	3737076.74	9.80791	(07073003)
379296.38	3737039.33	9.73383	(05101105)	379306.45	3736994.74	9.67176	(06101223)
379316.52	3736953.02	9.62096	(06092124)	379328.02	3736908.42	9.52129	(07061803)
379342.41	3736865.26	9.31869	(06100407)	379345.29	3736829.30	9.18502	(05112920)
378886.37	3737242.18	8.58740	(07101503)	378910.82	3737340.01	8.78298	(06100307)
378982.75	3737327.06	8.99508	(05071106)				

```
378981.32   3737220.60        8.87518  (07081903)
        379057.56   3737190.39        9.05701  (06100406)
379120.86   3737151.55        9.28277  (07070223)
        379172.65   3737118.46        9.41959  (07061305)
379224.44   3737076.74        9.59291  (05081303)
        379260.41   3737022.07        9.55762  (05101105)
379290.62   3736973.16        9.55883  (06101223)
        379287.74   3736883.96        9.30360  (07061803)
379197.11   3736869.58        8.96978  (05091804)
        379191.36   3736964.53        9.14800  (05031105)
379149.64   3737023.51        9.17468  (07073003)
        379089.21   3737070.98        9.04885  (07061305)
379018.72   3737108.39        8.86474  (07070223)
        378946.79   3737131.41        8.65737  (05053105)
378866.23   3737155.86        8.39813  (06080501)
        378840.33   3737065.23        8.23521  (05053105)
378932.40   3737033.58        8.40975  (07061305)
        379007.21   3736999.05        8.68283  (05081303)
379067.63   3736951.58        8.74208  (05101105)
        379113.67   3736869.58        8.69757  (06092124)
379020.16   3736876.77        8.32988  (05031105)
        378945.35   3736937.19        8.25004  (07073003)
378886.37   3736971.72        8.20776  (07101207)
        378820.19   3736990.42        7.99792  (07101207)
378856.16   3737332.81        8.58690  (06100307)
        378836.02   3737247.94        8.44625  (05071106)
378814.44   3737163.06        8.24070  (07081903)
        378798.61   3737076.74        8.12358  (05053105)
378772.72   3736996.18        7.92057  (07070223)
```

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 **MODELOPTs:  RegDFAULT CONC
ELEV
                                                                NODRYDPLT
NOWETDPLT

                              *** THE   1ST HIGHEST  1-HR AVERAGE
CONCENTRATION   VALUES FOR SOURCE GROUP:  ALL      ***
                                 INCLUDING SOURCE(S):     STCK1
, STCK2       , STCK3       , STCK4       , STCK5       ,
                STCK6       , STCK7       , STCK8       , STCK9
, STCK10      , STCK11      , STCK12      , STCK13      ,
                STCK14      , STCK15      , STCK16      , STCK17
, STCK18      , STCK19      , STCK20      , STCK21      ,
                STCK22      , STCK23      , STCK24      , STCK25
, STCK26      , PAREA1      , VOL1        ,  . . .      ,

                                                 *** DISCRETE
CARTESIAN RECEPTOR POINTS ***

                                            ** CONC OF XOQ      IN
MICROGRAMS/M**3                              **

      X-COORD (M)  Y-COORD (M)        CONC     (YYMMDDHH)
X-COORD (M)  Y-COORD (M)        CONC     (YYMMDDHH)
 - - - - - - - - - - - - - - - - - - - - - - - - - - - - - - - - - - - -
- - - - - - - - - - - - - - - - - - - - - - - - - - - - - - - - - - - - -
-
        378877.74   3737400.43     1018.04661  (07033104)
378926.65   3737406.18     1207.66687  (06103124)
        378978.44   3737414.82     1952.51665  (05091505)
379007.21   3737384.60     2359.95262  (05041606)
        379021.60   3737354.39     2241.54945  (07033104)
379035.98   3737322.74     2533.15809  (05090703)
        379047.49   3737286.78     2127.66289  (06021701)
379077.70   3737266.64     2835.58604  (05041606)
        379105.04   3737250.81     2020.04157  (06110101)
379132.37   3737230.67     1672.56942  (05091702)
        379161.14   3737209.09     1393.37120  (07033104)
379187.04   3737190.39     1760.28285  (07033104)
        379221.57   3737167.37     2191.68888  (06040802)
379250.34   3737147.23     2577.82237  (07112121)
        379280.55   3737127.09     3600.16656  (05092206)
379286.30   3737076.74     1982.24139  (05041606)
        379296.38   3737039.33     1342.14942  (05102824)
379306.45   3736994.74     1034.41937  (06101101)
        379316.52   3736953.02      912.68433  (06110101)
```

379328.02 3736908.42 764.60902 (06110101)
379342.41 3736865.26 677.29156 (05060624)
379345.29 3736829.30 613.02414 (05060624)
378886.37 3737242.18 862.68612 (07030804)
378910.82 3737340.01 1130.39215 (05051905)
378982.75 3737327.06 1621.75563 (05041606)
378981.32 3737220.60 867.99914 (07101404)
379057.56 3737190.39 1166.83270 (07101404)
379120.86 3737151.55 1041.05342 (05102923)
379172.65 3737118.46 1065.93205 (05090703)
379224.44 3737076.74 1146.08648 (06092703)
379260.41 3737022.07 987.66305 (05041606)
379290.62 3736973.16 915.71237 (05102824)
379287.74 3736883.96 665.81635 (06101101)
379197.11 3736869.58 506.69358 (05102824)
379191.36 3736964.53 657.21091 (07090702)
379149.64 3737023.51 678.70940 (05102722)
379089.21 3737070.98 772.45996 (05102824)
379018.72 3737108.39 845.67370 (05041606)
378946.79 3737131.41 667.97922 (05041606)
378866.23 3737155.86 719.48142 (05041603)
378840.33 3737065.23 594.76617 (05041603)
378932.40 3737033.58 573.69850 (05041606)
379007.21 3736999.05 626.44410 (07101404)
379067.63 3736951.58 623.62922 (05102824)
379113.67 3736869.58 474.14630 (06101101)
379020.16 3736876.77 515.21943 (05102824)
378945.35 3736937.19 525.42639 (05041606)
378886.37 3736971.72 547.81261 (05041606)
378820.19 3736990.42 518.99593 (05041606)
378856.16 3737332.81 929.09769 (05051905)
378836.02 3737247.94 722.42755 (05091505)
378814.44 3737163.06 617.38870 (07030804)
378798.61 3737076.74 582.92355 (07030804)
378772.72 3736996.18 500.22735 (07030804)

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 *** AERMOD - VERSION  11103 ***   *** C:\Documents and Settings
\HP_Administrator\My Documents\Lakes\AERMOD ***        06/16/11
                                     ***
***        18:52:09

PAGE  78
 **MODELOPTs:  RegDFAULT CONC
ELEV
                                                          NODRYDPLT
NOWETDPLT

                                         *** THE SUMMARY OF
MAXIMUM PERIOD ( 26280 HRS) RESULTS ***


                                      ** CONC OF XOQ      IN
MICROGRAMS/M**3                            **


NETWORK
GROUP ID                        AVERAGE CONC
RECEPTOR  (XR, YR, ZELEV, ZHILL, ZFLAG)  OF TYPE  GRID-ID
- - - - - - - - - - - - - - - - - - - - - - - - - - - - - - - - - - - -
- - - - - - - - - - - - - - - - - - - - - - - - - - - - - - -

SRCGP1    1ST HIGHEST VALUE IS      19.79161 AT (  378978.44,
3737414.82,    64.51,    75.90,    0.00)  DC
          2ND HIGHEST VALUE IS      16.40046 AT (  379007.21,
3737384.60,    60.79,    76.20,    0.00)  DC
          3RD HIGHEST VALUE IS      14.65307 AT (  378926.65,
3737406.18,    60.13,    99.36,    0.00)  DC
          4TH HIGHEST VALUE IS      13.43103 AT (  379021.60,
3737354.39,    59.22,    75.90,    0.00)  DC
          5TH HIGHEST VALUE IS      12.19331 AT (  378877.74,
3737400.43,    63.18,    98.15,    0.00)  DC
          6TH HIGHEST VALUE IS      11.18692 AT (  379035.98,
3737322.74,    59.33,    75.90,    0.00)  DC
          7TH HIGHEST VALUE IS      10.76553 AT (  378982.75,
3737327.06,    55.57,    92.96,    0.00)  DC
          8TH HIGHEST VALUE IS      10.09469 AT (  378910.82,
3737340.01,    57.58,    97.54,    0.00)  DC
          9TH HIGHEST VALUE IS       9.18174 AT (  379047.49,
3737286.78,    58.91,    73.76,    0.00)  DC
         10TH HIGHEST VALUE IS       8.41479 AT (  378856.16,
3737332.81,    58.03,    98.45,    0.00)  DC

SRCGP2    1ST HIGHEST VALUE IS     104.31422 AT (  378978.44,
3737414.82,    64.51,    75.90,    0.00)  DC
          2ND HIGHEST VALUE IS      77.28617 AT (  379007.21,
3737384.60,    60.79,    76.20,    0.00)  DC
          3RD HIGHEST VALUE IS      47.13622 AT (  379021.60,
3737354.39,    59.22,    75.90,    0.00)  DC
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          4TH HIGHEST VALUE IS      46.41586 AT (  378926.65,
3737406.18,    60.13,    99.36,    0.00)  DC
          5TH HIGHEST VALUE IS      31.95113 AT (  378982.75,
3737327.06,    55.57,    92.96,    0.00)  DC
          6TH HIGHEST VALUE IS      30.72058 AT (  379035.98,
3737322.74,    59.33,    75.90,    0.00)  DC
          7TH HIGHEST VALUE IS      28.34053 AT (  378877.74,
3737400.43,    63.18,    98.15,    0.00)  DC
          8TH HIGHEST VALUE IS      25.24948 AT (  378910.82,
3737340.01,    57.58,    97.54,    0.00)  DC
          9TH HIGHEST VALUE IS      20.95548 AT (  379047.49,
3737286.78,    58.91,    73.76,    0.00)  DC
         10TH HIGHEST VALUE IS      17.34856 AT (  378856.16,
3737332.81,    58.03,    98.45,    0.00)  DC

SRCGP3    1ST HIGHEST VALUE IS      10.35442 AT (  378978.44,
3737414.82,    64.51,    75.90,    0.00)  DC
          2ND HIGHEST VALUE IS      10.03024 AT (  379007.21,
3737384.60,    60.79,    76.20,    0.00)  DC
          3RD HIGHEST VALUE IS       9.29630 AT (  379021.60,
3737354.39,    59.22,    75.90,    0.00)  DC
          4TH HIGHEST VALUE IS       8.65386 AT (  379035.98,
3737322.74,    59.33,    75.90,    0.00)  DC
          5TH HIGHEST VALUE IS       7.97335 AT (  378926.65,
3737406.18,    60.13,    99.36,    0.00)  DC
          6TH HIGHEST VALUE IS       7.74961 AT (  379047.49,
3737286.78,    58.91,    73.76,    0.00)  DC
          7TH HIGHEST VALUE IS       7.49451 AT (  379077.70,
3737266.64,    58.58,    69.19,    0.00)  DC
          8TH HIGHEST VALUE IS       7.30597 AT (  378982.75,
3737327.06,    55.57,    92.96,    0.00)  DC
          9TH HIGHEST VALUE IS       7.11741 AT (  379105.04,
3737250.81,    57.16,    69.49,    0.00)  DC
         10TH HIGHEST VALUE IS       6.87546 AT (  378877.74,
3737400.43,    63.18,    98.15,    0.00)  DC

SRCGP4    1ST HIGHEST VALUE IS     142.04618 AT (  379035.98,
3737322.74,    59.33,    75.90,    0.00)  DC
          2ND HIGHEST VALUE IS     136.48906 AT (  379047.49,
3737286.78,    58.91,    73.76,    0.00)  DC
          3RD HIGHEST VALUE IS     134.03369 AT (  379077.70,
3737266.64,    58.58,    69.19,    0.00)  DC
          4TH HIGHEST VALUE IS      91.53756 AT (  379021.60,
3737354.39,    59.22,    75.90,    0.00)  DC
          5TH HIGHEST VALUE IS      90.72055 AT (  379105.04,
3737250.81,    57.16,    69.49,    0.00)  DC
          6TH HIGHEST VALUE IS      61.64257 AT (  379007.21,
3737384.60,    60.79,    76.20,    0.00)  DC
          7TH HIGHEST VALUE IS      52.66687 AT (  379132.37,
3737230.67,    53.00,    73.46,    0.00)  DC
          8TH HIGHEST VALUE IS      49.61854 AT (  378982.75,
3737327.06,    55.57,    92.96,    0.00)  DC
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          9TH HIGHEST VALUE IS      40.04069 AT (  378978.44,
3737414.82,    64.51,    75.90,    0.00)  DC
         10TH HIGHEST VALUE IS      34.54084 AT (  379057.56,
3737190.39,    48.41,    74.68,    0.00)  DC
```

**MODELOPTs: RegDFAULT CONC ELEV NODRYDPLT NOWETDPLT

*** THE SUMMARY OF MAXIMUM PERIOD (26280 HRS) RESULTS ***

** CONC OF XOQ IN MICROGRAMS/M**3 **

```
NETWORK
GROUP ID                          AVERAGE CONC
RECEPTOR  (XR, YR, ZELEV, ZHILL, ZFLAG)  OF TYPE  GRID-ID
- - - - - - - - - - - - - - - - - - - - - - - - - - - - - - - - - - - - -
- - - - - - - - - - - - - - - - - - - - - - - - - - - - - -

SRCGP5    1ST HIGHEST VALUE IS       9.97389 AT (  379187.04,
3737190.39,    58.48,    60.35,    0.00)  DC
          2ND HIGHEST VALUE IS       9.69928 AT (  379161.14,
3737209.09,    55.07,    67.67,    0.00)  DC
          3RD HIGHEST VALUE IS       9.52499 AT (  379221.57,
3737167.37,    58.24,    61.57,    0.00)  DC
          4TH HIGHEST VALUE IS       9.50631 AT (  379105.04,
3737250.81,    57.16,    69.49,    0.00)  DC
          5TH HIGHEST VALUE IS       9.40838 AT (  379132.37,
3737230.67,    53.00,    73.46,    0.00)  DC
          6TH HIGHEST VALUE IS       9.13997 AT (  379077.70,
3737266.64,    58.58,    69.19,    0.00)  DC
          7TH HIGHEST VALUE IS       8.94946 AT (  379035.98,
3737322.74,    59.33,    75.90,    0.00)  DC
          8TH HIGHEST VALUE IS       8.86444 AT (  379021.60,
3737354.39,    59.22,    75.90,    0.00)  DC
          9TH HIGHEST VALUE IS       8.74329 AT (  379007.21,
3737384.60,    60.79,    76.20,    0.00)  DC
         10TH HIGHEST VALUE IS       8.61122 AT (  379047.49,
3737286.78,    58.91,    73.76,    0.00)  DC

SRCGP6    1ST HIGHEST VALUE IS      56.29516 AT (  379187.04,
3737190.39,    58.48,    60.35,    0.00)  DC
          2ND HIGHEST VALUE IS      53.78465 AT (  379221.57,
3737167.37,    58.24,    61.57,    0.00)  DC
          3RD HIGHEST VALUE IS      47.53386 AT (  379161.14,
3737209.09,    55.07,    67.67,    0.00)  DC
```

```
          4TH HIGHEST VALUE IS      39.93221 AT (  379250.34,
3737147.23,    53.49,    65.84,    0.00)  DC
          5TH HIGHEST VALUE IS      37.45814 AT (  379132.37,
3737230.67,    53.00,    73.46,    0.00)  DC
          6TH HIGHEST VALUE IS      31.01862 AT (  379105.04,
3737250.81,    57.16,    69.49,    0.00)  DC
          7TH HIGHEST VALUE IS      29.35083 AT (  379280.55,
3737127.09,    52.04,    63.40,    0.00)  DC
          8TH HIGHEST VALUE IS      24.79120 AT (  379077.70,
3737266.64,    58.58,    69.19,    0.00)  DC
          9TH HIGHEST VALUE IS      23.88052 AT (  379172.65,
3737118.46,    47.17,    67.67,    0.00)  DC
         10TH HIGHEST VALUE IS      22.13790 AT (  379120.86,
3737151.55,    47.30,    69.49,    0.00)  DC

SRCGP7    1ST HIGHEST VALUE IS       4.69265 AT (  379280.55,
3737127.09,    52.04,    63.40,    0.00)  DC
          2ND HIGHEST VALUE IS       4.56974 AT (  379250.34,
3737147.23,    53.49,    65.84,    0.00)  DC
          3RD HIGHEST VALUE IS       4.52822 AT (  379221.57,
3737167.37,    58.24,    61.57,    0.00)  DC
          4TH HIGHEST VALUE IS       4.30544 AT (  379187.04,
3737190.39,    58.48,    60.35,    0.00)  DC
          5TH HIGHEST VALUE IS       4.12588 AT (  379286.30,
3737076.74,    46.69,    64.31,    0.00)  DC
          6TH HIGHEST VALUE IS       4.06706 AT (  379161.14,
3737209.09,    55.07,    67.67,    0.00)  DC
          7TH HIGHEST VALUE IS       3.82874 AT (  379132.37,
3737230.67,    53.00,    73.46,    0.00)  DC
          8TH HIGHEST VALUE IS       3.74669 AT (  379296.38,
3737039.33,    41.41,    67.06,    0.00)  DC
          9TH HIGHEST VALUE IS       3.72947 AT (  379105.04,
3737250.81,    57.16,    69.49,    0.00)  DC
         10TH HIGHEST VALUE IS       3.53857 AT (  379077.70,
3737266.64,    58.58,    69.19,    0.00)  DC

SRCGP8    1ST HIGHEST VALUE IS     270.33279 AT (  379280.55,
3737127.09,    52.04,    63.40,    0.00)  DC
          2ND HIGHEST VALUE IS     131.45734 AT (  379250.34,
3737147.23,    53.49,    65.84,    0.00)  DC
          3RD HIGHEST VALUE IS      95.20104 AT (  379286.30,
3737076.74,    46.69,    64.31,    0.00)  DC
          4TH HIGHEST VALUE IS      81.16891 AT (  379221.57,
3737167.37,    58.24,    61.57,    0.00)  DC
          5TH HIGHEST VALUE IS      50.53796 AT (  379296.38,
3737039.33,    41.41,    67.06,    0.00)  DC
          6TH HIGHEST VALUE IS      49.57784 AT (  379224.44,
3737076.74,    42.27,    68.28,    0.00)  DC
          7TH HIGHEST VALUE IS      45.57961 AT (  379187.04,
3737190.39,    58.48,    60.35,    0.00)  DC
          8TH HIGHEST VALUE IS      36.85206 AT (  379260.41,
3737022.07,    40.37,    66.45,    0.00)  DC
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```
          9TH HIGHEST VALUE IS      33.91474 AT (  379172.65,
3737118.46,    47.17,    67.67,    0.00)  DC
         10TH HIGHEST VALUE IS      30.23806 AT (  379161.14,
3737209.09,    55.07,    67.67,    0.00)  DC
```

**MODELOPTs: RegDFAULT CONC ELEV NODRYDPLT NOWETDPLT

*** THE SUMMARY OF MAXIMUM PERIOD (26280 HRS) RESULTS ***

** CONC OF XOQ IN MICROGRAMS/M**3 **

```
NETWORK
GROUP ID                          AVERAGE CONC
RECEPTOR  (XR, YR, ZELEV, ZHILL, ZFLAG)  OF TYPE  GRID-ID
- - - - - - - - - - - - - - - - - - - - - - - - - - - - - - - - - - - - -
- - - - - - - - - - - - - - - - - - - - - - - - - - - - - -

SRCGP9    1ST HIGHEST VALUE IS      15.62014 AT (  379280.55,
3737127.09,    52.04,    63.40,    0.00)  DC
          2ND HIGHEST VALUE IS      15.43992 AT (  379221.57,
3737167.37,    58.24,    61.57,    0.00)  DC
          3RD HIGHEST VALUE IS      15.35271 AT (  379250.34,
3737147.23,    53.49,    65.84,    0.00)  DC
          4TH HIGHEST VALUE IS      13.96115 AT (  379187.04,
3737190.39,    58.48,    60.35,    0.00)  DC
          5TH HIGHEST VALUE IS      12.27901 AT (  379161.14,
3737209.09,    55.07,    67.67,    0.00)  DC
          6TH HIGHEST VALUE IS      11.65410 AT (  379286.30,
3737076.74,    46.69,    64.31,    0.00)  DC
          7TH HIGHEST VALUE IS      10.70297 AT (  379132.37,
3737230.67,    53.00,    73.46,    0.00)  DC
          8TH HIGHEST VALUE IS      10.00703 AT (  379105.04,
3737250.81,    57.16,    69.49,    0.00)  DC
          9TH HIGHEST VALUE IS       9.52545 AT (  379296.38,
3737039.33,    41.41,    67.06,    0.00)  DC
         10TH HIGHEST VALUE IS       9.24696 AT (  379224.44,
3737076.74,    42.27,    68.28,    0.00)  DC

SRCGP10   1ST HIGHEST VALUE IS      29.31996 AT (  379286.30,
3737076.74,    46.69,    64.31,    0.00)  DC
          2ND HIGHEST VALUE IS      28.10149 AT (  379280.55,
3737127.09,    52.04,    63.40,    0.00)  DC
          3RD HIGHEST VALUE IS      27.24621 AT (  379296.38,
3737039.33,    41.41,    67.06,    0.00)  DC
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```
          4TH HIGHEST VALUE IS      23.69785 AT (  379306.45,
3736994.74,    38.75,    62.79,    0.00)  DC
          5TH HIGHEST VALUE IS      20.74095 AT (  379250.34,
3737147.23,    53.49,    65.84,    0.00)  DC
          6TH HIGHEST VALUE IS      20.10693 AT (  379316.52,
3736953.02,    37.38,    62.18,    0.00)  DC
          7TH HIGHEST VALUE IS      19.45310 AT (  379260.41,
3737022.07,    40.37,    66.45,    0.00)  DC
          8TH HIGHEST VALUE IS      19.30633 AT (  379290.62,
3736973.16,    38.29,    62.48,    0.00)  DC
          9TH HIGHEST VALUE IS      16.60023 AT (  379224.44,
3737076.74,    42.27,    68.28,    0.00)  DC
         10TH HIGHEST VALUE IS      16.28127 AT (  379328.02,
3736908.42,    35.28,    61.57,    0.00)  DC

SRCGP11   1ST HIGHEST VALUE IS       0.38992 AT (  378926.65,
3737406.18,    60.13,    99.36,    0.00)  DC
          2ND HIGHEST VALUE IS       0.38856 AT (  378856.16,
3737332.81,    58.03,    98.45,    0.00)  DC
          3RD HIGHEST VALUE IS       0.38382 AT (  378877.74,
3737400.43,    63.18,    98.15,    0.00)  DC
          4TH HIGHEST VALUE IS       0.38354 AT (  378910.82,
3737340.01,    57.58,    97.54,    0.00)  DC
          5TH HIGHEST VALUE IS       0.37823 AT (  378836.02,
3737247.94,    55.08,    95.40,    0.00)  DC
          6TH HIGHEST VALUE IS       0.37732 AT (  378982.75,
3737327.06,    55.57,    92.96,    0.00)  DC
          7TH HIGHEST VALUE IS       0.37669 AT (  378886.37,
3737242.18,    52.91,    94.79,    0.00)  DC
          8TH HIGHEST VALUE IS       0.36869 AT (  379007.21,
3737384.60,    60.79,    76.20,    0.00)  DC
          9TH HIGHEST VALUE IS       0.36771 AT (  378814.44,
3737163.06,    52.10,    92.05,    0.00)  DC
         10TH HIGHEST VALUE IS       0.36551 AT (  378978.44,
3737414.82,    64.51,    75.90,    0.00)  DC

SRCGP12   1ST HIGHEST VALUE IS       6.66059 AT (  379280.55,
3737127.09,    52.04,    63.40,    0.00)  DC
          2ND HIGHEST VALUE IS       6.23010 AT (  379250.34,
3737147.23,    53.49,    65.84,    0.00)  DC
          3RD HIGHEST VALUE IS       5.92126 AT (  379221.57,
3737167.37,    58.24,    61.57,    0.00)  DC
          4TH HIGHEST VALUE IS       5.89369 AT (  379286.30,
3737076.74,    46.69,    64.31,    0.00)  DC
          5TH HIGHEST VALUE IS       5.36420 AT (  379296.38,
3737039.33,    41.41,    67.06,    0.00)  DC
          6TH HIGHEST VALUE IS       5.32125 AT (  379187.04,
3737190.39,    58.48,    60.35,    0.00)  DC
          7TH HIGHEST VALUE IS       4.93603 AT (  379306.45,
3736994.74,    38.75,    62.79,    0.00)  DC
          8TH HIGHEST VALUE IS       4.81475 AT (  379161.14,
3737209.09,    55.07,    67.67,    0.00)  DC
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          9TH HIGHEST VALUE IS       4.70332 AT (  379224.44,
3737076.74,    42.27,    68.28,    0.00)  DC
         10TH HIGHEST VALUE IS       4.66574 AT (  379260.41,
3737022.07,    40.37,    66.45,    0.00)  DC
```

**MODELOPTs: RegDFAULT CONC ELEV NODRYDPLT NOWETDPLT

*** THE SUMMARY OF MAXIMUM PERIOD (26280 HRS) RESULTS ***

** CONC OF XOQ IN MICROGRAMS/M**3 **

```
NETWORK
GROUP ID                          AVERAGE CONC
RECEPTOR  (XR, YR, ZELEV, ZHILL, ZFLAG)  OF TYPE  GRID-ID
- - - - - - - - - - - - - - - - - - - - - - - - - - - - - - - - - - - - - - -
- - - - - - - - - - - - - - - - - - - - - - - - - - - - - - -

SRCGP13   1ST HIGHEST VALUE IS       8.47301 AT (  379280.55,
3737127.09,    52.04,    63.40,    0.00)  DC
          2ND HIGHEST VALUE IS       8.16439 AT (  379286.30,
3737076.74,    46.69,    64.31,    0.00)  DC
          3RD HIGHEST VALUE IS       7.78737 AT (  379296.38,
3737039.33,    41.41,    67.06,    0.00)  DC
          4TH HIGHEST VALUE IS       7.44648 AT (  379250.34,
3737147.23,    53.49,    65.84,    0.00)  DC
          5TH HIGHEST VALUE IS       7.39957 AT (  379306.45,
3736994.74,    38.75,    62.79,    0.00)  DC
          6TH HIGHEST VALUE IS       6.97922 AT (  379316.52,
3736953.02,    37.38,    62.18,    0.00)  DC
          7TH HIGHEST VALUE IS       6.69469 AT (  379290.62,
3736973.16,    38.29,    62.48,    0.00)  DC
          8TH HIGHEST VALUE IS       6.64522 AT (  379221.57,
3737167.37,    58.24,    61.57,    0.00)  DC
          9TH HIGHEST VALUE IS       6.57171 AT (  379260.41,
3737022.07,    40.37,    66.45,    0.00)  DC
         10TH HIGHEST VALUE IS       6.44831 AT (  379328.02,
3736908.42,    35.28,    61.57,    0.00)  DC

SRCGP14   1ST HIGHEST VALUE IS       3.25415 AT (  379221.57,
3737167.37,    58.24,    61.57,    0.00)  DC
          2ND HIGHEST VALUE IS       3.22676 AT (  379280.55,
3737127.09,    52.04,    63.40,    0.00)  DC
          3RD HIGHEST VALUE IS       3.09661 AT (  379250.34,
3737147.23,    53.49,    65.84,    0.00)  DC
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          4TH HIGHEST VALUE IS       3.08977 AT (  379187.04,
3737190.39,    58.48,    60.35,    0.00)  DC
          5TH HIGHEST VALUE IS       3.05053 AT (  379286.30,
3737076.74,    46.69,    64.31,    0.00)  DC
          6TH HIGHEST VALUE IS       2.90383 AT (  379296.38,
3737039.33,    41.41,    67.06,    0.00)  DC
          7TH HIGHEST VALUE IS       2.84856 AT (  379161.14,
3737209.09,    55.07,    67.67,    0.00)  DC
          8TH HIGHEST VALUE IS       2.74650 AT (  379306.45,
3736994.74,    38.75,    62.79,    0.00)  DC
          9TH HIGHEST VALUE IS       2.66773 AT (  379224.44,
3737076.74,    42.27,    68.28,    0.00)  DC
         10TH HIGHEST VALUE IS       2.64255 AT (  379260.41,
3737022.07,    40.37,    66.45,    0.00)  DC

SRCGP15   1ST HIGHEST VALUE IS       5.05471 AT (  379280.55,
3737127.09,    52.04,    63.40,    0.00)  DC
          2ND HIGHEST VALUE IS       4.84233 AT (  379286.30,
3737076.74,    46.69,    64.31,    0.00)  DC
          3RD HIGHEST VALUE IS       4.63326 AT (  379250.34,
3737147.23,    53.49,    65.84,    0.00)  DC
          4TH HIGHEST VALUE IS       4.59845 AT (  379296.38,
3737039.33,    41.41,    67.06,    0.00)  DC
          5TH HIGHEST VALUE IS       4.35614 AT (  379306.45,
3736994.74,    38.75,    62.79,    0.00)  DC
          6TH HIGHEST VALUE IS       4.25903 AT (  379221.57,
3737167.37,    58.24,    61.57,    0.00)  DC
          7TH HIGHEST VALUE IS       4.14669 AT (  379316.52,
3736953.02,    37.38,    62.18,    0.00)  DC
          8TH HIGHEST VALUE IS       4.05359 AT (  379260.41,
3737022.07,    40.37,    66.45,    0.00)  DC
          9TH HIGHEST VALUE IS       4.04284 AT (  379290.62,
3736973.16,    38.29,    62.48,    0.00)  DC
         10TH HIGHEST VALUE IS       3.89948 AT (  379224.44,
3737076.74,    42.27,    68.28,    0.00)  DC

SRCGP16   1ST HIGHEST VALUE IS       6.71925 AT (  379328.02,
3736908.42,    35.28,    61.57,    0.00)  DC
          2ND HIGHEST VALUE IS       6.65607 AT (  379316.52,
3736953.02,    37.38,    62.18,    0.00)  DC
          3RD HIGHEST VALUE IS       6.53587 AT (  379342.41,
3736865.26,    31.30,    61.26,    0.00)  DC
          4TH HIGHEST VALUE IS       6.44868 AT (  379306.45,
3736994.74,    38.75,    62.79,    0.00)  DC
          5TH HIGHEST VALUE IS       6.18852 AT (  379345.29,
3736829.30,    29.99,    29.99,    0.00)  DC
          6TH HIGHEST VALUE IS       6.17571 AT (  379296.38,
3737039.33,    41.41,    67.06,    0.00)  DC
          7TH HIGHEST VALUE IS       6.07252 AT (  379290.62,
3736973.16,    38.29,    62.48,    0.00)  DC
          8TH HIGHEST VALUE IS       5.82969 AT (  379286.30,
3737076.74,    46.69,    64.31,    0.00)  DC
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          9TH HIGHEST VALUE IS       5.67744 AT (  379287.74,
3736883.96,    34.54,    60.35,    0.00)  DC
         10TH HIGHEST VALUE IS       5.43358 AT (  379260.41,
3737022.07,    40.37,    66.45,    0.00)  DC
```

**MODELOPTs: RegDFAULT CONC ELEV NODRYDPLT NOWETDPLT

*** THE SUMMARY OF MAXIMUM PERIOD (26280 HRS) RESULTS ***

** CONC OF XOQ IN MICROGRAMS/M**3 **

```
NETWORK
GROUP ID                          AVERAGE CONC
RECEPTOR  (XR, YR, ZELEV, ZHILL, ZFLAG)  OF TYPE  GRID-ID
- - - - - - - - - - - - - - - - - - - - - - - - - - - - - - - - - - - - -
- - - - - - - - - - - - - - - - - - - - - - - - - - - - - -

SRCGP17   1ST HIGHEST VALUE IS       2.74864 AT (  379280.55,
3737127.09,    52.04,    63.40,    0.00)  DC
          2ND HIGHEST VALUE IS       2.65257 AT (  379296.38,
3737039.33,    41.41,    67.06,    0.00)  DC
          3RD HIGHEST VALUE IS       2.65104 AT (  379286.30,
3737076.74,    46.69,    64.31,    0.00)  DC
          4TH HIGHEST VALUE IS       2.60785 AT (  379306.45,
3736994.74,    38.75,    62.79,    0.00)  DC
          5TH HIGHEST VALUE IS       2.56200 AT (  379250.34,
3737147.23,    53.49,    65.84,    0.00)  DC
          6TH HIGHEST VALUE IS       2.55107 AT (  379316.52,
3736953.02,    37.38,    62.18,    0.00)  DC
          7TH HIGHEST VALUE IS       2.47978 AT (  379290.62,
3736973.16,    38.29,    62.48,    0.00)  DC
          8TH HIGHEST VALUE IS       2.46621 AT (  379328.02,
3736908.42,    35.28,    61.57,    0.00)  DC
          9TH HIGHEST VALUE IS       2.43182 AT (  379260.41,
3737022.07,    40.37,    66.45,    0.00)  DC
         10TH HIGHEST VALUE IS       2.36080 AT (  379221.57,
3737167.37,    58.24,    61.57,    0.00)  DC

SRCGP18   1ST HIGHEST VALUE IS       3.36227 AT (  379306.45,
3736994.74,    38.75,    62.79,    0.00)  DC
          2ND HIGHEST VALUE IS       3.35584 AT (  379296.38,
3737039.33,    41.41,    67.06,    0.00)  DC
          3RD HIGHEST VALUE IS       3.35226 AT (  379316.52,
3736953.02,    37.38,    62.18,    0.00)  DC
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          4TH HIGHEST VALUE IS       3.31767 AT (  379286.30,
3737076.74,    46.69,    64.31,    0.00)  DC
          5TH HIGHEST VALUE IS       3.28576 AT (  379328.02,
3736908.42,    35.28,    61.57,    0.00)  DC
          6TH HIGHEST VALUE IS       3.20589 AT (  379280.55,
3737127.09,    52.04,    63.40,    0.00)  DC
          7TH HIGHEST VALUE IS       3.19612 AT (  379290.62,
3736973.16,    38.29,    62.48,    0.00)  DC
          8TH HIGHEST VALUE IS       3.15186 AT (  379342.41,
3736865.26,    31.30,    61.26,    0.00)  DC
          9TH HIGHEST VALUE IS       3.04311 AT (  379260.41,
3737022.07,    40.37,    66.45,    0.00)  DC
         10TH HIGHEST VALUE IS       3.00816 AT (  379345.29,
3736829.30,    29.99,    29.99,    0.00)  DC

SRCGP19   1ST HIGHEST VALUE IS       2.63683 AT (  379342.41,
3736865.26,    31.30,    61.26,    0.00)  DC
          2ND HIGHEST VALUE IS       2.63192 AT (  379328.02,
3736908.42,    35.28,    61.57,    0.00)  DC
          3RD HIGHEST VALUE IS       2.59848 AT (  379316.52,
3736953.02,    37.38,    62.18,    0.00)  DC
          4TH HIGHEST VALUE IS       2.58665 AT (  379345.29,
3736829.30,    29.99,    29.99,    0.00)  DC
          5TH HIGHEST VALUE IS       2.55084 AT (  379306.45,
3736994.74,    38.75,    62.79,    0.00)  DC
          6TH HIGHEST VALUE IS       2.48389 AT (  379296.38,
3737039.33,    41.41,    67.06,    0.00)  DC
          7TH HIGHEST VALUE IS       2.46105 AT (  379290.62,
3736973.16,    38.29,    62.48,    0.00)  DC
          8TH HIGHEST VALUE IS       2.39242 AT (  379287.74,
3736883.96,    34.54,    60.35,    0.00)  DC
          9TH HIGHEST VALUE IS       2.33967 AT (  379286.30,
3737076.74,    46.69,    64.31,    0.00)  DC
         10TH HIGHEST VALUE IS       2.30434 AT (  379260.41,
3737022.07,    40.37,    66.45,    0.00)  DC

SRCGP20   1ST HIGHEST VALUE IS       3.72275 AT (  379342.41,
3736865.26,    31.30,    61.26,    0.00)  DC
          2ND HIGHEST VALUE IS       3.70302 AT (  379345.29,
3736829.30,    29.99,    29.99,    0.00)  DC
          3RD HIGHEST VALUE IS       3.66320 AT (  379328.02,
3736908.42,    35.28,    61.57,    0.00)  DC
          4TH HIGHEST VALUE IS       3.53879 AT (  379316.52,
3736953.02,    37.38,    62.18,    0.00)  DC
          5TH HIGHEST VALUE IS       3.39112 AT (  379306.45,
3736994.74,    38.75,    62.79,    0.00)  DC
          6TH HIGHEST VALUE IS       3.28523 AT (  379287.74,
3736883.96,    34.54,    60.35,    0.00)  DC
          7TH HIGHEST VALUE IS       3.28440 AT (  379290.62,
3736973.16,    38.29,    62.48,    0.00)  DC
          8TH HIGHEST VALUE IS       3.23635 AT (  379296.38,
3737039.33,    41.41,    67.06,    0.00)  DC
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          9TH HIGHEST VALUE IS       3.07353 AT (  379286.30,
3737076.74,    46.69,    64.31,    0.00)  DC
         10TH HIGHEST VALUE IS       2.98022 AT (  379260.41,
3737022.07,    40.37,    66.45,    0.00)  DC
```

**MODELOPTs: RegDFAULT CONC ELEV NODRYDPLT NOWETDPLT

*** THE SUMMARY OF MAXIMUM PERIOD (26280 HRS) RESULTS ***

** CONC OF XOQ IN MICROGRAMS/M**3 **

```
NETWORK
GROUP ID                          AVERAGE CONC
RECEPTOR  (XR, YR, ZELEV, ZHILL, ZFLAG)  OF TYPE  GRID-ID
- - - - - - - - - - - - - - - - - - - - - - - - - - - - - - - - - - - - -
- - - - - - - - - - - - - - - - - - - - - - - - - - - - - -

SRCGP21   1ST HIGHEST VALUE IS       7.37927 AT (  378978.44,
3737414.82,    64.51,    75.90,    0.00)  DC
          2ND HIGHEST VALUE IS       6.45140 AT (  379007.21,
3737384.60,    60.79,    76.20,    0.00)  DC
          3RD HIGHEST VALUE IS       6.34708 AT (  378926.65,
3737406.18,    60.13,    99.36,    0.00)  DC
          4TH HIGHEST VALUE IS       5.90137 AT (  378877.74,
3737400.43,    63.18,    98.15,    0.00)  DC
          5TH HIGHEST VALUE IS       5.71177 AT (  379021.60,
3737354.39,    59.22,    75.90,    0.00)  DC
          6TH HIGHEST VALUE IS       5.13603 AT (  379035.98,
3737322.74,    59.33,    75.90,    0.00)  DC
          7TH HIGHEST VALUE IS       4.94856 AT (  378982.75,
3737327.06,    55.57,    92.96,    0.00)  DC
          8TH HIGHEST VALUE IS       4.94157 AT (  378910.82,
3737340.01,    57.58,    97.54,    0.00)  DC
          9TH HIGHEST VALUE IS       4.54729 AT (  379047.49,
3737286.78,    58.91,    73.76,    0.00)  DC
         10TH HIGHEST VALUE IS       4.51219 AT (  378856.16,
3737332.81,    58.03,    98.45,    0.00)  DC

SRCGP22   1ST HIGHEST VALUE IS       5.59997 AT (  378978.44,
3737414.82,    64.51,    75.90,    0.00)  DC
          2ND HIGHEST VALUE IS       4.97721 AT (  378926.65,
3737406.18,    60.13,    99.36,    0.00)  DC
          3RD HIGHEST VALUE IS       4.96410 AT (  379007.21,
3737384.60,    60.79,    76.20,    0.00)  DC
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```
          4TH HIGHEST VALUE IS       4.73417 AT (  378877.74,
3737400.43,    63.18,    98.15,    0.00)  DC
          5TH HIGHEST VALUE IS       4.46201 AT (  379021.60,
3737354.39,    59.22,    75.90,    0.00)  DC
          6TH HIGHEST VALUE IS       4.06905 AT (  379035.98,
3737322.74,    59.33,    75.90,    0.00)  DC
          7TH HIGHEST VALUE IS       3.98643 AT (  378910.82,
3737340.01,    57.58,    97.54,    0.00)  DC
          8TH HIGHEST VALUE IS       3.94016 AT (  378982.75,
3737327.06,    55.57,    92.96,    0.00)  DC
          9TH HIGHEST VALUE IS       3.72021 AT (  378856.16,
3737332.81,    58.03,    98.45,    0.00)  DC
         10TH HIGHEST VALUE IS       3.65893 AT (  379047.49,
3737286.78,    58.91,    73.76,    0.00)  DC

SRCGP23   1ST HIGHEST VALUE IS       6.45522 AT (  378978.44,
3737414.82,    64.51,    75.90,    0.00)  DC
          2ND HIGHEST VALUE IS       5.85704 AT (  379007.21,
3737384.60,    60.79,    76.20,    0.00)  DC
          3RD HIGHEST VALUE IS       5.48017 AT (  378926.65,
3737406.18,    60.13,    99.36,    0.00)  DC
          4TH HIGHEST VALUE IS       5.29335 AT (  379021.60,
3737354.39,    59.22,    75.90,    0.00)  DC
          5TH HIGHEST VALUE IS       5.03576 AT (  378877.74,
3737400.43,    63.18,    98.15,    0.00)  DC
          6TH HIGHEST VALUE IS       4.83828 AT (  379035.98,
3737322.74,    59.33,    75.90,    0.00)  DC
          7TH HIGHEST VALUE IS       4.54968 AT (  378982.75,
3737327.06,    55.57,    92.96,    0.00)  DC
          8TH HIGHEST VALUE IS       4.39370 AT (  378910.82,
3737340.01,    57.58,    97.54,    0.00)  DC
          9TH HIGHEST VALUE IS       4.33987 AT (  379047.49,
3737286.78,    58.91,    73.76,    0.00)  DC
         10TH HIGHEST VALUE IS       4.09959 AT (  379077.70,
3737266.64,    58.58,    69.19,    0.00)  DC

SRCGP24   1ST HIGHEST VALUE IS       5.03743 AT (  378978.44,
3737414.82,    64.51,    75.90,    0.00)  DC
          2ND HIGHEST VALUE IS       4.88961 AT (  379007.21,
3737384.60,    60.79,    76.20,    0.00)  DC
          3RD HIGHEST VALUE IS       4.58856 AT (  379021.60,
3737354.39,    59.22,    75.90,    0.00)  DC
          4TH HIGHEST VALUE IS       4.40468 AT (  378926.65,
3737406.18,    60.13,    99.36,    0.00)  DC
          5TH HIGHEST VALUE IS       4.29767 AT (  379035.98,
3737322.74,    59.33,    75.90,    0.00)  DC
          6TH HIGHEST VALUE IS       3.98479 AT (  378982.75,
3737327.06,    55.57,    92.96,    0.00)  DC
          7TH HIGHEST VALUE IS       3.96737 AT (  378877.74,
3737400.43,    63.18,    98.15,    0.00)  DC
          8TH HIGHEST VALUE IS       3.94668 AT (  379047.49,
3737286.78,    58.91,    73.76,    0.00)  DC
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          9TH HIGHEST VALUE IS       3.81779 AT (  379077.70,
3737266.64,    58.58,    69.19,    0.00)  DC
         10TH HIGHEST VALUE IS       3.69512 AT (  378910.82,
3737340.01,    57.58,    97.54,    0.00)  DC
```

**MODELOPTs: RegDFAULT CONC ELEV NODRYDPLT NOWETDPLT

*** THE SUMMARY OF MAXIMUM PERIOD (26280 HRS) RESULTS ***

** CONC OF XOQ IN MICROGRAMS/M**3 **

```
NETWORK
GROUP ID                          AVERAGE CONC
RECEPTOR  (XR, YR, ZELEV, ZHILL, ZFLAG)  OF TYPE  GRID-ID
- - - - - - - - - - - - - - - - - - - - - - - - - - - - - - - - - - - - -
- - - - - - - - - - - - - - - - - - - - - - - - - - - - - -

SRCGP25   1ST HIGHEST VALUE IS       4.76446 AT (  378978.44,
3737414.82,    64.51,    75.90,    0.00)  DC
          2ND HIGHEST VALUE IS       4.41575 AT (  379007.21,
3737384.60,    60.79,    76.20,    0.00)  DC
          3RD HIGHEST VALUE IS       4.22215 AT (  378926.65,
3737406.18,    60.13,    99.36,    0.00)  DC
          4TH HIGHEST VALUE IS       4.06000 AT (  379021.60,
3737354.39,    59.22,    75.90,    0.00)  DC
          5TH HIGHEST VALUE IS       3.92557 AT (  378877.74,
3737400.43,    63.18,    98.15,    0.00)  DC
          6TH HIGHEST VALUE IS       3.76012 AT (  379035.98,
3737322.74,    59.33,    75.90,    0.00)  DC
          7TH HIGHEST VALUE IS       3.57884 AT (  378982.75,
3737327.06,    55.57,    92.96,    0.00)  DC
          8TH HIGHEST VALUE IS       3.49114 AT (  378910.82,
3737340.01,    57.58,    97.54,    0.00)  DC
          9TH HIGHEST VALUE IS       3.42824 AT (  379047.49,
3737286.78,    58.91,    73.76,    0.00)  DC
         10TH HIGHEST VALUE IS       3.27116 AT (  379077.70,
3737266.64,    58.58,    69.19,    0.00)  DC

SRCGP26   1ST HIGHEST VALUE IS       4.08390 AT (  378978.44,
3737414.82,    64.51,    75.90,    0.00)  DC
          2ND HIGHEST VALUE IS       3.96971 AT (  379007.21,
3737384.60,    60.79,    76.20,    0.00)  DC
          3RD HIGHEST VALUE IS       3.74246 AT (  379021.60,
3737354.39,    59.22,    75.90,    0.00)  DC
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          4TH HIGHEST VALUE IS       3.67182 AT (  378926.65,
3737406.18,    60.13,    99.36,    0.00)  DC
          5TH HIGHEST VALUE IS       3.51757 AT (  379035.98,
3737322.74,    59.33,    75.90,    0.00)  DC
          6TH HIGHEST VALUE IS       3.34362 AT (  378877.74,
3737400.43,    63.18,    98.15,    0.00)  DC
          7TH HIGHEST VALUE IS       3.32407 AT (  378982.75,
3737327.06,    55.57,    92.96,    0.00)  DC
          8TH HIGHEST VALUE IS       3.25376 AT (  379047.49,
3737286.78,    58.91,    73.76,    0.00)  DC
          9TH HIGHEST VALUE IS       3.15212 AT (  379077.70,
3737266.64,    58.58,    69.19,    0.00)  DC
         10TH HIGHEST VALUE IS       3.13102 AT (  378910.82,
3737340.01,    57.58,    97.54,    0.00)  DC

SRCGP27   1ST HIGHEST VALUE IS       2.07506 AT (  378877.74,
3737400.43,    63.18,    98.15,    0.00)  DC
          2ND HIGHEST VALUE IS       1.93163 AT (  378926.65,
3737406.18,    60.13,    99.36,    0.00)  DC
          3RD HIGHEST VALUE IS       1.92511 AT (  378978.44,
3737414.82,    64.51,    75.90,    0.00)  DC
          4TH HIGHEST VALUE IS       1.77218 AT (  378856.16,
3737332.81,    58.03,    98.45,    0.00)  DC
          5TH HIGHEST VALUE IS       1.69673 AT (  378910.82,
3737340.01,    57.58,    97.54,    0.00)  DC
          6TH HIGHEST VALUE IS       1.69611 AT (  379007.21,
3737384.60,    60.79,    76.20,    0.00)  DC
          7TH HIGHEST VALUE IS       1.55952 AT (  379021.60,
3737354.39,    59.22,    75.90,    0.00)  DC
          8TH HIGHEST VALUE IS       1.51330 AT (  378836.02,
3737247.94,    55.08,    95.40,    0.00)  DC
          9TH HIGHEST VALUE IS       1.50850 AT (  378982.75,
3737327.06,    55.57,    92.96,    0.00)  DC
         10TH HIGHEST VALUE IS       1.45701 AT (  379035.98,
3737322.74,    59.33,    75.90,    0.00)  DC

SRCGP28   1ST HIGHEST VALUE IS       2.31891 AT (  378877.74,
3737400.43,    63.18,    98.15,    0.00)  DC
          2ND HIGHEST VALUE IS       2.15853 AT (  378926.65,
3737406.18,    60.13,    99.36,    0.00)  DC
          3RD HIGHEST VALUE IS       2.15331 AT (  378978.44,
3737414.82,    64.51,    75.90,    0.00)  DC
          4TH HIGHEST VALUE IS       1.96016 AT (  378856.16,
3737332.81,    58.03,    98.45,    0.00)  DC
          5TH HIGHEST VALUE IS       1.88366 AT (  379007.21,
3737384.60,    60.79,    76.20,    0.00)  DC
          6TH HIGHEST VALUE IS       1.87943 AT (  378910.82,
3737340.01,    57.58,    97.54,    0.00)  DC
          7TH HIGHEST VALUE IS       1.72380 AT (  379021.60,
3737354.39,    59.22,    75.90,    0.00)  DC
          8TH HIGHEST VALUE IS       1.66568 AT (  378982.75,
3737327.06,    55.57,    92.96,    0.00)  DC
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          9TH HIGHEST VALUE IS       1.65759 AT (  378836.02,
3737247.94,    55.08,    95.40,    0.00)  DC
         10TH HIGHEST VALUE IS       1.60363 AT (  379035.98,
3737322.74,    59.33,    75.90,    0.00)  DC
```

**MODELOPTs: RegDFAULT CONC ELEV NODRYDPLT NOWETDPLT

*** THE SUMMARY OF MAXIMUM PERIOD (26280 HRS) RESULTS ***

** CONC OF XOQ IN MICROGRAMS/M**3 **

```
NETWORK
GROUP ID                          AVERAGE CONC
RECEPTOR  (XR, YR, ZELEV, ZHILL, ZFLAG)  OF TYPE  GRID-ID
- - - - - - - - - - - - - - - - - - - - - - - - - - - - - - - - - - - - -
- - - - - - - - - - - - - - - - - - - - - - - - - - - - - -

SRCGP29   1ST HIGHEST VALUE IS       2.38527 AT (  378877.74,
3737400.43,    63.18,    98.15,    0.00)  DC
          2ND HIGHEST VALUE IS       2.25991 AT (  378978.44,
3737414.82,    64.51,    75.90,    0.00)  DC
          3RD HIGHEST VALUE IS       2.24434 AT (  378926.65,
3737406.18,    60.13,    99.36,    0.00)  DC
          4TH HIGHEST VALUE IS       2.00587 AT (  378856.16,
3737332.81,    58.03,    98.45,    0.00)  DC
          5TH HIGHEST VALUE IS       1.97956 AT (  379007.21,
3737384.60,    60.79,    76.20,    0.00)  DC
          6TH HIGHEST VALUE IS       1.94341 AT (  378910.82,
3737340.01,    57.58,    97.54,    0.00)  DC
          7TH HIGHEST VALUE IS       1.81011 AT (  379021.60,
3737354.39,    59.22,    75.90,    0.00)  DC
          8TH HIGHEST VALUE IS       1.73926 AT (  378982.75,
3737327.06,    55.57,    92.96,    0.00)  DC
          9TH HIGHEST VALUE IS       1.68966 AT (  378836.02,
3737247.94,    55.08,    95.40,    0.00)  DC
         10TH HIGHEST VALUE IS       1.68243 AT (  379035.98,
3737322.74,    59.33,    75.90,    0.00)  DC

SRCGP30   1ST HIGHEST VALUE IS       0.66221 AT (  379345.29,
3736829.30,    29.99,    29.99,    0.00)  DC
          2ND HIGHEST VALUE IS       0.64981 AT (  379342.41,
3736865.26,    31.30,    61.26,    0.00)  DC
          3RD HIGHEST VALUE IS       0.61804 AT (  379328.02,
3736908.42,    35.28,    61.57,    0.00)  DC
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          4TH HIGHEST VALUE IS       0.60469 AT (  379287.74,
3736883.96,    34.54,    60.35,    0.00)  DC
          5TH HIGHEST VALUE IS       0.59588 AT (  379316.52,
3736953.02,    37.38,    62.18,    0.00)  DC
          6TH HIGHEST VALUE IS       0.57782 AT (  379306.45,
3736994.74,    38.75,    62.79,    0.00)  DC
          7TH HIGHEST VALUE IS       0.57592 AT (  379290.62,
3736973.16,    38.29,    62.48,    0.00)  DC
          8TH HIGHEST VALUE IS       0.55866 AT (  379197.11,
3736869.58,    35.95,    35.95,    0.00)  DC
          9TH HIGHEST VALUE IS       0.55327 AT (  379296.38,
3737039.33,    41.41,    67.06,    0.00)  DC
         10TH HIGHEST VALUE IS       0.54440 AT (  379260.41,
3737022.07,    40.37,    66.45,    0.00)  DC

SRCGP31   1ST HIGHEST VALUE IS       4.14345 AT (  379035.98,
3737322.74,    59.33,    75.90,    0.00)  DC
          2ND HIGHEST VALUE IS       3.88489 AT (  379047.49,
3737286.78,    58.91,    73.76,    0.00)  DC
          3RD HIGHEST VALUE IS       3.61037 AT (  379077.70,
3737266.64,    58.58,    69.19,    0.00)  DC
          4TH HIGHEST VALUE IS       3.52596 AT (  379021.60,
3737354.39,    59.22,    75.90,    0.00)  DC
          5TH HIGHEST VALUE IS       3.00619 AT (  379007.21,
3737384.60,    60.79,    76.20,    0.00)  DC
          6TH HIGHEST VALUE IS       2.73265 AT (  379105.04,
3737250.81,    57.16,    69.49,    0.00)  DC
          7TH HIGHEST VALUE IS       2.31076 AT (  378982.75,
3737327.06,    55.57,    92.96,    0.00)  DC
          8TH HIGHEST VALUE IS       2.30697 AT (  378978.44,
3737414.82,    64.51,    75.90,    0.00)  DC
          9TH HIGHEST VALUE IS       1.84663 AT (  379132.37,
3737230.67,    53.00,    73.46,    0.00)  DC
         10TH HIGHEST VALUE IS       1.52175 AT (  378981.32,
3737220.60,    51.81,    74.37,    0.00)  DC

SRCGP32   1ST HIGHEST VALUE IS       0.04813 AT (  379345.29,
3736829.30,    29.99,    29.99,    0.00)  DC
          2ND HIGHEST VALUE IS       0.04791 AT (  379342.41,
3736865.26,    31.30,    61.26,    0.00)  DC
          3RD HIGHEST VALUE IS       0.04778 AT (  379328.02,
3736908.42,    35.28,    61.57,    0.00)  DC
          4TH HIGHEST VALUE IS       0.04771 AT (  379221.57,
3737167.37,    58.24,    61.57,    0.00)  DC
          5TH HIGHEST VALUE IS       0.04763 AT (  379287.74,
3736883.96,    34.54,    60.35,    0.00)  DC
          6TH HIGHEST VALUE IS       0.04748 AT (  379280.55,
3737127.09,    52.04,    63.40,    0.00)  DC
          7TH HIGHEST VALUE IS       0.04746 AT (  379316.52,
3736953.02,    37.38,    62.18,    0.00)  DC
          8TH HIGHEST VALUE IS       0.04719 AT (  379197.11,
3736869.58,    35.95,    35.95,    0.00)  DC
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          9TH HIGHEST VALUE IS       0.04716 AT (  379250.34,
3737147.23,    53.49,    65.84,    0.00)  DC
         10TH HIGHEST VALUE IS       0.04712 AT (  379290.62,
3736973.16,    38.29,    62.48,    0.00)  DC
```

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 *** AERMOD - VERSION  11103 ***   *** C:\Documents and Settings
\HP_Administrator\My Documents\Lakes\AERMOD ***        06/16/11
                                     ***
***        18:52:09

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 **MODELOPTs:  RegDFAULT CONC
ELEV
                                                          NODRYDPLT
NOWETDPLT

                                         *** THE SUMMARY OF
MAXIMUM PERIOD ( 26280 HRS) RESULTS ***


                                      ** CONC OF XOQ      IN
MICROGRAMS/M**3                            **


NETWORK
GROUP ID                        AVERAGE CONC
RECEPTOR  (XR, YR, ZELEV, ZHILL, ZFLAG)  OF TYPE  GRID-ID
- - - - - - - - - - - - - - - - - - - - - - - - - - - - - - - - - - - -
- - - - - - - - - - - - - - - - - - - - - - - - - - - - - - -

SRCGP33   1ST HIGHEST VALUE IS       0.51982 AT (  379345.29,
3736829.30,    29.99,    29.99,    0.00)  DC
          2ND HIGHEST VALUE IS       0.51873 AT (  379342.41,
3736865.26,    31.30,    61.26,    0.00)  DC
          3RD HIGHEST VALUE IS       0.50357 AT (  379328.02,
3736908.42,    35.28,    61.57,    0.00)  DC
          4TH HIGHEST VALUE IS       0.49906 AT (  379316.52,
3736953.02,    37.38,    62.18,    0.00)  DC
          5TH HIGHEST VALUE IS       0.49699 AT (  379306.45,
3736994.74,    38.75,    62.79,    0.00)  DC
          6TH HIGHEST VALUE IS       0.49180 AT (  379287.74,
3736883.96,    34.54,    60.35,    0.00)  DC
          7TH HIGHEST VALUE IS       0.49139 AT (  379290.62,
3736973.16,    38.29,    62.48,    0.00)  DC
          8TH HIGHEST VALUE IS       0.48984 AT (  379296.38,
3737039.33,    41.41,    67.06,    0.00)  DC
          9TH HIGHEST VALUE IS       0.48146 AT (  379260.41,
3737022.07,    40.37,    66.45,    0.00)  DC
         10TH HIGHEST VALUE IS       0.47403 AT (  379286.30,
3737076.74,    46.69,    64.31,    0.00)  DC

ALL       1ST HIGHEST VALUE IS     436.54120 AT (  379280.55,
3737127.09,    52.04,    63.40,    0.00)  DC
          2ND HIGHEST VALUE IS     303.27323 AT (  379250.34,
3737147.23,    53.49,    65.84,    0.00)  DC
          3RD HIGHEST VALUE IS     297.60980 AT (  379035.98,
3737322.74,    59.33,    75.90,    0.00)  DC
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          4TH HIGHEST VALUE IS     284.35663 AT (  379077.70,
3737266.64,    58.58,    69.19,    0.00)  DC
          5TH HIGHEST VALUE IS     281.69326 AT (  379047.49,
3737286.78,    58.91,    73.76,    0.00)  DC
          6TH HIGHEST VALUE IS     268.42329 AT (  378978.44,
3737414.82,    64.51,    75.90,    0.00)  DC
          7TH HIGHEST VALUE IS     267.45593 AT (  379221.57,
3737167.37,    58.24,    61.57,    0.00)  DC
          8TH HIGHEST VALUE IS     264.27228 AT (  379007.21,
3737384.60,    60.79,    76.20,    0.00)  DC
          9TH HIGHEST VALUE IS     262.61819 AT (  379021.60,
3737354.39,    59.22,    75.90,    0.00)  DC
         10TH HIGHEST VALUE IS     248.47484 AT (  379105.04,
3737250.81,    57.16,    69.49,    0.00)  DC


 *** RECEPTOR TYPES:  GC = GRIDCART
                      GP = GRIDPOLR
                      DC = DISCCART
                      DP = DISCPOLR
```

**MODELOPTs: RegDFAULT CONC ELEV NODRYDPLT NOWETDPLT

*** THE SUMMARY OF HIGHEST 1-HR RESULTS ***

** CONC OF XOQ IN MICROGRAMS/M**3 **

NETWORK GROUP ID	RECEPTOR (XR, YR, ZELEV, ZHILL, ZFLAG)	AVERAGE CONC OF TYPE	DATE (YYMMDDHH) GRID-ID
SRCGP1 HIGH 1ST HIGH VALUE IS	385.31622	ON 07030804: AT	
	(378978.44, 3737414.82, 64.51, 75.90, 0.00)	DC	
SRCGP2 HIGH 1ST HIGH VALUE IS	1429.42730	ON 07102604: AT	
	(378978.44, 3737414.82, 64.51, 75.90, 0.00)	DC	
SRCGP3 HIGH 1ST HIGH VALUE IS	239.49412	ON 06092703: AT	
	(378978.44, 3737414.82, 64.51, 75.90, 0.00)	DC	
SRCGP4 HIGH 1ST HIGH VALUE IS	2128.05310	ON 05041606: AT	
	(379077.70, 3737266.64, 58.58, 69.19, 0.00)	DC	
SRCGP5 HIGH 1ST HIGH VALUE IS	254.53021	ON 05041606: AT	
	(379221.57, 3737167.37, 58.24, 61.57, 0.00)	DC	
SRCGP6 HIGH 1ST HIGH VALUE IS	1050.49984	ON 05041606: AT	
	(379221.57, 3737167.37, 58.24, 61.57, 0.00)	DC	
SRCGP7 HIGH 1ST HIGH VALUE IS	123.58367	ON 06092703: AT	
	(379280.55, 3737127.09, 52.04, 63.40, 0.00)	DC	
SRCGP8 HIGH 1ST HIGH VALUE IS	3188.96170	ON 05092206: AT	
	(379280.55, 3737127.09, 52.04, 63.40, 0.00)	DC	
SRCGP9 HIGH 1ST HIGH VALUE IS	333.19280	ON 06021701: AT	
	(379221.57, 3737167.37, 58.24, 61.57, 0.00)	DC	

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SRCGP10  HIGH   1ST HIGH VALUE IS     572.22101  ON 05051905: AT
(  379280.55,  3737127.09,    52.04,    63.40,    0.00)  DC

SRCGP11  HIGH   1ST HIGH VALUE IS      19.16902  ON 05092107: AT
(  378978.44,  3737414.82,    64.51,    75.90,    0.00)  DC

SRCGP12  HIGH   1ST HIGH VALUE IS     173.07658  ON 06110720: AT
(  379280.55,  3737127.09,    52.04,    63.40,    0.00)  DC

SRCGP13  HIGH   1ST HIGH VALUE IS     216.22317  ON 05090703: AT
(  379280.55,  3737127.09,    52.04,    63.40,    0.00)  DC

SRCGP14  HIGH   1ST HIGH VALUE IS     123.27377  ON 07090702: AT
(  379221.57,  3737167.37,    58.24,    61.57,    0.00)  DC

SRCGP15  HIGH   1ST HIGH VALUE IS     128.95614  ON 06103001: AT
(  379286.30,  3737076.74,    46.69,    64.31,    0.00)  DC

SRCGP16  HIGH   1ST HIGH VALUE IS     193.05736  ON 06040802: AT
(  379280.55,  3737127.09,    52.04,    63.40,    0.00)  DC

SRCGP17  HIGH   1ST HIGH VALUE IS      96.38382  ON 05090703: AT
(  379161.14,  3737209.09,    55.07,    67.67,    0.00)  DC

SRCGP18  HIGH   1ST HIGH VALUE IS     121.95767  ON 07042501: AT
(  379221.57,  3737167.37,    58.24,    61.57,    0.00)  DC

SRCGP19  HIGH   1ST HIGH VALUE IS     104.55259  ON 05102923: AT
(  379280.55,  3737127.09,    52.04,    63.40,    0.00)  DC

SRCGP20  HIGH   1ST HIGH VALUE IS     126.94324  ON 05121122: AT
(  379280.55,  3737127.09,    52.04,    63.40,    0.00)  DC

SRCGP21  HIGH   1ST HIGH VALUE IS     204.70805  ON 05041606: AT
(  378978.44,  3737414.82,    64.51,    75.90,    0.00)  DC

SRCGP22  HIGH   1ST HIGH VALUE IS     168.94318  ON 05041606: AT
(  378978.44,  3737414.82,    64.51,    75.90,    0.00)  DC

SRCGP23  HIGH   1ST HIGH VALUE IS     160.98185  ON 05041606: AT
(  379021.60,  3737354.39,    59.22,    75.90,    0.00)  DC

SRCGP24  HIGH   1ST HIGH VALUE IS     130.98689  ON 05091505: AT
(  378978.44,  3737414.82,    64.51,    75.90,    0.00)  DC

SRCGP25  HIGH   1ST HIGH VALUE IS     131.83780  ON 05041606: AT
(  379021.60,  3737354.39,    59.22,    75.90,    0.00)  DC
```

**MODELOPTs: RegDFAULT CONC ELEV NODRYDPLT NOWETDPLT

*** THE SUMMARY OF HIGHEST 1-HR RESULTS ***

** CONC OF XOQ IN MICROGRAMS/M**3 **

NETWORK GROUP ID	RECEPTOR (XR, YR, ZELEV, ZHILL, ZFLAG)	AVERAGE CONC OF TYPE	DATE (YYMMDDHH) GRID-ID
SRCGP26 HIGH 1ST HIGH VALUE IS	108.44763	ON 07030804: AT	
	(379007.21, 3737384.60, 60.79, 76.20, 0.00)	DC	
SRCGP27 HIGH 1ST HIGH VALUE IS	56.74528	ON 06101101: AT	
	(378877.74, 3737400.43, 63.18, 98.15, 0.00)	DC	
SRCGP28 HIGH 1ST HIGH VALUE IS	60.67010	ON 06101101: AT	
	(378926.65, 3737406.18, 60.13, 99.36, 0.00)	DC	
SRCGP29 HIGH 1ST HIGH VALUE IS	63.63192	ON 06101101: AT	
	(378978.44, 3737414.82, 64.51, 75.90, 0.00)	DC	
SRCGP30 HIGH 1ST HIGH VALUE IS	12.11197	ON 05090703: AT	
	(379316.52, 3736953.02, 37.38, 62.18, 0.00)	DC	
SRCGP31 HIGH 1ST HIGH VALUE IS	128.64539	ON 07123117: AT	
	(379035.98, 3737322.74, 59.33, 75.90, 0.00)	DC	
SRCGP32 HIGH 1ST HIGH VALUE IS	0.88025	ON 06110519: AT	
	(379187.04, 3737190.39, 58.48, 60.35, 0.00)	DC	
SRCGP33 HIGH 1ST HIGH VALUE IS	9.95717	ON 05081303: AT	
	(379280.55, 3737127.09, 52.04, 63.40, 0.00)	DC	
ALL HIGH 1ST HIGH VALUE IS	3600.16656	ON 05092206: AT	
	(379280.55, 3737127.09, 52.04, 63.40, 0.00)	DC	

```
*** RECEPTOR TYPES:  GC = GRIDCART
                     GP = GRIDPOLR
                     DC = DISCCART
                     DP = DISCPOLR
```

```
 *** AERMOD - VERSION  11103 ***   *** C:\Documents and Settings
\HP_Administrator\My Documents\Lakes\AERMOD ***        06/16/11
                                       ***
***        18:52:09

PAGE  89
 **MODELOPTs:  RegDFAULT CONC
ELEV
                                                          NODRYDPLT
NOWETDPLT

 *** Message Summary : AERMOD Model Execution ***

  --------- Summary of Total Messages --------

 A Total of            0 Fatal Error Message(s)
 A Total of            2 Warning Message(s)
 A Total of           97 Informational Message(s)

 A Total of        26280 Hours Were Processed

 A Total of            0 Calm Hours Identified

 A Total of           97 Missing Hours Identified (  0.37
Percent)


    ******** FATAL ERROR MESSAGES ********
               ***  NONE  ***


    ********   WARNING MESSAGES   ********
 SO W320     137  PPARM:Input Parameter May Be Out-of-Range for
Parameter            VS
 ME W396     227 MEOPEN:Met data from outdated version of AERMET,
version:        06341

    ************************************
    *** AERMOD Finishes Successfully ***
    ************************************
```

This file: c:\HARP\projects\demo\Rep_Can_70yr_DerAdj_AllRec_AllSrc_AllCh_ByRec_Site.txt

Created by HARP Version 1.4d Build 23.09.07
Uses ISC Version 99155
Uses BPIP (Dated: 04112)
Creation date: 6/18/2011 6:44:06 PM

EXCEPTION REPORT
   (there have been no changes or exceptions)

INPUT FILES:
   Source-Receptor file: C:\Users\dwaymire\Documents\Bluescape\Projects\Ponte Vista\Modeling\061611 Modeling\PVHRA616.SRC
   Averaging period adjustment factors file: not applicable
   Emission rates file: none
   Site parameters file: c:\HARP\projects\demo\project.sit

Coordinate system: UTM NAD27

Screening mode is OFF

Exposure duration: 70 year (adult resident)
Analysis method: Derived (Adjusted) Method
Health effect: Cancer Risk
Receptor(s):   All
Sources(s):   All
Chemicals(s):   All

SITE PARAMETERS

DEPOSITION

   Deposition rate (m/s)   0.05

DRINKING WATER

*** Pathway disabled ***

FISH

*** Pathway disabled ***

PASTURE

*** Pathway disabled ***

HOME GROWN PRODUCE

*** Pathway disabled ***

PIGS, CHICKENS AND EGGS

*** Pathway disabled ***

DERMAL ABSORPTION

*** Pathway disabled ***

SOIL INGESTION

*** Pathway disabled ***

MOTHER'S MILK

*** Pathway disabled ***

CHEMICAL CROSS-REFERENCE TABLE AND BACKGROUND CONCENTRATIONS

CHEM	CAS	ABBREVIATION	POLLUTANT NAME	BACKGROUND (ug/m^3)
0001	106990	1,3-Butadiene	1,3-Butadiene	0.000E+00
0002	75070	Acetaldehyde	Acetaldehyde	0.000E+00
0003	107028	Acrolein	Acrolein	0.000E+00
0004	7664417	NH3	Ammonia	0.000E+00
0005	7440382	Arsenic	Arsenic	0.000E+00
0006	1332214	Asbestos	Asbestos	0.000E+00
0007	71432	Benzene	Benzene	0.000E+00
0008	7440417	Beryllium	Beryllium	0.000E+00
0009	7440439	Cadmium	Cadmium	0.000E+00
0010	56235	CCl4	Carbon tetrachloride	0.000E+00
0011	7782505	Chlorine	Chlorine	0.000E+00
0012	18540299	Cr(VI)	Chromium, hexavalent (& compounds)	0.000E+00
0013	218019	Chrysene	Chrysene	0.000E+00
0014	7440508	Copper	Copper	0.000E+00
0015	9901	DieselExhPM	Diesel engine exhaust, particulate matter (Diesel PM)	0.000E+00
0016	100414	Ethyl Benzene	Ethyl benzene	0.000E+00
0017	111762	EGBE	Ethylene glycol monobutyl ether	0.000E+00
0018	109864	EGME	Ethylene glycol monomethyl ether	0.000E+00
0019	106934	EDB	Ethylene dibromide {EDB}	0.000E+00
0020	107062	EDC	Ethylene dichloride {EDC}	0.000E+00
0021	50000	Formaldehyde	Formaldehyde	0.000E+00
0022	110543	Hexane	Hexane	0.000E+00
0023	7647010	HCl	Hydrochloric acid	0.000E+00
0024	7783064	H2S	Hydrogen sulfide	0.000E+00
0025	7439921	Lead	Lead	0.000E+00
0026	71556	1,1,1-TCA	Methyl chloroform {1,1,1-Trichloroethane}	0.000E+00
0027	1634044	Me t-ButylEther	Methyl tert-butyl ether	0.000E+00
0028	7439965	Manganese	Manganese	0.000E+00
0029	7439976	Mercury	Mercury	0.000E+00
0030	67561	Methanol	Methanol	0.000E+00
0031	78933	MEK	Methyl ethyl ketone {2-Butanone}	0.000E+00
0032	75092	Methylene Chlor	Methylene chloride {Dichloromethane}	0.000E+00
0033	91203	Naphthalene	Naphthalene	0.000E+00
0034	7440020	Nickel	Nickel	0.000E+00
0035	1151	PAHs-w/o	PAHs, total, w/o individ. components reported [Treated as B(a)P for HRA]	0.000E+00
0036	127184	Perc	Perchloroethylene {Tetrachloroethene}	0.000E+00
0037	107982	PGME	Propylene glycol monomethyl ether	0.000E+00
0038	7782492	Selenium	Selenium	0.000E+00
0039	100425	Styrene	Styrene	0.000E+00
0040	7664939	Sulfuric Acid	Sulfuric acid	0.000E+00
0041	108883	Toluene	Toluene	0.000E+00
0042	79016	TCE	Trichloroethylene	0.000E+00
0043	75014	Vinyl Chloride	Vinyl chloride	0.000E+00
0044	1330207	Xylenes	Xylenes (mixed)	0.000E+00
0045	108383	m-Xylene	m-Xylene	0.000E+00
0046	95476	o-Xylene	o-Xylene	0.000E+00

CHEMICAL HEALTH VALUES

CHEM	CAS	ABBREVIATION	CancerPF(Inh) (mg/kg-d)^-1	CancerPF(Oral) (mg/kg-d)^-1	ChronicREL(Inh) ug/m^3	ChronicREL(Oral) mg/kg-d	AcuteREL ug/m^3
0001	106990	1,3-Butadiene	6.00E-01	*	2.00E+01	*	*
0002	75070	Acetaldehyde	1.00E-02	*	1.40E+02	*	4.70E+02
0003	107028	Acrolein	*	*	3.50E-01	*	2.50E+00

0004	7664417	NH3	*	*	2.00E+02	*	3.20E+03
0005	7440382	Arsenic	1.20E+01	1.50E+00	1.50E-02	3.50E-06	2.00E-01
0006	1332214	Asbestos	2.20E+02	*	*	*	*
0007	71432	Benzene	1.00E-01	*	6.00E+01	*	1.30E+03
0008	7440417	Beryllium	8.40E+00	*	7.00E-03	2.00E-03	*
0009	7440439	Cadmium	1.50E+01	*	2.00E-02	5.00E-04	*
0010	56235	CCl4	1.50E-01	*	4.00E+01	*	1.90E+03
0011	7782505	Chlorine	*	*	2.00E-01	*	2.10E+02
0012	18540299	Cr(VI)	5.10E+02	*	2.00E-01	2.00E-02	*
0013	218019	Chrysene	3.90E-02	1.20E-01	*	*	*
0014	7440508	Copper	*	*	*	*	1.00E+02
0015	9901	DieselExhPM	1.10E+00	*	5.00E+00	*	*
0016	100414	Ethyl Benzene	8.70E-03	*	2.00E+03	*	*
0017	111762	EGBE	*	*	*	*	1.40E+04
0018	109864	EGME	*	*	6.00E+01	*	9.30E+01
0019	106934	EDB	2.50E-01	*	8.00E-01	*	*
0020	107062	EDC	7.20E-02	*	4.00E+02	*	*
0021	50000	Formaldehyde	2.10E-02	*	9.00E+00	*	5.50E+01
0022	110543	Hexane	*	*	7.00E+03	*	*
0023	7647010	HCl	*	*	9.00E+00	*	2.10E+03
0024	7783064	H2S	*	*	1.00E+01	*	4.20E+01
0025	7439921	Lead	4.20E-02	8.50E-03	*	*	*
0026	71556	1,1,1-TCA	*	*	1.00E+03	*	6.80E+04
0027	1634044	Me t-ButylEther	1.80E-03	*	8.00E+03	*	*
0028	7439965	Manganese	*	*	9.00E-02	*	*
0029	7439976	Mercury	*	*	3.00E-02	1.60E-04	6.00E-01
0030	67561	Methanol	*	*	4.00E+03	*	2.80E+04
0031	78933	MEK	*	*	*	*	1.30E+04
0032	75092	Methylene Chlor	3.50E-03	*	4.00E+02	*	1.40E+04
0033	91203	Naphthalene	1.20E-01	*	9.00E+00	*	*
0034	7440020	Nickel	9.10E-01	*	5.00E-02	5.00E-02	6.00E+00
0035	1151	PAHs-w/o	3.90E+00	1.20E+01	*	*	*
0036	127184	Perc	2.10E-02	*	3.50E+01	*	2.00E+04
0037	107982	PGME	*	*	7.00E+03	*	*
0038	7782492	Selenium	*	*	2.00E+01	*	*
0039	100425	Styrene	*	*	9.00E+02	*	2.10E+04
0040	7664939	Sulfuric Acid	*	*	1.00E+00	*	1.20E+02
0041	108883	Toluene	*	*	3.00E+02	*	3.70E+04
0042	79016	TCE	7.00E-03	*	6.00E+02	*	*
0043	75014	Vinyl Chloride	2.70E-01	*	*	*	1.80E+05
0044	1330207	Xylenes	*	*	7.00E+02	*	2.20E+04
0045	108383	m-Xylene	*	*	7.00E+02	*	2.20E+04
0046	95476	o-Xylene	*	*	7.00E+02	*	2.20E+04

