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Air Resources Board

Mary D. Nichols, Chairman

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Methodology for Estimating Premature Deaths Associated with Long-term Exposures to Fine Airborne Particulate Matter in California

DRAFT
Staff Report

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California Environmental Protection Agency

Air Resources Board

California Environmental Protection Agency

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DRAFT **Staff Report**

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Acronyms and Abbreviations

ACS	American Cancer Society
AHSMOG	The Adventist Health Study of Smog
ARB	California Air Resources Board
Board	California Air Resources Board
BS	Black Smoke or British Smoke
CARB	California Air Resources Board
CHS	Children's Health Study
C-R Function	Concentration-Response Function
CRPAQS	California Regional PM ₁₀ /PM _{2.5} Air Quality Study
DPM	Diesel Particulate Matter
EI	Emission Inventory
EPA	United States Environmental Protection Agency
IMPROVE	Interagency Monitoring for Protected Visual Environments
NO	Nitric Oxide
NO ₂	Nitrogen Dioxide
NO _x	Nitrogen Oxides
OEHHA	Office of Environmental Health Hazard Assessment
PM	Particulate Matter
PM _{2.5}	Fine Particulate Matter; Particulate Matter 2.5 Micrometers in Diameter and Smaller
PM ₁₀	Particulate Matter 10 Micrometers in Diameter and Smaller
SA	Source Apportionment
SO _x	Sulfur Oxides
UFP	Ultrafine Particle
U.S. EPA	United States Environmental Protection Agency
VA	Veterans Administration

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Executive Summary

The California Air Resources Board (CARB) quantifies health impacts of exposure to particulate matter (PM) as part of the development of control measures for PM, including those for ports and goods movement. The methodology that CARB staff uses for quantifying premature death and other health impacts from PM exposure is based on a peer-reviewed methodology developed by the U.S. Environmental Protection Agency (EPA) for their risk assessments. This methodology is regularly updated by CARB staff as new epidemiological studies and other related studies are published that are relevant to California's health impacts analysis. This report discusses the results of staff's review of the recent scientific literature related to the mortality effects of exposure to fine PM (PM_{2.5}) and presents recommendations for revisions to the current methodology.

In this report, the relative risk of premature death due to PM_{2.5} exposure was reevaluated based on all relevant scientific literature, and a new relative risk factor was developed. This new relative risk factor is a 10% increase in premature death per 10 $\mu\text{g}/\text{m}^3$ increase in PM_{2.5} exposures (uncertainty interval: 3% to 20%). Using this new factor, staff estimates diesel PM contributes to 3,900 (uncertainty interval 1,200 to 7,100) premature deaths, statewide on an annual basis. Staff also used a systematic approach for assessing the lowest level of PM_{2.5} that can be associated with premature death. Although the recent literature is consistent with a no-threshold model, no empirical evidence has been reported to date for an effect of exposure below 7 $\mu\text{g}/\text{m}^3$ in a general population. Staff therefore recommends that the cut-off be presented as a range of results. Using this approach, exposures to ambient PM_{2.5} can be associated with about 14,000 to 24,000 premature deaths statewide annually, with uncertainty ranging from 4,300 to 41,000 deaths.

The methodologies and results presented in this report have been endorsed by our scientific advisors, Dr. Jonathan Levy of Harvard University, Dr. Bart Ostro of the Office of Environmental Health Hazard Assessment, and Dr. Arden Pope of Brigham Young University. This report underwent an external peer review by experts selected through a process involving the University of California at Berkeley, Institute of the Environment. The results of the peer review process have been incorporated into this report.

I. Introduction and Background

In 2002, when CARB established a new ambient air quality standard for PM_{2.5} in collaboration with the Office of Environmental Health Hazard Assessment, we estimated the human health impacts of public exposures to PM levels above various levels, including the new standard (CARB 2002). The quantification of premature death from PM exposure used by CARB staff in previous analyses is based on a peer-reviewed methodology developed by the U.S. Environmental Protection Agency for their risk assessments (U.S. EPA 2004, 2005). The quantified death estimates play an important role in CARB's cost-benefits analysis of plans and regulations as they make up for the majority of the health valuation. For example, as part of the development of emission reduction plans and control measures for PM, CARB quantifies the health impacts of reducing population exposure to ambient PM that would result through the implementation of the proposed measures (CARB 2003a, 2003b, 2003c, 2004a, 2004b, 2004c).

In all of the recent analyses, including that for goods movement (CARB 2006), CARB has relied on the results from the American Cancer Society (ACS) study (Pope et al. 1995, 2002) to estimate the premature deaths. In U.S. EPA's regulatory impact analyses of recent years, including those on the Clean Air Interstate Rule in 2005, U.S. EPA continued to base the concentration-response function relating PM exposure to premature death on the published results of Pope et al. (2002). A concentration-response function relates changes in exposures to ambient concentrations of a pollutant to changes in an adverse health effect. However, several new epidemiological studies and other related studies have been published which may be relevant to California's health impacts analysis. These recent studies prompted CARB to consider updating the PM_{2.5} mortality relationship. For example, Jerrett et al. (2005) analyzed the data in the Los Angeles region, and Laden et al. (2006) performed an extended follow-up to the Harvard Six Cities study. In addition, intervention studies (Clancy et al. 2002) examining the effect of significant decreases in air pollution exposures show that the PM-mortality relationship can be larger than predicted by daily time-series studies (Samet et al. 2000). Also, clinical and toxicological studies (Chen et al. 2005) have emerged that suggest mechanisms by which PM exposure may contribute to the cardiovascular disease process, thus adding to the plausibility of the positive association between PM exposure and disease found in the long-term cohort studies.

Additional information comes from the U.S. EPA, which has elicited the opinions of twelve experts on the PM_{2.5}-mortality relationship. Their opinions have been included in the latest regulatory impact analysis for the new national PM ambient air quality standard to characterize the uncertainty and range in the relationship¹, although Pope et al. (2002) results are still used in the primary analysis along with Laden et al. (2006).

At the April 20, 2006 Board meeting, staff presented the results of the goods movement

¹ <http://www.epa.gov/ttn/ecas/regdata/RIAs/Chapter%205--Benefits.pdf>

health impacts analysis (CARB 2006). Staff also informed the Board of plans to revise and improve the health impacts methodology by updating the health information that relates changes in PM_{2.5} exposures to premature death. This report is a product of this effort to update the methodology. In it, we summarize the health literature on the subject, interpret U.S. EPA's expert elicitation results, and explain how we apply these results to estimate the mortality impacts associated with Californians' exposures to ambient PM levels.

II. Methodology

The methodology presented in this report have been endorsed by our scientific advisors, Dr. Jonathan Levy of Harvard University, Dr. Bart Ostro of the Office of Environmental Health Hazard Assessment, and Dr. Arden Pope of Brigham Young University.

A. Summary of health studies on long-term PM exposures and premature death

The following is adapted with the authors' permission from the 2006 Critical Review in the Journal of Air and Waste Management Association by C. Arden Pope III and Douglas Dockery (Pope and Dockery 2006).

Daily time-series studies of acute exposures suggest short-term acute PM effects, but they provide little information about the degree of life shortening, pollution effects on longer-term premature death rates, or the role of pollution in inducing or accelerating the progress of chronic disease. As early as 1970, several analyses of pollution and premature death data reported that long-term average concentrations of PM_{2.5} or sulfate are associated with annual mortality rates across U.S. metropolitan areas. These population-based cross-sectional mortality rate studies were largely discounted by 1997 because of concern that they could not control for individual risk factors, such as cigarette smoking and body weight, which could potentially confound the air pollution effects. With regard to the premature death effects of long-term PM exposure, recent emphasis has been on prospective cohort studies that can control for individual differences in age, sex, smoking history, and other risk factors. However, since these studies require collecting information on large numbers of people and following them prospectively for long periods of time, conducting such studies can be costly, time consuming, and, therefore, much less common. A brief summary of results from these studies is presented in Table 1.

Below is a summary of the main long-term cohort studies published in the literature.

A.1 Original Harvard Six Cities and ACS Studies

In the mid-1990s, two cohort-based mortality studies had reported evidence of mortality effects of chronic exposure to fine particulate air pollution. The first study, often referred to as the Harvard Six Cities Study, reported on a 14- to 16-year prospective follow-up of

8,000 adults living in six U.S. cities (Dockery et al. 1993), representing a wide range of pollution exposure. The second study, referred to as the ACS (American Cancer Society) study, linked individual risk factor data from the ACS, Cancer Prevention Study II with national ambient air pollution data (Pope et al. 1995). The analysis included data from more than 500,000 adults who lived in 151 metropolitan areas and were followed prospectively from 1982 through 1989. About 50 metropolitan areas had PM and sulfate monitoring data. Both the Harvard Six Cities and the ACS cohort studies used Cox proportional hazard regression modeling to analyze survival times and to control for individual differences in age, sex, cigarette smoking, education levels, body mass index, and other individual risk factors. In both studies, cardiopulmonary mortality was significantly and most strongly associated with sulfate and PM2.5 concentrations.

Table 1: Summary of key studies and relative risks on long-term exposures to PM and premature death (Pope and Dockery 2006)

Study	Primary Source	Exposure Increment	Percent Increases in Relative Risk of Mortality (95% CI)		
			All Cause	Cardiopulmonary	Lung Cancer
Harvard Six Cities, original	Dockery et al. 1993	10 µg/m ³ PM2.5	13 (4.2, 23)	18 (6.0, 32)	18 (-11, 57)
Harvard Six Cities, HEI reanalysis	Krewski et al. 2000	10 µg/m ³ PM2.5	14 (5.4, 23)	19 (6.5, 33)	21 (-8.4, 60)
Harvard Six Cities, extended analysis	Laden et al. 2006	10 µg/m ³ PM2.5	16 (7, 26)	28 (13, 44) ^a	27 (-4, 69)
Harvard Six Cities, extended analysis between periods	Laden et al. 2006	10 µg/m ³ PM2.5	27 (5, 43)	31 (-1, 54)	6 (-57, 162)
ACS, original	Pope et al. 1995	10 µg/m ³ PM2.5	6.6 (3.5, 9.8)	12 (6.7, 17)	1.2 (-8.7, 12)
ACS, HEI reanalysis	Krewski et al. 2000	10 µg/m ³ PM2.5	7.0 (3.9, 10)	12 (7.4, 17)	0.8 (-8.7, 11)
ACS, extended analysis	Pope et al. 2002 Pope et al. 2004	10 µg/m ³ PM2.5	6.2 (1.6, 11)	9.3 (3.3, 16) 12 (8, 15) ^a	13.5 (4.4, 23)
ACS adjusted using various education weighting schemes	Dockery et al. 1993 Pope et al. 2002 Krewski et al. 2000	10 µg/m ³ PM2.5	8–11	12–14	3–24
ACS intrametro Los Angeles	Jerrett et al. 2005	10 µg/m ³ PM2.5	17 (5, 30)	12 (-3, 30)	44 (-2, 211)
Postneonatal infant mortality, U.S.	Woodruff et al. 1997	20 µg/m ³ PM10	8.0 (4, 14)	–	–
Postneonatal infant mortality, CA	Woodruff et al. 2006	10 µg/m ³ PM2.5	7.0 (-7, 24)	113 (12, 305) ^c	–
AHSMOG ^b	Abbey et al. 1999	20 µg/m ³ PM10	2.1 (-4.5, 9.2)	0.6 (-7.8, 10)	81 (14, 186)
AHSMOG, males only	McDonnell et al. 2000	10 µg/m ³ PM2.5	8.5 (-2.3, 21)	23 (-3, 55)	39 (-21, 150)
AHSMOG, females only	Chen et al. 2005	10 µg/m ³ PM2.5	–	42 (6, 90) ^a	–
Women's Health Initiative	Miller et al. 2004	10 µg/m ³ PM2.5	–	32 (1, 73) ^a	–
Women's Health Initiative	Miller et al. 2007	10 µg/m ³ PM2.5	–	76 (25, 147) ^a	–
VA, preliminary	Lipfert et al. 2000, 2003	10 µg/m ³ PM2.5	0.3 (NS) ^d	–	–
VA, extended	Lipfert et al. 2006	10 µg/m ³ PM2.5	15 (5, 26) ^e	–	–
11 CA counties, elderly	Enstrom 2005	10 µg/m ³ PM2.5	1 (-0.6, 2.6)	–	–
Netherlands	Hoek et al. 2002	10 µg/m ³ BS	17 (-24, 78)	34 (-32, 164)	–
Netherlands	Hoek et al. 2002	Near major road	41 (-6, 112)	95 (9, 251)	–
Netherlands	Beelen et al. 2008	10 µg/m ³ BS	–	22 (-1, 50) ^c	3 (-12, 20)
Netherlands	Beelen et al. 2008	10 µg/m ³ PM2.5	–	4 (-10, 21) ^c	6 (-18, 38)
Hamilton, Ontario, Canada	Finkelstein et al. 2004	Near major road	18 (2, 38)	–	–
French PAARC	Filleul et al. 2005	10 µg/m ³ BS	7 (3, 10) ^f	5 (-2, 12) ^f	3 (-8, 15) ^f
Cystic fibrosis	Goss et al. 2004	10 µg/m ³ PM2.5	32 (-9, 93)	–	–

^aCardiovascular only; ^bPooled estimates for males and females; pollution associations were observed primarily in males and not females; ^cRespiratory only; ^dReported to be nonsignificant by author; overall, effect estimates to various measure of particulate air pollution were highly unstable and not robust to selection of model and time windows; ^eEstimates from the single pollutant model and for 1989–1996 follow-up; effect estimates are much smaller and statistically insignificant in an analysis restricted to counties with nitrogen dioxide data and for the 1997–2001 follow-up; furthermore, county-level traffic density is a strong predictor of survival and stronger than PM2.5 when included with PM2.5 in joint regressions; ^fEstimates when six monitors that were heavily influenced by local traffic sources were excluded; when data from all 24 monitors in all areas were used, no statistically significant associations between mortality and pollution were observed.

Although both the Harvard Six Cities and ACS studies used similar study designs and methods, these two studies had different strengths and limitations. The strengths of the Harvard Six Cities Study were its elegant and relatively balanced study design, the prospective collection of study-specific air pollution data, and the ability to present the core results in a straightforward graphical format. On the other hand, the primary limitations of the Harvard Six Cities Study were the small number of subjects from a small number of study areas (that is, exposures) in the Eastern United States. In contrast, the major strength of the ACS study was the large number of participants and cities distributed across the entire United States. The primary limitation of the ACS was the lack of planned, prospective collection of study-specific air pollution and health data, and the reliance on limited, separately collected subject and pollution data. Nonetheless, the ACS study provided a test of the hypotheses generated from the Harvard Six Cities Study in an independently collected dataset. Therefore, these two studies were considered complementary.

A.2 Reanalyses and Extended Analyses of Harvard Six Cities and ACS Studies

In the mid-1990s, the Harvard Six Cities and the ACS prospective cohort studies provided compelling evidence of mortality effects from long-term fine particulate air pollution (Dockery et al. 1993, Pope et al. 1995). Nevertheless, these two studies were controversial. Subsequently, the data quality, accessibility, analytic methods, and validity of these studies came under intense scrutiny when the U.S. EPA considered them in the effort to revise the PM ambient air quality standards. There were serious constraints and concerns regarding the dissemination of confidential information and the intellectual property rights of the original investigators and their supporting institutions. In 1997, the investigators of the two studies agreed to provide the data for an intensive reanalysis by an independent research team under Health Effects Institute (HEI) oversight, management, sponsorship, and under conditions that assured the confidentiality of the information on individual study participants. The reanalysis included: (1) a quality assurance audit of the data, (2) a replication and validation of the originally reported results, and (3) sensitivity analyses to evaluate the robustness of the original findings. The reanalysis (Krewski et al. 2000, 2004) reported that the data were “generally of high quality” and that the results originally reported could be reproduced and validated. The data audit and validation efforts revealed some data and analytic issues that required some tuning. However, the adjusted results did not differ substantively from the original findings. The reanalysis demonstrated the robustness of the PM-mortality risk estimates to many alternative model specifications. Further, the reanalysis team also made a number of innovative methodological contributions that not only demonstrated the robustness of the PM-mortality results but substantially contributed to subsequent analyses. In the reanalysis, persons with higher educational attainment were found to have lower relative risks of premature death associated with PM_{2.5} in both studies.

Further extended analyses of the ACS cohort (Pope et al. 2002, 2004) included more than twice the follow-up time (more than 16 years) and approximately triple the number of deaths. The mortality associations with fine particulate and sulfur oxide pollution

persisted and were robust to control for individual risk factors including age, sex, race, smoking, education, marital status, body mass index, alcohol use, occupational exposures, and diet and the incorporation of both random effects and nonparametric spatial smoothing components. There was no evidence that the PM-mortality associations were due to regional or other spatial differences that were not controlled in the analysis. These analyses also evaluated associations with expanded pollution data, including gaseous co-pollutant data and new PM_{2.5} data. Elevated premature death risks were most strongly associated with measures of PM_{2.5} and sulfur oxide pollution. Coarse particles and gaseous pollutants, except for sulfur dioxide (SO₂), were generally not significantly associated with elevated premature death risk.

Jerrett et al. (2005a) assessed air pollution associations of the 23,000 subjects in the ACS cohort who lived in the metropolitan Los Angeles area. PM-mortality associations were estimated based on PM_{2.5} measures from 23 monitoring sites interpolated to 267 residential zip code centroids for 2000, and health data analyzed for the period between 1982 and 2000. Cox proportional hazards regression models controlled for age, sex, race, smoking, education, marital status, diet, alcohol use, occupational exposures, and body mass. In addition, because variations in exposure to air pollution within a city may correlate with socioeconomic gradients that influence health and susceptibility to environmental exposures, zip code-level ecological variables were used to control for potential “contextual neighborhood confounding” (Jerrett et al. 2003, 2005b). The premature death associations with the intra-metropolitan PM_{2.5} concentrations were generally larger than those observed previously in the ACS cohort across metropolitan areas. However, the associated confidence intervals were also wider than those previously reported in the ACS national cohort studies. Nonetheless, such results corroborate the Harvard Six Cities results (Dockery et al. 1993), making the possibility of a greater effect than observed in the full ACS cohort more plausible.

A recent analysis of the Harvard Six Cities cohort by Laden et al. (2006) extended the mortality follow-up for eight more years with approximately twice the number of deaths. PM_{2.5} concentrations for the extended follow-up years were estimated from PM₁₀ and visibility measures. PM_{2.5}-mortality associations, similar to those found in the original analysis, were observed for all-cause, cardiovascular, and lung cancer mortality. However, PM_{2.5} concentrations were substantially lower for the extended follow-up period than they were for the original analysis, especially for two of the most polluted cities. Reductions in PM_{2.5} concentrations were associated with reduced premature death risk and were largest in the cities with the largest declines in PM_{2.5} concentrations. The authors note that, “these findings suggest that mortality effects of long-term air pollution may be at least partially reversible over periods of a decade.” Further, it is noteworthy that the authors observed a substantial decrease in premature death risk corresponding to the decrease in PM_{2.5} concentrations between the two periods.

A.3 Other Independent Studies

The Adventist Health Study of Smog (AHSMOG)

The Adventist Health Study of Smog (AHSMOG) cohort study related air pollution to 1977–1992 mortality in more than 6000 non-smoking adults living in California, predominantly from San Diego, Los Angeles, and San Francisco (Abbey et al. 1999). All-cause mortality, nonmalignant respiratory mortality, and lung cancer mortality were significantly associated with ambient PM10 concentrations in males but not in females. Cardiopulmonary disease mortality was not significantly associated with PM10 in either males or females. This study did not have direct measures of PM2.5 but relied on TSP and PM10 data. In a follow-up analysis (McDonnell et al. 2000), visibility data were used to estimate PM2.5 exposures of a subset of males who lived near an airport. All-cause, lung cancer, and nonmalignant respiratory disease (either as the underlying or a contributing cause) were more strongly associated with PM2.5 than with PM10. In a recent analysis of the AHSMOG cohort, fatal coronary heart disease was significantly associated with PM among females but not among males (Chen et al. 2005).

Women's Health Initiative

The association between long-term PM2.5 exposure and first cardiovascular events (fatal and nonfatal) were explored in the Women's Health Initiative Observational Study (Miller et al. 2004, Miller et al. 2007). Based on measurements from the nearest monitor, air pollution exposures were estimated for about 66,000 post-menopausal women without prior cardiovascular disease in 36 metropolitan areas from 1994 to 1998. After adjusting for age, smoking, and various other risk factors, PM2.5 exposures were found to be significantly associated with increases in nonfatal cardiovascular and fatal cardiovascular events, including premature death from cardiovascular disease. The risk of death from exposure to PM2.5 was greater than nonfatal cardiovascular events. The hazard ratio estimated from this study was also larger than mortality estimates from other studies. The authors suggest that the larger hazard ratio may be due to efforts to reduce misclassification of outcomes and exposures. It may also be possible that the effects of PM2.5 may be greater in women than men. Because this study investigated the association between long-term PM2.5 exposure and first cardiovascular events, it is unlikely that the effects are limited only to women who are already ill.

Veterans Administration (VA)

Lipfert et al. (2000, 2003) assessed the association of total mortality and air pollution in a prospective cohort of about 50,000 middle-aged, hypertensive, male patients from 32 Veterans Administration (VA) clinics followed for about 21 years. The cohort had a disproportionately large number of current or former smokers (81%) and African-Americans (35%) relative to the U.S. population or to other cohorts that have been used to study air pollution. Air pollution exposures were estimated by averaging air pollution data for participants' county of residence at the time of entrance into the cohort. Only analyses of total mortality were reported. In addition to considering mortality and average exposures over the entire follow-up period, three sequential mortality periods and four exposure periods were defined and included in various analyses. Lipfert et al. (2006a) extended the follow-up of the VA cohort and focused on traffic density as the measure of environmental exposure. It was suggested that traffic density was a more "significant and robust predictor of survival in this cohort" than PM2.5. However, of the

various measures of ambient air pollution, PM_{2.5} was most strongly correlated with traffic density ($r = 0.50$). In single pollutant models, PM_{2.5} was associated with mortality risk resulting in risk estimates comparable to other cohorts. These results were also confirmed in another analysis by Lipfert et al. (2006b) examining PM_{2.5} constituents and related air quality variables as predictors of survival. Overall, in the VA analyses, effect estimates to various measures of PM were unstable and not robust to model selection, time windows used, or various other analytic decisions. It was difficult, based on the preliminary results presented, to make conclusive statistical inferences regarding PM-mortality associations.

Eleven California Counties

Enstrom (2005) reported an analysis of about 36,000 elderly males and females in 11 California counties followed between 1973 and 2002. Countywide PM_{2.5} concentrations were estimated from outdoor ambient monitoring for the time period 1979–1983. For approximately the first half of the follow-up period (1973–1983) and for the time period approximately concurrent with PM_{2.5} monitoring, a small PM_{2.5}-mortality association was observed. No PM_{2.5}-mortality risk associations were observed for the later follow-up (1983–2002). For the entire follow-up period, only a small statistically insignificant association was observed. When 1979-93 pollution and mortality data were examined, a statistically significant association was observed.

Netherlands Pilot Study

In a pilot study, Hoek et al. (2002) evaluated the associations between premature death and PM based on a random sample of 5000 participants in the Netherlands Cohort Study on Diet and Cancer, originally 55 to 69 years of age and followed for more than 8 years. Although the effect estimates were not very precise, the adjusted risk of cardiopulmonary mortality was nearly double for individuals who lived within 100 meters of a freeway or within 50 meters of a major urban road. Based on residential location of participants and interpolation of pollution data from the Netherlands' national air pollution monitoring network, average background concentrations of black smoke ([BS] or British smoke measured by optical densities or light absorbance of filters used to gather PM from the air) for the first 4 years of follow-up were estimated. Background plus local traffic-related black smoke exposures were estimated by adding to the background concentration a quantitative estimate of living near a major road. Cardiopulmonary mortality was associated with estimates of exposure to black smoke, and the association was nearly doubled when local traffic-related sources of black smoke in addition to background concentrations were modeled.

A more recent study on the same Cohort, Beelen et al. (2008), reinforces the conclusions of the pilot study. The authors found a positive association between traffic intensity on the nearest roadway to the subject's residence and death rate. They also confirmed the link between interpolated BS concentrations and cardiopulmonary mortality. While the associations between pollutants and mortality in this study were not statistically significant, the authors' methodology was very careful, and their results lend convincing support to the link between premature death and PM.

Hamilton, Ontario, Canada

In an exploration of the relationship between proximity to traffic air pollution and premature death observed in the Netherlands study, an analysis using a cohort of 5,228 persons greater than 40 years of age living in Hamilton, Ontario, Canada, was conducted (Finkelstein et al. 2004). Somewhat higher mortality risks were observed for individuals who lived within 100 meters of a highway or within 50 meters of a major road.

Air Pollution and Chronic Respiratory Diseases (PAARC) Survey in France

Filleul et al. (2005) reported an analysis of about 14,000 adults who resided in 24 areas from seven French cities as part of the Air Pollution and Chronic Respiratory Diseases (PAARC) survey. Participants were enrolled in 1974, and a 25-year mortality follow-up was conducted. Ambient air pollution monitoring for total suspended particulates, black smoke, nitrogen dioxide, and nitric oxide was conducted for three years in each of the 24 study areas. When survival analysis was conducted using data from all 24 monitors in all of the areas, no statistically significant associations between mortality and pollution were observed. However, when the six monitors that were heavily influenced by local traffic sources were excluded, non-accidental mortality was significantly associated with all four measures of pollution, including black smoke. In addition to PM, mortality was associated with nitric oxide. Nitric oxide concentrations were also significantly associated with mortality risk in a cohort of Norwegian men (Nafstad et al. 2004), but no measure of PM was available.

Cystic Fibrosis Foundation

A unique study of the effects of ambient air pollution was conducted utilizing a cohort of 20,000 patients more than 6 years old who were enrolled in the U.S.-based Cystic Fibrosis Foundation National Patient Registry in 1999 and 2000 (Goss et al. 2004). Annual average air pollution exposures were estimated by linking fixed-site ambient monitoring data with resident zip code. A positive, but not statistically significant, association between PM_{2.5} and premature death was observed. PM_{2.5} was associated with statistically significant declines in lung function (FEV₁) and an increase in the odds of two or more pulmonary exacerbations.

Postneonatal Infants

Woodruff et al. (1997) reported the results of an analysis of postneonatal infant mortality (deaths after one month of age and before one year of age determined from the U.S. National Center for Health Statistics birth and death records) for about 4 million infants in 86 U.S. metropolitan areas between 1989 and 1991 linked with U.S. EPA-collected PM₁₀ data. Postneonatal infant mortality was compared with levels of PM₁₀ concentrations during the 2 months after birth, controlling for maternal race, maternal education, marital status, month of birth, maternal smoking during pregnancy, and ambient temperatures. Postneonatal infant mortality for all causes, respiratory causes

and sudden infant death syndrome (SIDS) were associated with particulate air pollution. Woodruff et al. (2006) also linked monitored PM_{2.5} to infants who were born in California in 1999 and 2000 and who lived within 5 miles of a monitor, matching 788 postneonatal deaths to 3,089 survivors. Each 10 µg/m³ increase in PM_{2.5} was associated with a near doubling of the risk of postneonatal death because of respiratory causes and a statistically insignificant increase for death from all causes.

A.4 Summary

Cohort studies generally apply proportional hazards models controlling for many individual-level risk factors (such as body mass index, smoking, alcohol use, occupational exposures, age/race, etc. and ecologic factors) before air pollution is considered. Many of the above studies also correct for spatial autocorrelation to avoid misinterpretation of results.

Nonetheless, evaluating which studies to consider in assessing the public health impacts of air pollution is a difficult task. As recommended by both the National Research Council (2002) and the Science Advisory Board (U.S. EPA 2004), the U.S. EPA elicited experts for their assessment of the literature and opinion on the most appropriate concentration-response function relating premature death to long-term exposures to PM_{2.5}. This process asked experts to review all available studies to derive the plausible range of values that describe the PM_{2.5}-mortality relationship. These studies included not only the cohort studies described above but also intervention studies which show stronger effects compared to time-series or cohort studies. Also included were toxicological and clinical studies which suggest the mechanisms by which PM exposures can contribute to the cardiovascular disease process, thus adding to the plausibility of the positive association between exposures and disease found in the long-term cohort studies.

B. U.S. EPA elicitation process

In this section, we adapt a report by U.S. EPA's contractor, Industrial Economics (2006) to describe the U.S. EPA's expert elicitation. Similar information has been published in Environmental Science and Technology (Roman et al. 2008).

In its 2002 report to Congress titled *Estimating the Public Health Benefits of Proposed Air Pollution Regulations*, the National Research Council (2002) recommended that a better characterization of the uncertainty be performed for regulatory impact analyses, including estimating premature death associated with exposures to PM_{2.5} levels.² As a result, U.S. EPA convened a panel of twelve experts to assess the reduction in premature death in the adult U.S. population resulting from a long-term reduction in annual average PM_{2.5}. Our proposed methodology makes use of results from the panel's report. In their assessment, the experts considered all published literature on

² <http://www.nap.edu/catalog/10511.html>

the subject.³

B.1 Selection of experts

The twelve experts participating in the study were selected through a two-part peer nomination process and included experts in epidemiology, toxicology, and medicine. The peer nomination process was designed to obtain a balanced set of views and serves to minimize the influence of Industrial Economics and U.S. EPA on expert selection.

The first phase of the expert selection process was designed to select nine experts. The initial decision to include nine experts was based on several factors, including: 1) a literature search that found most of the elicitation studies conducted to date (60 percent) use panels of six to eight experts, and 90 percent use panels of 11 or fewer experts (Walker, 2004); 2) it was deemed that nine experts would provide a balanced set of views on this topic; 3) the pilot study conducted in 2004 was criticized for the small panel size of five experts (IE 2004); 4) government agencies are required to undergo an Information Collection Request process for the Paperwork Reduction Act if information is collected from more than nine individuals; and 5) resource and time requirements increase with each additional expert.

While this process featured a good acceptance rate and yielded nine experts, the panel exhibited less diversity in expertise than originally anticipated in design, with most experts being epidemiologists. In an effort to increase representation of the biological, medical, and toxicological disciplines, a second phase of selections was conducted. U.S. EPA sought additional nominations of experts in these fields based on nominations provided by the Health Effects Institute (HEI). The general criteria for nominations were the same as for the first part of the selection process (Holmstead 2005).

The following twelve individuals made up the panel of experts:

- Doug Dockery, Ph.D., Professor of Environmental Epidemiology
Department of Environmental Health, Harvard School of Public Health
- Kaz Ito, Ph.D., Assistant Professor of Environmental Medicine
New York University of Medicine
- Daniel Krewski, Ph.D., Director
R. Samuel McLaughlin Centre for Population Health Risk Assessment
University of Ottawa
- Nino Kuenzli, M.D., Ph.D., Associate Professor
Department of Preventive Medicine
University of Southern California Keck School of Medicine
- Morton Lippmann, Ph.D., Professor and Director of Aerosol Research
Laboratory, New York University School of Medicine
- Joe Mauderly, DVM, Vice President and Senior Scientist
Lovelace Respiratory Research Institute

³ <http://www.epa.gov/ttn/ecas/benefits.html>

- Bart Ostro, Ph.D., Chief
Air Pollution Epidemiology Unit,
California Environmental Protection Agency Office of Environmental Health
Hazard Assessment
- C. Arden Pope, III, Ph.D., Professor of Economics
Brigham Young University
- Richard Schlesinger, Ph.D., Biology and Health Sciences
Pace University
- Joel Schwartz, Ph.D., Professor of Environmental Health
Department of Environmental Health, Harvard School of Public Health
- George Thurston, Ph.D., New York University of Medicine,
- Mark Utell, M.D., Professor of Medicine and Environmental Medicine
University of Rochester School of Medicine and Dentistry

B.2 Elicitation process

A “briefing book” binder was sent to all experts at least two weeks in advance of their interview (IE 2006). The purpose of the briefing book was to provide experts with a baseline set of materials to assist them in preparing for their elicitation interview; however, experts were free to consider other materials not included in the briefing book. The briefing book contained the following materials: the elicitation interview protocol; a CD containing over 150 relevant papers and compendia, searchable both alphabetically and by topic area; a set of background information pages with recent U.S. data on air quality, health status, population demographics, and other topics that may factor into the experts’ probabilistic judgments; and background materials, including a document describing factors to consider when providing probability judgments in order to avoid potential sources of bias, and an excerpt from the National Research Council (2002) report on estimating public health benefits of proposed air rules.

The pre-elicitation workshop was designed to introduce the project, provide background information to the panel on expert judgment and the elicitation process, and to foster discussion about the key evidence available to answer the questions posed by the study. The key evidence includes not only the main studies on long-term exposures to PM and mortality but also short-term time-series studies, toxicological studies, intervention studies, and other studies.

Each elicitation interview lasted approximately eight hours and covered both qualitative and quantitative questions. The qualitative questions probed experts’ beliefs concerning key evidence and critical sources of uncertainty and were intended to make the conceptual basis for their quantitative judgments explicit. These questions covered topics such as potential biological mechanisms linking PM_{2.5} exposures with premature death; key scientific evidence on the magnitude of the PM-mortality relationship; sources of potential error or bias in epidemiological results; the likelihood of a causal relationship between PM_{2.5} and premature death; and the shape of the concentration-response (C-R) function. The main quantitative question asked each expert to provide a probabilistic distribution for the average expected decrease in U.S. annual, adult, all-cause mortality associated with a 1 µg/m³ decrease in annual average PM_{2.5} levels.

In addressing this question, the experts first specified a functional form for the PM2.5 mortality C-R function and then developed an uncertainty distribution for the slope of that function (the mortality impact per unit change in annual average PM2.5), taking into account the evidence and judgments discussed during the qualitative questions.

When answering the main quantitative question, each expert was instructed to consider that the total mortality effect of a $1 \mu\text{g}/\text{m}^3$ decrease in ambient annual average PM2.5 may reflect reductions in both short-term peak and long-term average exposures to PM2.5. Each expert was asked to aggregate the effects of both types of changes in his answers. Each expert was given the option to integrate their judgments about the likelihood of a causal relationship and/or threshold in the C-R function into his distribution or to provide a distribution "conditional on" one or both of these factors. The interviewers asked each expert to characterize his distribution by assigning values to fixed percentiles (5th, 25th, 50th, 75th, 95th). To assist experts in the elicitation process, the interviewers provided real-time feedback during the interviews in the form of graphs and example calculations, using spreadsheet tools and Internet teleconferencing. During the interviews, experts were able to view their responses plotted onto a distribution using a software interface. They then adjusted their estimates until the distribution represented the views they expressed during the day-long interview.

B.3 Results of U.S. EPA's elicitation

Figures 1 and 2 display the responses of the experts to the main quantitative elicitation question. The distributions provided by each expert, identified by the letters A through L, are depicted as box and whisker plots with the solid circle symbol showing the median (50th percentile); the open circle showing the mean; the box defining the interquartile range (bounded by the 25th and 75th percentiles); and the ends of the "whiskers" defining each expert's 5th and 95th percentiles.

Each expert's stated best estimate of the likelihood of a causal relationship between PM2.5 and premature death is shown on the x-axis and the experts are arrayed in order of decreasing certainty of causality. Figure 1 displays the distributions for the experts who chose to provide a distribution conditional on the existence of a causal relationship between PM2.5 and premature death. Figure 2 shows the distributions for the group who chose to integrate their judgments about the likelihood of causality directly into their distribution. Each figure displays the expert distributions for two different PM2.5 levels, $18 \mu\text{g}/\text{m}^3$ and $7 \mu\text{g}/\text{m}^3$, to observe the implications of four experts' (B, F, K, and L) assumptions about nonlinearities in the C-R function and about differing degrees of uncertainty in the slope of the function across specific ranges of PM. Also, as a point of reference for the results, we include box plots of two epidemiologic studies often used in U.S. EPA benefit analyses (Pope et al. 2002, Dockery et al. 1993).

Among the experts who provided distributions that were conditional on the existence of a causal relationship (Figure 1), median estimates ranged from a 0.4 to 2.0 percent decrease in annual, adult, all-cause mortality risk per $1 \mu\text{g}/\text{m}^3$ decrease in annual average PM2.5 exposures. Similarly, among the experts who directly incorporated their

views on the likelihood of a causal relationship into their distributions (Figure 2), the median estimates also ranged from a 0.7 to 1.6 percent decrease in annual, adult, all-cause mortality risk per 1 $\mu\text{g}/\text{m}^3$ decrease in annual-average PM_{2.5} exposures.

Figure 1: Expert uncertainty distributions for PM_{2.5}-mortality coefficient, conditional on the existence of a causal relationship (IE 2006)

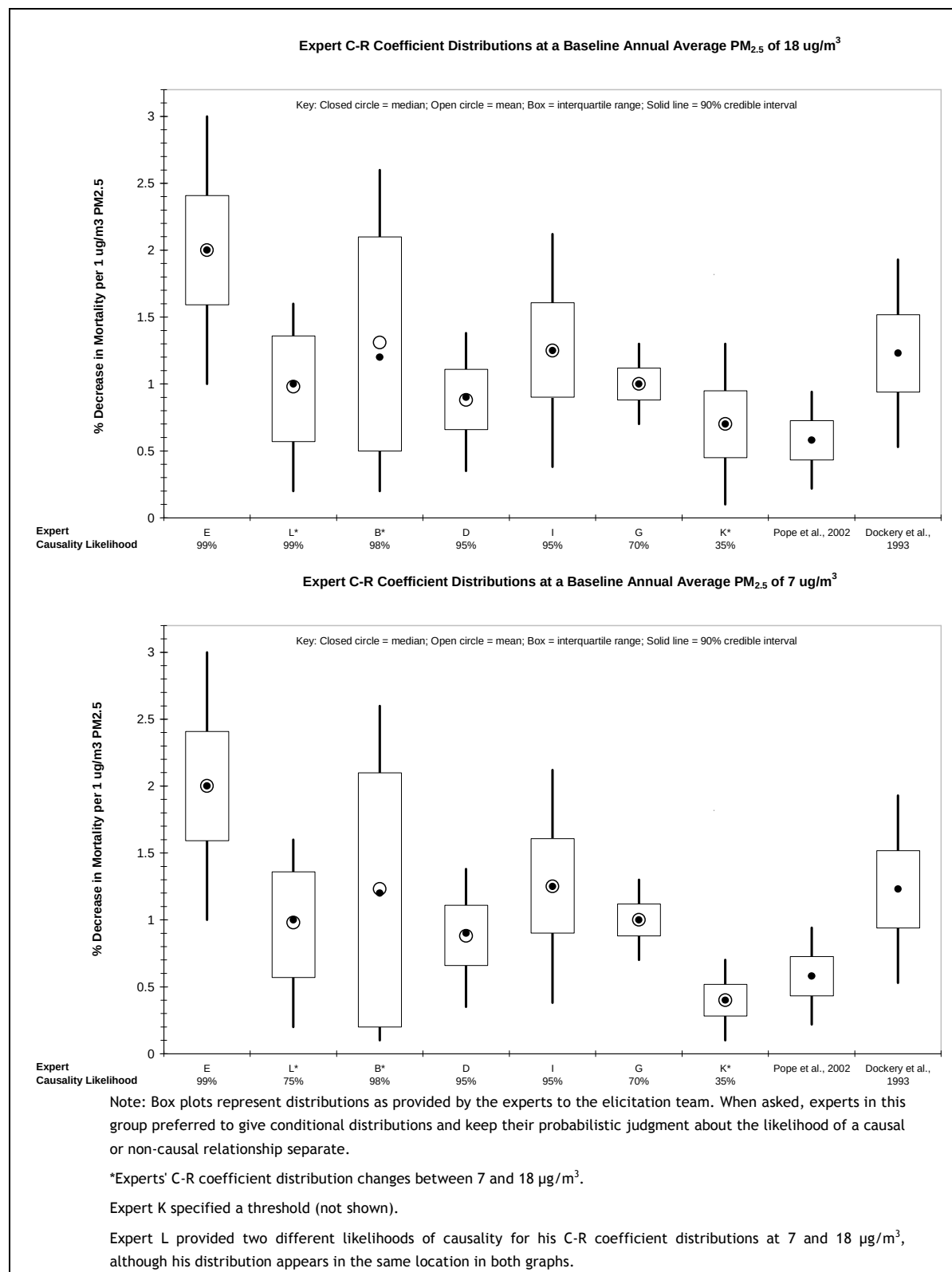
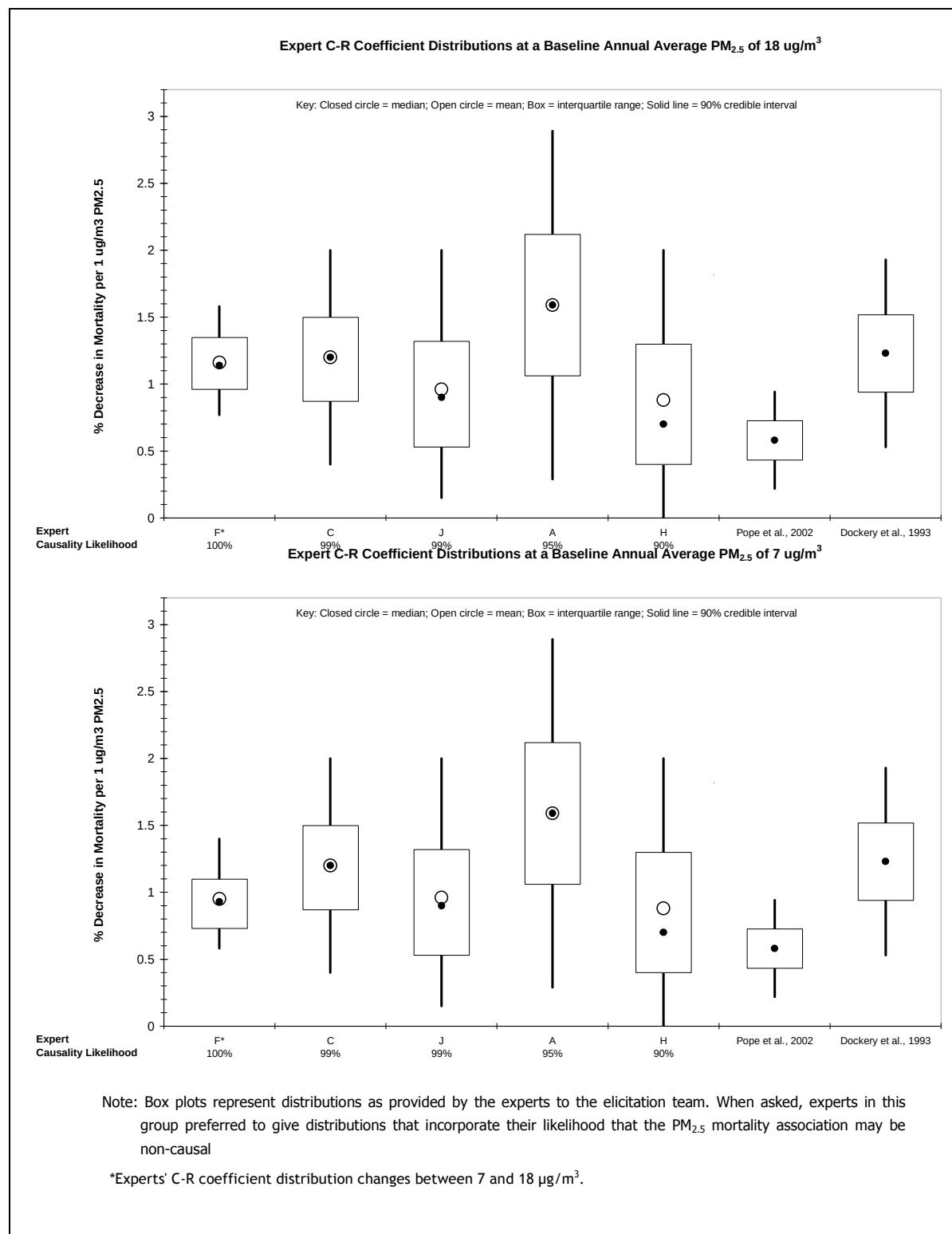


Figure 2: Expert uncertainty distributions for PM_{2.5}-mortality coefficient incorporating the experts' likelihood of a causal relationship (IE 2006)



Certain observations and conclusions can be drawn from these plots and from the experts' responses to the qualitative questions:

- Experts in this study tended to be confident that PM_{2.5} exposure can cause premature death. Ten of twelve experts believed that the likelihood of a causal relationship was 90 percent or higher. The remaining two experts gave causal probabilities of 35 and 70 percent. Recent research in both epidemiology (e.g., Jerrett et al. 2005, Laden et al. 2006) and toxicology (e.g., Sun et al. 2005) significantly contributed to experts' confidence.
- Only one of twelve experts explicitly incorporated a threshold into his C-R function. The rest believed there was a lack of empirical and/or theoretical support for a population threshold. However, three other experts gave differing effect estimate distributions above and below some cut-off concentration. The adjustments these experts made to median estimates and/or uncertainty at lower PM_{2.5} concentrations were modest.
- Experts relied upon a core set of cohort epidemiology studies to derive their quantitative estimates, mainly those associated with the ACS and Six Cities cohorts. The Six Cities results tended to be weighted more highly by experts in this study than in the pilot study. The greater emphasis on Six Cities appeared to result from corroborating evidence in the recent Six Cities follow-up (Laden et al., 2006) and from concerns about potential exposure misclassification issues and/or effect modification in the ACS cohort (see below). Expert K indicated that he was 50 percent sure that a threshold existed. If there were a threshold, he thought that there was an 80 percent chance that it would be less than or equal to 5 µg/m³, and a 20 percent chance that it would fall between 5 and 10 µg/m³. See Table 2a and 2b for a listing of core studies used by the experts.
- Although the quantitative question asked experts to consider mortality changes due both to short-term and long-term PM_{2.5} exposures, all experts based their median effect estimates on effects due to long-term exposures. Short-term exposure effects were sometimes used to derive lower-bound effect estimates.
- Confounding of epidemiological results tended to be a minor concern for most experts. Only one of twelve experts expressed substantial concern about confounding as a source of error in the key literature on PM_{2.5} and premature death.
- Experts' concerns regarding potential negative bias in the ACS main study results due to effect modification (see Pope and Dockery 2006) and/or exposure misclassification (Jerrett et al. 2005; Willis et al. 2003; and Mallick et al. 2002) led many experts to adjust the published results upwards when considering the percentiles of their distribution.
- A sensitivity analysis conducted using a simplified benefits analysis (IE 2006) demonstrated that no individual expert's distribution of effect estimates had more than a plus or minus 8 percent impact on an overall, pooled distribution of effects. The influence of individual experts appeared symmetrically distributed.

Table 2a: Key studies discussed by experts while answering conditioning questions (IE 2006)

	Women's Health Initiative ²	Woodruff et al., 1997	Filluel et al., 2005	Willis et al., 2002	Mallik et al., 2002	MESA Cohort ²	Finkelstein et al., 2004	Canadian Time-Series Studies (Burnett et al., 2000 & 2003)	NMMAAPS (Samet et. al., 2000)	APHEA ¹	Hong Kong Study (Hedley et al., 2002)	Elderly Californians Study (Enstrom et al., 2005)	Dublin Study (Clancy et al., 2002)	Veteran's (Lipfert et al., 2000, 2003 & 2006)	AHSMOG (Abbey et al., 1991 & 1999; McDonnell et al., 2000; Chen et al., 2005)	Netherlands Cohort Study (Hoek et al., 2002)	Utah Valley (Pope et al., 1989, 1991, 1996; Ghio et al., 2004)	ACS LA Reanalysis (Jerrett et al., 2003 & 2005)	ACS (Pope et al., 1995, 2002 & 2004; Krewski et al., 2000)	Six Cities (Dockery et al., 1993; Krewski et al., 2000; Laden et al., 2006)
Expert A						✓			✓	✓			✓			✓	✓	✓	✓	✓
Expert B					✓			✓	✓	✓				✓				✓	✓	✓
Expert C											✓		✓				✓	✓	✓	✓
Expert D												✓		✓			✓	✓	✓	✓
Expert E				✓												✓		✓	✓	✓
Expert F																		✓	✓	✓
Expert G											✓						✓		✓	✓
Expert H															✓				✓	✓
Expert I			✓							✓	✓	✓	✓	✓	✓	✓	✓	✓	✓	✓
Expert J		✓					✓					✓				✓		✓	✓	✓
Expert K													✓					✓	✓	✓
Expert L												✓			✓	✓		✓	✓	✓
Total:	1	1	1	1	1	1	1	1	2	3	3	4	4	5	5	5	5	10	12	12

¹ The Air Pollution and Health - A European Approach (APHEA) includes a large group of studies. For full list of papers, please consult http://airnet.iras.uu.nl/products/reports_and_annexes/APHEA/APHEA_publications.pdf.

² Study not yet published at the time of the interview.

Table 2b: Key studies relied upon by experts in creating their C-R uncertainty distributions (IE 2006).

	ACS (Pope et al., 2002)	ACS LA Reanalysis (Jerrett et al., 2005)	Six Cities (Dockery et al., 1993)	Six Cities (Laden et al., 2006 (Cross-Sectional))	ACS (Pope et al., 1995)	Netherlands Cohort Study (Hoek et al., 2002)	Six Cities (Laden et al., 2006 (Change estimate))	Mallick et al., 2002	Willis et al., 2002	NMMAAPS (Samet et al., 2000)	Women's Health Initiative ²	AHSMOG (Abbey et al., 1991 & 1999; McDonnell et al., 2000; Chen et al., 2005)
Expert A	○	⊙	○	⊙			○			○		
Expert B	⊙	⊙			○ ○			⊙				
Expert C	⊙	⊙	⊙									
Expert D	⊙		⊙									
Expert E	⊙	⊙		⊙		⊙	⊙		⊙			
Expert F	○	○	⊙	⊙								
Expert G	⊙ ○		⊙ ○									
Expert H	⊙	⊙ ○	○									
Expert I	⊙	⊙		⊙								
Expert J ¹	⊙	⊙ ○	⊙ ○			○				○	○	○
Expert K	⊙		⊙ ○									
Expert L	○	⊙ ○		○						○		
Total ⊙:	9	8	6	4	1	1	1	1	1	0	0	0
Total ○:	4	4	5	1	1	1	1	0	0	3	1	1

⊙ = Expert used the study to inform the median of his C-R coefficient distribution(s).

○ = Expert used the study to inform the uncertainty of his C-R coefficient distribution(s).

¹ Expert J also cited the following short-term studies as support for his uncertainty: Levy et al., 2000; Steib et al., 2002; Anderson et al., 2005; Ostro et al., 2005; Schwartz et al., 1996; Klemm et al., 2000; Burnett et al., 2003).

² Study not yet published at the time of the interview.

B.4 U.S. EPA's peer review process

Six reviewers were asked to participate in the peer review of U.S. EPA's elicitation. They include:

- Douglas Crawford-Brown, Ph.D.
Director, Institute for the Environment
Professor, Environmental Sciences and Engineering
University of North Carolina at Chapel Hill
- John S. Evans, Sc.D.
Senior Lecturer on Environmental Science
Harvard School of Public Health
- Granger Morgan, Ph.D.
Lord Chair Professor in Engineering
Carnegie Mellon University
- D. Warner North, Ph.D.
Department of Management Science and Engineering
Stanford University
- David Stieb, Ph.D.
Air Health Effects Division,
Health Canada
- Thomas S. Wallsten, Ph.D.
Department of Psychology
University of Maryland at College Park

Overall, the reviewers unanimously agreed that U.S. EPA conducted a high quality expert elicitation. The elicitation follows best practices and can serve as a model of good practice for expert elicitations in a variety of agency-wide settings. The reviewers agree that the elicitation protocol provides a reliable basis for eliciting the probabilistic distributions of uncertainty in the PM_{2.5} C-R relationship⁴.

C. Applicability of U.S. EPA's expert elicitation results to California

The experts' judgments on the PM_{2.5}-mortality relationship apply to regulatory impact analyses at the national scale. To fully understand how such results are applicable to California, it is helpful to discuss the strengths and weaknesses of the studies cited by the experts and evaluate how applicable they are in California.

The studies described in Section II.A provide significant evidence regarding the influence of PM_{2.5} on premature death. However, only a subset of these studies may be suitable for developing a relative risk applicable to general populations for use in regulatory impact analyses. While the relative risk in premature death per unit change in PM_{2.5} long-term exposures is derived from a formal expert elicitation protocol, as described in Section II.B, by highlighting the strengths and weaknesses of the various studies from the perspective of relative risk derivation, we can better interpret the expert

⁴ http://www.epa.gov/ttn/ecas/regdata/Uncertainty/pm_ee_peer_review_summary.pdf

elicitation output.

One key factor in choosing an appropriate study is the generalizability of the study population. As our objective is to derive a relative risk applicable to the general population of California, it is important to use studies that have a similar at-risk population. This criterion would eliminate direct application of studies like the Washington University-EPRI Veterans Cohort (Lipfert et al. 2000, 2003, 2006), which focused on male military veterans under treatment for hypertension, with 81 percent current or former smokers. Similarly, the Adventist Health Study on Smog (AHSMOG) (Abbey et al. 1999, McDonnell et al. 2000, Chen et al. 2005) focused on non-Hispanic white Seventh-Day Adventists who were nonsmokers. In addition, studies on infant mortality (Woodruff 1997, 2006) do not directly address long-term exposures to PM_{2.5}; hence, they do not apply to our assessment. It is important to recognize that the inability to utilize these studies directly to develop general population relative risks does not mean that they are invalid, nor does it mean that these studies did not influence the judgments of the experts within the expert elicitation. Findings regarding the effect of PM_{2.5} on populations either with a greater or lesser collection of risk factors than the general population are informative, but cannot directly provide a relative risk applicable to the general population of California.

Other criteria that can be applied involve utilizing only studies that measured the pollutant of interest (PM_{2.5}) and the health outcome of interest (all-cause mortality). Thus, while studies like Miller et al. (2004) and Chen et al. (2005) may be more interpretable by focusing on cardiovascular risk (an outcome for which there is extensive evidence supporting biological plausibility), if the aim is to develop a relative risk factor for all-cause mortality, these studies cannot be used directly. Similarly, studies that use an alternative measure of particulate matter like black smoke (Filleul et al. 2005) or proximity to a major road (Beelen et al. 2008, Hoek et al. 2003, Finkelstein et al. 2004) provide insight about the effects of motor vehicle-related particulate matter on premature death but cannot directly inform PM_{2.5} relative risk. In addition, the AHSMOG study also cannot be used directly, for it did not have direct measurement of PM_{2.5} but relied on TSP and PM₁₀ data.

Other important screening criteria include a desire for geographic appropriateness. This does not necessarily mean that only studies in California can be used for risk evaluations in California, but it means that significant factors that vary geographically should be addressed. This can occur at multiple levels. For example, a study in a developing country may not be directly applicable to the U.S., due to differences in age distributions, underlying disease patterns, pollutant composition, standard of health care, and many other factors. Within the U.S., regional differences could occur if the composition of PM_{2.5} differed significantly and more/less toxic agents could be identified, or if concentration-exposure relationships differed significantly (i.e., due to differences in air conditioning prevalence). While there are some noticeable differences between California and other states in terms of climate and concentrations of PM constituents, there is little evidence for California's relative risk to be differentiated from the U.S. average. More explicitly, there is not adequate evidence at present regarding the quantitative differential toxicity of different particle constituents, and national and

regional information about exposure-concentration differentials, to make any formal adjustments.

National-scale epidemiological studies addressing short-term effects of PM exposures using time-series analyses do not demonstrate an appreciable difference between California and other states or regions in relative risks. For example, in a publication on 91 U.S. cities addressed by the National Mortality Morbidity Air Pollution Study, Dominici et al. (2005) showed that the southern California relative risk was slightly higher than the national average, while that of the Northwest (which included northern California as well as Oregon, Washington) was slightly lower than the national average. A simple average of the southern California and Northwest relative risks gives a value almost identical to the national average. A recent publication investigating PM_{2.5} mortality in 27 large communities around the U.S. (Franklin et al. 2007) found that the C-R function was above the national average for San Diego and Sacramento but below the national average and insignificant for Riverside and Los Angeles. It should be noted that the cohort study by Jerrett et al. (2005) did find a statistically significant effect for the Los Angeles metropolitan area, once exposure was estimated with more geographic precision. Thus, the available evidence does not provide any rationale for excluding relative risks derived from studies across the U.S. to California.

In addition, studies used in developing a relative risk for use in quantifying public health impacts should ideally have controlled for co-pollutants and other potentially significant confounders, should have undergone extensive sensitivity analyses, and been validated through multiple measures (i.e., detailed quality assurance/quality control, re-analyses by multiple investigators). These represent standard quality criteria for including studies in any meta-analyses; they also serve to guide us in choosing studies for California's risk assessments as well. In this regard, the Enstrom (2005) study of elderly Californians neither adequately controlled for smoking nor adjusted for exposure to environmental tobacco smoke, two factors that could significantly alter the effect of PM exposures on premature death. Further, exposure misclassification is another issue of concern. In Enstrom's study, PM_{2.5} was assigned on the basis of data from just a few monitoring sites and at times on very few measurements (Brunekreef 2006). No discussion was provided as to the representativeness of sites; it is surprising, for instance, that Kern County ranked higher than Los Angeles in terms of PM exposures. Yet another issue is the long time passed since enrollment (1959) and follow-up (1973-2002), which must have been associated with many changes in diet, smoking, occupation, etc., factors for which the authors could not adequately control.

Based on the above criteria, the primary evidence for PM_{2.5} mortality C-R functions comes from multiple analyses from the Harvard Six Cities study (Dockery et al. 1993, Krewski et al. 2000, Laden et al. 2006) and the ACS cohort study (Pope et al. 1995, Krewski et al. 2000, Pope et al. 2002, Pope et al. 2004, Jerrett et al. 2005). Each of these studies addresses all-cause mortality associated with PM_{2.5} from a general population cohort, and each has undergone extensive peer review and re-analysis. In spite of the strengths, there are some limitations of each study. Namely, the Six Cities study focused on only white adults in six cities in the eastern half of the U.S., with resulting concerns for generalizability and for statistical power. The ACS study

addressed these concerns by considering a larger number of subjects and a more expansive geographic coverage, although some population representativeness issues remained due to the recruitment approach for the ACS Cancer Prevention Study II. There are also concerns that the retrospective exposure assessment (using existing monitors) may have contributed exposure misclassification, a point potentially supported by the greater C-R function in Jerrett et al. (2005) relative to earlier publications. Regardless, these studies fulfill all other criteria and can be used as a basis to develop a new relative risk for regulatory impact analyses in California. As can be seen in the discussion in Section II.B, the experts recruited by U.S. EPA relied heavily on these studies to develop their probability distributions of the PM_{2.5}-mortality relationship.

In summary, it is appropriate to rely on the U.S. EPA's experts' judgments for California's specific risk assessments. Both the ACS national study by Pope et al. (1995, 2002), which includes California counties, and the ACS sub-cohort study in Los Angeles (Jerrett et al. 2005) heavily influenced the experts' evaluations. Although the Harvard Six Cities studies do not include California, the range in PM levels observed in the six cities reflect those measured in California, and the analysis by Jerrett et al. (2005) produced results similar to those found in the Harvard Six Cities studies. Thus, it is justifiable to use Harvard Six Cities studies for California. Furthermore, time-series studies like NMMAPS show the PM-mortality relationship holds for broad geographic regions, including California (Dominici et al. 2005). Hence, it is appropriate to rely on U.S. EPA's expert elicitation results in developing a new relationship between premature death and long-term PM exposures for use in California.

D. Methodology for developing a concentration-response relationship

While the expert elicitation protocol yields significant insight regarding the strength of current scientific evidence and the range of C-R functions supported by experts in the field, some caution is necessary in interpreting a pooled estimate or the collective opinion of the panel. Some researchers (Morgan and Henrion 1990) assert that, if the range of expert opinions is significant enough to have major consequences for the outcome of the analysis, the opinions should generally not be combined to produce an "average" result. The empirical evidence seems to indicate good agreement among most experts regarding the appropriate C-R function, in which case any pooling approach would yield similar estimates, but there are some important differences that may be masked or exaggerated by a combined estimate.

If a pooled estimate is needed for a given policy application, as is the case here, there are a few basic approaches that could be used. The simplest approach is to average the individual assessments, or similarly, to use inverse-variance weighted averages. While this has the benefit of simplicity, this approach presumes that all experts are equally well-calibrated in their abilities to construct confidence intervals, which is not likely the case. Many expert elicitation applications use a series of calibration exercises, utilizing questions for which the answer is known or knowable, to determine the ability of experts to characterize uncertainty. This ability is characterized by calibration (i.e., 5 percent of estimates are outside of a 95 percent confidence interval) and

informativeness (confidence intervals are not excessively large).

Within U.S. EPA's expert elicitation, no calibration exercise was done, so we do not have the ability to construct individual weights beyond the reported confidence intervals. Thus, it is potentially most interpretable to examine the range of estimates provided and determine a central estimate and low/high estimate, without conducting a formal statistical pooling of estimates. Among measures of central tendency, the median is the statistic least influenced by outlying observations. With that in mind, staff chose the median to represent the point of central tendency among each expert's distribution of point estimates. The median of the experts' medians is then considered to be the overall estimate of central tendency for the PM-mortality relationship. We also used the medians of the experts' 5th and 95th percentiles as the lower and the upper bound of the credible range, respectively. Consequently, the credible range can be treated as a 90% uncertainty interval around the estimate of the PM-mortality relationship.

D.1 Sensitivity Analysis

Simple averaging of experts' distributions can be used to corroborate the above assessments, with sensitivity analyses on the relative weights used to determine the robustness of the pooled estimate. In addition, results will be compared against pooling empirical study results. Later, we demonstrate that alternative approaches for deriving the central, low, and high estimates yield similar results to the approach CARB staff has chosen. Below is a detailed discussion of these alternative approaches.

Developing a credible range of the PM-mortality relationship based on a wide range of evidence on the subject is without doubt challenging. We demonstrate the robustness of our chosen range by considering several alternative ways to interpret the data and arrive at other plausible C-R functions. These include:

1. Pooling three studies, Pope et al. (2002), Laden et al. (2006), and Jerrett et al. (2005) using equal weight — to treat the results from three studies equally. Note that since Jerrett's analysis uses a subset of the ACS cohort analyzed by Pope et al., it is technically incorrect to pool the non-independent results. However, for the purpose of demonstrating the robustness of the approach CARB staff has chosen, results are presented in this report.
2. Pooling Pope et al. (2002), Laden et al. (2006) and Jerrett et al. (2005) using inverse-variance weighting — to give more weight to studies with tighter confidence bounds than those with wider confidence bounds.

The remaining four alternative analyses rely on random effects pooling, of which a detailed discussion follows.

3. Pooling Pope et al. (2002), Laden et al. (2006), and Jerrett et al. (2005) using random effects in BenMAP⁵.
4. Pooling Pope et al. (2002) and Laden et al. (2006) using random effects in BenMAP.
5. Pooling all 12 expert distributions using random effects in BenMAP

⁵ <http://www.epa.gov/air/benmap/download.html>

6. Pooling 10 expert distributions (without experts E & H, who provided the highest and lowest estimates among the twelve experts). This analysis will assess the impact of outlying opinions using random effects in BenMAP.

A common method for weighting estimates involves using their variances. The variance takes into account both the consistency of data and the sample size used to obtain the estimate, two key factors that influence the reliability of results. The exact way in which variances are used to weight the estimates from different studies in a pooled estimate depends on the underlying model.

The fixed effects model assumes that there is a single true concentration-response relationship and therefore a single true value for the parameter in question. For example, in our discussion, the parameter would be the relative risk. Differences among parameters reported by different studies are therefore simply the result of sampling error. That is, each reported relative risk is an estimate of the *same underlying parameter*. The certainty of an estimate is reflected in its variance (the larger the variance, the less certain the estimate). Pooling that assumes a fixed effects model therefore weights each estimate under consideration in proportion to the *inverse* of the variance. This means that estimates with small variances (i.e., estimates with relatively little uncertainty surrounding them) receive large weights, and those with large variances receive small weights.

The estimate produced by pooling based on a fixed effects model, then, is just a weighted average of the estimates from the studies being considered, with the weights as defined to be equal, as in scenario (1) above, or inverse-variance, as in scenario (2). An alternative to the fixed effects model is the random effects model, which allows the possibility that the estimated relative risks from the different studies may in fact be estimates of *different* parameters, rather than just different estimates of a single underlying parameter. In studies of the effects of PM on premature death, for example, if the level of wood burning varies among study locations the underlying relationship between mortality and PM may be different from one study location to another. If wood burning associated with cold weather causes individuals to stay inside more on days with high PM (likely to occur during the winter in California), then the mortality risk may be lower in areas with high prevalence of wood burning. As such, one would expect the true value of the relative risk in cities with low wood burning prevalence to be greater than the true value of the relative risk in cities with high wood burning prevalence. This would violate the assumption of the fixed effects model.

Embedded in BenMAP is a procedure for testing whether it is appropriate to base the pooling on the random effects model (vs. the fixed effects model). If the evidence does not support the fixed effects model, then the random effects model is assumed, allowing the possibility that each study is estimating a different relative risk. The weights used in a pooling based on the random effects model must take into account not only the within-study variances (used in a meta-analysis based on the fixed effects model) but the between-study variance as well. The weighting scheme used in a pooling based on the random effects model is basically the same as that used if a fixed effects model is

assumed, but the variances used in the calculations are different. This is because a fixed effects model assumes that the variability among the estimates from different studies is due only to sampling error (i.e., each study is thought of as representing just another sample from the same underlying population), while the random effects model assumes that there is not only sampling error associated with each study, but that there is also *between-study* variability — each study is estimating a different underlying beta coefficient. Therefore, the sum of the within-study variance and the between-study variance yields an overall variance estimate. U.S. EPA's report⁶ provides a more detailed discussion of this weighting scheme.

Once a concentration-response function relating changes in PM exposures to premature death is derived, one can estimate the health impacts.

E. Methodology for estimating health impacts associated with PM exposures

In this section, we discuss the methodology developed to estimate the health impacts associated with PM exposures above a predetermined level. This methodology is consistent with that used in CARB's staff report on the PM ambient air quality standard (CARB, 2002). The major modification to that methodology is calculating impacts at an annual level for three years, then averaging the results, rather than averaging exposure estimates over three years and then calculating health impacts. This modification is an improvement over the previous methodology since the annual concentrations (not three-year average concentrations) are used to address the average-annual PM impact, and averaging over three years would yield results that are more representative of the current situation than just using one year of data. Detailed discussions of each step follow.

STEP 1: Obtain PM concentrations for all sites in California

The observed PM_{2.5} concentrations are obtained for years 2004, 2005, and 2006. In addition to the routine monitoring network, data from the IMPROVE (Interagency Monitoring for Protected Visual Environments) are included in the analysis. See Appendix 1 for a description of these special monitoring data. Annual averages of quarterly means are calculated for each site for consistency with the national and state definition of the PM standard attainment designations.

STEP 2: Estimate PM concentration per census tract

The concentration per census tract is estimated using the ambient annual average PM_{2.5} concentrations measured at monitoring sites. This step is done with BenMAP⁷, a software program developed by the U.S. EPA for estimating and mapping health impacts associated with air pollution. BenMAP interpolates PM concentrations using nearby monitored values with the inverse distance weighted squared method.

⁶<http://www.epa.gov/ttn/ecas/regdata/RIAs/Appendix%20H--Additional%20Details%20on%20Benefits%20Methodologies.pdf#search='epa%20benmap%20random%20effects%20pooling'>

⁷ <http://www.epa.gov/air/benmap/download.html>

The interpolation is confined to a 50-kilometer radius, with the weight assigned to each nearby monitored PM value as the inverse square of the distance from the monitor to the location of interpolation. In some areas of California, there may be no monitoring information within 50 kilometers. In these cases, the concentration that will be assigned will be from the closest monitor, regardless of the distance. The end result is a smooth contour surface of PM values throughout the entire state. The interpolated value is then assigned to each census tract center. This step is performed for each of the three years.

STEP 3: Estimate mortality impact

The concentration-response functions are applied to calculate mortality impacts due to long-term changes in PM exposure, using county-specific baseline incidence rates from the Center for Disease Control⁸.

For log-linear functions, the health impact is

$$\Delta Y = -Y_0 [\exp (-\beta \Delta PM - 1)] * \text{pop, where}$$

Y_0 = baseline mortality rates, which include all-cause deaths for the population over age 30. We used the mortality rate for the year 2005 to calculate health impacts for years 2004, 2005 and 2006.

β = beta coefficient derived from the relative risk of epidemiologic study results.

ΔPM = the difference between the estimated ambient PM concentration and a level below which we expect no PM-related mortality or cut-off level.

pop = population age 30 or above in each census block, from US Census for each year (2004-2006).

Note that the baseline mortality rate and population are available for various subgroups (age 30-34, 35-44, 45-54, 55-64, 65-74, 75-84, 85+). The health impact is actually calculated for each subgroup at the census tract level. After each change in health impacts is calculated for each census tract, we sum across the results for an air basin or for the entire state. Health impacts are calculated for each year; they are then averaged over three years to reduce the influence of any year with unusual meteorology on the overall results.

E.1 Cut-off Level

This section describes ARB's consideration of a cut-off level or level below which we expect no PM-related mortality. Recent evidence suggests that exposures to low PM_{2.5} levels may lead to adverse health impacts (Schwartz et al. 2002, Kappos et al. 2004, de Kok et al. 2006, Miller et al. 2007). In addition, most of the long-term exposure studies

⁸ <http://wonder.cdc.gov/mortSQL.html>

that examined the shape of the C-R function failed to demonstrate a flattening of the function at lower levels; linearity could not be rejected based on statistical tests (Krewski et al., 2000, Pope et al. 2002, Schwartz et al., 2008). Finally, many daily time-series mortality studies include concentrations very close to background levels (Ostro et al. 2006, Schwartz et al. 2002, Schwartz et al. 1996). For these reasons, we assessed the likelihood of a threshold by reviewing the scientific literature on this issue and by inferring from the conclusions of the U.S. EPA's expert elicitation.

As part of the protocol in the U.S. EPA's expert elicitation, the experts were asked for their individual judgment regarding whether a threshold exists in the PM_{2.5}-mortality function. The purpose was to assess expert judgments regarding theory and evidential support for a population threshold (i.e., the concentration below which no member of the study population would experience an increased risk of death). From a theoretical and conceptual standpoint, all experts generally believed that while a threshold may exist at the individual level, there was no evidence of a population-based threshold. Specifically, eleven of the twelve experts discounted the idea of a population threshold in the C-R function on a theoretical and/or empirical basis. Seven of the experts favored epidemiological studies as ideally the best means of addressing the population threshold issue, suggesting this approach is best to evaluate the full range of susceptible individuals at environmentally relevant exposure levels. However, those who favored epidemiologic studies generally acknowledged that definitive studies addressing thresholds would be difficult or impossible to conduct since they would need to include a very large and diverse population with wide variation in exposure and a long follow-up period. The following is a discussion of three alternatives for a threshold level: 7, 2.5, and 5 $\mu\text{g}/\text{m}^3$.

Cut-Off Level of 7 $\mu\text{g}/\text{m}^3$. As discussed above, in the U.S. EPA's expert elicitation, only one of twelve experts thought the shape of concentration-response function may change at a level at or below 7 $\mu\text{g}/\text{m}^3$, suggesting that this level may serve as a possible threshold. The level of 7 $\mu\text{g}/\text{m}^3$ also happens to be the lowest concentration observed in the American Cancer Society study (Pope 2002). In this large cohort study, Pope et al. (2002) provided empirical evidence that exposures to PM_{2.5} levels as low as 7 $\mu\text{g}/\text{m}^3$ can be associated with premature death. Also, since the ACS study is the largest cohort study conducted to date, it would be reasonable to use 7 $\mu\text{g}/\text{m}^3$ as a presumed cut-off level for calculating PM_{2.5}-related mortality. Thus, there is direct empirical evidence that some effects are likely to occur down to this level, although based on the limited data at these low concentrations, the uncertainty is greater than the uncertainty for PM levels in the middle range of the distribution (between 10 and 18 $\mu\text{g}/\text{m}^3$).

Cut-Off Level of 2.5 $\mu\text{g}/\text{m}^3$. A second alternative is to select the background level for PM_{2.5} as the cut-off level, which addresses all impacts due to anthropogenic PM exposures. In California, the background PM_{2.5} level is 2.5 $\mu\text{g}/\text{m}^3$ (Motallebi et al. 2003). As discussed above, there is no empirical evidence for long-term mortality effects at levels below 7 $\mu\text{g}/\text{m}^3$. Thus, quantifying human health impacts due to exposures at levels below 7 $\mu\text{g}/\text{m}^3$ would be the result of personal judgment and

inference from the available data on long-term studies. In the Women's Health Initiative Study (Miller et al. 2007), the investigators found significant relationships between long-term exposure to PM_{2.5} and the incidence of cardiovascular events at levels lower than 7 µg/m³. However, due to the subpopulation of older women being addressed in this study, we could not justify using the results for a general population.

Cut-Off Level of 5 µg/m³. During the review of the document, the peer reviewers were asked to consider the cut-off level in addressing premature death associated with PM_{2.5} exposures. The reviewers recognized that selecting a cut-off level involves professional judgment due to limited empirical evidence in the low PM_{2.5} range. The consensus of the peer review panel was that a cut-off level of 4 to 5 µg/m³ was reasonable based on the lowest observed short-term levels associated with mortality (Ostro et al. 2006, Schwartz et al. 2002, Schwartz et al. 1996).

Staff Recommendation. While empirical evidence indicates that mortality can be associated with long-term exposure to PM_{2.5} levels as low as 7 µg/m³, the consensus of the peer reviewers is that effects likely occur below this level. However, choosing a specific value for a threshold of effect is necessarily a matter of individual judgment, due to the lack of long-term data at low ambient concentrations of PM_{2.5}. Assuming that the probability of effects between 7 µg/m³ and 2.5 µg/m³ (background) is uniform, staff recommends that the cut-off level be expressed as a range of values from 2.5 to 7 µg/m³.

F. Methodology for estimating ambient concentrations of PM from diesel-fueled engine emissions

The following is a summary of an updated method for estimating ambient diesel PM (DPM) concentrations from ambient NO_x concentrations. A full discussion of the methodology can be found in the Appendix 3. It consists of a simple variation of a receptor model, which uses measurements of ambient chemical concentrations to infer source contributions, known as the tracer species method. A basic assumption in this method is that the ambient concentration of a tracer species, C, may be used alone to infer the ambient concentration of a pollutant from a specific source, S:

$$S = \alpha C,$$

where α is a scale factor that is independent of location. In the estimation of DPM, we take C to be the ambient concentration of NO_x and S to be the ambient concentration of DPM less than 2.5 µm (DPM_{2.5}). The factor α relates the concentration of PM produced by diesel-fueled engine emissions to the concentration of NO_x produced by all sources.

The estimates of the ratio DPM/NO_x from the emission inventory (EI)-population weighted and source apportionment (SA) studies compare very well: EI 0.023 (0.003 or 0.006) and SA South Coast Air Basin 0.026 (0.006) and San Joaquin Valley 0.027 (0.008). This agreement between EI and SA estimates for α , coupled with the uncertainty intervals, motivates the use of a single scaling factor for the whole state of

California to estimate annual average concentrations of DPM from annual average measurements of NO_x . We take the EI values for the average and standard deviations for high and low- NO_x emission counties as best estimates for a population weighted value of DPM/ NO_x : $\alpha = 0.023$ (0.003 high NO_x counties or 0.006 low- NO_x counties). The value of α gives a population weighted estimate of DPM/ NO_x for all locations in California; the standard deviation values indicate the uncertainty in this choice of α for a given county (based on population).

Based on the agreement between source apportionment and emissions inventory estimates of the scaling factor α , the ratio DPM/total NO_x , we propose the use of a single value of α for estimating the population-weighted annual average ambient DPM concentration for California from NO_x concentrations.

The proposed method to estimate ambient DPM concentrations has distinct advantages over the previous PM10 method (CARB, 1998) as well as several important limitations. The primary strengths of the method include the strong relation of DPM to (total) NO_x , simple application, estimates of uncertainty intervals, and ability to capture sub-county variations in DPM concentrations. In addition to these strengths, the approach is tied directly to the ARB emission inventory, and links bottom-up EI estimates with top-down SA estimates. Several limitations and caveats also bear on applications of the method. The limitations include all assumptions sufficient for application of EI estimates to ambient air, such as well-mixed air parcels (county scale), proportional removal rates for NO_x and DPM, proportionally uniform emission rates for all NO_x and DPM sources, etc. Verification of these assumptions is in general not possible; instead, agreement between EI and SA estimates is taken as best available evidence. The uncertainty intervals produced by the estimation method are based on variations between similar (low- or high- NO_x) counties and reflect differences in relative emission sources (primarily diesel vs. non-diesel). As such, the uncertainty describes the confidence in α to accurately describe either low- or high- NO_x counties. Further work is needed in strengthening the understanding of the contribution of various emission sources to ambient concentrations of both gases and particles. In this respect, source apportionment work that utilizes organic marker species is the best available approach; ideally, highly time-resolved studies would allow better characterization and support for single species scaling estimates, such as the NO_x -scaling method. The following is a discussion of the NO_x data used in this methodology.

Nitrogen Oxides Air Quality Data

Nitrogen dioxide (NO_2) and nitric oxide (NO) are products of all types of combustion. NO reacts with hydrocarbons in the presence of sunlight to form NO_2 . Routine ambient air nitrogen oxides are monitored continuously at more than 114 sites in California using federally approved chemiluminescence methods. The data for each monitoring site are reported as 1-hour average concentrations. Statewide estimates of annual average nitrogen oxides concentrations were calculated using data from routine and special monitoring programs, which are briefly described below.

- Continuous hourly measurements of nitrogen oxides data from the 12 Children's Health Study (CHS) air quality monitoring network located in the southern California. NO_2 was determined hourly from EPA-approved chemiluminescent

instruments measuring NO_x and NO.

- Continuous hourly measurements of nitrogen oxides data from the California Regional PM10/PM2.5 Air Quality Study (CRPAQS); measurements were made at a time resolution of 5 or 10 minutes using a gas chromatograph and luminol chemiluminescence detector.

At rural sites, in the absence of nitrogen oxides measurements, the best estimates were obtained using ammonium nitrate data from the Interagency Monitoring of Protected Visual Environments (IMPROVE) program monitoring sites. IMPROVE sites are located in federally protected Class 1 areas and are outside of urban areas. The IMPROVE sampler is programmed to collect two 24-hour duration samples per week. In this data analysis, the mass associated with ammonium nitrate can be estimated by multiplying the nitrate values by the ratio of the molecular weight of ammonium nitrate (80) to the molecular weight of nitrate (62), a factor of 1.29.

From previous data analysis work (Motallebi 2006), a quantitative relationship between precursor emissions and secondary ammonium nitrate was developed. To estimate the conversion of NO_x to PM nitrate, it was suggested that the fraction of NO_x emissions converted to nitrate ranged from 30 to 50 percent. For example, this could indicate that each gram of emitted NO_x produces approximately 0.30 - 0.50 grams of secondary PM (i.e., PM-Nitrate). In this analysis, a mid-range of 40 percent was used to convert ammonium nitrate to NO_x at IMPROVE monitoring sites.

The additional NO₂ data, based on PM nitrate, further improve the spatial coverage of the NO_x monitoring network.

G. Methodology for evaluating risk to small populations exposed to PM emissions from specific sources

Health impacts from PM exposure are commonly estimated at the statewide or a similarly large geographic scale because these estimates are based on epidemiologic studies that relied on single ambient air monitoring stations to represent regional exposures to the pollutant, and incidence rates are calculated at the county level. Our interest is in refining and applying such estimation techniques to finer scales, for small populations being affected by small changes in pollutant concentrations that would result from a single or few sources of emissions.

Below is a summary of two methodologies that are proposed for estimating health impacts associated with exposures to PM resulting from specific sources in a limited geographical area. The discussion is divided into two sections based on available information on the pollutant concentration: a) modeled concentrations and b) emissions data. Examples using ports and goods movement are shown to clarify the discussion.

G.1. Methodology based on modeled concentrations

In the first scenario, an air dispersion model is used to estimate ambient concentrations of PM in a limited geographic area affected by emissions from a specific source or group of sources. Examples would be locomotive emissions at a rail yard or all sources

of diesel (trucks, locomotives, ships) at a California port or harbor. In this scenario, the annual average ambient diesel PM concentration would be estimated by grid cells using a model such as U.S. EPA ISCST3. For each grid cell, the premature death could be estimated based on a C-R function, the population in that grid cell, and the baseline countywide incidence rates. The total impacts for the affected population in the modeling domain would then be obtained by summing the results from each grid cell. In the results section, an example on the Ports of Los Angeles and Long Beach is discussed.

G.2 Methodology based on emissions data only

When it is not feasible to model PM concentrations, emissions can be used to estimate health impacts as an alternative methodology. For example, to estimate health impacts associated with goods movement activities in California, an emissions inventory approach was used in all regions outside of the Ports of Los Angeles and Long Beach, as shown below. Details for this methodology can be found in the CARB 2006 report.

1. Use ARB's estimated county-specific PM_{2.5} concentrations attributed to diesel sources in year 2000 (CARB 1998).
2. Calculate the premature deaths for the base year 2000 by applying a C-R function to the exposed population for a county.
3. Associate the health impacts with the total diesel PM emission inventory for that county in the base year 2000 to determine the number of tons emitted per annual death. This is called the "tons-per-death" factor for the county.
4. Apply the tons-per-death factor to the diesel PM emission inventory for a single source to estimate the average annual deaths associated only with exposure to these emissions, adjusting for population growth between the year of interest and the base year 2000. Note that the diesel PM emissions from the single source may be small compared to the county's emission inventory used in step 3 above.

III. Results

A. General relationship (relative risk) for use in California

From the procedures described in Section II.D, the central estimate of the relative risk of premature death is 10 percent per 10 $\mu\text{g}/\text{m}^3$ increase in PM_{2.5} exposures, with 3 percent to 20 percent confidence interval. The central estimate is the median of the twelve experts' medians (adjusted for the causality likelihood in cases where the expert did not incorporate the likelihood directly into his distribution) from U.S. EPA's expert elicitation, while the lower and upper bounds are the medians of the experts' 5th percentiles and 95th percentiles, respectively. These three values represent our proposed credible range (or uncertainty interval) for the PM_{2.5}-mortality C-R function.

After our credible range was developed, the results from the European Expert Elicitation on the likely relationship between long-term PM_{2.5} exposures and premature death in the United States were published (Cooke et al. 2007). The median of the six selected European experts' medians is also 10 percent per 10 $\mu\text{g}/\text{m}^3$ change in PM_{2.5} exposures, confirming the reasonableness of our central estimate of 10 percent.

A.1 Results of Sensitivity Analyses

To demonstrate the robustness of the relative risk described above, we performed sensitivity analyses using alternative approaches described in Section II.E (Table 3). For each of the alternative scenarios considered, Table 3 presents results in terms of percent change in premature death per 10 $\mu\text{g}/\text{m}^3$ change in PM2.5 exposures, with low indicating 5th percentile and high indicating 95th percentile. For reference, our proposed credible range of the PM2.5-mortality C-R function is listed in the first row. These results showed that regardless of the method chosen, the mean factor relating PM2.5 exposure to premature death lies between 9.5 percent and 12 percent, which brackets our estimate of 10 percent.

Table 3: Percent change in mortality risk per 10 $\mu\text{g}/\text{m}^3$ increase in PM2.5 exposure

<i>Scenario</i>	<i>Low</i>	<i>Mean</i>	<i>High</i>
Proposed credible range	3%	10%	20%
1. 3 studies, equal weight	2%	12%	26%
2. 3 studies, inverse-variance weight	4%	11%	19%
3. 3 studies, random effects pooling	3%	11%	19%
4. 2 studies, random effects pooling	3%	10%	20%
5. twelve experts, random effects pooling	0%*	10%	21%
6. 10 experts, random effects pooling	0%*	9.5%	19%

*Whenever the lowest value in an expert's distribution includes zero, a pooled result (including this expert) can have zero as a lower bound.

B. Results on premature deaths associated with exposures to ambient PM

In this section, we present the results of estimating premature deaths associated with ambient PM exposures above certain cut-off levels. Tables 4a and 4b show the number of premature deaths using a 10 percent relative risk associated with PM2.5 exposures above 7 $\mu\text{g}/\text{m}^3$ and 2.5 $\mu\text{g}/\text{m}^3$, respectively. The level of 7 $\mu\text{g}/\text{m}^3$ represents a reasonable cut-off level based on empirical epidemiologic evidence; and 2.5 $\mu\text{g}/\text{m}^3$ represents the PM2.5 background, the concentration of PM2.5 in the absence of any PM from anthropogenic sources. For this analysis, PM2.5 monitoring data from years 2004 through 2006 were used to represent current ambient PM levels. The population data from the 2000 Census were grown to each corresponding year in BenMAP. As explained in Section II.E.1 above, the results are averages of annual impacts. All results greater than 100 have been rounded to two significant figures. As such, the totals may not add up. The significance of the variation in the results shown in Tables 4a-4d is discussed in Section IV.

Table 4a: Annual premature deaths associated with ambient PM2.5 levels above 7 µg/m³ *

<i>Air Basin</i>	<i>Low</i>	<i>Mean</i>	<i>High</i>
Great Basin Valleys	<1	1	1
Lake County	<1	1	2
Lake Tahoe	<1	<1	<1
Mojave Desert	37	120	220
Mountain Counties	18	59	110
North Central Coast	5	15	28
North Coast	7	25	45
Northeast Plateau	1	4	8
Sacramento Valley	260	850	1,500
Salton Sea	30	100	180
San Diego County	260	870	1,600
San Francisco Bay	530	1,800	3,200
San Joaquin Valley	610	2,000	3,500
South Central Coast	76	250	460
South Coast	2,500	8,100	14,000
Statewide Total	4,300	14,000	25,000

*Totals do not add up due to rounding; air quality data from years 2004 to 2006.

Table 4b: Annual premature deaths associated with ambient PM2.5 levels above 2.5 µg/m³ *

<i>Air Basin</i>	<i>Low</i>	<i>Mean</i>	<i>High</i>
Great Basin Valleys	3	8	15
Lake County	6	21	38
Lake Tahoe	1	3	6
Mojave Desert	100	330	580
Mountain Counties	62	210	370
North Central Coast	57	190	340
North Coast	40	130	230
Northeast Plateau	4	15	26
Sacramento Valley	510	1,700	2,900
Salton Sea	89	300	520
San Diego County	510	1,700	3,000
San Francisco Bay	1,100	3,700	6,600
San Joaquin Valley	900	2,900	5,000
South Central Coast	200	670	1,200
South Coast	3,600	12,000	20,000
Statewide Total	7,200	24,000	41,000

*Totals do not add up due to rounding; air quality data from years 2004 to 2006.

C. Results on premature deaths avoided by strategies designed to attain ambient air quality standards

In addition to examining the mortality impacts associated with exposures above certain PM_{2.5} levels, we also assessed the health benefits of attaining the established ambient air quality standards. Tables 4c and 4d presents the annual premature deaths that would be avoided if PM_{2.5} levels from the years 2004 through 2006 were reduced to attain the national standard of 15 µg/m³ and the State standard of 12 µg/m³. For this calculation the cut off level was set at 2.5 µg/m³. Interestingly, setting the cut off level to 7 µg/m³ did not alter the results significantly. The number of premature deaths avoided by attaining the national standard decreased from 5,514 to 5,506 (unrounded); for the State standard, it decreased from 9,300 to 9,200. Details on the methodology used in calculating these estimates are provided in Appendix 2.

Table 4c: Annual premature deaths avoided by attainment of the national annual PM_{2.5} standard of 15 µg/m³ *

<i>Air Basin</i>	<i>Low</i>	<i>Mean</i>	<i>High</i>
Great Basin Valleys	<1	<1	<1
Lake County	<1	<1	<1
Lake Tahoe	<1	<1	<1
Mojave Desert	8	27	49
Mountain Counties	2	5	10
North Central Coast	<1	<1	<1
North Coast	<1	<1	<1
Northeast Plateau	<1	<1	<1
Sacramento Valley	4	15	26
Salton Sea	<1	1	1
San Diego County	<1	2	3
San Francisco Bay	1	5	9
San Joaquin Valley	310	1,000	1,900
South Central Coast	1	4	8
South Coast	1,300	4,400	7,900
Statewide Total	1,700	5,500	9,900

*Totals do not add up due to rounding; air quality data from years 2004 to 2006.

Table 4d: Annual premature deaths avoided by attainment of the State annual PM2.5 standard of 12 µg/m³ *

<i>Air Basin</i>	<i>Low</i>	<i>Mean</i>	<i>High</i>
Great Basin Valleys	<1	<1	<1
Lake County	<1	<1	1
Lake Tahoe	<1	<1	<1
Mojave Desert	12	41	74
Mountain Counties	8	27	48
North Central Coast	1	4	7
North Coast	1	5	8
Northeast Plateau	<1	<1	<1
Sacramento Valley	130	420	760
Salton Sea	16	55	100
San Diego County	94	320	570
San Francisco Bay	210	710	1,300
San Joaquin Valley	460	1,500	2,700
South Central Coast	14	46	83
South Coast	1,900	6,200	11,000
Statewide Total	2,800	9,300	17,000

*Totals do not add up due to rounding; air quality data from years 2004 to 2006.

D. Results on premature deaths associated with exposures to diesel PM exposures

Table 5 lists the estimated premature deaths associated with exposure to diesel PM by air basin. The estimates reflect the central estimate of the relative risk of premature death of 10 percent per 10 µg/m³ increase in PM2.5 exposures, with 3 percent to 20 percent confidence interval. The concentration of ambient diesel PM concentrations were calculated using the ambient NO_x concentrations. A full discussion of the methodology for estimating diesel PM from NO_x concentrations can be found in the Appendix 3.

Table 5: Annual premature deaths associated with exposures to estimated primary diesel PM*

<i>Air Basin</i>	<i>Low</i>	<i>Mean</i>	<i>High</i>
Great Basin Valleys	<1	<1	1
Lake County	3	9	17
Lake Tahoe	<1	1	2
Mojave Desert	19	66	120
Mountain Counties	8	26	48
North Central Coast	7	22	40
North Coast	4	14	26
Northeast Plateau	<1	<1	<1
Sacramento Valley	55	190	340
Salton Sea	12	40	72
San Diego County	81	270	490
San Francisco Bay	190	640	1,200
San Joaquin Valley	84	280	510
South Central Coast	22	76	140
South Coast	690	2,300	4,100
Statewide Total	1,200	3,900	7,100

*Year 2000, based on the new PM2.5-mortality relative risk of 10 percent per 10 $\mu\text{g}/\text{m}^3$ increase in PM2.5 exposures. Totals do not add up due to rounding.

E. Results on premature deaths associated with exposures to specific sources

In this section, results are presented based on applications of two methodologies discussed in sections G.1 and G.2.

Ports of Los Angeles and Long Beach. We applied the methodology using modeled concentrations of diesel PM2.5 to assess the mortality effects (described in section G.1) to the area surrounding the Ports of Los Angeles and Long Beach. Using the new PM2.5-mortality function of 10 percent per 10 $\mu\text{g}/\text{m}^3$ change in PM2.5 exposures, staff estimated that based on modeled diesel PM concentrations for year 2002, the annual premature deaths associated with the ports' emissions are around 120, with uncertainty interval 36 to 310 deaths. The population data from the 2000 Census was grown to estimate the year 2002 populations affected. Details on the modeling methodology used can be found in the CARB 2006 report.