EMISSIONS DATA SOURCE: Emission rates loaded from file: C:\Users\dwaymire\Documents\Bluescape\Projects\Ponte Vista\Modeling\061611 Modeling\PV_HRA.ems
EMISSION RATES HAVE BEEN MANUALLY EDITED BY USER
CHEMICALS ADDED OR DELETED: none

EMISSIONS FOR FACILITY FAC=9999 DEV= PRO= STK=1 NAME=SRCGP1
SOURCE MULTIPLIER=1

CAS	ABBREV	MULTIPLIER	BG (ug/m^3)	AVRG (lbs/yr)	MAX (lbs/hr)
106990	1,3-Butadiene	1	0	0	0
75070	Acetaldehyde	1	0	0	0
107028	Acrolein	1	0	0	0
7664417	Ammonia	1	0	0	0
7440382	Arsenic	1	0	0	0
1332214	Asbestos	1	0	0	0
71432	Benzene	1	0	0	0
7440417	Berylium	1	0	0	0
7440439	Cadmium	1	0	0	0
56235	Carbon Tetrachlo	1	0	0	0
7782505	Chlorine	1	0	0	0

18540299	Chromium (VI)	1	0	0	0
218019	Chrysene	1	0	0	0
7440508	Copper	1	0	0	0
9901	DPM	1	0	0	0
100414	Ethyl Benzene	1	0	10.2900000	0
111762	Ethylene glycol	1	0	0	0
109864	Ethylene glycol	1	0	0.08000000	0
106934	Ethylene Dibromi	1	0	0	0
107062	Ethylene Dichlor	1	0	0	0
50000	Formaldehyde	1	0	0	0
110543	Hexane	1	0	0	0
7647010	Hydrochloric Aci	1	0	0	0
7783064	Hydrogen Sulfide	1	0	0	0
7439921	Lead (inorganic)	1	0	0	0
71556	Methyl Chlorofor	1	0	0	0
1634044	Metyl Tertiary B	1	0	0	0
7439965	Manganese	1	0	0	0
7439976	Mercury	1	0	0	0
67561	Methanol	1	0	0	0
78933	Methyl Ethyl Ket	1	0	0	0
75092	Methylene Chlori	1	0	0	0
91203	Naphthalene	1	0	0.3900000	0
7440020	Nickel	1	0	0	0
1151	PAHs	1	0	0	0
127184	Perchloroethylen	1	0	0	0
107982	Propylene glycol	1	0	0	0
7782492	Selenium	1	0	0	0
100425	Styrene	1	0	0	0
7664939	Sulfuric Acid	1	0	0	0
108883	Toluene	1	0	0	0
79016	Trichloroethylen	1	0	0	0
75014	Vinyl Chloride	1	0	0	0
1330207	Xylene	1	0	0	0
108383	M-Xylene	1	0	0	0
95476	O-Xylene	1	0	0	0

EMISSIONS FOR FACILITY FAC=9999 DEV= PRO= STK=2 NAME=SRCGP2
SOURCE MULTIPLIER=1

CAS	ABBREV	MULTIPLIER	BG (ug/m^3)	AVRG (lbs/yr)	MAX (lbs/hr)
106990	1,3-Butadiene	1	0	0	0
75070	Acetaldehyde	1	0	0	0
107028	Acrolein	1	0	0	0
7664417	Ammonia	1	0	0	0
7440382	Arsenic	1	0	0	0
1332214	Asbestos	1	0	0	0
71432	Benzene	1	0	0	0
7440417	Berylium	1	0	0	0
7440439	Cadmium	1	0	0	0
56235	Carbon Tetrachlo	1	0	0	0
7782505	Chlorine	1	0	0	0
18540299	Chromium (VI)	1	0	0	0
218019	Chrysene	1	0	0	0
7440508	Copper	1	0	0	0
9901	DPM	1	0	0	0
100414	Ethyl Benzene	1	0	10.2900000	0
111762	Ethylene glycol	1	0	0	0
109864	Ethylene glycol	1	0	0.08000000	0
106934	Ethylene Dibromi	1	0	0	0
107062	Ethylene Dichlor	1	0	0	0
50000	Formaldehyde	1	0	0	0
110543	Hexane	1	0	0	0
7647010	Hydrochloric Aci	1	0	0	0

7783064	Hydrogen Sulfide	1	0	0	0
7439921	Lead (inorganic)	1	0	0	0
71556	Methyl Chlorofor	1	0	0	0
1634044	Metyl Tertiary B	1	0	0	0
7439965	Manganese	1	0	0	0
7439976	Mercury	1	0	0	0
67561	Methanol	1	0	0	0
78933	Methyl Ethyl Ket	1	0	0	0
75092	Methylene Chlori	1	0	0	0
91203	Naphthalene	1	0	0.3900000	0
7440020	Nickel	1	0	0	0
1151	PAHs	1	0	0	0
127184	Perchloroethylen	1	0	0	0
107982	Propylene glycol	1	0	0	0
7782492	Selenium	1	0	0	0
100425	Styrene	1	0	0	0
7664939	Sulfuric Acid	1	0	0	0
108883	Toluene	1	0	0	0
79016	Trichloroethylen	1	0	0	0
75014	Vinyl Chloride	1	0	0	0
1330207	Xylene	1	0	0	0
108383	M-Xylene	1	0	0	0
95476	O-Xylene	1	0	0	0

EMISSIONS FOR FACILITY FAC=9999 DEV= PRO= STK=3 NAME=SRCGP3
SOURCE MULTIPLIER=1

CAS	ABBREV	MULTIPLIER	BG (ug/m^3)	AVRG (lbs/yr)	MAX (lbs/hr)
106990	1,3-Butadiene	1	0	0	0
75070	Acetaldehyde	1	0	0	0
107028	Acrolein	1	0	0	0
7664417	Ammonia	1	0	0	0
7440382	Arsenic	1	0	0	0
1332214	Asbestos	1	0	0	0
71432	Benzene	1	0	0	0
7440417	Berylium	1	0	0	0
7440439	Cadmium	1	0	0	0
56235	Carbon Tetrachlo	1	0	0	0
7782505	Chlorine	1	0	0	0
18540299	Chromium (VI)	1	0	0	0
218019	Chrysene	1	0	0	0
7440508	Copper	1	0	0	0
9901	DPM	1	0	0	0
100414	Ethyl Benzene	1	0	10.2900000	0
111762	Ethylene glycol	1	0	0	0
109864	Ethylene glycol	1	0	0.08000000	0
106934	Ethylene Dibromi	1	0	0	0
107062	Ethylene Dichlor	1	0	0	0
50000	Formaldehyde	1	0	0	0
110543	Hexane	1	0	0	0
7647010	Hydrochloric Aci	1	0	0	0
7783064	Hydrogen Sulfide	1	0	0	0
7439921	Lead (inorganic)	1	0	0	0
71556	Methyl Chlorofor	1	0	0	0
1634044	Metyl Tertiary B	1	0	0	0
7439965	Manganese	1	0	0	0
7439976	Mercury	1	0	0	0
67561	Methanol	1	0	0	0
78933	Methyl Ethyl Ket	1	0	0	0
75092	Methylene Chlori	1	0	0	0
91203	Naphthalene	1	0	0.3900000	0
7440020	Nickel	1	0	0	0
1151	PAHs	1	0	0	0

127184	Perchloroethylen	1	0	0	0
107982	Propylene glycol	1	0	0	0
7782492	Selenium	1	0	0	0
100425	Styrene	1	0	0	0
7664939	Sulfuric Acid	1	0	0	0
108883	Toluene	1	0	0	0
79016	Trichloroethylen	1	0	0	0
75014	Vinyl Chloride	1	0	0	0
1330207	Xylene	1	0	0	0
108383	M-Xylene	1	0	0	0
95476	O-Xylene	1	0	0	0

EMISSIONS FOR FACILITY FAC=9999 DEV= PRO= STK=4 NAME=SRCGP4
SOURCE MULTIPLIER=1

CAS	ABBREV	MULTIPLIER	BG (ug/m^3)	AVRG (lbs/yr)	MAX (lbs/hr)
106990	1,3-Butadiene	1	0	0	0
75070	Acetaldehyde	1	0	0	0
107028	Acrolein	1	0	0	0
7664417	Ammonia	1	0	0	0
7440382	Arsenic	1	0	0	0
1332214	Asbestos	1	0	0	0
71432	Benzene	1	0	0	0
7440417	Berylium	1	0	0	0
7440439	Cadmium	1	0	0	0
56235	Carbon Tetrachlo	1	0	0	0
7782505	Chlorine	1	0	0	0
18540299	Chromium (VI)	1	0	0	0
218019	Chrysene	1	0	0	0
7440508	Copper	1	0	0	0
9901	DPM	1	0	0	0
100414	Ethyl Benzene	1	0	10.2900000	0
111762	Ethylene glycol	1	0	0	0
109864	Ethylene glycol	1	0	0.08000000	0
106934	Ethylene Dibromi	1	0	0	0
107062	Ethylene Dichlor	1	0	0	0
50000	Formaldehyde	1	0	0	0
110543	Hexane	1	0	0	0
7647010	Hydrochloric Aci	1	0	0	0
7783064	Hydrogen Sulfide	1	0	0	0
7439921	Lead (inorganic)	1	0	0	0
71556	Methyl Chlorofor	1	0	0	0
1634044	Metyl Tertiary B	1	0	0	0
7439965	Manganese	1	0	0	0
7439976	Mercury	1	0	0	0
67561	Methanol	1	0	0	0
78933	Methyl Ethyl Ket	1	0	0	0
75092	Methylene Chlori	1	0	0	0
91203	Naphthalene	1	0	0.3900000	0
7440020	Nickel	1	0	0	0
1151	PAHs	1	0	0	0
127184	Perchloroethylen	1	0	0	0
107982	Propylene glycol	1	0	0	0
7782492	Selenium	1	0	0	0
100425	Styrene	1	0	0	0
7664939	Sulfuric Acid	1	0	0	0
108883	Toluene	1	0	0	0
79016	Trichloroethylen	1	0	0	0
75014	Vinyl Chloride	1	0	0	0
1330207	Xylene	1	0	0	0
108383	M-Xylene	1	0	0	0
95476	O-Xylene	1	0	0	0

EMISSIONS FOR FACILITY FAC=9999 DEV= PRO= STK=5 NAME=SRCGP5
SOURCE MULTIPLIER=1

CAS	ABBREV	MULTIPLIER	BG (ug/m^3)	AVRG (lbs/yr)	MAX (lbs/hr)
106990	1,3-Butadiene	1	0	0	0
75070	Acetaldehyde	1	0	0	0
107028	Acrolein	1	0	0	0
7664417	Ammonia	1	0	0	0
7440382	Arsenic	1	0	0	0
1332214	Asbestos	1	0	0	0
71432	Benzene	1	0	0	0
7440417	Berylium	1	0	0	0
7440439	Cadmium	1	0	0	0
56235	Carbon Tetrachlo	1	0	0	0
7782505	Chlorine	1	0	0	0
18540299	Chromium (VI)	1	0	0	0
218019	Chrysene	1	0	0	0
7440508	Copper	1	0	0	0
9901	DPM	1	0	0	0
100414	Ethyl Benzene	1	0	10.2900000	0
111762	Ethylene glycol	1	0	0	0
109864	Ethylene glycol	1	0	0.08000000	0
106934	Ethylene Dibromi	1	0	0	0
107062	Ethylene Dichlor	1	0	0	0
50000	Formaldehyde	1	0	0	0
110543	Hexane	1	0	0	0
7647010	Hydrochloric Aci	1	0	0	0
7783064	Hydrogen Sulfide	1	0	0	0
7439921	Lead (inorganic)	1	0	0	0
71556	Methyl Chlorofor	1	0	0	0
1634044	Metyl Tertiary B	1	0	0	0
7439965	Manganese	1	0	0	0
7439976	Mercury	1	0	0	0
67561	Methanol	1	0	0	0
78933	Methyl Ethyl Ket	1	0	0	0
75092	Methylene Chlori	1	0	0	0
91203	Naphthalene	1	0	0.3900000	0
7440020	Nickel	1	0	0	0
1151	PAHs	1	0	0	0
127184	Perchloroethylen	1	0	0	0
107982	Propylene glycol	1	0	0	0
7782492	Selenium	1	0	0	0
100425	Styrene	1	0	0	0
7664939	Sulfuric Acid	1	0	0	0
108883	Toluene	1	0	0	0
79016	Trichloroethylen	1	0	0	0
75014	Vinyl Chloride	1	0	0	0
1330207	Xylene	1	0	0	0
108383	M-Xylene	1	0	0	0
95476	O-Xylene	1	0	0	0

EMISSIONS FOR FACILITY FAC=9999 DEV= PRO= STK=6 NAME=SRCGP6
SOURCE MULTIPLIER=1

CAS	ABBREV	MULTIPLIER	BG (ug/m^3)	AVRG (lbs/yr)	MAX (lbs/hr)
106990	1,3-Butadiene	1	0	0	0
75070	Acetaldehyde	1	0	0	0
107028	Acrolein	1	0	0	0
7664417	Ammonia	1	0	0	0
7440382	Arsenic	1	0	0	0
1332214	Asbestos	1	0	0	0
71432	Benzene	1	0	0	0
7440417	Berylium	1	0	0	0
7440439	Cadmium	1	0	0	0

56235	Carbon Tetrachlo	1	0	0	0
7782505	Chlorine	1	0	0	0
18540299	Chromium (VI)	1	0	0	0
218019	Chrysene	1	0	0	0
7440508	Copper	1	0	0	0
9901	DPM	1	0	0	0
100414	Ethyl Benzene	1	0	10.2900000	0
111762	Ethylene glycol	1	0	0	0
109864	Ethylene glycol	1	0	0.08000000	0
106934	Ethylene Dibromi	1	0	0	0
107062	Ethylene Dichlor	1	0	0	0
50000	Formaldehyde	1	0	0	0
110543	Hexane	1	0	0	0
7647010	Hydrochloric Aci	1	0	0	0
7783064	Hydrogen Sulfide	1	0	0	0
7439921	Lead (inorganic)	1	0	0	0
71556	Methyl Chlorofor	1	0	0	0
1634044	Metyl Tertiary B	1	0	0	0
7439965	Manganese	1	0	0	0
7439976	Mercury	1	0	0	0
67561	Methanol	1	0	0	0
78933	Methyl Ethyl Ket	1	0	0	0
75092	Methylene Chlori	1	0	0	0
91203	Naphthalene	1	0	0.3900000	0
7440020	Nickel	1	0	0	0
1151	PAHs	1	0	0	0
127184	Perchloroethylen	1	0	0	0
107982	Propylene glycol	1	0	0	0
7782492	Selenium	1	0	0	0
100425	Styrene	1	0	0	0
7664939	Sulfuric Acid	1	0	0	0
108883	Toluene	1	0	0	0
79016	Trichloroethylen	1	0	0	0
75014	Vinyl Chloride	1	0	0	0
1330207	Xylene	1	0	0	0
108383	M-Xylene	1	0	0	0
95476	O-Xylene	1	0	0	0

EMISSIONS FOR FACILITY FAC=9999 DEV= PRO= STK=7 NAME=SRCGP7
SOURCE MULTIPLIER=1

CAS	ABBREV	MULTIPLIER	BG (ug/m^3)	AVRG (lbs/yr)	MAX (lbs/hr)
106990	1,3-Butadiene	1	0	0	0
75070	Acetaldehyde	1	0	0	0
107028	Acrolein	1	0	0	0
7664417	Ammonia	1	0	0	0
7440382	Arsenic	1	0	0	0
1332214	Asbestos	1	0	0	0
71432	Benzene	1	0	0	0
7440417	Berylium	1	0	0	0
7440439	Cadmium	1	0	0	0
56235	Carbon Tetrachlo	1	0	0	0
7782505	Chlorine	1	0	0	0
18540299	Chromium (VI)	1	0	0	0
218019	Chrysene	1	0	0	0
7440508	Copper	1	0	0	0
9901	DPM	1	0	0	0
100414	Ethyl Benzene	1	0	10.2900000	0
111762	Ethylene glycol	1	0	0	0
109864	Ethylene glycol	1	0	0.08000000	0
106934	Ethylene Dibromi	1	0	0	0
107062	Ethylene Dichlor	1	0	0	0
50000	Formaldehyde	1	0	0	0

110543	Hexane	1	0	0	0
7647010	Hydrochloric Aci	1	0	0	0
7783064	Hydrogen Sulfide	1	0	0	0
7439921	Lead (inorganic)	1	0	0	0
71556	Methyl Chlorofor	1	0	0	0
1634044	Metyl Tertiary B	1	0	0	0
7439965	Manganese	1	0	0	0
7439976	Mercury	1	0	0	0
67561	Methanol	1	0	0	0
78933	Methyl Ethyl Ket	1	0	0	0
75092	Methylene Chlori	1	0	0	0
91203	Naphthalene	1	0	0.3900000	0
7440020	Nickel	1	0	0	0
1151	PAHs	1	0	0	0
127184	Perchloroethylen	1	0	0	0
107982	Propylene glycol	1	0	0	0
7782492	Selenium	1	0	0	0
100425	Styrene	1	0	0	0
7664939	Sulfuric Acid	1	0	0	0
108883	Toluene	1	0	0	0
79016	Trichloroethylen	1	0	0	0
75014	Vinyl Chloride	1	0	0	0
1330207	Xylene	1	0	0	0
108383	M-Xylene	1	0	0	0
95476	O-Xylene	1	0	0	0

EMISSIONS FOR FACILITY FAC=9999 DEV= PRO= STK=8 NAME=SRCGP8
SOURCE MULTIPLIER=1

CAS	ABBREV	MULTIPLIER	BG (ug/m^3)	AVRG (lbs/yr)	MAX (lbs/hr)
106990	1,3-Butadiene	1	0	0	0
75070	Acetaldehyde	1	0	0	0
107028	Acrolein	1	0	0	0
7664417	Ammonia	1	0	0	0
7440382	Arsenic	1	0	0	0
1332214	Asbestos	1	0	0	0
71432	Benzene	1	0	0	0
7440417	Berylium	1	0	0	0
7440439	Cadmium	1	0	0	0
56235	Carbon Tetrachlo	1	0	0	0
7782505	Chlorine	1	0	0	0
18540299	Chromium (VI)	1	0	0	0
218019	Chrysene	1	0	0	0
7440508	Copper	1	0	0	0
9901	DPM	1	0	0	0
100414	Ethyl Benzene	1	0	10.2900000	0
111762	Ethylene glycol	1	0	0	0
109864	Ethylene glycol	1	0	0.08000000	0
106934	Ethylene Dibromi	1	0	0	0
107062	Ethylene Dichlor	1	0	0	0
50000	Formaldehyde	1	0	0	0
110543	Hexane	1	0	0	0
7647010	Hydrochloric Aci	1	0	0	0
7783064	Hydrogen Sulfide	1	0	0	0
7439921	Lead (inorganic)	1	0	0	0
71556	Methyl Chlorofor	1	0	0	0
1634044	Metyl Tertiary B	1	0	0	0
7439965	Manganese	1	0	0	0
7439976	Mercury	1	0	0	0
67561	Methanol	1	0	0	0
78933	Methyl Ethyl Ket	1	0	0	0
75092	Methylene Chlori	1	0	0	0
91203	Naphthalene	1	0	0.3900000	0

7440020	Nickel	1	0	0	0
1151	PAHs	1	0	0	0
127184	Perchloroethylen	1	0	0	0
107982	Propylene glycol	1	0	0	0
7782492	Selenium	1	0	0	0
100425	Styrene	1	0	0	0
7664939	Sulfuric Acid	1	0	0	0
108883	Toluene	1	0	0	0
79016	Trichloroethylen	1	0	0	0
75014	Vinyl Chloride	1	0	0	0
1330207	Xylene	1	0	0	0
108383	M-Xylene	1	0	0	0
95476	O-Xylene	1	0	0	0

EMISSIONS FOR FACILITY FAC=9999 DEV= PRO= STK=9 NAME=SRCGP9
SOURCE MULTIPLIER=1

CAS	ABBREV	MULTIPLIER	BG (ug/m^3)	AVRG (lbs/yr)	MAX (lbs/hr)
106990	1,3-Butadiene	1	0	0	0
75070	Acetaldehyde	1	0	0	0
107028	Acrolein	1	0	0	0
7664417	Ammonia	1	0	0	0
7440382	Arsenic	1	0	0	0
1332214	Asbestos	1	0	0	0
71432	Benzene	1	0	0	0
7440417	Berylium	1	0	0	0
7440439	Cadmium	1	0	0	0
56235	Carbon Tetrachlo	1	0	0	0
7782505	Chlorine	1	0	0	0
18540299	Chromium (VI)	1	0	0	0
218019	Chrysene	1	0	0	0
7440508	Copper	1	0	0	0
9901	DPM	1	0	0	0
100414	Ethyl Benzene	1	0	10.2900000	0
111762	Ethylene glycol	1	0	0	0
109864	Ethylene glycol	1	0	0.08000000	0
106934	Ethylene Dibromi	1	0	0	0
107062	Ethylene Dichlor	1	0	0	0
50000	Formaldehyde	1	0	0	0
110543	Hexane	1	0	0	0
7647010	Hydrochloric Aci	1	0	0	0
7783064	Hydrogen Sulfide	1	0	0	0
7439921	Lead (inorganic)	1	0	0	0
71556	Methyl Chlorofor	1	0	0	0
1634044	Metyl Tertiary B	1	0	0	0
7439965	Manganese	1	0	0	0
7439976	Mercury	1	0	0	0
67561	Methanol	1	0	0	0
78933	Methyl Ethyl Ket	1	0	0	0
75092	Methylene Chlori	1	0	0	0
91203	Naphthalene	1	0	0.3900000	0
7440020	Nickel	1	0	0	0
1151	PAHs	1	0	0	0
127184	Perchloroethylen	1	0	0	0
107982	Propylene glycol	1	0	0	0
7782492	Selenium	1	0	0	0
100425	Styrene	1	0	0	0
7664939	Sulfuric Acid	1	0	0	0
108883	Toluene	1	0	0	0
79016	Trichloroethylen	1	0	0	0
75014	Vinyl Chloride	1	0	0	0
1330207	Xylene	1	0	0	0
108383	M-Xylene	1	0	0	0

95476	O-Xylene	1	0	0	0

EMISSIONS FOR FACILITY FAC=9999 DEV= PRO= STK=10 NAME=SRCGP10
SOURCE MULTIPLIER=1

CAS	ABBREV	MULTIPLIER	BG (ug/m^3)	AVRG (lbs/yr)	MAX (lbs/hr)
106990	1,3-Butadiene	1	0	0	0
75070	Acetaldehyde	1	0	0	0
107028	Acrolein	1	0	0	0
7664417	Ammonia	1	0	0	0
7440382	Arsenic	1	0	0	0
1332214	Asbestos	1	0	0	0
71432	Benzene	1	0	0	0
7440417	Berylium	1	0	0	0
7440439	Cadmium	1	0	0	0
56235	Carbon Tetrachlo	1	0	0	0
7782505	Chlorine	1	0	0	0
18540299	Chromium (VI)	1	0	0	0
218019	Chrysene	1	0	0	0
7440508	Copper	1	0	0	0
9901	DPM	1	0	0	0
100414	Ethyl Benzene	1	0	10.2900000	0
111762	Ethylene glycol	1	0	0	0
109864	Ethylene glycol	1	0	0.08000000	0
106934	Ethylene Dibromi	1	0	0	0
107062	Ethylene Dichlor	1	0	0	0
50000	Formaldehyde	1	0	0	0
110543	Hexane	1	0	0	0
7647010	Hydrochloric Aci	1	0	0	0
7783064	Hydrogen Sulfide	1	0	0	0
7439921	Lead (inorganic)	1	0	0	0
71556	Methyl Chlorofor	1	0	0	0
1634044	Metyl Tertiary B	1	0	0	0
7439965	Manganese	1	0	0	0
7439976	Mercury	1	0	0	0
67561	Methanol	1	0	0	0
78933	Methyl Ethyl Ket	1	0	0	0
75092	Methylene Chlori	1	0	0	0
91203	Naphthalene	1	0	0.3900000	0
7440020	Nickel	1	0	0	0
1151	PAHs	1	0	0	0
127184	Perchloroethylen	1	0	0	0
107982	Propylene glycol	1	0	0	0
7782492	Selenium	1	0	0	0
100425	Styrene	1	0	0	0
7664939	Sulfuric Acid	1	0	0	0
108883	Toluene	1	0	0	0
79016	Trichloroethylen	1	0	0	0
75014	Vinyl Chloride	1	0	0	0
1330207	Xylene	1	0	0	0
108383	M-Xylene	1	0	0	0
95476	O-Xylene	1	0	0	0

EMISSIONS FOR FACILITY FAC=9999 DEV= PRO= STK=11 NAME=SRCGP11
SOURCE MULTIPLIER=1

CAS	ABBREV	MULTIPLIER	BG (ug/m^3)	AVRG (lbs/yr)	MAX (lbs/hr)
106990	1,3-Butadiene	1	0	0	0
75070	Acetaldehyde	1	0	0	0
107028	Acrolein	1	0	0	0
7664417	Ammonia	1	0	0	0
7440382	Arsenic	1	0	0	0
1332214	Asbestos	1	0	0	0
71432	Benzene	1	0	0	0

7440417	Berylium	1	0	0	0
7440439	Cadmium	1	0	0	0
56235	Carbon Tetrachlo	1	0	0	0
7782505	Chlorine	1	0	0	0
18540299	Chromium (VI)	1	0	0	0
218019	Chrysene	1	0	0	0
7440508	Copper	1	0	0	0
9901	DPM	1	0	0	0
100414	Ethyl Benzene	1	0	10.2900000	0
111762	Ethylene glycol	1	0	0	0
109864	Ethylene glycol	1	0	0.08000000	0
106934	Ethylene Dibromi	1	0	0	0
107062	Ethylene Dichlor	1	0	0	0
50000	Formaldehyde	1	0	0	0
110543	Hexane	1	0	0	0
7647010	Hydrochloric Aci	1	0	0	0
7783064	Hydrogen Sulfide	1	0	0	0
7439921	Lead (inorganic)	1	0	0	0
71556	Methyl Chlorofor	1	0	0	0
1634044	Metyl Tertiary B	1	0	0	0
7439965	Manganese	1	0	0	0
7439976	Mercury	1	0	0	0
67561	Methanol	1	0	0	0
78933	Methyl Ethyl Ket	1	0	0	0
75092	Methylene Chlori	1	0	0	0
91203	Naphthalene	1	0	0.3900000	0
7440020	Nickel	1	0	0	0
1151	PAHs	1	0	0	0
127184	Perchloroethylen	1	0	0	0
107982	Propylene glycol	1	0	0	0
7782492	Selenium	1	0	0	0
100425	Styrene	1	0	0	0
7664939	Sulfuric Acid	1	0	0	0
108883	Toluene	1	0	0	0
79016	Trichloroethylen	1	0	0	0
75014	Vinyl Chloride	1	0	0	0
1330207	Xylene	1	0	0	0
108383	M-Xylene	1	0	0	0
95476	O-Xylene	1	0	0	0

EMISSIONS FOR FACILITY FAC=9999 DEV= PRO= STK=12 NAME=SRCGP12
SOURCE MULTIPLIER=1

CAS	ABBREV	MULTIPLIER	BG (ug/m^3)	AVRG (lbs/yr)	MAX (lbs/hr)
106990	1,3-Butadiene	1	0	0	0
75070	Acetaldehyde	1	0	0	0
107028	Acrolein	1	0	0	0
7664417	Ammonia	1	0	0	0
7440382	Arsenic	1	0	0	0
1332214	Asbestos	1	0	0	0
71432	Benzene	1	0	0	0
7440417	Berylium	1	0	0	0
7440439	Cadmium	1	0	0	0
56235	Carbon Tetrachlo	1	0	0	0
7782505	Chlorine	1	0	0	0
18540299	Chromium (VI)	1	0	0	0
218019	Chrysene	1	0	0	0
7440508	Copper	1	0	0	0
9901	DPM	1	0	0	0
100414	Ethyl Benzene	1	0	10.2900000	0
111762	Ethylene glycol	1	0	0	0
109864	Ethylene glycol	1	0	0.08000000	0
106934	Ethylene Dibromi	1	0	0	0

107062	Ethylene Dichlor	1	0	0	0
50000	Formaldehyde	1	0	0	0
110543	Hexane	1	0	0	0
7647010	Hydrochloric Aci	1	0	0	0
7783064	Hydrogen Sulfide	1	0	0	0
7439921	Lead (inorganic)	1	0	0	0
71556	Methyl Chlorofor	1	0	0	0
1634044	Metyl Tertiary B	1	0	0	0
7439965	Manganese	1	0	0	0
7439976	Mercury	1	0	0	0
67561	Methanol	1	0	0	0
78933	Methyl Ethyl Ket	1	0	0	0
75092	Methylene Chlori	1	0	0	0
91203	Naphthalene	1	0	0.3900000	0
7440020	Nickel	1	0	0	0
1151	PAHs	1	0	0	0
127184	Perchloroethylen	1	0	0	0
107982	Propylene glycol	1	0	0	0
7782492	Selenium	1	0	0	0
100425	Styrene	1	0	0	0
7664939	Sulfuric Acid	1	0	0	0
108883	Toluene	1	0	0	0
79016	Trichloroethylen	1	0	0	0
75014	Vinyl Chloride	1	0	0	0
1330207	Xylene	1	0	0	0
108383	M-Xylene	1	0	0	0
95476	O-Xylene	1	0	0	0

EMISSIONS FOR FACILITY FAC=9999 DEV= PRO= STK=13 NAME=SRCGP13
SOURCE MULTIPLIER=1

CAS	ABBREV	MULTIPLIER	BG (ug/m^3)	AVRG (lbs/yr)	MAX (lbs/hr)
106990	1,3-Butadiene	1	0	0	0
75070	Acetaldehyde	1	0	0	0
107028	Acrolein	1	0	0	0
7664417	Ammonia	1	0	0	0
7440382	Arsenic	1	0	0	0
1332214	Asbestos	1	0	0	0
71432	Benzene	1	0	0	0
7440417	Berylium	1	0	0	0
7440439	Cadmium	1	0	0	0
56235	Carbon Tetrachlo	1	0	0	0
7782505	Chlorine	1	0	0	0
18540299	Chromium (VI)	1	0	0	0
218019	Chrysene	1	0	0	0
7440508	Copper	1	0	0	0
9901	DPM	1	0	0	0
100414	Ethyl Benzene	1	0	10.2900000	0
111762	Ethylene glycol	1	0	0	0
109864	Ethylene glycol	1	0	0.08000000	0
106934	Ethylene Dibromi	1	0	0	0
107062	Ethylene Dichlor	1	0	0	0
50000	Formaldehyde	1	0	0	0
110543	Hexane	1	0	0	0
7647010	Hydrochloric Aci	1	0	0	0
7783064	Hydrogen Sulfide	1	0	0	0
7439921	Lead (inorganic)	1	0	0	0
71556	Methyl Chlorofor	1	0	0	0
1634044	Metyl Tertiary B	1	0	0	0
7439965	Manganese	1	0	0	0
7439976	Mercury	1	0	0	0
67561	Methanol	1	0	0	0
78933	Methyl Ethyl Ket	1	0	0	0

75092	Methylene Chlori	1	0	0	0
91203	Naphthalene	1	0	0.3900000	0
7440020	Nickel	1	0	0	0
1151	PAHs	1	0	0	0
127184	Perchloroethylen	1	0	0	0
107982	Propylene glycol	1	0	0	0
7782492	Selenium	1	0	0	0
100425	Styrene	1	0	0	0
7664939	Sulfuric Acid	1	0	0	0
108883	Toluene	1	0	0	0
79016	Trichloroethylen	1	0	0	0
75014	Vinyl Chloride	1	0	0	0
1330207	Xylene	1	0	0	0
108383	M-Xylene	1	0	0	0
95476	O-Xylene	1	0	0	0

EMISSIONS FOR FACILITY FAC=9999 DEV= PRO= STK=14 NAME=SRCGP14
SOURCE MULTIPLIER=1

CAS	ABBREV	MULTIPLIER	BG (ug/m^3)	AVRG (lbs/yr)	MAX (lbs/hr)
106990	1,3-Butadiene	1	0	0	0
75070	Acetaldehyde	1	0	0	0
107028	Acrolein	1	0	0	0
7664417	Ammonia	1	0	0	0
7440382	Arsenic	1	0	0	0
1332214	Asbestos	1	0	0	0
71432	Benzene	1	0	0	0
7440417	Berylium	1	0	0	0
7440439	Cadmium	1	0	0	0
56235	Carbon Tetrachlo	1	0	0	0
7782505	Chlorine	1	0	0	0
18540299	Chromium (VI)	1	0	0	0
218019	Chrysene	1	0	0	0
7440508	Copper	1	0	0	0
9901	DPM	1	0	0	0
100414	Ethyl Benzene	1	0	10.2900000	0
111762	Ethylene glycol	1	0	0	0
109864	Ethylene glycol	1	0	0.08000000	0
106934	Ethylene Dibromi	1	0	0	0
107062	Ethylene Dichlor	1	0	0	0
50000	Formaldehyde	1	0	0	0
110543	Hexane	1	0	0	0
7647010	Hydrochloric Aci	1	0	0	0
7783064	Hydrogen Sulfide	1	0	0	0
7439921	Lead (inorganic)	1	0	0	0
71556	Methyl Chlorofor	1	0	0	0
1634044	Metyl Tertiary B	1	0	0	0
7439965	Manganese	1	0	0	0
7439976	Mercury	1	0	0	0
67561	Methanol	1	0	0	0
78933	Methyl Ethyl Ket	1	0	0	0
75092	Methylene Chlori	1	0	0	0
91203	Naphthalene	1	0	0.3900000	0
7440020	Nickel	1	0	0	0
1151	PAHs	1	0	0	0
127184	Perchloroethylen	1	0	0	0
107982	Propylene glycol	1	0	0	0
7782492	Selenium	1	0	0	0
100425	Styrene	1	0	0	0
7664939	Sulfuric Acid	1	0	0	0
108883	Toluene	1	0	0	0
79016	Trichloroethylen	1	0	0	0
75014	Vinyl Chloride	1	0	0	0

1330207	Xylene	1	0	0	0
108383	M-Xylene	1	0	0	0
95476	O-Xylene	1	0	0	0

EMISSIONS FOR FACILITY FAC=9999 DEV= PRO= STK=15 NAME=SRCGP15
SOURCE MULTIPLIER=1

CAS	ABBREV	MULTIPLIER	BG (ug/m^3)	AVRG (lbs/yr)	MAX (lbs/hr)
106990	1,3-Butadiene	1	0	0	0
75070	Acetaldehyde	1	0	0	0
107028	Acrolein	1	0	0	0
7664417	Ammonia	1	0	0	0
7440382	Arsenic	1	0	0	0
1332214	Asbestos	1	0	0	0
71432	Benzene	1	0	0	0
7440417	Berylium	1	0	0	0
7440439	Cadmium	1	0	0	0
56235	Carbon Tetrachlo	1	0	0	0
7782505	Chlorine	1	0	0	0
18540299	Chromium (VI)	1	0	0	0
218019	Chrysene	1	0	0	0
7440508	Copper	1	0	0	0
9901	DPM	1	0	0	0
100414	Ethyl Benzene	1	0	10.2900000	0
111762	Ethylene glycol	1	0	0	0
109864	Ethylene glycol	1	0	0.08000000	0
106934	Ethylene Dibromi	1	0	0	0
107062	Ethylene Dichlor	1	0	0	0
50000	Formaldehyde	1	0	0	0
110543	Hexane	1	0	0	0
7647010	Hydrochloric Aci	1	0	0	0
7783064	Hydrogen Sulfide	1	0	0	0
7439921	Lead (inorganic)	1	0	0	0
71556	Methyl Chlorofor	1	0	0	0
1634044	Metyl Tertiary B	1	0	0	0
7439965	Manganese	1	0	0	0
7439976	Mercury	1	0	0	0
67561	Methanol	1	0	0	0
78933	Methyl Ethyl Ket	1	0	0	0
75092	Methylene Chlori	1	0	0	0
91203	Naphthalene	1	0	0.3900000	0
7440020	Nickel	1	0	0	0
1151	PAHs	1	0	0	0
127184	Perchloroethylen	1	0	0	0
107982	Propylene glycol	1	0	0	0
7782492	Selenium	1	0	0	0
100425	Styrene	1	0	0	0
7664939	Sulfuric Acid	1	0	0	0
108883	Toluene	1	0	0	0
79016	Trichloroethylen	1	0	0	0
75014	Vinyl Chloride	1	0	0	0
1330207	Xylene	1	0	0	0
108383	M-Xylene	1	0	0	0
95476	O-Xylene	1	0	0	0

EMISSIONS FOR FACILITY FAC=9999 DEV= PRO= STK=16 NAME=SRCGP16
SOURCE MULTIPLIER=1

CAS	ABBREV	MULTIPLIER	BG (ug/m^3)	AVRG (lbs/yr)	MAX (lbs/hr)
106990	1,3-Butadiene	1	0	0	0
75070	Acetaldehyde	1	0	0	0
107028	Acrolein	1	0	0	0
7664417	Ammonia	1	0	0	0
7440382	Arsenic	1	0	0	0

1332214	Asbestos	1	0	0	0
71432	Benzene	1	0	0	0
7440417	Berylium	1	0	0	0
7440439	Cadmium	1	0	0	0
56235	Carbon Tetrachlo	1	0	0	0
7782505	Chlorine	1	0	0	0
18540299	Chromium (VI)	1	0	0	0
218019	Chrysene	1	0	0	0
7440508	Copper	1	0	0	0
9901	DPM	1	0	0	0
100414	Ethyl Benzene	1	0	10.2900000	0
111762	Ethylene glycol	1	0	0	0
109864	Ethylene glycol	1	0	0.08000000	0
106934	Ethylene Dibromi	1	0	0	0
107062	Ethylene Dichlor	1	0	0	0
50000	Formaldehyde	1	0	0	0
110543	Hexane	1	0	0	0
7647010	Hydrochloric Aci	1	0	0	0
7783064	Hydrogen Sulfide	1	0	0	0
7439921	Lead (inorganic)	1	0	0	0
71556	Methyl Chlorofor	1	0	0	0
1634044	Metyl Tertiary B	1	0	0	0
7439965	Manganese	1	0	0	0
7439976	Mercury	1	0	0	0
67561	Methanol	1	0	0	0
78933	Methyl Ethyl Ket	1	0	0	0
75092	Methylene Chlori	1	0	0	0
91203	Naphthalene	1	0	0.3900000	0
7440020	Nickel	1	0	0	0
1151	PAHs	1	0	0	0
127184	Perchloroethylen	1	0	0	0
107982	Propylene glycol	1	0	0	0
7782492	Selenium	1	0	0	0
100425	Styrene	1	0	0	0
7664939	Sulfuric Acid	1	0	0	0
108883	Toluene	1	0	0	0
79016	Trichloroethylen	1	0	0	0
75014	Vinyl Chloride	1	0	0	0
1330207	Xylene	1	0	0	0
108383	M-Xylene	1	0	0	0
95476	O-Xylene	1	0	0	0

EMISSIONS FOR FACILITY FAC=9999 DEV= PRO= STK=17 NAME=SRCGP17
SOURCE MULTIPLIER=1

CAS	ABBREV	MULTIPLIER	BG (ug/m^3)	AVRG (lbs/yr)	MAX (lbs/hr)
106990	1,3-Butadiene	1	0	0	0
75070	Acetaldehyde	1	0	0	0
107028	Acrolein	1	0	0	0
7664417	Ammonia	1	0	0	0
7440382	Arsenic	1	0	0	0
1332214	Asbestos	1	0	0	0
71432	Benzene	1	0	0	0
7440417	Berylium	1	0	0	0
7440439	Cadmium	1	0	0	0
56235	Carbon Tetrachlo	1	0	0	0
7782505	Chlorine	1	0	0	0
18540299	Chromium (VI)	1	0	0	0
218019	Chrysene	1	0	0	0
7440508	Copper	1	0	0	0
9901	DPM	1	0	0	0
100414	Ethyl Benzene	1	0	10.2900000	0
111762	Ethylene glycol	1	0	0	0

109864	Ethylene glycol	1	0	0.08000000	0
106934	Ethylene Dibromi	1	0	0	0
107062	Ethylene Dichlor	1	0	0	0
50000	Formaldehyde	1	0	0	0
110543	Hexane	1	0	0	0
7647010	Hydrochloric Aci	1	0	0	0
7783064	Hydrogen Sulfide	1	0	0	0
7439921	Lead (inorganic)	1	0	0	0
71556	Methyl Chlorofor	1	0	0	0
1634044	Metyl Tertiary B	1	0	0	0
7439965	Manganese	1	0	0	0
7439976	Mercury	1	0	0	0
67561	Methanol	1	0	0	0
78933	Methyl Ethyl Ket	1	0	0	0
75092	Methylene Chlori	1	0	0	0
91203	Naphthalene	1	0	0.3900000	0
7440020	Nickel	1	0	0	0
1151	PAHs	1	0	0	0
127184	Perchloroethylen	1	0	0	0
107982	Propylene glycol	1	0	0	0
7782492	Selenium	1	0	0	0
100425	Styrene	1	0	0	0
7664939	Sulfuric Acid	1	0	0	0
108883	Toluene	1	0	0	0
79016	Trichloroethylen	1	0	0	0
75014	Vinyl Chloride	1	0	0	0
1330207	Xylene	1	0	0	0
108383	M-Xylene	1	0	0	0
95476	O-Xylene	1	0	0	0

EMISSIONS FOR FACILITY FAC=9999 DEV= PRO= STK=18 NAME=SRCGP18
SOURCE MULTIPLIER=1

CAS	ABBREV	MULTIPLIER	BG (ug/m^3)	AVRG (lbs/yr)	MAX (lbs/hr)
106990	1,3-Butadiene	1	0	0	0
75070	Acetaldehyde	1	0	0	0
107028	Acrolein	1	0	0	0
7664417	Ammonia	1	0	0	0
7440382	Arsenic	1	0	0	0
1332214	Asbestos	1	0	0	0
71432	Benzene	1	0	0	0
7440417	Berylium	1	0	0	0
7440439	Cadmium	1	0	0	0
56235	Carbon Tetrachlo	1	0	0	0
7782505	Chlorine	1	0	0	0
18540299	Chromium (VI)	1	0	0	0
218019	Chrysene	1	0	0	0
7440508	Copper	1	0	0	0
9901	DPM	1	0	0	0
100414	Ethyl Benzene	1	0	10.2900000	0
111762	Ethylene glycol	1	0	0	0
109864	Ethylene glycol	1	0	0.08000000	0
106934	Ethylene Dibromi	1	0	0	0
107062	Ethylene Dichlor	1	0	0	0
50000	Formaldehyde	1	0	0	0
110543	Hexane	1	0	0	0
7647010	Hydrochloric Aci	1	0	0	0
7783064	Hydrogen Sulfide	1	0	0	0
7439921	Lead (inorganic)	1	0	0	0
71556	Methyl Chlorofor	1	0	0	0
1634044	Metyl Tertiary B	1	0	0	0
7439965	Manganese	1	0	0	0
7439976	Mercury	1	0	0	0

67561	Methanol	1	0	0	0
78933	Methyl Ethyl Ket	1	0	0	0
75092	Methylene Chlori	1	0	0	0
91203	Naphthalene	1	0	0.3900000	0
7440020	Nickel	1	0	0	0
1151	PAHs	1	0	0	0
127184	Perchloroethylen	1	0	0	0
107982	Propylene glycol	1	0	0	0
7782492	Selenium	1	0	0	0
100425	Styrene	1	0	0	0
7664939	Sulfuric Acid	1	0	0	0
108883	Toluene	1	0	0	0
79016	Trichloroethylen	1	0	0	0
75014	Vinyl Chloride	1	0	0	0
1330207	Xylene	1	0	0	0
108383	M-Xylene	1	0	0	0
95476	O-Xylene	1	0	0	0

EMISSIONS FOR FACILITY FAC=9999 DEV= PRO= STK=19 NAME=SRCGP19
SOURCE MULTIPLIER=1

CAS	ABBREV	MULTIPLIER	BG (ug/m^3)	AVRG (lbs/yr)	MAX (lbs/hr)
106990	1,3-Butadiene	1	0	0	0
75070	Acetaldehyde	1	0	0	0
107028	Acrolein	1	0	0	0
7664417	Ammonia	1	0	0	0
7440382	Arsenic	1	0	0	0
1332214	Asbestos	1	0	0	0
71432	Benzene	1	0	0	0
7440417	Berylium	1	0	0	0
7440439	Cadmium	1	0	0	0
56235	Carbon Tetrachlo	1	0	0	0
7782505	Chlorine	1	0	0	0
18540299	Chromium (VI)	1	0	0	0
218019	Chrysene	1	0	0	0
7440508	Copper	1	0	0	0
9901	DPM	1	0	0	0
100414	Ethyl Benzene	1	0	10.2900000	0
111762	Ethylene glycol	1	0	0	0
109864	Ethylene glycol	1	0	0.08000000	0
106934	Ethylene Dibromi	1	0	0	0
107062	Ethylene Dichlor	1	0	0	0
50000	Formaldehyde	1	0	0	0
110543	Hexane	1	0	0	0
7647010	Hydrochloric Aci	1	0	0	0
7783064	Hydrogen Sulfide	1	0	0	0
7439921	Lead (inorganic)	1	0	0	0
71556	Methyl Chlorofor	1	0	0	0
1634044	Metyl Tertiary B	1	0	0	0
7439965	Manganese	1	0	0	0
7439976	Mercury	1	0	0	0
67561	Methanol	1	0	0	0
78933	Methyl Ethyl Ket	1	0	0	0
75092	Methylene Chlori	1	0	0	0
91203	Naphthalene	1	0	0.3900000	0
7440020	Nickel	1	0	0	0
1151	PAHs	1	0	0	0
127184	Perchloroethylen	1	0	0	0
107982	Propylene glycol	1	0	0	0
7782492	Selenium	1	0	0	0
100425	Styrene	1	0	0	0
7664939	Sulfuric Acid	1	0	0	0
108883	Toluene	1	0	0	0

79016	Trichloroethylen	1	0	0	0
75014	Vinyl Chloride	1	0	0	0
1330207	Xylene	1	0	0	0
108383	M-Xylene	1	0	0	0
95476	O-Xylene	1	0	0	0

EMISSIONS FOR FACILITY FAC=9999 DEV= PRO= STK=20 NAME=SRCGP20
SOURCE MULTIPLIER=1

CAS	ABBREV	MULTIPLIER	BG (ug/m^3)	AVRG (lbs/yr)	MAX (lbs/hr)
106990	1,3-Butadiene	1	0	0	0
75070	Acetaldehyde	1	0	0	0
107028	Acrolein	1	0	0	0
7664417	Ammonia	1	0	0	0
7440382	Arsenic	1	0	0	0
1332214	Asbestos	1	0	0	0
71432	Benzene	1	0	0	0
7440417	Berylium	1	0	0	0
7440439	Cadmium	1	0	0	0
56235	Carbon Tetrachlo	1	0	0	0
7782505	Chlorine	1	0	0	0
18540299	Chromium (VI)	1	0	0	0
218019	Chrysene	1	0	0	0
7440508	Copper	1	0	0	0
9901	DPM	1	0	0	0
100414	Ethyl Benzene	1	0	10.2900000	0
111762	Ethylene glycol	1	0	0	0
109864	Ethylene glycol	1	0	0.08000000	0
106934	Ethylene Dibromi	1	0	0	0
107062	Ethylene Dichlor	1	0	0	0
50000	Formaldehyde	1	0	0	0
110543	Hexane	1	0	0	0
7647010	Hydrochloric Aci	1	0	0	0
7783064	Hydrogen Sulfide	1	0	0	0
7439921	Lead (inorganic)	1	0	0	0
71556	Methyl Chlorofor	1	0	0	0
1634044	Metyl Tertiary B	1	0	0	0
7439965	Manganese	1	0	0	0
7439976	Mercury	1	0	0	0
67561	Methanol	1	0	0	0
78933	Methyl Ethyl Ket	1	0	0	0
75092	Methylene Chlori	1	0	0	0
91203	Naphthalene	1	0	0.3900000	0
7440020	Nickel	1	0	0	0
1151	PAHs	1	0	0	0
127184	Perchloroethylen	1	0	0	0
107982	Propylene glycol	1	0	0	0
7782492	Selenium	1	0	0	0
100425	Styrene	1	0	0	0
7664939	Sulfuric Acid	1	0	0	0
108883	Toluene	1	0	0	0
79016	Trichloroethylen	1	0	0	0
75014	Vinyl Chloride	1	0	0	0
1330207	Xylene	1	0	0	0
108383	M-Xylene	1	0	0	0
95476	O-Xylene	1	0	0	0

EMISSIONS FOR FACILITY FAC=9999 DEV= PRO= STK=21 NAME=SRCGP21
SOURCE MULTIPLIER=1

CAS	ABBREV	MULTIPLIER	BG (ug/m^3)	AVRG (lbs/yr)	MAX (lbs/hr)
106990	1,3-Butadiene	1	0	0	0
75070	Acetaldehyde	1	0	0	0
107028	Acrolein	1	0	0	0

7664417	Ammonia	1	0	0	0
7440382	Arsenic	1	0	0	0
1332214	Asbestos	1	0	0	0
71432	Benzene	1	0	0	0
7440417	Berylium	1	0	0	0
7440439	Cadmium	1	0	0	0
56235	Carbon Tetrachlo	1	0	0	0
7782505	Chlorine	1	0	0	0
18540299	Chromium (VI)	1	0	0	0
218019	Chrysene	1	0	0	0
7440508	Copper	1	0	0	0
9901	DPM	1	0	0	0
100414	Ethyl Benzene	1	0	10.2900000	0
111762	Ethylene glycol	1	0	0	0
109864	Ethylene glycol	1	0	0.08000000	0
106934	Ethylene Dibromi	1	0	0	0
107062	Ethylene Dichlor	1	0	0	0
50000	Formaldehyde	1	0	0	0
110543	Hexane	1	0	0	0
7647010	Hydrochloric Aci	1	0	0	0
7783064	Hydrogen Sulfide	1	0	0	0
7439921	Lead (inorganic)	1	0	0	0
71556	Methyl Chlorofor	1	0	0	0
1634044	Metyl Tertiary B	1	0	0	0
7439965	Manganese	1	0	0	0
7439976	Mercury	1	0	0	0
67561	Methanol	1	0	0	0
78933	Methyl Ethyl Ket	1	0	0	0
75092	Methylene Chlori	1	0	0	0
91203	Naphthalene	1	0	0.4000000	0
7440020	Nickel	1	0	0	0
1151	PAHs	1	0	0	0
127184	Perchloroethylen	1	0	0	0
107982	Propylene glycol	1	0	0	0
7782492	Selenium	1	0	0	0
100425	Styrene	1	0	0	0
7664939	Sulfuric Acid	1	0	0	0
108883	Toluene	1	0	0	0
79016	Trichloroethylen	1	0	0	0
75014	Vinyl Chloride	1	0	0	0
1330207	Xylene	1	0	0	0
108383	M-Xylene	1	0	0	0
95476	O-Xylene	1	0	0	0

EMISSIONS FOR FACILITY FAC=9999 DEV= PRO= STK=22 NAME=SRCGP22
SOURCE MULTIPLIER=1

CAS	ABBREV	MULTIPLIER	BG (ug/m^3)	AVRG (lbs/yr)	MAX (lbs/hr)
106990	1,3-Butadiene	1	0	0	0
75070	Acetaldehyde	1	0	0	0
107028	Acrolein	1	0	0	0
7664417	Ammonia	1	0	0	0
7440382	Arsenic	1	0	0	0
1332214	Asbestos	1	0	0	0
71432	Benzene	1	0	0	0
7440417	Berylium	1	0	0	0
7440439	Cadmium	1	0	0	0
56235	Carbon Tetrachlo	1	0	0	0
7782505	Chlorine	1	0	0	0
18540299	Chromium (VI)	1	0	0	0
218019	Chrysene	1	0	0	0
7440508	Copper	1	0	0	0
9901	DPM	1	0	0	0

100414	Ethyl Benzene	1	0	10.2900000	0
111762	Ethylene glycol	1	0	0	0
109864	Ethylene glycol	1	0	0.08000000	0
106934	Ethylene Dibromi	1	0	0	0
107062	Ethylene Dichlor	1	0	0	0
50000	Formaldehyde	1	0	0	0
110543	Hexane	1	0	0	0
7647010	Hydrochloric Aci	1	0	0	0
7783064	Hydrogen Sulfide	1	0	0	0
7439921	Lead (inorganic)	1	0	0	0
71556	Methyl Chlorofor	1	0	0	0
1634044	Metyl Tertiary B	1	0	0	0
7439965	Manganese	1	0	0	0
7439976	Mercury	1	0	0	0
67561	Methanol	1	0	0	0
78933	Methyl Ethyl Ket	1	0	0	0
75092	Methylene Chlori	1	0	0	0
91203	Naphthalene	1	0	0.4000000	0
7440020	Nickel	1	0	0	0
1151	PAHs	1	0	0	0
127184	Perchloroethylen	1	0	0	0
107982	Propylene glycol	1	0	0	0
7782492	Selenium	1	0	0	0
100425	Styrene	1	0	0	0
7664939	Sulfuric Acid	1	0	0	0
108883	Toluene	1	0	0	0
79016	Trichloroethylen	1	0	0	0
75014	Vinyl Chloride	1	0	0	0
1330207	Xylene	1	0	0	0
108383	M-Xylene	1	0	0	0
95476	O-Xylene	1	0	0	0

EMISSIONS FOR FACILITY FAC=9999 DEV= PRO= STK=23 NAME=SRCGP23
SOURCE MULTIPLIER=1

CAS	ABBREV	MULTIPLIER	BG (ug/m^3)	AVRG (lbs/yr)	MAX (lbs/hr)
106990	1,3-Butadiene	1	0	0	0
75070	Acetaldehyde	1	0	0	0
107028	Acrolein	1	0	0	0
7664417	Ammonia	1	0	0	0
7440382	Arsenic	1	0	0	0
1332214	Asbestos	1	0	0	0
71432	Benzene	1	0	0	0
7440417	Berylium	1	0	0	0
7440439	Cadmium	1	0	0	0
56235	Carbon Tetrachlo	1	0	0	0
7782505	Chlorine	1	0	0	0
18540299	Chromium (VI)	1	0	0	0
218019	Chrysene	1	0	0	0
7440508	Copper	1	0	0	0
9901	DPM	1	0	0	0
100414	Ethyl Benzene	1	0	10.2900000	0
111762	Ethylene glycol	1	0	0	0
109864	Ethylene glycol	1	0	0.08000000	0
106934	Ethylene Dibromi	1	0	0	0
107062	Ethylene Dichlor	1	0	0	0
50000	Formaldehyde	1	0	0	0
110543	Hexane	1	0	0	0
7647010	Hydrochloric Aci	1	0	0	0
7783064	Hydrogen Sulfide	1	0	0	0
7439921	Lead (inorganic)	1	0	0	0
71556	Methyl Chlorofor	1	0	0	0
1634044	Metyl Tertiary B	1	0	0	0

7439965	Manganese	1	0	0	0
7439976	Mercury	1	0	0	0
67561	Methanol	1	0	0	0
78933	Methyl Ethyl Ket	1	0	0	0
75092	Methylene Chlori	1	0	0	0
91203	Naphthalene	1	0	0.4000000	0
7440020	Nickel	1	0	0	0
1151	PAHs	1	0	0	0
127184	Perchloroethylen	1	0	0	0
107982	Propylene glycol	1	0	0	0
7782492	Selenium	1	0	0	0
100425	Styrene	1	0	0	0
7664939	Sulfuric Acid	1	0	0	0
108883	Toluene	1	0	0	0
79016	Trichloroethylen	1	0	0	0
75014	Vinyl Chloride	1	0	0	0
1330207	Xylene	1	0	0	0
108383	M-Xylene	1	0	0	0
95476	O-Xylene	1	0	0	0

EMISSIONS FOR FACILITY FAC=9999 DEV= PRO= STK=24 NAME=SRCGP24
SOURCE MULTIPLIER=1

CAS	ABBREV	MULTIPLIER	BG (ug/m^3)	AVRG (lbs/yr)	MAX (lbs/hr)
106990	1,3-Butadiene	1	0	0	0
75070	Acetaldehyde	1	0	0	0
107028	Acrolein	1	0	0	0
7664417	Ammonia	1	0	0	0
7440382	Arsenic	1	0	0	0
1332214	Asbestos	1	0	0	0
71432	Benzene	1	0	0	0
7440417	Berylium	1	0	0	0
7440439	Cadmium	1	0	0	0
56235	Carbon Tetrachlo	1	0	0	0
7782505	Chlorine	1	0	0	0
18540299	Chromium (VI)	1	0	0	0
218019	Chrysene	1	0	0	0
7440508	Copper	1	0	0	0
9901	DPM	1	0	0	0
100414	Ethyl Benzene	1	0	10.2900000	0
111762	Ethylene glycol	1	0	0	0
109864	Ethylene glycol	1	0	0.08000000	0
106934	Ethylene Dibromi	1	0	0	0
107062	Ethylene Dichlor	1	0	0	0
50000	Formaldehyde	1	0	0	0
110543	Hexane	1	0	0	0
7647010	Hydrochloric Aci	1	0	0	0
7783064	Hydrogen Sulfide	1	0	0	0
7439921	Lead (inorganic)	1	0	0	0
71556	Methyl Chlorofor	1	0	0	0
1634044	Metyl Tertiary B	1	0	0	0
7439965	Manganese	1	0	0	0
7439976	Mercury	1	0	0	0
67561	Methanol	1	0	0	0
78933	Methyl Ethyl Ket	1	0	0	0
75092	Methylene Chlori	1	0	0	0
91203	Naphthalene	1	0	0.4000000	0
7440020	Nickel	1	0	0	0
1151	PAHs	1	0	0	0
127184	Perchloroethylen	1	0	0	0
107982	Propylene glycol	1	0	0	0
7782492	Selenium	1	0	0	0
100425	Styrene	1	0	0	0

7664939	Sulfuric Acid	1	0	0	0
108883	Toluene	1	0	0	0
79016	Trichloroethylen	1	0	0	0
75014	Vinyl Chloride	1	0	0	0
1330207	Xylene	1	0	0	0
108383	M-Xylene	1	0	0	0
95476	O-Xylene	1	0	0	0

EMISSIONS FOR FACILITY FAC=9999 DEV= PRO= STK=25 NAME=SRCGP25
SOURCE MULTIPLIER=1

CAS	ABBREV	MULTIPLIER	BG (ug/m^3)	AVRG (lbs/yr)	MAX (lbs/hr)
106990	1,3-Butadiene	1	0	0	0
75070	Acetaldehyde	1	0	0	0
107028	Acrolein	1	0	0	0
7664417	Ammonia	1	0	0	0
7440382	Arsenic	1	0	0	0
1332214	Asbestos	1	0	0	0
71432	Benzene	1	0	0	0
7440417	Berylium	1	0	0	0
7440439	Cadmium	1	0	0	0
56235	Carbon Tetrachlo	1	0	0	0
7782505	Chlorine	1	0	0	0
18540299	Chromium (VI)	1	0	0	0
218019	Chrysene	1	0	0	0
7440508	Copper	1	0	0	0
9901	DPM	1	0	0	0
100414	Ethyl Benzene	1	0	10.2900000	0
111762	Ethylene glycol	1	0	0	0
109864	Ethylene glycol	1	0	0.08000000	0
106934	Ethylene Dibromi	1	0	0	0
107062	Ethylene Dichlor	1	0	0	0
50000	Formaldehyde	1	0	0	0
110543	Hexane	1	0	0	0
7647010	Hydrochloric Aci	1	0	0	0
7783064	Hydrogen Sulfide	1	0	0	0
7439921	Lead (inorganic)	1	0	0	0
71556	Methyl Chlorofor	1	0	0	0
1634044	Metyl Tertiary B	1	0	0	0
7439965	Manganese	1	0	0	0
7439976	Mercury	1	0	0	0
67561	Methanol	1	0	0	0
78933	Methyl Ethyl Ket	1	0	0	0
75092	Methylene Chlori	1	0	0	0
91203	Naphthalene	1	0	0.4000000	0
7440020	Nickel	1	0	0	0
1151	PAHs	1	0	0	0
127184	Perchloroethylen	1	0	0	0
107982	Propylene glycol	1	0	0	0
7782492	Selenium	1	0	0	0
100425	Styrene	1	0	0	0
7664939	Sulfuric Acid	1	0	0	0
108883	Toluene	1	0	0	0
79016	Trichloroethylen	1	0	0	0
75014	Vinyl Chloride	1	0	0	0
1330207	Xylene	1	0	0	0
108383	M-Xylene	1	0	0	0
95476	O-Xylene	1	0	0	0

EMISSIONS FOR FACILITY FAC=9999 DEV= PRO= STK=26 NAME=SRCGP26
SOURCE MULTIPLIER=1

CAS	ABBREV	MULTIPLIER	BG (ug/m^3)	AVRG (lbs/yr)	MAX (lbs/hr)
106990	1,3-Butadiene	1	0	0	0

75070	Acetaldehyde	1	0	0	0
107028	Acrolein	1	0	0	0
7664417	Ammonia	1	0	0	0
7440382	Arsenic	1	0	0	0
1332214	Asbestos	1	0	0	0
71432	Benzene	1	0	0	0
7440417	Berylium	1	0	0	0
7440439	Cadmium	1	0	0	0
56235	Carbon Tetrachlo	1	0	0	0
7782505	Chlorine	1	0	0	0
18540299	Chromium (VI)	1	0	0	0
218019	Chrysene	1	0	0	0
7440508	Copper	1	0	0	0
9901	DPM	1	0	0	0
100414	Ethyl Benzene	1	0	10.2900000	0
111762	Ethylene glycol	1	0	0	0
109864	Ethylene glycol	1	0	0.08000000	0
106934	Ethylene Dibromi	1	0	0	0
107062	Ethylene Dichlor	1	0	0	0
50000	Formaldehyde	1	0	0	0
110543	Hexane	1	0	0	0
7647010	Hydrochloric Aci	1	0	0	0
7783064	Hydrogen Sulfide	1	0	0	0
7439921	Lead (inorganic)	1	0	0	0
71556	Methyl Chlorofor	1	0	0	0
1634044	Metyl Tertiary B	1	0	0	0
7439965	Manganese	1	0	0	0
7439976	Mercury	1	0	0	0
67561	Methanol	1	0	0	0
78933	Methyl Ethyl Ket	1	0	0	0
75092	Methylene Chlori	1	0	0	0
91203	Naphthalene	1	0	0.4000000	0
7440020	Nickel	1	0	0	0
1151	PAHs	1	0	0	0
127184	Perchloroethylen	1	0	0	0
107982	Propylene glycol	1	0	0	0
7782492	Selenium	1	0	0	0
100425	Styrene	1	0	0	0
7664939	Sulfuric Acid	1	0	0	0
108883	Toluene	1	0	0	0
79016	Trichloroethylen	1	0	0	0
75014	Vinyl Chloride	1	0	0	0
1330207	Xylene	1	0	0	0
108383	M-Xylene	1	0	0	0
95476	O-Xylene	1	0	0	0

EMISSIONS FOR FACILITY FAC=9999 DEV= PRO= STK=27 NAME=SRCGP27
SOURCE MULTIPLIER=1

CAS	ABBREV	MULTIPLIER	BG (ug/m^3)	AVRG (lbs/yr)	MAX (lbs/hr)
106990	1,3-Butadiene	1	0	0	0
75070	Acetaldehyde	1	0	0	0
107028	Acrolein	1	0	0	0
7664417	Ammonia	1	0	0	0
7440382	Arsenic	1	0	0	0
1332214	Asbestos	1	0	0	0
71432	Benzene	1	0	0	0
7440417	Berylium	1	0	0	0
7440439	Cadmium	1	0	0	0
56235	Carbon Tetrachlo	1	0	0	0
7782505	Chlorine	1	0	0	0
18540299	Chromium (VI)	1	0	0	0
218019	Chrysene	1	0	0	0

7440508	Copper	1	0	0	0
9901	DPM	1	0	0	0
100414	Ethyl Benzene	1	0	0	0
111762	Ethylene glycol	1	0	0	0
109864	Ethylene glycol	1	0	0	0
106934	Ethylene Dibromi	1	0	0	0
107062	Ethylene Dichlor	1	0	0	0
50000	Formaldehyde	1	0	0	0
110543	Hexane	1	0	0	0
7647010	Hydrochloric Aci	1	0	0	0
7783064	Hydrogen Sulfide	1	0	0	0
7439921	Lead (inorganic)	1	0	0	0
71556	Methyl Chlorofor	1	0	0	0
1634044	Metyl Tertiary B	1	0	0	0
7439965	Manganese	1	0	0	0
7439976	Mercury	1	0	0	0
67561	Methanol	1	0	0	0
78933	Methyl Ethyl Ket	1	0	0	0
75092	Methylene Chlori	1	0	0	0
91203	Naphthalene	1	0	3.1400000	0
7440020	Nickel	1	0	0	0
1151	PAHs	1	0	0	0
127184	Perchloroethylen	1	0	0	0
107982	Propylene glycol	1	0	0	0
7782492	Selenium	1	0	0	0
100425	Styrene	1	0	0	0
7664939	Sulfuric Acid	1	0	0	0
108883	Toluene	1	0	0	0
79016	Trichloroethylen	1	0	0	0
75014	Vinyl Chloride	1	0	0	0
1330207	Xylene	1	0	120.1200000	0.01000000
108383	M-Xylene	1	0	0	0
95476	O-Xylene	1	0	0	0

EMISSIONS FOR FACILITY FAC=9999 DEV= PRO= STK=28 NAME=SRCGP28
SOURCE MULTIPLIER=1

CAS	ABBREV	MULTIPLIER	BG (ug/m^3)	AVRG (lbs/yr)	MAX (lbs/hr)
106990	1,3-Butadiene	1	0	0	0
75070	Acetaldehyde	1	0	0	0
107028	Acrolein	1	0	0	0
7664417	Ammonia	1	0	0	0
7440382	Arsenic	1	0	0	0
1332214	Asbestos	1	0	0	0
71432	Benzene	1	0	0	0
7440417	Berylium	1	0	0	0
7440439	Cadmium	1	0	0	0
56235	Carbon Tetrachlo	1	0	0	0
7782505	Chlorine	1	0	0	0
18540299	Chromium (VI)	1	0	0	0
218019	Chrysene	1	0	0	0
7440508	Copper	1	0	0	0
9901	DPM	1	0	0	0
100414	Ethyl Benzene	1	0	0	0
111762	Ethylene glycol	1	0	0	0
109864	Ethylene glycol	1	0	0	0
106934	Ethylene Dibromi	1	0	0	0
107062	Ethylene Dichlor	1	0	0	0
50000	Formaldehyde	1	0	0	0
110543	Hexane	1	0	0	0
7647010	Hydrochloric Aci	1	0	0	0
7783064	Hydrogen Sulfide	1	0	0	0
7439921	Lead (inorganic)	1	0	0	0

71556	Methyl Chlorofor	1	0	0	0
1634044	Metyl Tertiary B	1	0	0	0
7439965	Manganese	1	0	0	0
7439976	Mercury	1	0	0	0
67561	Methanol	1	0	0	0
78933	Methyl Ethyl Ket	1	0	0	0
75092	Methylene Chlori	1	0	0	0
91203	Naphthalene	1	0	3.1400000	0
7440020	Nickel	1	0	0	0
1151	PAHs	1	0	0	0
127184	Perchloroethylen	1	0	0	0
107982	Propylene glycol	1	0	0	0
7782492	Selenium	1	0	0	0
100425	Styrene	1	0	0	0
7664939	Sulfuric Acid	1	0	0	0
108883	Toluene	1	0	0	0
79016	Trichloroethylen	1	0	0	0
75014	Vinyl Chloride	1	0	0	0
1330207	Xylene	1	0	120.1200000	0.01000000
108383	M-Xylene	1	0	0	0
95476	O-Xylene	1	0	0	0

EMISSIONS FOR FACILITY FAC=9999 DEV= PRO= STK=29 NAME=SRCGP29
SOURCE MULTIPLIER=1

CAS	ABBREV	MULTIPLIER	BG (ug/m^3)	AVRG (lbs/yr)	MAX (lbs/hr)
106990	1,3-Butadiene	1	0	0	0
75070	Acetaldehyde	1	0	0	0
107028	Acrolein	1	0	0	0
7664417	Ammonia	1	0	0	0
7440382	Arsenic	1	0	0	0
1332214	Asbestos	1	0	0	0
71432	Benzene	1	0	0	0
7440417	Berylium	1	0	0	0
7440439	Cadmium	1	0	0	0
56235	Carbon Tetrachlo	1	0	0	0
7782505	Chlorine	1	0	0	0
18540299	Chromium (VI)	1	0	0	0
218019	Chrysene	1	0	0	0
7440508	Copper	1	0	0	0
9901	DPM	1	0	0	0
100414	Ethyl Benzene	1	0	0	0
111762	Ethylene glycol	1	0	0	0
109864	Ethylene glycol	1	0	0	0
106934	Ethylene Dibromi	1	0	0	0
107062	Ethylene Dichlor	1	0	0	0
50000	Formaldehyde	1	0	0	0
110543	Hexane	1	0	0	0
7647010	Hydrochloric Aci	1	0	0	0
7783064	Hydrogen Sulfide	1	0	0	0
7439921	Lead (inorganic)	1	0	0	0
71556	Methyl Chlorofor	1	0	0	0
1634044	Metyl Tertiary B	1	0	0	0
7439965	Manganese	1	0	0	0
7439976	Mercury	1	0	0	0
67561	Methanol	1	0	0	0
78933	Methyl Ethyl Ket	1	0	0	0
75092	Methylene Chlori	1	0	0	0
91203	Naphthalene	1	0	3.1400000	0
7440020	Nickel	1	0	0	0
1151	PAHs	1	0	0	0
127184	Perchloroethylen	1	0	0	0
107982	Propylene glycol	1	0	0	0

7782492	Selenium	1	0	0	0
100425	Styrene	1	0	0	0
7664939	Sulfuric Acid	1	0	0	0
108883	Toluene	1	0	0	0
79016	Trichloroethylen	1	0	0	0
75014	Vinyl Chloride	1	0	0	0
1330207	Xylene	1	0	120.1200000	0.01000000
108383	M-Xylene	1	0	0	0
95476	O-Xylene	1	0	0	0

EMISSIONS FOR FACILITY FAC=9999 DEV= PRO= STK=30 NAME=SRCGP30
SOURCE MULTIPLIER=1

CAS	ABBREV	MULTIPLIER	BG (ug/m^3)	AVRG (lbs/yr)	MAX (lbs/hr)
106990	1,3-Butadiene	1	0	0	0
75070	Acetaldehyde	1	0	2926.4240000	0.3340667
107028	Acrolein	1	0	732.6700000	0.08363813
7664417	Ammonia	1	0	192607.4520000	21.9871521
7440382	Arsenic	1	0	0	0
1332214	Asbestos	1	0	0.8290000	0.00009463470
71432	Benzene	1	0	853.9590000	0.09748390
7440417	Berylium	1	0	2.4400000	0.0002785388
7440439	Cadmium	1	0	0	0
56235	Carbon Tetrachlo	1	0	0.2280000	0.00002602740
7782505	Chlorine	1	0	4.9090000	0.0005603881
18540299	Chromium (VI)	1	0	0	0
218019	Chrysene	1	0	0	0
7440508	Copper	1	0	0	0
9901	DPM	1	0	0	0
100414	Ethyl Benzene	1	0	1530.7840000	0.1747470
111762	Ethylene glycol	1	0	21.6780000	0.002474658
109864	Ethylene glycol	1	0	8.6100000	0.0009828767
106934	Ethylene Dibromi	1	0	0.2730000	0.00003116438
107062	Ethylene Dichlor	1	0	0.1440000	0.00001643836
50000	Formaldehyde	1	0	0	0
110543	Hexane	1	0	5730.6240000	0.6541808
7647010	Hydrochloric Aci	1	0	11.5130000	0.001314269
7783064	Hydrogen Sulfide	1	0	2298.9990000	0.2624428
7439921	Lead (inorganic)	1	0	0	0
71556	Methyl Chlorofor	1	0	0.8320000	0.00009497717
1634044	Metyl Tertiary B	1	0	1.2380000	0.0001413242
7439965	Manganese	1	0	0	0
7439976	Mercury	1	0	0	0
67561	Methanol	1	0	28520.0980000	3.2557189
78933	Methyl Ethyl Ket	1	0	862.2050000	0.09842523
75092	Methylene Chlori	1	0	0.5290000	0.00006038813
91203	Naphthalene	1	0	0	0
7440020	Nickel	1	0	0	0
1151	PAHs	1	0	0	0
127184	Perchloroethylen	1	0	276.6040000	0.03157580
107982	Propylene glycol	1	0	100.8300000	0.01151027
7782492	Selenium	1	0	0	0
100425	Styrene	1	0	17.7370000	0.002024772
7664939	Sulfuric Acid	1	0	37422.9340000	4.2720244
108883	Toluene	1	0	5705.2980000	0.6512897
79016	Trichloroethylen	1	0	2537.9800000	0.2897237
75014	Vinyl Chloride	1	0	0.09200000	0.00001050228
1330207	Xylene	1	0	7203.8050000	0.8223522
108383	M-Xylene	1	0	2.3310000	0.0002660959
95476	O-Xylene	1	0	0.8090000	0.00009235160

EMISSIONS FOR FACILITY FAC=9999 DEV= PRO= STK=31 NAME=SRCGP31
SOURCE MULTIPLIER=1

CAS	ABBREV	MULTIPLIER	BG (ug/m^3)	AVRG (lbs/yr)	MAX (lbs/hr)
106990	1,3-Butadiene	1	0	0	0
75070	Acetaldehyde	1	0	0	0
107028	Acrolein	1	0	0	0
7664417	Ammonia	1	0	0	0
7440382	Arsenic	1	0	0	0
1332214	Asbestos	1	0	0	0
71432	Benzene	1	0	0	0
7440417	Berylium	1	0	0	0
7440439	Cadmium	1	0	0	0
56235	Carbon Tetrachlo	1	0	0	0
7782505	Chlorine	1	0	0	0
18540299	Chromium (VI)	1	0	0	0
218019	Chrysene	1	0	0	0
7440508	Copper	1	0	0	0
9901	DPM	1	0	6.1494042	0.007764399
100414	Ethyl Benzene	1	0	0	0
111762	Ethylene glycol	1	0	0	0
109864	Ethylene glycol	1	0	0	0
106934	Ethylene Dibromi	1	0	0	0
107062	Ethylene Dichlor	1	0	0	0
50000	Formaldehyde	1	0	0	0
110543	Hexane	1	0	0	0
7647010	Hydrochloric Aci	1	0	0	0
7783064	Hydrogen Sulfide	1	0	0	0
7439921	Lead (inorganic)	1	0	0	0
71556	Methyl Chlorofor	1	0	0	0
1634044	Metyl Tertiary B	1	0	0	0
7439965	Manganese	1	0	0	0
7439976	Mercury	1	0	0	0
67561	Methanol	1	0	0	0
78933	Methyl Ethyl Ket	1	0	0	0
75092	Methylene Chlori	1	0	0	0
91203	Naphthalene	1	0	0	0
7440020	Nickel	1	0	0	0
1151	PAHs	1	0	0	0
127184	Perchloroethylen	1	0	0	0
107982	Propylene glycol	1	0	0	0
7782492	Selenium	1	0	0	0
100425	Styrene	1	0	0	0
7664939	Sulfuric Acid	1	0	0	0
108883	Toluene	1	0	0	0
79016	Trichloroethylen	1	0	0	0
75014	Vinyl Chloride	1	0	0	0
1330207	Xylene	1	0	0	0
108383	M-Xylene	1	0	0	0
95476	O-Xylene	1	0	0	0

EMISSIONS FOR FACILITY FAC=9999 DEV= PRO= STK=32 NAME=SRCGP32
SOURCE MULTIPLIER=1

CAS	ABBREV	MULTIPLIER	BG (ug/m^3)	AVRG (lbs/yr)	MAX (lbs/hr)
106990	1,3-Butadiene	1	0	2262.8820000	0.2583199
75070	Acetaldehyde	1	0	0	0
107028	Acrolein	1	0	0	0
7664417	Ammonia	1	0	0	0
7440382	Arsenic	1	0	8.3520000	0.0009534247
1332214	Asbestos	1	0	0	0
71432	Benzene	1	0	0	0
7440417	Berylium	1	0	0	0
7440439	Cadmium	1	0	11.0820000	0.001265068
56235	Carbon Tetrachlo	1	0	0	0
7782505	Chlorine	1	0	0	0

18540299	Chromium (VI)	1	0	1.9950000	0.0002277397
218019	Chrysene	1	0	0.04000000	0.00004566210
7440508	Copper	1	0	88.1720000	0.01006530
9901	DPM	1	0	0	0
100414	Ethyl Benzene	1	0	0	0
111762	Ethylene glycol	1	0	0	0
109864	Ethylene glycol	1	0	0	0
106934	Ethylene Dibromi	1	0	0	0
107062	Ethylene Dichlor	1	0	0	0
50000	Formaldehyde	1	0	2876.3620000	0.3283518
110543	Hexane	1	0	0	0
7647010	Hydrochloric Aci	1	0	0	0
7783064	Hydrogen Sulfide	1	0	0	0
7439921	Lead (inorganic)	1	0	25.3280000	0.002891324
71556	Methyl Chlorofor	1	0	0	0
1634044	Metyl Tertiary B	1	0	0	0
7439965	Manganese	1	0	468.8160000	0.05351781
7439976	Mercury	1	0	3.9570000	0.0004517123
67561	Methanol	1	0	0	0
78933	Methyl Ethyl Ket	1	0	0	0
75092	Methylene Chlori	1	0	0	0
91203	Naphthalene	1	0	552.8360000	0.06310913
7440020	Nickel	1	0	123.0220000	0.01404361
1151	PAHs	1	0	14.5250000	0.001658105
127184	Perchloroethylen	1	0	0	0
107982	Propylene glycol	1	0	0	0
7782492	Selenium	1	0	11.8760000	0.001355708
100425	Styrene	1	0	0	0
7664939	Sulfuric Acid	1	0	0	0
108883	Toluene	1	0	0	0
79016	Trichloroethylen	1	0	0	0
75014	Vinyl Chloride	1	0	0	0
1330207	Xylene	1	0	0	0
108383	M-Xylene	1	0	0	0
95476	O-Xylene	1	0	0	0

EMISSIONS FOR FACILITY FAC=9999 DEV= PRO= STK=33 NAME=SRCGP33
SOURCE MULTIPLIER=1

CAS	ABBREV	MULTIPLIER	BG (ug/m^3)	AVRG (lbs/yr)	MAX (lbs/hr)
106990	1,3-Butadiene	1	0	0	0
75070	Acetaldehyde	1	0	0	0
107028	Acrolein	1	0	0	0
7664417	Ammonia	1	0	0	0
7440382	Arsenic	1	0	0	0
1332214	Asbestos	1	0	0	0
71432	Benzene	1	0	0	0
7440417	Berylium	1	0	0	0
7440439	Cadmium	1	0	0	0
56235	Carbon Tetrachlo	1	0	0	0
7782505	Chlorine	1	0	0	0
18540299	Chromium (VI)	1	0	0	0
218019	Chrysene	1	0	0	0
7440508	Copper	1	0	0	0
9901	DPM	1	0	700.7160000	0.07999041
100414	Ethyl Benzene	1	0	0	0
111762	Ethylene glycol	1	0	0	0
109864	Ethylene glycol	1	0	0	0
106934	Ethylene Dibromi	1	0	0	0
107062	Ethylene Dichlor	1	0	0	0
50000	Formaldehyde	1	0	0	0
110543	Hexane	1	0	0	0
7647010	Hydrochloric Aci	1	0	0	0

7783064	Hydrogen Sulfide	1	0	0	0
7439921	Lead (inorganic)	1	0	0	0
71556	Methyl Chlorofor	1	0	0	0
1634044	Metyl Tertiary B	1	0	0	0
7439965	Manganese	1	0	0	0
7439976	Mercury	1	0	0	0
67561	Methanol	1	0	0	0
78933	Methyl Ethyl Ket	1	0	0	0
75092	Methylene Chlori	1	0	0	0
91203	Naphthalene	1	0	0	0
7440020	Nickel	1	0	0	0
1151	PAHs	1	0	0	0
127184	Perchloroethylen	1	0	0	0
107982	Propylene glycol	1	0	0	0
7782492	Selenium	1	0	0	0
100425	Styrene	1	0	0	0
7664939	Sulfuric Acid	1	0	0	0
108883	Toluene	1	0	0	0
79016	Trichloroethylen	1	0	0	0
75014	Vinyl Chloride	1	0	0	0
1330207	Xylene	1	0	0	0
108383	M-Xylene	1	0	0	0
95476	O-Xylene	1	0	0	0

CANCER RISK REPORT

REC	INHAL	DERM	SOIL	MOTHER	FISH	WATER	VEG	DAIRY	BEEF	CHICK	PIG	EGG	MEAT	ORAL	TOTAL
0001	2.02E-06	0.00E+00	0.00E+00	0.00E+00	0.00E+00	0.00E+00	0.00E+00	0.00E+00	0.00E+00	0.00E+00	0.00E+00	0.00E+00	0.00E+00	0.00E+00	2.02E-06
0002	2.12E-06	0.00E+00	0.00E+00	0.00E+00	0.00E+00	0.00E+00	0.00E+00	0.00E+00	0.00E+00	0.00E+00	0.00E+00	0.00E+00	0.00E+00	0.00E+00	2.12E-06
0003	2.21E-06	0.00E+00	0.00E+00	0.00E+00	0.00E+00	0.00E+00	0.00E+00	0.00E+00	0.00E+00	0.00E+00	0.00E+00	0.00E+00	0.00E+00	0.00E+00	2.21E-06
0004	2.32E-06	0.00E+00	0.00E+00	0.00E+00	0.00E+00	0.00E+00	0.00E+00	0.00E+00	0.00E+00	0.00E+00	0.00E+00	0.00E+00	0.00E+00	0.00E+00	2.32E-06
0005	2.40E-06	0.00E+00	0.00E+00	0.00E+00	0.00E+00	0.00E+00	0.00E+00	0.00E+00	0.00E+00	0.00E+00	0.00E+00	0.00E+00	0.00E+00	0.00E+00	2.40E-06
0006	2.48E-06	0.00E+00	0.00E+00	0.00E+00	0.00E+00	0.00E+00	0.00E+00	0.00E+00	0.00E+00	0.00E+00	0.00E+00	0.00E+00	0.00E+00	0.00E+00	2.48E-06
0007	2.52E-06	0.00E+00	0.00E+00	0.00E+00	0.00E+00	0.00E+00	0.00E+00	0.00E+00	0.00E+00	0.00E+00	0.00E+00	0.00E+00	0.00E+00	0.00E+00	2.52E-06
0008	2.57E-06	0.00E+00	0.00E+00	0.00E+00	0.00E+00	0.00E+00	0.00E+00	0.00E+00	0.00E+00	0.00E+00	0.00E+00	0.00E+00	0.00E+00	0.00E+00	2.57E-06
0009	2.59E-06	0.00E+00	0.00E+00	0.00E+00	0.00E+00	0.00E+00	0.00E+00	0.00E+00	0.00E+00	0.00E+00	0.00E+00	0.00E+00	0.00E+00	0.00E+00	2.59E-06
0010	2.65E-06	0.00E+00	0.00E+00	0.00E+00	0.00E+00	0.00E+00	0.00E+00	0.00E+00	0.00E+00	0.00E+00	0.00E+00	0.00E+00	0.00E+00	0.00E+00	2.65E-06
0011	2.67E-06	0.00E+00	0.00E+00	0.00E+00	0.00E+00	0.00E+00	0.00E+00	0.00E+00	0.00E+00	0.00E+00	0.00E+00	0.00E+00	0.00E+00	0.00E+00	2.67E-06
0012	2.70E-06	0.00E+00	0.00E+00	0.00E+00	0.00E+00	0.00E+00	0.00E+00	0.00E+00	0.00E+00	0.00E+00	0.00E+00	0.00E+00	0.00E+00	0.00E+00	2.70E-06
0013	2.78E-06	0.00E+00	0.00E+00	0.00E+00	0.00E+00	0.00E+00	0.00E+00	0.00E+00	0.00E+00	0.00E+00	0.00E+00	0.00E+00	0.00E+00	0.00E+00	2.78E-06
0014	2.90E-06	0.00E+00	0.00E+00	0.00E+00	0.00E+00	0.00E+00	0.00E+00	0.00E+00	0.00E+00	0.00E+00	0.00E+00	0.00E+00	0.00E+00	0.00E+00	2.90E-06
0015	3.05E-06	0.00E+00	0.00E+00	0.00E+00	0.00E+00	0.00E+00	0.00E+00	0.00E+00	0.00E+00	0.00E+00	0.00E+00	0.00E+00	0.00E+00	0.00E+00	3.05E-06
0016	3.02E-06	0.00E+00	0.00E+00	0.00E+00	0.00E+00	0.00E+00	0.00E+00	0.00E+00	0.00E+00	0.00E+00	0.00E+00	0.00E+00	0.00E+00	0.00E+00	3.02E-06
0017	3.08E-06	0.00E+00	0.00E+00	0.00E+00	0.00E+00	0.00E+00	0.00E+00	0.00E+00	0.00E+00	0.00E+00	0.00E+00	0.00E+00	0.00E+00	0.00E+00	3.08E-06
0018	3.12E-06	0.00E+00	0.00E+00	0.00E+00	0.00E+00	0.00E+00	0.00E+00	0.00E+00	0.00E+00	0.00E+00	0.00E+00	0.00E+00	0.00E+00	0.00E+00	3.12E-06
0019	3.14E-06	0.00E+00	0.00E+00	0.00E+00	0.00E+00	0.00E+00	0.00E+00	0.00E+00	0.00E+00	0.00E+00	0.00E+00	0.00E+00	0.00E+00	0.00E+00	3.14E-06
0020	3.19E-06	0.00E+00	0.00E+00	0.00E+00	0.00E+00	0.00E+00	0.00E+00	0.00E+00	0.00E+00	0.00E+00	0.00E+00	0.00E+00	0.00E+00	0.00E+00	3.19E-06
0021	3.28E-06	0.00E+00	0.00E+00	0.00E+00	0.00E+00	0.00E+00	0.00E+00	0.00E+00	0.00E+00	0.00E+00	0.00E+00	0.00E+00	0.00E+00	0.00E+00	3.28E-06
0022	3.29E-06	0.00E+00	0.00E+00	0.00E+00	0.00E+00	0.00E+00	0.00E+00	0.00E+00	0.00E+00	0.00E+00	0.00E+00	0.00E+00	0.00E+00	0.00E+00	3.29E-06
0023	2.22E-06	0.00E+00	0.00E+00	0.00E+00	0.00E+00	0.00E+00	0.00E+00	0.00E+00	0.00E+00	0.00E+00	0.00E+00	0.00E+00	0.00E+00	0.00E+00	2.22E-06
0024	2.16E-06	0.00E+00	0.00E+00	0.00E+00	0.00E+00	0.00E+00	0.00E+00	0.00E+00	0.00E+00	0.00E+00	0.00E+00	0.00E+00	0.00E+00	0.00E+00	2.16E-06
0025	2.33E-06	0.00E+00	0.00E+00	0.00E+00	0.00E+00	0.00E+00	0.00E+00	0.00E+00	0.00E+00	0.00E+00	0.00E+00	0.00E+00	0.00E+00	0.00E+00	2.33E-06
0026	2.40E-06	0.00E+00	0.00E+00	0.00E+00	0.00E+00	0.00E+00	0.00E+00	0.00E+00	0.00E+00	0.00E+00	0.00E+00	0.00E+00	0.00E+00	0.00E+00	2.40E-06
0027	2.57E-06	0.00E+00	0.00E+00	0.00E+00	0.00E+00	0.00E+00	0.00E+00	0.00E+00	0.00E+00	0.00E+00	0.00E+00	0.00E+00	0.00E+00	0.00E+00	2.57E-06
0028	2.68E-06	0.00E+00	0.00E+00	0.00E+00	0.00E+00	0.00E+00	0.00E+00	0.00E+00	0.00E+00	0.00E+00	0.00E+00	0.00E+00	0.00E+00	0.00E+00	2.68E-06
0029	2.78E-06	0.00E+00	0.00E+00	0.00E+00	0.00E+00	0.00E+00	0.00E+00	0.00E+00	0.00E+00	0.00E+00	0.00E+00	0.00E+00	0.00E+00	0.00E+00	2.78E-06
0030	2.94E-06	0.00E+00	0.00E+00	0.00E+00	0.00E+00	0.00E+00	0.00E+00	0.00E+00	0.00E+00	0.00E+00	0.00E+00	0.00E+00	0.00E+00	0.00E+00	2.94E-06
0031	3.02E-06	0.00E+00	0.00E+00	0.00E+00	0.00E+00	0.00E+00	0.00E+00	0.00E+00	0.00E+00	0.00E+00	0.00E+00	0.00E+00	0.00E+00	0.00E+00	3.02E-06
0032	3.09E-06	0.00E+00	0.00E+00	0.00E+00	0.00E+00	0.00E+00	0.00E+00	0.00E+00	0.00E+00	0.00E+00	0.00E+00	0.00E+00	0.00E+00	0.00E+00	3.09E-06
0033	3.12E-06	0.00E+00	0.00E+00	0.00E+00	0.00E+00	0.00E+00	0.00E+00	0.00E+00	0.00E+00	0.00E+00	0.00E+00	0.00E+00	0.00E+00	0.00E+00	3.12E-06
0034	2.94E-06	0.00E+00	0.00E+00	0.00E+00	0.00E+00	0.00E+00	0.00E+00	0.00E+00	0.00E+00	0.00E+00	0.00E+00	0.00E+00	0.00E+00	0.00E+00	2.94E-06
0035	2.91E-06	0.00E+00	0.00E+00	0.00E+00	0.00E+00	0.00E+00	0.00E+00	0.00E+00	0.00E+00	0.00E+00	0.00E+00	0.00E+00	0.00E+00	0.00E+00	2.91E-06
0036	2.81E-06	0.00E+00	0.00E+00	0.00E+00	0.00E+00	0.00E+00	0.00E+00	0.00E+00	0.00E+00	0.00E+00	0.00E+00	0.00E+00	0.00E+00	0.00E+00	2.81E-06

0037	2.68E-06	0.00E+00	0.00E+00	0.00E+00	0.00E+00	0.00E+00	0.00E+00	0.00E+00	0.00E+00	0.00E+00	0.00E+00	0.00E+00	0.00E+00	0.00E+00	2.68E-06
0038	2.54E-06	0.00E+00	0.00E+00	0.00E+00	0.00E+00	0.00E+00	0.00E+00	0.00E+00	0.00E+00	0.00E+00	0.00E+00	0.00E+00	0.00E+00	0.00E+00	2.54E-06
0039	2.40E-06	0.00E+00	0.00E+00	0.00E+00	0.00E+00	0.00E+00	0.00E+00	0.00E+00	0.00E+00	0.00E+00	0.00E+00	0.00E+00	0.00E+00	0.00E+00	2.40E-06
0040	2.26E-06	0.00E+00	0.00E+00	0.00E+00	0.00E+00	0.00E+00	0.00E+00	0.00E+00	0.00E+00	0.00E+00	0.00E+00	0.00E+00	0.00E+00	0.00E+00	2.26E-06
0041	2.30E-06	0.00E+00	0.00E+00	0.00E+00	0.00E+00	0.00E+00	0.00E+00	0.00E+00	0.00E+00	0.00E+00	0.00E+00	0.00E+00	0.00E+00	0.00E+00	2.30E-06
0042	2.45E-06	0.00E+00	0.00E+00	0.00E+00	0.00E+00	0.00E+00	0.00E+00	0.00E+00	0.00E+00	0.00E+00	0.00E+00	0.00E+00	0.00E+00	0.00E+00	2.45E-06
0043	2.59E-06	0.00E+00	0.00E+00	0.00E+00	0.00E+00	0.00E+00	0.00E+00	0.00E+00	0.00E+00	0.00E+00	0.00E+00	0.00E+00	0.00E+00	0.00E+00	2.59E-06
0044	2.72E-06	0.00E+00	0.00E+00	0.00E+00	0.00E+00	0.00E+00	0.00E+00	0.00E+00	0.00E+00	0.00E+00	0.00E+00	0.00E+00	0.00E+00	0.00E+00	2.72E-06
0045	2.82E-06	0.00E+00	0.00E+00	0.00E+00	0.00E+00	0.00E+00	0.00E+00	0.00E+00	0.00E+00	0.00E+00	0.00E+00	0.00E+00	0.00E+00	0.00E+00	2.82E-06
0046	2.70E-06	0.00E+00	0.00E+00	0.00E+00	0.00E+00	0.00E+00	0.00E+00	0.00E+00	0.00E+00	0.00E+00	0.00E+00	0.00E+00	0.00E+00	0.00E+00	2.70E-06
0047	2.59E-06	0.00E+00	0.00E+00	0.00E+00	0.00E+00	0.00E+00	0.00E+00	0.00E+00	0.00E+00	0.00E+00	0.00E+00	0.00E+00	0.00E+00	0.00E+00	2.59E-06
0048	2.44E-06	0.00E+00	0.00E+00	0.00E+00	0.00E+00	0.00E+00	0.00E+00	0.00E+00	0.00E+00	0.00E+00	0.00E+00	0.00E+00	0.00E+00	0.00E+00	2.44E-06
0049	2.33E-06	0.00E+00	0.00E+00	0.00E+00	0.00E+00	0.00E+00	0.00E+00	0.00E+00	0.00E+00	0.00E+00	0.00E+00	0.00E+00	0.00E+00	0.00E+00	2.33E-06
0050	2.08E-06	0.00E+00	0.00E+00	0.00E+00	0.00E+00	0.00E+00	0.00E+00	0.00E+00	0.00E+00	0.00E+00	0.00E+00	0.00E+00	0.00E+00	0.00E+00	2.08E-06
0051	2.13E-06	0.00E+00	0.00E+00	0.00E+00	0.00E+00	0.00E+00	0.00E+00	0.00E+00	0.00E+00	0.00E+00	0.00E+00	0.00E+00	0.00E+00	0.00E+00	2.13E-06
0052	2.18E-06	0.00E+00	0.00E+00	0.00E+00	0.00E+00	0.00E+00	0.00E+00	0.00E+00	0.00E+00	0.00E+00	0.00E+00	0.00E+00	0.00E+00	0.00E+00	2.18E-06
0053	2.23E-06	0.00E+00	0.00E+00	0.00E+00	0.00E+00	0.00E+00	0.00E+00	0.00E+00	0.00E+00	0.00E+00	0.00E+00	0.00E+00	0.00E+00	0.00E+00	2.23E-06
0054	2.26E-06	0.00E+00	0.00E+00	0.00E+00	0.00E+00	0.00E+00	0.00E+00	0.00E+00	0.00E+00	0.00E+00	0.00E+00	0.00E+00	0.00E+00	0.00E+00	2.26E-06

This file: c:\HARP\projects\demo\Rep_Chr_Res_DerOEH_AllRec_AllSrc_AllCh_ByRec_Site.txt

Created by HARP Version 1.4d Build 23.09.07
Uses ISC Version 99155
Uses BPIP (Dated: 04112)
Creation date: 6/20/2011 11:56:22 AM

EXCEPTION REPORT
   (there have been no changes or exceptions)

INPUT FILES:
   Source-Receptor file: C:\Users\dwaymire\Documents\Bluescape\Projects\Ponte Vista\Modeling\061611 Modeling\PVHRA616.SRC
   Averaging period adjustment factors file: not applicable
   Emission rates file: none
   Site parameters file: c:\HARP\projects\demo\project.sit

Coordinate system: UTM NAD27

Screening mode is OFF

Exposure duration: resident
Analysis method: Derived (OEHHA) Method
Health effect: Chronic HI
Receptor(s):   All
Sources(s):   All
Chemicals(s):   All

SITE PARAMETERS

DEPOSITION

   Deposition rate (m/s)   0.05

DRINKING WATER

*** Pathway disabled ***

FISH

*** Pathway disabled ***

PASTURE

*** Pathway disabled ***

HOME GROWN PRODUCE

*** Pathway disabled ***

PIGS, CHICKENS AND EGGS

*** Pathway disabled ***

DERMAL ABSORPTION

*** Pathway disabled ***

SOIL INGESTION

*** Pathway disabled ***

MOTHER'S MILK

*** Pathway disabled ***

CHEMICAL CROSS-REFERENCE TABLE AND BACKGROUND CONCENTRATIONS

CHEM	CAS	ABBREVIATION	POLLUTANT NAME	BACKGROUND (ug/m^3)
0001	106990	1,3-Butadiene	1,3-Butadiene	0.000E+00
0002	75070	Acetaldehyde	Acetaldehyde	0.000E+00
0003	107028	Acrolein	Acrolein	0.000E+00
0004	7664417	NH3	Ammonia	0.000E+00
0005	7440382	Arsenic	Arsenic	0.000E+00
0006	1332214	Asbestos	Asbestos	0.000E+00
0007	71432	Benzene	Benzene	0.000E+00
0008	7440417	Beryllium	Beryllium	0.000E+00
0009	7440439	Cadmium	Cadmium	0.000E+00
0010	56235	CCl4	Carbon tetrachloride	0.000E+00
0011	7782505	Chlorine	Chlorine	0.000E+00
0012	18540299	Cr(VI)	Chromium, hexavalent (& compounds)	0.000E+00
0013	218019	Chrysene	Chrysene	0.000E+00
0014	7440508	Copper	Copper	0.000E+00
0015	9901	DieselExhPM	Diesel engine exhaust, particulate matter (Diesel PM)	0.000E+00
0016	100414	Ethyl Benzene	Ethyl benzene	0.000E+00
0017	111762	EGBE	Ethylene glycol monobutyl ether	0.000E+00
0018	109864	EGME	Ethylene glycol monomethyl ether	0.000E+00
0019	106934	EDB	Ethylene dibromide {EDB}	0.000E+00
0020	107062	EDC	Ethylene dichloride {EDC}	0.000E+00
0021	50000	Formaldehyde	Formaldehyde	0.000E+00
0022	110543	Hexane	Hexane	0.000E+00
0023	7647010	HCl	Hydrochloric acid	0.000E+00
0024	7783064	H2S	Hydrogen sulfide	0.000E+00
0025	7439921	Lead	Lead	0.000E+00
0026	71556	1,1,1-TCA	Methyl chloroform {1,1,1-Trichloroethane}	0.000E+00
0027	1634044	Me t-ButylEther	Methyl tert-butyl ether	0.000E+00
0028	7439965	Manganese	Manganese	0.000E+00
0029	7439976	Mercury	Mercury	0.000E+00
0030	67561	Methanol	Methanol	0.000E+00
0031	78933	MEK	Methyl ethyl ketone {2-Butanone}	0.000E+00
0032	75092	Methylene Chlor	Methylene chloride {Dichloromethane}	0.000E+00
0033	91203	Naphthalene	Naphthalene	0.000E+00
0034	7440020	Nickel	Nickel	0.000E+00
0035	1151	PAHs-w/o	PAHs, total, w/o individ. components reported [Treated as B(a)P for HRA]	0.000E+00
0036	127184	Perc	Perchloroethylene {Tetrachloroethene}	0.000E+00
0037	107982	PGME	Propylene glycol monomethyl ether	0.000E+00
0038	7782492	Selenium	Selenium	0.000E+00
0039	100425	Styrene	Styrene	0.000E+00
0040	7664939	Sulfuric Acid	Sulfuric acid	0.000E+00
0041	108883	Toluene	Toluene	0.000E+00
0042	79016	TCE	Trichloroethylene	0.000E+00
0043	75014	Vinyl Chloride	Vinyl chloride	0.000E+00
0044	1330207	Xylenes	Xylenes (mixed)	0.000E+00
0045	108383	m-Xylene	m-Xylene	0.000E+00
0046	95476	o-Xylene	o-Xylene	0.000E+00

CHEMICAL HEALTH VALUES

CHEM	CAS	ABBREVIATION	CancerPF(Inh) (mg/kg-d)^-1	CancerPF(Oral) (mg/kg-d)^-1	ChronicREL(Inh) ug/m^3	ChronicREL(Oral) mg/kg-d	AcuteREL ug/m^3
0001	106990	1,3-Butadiene	6.00E-01	*	2.00E+01	*	*
0002	75070	Acetaldehyde	1.00E-02	*	1.40E+02	*	4.70E+02
0003	107028	Acrolein	*	*	3.50E-01	*	2.50E+00

0004	7664417	NH3	*	*	2.00E+02	*	3.20E+03
0005	7440382	Arsenic	1.20E+01	1.50E+00	1.50E-02	3.50E-06	2.00E-01
0006	1332214	Asbestos	2.20E+02	*	*	*	*
0007	71432	Benzene	1.00E-01	*	6.00E+01	*	1.30E+03
0008	7440417	Beryllium	8.40E+00	*	7.00E-03	2.00E-03	*
0009	7440439	Cadmium	1.50E+01	*	2.00E-02	5.00E-04	*
0010	56235	CCl4	1.50E-01	*	4.00E+01	*	1.90E+03
0011	7782505	Chlorine	*	*	2.00E-01	*	2.10E+02
0012	18540299	Cr(VI)	5.10E+02	*	2.00E-01	2.00E-02	*
0013	218019	Chrysene	3.90E-02	1.20E-01	*	*	*
0014	7440508	Copper	*	*	*	*	1.00E+02
0015	9901	DieselExhPM	1.10E+00	*	5.00E+00	*	*
0016	100414	Ethyl Benzene	8.70E-03	*	2.00E+03	*	*
0017	111762	EGBE	*	*	*	*	1.40E+04
0018	109864	EGME	*	*	6.00E+01	*	9.30E+01
0019	106934	EDB	2.50E-01	*	8.00E-01	*	*
0020	107062	EDC	7.20E-02	*	4.00E+02	*	*
0021	50000	Formaldehyde	2.10E-02	*	9.00E+00	*	5.50E+01
0022	110543	Hexane	*	*	7.00E+03	*	*
0023	7647010	HCl	*	*	9.00E+00	*	2.10E+03
0024	7783064	H2S	*	*	1.00E+01	*	4.20E+01
0025	7439921	Lead	4.20E-02	8.50E-03	*	*	*
0026	71556	1,1,1-TCA	*	*	1.00E+03	*	6.80E+04
0027	1634044	Me t-ButylEther	1.80E-03	*	8.00E+03	*	*
0028	7439965	Manganese	*	*	9.00E-02	*	*
0029	7439976	Mercury	*	*	3.00E-02	1.60E-04	6.00E-01
0030	67561	Methanol	*	*	4.00E+03	*	2.80E+04
0031	78933	MEK	*	*	*	*	1.30E+04
0032	75092	Methylene Chlor	3.50E-03	*	4.00E+02	*	1.40E+04
0033	91203	Naphthalene	1.20E-01	*	9.00E+00	*	*
0034	7440020	Nickel	9.10E-01	*	5.00E-02	5.00E-02	6.00E+00
0035	1151	PAHs-w/o	3.90E+00	1.20E+01	*	*	*
0036	127184	Perc	2.10E-02	*	3.50E+01	*	2.00E+04
0037	107982	PGME	*	*	7.00E+03	*	*
0038	7782492	Selenium	*	*	2.00E+01	*	*
0039	100425	Styrene	*	*	9.00E+02	*	2.10E+04
0040	7664939	Sulfuric Acid	*	*	1.00E+00	*	1.20E+02
0041	108883	Toluene	*	*	3.00E+02	*	3.70E+04
0042	79016	TCE	7.00E-03	*	6.00E+02	*	*
0043	75014	Vinyl Chloride	2.70E-01	*	*	*	1.80E+05
0044	1330207	Xylenes	*	*	7.00E+02	*	2.20E+04
0045	108383	m-Xylene	*	*	7.00E+02	*	2.20E+04
0046	95476	o-Xylene	*	*	7.00E+02	*	2.20E+04

EMISSIONS DATA SOURCE: Emission rates loaded from file: C:\Users\dwaymire\Documents\Bluescape\Projects\Ponte Vista\Modeling\061611 Modeling\PV_HRA.ems
EMISSION RATES HAVE BEEN MANUALLY EDITED BY USER
CHEMICALS ADDED OR DELETED: none

EMISSIONS FOR FACILITY FAC=9999 DEV= PRO= STK=1 NAME=SRCGP1
SOURCE MULTIPLIER=1

CAS	ABBREV	MULTIPLIER	BG (ug/m^3)	AVRG (lbs/yr)	MAX (lbs/hr)
106990	1,3-Butadiene	1	0	0	0
75070	Acetaldehyde	1	0	0	0
107028	Acrolein	1	0	0	0
7664417	Ammonia	1	0	0	0
7440382	Arsenic	1	0	0	0
1332214	Asbestos	1	0	0	0
71432	Benzene	1	0	0	0
7440417	Berylium	1	0	0	0
7440439	Cadmium	1	0	0	0
56235	Carbon Tetrachlo	1	0	0	0
7782505	Chlorine	1	0	0	0

18540299	Chromium (VI)	1	0	0	0
218019	Chrysene	1	0	0	0
7440508	Copper	1	0	0	0
9901	DPM	1	0	0	0
100414	Ethyl Benzene	1	0	10.2900000	0
111762	Ethylene glycol	1	0	0	0
109864	Ethylene glycol	1	0	0.08000000	0
106934	Ethylene Dibromi	1	0	0	0
107062	Ethylene Dichlor	1	0	0	0
50000	Formaldehyde	1	0	0	0
110543	Hexane	1	0	0	0
7647010	Hydrochloric Aci	1	0	0	0
7783064	Hydrogen Sulfide	1	0	0	0
7439921	Lead (inorganic)	1	0	0	0
71556	Methyl Chlorofor	1	0	0	0
1634044	Metyl Tertiary B	1	0	0	0
7439965	Manganese	1	0	0	0
7439976	Mercury	1	0	0	0
67561	Methanol	1	0	0	0
78933	Methyl Ethyl Ket	1	0	0	0
75092	Methylene Chlori	1	0	0	0
91203	Naphthalene	1	0	0.3900000	0
7440020	Nickel	1	0	0	0
1151	PAHs	1	0	0	0
127184	Perchloroethylen	1	0	0	0
107982	Propylene glycol	1	0	0	0
7782492	Selenium	1	0	0	0
100425	Styrene	1	0	0	0
7664939	Sulfuric Acid	1	0	0	0
108883	Toluene	1	0	0	0
79016	Trichloroethylen	1	0	0	0
75014	Vinyl Chloride	1	0	0	0
1330207	Xylene	1	0	0	0
108383	M-Xylene	1	0	0	0
95476	O-Xylene	1	0	0	0

EMISSIONS FOR FACILITY FAC=9999 DEV= PRO= STK=2 NAME=SRCGP2
SOURCE MULTIPLIER=1

CAS	ABBREV	MULTIPLIER	BG (ug/m^3)	AVRG (lbs/yr)	MAX (lbs/hr)
106990	1,3-Butadiene	1	0	0	0
75070	Acetaldehyde	1	0	0	0
107028	Acrolein	1	0	0	0
7664417	Ammonia	1	0	0	0
7440382	Arsenic	1	0	0	0
1332214	Asbestos	1	0	0	0
71432	Benzene	1	0	0	0
7440417	Berylium	1	0	0	0
7440439	Cadmium	1	0	0	0
56235	Carbon Tetrachlo	1	0	0	0
7782505	Chlorine	1	0	0	0
18540299	Chromium (VI)	1	0	0	0
218019	Chrysene	1	0	0	0
7440508	Copper	1	0	0	0
9901	DPM	1	0	0	0
100414	Ethyl Benzene	1	0	10.2900000	0
111762	Ethylene glycol	1	0	0	0
109864	Ethylene glycol	1	0	0.08000000	0
106934	Ethylene Dibromi	1	0	0	0
107062	Ethylene Dichlor	1	0	0	0
50000	Formaldehyde	1	0	0	0
110543	Hexane	1	0	0	0
7647010	Hydrochloric Aci	1	0	0	0

7783064	Hydrogen Sulfide	1	0	0	0
7439921	Lead (inorganic)	1	0	0	0
71556	Methyl Chlorofor	1	0	0	0
1634044	Metyl Tertiary B	1	0	0	0
7439965	Manganese	1	0	0	0
7439976	Mercury	1	0	0	0
67561	Methanol	1	0	0	0
78933	Methyl Ethyl Ket	1	0	0	0
75092	Methylene Chlori	1	0	0	0
91203	Naphthalene	1	0	0.3900000	0
7440020	Nickel	1	0	0	0
1151	PAHs	1	0	0	0
127184	Perchloroethylen	1	0	0	0
107982	Propylene glycol	1	0	0	0
7782492	Selenium	1	0	0	0
100425	Styrene	1	0	0	0
7664939	Sulfuric Acid	1	0	0	0
108883	Toluene	1	0	0	0
79016	Trichloroethylen	1	0	0	0
75014	Vinyl Chloride	1	0	0	0
1330207	Xylene	1	0	0	0
108383	M-Xylene	1	0	0	0
95476	O-Xylene	1	0	0	0

EMISSIONS FOR FACILITY FAC=9999 DEV= PRO= STK=3 NAME=SRCGP3
SOURCE MULTIPLIER=1

CAS	ABBREV	MULTIPLIER	BG (ug/m^3)	AVRG (lbs/yr)	MAX (lbs/hr)
106990	1,3-Butadiene	1	0	0	0
75070	Acetaldehyde	1	0	0	0
107028	Acrolein	1	0	0	0
7664417	Ammonia	1	0	0	0
7440382	Arsenic	1	0	0	0
1332214	Asbestos	1	0	0	0
71432	Benzene	1	0	0	0
7440417	Berylium	1	0	0	0
7440439	Cadmium	1	0	0	0
56235	Carbon Tetrachlo	1	0	0	0
7782505	Chlorine	1	0	0	0
18540299	Chromium (VI)	1	0	0	0
218019	Chrysene	1	0	0	0
7440508	Copper	1	0	0	0
9901	DPM	1	0	0	0
100414	Ethyl Benzene	1	0	10.2900000	0
111762	Ethylene glycol	1	0	0	0
109864	Ethylene glycol	1	0	0.08000000	0
106934	Ethylene Dibromi	1	0	0	0
107062	Ethylene Dichlor	1	0	0	0
50000	Formaldehyde	1	0	0	0
110543	Hexane	1	0	0	0
7647010	Hydrochloric Aci	1	0	0	0
7783064	Hydrogen Sulfide	1	0	0	0
7439921	Lead (inorganic)	1	0	0	0
71556	Methyl Chlorofor	1	0	0	0
1634044	Metyl Tertiary B	1	0	0	0
7439965	Manganese	1	0	0	0
7439976	Mercury	1	0	0	0
67561	Methanol	1	0	0	0
78933	Methyl Ethyl Ket	1	0	0	0
75092	Methylene Chlori	1	0	0	0
91203	Naphthalene	1	0	0.3900000	0
7440020	Nickel	1	0	0	0
1151	PAHs	1	0	0	0

127184	Perchloroethylen	1	0	0	0
107982	Propylene glycol	1	0	0	0
7782492	Selenium	1	0	0	0
100425	Styrene	1	0	0	0
7664939	Sulfuric Acid	1	0	0	0
108883	Toluene	1	0	0	0
79016	Trichloroethylen	1	0	0	0
75014	Vinyl Chloride	1	0	0	0
1330207	Xylene	1	0	0	0
108383	M-Xylene	1	0	0	0
95476	O-Xylene	1	0	0	0

EMISSIONS FOR FACILITY FAC=9999 DEV= PRO= STK=4 NAME=SRCGP4
SOURCE MULTIPLIER=1

CAS	ABBREV	MULTIPLIER	BG (ug/m^3)	AVRG (lbs/yr)	MAX (lbs/hr)
106990	1,3-Butadiene	1	0	0	0
75070	Acetaldehyde	1	0	0	0
107028	Acrolein	1	0	0	0
7664417	Ammonia	1	0	0	0
7440382	Arsenic	1	0	0	0
1332214	Asbestos	1	0	0	0
71432	Benzene	1	0	0	0
7440417	Berylium	1	0	0	0
7440439	Cadmium	1	0	0	0
56235	Carbon Tetrachlo	1	0	0	0
7782505	Chlorine	1	0	0	0
18540299	Chromium (VI)	1	0	0	0
218019	Chrysene	1	0	0	0
7440508	Copper	1	0	0	0
9901	DPM	1	0	0	0
100414	Ethyl Benzene	1	0	10.2900000	0
111762	Ethylene glycol	1	0	0	0
109864	Ethylene glycol	1	0	0.08000000	0
106934	Ethylene Dibromi	1	0	0	0
107062	Ethylene Dichlor	1	0	0	0
50000	Formaldehyde	1	0	0	0
110543	Hexane	1	0	0	0
7647010	Hydrochloric Aci	1	0	0	0
7783064	Hydrogen Sulfide	1	0	0	0
7439921	Lead (inorganic)	1	0	0	0
71556	Methyl Chlorofor	1	0	0	0
1634044	Metyl Tertiary B	1	0	0	0
7439965	Manganese	1	0	0	0
7439976	Mercury	1	0	0	0
67561	Methanol	1	0	0	0
78933	Methyl Ethyl Ket	1	0	0	0
75092	Methylene Chlori	1	0	0	0
91203	Naphthalene	1	0	0.3900000	0
7440020	Nickel	1	0	0	0
1151	PAHs	1	0	0	0
127184	Perchloroethylen	1	0	0	0
107982	Propylene glycol	1	0	0	0
7782492	Selenium	1	0	0	0
100425	Styrene	1	0	0	0
7664939	Sulfuric Acid	1	0	0	0
108883	Toluene	1	0	0	0
79016	Trichloroethylen	1	0	0	0
75014	Vinyl Chloride	1	0	0	0
1330207	Xylene	1	0	0	0
108383	M-Xylene	1	0	0	0
95476	O-Xylene	1	0	0	0

EMISSIONS FOR FACILITY FAC=9999 DEV= PRO= STK=5 NAME=SRCGP5
SOURCE MULTIPLIER=1

CAS	ABBREV	MULTIPLIER	BG (ug/m^3)	AVRG (lbs/yr)	MAX (lbs/hr)
106990	1,3-Butadiene	1	0	0	0
75070	Acetaldehyde	1	0	0	0
107028	Acrolein	1	0	0	0
7664417	Ammonia	1	0	0	0
7440382	Arsenic	1	0	0	0
1332214	Asbestos	1	0	0	0
71432	Benzene	1	0	0	0
7440417	Berylium	1	0	0	0
7440439	Cadmium	1	0	0	0
56235	Carbon Tetrachlo	1	0	0	0
7782505	Chlorine	1	0	0	0
18540299	Chromium (VI)	1	0	0	0
218019	Chrysene	1	0	0	0
7440508	Copper	1	0	0	0
9901	DPM	1	0	0	0
100414	Ethyl Benzene	1	0	10.2900000	0
111762	Ethylene glycol	1	0	0	0
109864	Ethylene glycol	1	0	0.08000000	0
106934	Ethylene Dibromi	1	0	0	0
107062	Ethylene Dichlor	1	0	0	0
50000	Formaldehyde	1	0	0	0
110543	Hexane	1	0	0	0
7647010	Hydrochloric Aci	1	0	0	0
7783064	Hydrogen Sulfide	1	0	0	0
7439921	Lead (inorganic)	1	0	0	0
71556	Methyl Chlorofor	1	0	0	0
1634044	Metyl Tertiary B	1	0	0	0
7439965	Manganese	1	0	0	0
7439976	Mercury	1	0	0	0
67561	Methanol	1	0	0	0
78933	Methyl Ethyl Ket	1	0	0	0
75092	Methylene Chlori	1	0	0	0
91203	Naphthalene	1	0	0.3900000	0
7440020	Nickel	1	0	0	0
1151	PAHs	1	0	0	0
127184	Perchloroethylen	1	0	0	0
107982	Propylene glycol	1	0	0	0
7782492	Selenium	1	0	0	0
100425	Styrene	1	0	0	0
7664939	Sulfuric Acid	1	0	0	0
108883	Toluene	1	0	0	0
79016	Trichloroethylen	1	0	0	0
75014	Vinyl Chloride	1	0	0	0
1330207	Xylene	1	0	0	0
108383	M-Xylene	1	0	0	0
95476	O-Xylene	1	0	0	0

EMISSIONS FOR FACILITY FAC=9999 DEV= PRO= STK=6 NAME=SRCGP6
SOURCE MULTIPLIER=1

CAS	ABBREV	MULTIPLIER	BG (ug/m^3)	AVRG (lbs/yr)	MAX (lbs/hr)
106990	1,3-Butadiene	1	0	0	0
75070	Acetaldehyde	1	0	0	0
107028	Acrolein	1	0	0	0
7664417	Ammonia	1	0	0	0
7440382	Arsenic	1	0	0	0
1332214	Asbestos	1	0	0	0
71432	Benzene	1	0	0	0
7440417	Berylium	1	0	0	0
7440439	Cadmium	1	0	0	0

56235	Carbon Tetrachlo	1	0	0	0
7782505	Chlorine	1	0	0	0
18540299	Chromium (VI)	1	0	0	0
218019	Chrysene	1	0	0	0
7440508	Copper	1	0	0	0
9901	DPM	1	0	0	0
100414	Ethyl Benzene	1	0	10.2900000	0
111762	Ethylene glycol	1	0	0	0
109864	Ethylene glycol	1	0	0.08000000	0
106934	Ethylene Dibromi	1	0	0	0
107062	Ethylene Dichlor	1	0	0	0
50000	Formaldehyde	1	0	0	0
110543	Hexane	1	0	0	0
7647010	Hydrochloric Aci	1	0	0	0
7783064	Hydrogen Sulfide	1	0	0	0
7439921	Lead (inorganic)	1	0	0	0
71556	Methyl Chlorofor	1	0	0	0
1634044	Metyl Tertiary B	1	0	0	0
7439965	Manganese	1	0	0	0
7439976	Mercury	1	0	0	0
67561	Methanol	1	0	0	0
78933	Methyl Ethyl Ket	1	0	0	0
75092	Methylene Chlori	1	0	0	0
91203	Naphthalene	1	0	0.3900000	0
7440020	Nickel	1	0	0	0
1151	PAHs	1	0	0	0
127184	Perchloroethylen	1	0	0	0
107982	Propylene glycol	1	0	0	0
7782492	Selenium	1	0	0	0
100425	Styrene	1	0	0	0
7664939	Sulfuric Acid	1	0	0	0
108883	Toluene	1	0	0	0
79016	Trichloroethylen	1	0	0	0
75014	Vinyl Chloride	1	0	0	0
1330207	Xylene	1	0	0	0
108383	M-Xylene	1	0	0	0
95476	O-Xylene	1	0	0	0

EMISSIONS FOR FACILITY FAC=9999 DEV= PRO= STK=7 NAME=SRCGP7
SOURCE MULTIPLIER=1

CAS	ABBREV	MULTIPLIER	BG (ug/m^3)	AVRG (lbs/yr)	MAX (lbs/hr)
106990	1,3-Butadiene	1	0	0	0
75070	Acetaldehyde	1	0	0	0
107028	Acrolein	1	0	0	0
7664417	Ammonia	1	0	0	0
7440382	Arsenic	1	0	0	0
1332214	Asbestos	1	0	0	0
71432	Benzene	1	0	0	0
7440417	Berylium	1	0	0	0
7440439	Cadmium	1	0	0	0
56235	Carbon Tetrachlo	1	0	0	0
7782505	Chlorine	1	0	0	0
18540299	Chromium (VI)	1	0	0	0
218019	Chrysene	1	0	0	0
7440508	Copper	1	0	0	0
9901	DPM	1	0	0	0
100414	Ethyl Benzene	1	0	10.2900000	0
111762	Ethylene glycol	1	0	0	0
109864	Ethylene glycol	1	0	0.08000000	0
106934	Ethylene Dibromi	1	0	0	0
107062	Ethylene Dichlor	1	0	0	0
50000	Formaldehyde	1	0	0	0

110543	Hexane	1	0	0	0
7647010	Hydrochloric Aci	1	0	0	0
7783064	Hydrogen Sulfide	1	0	0	0
7439921	Lead (inorganic)	1	0	0	0
71556	Methyl Chlorofor	1	0	0	0
1634044	Metyl Tertiary B	1	0	0	0
7439965	Manganese	1	0	0	0
7439976	Mercury	1	0	0	0
67561	Methanol	1	0	0	0
78933	Methyl Ethyl Ket	1	0	0	0
75092	Methylene Chlori	1	0	0	0
91203	Naphthalene	1	0	0.3900000	0
7440020	Nickel	1	0	0	0
1151	PAHs	1	0	0	0
127184	Perchloroethylen	1	0	0	0
107982	Propylene glycol	1	0	0	0
7782492	Selenium	1	0	0	0
100425	Styrene	1	0	0	0
7664939	Sulfuric Acid	1	0	0	0
108883	Toluene	1	0	0	0
79016	Trichloroethylen	1	0	0	0
75014	Vinyl Chloride	1	0	0	0
1330207	Xylene	1	0	0	0
108383	M-Xylene	1	0	0	0
95476	O-Xylene	1	0	0	0

EMISSIONS FOR FACILITY FAC=9999 DEV= PRO= STK=8 NAME=SRCGP8
SOURCE MULTIPLIER=1

CAS	ABBREV	MULTIPLIER	BG (ug/m^3)	AVRG (lbs/yr)	MAX (lbs/hr)
106990	1,3-Butadiene	1	0	0	0
75070	Acetaldehyde	1	0	0	0
107028	Acrolein	1	0	0	0
7664417	Ammonia	1	0	0	0
7440382	Arsenic	1	0	0	0
1332214	Asbestos	1	0	0	0
71432	Benzene	1	0	0	0
7440417	Berylium	1	0	0	0
7440439	Cadmium	1	0	0	0
56235	Carbon Tetrachlo	1	0	0	0
7782505	Chlorine	1	0	0	0
18540299	Chromium (VI)	1	0	0	0
218019	Chrysene	1	0	0	0
7440508	Copper	1	0	0	0
9901	DPM	1	0	0	0
100414	Ethyl Benzene	1	0	10.2900000	0
111762	Ethylene glycol	1	0	0	0
109864	Ethylene glycol	1	0	0.08000000	0
106934	Ethylene Dibromi	1	0	0	0
107062	Ethylene Dichlor	1	0	0	0
50000	Formaldehyde	1	0	0	0
110543	Hexane	1	0	0	0
7647010	Hydrochloric Aci	1	0	0	0
7783064	Hydrogen Sulfide	1	0	0	0
7439921	Lead (inorganic)	1	0	0	0
71556	Methyl Chlorofor	1	0	0	0
1634044	Metyl Tertiary B	1	0	0	0
7439965	Manganese	1	0	0	0
7439976	Mercury	1	0	0	0
67561	Methanol	1	0	0	0
78933	Methyl Ethyl Ket	1	0	0	0
75092	Methylene Chlori	1	0	0	0
91203	Naphthalene	1	0	0.3900000	0

7440020	Nickel	1	0	0	0
1151	PAHs	1	0	0	0
127184	Perchloroethylen	1	0	0	0
107982	Propylene glycol	1	0	0	0
7782492	Selenium	1	0	0	0
100425	Styrene	1	0	0	0
7664939	Sulfuric Acid	1	0	0	0
108883	Toluene	1	0	0	0
79016	Trichloroethylen	1	0	0	0
75014	Vinyl Chloride	1	0	0	0
1330207	Xylene	1	0	0	0
108383	M-Xylene	1	0	0	0
95476	O-Xylene	1	0	0	0

EMISSIONS FOR FACILITY FAC=9999 DEV= PRO= STK=9 NAME=SRCGP9
SOURCE MULTIPLIER=1

CAS	ABBREV	MULTIPLIER	BG (ug/m^3)	AVRG (lbs/yr)	MAX (lbs/hr)
106990	1,3-Butadiene	1	0	0	0
75070	Acetaldehyde	1	0	0	0
107028	Acrolein	1	0	0	0
7664417	Ammonia	1	0	0	0
7440382	Arsenic	1	0	0	0
1332214	Asbestos	1	0	0	0
71432	Benzene	1	0	0	0
7440417	Berylium	1	0	0	0
7440439	Cadmium	1	0	0	0
56235	Carbon Tetrachlo	1	0	0	0
7782505	Chlorine	1	0	0	0
18540299	Chromium (VI)	1	0	0	0
218019	Chrysene	1	0	0	0
7440508	Copper	1	0	0	0
9901	DPM	1	0	0	0
100414	Ethyl Benzene	1	0	10.2900000	0
111762	Ethylene glycol	1	0	0	0
109864	Ethylene glycol	1	0	0.08000000	0
106934	Ethylene Dibromi	1	0	0	0
107062	Ethylene Dichlor	1	0	0	0
50000	Formaldehyde	1	0	0	0
110543	Hexane	1	0	0	0
7647010	Hydrochloric Aci	1	0	0	0
7783064	Hydrogen Sulfide	1	0	0	0
7439921	Lead (inorganic)	1	0	0	0
71556	Methyl Chlorofor	1	0	0	0
1634044	Metyl Tertiary B	1	0	0	0
7439965	Manganese	1	0	0	0
7439976	Mercury	1	0	0	0
67561	Methanol	1	0	0	0
78933	Methyl Ethyl Ket	1	0	0	0
75092	Methylene Chlori	1	0	0	0
91203	Naphthalene	1	0	0.3900000	0
7440020	Nickel	1	0	0	0
1151	PAHs	1	0	0	0
127184	Perchloroethylen	1	0	0	0
107982	Propylene glycol	1	0	0	0
7782492	Selenium	1	0	0	0
100425	Styrene	1	0	0	0
7664939	Sulfuric Acid	1	0	0	0
108883	Toluene	1	0	0	0
79016	Trichloroethylen	1	0	0	0
75014	Vinyl Chloride	1	0	0	0
1330207	Xylene	1	0	0	0
108383	M-Xylene	1	0	0	0

95476	O-Xylene	1	0	0	0

EMISSIONS FOR FACILITY FAC=9999 DEV= PRO= STK=10 NAME=SRCGP10
SOURCE MULTIPLIER=1

CAS	ABBREV	MULTIPLIER	BG (ug/m^3)	AVRG (lbs/yr)	MAX (lbs/hr)
106990	1,3-Butadiene	1	0	0	0
75070	Acetaldehyde	1	0	0	0
107028	Acrolein	1	0	0	0
7664417	Ammonia	1	0	0	0
7440382	Arsenic	1	0	0	0
1332214	Asbestos	1	0	0	0
71432	Benzene	1	0	0	0
7440417	Berylium	1	0	0	0
7440439	Cadmium	1	0	0	0
56235	Carbon Tetrachlo	1	0	0	0
7782505	Chlorine	1	0	0	0
18540299	Chromium (VI)	1	0	0	0
218019	Chrysene	1	0	0	0
7440508	Copper	1	0	0	0
9901	DPM	1	0	0	0
100414	Ethyl Benzene	1	0	10.2900000	0
111762	Ethylene glycol	1	0	0	0
109864	Ethylene glycol	1	0	0.08000000	0
106934	Ethylene Dibromi	1	0	0	0
107062	Ethylene Dichlor	1	0	0	0
50000	Formaldehyde	1	0	0	0
110543	Hexane	1	0	0	0
7647010	Hydrochloric Aci	1	0	0	0
7783064	Hydrogen Sulfide	1	0	0	0
7439921	Lead (inorganic)	1	0	0	0
71556	Methyl Chlorofor	1	0	0	0
1634044	Metyl Tertiary B	1	0	0	0
7439965	Manganese	1	0	0	0
7439976	Mercury	1	0	0	0
67561	Methanol	1	0	0	0
78933	Methyl Ethyl Ket	1	0	0	0
75092	Methylene Chlori	1	0	0	0
91203	Naphthalene	1	0	0.3900000	0
7440020	Nickel	1	0	0	0
1151	PAHs	1	0	0	0
127184	Perchloroethylen	1	0	0	0
107982	Propylene glycol	1	0	0	0
7782492	Selenium	1	0	0	0
100425	Styrene	1	0	0	0
7664939	Sulfuric Acid	1	0	0	0
108883	Toluene	1	0	0	0
79016	Trichloroethylen	1	0	0	0
75014	Vinyl Chloride	1	0	0	0
1330207	Xylene	1	0	0	0
108383	M-Xylene	1	0	0	0
95476	O-Xylene	1	0	0	0

EMISSIONS FOR FACILITY FAC=9999 DEV= PRO= STK=11 NAME=SRCGP11
SOURCE MULTIPLIER=1

CAS	ABBREV	MULTIPLIER	BG (ug/m^3)	AVRG (lbs/yr)	MAX (lbs/hr)
106990	1,3-Butadiene	1	0	0	0
75070	Acetaldehyde	1	0	0	0
107028	Acrolein	1	0	0	0
7664417	Ammonia	1	0	0	0
7440382	Arsenic	1	0	0	0
1332214	Asbestos	1	0	0	0
71432	Benzene	1	0	0	0

7440417	Berylium	1	0	0	0
7440439	Cadmium	1	0	0	0
56235	Carbon Tetrachlo	1	0	0	0
7782505	Chlorine	1	0	0	0
18540299	Chromium (VI)	1	0	0	0
218019	Chrysene	1	0	0	0
7440508	Copper	1	0	0	0
9901	DPM	1	0	0	0
100414	Ethyl Benzene	1	0	10.2900000	0
111762	Ethylene glycol	1	0	0	0
109864	Ethylene glycol	1	0	0.08000000	0
106934	Ethylene Dibromi	1	0	0	0
107062	Ethylene Dichlor	1	0	0	0
50000	Formaldehyde	1	0	0	0
110543	Hexane	1	0	0	0
7647010	Hydrochloric Aci	1	0	0	0
7783064	Hydrogen Sulfide	1	0	0	0
7439921	Lead (inorganic)	1	0	0	0
71556	Methyl Chlorofor	1	0	0	0
1634044	Metyl Tertiary B	1	0	0	0
7439965	Manganese	1	0	0	0
7439976	Mercury	1	0	0	0
67561	Methanol	1	0	0	0
78933	Methyl Ethyl Ket	1	0	0	0
75092	Methylene Chlori	1	0	0	0
91203	Naphthalene	1	0	0.3900000	0
7440020	Nickel	1	0	0	0
1151	PAHs	1	0	0	0
127184	Perchloroethylen	1	0	0	0
107982	Propylene glycol	1	0	0	0
7782492	Selenium	1	0	0	0
100425	Styrene	1	0	0	0
7664939	Sulfuric Acid	1	0	0	0
108883	Toluene	1	0	0	0
79016	Trichloroethylen	1	0	0	0
75014	Vinyl Chloride	1	0	0	0
1330207	Xylene	1	0	0	0
108383	M-Xylene	1	0	0	0
95476	O-Xylene	1	0	0	0

EMISSIONS FOR FACILITY FAC=9999 DEV= PRO= STK=12 NAME=SRCGP12
SOURCE MULTIPLIER=1

CAS	ABBREV	MULTIPLIER	BG (ug/m^3)	AVRG (lbs/yr)	MAX (lbs/hr)
106990	1,3-Butadiene	1	0	0	0
75070	Acetaldehyde	1	0	0	0
107028	Acrolein	1	0	0	0
7664417	Ammonia	1	0	0	0
7440382	Arsenic	1	0	0	0
1332214	Asbestos	1	0	0	0
71432	Benzene	1	0	0	0
7440417	Berylium	1	0	0	0
7440439	Cadmium	1	0	0	0
56235	Carbon Tetrachlo	1	0	0	0
7782505	Chlorine	1	0	0	0
18540299	Chromium (VI)	1	0	0	0
218019	Chrysene	1	0	0	0
7440508	Copper	1	0	0	0
9901	DPM	1	0	0	0
100414	Ethyl Benzene	1	0	10.2900000	0
111762	Ethylene glycol	1	0	0	0
109864	Ethylene glycol	1	0	0.08000000	0
106934	Ethylene Dibromi	1	0	0	0

107062	Ethylene Dichlor	1	0	0	0
50000	Formaldehyde	1	0	0	0
110543	Hexane	1	0	0	0
7647010	Hydrochloric Aci	1	0	0	0
7783064	Hydrogen Sulfide	1	0	0	0
7439921	Lead (inorganic)	1	0	0	0
71556	Methyl Chlorofor	1	0	0	0
1634044	Metyl Tertiary B	1	0	0	0
7439965	Manganese	1	0	0	0
7439976	Mercury	1	0	0	0
67561	Methanol	1	0	0	0
78933	Methyl Ethyl Ket	1	0	0	0
75092	Methylene Chlori	1	0	0	0
91203	Naphthalene	1	0	0.3900000	0
7440020	Nickel	1	0	0	0
1151	PAHs	1	0	0	0
127184	Perchloroethylen	1	0	0	0
107982	Propylene glycol	1	0	0	0
7782492	Selenium	1	0	0	0
100425	Styrene	1	0	0	0
7664939	Sulfuric Acid	1	0	0	0
108883	Toluene	1	0	0	0
79016	Trichloroethylen	1	0	0	0
75014	Vinyl Chloride	1	0	0	0
1330207	Xylene	1	0	0	0
108383	M-Xylene	1	0	0	0
95476	O-Xylene	1	0	0	0

EMISSIONS FOR FACILITY FAC=9999 DEV= PRO= STK=13 NAME=SRCGP13
SOURCE MULTIPLIER=1

CAS	ABBREV	MULTIPLIER	BG (ug/m^3)	AVRG (lbs/yr)	MAX (lbs/hr)
106990	1,3-Butadiene	1	0	0	0
75070	Acetaldehyde	1	0	0	0
107028	Acrolein	1	0	0	0
7664417	Ammonia	1	0	0	0
7440382	Arsenic	1	0	0	0
1332214	Asbestos	1	0	0	0
71432	Benzene	1	0	0	0
7440417	Berylium	1	0	0	0
7440439	Cadmium	1	0	0	0
56235	Carbon Tetrachlo	1	0	0	0
7782505	Chlorine	1	0	0	0
18540299	Chromium (VI)	1	0	0	0
218019	Chrysene	1	0	0	0
7440508	Copper	1	0	0	0
9901	DPM	1	0	0	0
100414	Ethyl Benzene	1	0	10.2900000	0
111762	Ethylene glycol	1	0	0	0
109864	Ethylene glycol	1	0	0.08000000	0
106934	Ethylene Dibromi	1	0	0	0
107062	Ethylene Dichlor	1	0	0	0
50000	Formaldehyde	1	0	0	0
110543	Hexane	1	0	0	0
7647010	Hydrochloric Aci	1	0	0	0
7783064	Hydrogen Sulfide	1	0	0	0
7439921	Lead (inorganic)	1	0	0	0
71556	Methyl Chlorofor	1	0	0	0
1634044	Metyl Tertiary B	1	0	0	0
7439965	Manganese	1	0	0	0
7439976	Mercury	1	0	0	0
67561	Methanol	1	0	0	0
78933	Methyl Ethyl Ket	1	0	0	0

75092	Methylene Chlori	1	0	0	0
91203	Naphthalene	1	0	0.3900000	0
7440020	Nickel	1	0	0	0
1151	PAHs	1	0	0	0
127184	Perchloroethylen	1	0	0	0
107982	Propylene glycol	1	0	0	0
7782492	Selenium	1	0	0	0
100425	Styrene	1	0	0	0
7664939	Sulfuric Acid	1	0	0	0
108883	Toluene	1	0	0	0
79016	Trichloroethylen	1	0	0	0
75014	Vinyl Chloride	1	0	0	0
1330207	Xylene	1	0	0	0
108383	M-Xylene	1	0	0	0
95476	O-Xylene	1	0	0	0

EMISSIONS FOR FACILITY FAC=9999 DEV= PRO= STK=14 NAME=SRCGP14
SOURCE MULTIPLIER=1

CAS	ABBREV	MULTIPLIER	BG (ug/m^3)	AVRG (lbs/yr)	MAX (lbs/hr)
106990	1,3-Butadiene	1	0	0	0
75070	Acetaldehyde	1	0	0	0
107028	Acrolein	1	0	0	0
7664417	Ammonia	1	0	0	0
7440382	Arsenic	1	0	0	0
1332214	Asbestos	1	0	0	0
71432	Benzene	1	0	0	0
7440417	Berylium	1	0	0	0
7440439	Cadmium	1	0	0	0
56235	Carbon Tetrachlo	1	0	0	0
7782505	Chlorine	1	0	0	0
18540299	Chromium (VI)	1	0	0	0
218019	Chrysene	1	0	0	0
7440508	Copper	1	0	0	0
9901	DPM	1	0	0	0
100414	Ethyl Benzene	1	0	10.2900000	0
111762	Ethylene glycol	1	0	0	0
109864	Ethylene glycol	1	0	0.08000000	0
106934	Ethylene Dibromi	1	0	0	0
107062	Ethylene Dichlor	1	0	0	0
50000	Formaldehyde	1	0	0	0
110543	Hexane	1	0	0	0
7647010	Hydrochloric Aci	1	0	0	0
7783064	Hydrogen Sulfide	1	0	0	0
7439921	Lead (inorganic)	1	0	0	0
71556	Methyl Chlorofor	1	0	0	0
1634044	Metyl Tertiary B	1	0	0	0
7439965	Manganese	1	0	0	0
7439976	Mercury	1	0	0	0
67561	Methanol	1	0	0	0
78933	Methyl Ethyl Ket	1	0	0	0
75092	Methylene Chlori	1	0	0	0
91203	Naphthalene	1	0	0.3900000	0
7440020	Nickel	1	0	0	0
1151	PAHs	1	0	0	0
127184	Perchloroethylen	1	0	0	0
107982	Propylene glycol	1	0	0	0
7782492	Selenium	1	0	0	0
100425	Styrene	1	0	0	0
7664939	Sulfuric Acid	1	0	0	0
108883	Toluene	1	0	0	0
79016	Trichloroethylen	1	0	0	0
75014	Vinyl Chloride	1	0	0	0

1330207	Xylene	1	0	0	0
108383	M-Xylene	1	0	0	0
95476	O-Xylene	1	0	0	0

EMISSIONS FOR FACILITY FAC=9999 DEV= PRO= STK=15 NAME=SRCGP15
SOURCE MULTIPLIER=1

CAS	ABBREV	MULTIPLIER	BG (ug/m^3)	AVRG (lbs/yr)	MAX (lbs/hr)
106990	1,3-Butadiene	1	0	0	0
75070	Acetaldehyde	1	0	0	0
107028	Acrolein	1	0	0	0
7664417	Ammonia	1	0	0	0
7440382	Arsenic	1	0	0	0
1332214	Asbestos	1	0	0	0
71432	Benzene	1	0	0	0
7440417	Berylium	1	0	0	0
7440439	Cadmium	1	0	0	0
56235	Carbon Tetrachlo	1	0	0	0
7782505	Chlorine	1	0	0	0
18540299	Chromium (VI)	1	0	0	0
218019	Chrysene	1	0	0	0
7440508	Copper	1	0	0	0
9901	DPM	1	0	0	0
100414	Ethyl Benzene	1	0	10.2900000	0
111762	Ethylene glycol	1	0	0	0
109864	Ethylene glycol	1	0	0.08000000	0
106934	Ethylene Dibromi	1	0	0	0
107062	Ethylene Dichlor	1	0	0	0
50000	Formaldehyde	1	0	0	0
110543	Hexane	1	0	0	0
7647010	Hydrochloric Aci	1	0	0	0
7783064	Hydrogen Sulfide	1	0	0	0
7439921	Lead (inorganic)	1	0	0	0
71556	Methyl Chlorofor	1	0	0	0
1634044	Metyl Tertiary B	1	0	0	0
7439965	Manganese	1	0	0	0
7439976	Mercury	1	0	0	0
67561	Methanol	1	0	0	0
78933	Methyl Ethyl Ket	1	0	0	0
75092	Methylene Chlori	1	0	0	0
91203	Naphthalene	1	0	0.3900000	0
7440020	Nickel	1	0	0	0
1151	PAHs	1	0	0	0
127184	Perchloroethylen	1	0	0	0
107982	Propylene glycol	1	0	0	0
7782492	Selenium	1	0	0	0
100425	Styrene	1	0	0	0
7664939	Sulfuric Acid	1	0	0	0
108883	Toluene	1	0	0	0
79016	Trichloroethylen	1	0	0	0
75014	Vinyl Chloride	1	0	0	0
1330207	Xylene	1	0	0	0
108383	M-Xylene	1	0	0	0
95476	O-Xylene	1	0	0	0

EMISSIONS FOR FACILITY FAC=9999 DEV= PRO= STK=16 NAME=SRCGP16
SOURCE MULTIPLIER=1

CAS	ABBREV	MULTIPLIER	BG (ug/m^3)	AVRG (lbs/yr)	MAX (lbs/hr)
106990	1,3-Butadiene	1	0	0	0
75070	Acetaldehyde	1	0	0	0
107028	Acrolein	1	0	0	0
7664417	Ammonia	1	0	0	0
7440382	Arsenic	1	0	0	0

1332214	Asbestos	1	0	0	0
71432	Benzene	1	0	0	0
7440417	Berylium	1	0	0	0
7440439	Cadmium	1	0	0	0
56235	Carbon Tetrachlo	1	0	0	0
7782505	Chlorine	1	0	0	0
18540299	Chromium (VI)	1	0	0	0
218019	Chrysene	1	0	0	0
7440508	Copper	1	0	0	0
9901	DPM	1	0	0	0
100414	Ethyl Benzene	1	0	10.2900000	0
111762	Ethylene glycol	1	0	0	0
109864	Ethylene glycol	1	0	0.08000000	0
106934	Ethylene Dibromi	1	0	0	0
107062	Ethylene Dichlor	1	0	0	0
50000	Formaldehyde	1	0	0	0
110543	Hexane	1	0	0	0
7647010	Hydrochloric Aci	1	0	0	0
7783064	Hydrogen Sulfide	1	0	0	0
7439921	Lead (inorganic)	1	0	0	0
71556	Methyl Chlorofor	1	0	0	0
1634044	Metyl Tertiary B	1	0	0	0
7439965	Manganese	1	0	0	0
7439976	Mercury	1	0	0	0
67561	Methanol	1	0	0	0
78933	Methyl Ethyl Ket	1	0	0	0
75092	Methylene Chlori	1	0	0	0
91203	Naphthalene	1	0	0.3900000	0
7440020	Nickel	1	0	0	0
1151	PAHs	1	0	0	0
127184	Perchloroethylen	1	0	0	0
107982	Propylene glycol	1	0	0	0
7782492	Selenium	1	0	0	0
100425	Styrene	1	0	0	0
7664939	Sulfuric Acid	1	0	0	0
108883	Toluene	1	0	0	0
79016	Trichloroethylen	1	0	0	0
75014	Vinyl Chloride	1	0	0	0
1330207	Xylene	1	0	0	0
108383	M-Xylene	1	0	0	0
95476	O-Xylene	1	0	0	0

EMISSIONS FOR FACILITY FAC=9999 DEV= PRO= STK=17 NAME=SRCGP17
SOURCE MULTIPLIER=1

CAS	ABBREV	MULTIPLIER	BG (ug/m^3)	AVRG (lbs/yr)	MAX (lbs/hr)
106990	1,3-Butadiene	1	0	0	0
75070	Acetaldehyde	1	0	0	0
107028	Acrolein	1	0	0	0
7664417	Ammonia	1	0	0	0
7440382	Arsenic	1	0	0	0
1332214	Asbestos	1	0	0	0
71432	Benzene	1	0	0	0
7440417	Berylium	1	0	0	0
7440439	Cadmium	1	0	0	0
56235	Carbon Tetrachlo	1	0	0	0
7782505	Chlorine	1	0	0	0
18540299	Chromium (VI)	1	0	0	0
218019	Chrysene	1	0	0	0
7440508	Copper	1	0	0	0
9901	DPM	1	0	0	0
100414	Ethyl Benzene	1	0	10.2900000	0
111762	Ethylene glycol	1	0	0	0

109864	Ethylene glycol	1	0	0.08000000	0
106934	Ethylene Dibromi	1	0	0	0
107062	Ethylene Dichlor	1	0	0	0
50000	Formaldehyde	1	0	0	0
110543	Hexane	1	0	0	0
7647010	Hydrochloric Aci	1	0	0	0
7783064	Hydrogen Sulfide	1	0	0	0
7439921	Lead (inorganic)	1	0	0	0
71556	Methyl Chlorofor	1	0	0	0
1634044	Metyl Tertiary B	1	0	0	0
7439965	Manganese	1	0	0	0
7439976	Mercury	1	0	0	0
67561	Methanol	1	0	0	0
78933	Methyl Ethyl Ket	1	0	0	0
75092	Methylene Chlori	1	0	0	0
91203	Naphthalene	1	0	0.3900000	0
7440020	Nickel	1	0	0	0
1151	PAHs	1	0	0	0
127184	Perchloroethylen	1	0	0	0
107982	Propylene glycol	1	0	0	0
7782492	Selenium	1	0	0	0
100425	Styrene	1	0	0	0
7664939	Sulfuric Acid	1	0	0	0
108883	Toluene	1	0	0	0
79016	Trichloroethylen	1	0	0	0
75014	Vinyl Chloride	1	0	0	0
1330207	Xylene	1	0	0	0
108383	M-Xylene	1	0	0	0
95476	O-Xylene	1	0	0	0

EMISSIONS FOR FACILITY FAC=9999 DEV= PRO= STK=18 NAME=SRCGP18
SOURCE MULTIPLIER=1

CAS	ABBREV	MULTIPLIER	BG (ug/m^3)	AVRG (lbs/yr)	MAX (lbs/hr)
106990	1,3-Butadiene	1	0	0	0
75070	Acetaldehyde	1	0	0	0
107028	Acrolein	1	0	0	0
7664417	Ammonia	1	0	0	0
7440382	Arsenic	1	0	0	0
1332214	Asbestos	1	0	0	0
71432	Benzene	1	0	0	0
7440417	Berylium	1	0	0	0
7440439	Cadmium	1	0	0	0
56235	Carbon Tetrachlo	1	0	0	0
7782505	Chlorine	1	0	0	0
18540299	Chromium (VI)	1	0	0	0
218019	Chrysene	1	0	0	0
7440508	Copper	1	0	0	0
9901	DPM	1	0	0	0
100414	Ethyl Benzene	1	0	10.2900000	0
111762	Ethylene glycol	1	0	0	0
109864	Ethylene glycol	1	0	0.08000000	0
106934	Ethylene Dibromi	1	0	0	0
107062	Ethylene Dichlor	1	0	0	0
50000	Formaldehyde	1	0	0	0
110543	Hexane	1	0	0	0
7647010	Hydrochloric Aci	1	0	0	0
7783064	Hydrogen Sulfide	1	0	0	0
7439921	Lead (inorganic)	1	0	0	0
71556	Methyl Chlorofor	1	0	0	0
1634044	Metyl Tertiary B	1	0	0	0
7439965	Manganese	1	0	0	0
7439976	Mercury	1	0	0	0

67561	Methanol	1	0	0	0
78933	Methyl Ethyl Ket	1	0	0	0
75092	Methylene Chlori	1	0	0	0
91203	Naphthalene	1	0	0.3900000	0
7440020	Nickel	1	0	0	0
1151	PAHs	1	0	0	0
127184	Perchloroethylen	1	0	0	0
107982	Propylene glycol	1	0	0	0
7782492	Selenium	1	0	0	0
100425	Styrene	1	0	0	0
7664939	Sulfuric Acid	1	0	0	0
108883	Toluene	1	0	0	0
79016	Trichloroethylen	1	0	0	0
75014	Vinyl Chloride	1	0	0	0
1330207	Xylene	1	0	0	0
108383	M-Xylene	1	0	0	0
95476	O-Xylene	1	0	0	0

EMISSIONS FOR FACILITY FAC=9999 DEV= PRO= STK=19 NAME=SRCGP19
SOURCE MULTIPLIER=1

CAS	ABBREV	MULTIPLIER	BG (ug/m^3)	AVRG (lbs/yr)	MAX (lbs/hr)
106990	1,3-Butadiene	1	0	0	0
75070	Acetaldehyde	1	0	0	0
107028	Acrolein	1	0	0	0
7664417	Ammonia	1	0	0	0
7440382	Arsenic	1	0	0	0
1332214	Asbestos	1	0	0	0
71432	Benzene	1	0	0	0
7440417	Berylium	1	0	0	0
7440439	Cadmium	1	0	0	0
56235	Carbon Tetrachlo	1	0	0	0
7782505	Chlorine	1	0	0	0
18540299	Chromium (VI)	1	0	0	0
218019	Chrysene	1	0	0	0
7440508	Copper	1	0	0	0
9901	DPM	1	0	0	0
100414	Ethyl Benzene	1	0	10.2900000	0
111762	Ethylene glycol	1	0	0	0
109864	Ethylene glycol	1	0	0.08000000	0
106934	Ethylene Dibromi	1	0	0	0
107062	Ethylene Dichlor	1	0	0	0
50000	Formaldehyde	1	0	0	0
110543	Hexane	1	0	0	0
7647010	Hydrochloric Aci	1	0	0	0
7783064	Hydrogen Sulfide	1	0	0	0
7439921	Lead (inorganic)	1	0	0	0
71556	Methyl Chlorofor	1	0	0	0
1634044	Metyl Tertiary B	1	0	0	0
7439965	Manganese	1	0	0	0
7439976	Mercury	1	0	0	0
67561	Methanol	1	0	0	0
78933	Methyl Ethyl Ket	1	0	0	0
75092	Methylene Chlori	1	0	0	0
91203	Naphthalene	1	0	0.3900000	0
7440020	Nickel	1	0	0	0
1151	PAHs	1	0	0	0
127184	Perchloroethylen	1	0	0	0
107982	Propylene glycol	1	0	0	0
7782492	Selenium	1	0	0	0
100425	Styrene	1	0	0	0
7664939	Sulfuric Acid	1	0	0	0
108883	Toluene	1	0	0	0

79016	Trichloroethylen	1	0	0	0
75014	Vinyl Chloride	1	0	0	0
1330207	Xylene	1	0	0	0
108383	M-Xylene	1	0	0	0
95476	O-Xylene	1	0	0	0

EMISSIONS FOR FACILITY FAC=9999 DEV= PRO= STK=20 NAME=SRCGP20
SOURCE MULTIPLIER=1

CAS	ABBREV	MULTIPLIER	BG (ug/m^3)	AVRG (lbs/yr)	MAX (lbs/hr)
106990	1,3-Butadiene	1	0	0	0
75070	Acetaldehyde	1	0	0	0
107028	Acrolein	1	0	0	0
7664417	Ammonia	1	0	0	0
7440382	Arsenic	1	0	0	0
1332214	Asbestos	1	0	0	0
71432	Benzene	1	0	0	0
7440417	Berylium	1	0	0	0
7440439	Cadmium	1	0	0	0
56235	Carbon Tetrachlo	1	0	0	0
7782505	Chlorine	1	0	0	0
18540299	Chromium (VI)	1	0	0	0
218019	Chrysene	1	0	0	0
7440508	Copper	1	0	0	0
9901	DPM	1	0	0	0
100414	Ethyl Benzene	1	0	10.2900000	0
111762	Ethylene glycol	1	0	0	0
109864	Ethylene glycol	1	0	0.08000000	0
106934	Ethylene Dibromi	1	0	0	0
107062	Ethylene Dichlor	1	0	0	0
50000	Formaldehyde	1	0	0	0
110543	Hexane	1	0	0	0
7647010	Hydrochloric Aci	1	0	0	0
7783064	Hydrogen Sulfide	1	0	0	0
7439921	Lead (inorganic)	1	0	0	0
71556	Methyl Chlorofor	1	0	0	0
1634044	Metyl Tertiary B	1	0	0	0
7439965	Manganese	1	0	0	0
7439976	Mercury	1	0	0	0
67561	Methanol	1	0	0	0
78933	Methyl Ethyl Ket	1	0	0	0
75092	Methylene Chlori	1	0	0	0
91203	Naphthalene	1	0	0.3900000	0
7440020	Nickel	1	0	0	0
1151	PAHs	1	0	0	0
127184	Perchloroethylen	1	0	0	0
107982	Propylene glycol	1	0	0	0
7782492	Selenium	1	0	0	0
100425	Styrene	1	0	0	0
7664939	Sulfuric Acid	1	0	0	0
108883	Toluene	1	0	0	0
79016	Trichloroethylen	1	0	0	0
75014	Vinyl Chloride	1	0	0	0
1330207	Xylene	1	0	0	0
108383	M-Xylene	1	0	0	0
95476	O-Xylene	1	0	0	0