Goods Movement in California. We also used the emissions-based methodology (described in section G.2) to estimate the total mortality impacts associated with PM2.5 generated from all ports and goods movement activities in California. Details on the emissions related to goods movement are in the CARB 2006 report. Using this methodology, staff estimates that annually 3,700 premature deaths can be associated with PM2.5 exposure from goods movement activity statewide. Also noteworthy is that 2,000 premature deaths are associated with exposures to primary diesel PM from goods movement activities, which is slightly more than one-half the total estimated diesel PM impact (from all sources) shown in Table 5.

Table 6: Annual premature deaths associated with PM2.5 from Goods Movement activities¹

Pollutant	<i>Low</i>	<i>Mean</i>	<i>High</i>
Primary Diesel PM	600	2,000	3,500
Secondary Diesel PM (Nitrates)	480	1,600	2,800
Secondary Diesel PM (Organic Aerosols)	15	49	85
Other Primary PM2.5 ²	12	39	68
Statewide Total³	1,100	3,700	6,500

¹For the year 2005, these estimates do not include the contributions from particle sulfate formed from SO_x emissions, which is being addressed with several ongoing emissions, measurement, and modeling studies. Results listed are based on the previous emission inventories used in the Goods Movement Emission Reduction Plan in April of 2006 but with the new PM2.5-mortality relationship of 10 percent per 10 µg/m³ increase in PM2.5 exposures; these values may change if emissions inventories are updated.

²PM2.5 includes tire wear, brake wear, and particles from boilers, which are not covered under primary diesel PM.

³Totals do not add up due to rounding.

IV. Discussion

By evaluating the recent epidemiologic data and the results of the U.S. EPA's expert elicitation, we were able to systematically develop a new range for the relationship between long-term exposures to PM2.5 and the risk for premature death.

Up to now, CARB staff has calculated mortality impacts associated with PM2.5 exposures based on the C-R relationship from the American Cancer Society study (Krewski et al. 2003, Pope et al. 2002). Several recently published studies prompted CARB to consider updating the C-R function as well as other aspects of the methodology for quantifying mortality impacts. In this report, all relevant literature on PM2.5 mortality was reviewed and evaluated, and a new C-R function of 10 percent per 10 µg/m³ change in PM2.5 exposure was developed (with uncertainty interval from 3 percent to 20 percent). Although the interpretation of the recent literature mostly favors a no-threshold model, staff discussed several possible cut-off levels and presented a range of results. Because of uncertainties in the cut-off concentration below which we expect no PM2.5-related adverse health impacts, staff recommends using a range of cut-off values from 2.5 to 7 µg/m³. Depending on the cut-off level chosen, as shown in Tables 4a and 4b above, exposures to 2004-06 PM2.5 can be associated with about 14,000 to 24,000 premature deaths statewide annually, with uncertainty ranging from 4,300 to 41,000 deaths.

The methodology for estimating the premature deaths avoided by attaining the ambient PM2.5 annual standards has also been updated. With the new C-R function applied to the updated methodology, about 5,500 deaths (uncertainty: 1,700 to 9,900) are avoided annually if the current PM levels (years 2004 through 2006) are reduced statewide to attain the national standard of 15 µg/m³. Similarly, about 9,300 deaths (uncertainty: 2,800 to 17,000) would be avoided if the State standard of 12 µg/m³ is attained

statewide.

Treating diesel PM and ambient PM as equally toxic and using the new PM_{2.5}-mortality function, staff estimate that statewide, public exposures to diesel PM can be associated with about 3,900 deaths, with uncertainty ranging from 1,200 to 7,100.

The PM_{2.5}-mortality concentration-response function we developed can be applied in regional (i.e., by county) assessments of premature deaths associated with PM_{2.5} exposures, as most epidemiological studies relate death and health data with regional PM measurements that apply to large populations. However, recent advances in exposure classification techniques, as demonstrated by Jerrett et al. (2005) for example, suggest that it is also reasonable to apply the PM_{2.5}-mortality relationship to analyses involving populations of small sizes, as long as uncertainties and limitations are explicitly stated. Staff demonstrated such applications in estimating the mortality impacts associated with PM_{2.5} emissions related to port activities for the Ports of Los Angeles and Long Beach. Using the new PM_{2.5}-mortality relationship, it is estimated at about 110 premature deaths (uncertainty interval: 36 to 310) are associated with annual PM_{2.5} exposures to emissions resulting from such activities.

It should be noted that while this report focuses on premature death, additional quantified health impacts include hospital admissions, lost workdays, minor restricted activity days, and a number of other health endpoints (CARB 2006). Still, some other health effects (e.g. asthma exacerbation) cannot be quantified at this time (CARB 2006). Therefore, taken as a whole, the overall health benefits of PM reduction may be under-estimated.

V. Uncertainties and Limitations

There are a number of uncertainties involved in quantitatively estimating the health impacts associated with exposures to outdoor air pollution. Over time, some of these will be reduced as new research is conducted. However, some uncertainty will remain in any estimate. Below, some of the major uncertainties and limitations of the estimated health impacts presented in this report are briefly discussed.

Concentration-Response Function

A primary uncertainty is the choice of the specific studies and the associated concentration-response (C-R) functions used for quantification. Epidemiological studies used in this report have undergone extensive peer review and include sophisticated statistical models that account for the confounding effects of other pollutants, meteorology, and other factors. While there may be questions on whether C-R functions from the epidemiological studies are applicable to California, it should be noted that some of the cities in the ACS cohort are in California. Also, studies have shown that the mortality effects of PM in California are comparable to those found in other locations in the United States (Dominici et al. 2005, Franklin et al. 2007, Jerrett et al. 2005; Pope et al. 2002). The C-R function for PM_{2.5}-related mortality developed in this report was based on a careful review of all relevant scientific literature and a thorough consideration of their strengths and limitations. In addition, it was approved by our advisors and independent peer reviewers.

Many of the studies were conducted in areas having fairly low concentrations of ambient PM, with ranges in PM levels that cover California values. Thus, the extrapolation is within the range of the studies. Finally, the uncertainty in the C-R functions selected is reflected in the lower and upper estimates given in all the health impacts tables, which represent 95 percent confidence intervals.

Baseline Mortality Rate

Mortality baseline rates are entered into the C-R functions in order to calculate the estimates presented in this report, and there is uncertainty in these baseline rates. Often, one must assume a baseline incidence level to be consistent throughout the city or county of interest. In addition, incidence can change over time as lifestyles, income and other factors evolve. For this analysis, we utilized baseline rates that are used by U.S. EPA. Additional information were obtained from Department of Health Services and the Centers for Disease Control and Prevention. It is expected that incidence rates may change over time.

Diesel PM Compared to Ambient PM Relative Toxicity

In this assessment, staff assumed diesel PM is equally toxic as PM_{2.5}. Without definitive evidence to conclude otherwise, this approach may underestimate the true effects of diesel PM exposures on adverse health effects.

Diesel PM Concentrations

In the absence of a direct measurement method, ambient diesel PM concentrations were estimated from ambient NO_x concentrations. These diesel PM estimates depend upon the network of ambient NO_x measurements from ARB monitoring sites. A basic assumption in this method is that the ambient concentration of a tracer species may be used to infer the ambient concentration of diesel PM.

The limitations include all assumptions sufficient for application of emissions inventory estimates to ambient air, such as well-mixed air parcels (county scale), proportional removal rates for NO_x and diesel PM, proportionally uniform emission rates for all NO_x and diesel PM sources. Verification of these assumptions is in general not possible. Instead, agreement between emissions inventory and source apportionment estimates is taken as best available evidence. The uncertainty intervals produced by the estimation method are based on variations between low- NO_x counties and reflect differences in relative emission sources (primarily diesel vs. non-diesel). However, this uncertainty has not been incorporated into estimating the premature deaths associated with diesel PM exposure in this report.

Interpolation

Interpolation is the procedure of predicting the PM_{2.5} concentration at areas without ambient measurements. Interpolation is necessary when monitoring data do not cover the area of interest completely. The source of error for this analysis stems from measurement error and error associated with having enough monitors to get adequate spatial coverage. When data are abundant, most interpolation techniques give similar results. When data are sparse, however, the assumption made about the underlying variation that has been sampled and the choice of method and its parameters can be

critical if one is to avoid misleading results.

Exposure concentration

There are three methods for estimating the exposure concentration used to estimate PM_{2.5}-related mortality: ambient measurement, modeled concentration and emissions inventory. There are advantages, uncertainties, and limitations with each method.

Concentration is estimated from ambient measurement by interpolating in areas with no measured concentration. The technique used in this report was inverse distance weighted squared. It has the advantage of having a high degree of certainty of the pollutant concentration near the monitoring station. As the distance increases away from the monitoring station, the uncertainty in the interpolated concentration also increases. In areas with high spatial coverage and low variability in concentration, this method gives the most reliable estimate of concentration.

When ambient measurements are not available, modeled concentration estimates of ambient air quality are done using emission inventories and air quality models. The models may be simple box models that track the movement of an air parcel through a region or detailed models that incorporate photochemical reactions and complex terrain. This technique has the advantage of estimating the relative source of PM_{2.5} compared to other sources. It can, for example, estimate the amount of PM_{2.5} from ships, trucks, or stationary sources at a particular location. Modeling can also estimate localized concentrations with sharp gradients that would not be feasible to measure with air quality monitors. The downside to modeling is that it is labor intensive and has an uncertainty of about a factor of two. Nonetheless, it is the next best tool when ambient monitoring is not feasible.

The least reliable estimation of health impacts occurs when emissions are used to infer about air quality. As outlined in section II.G.2, this method estimates the health benefits associated with reductions in PM_{2.5} emissions due to ARB regulatory action. To infer health impacts due to emission reductions, this method applies a “tons of PM_{2.5} per death” factor to estimate the number of deaths avoided due to reductions in PM_{2.5}. The method may give an overestimate of mortality where sources are far from populated areas. For example, emissions from the Ports of Los Angeles and Long Beach are miles away from populated areas, and would result in an overestimate of mortality. It may also produce an underestimate where the source of PM_{2.5} is in close proximity to populated sources.

VI. Conclusions

This report was a product of an evaluation of the available published literature on PM mortality. A new relative risk factor of premature death associated with PM_{2.5} exposures was developed: 10 percent increase in premature death per 10 $\mu\text{g}/\text{m}^3$ increase in PM_{2.5} exposures (uncertainty interval: 3 percent to 20 percent). Also, staff proposed to use a range of cut-off levels between 2.5 to 7 $\mu\text{g}/\text{m}^3$ based on the health effects observed over the range of PM concentrations recorded in case-control studies.

Although the literature mostly favors a no-threshold model, without strong empirical evidence for long-term PM effects between 2.5 and 7 $\mu\text{g}/\text{m}^3$, we recommend this range for the purpose of assessing the premature deaths associated with long-term exposures to fine PM. The methodologies and results presented in this report have been endorsed by our scientific advisors and have undergone an external peer review process.

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APPENDICES

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Appendix 1 (PM_{2.5} Exposures)

Below are estimated basin-specific PM_{2.5} population-weighted concentrations for years 2004 to 2006 used in this report.

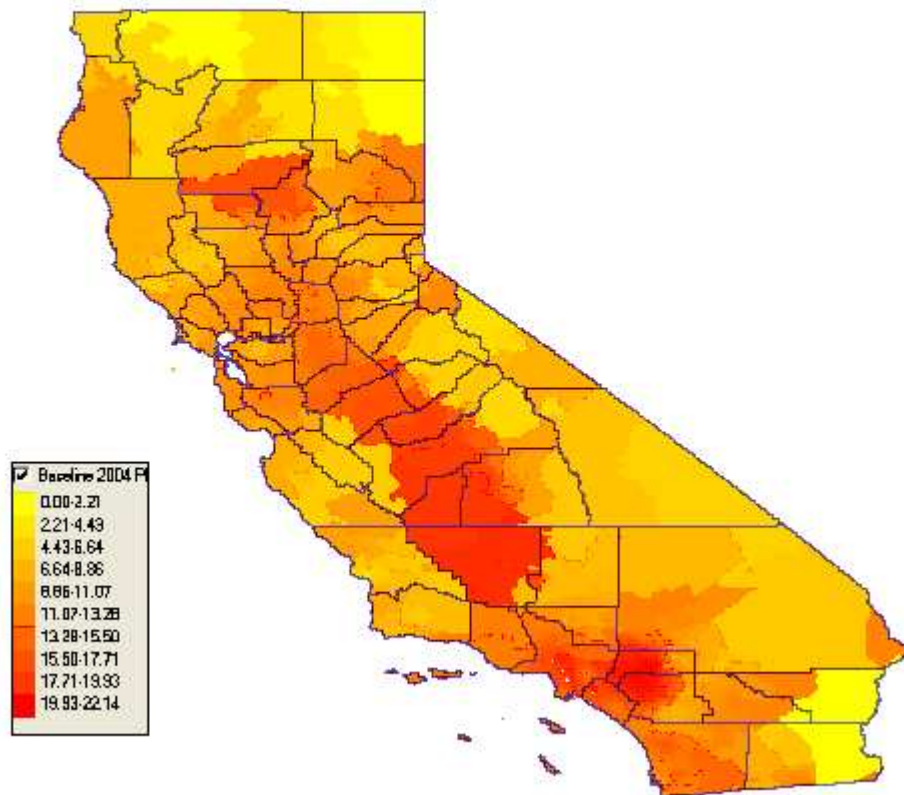
Air Basin	Census 2000 Population	PM _{2.5} (µg/m ³) Year 2004	PM _{2.5} (µg/m ³) Year 2005	PM _{2.5} (µg/m ³) Year 2006
Great Basin Valleys	32,006	6.18	6.69	3.44
Lake County	58,309	4.96	5.17	5.63
Lake Tahoe	46,200	4.31	3.55	3.63
Mojave Desert	816,742	9.16	8.80	8.50
Mountain Counties	408,039	7.60	7.41	8.39
North Central Coast	710,598	7.00	7.12	7.18
North Coast	310,061	7.11	6.98	7.49
Northeast Plateau	87,578	4.91	4.71	5.25
Sacramento Valley	2,334,277	11.41	10.84	11.82
Salton Sea	465,886	9.69	9.55	8.78
San Diego County	2,813,833	12.61	10.98	11.06
San Francisco Bay	6,605,921	11.51	10.70	10.69
San Joaquin Valley	3,189,385	16.32	16.48	16.74
South Central Coast	1,400,455	10.09	9.57	9.23
South Coast	14,592,351	17.57	16.09	14.87
<i>Statewide</i>	<i>33,871,641</i>	<i>14.34</i>	<i>13.36</i>	<i>12.91</i>

PM2.5 Air Quality Monitoring Program in California

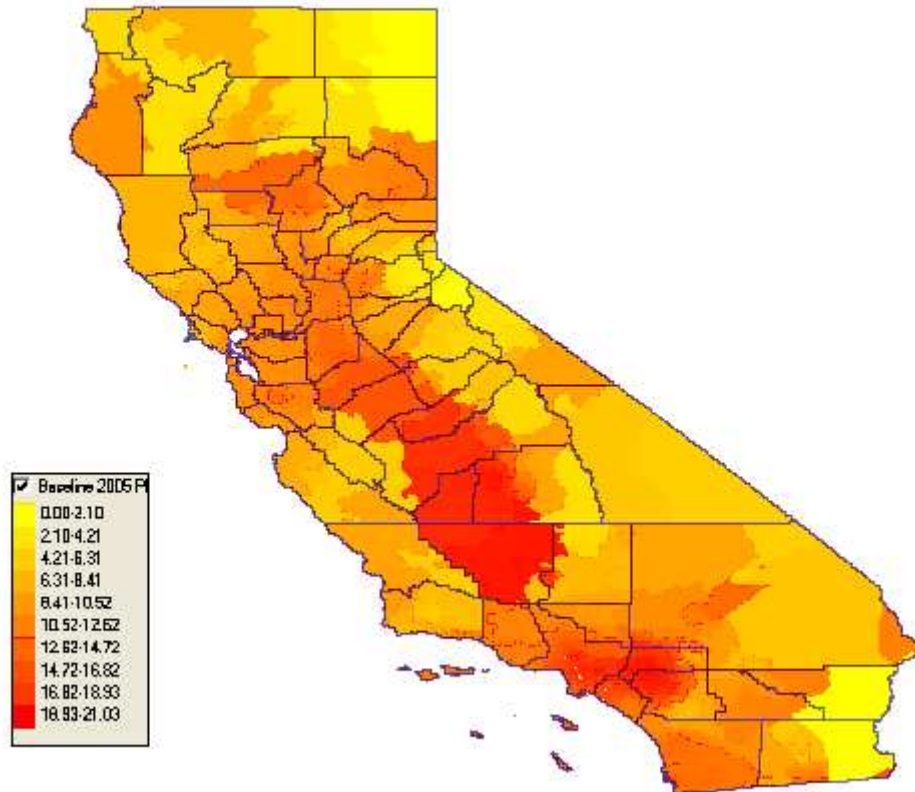
California's air quality monitoring program provides information used for determining which areas violate standards, characterizing the sources that contribute to pollution, determining background concentrations, assessing pollution transport, and supporting health studies and other research. To assess the nature and extent of the PM2.5 problem in California, ARB and air districts have significantly expanded the PM2.5 monitoring program since late 1998. The PM2.5 mass data used in this analysis have been derived from a variety of routine and special monitoring programs and databases. We analyzed the following ambient air quality data:

- 2004-2006 PM2.5 mass from the Federal Reference Method (FRM) monitors. California's PM2.5 monitoring network now includes 90 FRM monitoring sites. The FRM sites collect 24-hour mass data using federally approved methods, which means they satisfy specific federal regulatory requirements.
- 2004-2006 PM2.5 mass data from the Interagency Monitoring of Protected Visual Environments (IMPROVE) program. Since 1985, this program implemented an extensive long term monitoring program to establish the current visibility conditions, track changes in visibility and determine causal mechanism for the visibility impairment in the National Parks and Wilderness Areas. The IMPROVE sampler is programmed to collect two 24-hour duration samples per week.

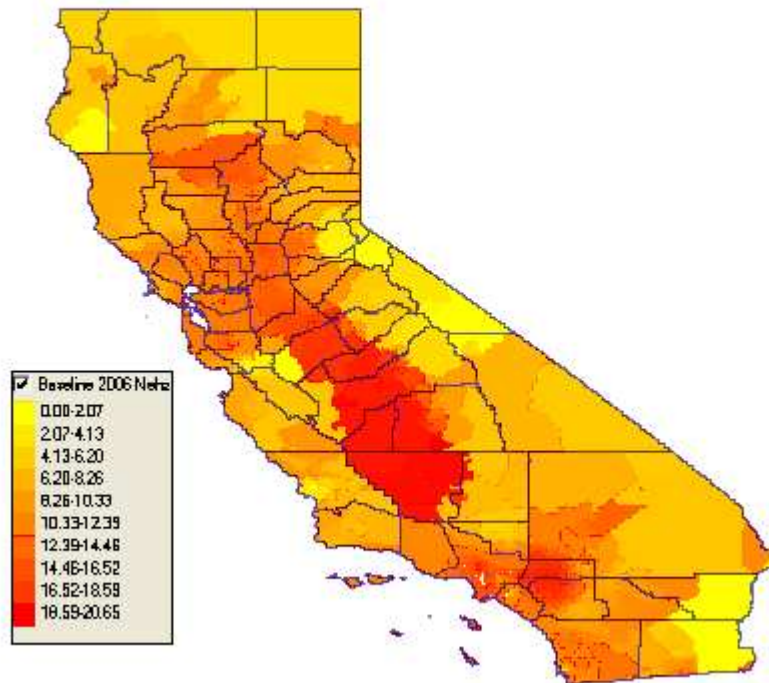
2004 Particulate Matter
Inverse Distance Squared Interpolation



2005 Particulate Matter
Inverse Distance Squared Interpolation



2006 Particulate Matter
Inverse Distance Squared Interpolation



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Appendix 2 (Methodology for Estimating Health Impacts Avoided by Strategies Designed to Attain the Standards)

In addition to examining the mortality impacts associated with exposures above certain PM_{2.5} levels, it is important to assess the health benefits of attaining the established ambient air quality standards. When evaluating the impacts associated with implementing strategies designed to attain an ambient air quality standard, we project a future scenario when the highest observed PM measurements are below the established standard – bringing the air basin into attainment of the standard. In this scenario, measurements at all sites within each air basin are also lower compared to current levels; hence their values are “rolled back” to reflect the attainment scenario. As shown in the section labeled “Justification for rollback” below, PM_{2.5} measurements within several air basins have declined at fairly consistent rates over time, justifying the assumption of a constant rate of reduction within each basin. Details on each step of this “rollback” methodology used to estimate the health impacts avoided by implementing strategies to attain the standards follow.

STEP 1: Obtain PM concentrations for all sites in California

The observed PM_{2.5} concentrations are obtained for years 2004, 2005, and 2006. In addition to the routine monitoring network, data from the IMPROVE (Interagency Monitoring for Protected Visual Environments) are included in the analysis. See Appendix 1 for a description of these special monitoring data. Annual averages of quarterly means are calculated for each site for consistency with the national and state definition of the PM standard attainment designations.

Consistent with the proportional roll-back procedure applied in the ozone standard staff report (CARB 2004) and published in JAWMA (Ostro et al. 2006), the PM annual averages of quarterly averages are rolled into attainment of a standard as follows.

Denote:

Current PM	= current annual PM value
Basin Max	= highest value in each basin during 2003-2005
Background	= background PM _{2.5} concentration of 2.5 µg/m ³
Standard	= 15 µg/m ³ for the federal, 12 µg/m ³ for the state
Attainment PM	= rolled-back PM value in the “attainment” scenario

First, the rollback factor for each basin was calculated as follows:

if Basin Max > Standard then

$$\text{Rollback Factor} = \frac{\text{Standard} - \text{Background}}{\text{Basin Max} - \text{Background}}$$

else

$$\text{Rollback Factor} = 1$$

That is, for each air basin, we assumed that only the portion of the PM_{2.5} average above background will decrease as progress toward attainment of a standard takes place. Thus, for each air basin, the rollback factor represents the percentage reduction needed to bring the basin high towards attainment of a standard.

Next, for all sites within the basin, the portion of the current PM annual average above background was shrunk by the rollback factor, as follows:

```
if Current PM > Background then
    Attainment PM = Background + (Rollback Factor) × (Current PM - Background)
else
    Attainment PM = Current PM
```

The assumption of applying a basin-specific rollback factor to all sites within each basin is justified by the investigation detailed below. Further, it is consistent with air quality plans which are aimed at attaining an appropriate air quality standard by designing programs that would bring down ambient measurements at the high site and at the same time reduce levels at other sites within each basin.

STEP 2: Estimate PM concentration per census tract

The concentration per census tract is estimated using the ambient annual average PM_{2.5} concentrations measured at monitoring sites. This step is done with BenMAP⁹, a software program developed by the U.S. EPA for estimating and mapping health impacts associated with air pollution. BenMAP interpolates PM concentrations using nearby monitored values with the inverse distance weighted squared method.

The interpolation is confined to a 50-kilometer radius, with the weight assigned to each nearby monitored PM value as the inverse square of the distance from the monitor to the location of interpolation. In some areas of California, there may be no monitoring information within 50 kilometers. In these cases, the concentration that will be assigned will be from the closest monitor, regardless of the distance. The end result is a smooth contour surface of PM values throughout the entire state. The interpolated value is then assigned to each census block center. This step is performed for each of the three years.

The same procedure is applied to obtain observed as well as rolled-back exposures in each tract. This step is performed for each of the three years.

STEP 3: Estimate mortality impact

The concentration-response functions are applied to calculate mortality impacts due to long-term changes in PM exposure, using county-specific baseline incidence rates from the Center for Disease Control¹⁰.

⁹ <http://www.epa.gov/air/benmap/download.html>

¹⁰ <http://wonder.cdc.gov/mortSQL.html>

For log-linear functions, the health impact is

$$\Delta Y = -Y_0 [\exp (-\beta \Delta PM - 1)] * pop, \text{ where}$$

Y_0 = baseline mortality rates, which include all-case deaths for the population over age 30. We used the mortality rate for the year 2005 to calculate health impacts for years 2004, 2005 and 2006.

β = beta coefficient derived from the relative risk of epidemiologic study results.

ΔPM = the difference between the current ambient PM concentration and the rolled-back or attainment PM level.

pop = population age 30 or above in each census block, from US Census for each year (2004-2006).

Note that the baseline mortality rate and population are available for various subgroups (age 30-34, 35-44, 45-54, 55-64, 65-74, 75-84, 85+). The health impact is actually calculated for each subgroup at the census tract level. After each change in health impacts is calculated for each census tract, we sum across the results for an air basin or for the entire state. Health impacts are calculated for each year; they are then averaged over three years to reduce the influence of any year with unusual meteorology on the overall results.

Justification for Rollback

In the discussion above, the roll-back methodology was based on an assumption of a constant rate of PM_{2.5} reductions within each basin. The validity of this assumption was investigated through an empirical analysis of historical PM_{2.5} data using various data sources. We examined the rate of decrease in PM levels in Mountain Counties, South Coast, San Francisco Bay Area, San Joaquin Valley, and Sacramento Valley Air Basins, where there were sufficient data between 2000 and 2005. The three-year measured average PM concentration above background of 2.5 $\mu\text{g}/\text{m}^3$ for each site within a given air basin was calculated for 2000-2003 and 2003-2005, and the rate of reduction considered. As shown in the following table, our analysis indicated that over the years, PM levels decreased at similar rates across sites within each of air basins examined in California.

Trends in Annual average PM2.5 Above Background, 2000-02 to 2003-05

Basin Name	County	Site	PM2.5 above background ($\mu\text{g}/\text{m}^3$)		% Change above background since 2000-02 ($\frac{\text{period2}-\text{period1}}{\text{period1}}$)
			2000-02 (period1)	2003-05 (period2)	
Mountain Counties	Calaveras	San Andreas-Gold Strike Road	6.5	5.3	-19%
	Nevada	Truckee-Fire Station	6.0	4.4	-26%
South Coast	Los Angeles	Lynwood	21.1	16.3	-23%
	Los Angeles	Pasadena-S Wilson Avenue	17.7	14.3	-19%
	Riverside	Riverside-Rubidoux	26.4	20.2	-24%
	Riverside	Riverside-Rubidoux	26.4	20.2	-24%
San Francisco Bay Area	Alameda	Fremont-Chapel Way	9.2	6.5	-29%
	Alameda	Livermore-793 Rincon Avenue	9.8	6.9	-30%
	San Mateo	Redwood City	8.7	6.5	-25%
	Solano	Vallejo-304 Tuolumne Street	10.1	7.5	-25%
	Sonoma	Santa Rosa-5th Street	8.0	5.7	-29%
	Sonoma	Santa Rosa-5th Street	8.0	5.7	-29%
San Joaquin Valley	Fresno	Fresno-Hamilton and Winery	16.9	14.8	-13%
	Kern	Bakersfield-Golden State Highway	20.4	16.5	-19%
	San Joaquin	Stockton-Hazelton Street	12.8	10.6	-17%
	Stanislaus	Modesto-14th Street	15.2	11.5	-24%
Sacramento Valley	Butte	Chico-Manzanita Avenue	12.1	10.1	-17%
	Placer	Roseville-N Sunrise Blvd	9.9	7.5	-25%

References for Appendix 2

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Appendix 3 (Methodology for Estimating Ambient Concentrations of Particulate Matter from Diesel-Fueled Engine Emissions)

Introduction

This document outlines a method to estimate annual average concentrations of diesel particulate matter (DPM) over large spatial scales. It consists of a simple variation of receptor model, which use measurements of ambient chemical concentrations to infer source contributions, known as the tracer species method.¹ A basic assumption in this method is that the ambient concentration of a tracer species, C, may be used alone to infer the ambient concentration of a pollutant from a specific source, S:

$$S = \alpha C,$$

where α is a scale factor that is independent of location. In the estimation of DPM, we take C to be the ambient concentration of NO_x and S to be the ambient concentration of DPM less than 2.5 μm (DPM_{2.5}). The factor α relates the concentration of PM produced by diesel-fueled engine emissions to the concentration of NO_x produced by all sources. In the following section, we demonstrate that estimates for α based on the emission inventory (EI) and on source apportionment (SA) studies agree within calculated uncertainties. We approximate the distribution of α values over counties by a Gaussian distribution with mean 0.023 and standard deviation 0.006 (for the year 2000). This single value for α and associated dispersion may be used to infer DPM concentrations from measurements of ambient NO_x concentrations in all air basins.

Background

The primary interest of the California Air Resources Board in the estimation of ambient DPM concentrations is for assessment of potential cancer risk. For this purpose, annual average ambient concentrations of DPM are needed. These values are used to calculate lifetime average daily doses²; multiplication of the average daily inhalation dose over 70 years with a cancer potency factor gives inhalation cancer risk estimates. In previous estimates³ of DPM₁₀ concentrations, the Air Resources Board (1998) used a method based on ambient total PM₁₀ concentrations. In this approach, one of two factors, rural or urban, which were determined from chemical mass balance source apportionment studies (CMB) and emission inventory estimates (EI), was used to scale PM₁₀ measurement values to obtain estimates of DPM₁₀ concentrations. Air basins that had more or less diesel to total PM₁₀ emissions than the base case had these DPM₁₀ estimates scaled by another factor (that was determined from the EI): the ratio of air basin to base case value of the relative DPM₁₀ to total PM₁₀ emissions. Application of this method, therefore, depends on several elements, the most important of which are: measurements of ambient PM₁₀ concentrations, previous source apportionment work in specific air basins (base cases), and emission inventory estimates. These components are also the primary weaknesses of the method. Specifically, PM₁₀ contains predominantly crustal material and the fraction associated with diesel PM is very small - at most approximately 0.065; early CMB studies may not

be as accurate as more recent organic marker species-based CMB methods; and early emission inventory estimates may not be as accurate in accounting for all source emissions as more recent models. We believe the proposed use of ambient NO_x concentrations is more direct than the PM10 method to estimate DPM concentrations: close linkage of diesel-engine produced NO_x to total emitted NO_x – about half total NO_x emissions are from NO_x from diesel sources – and relatively good correlation of ambient with recent emission inventory estimates for α .

Methods

In this section, we develop an approximate value for α , the ratio of ambient DPM to NO_x concentrations. First, we compare the ratio of ambient concentrations DPM/NO_x from several source apportionment (SA) studies with the ratio of annual emissions $(\text{DPM}/\text{NO}_x)_e$ from the 2000 emission inventory (EI). Currently, the source apportionment studies are considered the best available methods for determining ambient DPM concentrations (at selected monitoring sites); agreement between the SA and EI estimates of α is used to support the use of a single α value for the whole state of California. Second, based on this favorable comparison, we use the distribution of county EI estimates for the $(\text{DPM}/\text{NO}_x)_e$ to determine an average and standard deviation for α .

In the following, we estimate the ratio of DPM to NO_x concentrations for ambient air for two year-long and several short-term source apportionment modeling studies with co-located NO_x measurements. These studies utilize organic chemical speciation for chemical mass balance (CMB) apportionment of PM, which is considered to be essential for the accurate separation of gasoline from diesel-fueled engine emissions. A substantial source of uncertainty in all these studies, however, is in the off-road diesel source contribution. These sources are captured by CMB modeling only to the extent the emissions are similar in chemical composition to those of on-road diesel trucks. In light of the emission inventory estimate that approximately half the diesel contribution to PM and NO_x is from off-road sources, this poorly understood aspect of SA modeling warrants qualifications in all CMB estimates of DPM.

The first considered year-long PM source apportionment work was part of the Children's Health Study (CHS 1995), in which James Schauer carried out organic chemical PM CMB studies for 11 sites in the South Coast Air Basin.^{4,5} Hence, 11 annual average values for DPM and NO_x concentrations are available from this work. Two of the sites are centrally located (North Long Beach and Riverside), while the rest are in more or less outlying areas. The second considered SA study was carried out as part of the Central Regional Particulate Air Quality Study (CRPAQS 2000) by Desert Research Institute (DRI) in the San Joaquin Valley.⁶ From this work, 6 estimates of annual average DPM and associated NO_x are available. Most of these sites are in urban areas (with the exception of Bethel Island). Although J. Chow of DRI used a different methodology to measure elemental and organic carbon (IMPROVE method) than used by J. Schauer for CHS (NIOSH method), DRI utilized similar specific organic chemical markers for combustion sources. In addition to these long-term measurements, side-by-side CMB modeling was done at two sites for one week each in southern California in

1999 by the two foremost organic marker CMB modelers, E. Fujita and J. Schauer, as part of the Diesel-Gasoline Particulate Split Study (2000).^{7,8,9} An unexpected result from this study is that apportionment of PM depends on the specific carbon measurement method utilized (to determine relative organic/elemental carbon). Such differences in apportionment are currently not incorporated into uncertainty estimates. We also note that the Diesel-Gasoline Particulate Split Study raised several important, but still unresolved, questions in the interpretation of CMB modeling results. Specifically, SA estimates may be very sensitive to the choice of source profiles used; e.g. the characteristics of the “average” driving cycle, categories of vehicles, composition of the fleet (e.g. inclusion of high emitter categories such as gasoline “smoker” vehicles) and, information about average high emitter organic species emissions. These aspects bear directly upon SA attribution estimates in a poorly understood manner. Results from several recent short-term apportionment studies that do not utilize CMB modeling are also included below; these studies provide further evidence for a wide range of DPM estimates. Based on a comparison of SA and EI results, we develop an estimate of the DPM/ NO_x ratio from the EI.

Results

Figure 1 shows site-to-site variation of source apportionment estimates of the ratio (annual average DPM10 concentration)/(annual average total NO_x concentration) from the CHS (1995). The sampling sites are described in the CHS Final Report and represent 11 communities in the South Coast Air Basin; these include four urban sites, two sites in a mountainous region, one desert site, three rural coastal sites, and one rural inland site. NO_x measurements and filter samples (organic chemical marker measurements) were taken at the same locations. A straight average over all 11 sites of the ratio DPM10/ NO_x, gives the mean value as 0.024 (0.011), where here and in the following the value in parentheses denotes the standard deviation. An alternative estimate based on regression of DPM10 concentrations against ambient NO_x concentrations (over 11 sites) gives 0.022 (0.009); see Fig. 2. In this, and all following regressions, the intercept is set to zero, which makes the regression less sensitive to scatter and is physically meaningful, as one expects that diesel emissions tend to zero with total NO_x emissions. Removal of an outlying value (for Mira Loma) gives a slope of 0.026 (0.006), which is also shown in Fig. 2.

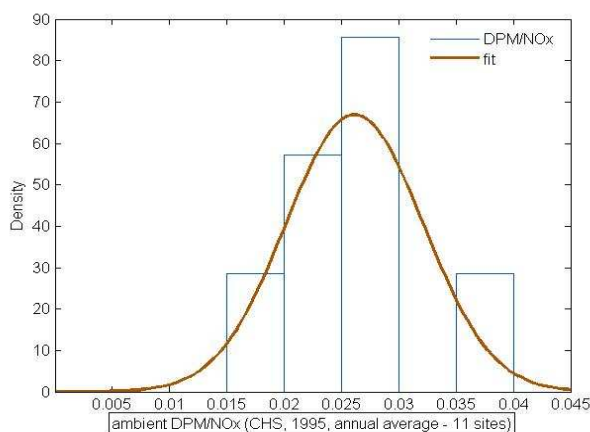


Figure 1

As expected, the dispersion in α is much larger over individual measurements of DPM/ NO_x than it is for the regression coefficient. It is unclear which choice of error is best for use in personal exposure estimates that use population weighting. The site-specific DPM/ NO_x values, Fig. 1, are best estimates for local DPM/ NO_x ratios, though specific meteorology and lack of population weighting may emphasize unrepresentative values. Similarly, DPM/ NO_x ratios obtained from linear regression (with zero intercept) are highly influenced by data with large NO_x and/or DPM values. Because ambient NO_x concentrations may not be related to population density, we believe the statistics for the ratio DPM/ NO_x are better estimates than regression coefficients for DPM exposure-related work. We take the standard deviation of the distribution as the measure of uncertainty in α for SA studies.

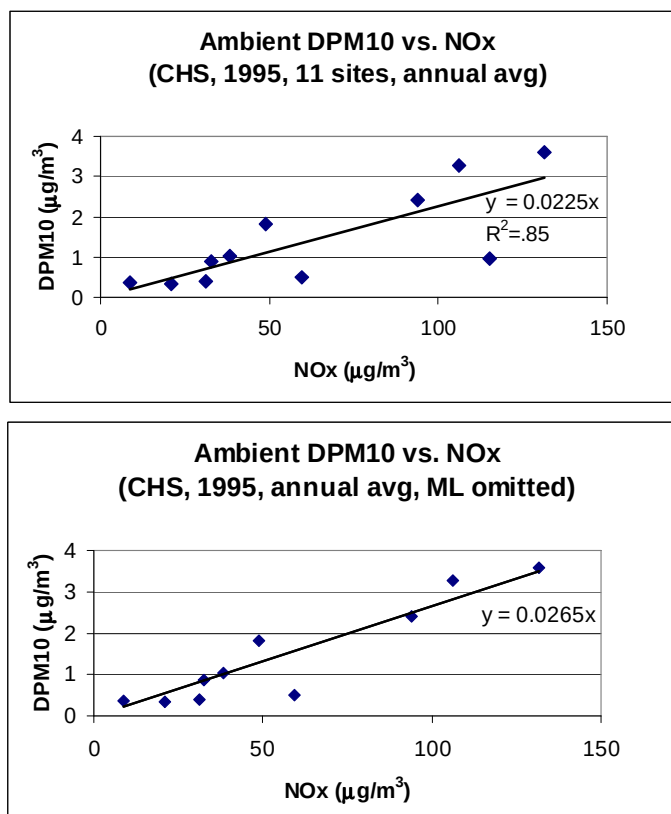


Figure 2

The other year-long SA estimate for α is from CRPAQS (DRI, 2000) for the San Joaquin Valley. A straight average of the ratio of SA DPM to NO_x concentration for 6 sites in SJV gives 0.017 (0.009). Figure 3 shows a regression of SA ambient DPM against NO_x, which gives a slope of 0.015 (0.004). As for the previous SA work, we take the standard deviation (0.009) from the distribution of DPM/ NO_x values as an indicator of the variability in ambient ratios.

We note that the relative variability of DPM/ NO_x in both studies is very large: standard deviation/average $\approx$.5 (.011/.024, .009/.017). We believe this large uncertainty in SA estimates best captures local variation of source composition, mixing, chemical reactions and other factors. Hence, this order of uncertainty is expected in any estimate of DPM based on ambient NO_x concentrations.

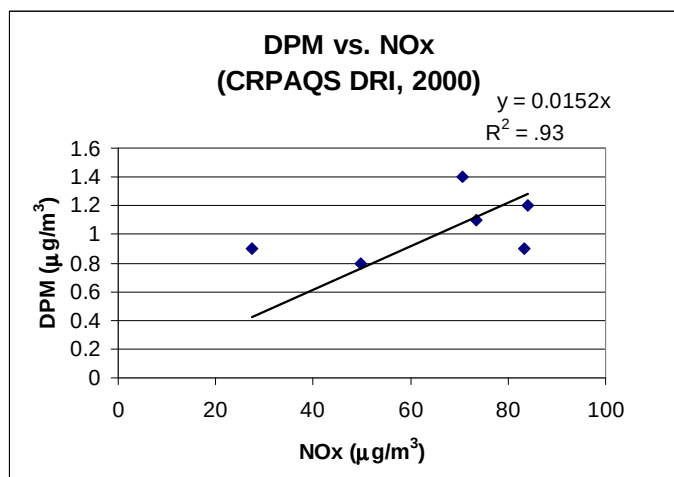


Figure 3

A recent short-term SA modeling

study investigated the sources of uncertainties in the relative contributions of diesel and gasoline vehicle emissions to PM_{2.5} in the south coast (2001) – the Gasoline/Diesel PM Split Study.^{7,8,9} In this work, James Schauer (University of Wisconsin, Madison) and Eric Fujita (Desert Research Institute) collected samples side-by-side for sources (57 light duty gasoline and 34 heavy duty diesel vehicles) and ambient air (two sites Los Angeles, N. Main, and Azusa), and carried out independent chemical and SA data analyses. The SA results show a lack of agreement between diesel PM estimates: apportionment of PM to diesel emission sources by the two groups differ by approximately a factor of two; see Fig. 4. Estimates for DPM_{2.5}/NO_x are: .010 (.003) Schauer and .023 (.004) Fujita. Because ambient and vehicle emission samples were collected side-by-side, these results indicate that the disparity in DPM estimates are driven by differences in SA methodology, which includes differences in carbon measurement methods (NIOSH vs. IMPROVE), organic marker chemical species, and chemical marker profiles for vehicles. Without *a priori* information about which method is more accurate, we believe both estimates should be weighted equally, giving DPM/NO_x = .0165 (.009).

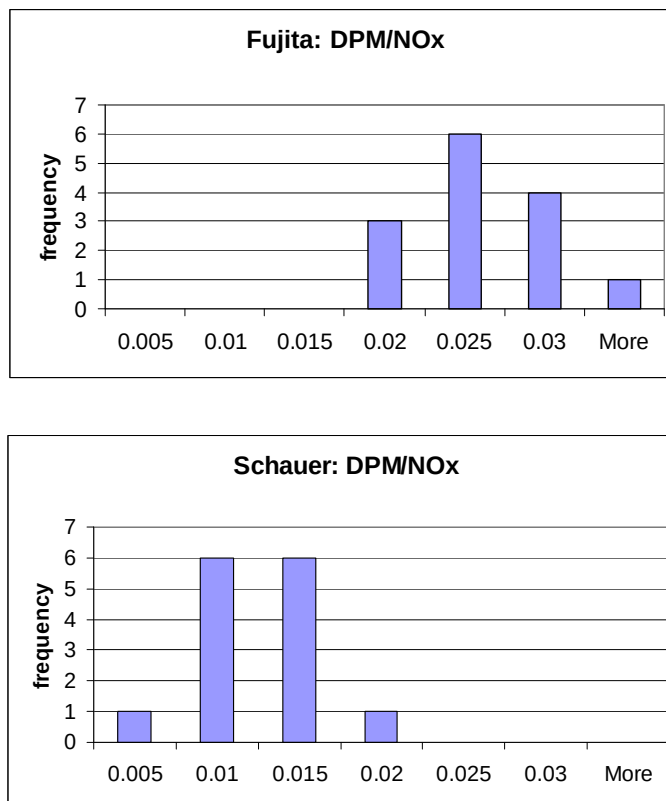


Figure 4

Recent analyses of ambient PM by Livermore National Laboratory (LLNL) in 2007 and ARB's Monitoring and Laboratory Division (MLD) in 2003 gave estimates of DPM concentrations that are similar to J. Schauer's, but not E. Fujita's, results for the Gasoline/Diesel PM Split study: DPM concentrations on the order of 1 µg/m³ (precise estimates and analyses with colocated NO_x measurements await further work). These values would presumably support the lower DPM/NO_x ratio of .01 (with a likely relative uncertainty of 50 percent). These studies used methods other than CMB to apportion PM to diesel sources: LLNL utilized fossil carbon measurements (based on Carbon 14) and MLD utilized n-octadecane as a tracer. LLNL show that the average fossil elemental carbon (FEC) at Wilmington is approximately 1.05 µg/m³ (based on the limited data), and the average FEC at Roseville is approximately 0.65 µg/m³, which, assuming that all FEC is from diesel emissions and that OC emissions from diesels are small in comparison, may be considered upper bound DPM concentrations. MLD's study yielded estimates of DPM for Wilmington as 1.2 µg/m³ and Sacramento as 0.8 µg/m³, and the statewide average as 1.0 µg/m³. These estimates, however, differ by

over a factor of 2 from the recent MATES III organic marker CMB estimate of more than $3 \mu\text{g}/\text{m}^3$ in 2004-2005 (in Wilmington). Therefore, while these two independent estimates, yielding approximately $1 \mu\text{g}/\text{m}^3$ ambient diesel PM (in the South Coast air basin), provide further support for the lower end of DPM/ NO_x ratio, considerable uncertainty remains (CHS, Schauer's Diesel/Gasoline PM Split, and MATES III support higher DPM concentration estimates).

A comparison of the above SA estimates with the emission inventory can not be made directly: emission inventory estimates are for whole counties while SA estimates are specific to monitoring sites and implicitly take into account meteorology, chemistry and deposition. Hence we compare average values for DPM/ NO_x from the previous SA studies with EI estimates of DPM to total NO_x emission ratios. For this purpose, the EI estimates for DPM and total NO_x emission rates for individual counties are utilized.¹⁰ These estimates may be visualized as tons of pollutants emitted each day into a well mixed box covering each county, with removal rates of DPM and NO_x proportionately the same. The assumption of equal removal rates is difficult to verify, given that the rates are caused by deposition, chemical reactions, and flow out of air basins. Further, while the atmospheric lifetimes for DPM and NO_x are typically very different (greater and less than a few days, respectively), which would bias the ratio of DPM/ NO_x toward higher values, the mean residence time of an air parcel in a coastal air basin is often a few hours, which would greatly lessen the difference in removal rates. Given this rough basin lifetime, we assume in the following equal removal rates for NO_x and DPM, and take the overall agreement between SA and EI estimates as support for this assumption.