EMISSIONS FOR FACILITY FAC=9999 DEV= PRO= STK=21 NAME=SRCGP21
SOURCE MULTIPLIER=1

CAS	ABBREV	MULTIPLIER	BG (ug/m^3)	AVRG (lbs/yr)	MAX (lbs/hr)
106990	1,3-Butadiene	1	0	0	0
75070	Acetaldehyde	1	0	0	0
107028	Acrolein	1	0	0	0

7664417	Ammonia	1	0	0	0
7440382	Arsenic	1	0	0	0
1332214	Asbestos	1	0	0	0
71432	Benzene	1	0	0	0
7440417	Berylium	1	0	0	0
7440439	Cadmium	1	0	0	0
56235	Carbon Tetrachlo	1	0	0	0
7782505	Chlorine	1	0	0	0
18540299	Chromium (VI)	1	0	0	0
218019	Chrysene	1	0	0	0
7440508	Copper	1	0	0	0
9901	DPM	1	0	0	0
100414	Ethyl Benzene	1	0	10.2900000	0
111762	Ethylene glycol	1	0	0	0
109864	Ethylene glycol	1	0	0.08000000	0
106934	Ethylene Dibromi	1	0	0	0
107062	Ethylene Dichlor	1	0	0	0
50000	Formaldehyde	1	0	0	0
110543	Hexane	1	0	0	0
7647010	Hydrochloric Aci	1	0	0	0
7783064	Hydrogen Sulfide	1	0	0	0
7439921	Lead (inorganic)	1	0	0	0
71556	Methyl Chlorofor	1	0	0	0
1634044	Metyl Tertiary B	1	0	0	0
7439965	Manganese	1	0	0	0
7439976	Mercury	1	0	0	0
67561	Methanol	1	0	0	0
78933	Methyl Ethyl Ket	1	0	0	0
75092	Methylene Chlori	1	0	0	0
91203	Naphthalene	1	0	0.4000000	0
7440020	Nickel	1	0	0	0
1151	PAHs	1	0	0	0
127184	Perchloroethylen	1	0	0	0
107982	Propylene glycol	1	0	0	0
7782492	Selenium	1	0	0	0
100425	Styrene	1	0	0	0
7664939	Sulfuric Acid	1	0	0	0
108883	Toluene	1	0	0	0
79016	Trichloroethylen	1	0	0	0
75014	Vinyl Chloride	1	0	0	0
1330207	Xylene	1	0	0	0
108383	M-Xylene	1	0	0	0
95476	O-Xylene	1	0	0	0

EMISSIONS FOR FACILITY FAC=9999 DEV= PRO= STK=22 NAME=SRCGP22
SOURCE MULTIPLIER=1

CAS	ABBREV	MULTIPLIER	BG (ug/m^3)	AVRG (lbs/yr)	MAX (lbs/hr)
106990	1,3-Butadiene	1	0	0	0
75070	Acetaldehyde	1	0	0	0
107028	Acrolein	1	0	0	0
7664417	Ammonia	1	0	0	0
7440382	Arsenic	1	0	0	0
1332214	Asbestos	1	0	0	0
71432	Benzene	1	0	0	0
7440417	Berylium	1	0	0	0
7440439	Cadmium	1	0	0	0
56235	Carbon Tetrachlo	1	0	0	0
7782505	Chlorine	1	0	0	0
18540299	Chromium (VI)	1	0	0	0
218019	Chrysene	1	0	0	0
7440508	Copper	1	0	0	0
9901	DPM	1	0	0	0

100414	Ethyl Benzene	1	0	10.2900000	0
111762	Ethylene glycol	1	0	0	0
109864	Ethylene glycol	1	0	0.08000000	0
106934	Ethylene Dibromi	1	0	0	0
107062	Ethylene Dichlor	1	0	0	0
50000	Formaldehyde	1	0	0	0
110543	Hexane	1	0	0	0
7647010	Hydrochloric Aci	1	0	0	0
7783064	Hydrogen Sulfide	1	0	0	0
7439921	Lead (inorganic)	1	0	0	0
71556	Methyl Chlorofor	1	0	0	0
1634044	Metyl Tertiary B	1	0	0	0
7439965	Manganese	1	0	0	0
7439976	Mercury	1	0	0	0
67561	Methanol	1	0	0	0
78933	Methyl Ethyl Ket	1	0	0	0
75092	Methylene Chlori	1	0	0	0
91203	Naphthalene	1	0	0.4000000	0
7440020	Nickel	1	0	0	0
1151	PAHs	1	0	0	0
127184	Perchloroethylen	1	0	0	0
107982	Propylene glycol	1	0	0	0
7782492	Selenium	1	0	0	0
100425	Styrene	1	0	0	0
7664939	Sulfuric Acid	1	0	0	0
108883	Toluene	1	0	0	0
79016	Trichloroethylen	1	0	0	0
75014	Vinyl Chloride	1	0	0	0
1330207	Xylene	1	0	0	0
108383	M-Xylene	1	0	0	0
95476	O-Xylene	1	0	0	0

EMISSIONS FOR FACILITY FAC=9999 DEV= PRO= STK=23 NAME=SRCGP23
SOURCE MULTIPLIER=1

CAS	ABBREV	MULTIPLIER	BG (ug/m^3)	AVRG (lbs/yr)	MAX (lbs/hr)
106990	1,3-Butadiene	1	0	0	0
75070	Acetaldehyde	1	0	0	0
107028	Acrolein	1	0	0	0
7664417	Ammonia	1	0	0	0
7440382	Arsenic	1	0	0	0
1332214	Asbestos	1	0	0	0
71432	Benzene	1	0	0	0
7440417	Berylium	1	0	0	0
7440439	Cadmium	1	0	0	0
56235	Carbon Tetrachlo	1	0	0	0
7782505	Chlorine	1	0	0	0
18540299	Chromium (VI)	1	0	0	0
218019	Chrysene	1	0	0	0
7440508	Copper	1	0	0	0
9901	DPM	1	0	0	0
100414	Ethyl Benzene	1	0	10.2900000	0
111762	Ethylene glycol	1	0	0	0
109864	Ethylene glycol	1	0	0.08000000	0
106934	Ethylene Dibromi	1	0	0	0
107062	Ethylene Dichlor	1	0	0	0
50000	Formaldehyde	1	0	0	0
110543	Hexane	1	0	0	0
7647010	Hydrochloric Aci	1	0	0	0
7783064	Hydrogen Sulfide	1	0	0	0
7439921	Lead (inorganic)	1	0	0	0
71556	Methyl Chlorofor	1	0	0	0
1634044	Metyl Tertiary B	1	0	0	0

7439965	Manganese	1	0	0	0
7439976	Mercury	1	0	0	0
67561	Methanol	1	0	0	0
78933	Methyl Ethyl Ket	1	0	0	0
75092	Methylene Chlori	1	0	0	0
91203	Naphthalene	1	0	0.4000000	0
7440020	Nickel	1	0	0	0
1151	PAHs	1	0	0	0
127184	Perchloroethylen	1	0	0	0
107982	Propylene glycol	1	0	0	0
7782492	Selenium	1	0	0	0
100425	Styrene	1	0	0	0
7664939	Sulfuric Acid	1	0	0	0
108883	Toluene	1	0	0	0
79016	Trichloroethylen	1	0	0	0
75014	Vinyl Chloride	1	0	0	0
1330207	Xylene	1	0	0	0
108383	M-Xylene	1	0	0	0
95476	O-Xylene	1	0	0	0

EMISSIONS FOR FACILITY FAC=9999 DEV= PRO= STK=24 NAME=SRCGP24
SOURCE MULTIPLIER=1

CAS	ABBREV	MULTIPLIER	BG (ug/m^3)	AVRG (lbs/yr)	MAX (lbs/hr)
106990	1,3-Butadiene	1	0	0	0
75070	Acetaldehyde	1	0	0	0
107028	Acrolein	1	0	0	0
7664417	Ammonia	1	0	0	0
7440382	Arsenic	1	0	0	0
1332214	Asbestos	1	0	0	0
71432	Benzene	1	0	0	0
7440417	Berylium	1	0	0	0
7440439	Cadmium	1	0	0	0
56235	Carbon Tetrachlo	1	0	0	0
7782505	Chlorine	1	0	0	0
18540299	Chromium (VI)	1	0	0	0
218019	Chrysene	1	0	0	0
7440508	Copper	1	0	0	0
9901	DPM	1	0	0	0
100414	Ethyl Benzene	1	0	10.2900000	0
111762	Ethylene glycol	1	0	0	0
109864	Ethylene glycol	1	0	0.08000000	0
106934	Ethylene Dibromi	1	0	0	0
107062	Ethylene Dichlor	1	0	0	0
50000	Formaldehyde	1	0	0	0
110543	Hexane	1	0	0	0
7647010	Hydrochloric Aci	1	0	0	0
7783064	Hydrogen Sulfide	1	0	0	0
7439921	Lead (inorganic)	1	0	0	0
71556	Methyl Chlorofor	1	0	0	0
1634044	Metyl Tertiary B	1	0	0	0
7439965	Manganese	1	0	0	0
7439976	Mercury	1	0	0	0
67561	Methanol	1	0	0	0
78933	Methyl Ethyl Ket	1	0	0	0
75092	Methylene Chlori	1	0	0	0
91203	Naphthalene	1	0	0.4000000	0
7440020	Nickel	1	0	0	0
1151	PAHs	1	0	0	0
127184	Perchloroethylen	1	0	0	0
107982	Propylene glycol	1	0	0	0
7782492	Selenium	1	0	0	0
100425	Styrene	1	0	0	0

7664939	Sulfuric Acid	1	0	0	0
108883	Toluene	1	0	0	0
79016	Trichloroethylen	1	0	0	0
75014	Vinyl Chloride	1	0	0	0
1330207	Xylene	1	0	0	0
108383	M-Xylene	1	0	0	0
95476	O-Xylene	1	0	0	0

EMISSIONS FOR FACILITY FAC=9999 DEV= PRO= STK=25 NAME=SRCGP25
SOURCE MULTIPLIER=1

CAS	ABBREV	MULTIPLIER	BG (ug/m^3)	AVRG (lbs/yr)	MAX (lbs/hr)
106990	1,3-Butadiene	1	0	0	0
75070	Acetaldehyde	1	0	0	0
107028	Acrolein	1	0	0	0
7664417	Ammonia	1	0	0	0
7440382	Arsenic	1	0	0	0
1332214	Asbestos	1	0	0	0
71432	Benzene	1	0	0	0
7440417	Berylium	1	0	0	0
7440439	Cadmium	1	0	0	0
56235	Carbon Tetrachlo	1	0	0	0
7782505	Chlorine	1	0	0	0
18540299	Chromium (VI)	1	0	0	0
218019	Chrysene	1	0	0	0
7440508	Copper	1	0	0	0
9901	DPM	1	0	0	0
100414	Ethyl Benzene	1	0	10.2900000	0
111762	Ethylene glycol	1	0	0	0
109864	Ethylene glycol	1	0	0.08000000	0
106934	Ethylene Dibromi	1	0	0	0
107062	Ethylene Dichlor	1	0	0	0
50000	Formaldehyde	1	0	0	0
110543	Hexane	1	0	0	0
7647010	Hydrochloric Aci	1	0	0	0
7783064	Hydrogen Sulfide	1	0	0	0
7439921	Lead (inorganic)	1	0	0	0
71556	Methyl Chlorofor	1	0	0	0
1634044	Metyl Tertiary B	1	0	0	0
7439965	Manganese	1	0	0	0
7439976	Mercury	1	0	0	0
67561	Methanol	1	0	0	0
78933	Methyl Ethyl Ket	1	0	0	0
75092	Methylene Chlori	1	0	0	0
91203	Naphthalene	1	0	0.4000000	0
7440020	Nickel	1	0	0	0
1151	PAHs	1	0	0	0
127184	Perchloroethylen	1	0	0	0
107982	Propylene glycol	1	0	0	0
7782492	Selenium	1	0	0	0
100425	Styrene	1	0	0	0
7664939	Sulfuric Acid	1	0	0	0
108883	Toluene	1	0	0	0
79016	Trichloroethylen	1	0	0	0
75014	Vinyl Chloride	1	0	0	0
1330207	Xylene	1	0	0	0
108383	M-Xylene	1	0	0	0
95476	O-Xylene	1	0	0	0

EMISSIONS FOR FACILITY FAC=9999 DEV= PRO= STK=26 NAME=SRCGP26
SOURCE MULTIPLIER=1

CAS	ABBREV	MULTIPLIER	BG (ug/m^3)	AVRG (lbs/yr)	MAX (lbs/hr)
106990	1,3-Butadiene	1	0	0	0

75070	Acetaldehyde	1	0	0	0
107028	Acrolein	1	0	0	0
7664417	Ammonia	1	0	0	0
7440382	Arsenic	1	0	0	0
1332214	Asbestos	1	0	0	0
71432	Benzene	1	0	0	0
7440417	Berylium	1	0	0	0
7440439	Cadmium	1	0	0	0
56235	Carbon Tetrachlo	1	0	0	0
7782505	Chlorine	1	0	0	0
18540299	Chromium (VI)	1	0	0	0
218019	Chrysene	1	0	0	0
7440508	Copper	1	0	0	0
9901	DPM	1	0	0	0
100414	Ethyl Benzene	1	0	10.2900000	0
111762	Ethylene glycol	1	0	0	0
109864	Ethylene glycol	1	0	0.08000000	0
106934	Ethylene Dibromi	1	0	0	0
107062	Ethylene Dichlor	1	0	0	0
50000	Formaldehyde	1	0	0	0
110543	Hexane	1	0	0	0
7647010	Hydrochloric Aci	1	0	0	0
7783064	Hydrogen Sulfide	1	0	0	0
7439921	Lead (inorganic)	1	0	0	0
71556	Methyl Chlorofor	1	0	0	0
1634044	Metyl Tertiary B	1	0	0	0
7439965	Manganese	1	0	0	0
7439976	Mercury	1	0	0	0
67561	Methanol	1	0	0	0
78933	Methyl Ethyl Ket	1	0	0	0
75092	Methylene Chlori	1	0	0	0
91203	Naphthalene	1	0	0.4000000	0
7440020	Nickel	1	0	0	0
1151	PAHs	1	0	0	0
127184	Perchloroethylen	1	0	0	0
107982	Propylene glycol	1	0	0	0
7782492	Selenium	1	0	0	0
100425	Styrene	1	0	0	0
7664939	Sulfuric Acid	1	0	0	0
108883	Toluene	1	0	0	0
79016	Trichloroethylen	1	0	0	0
75014	Vinyl Chloride	1	0	0	0
1330207	Xylene	1	0	0	0
108383	M-Xylene	1	0	0	0
95476	O-Xylene	1	0	0	0

EMISSIONS FOR FACILITY FAC=9999 DEV= PRO= STK=27 NAME=SRCGP27
SOURCE MULTIPLIER=1

CAS	ABBREV	MULTIPLIER	BG (ug/m^3)	AVRG (lbs/yr)	MAX (lbs/hr)
106990	1,3-Butadiene	1	0	0	0
75070	Acetaldehyde	1	0	0	0
107028	Acrolein	1	0	0	0
7664417	Ammonia	1	0	0	0
7440382	Arsenic	1	0	0	0
1332214	Asbestos	1	0	0	0
71432	Benzene	1	0	0	0
7440417	Berylium	1	0	0	0
7440439	Cadmium	1	0	0	0
56235	Carbon Tetrachlo	1	0	0	0
7782505	Chlorine	1	0	0	0
18540299	Chromium (VI)	1	0	0	0
218019	Chrysene	1	0	0	0

7440508	Copper	1	0	0	0
9901	DPM	1	0	0	0
100414	Ethyl Benzene	1	0	0	0
111762	Ethylene glycol	1	0	0	0
109864	Ethylene glycol	1	0	0	0
106934	Ethylene Dibromi	1	0	0	0
107062	Ethylene Dichlor	1	0	0	0
50000	Formaldehyde	1	0	0	0
110543	Hexane	1	0	0	0
7647010	Hydrochloric Aci	1	0	0	0
7783064	Hydrogen Sulfide	1	0	0	0
7439921	Lead (inorganic)	1	0	0	0
71556	Methyl Chlorofor	1	0	0	0
1634044	Metyl Tertiary B	1	0	0	0
7439965	Manganese	1	0	0	0
7439976	Mercury	1	0	0	0
67561	Methanol	1	0	0	0
78933	Methyl Ethyl Ket	1	0	0	0
75092	Methylene Chlori	1	0	0	0
91203	Naphthalene	1	0	3.1400000	0
7440020	Nickel	1	0	0	0
1151	PAHs	1	0	0	0
127184	Perchloroethylen	1	0	0	0
107982	Propylene glycol	1	0	0	0
7782492	Selenium	1	0	0	0
100425	Styrene	1	0	0	0
7664939	Sulfuric Acid	1	0	0	0
108883	Toluene	1	0	0	0
79016	Trichloroethylen	1	0	0	0
75014	Vinyl Chloride	1	0	0	0
1330207	Xylene	1	0	120.1200000	0.01000000
108383	M-Xylene	1	0	0	0
95476	O-Xylene	1	0	0	0

EMISSIONS FOR FACILITY FAC=9999 DEV= PRO= STK=28 NAME=SRCGP28
SOURCE MULTIPLIER=1

CAS	ABBREV	MULTIPLIER	BG (ug/m^3)	AVRG (lbs/yr)	MAX (lbs/hr)
106990	1,3-Butadiene	1	0	0	0
75070	Acetaldehyde	1	0	0	0
107028	Acrolein	1	0	0	0
7664417	Ammonia	1	0	0	0
7440382	Arsenic	1	0	0	0
1332214	Asbestos	1	0	0	0
71432	Benzene	1	0	0	0
7440417	Berylium	1	0	0	0
7440439	Cadmium	1	0	0	0
56235	Carbon Tetrachlo	1	0	0	0
7782505	Chlorine	1	0	0	0
18540299	Chromium (VI)	1	0	0	0
218019	Chrysene	1	0	0	0
7440508	Copper	1	0	0	0
9901	DPM	1	0	0	0
100414	Ethyl Benzene	1	0	0	0
111762	Ethylene glycol	1	0	0	0
109864	Ethylene glycol	1	0	0	0
106934	Ethylene Dibromi	1	0	0	0
107062	Ethylene Dichlor	1	0	0	0
50000	Formaldehyde	1	0	0	0
110543	Hexane	1	0	0	0
7647010	Hydrochloric Aci	1	0	0	0
7783064	Hydrogen Sulfide	1	0	0	0
7439921	Lead (inorganic)	1	0	0	0

71556	Methyl Chlorofor	1	0	0	0
1634044	Metyl Tertiary B	1	0	0	0
7439965	Manganese	1	0	0	0
7439976	Mercury	1	0	0	0
67561	Methanol	1	0	0	0
78933	Methyl Ethyl Ket	1	0	0	0
75092	Methylene Chlori	1	0	0	0
91203	Naphthalene	1	0	3.1400000	0
7440020	Nickel	1	0	0	0
1151	PAHs	1	0	0	0
127184	Perchloroethylen	1	0	0	0
107982	Propylene glycol	1	0	0	0
7782492	Selenium	1	0	0	0
100425	Styrene	1	0	0	0
7664939	Sulfuric Acid	1	0	0	0
108883	Toluene	1	0	0	0
79016	Trichloroethylen	1	0	0	0
75014	Vinyl Chloride	1	0	0	0
1330207	Xylene	1	0	120.1200000	0.01000000
108383	M-Xylene	1	0	0	0
95476	O-Xylene	1	0	0	0

EMISSIONS FOR FACILITY FAC=9999 DEV= PRO= STK=29 NAME=SRCGP29
SOURCE MULTIPLIER=1

CAS	ABBREV	MULTIPLIER	BG (ug/m^3)	AVRG (lbs/yr)	MAX (lbs/hr)
106990	1,3-Butadiene	1	0	0	0
75070	Acetaldehyde	1	0	0	0
107028	Acrolein	1	0	0	0
7664417	Ammonia	1	0	0	0
7440382	Arsenic	1	0	0	0
1332214	Asbestos	1	0	0	0
71432	Benzene	1	0	0	0
7440417	Berylium	1	0	0	0
7440439	Cadmium	1	0	0	0
56235	Carbon Tetrachlo	1	0	0	0
7782505	Chlorine	1	0	0	0
18540299	Chromium (VI)	1	0	0	0
218019	Chrysene	1	0	0	0
7440508	Copper	1	0	0	0
9901	DPM	1	0	0	0
100414	Ethyl Benzene	1	0	0	0
111762	Ethylene glycol	1	0	0	0
109864	Ethylene glycol	1	0	0	0
106934	Ethylene Dibromi	1	0	0	0
107062	Ethylene Dichlor	1	0	0	0
50000	Formaldehyde	1	0	0	0
110543	Hexane	1	0	0	0
7647010	Hydrochloric Aci	1	0	0	0
7783064	Hydrogen Sulfide	1	0	0	0
7439921	Lead (inorganic)	1	0	0	0
71556	Methyl Chlorofor	1	0	0	0
1634044	Metyl Tertiary B	1	0	0	0
7439965	Manganese	1	0	0	0
7439976	Mercury	1	0	0	0
67561	Methanol	1	0	0	0
78933	Methyl Ethyl Ket	1	0	0	0
75092	Methylene Chlori	1	0	0	0
91203	Naphthalene	1	0	3.1400000	0
7440020	Nickel	1	0	0	0
1151	PAHs	1	0	0	0
127184	Perchloroethylen	1	0	0	0
107982	Propylene glycol	1	0	0	0

7782492	Selenium	1	0	0	0
100425	Styrene	1	0	0	0
7664939	Sulfuric Acid	1	0	0	0
108883	Toluene	1	0	0	0
79016	Trichloroethylen	1	0	0	0
75014	Vinyl Chloride	1	0	0	0
1330207	Xylene	1	0	120.1200000	0.01000000
108383	M-Xylene	1	0	0	0
95476	O-Xylene	1	0	0	0

EMISSIONS FOR FACILITY FAC=9999 DEV= PRO= STK=30 NAME=SRCGP30
SOURCE MULTIPLIER=1

CAS	ABBREV	MULTIPLIER	BG (ug/m^3)	AVRG (lbs/yr)	MAX (lbs/hr)
106990	1,3-Butadiene	1	0	0	0
75070	Acetaldehyde	1	0	2926.4240000	0.3340667
107028	Acrolein	1	0	732.6700000	0.08363813
7664417	Ammonia	1	0	192607.4520000	21.9871521
7440382	Arsenic	1	0	0	0
1332214	Asbestos	1	0	0.8290000	0.00009463470
71432	Benzene	1	0	853.9590000	0.09748390
7440417	Berylium	1	0	2.4400000	0.0002785388
7440439	Cadmium	1	0	0	0
56235	Carbon Tetrachlo	1	0	0.2280000	0.00002602740
7782505	Chlorine	1	0	4.9090000	0.0005603881
18540299	Chromium (VI)	1	0	0	0
218019	Chrysene	1	0	0	0
7440508	Copper	1	0	0	0
9901	DPM	1	0	0	0
100414	Ethyl Benzene	1	0	1530.7840000	0.1747470
111762	Ethylene glycol	1	0	21.6780000	0.002474658
109864	Ethylene glycol	1	0	8.6100000	0.0009828767
106934	Ethylene Dibromi	1	0	0.2730000	0.00003116438
107062	Ethylene Dichlor	1	0	0.1440000	0.00001643836
50000	Formaldehyde	1	0	0	0
110543	Hexane	1	0	5730.6240000	0.6541808
7647010	Hydrochloric Aci	1	0	11.5130000	0.001314269
7783064	Hydrogen Sulfide	1	0	2298.9990000	0.2624428
7439921	Lead (inorganic)	1	0	0	0
71556	Methyl Chlorofor	1	0	0.8320000	0.00009497717
1634044	Metyl Tertiary B	1	0	1.2380000	0.0001413242
7439965	Manganese	1	0	0	0
7439976	Mercury	1	0	0	0
67561	Methanol	1	0	28520.0980000	3.2557189
78933	Methyl Ethyl Ket	1	0	862.2050000	0.09842523
75092	Methylene Chlori	1	0	0.5290000	0.00006038813
91203	Naphthalene	1	0	0	0
7440020	Nickel	1	0	0	0
1151	PAHs	1	0	0	0
127184	Perchloroethylen	1	0	276.6040000	0.03157580
107982	Propylene glycol	1	0	100.8300000	0.01151027
7782492	Selenium	1	0	0	0
100425	Styrene	1	0	17.7370000	0.002024772
7664939	Sulfuric Acid	1	0	37422.9340000	4.2720244
108883	Toluene	1	0	5705.2980000	0.6512897
79016	Trichloroethylen	1	0	2537.9800000	0.2897237
75014	Vinyl Chloride	1	0	0.09200000	0.00001050228
1330207	Xylene	1	0	7203.8050000	0.8223522
108383	M-Xylene	1	0	2.3310000	0.0002660959
95476	O-Xylene	1	0	0.8090000	0.00009235160

EMISSIONS FOR FACILITY FAC=9999 DEV= PRO= STK=31 NAME=SRCGP31
SOURCE MULTIPLIER=1

CAS	ABBREV	MULTIPLIER	BG (ug/m^3)	AVRG (lbs/yr)	MAX (lbs/hr)
106990	1,3-Butadiene	1	0	0	0
75070	Acetaldehyde	1	0	0	0
107028	Acrolein	1	0	0	0
7664417	Ammonia	1	0	0	0
7440382	Arsenic	1	0	0	0
1332214	Asbestos	1	0	0	0
71432	Benzene	1	0	0	0
7440417	Berylium	1	0	0	0
7440439	Cadmium	1	0	0	0
56235	Carbon Tetrachlo	1	0	0	0
7782505	Chlorine	1	0	0	0
18540299	Chromium (VI)	1	0	0	0
218019	Chrysene	1	0	0	0
7440508	Copper	1	0	0	0
9901	DPM	1	0	6.1494042	0.007764399
100414	Ethyl Benzene	1	0	0	0
111762	Ethylene glycol	1	0	0	0
109864	Ethylene glycol	1	0	0	0
106934	Ethylene Dibromi	1	0	0	0
107062	Ethylene Dichlor	1	0	0	0
50000	Formaldehyde	1	0	0	0
110543	Hexane	1	0	0	0
7647010	Hydrochloric Aci	1	0	0	0
7783064	Hydrogen Sulfide	1	0	0	0
7439921	Lead (inorganic)	1	0	0	0
71556	Methyl Chlorofor	1	0	0	0
1634044	Metyl Tertiary B	1	0	0	0
7439965	Manganese	1	0	0	0
7439976	Mercury	1	0	0	0
67561	Methanol	1	0	0	0
78933	Methyl Ethyl Ket	1	0	0	0
75092	Methylene Chlori	1	0	0	0
91203	Naphthalene	1	0	0	0
7440020	Nickel	1	0	0	0
1151	PAHs	1	0	0	0
127184	Perchloroethylen	1	0	0	0
107982	Propylene glycol	1	0	0	0
7782492	Selenium	1	0	0	0
100425	Styrene	1	0	0	0
7664939	Sulfuric Acid	1	0	0	0
108883	Toluene	1	0	0	0
79016	Trichloroethylen	1	0	0	0
75014	Vinyl Chloride	1	0	0	0
1330207	Xylene	1	0	0	0
108383	M-Xylene	1	0	0	0
95476	O-Xylene	1	0	0	0

EMISSIONS FOR FACILITY FAC=9999 DEV= PRO= STK=32 NAME=SRCGP32
SOURCE MULTIPLIER=1

CAS	ABBREV	MULTIPLIER	BG (ug/m^3)	AVRG (lbs/yr)	MAX (lbs/hr)
106990	1,3-Butadiene	1	0	2262.8820000	0.2583199
75070	Acetaldehyde	1	0	0	0
107028	Acrolein	1	0	0	0
7664417	Ammonia	1	0	0	0
7440382	Arsenic	1	0	8.3520000	0.0009534247
1332214	Asbestos	1	0	0	0
71432	Benzene	1	0	0	0
7440417	Berylium	1	0	0	0
7440439	Cadmium	1	0	11.0820000	0.001265068
56235	Carbon Tetrachlo	1	0	0	0
7782505	Chlorine	1	0	0	0

18540299	Chromium (VI)	1	0	1.9950000	0.0002277397
218019	Chrysene	1	0	0.04000000	0.00004566210
7440508	Copper	1	0	88.1720000	0.01006530
9901	DPM	1	0	0	0
100414	Ethyl Benzene	1	0	0	0
111762	Ethylene glycol	1	0	0	0
109864	Ethylene glycol	1	0	0	0
106934	Ethylene Dibromi	1	0	0	0
107062	Ethylene Dichlor	1	0	0	0
50000	Formaldehyde	1	0	2876.3620000	0.3283518
110543	Hexane	1	0	0	0
7647010	Hydrochloric Aci	1	0	0	0
7783064	Hydrogen Sulfide	1	0	0	0
7439921	Lead (inorganic)	1	0	25.3280000	0.002891324
71556	Methyl Chlorofor	1	0	0	0
1634044	Metyl Tertiary B	1	0	0	0
7439965	Manganese	1	0	468.8160000	0.05351781
7439976	Mercury	1	0	3.9570000	0.0004517123
67561	Methanol	1	0	0	0
78933	Methyl Ethyl Ket	1	0	0	0
75092	Methylene Chlori	1	0	0	0
91203	Naphthalene	1	0	552.8360000	0.06310913
7440020	Nickel	1	0	123.0220000	0.01404361
1151	PAHs	1	0	14.5250000	0.001658105
127184	Perchloroethylen	1	0	0	0
107982	Propylene glycol	1	0	0	0
7782492	Selenium	1	0	11.8760000	0.001355708
100425	Styrene	1	0	0	0
7664939	Sulfuric Acid	1	0	0	0
108883	Toluene	1	0	0	0
79016	Trichloroethylen	1	0	0	0
75014	Vinyl Chloride	1	0	0	0
1330207	Xylene	1	0	0	0
108383	M-Xylene	1	0	0	0
95476	O-Xylene	1	0	0	0

EMISSIONS FOR FACILITY FAC=9999 DEV= PRO= STK=33 NAME=SRCGP33
SOURCE MULTIPLIER=1

CAS	ABBREV	MULTIPLIER	BG (ug/m^3)	AVRG (lbs/yr)	MAX (lbs/hr)
106990	1,3-Butadiene	1	0	0	0
75070	Acetaldehyde	1	0	0	0
107028	Acrolein	1	0	0	0
7664417	Ammonia	1	0	0	0
7440382	Arsenic	1	0	0	0
1332214	Asbestos	1	0	0	0
71432	Benzene	1	0	0	0
7440417	Berylium	1	0	0	0
7440439	Cadmium	1	0	0	0
56235	Carbon Tetrachlo	1	0	0	0
7782505	Chlorine	1	0	0	0
18540299	Chromium (VI)	1	0	0	0
218019	Chrysene	1	0	0	0
7440508	Copper	1	0	0	0
9901	DPM	1	0	700.7160000	0.07999041
100414	Ethyl Benzene	1	0	0	0
111762	Ethylene glycol	1	0	0	0
109864	Ethylene glycol	1	0	0	0
106934	Ethylene Dibromi	1	0	0	0
107062	Ethylene Dichlor	1	0	0	0
50000	Formaldehyde	1	0	0	0
110543	Hexane	1	0	0	0
7647010	Hydrochloric Aci	1	0	0	0

7783064	Hydrogen Sulfide	1	0	0	0
7439921	Lead (inorganic)	1	0	0	0
71556	Methyl Chlorofor	1	0	0	0
1634044	Metyl Tertiary B	1	0	0	0
7439965	Manganese	1	0	0	0
7439976	Mercury	1	0	0	0
67561	Methanol	1	0	0	0
78933	Methyl Ethyl Ket	1	0	0	0
75092	Methylene Chlori	1	0	0	0
91203	Naphthalene	1	0	0	0
7440020	Nickel	1	0	0	0
1151	PAHs	1	0	0	0
127184	Perchloroethylen	1	0	0	0
107982	Propylene glycol	1	0	0	0
7782492	Selenium	1	0	0	0
100425	Styrene	1	0	0	0
7664939	Sulfuric Acid	1	0	0	0
108883	Toluene	1	0	0	0
79016	Trichloroethylen	1	0	0	0
75014	Vinyl Chloride	1	0	0	0
1330207	Xylene	1	0	0	0
108383	M-Xylene	1	0	0	0
95476	O-Xylene	1	0	0	0

CHRONIC HI REPORT

REC	CV	CNS	BONE	DEVEL	ENDO	EYE	GILV	IMMUN	KIDN	REPRO	RESP	SKIN	BLOOD	MAX
0001	3.27E-04	3.67E-03	0.00E+00	5.78E-04	1.27E-05	1.70E-05	4.48E-05	1.40E-03	4.47E-04	7.08E-05	1.68E-01	3.27E-04	1.50E-03	1.68E-01
0002	3.25E-04	3.66E-03	0.00E+00	5.89E-04	1.56E-05	1.80E-05	4.97E-05	1.49E-03	4.49E-04	7.12E-05	1.78E-01	3.25E-04	1.50E-03	1.78E-01
0003	3.35E-04	3.77E-03	0.00E+00	6.06E-04	2.24E-05	1.77E-05	5.59E-05	1.46E-03	4.68E-04	7.51E-05	1.76E-01	3.35E-04	1.54E-03	1.76E-01
0004	3.36E-04	3.79E-03	0.00E+00	6.21E-04	2.23E-05	1.92E-05	5.87E-05	1.58E-03	4.72E-04	7.53E-05	1.90E-01	3.36E-04	1.55E-03	1.90E-01
0005	3.39E-04	3.83E-03	0.00E+00	6.33E-04	2.24E-05	2.01E-05	6.04E-05	1.66E-03	4.77E-04	7.60E-05	1.99E-01	3.39E-04	1.56E-03	1.99E-01
0006	3.45E-04	3.90E-03	0.00E+00	6.49E-04	2.50E-05	2.06E-05	6.41E-05	1.70E-03	4.88E-04	7.79E-05	2.04E-01	3.45E-04	1.59E-03	2.04E-01
0007	3.51E-04	3.97E-03	0.00E+00	6.61E-04	2.40E-05	2.13E-05	6.44E-05	1.76E-03	4.95E-04	7.88E-05	2.11E-01	3.50E-04	1.62E-03	2.11E-01
0008	3.56E-04	4.03E-03	0.00E+00	6.75E-04	2.44E-05	2.21E-05	6.62E-05	1.82E-03	5.03E-04	8.00E-05	2.19E-01	3.55E-04	1.64E-03	2.19E-01
0009	3.58E-04	4.06E-03	0.00E+00	6.84E-04	2.20E-05	2.31E-05	6.57E-05	1.90E-03	5.05E-04	7.99E-05	2.28E-01	3.57E-04	1.66E-03	2.28E-01
0010	3.55E-04	4.05E-03	0.00E+00	6.96E-04	2.01E-05	2.48E-05	6.70E-05	2.05E-03	5.04E-04	7.90E-05	2.45E-01	3.55E-04	1.65E-03	2.45E-01
0011	3.65E-04	4.16E-03	0.00E+00	7.11E-04	2.04E-05	2.51E-05	6.79E-05	2.07E-03	5.16E-04	8.10E-05	2.48E-01	3.64E-04	1.69E-03	2.48E-01
0012	3.76E-04	4.28E-03	0.00E+00	7.25E-04	2.18E-05	2.50E-05	6.89E-05	2.06E-03	5.32E-04	8.37E-05	2.46E-01	3.76E-04	1.75E-03	2.46E-01
0013	3.83E-04	4.35E-03	0.00E+00	7.45E-04	2.41E-05	2.60E-05	7.32E-05	2.14E-03	5.43E-04	8.57E-05	2.56E-01	3.82E-04	1.78E-03	2.56E-01
0014	3.78E-04	4.33E-03	0.00E+00	7.63E-04	2.72E-05	2.82E-05	8.04E-05	2.32E-03	5.45E-04	8.57E-05	2.78E-01	3.78E-04	1.76E-03	2.78E-01
0015	3.81E-04	4.37E-03	0.00E+00	7.90E-04	3.73E-05	2.96E-05	9.31E-05	2.44E-03	5.61E-04	8.89E-05	2.91E-01	3.80E-04	1.78E-03	2.91E-01
0016	3.78E-04	4.37E-03	0.00E+00	7.93E-04	2.30E-05	3.17E-05	8.29E-05	2.62E-03	5.47E-04	8.48E-05	3.12E-01	3.77E-04	1.77E-03	3.12E-01
0017	3.75E-04	4.36E-03	0.00E+00	8.04E-04	1.90E-05	3.37E-05	8.24E-05	2.77E-03	5.43E-04	8.33E-05	3.31E-01	3.75E-04	1.77E-03	3.31E-01
0018	3.77E-04	4.40E-03	0.00E+00	8.18E-04	1.66E-05	3.52E-05	8.28E-05	2.90E-03	5.47E-04	8.33E-05	3.46E-01	3.77E-04	1.78E-03	3.46E-01
0019	3.81E-04	4.45E-03	0.00E+00	8.31E-04	1.52E-05	3.63E-05	8.36E-05	2.99E-03	5.51E-04	8.36E-05	3.56E-01	3.80E-04	1.80E-03	3.56E-01
0020	3.83E-04	4.49E-03	0.00E+00	8.47E-04	1.43E-05	3.76E-05	8.51E-05	3.10E-03	5.56E-04	8.40E-05	3.69E-01	3.83E-04	1.82E-03	3.69E-01
0021	3.84E-04	4.52E-03	0.00E+00	8.66E-04	1.37E-05	3.95E-05	8.81E-05	3.26E-03	5.60E-04	8.42E-05	3.88E-01	3.84E-04	1.83E-03	3.88E-01
0022	3.86E-04	4.55E-03	0.00E+00	8.75E-04	1.32E-05	4.03E-05	8.90E-05	3.32E-03	5.63E-04	8.45E-05	3.96E-01	3.85E-04	1.84E-03	3.96E-01
0023	3.34E-04	3.78E-03	0.00E+00	6.20E-04	1.12E-05	2.06E-05	5.02E-05	1.70E-03	4.60E-04	7.20E-05	2.04E-01	3.33E-04	1.54E-03	2.04E-01
0024	3.29E-04	3.72E-03	0.00E+00	6.02E-04	1.33E-05	1.90E-05	4.93E-05	1.57E-03	4.54E-04	7.16E-05	1.88E-01	3.29E-04	1.52E-03	1.88E-01
0025	3.34E-04	3.78E-03	0.00E+00	6.26E-04	1.71E-05	2.06E-05	5.60E-05	1.70E-03	4.66E-04	7.36E-05	2.03E-01	3.33E-04	1.54E-03	2.03E-01
0026	3.42E-04	3.89E-03	0.00E+00	6.52E-04	1.37E-05	2.25E-05	5.63E-05	1.86E-03	4.77E-04	7.46E-05	2.22E-01	3.42E-04	1.59E-03	2.22E-01
0027	3.48E-04	3.97E-03	0.00E+00	6.82E-04	1.53E-05	2.49E-05	6.23E-05	2.05E-03	4.90E-04	7.62E-05	2.45E-01	3.47E-04	1.62E-03	2.45E-01
0028	3.56E-04	4.08E-03	0.00E+00	7.12E-04	1.58E-05	2.68E-05	6.65E-05	2.21E-03	5.04E-04	7.82E-05	2.64E-01	3.56E-04	1.66E-03	2.64E-01
0029	3.64E-04	4.19E-03	0.00E+00	7.37E-04	1.70E-05	2.84E-05	7.05E-05	2.34E-03	5.18E-04	8.02E-05	2.79E-01	3.64E-04	1.70E-03	2.79E-01
0030	3.66E-04	4.24E-03	0.00E+00	7.68E-04	1.80E-05	3.11E-05	7.67E-05	2.56E-03	5.27E-04	8.12E-05	3.06E-01	3.66E-04	1.72E-03	3.06E-01
0031	3.73E-04	4.33E-03	0.00E+00	7.94E-04	1.67E-05	3.31E-05	7.92E-05	2.73E-03	5.38E-04	8.23E-05	3.26E-01	3.73E-04	1.76E-03	3.26E-01
0032	3.78E-04	4.41E-03	0.00E+00	8.17E-04	1.54E-05	3.50E-05	8.15E-05	2.89E-03	5.46E-04	8.30E-05	3.45E-01	3.77E-04	1.79E-03	3.45E-01
0033	3.82E-04	4.47E-03	0.00E+00	8.36E-04	1.33E-05	3.68E-05	8.26E-05	3.03E-03	5.52E-04	8.34E-05	3.62E-01	3.81E-04	1.81E-03	3.62E-01
0034	3.78E-04	4.40E-03	0.00E+00	8.04E-04	1.19E-05	3.40E-05	7.60E-05	2.80E-03	5.41E-04	8.22E-05	3.34E-01	3.78E-04	1.78E-03	3.34E-01
0035	3.72E-04	4.32E-03	0.00E+00	7.81E-04	1.33E-05	3.23E-05	7.42E-05	2.66E-03	5.32E-04	8.12E-05	3.18E-01	3.72E-04	1.75E-03	3.18E-01
0036	3.66E-04	4.23E-03	0.00E+00	7.52E-04	1.36E-05	3.00E-05	7.02E-05	2.47E-03	5.20E-04	7.99E-05	2.95E-01	3.66E-04	1.72E-03	2.95E-01

0037	3.59E-04	4.13E-03	0.00E+00	7.21E-04	1.31E-05	2.77E-05	6.53E-05	2.28E-03	5.07E-04	7.82E-05	2.72E-01	3.59E-04	1.68E-03	2.72E-01
0038	3.53E-04	4.03E-03	0.00E+00	6.90E-04	1.23E-05	2.54E-05	6.02E-05	2.09E-03	4.94E-04	7.65E-05	2.50E-01	3.52E-04	1.64E-03	2.50E-01
0039	3.46E-04	3.94E-03	0.00E+00	6.64E-04	1.12E-05	2.35E-05	5.56E-05	1.94E-03	4.82E-04	7.48E-05	2.32E-01	3.46E-04	1.61E-03	2.32E-01
0040	3.41E-04	3.86E-03	0.00E+00	6.36E-04	1.00E-05	2.15E-05	5.07E-05	1.77E-03	4.69E-04	7.32E-05	2.12E-01	3.40E-04	1.58E-03	2.12E-01
0041	3.45E-04	3.91E-03	0.00E+00	6.50E-04	9.11E-06	2.26E-05	5.17E-05	1.86E-03	4.75E-04	7.38E-05	2.23E-01	3.44E-04	1.60E-03	2.23E-01
0042	3.52E-04	4.02E-03	0.00E+00	6.82E-04	1.01E-05	2.48E-05	5.69E-05	2.05E-03	4.90E-04	7.58E-05	2.45E-01	3.52E-04	1.64E-03	2.45E-01
0043	3.58E-04	4.11E-03	0.00E+00	7.12E-04	1.08E-05	2.71E-05	6.19E-05	2.23E-03	5.02E-04	7.73E-05	2.67E-01	3.58E-04	1.67E-03	2.67E-01
0044	3.65E-04	4.20E-03	0.00E+00	7.43E-04	1.11E-05	2.94E-05	6.66E-05	2.42E-03	5.15E-04	7.89E-05	2.89E-01	3.64E-04	1.71E-03	2.89E-01
0045	3.73E-04	4.32E-03	0.00E+00	7.76E-04	1.10E-05	3.19E-05	7.11E-05	2.63E-03	5.29E-04	8.07E-05	3.14E-01	3.72E-04	1.75E-03	3.14E-01
0046	3.66E-04	4.22E-03	0.00E+00	7.47E-04	1.00E-05	2.99E-05	6.64E-05	2.46E-03	5.16E-04	7.88E-05	2.94E-01	3.65E-04	1.71E-03	2.94E-01
0047	3.56E-04	4.09E-03	0.00E+00	7.13E-04	9.62E-06	2.76E-05	6.17E-05	2.27E-03	4.99E-04	7.66E-05	2.72E-01	3.55E-04	1.66E-03	2.72E-01
0048	3.52E-04	4.02E-03	0.00E+00	6.84E-04	9.15E-06	2.51E-05	5.66E-05	2.07E-03	4.89E-04	7.55E-05	2.48E-01	3.51E-04	1.64E-03	2.48E-01
0049	3.47E-04	3.95E-03	0.00E+00	6.61E-04	8.56E-06	2.34E-05	5.28E-05	1.93E-03	4.80E-04	7.43E-05	2.31E-01	3.47E-04	1.61E-03	2.31E-01
0050	3.27E-04	3.68E-03	0.00E+00	5.90E-04	1.12E-05	1.83E-05	4.59E-05	1.51E-03	4.48E-04	7.05E-05	1.81E-01	3.26E-04	1.50E-03	1.81E-01
0051	3.32E-04	3.75E-03	0.00E+00	6.06E-04	1.01E-05	1.95E-05	4.70E-05	1.61E-03	4.55E-04	7.13E-05	1.93E-01	3.32E-04	1.53E-03	1.93E-01
0052	3.37E-04	3.81E-03	0.00E+00	6.21E-04	9.24E-06	2.05E-05	4.81E-05	1.69E-03	4.62E-04	7.21E-05	2.03E-01	3.36E-04	1.56E-03	2.03E-01
0053	3.41E-04	3.87E-03	0.00E+00	6.37E-04	8.66E-06	2.17E-05	4.96E-05	1.79E-03	4.69E-04	7.29E-05	2.14E-01	3.41E-04	1.58E-03	2.14E-01
0054	3.44E-04	3.91E-03	0.00E+00	6.48E-04	8.12E-06	2.25E-05	5.06E-05	1.85E-03	4.73E-04	7.34E-05	2.22E-01	3.43E-04	1.59E-03	2.22E-01

This file: c:\HARP\projects\demo\Rep_Acu_AllRec_AllSrc_AllCh_ByRec.txt

Created by HARP Version 1.4d Build 23.09.07
Uses ISC Version 99155
Uses BPIP (Dated: 04112)
Creation date: 6/20/2011 12:01:29 PM

EXCEPTION REPORT
(there have been no changes or exceptions)

INPUT FILES:
Source-Receptor file: C:\Users\dwaymire\Documents\Bluescape\Projects\Ponte Vista\Modeling\061611 Modeling\PVHRA616.SRC
Averaging period adjustment factors file: not applicable
Emission rates file: none
Site parameters file: c:\HARP\projects\demo\project.sit

Coordinate system: UTM NAD27

Screening mode is OFF

Analysis method: Point Estimate
Health effect: Acute HI Simple (Concurrent Max.)
Receptor(s): All
Sources(s): All
Chemicals(s): All

CHEMICAL CROSS-REFERENCE TABLE AND BACKGROUND CONCENTRATIONS

CHEM	CAS	ABBREVIATION	POLLUTANT NAME	BACKGROUND (ug/m^3)
0001	106990	1,3-Butadiene	1,3-Butadiene	0.000E+00
0002	75070	Acetaldehyde	Acetaldehyde	0.000E+00
0003	107028	Acrolein	Acrolein	0.000E+00
0004	7664417	NH3	Ammonia	0.000E+00
0005	7440382	Arsenic	Arsenic	0.000E+00
0006	1332214	Asbestos	Asbestos	0.000E+00
0007	71432	Benzene	Benzene	0.000E+00
0008	7440417	Beryllium	Beryllium	0.000E+00
0009	7440439	Cadmium	Cadmium	0.000E+00
0010	56235	CCl4	Carbon tetrachloride	0.000E+00
0011	7782505	Chlorine	Chlorine	0.000E+00
0012	18540299	Cr(VI)	Chromium, hexavalent (& compounds)	0.000E+00
0013	218019	Chrysene	Chrysene	0.000E+00
0014	7440508	Copper	Copper	0.000E+00
0015	9901	DieselExhPM	Diesel engine exhaust, particulate matter (Diesel PM)	0.000E+00
0016	100414	Ethyl Benzene	Ethyl benzene	0.000E+00
0017	111762	EGBE	Ethylene glycol monobutyl ether	0.000E+00
0018	109864	EGME	Ethylene glycol monomethyl ether	0.000E+00
0019	106934	EDB	Ethylene dibromide {EDB}	0.000E+00
0020	107062	EDC	Ethylene dichloride {EDC}	0.000E+00
0021	50000	Formaldehyde	Formaldehyde	0.000E+00
0022	110543	Hexane	Hexane	0.000E+00
0023	7647010	HCl	Hydrochloric acid	0.000E+00
0024	7783064	H2S	Hydrogen sulfide	0.000E+00
0025	7439921	Lead	Lead	0.000E+00
0026	71556	1,1,1-TCA	Methyl chloroform {1,1,1-Trichloroethane}	0.000E+00
0027	1634044	Me t-ButylEther	Methyl tert-butyl ether	0.000E+00
0028	7439965	Manganese	Manganese	0.000E+00
0029	7439976	Mercury	Mercury	0.000E+00
0030	67561	Methanol	Methanol	0.000E+00
0031	78933	MEK	Methyl ethyl ketone {2-Butanone}	0.000E+00
0032	75092	Methylene Chlor	Methylene chloride {Dichloromethane}	0.000E+00
0033	91203	Naphthalene	Naphthalene	0.000E+00

0034	7440020	Nickel	Nickel	0.000E+00
0035	1151	PAHs-w/o	PAHs, total, w/o individ. components reported [Treated as B(a)P for HRA]	0.000E+00
0036	127184	Perc	Perchloroethylene {Tetrachloroethene}	0.000E+00
0037	107982	PGME	Propylene glycol monomethyl ether	0.000E+00
0038	7782492	Selenium	Selenium	0.000E+00
0039	100425	Styrene	Styrene	0.000E+00
0040	7664939	Sulfuric Acid	Sulfuric acid	0.000E+00
0041	108883	Toluene	Toluene	0.000E+00
0042	79016	TCE	Trichloroethylene	0.000E+00
0043	75014	Vinyl Chloride	Vinyl chloride	0.000E+00
0044	1330207	Xylenes	Xylenes (mixed)	0.000E+00
0045	108383	m-Xylene	m-Xylene	0.000E+00
0046	95476	o-Xylene	o-Xylene	0.000E+00

CHEMICAL HEALTH VALUES

CHEM	CAS	ABBREVIATION	CancerPF(Inh) (mg/kg-d)^-1	CancerPF(Oral) (mg/kg-d)^-1	ChronicREL(Inh) ug/m^3	ChronicREL(Oral) mg/kg-d	AcuteREL ug/m^3
0001	106990	1,3-Butadiene	6.00E-01	*	2.00E+01	*	*
0002	75070	Acetaldehyde	1.00E-02	*	1.40E+02	*	4.70E+02
0003	107028	Acrolein	*	*	3.50E-01	*	2.50E+00
0004	7664417	NH3	*	*	2.00E+02	*	3.20E+03
0005	7440382	Arsenic	1.20E+01	1.50E+00	1.50E-02	3.50E-06	2.00E-01
0006	1332214	Asbestos	2.20E+02	*	*	*	*
0007	71432	Benzene	1.00E-01	*	6.00E+01	*	1.30E+03
0008	7440417	Beryllium	8.40E+00	*	7.00E-03	2.00E-03	*
0009	7440439	Cadmium	1.50E+01	*	2.00E-02	5.00E-04	*
0010	56235	CCl4	1.50E-01	*	4.00E+01	*	1.90E+03
0011	7782505	Chlorine	*	*	2.00E-01	*	2.10E+02
0012	18540299	Cr(VI)	5.10E+02	*	2.00E-01	2.00E-02	*
0013	218019	Chrysene	3.90E-02	1.20E-01	*	*	*
0014	7440508	Copper	*	*	*	*	1.00E+02
0015	9901	DieselExhPM	1.10E+00	*	5.00E+00	*	*
0016	100414	Ethyl Benzene	8.70E-03	*	2.00E+03	*	*
0017	111762	EGBE	*	*	*	*	1.40E+04
0018	109864	EGME	*	*	6.00E+01	*	9.30E+01
0019	106934	EDB	2.50E-01	*	8.00E-01	*	*
0020	107062	EDC	7.20E-02	*	4.00E+02	*	*
0021	50000	Formaldehyde	2.10E-02	*	9.00E+00	*	5.50E+01
0022	110543	Hexane	*	*	7.00E+03	*	*
0023	7647010	HCl	*	*	9.00E+00	*	2.10E+03
0024	7783064	H2S	*	*	1.00E+01	*	4.20E+01
0025	7439921	Lead	4.20E-02	8.50E-03	*	*	*
0026	71556	1,1,1-TCA	*	*	1.00E+03	*	6.80E+04
0027	1634044	Me t-ButylEther	1.80E-03	*	8.00E+03	*	*
0028	7439965	Manganese	*	*	9.00E-02	*	*
0029	7439976	Mercury	*	*	3.00E-02	1.60E-04	6.00E-01
0030	67561	Methanol	*	*	4.00E+03	*	2.80E+04
0031	78933	MEK	*	*	*	*	1.30E+04
0032	75092	Methylene Chlor	3.50E-03	*	4.00E+02	*	1.40E+04
0033	91203	Naphthalene	1.20E-01	*	9.00E+00	*	*
0034	7440020	Nickel	9.10E-01	*	5.00E-02	5.00E-02	6.00E+00
0035	1151	PAHs-w/o	3.90E+00	1.20E+01	*	*	*
0036	127184	Perc	2.10E-02	*	3.50E+01	*	2.00E+04
0037	107982	PGME	*	*	7.00E+03	*	*
0038	7782492	Selenium	*	*	2.00E+01	*	*
0039	100425	Styrene	*	*	9.00E+02	*	2.10E+04
0040	7664939	Sulfuric Acid	*	*	1.00E+00	*	1.20E+02
0041	108883	Toluene	*	*	3.00E+02	*	3.70E+04
0042	79016	TCE	7.00E-03	*	6.00E+02	*	*
0043	75014	Vinyl Chloride	2.70E-01	*	*	*	1.80E+05
0044	1330207	Xylenes	*	*	7.00E+02	*	2.20E+04

0045	108383	m-Xylene	*	*	7.00E+02	*	2.20E+04
0046	95476	o-Xylene	*	*	7.00E+02	*	2.20E+04

EMISSIONS DATA SOURCE: Emission rates loaded from file: C:\Users\dwaymire\Documents\Bluescape\Projects\Ponte Vista\Modeling\061611 Modeling\PV_HRA.ems
EMISSION RATES HAVE BEEN MANUALLY EDITED BY USER
CHEMICALS ADDED OR DELETED: none

EMISSIONS FOR FACILITY FAC=9999 DEV= PRO= STK=1 NAME=SRCGP1
SOURCE MULTIPLIER=1

CAS	ABBREV	MULTIPLIER	BG (ug/m^3)	AVRG (lbs/yr)	MAX (lbs/hr)
106990	1,3-Butadiene	1	0	0	0
75070	Acetaldehyde	1	0	0	0
107028	Acrolein	1	0	0	0
7664417	Ammonia	1	0	0	0
7440382	Arsenic	1	0	0	0
1332214	Asbestos	1	0	0	0
71432	Benzene	1	0	0	0
7440417	Berylium	1	0	0	0
7440439	Cadmium	1	0	0	0
56235	Carbon Tetrachlo	1	0	0	0
7782505	Chlorine	1	0	0	0
18540299	Chromium (VI)	1	0	0	0
218019	Chrysene	1	0	0	0
7440508	Copper	1	0	0	0
9901	DPM	1	0	0	0
100414	Ethyl Benzene	1	0	10.2900000	0
111762	Ethylene glycol	1	0	0	0
109864	Ethylene glycol	1	0	0.08000000	0
106934	Ethylene Dibromi	1	0	0	0
107062	Ethylene Dichlor	1	0	0	0
50000	Formaldehyde	1	0	0	0
110543	Hexane	1	0	0	0
7647010	Hydrochloric Aci	1	0	0	0
7783064	Hydrogen Sulfide	1	0	0	0
7439921	Lead (inorganic)	1	0	0	0
71556	Methyl Chlorofor	1	0	0	0
1634044	Metyl Tertiary B	1	0	0	0
7439965	Manganese	1	0	0	0
7439976	Mercury	1	0	0	0
67561	Methanol	1	0	0	0
78933	Methyl Ethyl Ket	1	0	0	0
75092	Methylene Chlori	1	0	0	0
91203	Naphthalene	1	0	0.3900000	0
7440020	Nickel	1	0	0	0
1151	PAHs	1	0	0	0
127184	Perchloroethylen	1	0	0	0
107982	Propylene glycol	1	0	0	0
7782492	Selenium	1	0	0	0
100425	Styrene	1	0	0	0
7664939	Sulfuric Acid	1	0	0	0
108883	Toluene	1	0	0	0
79016	Trichloroethylen	1	0	0	0
75014	Vinyl Chloride	1	0	0	0
1330207	Xylene	1	0	0	0
108383	M-Xylene	1	0	0	0
95476	O-Xylene	1	0	0	0

EMISSIONS FOR FACILITY FAC=9999 DEV= PRO= STK=2 NAME=SRCGP2
SOURCE MULTIPLIER=1

CAS	ABBREV	MULTIPLIER	BG (ug/m^3)	AVRG (lbs/yr)	MAX (lbs/hr)
106990	1,3-Butadiene	1	0	0	0
75070	Acetaldehyde	1	0	0	0

107028	Acrolein	1	0	0	0
7664417	Ammonia	1	0	0	0
7440382	Arsenic	1	0	0	0
1332214	Asbestos	1	0	0	0
71432	Benzene	1	0	0	0
7440417	Berylium	1	0	0	0
7440439	Cadmium	1	0	0	0
56235	Carbon Tetrachlo	1	0	0	0
7782505	Chlorine	1	0	0	0
18540299	Chromium (VI)	1	0	0	0
218019	Chrysene	1	0	0	0
7440508	Copper	1	0	0	0
9901	DPM	1	0	0	0
100414	Ethyl Benzene	1	0	10.2900000	0
111762	Ethylene glycol	1	0	0	0
109864	Ethylene glycol	1	0	0.08000000	0
106934	Ethylene Dibromi	1	0	0	0
107062	Ethylene Dichlor	1	0	0	0
50000	Formaldehyde	1	0	0	0
110543	Hexane	1	0	0	0
7647010	Hydrochloric Aci	1	0	0	0
7783064	Hydrogen Sulfide	1	0	0	0
7439921	Lead (inorganic)	1	0	0	0
71556	Methyl Chlorofor	1	0	0	0
1634044	Metyl Tertiary B	1	0	0	0
7439965	Manganese	1	0	0	0
7439976	Mercury	1	0	0	0
67561	Methanol	1	0	0	0
78933	Methyl Ethyl Ket	1	0	0	0
75092	Methylene Chlori	1	0	0	0
91203	Naphthalene	1	0	0.3900000	0
7440020	Nickel	1	0	0	0
1151	PAHs	1	0	0	0
127184	Perchloroethylen	1	0	0	0
107982	Propylene glycol	1	0	0	0
7782492	Selenium	1	0	0	0
100425	Styrene	1	0	0	0
7664939	Sulfuric Acid	1	0	0	0
108883	Toluene	1	0	0	0
79016	Trichloroethylen	1	0	0	0
75014	Vinyl Chloride	1	0	0	0
1330207	Xylene	1	0	0	0
108383	M-Xylene	1	0	0	0
95476	O-Xylene	1	0	0	0

EMISSIONS FOR FACILITY FAC=9999 DEV= PRO= STK=3 NAME=SRCGP3
SOURCE MULTIPLIER=1

CAS	ABBREV	MULTIPLIER	BG (ug/m^3)	AVRG (lbs/yr)	MAX (lbs/hr)
106990	1,3-Butadiene	1	0	0	0
75070	Acetaldehyde	1	0	0	0
107028	Acrolein	1	0	0	0
7664417	Ammonia	1	0	0	0
7440382	Arsenic	1	0	0	0
1332214	Asbestos	1	0	0	0
71432	Benzene	1	0	0	0
7440417	Berylium	1	0	0	0
7440439	Cadmium	1	0	0	0
56235	Carbon Tetrachlo	1	0	0	0
7782505	Chlorine	1	0	0	0
18540299	Chromium (VI)	1	0	0	0
218019	Chrysene	1	0	0	0
7440508	Copper	1	0	0	0

9901	DPM	1	0	0	0
100414	Ethyl Benzene	1	0	10.2900000	0
111762	Ethylene glycol	1	0	0	0
109864	Ethylene glycol	1	0	0.08000000	0
106934	Ethylene Dibromi	1	0	0	0
107062	Ethylene Dichlor	1	0	0	0
50000	Formaldehyde	1	0	0	0
110543	Hexane	1	0	0	0
7647010	Hydrochloric Aci	1	0	0	0
7783064	Hydrogen Sulfide	1	0	0	0
7439921	Lead (inorganic)	1	0	0	0
71556	Methyl Chlorofor	1	0	0	0
1634044	Metyl Tertiary B	1	0	0	0
7439965	Manganese	1	0	0	0
7439976	Mercury	1	0	0	0
67561	Methanol	1	0	0	0
78933	Methyl Ethyl Ket	1	0	0	0
75092	Methylene Chlori	1	0	0	0
91203	Naphthalene	1	0	0.3900000	0
7440020	Nickel	1	0	0	0
1151	PAHs	1	0	0	0
127184	Perchloroethylen	1	0	0	0
107982	Propylene glycol	1	0	0	0
7782492	Selenium	1	0	0	0
100425	Styrene	1	0	0	0
7664939	Sulfuric Acid	1	0	0	0
108883	Toluene	1	0	0	0
79016	Trichloroethylen	1	0	0	0
75014	Vinyl Chloride	1	0	0	0
1330207	Xylene	1	0	0	0
108383	M-Xylene	1	0	0	0
95476	O-Xylene	1	0	0	0

EMISSIONS FOR FACILITY FAC=9999 DEV= PRO= STK=4 NAME=SRCGP4
SOURCE MULTIPLIER=1

CAS	ABBREV	MULTIPLIER	BG (ug/m^3)	AVRG (lbs/yr)	MAX (lbs/hr)
106990	1,3-Butadiene	1	0	0	0
75070	Acetaldehyde	1	0	0	0
107028	Acrolein	1	0	0	0
7664417	Ammonia	1	0	0	0
7440382	Arsenic	1	0	0	0
1332214	Asbestos	1	0	0	0
71432	Benzene	1	0	0	0
7440417	Berylium	1	0	0	0
7440439	Cadmium	1	0	0	0
56235	Carbon Tetrachlo	1	0	0	0
7782505	Chlorine	1	0	0	0
18540299	Chromium (VI)	1	0	0	0
218019	Chrysene	1	0	0	0
7440508	Copper	1	0	0	0
9901	DPM	1	0	0	0
100414	Ethyl Benzene	1	0	10.2900000	0
111762	Ethylene glycol	1	0	0	0
109864	Ethylene glycol	1	0	0.08000000	0
106934	Ethylene Dibromi	1	0	0	0
107062	Ethylene Dichlor	1	0	0	0
50000	Formaldehyde	1	0	0	0
110543	Hexane	1	0	0	0
7647010	Hydrochloric Aci	1	0	0	0
7783064	Hydrogen Sulfide	1	0	0	0
7439921	Lead (inorganic)	1	0	0	0
71556	Methyl Chlorofor	1	0	0	0

1634044	Metyl Tertiary B	1	0	0	0
7439965	Manganese	1	0	0	0
7439976	Mercury	1	0	0	0
67561	Methanol	1	0	0	0
78933	Methyl Ethyl Ket	1	0	0	0
75092	Methylene Chlori	1	0	0	0
91203	Naphthalene	1	0	0.3900000	0
7440020	Nickel	1	0	0	0
1151	PAHs	1	0	0	0
127184	Perchloroethylen	1	0	0	0
107982	Propylene glycol	1	0	0	0
7782492	Selenium	1	0	0	0
100425	Styrene	1	0	0	0
7664939	Sulfuric Acid	1	0	0	0
108883	Toluene	1	0	0	0
79016	Trichloroethylen	1	0	0	0
75014	Vinyl Chloride	1	0	0	0
1330207	Xylene	1	0	0	0
108383	M-Xylene	1	0	0	0
95476	O-Xylene	1	0	0	0

EMISSIONS FOR FACILITY FAC=9999 DEV= PRO= STK=5 NAME=SRCGP5
SOURCE MULTIPLIER=1

CAS	ABBREV	MULTIPLIER	BG (ug/m^3)	AVRG (lbs/yr)	MAX (lbs/hr)
106990	1,3-Butadiene	1	0	0	0
75070	Acetaldehyde	1	0	0	0
107028	Acrolein	1	0	0	0
7664417	Ammonia	1	0	0	0
7440382	Arsenic	1	0	0	0
1332214	Asbestos	1	0	0	0
71432	Benzene	1	0	0	0
7440417	Berylium	1	0	0	0
7440439	Cadmium	1	0	0	0
56235	Carbon Tetrachlo	1	0	0	0
7782505	Chlorine	1	0	0	0
18540299	Chromium (VI)	1	0	0	0
218019	Chrysene	1	0	0	0
7440508	Copper	1	0	0	0
9901	DPM	1	0	0	0
100414	Ethyl Benzene	1	0	10.2900000	0
111762	Ethylene glycol	1	0	0	0
109864	Ethylene glycol	1	0	0.08000000	0
106934	Ethylene Dibromi	1	0	0	0
107062	Ethylene Dichlor	1	0	0	0
50000	Formaldehyde	1	0	0	0
110543	Hexane	1	0	0	0
7647010	Hydrochloric Aci	1	0	0	0
7783064	Hydrogen Sulfide	1	0	0	0
7439921	Lead (inorganic)	1	0	0	0
71556	Methyl Chlorofor	1	0	0	0
1634044	Metyl Tertiary B	1	0	0	0
7439965	Manganese	1	0	0	0
7439976	Mercury	1	0	0	0
67561	Methanol	1	0	0	0
78933	Methyl Ethyl Ket	1	0	0	0
75092	Methylene Chlori	1	0	0	0
91203	Naphthalene	1	0	0.3900000	0
7440020	Nickel	1	0	0	0
1151	PAHs	1	0	0	0
127184	Perchloroethylen	1	0	0	0
107982	Propylene glycol	1	0	0	0
7782492	Selenium	1	0	0	0

100425	Styrene	1	0	0	0
7664939	Sulfuric Acid	1	0	0	0
108883	Toluene	1	0	0	0
79016	Trichloroethylen	1	0	0	0
75014	Vinyl Chloride	1	0	0	0
1330207	Xylene	1	0	0	0
108383	M-Xylene	1	0	0	0
95476	O-Xylene	1	0	0	0

EMISSIONS FOR FACILITY FAC=9999 DEV= PRO= STK=6 NAME=SRCGP6
SOURCE MULTIPLIER=1

CAS	ABBREV	MULTIPLIER	BG (ug/m^3)	AVRG (lbs/yr)	MAX (lbs/hr)
106990	1,3-Butadiene	1	0	0	0
75070	Acetaldehyde	1	0	0	0
107028	Acrolein	1	0	0	0
7664417	Ammonia	1	0	0	0
7440382	Arsenic	1	0	0	0
1332214	Asbestos	1	0	0	0
71432	Benzene	1	0	0	0
7440417	Berylium	1	0	0	0
7440439	Cadmium	1	0	0	0
56235	Carbon Tetrachlo	1	0	0	0
7782505	Chlorine	1	0	0	0
18540299	Chromium (VI)	1	0	0	0
218019	Chrysene	1	0	0	0
7440508	Copper	1	0	0	0
9901	DPM	1	0	0	0
100414	Ethyl Benzene	1	0	10.2900000	0
111762	Ethylene glycol	1	0	0	0
109864	Ethylene glycol	1	0	0.08000000	0
106934	Ethylene Dibromi	1	0	0	0
107062	Ethylene Dichlor	1	0	0	0
50000	Formaldehyde	1	0	0	0
110543	Hexane	1	0	0	0
7647010	Hydrochloric Aci	1	0	0	0
7783064	Hydrogen Sulfide	1	0	0	0
7439921	Lead (inorganic)	1	0	0	0
71556	Methyl Chlorofor	1	0	0	0
1634044	Metyl Tertiary B	1	0	0	0
7439965	Manganese	1	0	0	0
7439976	Mercury	1	0	0	0
67561	Methanol	1	0	0	0
78933	Methyl Ethyl Ket	1	0	0	0
75092	Methylene Chlori	1	0	0	0
91203	Naphthalene	1	0	0.3900000	0
7440020	Nickel	1	0	0	0
1151	PAHs	1	0	0	0
127184	Perchloroethylen	1	0	0	0
107982	Propylene glycol	1	0	0	0
7782492	Selenium	1	0	0	0
100425	Styrene	1	0	0	0
7664939	Sulfuric Acid	1	0	0	0
108883	Toluene	1	0	0	0
79016	Trichloroethylen	1	0	0	0
75014	Vinyl Chloride	1	0	0	0
1330207	Xylene	1	0	0	0
108383	M-Xylene	1	0	0	0
95476	O-Xylene	1	0	0	0

EMISSIONS FOR FACILITY FAC=9999 DEV= PRO= STK=7 NAME=SRCGP7
SOURCE MULTIPLIER=1

CAS	ABBREV	MULTIPLIER	BG (ug/m^3)	AVRG (lbs/yr)	MAX (lbs/hr)

106990	1,3-Butadiene	1	0	0	0
75070	Acetaldehyde	1	0	0	0
107028	Acrolein	1	0	0	0
7664417	Ammonia	1	0	0	0
7440382	Arsenic	1	0	0	0
1332214	Asbestos	1	0	0	0
71432	Benzene	1	0	0	0
7440417	Berylium	1	0	0	0
7440439	Cadmium	1	0	0	0
56235	Carbon Tetrachlo	1	0	0	0
7782505	Chlorine	1	0	0	0
18540299	Chromium (VI)	1	0	0	0
218019	Chrysene	1	0	0	0
7440508	Copper	1	0	0	0
9901	DPM	1	0	0	0
100414	Ethyl Benzene	1	0	10.2900000	0
111762	Ethylene glycol	1	0	0	0
109864	Ethylene glycol	1	0	0.08000000	0
106934	Ethylene Dibromi	1	0	0	0
107062	Ethylene Dichlor	1	0	0	0
50000	Formaldehyde	1	0	0	0
110543	Hexane	1	0	0	0
7647010	Hydrochloric Aci	1	0	0	0
7783064	Hydrogen Sulfide	1	0	0	0
7439921	Lead (inorganic)	1	0	0	0
71556	Methyl Chlorofor	1	0	0	0
1634044	Metyl Tertiary B	1	0	0	0
7439965	Manganese	1	0	0	0
7439976	Mercury	1	0	0	0
67561	Methanol	1	0	0	0
78933	Methyl Ethyl Ket	1	0	0	0
75092	Methylene Chlori	1	0	0	0
91203	Naphthalene	1	0	0.3900000	0
7440020	Nickel	1	0	0	0
1151	PAHs	1	0	0	0
127184	Perchloroethylen	1	0	0	0
107982	Propylene glycol	1	0	0	0
7782492	Selenium	1	0	0	0
100425	Styrene	1	0	0	0
7664939	Sulfuric Acid	1	0	0	0
108883	Toluene	1	0	0	0
79016	Trichloroethylen	1	0	0	0
75014	Vinyl Chloride	1	0	0	0
1330207	Xylene	1	0	0	0
108383	M-Xylene	1	0	0	0
95476	O-Xylene	1	0	0	0

EMISSIONS FOR FACILITY FAC=9999 DEV= PRO= STK=8 NAME=SRCGP8
SOURCE MULTIPLIER=1

CAS	ABBREV	MULTIPLIER	BG (ug/m^3)	AVRG (lbs/yr)	MAX (lbs/hr)
106990	1,3-Butadiene	1	0	0	0
75070	Acetaldehyde	1	0	0	0
107028	Acrolein	1	0	0	0
7664417	Ammonia	1	0	0	0
7440382	Arsenic	1	0	0	0
1332214	Asbestos	1	0	0	0
71432	Benzene	1	0	0	0
7440417	Berylium	1	0	0	0
7440439	Cadmium	1	0	0	0
56235	Carbon Tetrachlo	1	0	0	0
7782505	Chlorine	1	0	0	0
18540299	Chromium (VI)	1	0	0	0

218019	Chrysene	1	0	0	0
7440508	Copper	1	0	0	0
9901	DPM	1	0	0	0
100414	Ethyl Benzene	1	0	10.2900000	0
111762	Ethylene glycol	1	0	0	0
109864	Ethylene glycol	1	0	0.08000000	0
106934	Ethylene Dibromi	1	0	0	0
107062	Ethylene Dichlor	1	0	0	0
50000	Formaldehyde	1	0	0	0
110543	Hexane	1	0	0	0
7647010	Hydrochloric Aci	1	0	0	0
7783064	Hydrogen Sulfide	1	0	0	0
7439921	Lead (inorganic)	1	0	0	0
71556	Methyl Chlorofor	1	0	0	0
1634044	Metyl Tertiary B	1	0	0	0
7439965	Manganese	1	0	0	0
7439976	Mercury	1	0	0	0
67561	Methanol	1	0	0	0
78933	Methyl Ethyl Ket	1	0	0	0
75092	Methylene Chlori	1	0	0	0
91203	Naphthalene	1	0	0.3900000	0
7440020	Nickel	1	0	0	0
1151	PAHs	1	0	0	0
127184	Perchloroethylen	1	0	0	0
107982	Propylene glycol	1	0	0	0
7782492	Selenium	1	0	0	0
100425	Styrene	1	0	0	0
7664939	Sulfuric Acid	1	0	0	0
108883	Toluene	1	0	0	0
79016	Trichloroethylen	1	0	0	0
75014	Vinyl Chloride	1	0	0	0
1330207	Xylene	1	0	0	0
108383	M-Xylene	1	0	0	0
95476	O-Xylene	1	0	0	0

EMISSIONS FOR FACILITY FAC=9999 DEV= PRO= STK=9 NAME=SRCGP9
SOURCE MULTIPLIER=1

CAS	ABBREV	MULTIPLIER	BG (ug/m^3)	AVRG (lbs/yr)	MAX (lbs/hr)
106990	1,3-Butadiene	1	0	0	0
75070	Acetaldehyde	1	0	0	0
107028	Acrolein	1	0	0	0
7664417	Ammonia	1	0	0	0
7440382	Arsenic	1	0	0	0
1332214	Asbestos	1	0	0	0
71432	Benzene	1	0	0	0
7440417	Berylium	1	0	0	0
7440439	Cadmium	1	0	0	0
56235	Carbon Tetrachlo	1	0	0	0
7782505	Chlorine	1	0	0	0
18540299	Chromium (VI)	1	0	0	0
218019	Chrysene	1	0	0	0
7440508	Copper	1	0	0	0
9901	DPM	1	0	0	0
100414	Ethyl Benzene	1	0	10.2900000	0
111762	Ethylene glycol	1	0	0	0
109864	Ethylene glycol	1	0	0.08000000	0
106934	Ethylene Dibromi	1	0	0	0
107062	Ethylene Dichlor	1	0	0	0
50000	Formaldehyde	1	0	0	0
110543	Hexane	1	0	0	0
7647010	Hydrochloric Aci	1	0	0	0
7783064	Hydrogen Sulfide	1	0	0	0

7439921	Lead (inorganic)	1	0	0	0
71556	Methyl Chlorofor	1	0	0	0
1634044	Metyl Tertiary B	1	0	0	0
7439965	Manganese	1	0	0	0
7439976	Mercury	1	0	0	0
67561	Methanol	1	0	0	0
78933	Methyl Ethyl Ket	1	0	0	0
75092	Methylene Chlori	1	0	0	0
91203	Naphthalene	1	0	0.3900000	0
7440020	Nickel	1	0	0	0
1151	PAHs	1	0	0	0
127184	Perchloroethylen	1	0	0	0
107982	Propylene glycol	1	0	0	0
7782492	Selenium	1	0	0	0
100425	Styrene	1	0	0	0
7664939	Sulfuric Acid	1	0	0	0
108883	Toluene	1	0	0	0
79016	Trichloroethylen	1	0	0	0
75014	Vinyl Chloride	1	0	0	0
1330207	Xylene	1	0	0	0
108383	M-Xylene	1	0	0	0
95476	O-Xylene	1	0	0	0

EMISSIONS FOR FACILITY FAC=9999 DEV= PRO= STK=10 NAME=SRCGP10
SOURCE MULTIPLIER=1

CAS	ABBREV	MULTIPLIER	BG (ug/m^3)	AVRG (lbs/yr)	MAX (lbs/hr)
106990	1,3-Butadiene	1	0	0	0
75070	Acetaldehyde	1	0	0	0
107028	Acrolein	1	0	0	0
7664417	Ammonia	1	0	0	0
7440382	Arsenic	1	0	0	0
1332214	Asbestos	1	0	0	0
71432	Benzene	1	0	0	0
7440417	Berylium	1	0	0	0
7440439	Cadmium	1	0	0	0
56235	Carbon Tetrachlo	1	0	0	0
7782505	Chlorine	1	0	0	0
18540299	Chromium (VI)	1	0	0	0
218019	Chrysene	1	0	0	0
7440508	Copper	1	0	0	0
9901	DPM	1	0	0	0
100414	Ethyl Benzene	1	0	10.2900000	0
111762	Ethylene glycol	1	0	0	0
109864	Ethylene glycol	1	0	0.08000000	0
106934	Ethylene Dibromi	1	0	0	0
107062	Ethylene Dichlor	1	0	0	0
50000	Formaldehyde	1	0	0	0
110543	Hexane	1	0	0	0
7647010	Hydrochloric Aci	1	0	0	0
7783064	Hydrogen Sulfide	1	0	0	0
7439921	Lead (inorganic)	1	0	0	0
71556	Methyl Chlorofor	1	0	0	0
1634044	Metyl Tertiary B	1	0	0	0
7439965	Manganese	1	0	0	0
7439976	Mercury	1	0	0	0
67561	Methanol	1	0	0	0
78933	Methyl Ethyl Ket	1	0	0	0
75092	Methylene Chlori	1	0	0	0
91203	Naphthalene	1	0	0.3900000	0
7440020	Nickel	1	0	0	0
1151	PAHs	1	0	0	0
127184	Perchloroethylen	1	0	0	0

107982	Propylene glycol	1	0	0	0
7782492	Selenium	1	0	0	0
100425	Styrene	1	0	0	0
7664939	Sulfuric Acid	1	0	0	0
108883	Toluene	1	0	0	0
79016	Trichloroethylen	1	0	0	0
75014	Vinyl Chloride	1	0	0	0
1330207	Xylene	1	0	0	0
108383	M-Xylene	1	0	0	0
95476	O-Xylene	1	0	0	0

EMISSIONS FOR FACILITY FAC=9999 DEV= PRO= STK=11 NAME=SRCGP11
SOURCE MULTIPLIER=1

CAS	ABBREV	MULTIPLIER	BG (ug/m^3)	AVRG (lbs/yr)	MAX (lbs/hr)
106990	1,3-Butadiene	1	0	0	0
75070	Acetaldehyde	1	0	0	0
107028	Acrolein	1	0	0	0
7664417	Ammonia	1	0	0	0
7440382	Arsenic	1	0	0	0
1332214	Asbestos	1	0	0	0
71432	Benzene	1	0	0	0
7440417	Berylium	1	0	0	0
7440439	Cadmium	1	0	0	0
56235	Carbon Tetrachlo	1	0	0	0
7782505	Chlorine	1	0	0	0
18540299	Chromium (VI)	1	0	0	0
218019	Chrysene	1	0	0	0
7440508	Copper	1	0	0	0
9901	DPM	1	0	0	0
100414	Ethyl Benzene	1	0	10.2900000	0
111762	Ethylene glycol	1	0	0	0
109864	Ethylene glycol	1	0	0.08000000	0
106934	Ethylene Dibromi	1	0	0	0
107062	Ethylene Dichlor	1	0	0	0
50000	Formaldehyde	1	0	0	0
110543	Hexane	1	0	0	0
7647010	Hydrochloric Aci	1	0	0	0
7783064	Hydrogen Sulfide	1	0	0	0
7439921	Lead (inorganic)	1	0	0	0
71556	Methyl Chlorofor	1	0	0	0
1634044	Metyl Tertiary B	1	0	0	0
7439965	Manganese	1	0	0	0
7439976	Mercury	1	0	0	0
67561	Methanol	1	0	0	0
78933	Methyl Ethyl Ket	1	0	0	0
75092	Methylene Chlori	1	0	0	0
91203	Naphthalene	1	0	0.3900000	0
7440020	Nickel	1	0	0	0
1151	PAHs	1	0	0	0
127184	Perchloroethylen	1	0	0	0
107982	Propylene glycol	1	0	0	0
7782492	Selenium	1	0	0	0
100425	Styrene	1	0	0	0
7664939	Sulfuric Acid	1	0	0	0
108883	Toluene	1	0	0	0
79016	Trichloroethylen	1	0	0	0
75014	Vinyl Chloride	1	0	0	0
1330207	Xylene	1	0	0	0
108383	M-Xylene	1	0	0	0
95476	O-Xylene	1	0	0	0

EMISSIONS FOR FACILITY FAC=9999 DEV= PRO= STK=12 NAME=SRCGP12

SOURCE MULTIPLIER=1

CAS	ABBREV	MULTIPLIER	BG (ug/m^3)	AVRG (lbs/yr)	MAX (lbs/hr)
106990	1,3-Butadiene	1	0	0	0
75070	Acetaldehyde	1	0	0	0
107028	Acrolein	1	0	0	0
7664417	Ammonia	1	0	0	0
7440382	Arsenic	1	0	0	0
1332214	Asbestos	1	0	0	0
71432	Benzene	1	0	0	0
7440417	Berylium	1	0	0	0
7440439	Cadmium	1	0	0	0
56235	Carbon Tetrachlo	1	0	0	0
7782505	Chlorine	1	0	0	0
18540299	Chromium (VI)	1	0	0	0
218019	Chrysene	1	0	0	0
7440508	Copper	1	0	0	0
9901	DPM	1	0	0	0
100414	Ethyl Benzene	1	0	10.2900000	0
111762	Ethylene glycol	1	0	0	0
109864	Ethylene glycol	1	0	0.08000000	0
106934	Ethylene Dibromi	1	0	0	0
107062	Ethylene Dichlor	1	0	0	0
50000	Formaldehyde	1	0	0	0
110543	Hexane	1	0	0	0
7647010	Hydrochloric Aci	1	0	0	0
7783064	Hydrogen Sulfide	1	0	0	0
7439921	Lead (inorganic)	1	0	0	0
71556	Methyl Chlorofor	1	0	0	0
1634044	Metyl Tertiary B	1	0	0	0
7439965	Manganese	1	0	0	0
7439976	Mercury	1	0	0	0
67561	Methanol	1	0	0	0
78933	Methyl Ethyl Ket	1	0	0	0
75092	Methylene Chlori	1	0	0	0
91203	Naphthalene	1	0	0.3900000	0
7440020	Nickel	1	0	0	0
1151	PAHs	1	0	0	0
127184	Perchloroethylen	1	0	0	0
107982	Propylene glycol	1	0	0	0
7782492	Selenium	1	0	0	0
100425	Styrene	1	0	0	0
7664939	Sulfuric Acid	1	0	0	0
108883	Toluene	1	0	0	0
79016	Trichloroethylen	1	0	0	0
75014	Vinyl Chloride	1	0	0	0
1330207	Xylene	1	0	0	0
108383	M-Xylene	1	0	0	0
95476	O-Xylene	1	0	0	0

EMISSIONS FOR FACILITY FAC=9999 DEV= PRO= STK=13 NAME=SRCGP13

SOURCE MULTIPLIER=1

CAS	ABBREV	MULTIPLIER	BG (ug/m^3)	AVRG (lbs/yr)	MAX (lbs/hr)
106990	1,3-Butadiene	1	0	0	0
75070	Acetaldehyde	1	0	0	0
107028	Acrolein	1	0	0	0
7664417	Ammonia	1	0	0	0
7440382	Arsenic	1	0	0	0
1332214	Asbestos	1	0	0	0
71432	Benzene	1	0	0	0
7440417	Berylium	1	0	0	0
7440439	Cadmium	1	0	0	0
56235	Carbon Tetrachlo	1	0	0	0

7782505	Chlorine	1	0	0	0
18540299	Chromium (VI)	1	0	0	0
218019	Chrysene	1	0	0	0
7440508	Copper	1	0	0	0
9901	DPM	1	0	0	0
100414	Ethyl Benzene	1	0	10.2900000	0
111762	Ethylene glycol	1	0	0	0
109864	Ethylene glycol	1	0	0.08000000	0
106934	Ethylene Dibromi	1	0	0	0
107062	Ethylene Dichlor	1	0	0	0
50000	Formaldehyde	1	0	0	0
110543	Hexane	1	0	0	0
7647010	Hydrochloric Aci	1	0	0	0
7783064	Hydrogen Sulfide	1	0	0	0
7439921	Lead (inorganic)	1	0	0	0
71556	Methyl Chlorofor	1	0	0	0
1634044	Metyl Tertiary B	1	0	0	0
7439965	Manganese	1	0	0	0
7439976	Mercury	1	0	0	0
67561	Methanol	1	0	0	0
78933	Methyl Ethyl Ket	1	0	0	0
75092	Methylene Chlori	1	0	0	0
91203	Naphthalene	1	0	0.3900000	0
7440020	Nickel	1	0	0	0
1151	PAHs	1	0	0	0
127184	Perchloroethylen	1	0	0	0
107982	Propylene glycol	1	0	0	0
7782492	Selenium	1	0	0	0
100425	Styrene	1	0	0	0
7664939	Sulfuric Acid	1	0	0	0
108883	Toluene	1	0	0	0
79016	Trichloroethylen	1	0	0	0
75014	Vinyl Chloride	1	0	0	0
1330207	Xylene	1	0	0	0
108383	M-Xylene	1	0	0	0
95476	O-Xylene	1	0	0	0

EMISSIONS FOR FACILITY FAC=9999 DEV= PRO= STK=14 NAME=SRCGP14
SOURCE MULTIPLIER=1

CAS	ABBREV	MULTIPLIER	BG (ug/m^3)	AVRG (lbs/yr)	MAX (lbs/hr)
106990	1,3-Butadiene	1	0	0	0
75070	Acetaldehyde	1	0	0	0
107028	Acrolein	1	0	0	0
7664417	Ammonia	1	0	0	0
7440382	Arsenic	1	0	0	0
1332214	Asbestos	1	0	0	0
71432	Benzene	1	0	0	0
7440417	Berylium	1	0	0	0
7440439	Cadmium	1	0	0	0
56235	Carbon Tetrachlo	1	0	0	0
7782505	Chlorine	1	0	0	0
18540299	Chromium (VI)	1	0	0	0
218019	Chrysene	1	0	0	0
7440508	Copper	1	0	0	0
9901	DPM	1	0	0	0
100414	Ethyl Benzene	1	0	10.2900000	0
111762	Ethylene glycol	1	0	0	0
109864	Ethylene glycol	1	0	0.08000000	0
106934	Ethylene Dibromi	1	0	0	0
107062	Ethylene Dichlor	1	0	0	0
50000	Formaldehyde	1	0	0	0
110543	Hexane	1	0	0	0

7647010	Hydrochloric Aci	1	0	0	0
7783064	Hydrogen Sulfide	1	0	0	0
7439921	Lead (inorganic)	1	0	0	0
71556	Methyl Chlorofor	1	0	0	0
1634044	Metyl Tertiary B	1	0	0	0
7439965	Manganese	1	0	0	0
7439976	Mercury	1	0	0	0
67561	Methanol	1	0	0	0
78933	Methyl Ethyl Ket	1	0	0	0
75092	Methylene Chlori	1	0	0	0
91203	Naphthalene	1	0	0.3900000	0
7440020	Nickel	1	0	0	0
1151	PAHs	1	0	0	0
127184	Perchloroethylen	1	0	0	0
107982	Propylene glycol	1	0	0	0
7782492	Selenium	1	0	0	0
100425	Styrene	1	0	0	0
7664939	Sulfuric Acid	1	0	0	0
108883	Toluene	1	0	0	0
79016	Trichloroethylen	1	0	0	0
75014	Vinyl Chloride	1	0	0	0
1330207	Xylene	1	0	0	0
108383	M-Xylene	1	0	0	0
95476	O-Xylene	1	0	0	0

EMISSIONS FOR FACILITY FAC=9999 DEV= PRO= STK=15 NAME=SRCGP15
SOURCE MULTIPLIER=1

CAS	ABBREV	MULTIPLIER	BG (ug/m^3)	AVRG (lbs/yr)	MAX (lbs/hr)
106990	1,3-Butadiene	1	0	0	0
75070	Acetaldehyde	1	0	0	0
107028	Acrolein	1	0	0	0
7664417	Ammonia	1	0	0	0
7440382	Arsenic	1	0	0	0
1332214	Asbestos	1	0	0	0
71432	Benzene	1	0	0	0
7440417	Berylium	1	0	0	0
7440439	Cadmium	1	0	0	0
56235	Carbon Tetrachlo	1	0	0	0
7782505	Chlorine	1	0	0	0
18540299	Chromium (VI)	1	0	0	0
218019	Chrysene	1	0	0	0
7440508	Copper	1	0	0	0
9901	DPM	1	0	0	0
100414	Ethyl Benzene	1	0	10.2900000	0
111762	Ethylene glycol	1	0	0	0
109864	Ethylene glycol	1	0	0.08000000	0
106934	Ethylene Dibromi	1	0	0	0
107062	Ethylene Dichlor	1	0	0	0
50000	Formaldehyde	1	0	0	0
110543	Hexane	1	0	0	0
7647010	Hydrochloric Aci	1	0	0	0
7783064	Hydrogen Sulfide	1	0	0	0
7439921	Lead (inorganic)	1	0	0	0
71556	Methyl Chlorofor	1	0	0	0
1634044	Metyl Tertiary B	1	0	0	0
7439965	Manganese	1	0	0	0
7439976	Mercury	1	0	0	0
67561	Methanol	1	0	0	0
78933	Methyl Ethyl Ket	1	0	0	0
75092	Methylene Chlori	1	0	0	0
91203	Naphthalene	1	0	0.3900000	0
7440020	Nickel	1	0	0	0

1151	PAHs	1	0	0	0
127184	Perchloroethylen	1	0	0	0
107982	Propylene glycol	1	0	0	0
7782492	Selenium	1	0	0	0
100425	Styrene	1	0	0	0
7664939	Sulfuric Acid	1	0	0	0
108883	Toluene	1	0	0	0
79016	Trichloroethylen	1	0	0	0
75014	Vinyl Chloride	1	0	0	0
1330207	Xylene	1	0	0	0
108383	M-Xylene	1	0	0	0
95476	O-Xylene	1	0	0	0

EMISSIONS FOR FACILITY FAC=9999 DEV= PRO= STK=16 NAME=SRCGP16
SOURCE MULTIPLIER=1

CAS	ABBREV	MULTIPLIER	BG (ug/m^3)	AVRG (lbs/yr)	MAX (lbs/hr)
106990	1,3-Butadiene	1	0	0	0
75070	Acetaldehyde	1	0	0	0
107028	Acrolein	1	0	0	0
7664417	Ammonia	1	0	0	0
7440382	Arsenic	1	0	0	0
1332214	Asbestos	1	0	0	0
71432	Benzene	1	0	0	0
7440417	Berylium	1	0	0	0
7440439	Cadmium	1	0	0	0
56235	Carbon Tetrachlo	1	0	0	0
7782505	Chlorine	1	0	0	0
18540299	Chromium (VI)	1	0	0	0
218019	Chrysene	1	0	0	0
7440508	Copper	1	0	0	0
9901	DPM	1	0	0	0
100414	Ethyl Benzene	1	0	10.2900000	0
111762	Ethylene glycol	1	0	0	0
109864	Ethylene glycol	1	0	0.08000000	0
106934	Ethylene Dibromi	1	0	0	0
107062	Ethylene Dichlor	1	0	0	0
50000	Formaldehyde	1	0	0	0
110543	Hexane	1	0	0	0
7647010	Hydrochloric Aci	1	0	0	0
7783064	Hydrogen Sulfide	1	0	0	0
7439921	Lead (inorganic)	1	0	0	0
71556	Methyl Chlorofor	1	0	0	0
1634044	Metyl Tertiary B	1	0	0	0
7439965	Manganese	1	0	0	0
7439976	Mercury	1	0	0	0
67561	Methanol	1	0	0	0
78933	Methyl Ethyl Ket	1	0	0	0
75092	Methylene Chlori	1	0	0	0
91203	Naphthalene	1	0	0.3900000	0
7440020	Nickel	1	0	0	0
1151	PAHs	1	0	0	0
127184	Perchloroethylen	1	0	0	0
107982	Propylene glycol	1	0	0	0
7782492	Selenium	1	0	0	0
100425	Styrene	1	0	0	0
7664939	Sulfuric Acid	1	0	0	0
108883	Toluene	1	0	0	0
79016	Trichloroethylen	1	0	0	0
75014	Vinyl Chloride	1	0	0	0
1330207	Xylene	1	0	0	0
108383	M-Xylene	1	0	0	0
95476	O-Xylene	1	0	0	0

EMISSIONS FOR FACILITY FAC=9999 DEV= PRO= STK=17 NAME=SRCGP17
SOURCE MULTIPLIER=1

CAS	ABBREV	MULTIPLIER	BG (ug/m^3)	AVRG (lbs/yr)	MAX (lbs/hr)
106990	1,3-Butadiene	1	0	0	0
75070	Acetaldehyde	1	0	0	0
107028	Acrolein	1	0	0	0
7664417	Ammonia	1	0	0	0
7440382	Arsenic	1	0	0	0
1332214	Asbestos	1	0	0	0
71432	Benzene	1	0	0	0
7440417	Berylium	1	0	0	0
7440439	Cadmium	1	0	0	0
56235	Carbon Tetrachlo	1	0	0	0
7782505	Chlorine	1	0	0	0
18540299	Chromium (VI)	1	0	0	0
218019	Chrysene	1	0	0	0
7440508	Copper	1	0	0	0
9901	DPM	1	0	0	0
100414	Ethyl Benzene	1	0	10.2900000	0
111762	Ethylene glycol	1	0	0	0
109864	Ethylene glycol	1	0	0.08000000	0
106934	Ethylene Dibromi	1	0	0	0
107062	Ethylene Dichlor	1	0	0	0
50000	Formaldehyde	1	0	0	0
110543	Hexane	1	0	0	0
7647010	Hydrochloric Aci	1	0	0	0
7783064	Hydrogen Sulfide	1	0	0	0
7439921	Lead (inorganic)	1	0	0	0
71556	Methyl Chlorofor	1	0	0	0
1634044	Metyl Tertiary B	1	0	0	0
7439965	Manganese	1	0	0	0
7439976	Mercury	1	0	0	0
67561	Methanol	1	0	0	0
78933	Methyl Ethyl Ket	1	0	0	0
75092	Methylene Chlori	1	0	0	0
91203	Naphthalene	1	0	0.3900000	0
7440020	Nickel	1	0	0	0
1151	PAHs	1	0	0	0
127184	Perchloroethylen	1	0	0	0
107982	Propylene glycol	1	0	0	0
7782492	Selenium	1	0	0	0
100425	Styrene	1	0	0	0
7664939	Sulfuric Acid	1	0	0	0
108883	Toluene	1	0	0	0
79016	Trichloroethylen	1	0	0	0
75014	Vinyl Chloride	1	0	0	0
1330207	Xylene	1	0	0	0
108383	M-Xylene	1	0	0	0
95476	O-Xylene	1	0	0	0

EMISSIONS FOR FACILITY FAC=9999 DEV= PRO= STK=18 NAME=SRCGP18
SOURCE MULTIPLIER=1

CAS	ABBREV	MULTIPLIER	BG (ug/m^3)	AVRG (lbs/yr)	MAX (lbs/hr)
106990	1,3-Butadiene	1	0	0	0
75070	Acetaldehyde	1	0	0	0
107028	Acrolein	1	0	0	0
7664417	Ammonia	1	0	0	0
7440382	Arsenic	1	0	0	0
1332214	Asbestos	1	0	0	0
71432	Benzene	1	0	0	0
7440417	Berylium	1	0	0	0

7440439	Cadmium	1	0	0	0
56235	Carbon Tetrachlo	1	0	0	0
7782505	Chlorine	1	0	0	0
18540299	Chromium (VI)	1	0	0	0
218019	Chrysene	1	0	0	0
7440508	Copper	1	0	0	0
9901	DPM	1	0	0	0
100414	Ethyl Benzene	1	0	10.2900000	0
111762	Ethylene glycol	1	0	0	0
109864	Ethylene glycol	1	0	0.08000000	0
106934	Ethylene Dibromi	1	0	0	0
107062	Ethylene Dichlor	1	0	0	0
50000	Formaldehyde	1	0	0	0
110543	Hexane	1	0	0	0
7647010	Hydrochloric Aci	1	0	0	0
7783064	Hydrogen Sulfide	1	0	0	0
7439921	Lead (inorganic)	1	0	0	0
71556	Methyl Chlorofor	1	0	0	0
1634044	Metyl Tertiary B	1	0	0	0
7439965	Manganese	1	0	0	0
7439976	Mercury	1	0	0	0
67561	Methanol	1	0	0	0
78933	Methyl Ethyl Ket	1	0	0	0
75092	Methylene Chlori	1	0	0	0
91203	Naphthalene	1	0	0.3900000	0
7440020	Nickel	1	0	0	0
1151	PAHs	1	0	0	0
127184	Perchloroethylen	1	0	0	0
107982	Propylene glycol	1	0	0	0
7782492	Selenium	1	0	0	0
100425	Styrene	1	0	0	0
7664939	Sulfuric Acid	1	0	0	0
108883	Toluene	1	0	0	0
79016	Trichloroethylen	1	0	0	0
75014	Vinyl Chloride	1	0	0	0
1330207	Xylene	1	0	0	0
108383	M-Xylene	1	0	0	0
95476	O-Xylene	1	0	0	0

EMISSIONS FOR FACILITY FAC=9999 DEV= PRO= STK=19 NAME=SRCGP19
SOURCE MULTIPLIER=1

CAS	ABBREV	MULTIPLIER	BG (ug/m^3)	AVRG (lbs/yr)	MAX (lbs/hr)
106990	1,3-Butadiene	1	0	0	0
75070	Acetaldehyde	1	0	0	0
107028	Acrolein	1	0	0	0
7664417	Ammonia	1	0	0	0
7440382	Arsenic	1	0	0	0
1332214	Asbestos	1	0	0	0
71432	Benzene	1	0	0	0
7440417	Berylium	1	0	0	0
7440439	Cadmium	1	0	0	0
56235	Carbon Tetrachlo	1	0	0	0
7782505	Chlorine	1	0	0	0
18540299	Chromium (VI)	1	0	0	0
218019	Chrysene	1	0	0	0
7440508	Copper	1	0	0	0
9901	DPM	1	0	0	0
100414	Ethyl Benzene	1	0	10.2900000	0
111762	Ethylene glycol	1	0	0	0
109864	Ethylene glycol	1	0	0.08000000	0
106934	Ethylene Dibromi	1	0	0	0
107062	Ethylene Dichlor	1	0	0	0

50000	Formaldehyde	1	0	0	0
110543	Hexane	1	0	0	0
7647010	Hydrochloric Aci	1	0	0	0
7783064	Hydrogen Sulfide	1	0	0	0
7439921	Lead (inorganic)	1	0	0	0
71556	Methyl Chlorofor	1	0	0	0
1634044	Metyl Tertiary B	1	0	0	0
7439965	Manganese	1	0	0	0
7439976	Mercury	1	0	0	0
67561	Methanol	1	0	0	0
78933	Methyl Ethyl Ket	1	0	0	0
75092	Methylene Chlori	1	0	0	0
91203	Naphthalene	1	0	0.3900000	0
7440020	Nickel	1	0	0	0
1151	PAHs	1	0	0	0
127184	Perchloroethylen	1	0	0	0
107982	Propylene glycol	1	0	0	0
7782492	Selenium	1	0	0	0
100425	Styrene	1	0	0	0
7664939	Sulfuric Acid	1	0	0	0
108883	Toluene	1	0	0	0
79016	Trichloroethylen	1	0	0	0
75014	Vinyl Chloride	1	0	0	0
1330207	Xylene	1	0	0	0
108383	M-Xylene	1	0	0	0
95476	O-Xylene	1	0	0	0

EMISSIONS FOR FACILITY FAC=9999 DEV= PRO= STK=20 NAME=SRCGP20
SOURCE MULTIPLIER=1

CAS	ABBREV	MULTIPLIER	BG (ug/m^3)	AVRG (lbs/yr)	MAX (lbs/hr)
106990	1,3-Butadiene	1	0	0	0
75070	Acetaldehyde	1	0	0	0
107028	Acrolein	1	0	0	0
7664417	Ammonia	1	0	0	0
7440382	Arsenic	1	0	0	0
1332214	Asbestos	1	0	0	0
71432	Benzene	1	0	0	0
7440417	Berylium	1	0	0	0
7440439	Cadmium	1	0	0	0
56235	Carbon Tetrachlo	1	0	0	0
7782505	Chlorine	1	0	0	0
18540299	Chromium (VI)	1	0	0	0
218019	Chrysene	1	0	0	0
7440508	Copper	1	0	0	0
9901	DPM	1	0	0	0
100414	Ethyl Benzene	1	0	10.2900000	0
111762	Ethylene glycol	1	0	0	0
109864	Ethylene glycol	1	0	0.08000000	0
106934	Ethylene Dibromi	1	0	0	0
107062	Ethylene Dichlor	1	0	0	0
50000	Formaldehyde	1	0	0	0
110543	Hexane	1	0	0	0
7647010	Hydrochloric Aci	1	0	0	0
7783064	Hydrogen Sulfide	1	0	0	0
7439921	Lead (inorganic)	1	0	0	0
71556	Methyl Chlorofor	1	0	0	0
1634044	Metyl Tertiary B	1	0	0	0
7439965	Manganese	1	0	0	0
7439976	Mercury	1	0	0	0
67561	Methanol	1	0	0	0
78933	Methyl Ethyl Ket	1	0	0	0
75092	Methylene Chlori	1	0	0	0

91203	Naphthalene	1	0	0.3900000	0
7440020	Nickel	1	0	0	0
1151	PAHs	1	0	0	0
127184	Perchloroethylen	1	0	0	0
107982	Propylene glycol	1	0	0	0
7782492	Selenium	1	0	0	0
100425	Styrene	1	0	0	0
7664939	Sulfuric Acid	1	0	0	0
108883	Toluene	1	0	0	0
79016	Trichloroethylen	1	0	0	0
75014	Vinyl Chloride	1	0	0	0
1330207	Xylene	1	0	0	0
108383	M-Xylene	1	0	0	0
95476	O-Xylene	1	0	0	0

EMISSIONS FOR FACILITY FAC=9999 DEV= PRO= STK=21 NAME=SRCGP21
SOURCE MULTIPLIER=1

CAS	ABBREV	MULTIPLIER	BG (ug/m^3)	AVRG (lbs/yr)	MAX (lbs/hr)
106990	1,3-Butadiene	1	0	0	0
75070	Acetaldehyde	1	0	0	0
107028	Acrolein	1	0	0	0
7664417	Ammonia	1	0	0	0
7440382	Arsenic	1	0	0	0
1332214	Asbestos	1	0	0	0
71432	Benzene	1	0	0	0
7440417	Berylium	1	0	0	0
7440439	Cadmium	1	0	0	0
56235	Carbon Tetrachlo	1	0	0	0
7782505	Chlorine	1	0	0	0
18540299	Chromium (VI)	1	0	0	0
218019	Chrysene	1	0	0	0
7440508	Copper	1	0	0	0
9901	DPM	1	0	0	0
100414	Ethyl Benzene	1	0	10.2900000	0
111762	Ethylene glycol	1	0	0	0
109864	Ethylene glycol	1	0	0.08000000	0
106934	Ethylene Dibromi	1	0	0	0
107062	Ethylene Dichlor	1	0	0	0
50000	Formaldehyde	1	0	0	0
110543	Hexane	1	0	0	0
7647010	Hydrochloric Aci	1	0	0	0
7783064	Hydrogen Sulfide	1	0	0	0
7439921	Lead (inorganic)	1	0	0	0
71556	Methyl Chlorofor	1	0	0	0
1634044	Metyl Tertiary B	1	0	0	0
7439965	Manganese	1	0	0	0
7439976	Mercury	1	0	0	0
67561	Methanol	1	0	0	0
78933	Methyl Ethyl Ket	1	0	0	0
75092	Methylene Chlori	1	0	0	0
91203	Naphthalene	1	0	0.4000000	0
7440020	Nickel	1	0	0	0
1151	PAHs	1	0	0	0
127184	Perchloroethylen	1	0	0	0
107982	Propylene glycol	1	0	0	0
7782492	Selenium	1	0	0	0
100425	Styrene	1	0	0	0
7664939	Sulfuric Acid	1	0	0	0
108883	Toluene	1	0	0	0
79016	Trichloroethylen	1	0	0	0
75014	Vinyl Chloride	1	0	0	0
1330207	Xylene	1	0	0	0

108383	M-Xylene	1	0	0	0
95476	O-Xylene	1	0	0	0

EMISSIONS FOR FACILITY FAC=9999 DEV= PRO= STK=22 NAME=SRCGP22
SOURCE MULTIPLIER=1

CAS	ABBREV	MULTIPLIER	BG (ug/m^3)	AVRG (lbs/yr)	MAX (lbs/hr)
106990	1,3-Butadiene	1	0	0	0
75070	Acetaldehyde	1	0	0	0
107028	Acrolein	1	0	0	0
7664417	Ammonia	1	0	0	0
7440382	Arsenic	1	0	0	0
1332214	Asbestos	1	0	0	0
71432	Benzene	1	0	0	0
7440417	Berylium	1	0	0	0
7440439	Cadmium	1	0	0	0
56235	Carbon Tetrachlo	1	0	0	0
7782505	Chlorine	1	0	0	0
18540299	Chromium (VI)	1	0	0	0
218019	Chrysene	1	0	0	0
7440508	Copper	1	0	0	0
9901	DPM	1	0	0	0
100414	Ethyl Benzene	1	0	10.2900000	0
111762	Ethylene glycol	1	0	0	0
109864	Ethylene glycol	1	0	0.08000000	0
106934	Ethylene Dibromi	1	0	0	0
107062	Ethylene Dichlor	1	0	0	0
50000	Formaldehyde	1	0	0	0
110543	Hexane	1	0	0	0
7647010	Hydrochloric Aci	1	0	0	0
7783064	Hydrogen Sulfide	1	0	0	0
7439921	Lead (inorganic)	1	0	0	0
71556	Methyl Chlorofor	1	0	0	0
1634044	Metyl Tertiary B	1	0	0	0
7439965	Manganese	1	0	0	0
7439976	Mercury	1	0	0	0
67561	Methanol	1	0	0	0
78933	Methyl Ethyl Ket	1	0	0	0
75092	Methylene Chlori	1	0	0	0
91203	Naphthalene	1	0	0.4000000	0
7440020	Nickel	1	0	0	0
1151	PAHs	1	0	0	0
127184	Perchloroethylen	1	0	0	0
107982	Propylene glycol	1	0	0	0
7782492	Selenium	1	0	0	0
100425	Styrene	1	0	0	0
7664939	Sulfuric Acid	1	0	0	0
108883	Toluene	1	0	0	0
79016	Trichloroethylen	1	0	0	0
75014	Vinyl Chloride	1	0	0	0
1330207	Xylene	1	0	0	0
108383	M-Xylene	1	0	0	0
95476	O-Xylene	1	0	0	0

EMISSIONS FOR FACILITY FAC=9999 DEV= PRO= STK=23 NAME=SRCGP23
SOURCE MULTIPLIER=1

CAS	ABBREV	MULTIPLIER	BG (ug/m^3)	AVRG (lbs/yr)	MAX (lbs/hr)
106990	1,3-Butadiene	1	0	0	0
75070	Acetaldehyde	1	0	0	0
107028	Acrolein	1	0	0	0
7664417	Ammonia	1	0	0	0
7440382	Arsenic	1	0	0	0
1332214	Asbestos	1	0	0	0

71432	Benzene	1	0	0	0
7440417	Berylium	1	0	0	0
7440439	Cadmium	1	0	0	0
56235	Carbon Tetrachlo	1	0	0	0
7782505	Chlorine	1	0	0	0
18540299	Chromium (VI)	1	0	0	0
218019	Chrysene	1	0	0	0
7440508	Copper	1	0	0	0
9901	DPM	1	0	0	0
100414	Ethyl Benzene	1	0	10.2900000	0
111762	Ethylene glycol	1	0	0	0
109864	Ethylene glycol	1	0	0.08000000	0
106934	Ethylene Dibromi	1	0	0	0
107062	Ethylene Dichlor	1	0	0	0
50000	Formaldehyde	1	0	0	0
110543	Hexane	1	0	0	0
7647010	Hydrochloric Aci	1	0	0	0
7783064	Hydrogen Sulfide	1	0	0	0
7439921	Lead (inorganic)	1	0	0	0
71556	Methyl Chlorofor	1	0	0	0
1634044	Metyl Tertiary B	1	0	0	0
7439965	Manganese	1	0	0	0
7439976	Mercury	1	0	0	0
67561	Methanol	1	0	0	0
78933	Methyl Ethyl Ket	1	0	0	0
75092	Methylene Chlori	1	0	0	0
91203	Naphthalene	1	0	0.4000000	0
7440020	Nickel	1	0	0	0
1151	PAHs	1	0	0	0
127184	Perchloroethylen	1	0	0	0
107982	Propylene glycol	1	0	0	0
7782492	Selenium	1	0	0	0
100425	Styrene	1	0	0	0
7664939	Sulfuric Acid	1	0	0	0
108883	Toluene	1	0	0	0
79016	Trichloroethylen	1	0	0	0
75014	Vinyl Chloride	1	0	0	0
1330207	Xylene	1	0	0	0
108383	M-Xylene	1	0	0	0
95476	O-Xylene	1	0	0	0

EMISSIONS FOR FACILITY FAC=9999 DEV= PRO= STK=24 NAME=SRCGP24
SOURCE MULTIPLIER=1

CAS	ABBREV	MULTIPLIER	BG (ug/m^3)	AVRG (lbs/yr)	MAX (lbs/hr)
106990	1,3-Butadiene	1	0	0	0
75070	Acetaldehyde	1	0	0	0
107028	Acrolein	1	0	0	0
7664417	Ammonia	1	0	0	0
7440382	Arsenic	1	0	0	0
1332214	Asbestos	1	0	0	0
71432	Benzene	1	0	0	0
7440417	Berylium	1	0	0	0
7440439	Cadmium	1	0	0	0
56235	Carbon Tetrachlo	1	0	0	0
7782505	Chlorine	1	0	0	0
18540299	Chromium (VI)	1	0	0	0
218019	Chrysene	1	0	0	0
7440508	Copper	1	0	0	0
9901	DPM	1	0	0	0
100414	Ethyl Benzene	1	0	10.2900000	0
111762	Ethylene glycol	1	0	0	0
109864	Ethylene glycol	1	0	0.08000000	0

106934	Ethylene Dibromi	1	0	0	0
107062	Ethylene Dichlor	1	0	0	0
50000	Formaldehyde	1	0	0	0
110543	Hexane	1	0	0	0
7647010	Hydrochloric Aci	1	0	0	0
7783064	Hydrogen Sulfide	1	0	0	0
7439921	Lead (inorganic)	1	0	0	0
71556	Methyl Chlorofor	1	0	0	0
1634044	Metyl Tertiary B	1	0	0	0
7439965	Manganese	1	0	0	0
7439976	Mercury	1	0	0	0
67561	Methanol	1	0	0	0
78933	Methyl Ethyl Ket	1	0	0	0
75092	Methylene Chlori	1	0	0	0
91203	Naphthalene	1	0	0.4000000	0
7440020	Nickel	1	0	0	0
1151	PAHs	1	0	0	0
127184	Perchloroethylen	1	0	0	0
107982	Propylene glycol	1	0	0	0
7782492	Selenium	1	0	0	0
100425	Styrene	1	0	0	0
7664939	Sulfuric Acid	1	0	0	0
108883	Toluene	1	0	0	0
79016	Trichloroethylen	1	0	0	0
75014	Vinyl Chloride	1	0	0	0
1330207	Xylene	1	0	0	0
108383	M-Xylene	1	0	0	0
95476	O-Xylene	1	0	0	0

EMISSIONS FOR FACILITY FAC=9999 DEV= PRO= STK=25 NAME=SRCGP25
SOURCE MULTIPLIER=1

CAS	ABBREV	MULTIPLIER	BG (ug/m^3)	AVRG (lbs/yr)	MAX (lbs/hr)
106990	1,3-Butadiene	1	0	0	0
75070	Acetaldehyde	1	0	0	0
107028	Acrolein	1	0	0	0
7664417	Ammonia	1	0	0	0
7440382	Arsenic	1	0	0	0
1332214	Asbestos	1	0	0	0
71432	Benzene	1	0	0	0
7440417	Berylium	1	0	0	0
7440439	Cadmium	1	0	0	0
56235	Carbon Tetrachlo	1	0	0	0
7782505	Chlorine	1	0	0	0
18540299	Chromium (VI)	1	0	0	0
218019	Chrysene	1	0	0	0
7440508	Copper	1	0	0	0
9901	DPM	1	0	0	0
100414	Ethyl Benzene	1	0	10.2900000	0
111762	Ethylene glycol	1	0	0	0
109864	Ethylene glycol	1	0	0.08000000	0
106934	Ethylene Dibromi	1	0	0	0
107062	Ethylene Dichlor	1	0	0	0
50000	Formaldehyde	1	0	0	0
110543	Hexane	1	0	0	0
7647010	Hydrochloric Aci	1	0	0	0
7783064	Hydrogen Sulfide	1	0	0	0
7439921	Lead (inorganic)	1	0	0	0
71556	Methyl Chlorofor	1	0	0	0
1634044	Metyl Tertiary B	1	0	0	0
7439965	Manganese	1	0	0	0
7439976	Mercury	1	0	0	0
67561	Methanol	1	0	0	0

78933	Methyl Ethyl Ket	1	0	0	0
75092	Methylene Chlori	1	0	0	0
91203	Naphthalene	1	0	0.4000000	0
7440020	Nickel	1	0	0	0
1151	PAHs	1	0	0	0
127184	Perchloroethylen	1	0	0	0
107982	Propylene glycol	1	0	0	0
7782492	Selenium	1	0	0	0
100425	Styrene	1	0	0	0
7664939	Sulfuric Acid	1	0	0	0
108883	Toluene	1	0	0	0
79016	Trichloroethylen	1	0	0	0
75014	Vinyl Chloride	1	0	0	0
1330207	Xylene	1	0	0	0
108383	M-Xylene	1	0	0	0
95476	O-Xylene	1	0	0	0

EMISSIONS FOR FACILITY FAC=9999 DEV= PRO= STK=26 NAME=SRCGP26
SOURCE MULTIPLIER=1

CAS	ABBREV	MULTIPLIER	BG (ug/m^3)	AVRG (lbs/yr)	MAX (lbs/hr)
106990	1,3-Butadiene	1	0	0	0
75070	Acetaldehyde	1	0	0	0
107028	Acrolein	1	0	0	0
7664417	Ammonia	1	0	0	0
7440382	Arsenic	1	0	0	0
1332214	Asbestos	1	0	0	0
71432	Benzene	1	0	0	0
7440417	Berylium	1	0	0	0
7440439	Cadmium	1	0	0	0
56235	Carbon Tetrachlo	1	0	0	0
7782505	Chlorine	1	0	0	0
18540299	Chromium (VI)	1	0	0	0
218019	Chrysene	1	0	0	0
7440508	Copper	1	0	0	0
9901	DPM	1	0	0	0
100414	Ethyl Benzene	1	0	10.2900000	0
111762	Ethylene glycol	1	0	0	0
109864	Ethylene glycol	1	0	0.08000000	0
106934	Ethylene Dibromi	1	0	0	0
107062	Ethylene Dichlor	1	0	0	0
50000	Formaldehyde	1	0	0	0
110543	Hexane	1	0	0	0
7647010	Hydrochloric Aci	1	0	0	0
7783064	Hydrogen Sulfide	1	0	0	0
7439921	Lead (inorganic)	1	0	0	0
71556	Methyl Chlorofor	1	0	0	0
1634044	Metyl Tertiary B	1	0	0	0
7439965	Manganese	1	0	0	0
7439976	Mercury	1	0	0	0
67561	Methanol	1	0	0	0
78933	Methyl Ethyl Ket	1	0	0	0
75092	Methylene Chlori	1	0	0	0
91203	Naphthalene	1	0	0.4000000	0
7440020	Nickel	1	0	0	0
1151	PAHs	1	0	0	0
127184	Perchloroethylen	1	0	0	0
107982	Propylene glycol	1	0	0	0
7782492	Selenium	1	0	0	0
100425	Styrene	1	0	0	0
7664939	Sulfuric Acid	1	0	0	0
108883	Toluene	1	0	0	0
79016	Trichloroethylen	1	0	0	0

75014	Vinyl Chloride	1	0	0	0
1330207	Xylene	1	0	0	0
108383	M-Xylene	1	0	0	0
95476	O-Xylene	1	0	0	0

EMISSIONS FOR FACILITY FAC=9999 DEV= PRO= STK=27 NAME=SRCGP27
SOURCE MULTIPLIER=1

CAS	ABBREV	MULTIPLIER	BG (ug/m^3)	AVRG (lbs/yr)	MAX (lbs/hr)
106990	1,3-Butadiene	1	0	0	0
75070	Acetaldehyde	1	0	0	0
107028	Acrolein	1	0	0	0
7664417	Ammonia	1	0	0	0
7440382	Arsenic	1	0	0	0
1332214	Asbestos	1	0	0	0
71432	Benzene	1	0	0	0
7440417	Berylium	1	0	0	0
7440439	Cadmium	1	0	0	0
56235	Carbon Tetrachlo	1	0	0	0
7782505	Chlorine	1	0	0	0
18540299	Chromium (VI)	1	0	0	0
218019	Chrysene	1	0	0	0
7440508	Copper	1	0	0	0
9901	DPM	1	0	0	0
100414	Ethyl Benzene	1	0	0	0
111762	Ethylene glycol	1	0	0	0
109864	Ethylene glycol	1	0	0	0
106934	Ethylene Dibromi	1	0	0	0
107062	Ethylene Dichlor	1	0	0	0
50000	Formaldehyde	1	0	0	0
110543	Hexane	1	0	0	0
7647010	Hydrochloric Aci	1	0	0	0
7783064	Hydrogen Sulfide	1	0	0	0
7439921	Lead (inorganic)	1	0	0	0
71556	Methyl Chlorofor	1	0	0	0
1634044	Metyl Tertiary B	1	0	0	0
7439965	Manganese	1	0	0	0
7439976	Mercury	1	0	0	0
67561	Methanol	1	0	0	0
78933	Methyl Ethyl Ket	1	0	0	0
75092	Methylene Chlori	1	0	0	0
91203	Naphthalene	1	0	3.1400000	0
7440020	Nickel	1	0	0	0
1151	PAHs	1	0	0	0
127184	Perchloroethylen	1	0	0	0
107982	Propylene glycol	1	0	0	0
7782492	Selenium	1	0	0	0
100425	Styrene	1	0	0	0
7664939	Sulfuric Acid	1	0	0	0
108883	Toluene	1	0	0	0
79016	Trichloroethylen	1	0	0	0
75014	Vinyl Chloride	1	0	0	0
1330207	Xylene	1	0	120.1200000	0.01000000
108383	M-Xylene	1	0	0	0
95476	O-Xylene	1	0	0	0

EMISSIONS FOR FACILITY FAC=9999 DEV= PRO= STK=28 NAME=SRCGP28
SOURCE MULTIPLIER=1

CAS	ABBREV	MULTIPLIER	BG (ug/m^3)	AVRG (lbs/yr)	MAX (lbs/hr)
106990	1,3-Butadiene	1	0	0	0
75070	Acetaldehyde	1	0	0	0
107028	Acrolein	1	0	0	0
7664417	Ammonia	1	0	0	0

7440382	Arsenic	1	0	0	0
1332214	Asbestos	1	0	0	0
71432	Benzene	1	0	0	0
7440417	Berylium	1	0	0	0
7440439	Cadmium	1	0	0	0
56235	Carbon Tetrachlo	1	0	0	0
7782505	Chlorine	1	0	0	0
18540299	Chromium (VI)	1	0	0	0
218019	Chrysene	1	0	0	0
7440508	Copper	1	0	0	0
9901	DPM	1	0	0	0
100414	Ethyl Benzene	1	0	0	0
111762	Ethylene glycol	1	0	0	0
109864	Ethylene glycol	1	0	0	0
106934	Ethylene Dibromi	1	0	0	0
107062	Ethylene Dichlor	1	0	0	0
50000	Formaldehyde	1	0	0	0
110543	Hexane	1	0	0	0
7647010	Hydrochloric Aci	1	0	0	0
7783064	Hydrogen Sulfide	1	0	0	0
7439921	Lead (inorganic)	1	0	0	0
71556	Methyl Chlorofor	1	0	0	0
1634044	Metyl Tertiary B	1	0	0	0
7439965	Manganese	1	0	0	0
7439976	Mercury	1	0	0	0
67561	Methanol	1	0	0	0
78933	Methyl Ethyl Ket	1	0	0	0
75092	Methylene Chlori	1	0	0	0
91203	Naphthalene	1	0	3.1400000	0
7440020	Nickel	1	0	0	0
1151	PAHs	1	0	0	0
127184	Perchloroethylen	1	0	0	0
107982	Propylene glycol	1	0	0	0
7782492	Selenium	1	0	0	0
100425	Styrene	1	0	0	0
7664939	Sulfuric Acid	1	0	0	0
108883	Toluene	1	0	0	0
79016	Trichloroethylen	1	0	0	0
75014	Vinyl Chloride	1	0	0	0
1330207	Xylene	1	0	120.1200000	0.01000000
108383	M-Xylene	1	0	0	0
95476	O-Xylene	1	0	0	0

EMISSIONS FOR FACILITY FAC=9999 DEV= PRO= STK=29 NAME=SRCGP29
SOURCE MULTIPLIER=1

CAS	ABBREV	MULTIPLIER	BG (ug/m^3)	AVRG (lbs/yr)	MAX (lbs/hr)
106990	1,3-Butadiene	1	0	0	0
75070	Acetaldehyde	1	0	0	0
107028	Acrolein	1	0	0	0
7664417	Ammonia	1	0	0	0
7440382	Arsenic	1	0	0	0
1332214	Asbestos	1	0	0	0
71432	Benzene	1	0	0	0
7440417	Berylium	1	0	0	0
7440439	Cadmium	1	0	0	0
56235	Carbon Tetrachlo	1	0	0	0
7782505	Chlorine	1	0	0	0
18540299	Chromium (VI)	1	0	0	0
218019	Chrysene	1	0	0	0
7440508	Copper	1	0	0	0
9901	DPM	1	0	0	0
100414	Ethyl Benzene	1	0	0	0

111762	Ethylene glycol	1	0	0	0
109864	Ethylene glycol	1	0	0	0
106934	Ethylene Dibromi	1	0	0	0
107062	Ethylene Dichlor	1	0	0	0
50000	Formaldehyde	1	0	0	0
110543	Hexane	1	0	0	0
7647010	Hydrochloric Aci	1	0	0	0
7783064	Hydrogen Sulfide	1	0	0	0
7439921	Lead (inorganic)	1	0	0	0
71556	Methyl Chlorofor	1	0	0	0
1634044	Metyl Tertiary B	1	0	0	0
7439965	Manganese	1	0	0	0
7439976	Mercury	1	0	0	0
67561	Methanol	1	0	0	0
78933	Methyl Ethyl Ket	1	0	0	0
75092	Methylene Chlori	1	0	0	0
91203	Naphthalene	1	0	3.1400000	0
7440020	Nickel	1	0	0	0
1151	PAHs	1	0	0	0
127184	Perchloroethylen	1	0	0	0
107982	Propylene glycol	1	0	0	0
7782492	Selenium	1	0	0	0
100425	Styrene	1	0	0	0
7664939	Sulfuric Acid	1	0	0	0
108883	Toluene	1	0	0	0
79016	Trichloroethylen	1	0	0	0
75014	Vinyl Chloride	1	0	0	0
1330207	Xylene	1	0	120.1200000	0.01000000
108383	M-Xylene	1	0	0	0
95476	O-Xylene	1	0	0	0

EMISSIONS FOR FACILITY FAC=9999 DEV= PRO= STK=30 NAME=SRCGP30
SOURCE MULTIPLIER=1

CAS	ABBREV	MULTIPLIER	BG (ug/m^3)	AVRG (lbs/yr)	MAX (lbs/hr)
106990	1,3-Butadiene	1	0	0	0
75070	Acetaldehyde	1	0	2926.4240000	0.3340667
107028	Acrolein	1	0	732.6700000	0.08363813
7664417	Ammonia	1	0	192607.4520000	21.9871521
7440382	Arsenic	1	0	0	0
1332214	Asbestos	1	0	0.8290000	0.00009463470
71432	Benzene	1	0	853.9590000	0.09748390
7440417	Berylium	1	0	2.4400000	0.0002785388
7440439	Cadmium	1	0	0	0
56235	Carbon Tetrachlo	1	0	0.2280000	0.00002602740
7782505	Chlorine	1	0	4.9090000	0.0005603881
18540299	Chromium (VI)	1	0	0	0
218019	Chrysene	1	0	0	0
7440508	Copper	1	0	0	0
9901	DPM	1	0	0	0
100414	Ethyl Benzene	1	0	1530.7840000	0.1747470
111762	Ethylene glycol	1	0	21.6780000	0.002474658
109864	Ethylene glycol	1	0	8.6100000	0.0009828767
106934	Ethylene Dibromi	1	0	0.2730000	0.00003116438
107062	Ethylene Dichlor	1	0	0.1440000	0.00001643836
50000	Formaldehyde	1	0	0	0
110543	Hexane	1	0	5730.6240000	0.6541808
7647010	Hydrochloric Aci	1	0	11.5130000	0.001314269
7783064	Hydrogen Sulfide	1	0	2298.9990000	0.2624428
7439921	Lead (inorganic)	1	0	0	0
71556	Methyl Chlorofor	1	0	0.8320000	0.00009497717
1634044	Metyl Tertiary B	1	0	1.2380000	0.0001413242
7439965	Manganese	1	0	0	0

7439976	Mercury	1	0	0	0
67561	Methanol	1	0	28520.0980000	3.2557189
78933	Methyl Ethyl Ket	1	0	862.2050000	0.09842523
75092	Methylene Chlori	1	0	0.5290000	0.00006038813
91203	Naphthalene	1	0	0	0
7440020	Nickel	1	0	0	0
1151	PAHs	1	0	0	0
127184	Perchloroethylen	1	0	276.6040000	0.03157580
107982	Propylene glycol	1	0	100.8300000	0.01151027
7782492	Selenium	1	0	0	0
100425	Styrene	1	0	17.7370000	0.002024772
7664939	Sulfuric Acid	1	0	37422.9340000	4.2720244
108883	Toluene	1	0	5705.2980000	0.6512897
79016	Trichloroethylen	1	0	2537.9800000	0.2897237
75014	Vinyl Chloride	1	0	0.09200000	0.00001050228
1330207	Xylene	1	0	7203.8050000	0.8223522
108383	M-Xylene	1	0	2.3310000	0.0002660959
95476	O-Xylene	1	0	0.8090000	0.00009235160

EMISSIONS FOR FACILITY FAC=9999 DEV= PRO= STK=31 NAME=SRCGP31
SOURCE MULTIPLIER=1

CAS	ABBREV	MULTIPLIER	BG (ug/m^3)	AVRG (lbs/yr)	MAX (lbs/hr)
106990	1,3-Butadiene	1	0	0	0
75070	Acetaldehyde	1	0	0	0
107028	Acrolein	1	0	0	0
7664417	Ammonia	1	0	0	0
7440382	Arsenic	1	0	0	0
1332214	Asbestos	1	0	0	0
71432	Benzene	1	0	0	0
7440417	Berylium	1	0	0	0
7440439	Cadmium	1	0	0	0
56235	Carbon Tetrachlo	1	0	0	0
7782505	Chlorine	1	0	0	0
18540299	Chromium (VI)	1	0	0	0
218019	Chrysene	1	0	0	0
7440508	Copper	1	0	0	0
9901	DPM	1	0	6.1494042	0.007764399
100414	Ethyl Benzene	1	0	0	0
111762	Ethylene glycol	1	0	0	0
109864	Ethylene glycol	1	0	0	0
106934	Ethylene Dibromi	1	0	0	0
107062	Ethylene Dichlor	1	0	0	0
50000	Formaldehyde	1	0	0	0
110543	Hexane	1	0	0	0
7647010	Hydrochloric Aci	1	0	0	0
7783064	Hydrogen Sulfide	1	0	0	0
7439921	Lead (inorganic)	1	0	0	0
71556	Methyl Chlorofor	1	0	0	0
1634044	Metyl Tertiary B	1	0	0	0
7439965	Manganese	1	0	0	0
7439976	Mercury	1	0	0	0
67561	Methanol	1	0	0	0
78933	Methyl Ethyl Ket	1	0	0	0
75092	Methylene Chlori	1	0	0	0
91203	Naphthalene	1	0	0	0
7440020	Nickel	1	0	0	0
1151	PAHs	1	0	0	0
127184	Perchloroethylen	1	0	0	0
107982	Propylene glycol	1	0	0	0
7782492	Selenium	1	0	0	0
100425	Styrene	1	0	0	0
7664939	Sulfuric Acid	1	0	0	0

108883	Toluene	1	0	0	0
79016	Trichloroethylen	1	0	0	0
75014	Vinyl Chloride	1	0	0	0
1330207	Xylene	1	0	0	0
108383	M-Xylene	1	0	0	0
95476	O-Xylene	1	0	0	0

EMISSIONS FOR FACILITY FAC=9999 DEV= PRO= STK=32 NAME=SRCGP32
SOURCE MULTIPLIER=1

CAS	ABBREV	MULTIPLIER	BG (ug/m^3)	AVRG (lbs/yr)	MAX (lbs/hr)
106990	1,3-Butadiene	1	0	2262.8820000	0.2583199
75070	Acetaldehyde	1	0	0	0
107028	Acrolein	1	0	0	0
7664417	Ammonia	1	0	0	0
7440382	Arsenic	1	0	8.3520000	0.0009534247
1332214	Asbestos	1	0	0	0
71432	Benzene	1	0	0	0
7440417	Berylium	1	0	0	0
7440439	Cadmium	1	0	11.0820000	0.001265068
56235	Carbon Tetrachlo	1	0	0	0
7782505	Chlorine	1	0	0	0
18540299	Chromium (VI)	1	0	1.9950000	0.0002277397
218019	Chrysene	1	0	0.04000000	0.00004566210
7440508	Copper	1	0	88.1720000	0.01006530
9901	DPM	1	0	0	0
100414	Ethyl Benzene	1	0	0	0
111762	Ethylene glycol	1	0	0	0
109864	Ethylene glycol	1	0	0	0
106934	Ethylene Dibromi	1	0	0	0
107062	Ethylene Dichlor	1	0	0	0
50000	Formaldehyde	1	0	2876.3620000	0.3283518
110543	Hexane	1	0	0	0
7647010	Hydrochloric Aci	1	0	0	0
7783064	Hydrogen Sulfide	1	0	0	0
7439921	Lead (inorganic)	1	0	25.3280000	0.002891324
71556	Methyl Chlorofor	1	0	0	0
1634044	Metyl Tertiary B	1	0	0	0
7439965	Manganese	1	0	468.8160000	0.05351781
7439976	Mercury	1	0	3.9570000	0.0004517123
67561	Methanol	1	0	0	0
78933	Methyl Ethyl Ket	1	0	0	0
75092	Methylene Chlori	1	0	0	0
91203	Naphthalene	1	0	552.8360000	0.06310913
7440020	Nickel	1	0	123.0220000	0.01404361
1151	PAHs	1	0	14.5250000	0.001658105
127184	Perchloroethylen	1	0	0	0
107982	Propylene glycol	1	0	0	0
7782492	Selenium	1	0	11.8760000	0.001355708
100425	Styrene	1	0	0	0
7664939	Sulfuric Acid	1	0	0	0
108883	Toluene	1	0	0	0
79016	Trichloroethylen	1	0	0	0
75014	Vinyl Chloride	1	0	0	0
1330207	Xylene	1	0	0	0
108383	M-Xylene	1	0	0	0
95476	O-Xylene	1	0	0	0

EMISSIONS FOR FACILITY FAC=9999 DEV= PRO= STK=33 NAME=SRCGP33
SOURCE MULTIPLIER=1

CAS	ABBREV	MULTIPLIER	BG (ug/m^3)	AVRG (lbs/yr)	MAX (lbs/hr)
106990	1,3-Butadiene	1	0	0	0
75070	Acetaldehyde	1	0	0	0

107028	Acrolein	1	0	0	0
7664417	Ammonia	1	0	0	0
7440382	Arsenic	1	0	0	0
1332214	Asbestos	1	0	0	0
71432	Benzene	1	0	0	0
7440417	Berylium	1	0	0	0
7440439	Cadmium	1	0	0	0
56235	Carbon Tetrachlo	1	0	0	0
7782505	Chlorine	1	0	0	0
18540299	Chromium (VI)	1	0	0	0
218019	Chrysene	1	0	0	0
7440508	Copper	1	0	0	0
9901	DPM	1	0	700.7160000	0.07999041
100414	Ethyl Benzene	1	0	0	0
111762	Ethylene glycol	1	0	0	0
109864	Ethylene glycol	1	0	0	0
106934	Ethylene Dibromi	1	0	0	0
107062	Ethylene Dichlor	1	0	0	0
50000	Formaldehyde	1	0	0	0
110543	Hexane	1	0	0	0
7647010	Hydrochloric Aci	1	0	0	0
7783064	Hydrogen Sulfide	1	0	0	0
7439921	Lead (inorganic)	1	0	0	0
71556	Methyl Chlorofor	1	0	0	0
1634044	Metyl Tertiary B	1	0	0	0
7439965	Manganese	1	0	0	0
7439976	Mercury	1	0	0	0
67561	Methanol	1	0	0	0
78933	Methyl Ethyl Ket	1	0	0	0
75092	Methylene Chlori	1	0	0	0
91203	Naphthalene	1	0	0	0
7440020	Nickel	1	0	0	0
1151	PAHs	1	0	0	0
127184	Perchloroethylen	1	0	0	0
107982	Propylene glycol	1	0	0	0
7782492	Selenium	1	0	0	0
100425	Styrene	1	0	0	0
7664939	Sulfuric Acid	1	0	0	0
108883	Toluene	1	0	0	0
79016	Trichloroethylen	1	0	0	0
75014	Vinyl Chloride	1	0	0	0
1330207	Xylene	1	0	0	0
108383	M-Xylene	1	0	0	0
95476	O-Xylene	1	0	0	0

ACUTE HI REPORT

REC	CV	CNS	BONE	DEVEL	ENDO	EYE	GILV	IMMUN	KIDN	REPRO	RESP	SKIN	BLOOD	MAX
0001	5.19E-04	8.79E-03	0.00E+00	7.33E-04	0.00E+00	5.34E-02	1.76E-08	3.51E-04	0.00E+00	1.32E-04	9.87E-02	0.00E+00	9.62E-05	9.87E-02
0002	5.16E-04	9.00E-03	0.00E+00	7.33E-04	0.00E+00	5.47E-02	1.80E-08	3.52E-04	0.00E+00	1.36E-04	1.01E-01	0.00E+00	9.86E-05	1.01E-01
0003	5.23E-04	8.99E-03	0.00E+00	7.41E-04	0.00E+00	5.47E-02	1.80E-08	3.55E-04	0.00E+00	1.36E-04	1.01E-01	0.00E+00	9.85E-05	1.01E-01
0004	5.16E-04	9.19E-03	0.00E+00	7.36E-04	0.00E+00	5.60E-02	1.84E-08	3.54E-04	0.00E+00	1.39E-04	1.04E-01	0.00E+00	1.01E-04	1.04E-01
0005	5.18E-04	9.28E-03	0.00E+00	7.41E-04	0.00E+00	5.66E-02	1.86E-08	3.57E-04	0.00E+00	1.40E-04	1.05E-01	0.00E+00	1.02E-04	1.05E-01
0006	5.21E-04	9.30E-03	0.00E+00	7.44E-04	0.00E+00	5.67E-02	1.87E-08	3.58E-04	0.00E+00	1.41E-04	1.05E-01	0.00E+00	1.02E-04	1.05E-01
0007	5.19E-04	9.30E-03	0.00E+00	7.42E-04	0.00E+00	5.67E-02	1.87E-08	3.57E-04	0.00E+00	1.41E-04	1.05E-01	0.00E+00	1.02E-04	1.05E-01
0008	5.15E-04	9.36E-03	0.00E+00	7.38E-04	0.00E+00	5.71E-02	1.88E-08	3.56E-04	0.00E+00	1.42E-04	1.06E-01	0.00E+00	1.03E-04	1.06E-01
0009	5.18E-04	9.47E-03	0.00E+00	7.43E-04	0.00E+00	5.77E-02	1.90E-08	3.58E-04	0.00E+00	1.43E-04	1.07E-01	0.00E+00	1.04E-04	1.07E-01
0010	5.19E-04	9.66E-03	0.00E+00	7.47E-04	0.00E+00	5.90E-02	1.94E-08	3.61E-04	0.00E+00	1.46E-04	1.09E-01	0.00E+00	1.06E-04	1.09E-01
0011	5.24E-04	9.66E-03	0.00E+00	7.53E-04	0.00E+00	5.89E-02	1.94E-08	3.64E-04	0.00E+00	1.46E-04	1.09E-01	0.00E+00	1.06E-04	1.09E-01
0012	5.29E-04	9.59E-03	0.00E+00	7.57E-04	0.00E+00	5.85E-02	1.93E-08	3.65E-04	0.00E+00	1.45E-04	1.08E-01	0.00E+00	1.06E-04	1.08E-01
0013	5.28E-04	9.67E-03	0.00E+00	7.58E-04	0.00E+00	5.90E-02	1.94E-08	3.66E-04	0.00E+00	1.46E-04	1.09E-01	0.00E+00	1.06E-04	1.09E-01
0014	5.20E-04	9.89E-03	0.00E+00	7.52E-04	0.00E+00	6.05E-02	1.99E-08	3.64E-04	0.00E+00	1.50E-04	1.12E-01	0.00E+00	1.09E-04	1.12E-01
0015	5.13E-04	1.00E-02	0.00E+00	7.46E-04	0.00E+00	6.12E-02	2.02E-08	3.62E-04	0.00E+00	1.52E-04	1.13E-01	0.00E+00	1.10E-04	1.13E-01

0016	5.06E-04	1.01E-02	0.00E+00	7.39E-04	0.00E+00	6.19E-02	2.04E-08	3.60E-04	0.00E+00	1.54E-04	1.15E-01	0.00E+00	1.12E-04	1.15E-01
0017	5.06E-04	1.02E-02	0.00E+00	7.42E-04	0.00E+00	6.28E-02	2.07E-08	3.62E-04	0.00E+00	1.56E-04	1.16E-01	0.00E+00	1.13E-04	1.16E-01
0018	5.06E-04	1.03E-02	0.00E+00	7.43E-04	0.00E+00	6.32E-02	2.08E-08	3.63E-04	0.00E+00	1.57E-04	1.17E-01	0.00E+00	1.14E-04	1.17E-01
0019	5.01E-04	1.03E-02	0.00E+00	7.37E-04	0.00E+00	6.34E-02	2.09E-08	3.60E-04	0.00E+00	1.57E-04	1.17E-01	0.00E+00	1.14E-04	1.17E-01
0020	4.94E-04	1.03E-02	0.00E+00	7.30E-04	0.00E+00	6.33E-02	2.09E-08	3.57E-04	0.00E+00	1.57E-04	1.17E-01	0.00E+00	1.14E-04	1.17E-01
0021	4.93E-04	1.03E-02	0.00E+00	7.28E-04	0.00E+00	6.33E-02	2.09E-08	3.56E-04	0.00E+00	1.57E-04	1.17E-01	0.00E+00	1.14E-04	1.17E-01
0022	4.96E-04	1.02E-02	0.00E+00	7.30E-04	0.00E+00	6.25E-02	2.06E-08	3.56E-04	0.00E+00	1.55E-04	1.16E-01	0.00E+00	1.13E-04	1.16E-01
0023	5.08E-04	8.96E-03	0.00E+00	7.24E-04	0.00E+00	5.45E-02	1.80E-08	3.48E-04	0.00E+00	1.35E-04	1.01E-01	0.00E+00	9.83E-05	1.01E-01
0024	5.17E-04	9.02E-03	0.00E+00	7.34E-04	0.00E+00	5.49E-02	1.81E-08	3.53E-04	0.00E+00	1.36E-04	1.01E-01	0.00E+00	9.89E-05	1.01E-01
0025	5.16E-04	9.27E-03	0.00E+00	7.37E-04	0.00E+00	5.65E-02	1.86E-08	3.55E-04	0.00E+00	1.40E-04	1.04E-01	0.00E+00	1.02E-04	1.04E-01
0026	5.12E-04	9.23E-03	0.00E+00	7.33E-04	0.00E+00	5.62E-02	1.85E-08	3.53E-04	0.00E+00	1.40E-04	1.04E-01	0.00E+00	1.01E-04	1.04E-01
0027	5.17E-04	9.49E-03	0.00E+00	7.42E-04	0.00E+00	5.79E-02	1.91E-08	3.58E-04	0.00E+00	1.44E-04	1.07E-01	0.00E+00	1.04E-04	1.07E-01
0028	5.17E-04	9.68E-03	0.00E+00	7.45E-04	0.00E+00	5.91E-02	1.95E-08	3.60E-04	0.00E+00	1.47E-04	1.09E-01	0.00E+00	1.07E-04	1.09E-01
0029	5.11E-04	9.78E-03	0.00E+00	7.41E-04	0.00E+00	5.98E-02	1.97E-08	3.59E-04	0.00E+00	1.48E-04	1.11E-01	0.00E+00	1.08E-04	1.11E-01
0030	5.01E-04	1.00E-02	0.00E+00	7.33E-04	0.00E+00	6.14E-02	2.03E-08	3.57E-04	0.00E+00	1.53E-04	1.14E-01	0.00E+00	1.11E-04	1.14E-01
0031	5.07E-04	1.01E-02	0.00E+00	7.41E-04	0.00E+00	6.20E-02	2.04E-08	3.61E-04	0.00E+00	1.54E-04	1.15E-01	0.00E+00	1.12E-04	1.15E-01
0032	5.05E-04	1.02E-02	0.00E+00	7.41E-04	0.00E+00	6.28E-02	2.07E-08	3.62E-04	0.00E+00	1.56E-04	1.16E-01	0.00E+00	1.13E-04	1.16E-01
0033	4.93E-04	1.01E-02	0.00E+00	7.26E-04	0.00E+00	6.21E-02	2.05E-08	3.54E-04	0.00E+00	1.54E-04	1.15E-01	0.00E+00	1.12E-04	1.15E-01
0034	4.96E-04	9.75E-03	0.00E+00	7.23E-04	0.00E+00	5.97E-02	1.97E-08	3.51E-04	0.00E+00	1.48E-04	1.11E-01	0.00E+00	1.08E-04	1.11E-01
0035	5.08E-04	9.89E-03	0.00E+00	7.38E-04	0.00E+00	6.05E-02	1.99E-08	3.59E-04	0.00E+00	1.50E-04	1.12E-01	0.00E+00	1.09E-04	1.12E-01
0036	5.04E-04	9.72E-03	0.00E+00	7.32E-04	0.00E+00	5.95E-02	1.96E-08	3.55E-04	0.00E+00	1.48E-04	1.10E-01	0.00E+00	1.07E-04	1.10E-01
0037	5.05E-04	9.54E-03	0.00E+00	7.29E-04	0.00E+00	5.83E-02	1.92E-08	3.53E-04	0.00E+00	1.45E-04	1.08E-01	0.00E+00	1.05E-04	1.08E-01
0038	5.12E-04	9.29E-03	0.00E+00	7.34E-04	0.00E+00	5.67E-02	1.87E-08	3.54E-04	0.00E+00	1.41E-04	1.05E-01	0.00E+00	1.02E-04	1.05E-01
0039	5.14E-04	9.09E-03	0.00E+00	7.33E-04	0.00E+00	5.54E-02	1.82E-08	3.52E-04	0.00E+00	1.37E-04	1.02E-01	0.00E+00	9.98E-05	1.02E-01
0040	5.13E-04	8.85E-03	0.00E+00	7.27E-04	0.00E+00	5.38E-02	1.77E-08	3.49E-04	0.00E+00	1.33E-04	9.94E-02	0.00E+00	9.70E-05	9.94E-02
0041	5.05E-04	8.76E-03	0.00E+00	7.17E-04	0.00E+00	5.32E-02	1.75E-08	3.44E-04	0.00E+00	1.32E-04	9.84E-02	0.00E+00	9.60E-05	9.84E-02
0042	5.07E-04	9.02E-03	0.00E+00	7.24E-04	0.00E+00	5.50E-02	1.81E-08	3.48E-04	0.00E+00	1.36E-04	1.02E-01	0.00E+00	9.91E-05	1.02E-01
0043	5.01E-04	9.26E-03	0.00E+00	7.20E-04	0.00E+00	5.65E-02	1.86E-08	3.48E-04	0.00E+00	1.40E-04	1.04E-01	0.00E+00	1.02E-04	1.04E-01
0044	5.07E-04	9.48E-03	0.00E+00	7.31E-04	0.00E+00	5.79E-02	1.91E-08	3.53E-04	0.00E+00	1.44E-04	1.07E-01	0.00E+00	1.04E-04	1.07E-01
0045	4.98E-04	9.50E-03	0.00E+00	7.21E-04	0.00E+00	5.81E-02	1.92E-08	3.49E-04	0.00E+00	1.44E-04	1.08E-01	0.00E+00	1.05E-04	1.08E-01
0046	5.02E-04	9.27E-03	0.00E+00	7.21E-04	0.00E+00	5.66E-02	1.86E-08	3.48E-04	0.00E+00	1.40E-04	1.05E-01	0.00E+00	1.02E-04	1.05E-01
0047	5.01E-04	9.15E-03	0.00E+00	7.19E-04	0.00E+00	5.58E-02	1.84E-08	3.47E-04	0.00E+00	1.39E-04	1.03E-01	0.00E+00	1.01E-04	1.03E-01
0048	5.02E-04	8.92E-03	0.00E+00	7.16E-04	0.00E+00	5.43E-02	1.79E-08	3.44E-04	0.00E+00	1.35E-04	1.00E-01	0.00E+00	9.79E-05	1.00E-01
0049	5.07E-04	8.69E-03	0.00E+00	7.18E-04	0.00E+00	5.28E-02	1.74E-08	3.44E-04	0.00E+00	1.31E-04	9.77E-02	0.00E+00	9.52E-05	9.77E-02
0050	5.17E-04	8.86E-03	0.00E+00	7.32E-04	0.00E+00	5.38E-02	1.77E-08	3.51E-04	0.00E+00	1.34E-04	9.95E-02	0.00E+00	9.70E-05	9.95E-02
0051	5.12E-04	8.78E-03	0.00E+00	7.26E-04	0.00E+00	5.34E-02	1.76E-08	3.48E-04	0.00E+00	1.32E-04	9.87E-02	0.00E+00	9.62E-05	9.87E-02
0052	5.10E-04	8.70E-03	0.00E+00	7.22E-04	0.00E+00	5.29E-02	1.74E-08	3.46E-04	0.00E+00	1.31E-04	9.77E-02	0.00E+00	9.53E-05	9.77E-02
0053	5.06E-04	8.64E-03	0.00E+00	7.17E-04	0.00E+00	5.25E-02	1.73E-08	3.43E-04	0.00E+00	1.30E-04	9.70E-02	0.00E+00	9.46E-05	9.70E-02
0054	5.07E-04	8.56E-03	0.00E+00	7.15E-04	0.00E+00	5.19E-02	1.71E-08	3.42E-04	0.00E+00	1.29E-04	9.60E-02	0.00E+00	9.36E-05	9.60E-02

EXHIBIT G

BOYNTON AVENUE RESIDENTIAL PROJECT – COMMUNITY HEALTH RISK ASSESSMENT SAN JOSE, CALIFORNIA

October 2, 2013

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Project 13-163

INTRODUCTION

This report provides the results of an assessment of potential health risk impacts from the proposed residential townhome project at 978 Boynton Avenue in San Jose, California. The proposed project would demolish the existing residential structures and hardscape on-site and construct 10 detached townhouses on-site. The townhouses would be three stories. Two impacts with respect to health risk were evaluated: (1) impacts to new sensitive receptors that will live in close proximity of Williams Road and San Tomas Expressway and (2) impacts to existing sensitive receptors from project construction activities.

Discussion of TACs

Toxic Air Contaminants (TACs) are a broad class of compounds known to cause morbidity or mortality (usually because they cause cancer or serious illness) and include, but are not limited to, criteria air pollutants. TACs are found in ambient air, especially in urban areas, and are caused by industry, agriculture, fuel combustion, and commercial operations (e.g., dry cleaners). TACs are typically found in low concentrations, even near their source (e.g., diesel particulate matter near a highway). Because chronic exposure can result in adverse health effects, TACs are regulated at the regional, state, and federal level. The identification, regulation, and monitoring of TACs is relatively new compared to that for criteria air pollutants that have established ambient air quality standards. TACs are regulated or evaluated on the basis of risk to human health rather than comparison to an ambient air quality standard or emission-based threshold.

Diesel Particulate Matter

Diesel exhaust, in the form of diesel particulate matter (DPM), is the predominant TAC in urban air with the potential to cause cancer. It is estimated to represent about two-thirds of the cancer risk from TACs (based on the statewide average). According to the California Air Resource Board (CARB), diesel exhaust is a complex mixture of gases, vapors, and fine particles. This complexity makes the evaluation of health effects of diesel exhaust a complex scientific issue. Some of the chemicals in diesel exhaust, such as benzene and formaldehyde, have been previously identified as TACs by the CARB, and are listed as carcinogens either under the State's Proposition 65 or under the federal Hazardous Air Pollutants programs. California has adopted a comprehensive diesel risk reduction program. The U.S. Environmental Protection Agency (EPA) and the CARB have adopted low-sulfur diesel fuel standards in 2006 that reduces diesel particulate matter substantially. The CARB recently adopted new regulations requiring the retrofit and/or replacement of construction equipment, on-highway diesel trucks, and diesel buses in order to lower fine particulate matter ($PM_{2.5}$) emissions and reduce statewide cancer risk from diesel exhaust.

Fine Particulate Matter ($PM_{2.5}$)

Particulate matter in excess of state and federal standards represents another challenge for the Bay Area. Elevated concentrations of $PM_{2.5}$ are the result of both region-wide (or cumulative) emissions and localized emissions. High particulate matter levels aggravate respiratory and cardiovascular diseases, reduce lung function, increase mortality (e.g., lung cancer), and result in reduced lung function growth in children.

Sensitive Receptors

There are groups of people more affected by air pollution than others. CARB has identified the following persons who are most likely to be affected by air pollution: children under 14, the elderly over 65, athletes, and people with cardiovascular and chronic respiratory diseases. These groups are classified as sensitive receptors. Locations that may contain a high concentration of these sensitive population groups include residential areas, hospitals, daycare facilities, elder care facilities, elementary schools, and parks. For cancer risk assessments, children are the most sensitive receptors, since they are more susceptible to cancer causing TACs. Residential locations are assumed to include infants and small children. The closest sensitive receptors to the project site are existing residential land uses that surround the site. Additionally, the Boynton High School is about 330 feet north of the project site.