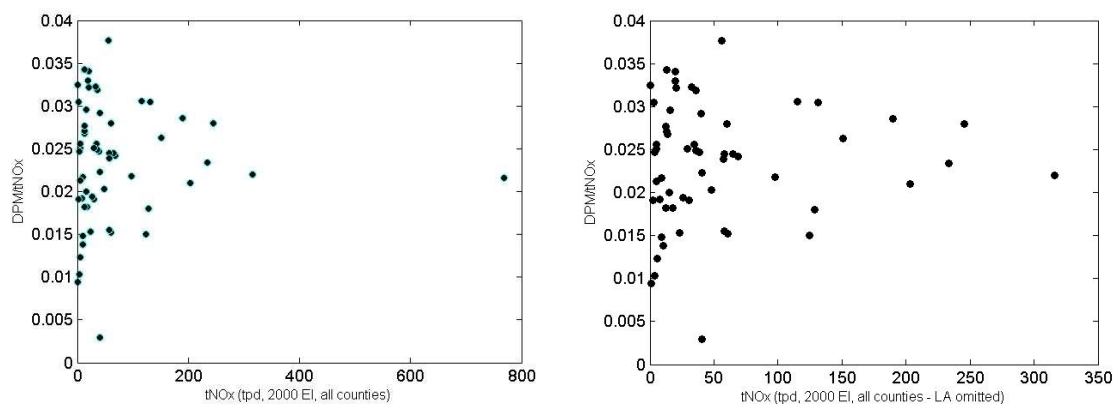


Figure 5

Emissions inventory estimates incorporate spatial and temporal averaging over large scales and therefore may be used to estimate average ambient DPM/ NO_x ratios directly (in this and following expressions, we abbreviate total NO_x by NO_x alone). A plot of (DPM/ NO_x) against NO_x for all counties in California is shown in Fig. 5. Omission of Los Angeles county, which contributes an extremely high value of NO_x (average tons per day), results in the second plot in Fig. 5. These scatter plots show that the ratios DPM/NO_x are clustered about an average and that the dispersion depends on the

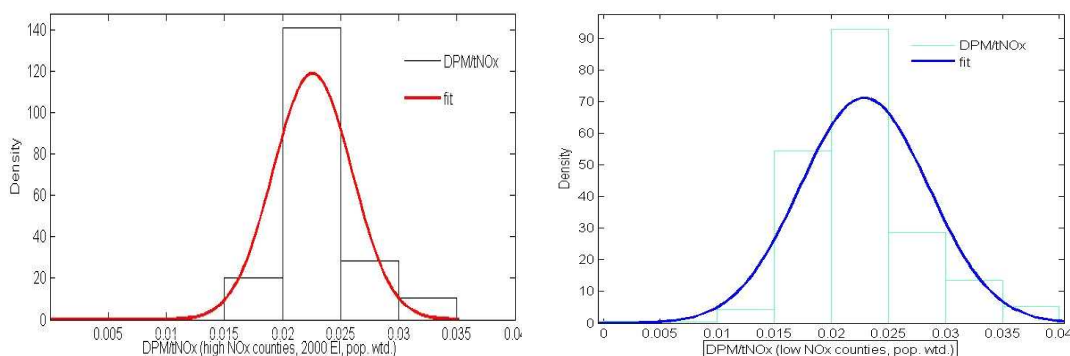


Figure 6

average annual NO_x emission rate. The second plot in Fig. 5 shows that a separation of high-NO_x from lower-NO_x emission counties occurs with a division around an annual average of 80 tons per day. (High- NO_x counties are listed in the section Results.) High-NO_x counties are highly urban and have similar composition of diesel to non-diesel emission sources. To better capture exposure-related estimates of DPM/ NO_x, each county value is weighted by its population; weighted histograms are approximated by normal distributions. Figure 6 shows the high- and low-NO_x emission distributions for α . The mean and standard deviation for α are: 0.023 (0.003) for the high-NO_x county estimate and 0.023 (0.006) for the low-NO_x county estimate. In summary, the distribution for the factor α is described by a single mean value, independent of high and low-NO_x counties, and a dispersion that depends on whether the county is highly urban or not. We take the greater deviation of DPM/ NO_x ratio for low- NO_x counties as measure of the variability that is locally encountered within air basins.

The above estimates of the ratio DPM/NO_x from the EI-population weighted and SA studies compare well, given the relatively large uncertainty: EI: county average 0.023 (0.006); and SA: SC 0.026 (0.006), SJV 0.017 (0.009), and Gasoline/Diesel PM (GDPM) Split SCAB 0.017 (.009); see Fig. 7. This agreement between EI and SA estimates for α motivates the use of a single scaling factor for the whole state of California to estimate annual average concentrations of DPM from annual average measurements of NO_x. We take the EI

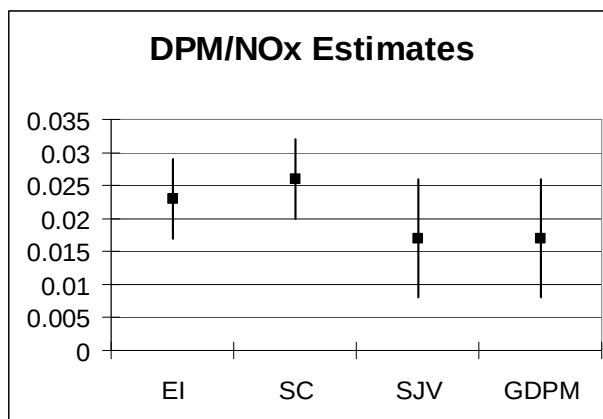


Figure 7

values for the average and standard deviations low-NO_x emission counties as best estimates for DPM/ NO_x; these counties capture some of the variation in emission sources that is encountered locally. The value $\alpha = 0.023$ (0.006) is a population weighted estimate of DPM/NO_x for all locations in California; the standard deviation indicates the uncertainty in this choice of α for a given county.

Conclusions

Based on the agreement between SA and EI estimates of the scaling factor α , the ratio DPM/total NO_x, we propose the use of a single value of α for estimating the population-weighted annual average ambient DPM concentration for California. These DPM estimates depend upon the network of ambient NO_x measurements from the ARB monitoring sites. In the following, we outline a method to calculate such averages. First, the annual average DPM concentration at each monitoring site is estimated as the product of annual average NO_x concentration value and α . The uncertainty associated with this DPM estimate is the product of the annual average NO_x measurement value and the low-NO_x county standard deviation, .006. [Although not utilized, the following twelve counties are considered high-NO_x (annual average NO_x more than .80 tons per day): Los Angeles, San Bernardino, Kern, San Diego, Orange, Riverside, Alameda, Fresno, Santa Clara, Contra

Costa, San Joaquin, and Sacramento; the remaining 46 counties are considered low-NO_x counties.] From this set of spatially discrete DPM concentration estimates a smooth DPM concentration surface may be constructed using kriging or other methods. In remote areas without monitoring sites, the smoothing method may be modified to incorporate a minimum concentration, which reflects a nonzero background value (or such areas may be removed, if the population is sufficiently small). Second, census data for California is used to

DPM concentration estimates ($\mu\text{g}/\text{m}^3$)			
Air Basin	Population	Previous	Proposed
Great Basin Valleys	32006	0.1	0.18
Lake County	58309	0.2	0.54
Lake Tahoe	46200	0.4	0.24
Mojave Desert	816742	0.1	1.46
Mountain Counties	408039	0.1	0.43
North Central Coast	710598	0.8	0.59
North Coast	310061	0.8	0.33
Northeast Plateau	87578	0.7	0.18
Sacramento Valley	2334277	1.3	1.02
Salton Sea	465886	1.5	1.29
San Diego County	2813833	1.4	1.49
San Francisco Bay	6605921	1.6	1.62
San Joaquin Valley	3189385	1.3	1.36
South Central Coast	1399218	1.1	0.93
South Coast	14592351	2.4	2.90
Statewide (pop. wtd.)	33870404	1.8	2.00

Table 1

approximate a population density surface (population fraction per unit area) and the product of the population density and DPM concentration surfaces (pointwise) is taken. This product may be integrated over any region and divided by the fraction of California population within that region to give a population-weighted average DPM concentration; in particular, integration of the product may be performed over the state to give an average population-weighted ambient DPM concentration. Once ambient diesel PM concentrations have been estimated for a baseline year (2000), linear rollback techniques may be used to project concentrations for future years.

A comparison of DPM concentration estimates for the year 2000 from the proposed NO_x-scaling method (proposed) with the projections from the previous PM10-scaling method³ is given in Table 1. The overall agreement between DPM concentration estimates is good, and for the six highest population air basins is very good. More specifically, the six highest population air basins contain over 90 percent of the population of California and contribute greater than 96 percent of the population weighted DPM concentration; in each of these air basins, the difference between the proposed and the previous DPM concentrations is less than approximately 20 percent (of the previous estimate). It should be noted that the previous estimates use a baseline year 1990 and are projected forward by a decade based on linear rollback, and so do not constitute the best approximation for year 2000. Greater variation of agreement between proposed and previous methods is found for lower population air basins. Many factors contribute to this variability, several of which are: the larger dispersion in the DPM to NO_x ratio (.006), uncertainty in application of PM10 scaling method to regions less similar to the SJV, and greater influence of localized emission sources. Altogether, the proposed, population-weighted DPM concentration for California is increased by 11 percent over the previous estimate. This high level of agreement between the population-weighted DPM estimates gives confidence that the proposed method is consistent with the previous technique and represents a viable approach to estimate DPM exposure.

In summary, the proposed method to estimate ambient DPM concentrations has distinct advantages over the previous PM10 method as well as several important limitations. The primary strengths of the method include the strong relation of DPM to (total) NO_x; simple application; estimates of uncertainty intervals; and ability to capture sub-county variations in DPM concentrations. In addition to these strengths, the approach is tied directly to the ARB emission inventory, and links bottom-up EI estimates with top-down SA estimates. Several limitations and caveats also bear on applications of the method. The limitations include all assumptions sufficient for application of EI estimates to ambient air, such as well-mixed air parcels (county scale), proportional removal rates for NO_x and DPM, proportionally uniform emission rates for all NO_x and DPM sources, etc. Verification of these assumptions is in general not possible; instead, agreement between EI and SA estimates is taken as best available evidence. The uncertainty intervals produced by the estimation method are based on variations between low- NO_x counties and reflect differences in relative emission sources (primarily diesel vs. non-diesel). As such, the uncertainty describes the confidence in α to accurately describe local NO_x emission sources. Further work is needed in strengthening the understanding of the contribution of various emission sources to ambient concentrations of both gases and particles. In this respect, source apportionment work that utilizes organic marker species is the best available approach; ideally, highly time-resolved studies would allow better characterization and support for single species scaling estimates, such as the NO_x-scaling method. Finally, off-road diesel sources, which are a large source of uncertainty in current CMB modeling, need to be explicitly included in future source apportionment studies (i.e. chemically characterize emissions as a function of operating mode and construct a source profile for CMB modeling work).

References for Appendix 3

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- 4 Manchester J., Schauer J., and Cass G. *Determination of the Elemental Carbon, Organic Compounds and Source Contributions to Atmospheric Particles During the Southern California Children's Health Study: Part B; The Distribution of Particle-Phase Organic Compounds in the Atmosphere and Source Contributions to Atmospheric Particulate Matter Concentrations During the Southern California Children's Health Study*, 1995. Final Report for California Air Resources Board.
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- 6 Chow J., Chen L.W., Lowenthal D., Doraiswamy P., Park K., Kohl S., Trimble D., and Watson J. *California Regional PM₁₀/PM_{2.5} Air Quality Study (CRPAQS): Initial Data Analysis of Field Program Measurements, Final Report, 2005* for the California Air Resources Board.
- 7 The DOE Gasoline/Diesel PM Split Study, Presentations by D. Lawson, E. Fujita and J. Schauer, California Air Resources Board Seminars webpage; and DOE/NREL Gasoline/Diesel PM Split Study webpage.
- 8 Fujita E., Campbell D., Arnott W.P., Chow J., and Zelinska B., *Evaluations of the Chemical Mass Balance Method for Determining Contributions of Gasoline and Diesel Exhaust to Ambient Carbonaceous Aerosols* (2007) *Journal of the Air and Waste Management Association*. 57, 721-740.
- 9 Lough G. and Schauer J., *Sensitivity of Source Apportionment of Urban Particulate Matter to Uncertainty in Motor Vehicle Emissions Profiles* (2007) *Journal of the Air and Waste Management Association*. 57, 1200-1213.
- 10 California Air Resources Board, 2007 Emission Inventory, Planning and Technical Support Division.

Appendix 4 (Peer Review Process and Results)

Cal/EPA has a new Interagency Agreement with the University of California (UC) for External Scientific Peer Review. The Agreement incorporates guidelines for Cal/EPA organizations requesting external review. Reviewer candidates are independently identified by the University of California at Berkeley, Institute of the Environment, in collaboration with UC colleagues.

The request for reviewers to the Cal/EPA Project Director for the proposed methodology resulted in six reviewers being identified and approved for this assignment. Collectively their expertise is based on research in the following areas: chronic obstructive pulmonary disease related to air pollution; statistical analysis of epidemiological data; particle formation and measurements in air; air quality risk management; air pollution and daily mortality associations; and epidemiology. These reviewers received a draft report dated August 23, 2007 and evaluated whether CARB staff correctly interpreted the results published in the literature, including U.S. EPA's expert elicitation, and whether staff correctly developed methods for estimating premature deaths associated with public exposures to ambient PM. The peer reviewers provided staff with written comments on a draft of this report. Staff then addressed and incorporated the results of the peer review into this report.

In addition, the peer reviewers considered the two scenarios and concluded that mortality C-R functions can be applied to small areas and populations, as long as uncertainties and limitations are explicitly stated, including:

- The composition of PM must be limited to sources known to be toxic, such as diesel PM.
- For small populations, the risk can be described as the risk reduced by a certain percentage.
- Demographics of the affected population should reflect the general demographics of the population considered in the original epidemiological studies.
- The concentration of PM should not vary significantly for the population affected.

The peer reviewers also suggested that staff consider that the concentration of PM may vary by an order of magnitude over a distance of 0.5 km, and fine scale modeling may be needed. They also cautioned that the demographics of the small population may not reflect the county population, and adjusting the incidence rate for age, gender and socioeconomic status differences may be needed.

Based on their expertise, two of the peer reviewers were also asked to comment on the proposed methodology for estimating diesel PM concentrations. Their comments are also included in this appendix.

The peer reviewers and their affiliations are:

Jeffrey Brook, Ph.D.
Environment Canada
Adjunct Professor
Public Health Sciences/Chemical Engineering
University of Toronto

Mark D. Eisner, M.D., M.P.H.
Associate Professor
Pulmonary and Critical Care Division
UC San Francisco

Richard C. Flagan, Ph.D.
Professor
Chemical Engineering/Environmental Science and Engineering
California Institute of Technology

Alan Hubbard, Ph.D.
Assistant Professor
Biostatistics
UC Berkeley

Joel Kaufman, M.D., M.P.H.
Professor
Environmental and Occupational Health Sciences
University of Washington

Joel Schwartz, Ph.D.
Professor
Environmental Health/Epidemiology
Harvard University

A. Comments on General Methodology Described in the Draft Report

In this section, a summary of comments from the peer reviewers is presented, followed by individual comments from the six experts.

Summary of Peer Reviewer Comments
On General Methodology Described in the August 2007 Draft Report

Issue	J Brook	M Eisner	R Flagan	A Hubbard	J Kaufman	J Schwartz
Credible Range	10% ok. Upper and lower bounds could be better.	Good.	10% ok. No comment on range.	10% is good.	Good. Should discuss Miller 2007 and newer publications.	Did not fully discuss opinion.
Sensitivity Analysis	Results presented show wider ranges than adopted as credible range. Recommend pooling all 12 expert or 10 expert distributions, but recognize the lower limit of 0 would be problematic.	Delete Jerrett 2005 in one sensitivity run. Pool results of all studies in another run.	No comment.	Consider using sensitivity results to develop upper and lower bounds of credible range.	Do not include both Pope and Jerrett in one run.	Can pool Pope with Jerrett. Point out bias in Adventist study. Add Laden's results on PM change between periods and give Laden more weight.
Cut-off Level	7 ug/m3 is good.	7 ug/m3 is not well-justified. Consider 2.5 ug/m3 as an alternative.	Need to justify dropping 0 ug/m3. Should consider no threshold.	No comment.	No comment.	7 ug/m3 is not defensible. Should use 2.5 ug/m3.
Roll-back	Reasonable. Clarify the use of background 2.5 ug/m3.	No comment.	Revise the formulae and explanations.	Reasonable	No comment.	Revise description for rollback method; as written, it is unrealistic.
Overall	Good.	Good.	Need clarity in several places.	Good.	Good.	Generally good.

A.1 Jeffery Brook

Scientific Review of the Air Resources Board (ARB) Draft Report on “Methodology for Estimating the Premature Deaths Associated with Long-term Exposures to Fine Particulate Matter in California”

Reviewer: Dr. Jeffrey R. Brook, Senior Research Scientist, Environment Canada;
Adjunct Professor, University of Toronto.

Comments

The comments below focus on the three key components identified in Attachment II. In reviewing the material provided I have considered whether the methodology described represents sound scientific knowledge, judgment, methods and practices. Although knowledge on PM_{2.5} health effects and PM_{2.5} exposure has advanced dramatically in the past 10+ years, understanding of the issue is far from complete. Much remains to be learned about the relative toxicity of different particles based upon their physical and chemical features and how they vary by source and as a result of atmospheric processes. The role of gaseous pollutants in the mix that people breathe and their interactions with and interactive effects with particles also requires clarification. The possibility that the net effect a given particle type can have on health also varies by endpoint (e.g., cardiovascular vs. respiratory mortality) and according to a person's susceptibility is also very real and not well understood. Furthermore, any information we have on these issues has yet to provide a means for more refined concentration-response functions (CRF). Consequently, a significant amount of assumptions must necessarily underlie any method for estimating avoided mortalities associated with decreasing PM_{2.5} concentrations. Above all, this requires scientific judgment, with frank discussion of the assumptions made and the limitations of the method. Overall, the ARB draft report meets these criteria, although below are some comments that may help improve the document and spark some further thinking.

The development of a credible range based on expert opinions from a panel of experts selected by U.S. EPA

ARB's use of the U.S. EPA expert panel process implies two key assumptions:

- That the EPA process was appropriate and rigorous and represents the best approach to developing a CRF given the existing uncertainties, which are exemplified by the range of coefficients found in the different studies considered.
- That all the studies considered by the U.S. EPA (EPA) are relevant for the population and exposure conditions present in California.

In terms of the first assumption, the ARB is fully justified in building on the U.S. EPA's effort for two reasons. Firstly, the EPA's effort was itself thoroughly reviewed and, although there were some concerns expressed by its reviewers, it was deemed to be necessary and of high quality. For an assessment of the CRF relating premature mortality to long term PM_{2.5} exposure, it is unlikely that this effort and its outcome could

be improved upon, given current information.

The second assumption is more difficult to judge due to the limited number of cohort studies of the premature risk posed by long term PM_{2.5} exposure (as represented by an annual or multi-year average ambient concentration). The ARB staff adequately discussed this issue in the draft report. Given the fact that some of the studies were from populations in California, entirely or in part, and the lack of any evidence indicating that the study results are not applicable to California, I find that this assumption is justified.

Therefore, the information used by the ARB staff to develop the low, central and high CRF estimates is appropriate. Among these values, the central estimate of 10% is well explained. Using the median of the medians among all the experts involved in the EPA process is scientifically acceptable. It reflects current knowledge and I do not think that there are any other reasonable approaches that could have been followed. Furthermore, the sensitivity analysis supports this value and so it is well-justified

The values selected for the low and high points in the range are more difficult to assess and the ARB staff pointed out the challenge of determining these points. The question is whether or not the values identified have led to a credible range. From my perspective this is equally difficult to assess since no criteria were provided for what constitutes credible. I will assume here that credible means that there is some science-based evidence to support the range and that the high and low values are reasonable in terms of leaning towards being somewhat conservative and hence not likely to be controversial. Based upon this definition it is my view that the range of 4% to 16% is credible.

There are some important issues that should be addressed in the final version of the report. Firstly, it (the final report) should provide ARB's view of what the high and low values of the CRF actually signify. On page 5 of the report it is stated that they are an uncertainty interval, but is that truly what they are? Perhaps they represent uncertainty in a more subjective manner, but not in the purely objective, quantitative sense that some readers may expect from uncertainty values. Secondly, and related to the first point, the final report should provide a discussion of how ARB would use (i.e., communicate) results calculated from the upper and lower limits. Given how they were determined, it does not seem, as indicated above and below, that truly they express the degree of uncertainty about the central estimate. These comments are somewhat outside pure scientific review, however, selecting the range involves both objectivity and subjectivity and thus, it is important to clarify what the purpose or meaning of those values is expected to be. Ultimately, that is the only way to guide their quantification and application.

In the final report the way in which the upper and lower values in the range were determined needs to be explained in more detail to assist readers in assessing their scientific credibility. The general concept of bounding the range based upon the larger value from the "Six Cities follow up" and the lower value from the ACS is clearly

described. The reason for doing this is that the ARB staff speculated that developing the upper and lower bound from the full spectrum of expert opinions may be highly influenced by their “high” and “low” opinions. This may be possible, however, the full outcome of the expert solicitation should not be taken lightly. In their independent and collective deliberations they were equally aware of which studies were the key ones (i.e., ACS and Six Cities) and which ones could inform the possible range or uncertainty. In the draft report it is stated in the middle of page 27 that “Staff chose to rely on empirical evidence to bound the central estimate.” I assume that what is meant by “empirical evidence” is that the result of a single study is considered to be empirical because it was purely a quantitative, statistical analysis, as opposed to expert opinion. The final report should clarify this and indicate exactly how 4% and 16% were obtained.

The upper bound of 16% appears to be in Table 1 (directly from Laden et al.). This value is further supported as being a plausible based upon the recent ACS L.A. sub-study (Jerrett et al., 2005). However, both of these studies (i.e., Laden et al. and Jerrett et al.) had upper confidence limits of 26-30% and so choosing the risk coefficients obviously is not recognizing the full range of uncertainty found in that research. Thus, a key point to realize is that ARB’s recommended upper bound is smaller than the upper confidence limits of some of the studies and of some of the expert panel member’s opinions. Thus, ARB has leaned towards being conservative on this issue. This is a prudent choice and any impact or benefit calculations using the upper bound should be less likely to be controversial. The final report should consider pointing this out.

The lower bound is potentially more controversial. It is also not clear where 4% came from based upon information in the figures or on Table 1. Thus, as indicated above, the final report needs to expand the middle paragraph in page 27 with more specifics. More about the lower bound will be discussed in the next section on sensitivity analysis.

Sensitivity Analysis

This analysis is important due to the lack of a single best approach to determine upper and lower bounds (i.e., the credible range) and the central or mean CRF. It helps support the values proposed by the ARB. Given the available information, the method developed by the ARB staff is scientifically acceptable in that multiple approaches were considered and evaluated against the recommended values. However, it is noted that ARB’s range is narrower than any of these approaches. For the upper end, this implies that ARB is being conservative, but this is not the case in the choice of a larger lower end.

One difficulty from the results of the sensitivity analysis and from the range recommended by ARB is that any of the seven approaches included in the sensitivity analysis could probably be rationalized as being a credible approach. Overall, the most objective ones are probably #6 and #7 as they essentially remove ARB staff from the equation. If credible scientists rigorously polled highly reputable experts and other experts carefully reviewed the process (i.e., EPA’s expert elicitation), then why not let that process speak for itself (i.e., used #6 or #7 to get the range)?

Although it is hard to follow how the draft report's description of what the random effects approach is supposed to account for (i.e., that the different values may have come from different distributions due to there being different CRFs potentially because of varying PM_{2.5} composition) justifies its use for pooling expert opinions, the bottom line is that it is probably a more conservative approach than just taking a variance-weighted average. However, the challenge is that Table 3 shows that a lower limit of zero was obtained. There is a big difference between zero and 4% (the lower bound selected by ARB). Thus, the final report needs to provide a reason for the lower limit being positive and why that is more credible. I suggest that there is more than enough *in vivo* and *in vitro* toxicological data and human clinical data (i.e., biological plausibility) to support the notion that PM_{2.5} does have an effect. Thus, it is highly likely that the lower bound is not zero and the evidence for this is much greater today than 10 years ago. Furthermore, given the tendency for the more recent cohort analyses and intervention studies to yield larger effects than the earlier work probably supports the larger lower range (i.e., 4%) compared to the other non-zero lower bounds derived from the sensitivity analysis.

The overall picture is that I do feel that sensitivity analysis provides some added and valuable scientific rigor to ARB's work, it was reasonably well done and it helps support what I agree to be a credible range of 4-16%.

Estimation of premature death associated with exposures to PM_{2.5}

The approach ARB proposes to use is discussed on pages 30-34. My opinion is that what is proposed is based upon sound scientific knowledge, judgment, methods and practices. Where possible, units should be stated for the variables in the equations (γ_0 and β). The available PM_{2.5} data are used appropriately to estimate the population exposure. Although the interpolation method used to assign monitoring site PM_{2.5} concentrations to census blocks is relatively simple and does not consider terrain features or prevailing meteorological features that might distribute the particles differently across the state, it would require considerably more work to gain any improvements. Newer approaches such as land-use regression or data fusion are currently beyond the scope of the current draft report. ARB should check the maps in Appendix 1. The interpolation and contouring results for the latter two years and for the far SE portion of the state look different than I would expect given the concentrations around the nearest monitoring sites. Clearly, this would have little impact on any results.

Three cut-off levels, below which there are no benefits (avoided mortalities) to further reductions in annual average PM_{2.5}, were discussed in the report. Given the lack of information regarding the true value, if one exists given the ranges of susceptibility in the population and the possibility that it would be different for different endpoints or causes of mortality, the proposed value of 7 $\mu\text{g}/\text{m}^3$ represents sound scientific judgment. I agree that 2.5 $\mu\text{g}/\text{m}^3$ is too low and there are not sufficient data to adequately evaluate if annual average PM_{2.5} levels between 2.5 and 7.0 $\mu\text{g}/\text{m}^3$ are associated with changes in mortality rate or whether or not β is different in this range. However, using a value as low as 7 $\mu\text{g}/\text{m}^3$ as opposed to 12 $\mu\text{g}/\text{m}^3$ is well-justified based upon the ACS range and Pope et al.'s findings. Furthermore, time series studies indicate that there are acute mortalities occurring in communities with annual averages less than 12 $\mu\text{g}/\text{m}^3$. Thus,

this value is clearly too high.

To better understand the impact of these different cut-off values the ARB may want to consider future sensitivity studies where the number of avoided mortalities due to a proposed policy or a roll-back to attainment is computed using each of the values and then are compared. In the context of the types of changes in emissions to be expected via new policies on “goods movement”, it seems unlikely that the use of 2.5 or 7 $\mu\text{g}/\text{m}^3$ for the cut-off would make much difference. However, using different values between 7 and 12 $\mu\text{g}/\text{m}^3$ could affect such results.

In the second part of this section of the draft report, where ARB describes how to determine ΔPM given the max concentration in a basin and the cut-off value, there is one key assumption. That is that any roll-back strategy (i.e., the emissions reductions to attain the standard) to get the BasinMax into attainment will proportionately affect all other $\text{PM}_{2.5}$ monitoring sites and hence the population exposures within the basin. This is a reasonable assumption for crude roll-back analyses and, in general, data in the Appendix support it. However, in the context of the types of changes in emissions to be expected via new policies on “goods movement” this assumption would not likely hold. Clearly, ARB must be aware of this fact and would be constructing much more detailed base case and future case exposure maps under different policy scenarios. Finally, in this part ARB has set $\text{BG}=2.5 \mu\text{g}/\text{m}^3$. It is not clear to me if this is where the new cut-off value would be used. If this is the case, then I presume that 2.5 $\mu\text{g}/\text{m}^3$ is a “typo”. If this is not the case then where and how does the cut-off value enter into the estimation of avoided health impacts?

Final Comments

The draft report and the methodology described are scientifically sound given current information on $\text{PM}_{2.5}$ health effects. The range for the CRF is credible and reasonably conservative and, as pointed out in the draft report, the true benefits that can be ascribed to reducing $\text{PM}_{2.5}$ are likely to be larger still because of endpoints that currently cannot be quantified. There are parts of the draft report that would benefit from some clarification and additional discussion, as noted above.

A.2 Mark D. Eisner

Critique of “Methodology for estimating the premature deaths associated with long-term exposures to fine airborne particulate matter in California.” ARB, California EPA.

Mark D. Eisner, MD, MPH
UCSF

1. DEVELOPMENT OF A CREDIBLE RANGE BASED ON EXPERT OPINION

The elicitation process used by U.S. EPA and adapted by this report is robust and appropriate.

The issue of geographic appropriateness regarding the health effects estimates for PM_{2.5} was discussed on page 24. One issue to consider is potential interactions between SO_x, ozone, and PM_{2.5}. Because ozone and SO_x levels vary geographically, would the health effects of PM differ in California vs. other areas with different ozone and SO_x levels?

2. SENSITIVITY ANALYSIS

The use of the ACS and Six Cities studies to develop the upper and lower uncertainty limits does not take into account the variability around the risk estimates from each study (i.e., the 95% confidence intervals). The authors should consider an additional sensitivity analysis in which the lower 95% CI bound of the ACS and the upper 95% CI bound of the Six Cities studies are used. This would better reflect the variability implicit in those estimates.

On page 27 it is stated that it is technically incorrect to pool non-independent results from the same underlying cohort study (i.e., Pope 2002 and Jerrett 2005). It is therefore difficult to understand why it was done. The effect is to give greater weight to the ACS study. Consideration should be given to deleting the Jerrett analysis from the sensitivity analysis.

A suggestion for an additional sensitivity analysis would be to pool the results of all studies that measure PM_{2.5} and all cause mortality, even those that have issues of generalizability to the overall California population (e.g., ASHMOG). The inclusion of non-generalizable studies would appear to be a less serious issue than the inclusion of more than one analysis of the same study (i.e., non-independence).

3. ESTIMATION OF PREMATURE DEATH

Estimation of PM concentration. It is stated on p.30 that there may be no monitoring information within 50 km. More information should be provided about what proportion of census blocks for which this is true. A sensitivity analysis excluding these centers should be considered to evaluate the impact of these centers on the effect estimates for

PM_{2.5} and mortality.

Estimation of the mortality impact (p.30). The equation indicates a Beta coefficient. One presumes that this is for a 1 ug/m³ PM_{2.5} increment, but this should be clarified. In addition, there is a discrepancy between the baseline death rates, which includes all deaths over the entire population of all ages, and the “pop” variable which includes the population aged 30 years or greater. Can the baseline death rate and population variables be based on the same age ranges?

The issue of a PM_{2.5} cut-off value. The analysis uses a cut-off PM_{2.5} value of 7ug/m³. Yet it is stated that 11/12 experts agreed that health effects may be observed at all levels of PM_{2.5}. The proposed analysis defines all exposure less than 7ug/m³ as zero exposure. This does not seem appropriate given the lack of evidence for a threshold effect. At a minimum, an alternate analysis that allows for linear extrapolation down to the background level of 2.5ug/m³ should be performed.

On page 37 the statement is made that “Although the literature mostly favors a no-threshold model, without empirical evidence for PM effect between 2.5 and 7ug/m³ we recommend that no premature deaths be associated with PM exposures in this range. As discussed above, this seems illogical. Although the functional form of the relationship between PM_{2.5} and mortality in this range is not known, assumption of a linear relationship would appear to be more sound than to assume no health effects at all.

There are no results presented for the roll-back analysis. The methodology is presented, but the results are not.

A.3 Richard Flagan

Review of Proposed Methodology to Estimate Premature Deaths Associated with Long-Term Exposures to Fine Airborne Particulate Matter in California. (R. Flagen)

The methodologies described in this report are based upon results of a series of epidemiological cohort studies that provide an empirical basis for estimating premature deaths associated with exposure to fine particulate matter. At the same time, the challenges faced by the researchers who performed those studies raise fundamental questions about strategies for monitoring air quality, and that limit the resolution of the statistical analyses. The studies that were ascribed the highest reliability by the experts consulted in the EPA study employed PM_{2.5} measurements of atmospheric, fine particle mass concentrations. Decades of such measurements at community monitoring stations in a number of cities have enabled the development of the methodology outlined in this report. Recent literature raises serious questions that suggest that PM_{2.5} may just be the tip of the iceberg - that associations with smaller particles should be explored, but the data for such proactive studies neither exist nor are likely to become available in the near future.

Traditional aerosol exposure monitoring reports only mass concentrations in a few broad size ranges: PM₁₀ - particles smaller than 10 μm in diameter ($D_p < 10 \mu\text{m}$), and PM_{2.5} - fine particles for which $D_p < 2.5 \mu\text{m}$. Exposures to fine particles are associated with a range of health consequences (Pope and Dockery, 2006) from increased asthmatic symptoms (McConnell et al., 1999) to decreased lung growth (Gauderman et al., 2000, Gauderman et al., 2002) to mortality (Pope et al., 2002, Jerrett et al., 2005). Mass based PM₁₀ and PM_{2.5} measurements are, for several reasons, blunt instruments for the assessment of exposures to potentially harmful particulate matter. Within any size fraction, the mass concentration is biased to the largest particles in the included size range. Numerous studies provide evidence that particle mass is not the best measure for potential health effects of fine particles, and that the smallest particles in the fine particle size fraction may have the most profound health effects (Oberdorster, 2000; Donaldson, et al. 2002). These effects cannot be found in epidemiological studies because the vast majority of air quality measurements are limited to those parameters that are covered in present regulations. This is a fundamental failing of the present air quality monitoring system. Until air quality monitoring goes beyond the presently regulated quantities, it will remain impossible to develop health effect associations with suspected, but unregulated (and hence unmeasured) atmospheric contaminants.

A more effective partnership between epidemiologists and health researchers, atmospheric scientists, and regulatory agencies will be required if emerging health problems are to be identified without decades of delay as fine particulate matter health impacts have required. This will require investment in the measurement infrastructure in addition to acquisition of health-related atmospheric exposure data. Instruments need to be developed that can provide data on contaminants of interest that meet the stringent needs of epidemiological studies, especially the ability to provide robust data at a cost that is compatible with extended duration, large scale studies. Lacking such foresight,

future attempts to assess health impacts will, like the present studies, be forced to rely on studies that do not fully constrain the exposure assessments.

The present methodology document does not address the questions raised above, but rather works within the constraints of the existing air quality and epidemiological data. In the discussion that follows, I have focused my comments on three basic questions that arise from the proposed methodology.

Question 1: Does the methodology in the present report provide a rigorous basis for the new relationship for estimating premature deaths associated with long-term exposures to fine particulate matter in California?

The methodology is based upon a careful review of the relevant literature; with emphasis upon the studies that are most widely accepted for provide the best quantitative estimates for the prediction of premature death rates. The data employed in those studies is limited, as outlined above, and some of the studies did not even have the full PM_{2.5} data. In spite of the atmospheric data challenges, the studies produce a remarkably consistent picture of the effects of fine particle exposures. The methodology development study has also consulted EPA expert evaluations of the previous studies, which involved interviews to elicit assessments from 12 world-renowned experts on health effects of air pollutants. The CARB analysis of those studies considered subtle factors that might have influenced the EPA recommendations, and provide a clear basis for the recommendation that the relative risk of exposure to PM_{2.5} be a 10% increase in premature death rate per 10 µg/m³ increase of PM_{2.5} exposures.

Question 2: Does the methodology provide a reasonable basis for the assessment of the threshold for the effect of PM_{2.5} exposure on the premature death rate?

Here, I have difficulty in understanding the rationale presented for the premature death rate. The report notes that the suggested threshold of 7 µg/m³ corresponds to the lowest levels observed in the Pope et al. (2002) study. Eleven of the twelve experts consulted by the EPA discounted the idea that a threshold exists in the influence of PM_{2.5} on the premature death rate. The experts who favored epidemiological studies for determination of threshold effects conceded that definitive studies needed to ascribe a threshold would be difficult or impossible.

In their considerations for the present methodology report, the CARB considered three alternatives for a threshold value, 2, 12, and 2.5 µg/m³. No justification is provided for excluding 0 g/m³ in their evaluation. One of the twelve experts consulted by the EPA thought that the shape of the concentration-response function may change at 7 µg/m³, suggesting that this level may serve as a possible threshold. A suspected change in the shape of a continuous function by one of 12 experts seems a tenuous basis for saying that any effects below this value should be neglected. As stated in the report, Pope et al. (2002) do show that levels as low as 7 µg/m³ can be associated with premature death. Lacking data below that value, that study could not quantitatively assess effects below that value.

The basis for the ascribed threshold seems to be that there is no empirical evidence for mortality effects below the values measured in the ACS study. No evidence other than a single speculation by one of twelve experts consulted by the EPA is provided in support

for the existence of a threshold at all. Applying the proportionality outlined by the proposed methodology to clean regions suggests that the assignment of a threshold may underestimate the premature death rate by 2.5 to 7% for the population in those regions. Lacking some empirical or physiological rationale for assuming that a threshold exists, I seriously question the inclusion of a threshold value.

Question 3: Is the methodology for estimating health impacts avoided by strategies designed to attain the standards reasonable and justified?

The methodology for estimating the health impacts avoided of strategies designed to attain air quality standards is convoluted and confusing. The Ostro reference on which it is supposedly based does not appear in the bibliography, nor does it appear as cited when I do a brief literature search. I have attempted to see if I can rationalize the approach taken. Unfortunately, the meaning or significance of PM_{attain} is not described.

When I go through the algebra for the case where PM_{max} exceeds the standard, I do not recover a meaningful quantity to tell me the meaning or purpose of the reduction factor or PM_{attain} . The statement of the roll-back/attainment model needs to be rewritten to make it clear and unambiguous. It appears that PM_{attain} is intended to mean the PM level that one would estimate from the current year loadings if the PM levels were rolled back to meet the standard.

This would allow for year-to-year fluctuations in PM loadings in estimating health impacts, which seems reasonable.

Given a workable model, existing data would be used to estimate PM concentrations in each census block, using interpolation where local data are not available. Census data would then be used to estimate the population exposed. This seems reasonable. Results from census blocks would then be used to determine population-weighted exposure for each county, and applied to subsequent mortality impact assessments. Since more localized census block assessments are being determined in the methodology, one could also do exposure assessments and mortality impact assessments. Depending upon the nature of the mortality impact model used this could lead to different estimations of mortality than areal averaging of exposure data would suggest.

In estimating the mortality impact, the methodology does not state explicitly what model is to be employed, but rather provides an example of a log-linear function whose origin is not stated. This appears to be the result of applying Poisson statistics to the estimation of the number of deaths occurring in a population. As such, there appears to be a typographical error in the equation which, if I am correct, should read

$$\Delta Y = Y_0 [\exp(\Delta PM) - 1] * pop$$

It should be noted that this model introduces the nonlinearities in the statistics described above that raise questions about the use of county average exposures rather than census tract exposures in estimating mortality effects. Further, its application requires that the mathematical estimation of the change in PM levels be unambiguous, which not the case in the present methodology report.

In summary, the proposed methodology document needs work to make it clear to the

reader. The basis for the proportionality constant is based upon good scientific reasoning. The decision to impose a threshold needs to be better justified if it is to be maintained. Moreover, if it is maintained, the methodology for estimating excess deaths needs to reflect that quantity. The mathematical statements in the report require particular attention to correct a number of apparent errors. The bibliography should include all papers cited.

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A.4 Alan Hubbard

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SCHOOL OF PUBLIC HEALTH

Division of Biostatistics October 1, 2007

Comments on Methodology for Estimating the Premature Deaths Associated with Long-term Exposures to Fine Airborne Particulate Matter in California.

Development of a credible range based on expert opinions from a panel of experts selected by U.S. EPA.

This section concerns the standardized methodology used to combine the opinions of 12 experts regarding the health hazards of PM_{2.5}. This results is, per question asked, a set of subjective percentiles characterizing of the probability distribution (sort of an informal posterior probability) of the parameters relating PM_{2.5} to pre-mature death. For instance, the percentiles of the distribution specifying the slope of the dose-response relationship of PM_{2.5} and pre-mature death (that is, the change in mortality versus change in 1 $\mu\text{g}/\text{m}^3$ of PM_{2.5}). These percentiles characterize both the central tendency of this distribution but also the range of probable values.

I agree that performing a formal aggregation of the expert opinions on the effect-size of PM_{2.5} exposure as well as providing formal inference would be unwarranted here. First, the sample size is small (only 12) and so any inferential procedures would be based on strong assumptions. Second, it is a stretch to think of this as a random draw of 12 experts from a large population of potential experts, which renders formal inference problematic. So, I think using the median values of the experts' median values seems a reasonable choice for the estimate of the effect size.

Sensitivity Analyses

I am not sure how to interpret taking the upper confidence bound from one study and lower one from other. I think a more defensible method for calculating the uncertainty bounds on the effect estimate would be a more formal method, such as those presented in the sensitivity analyses. For instance, taking the medians of the 95% credible ranges of the various experts. I could also see avoiding the entire expert panel and using the two main studies to derive the estimates and uncertainty bounds. In fact, the sensitivity analyses lead me to think, why not just do a formal meta-analysis since the report appears to be approximating that informally? However, because the analyses do not differ substantially, both in the mean and the range estimates, for the actual estimates and credibility bounds it is a moot point. My only technical comment, which is alluded to in the report, is that two of the studies use the same data and so the analyses formally combining the estimates really only have two independent studies which would certainly

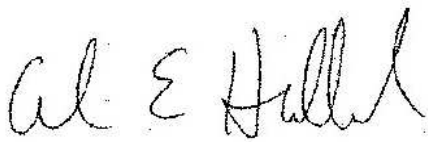
make the confidence limits reported in Table 3 (2 through 5) increase if one accounted properly for this dependence.

Methods for estimating health impacts associated with PM exposures

These appear sensible to me, finding the relative risk for a change in PM_{2.5} exposure based on the consensus effect size and based on changing each region from its typical exposure (as described in the report) to the roll-back value (or 0 if roll-back value bigger than typical exposure).

Other Comments

I would add a concern about the main studies that the 12 reviewers did not share, which Jerret, et al. (2005) exemplifies. That is, the adjustment for a large number of confounders in regression models. For instance, Jerret, et al. (2005) adjust for some 40+ confounders. Given how these confounders are entered are typically arbitrary (e.g., linear terms) the final results depend strongly arbitrary choices of model structures. Nonparametric causal inference, assuming you have measured all the confounders, requires that one has an unexposed person precisely matched (on all confounders) for every exposed person. Of course, with continuous exposure and high-dimensional covariates (confounders) this is impossible, so models are assumed. In this case, because the space of possible models is huge, one can only examine a tiny fraction of them, or just arbitrarily choose one. Treating the model as known, which is I know commonly done, really gives distorted inference at the end. There are techniques, which are no panacea, but at least attack this curse of dimensionality in a practical way and provide statistical inference at the end which is more commiserate with the lack of knowledge about the true underlying model. Broadly, these “causal inference” techniques are implemented using inverse weighted procedures (such as estimated of the so-called marginal structure model using inverse probability of treatment weighted estimators) – other more robust estimators are possible. My guess is they would provide at least very different inference (standard errors).

A handwritten signature in black ink, appearing to read 'Alan Hubbard'.

Alan Hubbard
Assistant Professor of Biostatistics
UC Berkeley

A.5 Joel Kaufman

Peer review of draft report entitled “Methodology for Estimating the Premature Deaths Associated with Long-term Exposures to Fine Airborne Particulate Matter in California” draft not dated / version not numbered, but received with cover letter dated August 27, 2007.

Reviewer: Joel Kaufman
General comments:

In general, this is a reasonably well-written description of a methodology, which is basically sound and well-reasoned. I have a few major and a few minor quibbles. I will sort my comments into the sections provided in Attachment II of the mailing, to the extent possible.

1. Development of a credible range based on expert opinions from a panel of experts selected by U.S. EPA.

The expert elicitation process seems reasonable as a way to determine a credible range. I am puzzled by the introductory comments which indicate that the process would take into account newer studies, when the expert elicitation did not have access to most of that newer information. In particular, the introduction and Table I include studies not fully considered by the experts in that process. I would advise that the whole process needs to take into account available literature at the time of the document, OR say that you are relying on what was available at the time of the expert elicitation. I think that the dismissal of the Miller et al NEJM paper is a bit facile—since cardiovascular disease is the leading cause of premature mortality and the presumed cause of most PM-related excess mortality, to say that this study can't be included due to not providing estimates of all-cause mortality strikes this reader as difficult to defend. Most epidemiologists strongly prefer research that studies cause-specific mortality to all-cause mortality as being much more robust and meaningful. Again, I would advise that the process either needs to include this study or say that the whole process is based on information published at the time of the expert elicitation. If including the Miller et al paper, I think that the credible range needs to be expanded upward, since this paper not only has a larger magnitude effect-estimate, but also has improved information on exposure measurement, outcome assessment, and control of confounding compared with Six Cities and ACS.

2. Sensitivity analysis.

The section on the concentration-response relationship seems reasonable. I presume that the request for peer review is interested in the section on sensitivity analysis included in this section. I think this is basically fine, though I don't think it is reasonable to include both Jerrett and Pope papers in same pooling; should use one or the other. Also, BenMap is not described or cited in full, so a reader doesn't know what this application does “under the hood” and whether it has been validated in some way.

3. Estimation of premature death associated with exposures to PM2.5.

Assuming that the issues are resolved with regard to the mortality impact (see comments above), then this seems largely reasonable. I am a bit confused by what was done in Step 4. In particular, does the process take into account the age-distribution for each county? It would seem that age-standardization (between the population in the cohort studies and counties for which projections are being done) would be optimal for this, and if you can't do it for some reason, you need to do some simulations regarding various age-distributions to show that the results are robust to varying age-distributions. I fear that mortality impact forecasting will not be robust to different age-distributions of these counties when compared to the cohorts under study. Step five refers to death rates over the entire population of all ages, then pop refers to population age 30 or above in each county.

The Big Picture

(a) In reading the proposed methodology, are there any additional scientific issues that are part of the scientific basis of the proposed methodology not described above?

No.

(b) Taken as a whole, is the scientific portion of the proposed methodology based upon sound scientific knowledge methods, and practices?

I am mostly concerned about the incorporation or non-incorporation of research published since the expert-elicitation. The methodology needs to be more clear about this.

A.6 Joel Schwartz

Friday, September 28, 2007
Linda Tombras Smith, Ph.D.
Chief, Health and Exposure Assessment Branch
Air Resources Board

Dear Dr Smith

I have reviewed the proposed methodology for the estimation of PM benefits as a result of alternative environmental standards in California. I found the methodology generally reasonable, but felt there was room for improvement. My specific comments are below.