TAC Thresholds of Significance

The Bay Area Air Quality Management District (BAAQMD) identified significance thresholds for exposure to TACs and $PM_{2.5}$ as part of its May 2011 *CEQA Air Quality Guidelines*[1]. This report uses the thresholds and methodologies from BAAQMD's May 2011 *CEQA Air Quality Guidelines* to determine whether there would be any project health risk impacts.

Single Source Impacts

If emissions of TACs or $PM_{2.5}$ exceed any of the thresholds of significance listed below, the proposed project would result in a significant impact and mitigation would be required.

- An excess cancer risk level of more than 10 in 1 million, or a non-cancer (chronic or acute) hazard index greater than 1.0.
- An incremental increase of more than 0.3 micrograms per cubic meter ($\mu g/m^3$) annual average $PM_{2.5}$.

Cumulative Source Impacts

A project would have a cumulatively considerable impact if the aggregate total of all past, present, and foreseeable future sources within a 1,000 foot radius of the fence line of a source or from the location of a receptor, plus the contribution from the project, exceeds the following thresholds.

- An excess cancer risk levels of more than 100 in one million or a chronic non-cancer hazard index (from all local sources) greater than 10.0.
- 0.8 $\mu g/m^3$ annual average $PM_{2.5}$.

TAC Sources Considered

Community health risk assessments typically look at all substantial sources of TACs located within 1,000 feet of project sites. These sources include freeways or State highways, busy surface streets and stationary sources identified by BAAQMD. A review of the project are indicates that traffic on San Tomas Expressway and Williams Road, and an emergency diesel generator are the only sources of TAC emissions identified within 1,000 feet of the project site. Other surface streets with high volumes of traffic were not identified near the project site. A review of BAAQMD's Google Earth map tool used to identify stationary sources and associated estimated risk and hazard impacts, did not reveal any other sources near the project site.

[1] BAAQMD, 2011. *BAAQMD CEQA Air Quality Guidelines*. May.

This health risk assessment evaluated impacts of San Tomas Expressway and Williams Road traffic by utilizing a screening level review. Risk from one stationary source, the diesel generator, was predicted using the ISCST3 dispersion model. The construction emissions impact from the project upon existing sensitive receptors was also evaluated.

Roadway Community Risk Impacts

San Tomas Expressway

According to the *Existing Roadway Segment Average Daily Traffic* table of the San Jose General Plan Draft Program EIR,[2] San Tomas Expressway has a traffic volume of 37,500 vehicles per day in the area of Williams Road. Using the BAAQMD Roadway Screening Analysis Table for Santa Clara County for north-south directional roadways and at a distance of approximately 500 feet, estimated cancer risk from San Tomas Expressway at the project site would be 1.8 in one million or less, which is below the BAAQMD community risk significance threshold of 10 in one million. The estimated $PM_{2.5}$ concentration of 0.07 $\mu g/m^3$ or less and a Hazard Index of less than 0.03 associated with this source would be well below the BAAQMD community risk significance thresholds.

Williams Road

An exact daily traffic volume for Williams Road is not known and is not published in the *Existing Roadway Segment Average Daily Traffic* table. However, it can reasonably be assumed that Williams Road has a lower traffic volume than San Tomas Expressway. For the purposes of this assessment, Williams Road is assumed to have the same daily traffic volume of less than San Tomas Expressway. Using the BAAQMD Roadway Screening Analysis Table for Santa Clara County for east-west directional roadways and at a distance of approximately 50 feet, estimated cancer risk from Williams Road at the project site would be 8.1 in one million or less, which is below the BAAQMD community risk significance threshold of 10 in one million. The estimated $PM_{2.5}$ concentration of 0.348 $\mu g/m^3$ or less and a Hazard Index of less than 0.03 associated with this source would be at the BAAQMD community risk significance threshold for $PM_{2.5}$ and well below of Hazard Index.

Stationary Sources

Stationary sources that emit TACs were searched using the BAAQMD Google Earth Stationary Source Screening Analysis Tool. One source within 1,000 of the project site was identified: A diesel generator operated by the San Jose Water Company at 3601 Williams Road (approximately 873 feet from planned residences). The ISCST3 dispersion model was used to calculate DPM concentrations within the project site. DPM emissions for the diesel generator, identified as 46.12 pounds per year based on the BAAQMD's 2011 Toxic Inventory, were used in the modeling. Concentrations were calculated at receptors placed every 10 meters within the project site. Meteorological data from the San Jose Airport for the period 1991 – 1995, available from the BAAQMD, were used with the modeling. The maximum modeled annual average DPM concentration was 0.00204 $\mu g/m^3$, occurring in the northeast corner of the project site. The maximum cancer risk for this DPM concentration is 1.1 in one million and the maximum hazard index (HI) is 0.0004. The maximum cancer risk, $PM_{2.5}$ concentration, and HI are well below the BAAQMD significance thresholds. Modeling results are included in *Attachment 1*.

[2] City of San Jose. 2011. *Envision San Jose 2040 General Plan*. June

Construction TAC Impacts

Construction activity is anticipated to include demolition of existing buildings and paved areas, excavation, grading, building construction, paving and application of architectural coatings. During demolition, excavation, grading, and some building construction activities, substantial amounts of dust could be generated. Most of the dust would result during grading activities. The amount of dust generated would be highly variable and would be dependent on the size of the area disturbed at any given time, amount of activity, soil conditions, and meteorological conditions. To address fugitive dust emissions that lead to elevated PM_{10} and $PM_{2.5}$ levels near construction sites, the BAAQMD *CEQA Air Quality Guidelines* identify best control measures. If included in construction projects, these impacts will be considered less than significant.

Construction equipment and associated heavy-duty truck traffic generates diesel exhaust, which is a TAC. BAAQMD has developed screening tables for evaluating potential impacts from toxic air contaminants emitted at construction projects.[3] The screening tables are described by BAAQMD as "environmentally conservative interim guidance" and are meant to be used to identify potentially significant impacts that should be modeled using refined techniques. These screening tables indicate that construction activities similar to this project could have significant impacts at distances beyond 100 meters or 330 feet, with the primary impact being excess cancer risk. Since project construction activities would include demolition, excavation, grading, and building construction that would last longer than 6 months and would be located within 330 feet of residences, a more refined- level study of community risk assessment was conducted. Because the gross analysis indicated that impacts were possible, a refined analysis was conducted to evaluate whether impact would be significant, and if so, identify the project features or mitigation measures that would be necessary to avoid significant impacts in terms of community risk impacts to nearby sensitive receptors (e.g., adjacent residences).

The refined health risk assessment focused on modeling on-site construction activity using construction fleet information included in the project design features. For these reasons, construction period emissions were modeled using the California Emissions Estimator Model, Version 2013.2.1 (CalEEMod) along with projected construction activity. The number and types of construction equipment and diesel vehicles, along with the anticipated length of their use for different phases of construction were based on site-specific construction activity schedules. Construction of the project is expected to occur over about a nine month period beginning in June 2014. The CalEEMod model provided total annual $PM_{2.5}$ exhaust emissions (assumed to be diesel particulate matter) for the off-road construction equipment and for exhaust emissions from on-road vehicles (haul trucks, vendor trucks, and worker vehicles), with total emissions of 0.247 tons (49.4 pounds). The on-road emissions are a result of haul truck travel during demolition and grading activities, worker travel, and vendor deliveries during building construction. A trip length of 0.3 miles was used to represent vehicle travel while at or near the construction site. It was assumed that these emissions from on-road vehicles traveling at or near the site would occur at the construction site. Fugitive $PM_{2.5}$ dust emissions were calculated by CalEEMod as 0.0203 tons (40.6 pounds) for the overall construction period. The project emission calculations are provided in *Attachment 2*.

The U.S. EPA ISCST3 dispersion model was used to predict concentrations of DPM at existing sensitive receptors in the vicinity of the project site. The ISCST3 modeling utilized two area sources to represent the on-site construction emissions, one for DPM exhaust emissions and one for fugitive dust emissions. To represent the construction equipment exhaust emissions, an emission release height of 6 meters was used for the area source. The elevated source height reflects the height of the equipment exhaust pipes and buoyancy of the exhaust plume. For modeling fugitive $PM_{2.5}$ emissions,

[3] BAAQMD. 2010. *Screening Tables for Air Toxics Evaluation During Construction*. May.

a near ground level release height of 2 meters was used for the area source. Emissions from truck travel at the project site were also included in the area source for exhaust emissions. Emissions were modeled as occurring daily between 7 am - 4 pm. The model used a 5-year data set (1991 - 1995) of hourly meteorological data from the San Jose Airport available from the BAAQMD. Annual DPM concentrations from construction activities were predicted for 2014 through 2015, with the annual average concentrations based on the 5-year average concentrations from modeling 5 years of meteorological data. DPM concentrations were calculated for two heights; 1.5 meters and 4.5 meters. A receptor height of 1.5 meters was used for single-family homes and receptor heights of 1.5 and 4.5 meters were used to represent of the first two stories of nearby apartments.

The maximum-modeled DPM concentration occurred at the residence adjacent to the southern boundary of the construction area. The location of this receptor is identified on Figure 1. Increased cancer risks were calculated using the modeled annual concentrations and BAAQMD recommended risk assessment methods for both a child exposure (3rd trimester through 2 years of age) and for an adult exposure. Since the modeling was conducted under the conservative assumption that emissions occurred 365 days per year, the default BAAQMD exposure period of 350 days per year was used. Additionally, increased cancer risks at the school were calculated using modeled DPM concentrations at the school and a child breathing rate. It was conservatively assumed that the students would be exposed for the entire construction period.

Results of this assessment indicate that, with project construction, the incremental child cancer risk at the maximum exposed individual (MEI) would be 15.3 in one million and the adult incremental cancer risk would be 0.8 in one million. The predicted excess child cancer risk of 15.3 in one million would exceed the BAAQMD significance threshold of 10 in one million and be considered significant. The maximum increased child cancer risk at the Boynton High School would be 0.5 in one million, well below the BAAQMD threshold. The modeled maximum annual $PM_{2.5}$ concentration was 0.46 micrograms per cubic meter ($\mu g/m^3$) occurring at the residence adjacent to the southern boundary of the construction area. This $PM_{2.5}$ concentration is greater than the threshold of 0.3 $\mu g/m^3$ used to judge the significance of impacts for $PM_{2.5}$.

Potential non-cancer health effects due to chronic exposure to DPM were also evaluated. The chronic inhalation reference exposure level (REL) for DPM is 5 $\mu g/m^3$. The maximum predicted annual DPM concentration was 0.17 $\mu g/m^3$, which is much lower than the REL. The Hazard Index (HI), which is the ratio of the annual DPM concentration to the REL, is 0.034. This HI is much lower than the BAAQMD significance criterion of a HI greater than 1.0.

The resulting excess child cancer risk and $PM_{2.5}$ concentrations exceed the significance thresholds used, and therefore, are considered significant. Mitigation measures are presented below to reduce this impact to a less-than-significant level.

Implementation of Mitigation Measure AQ-1 is considered to reduce exhaust emissions by 5 percent. Implementation of Mitigation Measure AQ-2 would further reduce on-site diesel exhaust emissions. The computed maximum excess child cancer risk with implementation of Mitigation Measure AQ-1 and AQ-2 would be 9.8 per million and the $PM_{2.5}$ concentration would be 0.22 $\mu g/m^3$. As a result, the project with mitigation measures would have *a less-than-significant* impact with respect to community risk caused by construction activities.

Attachment 2 includes the emission calculations used for the area source modeling and the cancer risk calculations.

Mitigation Measure AQ-1: Implement BAAQMD Recommended Best Control Measures for reducing fugitive dust emissions.

The project design features for construction include BAAQMD recommended "Best Management Practices" along with construction equipment selection, techniques and scheduling that reduce impacts. This construction design features is intended to establish a process that minimizes fugitive dust and exhaust emissions that protects the health and safety of nearby sensitive receptors such that temporary construction emissions would not exceed the BAAQMD significance thresholds for community risk and hazard impacts. These features will include some combination of the following:

1. All exposed surfaces (e.g., parking areas, staging areas, soil piles, graded areas, and unpaved access roads) shall be watered two times per day.
2. All haul trucks transporting soil, sand, or other loose material off-site shall be covered.
3. All visible mud or dirt track-out onto adjacent public roads shall be removed using wet power vacuum street sweepers at least once per day. The use of dry power sweeping is prohibited.
4. All vehicle speeds on unpaved roads shall be limited to 15 mph.
5. All roadways, driveways, and sidewalks to be paved shall be completed as soon as possible. Building pads shall be laid as soon as possible after grading unless seeding or soil binders are used.
6. Idling times shall be minimized either by shutting equipment off when not in use or reducing the maximum idling time to 5 minutes (as required by the California airborne toxics control measure Title 13, Section 2485 of California Code of Regulations). Clear signage shall be provided for construction workers at all access points.
7. All construction equipment shall be maintained and properly tuned in accordance with manufacturer's specifications. All equipment shall be checked by a certified mechanic and determined to be running in proper condition prior to operation.
8. Post a publicly visible sign with the telephone number and person to contact at the Lead Agency regarding dust complaints. This person shall respond and take corrective action within 48 hours. The Air District's phone number shall also be visible to ensure compliance with applicable regulations.

Mitigation Measure AQ-2: Selection of equipment during demolition, grading, and trenching construction phases to minimize emissions. Such equipment selection would include the following:

1. All diesel-powered off-road equipment larger than 50 horsepower and operating at the site for more than two days continuously shall meet U.S. EPA particulate matter emissions standards for Tier 2 engines or equivalent;
2. All diesel powered forklifts and aerial lifts shall meet U.S. EPA particulate matter emissions standards for Tier 4 engines or equivalent;
3. Diesel-powered generators or air compressors shall not be used on-site for more than two days;
4. Minimize the number of hours that equipment will operate including the use of idling restrictions.

Cumulative Risk

Cumulative TAC impacts to proposed sensitive receptors were evaluated by adding the cancer risk, Hazard Index and $PM_{2.5}$ concentrations from each source and comparing those to the BAAQMD Community Risk significance thresholds for cumulative sources. Table 1 shows the community risk impacts from each source

upon sensitive receptors. As shown in Table, cumulative risk to the project from nearby sources would be less than significant.

Table 1. Impacts from Cumulative Sources

Source	Maximum Cancer Risk (per million)	Maximum Hazard Index	Maximum Annual $PM_{2.5}$ Concentration ($\mu g/m^3$)
San Tomas Expressway	1.8	<0.03	0.070
Williams Road	8.1	<0.03	0.348
Plant No. 19806 – San Jose Water Company diesel generator	1.1	<0.01	0.002
Maximum Single Source	8.1	<0.03	0.348
BAAQMD Threshold - Single Source	***10***	***1.0***	***0.3***
Cumulative Sources	11	<0.07	0.420
BAAQMD Threshold – Cumulative Sources	***100***	***10.0***	***0.8***

Figure 1 – Project Construction Site, Receptors and Maximum Risk Location

DPM Cancer Risk From Diesel Emergency Generators
970 Boynton, San Jose, CA- BAAQMD Source #19806

DPM Emission Rates			
	Annual	DPM Emissions	
Source Type	Operation (hr)	Daily* (lb/day)	Annual (lb/yr)
Generator	-	0.12636	46.1

* From BAAQMD 2011 Toxic Inventory

Modeling Information		
Model:	ISCST3	
Source	Generator	
Source Type	Point	
Distance to Residences (ft)	Receptor grid spaced every 10 meters	
Receptor Height (m)	1.5 m	
Meteorological Data	1991-1995 San Jose Airport	
Point Source Stack Parameters		
Generator engine size (hp)	unknown	
Stack Height** (ft)	6	
Stack Diameter** (ft)	0.25	
Stack Exit Velocity** (ft/sec)	164	
Exhaust Temperature** (F)	656	
Annual Emission Rate (lb/year)	46.12	from BAAQMD 2011 Toxic Inventory (Source No. 19806)
Hourly Emission Rate (lb/hr)***	0.005265	

** BAAQMD default generator parameters

**** Hourly emission rate based on annual emissions and 8,760 hours per year.

Cancer Risk Calculation Method

Inhalation Dose = C_{air} x DBR x A x HD x EF x ED x 10^{-6} / AT

Where: C_{air} = concentration in air ($\mu g/m^3$)
DBR = daily breathing rate (L/kg body weight-day)
A = Inhalation absorption factor
EF = Exposure frequency (days/year)
HD = daily exposure (hours/day/24)
ED = Exposure duration (years)
AT = Averaging time period over which exposure is averaged.
10^{-6} = Conversion factor

Inhalation Dose Factors

	Value[1]							
Exposure Type	DBR (L/kg BW-day)	A (-)	Exposure (hr/day)	Exposure (days/week)	Exposure (week/year)	EF (days/yr)	ED (Years)	AT (days)
Residential (70-Year)	302	1	24	7	50	350	70	25,550

[1] Default values recommended by OEHHA& Bay Area Air Quality Management District

Cancer Risk (per million) = Inhalation Dose x CRAF x CPF x 10^6
= URF x Cair

Where: CPF = Cancer potency factor $(mg/kg\text{-}day)^{-1}$
CRAF = Cancer Risk Adjustment Factor
URF=Unit risk factor (cancer risk per $\mu g/m^3$)

Unit Risk Factor for DPM

Exposure Type	CPF $(mg/kg\text{-}day)^{-1}$	CRAF (-)	URF *DPM*
Residential (70-Yr Exposure)	1.10E+00	1.7	**541.5**

Model Results and Cancer Risks

			DPM/PM2.5		DPM
Exposure Type	Distance		Max 1-Hr ($\mu g/m^3$)	Annual Ave ($\mu g/m^3$)	Cancer Risk (per million)
Residential (70-Yr Exposure)	873 feet	266 meters	-	0.00204	1.10

Boynton Ave, San Jose, CA - Construction Impacts (Unmitigated)
DPM Construction Emissions amd Modeling Emission Rates

Unmitigated Emissions

Construction Year	DPM Emissions (ton/year)	Area Source	DPM Emissions (lb/yr)	(lb/hr)	(g/s)	Modeled Area (m^2)	DPM Emisson Rate $g/s/m^2$
2014	0.0243	CON_DPM	49	0.01479	1.86E-03	2,955	6.31E-07
2015	0.0004	CON_DPM	1	0.00025	3.15E-05	2,955	1.06E-08

Notes: 0.0247

Emissions assumed to be evenly distributed over each construction areas

hr/day =	9	(7am - 4pm)
days/yr =	365	
hours/year =	3285	

Boynton Ave, San Jose, CA - Construction Impacts (Mitigated)
DPM Construction Emissions amd Modeling Emission Rates

Mitigated Emissions

Construction Year	DPM Emissions (ton/year)	Area Source	DPM Emissions (lb/yr)	(lb/hr)	(g/s)	Modeled Area (m^2)	DPM Emisson Rate $g/s/m^2$
2014	0.0156	CON_DPM	31	0.00950	1.20E-03	2,955	4.05E-07
2015	0.0002	CON_DPM	0	0.00013	1.69E-05	2,955	5.71E-09

Notes:

Emissions assumed to be evenly distributed over each construction areas

hr/day =	9	(7am - 4pm)
days/yr =	365	
hours/year =	3285	

Boynton Ave, San Jose, CA - Construction Impacts (Unmitigated)
PM2.5 Fugitive Dust Construction Emissions for Modeling

Unmitigated Emissions

Construction Year	Area Source	PM2.5 Emissions (ton/year)	(lb/yr)	(lb/hr)	(g/s)	Modeled Area (m^2)	PM2.5 Emission Rate $g/s/m^2$
2014	CON_PM25	0.0203	40.6	0.01236	1.56E-03	2,955	5.27E-07
2015	CON_PM25	0.0000	0.0	0.00000	0.0E+00	2,955	0.00E+00

Notes: 0.0203

Emissions assumed to be evenly distributed over each construction areas

hr/day =	9	(7am - 4pm)
days/yr =	365	
hours/year =	3285	

Boynton Ave, San Jose, CA - Construction Impacts (Mitigated)
PM2.5 Fugitive Dust Construction Emissions for Modeling

Mitigated Emissions

Construction Year	Area Source	PM2.5 Emissions (ton/year)	(lb/yr)	(lb/hr)	(g/s)	Modeled Area (m^2)	PM2.5 Emission Rate $g/s/m^2$
2014	CON_PM25	0.0079	15.9	0.00483	6.08E-04	2,955	2.06E-07
2015	CON_PM25	0.0000	0.0	0.00000	0.00E+00	2,955	0.00E+00

Notes:

Emissions assumed to be evenly distributed over each construction areas

hr/day =	9	(7am - 4pm)
days/yr =	365	
hours/year =	3285	

Boynton Ave, San Jose, CA - Construction Impacts (Unmitigated)
Maximum DPM Cancer Risk Calculations From Construction
Adjacent Residence: Receptor Height = 1.5 meters

Cancer Risk (per million) = CPF x Inhalation Dose x 1.0E6

Where: CPF = Cancer potency factor $(mg/kg\text{-}day)^{-1}$

Inhalation Dose = C_{air} x DBR x A x EF x ED x 10^{-6} / AT

Where: C_{air} = concentration in air ($\mu g/m^3$)
DBR = daily breathing rate (L/kg body weight-day)
A = Inhalation absorption factor
EF = Exposure frequency (days/year)
ED = Exposure duration (years)
AT = Averaging time period over which exposure is averaged.
10^{-6} = Conversion factor

Values

Parameter	Child	Adult
CPF =	1.10E+00	1.10E+00
DBR =	581	302
A =	1	1
EF =	350	350
AT =	25,550	25,550

Construction Cancer Risk by Year - Maximum Impact Receptor Location - Receptor Height: 1.5 meters

Year	Exposure Exposure Duration (years)	Child - Exposure Information DPM Conc (ug/m3) Year	Annual	Exposure Adjust Factor	Child Cancer Risk (per million)	Adult - Exposure Information Modeled DPM Conc (ug/m3) Year	Annual	Exposure Adjust Factor	Adult Cancer Risk (per million)
1	1	2014	0.1716	10	15.02	2014	0.1716	1	0.78
2	1	2015	0.0029	10	0.25	2015	0.0029	1	0.01
3	1		0.0000	4.75	0.00		0.0000	1	0.00
4	1		0.0000	3	0.00		0.0000	1	0.00
5	1		0.0000	3	0.00		0.0000	1	0.00
6	1		0.0000	3	0.00		0.0000	1	0.00
7	1		0.0000	3	0.00		0.0000	1	0.00
8	1		0.0000	3	0.00		0.0000	1	0.00
9	1		0.0000	3	0.00		0.0000	1	0.00
10	1		0.0000	3	0.00		0.0000	1	0.00
11	1		0.0000	3	0.00		0.0000	1	0.00
12	1		0.0000	3	0.00		0.0000	1	0.00
13	1		0.0000	3	0.00		0.0000	1	0.00
14	1		0.0000	3	0.00		0.0000	1	0.00
15	1		0.0000	3	0.00		0.0000	1	0.00
16	1		0.0000	3	0.00		0.0000	1	0.00
17	1		0.0000	1.5	0.00		0.0000	1	0.00
18	1		0.0000	1	0.00		0.0000	1	0.00
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.•	.•	.•	.•	.•	.•	.•	.•	.•	.•
65	1		0.0000	1	0.00		0.0000	1	0.00
66	1		0.0000	1	0.00		0.0000	1	0.00
67	1		0.0000	1	0.00		0.0000	1	0.00
68	1		0.0000	1	0.00		0.0000	1	0.00
69	1		0.0000	1	0.00		0.0000	1	0.00
70	1		0.0000	1	0.00		0.0000	1	0.00
Total Increased Cancer Risk					**15.3**				**0.8**

Boynton Ave, San Jose, CA - Construction Impacts (with Mitigation)
Maximum DPM Cancer Risk Calculations From Construction
Adjacent Residence: Receptor Height = 1.5 meters

Cancer Risk (per million) = CPF x Inhalation Dose x 1.0E6

Where: CPF = Cancer potency factor $(mg/kg\text{-}day)^{-1}$

Inhalation Dose = C_{air} x DBR x A x EF x ED x 10^{-6} / AT

Where: C_{air} = concentration in air ($\mu g/m^3$)
DBR = daily breathing rate (L/kg body weight-day)
A = Inhalation absorption factor
EF = Exposure frequency (days/year)
ED = Exposure duration (years)
AT = Averaging time period over which exposure is averaged.
10^{-6} = Conversion factor

Values

Parameter	Child	Adult
CPF =	1.10E+00	1.10E+00
DBR =	581	302
A =	1	1
EF =	350	350
AT =	25,550	25,550

Construction Cancer Risk by Year - Maximum Impact Receptor Location

Year	Exposure Exposure Duration (years)	Child - Exposure Information DPM Conc (ug/m3) Year	Child - Exposure Information DPM Conc (ug/m3) Annual	Child Exposure Adjust Factor	Child Cancer Risk (per million)	Adult - Exposure Information Modeled DPM Conc (ug/m3) Year	Adult - Exposure Information Modeled DPM Conc (ug/m3) Annual	Adult Exposure Adjust Factor	Adult Cancer Risk (per million)
1	1	2014	0.1101	10	9.64	2014	0.1101	1	0.50
2	1	2015	0.0016	10	0.14	2015	0.0016	1	0.01
3	1		0.0000	4.75	0.00		0.0000	1	0.00
4	1		0.0000	3	0.00		0.0000	1	0.00
5	1		0.0000	3	0.00		0.0000	1	0.00
6	1		0.0000	3	0.00		0.0000	1	0.00
7	1		0.0000	3	0.00		0.0000	1	0.00
8	1		0.0000	3	0.00		0.0000	1	0.00
9	1		0.0000	3	0.00		0.0000	1	0.00
10	1		0.0000	3	0.00		0.0000	1	0.00
11	1		0.0000	3	0.00		0.0000	1	0.00
12	1		0.0000	3	0.00		0.0000	1	0.00
13	1		0.0000	3	0.00		0.0000	1	0.00
14	1		0.0000	3	0.00		0.0000	1	0.00
15	1		0.0000	3	0.00		0.0000	1	0.00
16	1		0.0000	3	0.00		0.0000	1	0.00
17	1		0.0000	1.5	0.00		0.0000	1	0.00
18	1		0.0000	1	0.00		0.0000	1	0.00
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.•	.•	.•	.•	.•	.•	.•	.•	.•	.•
65	1		0.0000	1	0.00		0.0000	1	0.00
66	1		0.0000	1	0.00		0.0000	1	0.00
67	1		0.0000	1	0.00		0.0000	1	0.00
68	1		0.0000	1	0.00		0.0000	1	0.00
69	1		0.0000	1	0.00		0.0000	1	0.00
70	1		0.0000	1	0.00		0.0000	1	0.00
Total Increased Cancer Risk					**9.8**				**0.51**

EXHIBIT 2

March 21, 2014

Mr. Ash Pirayou
Rutan & Tucker, LLP
3000 El Camino Real, Suite 200
Palo Alto, CA 94306

Subject: Comments on Final EIR for McKinley Village Development

Dear Mr. Pirayou:

Hexagon Transportation Consultants, Inc. has reviewed the responses to our comments on the DEIR for the proposed McKinley Village development in East Sacramento. The responses are incorporated in the Final EIR dated March 2014 and available on the City of Sacramento website. We are disappointed to find that many of the responses are incomplete or completely unresponsive. We understand that the purpose of EIRs is to disclose information to decision makers and the public so they have a clear picture of what would happen in the future if the project were to be built. We believe the EIR is still lacking information in several categories such that informed decisions cannot be made. The following summarizes our concerns.

The responses say that the mitigation measures at the intersections of Alhambra/H and Alhambra/E have been checked by the City Engineer, are feasible, and would not affect bikes, but the City Council has the final say whether they will be required to be built. (We said they would eliminate bike lanes.) If the intersection improvements have been designed enough to reach these conclusions, we want to see the designs. We question how the City Council can reach the conclusion that the intersection improvements are feasible and desirable if they haven't seen any designs.

The cumulative road network includes a new interchange at SR51/Sutters Landing Parkway. We asked how the interchange would fit with the McKinley Village project and maintain access to McKinley Village. The response simply says that they would both fit. How did someone reach that conclusion? We've never seen a drawing of the new interchange. We would like to see a drawing to prove that McKinley Village would not interfere with the interchange design.

We said the EIR should study traffic around the schools. Our comment specifically asked for an analysis of drop-off and pick-up operations in front of Theodore Judah Elementary School and Sutter Middle School. The project would add traffic to these schools, and the potential safety impacts need to be studied. The FEIR response just repeats the text from the DEIR without any additional analysis.

We said that the project isn't served by transit so that should be flagged as an impact. The response claims that the site is served by transit, but it really isn't. The closest bus stops are very far away. Here is the impact criterion from the DEIR: The project would be said to have a significant transit impact if it "fails to adequately provide access to transit." Clearly the project does not provide access to transit. This impact should be identified and mitigated.

We asked for explanations for why volumes increased on certain streets in the cumulative scenario where those increases were not intuitive. The response just says that the analysis used the SACMET model and that is what the model said. Clearly that is not an explanation. The EIR needs to explain in much more detail how the cumulative traffic forecasts were derived. For example, traffic is shown to increase on McKinley Boulevard. Why is that? Is that due to expected growth in East Sacramento? If so, what growth? If not, then it must be cut-through traffic. Where is it originating and where is it going? The people in East Sacramento are very concerned about how traffic volume will change in the future, and the EIR does not provide adequate explanations.

Thank you for the opportunity to review the FEIR. If you have any questions, please do not hesitate to call.

Sincerely,

Hexagon Transportation Consultants, Inc.

Gary K. Black, President

EXHIBIT 3

Original

BINGHAM MCCUTCHEN LLP
Stephen L. Kostka (SBN 57514)
Verne Ball (SBN 244014)
Jessica Tucker-Mohl (SBN 262280)
Three Embarcadero Center
San Francisco, CA 94111-4067
Telephone. (415) 393-2000
Facsimile: (415) 393-2286
stephen kostka@bingham.com

Attorneys for Real Party in Interest M & H Realty Partners VI, LP

FILED/ENDORSED
APR 26 2010
By D JOHNSON
DEPUTY CLERK

SUPERIOR COURT OF THE STATE OF CALIFORNIA

COUNTY OF SACRAMENTO

STONE LAKES NATIONAL WILDLIFE REFUGE ASSOCIATION, FREEPORT PRESERVATION COALITION, COALITION FOR RESPONSIBLE DEVELOPMENT, TRACY OTO, FRANK ALBERT, GARY KRULA AND BRIAN LUJAN, Petitioners and Plaintiffs, v. CITY OF SACRAMENTO, a municipal corporation; CITY COUNCIL OF SACRAMENTO; and DOES 1 through 10, inclusive, Respondents and Defendants M & H REALTY PARTNERS, L.P., Real Parties in Interest.	Case No. 34-2009-80000166 **NOTICE OF ENTRY OF JUDGMENT** **(Pursuant to Code Civ. Proc. § 664.5)** Assigned to Hon Michael P Kenny Department 31 Action filed February 13, 2009

TO ALL PARTIES AND TO THEIR ATTORNEYS OF RECORD:

PLEASE TAKE NOTICE: that on April 22, 2010, the court entered and filed the attached Judgment. Attached as Exhibit A is a true and correct copy of the Court's Judgment Pursuant to Public Resources Code Section 21168.9

DATED: April 23, 2010

BINGHAM McCUTCHEN LLP

By: _____
Verne Ball
Attorneys for Real Party in Interest
M & H REALTY PARTNERS VI, LP

PROOF OF SERVICE

I am over 18 years of age, not a party to this action and employed in the County of San Francisco, California at Three Embarcadero Center, San Francisco, California 94111. I am readily familiar with the practice of this office for collection and processing of correspondence for next business day delivery by Federal Express, and correspondence is deposited with Federal Express that same day in the ordinary course of business.

Today I served the attached·

NOTICE OF ENTRY OF JUDGMENT

by causing a true and correct copy of the above to be delivered by Federal Express from San Francisco, California in sealed envelope(s) with all fees prepaid, addressed as follows·

Daniel L Cardozo Thomas A Enslow Adams Broadwell Joseph & Cardozo 520 Capitol Mall, Suite 350 Sacramento, CA 95814	Sheryl N. Patterson Senior Deputy City Attorney Office of the City Attorney 915 I Street, Fourth Floor Sacramento, CA 95814-2604

I declare under penalty of perjury under the laws of the State of California that the foregoing is true and correct and that this declaration was executed on April 23, 2010.

Margaret Pavao

Margaret Pavao

EXHIBIT A

FILED
ENT'D
APR 22 2010
By _____ Deputy Clerk

SUPERIOR COURT OF CALIFORNIA

COUNTY OF SACRAMENTO

STONE LAKES NATIONAL WILDLIFE REFUGE ASSOCIATION, FREEPORT PRESERVATION COALITION, COALITION FOR RESPONSIBLE DEVELOPMENT, TRACY OTO, FRANK ALBERT, GARY KRULA AND BRIAN LUJAN, Petitioners and Plaintiffs, vs. CITY OF SACRAMENTO, a municipal corporation; CITY COUNCIL OF SACRAMENTO; and DOES 1 through 10, inclusive, Respondents and Defendants.	Case No.: 34-2009-80000166 **[~~Proposed~~]** **JUDGMENT PURSUANT TO PUBLIC RESOURCES CODE SECTION 21168.9** (California Environmental Quality Act, Pub. Resources Code, § 21000 et seq.; Code Civ. Proc., §§ 1094.5.) JUDGE ASSIGNED FOR ALL PURPOSES: Honorable Michael P. Kenny Department: 31
M & H REALTY PARTNERS, LP; MERLONE GEIER PARTNERS, LP, M & H REALTY PARTNERS VI, L.P.; and DOES 12 through 20, inclusive, Real Parties In Interest.	Writ Hearing: November 20, 2009 Time: 9:00 a.m. Dept.: 31 Filing Date of Action: February 13, 2009

The matter of the hearing on the Petition for Writ of Mandate (Case No. 34-2009-80000166) came on regularly for hearing on November 20, 2009 in Department 31 of the Sacramento County Superior Court, the Honorable Michael P. Kenny presiding. Thomas A. Enslow of Adams, Broadwell, Joseph & Cardozo appeared for petitioners the Stone Lakes National Wildlife Refuge Association, the Freeport Preservation Coalition, the Coalition for Responsible Development, Tracy Oto, Frank Albert, Gary Krula and Brian Lujan ("Petitioners"). Sheryl N. Patterson of the Sacramento City Attorney's Office appeared for respondents City of Sacramento and the City Council of Sacramento ("Respondents") Stephen L. Kostka of Bingham McCutchen appeared on behalf of Real Party in Interest, M & H Realty Partners VI, L P ("Real Party").

The Court having reviewed the record of Respondents' proceedings in this matter, the briefs submitted by counsel, and the arguments of counsel, and the matter having been submitted for decision, the Court entered a Ruling on Submitted Matter dated February 11, 2010, that judgment and a peremptory writ of mandate issue in this proceeding. For the reasons set forth in the Court's February 11, 2010 Ruling, which is attached hereto as Exhibit A and incorporated herein,

IT IS ORDERED, ADJUDGED AND DECREED:

1. For failure to comply with the requirements of the California Environmental Quality Act ("CEQA"), let a peremptory writ of mandate issue requiring Respondents to: (1) vacate and set aside their approval and adoption of the Delta Shores project to the extent that the approval is based on analysis and findings that the project would not substantially increase future project residents' exposure to and health risks from freeway mobile-source TACs and that the project health impacts in this regard would be less than significant; (2) conduct further analysis, in accordance with CEQA and the CEQA Guidelines, to determine whether freeway mobile-source TACs would substantially increase health risk impacts to future project residents and constitute a significant impact, and whether any identified significant impacts can be avoided or minimized by feasible mitigation measures; (3) certify the results of the further analysis in accordance with CEQA and the CEQA Guidelines prior

to any re-approval of the project; and (4) within 120 days of receipt of this Court's peremptory writ of mandate, file a return to the peremptory writ describing the action they have taken to comply with the writ pursuant to Public Resources Code section 21168.9, subsection (b).

2. Under Public Resources Code section 21168.9, subsection (b), this Court reserves jurisdiction over Respondents' proceedings by way of a return to the peremptory writ of mandate until the Court has determined that Respondents have complied with the provisions of CEQA and the CEQA Guidelines as required by Paragraph 1 of this Judgment.

3. Petitioners are awarded their costs of suit.

4 This Court retains jurisdiction to determine Petitioners' entitlement to attorneys' fees.

Date: _____

_____
Honorable Michael P. Kenny
Judge of the Superior Court

SUBMITTED BY:

Date: 7/08/10

Thomas A. Enslow
Adams, Broadwell, Joseph & Cardozo
Attorneys for Petitioners

APPROVED AS TO FORM:

Date: _____

_____
Sheryl N. Patterson
Sacramento City Attorney's Office
Attorneys for Respondents

Date: _____

_____
Stephen L. Kostka
Bingham McCutchen
Attorneys for Real Party in Interest

to any re-approval of the project; and (4) within 120 days of receipt of this Court's peremptory writ of mandate, file a return to the peremptory writ describing the action they have taken to comply with the writ pursuant to Public Resources Code section 21168.9, subsection (b).

2. Under Public Resources Code section 21168.9, subsection (b), this Court reserves jurisdiction over Respondents' proceedings by way of a return to the peremptory writ of mandate until the Court has determined that Respondents have complied with the provisions of CEQA and the CEQA Guidelines as required by Paragraph 1 of this Judgment.

3. Petitioners are awarded their costs of suit.

4. This Court retains jurisdiction to determine Petitioners' entitlement to attorneys' fees.

Date. _____

_____
Honorable Michael P. Kenny
Judge of the Superior Court

SUBMITTED BY:

Date: 4/08/10

Thomas A. Enslow
Adams, Broadwell, Joseph & Cardozo
Attorneys for Petitioners

APPROVED AS TO FORM:

Date: 4/09/10

Sheryl N. Patterson
Sacramento City Attorney's Office
Attorneys for Respondents

Date: _____

_____
Stephen L. Kostka
Bingham McCutchen
Attorneys for Real Party in Interest

to any re-approval of the project; and (4) within 120 days of receipt of this Court's peremptory writ of mandate, file a return to the peremptory writ describing the action they have taken to comply with the writ pursuant to Public Resources Code section 21168 9, subsection (b).

2 Under Public Resources Code section 21168.9, subsection (b), this Court reserves jurisdiction over Respondents' proceedings by way of a return to the peremptory writ of mandate until the Court has determined that Respondents have complied with the provisions of CEQA and the CEQA Guidelines as required by Paragraph 1 of this Judgment.

3 Petitioners are awarded their costs of suit.

4 This Court retains jurisdiction to determine Petitioners' entitlement to attorneys' fees.

Date: 4/22/10

Honorable Michael P. Kenny
Judge of the Superior Court

SUBMITTED BY:

Date: 4/08/10

Thomas A. Enslow
Adams, Broadwell, Joseph & Cardozo
Attorneys for Petitioners

APPROVED AS TO FORM:

Date: _____

Sheryl N. Patterson
Sacramento City Attorney's Office
Attorneys for Respondents

Date: 4/9/10

Jessica Tucker-Hall for Stephen L. Kostka

Stephen L. Kostka
Bingham McCutchen
Attorneys for Real Party in Interest

Stone Lakes National Wildlife Assn., et al v. City of Sacramento, et al
Sacramento County Superior Court No.: 34-2009-80000166

PROOF OF SERVICE

I am a citizen of the United States, employed in the City and County of Sacramento. My business address is 520 Capitol Mall, Suite 350, Sacramento, California 95814 I am over the age of 18 years and not a party to the above-entitled action.

I am familiar with Adams Broadwell Joseph & Cardozo's practice whereby the mail is sealed, given the appropriate postage and placed in a designated mail collection area. Each day's mail is collected and deposited in a U.S. mailbox after the close of each day's business.

On April 9, 2010, I served the following:

JUDGMENT AND ORDER
PURSUANT TO PUBLIC RESOURCES CODE SECTION 21168.9

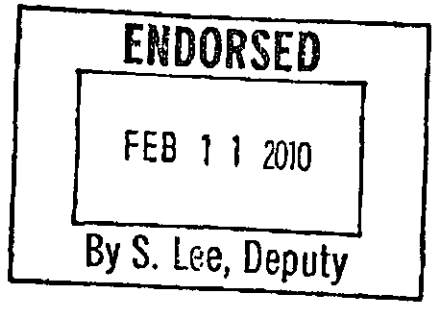
on the parties in this action by causing a true copy thereof to be placed in a sealed envelope with postage thereon fully prepaid in the designated area for outgoing mail addressed as follows:

EILEEN M. TEICHERT
SHERYL N PATTERSON
Office of the City Attorney
City of Sacramento
P.O. Box 1948
Sacramento, CA 95812
spatterson@cityofsacramento.org
Attorney for Real Party in Interest and Defendants

STEPHEN L. KOSTKA
Bingham McCutchen
3 Embarcadero Center
San Francisco, CA 94111-4507
stephen.kostka@bingham.com
Attorney for Respondents

I declare under penalty of perjury that the foregoing is true and correct and that this Proof of Service was executed this 9th day of April, 2010, at Sacramento, California.

Carol N. Horton



SUPERIOR COURT OF CALIFORNIA

COUNTY OF SACRAMENTO

STONE LAKES NATIONAL WILDLIFE, REFUGE ASSOCIATION, FREEPORT PRESERVATION COALITION, COALITION FOR RESPONSIBLE DEVELOPMENT, TRACY OTO, FRANK ALBERT, GARY KRULA, AND BRIAN LUJAN,

Petitioners and Plaintiffs,

v.

CITY OF SACRAMENTO, a municipal corporation, CITY COUNCIL OF SACRAMENTO; and DOES I through 10, inclusive,

Respondents and Defendants

M & H REALTY PARTNERS VI, L P ,

Real Parties in Interest

_____/

Case No 34-2009-80000166-CU-WM-GDS
Dept 31

RULING ON SUBMITTED MATTER

On January 13, 2009, respondents City of Sacramento and City Council of Sacramento ("City") approved Delta Shores, a project by real parties in interest to develop a master planned community on approximately 782 acres of agricultural land and open space adjacent to the southern border of the City and bisected by Interstate 5 (AR, pp 20-25, 925, 1302-1378.)[1] The project includes approximately 5,222 residences, two centers with retail,

[1] Citations to the record of administrative proceedings conducted by the City on the Delta Shores project consist of "AR" followed by relevant page numbers

commercial and office uses, and 118 acres of parks, trails, open space and wetland restoration areas (*Ibid.*)

Prior to approving the Delta Shores project, the City prepared and certified an environmental impact report ("EIR"), which was circulated for public comment and reviewed in accordance with the requirements of the California Environmental Quality Act (CEQA") (AR922-924). The City adopted findings of fact and a statement of overriding considerations pursuant to CEQA (AR 925-1001) and adopted a Mitigation Monitoring Plan (AR 1002-1038) Petitioners challenge the adequacy of the analysis in the EIR under CEQA with respect to certain impacts from the project on the environment

Specifically, the City challenges the analysis of the health risks resulting from toxic air contaminants emitted by vehicular traffic on I-5, the impact of the project's greenhouse gas emissions on global climate change, the loss of the foraging habitat for Swainson's hawks on the project site, the impact of increased stormwater runoff from the project site on the Stone Lakes National Wildlife Refuge and other environmentally sensitive areas in the Sacramento watershed, and the impact of the project's development on the historic river-town character of the Town of Freeport.

Health Impacts of Toxic Air Contaminants ("TACs")

Air pollution studies indicate that residing in close proximity to freeways and heavily traveled roadways increases residents' exposure to TACS, particularly diesel exhaust particulate matter ("DPM"). (AR 7978.). These studies link the residents' increased exposure to an increase in the residents' cancer risk over and above the cancer risk in the region. (AR 7978-7979) Other studies show that exposure to vehicle-emitted pollutants declines as distance from the road increases -- particularly within the first 500 feet (AR 7979.)

On the basis of these studies, the California Air Resources Board ("CARB") formulated recommendations, published in *Air Quality and Land Use Manual A Community Health Perspective*, that land use agencies avoid locating or siting residential and other sensitive land uses within 500 feet of a freeway -- the specified distance within which particulate pollution levels and health risks drop by 70 percent (AR 7979-7980.) The Sacramento Metropolitan Air

Quality Management District ("Air District") developed and set forth a methodology adapting the CARB recommendations to Sacramento regional traffic volumes and meteorological conditions in a publication entitled *Recommended Protocol for Evaluating the Location of Sensitive Land Uses adjacent to Major Roadways* ("Protocol") (AR 8583.1ff.)

The Air District's Protocol is intended to provide land use decision makers with a methodology to assist them in making informed decisions regarding the siting of new residential projects and other sensitive land uses within 500 feet of a freeway or other high-traffic volume roadway. (AR 8583 4.) The initial steps in the methodology consist of a screening process to determine an incremental cancer risk level for the residential use closest to the freeway or roadway (i e., the level separate from the regional background cancer risk level of 360 cancer cases per million persons) and to compare that incremental risk level to the value of a specified evaluation criterion, (which was 446 cancer cases per million persons at the time the Delta Shores project EIR was prepared)[2] (AR 8583 5, 8583 6-8583 10)

The evaluation criterion represents the incremental cancer risk level that corresponds to a 70 percent reduction from the highest risk level at 10 feet from the edge of the roadway -- the worst case siting situation within the boundaries of the Air District It does not represent a safe or acceptable risk level or a regulatory threshold; and it does not include the existing background cancer risk of 360 cancer cases per million in Sacramento County.[3] (AR 8583 10.) If the evaluation criterion is found during screening to be lower than the incremental cancer risk level of the residential use closest to the freeway, a health risk assessment ("HRA") specific to the site should be completed using methodology described in the Protocol (AR 8583 6, 8583 10, 8583.11-8583.16.) If the evaluation criterion is determined to be higher than the incremental cancer risk level of the residential use closest to the freeway, no further analysis is required, and screening results are provided to the land use decision makers for their use in deciding how far from the roadway to site (AR 8583.6, 8583.7)

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[2] The Air District recalculated the value of the evaluation criterion in a 2008 revision of the Protocol as 319 cancer cases per million. (AR 8593)

[3] The background cancer risk localized to the project site is 100 to 250 cancer cases per million persons (AR 177)

Because residential uses proposed for the Delta Shores project are within 500 feet of I-5, the project EIR evaluated the increased cancer risk potentially posed by the exhaust emissions of DPM to future project residents in accordance with the Air District's Protocol (AR 184-185.) Project screening estimated that the incremental cancer risk to residents closest to I-5 (within 117 feet east of I-5 and within 127 feet west of I-5) would be 354 per million east of I-5 and 189 per million west of I-5, less than the evaluation criterion of 446 per million (AR 195, 2994-2996.) A site-specific HRA determined the increased cancer risk associated with motor vehicle DPM from I-5 would be 168 per million, again less than the Protocol's evaluation criterion of 446 per million. (AR 196-197, 3003.) On the basis of these results that showed that the project would not expose future residents near I-5 to TAC emissions above the evaluation criterion, the EIR concluded that the mobile-source TAC health risk impacts are less than significant and require no mitigation. (AR 197-198, 2181-2182.)

The Final EIR rejected comments from petitioners that the assessment of cancer risk from exposure to mobile–source DPM improperly used the evaluation criterion of 446 per million in the Protocol as a threshold for determining the significance of the cancer risk They further argued the Air District's *Guide to Air Quality Assessment in Sacramento County* ("Guide") identified an acceptable level of risk for TAC exposure at 10 per million – substantially lower than the project risk numbers. (AR 822-826)

The Final EIR responded that, even though the Protocol does not consider the evaluation criterion to represent either an acceptable risk level or a regulatory threshold, the Protocol does not preclude the City as a lead agency from deciding that the evaluation criterion provides an appropriate risk level for future project residents near I-5; nor does the Protocol prevent the City from exercising its discretionary land use authority and jurisdiction to decide that the benefits to the larger community from a proposed development outweigh the risks to its future residents from exposure to mobile source TACs Rather, the Protocol contemplated the City using the screening results to make discretionary residential siting decisions (AR 823, 825, 8583 7.) The Final EIR noted that the threshold of 10 cancer cases in a million set forth in the Air District's Guide applied to stationary sources of TACs The EIR further noted that the 10 in

a million number is inapplicable to mobile-source TACs like DPM, as demonstrated by the Air District's development of an alternate risk evaluation criterion for mobile-source TACs in the Protocol. (AR 822-823, 824.)

The Final EIR also rejected petitioners' comments that the assessment of the cancer risk from exposure to mobile-source TACs should have included consideration of TACs in addition to DPM, including 1,3-butadiene and benzene; that the assessment should have taken into account projected increases in traffic along I-5, and that non-carcinogenic health risks of residing close to I-5 should have been evaluated using a health hazard index set by the California Office of Environmental Health Hazard Assessment ("OEHHA") (AR 821-822)

In response, the Final EIR cited data indicating that the cancer risk posed by mobile-source TACs is dominated by DPM, which constitutes about 70 percent of the total ambient air toxics risk (AR 180, 822), noted that the assessment results would not be significantly affected by increases in traffic volumes expected on I-5 in the future because mobile-source emissions of DPM would decrease as a result of CARB programs (AR 827); and indicated that the OEHHA health hazard index applies to emissions from stationary sources, not mobile-source freeway emissions. Nonetheless, following a recommendation in the Protocol, the Final EIR added a qualitative discussion of non-cancer health risks of living near freeways and major roadways (AR 577, 826-827, 8583 6)

In this proceeding, petitioners again contend that the EIR failed to properly assess the health risks imposed on future project residents by their exposure to mobile-source TACs from traffic on I-5. According to petitioners, the EIR assessment improperly used the evaluation criterion in the Air District's Protocol as a threshold of significance to erroneously determine the project would not significantly increase the cancer risk to future project residents close to I-5 The EIR assessment arguably also failed to account for increases in cancer risk as a result of the residents' exposure to TACs other than DPM and future increases in traffic volume along I-5 Finally, petitioners argued the health risks from non-carcinogenic TACs emitted by traffic along I-5 were not adequately analyzed

Discussion of Evaluation Criterion Contentions

Petitioners are correct that 1) the EIR improperly used the evaluation criterion in the Air District's Protocol to determine that the project would not substantially increase the cancer risk to future project residents in close proximity to I-5, 2) that the project impacts on the residents' cancer risk was less than significant, and 3) that no mitigation of the impact was required. (AR 194-198)

These determinations involve discretionary decision-making by the City and call for careful policy judgments, based to the extent possible on scientific and factual data (CEQA Guideline 15064, subd (b); *Eureka Citizens for Responsible Government v City of Eureka* (2007) 147 Cal App.4th 357, 376, citing *Mira Mar Mobile Community v City of Oceanside* (2004) 199 Cal.App 4th 477, 492-493.) Such discretionary decision-making is entitled to deference by the court unless, as here, discretion is exercised unreasonably and lacks a substantial evidentiary basis in the administrative record. (See *Western States Petroleum Assn v Superior Court* (1995) 9 Cal.4th 559, 572-573.)

In using the evaluation criterion of 446 per million from the Air District's Protocol as a standard of significance, the City distorts the meaning and function of the criterion. Under the Protocol, the criterion provides information on the incremental cancer risk to future project residents -- over and above the background cancer risk of 100 to 250 cancer cases per million persons in the project area -- from exposure to mobile-source DPM from I-5 at a distance that achieves a 70 percent reduction in the DPM level and cancer risk from the worst case siting situation (10 feet from the freeway). (AR 8583 10.) By its terms, the evaluation criterion does not provide information about the acceptability of the remaining 30 percent of the incremental cancer risk attributable to DPM exposure at that distance from I-5, and it "does *not* represent a 'safe' risk level." (*Ibid.* (Italics in original.).) Nonetheless, without any explanation based on scientific, technical or policy considerations, the EIR treats the criterion of 446 per million as an acceptable level of cancer risk and as a significance threshold. The EIR rejects as inapplicable the significance threshold of 10 cancer cases per million recommended in the Air District's

Guide, and defines a range between 10 per million and 446 per million within which the City may exercise its discretion by weighing the benefits of the development project to the larger community against the risks to the project's future occupants from the mobile source TACs to which they would be exposed [4] (AR 822-825.)

By treating the evaluation criterion of 446 per million as an acceptable level of cancer risk and as a significance threshold, the EIR fails to disclose and evaluate the significance of the remaining incremental cancer risk from mobile-source DPM to future project residents represented by the evaluation criterion. Rather, the EIR effectively dismisses that remaining incremental risk as insignificant, without a scientifically based explanation for doing so Respondents assume too much when they conclude that the mobile-source TAC health impacts of the project are less than significant because the HRA-calculated incremental risk of 168 cancer cases per million for future project residents closest to I-5 is below the risk level of the criterion Respondents further minimize the health risks because project residents would not be exposed to TAC emissions above the risk level of the criterion. (AR 197, 202.) This finding of insignificance precludes any consideration in the EIR of feasible mitigation measures to avoid or minimize the remaining cancer risk. (*Ibid.*)

The comments by the Air District on the Draft EIR implicitly highlight the shortcomings in the EIR's significance analysis of the TAC health impacts. In its comments, the Air District noted that residential units to be built on the project site within 500 feet of I-5 "have been shown to be at relatively low risk levels" from TACs by the screening and HRA performed pursuant to the Air District's Protocol. (AR 634.) Given the residential units' proximity to the freeway, however, the Air District recommends that "strong consideration be given" to mitigation for TACs, namely a vegetation buffer to act as a barrier between the freeway and the residential units (*Ibid.*) In making this recommendation, the Air District demonstrates its

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[4] The City's exercise of discretion described in the EIR, weighing the benefits of the development project to the larger community against the risks to the project's future occupants from exposure to mobile-source TACs within a range between 10 per million and 446 per million, appears to reflect an exercise of discretion associated with a statement of overriding considerations pursuant to subdivision (b) of Public Resources Code section 21081 and CEQA Guidelines 15043 and 15093, not an impact analysis and significance determination which does not consider the economic benefits of a project

continuing concern about TAC health impacts on occupants of the residential units despite the relatively low risk levels related to TACs. To the Air District, these low risk levels below the Protocol's evaluation criterion are not insignificant and warrant mitigation.

The court concludes that the EIR's significance analysis of the TAC health impacts on future project residents in close proximity to I-5 is based on a standard or threshold analysis that is not reasonably supported by the evidence in the administrative record. As a result, the significance analysis fails to provide the information about TAC impacts and feasible mitigation measures necessary to informed participation by the public and informed decision-making by the City that is required by CEQA. The City must correct these legal and informational deficiencies upon remand

Discussion.

With respect to petitioners' other TAC-related contentions, the Court finds that the City's analysis appropriately performs a qualitative analysis of the non-carcinogenic TACs in accordance with the recommendation of the Air District's Protocol (AR 827, 8583 5) Petitioners are incorrect in claiming that the HRA underestimated the TAC-related cancer risk by basing its analysis on data that understates actual traffic levels upon completion of the project and the Consumnes River Boulevard Exchange· a review of the HRA indicates that it used cumulative traffic data for the year 2015, the year when the project build-out is anticipated (AR 3007, 3009)

Because Petitioners' claim regarding the contribution of mobile-source TACs other than DPM to increases in cancer risk to future project residents is closely linked to the TAC health risk impacts analysis that must be revised on remand, the City must also consider that claim on remand.

Global Climate Change

The EIR analyzes the potential impacts of greenhouse gases ("GHGs") likely to be emitted by the project on global climate change, concludes that the impacts cannot be measured by available methodologies but also concludes they are potentially cumulatively considerable, sets forth measures that will reduce the impacts, and applies the City's Statement of Overriding

Considerations to the impacts. (AR 490-491, 504-507, 570-573, 828-840, 899-902, 987-996, 998) This analysis is premised on the general scientific consensus that global climate change is occurring at least partially as a result of increasing GHG emissions and is shaped by current limitations in scientific knowledge and methodology necessary to identify and measure the relationship between a project's GHG emissions and global climate change (*Ibid*)

Specifically, the EIR estimates the GHGs likely to be emitted by the project and project-related activities during construction and during operations at buildout (AR 508-513, 990-992.) After reviewing the scientific and regulatory context of global climate change, the EIR determines that no scientific basis, technical methodology, or regulatory guidance is presently available to evaluate the impacts of the estimated GHG emissions on global climate change, to establish a threshold of significance for the emissions, or to otherwise determine the significance of the impacts for purposes of CEQA. (AR 504-507, 828-835, 987-990) Instead, the EIR finds that the impacts of the project on global climate change, though speculative, are potentially cumulatively considerable and identifies project design features and other measures to avoid or minimize the project's emissions of GHGs by reducing vehicle travel, promoting public transit, and reducing energy use. (AR 193, 513-517, 835-840, 907-908, 940-944, 992-996) These measures are incorporated into the Mitigation Monitoring Plan approved by the City for the project and are binding on real parties in interest in developing the project pursuant to their development agreement with the City and the City's approval of project entitlements (AR 923, 1031-1034, 1306, 1598-1599, 1620, 1665.) In addition, the development agreement obligates real parties to develop the project in compliance with city-wide GHG reduction ordinances or resolutions enacted by the City in the future. (AR 1622.)

Petitioners contend that the EIR violated CEQA by failing to make findings of whether the impacts of the project's GHG emissions on global climate change would be significant and whether the impacts would remain significant after all feasible mitigation measures were imposed. Petitioners reject the EIR's premise that no science, technical methodology or regulatory guidance exists to make a significance determination They point to *CEQA & Climate Change*, a white paper published by the California Air Pollution Control

Officers Association ("CAPCOA") which describes and evaluates alternative approaches to setting a threshold of significance for use in determining whether the impact of a project's GHG emissions are significant. (AR 4753-4819.) Petitioners also contend that the measures identified in the EIR to reduce the project's GHG emissions and mitigate its impact on global warming are inadequate under CEQA because the measures are vaguely worded, depend on the voluntary compliance of real parties in developing the project, and are otherwise unenforceable without a finding of significance.

Discussion

Contrary to petitioners' contention, the City properly declined to make a significance finding with respect to the impacts of the project's GHG emissions on global climate change (See AR 995) After conducting a thorough and evenhanded review of the science, possible methodologies, and regulatory guidance for determining whether project-specific GHG emissions would make a significant contribution to global climate change, the EIR reasonably concludes that the science and methodology for making a significance determination is uncertain or unavailable and any significance finding would be speculative. (AR 504-507, 828-829, 832, 987-989 See *Berkeley Keep Jets Over the Bay Committee v Board of Commissioners* (2001) 91 Cal.App 4th 1344, 1370-1371.) The position is consistent with approaches suggested by the Association of Environmental Professionals ("AEP") in *Alternative Approaches to Analyzing Greenhouse Gas Emissions and Global Climate Change in CEQA Documentation* (AR 505, 4686-4689) as well as the CAPCOA's assessment that a local agency may decide to defer any consideration of significance thresholds for use in analyses of climate change impacts until the state has established a framework of GHG emission reduction targets for new land use projects (AR 4783.) Notably, the significance thresholds suggested by CAPCOA appear to assign GHG reduction goals to various types of projects by referring to legislatively established targets instead of scientific analysis. (AR 4787-4817.)

In declining to make a finding of significance about the project's climate change impacts, the EIR adopts the environmentally protective position that the project impacts on

climate change are potentially cumulatively considerable [5] (AR 835, 992) This position suggests, without finding, that the project impacts on global climate change *could* be significant, thereby providing a basis for a discussion of multiple mitigation measures to reduce the project's GHG emissions impact. The EIR discloses important information about the project's environmental impacts to members of the public and the City officials making decisions about the project. (AR 835-840, 992-995.) These GHG emission reduction measures are fully enforceable without a finding of significance through their incorporation in the Mitigation Monitoring Plan and the incorporation of the Mitigation Monitoring plan in the project entitlements and real parties' binding agreement to comply with the Mitigation Monitoring Plan, as well as GHG reduction measures adopted by the City in the future. (AR 923, 1031-1034, 1306, 1598-1599, 1620, 1622, 1665)

Loss of Foraging Habitat for Swainson's Hawks ("SWH")

Agricultural fields on the project site provide approximately 765 acres of suitable foraging habitat for the SWH, a threatened species under the California Endangered Species Act ("CESA"). The CESA is administered by the California Department of Fish and Game ("DFG") (AR 218, 232, 579.) Suitable foraging habitat is defined as annual grasslands, fallow fields, dry and irrigated pasture, and farmland growing alfalfa, beet, tomato and other low-growing crops, and cereal grains. (AR

The SWH can forage as far as 10 miles from the nest, but SWH nests are generally more successful if suitable foraging habitat is present within an approximate five-mile radius (AR 219.) Development of the project site would result in the conversion of approximately 765 acres of suitable foraging habitat and could have a potentially significant impact on the SWH by requiring the raptor to travel farther and expend more energy in gathering prey to feed their offspring -- thereby increasing nest mortality. (AR 231-232)

[5] Petitioners argue that the characterization of the project's impacts on global climate change as potentially cumulatively considerable appears for the first time in the Final EIR, constitutes a new finding of a significant project impact, and requires recirculation of the Draft EIR for public comment under CEQA Because the court finds that the potentially cumulatively considerable determination is not a finding of significance, recirculation is unnecessary

To mitigate the project's potential impact on the SWH to a less-than-significant level, the EIR proposes Mitigation Measure 5 4-3. (AR 948-949, 1012 See earlier versions at AR 232, 602-603, 911-914.) The measure, as ultimately adopted by the City, would require real parties in interest, prior to the issuance of grading permits, to preserve an equal amount of suitable raptor foraging habitat at a 1:1 ratio. one acre would be preserved for every acre developed on the project site through the purchase of credits at a DFG-approved mitigation bank which has the project within its service area or through the purchase of conservation easements or fee title of lands with suitable foraging habitat within a maximum 10-mile radius of the perimeter of the project site, or through any combination of these two methods (AR 949) Any parcel identified by real parties for preservation would be evaluated by the City in consultation with the DFG using five criteria:

1 Does the parcel provide suitable foraging habitat?

2. Is the parcel located in close proximity to the impacted foraging habitat?

3 Is the parcel occupied or adjacent to active SWH nests?

4. Is the parcel adjacent to other protected habitat, thereby contributing to a larger preserve?

5. Is the parcel outside of areas identified for urban growth?

In addition, real parties would be required to submit a mitigation plan to the City for approval prior to the issuance of grading permits (*Ibid.*) The plan would be required to include details on mitigation site location, development, maintenance and monitoring. Land and easements must be approved by the City in consultation with the DFG (*Ibid*)

Petitioners contend that substantial evidence does not exist in the administrative record to support the EIR's conclusion that Mitigation Measure 5 4-3 will reduce the project's impact on the SWH to a less-than-significant level Petitioners argue the record is deficient because Mitigation Measure 5 4-3 fails to adequately address the distance between the project site and mitigation lands or mitigation banks and the inclusion of fallow land in the definition of suitable foraging habitat

Discussion of 10-Mile Distance Contentions

First, petitioners claim that in allowing the acquisition of mitigation parcels up to 10 miles from the project site, the measure would negatively impact the SWH's reproductive success. According to petitioners, the SWH requires foraging habitat within five miles of nests Foraging habitat between five and ten miles from nests is less valuable and requires the SWH to expend greater energy in gathering necessary food for their offspring with a consequent increase in nest mortality

Substantial evidence in the administrative record indicates that SWH foraging habitat within 10 miles of the project site would be suitable and effective in avoiding nest mortality Much of this evidence is found in technical materials and correspondence submitted during administrative proceedings by the DFG as trustee for the State's fish and wildlife and as the administrator of CESA under which the SWH receives protection as a threatened species DFG's 1994 *Staff Report regarding Mitigation for Impacts to Swainson's Hawks (*Bueo swainsoni*) in the Central Valley of Sacramento*, relied on specified telemetry studies to recognize a 10-mile radius as the flight distance of the SWH between active and successful nest sites and suitable foraging habitats. (AR 5404-5405, 5409.) A February 2008 letter from DFG recommends the five criteria that were subsequently incorporated into Mitigation Measure 5.4-3, including "close proximity to the foraging habitat." (AR 5418-5419.)

An October 2008 letter from DFG agrees with several statements in the Draft EIR indicating that SWHs can forage as far as 10 miles from the nest, but nests are generally more successful if suitable foraging is present within an approximately 5-mile radius, that loss of foraging habitat on the project site could force nesting SWHs to travel farther and expend more energy gathering prey to feed their offspring, and, that as a result, nest mortality for any such pairs of SWHs could likely increase. (AR 594-595) The DFG bases its agreement with these statements on the same telemetry studies cited in the DFG's 1994 *Staff Report* and observed that "[s]uitable foraging habitat mitigation lands should be located within an energetically efficient distance from the active Swainson's hawk nests affected by the project, so that adult hawks potentially affected by the proposed project can achieve an energy balance between the need of

themselves and the demands of nestlings and fledglings." (AR 595.) Language proposed by the DFG for a revision of Mitigation Measure 5.4-3 includes the following initial sentence subsequently incorporated into Mitigation Measure 5.4-3: "Prior to the issuance of grading permits, the project applicant shall preserve an equal amount of suitable raptor foraging habitat, at a 1:1 ratio, within close proximity of the proposed project site." (*Ibid*) None of the language proposed by DFG mentions a specific distance, such as 5 or 10 miles, between the project site and the land acquired to mitigate foraging habitat losses resulting from project development (*Ibid.*)

A December 18, 2008 letter from DFG responds to a proposed revision of Mitigation Measure 5.4-3 in the Final EIR providing for the location of mitigation habitat lands at Brannan Island Farms (approximately 20 miles from the project site) because sufficient mitigation lands within five miles of the project site were in short supply (AR 579-580, 602-603, 1737-1741)) The DFG's December 2008 letter indicates that Brannan Island Farms does not meet the close proximity requirement for SWH habitat mitigation land or the "biologically credible distance" of five miles from the project site. The DFG indicates that, if viable mitigation lands cannot be located within the five-mile distance identified as necessary in the Draft DEIR (AR 219), "then mitigation lands should be identified within as close proximity to the proposed project site as possible." (AR 1739.)

Finally, a January 12, 2009 email from DFG responds to a proposed revision of Mitigation Measure 5.4-3 in Errata No. 3 to the Final EIR (AR 911-914, 1926) Errata No 3 proposed the version of Mitigation Measure 5 4-3 ultimately approved by the City (AR 913-914, 949). It provides for the purchase of habitat mitigation lands no further than ten miles from the project on the basis of "a recognition that land within 10 miles of the project site could provide adequate mitigation if other required components of habitat were met This would ensure that land identified for replacement habitat would respond to the species requirements relating to energy efficiency, survival of nesting chicks and reproductive success " (AR 913) The DFG's email objects to the 10-mile limit and asserts a five-mile limit on the ground that lands between 5 and 10 miles are much less valuable in meeting the requirements of SWHs for energy efficiency

and reproductive nesting success. (AR 1926.) The DFG recommends a revision of Mitigation Measure 5.4-3 requiring the location of mitigation lands within five miles of the project site or as close to five miles as possible. (*Ibid*)

Although the DFG's position in the foregoing communications on Mitigation Measure 5 4-3 varies somewhat regarding the "close proximity" requirement for effective habitat mitigation lands, its position essentially reflects the statement in the Draft EIR with which the DFG agreed in its October 2008 letter· "Swainson's hawks can forage as far as 10 miles from the nest, but nests are generally more successful if suitable foraging habitat is present within an approximate 5-mile radius " (AR 219, 594-595.) The DFG's 1994 *Staff Report* endorses, without qualification, a 10-mile radius for effective habitat mitigation lands in reliance on the same telemetry studies cited in the DFG's October 2008 letter. (AR 595, 5404-5405, 5409) The subsequent DFG December 2008 letter and January 2009 email endorse a five-mile radius as the "biologically credible distance" but advise that, if viable mitigation lands cannot be located within five miles of the project site, mitigation lands should be identified within as close proximity to the project site as possible " (AR 1739, 1926)

Comments by members of the public possessing special knowledge of SWH requirements are consistent in recognizing that a five-mile distance is most effective in meeting those requirements but that the requirements can be adequately met at a distance up to 10 miles (AR 913, 949.) For example, Friends of Swainson's Hawk commented that "[n]o mitigation land should be located more than 10 miles from the project site"; "beyond 10 miles, the energy efficiency of serving the nest drops significantly " (AR 1726, 1929) Defenders of Wildlife commented that "Swainson's Hawk mitigation should be sited no more than 10 miles away from the impacted area in order to provide habitat within the range of the impacted species " (AR 1964.) A consulting ecologist who had done work involving the SWH indicated that SWH foraging habitat should be located within 5 to 10 miles of affected nests. (AR 2008.) No comments or other evidence in the administrative record unequivocally supports a position that the location of SWH foraging habitat mitigation lands more than five miles but no more than 10 miles from the project site are inadequate

Thus, it is not unreasonable for the EIR to conclude that the "close proximity" criterion in Mitigation Measure 5.4-3 for evaluating the adequacy of mitigation lands encompasses a distance up to but no further than 10 miles from the project site Substantial evidence in the administrative record, including the expert opinions of the DFG, reasonably supports this conclusion (See *Laurel Heights Improvement Assn v Regents of University of California* (1988) 47 Cal.3d 376, 393.)

Discussion of Mitigation Bank Contentions

In a related claim, petitioners contend the SWH would be negatively impacted by Mitigation Measure 5.4-3 because the measure permits the purchase of credits from a mitigation bank within the project's service area -- regardless of whether the bank is within five or ten miles of the project site. According to petitioners, this provision does not ensure suitable foraging habitat within even 10 miles of the project site because there are no mitigation banks within that distance. The nearest mitigation bank containing the project within its service area is 19 miles away -- a distance that would have significant adverse impacts on the reproductive success of SWHs.

Under Mitigation Measure 5.4-3, whether foraging habitat mitigation would be secured through the purchase of credits at a CDFG-approved mitigation bank or through the purchase of either conservation easements and/or fee title of lands within a 10-mile radius of the project site, the mitigation would still be evaluated by the City in consultation with the DFG using the five criteria, including the "close proximity" criterion (AR 949) Before the issuance of grading permits to commence implementation of the project, the City in consultation with the DFG would be required to approve a mitigation plan submitted by real parties which includes confirmation of title and encumbrances, details on mitigation site location, development, maintenance and monitoring (*Ibid.*)

These evaluation and approval procedures would ensure that foraging habitat mitigation secured through the purchase of mitigation bank credits and/or conservation easements and fee title lands would be located close enough to the project site to adequately serve as foraging habitat Indeed, these procedures are virtually identical to the procedures

suggested by the DFG to avoid inadequate mitigation through mitigation bank credits (AR 1926)

Discussion of Fallow Fields Contentions

Third, petitioners contend that the term "fallow fields" in the definition of "suitable foraging habitat" under Mitigation Measure 5.4-3 is not narrowly defined They argue it could be used to implement the measure with fields unsuitable for SWH foraging habitat Petitioners explain that the term "fallow fields" is vague and could be interpreted to refer to permanently fallowed fields which develop dense stands of tall herbaceous weeds not suited to foraging by the SWH. To prevent this misinterpretation and ensure fields are suitable for foraging, "fallow fields" must be explicitly limited to agricultural fields that are fallowed in the traditional agricultural sense, i.e., left uncultivated for one or two years so that the soil can recover from intensive cultivation.

Petitioners' contention is based on a highly unusual, even odd, meaning of "fallow fields" As the City points out, "fallow fields" in Mitigation Measure 5 4-3 must be interpreted in accordance with its common meaning, its use in the DFG's 1994 *Staff Report*, and its EIR context to refer to traditionally uncultivated fields during the growing season In the 1994 *Staff Report*, "fallow fields" is included without clarifying language in the list of "preferred foraging habitats for Swainson's hawks". It is contrasted with unsuitable foraging habitat such as vineyards and orchards where the vegetation makes prey unavailable to the hawks (AR 5405, 5409.) The Draft EIR tracks the 1994 *Staff Report* by including "fallow fields" in the definition of suitable foraging habitat for SWHs (AR 219.) The inclusion of fallow land in the definition of suitable foraging habitat in Mitigation Measure 5 4-3 simply follows the definitional terms of both the *Staff Report* and the Draft EIR and reasonably includes fallow fields within the meaning of traditional agricultural practices.

Further, any concerns that the "fallow fields" definition in Mitigation Measure 5 4-3 would be improperly applied to fields where the cultivation of crops has been permanently terminated (and thus become unsuitable as SWH foraging habitat) would be eliminated by the procedures for obtaining City approval In sum, those procedures require consultation with the

DFG about habitat mitigation lands, as well as plans for management of the lands, before the issuance of grading permits The application of these procedures would prevent the approval of any cultivation practice or use of the lands in a manner that is inconsistent with suitable SWH habitat. (AR 949, 1928.)

Stormwater Runoff

The project site is in the Morrison Creek watershed, a sub-watershed of the Sacramento River watershed. (AR 249, 253) The project site is partially bounded on the south by Morrison Creek, a levee channel that flows west/southwest through urban residential, industrial and commercial areas before flowing south to the Beach-Stone Lakes basin which connects hydraulically to the Sacramento River. (AR 253) The Beach-Stone Lakes basin includes the Stone Lakes National Wildlife Refuge -- an environmentally sensitive area supporting a diversity of wildlife and plant species, including threatened and endangered species

Stormwater runoff flows from the project site to a pump station sump located at the southern boundary of the project site It is then pumped into Morrison Creek through a levee constructed on the banks of the creek. (AR 36, 249, 254.) Because development of the project site would replace existing agricultural land and increase impervious surface areas by 49 percent, the rate and amount of stormwater runoff would substantially increase (AR 255, 268, 277) The runoff could transport and discharge pollutants into Morrison Creek which would adversely affect the water quality and beneficial uses of the creek and the waters into which it flows (*Ibid.*) The Central Valley Regional Water Quality Control Board ("Regional Water Board") has identified the beneficial uses of these waters to include municipal and domestic use, agricultural supply, recreational use, and fish and wildlife enhancement (See *Water Quality Control Plan for the Sacramento and San Joaquin River Basins.*) (AR 251, 258, 7177 (¶ 45))

The EIR concludes the impact of storm water discharges from the project site on the water quality and beneficial uses in the Morrison Creek watershed or the Sacramento River would be less than significant. (AR 271) The City contends that stormwater discharges would be prevented from degrading water quality or impairing beneficial uses of the receiving waters This would be accomplished by the stormwater drainage system planned for the project and by

operation of the project in compliance with the City's NPDES MS4 permit (i e , National Pollutant Discharge Elimination System permit for Municipal Separate Storm Sewer Systems) The permit is issued by the Regional Water Board under the federal Clean Water Act and the Porter-Cologne Water Quality Control Act. (AR 256-257, 262, 268-271, 7167ff)

The NPDES MS4 permit incorporates and implements the City's *Stormwater Quality Improvement Plan* ("SQIP") and the *Stormwater Quality Design Manual for the Sacramento and South Placer Regions* ("Design Manual").[6] It requires the use of best management practices by new developments like the Delta Shores project. Those practices are designed to monitor and control pollutants in stormwater on the project site and to reduce pollutants in stormwater discharged from the site to the maximum extent practicable (AR 256-257, 268-269, 566, 7169 (¶13), 7174 (¶¶ 31, 33), 7183-7187, 7210-7211, 7331ff , 7604ff) The NPDES MS4 permit also requires measures by new developments to attain water quality objectives protective of the beneficial uses of receiving waters (AR 7179 (¶13), 7170 (¶ 18), 7176 (¶39), 7180) Pursuant to the NPDES MS4 permit, discharges may not cause or contribute to violations of water quality standards set by the Regional Water Board that would impair the water quality of receiving waters. (AR 260, 566, 7176 (¶¶ 39, 44), 7194 (Discharge Prohibitions-Storm Water Discharges), 7197 (¶2-3).)

To comply with the requirements of the NPDES MS4 permit, the preferred stormwater drainage system for the Delta Shores project includes a pollution control system oversized to manage stormwater runoff from both the project site and from existing developments where stormwater runoff flows untreated into Morrison Creek[7] (AR 269-270)

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[6] The Design Manual is a collaborative effort by the County of Sacramento and the Cities of Citrus Heights, Elk Grove, Folsom, Galt, Rancho Cordova, Sacramento and Roseville (AR 7347)

[7] The EIR refers to a preferred drainage system consisting of four detention ponds and the restored wetland preserve and an alternative drainage system consisting of five detention ponds and avoidance of much of the wetland area (AR 269-270) As clarified at the hearings on the EIR, the project applicant intends to construct the preferred alternative, including the wetland preserve, once the U S Army Corps of Engineers grants the developer's application for a permit to restore the wetlands under section 401 of the federal Clean Water Act (AR 2233-2234 See AR 228 (wetlands preservation to mitigate loss of wetlands habitat resulting project development)) The EIR describes and discusses the alternative drainage system only in the event that the Corps were to deny the developer's application (*Ibid*) The City's approval of the project is conditioned on the developer's compliance with the Planned Unit Development Guidelines for the project, which include restored wetlands to operate in conjunction with detention ponds (AR 1306 (Condition A4), 1343 (Condition B94), 1232-1233)

The system includes two wet water quality/detention ponds and at least two dry water quality/detention ponds which are integrated with a 28-acre wetland preserve on the project site to treat and remove pollutants in stormwater runoff before discharge into Morrison Creek (AR 29-30, 36-37, 254, 255, 269-271, 816-817, 1232-1233, 6679-6697, 9233)

Petitioners contend the EIR fails to evaluate the potential adverse impacts of urban pollutants from the project site's stormwater runoff on the sensitive biological resources in the Beach-Stone Lakes basin. Petitioners highlight the threatened and endangered wildlife and plants in the Stone Lakes National Wildlife Refuge. According to petitioners, the EIR's data and analysis do not support its conclusion that compliance with the NPDES M4 permit would avoid or minimize the downstream impacts of urban pollutants discharged into stormwater from the project As a result, Petitioners contend there is inadequate support for the conclusion that the impact of the project's increased stormwater runoff would be less than significant

Petitioners further argue that, although the NPDES M4 permit acknowledges a need for additional measures to reduce pollutants in runoff from a new development adjacent to an environmentally sensitive area like the Refuge, the permit and the Design Manual implementing the permit do not identify any additional reduction measures specific to environmentally sensitive areas. They also do not require the reduction of stormwater impacts to a less than significant level and would permit the degradation of water quality and beneficial uses in receiving waters to allow for the project's economic benefits. Petitioners note the conclusion of the United States Fish and Wildlife Service in its comprehensive conservation plan for the Refuge that stormwater detention basins constructed pursuant to Sacramento County's NPDES municipal permit were effective in reducing pollutants in stormwater discharges into Morrison Creek by 30 to 90 percent and that the pollutants not detained were likely to enter the Refuge and potentially affect fish and wildlife. (See AR 725, 727)

Discussion

Contrary to petitioners' contention, substantial evidence exists in the administrative record to support the conclusion of the EIR that the stormwater drainage system planned and designed for the project in compliance with the City's NPDES MS4 permits and Design Manual

would reduce the potential impacts of pollutants from the project site's stormwater runoff to a level of insignificance. The project's stormwater drainage system and the project design incorporate measures from the Design Manual to control pollutant sources on the site, to reduce stormwater runoff through project design features that manage and retain stormwater on site, and to treat and remove pollutants from stormwater runoff before it is discharged into Morrison Creek. (See AR 7183-7185, 7210-7213, 7365-7368, 7370ff, 7390ff, 7445ff, 29-30, 36-37, 254, 255, 269-271, 816-817, 1232-1233, 1275, 1284, 6679-6697, 9233) The effectiveness of these control measures from the Design Manual to reduce stormwater pollutant discharges and minimize impacts to water quality and beneficial uses in receiving waters has been studied and evaluated as part of the City's stormwater management program. (See the City's SQIP, Report of Waste Discharge prepared by the City in connection with the reissuance of its NPDES MS4 permit; and an analysis pursuant to California's anti-degradation policy demonstrating that increased stormwater pollutant discharges from new urban development and economic expansion results in minimal degradation of water quality and exceedances of water quality objectives) (AR 7167, 7179-7180, 7182-7183, 7640ff., 7676, 7679-7680, 7817-7818, 7906ff) Relying on the demonstrated effectiveness of these control measures, the NPDES MS4 permit prohibits discharges of stormwater pollutants from the project site that cause or contribute to exceedances of water quality standards and objectives in order to protect beneficial uses of receiving waters (AR 7194, 7196-7197, 7211)

Thus, further evaluation by the EIR of stormwater runoff control measures to protect the environmentally sensitive area of the Stone Lakes National Wildlife Refuge from the impacts of stormwater pollutants discharged from the project site is not, as petitioners claim, necessary or appropriate. The evaluation provided in the EIR indicates that control measures incorporated into the project's stormwater drainage system and project design are formulated to attain water quality standards and to protect the beneficial uses designated by the Regional Water Board for Stone Lakes and other receiving waters in the Morrison Creek watershed This includes beneficial uses related to the preservation and enhancement of fish, wildlife and other aquatic resources. The effectiveness of the control measures in protecting these beneficial uses has been

evaluated and will continue to be evaluated, monitored and enforced by the City during operation of the project pursuant to the NPDES MS4 permit, the SQIP and the Design Manual [8] Consistent with California's anti-degradation policy, the water quality and beneficial uses of receiving waters, including Stone Lakes, would not be impaired to allow for economic benefits from the project.

Impacts on the Town of Freeport

The Town of Freeport is located just west of the project site along the east bank of the Sacramento River and is characterized by a mix of architectural styles and rural characteristics (AR 132, 144-145, 1122-1124.) The agricultural lands and open space of the project site adjacent to Freeport's commercial and residential areas (west of I-5) would be developed with mostly low-density residential units and some medium-density residential units High-density housing would be sited at the northern edge of Freeport where there are no existing residences. A landscaped buffer would be located along the boundary between the project site and Freeport, along with a six-acre park, trails, and bikeways (AR 26, 34, 106-107, 145, 847) The project site design, building styles and landscaping would be compatible with the characteristics of Freeport, as detailed in the Delta Shores Planned Unit Development Guidelines ("PUD Guidelines"), and would maintain Freeport's existing character. (AR 145, 1125-1143)

The Draft EIR does not address project impacts on the historical significance of Freeport An evaluation conducted during the initial study for the project identified no historical resource in Freeport that would be impacted by the project (AR 2695-2699) Petitioners commented on this omission in the Draft EIR Petitioners stated the Draft EIR failed to analyze the significance of the impacts of the dense urban project development surrounding Freeport's rural historical landscape and failed to mitigate such impacts with agricultural and open space buffers. (AR7712-714.) The City responded that it did not consider whether the project would

[8] Petitioners inappropriately rely on the opinion of the United States Fish and Wildlife Service that stormwater detention basins constructed pursuant to the NPDES municipal permit of Sacramento County were effective in reducing pollutants in stormwater discharges to Morrison Creek by 30 to 90 percent (See AR 725) That opinion does not consider the extensive stormwater pollutant source, reduction and treatment control measures to be used by the project in minimizing the discharge of pollutants to receiving waters

cause a significant change in the buildings or landscape of Freeport because the project would not physically demolish or materially alter the buildings or landscape -- a requirement for significantly impacting a historical resource under CEQA Guideline 15064 5 (AR 846) The City also responded that the project provided landscaped and open space buffers between existing uses in Freeport and the project uses, and any project development would be subject to review for negative impacts on Freeport's character (*Ibid*)

Addressing the impacts of Freeport's scenic view of the project site, the EIR concluded that the view would substantially change The existing undeveloped agricultural space would change to a developed neighborhood containing low, medium and high density housing (AR 144) The EIR determined that compliance with the design principles and styles of the PUD Guidelines would ensure compatibility between the project's architectural styles and the existing styles in the town of Freeport. Appropriate landscape and open space buffers would further reduce the changes to the visual character of the project and its surroundings (AR 145) Therefore, the EIR concludes, the project would not substantially degrade the existing visual character or quality of the site or its surroundings, and the project's visual impacts would be less than significant. (*Ibid.*)

Petitioners contend the EIR fails to accurately disclose and fairly evaluate evidence of the project's negative impacts on the historical character and visual characteristics of Freeport Petitioners point out that Freeport was established in 1862 as a port on the Sacramento River and has endured as a rural river town of residences, neighborhood retail businesses, offices and marinas relatively isolated from urban pressures Petitioners note that the County of Sacramento has adopted a Neighborhood Preservation Ordinance to preserve and protect the "existing river town atmosphere" and "unique historical characteristics" of Freeport from the City's approaching urban development and to minimize incompatible designs in the surrounding area (AR 795-796) Similarly, the City has adopted planning policies to retain Freeport's "delta river town identity and unique historical characteristics" and to ensure that future development will integrate with and reinforce the "existing rural small-town development patterns and river lifestyle " (AR 790-793.) Despite such evidence, petitioners contend, the EIR fails to identify the river town as a

historical resource listed on a local register of historic resources pursuant to Public Resources Code section 21084.1 and CEQA Guideline section 15064 5(a). Petitioners also contend the EIR fails to evaluate the project's impact on this resource and to require feasible mitigation

Petitioners further contend the EIR's conclusion that compliance with the PUD Guidelines would avoid visual impacts on the existing visual character of the project site or its surroundings is not supported by substantial evidence According to petitioners, compliance with the design principles of the PUD Guidelines does not address the need for an open space buffer between Freeport and the urban development of the project Petitioners contend more is required to protect Freeport's rural river town atmosphere

Discussion

Petitioners' contention that the EIR was required to analyze the impacts of the project on Freeport as a historical resource lacks merit First, there is insufficient evidence in the record to reasonably support a conclusion that the rural river town atmosphere of Freeport qualifies as a historical resource under the definition of historical resource in Public Resources Code section 21084 1 and CEQA Guideline 15064.5(a) Freeport's rural river town atmosphere is not listed on any federal, state or local register of historic places or resources, and there is no evidence in the administrative record suggesting that it would meet the eligibility criteria for such listing. The use of the term "historical" or "historic" in planning documents of the City or the County of Sacramento is insufficient to establish Freeport's eligibility as a historical resource

Second, even if Freeport's rural river town atmosphere were to qualify as a historical resource, there is insufficient evidence in the record to demonstrate an adverse impact on Freeport's atmosphere by the project's development. There is no evidence that the development would, as required by CEQA Guideline 15064.5(b), physically impact or materially alter Freeport's atmosphere. Rather, any impact would be substantially minimized by the project's development in compliance with the design principles of the PUD Guidelines, ensuring consistency and compatibility between the architecture and design of the development and Freeport

For similar reasons, petitioners' contention regarding the project's negative visual impacts on Freeport's rural river town atmosphere lacks merit The EIR acknowledges the substantial visual changes resulting from the development of the project site adjacent to Freeport and reasonably concludes that the project's development in compliance with the design principles of the PUD Guidelines would not substantially degrade the existing visual character or quality of the project site or its surroundings. The project's predominantly low density residential development is in accordance with PUD Guidelines. The six-acre park on the project site and the landscape buffers between Freeport and the project site would be compatible with and maintain, rather than depart from, the existing character of Freeport

Relief

The petition is granted in part The court will order the issuance of a peremptory writ of mandate requiring respondents to (1) set aside their approval of the Delta Shores project to the extent that the approval is based on analysis and findings that the project would not substantially increase future project residents' exposure to and health risks from freeway mobile-source TACs and that the project health impacts in this regard would be less than significant, (2) conduct further analysis consistent with this ruling and CEQA requirements to determine whether freeway mobile-source TACs would substantially increase health risk impacts to future project residents and constitute a significant impact, and whether any identified significant impacts can be avoided or minimized by feasible mitigation measures; (3) certify the results of the further analysis in accordance with CEQA procedures prior to any re-approval of the project, and (4) file a return to the writ with this court within 120 days of receiving personal service of the writ, indicating what has been done to comply with the writ

In all other respects, the petition is denied. Counsel for petitioners is directed to prepare a proposed judgment and a proposed peremptory writ of mandate consistent with this

ruling, which shall be incorporated as an exhibit to the judgment. Counsel shall serve the proposed judgment and writ upon respondents for approval as to form and then submit it to this court pursuant to rule 3 1312 of the California Rules of Court.

Dated February 11, 2010

MICHAEL KENNY

MICHAEL P. KENNY,
Judge of the Superior Court of California,
County of Sacramento

SUPERIOR COURT OF CALIFORNIA
COUNTY OF SACRAMENTO

STONE LAKES NATIONAL WILDLIFE REFUGE ASSOCIATION, FREEPORT PRESERVATION COALITION, COALITION FOR RESPONSIBLE DEVELOPMENT, TRACY OTO, FRANK ALBERT, GARY KRULA and BRIAN LUJAN,
Petitioners and Plaintiffs,

vs.

CITY OF SACRAMENTO, a municipal corporation; CITY COUNCIL OF SACRAMENTO, et al.,
Respondents and Defendants,

M&H REALTY PARTNERS,LP; MERLONE GEIER PARTNERS, LP; M&H REALTY PARTNERS VI, L.P., et al.,
Real Parties in Interest.

Case Number: 34-2009-80000166-CU-WM-GDS

Department: 31

CERTIFICATE OF SERVICE BY MAILING
(C.C.P. Sec. 1013a(4))

I, the Clerk of the Superior Court of California, County of Sacramento, certify that I am not a party to this cause, and on the date shown below I served the foregoing **RULING ON SUBMITTED MATTER** by depositing true copies thereof, enclosed in separate, sealed envelopes with the postage fully prepaid, in the United States Mail at Sacramento, California, each of which envelopes was addressed respectively to the persons and addresses shown below

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I, the undersigned Deputy Clerk, declare under penalty of perjury that the foregoing is true and correct

Dated February 11, 2010

SUPERIOR COURT OF CALIFORNIA
COUNTY OF SACRAMENTO

By S LEE,
Deputy Clerk

EXHIBIT 4

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FILED
SEP 24 2010
By Deputy Clerk

SUPERIOR COURT OF THE STATE OF CALIFORNIA

COUNTY OF SACRAMENTO

STONE LAKES NATIONAL WILDLIFE REFUGE ASSOCIATION, et al., Petitioners and Plaintiffs, v. CITY OF SACRAMENTO, a municipal corporation, et al., Respondents and Defendants. M & H REALTY PARTNERS, L.P., Real Parties in Interest	No. 34-2009-80000166 **STIPULATION FOR ORDER DISMISSING ACTION BASED ON SETTLEMENT AGREEMENT AND ~~[PROPOSED~~] ORDER THEREON** Assigned to Hon. Michael P. Kenny Department 31 Action filed: February 13, 2009 Judgment entered April 22, 2010

A/73507320 2

A. Background

1. This proceeding, filed on February 13, 2009, involves a challenge to the Environmental Impact Report certified by the City of Sacramento for the Delta Shores project In its ruling on the merits, the court found the EIR deficient in one respect: the standard used to assess the significance of potential impacts to project residents due to toxic air contaminants generated by traffic on I-5. The court rejected all of the other claims raised by Petitioners regarding the adequacy of the EIR.

2. On April 22, 2010, the court entered judgment ordering that a peremptory writ of mandate issue requiring Respondents to take certain actions to correct the deficiency relating to the analysis of Toxic Air Contaminants identified in the judgment Petitioners subsequently filed an appeal from the judgment and Respondents and Real Party in Interest then filed a cross-appeal from the judgment.

3. The parties have since entered into a Settlement Agreement which fully resolves all claims in this proceeding. The Settlement both cures the deficiencies in the EIR's Toxic Air Contaminants analysis that were identified in the Court's Judgment and includes additional measures to protect the environment above and beyond what was required in the Judgment. Pursuant to the terms of the Settlement Agreement, all parties have dismissed their appeals. The Settlement Agreement further provides for the parties to submit a joint application to the court for issuance of an appropriate order disposing of the case in accordance with the terms of the Settlement Agreement.

B. Summary Of Substantive Provisions Of Settlement Agreement

4 Toxic air contaminants. To correct the deficiency in the EIR's treatment of the impacts of toxic air contaminants the judgment requires that the city conduct further analysis to determine whether freeway mobile source TACs would substantially increase the health risks to future project residents and whether any identified significant impacts can be avoided or minimized through adoption of feasible mitigation measures. Under the terms of the settlement agreement, the following steps will be taken with respect to TAC impacts·

a. A new health risk assessment ("HRA") will be prepared for the Project by a qualified expert to evaluate the cancer risk from future Project residents' exposure to the mobile-source TACs specified in the court's ruling.

b. With respect to any residential units where the HRA determines that the potential additional cancer risk above background levels to residents from TACs is more than ten-in-one million over a 70-year exposure period, the following mitigation measures will be implemented:

(1) Trees will be planted along Interstate 5 on those parcels zones for residential development adjacent to Interstate 5. The trees will be of a type that is considered to be effective in reducing particulates;

(2) All multi-family residential buildings located within 500 feet of Interstate 5 will have building air intakes located as far away from Interstate 5 as feasible;

(3) All residential development on parcels located within 500 feet of Interstate 5 shall include air filtering systems designed and to filter particulates; and

(4) Any windows with a view facing Interstate 5 in residences located within 500 feet of Interstate 5 shall be non-operable.

c. The requirements relating to TACs described above will be enforceable as conditions of project approval through amendment of the Development Agreement for the project to incorporate them as landowner obligations under the special conditions in Exhibit C of the Development Agreement.

5 The Settlement Agreement also contains provisions that address several other issues raised by Petitioners in the litigation. These include an agreement about interpretation of the term "fallow fields" in the definition of suitable foraging habitat in the mitigation measure relating to Swainson's hawk foraging habitat; a commitment to construction of the wetland biofiltration drainage system if it is approved by the Army Corps of Engineers; and funding for restoration of the Victory Trees Memorial in Freeport. The agreement also resolves Petitioners' pending motion for an award of attorneys' fees.

C. Order Sought By The Parties

6. The Settlement Agreement provides that within ten days after the appeal and cross-appeals are dismissed, counsel will submit a joint application to this court for an order dismissing the case with prejudice based upon the Settlement Agreement. Accordingly, the parties to this proceeding stipulate and jointly request that the court enter the order of dismissal accompanying this stipulation.

DATED: September 22, 2010

CITY OF SACRAMENTO

By: _____
SHERYL N. PATTERSON
Attorneys for Respondents/Defendants
CITY OF SACRAMENTO and
CITY COUNCIL OF SACRAMENTO

DATED: September 22, 2010

ADAMS BROADWELL JOSEPH & CARDOZO

By: _____
THOMAS A. ENSLOW
Attorneys for Petitioners/Plaintiffs
STONE LAKES NATIONAL WILDLIFE
REFUGE ASSOCIATION, et al.

DATED: September 22, 2010

BINGHAM McCUTCHEN LLP

By. _____
STEPHEN L. KOSTKA
Attorneys for Real Party in Interest
M&H REALTY PARTNERS, VI, L.P.

ORDER

The parties having jointly stipulated to an order dismissing this case with prejudice based upon the terms of a settlement agreement entered into by the parties, and good cause appearing therefore, it is hereby ordered that this case be dismissed with prejudice.

Dated: 9/24/10

Hon. Michael P. Kenny

Stone Lakes National Wildlife Assn., et al. v. City of Sacramento, et al.
Sacramento County Superior Court No.: 34-2009-80000166

PROOF OF SERVICE

I am employed in the County of Sacramento, California. I am over the age of 18 and not a party to this action. My business address is 520 Capitol Mall, Suite 350, Sacramento, CA 95814.

On September 23, 2010 I served the foregoing document described as

STIPULATION FOR ORDER DISMISSING ACTION BASED ON SETTLEMENT AGREEMENT AND [PROPOSED] ORDER THEREON

on the parties listed below by placing a true and correct copy thereof in a sealed envelope and by causing the envelope to be sent by U.S. Mail addressed to:

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Attorney for Respondents and Defendants

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Bingham McCutchen
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San Francisco, CA 94111-4507

Attorney for Real Party in Interest

I declare under penalty of perjury of the laws of the State of California that the foregoing is true and correct and that this was executed on September 23, 2010 in Sacramento, California.

Carol N. Horton

Carol N. Horton

Sacramento Audubon Society

P. O. Box 160694, Sacramento, CA 95816-0694

March 27, 2014

Via e-mail

Chair Kiyomi Burchill and
Commission Members
City of Sacramento
Planning and Design Commission
915 "I" St.
Sacramento, CA 95814

Re: **OPPOSE** - Proposed McKinley Village Project (File No. P08-086, Agenda Item #3, March 27, 2014 PDC agenda)

Dear Chair Burchill and Commissioners,

I write on behalf of Sacramento Audubon Society, Inc. (SAS), to object to the above project. SAS asks that you do not certify the EIR or approve the McKinley Village Project as presently formulated. SAS has over 2,500 members in the Sacramento area. Our mission is to promote the protection and scientific study of wild birds; promote the enjoyment and appreciation of wild birds through community outreach; provide, encourage and support environmental educational opportunities; and promote the conservation of open space in Sacramento.

SAS has reviewed and hereby joins in and incorporates on its own behalf each of the more detailed objections to the project and EIR raised by Friends of the Swainson's Hawk. The project would eliminate foraging habitat within the City for nesting Swainson's hawks and white tailed kites. The project documents propose to mitigate for this loss of habitat by setting aside mitigation land 10-miles away. This mitigation measure may sustain bird populations at that location, but our local avian populations would suffer. Some of the wildlife activities and phenomena that our members enjoy observing – such as watching birds nest and raise young, or watching migratory birds as they stop over during their annual journeys – are likely to be adversely impacted when these foraging grounds are diminished by the proposed project.

Birding is an important recreational opportunity Sacramento (see attached report: Birding in the United States: A Demographic and Economic Analysis – Addendum to the 2011 National Survey of Fishing, Hunting, and Wildlife-Associated Recreation), and birds are an important part of our urban environment. SAS objects to the McKinley Village project to the extent it fails to avoid or locally mitigate habitat loss.

Sincerely

Keith G. Wagner

Keith Wagner
Conservation Chair
Sacramento Audubon Society, Inc.

U.S. Fish & Wildlife Service

Birding in the United States: A Demographic and Economic Analysis

Addendum to the 2011 National Survey of Fishing, Hunting, and Wildlife-Associated Recreation

Report 2011-1

Birding in the United States: A Demographic and Economic Analysis

Addendum to the 2011 National Survey of Fishing, Hunting, and Wildlife-Associated Recreation

Report 2011-1

December 2013
Erin Carver
U.S. Fish and Wildlife Service
Division of Economics
Arlington VA

This report is intended to complement the National and State reports from the 2011 National Survey of Fishing, Hunting, and Wildlife-Associated Recreation. The conclusions are the author's and do not represent official positions of the U.S. Fish and Wildlife Service.

The author thanks Sylvia Cabrera, Richard Aiken, and Matthew Fuller for their input into this report.

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Introduction

The following report provides up-to-date information so birders and policy makers can make informed decisions regarding the management of birds and their habitats. This report identifies who birders are, where they live, how avid they are, and what kinds of birds they watch. In addition to demographic information, this report also provides an economic measure of birding. It estimates how much birders spend on their hobby and the economic impact of these expenditures.

By understanding who birders are, they can be more easily reached and informed about pressures facing birds and bird habitats. Conversely, by knowing who is likely *not* a birder, or who is potentially a birder, information can be more effectively tailored. The economic values presented here can be used by resource managers and policy makers to demonstrate the economic might of birders, the value of birding – and by extension, the value of birds.

All data presented here are from the wildlife-watching section of the 2011 National Survey of Fishing, Hunting, and Wildlife-Associated Recreation (FHWAR). It is the most comprehensive survey of wildlife recreation in the United States. Overall, about 9,300 detailed wildlife-watching interviews were completed with a response rate of 67 percent. The Survey focused on 2011 participation and expenditures by U.S. residents 16 years of age and older.

Al Milliken/USFWS

Birders

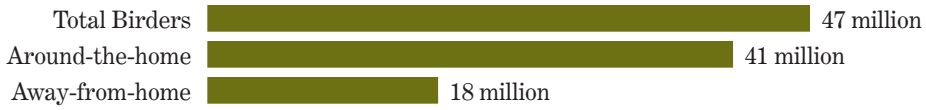
In 2011, there were 47 million birdwatchers (birders), 16 years of age and older, in the United States – about 20 percent of the population. What is a birder? The National Survey uses a conservative definition. To be counted as a birder, an individual must have either taken a trip one mile or more from home for the primary purpose of observing birds and/or closely observed or tried to identify birds around the home. Thus, people who happened to notice birds while they were mowing the lawn or picnicking at the beach were not counted as birders. Trips to zoos and observing captive birds also did not count.

Backyard birding or watching birds around the home is the most common form of bird-watching. Eighty-eight percent (41 million) of birders are backyard birders. The more active form of birding, taking trips away from home, is less common with 38 percent (18 million) of birders partaking.

The average birder is 53 years old and more than likely has a better than average income and education. She is slightly more likely to be female and highly likely to be white. There is also a good chance that this birder lives in the south in an urban area. Does this paint an accurate picture of a birder? Like all generalizations, the description of an "average" birder does not reflect the variety of people who bird, with millions falling outside this box. The tables and charts show numbers and participation rates (the percentage of people who participate) of birders by various demographic breakdowns.

The tendency of birders to be middle-age or older is reflected in both the number of birders and participation rates. Looking at the different age categories in Table 1, the greatest number of birders were in the 55 plus age group. People over the age of 55 had the highest participation rates while the participation rate was particularly low for people ages 16 to 24.

Chart 1. Birders in the United States: 2011
(16 years of age and older.)

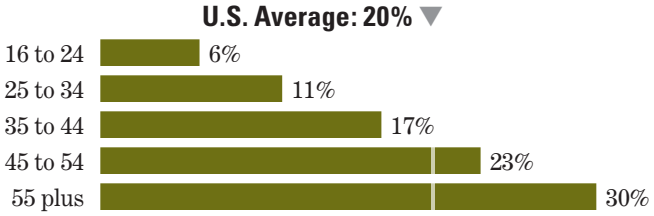


Note: Detail does not add to total because of multiple responses.

Table 1. Age Distribution of the U.S. Population and Birders: 2011
(Population 16 years of age and older. Numbers in thousands.)

Age	*U.S. Population*	*Number of Birders*	*Participation Rate*
16 to 24	34,169	1,939	6%
25 to 34	41,613	4,767	11%
35 to 44	40,779	6,799	17%
45 to 54	46,167	10,396	23%
55 plus	76,586	22,840	30%

Chart 2. Birders' Participation Rate by Age: 2011



The higher the income and education level the more likely a person is to be a birder. Birders with incomes above the median participated at a higher rate than the average birder while birders with incomes below the median participated at a lower rate. Education, which is often highly correlated with income, shows the same trend. People with less than high school education participated at 11 percent – far below the national average – while people with a college degree had the highest participation rate at 28 percent. See Tables 2 and 3 for more information.

Unlike hunting and fishing where men were overwhelmingly in the majority, a larger percent of birders were women – 56 percent in 2011 (See Chart 5).

Steve Hillebrand/USFWS

Table 2. Income Distribution of the U.S. Population and Birders: 2011
(Population 16 years of age and older. Numbers in thousands.)

Income	*U.S. Population*	*Number of Birders*	*Participation Rate*
Less than $20,000	30,550	4,455	15%
$20,000 to $29,999	23,154	3,661	16%
$30,000 to $49,999	40,036	7,734	19%
$50,000 to $74,999	33,850	8,432	25%
$75,000 or more	66,177	15,862	24%

Chart 3. Birders' Participation Rate by Income: 2011

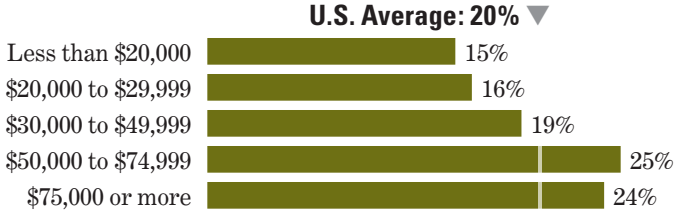


Table 3. Educational Distribution of the U.S. Population and Birders: 2011
(Population 16 years of age and older. Numbers in thousands.)

Education	*U.S. Population*	*Number of Birders*	*Participation Rate*
11 years or less	31,574	3,340	11%
High School Graduate	81,984	12,462	15%
Some College	55,014	10,849	20%
College Graduate +	70,740	20,089	28%

Chart 4. Birders' Participation Rate by Education: 2011

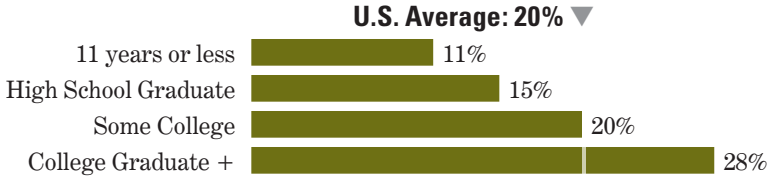
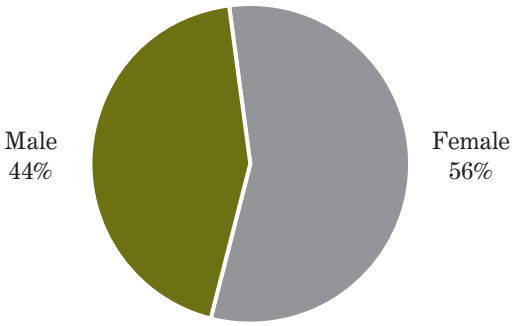


Chart 5. Percent of Birders by Gender: 2011
(Population 16 years of age and older.)



Excluding people that categorize their race as "Other", birders are not a racially or ethnically diverse group. Ninety-three percent of birders identified themselves as white. The scarcity of minority birders is not just a reflection of their relatively low numbers in the population at large; it's also a function of low participation rates. The participation rates of Hispanics, African-Americans, Asians, and "Other" were all 8 percent or lower while the rate for whites, 24 percent, was slightly above the 20 percent national average.

The sparser populated an area, the more likely its residents were to watch birds. The participation rate for people living in small cities and rural areas was 22 percent – 2 percent above the national average. Whereas large metropolitan areas (1 million residents or more) had the greatest number of birders, their residents had the lowest participation rate, 12 percent. See Table 5.

Table 4. Racial and Ethnic Distribution of the U.S. Population and Birders: 2006
(Population 16 years of age and older. Numbers in thousands.)

Race	*U.S. Population*	*Number of Birders*	*Participation Rate*
Hispanic	32,557	2,578	8%
White	182,872	43,323	24%
African American	23,402	1,697	7%
Asian	11,647	410	4%
All Others	21,392	1,105	5%

Chart 6. Birders' Participation Rate by Race and Ethnicity: 2011

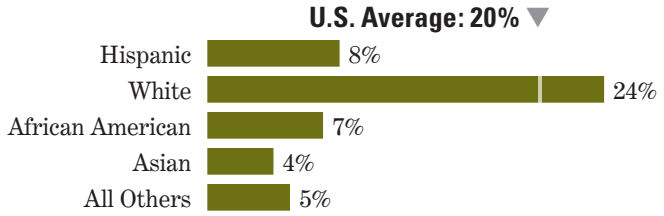


Table 5. Percent of U.S. Population Who Birded by Residence: 2011
(Population 16 years of age and older. Numbers in thousands.)

Metropolitan Statistical Area	*U.S. Population*	*Number of Birders*	*Participation Rate*
1,000,000 or more	127,462	15,141	12%
250,000 to 999,999	48,157	7,479	16%
Less than 249,000	48,406	7,085	15%
Outside MSA	15,288	3,410	22%

Steve Hillebrand/USFWS

Robert Burton/USFWS

Participation rates are varied across the United States. However, the highest participation rates are prevalent in the northern half of the country (with the exception of West Virginia), where the top 5 States include Vermont, Wisconsin, West Virginia, Wyoming, and Alaska. See Chart 7 for more details.

Chart 7. Birding Participation Ratees by State Residents: 2011

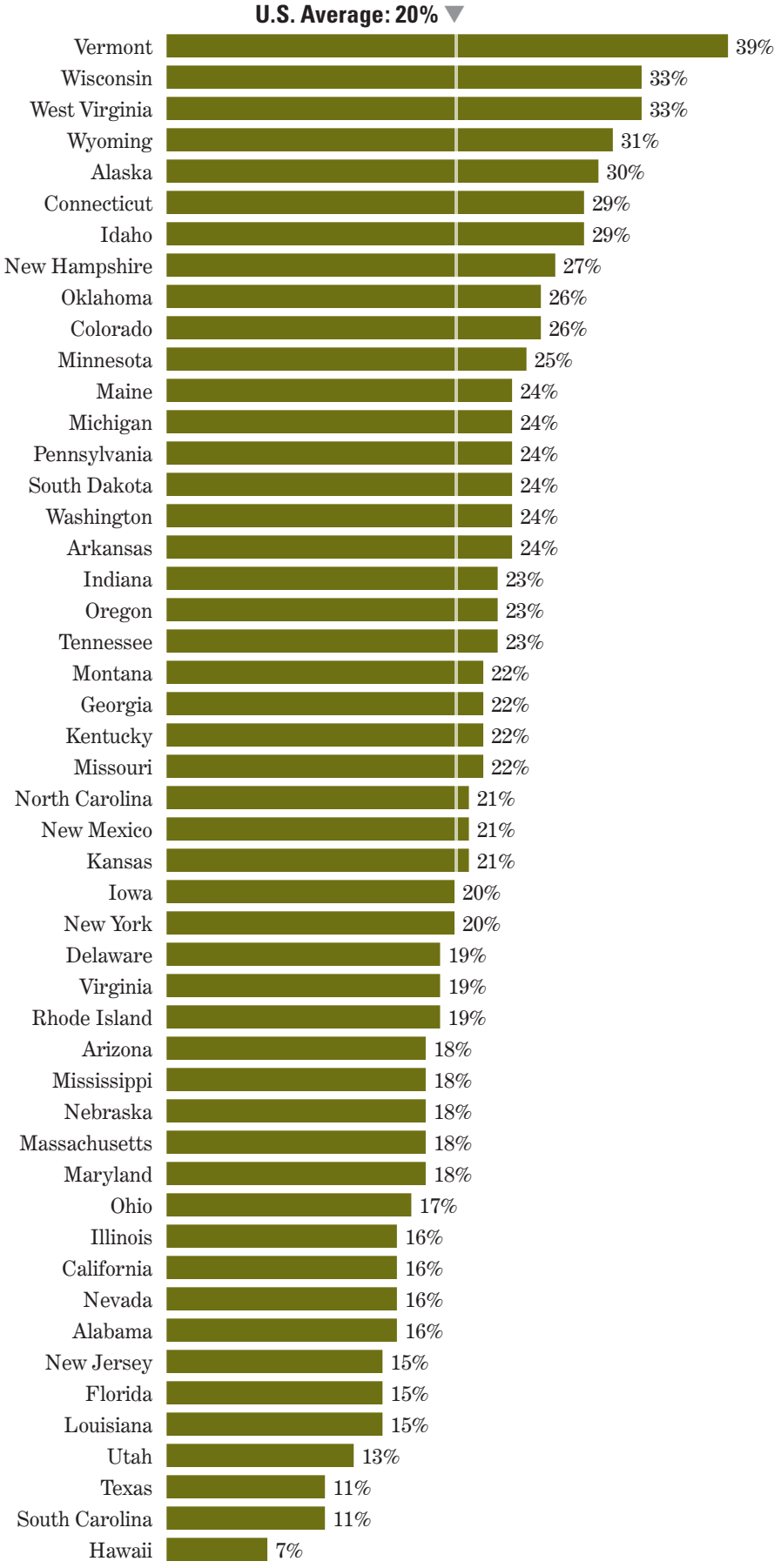
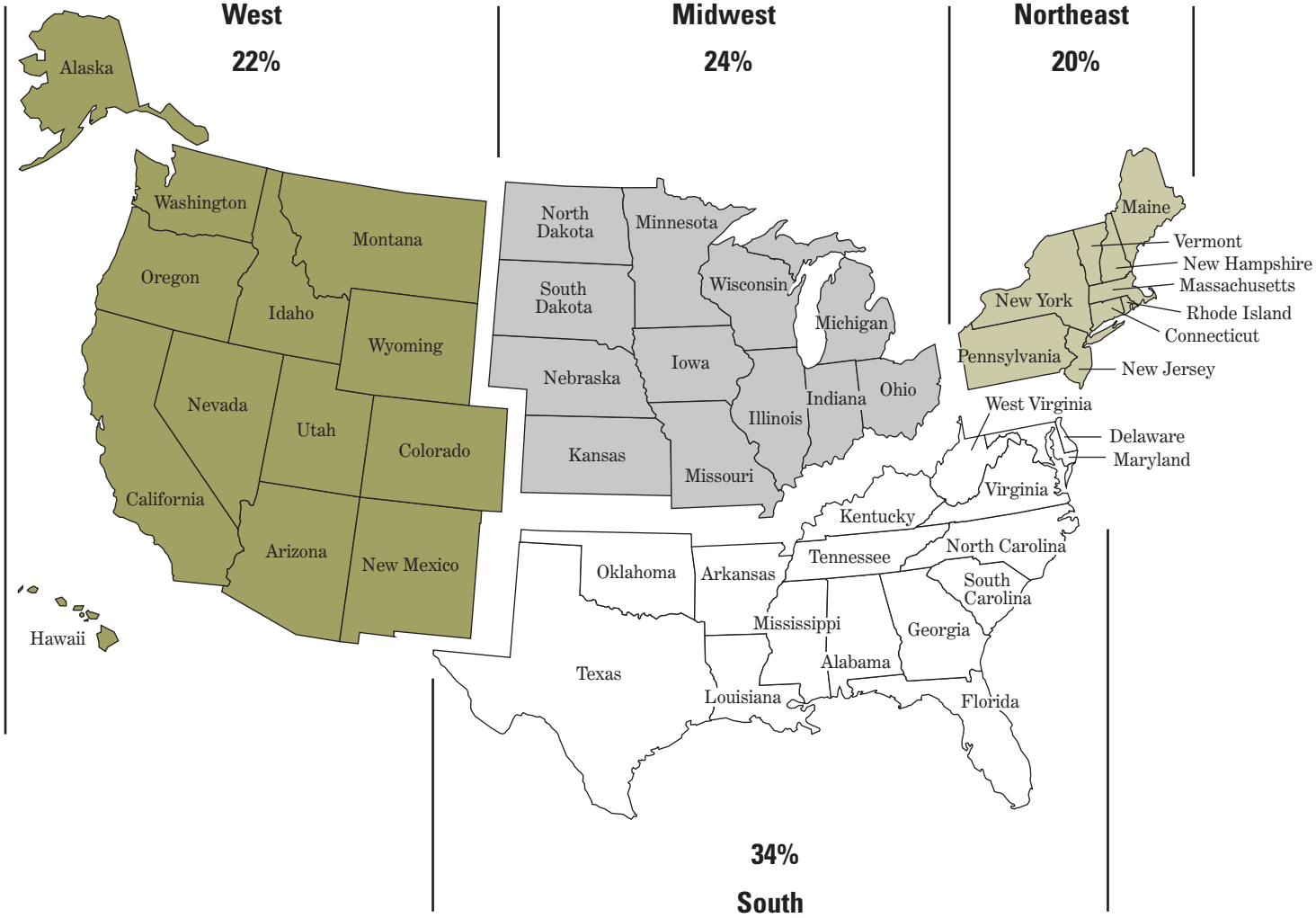


Figure 1. Participation by Region of Residence: 2011
(Population 16 years of age and older.)



There were more participants in the South (34 percent) compared to the rest of the United States (see Figure 1). The Midwest had the second highest participation at 24 percent. The West and Northeast had lower participation of 22 percent and 20 percent, respectively.

Steve Maslowski ©

Bird watching by state residents tells only part of the story. Many people travel out-of-state to watch birds, and some states are natural birding destinations. Hawaii reaped the benefits of this tourism with 73 percent of their total birders coming from other states. Three other states (Alaska, Wyoming, and Maine) had more than 60 percent of their total birders coming from other states. (See Table 6.)

USFWS

Table 6. Birding by State Residents and Nonresidents: 2011
(Population 16 years of age and older. Numbers in thousands).

State	*Total Birders*	*Percent State Residents*	*Percent Nonresidents*
Alabama	607	94%	–
Alaska	512	31%	69%
Arizona	1,110	82%	18%*
Arkansas	539	98%	–
California	4,864	94%	6%
Colorado	1,188	85%	15%
Connecticut	873	93%	7%*
Delaware	171	80%	–
Florida	2,966	75%	25%
Georgia	1,903	87%	13%*
Hawaii	254	27%	73%*
Idaho	419	81%	19%*
Illinois	1,811	90%	10%*
Indiana	1,175	99%	–
Iowa	531	89%	–
Kansas	476	95%	–
Kentucky	827	90%	10%*
Louisiana	712	71%	–
Maine	689	38%	63%
Maryland	934	84%	16%*
Massachusetts	1,238	75%	25%
Michigan	2,015	93%	7%*
Minnesota	1,112	93%	7%*
Mississippi	456	87%	–
Missouri	1,110	92%	8%*
Montana	291	60%	40%*
Nebraska	273	89%	–
Nevada	447	72%	28%*
New Hampshire	527	55%	45%*
New Jersey	1,195	87%	13%*
New Mexico	415	78%	22%*
New York	3,272	93%	7%
North Carolina	1,854	84%	16%
Ohio	1,583	97%	–
Oklahoma	773	97%	–
Oregon	892	79%	21%*
Pennsylvania	2,699	89%	11%
Rhode Island	201	80%	20%
South Carolina	536	72%	28%*
South Dakota	235	64%	36%
Tennessee	1,382	82%	18%
Texas	2,238	95%	5%*
Utah	410	69%	31%
Vermont	292	69%	31%*
Virginia	1,425	81%	19%*
Washington	1,516	83%	17%*
West Virginia	547	88%	–
Wisconsin	1,678	89%	11%*
Wyoming	417	31%	69%

Note: A hyphen (–) denotes sample sizes that are too small to report reliably (9 or less). An asterisk (*) denotes an estimate based on a sample size of 10 to 29. This sample size criteria is consistent with the "2011 National Survey of Fishing, Hunting, and Wildlife-Associated Recreation."

Where and What are They Watching?

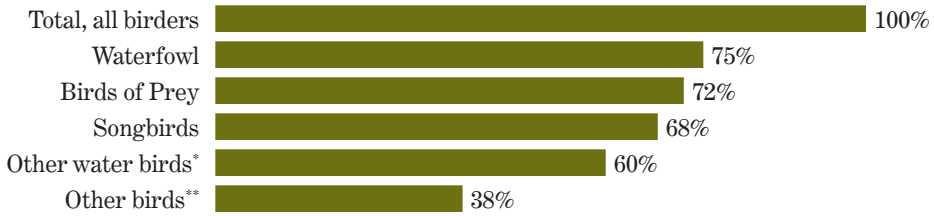
Backyard birding is the most prevalent form of birding with 88 percent of participants watching birds from the comfort of their homes. Thirty-eight percent of birders travel more than a mile from home to bird visiting both private and public lands.

What kinds of birds are they looking at? Seventy-five percent of away-from-home birders reported observing waterfowl (ducks, geese, etc.), making those the most watched type of bird. Birds of prey (hawks, eagles, etc.) were also popular with 72 percent of birders watching them, followed in popularity by songbirds such as cardinals and robins (68 percent) and other water birds such as herons and shorebirds (60 percent). See Chart 8.

Avidity

All people identified as birders in this report said that they took an active interest in birds – defined as trying to closely observe or identify different species. But what is the extent of their interest? In order to determine their "avidity" the number of days spent bird watching was considered.

Chart 8. Types of Birds Observed by Away-From-Home Birders: 2011



** shorebirds, herons, etc.*
***pheasants, turkeys, etc.*

Table 7. National Birding Trends

	2006	*2011*	*Percent Change**
Total Birders	47,693	46,741	–2%
Around-the-home	41,821	41,346	–1%
Away-from-home	19,860	17,818	–10%*
Total Days	5,473,398	5,161,909	–6%
Around the home	5,202,536	4,923,873	–5%
Away-from-home	270,861	238,036	–12%

Note: An asterisk denotes the change is significant at the 95% level. All other "percent changes" are not statistically significant.

Lavonda Walton/USFWS

Presumably because of the relative ease of backyard birding, birders around the home spent nine times as many days watching birds as did people who traveled more than a mile from home to bird watch. In 2011, the mean number of days for all birders was 110, for backyard birders it was 119, and for away-from-home birders it was 13. Avidity for all birders is shown in Chart 9. Although avidity is varied across the country, birders' avidity in 11 States was higher than the national average. Most notably, Mississippi averaged 155 days per birder.

Table 7 shows how avidity has changed from 2006 to 2011. The only change that is significant at the 95 percent level is "Total Away-from-Home Birders." As shown, the number of away-from-home birders has decreased 10 percent as less birders are traveling to observe birds.

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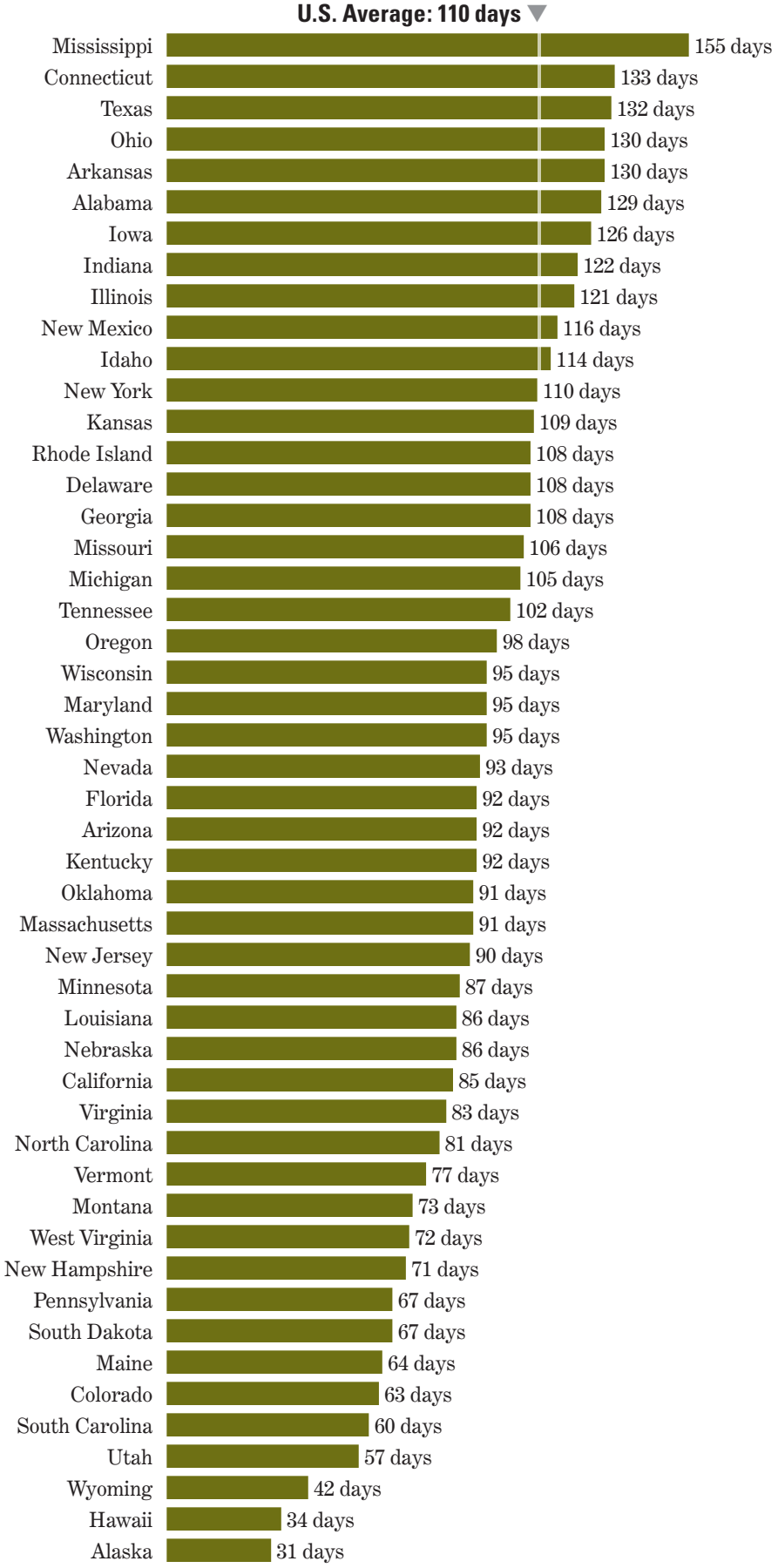
Chart 9. Birding Avidity by State: 2011

(Population 16 years of age and older.)



Note: North Dakota is not included due to small sample sizes.

The Economics of Bird Watching

Birders spend money on a variety of goods and services for their trip-related and equipment-related purchases. Trip-related expenditures include food, lodging, transportation, and other incidental expenses. Equipment expenditures consist of binoculars, cameras, camping equipment, and other costs. By having ripple effects throughout the economy, these direct expenditures are only part of the economic impact of birding. The effect on the economy in excess of direct expenditures is known as the multiplier effect. For example, an individual may purchase a bird house to enhance birding at home. Part of the purchase price will stay with the local retailer. The local retailer, in turn, pays a wholesaler who in turn pays the manufacturer of the bird houses. The manufacturer then spends a portion of this income to pay businesses supplying the manufacturer. In this sense, each dollar of local retail expenditures can affect a variety of businesses. Thus, expenditures associated with birding can ripple through the economy by impacting economic activity, employment, and household income. To measure these effects, a regional input-output modeling method[1] is utilized to derive estimates for total industry output, employment, employment income, and tax revenue associated with birding.

David Haggard/USFWS

[1] The estimates for total industry output, employment, employment income, and federal and state taxes were derived using IMPLAN, a regional input-output model and software system.

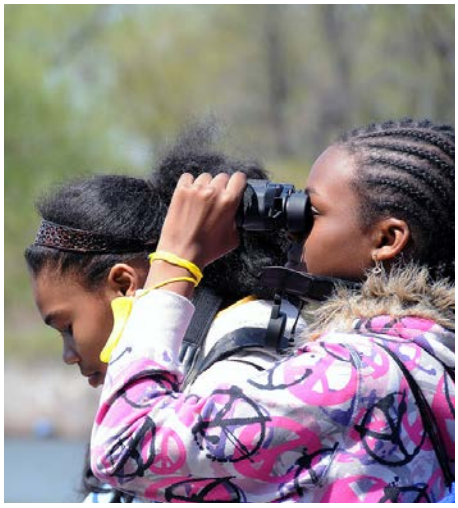


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Table 8 highlights birders' trip-related and equipment-related expenditures in 2011.[2] Birders spent an estimated $15 billion on their trips and $26 billion on equipment in 2011. For trip expenditures, 52 percent was food and lodging, 34 percent was transportation, and 14 percent was other costs such as guide fees, user fees, and equipment rental (Chart 10). Equipment expenditures were relatively evenly distributed among wildlife watching equipment (29 percent), special equipment (37 percent), and other items (30 percent) (Chart 11). Auxiliary equipment accounted for only 4 percent of all equipment expenditures.

[2] The Survey does not have an expenditure category for birding. Therefore, expenditures are prorated by multiplying wildlife watching expenditures by a ratio to derive birding expenditures. For trip-related expenditures, the ratio includes only away-from-home birders and is (total number of away-from-home days watching birds)/(total number of away-from-home days watching wildlife). For equipment-related expenditures, the ratio includes both away-from-home birders and around-the-home birders. The equipment-related expenditure ratio is (total number of days watching birds)/(total number of days watching wildlife).

Table 8. Trip and Equipment Expenditures for Birding by Category: 2011

Total Trip and Equipment Expenditures	**$40,942,680,033**
Trip-Related Expenditures*, total	**$14,868,424,740**
Food	$4,625,942,734
Lodging	$3,105,418,864
Transportation	$5,084,858,642
Other	$2,052,204,500
Equipment, total**	**$26,074,255,293**
Wildlife-watching equipment	$7,573,105,647
Auxilliary equipment	$1,034,484,181
Special Equipment	$9,534,331,263
Other Items	$7,932,334,202

**Trip-related expenditures include food, drink, lodging; public and private transportation; and other trip-related costs such as guide fees, pack trip or package fees, public and private land use access fees, equipment rental, boating costs, and heating and cooking fuel.*

***Wildlife-watching equipment expenditures include: bird food, nest boxes, bird houses, bird baths, binoculars, cameras and camera equipment, photo processing, day packs, carrying cases, special clothing and other wildlife-watching items such as field guides and maps. Auxiliary equipment includes tents, tarps, frame packs, and backpacking equipment, and other camping equipment, and other auxiliary equipment such as blinds and GPS devices. Special Equipment includes big ticket items such as boats and boat accessories, campers, trucks, and cabins. Other items include land leasing and ownership, plantings, membership dues and contributions, and magazine books, and DVDs.*

Chart 10. Trip-Related Expenditures
(Total Expenditures: $14.9 billion)

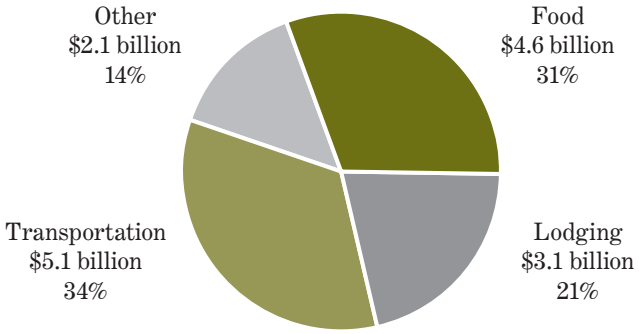
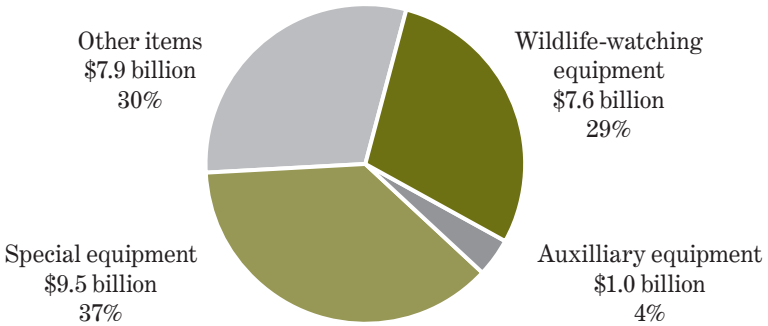


Chart 11. Equipment Expenditures
(Total expenditures: $26.1 billion)



Total Industry Output

Table 9 lists the economic effect of bird watching expenditures in 2011. The trip and equipment expenditures of $41 billion in 2011 generated $107 billion in total industry output across the United States. Total industry output includes the direct, indirect, and induced effects of the expenditures associated with bird watching.

Direct effects are the initial effects or impacts of spending money; for example, an individual purchasing a bird house is an example of a direct effect. An example of an indirect effect would be the purchase of the bird house by a retailer from the manufacturer. Finally, induced effects refer to the changes in production associated with changes in household income (and spending) caused by changes in employment related to both direct and indirect effects. More simply, people who are employed by the retailer, by the wholesaler, and by the birdhouse manufacturer spend their income on various goods and services which in turn generate a given level of output (induced effects).

Employment and Employment Income

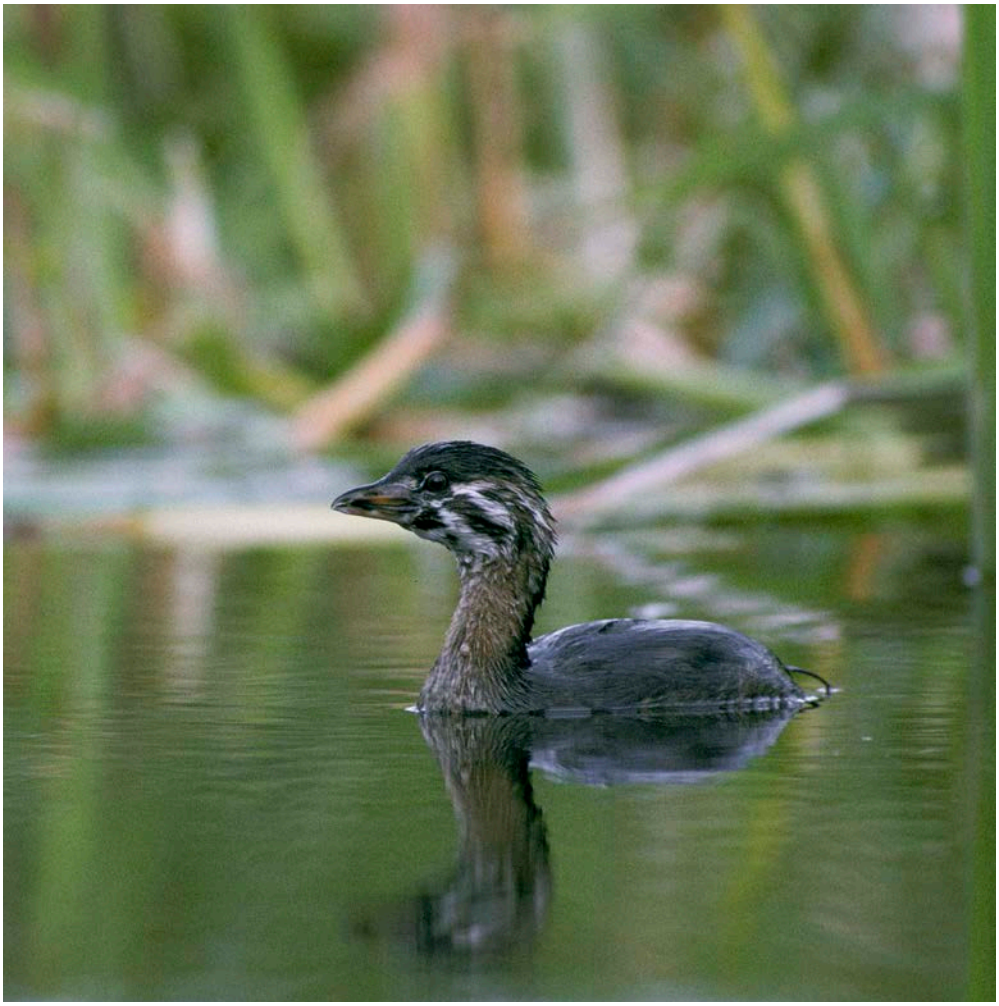
Table 9 shows that birding expenditures in 2011 created 666,000 jobs and $31 billion in employment income. Jobs include both full-time and part-time jobs, with a job defined as one person working for at least part of the calendar year. Employment income consists of both employee compensation and proprietor income.

Federal and State Taxes

Federal and State tax revenue are derived from birding-related recreational spending. In 2011, $6 billion in State tax revenue and $7 billion in Federal tax revenue were generated.

Table 9. Summary of Economic Impacts

Birders	46,741,000
Total Expenditures	$40,942,680,000
Total Output	$106,977,730,000
Jobs	666,000
Employment Income	$31,391,977,000
State Tax Revenues	$6,000,203,000
Federal Tax Revenues	$7,089,387,000



Dave Menke/USFWS

Conclusion

This report presented information on the participation and expenditure patterns of 47 million birders in 2011. Trip-related and equipment-related expenditures associated with birding generated nearly $107 billion in total industry output, 666,000 jobs, and $13 billion in local, state, and federal tax revenue. This impact was distributed across local, state, and national economies.

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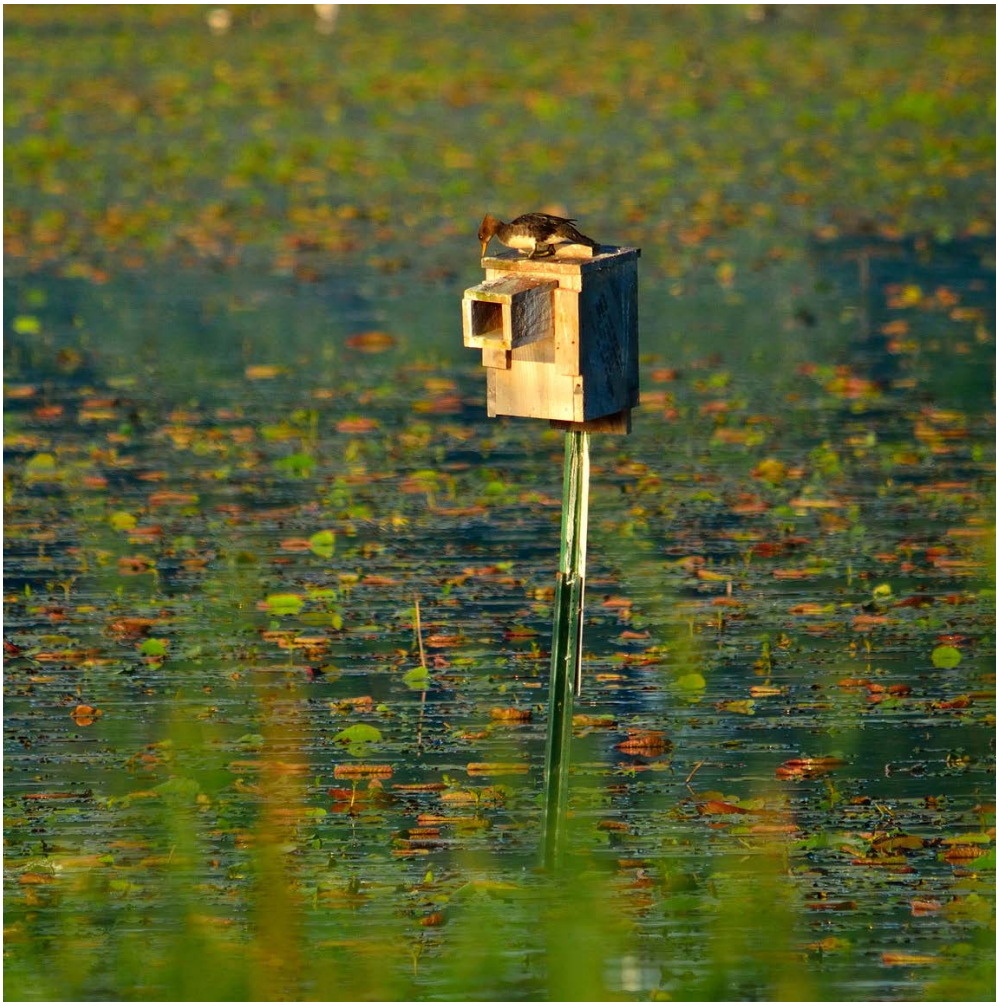
References

MIG, Inc. *IMPLAN System (2008 Data and Software)*. 1940 South Greeley Street, Suite 101, Stillwater, MN 55082. 2008.

U.S. Department of the Interior, U.S. Fish and Wildlife Service, and U.S. Department of Commerce, U.S. Census Bureau. *2011 National Survey of Fishing, Hunting, and Wildlife-Associated Recreation*.



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U.S. Department of the Interior
U.S. Fish & Wildlife Service
http://wsfrprograms.fws.gov

December 2013

Cover photo: Steve Hillebrand/USFWS

From:	Frederick Tornatore
To:	Evan Compton
Subject:	McKinley Village
Date:	Thursday, March 27, 2014 10:08:56 AM

Evan:

I am very pleased to see that City staff recommends that the Planning Commission approve the McKinley Village project. I fully support the project as it is a great urban in-fill project and its design has been very well thought-out for the area it will occupy.

Thank you and your associates for your hard work in coming to the conclusion to recommend the project.

Frederick Tornatore
5430 Carlson Dr.
Sacramento, CA

I'm a homeowner/resident on C St near 39th St. In addition to agreeing with the general comments coming from neighborhood groups regarding the need for additional vehicle access to the project site at Alhambra Bl; I'm providing the following specific comments regarding the project documents.

1. Proposed Condition of Approval I27 leaves the inclusion, location, and selection of neighborhood traffic calming measures up to City discretion, and uses the term "may require". The condition also states that undulations "will" be required near school/park combinations. The use of "may" and "will" in the same condition makes the condition confusing and open ended, the word "shall" should be used instead. The condition should also include a specific dollar range or at least a limit for the cost of improvements to give both the applicant and community more certainty. It also needs more specific details about where the improvements will be located. Please see condition B9 below from that latest modification to the C St Business Park Conditional Use Permit (CUP) as an example.

   Proposed Condition of Approval I28(a)(b) would require stop signs at the intersections of 36th St & San Antonio Way and at 36th St & 40th St. This will result in significant traffic going to and from the project site down 39th St because there are no stop signs in the north and south bound approaches to the intersection of 36th St and 39th St. This intersection is a pedestrian thoroughfare, especially for children, to the back entrance of Theodore Judah Elementary. Therefore, Conditions of Approval I27 and I28 should be revised to specifically require additional stop signs and/or traffic calming measures at the intersection of 36th St and 39th St. (See StreetView images of this intersection below.)

   Furthermore, 39th St is already the main cut-through street in the area because it runs all the way from C St, to McKinley Bl, H St, J St (passing Mercy Hospital), Folsom Bl, the lightrail station at R St, under Hwy 50, and to the UCD Med Center at Stockton Bl. Whereas, San Antonio Way terminates at McKinley Bl, and 40th St terminates at H St. (See maps below.) 39th St is also wider than 40th St and San Antonio Way, thus making it more accommodating and inviting to vehicular traffic.

   FEIR Section 3, Comments and Responses, Master Response 5, on page 3-30, states that less than one percent or less of project trips are projected to use the McKinley Bl & 39th St intersection, which equates to less than 40 daily trips and about 3 or 4 peak hour trips. With the inclusion of the stop signs in Condition of Approval I28(a)(b) and based on the additional information I've provided, this projection of trips at McKinley Bl & 39th St appears to be far too low. There would most certainly be a many more trips traveling down 39th St.

2. There is an existing CUP for the C St Business Park which was most recently modified by the Planning Commission on April 24, 2008 under planning file number P07-138. Section 17.808.440 of the Planning and Development Code states that a major modification is one that will result in a material change in the nature of the project, including but not limited to any major change in the pattern or volume of traffic flow either on or of any property covered by the permit and any change in the nature of the use. Approval of the McKinley Village project would entitle the construction of a residential street on the eastern portion of the property currently covered by the CUP for the C Street Business Park, which would be in conflict with the existing approved site plan for the business park and also require the removal of several parking spaces (See P07-138 Site Plan below). Therefore, an application for a major modification to the existing C Street Business Park CUP should be publicly noticed and considered concurrently with any actions on the McKinley Village Project.

3. The analyses for the project and recommended conditions of approval do not specify where construction staging and laydown areas will be for the construction of the extension of 40th St and the railroad undercrossing. If the vacant portion of land within the business park surrounding where the extension of 40th St would be (see aerial image below) is used for staging and laydown and construction activities, conditions of approval restricting delivery hours, queuing of delivery trucks, construction hours, fencing, lighting, and construction vehicle and worker parking on C St should be incorporated to avoid any potential impacts to the adjacent neighborhood.

Thank you for your thorough consideration of these issues.

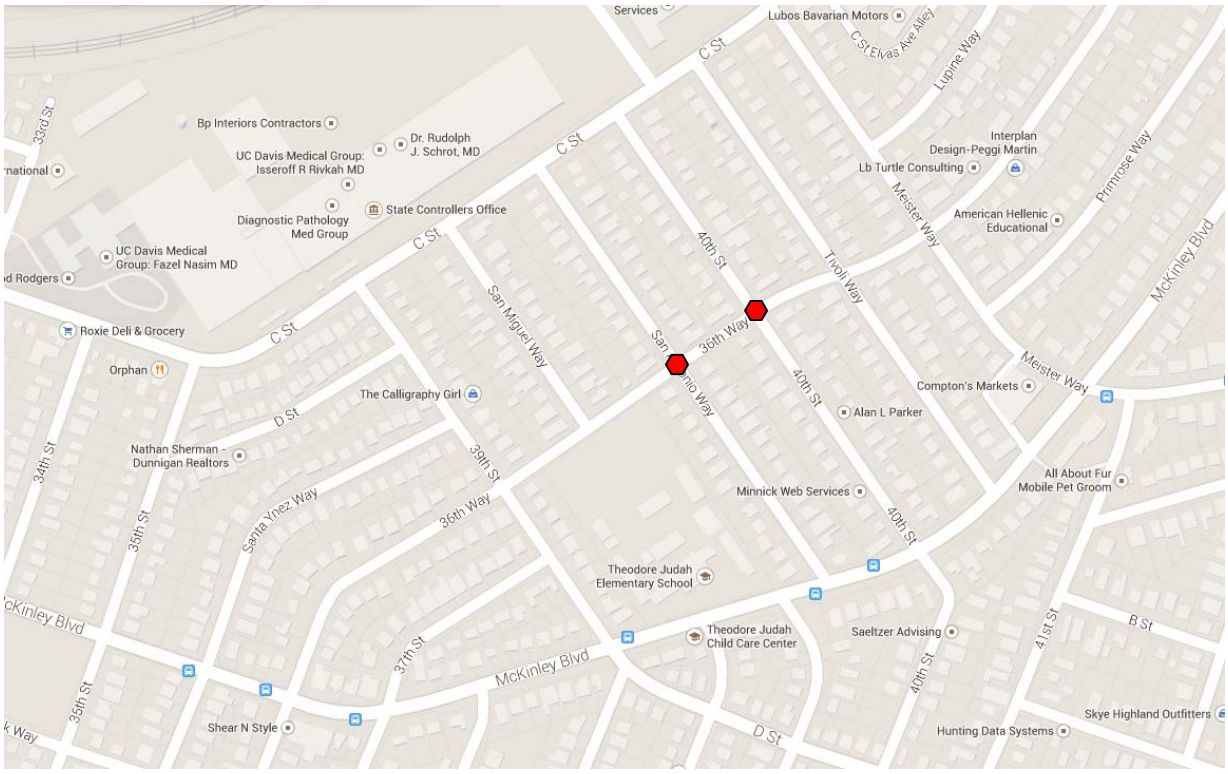
Sincerely,

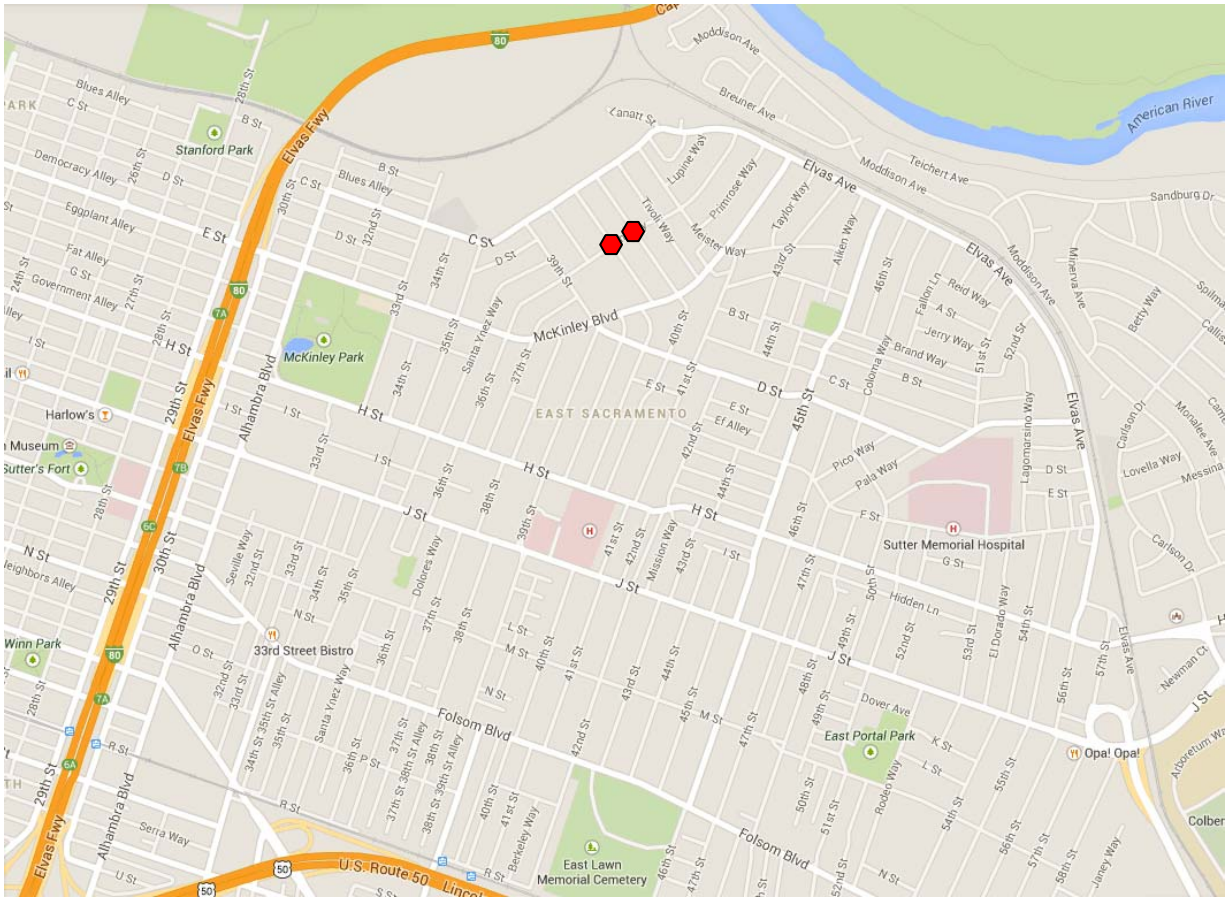
Steve Kerr

Intersection of 39th St and 36th St

View looking south down 39th St toward C St

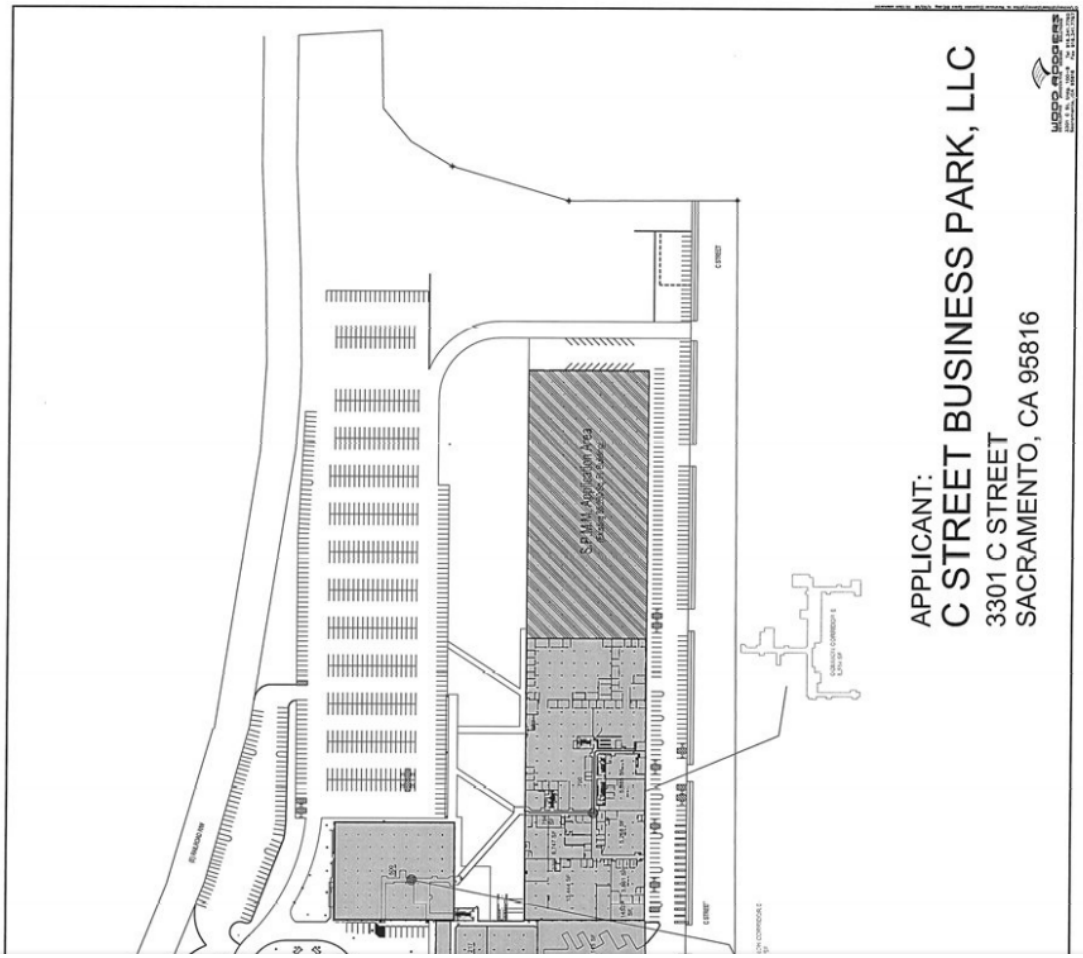
View looking east down 36th St toward back entrance to Theodore Judah Elem. School





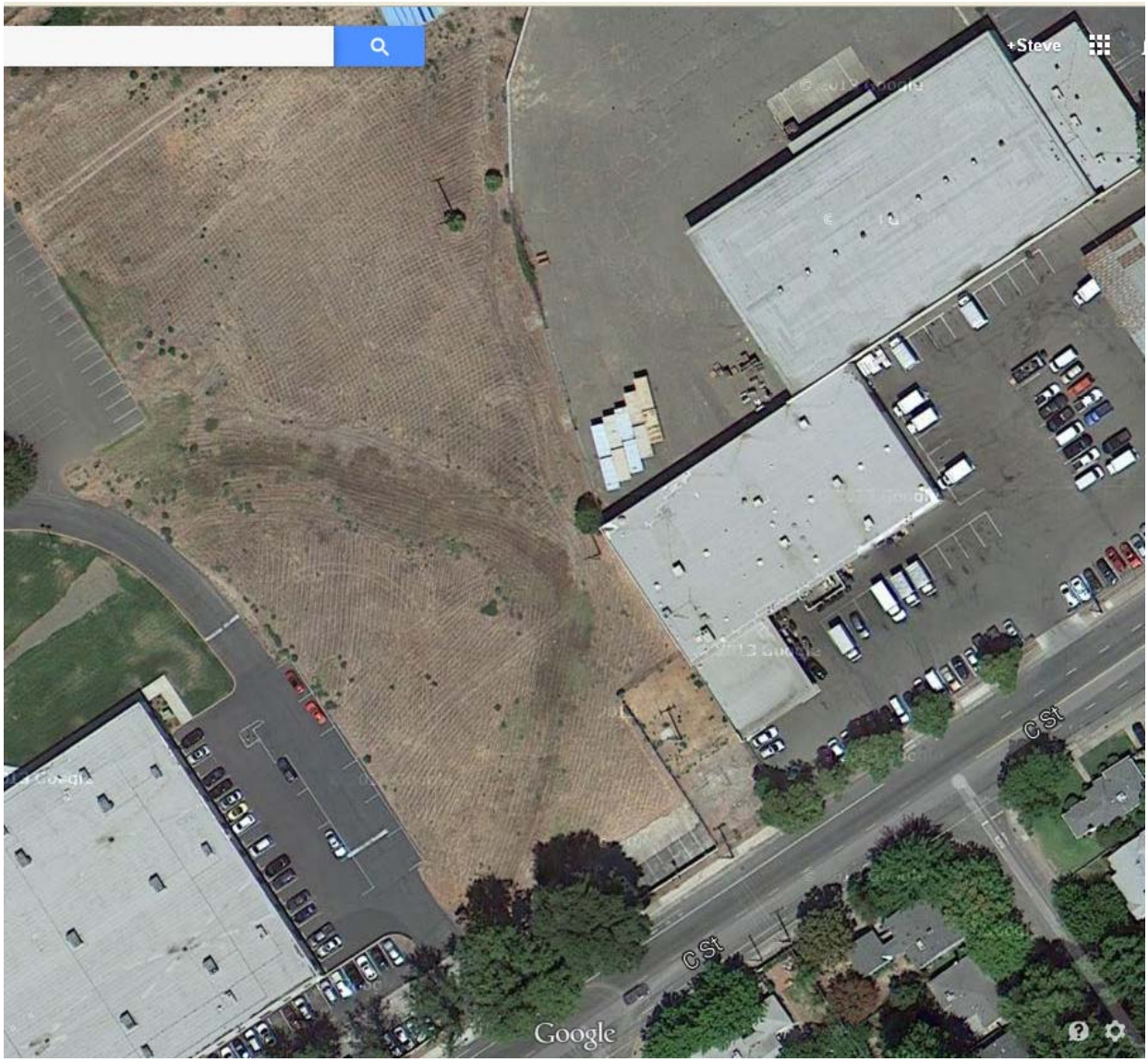
: Locations of new stop signs as proposed in Condition of Approval I28(a)(b)

Exhibit 1A: Site Plan



B9. The applicant has agreed to pay for neighborhood traffic calming measures that may include speed humps, new crosswalks, or other improvements for a sum not to exceed $10,000 along C Street, 35th Street, or as designated by the Department of Transportation.