Sincerely,

Joel Schwartz
Professor of Environmental Epidemiology
Harvard School of Public Health
Director, Harvard Center for Risk Analysis

I continue to be puzzled by benefit methodologies that say there is no evidence for a threshold, and then assume a de facto threshold for computing benefits. The only rational way to explain this is that the authors have very strong priors that are virtually immune to data. In that case, the authors owe us:

- a) An explanation of those priors
- b) A Bayesian analysis that shows us quantitatively how strong the priors had to be to result in the assumption of a threshold.
- c) An alternative analysis assuming no threshold.

The likely absence of a threshold means that there would be health benefits associated with reducing exposures even in communities in attainment of the standards. Recognizing this, the European Union has adopted regulations that require percentage rollbacks in all areas, even when in attainment of their guidelines. While it is not my job to recommend alternative regulations, it is worth noting that some approaches to achieving attainment in non-attainment areas will produce reductions in exposure in attainment areas. A good example is the US EPA Clean Air Interstate Rule. These benefits should be estimated, and when a choice of approaches is available to reach attainment, the consideration of those benefits would then be available.

In 1970, Lave and Seskin published a paper regression age standardized mortality rates in US cities against average particle concentrations in those cities. The advantage of that study was that the mortality experience of the entire population of each city was

compared to the average of the population- oriented monitors in the city. While individual exposures differed from the mean exposure, it seemed reasonable to assume that the exposure error was Berkson, and produced no downward bias in the estimated effect, since the average of all persons experience was being compared to the average exposure. The difficulty was that no individual level covariates were controlled, raising questions about confounding (e.g. by SES, smoking, or occupational exposures) and ecological bias.

The studies that EPA and CARB have relied on have alleviated that problem by using cohorts, with individual covariates. The problem with most of those cohort studies is that they are convenience samples, and unlike Lave and Seskin, do not capture the population mortality experience or the population average difference from the monitored exposure. If the convenience sample differed in health and exposure from the population mean identically in all locations, this would be less of a problem. However, there is no reason to believe this is true. Specifically the friends of the ACS volunteers in city A may represent a healthier, and less exposed subset of city A then they do in city B. This, clearly, can introduce bias into the estimates.

First there is potential confounding if, for example, the cities with higher exposures had systematically less healthy subjects recruited. I know of no reason to assume that this bias will always be in the same direction. However, it does introduce a greater uncertainty (above the statistical uncertainty derived from the standard error of the estimate) into the estimate from such a study. Moreover, the greater the possibility of the relation between sample health and population health varying from city to city, the greater this additional uncertainty. Second, there is no longer any reason to assume that the exposure error is predominantly Berkson. This, fairly unambiguously introduces a downward bias.

These concerns apply to all of the cohort studies, with the obvious exception of the Six City Study. The Six City Study chose a neighborhood within each city, recruited a **random** sample of that neighborhood, and put a population oriented monitor in the middle of each neighborhood. Most subjects lived within a few kilometers of that central monitor, and the assumption of Berkson error seems valid. Further, bias due to differential sampling in different locations was eliminated by the random sampling. This means that the extra source of uncertainty, and extra downward bias, present in the other studies is not present in the Six City Analysis, requiring that it be given greater weight. This does not comport with the approach of treating it as the high estimate.

The two studies standing in greatest contrast to this are the Adventist study and the VA study. While the Adventist study recruited from the same population (Adventists) everywhere, they did not necessarily live in locations within counties that had the same relation between exposure and county monitors in each location. While the Methodology discusses this study viz a viz generalizability, this potential source of bias is not discussed. The VA cohort of hypertensives could not control for cardiovascular medicine, despite known large geographic differences in the use of such medicine in hypertensives. For example, beta blockers are more commonly prescribed in the

Northeast than the rest of the US. This presents a substantial risk of confounding, since, for example, sulfate levels are higher than average in the Northeast. In addition the sampling frame is unclear, and may represent a different subset of the population in different cities. Again, the Methodology only discusses generalizability for this study, and not the high potential for bias. Hence I would give these studies less weight, and suggest at least a brief discussion of the issues raised above with respect to all studies. The second point is that most of the cohort studies, including the original Six City Study, have contrasted a surrogate for long-term exposure with long term survival. They tell us that people live less long in more polluted cities. But the question that CARB needs to answer in order to do an analysis of the benefits of **reducing** air pollution is what mortality reduction accompanies a reduction in exposure. A cross-sectional analysis of mortality rates and air pollution does not tell us that, no matter how sophisticated the Cox proportionate hazard model is. It is an extrapolation to estimate change in mortality for change in pollution. However, the Laden paper provides precisely the estimate that CARB needs. In that sense, it is the only relevant study. Allowing that the extrapolation of the other studies is never the less reasonable, one still needs to give less weight to extrapolations than to studies directly addressing the question. These issues should be recognized and discussed in the health summary. Moreover, the summary of the Laden paper (Table 1) merely quotes the cross-sectional mortality analysis for the extended follow-up, and does not mention, let alone focus on, the coefficient relating change in mortality to change in pollution between two follow-up periods. This should be corrected. Again, greater weight should be given to the Laden study, and it should not be treated as the upper bound estimate.

Regarding the pooling procedure, the methodology correctly identifies issues, such as lack of calibration, which make formal pooling more difficult. However, their central tendency is, in fact, an unweighted median of medians, which is a form of pooling. What is left out is a formal estimate of the statistical uncertainty about that estimate. Instead ranges are taken by looking at the individual studies. That is a reasonable approach, but it could benefit from the alternative, also reasonable approach, of doing a formal estimation of uncertainty.

A meta-analysis has the great advantage of producing an estimate of how much variation among studies is likely due to chance versus true variation in result across study. This could be applied to the underlying studies to estimate statistical uncertainty. Of course, this does not capture the other sources of uncertainty, such as potential confounding, the issues I raised above, etc. That is the reason for expert elicitation—to provide a formal way to capture such uncertainty. That said, the variation in estimates across experts likely reflects both some true variation in how they assess these issue, and interpret the studies underlying their judgment, as well as some stochastic variability. A meta-analysis of their judgments can help estimate how much of the observed heterogeneity across them would be expected by chance and how much represents true uncertainty. Similarly, a Bayesian pooling could examine posterior distributions of estimates based on more or less informative priors. This would be a nice sensitivity analysis to the chosen approach. It would also avoid the difficulty highlighted by the Methodology—that high and low opinions of experts, essentially the outliers of

judgment, would drive the range. The random effects meta-analysis or Bayesian pooling approaches shrink these extremes toward the mean, and provide shrunken range of plausible dose-response curves.

I don't see any problem of pooling Jerrett with Pope, while formally it is a subset of the Pope study, the exposure gradient is entirely within urban area, while Pope's exposure gradient is entirely across urban areas. So these really are different analyses.

I am not sure what Benmap does to estimate random effects meta-analysis. Is it method of moments? Maximum Likelihood? REML? The meta-analysis program in stata will do all three, and I recommend REML.

Inverse distance weighting is a reasonable method for estimating census block level PM2.5 concentrations. If possible some consideration should be given to incorporating traffic density data. For example, regress measured annual PM2.5 at each monitor against traffic density in the block containing the monitor, and use this to adjust the smoothed estimates for each block, which will not otherwise capture the local traffic effects. I recognize this is a nontrivial effort.

Again, I am concerned with the use of a cutoff of $7 \mu\text{g}/\text{m}^3$. It not only flies in the face of the expert judgment, it has potentially important consequences. If an strategy to bring one area into attainment results in the lowering of PM2.5 to, for example, $6 \mu\text{g}/\text{m}^3$, then CARB will assume there are no health benefits associated with that reduction. Given the empirical and theoretical arguments against a threshold, this would seem to be an approach that would systematically underestimate benefits, and hence systematically bias control strategies towards those that only have local impacts, against those that also impact neighboring locations which are already in attainment. For this reason, I recommend using the background PM2.5 concentration as the cutoff in computing benefits.

I believe that the rollback scenarios are unrealistic. They imply that only locations that exceed the standard rollback by the rollback factor, while sites within the same air basin that meet the standard do not reduce further. But the control strategies that bring the non-attainment sites into attainment will undoubtedly reduce concentrations at all locations in the air basin, regardless of attainment status. Hence this scenario systematically underestimates the benefits of pollution reduction strategies. What if you took the empirical distribution of PM2.5 concentrations in an airshed and rolled the entire distribution down, until the standard was met at all sites. That seems a more likely scenario.

B. Comments on Application to Specific Emission Sources

In this section, a summary of comments from the peer reviewers is presented, followed by individual comments from the six experts.

Summary of Peer Reviewer Comments

On ARB's Proposed Methodology for Estimating Health Impacts Associated with Exposures to Specific Emission Sources

Issue		J. Brook	M Eisner	R Flagan	A Hubbard	J Kaufman	J Schwartz
Modeled Data							
	Aggregate grid cells	Yes	Appropriate, but small grid cells may lead to high variability and uncertainty	No comment	Appropriate considering C-R function accuracy	Yes, uncertainties need to be explicitly stated	Yes, appropriate. Errors tend to cancel. Not appropriate to report grid cell result
	Applying county incidence rate to smaller area	Within county death rates vary by age, SES.	Yes, but adjust for age and sex distribution of population	Small population samples may introduce systematic uncertainties, in exposure, susceptibility.	Depends on assumptions of C-R function and accuracy of incidence rate.	Yes, appropriate.	Death rates likely higher near port and railyard due to lower SES. Applying county incidence rate underestimates mortality. Age also important
	Minimum size population	5,000 to 50,000	Will depend on variability and confidence intervals	No comment	No comment	Depends on confidence intervals.	Pop size determines noise in estimate. Smaller excess death predictions have higher uncertainty
	Demographics	Risk will vary by age and health status	Age, sex, race and ethnicity may be different in small pop versus county	Small pop samples may introduce systematic uncertainties, both in exposure, and susceptibility.	If C-R function vary by demographic characteristics, then they become important.	Estimates need to be standardized by age and gender.	Very important. See above.
	Single source appropriate	CRF will vary depending on source of PM	Yes, with above caveats	No comment	No comment	Depends on robustness of modeling.	Yes, with concerns above.
	Type of source	Yes	Yes	PM from CR function in epi study may differ from the single source. If from DPM, approach may provide lower-	No comment	The method would be applicable and needed in certain regions, esp for ammonium nitrate.	2ndary more uniform and more certain. Wood smoke and traffic likely underestimate mortality because efficient exposure.

Issue		J. Brook	M Eisner	R Flagan	A Hubbard	J Kaufman	J Schwartz
				bound estimate.			
	Other		No comment	No comment	CRF and incidence rate must be same in small/large pops	Emphasize uncertainty at each stage, esp exposure.	No comment.
Emissions Data							
	Appropriate	Only if CRF applies to source and concentration well estimated	Variability and confidence intervals will be an issue	This approach assumes that there is no threshold, which may not be an issue near sources.	Yes, appropriate	Depends on accuracy of emissions inventories.	Yes, appropriate. C-R function may need adjusting. For example, diesel PM may need higher C-R.
	Minimum size	Larger more like CRF	Uncertain	No comment	Same as comments above	Depends on confidence intervals.	Same as comments above
	Demographics	Pop should be like CRF study.	No comment	No comment	Pop demographics should be the same as C-R function.	Estimates need to be standardized by age and gender.	Demographics affect incidence rate.
	Type of source	Yes	Yes, potentially	No comment	No comment	2ndary PM would be more difficult due to chemistry.	Not appropriate to use linear rollback for 2ndary PM because complex chemistry.
	Other	Sensitivity analysis and population mobility;	Is it too imprecise to be meaningful? Is the population exposed to point source similar to epi study population?		Perhaps in log-linear or linear dose-response model, the relative hazard is equivalent to what is proposed, but this will not be true in general.	Emphasize accurate estimates of uncertainty at each stage, esp exposure, and incorporate these uncertainties into calculation of CI.	

B.1 Jeffery Brook

Brief Comments on Proposed Methodology for Estimating Health Impacts Associated with Exposures to Specific Emission Sources

*Reviewer: Dr. Jeffrey R. Brook, Senior Research Scientist, Environment Canada;
Adjunct Professor, University of Toronto.*

The proposed methodologies clearly represent a logical and thought out effort to address the issue of estimating health benefits associated with air pollutant reductions associated with specific sources that tend to impact more localized areas. As in any such assessment, the reliability, representativeness and true meaning of the concentration-response function (CRF) to be applied is an important consideration. The health endpoint(s) considered are also important and a fixation on premature mortality only tells a part of the story. In the applications described in this document the issues of differential susceptibility and differential toxicity/potency of particulate matter of different compositions likely become increasingly important. The former implies that the one CRF may not be ideal, especially in applying it to smaller geographic subsets of the population where there may be spatial clustering of demographic groups (population characteristics) in term of age, race, SES and possible pre-existing conditions that influence susceptibility. Ideally, to get a better feel for these issues, sensitivity analyses based upon a range of realistic assumptions about variability or potential biases, driven by true small scale data on spatial variations in PM levels and composition and population characteristics may provide insights as to how the bottom-line: reduced premature mortality; changes or becomes more uncertain could be helpful.

A. Methodology based on modeled concentrations

The assumes that the incidence rate for the county is the same in each grid cell. It seems logical to expect that this is variable spatially within a county and areas of higher incidence rate would be pointing towards populations with greater susceptibility and/or greater exposures. SES may be a proxy as could age. It would be worthwhile to examine how these vary among grid squares using census data or any data that might be accessible.

This assumes that the susceptibility distribution of the population in the grid is the same as in the population used to derive the CRF.

There are perhaps two core issues:

Is the CRF the same for different types of PM?

How do we know that all people in an area will see the same size decrease in exposure?

Original CRF's are calibrated to 'area monitors' and so we have some confidence that the changes in mass detected at these monitors reflect the average change in exposure across the population. This is not as safe of an assumption at the local scale.

Responses to Questions for peer reviewers:

Is it appropriate to estimate PM mortality for each grid cell, then sum the results across the grids?

Conceptually, this seems OK, but issues related to the next questions raise concerns.

Is it appropriate to use countywide incidence rates for applications to smaller populations within a given county?

The potential for the validity of this assumption to vary by county seems relatively high. A look at how census-based data on demographics (age, sex, race, SES) varies spatially within counties would shed some light on this. If census data are not sufficient then perhaps property values, percentages of residential property types could be obtained and would be informative. It seems likely there will be counties where variable incidence rate could be expected. Given this, then one needs to consider if the CRF would be different among segments of the population with a higher mortality rate. If we hypothesize that a higher incidence rate is due to a greater prevalence of a pre-existing condition such as TII diabetes (DM) or to an older population then we should expect that a 'general' CRF would be too small. If higher incidence rate is related to SES and the lifestyles that increase the rate then the jury is still out as to whether this itself makes a person more susceptible to air pollution.

How limited can the population size be? What is the minimum affected population size that would make this type of calculation meaningful?

This potentially also varies by geographic region. The more homogenous a population and the more that population is similar to those in ACS and Six Cities the smaller the size that could be considered. Again some sensitivity analyses with census and other spatial data on populations may shed some light on this. If I had to guess I would say 50,000 would mostly likely be safe and there are places where you might be able to get away with about 5000.

Are the population demographics important?

Absolutely, and other variations in susceptibility. There have been acute studies done that show that risk increases with age and it varies depending upon pre-existing conditions such as CHF, DM, COPD, HT, unstable plaque.

Would this methodology be appropriate to estimate the impacts associated with a single source or a limited number of sources of PM?

Most researchers hypothesize that different PM (i.e., from a different source or of a different chemical composition) have different toxicities. Are they different enough to be reflected in a population based CRF is an open question, but it is logical to expect that the CRF should vary by PM type and individual susceptibility. Certainly, evidence grows that traffic PM is a concern and we know about the hazardous nature of DPM. Controlled human exposure studies also seem to get much clearer effects when these are done with diesel exhaust vs. general CAPS from ambient air.

Is the source of PM important in this application?

Yes it is important.

Could this methodology be used if the PM is from gasoline combustion or woodsmoke, or a non-combustion type of source?

If we had robust, population-based CRFs for each source. However, obtaining these and having proof that they are significantly different from one another continues to be very illusive. The issue of endpoints comes up too although the one here is mortality. To some extent, these differences are likely encompassed by the low and high ranges of the CRF and so we may hypothesize that using the same CRF and range (upper and lower bounds) for all different PM includes such variations in the uncertainty or bounds. The issue of what co-pollutants (gases) are associated with the different PM types may magnify the differences between sources, however, and in acute studies (time series) the total risk from two or multi-pollutant models are larger and potentially more stable than just the PM risk alone. See Burnett's et al.'s *Cdn J of Pub Health* paper (Reference below).

Also, in addition to directly emitted PM emissions (primary PM), the conversion of nitrogen oxides to ammonium nitrates (secondary PM) can be modeled. Should one consider the relative contribution of secondary sources compared to the primary PM source in a small population?

Ideally yes, but the PM exposures in the studies that the CRFs have been derived from included both types of PM. One bottom line is that we are getting more confidence that certain PM is more potent, in epi studies, than general PM (e.g., traffic or diesel or possibly metal-enriched PM). Tox studies support this notion of particles being different (DTT assays, etc). But, one should be aware that fine particle nitrate (pNO₃), which is semi-volatile does not necessary condense on particles alone. There are likely secondary organics including N-containing species, which can also include amines, that partition more to particles when the thermodynamics also favors pNO₃ formation. Of course, actual exposure potential is also an issue here in that in some climates semi-volatile species don't penetrate and/or persist indoors as much as, black carbon, sulfate or heavy PAHs, for example.

What other criteria should be used to determine when such an estimation is appropriate?

Sensitivity analyses

B. Methodology based on emissions data only

Use ARB's estimated county-specific PM_{2.5} concentrations attributed to diesel sources in year 2000 (CARB 1998).

How well can this be done and what basis is there for assuming that the annual diesel PM concentration is the same across the county when we know it is not? It will be much higher closer to the source(s) of interest, but perhaps one could argue that the actual magnitude varies spatially but the ultimate change in mass will be more uniform across the county. Actually, I don't think so. It might be somewhat more justifiable to assume that the percent change in mass is uniform and then one needs to know the spatial

details of the concentration relative to the population. However, if we consider the typical application of a CRF over a larger area or the actual data used to get the CRF then we have to acknowledge that within that base population there is already

Responses to Questions for peer reviewers:

Is it appropriate to estimate PM mortality based solely on the emissions from a particular source?

This can be reasonable if the relationship between emissions and ambient concentration is linear and correctly quantified (i.e., the data used to get the ratio are reliable and appropriately applied). For the case of DPM, having an appropriate CRF, as opposed to a CRF from total PM_{2.5}, is an issue, just as discussed above.

How limited can the size of the population affected by the emissions from a single source be?

It can be very limited if the source is small, if its location is such that the prevailing winds very consistently blow the emissions in a very consistent direction such as with the sea breeze blowing a plume inland. Other meteorological factors can also limit the size.

What is the minimum affected population size that would make this type of calculation meaningful?

This depends upon the distribution of susceptibility in the population. The larger the size the more likely the distribution will look like the average and more importantly like the population that the original CRF came from. Assuming this is not an issue then the size can be small if the exposure change is known reliably.

What should the population demographics be?

Like those where the CRF came from, in every sense. This was mentioned above.

Is the source of PM important in this application?

Yes, as in my previous discussion.

As described in the previous section, could other sources of PM be considered? It would depend upon the ability to have reliable emissions for the county and reliable estimates of the amount of PM mass in the air that is from that source.

Also, should one consider the relative contribution of secondary PM compared to primary PM?

Same issues as raised above.

What other criteria should be used to determine when such an estimation is appropriate?

Sensitivity analyses of the impact of spatial heterogeneity in population demographics and exposure using reasonable assumptions should be considered.

Population mobility may become more important because the smaller the area influenced by the source(s) of concern the more likely it could be that individuals in the surrounding population move out of the zone of influence regularly and for long periods and also possibly move into the area or at least to where concentrations go up.

References

Burnett R.T., Cakmak S. and Brook J.R., 1998 The effect of the urban ambient air pollution mix on daily mortality rates in Canadian Cities. *Canadian J. Public Health*, **89**(3):152-156.

B.2 Mark Eisner

Proposed Methodology for Estimating Health Impacts Associated with Exposures to Specific Emission Sources

Health impacts from PM exposure are commonly estimated at the statewide or a similarly large geographic scale because (in part) these estimates are based on epidemiologic studies that relied on single ambient air monitoring stations to represent regional exposures to the pollutant. Our interest is in refining and applying such estimation techniques to finer scales, for small populations being affected by small changes in pollutant concentrations that would result from a single or few sources of emissions. The peer reviewers are being asked to comment on these applications.

Below is a summary of two methodologies that could be used to estimate health impacts associated with exposures to PM resulting from specific sources in a limited geographical area. The discussion is divided into two sections based on available information on the pollutant concentration: a) modeled concentrations and b) emissions data. Examples using ports and goods movement are shown to facilitate the discussion.

A. Methodology based on modeled concentrations

In the first scenario, suppose an air dispersion model is used to estimate ambient concentrations of PM in a limited geographic area affected by emissions from a specific source or group of sources. Examples would be locomotive emissions at a rail yard or all sources of diesel (trucks, locomotives, ships) at a California port or harbor. In this scenario, the annual average ambient diesel PM concentration would be estimated by grid cells using a model such as U.S. EPA ISCST3. For each grid cell, the premature death could be estimated based on a concentration-response (C-R) function, the population in that grid cell, and the baseline countywide incidence rates. The total impacts for the affected population in the modeling domain would then be obtained by summing the results from each grid cell.

Hypothetical Example:

A small 2 mile by 2 mile region next to a rail yard within county X has about 10,000 persons over the age of 30, exposed to an estimated diesel PM annual-average concentration of $0.2 \mu\text{g}/\text{m}^3$. Using the baseline death rate of 0.009 death/person/year in county X and the C-R function of 10% increase in premature death risk per $10\text{-}\mu\text{g}/\text{m}^3$ increase in PM_{2.5} exposure, we would estimate about 0.9 death to result from this small population being exposed to PM.

Questions for peer reviewers:

- Is it appropriate to estimate PM mortality for each grid cell, then sum the results across the grids? It may be appropriate, but one issue will be small grid cell sizes leading to the potential for high variability or uncertainty of results.
- Is it appropriate to use countywide incidence rates for applications to smaller populations within a given county? If this is adjusted for differences in the age and sex distribution of the population, it is probably valid.

- How limited can the population size be? What is the minimum affected population size that would make this type of calculation meaningful? This will depend on variability and the size of the resultant confidence intervals (i.e., if the CI is too wide and the uncertainty is too high, then the results will be less meaningful)
- Are the population demographics important? Yes, because differences in the age-sex distribution of the small population vs. countywide population could introduce confounding. If there are differences in race-ethnicity, effect modification could potentially be an issue as well.
- Would this methodology be appropriate to estimate the impacts associated with a single source or a limited number of sources of PM? Yes, with the limitations above.
- Is the source of PM important in this application? Could this methodology be used if the PM is from gasoline combustion or woodsmoke, or a non-combustion type of source? Also, in addition to directly emitted PM emissions (primary PM), the conversion of nitrogen oxides to ammonium nitrates (secondary PM) can be modeled. Should one consider the relative contribution of secondary sources compared to the primary PM source in a small population? Yes.-
- What other criteria should be used to determine when such an estimation is appropriate?

B. Methodology based on emissions data only

When it is not feasible to model PM concentrations, emissions can be used to estimate health impacts as an alternative methodology. For example, to estimate health impacts associated with Goods Movement activities in the port of Los Angeles, an emissions inventory approach was used as shown below. Details for this methodology can be found in the CARB 2006 report.

5. Use ARB's estimated county-specific PM_{2.5} concentrations attributed to diesel sources in year 2000 (CARB 1998).
6. Calculate the premature deaths for the base year 2000 by applying a C-R function to the exposed population for a county.
7. Associate the health impacts with the total diesel PM emission inventory for that county in the base year 2000 to determine the number of tons emitted per annual death. This is called the "tons-per-death" factor for the county.
8. Apply the tons-per-death factor to the diesel PM emission inventory for a single source to estimate the average annual deaths associated only with exposure to these emissions, adjusting for population growth between the year of interest and the base year 2000¹¹. Note that the diesel PM emissions from the single source may be small compared to the county's emission inventory used in step 3 above.

¹¹ The impact for year 2005 Goods Movement emissions would be calculated by dividing the emissions by the "tons per death" factor in each county, multiplied by the ratio of year 2005 population over year 2000 population.

Hypothetical Example:

ARB estimated that the diesel PM concentration in county Y is $2 \mu\text{g}/\text{m}^3$ for year 2000. This value is used in conjunction with the county's population of 800,000 persons and baseline death rate of 0.009 death/person/year to derive an estimated 136 premature deaths. The total diesel PM emission inventory in county Y is 1,360 tons in year 2000; hence, the tons-per-death factor is 10. A single source which produces 20 annual tons of diesel PM emissions in year 2005 is then estimated to be responsible for about 2.2 premature deaths by using $(20 \text{ tons}/10 \text{ tons-per-death}) * (880,000 \text{ persons}/800,000 \text{ persons})$, where 880,000 indicates the county's population in 2005.

Questions for peer reviewers:

- Is it appropriate to estimate PM mortality based solely on the emissions from a particular source? An issue will be the variability of estimates and how wide the confidence interval will be for estimation of the impact of a single source.
- How limited can the size of the population affected by the emissions from a single source be? What is the minimum affected population size that would make this type of calculation meaningful? Uncertain
- What should the population demographics be?
- Is the source of PM important in this application? As described in the previous section, could other sources of PM be considered? Yes, potentially. Also, should one consider the relative contribution of secondary PM compared to primary PM?
- What other criteria should be used to determine when such an estimation is appropriate? Key issues are variability / precision of the estimate (is it too unprecise to be meaningful); generalizability (is the population exposed to the point source sufficiently similar to that from which health effects estimates were derived); impact of specific types of PM.

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CARB 1998. California Air Resources Board, Proposed Identification of Diesel Exhaust as a Toxic Air Contaminant. Appendix III. Part A: Exposure Assessment, available at http://www.arb.ca.gov/toxics/id/summary/diesel_a.pdf.

CARB 2006. California Air Resources Board, "Quantification of the Health Impacts and Economic Valuation of Air Pollution From Ports and Goods Movement in California." Appendix A in Emission Reduction Plan for Ports and Goods Movement. March 22, 2006, available at http://www.CARB.ca.gov/planning/qmerp/march21plan/appendix_a.pdf

B.3 Richard Flagan

Comments on Proposed Methodology for Estimating Health Impacts Associated with Exposures to Specific Emission Sources

In my comments on the proposed methodology for county-wide estimation of health impacts, I raised a question that becomes even more important when one seeks to apply that methodology to estimate health impacts of specific emission sources: present

air quality data is obtained using equipment that provides mass based measurements of relatively coarse size fractions (PM_{2.5} and PM₁₀) from instruments located at a small number of monitoring stations.

Numerous recent studies indicate that small particles that contribute little to the aerosol mass loading may impact health much more significantly than their mass concentrations would suggest (Oberdorster et al., 2000; Donaldson et al., 200). Moreover, studies of health impacts of exposures to ultrafine particles near busy highways (Brunekreef et al., 1997), combined with direct measurements of ultrafine particles as a function of distance from the highway (Zhu et al., 2002; Shi et al., 2001; Zhang et al., 2005; Jacobson et al., 2005), raise questions about the suitability of data obtained at present community monitoring stations for assessing health impacts of some of the sources identified in this proposed methodology; community monitoring stations have traditionally been located some distance from local sources to prevent biasing *samples* in the way that *exposures* will naturally be biased. The aforementioned highway studies reported substantial concentration, and hence exposure, variations over distances of a few hundred meters. The probabilistic health impact model is exponential in PM exposure (if my interpretation of the original methodology report is correct), so averaging exposures over a range with substantial variations will underestimate the health impacts on those individuals closest to the source if such variations are important for the sources of interest. Thus, it is reasonable to consider alternate approaches when addressing individual sources.

Coupling of emission data with an air dispersion model could address these variations in exposure, although the 2 mile by 2 mile grid cell suggested in the example calculation would miss the effects seen in the exposures to diesel emissions near highways carrying significant heavy-duty truck traffic. If the model were based upon the interpolation of data from the carefully sited community monitoring stations, exposure estimates might differ significantly from reality. Moreover, if the model only addresses dispersion, excluding the coagulation, condensation, evaporation, and chemical reaction processes that have been found to lead to the observed rapid variations in fine particle concentrations, exposure estimates may be further compromised.

What is missing in the present epidemiological data is an assessment of the impact of particular constituents of the atmospheric aerosol, either alone or in combination with other constituents of the aerosol or, perhaps, gaseous pollutants. When one applies the broad area results to a specific source, there is a danger that the local emissions doseresponse function may differ dramatically from that of the urban air-shed average. Exposure to a high PM_{2.5} level near a harbor or rail yard with a large influence of diesel emission would be very different than an equal mass exposure to a marine aerosol (sea salt) at the beach. On the other hand, if the local source is reflective of major pollutant emissions in the urban area, application of the empirical dose-response function could be an excellent approximation; in other cases, it might provide a lower-bound estimate of the health impacts.

The use of the emissions-data-only approach assumes that the health impacts are

strictly linear in particulate-mass concentration; one important implication of this result is that the hypothesized threshold for health effects is dropped from consideration. This may not be an issue since, when near sources, concentrations below the threshold are unlikely. This model assumes that all sources impact health equally on a mass emission basis. Lacking more detailed information about the origins of the health impacts, the approach should provide reasonable estimates.

Small population samples may introduce systematic uncertainties, both in exposure and in susceptibility. On the other hand, applying the health effects correlations to a spatially resolved population exposure may give better estimates of aggregate impacts than would calculations based upon exposures averaged over a city, particularly if the response function is nonlinear.

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B.4 Alan Hubbard

I will answer the questions below, but make a few general comments first. I am not an expert in risk assessment and I assume this document is addressing different methods of risk assessment given the parameters (dose-response) of PM exposure and baseline population mortality risk have been estimated. My expertise is in estimating these parameters, not risk assessment based on the estimated parameters. Thus, my comments should be taken in this context.

Proposed Methodology for Estimating Health Impacts Associated with Exposures to Specific Emission Sources

Health impacts from PM exposure are commonly estimated at the statewide or a similarly large geographic scale because (in part) these estimates are based on epidemiologic studies that relied on single ambient air monitoring stations to represent regional exposures to the pollutant. Our interest is in refining and applying such estimation techniques to finer scales, for small populations being affected by small changes in pollutant concentrations that would result from a single or few sources of emissions. The peer reviewers are being asked to comment on these applications.

Below is a summary of two methodologies that could be used to estimate health impacts associated with exposures to PM resulting from specific sources in a limited geographical area. The discussion is divided into two sections based on available information on the pollutant concentration: a) modeled concentrations and b) emissions data. Examples using ports and goods movement are shown to facilitate the discussion.

A. Methodology based on modeled concentrations

In the first scenario, suppose an air dispersion model is used to estimate ambient concentrations of PM in a limited geographic area affected by emissions from a specific source or group of sources. Examples would be locomotive emissions at a rail yard or all sources of diesel (trucks, locomotives, ships) at a California port or harbor. In this scenario, the annual average ambient diesel PM concentration would be estimated by grid cells using a model such as U.S. EPA ISCST3. For each grid cell, the premature death could be estimated based on a concentration-response (C-R) function, the population in that grid cell, and the baseline countywide incidence rates. The total impacts for the affected population in the modeling domain would then be obtained by summing the results from each grid cell.

Hypothetical Example:

A small 2 mile by 2 mile region next to a rail yard within county X has about 10,000 persons over the age of 30, exposed to an estimated diesel PM annual-average concentration of $0.2 \mu\text{g}/\text{m}^3$. Using the baseline death rate of 0.009 death/person/year in county X and the C-R function of 10% increase in premature death risk per $10\text{-}\mu\text{g}/\text{m}^3$ increase in PM_{2.5} exposure, we would estimate about 0.9 death to result from this small population being exposed to PM.

Questions for peer reviewers:

- Is it appropriate to estimate PM mortality for each grid cell, then sum the results across the grids?

Given the accuracy of dose-response model and baseline mortality estimate, I can not see an obvious reasons why this would not be appropriate.

- Is it appropriate to use countywide incidence rates for applications to smaller populations within a given county?

That depends on the modeling assumptions of the dose response and the accuracy of the baseline hazard rate in the small population: is the relative hazard (RH) for a unit increase in PM the same, no matter what the baseline characteristics (is there no effect modification) and can one estimate accurately the baseline hazard in this group?

- How limited can the population size be? What is the minimum affected population size that would make this type of calculation meaningful?

Not qualified to answer this. Depends on how generally the dose-response model applies.

- Are the population demographics important?

In so much as the dose-response model varies by the demographic characteristics, then they become important.

- Would this methodology be appropriate to estimate the impacts associated with a single source or a limited number of sources of PM?

Not qualified to answer this.

- Is the source of PM important in this application? Could this methodology be used if the PM is from gasoline combustion or woodsmoke, or a non-combustion type of source? Also, in addition to directly emitted PM emissions (primary PM), the conversion of nitrogen oxides to ammonium nitrates (secondary PM) can be modeled. Should one consider the relative contribution of secondary sources compared to the primary PM source in a small population?

Not qualified to answer this.

- What other criteria should be used to determine when such an estimation is appropriate?

Just main points above – to determine the number of excess deaths due to PM accurately, requires that the dose-response model and baseline rate, as estimated on a larger population, are the same in smaller sub-populations.

B. Methodology based on emissions data only

When it is not feasible to model PM concentrations, emissions can be used to estimate health impacts as an alternative methodology. For example, to estimate health impacts

associated with Goods Movement activities in the port of Los Angeles, an emissions inventory approach was used as shown below. Details for this methodology can be found in the CARB 2006 report.

9. Use ARB's estimated county-specific PM_{2.5} concentrations attributed to diesel sources in year 2000 (CARB 1998).
10. Calculate the premature deaths for the base year 2000 by applying a C-R function to the exposed population for a county.
11. Associate the health impacts with the total diesel PM emission inventory for that county in the base year 2000 to determine the number of tons emitted per annual death. This is called the "tons-per-death" factor for the county.
12. Apply the tons-per-death factor to the diesel PM emission inventory for a single source to estimate the average annual deaths associated only with exposure to these emissions, adjusting for population growth between the year of interest and the base year 2000¹². Note that the diesel PM emissions from the single source may be small compared to the county's emission inventory used in step 3 above.

¹² The impact for year 2005 Goods Movement emissions would be calculated by dividing the emissions by the "tons per death" factor in each county, multiplied by the ratio of year 2005 population over year 2000 population.

Hypothetical Example:

ARB estimated that the diesel PM concentration in county Y is $2 \mu\text{g}/\text{m}^3$ for year 2000. This value is used in conjunction with the county's population of 800,000 persons and baseline death rate of 0.009 death/person/year to derive an estimated 136 premature deaths. The total diesel PM emission inventory in county Y is 1,360 tons in year 2000; hence, the tons-per-death factor is 10. A single source which produces 20 annual tons of diesel PM emissions in year 2005 is then estimated to be responsible for about 2.2 premature deaths by using $(20 \text{ tons}/10 \text{ tons-per-death}) * (880,000 \text{ persons}/800,000 \text{ persons})$, where 880,000 indicates the county's population in 2005.

Questions for peer reviewers:

- Is it appropriate to estimate PM mortality based solely on the emissions from a particular source?

Seems appropriate to me.

- How limited can the size of the population affected by the emissions from a single source be? What is the minimum affected population size that would make this type of calculation meaningful?

Comments in previous example about the population size apply here.

- What should the population demographics be?

Distribution of demographic characteristics should be the same as those used to estimate the dose-response.

- Is the source of PM important in this application? As described in the previous section, could other sources of PM be considered? Also, should one consider the relative contribution of secondary PM compared to primary PM?

Not qualified to answer this.

- What other criteria should be used to determine when such an estimation is appropriate?

I have a more general comment about the parameter of interest. My guess is that the parameter of interest is the relative hazard (or excess deaths due to PM) comparing the current situation (distribution of PM) to a counterfactual scenario where a particular point source is removed. For instance, using the dose-response model, determine the excess deaths based on current PM concentrations (equivalent in the example to 1360 tons) and a scenario based on the concentration that would result when a particular point source is removed (in the example, $1360 - 20 = 1340$ tons). Perhaps in a log-linear or linear dose-response model, the results are equivalent to what is proposed, but this will not be true in general.

References

CARB 1998. California Air Resources Board, Proposed Identification of Diesel Exhaust

as a Toxic Air Contaminant. Appendix III. Part A: Exposure Assessment, available at http://www.arb.ca.gov/toxics/id/summary/diesel_a.pdf.

CARB 2006. California Air Resources Board, "Quantification of the Health Impacts and Economic Valuation of Air Pollution From Ports and Goods Movement in California." Appendix A in Emission Reduction Plan for Ports and Goods Movement. March 22, 2006, available at http://www.CARB.ca.gov/planning/gmerp/march21plan/appendix_a.pdf

B.5 Joel Kaufman

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A. Methodology based on modeled concentrations

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Hypothetical Example:

A small 2 mile by 2 mile region next to a rail yard within county X has about 10,000 persons over the age of 30, exposed to an estimated diesel PM annual-average concentration of $0.2 \mu\text{g}/\text{m}^3$. Using the baseline death rate of 0.009 death/person/year in county X and the C-R function of 10% increase in premature death risk per $10\text{-}\mu\text{g}/\text{m}^3$ increase in PM_{2.5} exposure, we would estimate about 0.9 death to result from this small population being exposed to PM.

Questions for peer reviewers:

- Is it appropriate to estimate PM mortality for each grid cell, then sum the results across the grids?
 - o Probably it is, but the uncertainties of estimates need to be explicitly stated.

- Is it appropriate to use countywide incidence rates for applications to smaller populations within a given county?
 - o This is probably the most appropriate approach
- How limited can the population size be? What is the minimum affected population size that would make this type of calculation meaningful?
 - o This needs to be answered based on calculation of the confidence intervals from the calculation.
- Are the population demographics important?
 - o Yes, especially age and gender; estimates need to be standardized by age and gender. Race/Ethnicity would be of secondary importance.
- Would this methodology be appropriate to estimate the impacts associated with a single source or a limited number of sources of PM?
 - o That depends on the robustness of the source-specific models. I would imagine that a limited number of sources could be modeled robustly in specific areas of the state.
- Is the source of PM important in this application? Could this methodology be used if the PM is from gasoline combustion or woodsmoke, or a non-combustion type of source? Also, in addition to directly emitted PM emissions (primary PM), the conversion of nitrogen oxides to ammonium nitrates (secondary PM) can be modeled. Should one consider the relative contribution of secondary sources compared to the primary PM source in a small population?
 - o I would think the method would be applicable and would be needed in certain regions of the state, esp for ammonium nitrate.
- What other criteria should be used to determine when such an estimation is appropriate?
 - o I would again emphasize the use of accurate estimates of uncertainty at each stage of the process (especially exposure estimation), and incorporating these uncertainties into the calculation of confidence intervals.

B. Methodology based on emissions data only

When it is not feasible to model PM concentrations, emissions can be used to estimate health impacts as an alternative methodology. For example, to estimate health impacts associated with Goods Movement activities in the port of Los Angeles, an emissions inventory approach was used as shown below. Details for this methodology can be found in the CARB 2006 report.

1. Use ARB's estimated county-specific PM_{2.5} concentrations attributed to diesel sources in year 2000 (CARB 1998).
2. Calculate the premature deaths for the base year 2000 by applying a C-R function to the exposed population for a county.
3. Associate the health impacts with the total diesel PM emission inventory for that county in the base year 2000 to determine the number of tons emitted per annual death. This is called the "tons-per-death" factor for the county.

4. Apply the tons-per-death factor to the diesel PM emission inventory for a single source to estimate the average annual deaths associated only with exposure to these emissions, adjusting for population growth between the year of interest and the base year 2000¹³. Note that the diesel PM emissions from the single source may be small compared to the county's emission inventory used in step 3 above.

¹³ The impact for year 2005 Goods Movement emissions would be calculated by dividing the emissions by the "tons per death" factor in each county, multiplied by the ratio of year 2005 population over year 2000 population.

Hypothetical Example:

ARB estimated that the diesel PM concentration in county Y is $2 \mu\text{g}/\text{m}^3$ for year 2000. This value is used in conjunction with the county's population of 800,000 persons and baseline death rate of 0.009 death/person/year to derive an estimated 136 premature deaths. The total diesel PM emission inventory in county Y is 1,360 tons in year 2000; hence, the tons-per-death factor is 10. A single source which produces 20 annual tons of diesel PM emissions in year 2005 is then estimated to be responsible for about 2.2 premature deaths by using $(20 \text{ tons}/10 \text{ tons-per-death}) * (880,000 \text{ persons}/800,000 \text{ persons})$, where 880,000 indicates the county's population in 2005.

Questions for peer reviewers:

- Is it appropriate to estimate PM mortality based solely on the emissions from a particular source?
 - o The issue again is the accuracy of the emission inventories.
- How limited can the size of the population affected by the emissions from a single source be? What is the minimum affected population size that would make this type of calculation meaningful?
 - o This needs to be answered based on calculation of the confidence intervals from the calculation.
- What should the population demographics be?
 - o Estimates need to be standardized by age and gender.
- Is the source of PM important in this application? As described in the previous section, could other sources of PM be considered? Also, should one consider the relative contribution of secondary PM compared to primary PM?
 - o It is my understanding that estimates of exposure to secondary PM requires modeling as described above so would not be easily done in this approach.
- What other criteria should be used to determine when such an estimation is appropriate?
 - o I would again emphasize the use of accurate estimates of uncertainty at each stage of the process (especially exposure estimation), and incorporating these uncertainties into the calculation of confidence intervals.

References

CARB 1998. California Air Resources Board, Proposed Identification of Diesel Exhaust as a Toxic Air Contaminant. Appendix III. Part A: Exposure Assessment, available at http://www.arb.ca.gov/toxics/id/summary/diesel_a.pdf.

CARB 2006. California Air Resources Board, "Quantification of the Health Impacts and Economic Valuation of Air Pollution From Ports and Goods Movement in California." Appendix A in Emission Reduction Plan for Ports and Goods Movement. March 22, 2006, available at http://www.CARB.ca.gov/planning/gmerp/march21plan/appendix_a.pdf

B.6 Joel Schwartz

Additional Comments of Joel Schwartz

Here are my responses to the additional questions asked about local risk estimation.

General Comment: The expected value of uncertainty is not zero. Yet if a risk assessment is not done, all statements of qualification to the contrary notwithstanding, decision makers will tend to make decisions as if the risk is zero. This is clearly inappropriate. Hence, the appropriate thing is always to do a risk assessment, but to appropriately qualify the uncertainties. When the direction of likely bias is known, say that. Equally importantly, when the uncertainty is as likely to be an underestimate as an overestimate, say that. These statements are more important than actual estimates of the magnitude of the uncertainty for three reasons. First, they are subject to less error. It is easier to determine the sign of an effect than its magnitude. Second, they are important for decision making—an intelligent decision maker needs to know if most of the uncertainty would push the estimates in a particular direction. And third, if the estimates are likely unbiased (that is, as likely an overestimate as an underestimate), then while any particular decision may, in the light of future further evidence, have over or under estimated the risk benefit ratio, on average, such decisions will be the correct ones, and that is also important for decision makers to know. So my general comment is yes, do the risk estimation, but....spend a good amount of effort identifying the sources of uncertainty, their likely direction of bias if any, and their likely magnitude. But do something.

One key issue that applies to most of what follows is the question of whether it is best to use the same C-R relationship between PM of different sources and mortality. The most commonly available information is for PM2.5. However, the Dutch cohort, which has just produced a new report, clearly sees effect estimates for traffic particles (measured as BS) that are larger than the average estimate for PM2.5. This suggests that Diesel particles, the major source of black particles, are more than averagely toxic.

Specific Comments:

Questions for peer reviewers:

- *Is it appropriate to estimate PM mortality for each grid cell, then sum the results across the grids?*

Yes, it is appropriate to estimate mortality within small grid cells, because that better captures the highly non-uniform distribution of the exposure across the county. If done reasonably, and summed across all grid cells within the county, many of the sources of error will tend to cancel out for the sum over the county. It would be appropriate, after paying attention to my further comments below, to report that sum. It would not be appropriate to report the values in each cell, because the high degree of uncertainty within them makes the individual cell estimates too noisy to base more local risk decisions on, and too noisy to communicate to the residents.

- *Is it appropriate to use countywide incidence rates for applications to smaller populations within a given county?*

This requires more care. If the distribution of population characteristics that determine baseline rates is random with respect to exposure, then again, performing such estimates creates random noise, which cancels out when averaged over all cells. However, it is unlikely that this is the case. Consider the examples, such as a port or rail yard, where concentrations of diesel particles likely falls off quickly with distance. Clearly, exposure is concentrated closer to the source. What about susceptibility? Death rates are considerably higher in persons of lower socio-economic condition, and such persons are much more likely to live close to undesirable activities, such as rail yards. Hence it would be appropriate to take this into account. SES data is available on the block group level, which is a geographic area with a typical population of 1500, so this information could be easily obtained by your 4 sq mile grid cells. Baseline mortality rates by county may not be computed by SES routinely. However, it would be better to look at the relative mortality by SES for the entire state, and apply that relative ratio to the County mortality in the county of interest, and then, based on census data, calculate an adjusted baseline mortality rate in each grid cell. Why? Because if poorer people live closer to the sources of emissions and have higher baseline mortality rates, ignoring this is a source of bias, whereas the procedure outlined above has considerable uncertainty, but no obvious bias. No doubt, better approaches could be derived.

A related issue is age. Mortality rates vary considerably by age, and small areas can differ substantially from the county average. I recently did an analysis where an entire census block group was an elderly housing complex. Clearly, it had a considerably different baseline mortality rate. Whether this is an issue or not in your assessments I do not know. But you should certainly check to see whether the population age distribution is different in your 4 square mile cell than in the county as a whole. If they are similar, fine, if there is a substantial difference, you can adjust as above.

- *How limited can the population size be? What is the minimum affected population size that would make this type of calculation meaningful?*

What the population size determines is the noise in the estimate. Meaningful is a different question. A model that predicts 2 excess deaths in one case and 50 in another presumably has considerable uncertainty bands around those estimates. What is less uncertain is that the effect in the first case is smaller than the effect in the second. This is presumably meaningful.

- *Are the population demographics important?*

Very important. See above.

- *Would this methodology be appropriate to estimate the impacts associated with a single source or a limited number of sources of PM?*

Yes, subject to the concerns stated above.

- *Is the source of PM important in this application? Could this methodology be used if the PM is from gasoline combustion or woodsmoke, or a non-combustion type of source? Also, in addition to directly emitted PM emissions (primary PM), the conversion of nitrogen oxides to ammonium nitrates (secondary PM) can be modeled. Should one consider the relative contribution of secondary sources compared to the primary PM source in a small population?*

The approaches are applicable to other sources. Care again, is critical. First of all, since a major source of both bias and uncertainty is the variation in the baseline mortality rate in small areas, sources that are more homogeneously distributed, such as secondary secondary nitrates, are actually easier to deal with. While the attributable risk in each area will be smaller because the risk is not as concentrated geographically, this is actually an advantage in coming up with an estimate of overall effect. Of course, the estimates are only as good as the model, and models for secondary aerosols, whether nitrates, organic carbon, or whatever, have two parts—dispersion, similar to the models for primary particles, and atmospheric chemistry, which adds a layer of complexity and uncertainty. But unless there is evidence from monitored data that the models are biased, it is still reasonable to use them, subject to the usual caveats.

Wood smoke is a tricky one because it is emitted from low chimneys, near where people live, and one expects that the exposure efficiency is much greater than the models would estimate. This is also true for traffic particles, and please examine the literature on exposure efficiency. Basically, the probability of such a particle making it into a lung is greater than would be expected from models that predict exposure on scales of a few hundred meters and larger. There is immediate exposure from the source to people right there that is usually underestimated by models that focus on the pollutant when it is better mixed.

As I noted in the introduction, there is the issue of whether the same PM_{2.5} coefficient should be used for all sources.

- *What other criteria should be used to determine when such an estimation is appropriate?*

2nd Method: Questions for peer reviewers:

- *Is it appropriate to estimate PM mortality based solely on the emissions from a particular source?*

It is certainly appropriate. The issue is whether the coefficient should be adjusted. I think that the evidence is probably strong enough to suggest a larger coefficient for Diesel particles, and not yet clear for others. After all, what one is presumably estimating is the incremental increase in mortality for an increment in particles. So, if you know enough to use a different C-R, do so. If you don't, then as far as you can tell, the average one (i.e. the one for PM_{2.5}), is appropriate.

- *How limited can the size of the population affected by the emissions from a single source be? What is the minimum affected population size that would make this type of calculation meaningful?*

This is really the same question (and answer as for the other method).

- *What should the population demographics be?*

It is important to take demographics into account as they at minimum affect baseline mortality. There is also some evidence of differential effects of PM.

- *Is the source of PM important in this application? As described in the previous section, could other sources of PM be considered? Also, should one consider the relative contribution of secondary PM compared to primary PM?*

It would not be appropriate to use linear rollback from emissions for secondary particles, as there are substantial nonlinearities in the atmospheric chemistry. Other sources could be considered, but again, as above, some attention needs to be paid to the intake fraction literature.

- *What other criteria should be used to determine when such an estimation is appropriate?*

C. Comments on Diesel PM Methodology

Two of the peer reviewers had expertise relevant to the development of the methodology for estimating diesel PM concentrations. Their comments are included in this section.

C.1 Jeffery Brook

Brief Comments on Methodology for Estimating Ambient Concentrations of Particulate Matter from Diesel-Fueled Engine Emissions

Reviewer: Dr. Jeffrey R. Brook, Senior Research Scientist, Environment Canada; Adjunct Professor, University of Toronto.

In light of the amount of information available, the proposed methodology is reasonable. Linking diesel particulate matter to NO_x concentration is attractive given a relatively large number of NO_x monitoring sites. The cross-checking with the past approach and with an alternate approach to determine α based upon source apportionment helps strengthen the results and ARB has highlighted assumptions and uncertainties and the overall lack of all the desired information clearly in this report.

A few issues to consider (along with the attached marked up version of the report):

The lower DRI estimate is discounted too readily based upon limited arguments. Why were 1995 and 2000 results compared to get 1.8 instead of comparisons this report implies were done for the gasoline-diesel split study? What is the possibility that the lower DRI result is due to changing engine technologies so that diesel particulate matter (DPM) emissions are less relative to NO_x ? In comparing these two years and groups the larger number of sample days considered by DRI should also carry some weight in the decision. If the DRI results are reconsidered then this suggests that the source apportionment approach may be leading to a lower α than selected here. This implies that the ARB approach is less conservative.

It should also be noted that the source apportionment approach to get DPM typically apportions the diesel contribution to OC and then scales to total PM. This potentially ignores the amount of EC that is from diesel emissions, as well as some inorganic species such as trace metals and primary sulfate. These additional PM constituents would likely increase the value of α .

In general, given the additional loss mechanism for NO_x in the atmosphere (chemical) compared to fine DPM, the expectation would be that α derived from ambient data would be larger than that derived from the emissions inventory. The results here, using Schauer's source apportionment values, support this. The DRI do not. However, it may well be that the DPM from the emissions inventory does include more than just organics and so the resulting α is larger. Thus, it would be useful for some more information on how the emissions inventory DPM is determined. Is this through the typical applications of the MOBILE emissions model with currently accepted emission factors?

Comments on Methodology for Estimating Ambient Concentrations of

Particulate Matter from Diesel-Fueled Engine Emissions

The proposed methodology would employ NO_x data to estimate particulate matter from diesel-fueled engine emissions. The approach is reasonable given that diesel-fueled engines are responsible for a major portion of the NO_x emissions state-wide, but only a small fraction of the particulate matter. Previously, diesel particulate matter was taken to be proportional to the PM_{10} mass concentration, a very tenuous assumption even though different scaling factors were applied in urban or rural environments. The use of PM_{10} is particularly problematic since the mechanisms of formation of particles larger than $2.5\mu\text{m}$ (or even $1\mu\text{m}$) differ dramatically from those that produce smaller particles. The coarse part of the size range of PM_{10} is dominated by crustal materials; $\text{PM}_{2.5}$ contains less, but still significant crustal and mechanically generated material.

The proposed methodology examines results from Schauer et al., and from the DRI group of Chow and coworkers. One citation is to work of Fujita et al., which appears to be reported only in a web page and is likely to be work that has not undergone critical peer review. The methodology uses the Schauer work as the primary reference. The results of the two studies appear to be in reasonable agreement, at least when corrected by the ratio of the means (1.8). Comparing the correlations shown in Fig. 3 (CHS, 1995) and Fig. 4 (DRI, 2000) one sees striking differences. The earlier study shows a correlation that appears to be consistent with a zero-intercept; the later one has fewer and more scattered data that do not appear consistent with the zero-intercept to which the correlation was forced. One outlier was removed from the early data to improve the fit; the uncertainty in the slope observed when it was not removed was comparable to that obtained in the later data set, a possible indication that the more recent experiments included a broader range of locations than did the earlier ones.

The comparison of the DPM/NO_x ratios suggests that at higher levels the range of values of the ratio decreases, but the means do not vary with the NO_x emission rates. This suggests that the method may provide useful estimates, with some caveats. The NO_x measurements are measured at community monitoring stations. The method proposes using an interpolation method to generate a smooth DPM curve from that sparse data set. For basin-wide exposure estimates, this approach will probably be reasonable; however it will likely underestimate the concentrations near sources because the community monitoring site locations have been chosen to minimize local source effects. Concentrations of some types of diesel particle vary dramatically with distance from highways or other sources as do some health effects (Brunekreef et al., 1997; Zhu et al., 2002; Shi et al., 2001; Zhang et al., 2005; Jacobson et al., 2005). Care will have to be exercised to ensure that the data smoothing does not introduce negative biases in regions that are strongly influenced by local emissions. For basin-wide estimates, this may be a relatively minor point, but it could be important for some calculations.

Minor points on report formatting

The report presents a number of figures, without limited discussion. The figures require

captions that explain what is being plotted; units are also required on the axis labels, e.g., what are the units of DMP/NO_x? One can guess from those plots that do have labels, but the reader shouldn't have to guess. I guess that NO_x refers to tons per day of emissions - again, I shouldn't have to guess.

References

Bruneekreef B, Janssen NAH, deHartog J, Harssema H, Knape M, vanVliet P. Air pollution from truck traffic and lung function in children living near motorways. *Epidemiology* 8:298-303 (1997).

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Zhang KM, Wexler AS, Niemeier DA, Zhu YF, Hinds WC, Sioutas C. Evolution of particle number distribution near roadways. Part III: Traffic analysis and on-road size resolved particulate emission factors. *Atmospheric Environment* 39:4155-4166 (2005).

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C.2 Richard Flagan

Comments on Methodology for Estimating Ambient Concentrations of Particulate Matter from Diesel-Fueled Engine Emissions

Richard C. Flagan, Ph.D.

California Institute of Technology

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Area Designations Maps / State and National

This page last reviewed September 7, 2010

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In contrast to the State area designations, the U.S. Environmental Protection Agency (U.S. EPA) makes national area designations for five criteria pollutants: ozone (8-hour standards; the 1-hour standard was revoked effective June 15, 2005), PM10, carbon monoxide, nitrogen dioxide, and sulfur dioxide. Although maps for the national area designations are provided below (designations as of September 2006), please refer to the [U.S. EPA website](#) for the most current information on the national area designations.

2010 State Area Designations

These changes were approved by the Board on March 25, 2010. These maps are the most current available and represent air quality based on 2006 to 2008 monitoring data.

- Ozone ([2010 area designation map](#), [1-hour area classification map](#))
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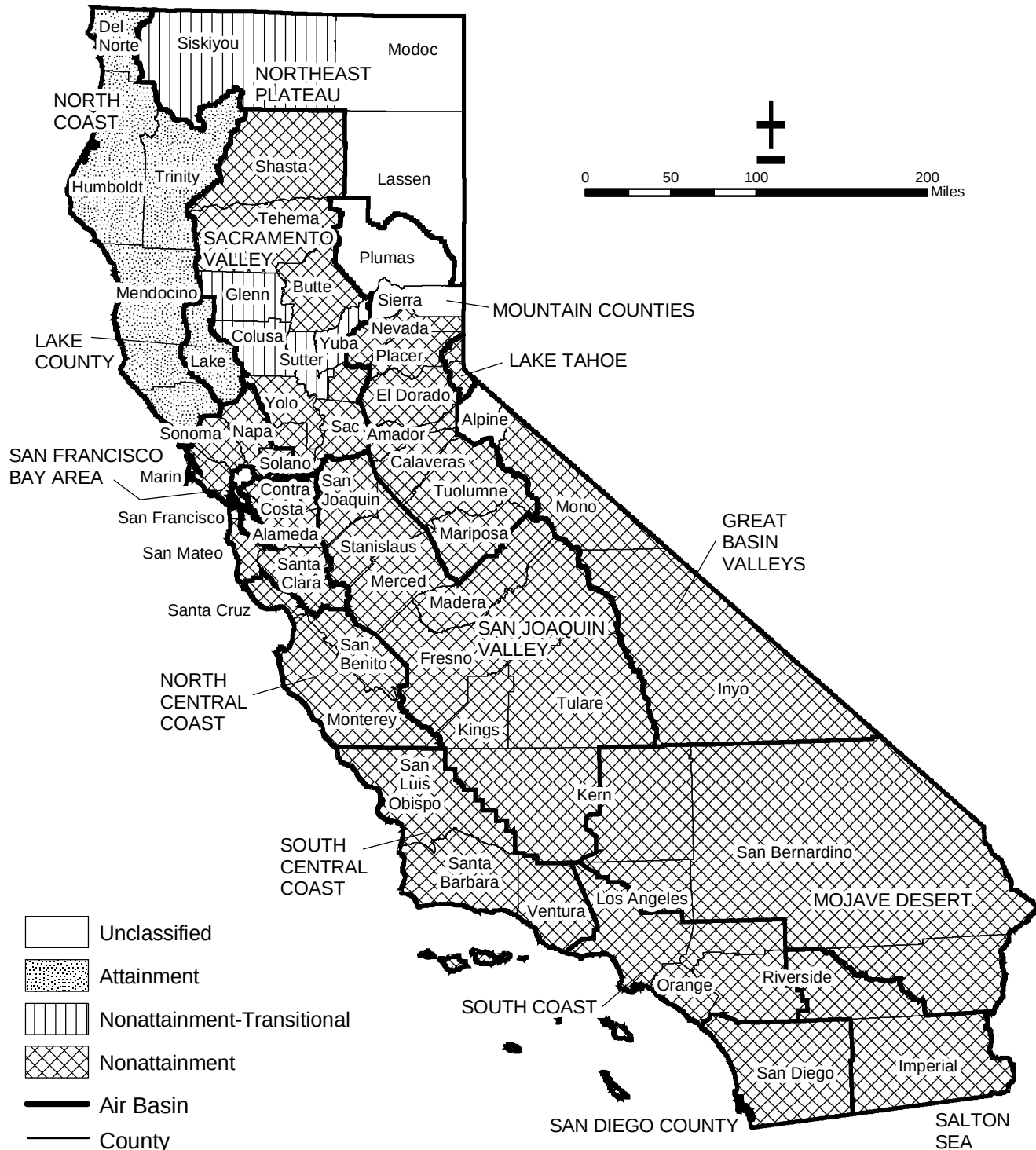
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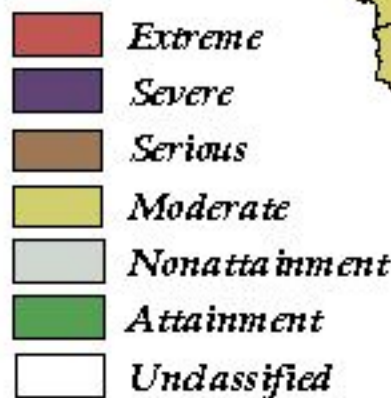
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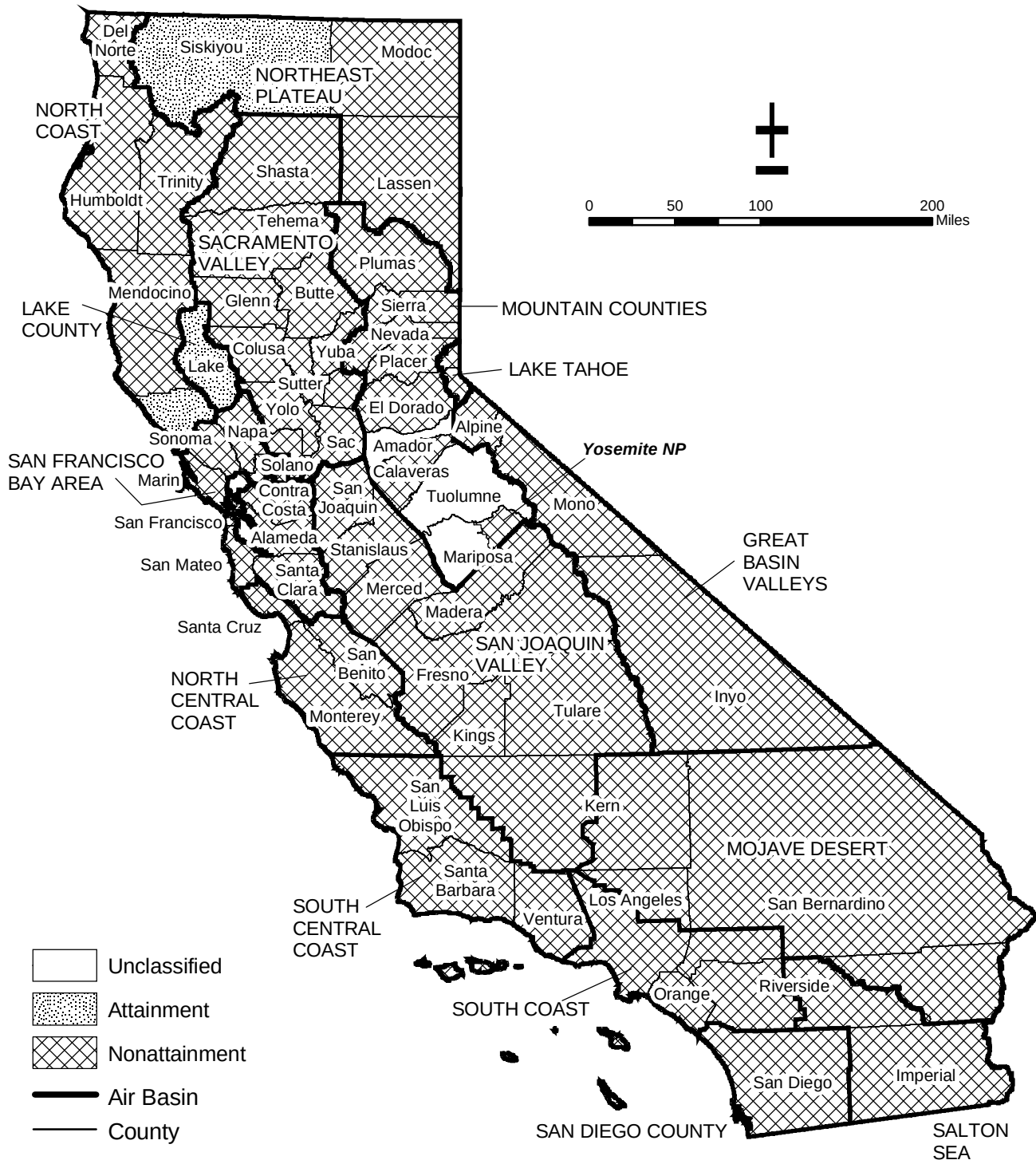
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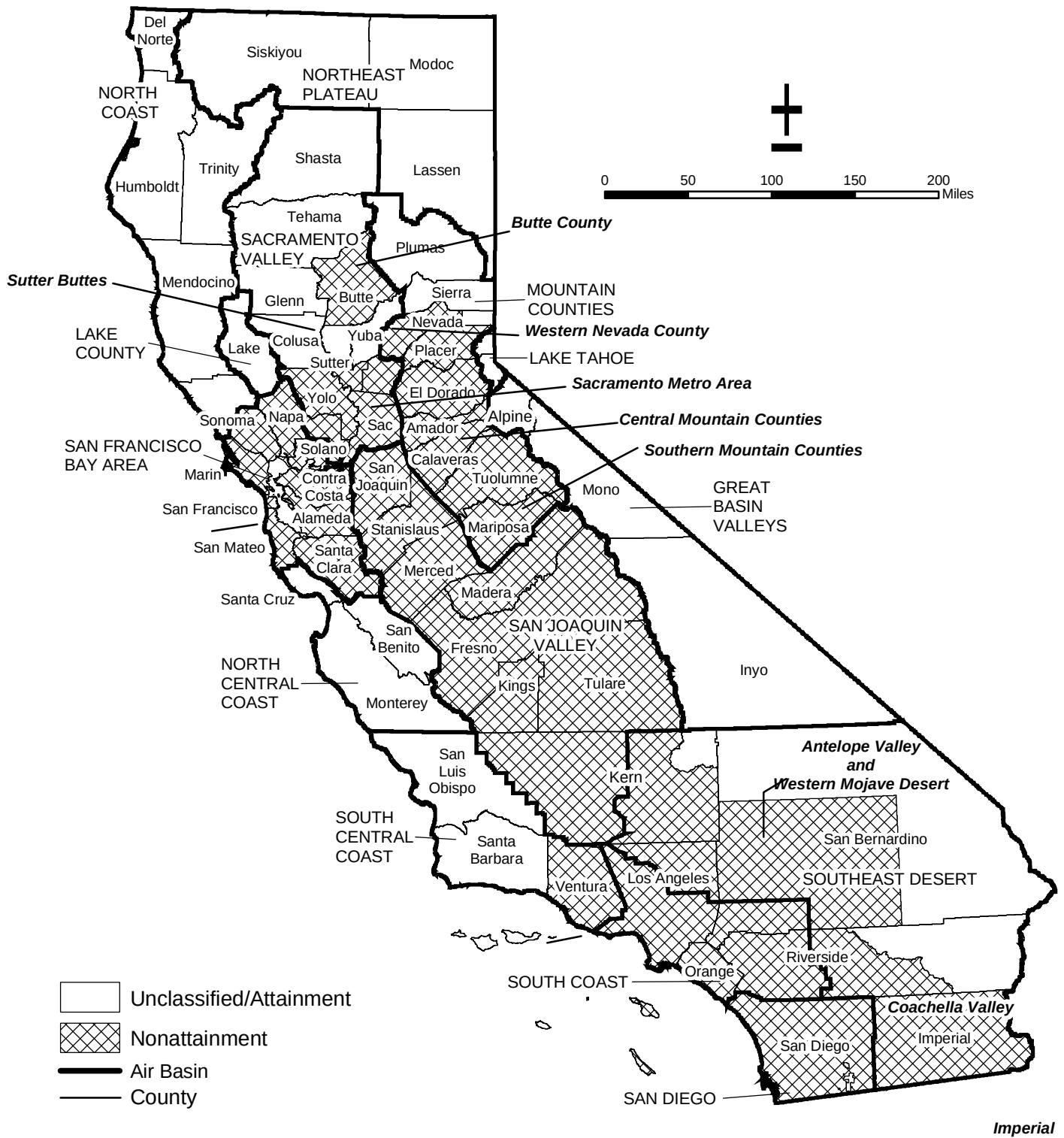
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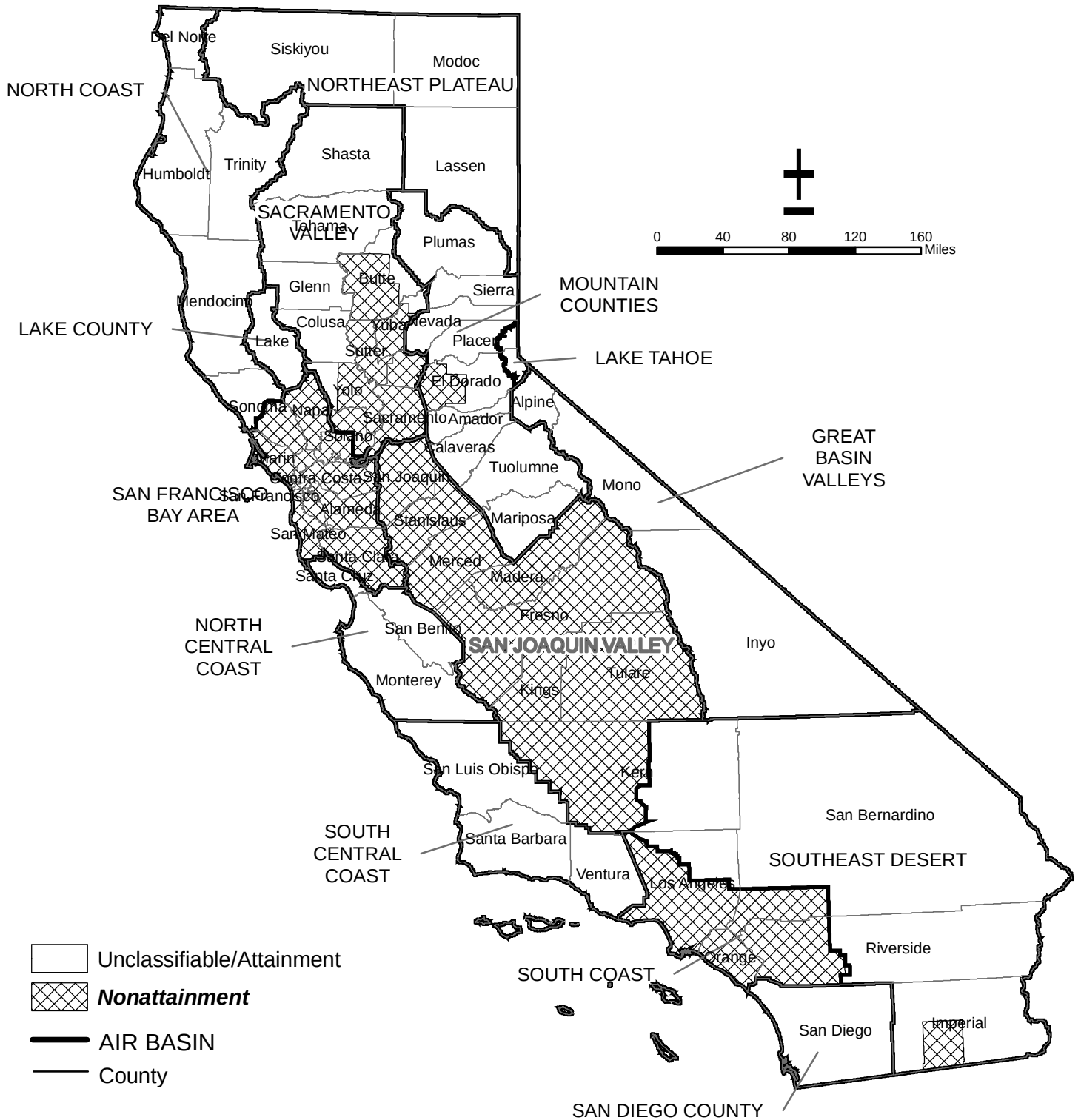
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Area Designations for National Ambient Air Quality Standards PM2.5



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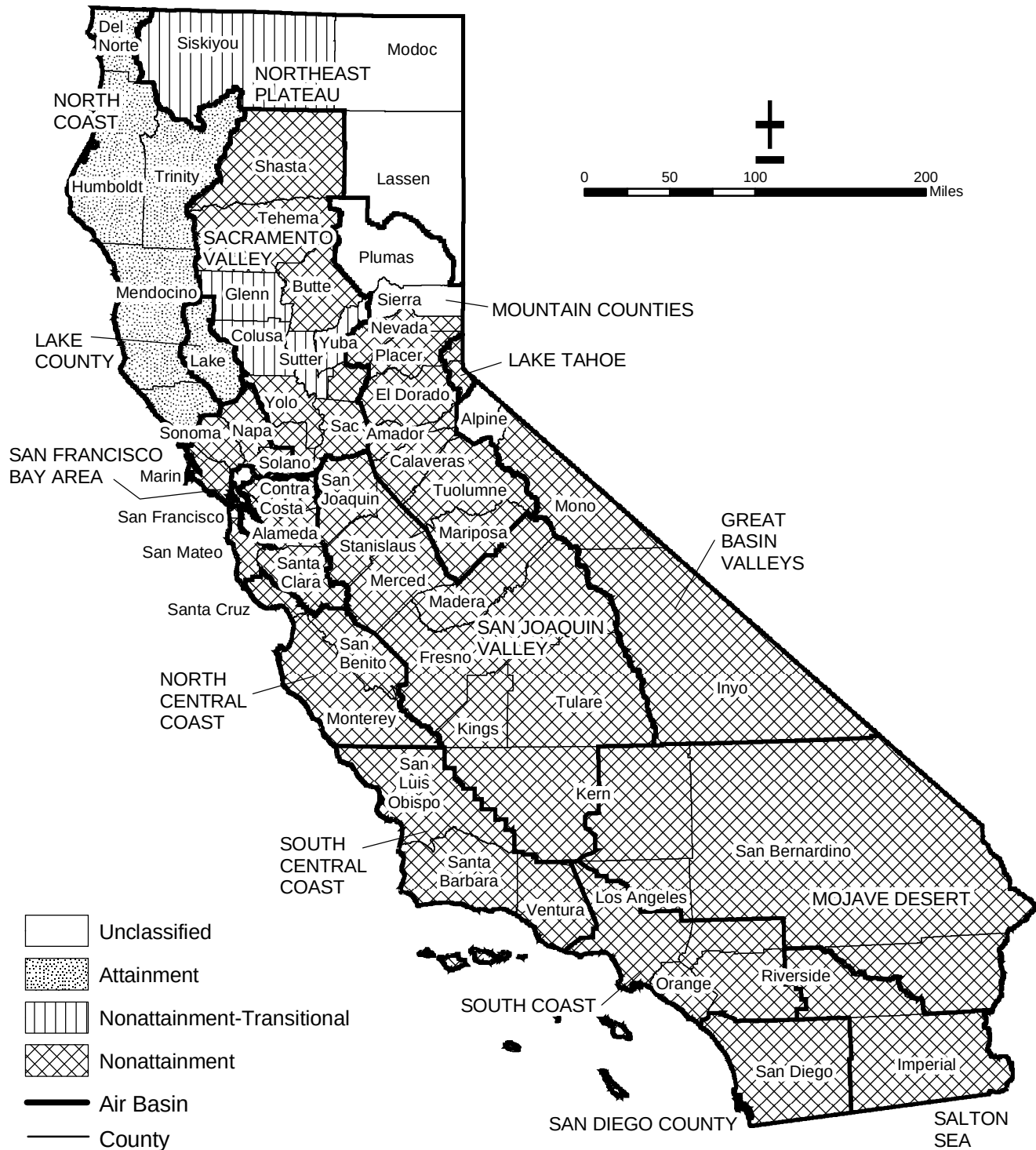
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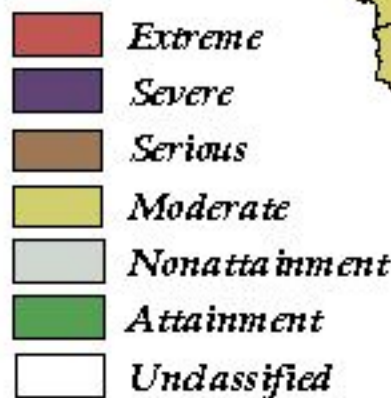
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Area Classification
OZONE*



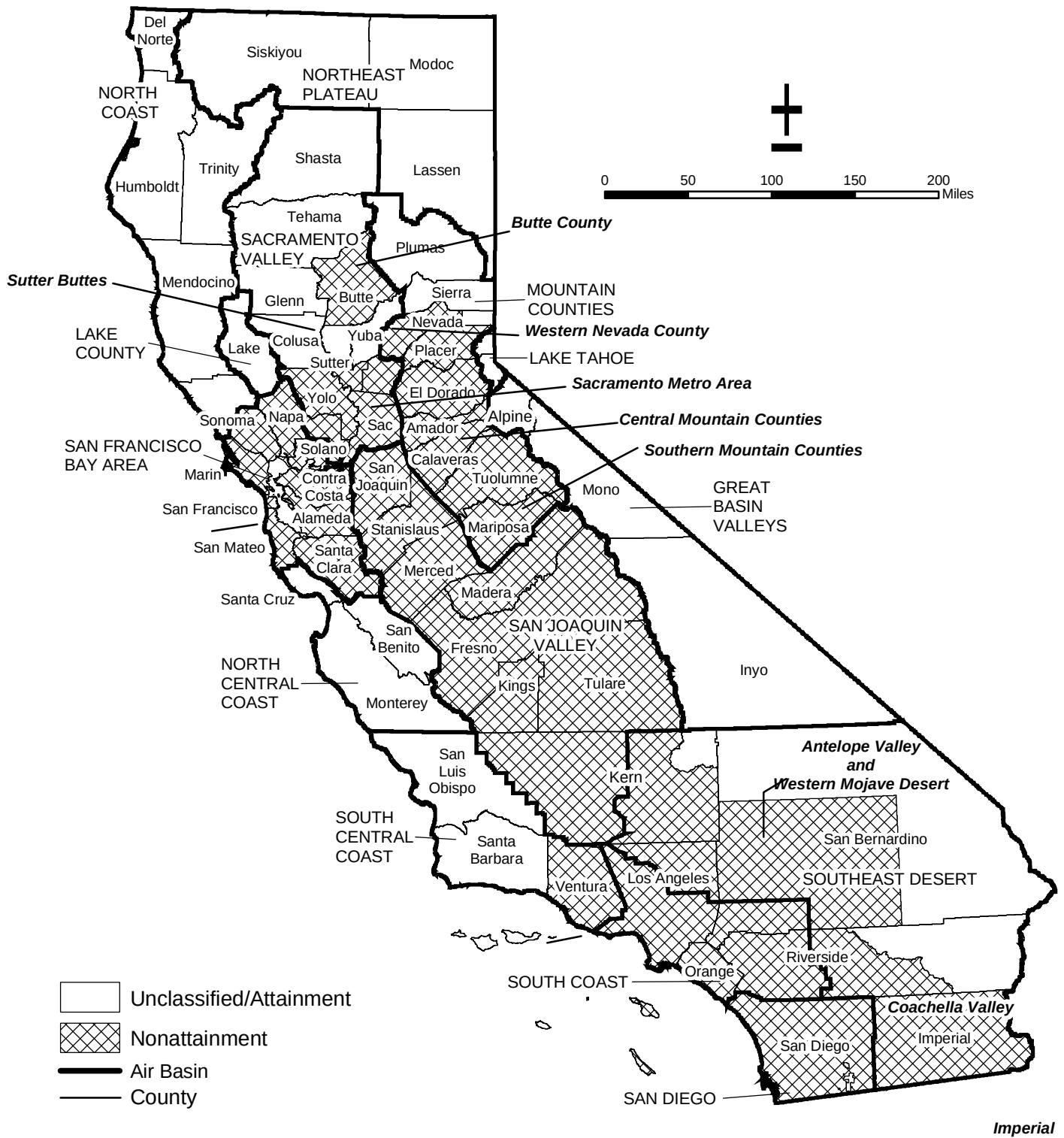
2010 Area Designations for State Ambient Air Quality Standards PM_{2.5}



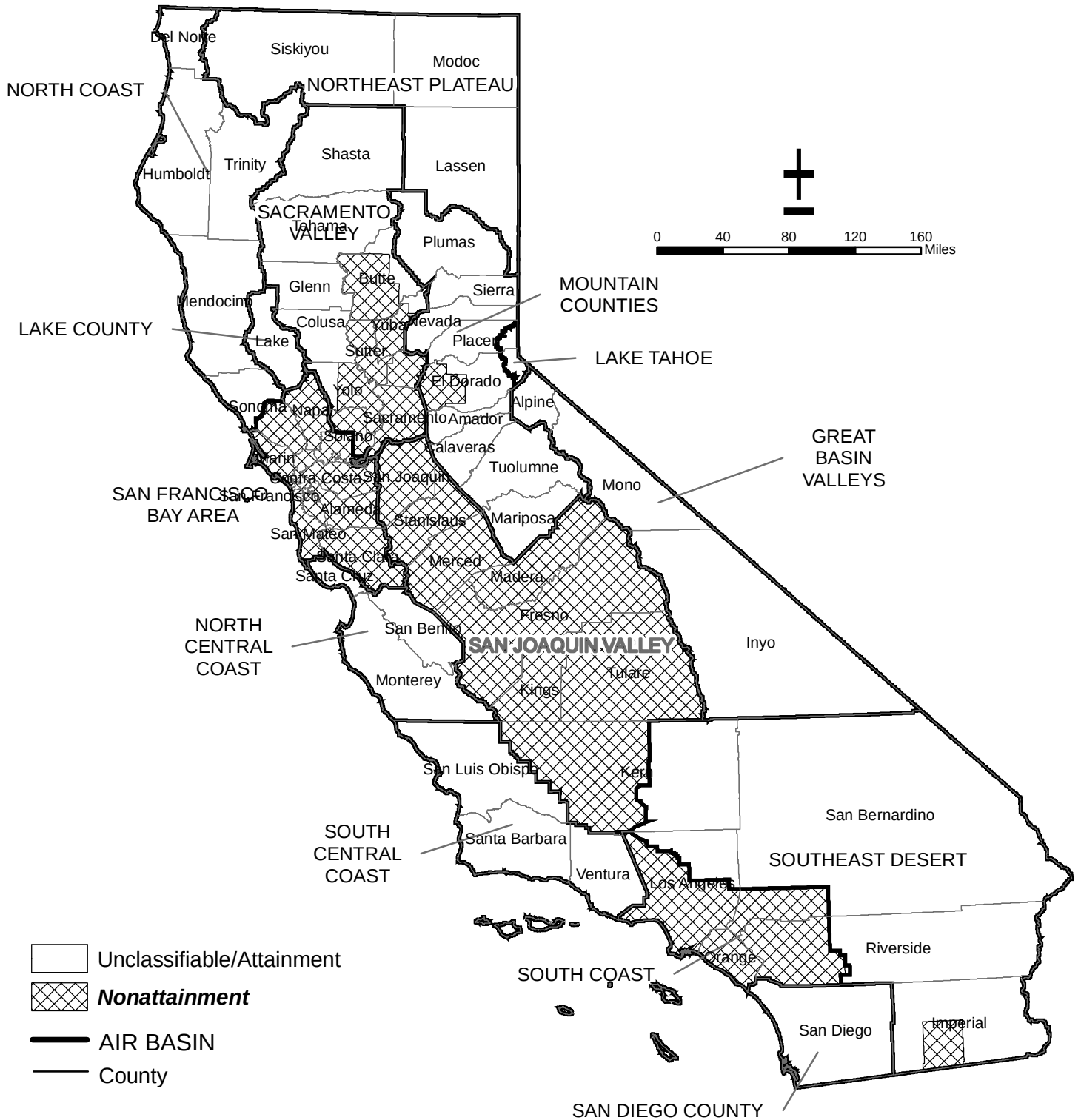
2010 Area Designations for State Ambient Air Quality Standards PM10



Area Designations for National Ambient Air Quality Standards 8-HOUR OZONE



Area Designations for National Ambient Air Quality Standards PM2.5



2010 Area Designations for State Ambient Air Quality Standards NITROGEN DIOXIDE



Ambient Air Quality Standards

Pollutant	Averaging Time	California Standards ¹		Federal Standards ²		
		Concentration ³	Method ⁴	Primary ^{3,5}	Secondary ^{3,6}	Method ⁷
Ozone (O ₃)	1 Hour	0.09 ppm (180 µg/m ³)	Ultraviolet Photometry	—	Same as Primary Standard	Ultraviolet Photometry
	8 Hour	0.070 ppm (137 µg/m ³)		0.075 ppm (147 µg/m ³)		
Respirable Particulate Matter (PM ₁₀)	24 Hour	50 µg/m ³	Gravimetric or Beta Attenuation	150 µg/m ³	Same as Primary Standard	Inertial Separation and Gravimetric Analysis
	Annual Arithmetic Mean	20 µg/m ³		—		
Fine Particulate Matter (PM _{2.5})	24 Hour	No Separate State Standard		35 µg/m ³	Same as Primary Standard	Inertial Separation and Gravimetric Analysis
	Annual Arithmetic Mean	12 µg/m ³	Gravimetric or Beta Attenuation	15.0 µg/m ³		
Carbon Monoxide (CO)	8 Hour	9.0 ppm (10mg/m ³)	Non-Dispersive Infrared Photometry (NDIR)	9 ppm (10 mg/m ³)	None	Non-Dispersive Infrared Photometry (NDIR)
	1 Hour	20 ppm (23 mg/m ³)		35 ppm (40 mg/m ³)		
	8 Hour (Lake Tahoe)	6 ppm (7 mg/m ³)		—	—	—
Nitrogen Dioxide (NO ₂)	Annual Arithmetic Mean	0.030 ppm (57 µg/m3)	Gas Phase Chemiluminescence	53 ppb (100 µg/m ³) (see footnote 8)	Same as Primary Standard	Gas Phase Chemiluminescence
	1 Hour	0.18 ppm (339 µg/m ³)		100 ppb (188 µg/m ³) (see footnote 8)	None	
Sulfur Dioxide (SO ₂)	24 Hour	0.04 ppm (105 µg/m ³)	Ultraviolet Fluorescence	—	—	Ultraviolet Fluorescence; Spectrophotometry (Pararosaniline Method) ⁹
	3 Hour	—		—	0.5 ppm (1300 µg/m ³) (see footnote 9)	
	1 Hour	0.25 ppm (655 µg/m ³)		75 ppb (196 µg/m ³) (see footnote 9)	—	
Lead ¹⁰	30 Day Average	1.5 µg/m ³	Atomic Absorption	—	—	—
	Calendar Quarter	—		1.5 µg/m ³	Same as Primary Standard	High Volume Sampler and Atomic Absorption
	Rolling 3-Month Average ¹¹	—		0.15 µg/m ³		
Visibility Reducing Particles	8 Hour	Extinction coefficient of 0.23 per kilometer — visibility of ten miles or more (0.07 — 30 miles or more for Lake Tahoe) due to particles when relative humidity is less than 70 percent. Method: Beta Attenuation and Transmittance through Filter Tape.		No Federal Standards		
Sulfates	24 Hour	25 µg/m ³	Ion Chromatography			
Hydrogen Sulfide	1 Hour	0.03 ppm (42 µg/m ³)	Ultraviolet Fluorescence			
Vinyl Chloride ¹⁰	24 Hour	0.01 ppm (26 µg/m ³)	Gas Chromatography			

See footnotes on next page ...

For more information please call ARB-PIO at (916) 322-2990

California Air Resources Board (09/08/10)

1. California standards for ozone, carbon monoxide (except Lake Tahoe), sulfur dioxide (1 and 24 hour), nitrogen dioxide, suspended particulate matter—PM₁₀, PM_{2.5}, and visibility reducing particles, are values that are not to be exceeded. All others are not to be equaled or exceeded. California ambient air quality standards are listed in the Table of Standards in Section 70200 of Title 17 of the California Code of Regulations.
2. National standards (other than ozone, particulate matter, and those based on annual averages or annual arithmetic mean) are not to be exceeded more than once a year. The ozone standard is attained when the fourth highest eight hour concentration in a year, averaged over three years, is equal to or less than the standard. For PM₁₀, the 24 hour standard is attained when the expected number of days per calendar year with a 24-hour average concentration above 150 µg/m³ is equal to or less than one. For PM_{2.5}, the 24 hour standard is attained when 98 percent of the daily concentrations, averaged over three years, are equal to or less than the standard. Contact U.S. EPA for further clarification and current federal policies.
3. Concentration expressed first in units in which it was promulgated. Equivalent units given in parentheses are based upon a reference temperature of 25°C and a reference pressure of 760 torr. Most measurements of air quality are to be corrected to a reference temperature of 25°C and a reference pressure of 760 torr; ppm in this table refers to ppm by volume, or micromoles of pollutant per mole of gas.
4. Any equivalent procedure which can be shown to the satisfaction of the ARB to give equivalent results at or near the level of the air quality standard may be used.
5. National Primary Standards: The levels of air quality necessary, with an adequate margin of safety to protect the public health.
6. National Secondary Standards: The levels of air quality necessary to protect the public welfare from any known or anticipated adverse effects of a pollutant.
7. Reference method as described by the EPA. An “equivalent method” of measurement may be used but must have a “consistent relationship to the reference method” and must be approved by the EPA.
8. To attain this standard, the 3-year average of the 98th percentile of the daily maximum 1-hour average at each monitor within an area must not exceed 0.100 ppm (effective January 22, 2010). Note that the EPA standards are in units of parts per billion (ppb). California standards are in units of parts per million (ppm). To directly compare the national standards to the California standards the units can be converted from ppb to ppm. In this case, the national standards of 53 ppb and 100 ppb are identical to 0.053 ppm and 0.100 ppm, respectively.
9. On June 2, 2010, the U.S. EPA established a new 1-hour SO₂ standard, effective August 23, 2010, which is based on the 3-year average of the annual 99th percentile of 1-hour daily maximum concentrations. EPA also proposed a new automated Federal Reference Method (FRM) using ultraviolet technology, but will retain the older pararosaniline methods until the new FRM have adequately permeated State monitoring networks. The EPA also revoked both the existing 24-hour SO₂ standard of 0.14 ppm and the annual primary SO₂ standard of 0.030 ppm, effective August 23, 2010. The secondary SO₂ standard was not revised at that time; however, the secondary standard is undergoing a separate review by EPA. Note that the new standard is in units of parts per billion (ppb). California standards are in units of parts per million (ppm). To directly compare the new primary national standard to the California standard the units can be converted to ppm. In this case, the national standard of 75 ppb is identical to 0.075 ppm.
10. The ARB has identified lead and vinyl chloride as 'toxic air contaminants' with no threshold level of exposure for adverse health effects determined. These actions allow for the implementation of control measures at levels below the ambient concentrations specified for these pollutants.
11. National lead standard, rolling 3-month average: final rule signed October 15, 2008.



Toxic Air Contaminant Identification List

This page last reviewed October 27, 2010

This page provides information on substances identified as California toxic air contaminants.

Title 17, CCR, § 93000. Substances Identified As Toxic Air Contaminants.

Each substance identified in this section has been determined by the State Board to be a toxic air contaminant as defined in Health and Safety Code section 39655. If the State Board has found there to be a threshold exposure level below which no significant adverse health effects are anticipated from exposure to the identified substance, that level is specified as the threshold determination. If the Board has found there to be no threshold exposure level below which no significant adverse health effects are anticipated from exposure to the identified substance, a determination of "no threshold" is specified. If the Board has found that there is not sufficient available scientific evidence to support the identification of a threshold exposure level, the "Threshold" column specifies "None identified."