Aerial Image of eastern portion of C St Business Park/proposed location of40th St extension



Burrowing Owl Preservation Society

A non profit organization dedicated to increasing the burrowing owl population through education and enhancement of grassland habitat

14841 CR 91 B, Woodland CA 95695

cportman@gamil.com **530-666-0882** **EIN 55-0862131**

www.burrowingowlpreservation.org

March 27, 2014

Sacramento City Planning and Design Commission
915 I St.
Sacramento, CA

Dear Commissioners,

As a wildlife advocacy organization, the Society works to assure that project mitigations comply with CEQA.

We oppose the McKinley Village project's proposed mitigation for Swainson's Hawk foraging habitat. This project results in the loss of essential foraging habitat, a significant impact, to nesting Swainson's Hawks.

When Swainson parents have to fly greater distances to get food, chances of fledging young decreases. Mitigation near the project site improves the chances of successful reproduction. In order to lessen an impact, mitigation needs to happen near the impact. This project's proposed mitigation is in Yolo County.

A one day biological assessment is inadequate. An adequate burrowing owl survey requires at least three site visits over the seasons to assess for nesting and winter migrant use. The project needs a careful review of wildlife impacts

The surveys and mitigation for burrowing owl that McKinley Village EIR proposes are not compliant with the CDFW Staff Report On Burrowing Owl Mitigation of 2012, and adhere to mitigation measures that are now known to have contributed to the decline of the owls in the state.
http://www.dfg.ca.gov/wildlife/nongame/docs/BUOWStaffReport.pdf

"Occupancy of burrowing owl habitat is confirmed at a site when at least one burrowing owl, or its sign at or near a burrow entrance, is observed within the last three years (Rich 1984). Burrowing owls are more detectable during the breeding season with detection probabilities being highest during the nestling stage (Conway et al. 2008). In California, the burrowing owl breeding season extends from 1 February to 31 August (Haug et al. 1993, Thompsen 1971) with some variances by geographic location and climatic conditions. Several researchers suggest three or more survey visits during daylight hours (Haug and Diduik 1993, CBOC 1997, Conway and Simon 2003) and recommend each

visit occur at least three weeks apart during the peak of the breeding season, commonly accepted in California as between 15 April and 15 July (CBOC 1997)."

Occasional sightings of burrowing owls still occur at Sutter Landing Park, and that with stewardship - a population could be re-established there for the enjoyment of City residents.

Thank you for your thoughtful consideration,

Catherine Portman, President

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March 27, 2014

Chair and Members of the Planning and Design Commission
Dana Allen, Associate Planner
Community Development Department
City of Sacramento
300 Richards Blvd, 3rd Floor
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Friends of the Swainson's Hawk is concerned about the inadequate biological analysis and inappropriate mitigation for the direct and cumulative impacts on Swainson's Hawk of the McKinley Village Project.

Our organization has events at nearby Sutter's Landing Park to introduce people to the Swainson's Hawk and its presence in our region. Last year at our April event we had two Swainson's hawk pairs over our event. Over 90 percent of all Swainson's Hawk nesting sites are in rural areas, difficult to locate and visit. Sutter Landing Park is a very rare and special location for public education because of the adjacent Swainson's Hawk nesting site on the American River immediately north of the 100 acre grassy mound (covered former landfill which is part of Sutter Landing Park). Raptors been observed foraging on the grassy mound very frequently during nesting season. Swainson's Hawk biologists report that the most important foraging for nesting success is within one mile of a nest.

The McKinley Village site is adjacent to and ecologically a part of the Sutter Landing Park area from an avian point of view. (See Figure 10 below)

We believe the EIR should be carefully considered by the Planning Commissioners before they make any recommendation to the Council.

FOSH disputes findings in the EIR regarding:

a) the quality of the foraging habitat at the site and its importance to the reproduction of nesting Swainson's Hawks within one mile of the property is far greater than estimated by project biological report; (foraging habitat is open area with low vegetation where hawks can capture rodents and other prey to eat or to take back to the nest for nestlings to eat).

b) the significance of the scarcity of suitable foraging habitat in the area within two miles of

nesting activity for successful reproduction at nesting sites near the project site is significantly underestimated.

c) the precedent-setting placement of mitigation for impacts out of county (in Yolo County) where foraging habitat is abundant ignores long-standing policy that mitigation will be in county. The City has not mitigated out of county before this and neither have other jurisdictions in the county. Yolo County will require a permit for mitigation to be placed in Yolo.

d) the performance measures for determining whether mitigation is appropriate are inadequate to mitigate to less than significant.

e) the significance of the project property as part of the wildlife corridor along the American River is overlooked;

e) the impact of the development of A Street as an access road for vehicles on Sutter Landing Park, its wildlife, and its wildlife education value is underestimated.

Mitigation for project impacts on nesting Swainson's Hawks should be performed within two miles of the site and contribute to the wildlife corridor in this area.

It will be very difficult to maintain wildlife in the American River corridor if projects are allowed to mitigate 5-10 miles away. The cumulative effects of adopting this EIR are considerable for Swainson's Hawk and similar wildlife.

We hope you will support the conservation of our scarce wildlife resource near Sutter Landing Park by recommending that mitigation be within two miles of the project site, in this corridor and contribute to the viability of Swainson's Hawk reproduction in this corridor.

Our Specific Comments on the Final EIR and Its Adequacy

The Final EIR (FEIR) at 3-152 states

> "With respect to mitigation, because the site itself is expected to be minimally important as foraging habitat due to its degraded, fragmented, and heavily managed nature, the mitigation proposed in the Draft EIR is considered adequate to offset the loss of the site as Swainson's hawk foraging habitat (DEIR p. 4.2-32)."
>
> And
>
> "The land proposed as a mitigation site for Swainson's hawk foraging habitat that would be lost through implementation of the proposed project is the "Notch" property, located in the Yolo Bypass just west of the City of West Sacramento (APN 033-300-021-000). This land comprises more than 100 acres, of which the applicant will provide 51.5 acres of mitigation: 50 acres to mitigate for the loss of potential foraging habitat associated with on the project site and 1.5 acres to mitigate for the loss of foraging habitat due to the extension of A Street and construction of off-site detention basins. This land consists of habitat considered by the CDFW as suitable for Swainson's hawk, will be located within a 10-mile radius of the

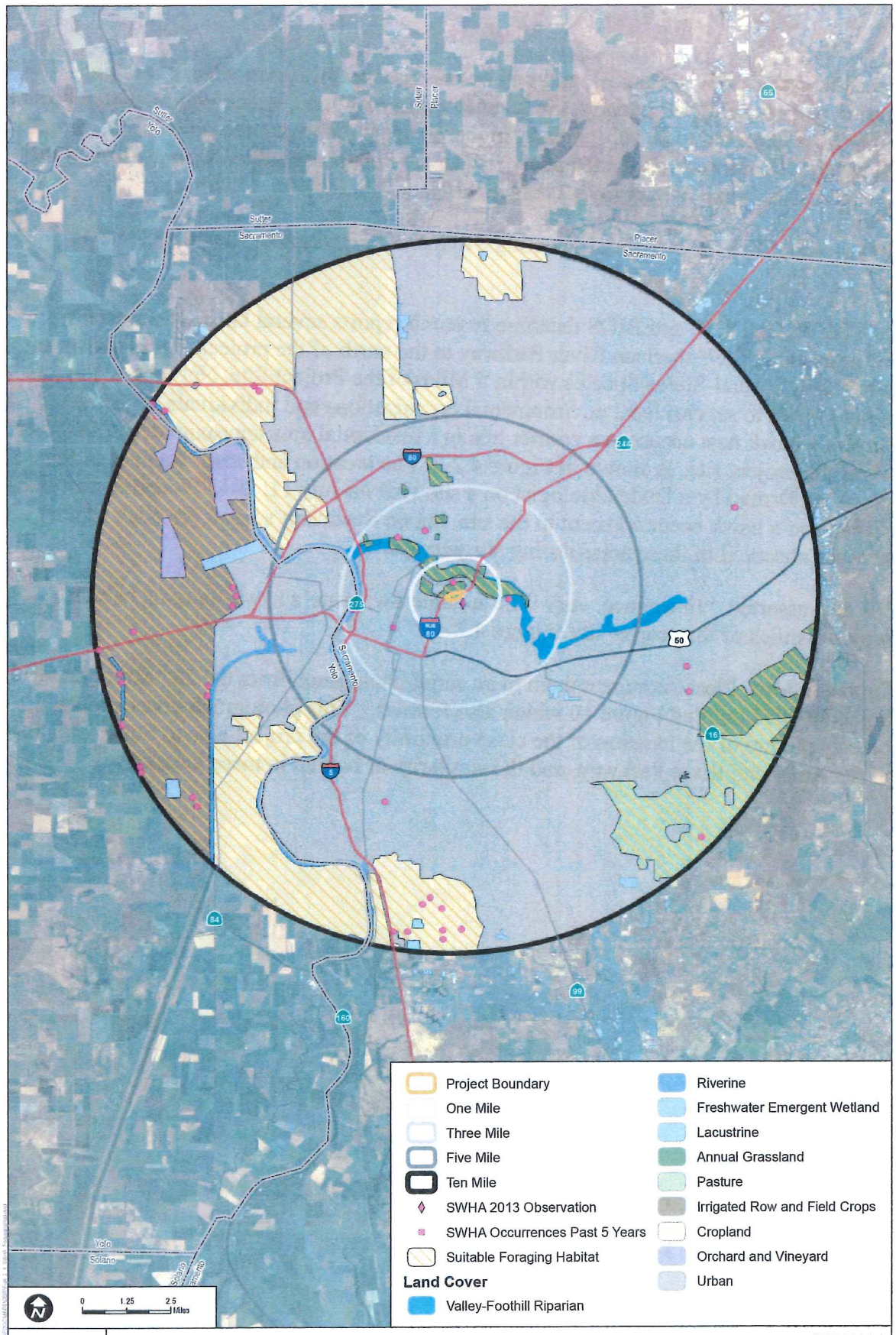
project site (per CDFW guidance), and will be managed as Swainson's hawk foraging habitat in perpetuity. Consequently, the selected mitigation land, which will require approval by CDFW, is expected to be substantially higher in value than what the project site currently provides and, therefore, would adequately reduce the impact associated with the loss of the project site as foraging habitat to less than significant."

The Draft EIR identifies the presence of nesting Swainson's Hawks near the project site as follows:

> "The CDFW, CNDDB, and BIOS database research reports several known Swainson's hawk nests along the American River Parkway to the north of the project site, as shown in Figure 4.2-2, Special-Status Species within 5 Miles of the Project Site. Not reported in this data but known to several local environmental organizations and individuals, an active Swainson's hawk nest occurs in a conifer tree in a residential area approximately 1,000 feet south of the project site, as shown in Figure 4.2-3. The location and status (active) of this nest was confirmed by a Dudek biologist on a site visit on July 11, 2013. Potential nest trees for Swainson's hawk occur adjacent to the site, but no Swainson's hawk (or other raptor) nests were observed in these areas during site surveys."

The DEIR also asserted: "In essence, very little suitable Swainson's hawk foraging habitat occurs within 5 miles of the project site (Figure 4.2-4)."

These figures follow. Please compare them to an aerial photograph from the 28th Street Landfill Solar Project in 2011 entitled Figure 10 which also follows. This photograph gives a much more accurate picture of the location of the close proximity of the project area to Sutter Landing Park and the American River Parkway, and the similarity of habitat in these locations.



SOURCE: ESRI 2013; County of Sacramento 2012

FIGURE 4.2-4
Swainson's Hawk Foraging Habitat

7828

MCKINLEY VILLAGE PROJECT EIR

Urban Nesting Requires Foraging Habitat in Closer Proximity

Figure 4.2.4 and this finding (The DEIR also found: "In essence, very little suitable Swainson's hawk foraging habitat occurs within 5 miles of the project site (Figure 4.2-4).") are highly significant because

> "Swainson's hawks have not been found in apparently suitable urban areas in the Central Valley where foraging habitat is unavailable for 5-8 km. . .[3 miles to 4.8 miles] thus requiring long-distance transport of prey throughout the entire nesting cycle." ("Nest-Site Selection and Reproductive Performance of Urban-Nesting Swainson's Hawks in the Central Valley of California", A. England, J. Estep, W. Holt, *J. Raptor Research* 29 (3): 179-186, 1995, The Raptor Research Foundation, Inc.)

This study of urban nest productivity demonstrates that fewer young are fledged from nests in urban settings. (p. 184) Hence the importance of maintaining close by foraging that will sustain reproduction in order to maintain the range of the species. Mitigation with land beyond five miles is not going to mitigate for the loss of foraging habitat within a mile or two of several urban nest sites.

As we stated in our comments on the project's NOP,

> We are aware of several nesting sites that are in close proximity to the project site. Our concern is that the project site be mitigated for loss of foraging habitat at a ratio of one to one in close proximity to the project site in order to protect the foraging of these nesting pairs during reproductive season. This SWH population may be all that remains of the historic population that nested along the American River. If this population does not survive, a very important element of the American River Parkway ecology will have been eliminated. Mitigation should be required to be in the parkway corridor, in close proximity to pairs now nesting near the project site, and be in the form of returning acres to foraging habitat that are presently not available for raptor foraging but in close proximity. Mitigation measures also must include protections against incidental take.

Figures 4.2.4 shows that 5-6 nesting sites occur within three miles of the project area and they depend on a <u>very narrow band of suitable foraging habitat,</u> of which the <u>project site is part</u>. These pairs must also share the foraging habitat with numerous red tailed hawks, red shouldered hawks and white tailed kites. Loss of foraging habitat at the site could significantly affect reproductive success and cumulatively the survival of the species in this location. Ultimately the range of the Swainson's Hawk in California could be reduced if mitigation is not required within 2-3 miles of this site.

The use of the ten mile radius, derived from the 90 percent of Swainson's Hawk nesting sites that are located in rural areas, is inappropriate for use in this urban setting. Proximity of habitat mitigation land should be no more than 5 miles away.

SOURCE: ESRI; County of Sacramento 2012

FIGURE 4.2-3
Location of Swainson's Hawk Nest

7828

MCKINLEY VILLAGE PROJECT EIR

SOURCE: NAIP Aerial Photograph, 6/21/2009; AES, 2011

Figure 10
Project Impacts

Assessment of the Habitat Quality and Impact of Loss

Figure 4.2.3 shows the McKinley project site, the location of a nesting site in 2013 that was 1,000 feet from the project site, and the Sutter Landing park grassy mound habitat area with the freeway separating McKinley Village from the Sutter Landing site. Draft EIR, Figure 4.2-3 demonstrates by aerial photograph little difference in land use between this site and the Sutter Landing Park grassy mound (closed landfill). The latter site has previously been shown to the City, in its assessment of the grassy mound as a potential solar facility, to be quality habitat relied upon by raptors nesting on the American River near the park to provision nesting sites.

Compare Figure 4.2.3 with the following Figure 10 from the 28th Street Solar Photovoltaic Farm BRA in 2011. Note that the latter EIR identifies the grassy mound as annual grassland (not ruderal). It also shows the McKinley project site is not bare dirt in most places.

Figure 10 from the 28th Street Solar Photovoltaic Farm BRA in 2011 is very helpful in showing the location of the project site in relationship to Sutter Landing Park and the American River and American River Parkway wildlife corridor. This information was poorly presented in the McKinley Village EIR.

The Dudek Biological Report for the McKinley Village Project attempted to show that the prey values on the property were low.

Page 21, Dudek Biological Technical Report, Appendix D to the DEIR for McKinley Village Project acknowledges that the site is likely to harbor the two most common prey items for Swainson's Hawk during nesting season: the California vole and the ground squirrel. However, Draft EIR, p. 4.2-2 describes the site as "The majority of the site consists of ruderal habitat (non-native annual grass species and non-native forbs and/or bare dirt) (see Figure 4.2-1, Vegetation Communities). The site is annually mowed and disked in the late spring to early summer months . . . ."

The DEIR, 4.2-2, in describing the project sites says: "The project site is currently vacant and contains a fallow field dominated by non-native grasses. . . ."Throughout the biological discussion, however, the word ruderal is used without defining the difference between ruderal and fallow fields. DFW considers fallow fields among the highest quality foraging habitats for Swainson's Hawks (CDFG (California Department of Fish and Game). 1994. Staff report regarding mitigation for impacts to Swainson's hawks (*Buteo swainsoni*) in the Central Valley of California. California Department of Fish and Game, Sacramento.). The EIR's characterization of the project area as ruderal rather than fallow is a distinction without a difference. Ruderal fields typically have been abandoned by the landowner for agricultural purposes but otherwise are quite similar to fallow fields.

The characterization of the project area as having low habitat value for nesting Swainson's Hawks is not based on any analysis of the prey presence and use by hawks during the nesting season, but instead on the fact that the landowner has abandoned the field for agricultural use. If the same field had been used for grazing, it could not have been classified as ruderal by the biological consultant.

The Biological Resources Assessment of the proposed City Of Sacramento's "28th Street Solar Photovoltaic Farm," August 2011, characterizes the grassy mound area (the capped landfill on Sutter Landing Park) just across the freeway from the project area as "non-native grasslands." There is no significant difference in how the grassy mound and the McKinley Village properties look and are managed. Independent biologists investigating the prey values at the grassy mound found that the assessment of prey values was improperly underestimated. Their comments are equally applicable to the McKinley Village environmental assessment of the foraging value of the site for Swainson's Hawk.

In a September 29, 2011, letter to Dana Allen, Plant Biologist Glen Holstein, Ph.D., on behalf of the Sacramento Valley Chapter of the California Native Plant Society, made the following observations which equally apply to the biological analysis performed for the McKinley Village site.

> "A single day visual site survey like the one apparently done at Sutter Landing can provide no evidence whether or not a Swainson's Hawk prey base is present. The small rodents constituting the primary prey base of the hawk are too cryptic to be readily seen by any such visual survey and most do not even make burrows. These are the native species Western Harvest Mouse (*Reithrodontomys megalotis*), Deer Mouse (*Peromyscus maniculatus*), and California Vole (*Microtus californicus*) as well as the non-native species House Mouse (*Mus musculus*) and Norway Rat (*Rattus norvegicus*). Based on the environmental report's apparently accurate description of the site's vegetation, any or all of these species are likely to be abundant there. Of these, however, only the vole makes burrows, and these are miniscule, easily overlooked, and only made facultatively (Zeiner et al. 1990a; 1990b)"
>
> and
>
> "Five mammal species constituting the major prey base of Swainson's Hawk are likely to be present and abundant at Sutter Landing, but none are likely to be seen by a casual visual survey. Only an extensive trapping program could demonstrate their absence. Until that is done, their presence should be assumed. So should the presence of grasshoppers, another important Swainson's Hawk prey item (Zeiner et al. 1990a)." (letter attached)

Similarly, Ecologist Shawn Smallwood (Ph.D., 1990, UCD), in a letter to Dana Allen dated October 31, 2011, agreed that a one day biological survey was inadequate and that " A single survey on a single day was grossly insufficient for characterizing environmental conditions relevant to multiple special status species, and it was grossly insufficient for predicting project impacts." (letter attached) Smallwood agreed with Holstein that key prey do not use burrows and "it is untrue to conclude that the lack of burrows qualifies the landfill as unsuitable Swainson's hawk foraging habitat." Smallwood's letter addresses other deficiencies in the environmental analysis which are duplicated in the McKinley Village Project biological analysis.

Note that the aerial photograph shown in the 2011 Biological Resources for City 28th Street Solar

project shows much more green vegetation on the McKinley Village site (Figure 3) than the photograph in the McKinley Village DEIR, suggesting that the MV EIR presents a biased visual image of the project site, intended to lead to the inference that the site is bare soil incapable of supporting prey.

Finding of no significant impact after mitigation; inadequacy of the performance measures.

Due to the EIR's inadequate analysis of the importance of the nesting pairs within close proximity to the project site, and the availability of prey there to sustain reproductive success, the EIR finding of no significant impact after mitigation is in error.

The final EIR at 3.155 states:

> ". . . since virtually all the land within 2 to 5 miles of the project area is urbanized, planned for future development, or already included in the protected American River Parkway, it is unlikely it is feasible that additional lands suitable for foraging habitat can be found within that radius that can serve as mitigation for this project. In addition, the CDFW does not have a requirement or include a policy that mitigation lands be located within 2 to 5 miles of where foraging habitat will be replaced."

There is no substantial evidence presented to show that it is not possible to acquire 51.5 acres of land to be used as mitigation land within 2 to 5 miles of the project. The City wants to expand the wildlife corridor along the American River and there are private holdings in the American River Parkway. Just recently, Sacramento Open Space Conservancy purchased Camp Pollack from the Boy Scouts of America. There are parcels that have in the past been used for industrial use that could be converted back into habitat, thus expanding the availability of raptor forage in a very key site where such land is scarce. City Parks is well aware of parcels that would be suitable for addition to the Parkway and could be managed for foraging habitat (although some demolition and recovery would be needed).

The performance standard allowing mitigation to be located within 10 miles is not adequate to reduce the level of significance of the impact on Swainson's Hawk to less than significant.

The performance standard allowing mitigation outside the county is not supported by other jurisdictions in the county that have not allowed out of county mitigation. Nor is it consistent with the City's practice.

The finding that there are no significant cumulative impacts given current mitigation ratios is absurd on its face since the 1:1 habitat mitigation ratio will result in preservation of only half of the available foraging habitat.

Mitigation Measure 4.2-1(b) (FEIR 3-154) is vague and lacks essential elements necessary for implementation, monitoring and enforceability. There is no requirement that there be a third party non-profit conservation organization, or any other entity, responsible for monitoring and enforcement of the conservation easement on SWH mitigation land. There is no requirement that the applicant provide a monetary endowment to fund third party monitoring and enforcement to ensure that the conservation easement is implemented in perpetuity. Nothing in the document provides for penalty or even correction if the conservation operator is not in

compliance with the conservation easement. There is no requirement that CDFW approve the location of the mitigation land, the provisions of the conservation easement, the conservation operator, or the third party conservation organization that would be charged with monitoring and enforcing the conservation easement. The project applicant is required to only consult with CDFW and have CDFW review the terms of the conservation easement. The applicant would be free to ignore CDFW's recommendation. The EIR is misleading in that it says that CDFG will approve the mitigation land, but the Mitigation Measure does not require that approval.

Therefore the project violates CEQA by failing to mitigate project impacts to Swainson's Hawks to less than significant or to the extent feasible. The proposed findings that project impacts to Swainson's Hawks would be mitigated to less than significant is not supported by law or substantial evidence and therefore violates CEQA.

Thank you for this opportunity to comment.

Jude Lamare

Judith Lamare, President
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Attachments -

Holstein letter 9/29/2011
Smallwood letter 10/31/2011

California Native Plant Society
Sacramento Valley Chapter
www.SacValleyCNPS.org

September 29, 2011

Dana Allen, Associate Planner
Community Development DepartmentCity of Sacramento
300 Richards Boulevard, 3rd Floor
Sacramento, CA 95811 dallen@cityofsacramento.org

SUBJECT: Mitigated Negative Declaration for P11-016 – Sutter Landing Photovoltaic Installation at 28th Street Closed Landfill

Dear Dana Allen:

I am a biologist with over 20 years experience consulting on wildlife habitat relationships in central California and have contributed to the scientific literature on the region's habitats. Currently I am the California Native Plant Society Sacramento Valley Chapter's Botanist. Significant questions and apparent errors in the environmental report used to justify a Mitigated Negative Declaration for the proposed Sutter Landing Photovoltaic Installation have come to my attention.

Your environmental report states that "No rodents or rodent burrows, which would provide evidence of sources of prey, were observed within the grassland during the May 27, 2011 biological survey, most likely due to annual soil compaction of the study area. Several black-tailed jackrabbits (*Lepis californicus*) [sic], less preferable sources of prey, were observed within the study area. A Swainson's Hawk pair was observed foraging within the nonnative grassland within the study area and on land to the north of the study area, north of the American River during the May 27, 2011 biological survey. Because the landfill mound lacks preferable prey base due to the absence of small rodents and rodent burrows as a result of annual soil compaction within the managed nonnative grassland, Swainson's Hawk has a low potential to forage within the study area."

This statement is self-contradictory and demonstrates profound unfamiliarity with basic ecological relationships occurring in Sacramento County and its environs. A single day visual site survey like the one apparently done at Sutter Landing can provide no

evidence whether or not a Swainson's Hawk prey base is present. The small rodents constituting the primary prey base of the hawk are too cryptic to be readily seen by any such visual survey and most do not even make burrows. These are the native species Western Harvest Mouse (*Reithrodontomys megalotis*), Deer Mouse (*Peromyscus maniculatus*), and California Vole (*Microtus californicus*) as well as the non-native species House Mouse (*Mus musculus*) and Norway Rat (*Rattus norvegicus*). Based on the environmental report's apparently accurate description of the site's vegetation, any or all of these species are likely to be abundant there. Of these, however, only the vole makes burrows, and these are miniscule, easily overlooked, and only made facultatively (Zeiner et al. 1990a; 1990b)

The vole is the primary Swainson's Hawk food item (Thelander 1994) and is particularly abundant in alfalfa fields (Jameson & Peeters 1988), which accounts for the extensive use of alfalfa fields and other row crops for foraging by the hawk (Thelander 1994). These are habitats at least as disturbed and free of burrows as the grassland at Sutter Landing.

Five mammal species constituting the major prey base of Swainson's Hawk are likely to be present and abundant at Sutter Landing, but none are likely to be seen by a casual visual survey. Only an extensive trapping program could demonstrate their absence. Until that is done, their presence should be assumed. So should the presence of grasshoppers, another important Swainson's Hawk prey item (Zeiner et al. 1990a). The Swainson's Hawk pair observed foraging at the site by the May 27 almost certainly knew what they were doing. The Sutter Landing site is likely to currently be the most extensive tract of good foraging habitat left for this threatened species in central Sacramento.

Glen Holstein, PhD
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CC via email: Jude Lamare, President Friends of the Swainson's Hawk

REFERENCES

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Zeiner, D.; W. Laudenslayer, Jr.; K. Mayer; & M. White. 1990a. California's Wildlife: Volume II, Birds. California Department of Fish and Game. Sacramento.
_____. 1990b. California's Wildlife: Volume III, Mammals. California Department of Fish and Game, Sacramento.

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31 October 2011

RE: **Comment on Sutter Landing Park Solar Photovoltaic Project MND**

Dear Ms. Allen,

The following comments on the Initial Study/Mitigated Negative Declaration ("IS/MND") for the Sutter Landing Park Solar Photovoltaic Project Mitigated Negative Declaration (MND) are submitted on behalf of Friends of the Swainson's Hawk. My qualifications for preparing expert comments are the following. I earned a Ph.D. degree in Ecology from the University of California at Davis in 1990, where I subsequently worked for 4 years as a post-graduate researcher in the Department of Agronomy and Range Sciences. My research has been on the ecology of invading species, animal density and distribution, habitat selection, habitat restoration, interactions between wildlife and human infrastructure and activities, and on conservation of rare and endangered species. I have authored numerous papers on special-status species issues, including "Using the best scientific data for endangered species conservation," published in Environmental Management (Smallwood et al. 1999), and "Suggested standards for science applied to conservation issues" published in the Transactions of the Western Section of The Wildlife Society (Smallwood et al. 2001). I served as Chair of the Conservation Affairs Committee for The Wildlife Society – Western Section. I am a member of The Wildlife Society and the Raptor Research Foundation, and I've been a part-time lecturer at California State University, Sacramento. I was also Associate Editor of wildlife biology's premier scientific

journal, The Journal of Wildlife Management, as well as of Biological Conservation, and I was on the Editorial Board of Environmental Management.

I have performed avian surveys in California for twenty-two years (Smallwood et al. 1996, Smallwood and Nakamoto 2009). Over these years, I studied the impacts of human activities and human infrastructure on birds and other animals, including on Swainson's hawks (Smallwood 1995), burrowing owls (Smallwood et al. 2007), white-tailed kites (Erichsen et al. 1996, Smallwood and Nakamoto 2009), and other species. I studied fossorial animals (i.e., animals that burrow into soil, where they live much of their lives), including pocket gophers, ground squirrels, kangaroo rats, voles, harvester ants, and many other functionally similar groups. I studied how fossorial animals interacted with soil caps on hazardous waste (Morrison et al. 1997, Smallwood and Morrison 1999, Smallwood et al. 1998), and I have surveyed for wildlife on hazardous waste sites and on other industrial sites such as gravel mines and landfills (numerous reports are available on request).

SUFFICIENCY OF MND AS AN INFORMATIVE DOCUMENT

Under CEQA, "[A] paramount consideration is the right of the public to be informed in such a way that it can intelligently weigh the environmental consequences of any contemplated action and have an appropriate voice in the formulation of any decision."[1] The public needs information that is thorough, relevant, unbiased, and honest; the public needs full disclosure of the environmental setting and possible cumulative impacts. Documents presenting information from a biased perspective will tend to include omissions, logical fallacies, internal contradictions, and unfounded responses to substantial issues. In my review of the IS/MND, I found these types of problems, indicating that the IS/MND is insufficient in its provision of relevant information to the public.

To begin with, environmental consultants visited the project site on only one day. A single survey on a single day was grossly insufficient for characterizing environmental conditions

[1] Environmental Planning and Information Council vs. County of El Dorado (1982) 131 Cal. App. 3d 350, 354.

relevant to multiple special status species, and it was grossly insufficient for predicting project impacts (Smallwood et al. 2001). Furthermore, the IS/MND did not identify who performed the single day of survey, nor did it provide the public with the means to assess the qualifications of whomever it was who performed the survey. There were no details about the survey, such as how long it lasted, what time of day it was performed, and how the survey was performed. In summary, the MND fails to provide the public with sufficient information to assess the credibility of the biological survey.

Burrowing Owls

On page 39, the IS/MND states, "Burrowing owls occur in suitable habitat throughout California, except in northwestern coastal forests and on high mountains." However, the range of burrowing owls is much more restricted than indicated by this statement. Burrowing owls are scarce to absent in hilly terrain higher than about 500 feet elevation. The range of the burrowing owl has also contracted in recent years, including substantial losses of habitat in the Sacramento region. The MND should honestly reveal that Sacramento is within the geographic range of the burrowing owl, provides habitat for the burrowing owl, and has contributed substantially to the decline of the species as a result of extensive land conversions. The MND should explain that the landfill cover provides one of the very last habitat patches for burrowing owls in the greater Sacramento metropolis.

On page 39, the IS/MND states, "Occupied nests can be identified by the lining of feathers, pellets, debris, and grass." Burrowing owl nests, however, are not always evident by the sign listed in this statement. Sign of nesting is often absent until the owls are committed to nesting at a particular site, which often does not happen by May 27 -- the date of the reconnaissance survey relied upon in the IS/MND. I have documented burrowing owl pairs that were nesting in September, including one pair with two chicks on 28 September 2011. In my experience, the late-nesting burrowing owls would not be detectable in the manner described in the MND on May 27. A single day of reconnaissance survey on the project site is grossly inadequate for detecting burrowing owls on the site.

On page 39, the IS/MND included the statement, "The majority of the nonnative grassland is maintained on an annual basis through soil compaction and vegetation mowing which reduces the likelihood of the presence of burrowing animals." This statement is incorrect. Mowed vegetation is ideal for burrowing owls, and soil compaction provides the burrowing owl with a disturbance regime that it can capitalize on to obtain food. For example, burrowing owls often occupy canal banks, which are routinely graded, compacted, and cleared of vegetation. The public needs accurate information to make informed decisions about the Project's likely impacts.

The next sentence on page 39 reads, "The study area provides potential habitat for burrowing owls where annual disturbance from routine maintenance is limited, such as along the margins of the maintained nonnative grassland in the vicinity of the cottonwood forest and the elderberry savanna." This statement is also incorrect. Burrowing owls do not occur near or within cottonwood forest or elderberry savannah.

On page 39, the IS/MND states, "No ground squirrel burrows, burrowing owls, or their sign were observed during the May 27, 2011 biological survey of the study area." This statement is meaningless, because a single day of a reconnaissance survey over 103 acres and involving multiple objectives is grossly inadequate for detecting burrowing owls. During the past April-May portion of the nesting season, one of my colleagues (Joanne Mount) and I devoted 25 to 30 person-hours per study plot among 46 plots of about 135 acres each in the Altamont Pass Wind Resource Area, California. Our surveys were in intensely grazed annual grassland, which is easier to search for burrowing owls than the vegetation at the proposed project site. In my experience, unless many experienced biologists performed focused burrowing owl surveys on that single day of survey, it was highly unlikely that a single day of reconnaissance on May 27 would have sufficed for detecting all burrowing owls on the project site. The public should be informed of the true likelihood that burrowing owls could have been detected during a single survey on 27 May.

Swainson's Hawks

On pages 39-40, the IS/MND states, "Suitable Swainson's hawk foraging habitat includes alfalfa, fallow fields, beet, tomato, and other low-growing row or field crops, dry-land and irrigated pasture, rice land (when not flooded), and cereal grain crops (including corn after harvest)." This statement over-simplifies foraging patterns of Swainson's hawks, and it omits the most reliable foraging habitat of all, which is annual grassland (Smallwood 1995). Patches of annual grassland are most important for Swainson's hawk foraging because they are reliable seasonally and inter-annually. Agricultural crops, including alfalfa, are less reliable because they are rotated. Even alfalfa is rotated every four or five years in the Sacramento Valley, and alfalfa does not provide many food resources until the third year of the rotation, because it takes time for mammals to build their numbers after alfalfa is planted (Smallwood et al. 2001). A soil cap on a landfill would serve as Swainson's hawk foraging habitat.

On page 40, the IS/MND states, "The study area provides marginal nesting habitat within the cottonwood forest for Swainson's hawk, however, given that the cottonwood forest is comprised of a dense, even-age stand of trees and that the trees are less than 40 feet in height." This conclusion appears to have been based on a preceding statement, "Valley oak, Fremont cottonwood, walnut, and large willow trees, ranging in height from 41 to 82 feet, are the most commonly used nest trees in the Central Valley (County of Sacramento, 2007)." I could not check on the credibility of the source document cited (County of Sacramento 2007), because it was not identified in the list of references cited. This conclusion, however, does not flow logically from its premise. The premise is that most nest trees are taller than 40 feet, whereas the IS/MND erroneously concluded that trees of 40 feet in height are marginal in their suitability as nest trees for Swainson's hawks. I have documented Swainson's hawks nesting in numerous trees shorter than 40 feet (e.g., Photo 1). Trees that are 40 feet in height are not marginal; Swainson's hawks will readily nest in them, so long as adequate foraging habitat can be found nearby.

Photo 1. Trees of 26-foot height that were used by Swainson's hawks for nesting.

On page 40, the IS/MND states, "Several raptors nests were observed during the May 27, 2011 biological survey in the canopies of the cottonwood, California sycamore, and willow trees along the American River to the north of the study area. There was no visible bird activity in the vicinity of the nests at the time of the survey, so it is unclear what species of raptor utilize these nest sites." A single visit to the project site is insufficient to determine whether Swainson's hawks are nesting at the site, especially considering the site visit included multiple objectives. However, that said, the consultant's report included a Swainson's hawk detection on the proposed project site. (AES 2011:24.) Why was there no mention of this siting in the discussion of the nests that were observed nearby?

The IS/MND contains internal inconsistency. The IS/MND states, "As noted above, because the nonnative grassland on the landfill mound is of low quality given the lack of preferable prey base due to the lack of small rodents and rodent burrows as a result of annual soil compaction within the managed nonnative grassland, Swainson's hawk has a low potential to forage within the study area." This statement implied that rodent burrows are a necessary pre-requisite for a site to be suitable as Swainson's hawk foraging habitat. How then, can the City of Sacramento defend its previous claim that suitable Swainson's hawk habitat includes rice fields, beets, tomatoes,

low-growing row or field crops, and cereal grain crops? Fossorial mammals -- including rodents that construct burrows -- occur in none of these types of fields, yet the IS/MND claims that they serve as suitable foraging habitat for Swainson's hawks. In fact, they do provide suitable foraging habitat for Swainson's hawks during certain phases of cultivation, and because they provide Swainson's hawks with opportunities for capturing crickets, grasshoppers, deer mice, house mice, black rats, brown rats, snakes, and many other types of animal prey that do not burrow into the soil. It was untrue to conclude that the lack of burrows qualifies the landfill as unsuitable Swainson's hawk foraging habitat.

Furthermore, the claim is misleading that burrowing animals are absent from the landfill. As pointed out in the IS/MND, staff members are required once per year to fill all burrows they find on the landfill cap. The IS/MND went on to state that the landfill staff indeed fills the burrows once per year. This means that burrows are present for part of the year, because they had to have been constructed prior to staff finding and filling them. The animals that constructed the burrows were obviously available to be detected and captured by Swainson's hawks prior to staff filling the burrows.

IMPACTS ASSESSMENT

Lacking an adequate description of the environmental setting, as discussed earlier, it was unlikely that the impacts assessment would be adequate. The list of species likely to occur on the site was determined by a single day's visit to the site and reliance on the California Natural Diversity Database (CNDDB). CNDDB records, however, are voluntarily reported and many are not derived from scientific sampling, which means that lack of CNDDB records does not equal species absence. To help get this message across, the California Department of Fish and Game ("CDFG") posts a disclaimer on its CNDDB web site: "*We work very hard to keep the CNDDB and the Spotted Owl Database as current and up-to-date as possible given our capabilities and resources. However, we cannot and do not portray the CNDDB as an exhaustive and comprehensive inventory of all rare species and natural communities statewide. Field verification for the presence or absence of sensitive species will always be an important obligation of our customers.*" Similarly, the California Native Plant Society's ("CNPS")

Inventory of Rare and Endangered Species states the following: "***A reminder:*** *Species not recorded for a given area may nonetheless be present, especially where favorable conditions occur.*" I concur with the CNDDB and CNPS caveats warning that lack of CNDDB records does not mean the associated species are absent from a site. The City of Sacramento inappropriately used CNDDB records, which were no substitute for protocol-level field surveys.

Rather than relying on CNDDB records to determine the likelihood of presence of special-status species, the MND should have relied on whether the project site can serve as habitat of the species, and then it should have assessed how much habitat would be lost due to the proposed project. The amount of habitat to be taken should have then been interpreted in terms of the impacts on specific demographic units of each species. (Smallwood 2001.) Furthermore, the impacts on specific demographic units needed to be assessed due to the project's contribution to habitat fragmentation and cumulative impacts, which was not done. For example, it has been established that as foraging habitat is replaced by urban and industrial uses, nest sites within the interior of city environments will be abandoned because the distances between nest sites and foraging habitat grows too far. (England et al. 1995). The environmental review for the proposed project should examine how many Swainson's hawk nest sites in the region are likely to be lost due to the loss of foraging habitat at the project site.

MITIGATION

The proposed mitigation measures are inadequate partly because the impacts assessment is incomplete and inaccurate. The list of species affected is incomplete, and the numbers of burrowing owls and Swainson's hawks likely to be adversely affected remains unknown. Also, the habitat replacement ratios are lower than the ratios recommended by the California Department of Fish and Game.

The IS/MND promises a mere 0.5:1 habitat replacement ratio for the taking of Swainson's hawk foraging habitat, amounting to 48.5 acres. (Mitigation BIO 3.) This ratio falls short of the ratio expected by the California Department of Fish and Game (1994), which was a 1:1 replacement ratio. The IS/MND presents its 0.5:1 ratio as though it is the City of Sacramento's gift to

Swainson's hawks, because the consultants had recommended only a 0.25:1 replacement ratio. (AES 2011.) The ratio promised in the IS/MND, however, is inadequate by not meeting the CDFG standard, and because Swainson's hawk nesting has been recorded nearby and Swainson's hawks observed foraging on site. (AES 2011.)

The IS/MND also promises that the replacement habitat for Swainson's hawk shall be acquired in fee title or conservation easement within five miles of the project site. The MND, however, identify no candidate sites that would provide alfalfa or low-growing row crops adjacent to active Swainson's hawk nest sites. Given the urban and commercial nature of the region surrounding the project site, the City of Sacramento should identify candidate sites with willing sellers of easements or fee title. This step is necessary to avoid the situation that arose with the certification of the Natomas Basin Habitat Conservation Plan, after which it was found willing sellers were too few within the Natomas Basin to achieve the mitigation that had been promised. (Smallwood 2000.)

For burrowing owls, the IS/MND promises passive relocation if burrows are found on site. Passively relocated burrowing owls, however, will likely have no place to go within a long distance of the project site. Excluding burrowing owls from this site would likely qualify as a significant cumulative impact, which could not be mitigated by the proposed measure.

The mitigation measure described for migratory birds and birds of prey was a minimization measure, only. The City of Sacramento fails to propose any type of compensatory mitigation for the impacts to these species. I recommend that a more thorough impacts assessment be performed for these groups of birds, and that the impacts by suitably mitigated.

MITIGATION MONITORING

The IS/MND fails to include any description of a mitigation monitoring plan.

SUMMARY

The MND contains an inadequate description of the environmental setting, an inadequate impacts assessment, and an insufficient mitigation plan. All of these important aspects of environmental review must be improved. Given the Project's size and duration, the biological species affected, and the Project's likely cumulative impacts , an Environmental Impact Report (EIR) is warranted.

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From:	Tom Buford
To:	Evan Compton
Subject:	FW: McKinley Village
Date:	Wednesday, April 16, 2014 10:20:37 AM

Please include Ms. Lamare's email in comments received for the staff report.

From: Judith Lamare [mailto:judelam@sbcglobal.net]
Sent: Tuesday, April 15, 2014 1:28 PM
To: Tom Buford
Subject: McKinley Village

Dear Tom

Thanks for the discussion of mitigation re Swainson's Hawk for McKinley Village. As I mentioned we do consider the wildlife corridor issue a real one. This is a narrow band of open space in the middle of the urban area and really important to preserve and to enhance the wildlife values in the corridor - not somewhere else in the County.

You mentioned that you received our letter on the FEIR just before the Planning Commission hearing (or after) but we were given just about a week to review the FEIR and provide comment to PC (as shown below in email exchange with Dana Allen re process for this project).

The main thing we were looking for in terms of performance standards that you did not provide was CDFW approval of location and easement language, and independent third party conservation organization monitoring and enforcement endowment. An annual report hardly matters if there is no responsibility anywhere to monitor and enforce the mitigation requirement. The language was provided in our comment letter on the DEIR. No response on that. It is standard practice in Elk Grove and County of Sacramento.

Begin forwarded message:

From: Dana Allen <DAllen@cityofsacramento.org>
Subject: FW: McKinley Village
Date: March 17, 2014 1:50:58 PM PDT
To: Jude Lamare <judelam@sbcglobal.net>
Cc: Evan Compton <ECompton@cityofsacramento.org>

Hello Jude,

Evan asked if I would respond regarding your question on the Final EIR. The PDC hearing is a review and recommendation action, so they are not taking action on certifying the EIR. Their recommendation will be to Council. Council will be requested to hear the project and take action on the EIR on April 29. Technically, we are required to send the Response to Comments (FEIR) to the

State Agencies that commented on the document 10 days prior to the hearing on the project and environmental document. However, we are posting the FEIR on our webpage on March 21 for the public. I will be sending out a notification email on that date with instructions on how to access the FEIR.

Thank you for your question.

Dana L. Allen, Associate Planner
Environmental Planning Services
Community Development Department
City of Sacramento
300 Richards Blvd., 3rd Floor
Sacramento, CA 95811
Phone: (916) 808-2762

Sent from my PC

From: Judith Lamare [mailto:swainsonshawk@sbcglobal.net]
Sent: Monday, March 17, 2014 1:37 PM
To: Evan Compton
Subject: McKinley Village

Dear Mr Compton

I have heard from friends that you advised them

This email is to notify you that the McKinley Village project has been scheduled for a final Planning and Design Commission hearing on **Thursday, March 27, 2014**. The hearing will be held at New City Hall, 915 I Street and will begin at 5:30 pm. The project will also require a City Council hearing which will be noticed at a later date. Please see the public notice attached for more information.

The Final EIR is still not available to the public, nor I assume to the Commissioners. What is the City's policy about availability of FEIR prior to Planning Commission hearing?

Jude Lamare

Judith Lamare, President
Friends of the Swainson's Hawk
717 K Street, Ste 529

Sacramento, CA 95814
916 447 4956
www.swainsonshawk.org
swainsonshawk@sbcglobal.net

Appendix E

California Department of Fish and Game Mitigation Guidelines for Swainson's Hawk

State of California

Memorandum

To : Div. Chiefs - IFD, BDD, NHD, WMD
Reg. Mgrs. - Regions 1, 2, 3, 4

Date : November 8, 1994

From : Department of Fish and Game

Subject: Staff Report Regarding Mitigation for Impacts to Swainson's Hawks (*Buteo swainsoni*) in the Central Valley of California

I am hereby transmitting the Staff Report Regarding Mitigation for Impacts to Swainson's Hawks in the Central Valley of California for your use in reviewing projects (California Environmental Quality Act [CEQA] and others) and in developing 2081 Management Authorizations and 2090 Biological Opinions which may affect Swainson's hawk habitat in the Central Valley. The staff report has been developed during the last 18 months by the Environmental Services Division (ESD) in cooperation with the Wildlife Management Division (WMD) and Regions 1, 2, and 4. It has been sent out for public review on several occasions and redrafted as appropriate.

Either the mitigation measures in the staff report may be used or project specific measures may be developed. Alternative project specific mitigation measures proposed by the Department Divisions/Regions or by project sponsors will also be considered. However, such mitigation measures must be submitted to ESD for review. The review process will focus on the consistency of the proposed measure with Department, Fish and Game Commission, and legislative policy and with laws regarding raptors and listed species. ESD will coordinate project specific mitigation measure review with WMD.

If you have any questions regarding the report, please contact Mr. Ron Rempel, Program Supervisor, Habitat Conservation Planning and Endangered Species Permitting, Environmental Services Division at (916) 654-9980.

COPY Original signed by
A. Petrovich, Jr.
For
Boyd Gibbons
Direction

Enclosure

cc: Mr. Ron Rempel
Department of Fish and Game
Sacramento

file; d, exfile, esd, chron
Vouchilas/seh/pdl SRPBUTEO.DS1

Staff Report regarding Mitigation for Impacts to Swainson's Hawks (*Buteo swainsoni*) in the Central Valley of California

INTRODUCTION

The Legislature and the Fish and Game Commission have developed the policies, standards and regulatory mandates which, if implemented, are intended to help stabilize and reverse dramatic population declines of threatened and endangered species. In order to determine how the Department of Fish and Game (Department) could judge the adequacy of mitigation measures designed to offset impacts to Swainson's hawks in the Central Valley, Staff (WMD, ESD and Regions) has prepared this report. To ensure compliance with legislative and Commission policy, mitigation requirements which are consistent with this report should be incorporated into: (1) Department comments to Lead Agencies and project sponsors pursuant to the California Environmental Quality Act (CEQA); (2) Fish and Game Code Section 2081 Management Authorizations (Management Authorizations); and (3) Fish and Game Code Section 2090 Consultations with State CEQA Lead Agencies.

The report is designed to provide the Department (including regional offices and divisions), CEQA Lead Agencies and project proponents the context in which the Environmental Services Division (ESD) will review proposed project specific mitigation measures. This report also includes "model" mitigation measures which have been judged to be consistent with policies, standards and legal mandates of the Legislature and Fish and Game Commission. Alternative mitigation measures, tailored to specific projects, may be developed if consistent with this report. Implementation of mitigation measures consistent with this report are intended to help achieve the conservation goals for the Swainson's hawk and should complement multi-species habitat conservation planning efforts currently underway.

The Department is preparing a recovery plan for the species and it is anticipated that this report will be revised to incorporate recovery plan goals. It is anticipated that the recovery plan will be completed by the end of 1995. The Swainson's hawk recovery plan will establish criteria for species recovery through preservation of existing habitat, population expansion into former habitat, recruitment of young into the population, and other specific recovery efforts.

During project review the Department should consider whether a proposed project will adversely affect suitable foraging habitat within a ten (10) mile radius of an active (used during one or more of the last 5 years) Swainson's hawk nest(s). Suitable Swainson's hawk foraging habitat will be those habitats and crops identified in Bechard (1983), Bloom (1980), and Estep (1989). The following vegetation types/agricultural crops are considered small mammal and insect foraging habitat

for Swainson's hawks:

- alfalfa
- fallow fields
- beet, tomato, and other low-growing row or field crops
- dry-land and irrigated pasture
- rice land (when not flooded)
- cereal grain crops (including corn after harvest)

The ten mile radius standard is the flight distance between active (and successful) nest sites and suitable foraging habitats, as documented in telemetry studies (Estep 1989, Babcock 1993). Based on the ten mile radius, new development projects which adversely modify nesting and/or foraging habitat should mitigate the project's impacts to the species. The ten mile foraging radius recognizes a need to strike a balance between the biological needs of reproducing pairs (including eggs and nestlings) and the economic benefit of development(s) consistent with Fish and Game Code Section 2053.

Since over 95% of Swainson's hawk nests occur on private land, the Department's mitigation program should include incentives that preserve agricultural lands used for the production of crops, which are compatible with Swainson's hawk foraging needs, while providing an opportunity for urban development and other changes in land use adjacent to existing urban areas.

LEGAL STATUS

Federal

The Swainson's hawk is a migratory bird species protected under the Migratory Bird Treaty Act (MBTA) of 1918 (16 U.S.C. 703-711). The MBTA makes it unlawful to take, possess, buy, sell, purchase, or barter any migratory bird listed in Section 50 of the Code of Federal Regulations (C.F.R.) Part 10, including feathers or other parts, nests, eggs or products, except as allowed by implementing regulations (50 C.F.R. 21).

State

The Swainson's hawk has been listed as a threatened species by the California Fish and Game Commission pursuant to the California Endangered Species Act (CESA), see Title 14, California Code of Regulations, Section 670.5(b)(5)(A).

LEGISLATIVE AND COMMISSION POLICIES, LEGAL MANDATES AND STANDARDS

The FGC policy for threatened species is, in part, to: "Protect and preserve all native species...and their habitats...." This policy also directs the Department to work with all interested persons to protect and preserve sensitive resources and their habitats. Consistent with this policy and direction, the Department is enjoined to implement measures that assure protection for the Swainson's hawk.

The California State Legislature, when enacting the provisions of CESA, made the following findings and declarations in Fish and Game Code Section 2051:

a) "Certain species of fish, wildlife, and plants have been rendered extinct as a consequence of man's activities, untempered by adequate concern and conservation";

b) "Other species of fish, wildlife, and plants are in danger of, or threatened with, extinction because their habitats are threatened with destruction, adverse modification, or severe curtailment because of overexploitation, disease, predation, or other factors (emphasis added)";and

c) "These species of fish, wildlife, and plants are of ecological, educational, historical, recreational, esthetic, economic, and scientific value to the people of this state, and the conservation, protection, and enhancement of these species and their habitat is of statewide concern" (emphasis added).

The Legislature also proclaimed that it "is the policy of the state to conserve, protect, restore, and enhance any endangered or threatened species and its habitat and that it is the intent of the Legislature, consistent with conserving the species, to acquire lands for habitat for these species" (emphasis added).

Section 2053 of the Fish and Game Code states, in part, "it is the policy of the state that state agencies should not approve projects as proposed which would jeopardize the continued existence of any endangered or threatened species or result in the destruction or adverse modification of habitat essential to the continued existence of those species, if there are reasonable and prudent alternatives available consistent with conserving the species and or its habitat which would prevent jeopardy" (emphasis added).

Section 2054 states "The Legislature further finds and declares that, in the event specific economic, social, and or other conditions make infeasible such alternatives, individual projects may be approved if appropriate mitigation and enhancement measures are provided" (emphasis added).

Loss or alteration of foraging habitat or nest site disturbance which results in:

(1) nest abandonment; (2) loss of young; (3) reduced health and vigor of eggs and/or nestlings (resulting in reduced survival rates), may ultimately result in the take (killing) of nestling or fledgling Swainson's hawks incidental to otherwise lawful activities. The taking of Swainson's hawks in this manner can be a violation of Section 2080 of the Fish and Game Code. This interpretation of take has been judicially affirmed by the landmark appellate court decision pertaining to CESA (DFG v. ACID, 8 CA App.4, 41554). The essence of the decision emphasized that the intent and purpose of CESA applies to all activities that take or kill endangered or threatened species, even when the taking is incidental to otherwise legal activities. To avoid potential violations of Fish and Game Code Section 2080, the Department recommends and encourages project sponsors to obtain 2081 Management Authorizations for their projects.

Although this report has been prepared to assist the Department in working with the development community, the prohibition against take (Fish and Game Code Section 2080) applies to all persons, including those engaged in agricultural activities and routine maintenance of facilities. In addition, sections 3503, 3503.5, and 3800 of the Fish and Game Code prohibit the take, possession, or destruction of birds, their nests or eggs.

To avoid potential violation of Fish and Game Code Section 2080 (i.e. killing of a listed species), project-related disturbance at active Swainson's hawk nesting sites should be reduced or eliminated during critical phases of the nesting cycle (March 1 - September 15 annually). Delineation of specific activities which could cause nest abandonment (take) of Swainson's hawk during the nesting period should be done on a case-by-case basis.

CEQA requires a mandatory findings of significance if a project's impacts to threatened or endangered species are likely to occur (Sections 21001 {c}, 21083, Guidelines Sections 15380, 15064, 15065). Impacts must be avoided or mitigated to less than significant levels unless the CEQA Lead Agency makes and supports findings of Overriding Consideration. The CEQA Lead Agency's Findings of Overriding Consideration does not eliminate the project sponsor's obligation to comply with Fish and Game Code Section 2080.

NATURAL HISTORY

The Swainson's hawk (*Buteo swainsoni*) is a large, broad winged buteo which frequents open country. They are about the same size as a red-tailed hawk (*Buteo jamaicensis*), but trimmer, weighing approximately 800-1100 grams (1.75 - 2 lbs). They have about a 125 cm. (4+foot) wingspan. The basic body plumage may be highly variable and is characterized by several color morphs - light, dark, and rufous. In dark phase birds, the entire body of the bird may be sooty black. Adult birds generally have dark backs. The ventral or underneath sections may be light with a characteristic dark, wide "bib" from the lower throat down to the upper

breast, light colored wing linings and pointed wing tips. The tail is gray ventrally with a subterminal dusky band, and narrow, less conspicuous barring proximally. The sexes are similar in appearance; females however, are slightly larger and heavier than males, as is the case in most sexually dimorphic raptors. There are no recognized subspecies (Palmer 1988).

The Swainson's hawk is a long distance migrator. The nesting grounds occur in northwestern Canada, the western U.S., and Mexico and most populations migrate to wintering grounds in the open pampas and agricultural areas of South America (Argentina, Uruguay, southern Brazil). The species is included among the group of birds known as "neotropical migrants". Some individuals or small groups (20-30 birds) may winter in the U.S., including California (Delta Islands). This round trip journey may exceed 14,000 miles. The birds return to the nesting grounds and establish nesting territories in early March.

Swainson's hawks are monogamous and remain so until the loss of a mate (Palmer 1988). Nest construction and courtship continues through April. The clutch (commonly 3-4 eggs) is generally laid in early April to early May, but may occur later. Incubation lasts 34-35 days, with both parents participating in the brooding of eggs and young. The young fledge (leave the nest) approximately 42-44 days after hatching and remain with their parents until they depart in the fall. Large groups (up to 100+ birds) may congregate in holding areas in the fall and may exhibit a delayed migration depending upon forage availability. The specific purpose of these congregation areas is as yet unknown, but is likely related to: increasing energy reserves for migration; the timing of migration; aggregation into larger migratory groups (including assisting the young in learning migration routes); and providing a pairing and courtship opportunity for unattached adults.

Foraging Requirements

Swainson's hawk nests in the Central Valley of California are generally found in scattered trees or along riparian systems adjacent to agricultural fields or pastures. These open fields and pastures are the primary foraging areas. Major prey items for Central Valley birds include: California voles (*Microtus californicus*), valley pocket gophers (*Thomomys bottae*), deer mice (*Peromyscus maniculatus*), California ground squirrels (*Spermophilus beecheyi*), mourning doves (*Zenaida macroura*), ring-necked pheasants (*Phasianus colchicus*), meadowlarks (*Sturnella neglecta*), other passerines, grasshoppers (*Conocephalinae* sp.), crickets (*Gryllidae* sp.), and beetles (Estep 1989). Swainson's hawks generally search for prey by soaring in open country and agricultural fields similar to northern hariers (*Circus cyaneus*) and ferruginous hawks (*Buteo regalis*). Often several hawks may be seen foraging together following tractors or other farm equipment capturing prey escaping from farming operations. During the breeding season, Swainson's hawks eat mainly vertebrates (small rodents and reptiles), whereas during migration vast numbers of insects are consumed (Palmer 1988).

Department funded research has documented the importance of suitable foraging habitats (e.g., annual grasslands, pasture lands, alfalfa and other hay crops, and combinations of hay, grain and row crops) within an energetically efficient flight distance from active Swainson's hawk nests (Estep pers. comm.). Recent telemetry studies to determine foraging requirements have shown that birds may use in excess of 15,000 acres of habitat or range up to 18.0 miles from the nest in search of prey (Estep 1989, Babcock 1993). The prey base (availability and abundance) for the species is highly variable from year to year, with major prey population (small mammals and insects) fluctuations occurring based on rainfall patterns, natural cycles and agricultural cropping and harvesting patterns. Based on these variables, significant acreages of potential foraging habitat (primarily agricultural lands) should be preserved per nesting pair (or aggregation of nesting pairs) to avoid jeopardizing existing populations. Preserved foraging areas should be adequate to allow additional Swainson's hawk nesting pairs to successfully breed and use the foraging habitat during good prey production years.

Suitable foraging habitat is necessary to provide an adequate energy source for breeding adults, including support of nestlings and fledglings. Adults must achieve an energy balance between the needs of themselves and the demands of nestlings and fledglings, or the health and survival of both may be jeopardized. If prey resources are not sufficient, or if adults must hunt long distances from the nest site, the energetics of the foraging effort may result in reduced nestling vigor with an increased likelihood of disease and/or starvation. In more extreme cases; the breeding pair, in an effort to assure their own existence, may even abandon the nest and young (Woodbridge 1985).

Prey abundance and availability is determined by land and farming patterns including crop types, agricultural practices and harvesting regimes. Estep (1989) found that 73.4% of observed prey captures were in fields being harvested, disced, mowed, or irrigated. Preferred foraging habitats for Swainson's hawks include:

- alfalfa;
- fallow fields;
- beet, tomato, and other low-growing row or field crops;
- dry-land and irrigated pasture;
- rice land (during the non-flooded period); and
- cereal grain crops (including corn after harvest).

Unsuitable foraging habitat types include crops where prey species (even if present) are not available due to vegetation characteristics (e.g. vineyards, mature orchards, and cotton fields, dense vegetation).

Nesting Requirements

Although the Swainson's hawk's current nesting habitat is fragmented and unevenly distributed, Swainson's hawks nest throughout most of the Central Valley floor. More than 85% of the known nests in the Central Valley are within riparian systems in Sacramento, Sutter, Yolo, and San Joaquin counties. Much of the potential nesting habitat remaining in this area is in riparian forests, although isolated and roadside trees are also used. Nest sites are generally adjacent to or within easy flying distance to alfalfa or hay fields or other habitats or agricultural crops which provide an abundant and available prey source. Department research has shown that valley oaks (*Quercus lobata*), Fremont's cottonwood (*Populus fremontii*), willows (*Salix* spp.), sycamores (*Platanus* spp.), and walnuts (*Juglans* spp.) are the preferred nest trees for Swainson's hawks (Bloom 1980, Schlorff and Bloom 1983, Estep 1989).

Fall and Winter Migration Habitats

During their annual fall and winter migration periods, Swainson's hawks may congregate in large groups (up to 100+ birds). Some of these sites may be used during delayed migration periods lasting up to three months. Such sites have been identified in Yolo, Tulare, Kern and San Joaquin counties and protection is needed for these critical foraging areas which support birds during their long migration.

Historical and Current Population Status

The Swainson's hawk was historically regarded as one of the most common and numerous raptor species in the state, so much so that they were often not given special mention in field notes. The breeding population has declined by an estimated 91% in California since the turn of the century (Bloom 1980). The historical Swainson's hawk population estimates are based on current densities and extrapolated based on the historical amount of available habitat. The historical population estimate is 4,284-17,136 pairs (Bloom 1980). In 1979, approximately 375 ($\pm$ 50) breeding pairs of Swainson's hawks were estimated in California, and 280 (75%) of those pairs were estimated to be in the Central Valley (Bloom 1980). In 1988, 241 active breeding pairs were found in the Central Valley, with an additional 78 active pairs known in northeastern California. The 1989 population estimate was 430 pairs for the Central Valley and 550 pairs statewide (Estep, 1989). This difference in population estimates is probably a result of increased survey effort rather than an actual population increase.

Reasons for decline

The dramatic Swainson's hawk population decline has been attributed to loss of

native nesting and foraging habitat, and more recently to the loss of suitable nesting trees and the conversion of agricultural lands. Agricultural lands have been converted to urban land uses and incompatible crops. In addition, pesticides, shooting, disturbance at the nest site, and impacts on wintering areas may have contributed to their decline. Although losses on the wintering areas in South America may occur, they are not considered significant since breeding populations outside of California are stable. The loss of nesting habitat within riparian areas has been accelerated by flood control practices and bank stabilization programs. Smith (1977) estimated that in 1850 over 770,000 acres of riparian habitat were present in the Sacramento Valley. By the mid-1980s, Warner and Hendrix (1984) estimated that there was only 120,000 acres of riparian habitat remaining in the Central Valley (Sacramento and San Joaquin Valleys combined). Based on Warner and Hendrix's estimates approximately 93% of the San Joaquin Valley and 73% of the Sacramento Valley riparian habitat has been eliminated since 1850.

MANAGEMENT STRATEGIES

Management and mitigation strategies for the Central Valley population of the Swainson's hawk should ensure that:

- suitable nesting habitat continues to be available (this can be accomplished by protecting existing nesting habitat from destruction or disturbance and by increasing the number of suitable nest trees); and

- foraging habitat is available during the period of the year when Swainson's hawks are present in the Central Valley (this should be accomplished by maintaining or creating adequate and suitable foraging habitat in areas of existing and potential nest sites and along migratory routes within the state).

A key to the ultimate success in meeting the Legislature's goal of maintaining habitat sufficient to preserve this species is the implementation of these management strategies in cooperation with project sponsors and local, state and federal agencies.

DEPARTMENT'S ROLES AND RESPONSIBILITIES IN PROJECT CONSULTATION AND ADMINISTRATION OF CEQA AND THE FISH AND GAME CODE

The Department, through its administration of the Fish and Game Code and its trust responsibilities, should continue its efforts to minimize further habitat destruction and should seek mitigation to offset unavoidable losses by (1) including the mitigation measures in this document in CEQA comment letters and/or as

management conditions in Department issued Management Authorizations or (2) by developing project specific mitigation measures (consistent with the Commission's and the Legislature's mandates) and including them in CEQA comment letters and/or as management conditions in Fish and Game Code Section 2081 Management Authorizations issued by the Department and/or in Fish and Game Code Section 2090 Biological Opinions.

The Department should submit comments to CEQA Lead Agencies on all projects which adversely affect Swainson's hawks. CEQA requires a mandatory findings of significance if a project's impacts to threatened or endangered species are likely to occur (Sections 21001 {c}, 21083. Guidelines 15380, 15064, 15065). Impacts must be: (1) avoided; or (2) appropriate mitigation must be provided to reduce impacts to less than significant levels; or (3) the lead agency must make and support findings of overriding consideration. If the CEQA Lead Agency makes a Finding of Overriding Consideration, it does not eliminate the project sponsor's obligation to comply with the take prohibitions of Fish and Game Code Section 2080. Activities which result in (1) nest abandonment; (2) starvation of young; and/or (3) reduced health and vigor of eggs and nestlings may result in the take (killing) of Swainson's hawks incidental to otherwise lawful activities (urban development, recreational activities, agricultural practices, levee maintenance and similar activities. The taking of Swainson's hawk in this manner may be a violation of Section 2080 of the Fish and Game Code. To avoid potential violations of Fish and Game Code Section 2080, the Department should recommend and encourage project sponsors to obtain 2081 Management Authorizations.

In aggregate, the mitigation measures incorporated into CEQA comment letters and/or 2081 Management Authorizations for a project should be consistent with Section 2053 and 2054 of the Fish and Game Code. Section 2053 states, in part, "it is the policy of the state that state agencies should not approve projects as proposed which would jeopardize the continued existence of any endangered or threatened species or result in the destruction or adverse modification of habitat essential to the continued existence of those species, if there are reasonable and prudent alternatives available consistent with conserving the species and or its habitat which would prevent jeopardy" . Section 2054 states: "The Legislature further finds and declares that, in the event specific economic, social, and or other conditions make infeasible such alternatives, individual projects may be approved if appropriate mitigation and enhancement measures are provided."

State lead agencies are required to consult with the Department pursuant to Fish and Game Code Section 2090 to ensure that any action authorized, funded, or carried out by that state agency will not jeopardize the continued existence of any threatened or endangered species. Comment letters to State Lead Agencies should also include a reminder that the State Lead Agency has the responsibility to consult with the Department pursuant to Fish and Game Code Section 2090 and obtain a written findings (Biological Opinion). Mitigation measures included in Biological Opinions issued to State Lead Agencies must be consistent with Fish and Game

Code Sections 2051-2054 and 2091-2092.

NEST SITE AND HABITAT LOCATION INFORMATION SOURCES

The Department's Natural Diversity Data Base (NDDB) is a continually updated, computerized inventory of location information on the State's rarest plants, animals, and natural communities. Department personnel should encourage project proponents and CEQA Lead Agencies, either directly or through CEQA comment letters, to purchase NDDB products for information on the locations of Swainson's hawk nesting areas as well as other sensitive species. The Department's Nongame Bird and Mammal Program also maintains information on Swainson's hawk nesting areas and may be contacted for additional information on the species.

Project applicants and CEQA Lead Agencies may also need to conduct site specific surveys (conducted by qualified biologists at the appropriate time of the year using approved protocols) to determine the status (location of nest sites, foraging areas, etc.) of listed species as part of the CEQA and 2081 Management Authorization process. Since these studies may require multiple years to complete, the Department shall identify any needed studies at the earliest possible time in the project review process. To facilitate project review and reduce the potential for costly project delays, the Department should make it a standard practice to advise developers or others planning projects that may impact one or more Swainson's hawk nesting or foraging areas to initiate communication with the Department as early as possible .

MANAGEMENT CONDITIONS

Staff believes the following mitigation measures (nos. 1-4) are adequate to meet the Commission's and Legislature's policy regarding listed species and are considered as preapproved for incorporation into any Management Authorizations for the Swainson's hawk issued by the Department. The incorporation of measures 1-4 into a CEQA document should reduce a project's impact to a Swainson's hawk(s) to less than significant levels. Since these measures are Staff recommendations, a project sponsor or CEQA Lead agency may choose to negotiate project specific mitigation measures which differ. In such cases, the negotiated Management Conditions must be consistent with Commission and Legislative policy and be submitted to the ESD for review and approval prior to reaching agreement with the project sponsor or CEQA Lead Agency.

Staff recommended Management Conditions are:

1. No intensive new disturbances (e.g. heavy equipment operation associated with construction, use of cranes or draglines, new rock crushing

activities) or other project related activities which may cause nest abandonment or forced fledging, should be initiated within 1/4 mile (buffer zone) of an active nest between March 1 - September 15 or until August 15 if a Management Authorization or Biological Opinion is obtained for the project. The buffer zone should be increased to 1/2 mile in nesting areas away from urban development (i.e. in areas where disturbance [e.g. heavy equipment operation associated with construction, use of cranes or draglines, new rock crushing activities] is not a normal occurrence during the nesting season). Nest trees should not be removed unless there is no feasible way of avoiding it. If a nest tree must be removed, a Management Authorization (including conditions to off-set the loss of the nest tree) must be obtained with the tree removal period specified in the Management Authorization, generally between October 1- February 1. If construction or other project related activities which may cause nest abandonment or forced fledging are necessary within the buffer zone, monitoring of the nest site (funded by the project sponsor) by a qualified biologist (to determine if the nest is abandoned) should be required . If it is abandoned and if the nestlings are still alive, the project sponsor shall fund the recovery and hacking (controlled release of captive reared young) of the nestling(s). Routine disturbances such as agricultural activities, commuter traffic, and routine facility maintenance activities within 1/4 mile of an active nest should not be prohibited.

2. Hacking as a substitute for avoidance of impacts during the nesting period may be used in unusual circumstances after review and approval of a hacking plan by ESD and WMD. Proponents who propose using hacking will be required to fund the full costs of the effort, including any telemetry work specified by the Department.

3. To mitigate for the loss of foraging habitat (as specified in this document), the Management Authorization holder/project sponsor shall provide Habitat Management (HM) lands to the Department based on the following ratios:

(a) Projects within 1 mile of an active nest tree shall provide:

- one acre of HM land (at least 10% of the HM land requirements shall be met by fee title acquisition or a conservation easement allowing for the active management of the habitat, with the remaining 90% of the HM lands protected by a conservation easement [acceptable to the Department] on agricultural lands or other suitable habitats which provide foraging habitat for Swainson's hawk) for each acre of development authorized (1:1 ratio); or

- one-half acre of HM land (all of the HM land requirements shall be met by fee title acquisition or a conservation easement

[acceptable to the Department] which allows for the active management of the habitat for prey production on the HM lands) for each acre of development authorized (0.5:1 ratio).

(b) Projects within 5 miles of an active nest tree but greater than 1 mile from the nest tree shall provide 0.75 acres of HM land for each acre of urban development authorized (0.75:1 ratio). All HM lands protected under this requirement may be protected through fee title acquisition or conservation easement (acceptable to the Department) on agricultural lands or other suitable habitats which provide foraging habitat for Swainson's hawk.

(c) Projects within 10 miles of an active nest tree but greater than 5 miles from an active nest tree shall provide 0.5 acres of HM land for each acre of urban development authorized (0.5:1 ratio). All HM lands protected under this requirement may be protected through fee title acquisition or a conservation easement (acceptable to the Department) on agricultural lands or other suitable habitats which provide foraging habitat for Swainson's hawk.

4. Management Authorization holders/project sponsors shall provide for the long-term management of the HM lands by funding a management endowment (the interest on which shall be used for managing the HM lands) at the rate of $400 per HM land acre (adjusted annually for inflation and varying interest rates).

Some project sponsors may desire to provide funds to the Department for HM land protection. This option is acceptable to the extent the proposal is consistent with Department policy regarding acceptance of funds for land acquisition. All HM lands should be located in areas which are consistent with a multi-species habitat conservation focus. Management Authorization holders/project sponsors who are willing to establish a significant mitigation bank (> 900 acres) should be given special consideration such as 1.1 acres of mitigation credit for each acre preserved.

PROJECT SPECIFIC MITIGATION MEASURES

Although this report includes recommended Management Measures, the Department should encourage project proponents to propose alternative mitigation strategies that provide equal or greater protection of the species and which also expedite project environmental review or issuance of a CESA Management Authorization. The Department and sponsor may choose to conduct cooperative, multi-year field studies to assess the site's habitat value and determine its use by nesting and foraging Swainson's hawk. Study plans should include clearly defined criteria for judging the project's impacts on Swainson's hawks and the methodologies (days of monitoring, foraging effort/efficiency, etc.) that will be used.

The study plans should be submitted to the Wildlife Management Division and ESD for review. Mitigation measures developed as a result of the study must be reviewed by ESD (for consistency with the policies of the Legislature and Fish and Game Commission) and approved by the Director.

EXCEPTIONS

Cities, counties and project sponsors should be encouraged to focus development on open lands within already urbanized areas. Since small disjunct parcels of habitat seldom provide foraging habitat needed to sustain the reproductive effort of a Swainson's hawk pair, Staff does not recommend requiring mitigation pursuant to CEQA nor a Management Authorization by the Department for infill (within an already urbanized area) projects in areas which have less than 5 acres of foraging habitat and are surrounded by existing urban development, unless the project area is within 1/4 mile of an active nest tree.

REVIEW

Staff should revise this report at least annually to determine if the proposed mitigation strategies should be retained, modified or if additional mitigation strategies should be included as a result of new scientific information.

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