Substance	Threshold Determination
Benzene (C ₆ H ₆)	None identified
Ethylene Dibromide (BrCH ₂ CH ₂ Br; 1,2-dibromoethane)	None identified
Ethylene Dichloride (ClCH ₂ CH ₂ Cl; 1,2-dichloroethane)	None identified
Hexavalent chromium (Cr (VI))	None identified
Asbestos [asbestiform varieties of serpentine (chrysotile), riebeckite (crocidolite), cummingtonite-grunerite (amosite), tremolite, actinolite, and anthophyllite]	None identified
Dibenzo-p-dioxins and Dibenzofurans chlorinated in the 2,3,7 and 8 positions and containing 4,5,6 or 7 chlorine atoms	None identified
Cadmium (metallic cadmium and cadmium compounds)	None identified
Carbon Tetrachloride (CCl ₄ ; tetrachloromethane)	None identified
Ethylene Oxide (1,2-epoxyethane)	None identified
Methylene Chloride (CH ₂ Cl ₂ ; Dichloromethane)	None identified
Trichloroethylene (CCl ₂ CHCl; Trichloroethene)	None identified
Chloroform (CHCl ₃)	None identified
Vinyl chloride (C ₂ H ₃ Cl; Chloroethylene)	None identified
Inorganic Arsenic	None identified
Nickel (metallic nickel and inorganic nickel compounds)	None identified
Perchloroethylene (C ₂ Cl ₄ ; Tetrachloroethylene)	None identified
Formaldehyde (HCHO)	None identified
1,3-Butadiene (C ₄ H ₆)	None identified
Inorganic Lead	None identified
Particulate Emissions from Diesel-Fueled Engines	None identified
Environmental Tobacco Smoke	None identified

Note: Authority cited: Sections 39600, 39601 and 39662, Health and Safety Code. Reference: Sections 39650, 39660, 39661 and 39662, Health and Safety Code.

HISTORY

1. New section filed 9-23-85; effective thirtieth day thereafter (Register 85, No. 39). For history of former subchapter 7, see Registers 84, No. 10; 83, No. 2; 81, No. 48; 77, No. 12; and 74, No. 47.
2. Amendment filed 1-14-86; effective thirtieth day thereafter (Register 86, No. 3).
3. Amendment filed 2-10-86; effective thirtieth day thereafter (Register 86, No. 7).
4. Amendment filed 10-9-86; effective thirtieth day thereafter (Register 86, No. 43).

5. Amendment filed 11-25-86; effective thirtieth day thereafter (Register 86, No. 48).
6. Amendment filed 2-23-87; effective thirtieth day thereafter (Register 87, No. 9).
7. Amendment filed 10-8-87; operative 11-7-87 (Register 87, No. 43).
8. Amendment filed 3-15-88; operative 4-14-88 (Register 88, No. 13).
9. Amendment filed 7-22-88; operative 8-21-88 (Register 88, No. 31).
10. Amendment adding Methylene Chloride filed 6-7-90; operative 7-7-90 (Register 90, No. 30).
11. Amendment adding Trichloroethylene filed 2-27-91; operative 3-29-91 (Register 91, No. 13).
12. Amendment adding Vinyl chloride filed 5-10-91; operative 6-9-91 (Register 91, No. 25).
13. Editorial correction, including removal of Inorganic arsenic (Register 91, No. 25).
14. Amendment adding Chloroform filed 5-10-91; operative 6-9-91 (Register 91, No. 25).
15. Amendment adding Inorganic Arsenic filed 6-6-91; operative 7-6-91 (Register 91, No. 26).
16. Change without regulatory effect amending Trichloroethylene and adding Nickel filed 7-14-92 pursuant to section 100, title 1, California Code of Regulations (Register 92, No. 29).
17. Amendment adding Perchloroethylene filed 10-2-92; operative 11-1-92 (Register 92, No. 40).
18. Amendment adding Formaldehyde filed 3-2-93; operative 4-1-93 (Register 93, No. 10).
19. Amendment adding 1,3-Butadiene filed 4-14-93; operative 5-14-93 (Register 93, No. 16).
20. Editorial correction (Register 98, No. 16).
21. Amendment adding inorganic lead filed 4-14-98; operative 5-14-98 (Register 98, No. 16).
22. Amendment adding "Particulate Emissions from Diesel-Fueled Engines" filed 7-21-99; operative 8-20-99 (Register 99, No. 30).
23. Amendment adding "Environmental Tobacco Smoke" filed 1-9-2007; operative 2- 8-2007 (Register 2007, No. 2).

Title 17, CCR, § 93001. Hazardous Air Pollutants Identified as Toxic Air Contaminants

Each substance listed in this section has been identified as a hazardous air pollutant pursuant to subsection (b) of Section 112 of the federal Clean Air Act (42 U.S.C. Section 7412(b)) and has been designated by the State Board to be a toxic air contaminant pursuant to Health and Safety Code Section 39657.

Substance

Acetaldehyde
 Acetamide
 Acetonitrile
 Acetophenone
 2-Acetylaminofluorene
 Acrolein
 Acrylamide
 Acrylic acid
 Acrylonitrile
 Allyl chloride
 4-Aminobiphenyl
 Aniline
 o-Anisidine
 Asbestos
 Benzene (including benzene from gasoline)
 Benidine
 Benzotrachloride
 Benzyl chloride
 Biphenyl
 Bis (2-ethylhexyl) phthalate (DEHP)
 Bis (chloromethyl) ether
 Bromoform
 1,3-Butadiene
 Calcium cyanamide
 Caprolactam
 Captan
 Carbaryl
 Carbon disulfide
 Carbon tetrachloride
 Carbonyl sulfide
 Catechol
 Chloramben
 Chlordane
 Chlorine
 Chloroacetic acid
 2-Chloroacetophenone
 Chlorobenzene
 Chlorobenzilate
 Chloroform
 Chloromethyl methyl ether
 Chloroprene
 Cresols/Cresylic acid (isomers and mixture)

o-Cresol
m-Cresol
p-Cresol
Cumene
2,4-D, salts and esters
DDE
Diazomethane
Dibenzofurans
1,2-Dibromo-3-chloropropane
Dibutylphthalate
1,4-Dichlorobenzene (p)
3,3-Dichlorobenzidine
Dichloroethyl ether (Bis (2-chloroethyl) ether)
1,3-Dichloropropene
Dichlorvos
Diethanolamine
N,N-Diethyl aniline (N,N-Dimethylaniline)
Diethyl sulfate
3,3-Dimethoxybenzidine
Dimethyl aminoazobenzene
3,3-Dimethyl benzidine
Dimethyl carbamoyl chloride
Dimethyl formamide
1,1-Dimethyl hydrazine
Dimethyl phthalate
Dimethyl sulfate
4,6-Dinitro-o-cresol, and salts
2,4-Dinitrophenol
2,4-Dinitrotoluene
1,4-Dioxane (1,4-Diethyleneoxide)
1,2-Diphenylhydrazine
Epichlorohydrin (1-Chloro-2,3-epoxypropane)
1,2-Epoxybutane
Ethyl acrylate
Ethyl benzene
Ethyl carbamate (Urethane)
Ethyl chloride (Chloroethane)
Ethylene dibromide (Dibromoethane)
Ethylene dichloride (1,2-Dichloroethane)
Ethylene glycol
Ethylene imine (Aziridine)
Ethylene oxide
Ethylene thiourea
Ethylidene dichloride (1,1-Dichloroethane)
Formaldehyde
Heptachlor
Hexachlorobenzene
Hexachlorobutadiene
Hexachlorocyclopentadiene
Hexachloroethane
Hexamethylene-1,6-diisocyanate
Hexamethylphosphoramide
Hexane
Hydrazine
Hydrochloric acid
Hydrogen fluoride (Hydrofluoric acid)
Hydroquinone
Isophorone
Lindane (all isomers)
Maleic anhydride
Methanol
Methoxychlor
Methyl bromide (Bromomethane)
Methyl chloride (Chloromethane)
Methyl chloroform (1,1,1-Trichloroethane)
Methyl ethyl ketone (2-Butanone)
Methyl hydrazine
Methyl iodide (Iodomethane)
Methyl isobutyl ketone (Hexone)
Methyl isocyanate
Methyl methacrylate
Methyl tert butyl ether
4,4-Methylene bis(2-chloroaniline)
Methylene chloride (Dichloromethane)
Methylene diphenyl diisocyanate (MDI)
4,4-Methylenedianiline
Naphthalene
Nitrobenzene
4-Nitrobiphenyl
4-Nitrophenol
2-Nitropropane
N-Nitroso-N-methylurea
N-Nitrosodimethylamine
N-Nitrosomorpholine
Parathion
Pentachloronitrobenzene (Quintobenzene)
Pentachlorophenol

Phenol
 p-Phenylenediamine
 Phosgene
 Phosphine
 Phosphorus
 Phthalic anhydride
 Polychlorinated biphenyls (Aroclors)
 1,3-Propane sultone
 beta-Propiolactone
 Propionaldehyde
 Propoxur (Baygon)
 Propylene dichloride (1,2-Dichloropropane)
 Propylene oxide
 1,2-Propylenimine (2-Methylaziridine)
 Quinoline
 Quinone
 Styrene
 Styrene oxide
 2,3,7,8-Tetrachlorodibenzo-p-dioxin
 1,1,2,2-Tetrachloroethane
 Tetrachloroethylene (Perchloroethylene)
 Titanium tetrachloride
 Toluene
 2,4-Toluene diamine
 2,4-Toluene diisocyanate
 o-Toluidine
 Toxaphene (chlorinated camphene)
 1,2,4-Trichlorobenzene
 1,1,2-Trichloroethane
 Trichloroethylene
 2,4,5-Trichlorophenol
 2,4,6-Trichlorophenol
 Triethylamine
 Trifluralin
 2,2,4-Trimethylpentane
 Vinyl acetate
 Vinyl bromide
 Vinyl chloride
 Vinylidene chloride (1,1-Dichloroethylene)
 Xylenes (isomers and mixture)
 o-Xylenes
 m-Xylenes
 p-Xylenes
 Antimony Compounds
 Arsenic Compounds (inorganic including arsine)
 Beryllium Compounds
 Cadmium Compounds
 Chromium Compounds
 Cobalt Compounds
 Coke Oven Emissions
 Cyanide Compounds [FN1]
 Glycol ethers [FN2]
 Lead Compounds
 Manganese Compounds
 Mercury Compounds
 Fine mineral fibers [FN3]
 Nickel Compounds
 Polycyclic Organic Matter [FN4]
 Radionuclides (including radon) [FN5]
 Selenium Compounds

Note: For all listing above which contain the word "compounds" and for glycol ethers, the following applies: Unless otherwise specified, these listings are defined as including any unique chemical substance that contains the named chemical (i.e., antimony, arsenic, etc) as part of that chemical's infrastructure.

[FN1] X'CN where X = H' or any other group where a formal dissociation may occur. For example KCN or Ca(CN)₂

[FN2] includes mono- and di-ethers of ethylene glycol, diethylene glycol, and triethylene glycol (R(OCH₂CH₂)_n-OR' where

n = 1, 2 or 3

R = alkyl or aryl groups

R' = R, H, or groups which, when removed, yield glycol ethers with the structure; R(OCH₂CH₂)_n-OH. Polymers are excluded from the glycol category.

[FN3] includes mineral fiber emissions from facilities manufacturing or processing glass, rock, or slag fibers (or other mineral derived fibers) of average diameter 1 micrometer or less.

[FN4] includes organic compounds with more than one benzene ring, and which have a boiling point greater than or equal to 100 degrees °C

[FN5] a type of atom which spontaneously undergoes radioactive decay.

Note: Authority cited: Sections 39657, 39600, 39601 and 39662, Health and Safety Code. Reference: Sections 39650, 39655, 39656, 39657, 39658, 39659, 39660, 39661 and 39662, Health and Safety Code.

HISTORY

1. New section filed 3-9-94; operative 4-8-94. Submitted to OAL for printing only (Register 94, No. 10).

17 CCR § 93001, 17
1CAC

17

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Year:	2008		2009		2010	
	Date	Measurement	Date	Measurement	Date	Measurement
First High:	Jul 3	0.142	Jul 18	0.125	Jun 5	0.122
Second High:	Jul 24	0.136	Jul 22	0.121	Apr 7	0.121
Third High:	Aug 1	0.126	Aug 20	0.121	Apr 3	0.120
Fourth High:	Aug 14	0.126	Aug 18	0.118	Apr 4	0.120
# Days Above State Standard:		65		53		46
California Designation Value:		0.14		0.13		0.13
Expected Peak Day Conc.:		0.143		0.133		0.132
# Days Above Nat'l Standard:		4		1		0
National Design Value:		0.142		0.135		0.126
Year Coverage:		99		100		97
Go Backward One Year		New Top 4 Summary		Go Forward One Year		

Notes: All concentrations are expressed in parts per million.The national 1-hour ozone standard was revoked in June 2005 and is no longer in effect. Statistics related to the revoked standard are shown in *italics* or *italics*.State exceedances are shown in **yellow**. Exceedances of the revoked national 1-hour standard are shown in **orange**.

An exceedance is not necessarily a violation.

Year Coverage indicates the extent to which available monitoring data represent the time of the year when concentrations are expected to be highest. 0 means that data represent none of the high period; 100 means that data represent the entire high period. A high Year Coverage does not mean that there was sufficient data for annual statistics to be considered valid.

* There was insufficient (or no) data available to determine the value.

Switch:	8-Hour Ozone	PM2.5	PM10	Carbon Monoxide	Nitrogen Dioxide	Sulfur Dioxide	Hydrogen Sulfide
Go to:	Data Statistics Home Page			Top 4 Summaries Start Page			

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Year:	2008		2009		2010	
	Date	8-Hr Average	Date	8-Hr Average	Date	8-Hr Average
National:						
First High:	Jul 3	0.114	Aug 20	0.108	Jun 5	0.107
Second High:	Jul 4	0.114	Aug 18	0.105	Jun 23	0.101
Third High:	Jul 24	0.109	Aug 11	0.101	Jun 24	0.101
Fourth High:	Jul 8	0.106	Aug 12	0.101	Jun 30	0.099
California:						
First High:	Jul 4	0.115	Aug 20	0.109	Jun 5	0.108
Second High:	Jul 3	0.114	Aug 18	0.106	Jun 23	0.102
Third High:	Jul 24	0.109	Aug 11	0.102	Jun 24	0.101
Fourth High:	Jul 8	0.106	Aug 12	0.101	Jun 30	0.100
National:						
# Days Above '08 Nat'l Std.:		77		67		50
'08 Nat'l Std. Design Value:		0.107		0.103		0.102
National Year Coverage:		100		99		99
California:						
# Days Above State Standard:		94		88		77
California Designation Value:		0.123		0.117		0.115
Expected Peak Day Conc.:		0.123		0.120		0.117
California Year Coverage:		99		99		97
Go Backward One Year		New Top 4 Summary		Go Forward One Year		

Notes: All averages are expressed in parts per million.National exceedances are shown in **orange**. State exceedances are shown in **yellow**.

An exceedance is not necessarily a violation.

Year Coverage indicates the extent to which available monitoring data represent the time of the year when concentrations are expected to be highest. 0 means that data represent none of the high period; 100 means that data represent the entire high period. A high Year Coverage does not mean that there was sufficient data for annual statistics to be considered valid.

* There was insufficient (or no) data available to determine the value.

Switch:	Hourly Ozone	PM2.5	PM10	Carbon Monoxide	Nitrogen Dioxide	Sulfur Dioxide	Hydrogen Sulfide
Go to:	Data Statistics Home Page			Top 4 Summaries Start Page			

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Air Resources Board



Highest 4 Daily 24-Hour PM10 Averages

Perris

FAQs

Year:	2008		2009		2010	
	Date	24-Hr Average	Date	24-Hr Average	Date	24-Hr Average
National:						
First High:	Nov 20	85.0	Oct 28	80.0	Dec 10	51.0
Second High:	Oct 9	68.0	Nov 3	66.0	Aug 24	47.0
Third High:	Oct 27	65.0	Nov 9	57.0	Jul 1	44.0
Fourth High:	Sep 15	62.0	Oct 22	56.0	Jun 25	41.0
California:						
First High:	Nov 20	87.0	Oct 28	76.0	Dec 10	48.0
Second High:	Oct 27	66.0	Nov 3	62.0	Aug 24	45.0
Third High:	Oct 9	65.0	Nov 9	54.0	Jul 1	41.0
Fourth High:	Sep 15	58.0	Dec 3	54.0	Jun 25	39.0
Measured:						
# Days Above Nat'l Standard:		0		0		0
# Days Above State Standard:		8		6		0
Estimated:						
3-Yr Avg # Days Above Nat'l Std:		*		*		*
# Days Above Nat'l Standard:		*		0.0		0.0
# Days Above State Standard:		*		38.5		0.0
State 3-Yr Maximum Average:		*		34		34
State Annual Average:		*		33.7		26.6
National 3-Year Average:		47		43		31
National Annual Average:		29.6		34.8		28.0
Year Coverage:		84		95		100
Go Backward One Year		New Top 4 Summary		Go Forward One Year		

Notes: All concentrations are expressed in micrograms per cubic meter.

The national annual average PM10 standard was revoked in December 2006 and is no longer in effect.

Statistics related to the revoked standard are shown in *italics* or *italics*.

National exceedances are shown in **orange**. State exceedances are shown in **yellow**.

An exceedance is not necessarily a violation.

Statistics may include data that are related to an [exceptional event](#).

State and national statistics may differ for the following reasons:

State statistics are based on California approved samplers, whereas national statistics are based on samplers using federal reference or equivalent methods.

State and national statistics may therefore be based on different samplers.

State statistics for 1998 and later are based on *local* conditions (except for sites in the South Coast Air Basin, where State statistics for 2002 and later are based on *local* conditions).

National statistics are based on *standard* conditions.

State criteria for ensuring that data are sufficiently complete for calculating valid annual averages are more stringent than the national criteria.

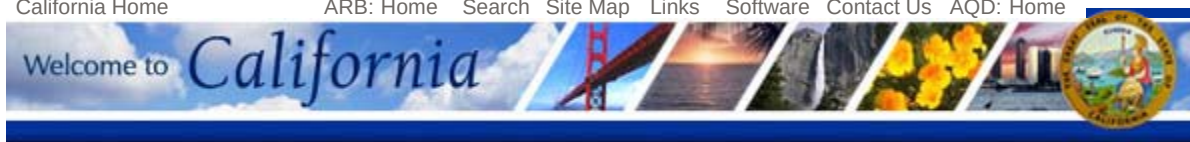
Measurements are usually collected every six days. Measured days counts the days that a measurement was greater than the level of the standard; Estimated days mathematically estimates how many days concentrations would have been greater than the level of the standard had each day been monitored.

3-Year statistics represent the listed year and the 2 years before the listed year.

Year Coverage indicates the extent to which available monitoring data represent the time of the year when concentrations are expected to be highest. 0 means that data represent none of the high period; 100 means that data represent the entire high period. A high Year Coverage does not mean that there was sufficient data for annual statistics to be considered valid.

* There was insufficient (or no) data available to determine the value.

Switch:	Hourly Ozone	8-Hour Ozone	PM2.5	Carbon Monoxide	Nitrogen Dioxide	Sulfur Dioxide	Hydrogen Sulfide
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Year:	2006		2007		2008	
	Date	Measurement	Date	Measurement	Date	Measurement
First High:	Jul 25	0.169	Jul 5	0.138	Jul 3	0.142
Second High:	Jun 3	0.155	Jul 4	0.135	Jul 24	0.136
Third High:	Jul 24	0.152	Aug 3	0.129	Aug 1	0.126
Fourth High:	Jul 14	0.140	Jun 29	0.126	Aug 14	0.126
# Days Above State Standard:		77		66		65
California Designation Value:		0.17		0.17		0.14
Expected Peak Day Conc.:		*		*		0.143
# Days Above Nat'l Standard:		12		4		4
National Design Value:		0.152		0.152		0.142
Year Coverage:		99		99		99
Go Backward One Year		New Top 4 Summary		Go Forward One Year		

Notes: All concentrations are expressed in parts per million.The national 1-hour ozone standard was revoked in June 2005 and is no longer in effect. Statistics related to the revoked standard are shown in *italics* or *italics*.State exceedances are shown in **yellow**. Exceedances of the revoked national 1-hour standard are shown in *orange*.

An exceedance is not necessarily a violation.

Year Coverage indicates the extent to which available monitoring data represent the time of the year when concentrations are expected to be highest. 0 means that data represent none of the high period; 100 means that data represent the entire high period. A high Year Coverage does not mean that there was sufficient data for annual statistics to be considered valid.

* There was insufficient (or no) data available to determine the value.

Switch:	8-Hour Ozone	PM2.5	PM10	Carbon Monoxide	Nitrogen Dioxide	Sulfur Dioxide	Hydrogen Sulfide
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Highest 4 Daily Maximum 8-Hour Ozone Averages

Perris

[FAQs](#)

Year:	2006		2007		2008	
	Date	8-Hr Average	Date	8-Hr Average	Date	8-Hr Average
National:						
First High:	Jul 24	0.122	Jul 5	0.116	Jul 3	0.114
Second High:	Jun 3	0.116	Jul 4	0.114	Jul 4	0.114
Third High:	Jul 15	0.116	Aug 11	0.106	Jul 24	0.109
Fourth High:	Jun 23	0.114	Jun 29	0.103	Jul 8	0.106
California:						
First High:	Jul 24	0.123	Jul 5	0.117	Jul 4	0.115
Second High:	Jun 3	0.117	Jul 4	0.114	Jul 3	0.114
Third High:	Jul 15	0.117	Aug 11	0.106	Jul 24	0.109
Fourth High:	Jun 22	0.114	Jun 29	0.104	Jul 8	0.106
National:						
# Days Above '08 Nat'l Std.:		83		73		77
'08 Nat'l Std. Design Value:		0.087		0.090		0.107
National Year Coverage:		99		99		100
California:						
# Days Above State Standard:		98		88		94
California Designation Value:		0.123		0.123		0.123
Expected Peak Day Conc.:		*		*		0.123
California Year Coverage:		99		97		99
Go Backward One Year		New Top 4 Summary		Go Forward One Year		

Notes: All averages are expressed in parts per million.

National exceedances are shown in **orange**. State exceedances are shown in **yellow**.

An exceedance is not necessarily a violation.

Year Coverage indicates the extent to which available monitoring data represent the time of the year when concentrations are expected to be highest. 0 means that data represent none of the high period; 100 means that data represent the entire high period. A high Year Coverage does not mean that there was sufficient data for annual statistics to be considered valid.

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Switch:	Hourly Ozone	PM2.5	PM10	Carbon Monoxide	Nitrogen Dioxide	Sulfur Dioxide	Hydrogen Sulfide
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Air Resources Board



Highest 4 Daily 24-Hour PM10 Averages

Perris

FAQs

Year:	2006		2007		2008	
	Date	24-Hr Average	Date	24-Hr Average	Date	24-Hr Average
National:						
First High:	Nov 1	125.0	Oct 21	1212.0	Nov 20	85.0
Second High:	Sep 20	101.0	Apr 12	167.0	Oct 9	68.0
Third High:	Nov 7	88.0	Feb 17	120.0	Oct 27	65.0
Fourth High:	Dec 7	80.0	Jul 5	92.0	Sep 15	62.0
California:						
First High:	Nov 1	119.0	Oct 21	1155.0	Nov 20	87.0
Second High:	Sep 20	96.0	Apr 12	159.0	Oct 27	66.0
Third High:	Nov 7	83.0	Feb 17	114.0	Oct 9	65.0
Fourth High:	Dec 7	76.0	Jul 5	87.0	Sep 15	58.0
Measured:						
# Days Above Nat'l Standard:		0		2		0
# Days Above State Standard:		18		25		8
Estimated:						
3-Yr Avg # Days Above Nat'l Std:		0.0		*		*
# Days Above Nat'l Standard:		0.0		*		*
# Days Above State Standard:		*		*		*
State 3-Yr Maximum Average:		37		37		*
State Annual Average:		*		*		*
National 3-Year Average:		42		50		47
National Annual Average:		44.9		65.4		29.6
Year Coverage:		84		82		84
Go Backward One Year		New Top 4 Summary		Go Forward One Year		

Notes: All concentrations are expressed in micrograms per cubic meter.

The national annual average PM10 standard was revoked in December 2006 and is no longer in effect.

Statistics related to the revoked standard are shown in *italics* or *italics*.

National exceedances are shown in **orange**. State exceedances are shown in **yellow**.

An exceedance is not necessarily a violation.

Statistics may include data that are related to an [exceptional event](#).

State and national statistics may differ for the following reasons:

State statistics are based on California approved samplers, whereas national statistics are based on samplers using federal reference or equivalent methods.

State and national statistics may therefore be based on different samplers.

State statistics for 1998 and later are based on *local* conditions (except for sites in the South Coast Air Basin, where State statistics for 2002 and later are based on *local* conditions).

National statistics are based on *standard* conditions.

State criteria for ensuring that data are sufficiently complete for calculating valid annual averages are more stringent than the national criteria.

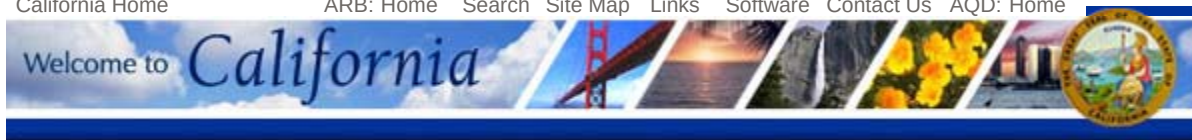
Measurements are usually collected every six days. Measured days counts the days that a measurement was greater than the level of the standard; Estimated days mathematically estimates how many days concentrations would have been greater than the level of the standard had each day been monitored.

3-Year statistics represent the listed year and the 2 years before the listed year.

Year Coverage indicates the extent to which available monitoring data represent the time of the year when concentrations are expected to be highest. 0 means that data represent none of the high period; 100 means that data represent the entire high period. A high Year Coverage does not mean that there was sufficient data for annual statistics to be considered valid.

* There was insufficient (or no) data available to determine the value.

Switch:	Hourly Ozone	8-Hour Ozone	PM2.5	Carbon Monoxide	Nitrogen Dioxide	Sulfur Dioxide	Hydrogen Sulfide
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Year:	2008		2009		2010	
	Date	24-Hr Average	Date	24-Hr Average	Date	24-Hr Average
National:						
First High:	Feb 18	42.9	Jan 1	42.1	Nov 19	43.7
Second High:	Jan 10	40.3	Mar 20	39.7	Dec 10	38.7
Third High:	Dec 2	39.0	Feb 27	33.9	Dec 4	27.3
Fourth High:	Nov 29	36.3	Nov 21	33.7	Oct 14	25.0
California:						
First High:	Feb 18	42.9	Jan 1	42.1	Nov 19	56.6
Second High:	Jan 10	40.3	Mar 20	39.7	Oct 15	46.2
Third High:	Dec 2	39.0	Feb 27	33.9	Jul 5	44.5
Fourth High:	Nov 29	36.3	Nov 21	33.7	Dec 10	43.1
Estimated Days > Nat'l 24-Hr Std:		12.4		6.0		6.3
Measured Days > Nat'l 24-Hr Std:		4		2		2
Nat'l 24-Hr Std Design Value:		48		44		33
Nat'l 24-Hr Std 98th Percentile:		39.0		33.9		27.3
National Annual Std Design Value:		16.2		15.0		12.5
National Annual Average:		13.2		13.3		11.0
State Ann'l Std Designation Value:		13		13		13
State Annual Average:		13.3		*		*
Year Coverage:		97		94		94
Go Backward One Year		New Top 4 Summary		Go Forward One Year		

Notes: All concentrations are expressed in micrograms per cubic meter.National exceedances are shown in **orange**. State exceedances are shown in **yellow**.

An exceedance is not necessarily a violation.

State and national statistics may differ for the following reasons:

State statistics are based on California approved samplers, whereas national statistics are based on samplers using federal reference or equivalent methods.

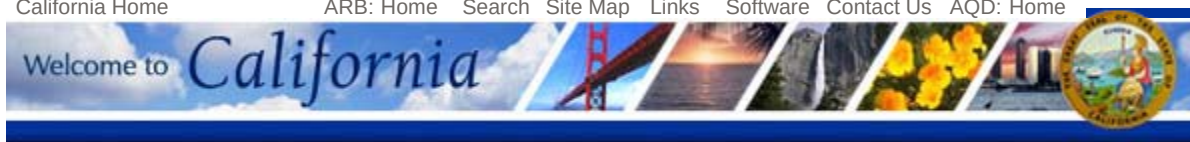
State and national statistics may therefore be based on different samplers.

State criteria for ensuring that data are sufficiently complete for calculating valid annual averages are more stringent than the national criteria.

Year Coverage indicates the extent to which available monitoring data represent the time of the year when concentrations are expected to be highest. 0 means that data represent none of the high period; 100 means that data represent the entire high period. A high Year Coverage does not mean that there was sufficient data for annual statistics to be considered valid.

* There was insufficient (or no) data available to determine the value.

Switch:	Hourly Ozone	8-Hour Ozone	PM10	Carbon Monoxide	Nitrogen Dioxide	Sulfur Dioxide	Hydrogen Sulfide
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Year:	2008		2009		2010	
	Date	Measurement	Date	Measurement	Date	Measurement
First High:	Oct 27	0.086	Nov 2	0.080	Sep 26	0.061
Second High:	Oct 29	0.067	Sep 25	0.064	Sep 3	0.060
Third High:	Oct 26	0.066	Oct 16	0.064	Sep 24	0.060
Fourth High:	Oct 28	0.066	Aug 28	0.063	Sep 27	0.057
# Days Above State Standard:	0		0		0	
Annual Average:	*		0.020		0.017	
Year Coverage:	23		98		94	
Go Backward One Year		New Top 4 Summary		Go Forward One Year		

Notes: All averages are expressed in parts per million.National exceedances are shown in **orange**. State exceedances are shown in **yellow**.

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Year Coverage indicates the extent to which available monitoring data represent the time of the year when concentrations are expected to be highest. 0 means that data represent none of the high period; 100 means that data represent the entire high period. A high Year Coverage does not mean that there was sufficient data for annual statistics to be considered valid.

* There was insufficient (or no) data available to determine the value.

Switch:	Hourly Ozone	8-Hour Ozone	PM2.5	PM10	Carbon Monoxide	Sulfur Dioxide	Hydrogen Sulfide
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Year:	2006		2007		2008	
	Date	24-Hr Average	Date	24-Hr Average	Date	24-Hr Average
National:						
First High:	Feb 4	55.3	Nov 8	68.5	Feb 18	42.9
Second High:	Nov 1	48.2	Nov 17	58.0	Jan 10	40.3
Third High:	May 11	47.7	Nov 5	56.6	Dec 2	39.0
Fourth High:	May 2	44.4	Nov 2	50.4	Nov 29	36.3
California:						
First High:	Feb 4	55.3	Nov 8	68.5	Feb 18	42.9
Second High:	Nov 1	48.2	Nov 17	58.0	Jan 10	40.3
Third High:	May 11	47.7	Nov 5	56.6	Dec 2	39.0
Fourth High:	May 2	44.4	Nov 2	50.4	Nov 29	36.3
Estimated Days > Nat'l 24-Hr Std:		31.3		*		12.4
Measured Days > Nat'l 24-Hr Std:		9		8		4
Nat'l 24-Hr Std Design Value:		47		49		48
Nat'l 24-Hr Std 98th Percentile:		47.7		58.0		39.0
National Annual Std Design Value:		18.6		17.7		16.2
National Annual Average:		16.9		18.3		13.2
State Ann'l Std Designation Value:		*		*		13
State Annual Average:		*		*		13.3
Year Coverage:		82		84		97
Go Backward One Year		New Top 4 Summary		Go Forward One Year		

Notes: All concentrations are expressed in micrograms per cubic meter.National exceedances are shown in **orange**. State exceedances are shown in **yellow**.

An exceedance is not necessarily a violation.

State and national statistics may differ for the following reasons:

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Year Coverage indicates the extent to which available monitoring data represent the time of the year when concentrations are expected to be highest. 0 means that data represent none of the high period; 100 means that data represent the entire high period. A high Year Coverage does not mean that there was sufficient data for annual statistics to be considered valid.

* There was insufficient (or no) data available to determine the value.

Switch:	Hourly Ozone	8-Hour Ozone	PM10	Carbon Monoxide	Nitrogen Dioxide	Sulfur Dioxide	Hydrogen Sulfide
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Year:	2006		2007		2008	
	Date	Measurement	Date	Measurement	Date	Measurement
First High:		*		*	Oct 27	0.086
Second High:		*		*	Oct 29	0.067
Third High:		*		*	Oct 26	0.066
Fourth High:		*		*	Oct 28	0.066
# Days Above State Standard:		0		0		0
Annual Average:		*		*		*
Year Coverage:		*		*		23
Go Backward One Year		New Top 4 Summary		Go Forward One Year		

Notes: All averages are expressed in parts per million.National exceedances are shown in **orange**. State exceedances are shown in **yellow**.

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Switch:	Hourly Ozone	8-Hour Ozone	PM2.5	PM10	Carbon Monoxide	Sulfur Dioxide	Hydrogen Sulfide
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Year:	2008		2009		2010	
	Date	Measurement	Date	Measurement	Date	Measurement
First High:	Jul 3	0.142	Jul 18	0.125	Jun 5	0.122
Second High:	Jul 24	0.136	Jul 22	0.121	Apr 7	0.121
Third High:	Aug 1	0.126	Aug 20	0.121	Apr 3	0.120
Fourth High:	Aug 14	0.126	Aug 18	0.118	Apr 4	0.120
# Days Above State Standard:		65		53		46
California Designation Value:		0.14		0.13		0.13
Expected Peak Day Conc.:		0.143		0.133		0.132
# Days Above Nat'l Standard:		4		1		0
National Design Value:		0.142		0.135		0.126
Year Coverage:		99		100		97
Go Backward One Year		New Top 4 Summary		Go Forward One Year		

Notes: All concentrations are expressed in parts per million.The national 1-hour ozone standard was revoked in June 2005 and is no longer in effect. Statistics related to the revoked standard are shown in *italics* or *italics*.State exceedances are shown in **yellow**. Exceedances of the revoked national 1-hour standard are shown in **orange**.

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Year Coverage indicates the extent to which available monitoring data represent the time of the year when concentrations are expected to be highest. 0 means that data represent none of the high period; 100 means that data represent the entire high period. A high Year Coverage does not mean that there was sufficient data for annual statistics to be considered valid.

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Switch:	8-Hour Ozone	PM2.5	PM10	Carbon Monoxide	Nitrogen Dioxide	Sulfur Dioxide	Hydrogen Sulfide
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Year:	2008		2009		2010	
	Date	8-Hr Average	Date	8-Hr Average	Date	8-Hr Average
National:						
First High:	Jul 3	0.114	Aug 20	0.108	Jun 5	0.107
Second High:	Jul 4	0.114	Aug 18	0.105	Jun 23	0.101
Third High:	Jul 24	0.109	Aug 11	0.101	Jun 24	0.101
Fourth High:	Jul 8	0.106	Aug 12	0.101	Jun 30	0.099
California:						
First High:	Jul 4	0.115	Aug 20	0.109	Jun 5	0.108
Second High:	Jul 3	0.114	Aug 18	0.106	Jun 23	0.102
Third High:	Jul 24	0.109	Aug 11	0.102	Jun 24	0.101
Fourth High:	Jul 8	0.106	Aug 12	0.101	Jun 30	0.100
National:						
# Days Above '08 Nat'l Std.:		77		67		50
'08 Nat'l Std. Design Value:		0.107		0.103		0.102
National Year Coverage:		100		99		99
California:						
# Days Above State Standard:		94		88		77
California Designation Value:		0.123		0.117		0.115
Expected Peak Day Conc.:		0.123		0.120		0.117
California Year Coverage:		99		99		97
Go Backward One Year		New Top 4 Summary		Go Forward One Year		

Notes: All averages are expressed in parts per million.National exceedances are shown in **orange**. State exceedances are shown in **yellow**.

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Switch:	Hourly Ozone	PM2.5	PM10	Carbon Monoxide	Nitrogen Dioxide	Sulfur Dioxide	Hydrogen Sulfide
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Highest 4 Daily 24-Hour PM10 Averages

Perris

FAQs

Year:	2008		2009		2010	
	Date	24-Hr Average	Date	24-Hr Average	Date	24-Hr Average
National:						
First High:	Nov 20	85.0	Oct 28	80.0	Dec 10	51.0
Second High:	Oct 9	68.0	Nov 3	66.0	Aug 24	47.0
Third High:	Oct 27	65.0	Nov 9	57.0	Jul 1	44.0
Fourth High:	Sep 15	62.0	Oct 22	56.0	Jun 25	41.0
California:						
First High:	Nov 20	87.0	Oct 28	76.0	Dec 10	48.0
Second High:	Oct 27	66.0	Nov 3	62.0	Aug 24	45.0
Third High:	Oct 9	65.0	Nov 9	54.0	Jul 1	41.0
Fourth High:	Sep 15	58.0	Dec 3	54.0	Jun 25	39.0
Measured:						
# Days Above Nat'l Standard:		0		0		0
# Days Above State Standard:		8		6		0
Estimated:						
3-Yr Avg # Days Above Nat'l Std:		*		*		*
# Days Above Nat'l Standard:		*		0.0		0.0
# Days Above State Standard:		*		38.5		0.0
State 3-Yr Maximum Average:		*		34		34
State Annual Average:		*		33.7		26.6
National 3-Year Average:		47		43		31
National Annual Average:		29.6		34.8		28.0
Year Coverage:		84		95		100
Go Backward One Year		New Top 4 Summary		Go Forward One Year		

Notes: All concentrations are expressed in micrograms per cubic meter.

The national annual average PM10 standard was revoked in December 2006 and is no longer in effect.

Statistics related to the revoked standard are shown in *italics* or *italics*.

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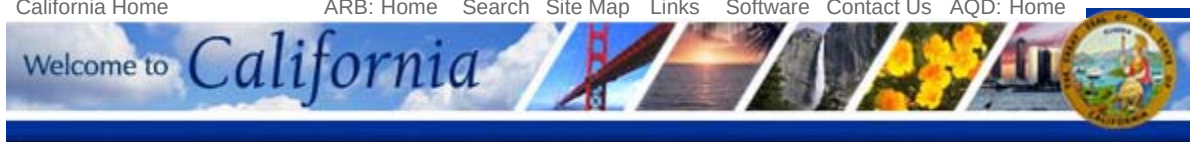
Measurements are usually collected every six days. Measured days counts the days that a measurement was greater than the level of the standard; Estimated days mathematically estimates how many days concentrations would have been greater than the level of the standard had each day been monitored.

3-Year statistics represent the listed year and the 2 years before the listed year.

Year Coverage indicates the extent to which available monitoring data represent the time of the year when concentrations are expected to be highest. 0 means that data represent none of the high period; 100 means that data represent the entire high period. A high Year Coverage does not mean that there was sufficient data for annual statistics to be considered valid.

* There was insufficient (or no) data available to determine the value.

Switch:	Hourly Ozone	8-Hour Ozone	PM2.5	Carbon Monoxide	Nitrogen Dioxide	Sulfur Dioxide	Hydrogen Sulfide
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Year:	2006		2007		2008	
	Date	Measurement	Date	Measurement	Date	Measurement
First High:	Jul 25	0.169	Jul 5	0.138	Jul 3	0.142
Second High:	Jun 3	0.155	Jul 4	0.135	Jul 24	0.136
Third High:	Jul 24	0.152	Aug 3	0.129	Aug 1	0.126
Fourth High:	Jul 14	0.140	Jun 29	0.126	Aug 14	0.126
# Days Above State Standard:		77		66		65
California Designation Value:		0.17		0.17		0.14
Expected Peak Day Conc.:		*		*		0.143
# Days Above Nat'l Standard:		12		4		4
National Design Value:		0.152		0.152		0.142
Year Coverage:		99		99		99
Go Backward One Year		New Top 4 Summary		Go Forward One Year		

Notes: All concentrations are expressed in parts per million.The national 1-hour ozone standard was revoked in June 2005 and is no longer in effect. Statistics related to the revoked standard are shown in *italics* or *italics*.State exceedances are shown in **yellow**. Exceedances of the revoked national 1-hour standard are shown in **orange**.

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Year Coverage indicates the extent to which available monitoring data represent the time of the year when concentrations are expected to be highest. 0 means that data represent none of the high period; 100 means that data represent the entire high period. A high Year Coverage does not mean that there was sufficient data for annual statistics to be considered valid.

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Switch:	8-Hour Ozone	PM2.5	PM10	Carbon Monoxide	Nitrogen Dioxide	Sulfur Dioxide	Hydrogen Sulfide
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Year:	2006		2007		2008	
	Date	8-Hr Average	Date	8-Hr Average	Date	8-Hr Average
National:						
First High:	Jul 24	0.122	Jul 5	0.116	Jul 3	0.114
Second High:	Jun 3	0.116	Jul 4	0.114	Jul 4	0.114
Third High:	Jul 15	0.116	Aug 11	0.106	Jul 24	0.109
Fourth High:	Jun 23	0.114	Jun 29	0.103	Jul 8	0.106
California:						
First High:	Jul 24	0.123	Jul 5	0.117	Jul 4	0.115
Second High:	Jun 3	0.117	Jul 4	0.114	Jul 3	0.114
Third High:	Jul 15	0.117	Aug 11	0.106	Jul 24	0.109
Fourth High:	Jun 22	0.114	Jun 29	0.104	Jul 8	0.106
National:						
# Days Above '08 Nat'l Std.:		83		73		77
'08 Nat'l Std. Design Value:		0.087		0.090		0.107
National Year Coverage:		99		99		100
California:						
# Days Above State Standard:		98		88		94
California Designation Value:		0.123		0.123		0.123
Expected Peak Day Conc.:		*		*		0.123
California Year Coverage:		99		97		99
Go Backward One Year		New Top 4 Summary		Go Forward One Year		

Notes: All averages are expressed in parts per million.National exceedances are shown in **orange**. State exceedances are shown in **yellow**.

An exceedance is not necessarily a violation.

Year Coverage indicates the extent to which available monitoring data represent the time of the year when concentrations are expected to be highest. 0 means that data represent none of the high period; 100 means that data represent the entire high period. A high Year Coverage does not mean that there was sufficient data for annual statistics to be considered valid.

* There was insufficient (or no) data available to determine the value.

Switch:	Hourly Ozone	PM2.5	PM10	Carbon Monoxide	Nitrogen Dioxide	Sulfur Dioxide	Hydrogen Sulfide
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Air Resources Board



Highest 4 Daily 24-Hour PM10 Averages

Perris

FAQs

Year:	2006		2007		2008	
	Date	24-Hr Average	Date	24-Hr Average	Date	24-Hr Average
National:						
First High:	Nov 1	125.0	Oct 21	1212.0	Nov 20	85.0
Second High:	Sep 20	101.0	Apr 12	167.0	Oct 9	68.0
Third High:	Nov 7	88.0	Feb 17	120.0	Oct 27	65.0
Fourth High:	Dec 7	80.0	Jul 5	92.0	Sep 15	62.0
California:						
First High:	Nov 1	119.0	Oct 21	1155.0	Nov 20	87.0
Second High:	Sep 20	96.0	Apr 12	159.0	Oct 27	66.0
Third High:	Nov 7	83.0	Feb 17	114.0	Oct 9	65.0
Fourth High:	Dec 7	76.0	Jul 5	87.0	Sep 15	58.0
Measured:						
# Days Above Nat'l Standard:		0		2		0
# Days Above State Standard:		18		25		8
Estimated:						
3-Yr Avg # Days Above Nat'l Std:		0.0		*		*
# Days Above Nat'l Standard:		0.0		*		*
# Days Above State Standard:		*		*		*
State 3-Yr Maximum Average:		37		37		*
State Annual Average:		*		*		*
National 3-Year Average:		42		50		47
National Annual Average:		44.9		65.4		29.6
Year Coverage:		84		82		84
Go Backward One Year		New Top 4 Summary		Go Forward One Year		

Notes: All concentrations are expressed in micrograms per cubic meter.

The national annual average PM10 standard was revoked in December 2006 and is no longer in effect.

Statistics related to the revoked standard are shown in *italics* or *italics*.

National exceedances are shown in **orange**. State exceedances are shown in **yellow**.

An exceedance is not necessarily a violation.

Statistics may include data that are related to an [exceptional event](#).

State and national statistics may differ for the following reasons:

State statistics are based on California approved samplers, whereas national statistics are based on samplers using federal reference or equivalent methods.

State and national statistics may therefore be based on different samplers.

State statistics for 1998 and later are based on *local* conditions (except for sites in the South Coast Air Basin, where State statistics for 2002 and later are based on *local* conditions).

National statistics are based on *standard* conditions.

State criteria for ensuring that data are sufficiently complete for calculating valid annual averages are more stringent than the national criteria.

Measurements are usually collected every six days. Measured days counts the days that a measurement was greater than the level of the standard; Estimated days mathematically estimates how many days concentrations would have been greater than the level of the standard had each day been monitored.

3-Year statistics represent the listed year and the 2 years before the listed year.

Year Coverage indicates the extent to which available monitoring data represent the time of the year when concentrations are expected to be highest. 0 means that data represent none of the high period; 100 means that data represent the entire high period. A high Year Coverage does not mean that there was sufficient data for annual statistics to be considered valid.

* There was insufficient (or no) data available to determine the value.

Switch:	Hourly Ozone	8-Hour Ozone	PM2.5	Carbon Monoxide	Nitrogen Dioxide	Sulfur Dioxide	Hydrogen Sulfide
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Highest 4 Daily 24-Hour PM2.5 Averages

Riverside-Magnolia

[FAQs](#)

Year:	2008		2009		2010	
	Date	24-Hr Average	Date	24-Hr Average	Date	24-Hr Average
National:						
First High:	Feb 18	42.9	Jan 1	42.1	Nov 19	43.7
Second High:	Jan 10	40.3	Mar 20	39.7	Dec 10	38.7
Third High:	Dec 2	39.0	Feb 27	33.9	Dec 4	27.3
Fourth High:	Nov 29	36.3	Nov 21	33.7	Oct 14	25.0
California:						
First High:	Feb 18	42.9	Jan 1	42.1	Nov 19	56.6
Second High:	Jan 10	40.3	Mar 20	39.7	Oct 15	46.2
Third High:	Dec 2	39.0	Feb 27	33.9	Jul 5	44.5
Fourth High:	Nov 29	36.3	Nov 21	33.7	Dec 10	43.1
Estimated Days > Nat'l 24-Hr Std:		12.4		6.0		6.3
Measured Days > Nat'l 24-Hr Std:		4		2		2
Nat'l 24-Hr Std Design Value:		48		44		33
Nat'l 24-Hr Std 98th Percentile:		39.0		33.9		27.3
National Annual Std Design Value:		16.2		15.0		12.5
National Annual Average:		13.2		13.3		11.0
State Ann'l Std Designation Value:		13		13		13
State Annual Average:		13.3		*		*
Year Coverage:		97		94		94
Go Backward One Year		New Top 4 Summary		Go Forward One Year		

Notes: All concentrations are expressed in micrograms per cubic meter.

National exceedances are shown in **orange**. State exceedances are shown in **yellow**.

An exceedance is not necessarily a violation.

State and national statistics may differ for the following reasons:

State statistics are based on California approved samplers, whereas national statistics are based on samplers using federal reference or equivalent methods.

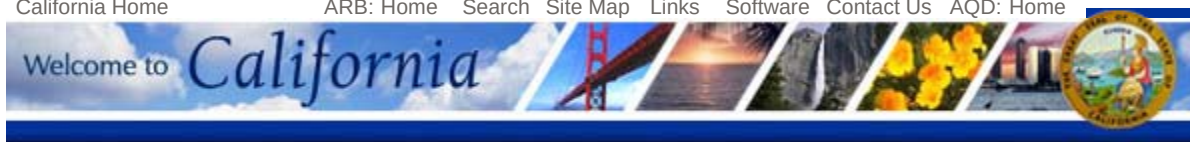
State and national statistics may therefore be based on different samplers.

State criteria for ensuring that data are sufficiently complete for calculating valid annual averages are more stringent than the national criteria.

Year Coverage indicates the extent to which available monitoring data represent the time of the year when concentrations are expected to be highest. 0 means that data represent none of the high period; 100 means that data represent the entire high period. A high Year Coverage does not mean that there was sufficient data for annual statistics to be considered valid.

* There was insufficient (or no) data available to determine the value.

Switch:	Hourly Ozone	8-Hour Ozone	PM10	Carbon Monoxide	Nitrogen Dioxide	Sulfur Dioxide	Hydrogen Sulfide
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Year:	2008		2009		2010	
	Date	Measurement	Date	Measurement	Date	Measurement
First High:	Oct 27	0.086	Nov 2	0.080	Sep 26	0.061
Second High:	Oct 29	0.067	Sep 25	0.064	Sep 3	0.060
Third High:	Oct 26	0.066	Oct 16	0.064	Sep 24	0.060
Fourth High:	Oct 28	0.066	Aug 28	0.063	Sep 27	0.057
# Days Above State Standard:	0		0		0	
Annual Average:	*		0.020		0.017	
Year Coverage:	23		98		94	
Go Backward One Year		New Top 4 Summary		Go Forward One Year		

Notes: All averages are expressed in parts per million.National exceedances are shown in **orange**. State exceedances are shown in **yellow**.

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Switch:	Hourly Ozone	8-Hour Ozone	PM2.5	PM10	Carbon Monoxide	Sulfur Dioxide	Hydrogen Sulfide
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Year:	2006		2007		2008	
	Date	24-Hr Average	Date	24-Hr Average	Date	24-Hr Average
National:						
First High:	Feb 4	55.3	Nov 8	68.5	Feb 18	42.9
Second High:	Nov 1	48.2	Nov 17	58.0	Jan 10	40.3
Third High:	May 11	47.7	Nov 5	56.6	Dec 2	39.0
Fourth High:	May 2	44.4	Nov 2	50.4	Nov 29	36.3
California:						
First High:	Feb 4	55.3	Nov 8	68.5	Feb 18	42.9
Second High:	Nov 1	48.2	Nov 17	58.0	Jan 10	40.3
Third High:	May 11	47.7	Nov 5	56.6	Dec 2	39.0
Fourth High:	May 2	44.4	Nov 2	50.4	Nov 29	36.3
Estimated Days > Nat'l 24-Hr Std:		31.3		*		12.4
Measured Days > Nat'l 24-Hr Std:		9		8		4
Nat'l 24-Hr Std Design Value:		47		49		48
Nat'l 24-Hr Std 98th Percentile:		47.7		58.0		39.0
National Annual Std Design Value:		18.6		17.7		16.2
National Annual Average:		16.9		18.3		13.2
State Ann'l Std Designation Value:		*		*		13
State Annual Average:		*		*		13.3
Year Coverage:		82		84		97
Go Backward One Year		New Top 4 Summary		Go Forward One Year		

Notes: All concentrations are expressed in micrograms per cubic meter.

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Switch:	Hourly Ozone	8-Hour Ozone	PM10	Carbon Monoxide	Nitrogen Dioxide	Sulfur Dioxide	Hydrogen Sulfide
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Year:	2006		2007		2008	
	Date	Measurement	Date	Measurement	Date	Measurement
First High:		*		*	Oct 27	0.086
Second High:		*		*	Oct 29	0.067
Third High:		*		*	Oct 26	0.066
Fourth High:		*		*	Oct 28	0.066
# Days Above State Standard:		0		0		0
Annual Average:		*		*		*
Year Coverage:		*		*		23
Go Backward One Year		New Top 4 Summary		Go Forward One Year		

Notes: All averages are expressed in parts per million.National exceedances are shown in **orange**. State exceedances are shown in **yellow**.

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Year Coverage indicates the extent to which available monitoring data represent the time of the year when concentrations are expected to be highest. 0 means that data represent none of the high period; 100 means that data represent the entire high period. A high Year Coverage does not mean that there was sufficient data for annual statistics to be considered valid.

* There was insufficient (or no) data available to determine the value.

Switch:	Hourly Ozone	8-Hour Ozone	PM2.5	PM10	Carbon Monoxide	Sulfur Dioxide	Hydrogen Sulfide
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Air Toxics Hot Spots Program Risk Assessment Guidelines

The Air Toxics Hot Spots Program Guidance Manual for Preparation of Health Risk Assessments

August 2003

**Secretary for Environmental Protection
California Environmental Protection Agency
Winston H. Hickox**

**Director
Office of Environmental Health Hazard Assessment
Joan E. Denton, Ph.D.**



The Air Toxics Hot Spots Program Guidance Manual for Preparation of Health Risk Assessments

August 2003

Office of Environmental Health Hazard Assessment
California Environmental Protection Agency
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The Air Toxics Hot Spots Program Guidance Manual for Preparation of Health Risk Assessments. August 2003.

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The Air Toxics Hot Spots Program
Guidance Manual for Preparation of Health Risk Assessments

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Executive Summary

The Air Toxics Hot Spots Program Guidance Manual for Preparation of Health Risk Assessments (OEHHA, 2003) (Guidance Manual) is a concise description of the algorithms, recommended exposure variates, and cancer and noncancer health values needed to perform a health risk assessment (HRA) under the Air Toxics Hot Spots Information and Assessment Act of 1987 (Hot Spots or AB 2588) (AB 2588, Connelly, Statutes of 1987; Health and Safety Code Section 44300 et seq.) (see Appendix B). The information presented in the Guidance Manual is a compilation of information presented in the four technical support documents (TSDs) released by the Office of Environmental Health Hazard Assessment (OEHHA) for the Hot Spots Program. The four TSDs underwent public comment and peer review and were adopted for use in the Air Toxics Hot Spots program by the Director of OEHHA. These four TSDs present detailed information on cancer and noncancer health effects values and exposure pathway information. Excerpts of these four documents are presented in this document. All four TSDs are available on OEHHA's web site at www.oehha.ca.gov. There is relatively little new information in the Guidance Manual since the previously adopted TSDs form the basis of the Guidance Manual.

The Guidance Manual supercedes the risk assessment methods presented in *The California Air Pollution Control Officer's Association (CAPCOA) Air Toxics Hot Spots Program; Revised 1992; Risk Assessment Guidelines, October 1993* (CAPCOA, 1993). The Guidance Manual scientifically updates health effects values, exposure pathway variates (e.g., breathing rates), and presents a tiered approach for performing HRAs. The tiered approach provides a risk assessor with flexibility and allows consideration of site-specific differences. Furthermore, risk assessors can tailor the level of effort and refinement of an HRA by using the point-estimate exposure assumptions or the stochastic treatment of data distributions. The four-tiered approach to risk assessment primarily applies to residential cancer risk assessment. OEHHA is not recommending a stochastic approach (Tier-3 and Tier-4) for worker receptors or for noncancer chronic evaluations. Only Tier-1 applies to acute exposure evaluations. Compared to the CAPCOA 1993 document, the exposure pathways in the Guidance Manual remain the same, the exposure algorithms are similar, and risk algorithms have been revised to accept the data needed for the tiered risk assessment approach.

The Guidance Manual also contains example calculations and an outline for a modeling protocol and a HRA report. A software program, the Hot Spots Analysis and Reporting Program (HARP), has been developed by a contractor in consultation with OEHHA, the Air Resources Board (ARB), and the Air Pollution Control or Air Quality Management District (District) representatives. The HARP software is the recommended model for calculating and presenting HRA results for the Hot Spots Program. Information on obtaining the HARP software can be found on the ARB's web site at www.arb.ca.gov under the Hot Spots Program.

The intent in developing this Guidance Manual and the HARP software is to provide consistent risk assessment procedures. The use of consistent risk assessment methods and report presentation has many benefits, such as, expediting the preparation and review of HRAs, minimizing revision and resubmission of HRAs, allowing a format for facility comparisons, and cost-effective implementation of

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HRAs and the Hot Spots Program. Risk assessments prepared with this Guidance Manual may be used for permitting new or modified stationary sources, or public notification, and risk reduction requirements of the Hot Spots Program.

1. Introduction

1.1 Development of Guidelines

The Hot Spots Act is designed to provide information to state and local agencies and to the general public on the extent of airborne emissions from stationary sources and the potential public health impacts of those emissions. The Hot Spots Act requires that OEHHA develop risk assessment guidelines for the Hot Spots program (Health and Safety Code (HSC) Section 44360(b)(2)) (see Appendix B for the text of the HSC). In addition, the Hot Spots Act specifically requires OEHHA to develop a “likelihood of risks” approach to health risk assessment. In response, OEHHA developed a tiered approach to risk assessment where a point-estimate approach is first employed. If a more detailed analysis is needed, OEHHA has developed a stochastic, or probabilistic, approach using exposure factor distributions that can be applied in a stochastic estimate of the exposure. A detailed presentation of the tiered approach, risk assessment algorithms, selected exposure variates (e.g., breathing rate), and distributions with a literature review is presented in the *Air Toxics Hot Spots Risk Assessment Guidelines; Part IV; Exposure Assessment and Stochastic Analysis Technical Support Document (OEHHA, 2000b)* (Part IV TSD). A summary of this information can be found in Chapter 5 of this document.

Cancer and noncancer (acute and chronic) dose-response relationships (health effects values) for many Hot Spots substances are presented in the first three Technical Support Documents. *The Air Toxics Hot Spots Program Risk Assessment Guidelines; Part I; The Determination of Acute Reference Exposure Levels for Airborne Toxicants (OEHHA, 1999a)* presents acute Reference Exposure Levels (RELs) for 51 toxicants and toxicant compound classes. *The Air Toxics Hot Spots Program Risk Assessment Guidelines; Part II; Technical Support Document for Describing Available Cancer Potency Factors (OEHHA, 1999b and 2002)* contains inhalation cancer potency factors and oral cancer potency factors for 122 toxicants and toxicant compound classes developed by OEHHA or developed by other authoritative bodies and endorsed by OEHHA. *The Air Toxics Hot Spots Program Risk Assessment Guidelines; Part III; Technical Support Document for the Determination of Noncancer Chronic Reference Exposure Levels (OEHHA, 2000a)* documents the development of chronic noncancer inhalation RELs for 72 toxicants and toxicant classes. The OEHHA website (www.oehha.ca.gov) should be consulted for chronic RELs adopted subsequent to (OEHHA, 2000a). In addition, for a small subset of these substances that are subject to airborne deposition and hence human oral and dermal exposure, oral chronic RELs are presented. A summary of cancer and noncancer health effects values can be found in Appendix L and Chapters 6 and 7 of the Guidance Manual. All four Technical Support Documents have undergone public and peer review and have been endorsed by the state’s Scientific Review Panel on Toxic Air Contaminants and adopted by OEHHA. The Guidance Manual has also undergone the same public and peer review process.

The Guidance Manual contains a concise description of the algorithms, recommended exposure variates, and cancer and noncancer health values needed to perform a Hot Spots risk assessment under the Hot Spots Act (see Appendix B). The information for the Guidance Manual is taken from the other four TSDs. The Guidance Manual is the successor document to *The CAPCOA Air Toxics “Hot*

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Spots” Program; Revised 1992; Risk Assessment Guidelines, October 1993 prepared by CAPCOA (CAPCOA, 1993). The Guidance Manual scientifically updates risk assessment variates and presents a tiered approach including a stochastic as well as a point-estimate approach to exposure and risk assessment. The exposure pathways remain the same and the algorithms are similar to the 1993 CAPCOA document.

The Guidance Manual is intended to address health risks from airborne contaminants released by stationary sources. Some of the methodology used is common to other regulatory risk assessment applications, particularly for California programs. However, if the reader needs to prepare an HRA under another program, the HRA may need additional analyses. Therefore, appropriate California and federal agencies should be contacted. For example, if a facility must comply with HRA requirements under the Resource Conservation and Recovery Act (RCRA) or the Comprehensive Environmental Response, Compensation and Liability Act (CERCLA), the California Department of Toxic Substances Control (DTSC) must be contacted to determine if an HRA written to comply with AB 2588 will also satisfy RCRA/CERCLA requirements.

1.2 Use of the Guidance Manual

The intent in developing this Guidance Manual is to provide HRA procedures for use in the Air Toxics Hot Spots Program or for the permitting of new or modified stationary sources. See the ARB’s website at www.arb.ca.gov for more information on the Hot Spots Program and for risk management guidelines that provide recommendations for permitting new or modified stationary sources. The use of consistent risk assessment procedures and report presentation allows comparison of one facility to another, expedites the review of HRAs by reviewing agencies, and minimizes revision and resubmission of HRAs. However, OEHHA recognizes that no one risk assessment procedure or set of exposure variates could perfectly address the many types of stationary facilities in diverse locations in California. Therefore a tiered risk assessment approach was developed to provide flexibility and allow consideration of site-specific differences.

These guidelines should be used in conjunction with the emission data collected and reported pursuant to requirements of the ARB’s *Emission Inventory Criteria and Guidelines Regulations (Title 17, California Code of Regulations, Sections 93300-93300.5)*, and the *Emission Inventory Criteria and Guidelines Report for the Air Toxics “Hot Spots” Program* (EICG Report), which is incorporated by reference therein (ARB, 1997). This regulation outlines requirements for the collection of emission data, based on an inventory plan, which must be approved by the Air Pollution Control or Air Quality Management District (District). The emissions reported under this program are routine or predictable and include continuous and intermittent releases and predictable process upsets or leaks. Emissions for unpredictable releases (e.g., accidental catastrophic releases) are not reported under this program.

For landfill sites, these guidelines should be applied to the results of the landfill testing required under Health and Safety Code Section 41805.5 as well as to any emissions reported under the emission

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inventory requirements of the Air Toxics Hot Spots Act (e.g., from flares or other on-site equipment). Districts should be consulted to determine the specific landfill testing data to be used.

1.3 Who is Required to Conduct a Risk Assessment

The Hot Spots Act requires that each local District determine which facilities will prepare an HRA. As defined under the Hot Spots Act, an HRA includes a comprehensive analysis of the dispersion of hazardous substances in the environment, their potential for human exposure, and a quantitative assessment of both individual and populationwide health risks associated with those levels of exposure.

Districts are to determine which facilities will prepare an HRA based on a prioritization process outlined in the law. The process by which Districts identify priority facilities for risk assessment involves consideration of potency, toxicity, quantity of emissions, and proximity to sensitive receptors such as hospitals, daycare centers, schools, work-sites, and residences. The District may also consider other factors that may contribute to an increased potential for significant risk to human receptors. As part of this process Districts are to categorize facilities as high, intermediate, or low priority. The District prioritization process is described in the *CAPCOA Air Toxics Hot Spots Program Facility Prioritization Guidelines, July 1990 (CAPCOA, 1990)*. Consult the District for updates to the Prioritization Guidelines. See the Hot Spots Program on ARB's web site at www.arb.ca.gov for more information on facility prioritization procedures.

Facilities designated by a District as "high priority" are required to submit an HRA to the District within 150 days. Districts may grant a 30-day extension. However, a District may require any facility to prepare and submit an HRA according to the District priorities established for purposes of the Hot Spots Act.

1.4 The Hot Spots Analysis and Reporting Program (HARP) Software

The ARB and the Districts have identified a critical need for software to assist with the programmatic aspects of the Hot Spots Program. HARP is a single integrated software package used by the ARB, OEHHA, Districts, and facility operators to promote statewide consistency, efficiency, and cost-effective implementation of HRAs and the Hot Spots Program. The HARP software package consists of three modules that include: 1) the Emissions Inventory Database Module, 2) the Air Dispersion Modeling Module, and 3) the Risk Analysis and Mapping Module. The user-friendly Windows-based package provides for:

1. Electronic implementation of the risk assessment methods presented in the OEHHA guidelines (Guidance Manual);
2. Electronic data transfer from facilities and Districts;
3. The production of reports;
4. Facility prioritization and identification;
5. Air dispersion modeling (ISCST3) of multiple emission releases or facilities for cumulative impact evaluations;

6. A summary report of acute and chronic health hazard quotients or indices, and cancer risk at the point of maximum impact (PMI), maximally exposed individual resident (MEIR), and the maximally exposed individual worker (MEIW). (Other receptors may be evaluated as needed.);
7. Mapping displays of facility property boundaries, risk isopleths, street maps, and elevation contours;
8. The ability to display combined risk contours from multiple facilities;
9. Output of data for use in other “off-the-shelf” Geographic Information Systems (GIS) programs for additional types of analysis; and
10. Census data for determining the number of people exposed at various cancer risk levels and cancer burden.

1.5 Risk Assessment Review Process

The Hot Spots Act risk assessments are reviewed by the local District and by OEHHA. The Districts focus their review on the emissions data and the air dispersion modeling. OEHHA provides comments on the HRA’s general concordance with the Guidelines Manual and the completeness of the reported health risks. The District, taking into account the comments of OEHHA, approves the HRA or returns it to the facility for revision and resubmission. If the HRA is not revised and resubmitted by the facility within 60 days, the District may modify the HRA and approve it as modified. Based on the approved HRA, the District determines if there is a significant health risk associated with emissions from the facility. If the District determines that facility emissions pose a significant health risk, the facility operator provides notice to all exposed individuals regarding the results of the HRA and may be required to take steps to reduce emissions by implementing a risk reduction audit and plan. Notification is to be made according to procedures specified by the District. Each District determines its own levels of significance for cancer and noncancer health effects for notification and risk reduction. See the Hot Spots Program on ARB’s web site at www.arb.ca.gov for more information on significance levels selected by each District.

1.6 Uncertainty in Risk Assessment

OEHHA has striven to use the best science available in developing these risk assessment guidelines. However, there is a great deal of uncertainty associated with the process of risk assessment. The uncertainty arises from lack of data in many areas necessitating the use of assumptions. The assumptions used in these guidelines are designed to err on the side of health protection in order to avoid underestimation of risk to the public. Sources of uncertainty, which may either overestimate or underestimate risk, include: 1) extrapolation of toxicity data in animals to humans, 2) uncertainty in the estimation of emissions, 3) uncertainty in the air dispersion models, and 4) uncertainty in the exposure estimates. Uncertainty may be defined as what is not known and may be reduced with further scientific studies. In addition to uncertainty, there is a natural range or variability in the human population in such properties as height, weight, and susceptibility to chemical toxicants. Scientific studies with representative individuals and large enough sample size can characterize this variability.

Interactive effects of exposure to more than one carcinogen or toxicant are also not necessarily quantified in the HRA. Cancer risks from all emitted carcinogens are typically added, and hazard quotients for substances impacting the same target organ/system are added to determine the hazard index (HI). Many examples of additivity and synergism (interactive effects greater than additive) are known. For substances that act synergistically, the HRA could underestimate the risks. Some substances may have antagonistic effects (lessen the toxic effects produced by another substance). For substances that act antagonistically, the HRA could overestimate the risks.

Other sources of uncertainty, which may underestimate or overestimate risk, can be found in exposure estimates where little or no data are available (e.g., soil half-life and dermal penetration of some substances from a soil matrix).

The differences among species and within human populations usually cannot be easily quantified and incorporated into risk assessments. Factors including metabolism, target site sensitivity, diet, immunological responses, and genetics may influence the response to toxicants. The human population is much more diverse both genetically and culturally (e.g., lifestyle, diet) than inbred experimental animals. The intraspecies variability among humans is expected to be much greater than in laboratory animals. Adjustment for tumors at multiple sites induced by some carcinogens could result in a higher potency. Other uncertainties arise 1) in the assumptions underlying the dose-response model used, and 2) in extrapolating from large experimental doses, where, for example, other toxic effects may compromise the assessment of carcinogenic potential, to usually much smaller environmental doses. Also, only single tumor sites induced by a substance are usually considered. When epidemiological data are used to generate a carcinogenic potency, less uncertainty is involved in the extrapolation from workplace exposures to environmental exposures. However, children, a subpopulation whose hematological, nervous, endocrine, and immune systems, for example, are still developing and who may be more sensitive to the effects of carcinogens on their developing systems, are not included in the worker population and risk estimates based on occupational epidemiological data are more uncertain for children than adults. Finally, the quantification of each uncertainty applied in the estimate of cancer potency is itself uncertain.

Thus, risk estimates generated by an HRA 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 a number of assumptions. Additionally, the uncertainty factors integrated within the estimates of noncancer RELs are meant to err on the side of public health protection in order to avoid underestimation of risk. Risk assessment is best used as a ruler to compare one source with another and to prioritize concerns. Consistent approaches to risk assessment are necessary to fulfill this function.

2. Overview of Health Risk Assessment

2.1 The Model for Risk Assessment

The standard approach currently used for health risk assessment (HRA) was originally proposed by the National Academy of Sciences in the 1983 book: *Risk Assessment in the Federal Government: Managing the Process* (NAS, 1983) and was updated in the Academy's 1994 book: *Science and Judgment in Risk Assessment* (NAS, 1994). The four steps involved in the risk assessment process are 1) hazard identification, 2) exposure assessment, 3) dose-response assessment, and 4) risk characterization. These four steps are briefly discussed below.

2.2 Hazard Identification

For air toxics sources, hazard identification involves identifying if a hazard exists, and if so, what are the exact pollutant(s) of concern and whether a pollutant is a potential human carcinogen or is associated with other types of adverse health effects. For the Air Toxics Hot Spots Program (Hot Spots), the emitted substances that are addressed in a risk assessment are found in the list of hazardous substances designated in the ARB's *Emission Inventory Criteria and Guidelines Regulations (Title 17, California Code of Regulations, Sections 93300-93300.5)*, and the *Emission Inventory Criteria and Guidelines Report* (EICG Report), which is incorporated by reference therein (ARB, 1997). This list of substances is contained in Appendix A of this document and the EICG Report. The list of substances also identifies those substances that are considered human carcinogens or potential human carcinogens.

2.3 Exposure Assessment

The purpose of the exposure assessment is to estimate the extent of public exposure to each substance for which potential cancer risk or acute and chronic noncancer effects will be evaluated. This involves emission quantification, modeling of environmental transport, evaluation of environmental fate, identification of exposure routes, identification of exposed populations, and estimation of short-term and long-term exposure levels. These activities are described in Chapters 4 and 5. Chapter 5 also discusses the tiered approach to risk assessment.

The ARB's EICG Report provides assistance in determining those substances that must be evaluated in an HRA and the reporting requirements of facilities, while the Hot Spots Analysis and Reporting Program (HARP) software can be used to model ground level concentrations at specific off-site locations resulting from facility emissions. Currently, the most commonly used air modeling software is the ISCST3 (Industrial Source Complex Dispersion Model). This air modeling software is incorporated into HARP, which allows the user to input all dispersion parameters directly into the program to generate air dispersion data. Alternatively, the air dispersion data may be generated separately from HARP using other air dispersion models, and then imported into HARP to generate risk estimates. Data imported into HARP must already be in the format required by HARP. HARP has the

flexibility to generate a summary of the risk data necessary for an HRA by either of the above approaches.

Most of the toxicants assessed under the Hot Spots program 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. A small subset of Hot Spots substances, semi-volatile organic and metal toxicants, is 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. Table 5.1 in Chapter 5, Table 6.3 in Chapter 6, and Table 7.1 in Chapter 7 list the substances that must be evaluated for multipathway impacts. HARP is designed to assess potential health impacts posed by substances that must be analyzed by a multipathway approach.

2.4 Dose-Response Assessment

Dose-response assessment is the process of characterizing the relationship between exposure to an agent and incidence of an adverse health effect in exposed populations. In quantitative carcinogenic risk assessment, the dose-response relationship is expressed in terms of a potency slope that is used to calculate the probability or risk of cancer associated with an estimated exposure. Cancer potency factors are expressed as the 95th percent upper confidence limit of the slope of the dose response curve estimated assuming continuous lifetime exposure to a substance at a dose of one milligram per kilogram of body weight-day and commonly expressed in units of inverse dose (i.e., (mg/kg/day)⁻¹). It is assumed in cancer risk assessments that risk is directly proportional to dose and that there is no threshold for carcinogenesis. The Office of Environmental Health Hazard Assessment (OEHHA) has compiled cancer potency factors, which should be used in risk assessments for the Hot Spots program, in Table 7.1. For clarity, consistency, and to assure proper use in risk assessment, cancer potencies should not be modified. Cancer potency factors listed in Table 7.1 were derived either by the United States Environmental Protection Agency (U.S. EPA) or by OEHHA and underwent public and peer-review and were adopted for use in the program. Chapter 8 describes procedures for use of potency values in estimating excess cancer risk. For a detailed description of cancer potency factors, refer to *The Air Toxics Hot Spots Program Risk Assessment Guidelines; Part II; Technical Support Document for Describing Available Cancer Potency Factors* (OEHHA, 1999b and 2002).

For noncarcinogenic effects, dose-response data developed from animal or human studies are used to develop acute and chronic noncancer Reference Exposure Levels (RELs). The acute and chronic RELs are defined as the concentration at which no adverse noncancer adverse health effects are anticipated. The most sensitive health effect is chosen to determine the REL if the chemical affects multiple organ systems. Unlike cancer health effects, noncancer acute and chronic health effects are generally assumed to have thresholds for adverse effects. In other words, acute or chronic injury from a pollutant will not occur until exposure to that pollutant has reached or exceeded a certain concentration (i.e., threshold). The acute and chronic RELs are intended to be below the threshold for health effects for the general population. The actual threshold for health effects in the general population is generally

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not known with any precision. Uncertainty factors are applied to the Lowest Observed Adverse Effects Level (LOAEL) or No Observed Adverse Effects Level (NOAEL) or Benchmark Concentration values from animal or human studies to help ensure that the chronic and acute REL values are below the threshold for human health for nearly all individuals. This guidance manual provides the acute and chronic Reference Exposure Levels in Tables 6.1 and 6.2, respectively. Some substances that pose a chronic inhalation hazard may also present a chronic hazard via non-inhalation routes of exposure (e.g., ingestion of contaminated water, foods, or soils, and dermal absorption). The 'oral' RELs for these substances are presented in Table 6.3. The methodology and derivations for acute and chronic RELs are described in the *Air Toxics Hot Spots Program Risk Assessment Guidelines; Part I; The Determination of Acute Reference Exposure Levels for Airborne Toxicants (Part I TSD)* (OEHHA 1999a) and *Air Toxics Hot Spots Program Risk Assessment Guidelines; Part III; Technical Support Document for the Determination of Chronic Reference Exposure Levels (Part III TSD)* (OEHHA 2000a).

2.5 Risk Characterization

This is the final step of risk assessment. In this step, modeled concentrations and public exposure information, which are determined through exposure assessment, are combined with potency factors and RELs that are developed through dose-response assessment. The use of cancer potency factors to assess total cancer risk and the use of the hazard index approach for evaluating the potential for noncarcinogenic health effects are described in Chapter 8. Example calculations for determining (inhalation) cancer risk and acute and chronic hazard quotients and hazard indices are presented in Appendix I. Chapter 9 provides an outline that specifies the content and recommended format of HRA results.

Under the Hot Spots Act, health risk assessments are to quantify both individual and population-wide health impacts (Health and Safety Code, Section 44306). The health risk assessments are facility specific and the calculated risk should be combined for all pollutants emitted by a single facility. For example, cancer risk from multiple carcinogens is considered additive. For exposures to multiple non-carcinogen pollutants, a hazard index approach is applied for air contaminants affecting the same organ system. Any emitted toxicant, that is not included in the quantitative analysis due to lack of a potency value or REL, should be qualitatively identified.

For assessing risk, OEHHA has developed two methods for determining dose via inhalation, dermal absorption, and ingestion pathways. These two methods, the point-estimate approach and the stochastic exposure assessment approach, are described below and in Chapters 5 and 8. Detailed presentations of these methods can be found in *The Air Toxics Hot Spots Program Risk Assessment Guidelines; Part IV; Technical Support Document for Exposure Assessment and Stochastic Analysis* (OEHHA, 2000b) (Part IV TSD).

2.5.1 Point-Estimate Approach

The traditional approach used in the previous *California Air Pollution Control Officer's Association (CAPCOA) Air Toxics Hot Spots Program; Revised 1992; Risk Assessment Guidelines, October 1993* (CAPCOA, 1993) (CAPCOA Guidelines) for exposure and risk assessment has been to assign a single high-end point-estimate for each exposure pathway (e.g., breathing rate). A high-end value was generally chosen so that the potential cancer risk will not be underestimated. However, in the past, the high-end point-estimate has not been well defined as to where it fell on a data distribution. An improvement over the single point-estimate approach is to select two values, one representing an average and another representing a defined high-end value. OEHHA provides information in this document on average and high-end values for key exposure pathways (e.g., breathing rate). The average and high-end of point-estimates in this document are defined in terms of the probability distribution of values for that variate. The mean represents the average values for point-estimates and the 95th percentiles represent the high-end point-estimates from the distributions identified in OEHHA (2000b). Thus, within the limitations of the data, average, and high-end point-estimates are supported by the distribution.

Tier-1 of the tiered approach to risk assessment, which is briefly discussed in Section 2.5.3 and presented in more detail in Chapter 8, utilizes a combination of the average and high-end point-estimates to more realistically estimate exposure. This method uses high-end exposure estimates for driving exposure pathways and the average point-estimate for non-driving exposure pathways. The HARP software can perform this analysis.

In addition to using an estimate of average and high-end consumption rates, cancer risk evaluations for 9, 30, and 70-year exposure durations can be presented instead of just a single 70-year exposure duration. While 9 and 30-year exposure durations are available to present potential impacts over a range of residency periods, all HRAs must present the results based on 70-year exposure. The 9- and 30-year durations correspond to the central tendency and high-end estimates for residency time recommended by (U.S. EPA, 1997b). The parameters used for the 9-year exposure scenario are for the first 9-years of life and are thus protective of children. Children have higher intake rates on a per kilogram body weight basis and thus receive a higher dose from contaminated media. See Chapter 5 for the point-estimates that can be used to estimate impacts for children. Chapters 5 and 8 discuss how to calculate cancer risk based on various exposure durations and point-estimates. Appendix I contains an example calculation and Chapter 9 clarifies how to present the findings in an HRA.

2.5.2 Stochastic Exposure Assessment

OEHHA was directed under Senate Bill (SB) 1731 to develop a "likelihood of risk" approach to risk assessment. To satisfy this requirement, OEHHA developed a stochastic approach to risk assessment that utilizes distributions for exposure variates such as breathing rate and water consumption rate rather than a single point-estimate. The variability in exposure can be propagated through the risk assessment model using the distributions as input and a Monte Carlo or similar method. The result of such an analysis is a range of risks that at least partially characterizes variability in exposure.

Distributions of key exposure variates that are presented in the Part IV TSD were taken from the literature, if adequate, or developed from raw data of original studies. Intake variates such as vegetable consumption are relatively data rich; for these variates reasonable probability distributions can be constructed. However, the data necessary to characterize the variability in risk assessment variates are not always available. For example, for the fate and transport parameters (e.g., fish bioconcentration factors), there are only a few measurements available which precludes the adequate characterization of a probability distribution. We only developed distributions for those key exposure variates that were adequately characterized by data. Development of distributions is described in detail in the Part IV TSD.

2.5.3 *Tiered Approach to Risk Assessment*

OEHHA recommends using a tiered approach to risk assessment. Tier-1 is a standard point-estimate approach using the recommended point-estimates presented in this document. If site-specific information is available to modify some point-estimates developed in the Part IV TSD and is more appropriate to use than the recommended point-estimates in this document, then Tier-2 allows use of that site-specific information. In Tier-3, a stochastic approach to exposure assessment is used with the data distributions developed in Part IV TSD and presented in this document. Tier-4 is also a stochastic approach but allows for utilization of site-specific distributions, if they are justifiable and more appropriate for the site under evaluation than those recommended in this document. Persons preparing an HRA that has a Tier-2 through Tier-4 evaluation must also include the results of a Tier-1 evaluation. Tier-1 evaluations are required for all HRAs prepared for the Hot Spots Program. Chapter 8 provides a summary of the tiered approach and the Part IV TSD discusses it in detail. Chapter 9 provides an outline that specifies the content and recommended format of HRA results.

3. *Hazard Identification - Air Toxics Hot Spots Emissions*

3.1 *The Air Toxics Hot Spots List of Substances and Emissions Inventory*

For air toxics sources, hazard identification involves identifying pollutants of concern and whether these pollutants are potential human carcinogens or associated with other types of adverse health effects. For the Air Toxics Hot Spots (Hot Spots) Program, the emitted substances that are addressed in a health risk assessment (HRA) are found in the list of hazardous substances designated in the Air Resources Board's (ARB's) *Emission Inventory Criteria and Guidelines Regulations (Title 17, California Code of Regulations, Sections 93300-93300.5)*, and the *Emission Inventory Criteria and Guidelines Report* (EICG Report), which is incorporated by reference therein (ARB, 1997). This list of substances is contained in Appendix A of this document and the EICG Report. The list of substances also identifies those substances that are considered human carcinogens or potential human carcinogens.

The substances included on the Hot Spots Program list of substances are defined in the statute as those substances found on lists developed by the following sources:

- International Agency for Research on Cancer (IARC);
- U.S. Environmental Protection Agency (U.S. EPA);
- U.S. National Toxicology Program (NTP);
- ARB Toxic Air Contaminant Identification Program List;
- Hazard Evaluation System and Information Service (HESIS) (State of California);
- Proposition 65 Safe Drinking Water and Toxic Enforcement Act of 1986 list of carcinogens and reproductive toxicants (State of California).

All substances emitted by the facility that are on the Hot Spots Act list of substances must be identified in the HRA.

The ARB EICG Report specifies that each facility subject to the Hot Spots Act must submit an Emission Inventory Report to the local air pollution control or air quality management district. This Emission Inventory Report must identify and account for all listed substances used, manufactured, formulated, or released by the facility. All routine, predictable releases must be reported. These inventory reports include the emission data necessary to estimate off-site levels of facility-released Hot Spots substances. These inventory reports will be discussed in further detail in Chapter 4. See Chapter 9 for an outline that specifies the content and recommended format for presenting the air dispersion modeling and HRA results. As presented in Appendix A, the EICG Report divides the list into three groups for reporting purposes. Potency or severity of toxic effects and potential for facility emission were considered in placing compounds into the three groups.

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For the first group (listed in these guidelines in Appendix A-I), all emissions of these substances must be quantified in the HRA. For substances in the second group (listed in these guidelines in Appendix A-II), emissions are not quantified; however, facilities must report whether the substance is used, produced, or otherwise present on-site (i.e., these substances are simply listed in a table in the HRA). Lastly, substances in the third group (Appendix A-III) also only need to be reported in a table in the HRA if they are manufactured by the reporting facility.

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 California Department of Toxic Substances Control (DTSC) Remedial Project Manager to determine which substances must be evaluated in their risk assessment. Some RCRA/CERCLA facilities may emit substances which are not currently listed under the Hot Spots Program but which may require evaluation in a RCRA/CERCLA risk assessment.

4. Air Dispersion Modeling

The information contained in this section is primarily an abbreviated version of the material found in Chapter II of the *Air Toxics Hot Spots Risk Assessment Guidelines; Part IV; Exposure Assessment and Stochastic Analysis Technical Support Document (OEHHA, 2000b)* (Part IV TSD). Several references have been included in this section to indicate those areas that are covered in more detail in the Part IV TSD. However, some air dispersion concepts and procedures have been added or updated to assist the reader in the health risk assessment (HRA) process. In particular, a brief summary of the Hot Spots Analysis and Reporting Program (HARP) software applicability to air dispersion analysis has been included. The HARP software has been developed by a contractor through the consultation of OEHHA, Air Resources Board (ARB), and Air Pollution Control or Air Quality Management District (District) representatives. The HARP software is the recommended model for calculating and presenting HRA results for the Air Toxics Hot Spots Program (Hot Spots). Information on obtaining the HARP software can be found under the Hot Spots Program on the ARB's web site at www.arb.ca.gov. See Chapter 9 for an outline that specifies the content and recommended format for presenting the air dispersion modeling and HRA results.

Additionally, there are many direct references to the United States Environmental Protection Agency (U.S. EPA) ISCST3 air dispersion model. Recently the U.S. EPA has been promoting a new air dispersion model to effectively replace the ISCST3 model. Currently this new model, AERMOD, is available for testing and review. Once the U.S. EPA adopts the AERMOD air dispersion model into their list of regulatory approved models, the references and recommendations to specific models in this document are likely to change.

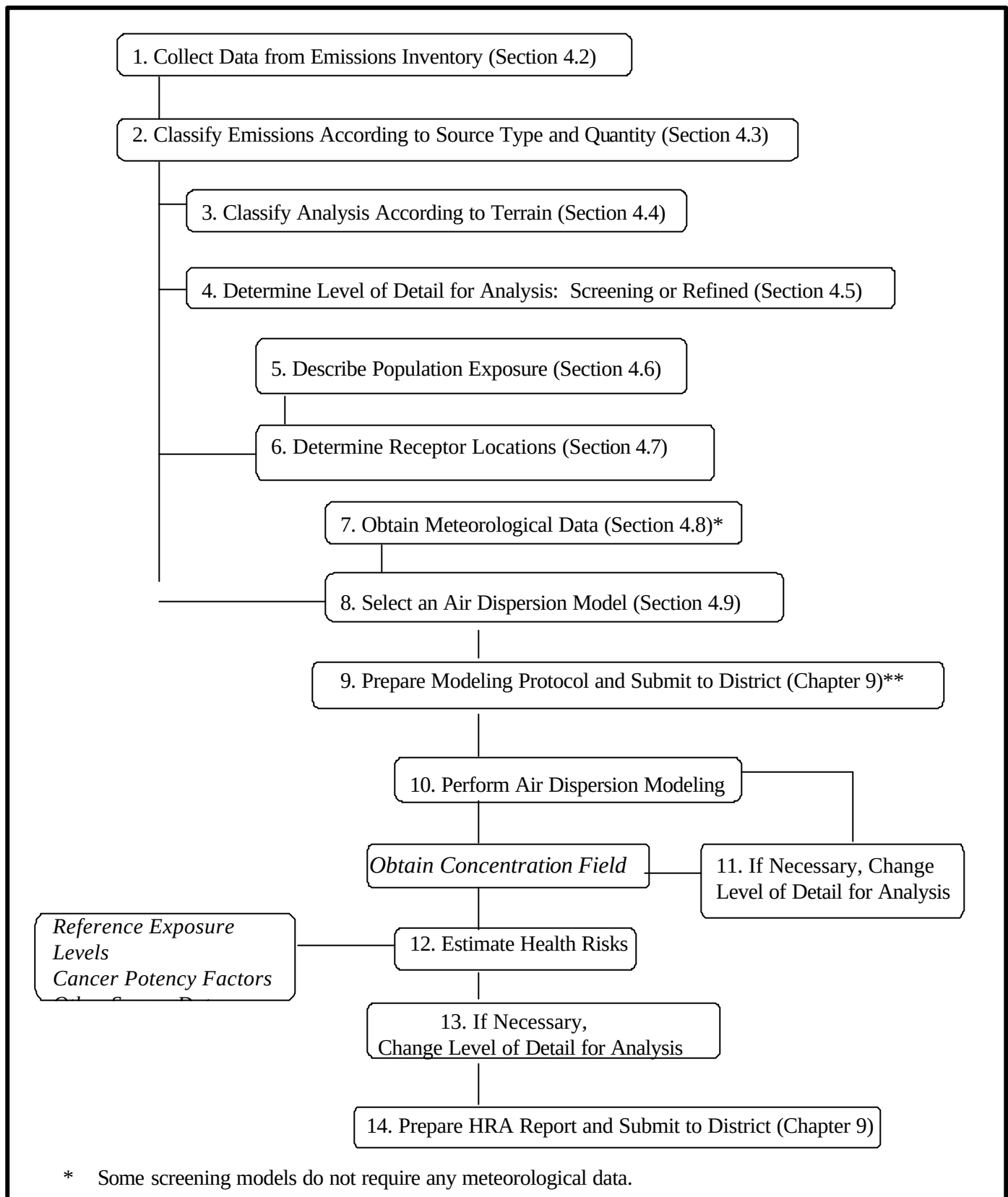
4.1 Air Dispersion Modeling in Exposure Assessment: Overview

The concentration of pollutants in ambient air is needed to characterize both inhalation and noninhalation exposure pathways. Pollutant concentrations are required in HRA calculations to estimate the potential cancer risk or hazard indices associated with the emissions of any given facility. Although monitoring of a pollutant provides excellent characterization of its concentrations, it is time consuming, costly, and typically limited to a few receptor locations and snapshots in time. Air dispersion modeling has the advantage of being relatively inexpensive and is less time consuming, provided that all the model inputs are available. In addition, air dispersion modeling provides greater flexibility for placement of receptors, assessment of individual and cumulative source contributions, and characterization of concentration over greater spatial extents.

Air dispersion modeling requires the execution of the following steps (see Fig 1):

1. Complete an emission inventory of the toxic releases (Section 4.2);
2. Classify the emissions according to source type and source quantity (Section 4.3);
3. Classify the analysis according to terrain (Section 4.4);

Figure 1. Overview of the Air Dispersion Modeling Process.



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** Optional but strongly recommended.

4. Determine level of detail for the analysis: refined or screening analysis (Section 4.5);
5. Identify the population exposure (Section 4.6);
6. Determine the receptor locations where impacts need to be analyzed (Section 4.7);
7. Obtain meteorological data (for refined air dispersion modeling only) (Section 4.8);
8. Select an air dispersion model (Section 4.9);
9. Prepare modeling protocol and submit to the local Air District (Chapter 9);
10. Perform an air dispersion analysis;
11. If necessary, redefine the receptor network and return to Step 10;
12. Perform HRA;
13. If necessary, change from screening to refined model and return to Step 8; and
14. Present the HRA results (Chapter 9 provides an outline that specifies the content and recommended format of HRA results).

The output of an air dispersion modeling analysis will be a receptor field of concentrations of the pollutant in ambient air. These concentrations in air need to be coupled with Reference Exposure Levels and cancer potency factors to estimate the hazard indices and potential carcinogenic risks. It should be noted that in the Hot Spots program emissions are considered inert for the purpose of transport and dispersion towards downwind receptors. Atmospheric transformations are not currently estimated.

4.2 Emission Inventories

The Emission Inventory Reports (Inventory Reports) developed under the Hot Spots Program provide data to be used in the HRA and in the air dispersion modeling process. The Inventory Reports contain information regarding emission sources, emitted substances, emission rates, emission factors, process rates, and release parameters (area and volume sources may require additional release data beyond that generally available in Emissions Inventory reports). This information is developed according to the ARB's *Emission Inventory Criteria and Guidelines Regulations (Title 17, California Code of Regulations, Sections 93300-93300.5)*, and the *Emission Inventory Criteria and Guidelines Report* (EICG Report), which is incorporated by reference therein (ARB, 1997).

4.2.1 Air Toxics Hot Spots Emissions

As noted in Chapter 3, Hazard Identification, the HRA should identify all substances emitted by the facility, which are on the Hot Spots Act list of substances (see Appendix A of the Guidance Manual or the EICG Report). The EICG Report specifies that Inventory Reports must identify and account for all listed substances used, manufactured, formulated, or released by the facility. All routine, predictable releases must be reported. Substances on the "list to be quantified" must be listed with emission quantities in a table in the HRA. For substances in the second and third groups, emissions do not need to be quantified; these substances should be listed in a separate table in the HRA. Chapter 9 provides an outline that specifies the content and recommended format of HRA results.

4.2.1.1 Emission Estimates Used in the Risk Assessment

The HRA must include emission estimates for all substances that are required to be quantified in the facility's emission inventory report. Specifically, HRAs should include both annual average emissions and maximum 1-hour emissions for each pollutant. Emissions for each substance must be reported for individual emitting processes associated with unique 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 HRA. The HRA report must clearly state what emissions are being used and when any reductions became effective. Specifically, a table presenting emission estimates included in the previously submitted emission inventory report as well as those used for the HRA should be presented. The District should be consulted concerning the specific format for presenting the emission information. Chapter 9 provides an outline that specifies the content and recommended format of HRA results. A revised emission inventory report must be submitted to the District prior to submitting the HRA and forwarded by the District to the ARB, if revised emission data are used.

Facilities that must also comply with RCRA/CERCLA requirements for HRAs need to consult the Cal/EPA Department of Toxic Substances Control (DTSC) Remedial Project Manager to determine what constitutes appropriate emissions data for use in the HRA. 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 DTSC on RCRA/CERCLA facilities.

A. Molecular Weight Adjustments for the Emissions of Metal Compounds

For most of the Hot Spots toxic metals, the OEHHHA cancer potency factors apply to the weight of the toxic metal atom contained in the overall compound. Some of the Hot Spots compounds contain various elements along with the toxic metal atom (e.g., "Nickel hydroxide", CAS number 12054-48-7, has a formula of H_2NiO_2). Therefore, an adjustment to the reported pounds of the overall compound is needed before applying the OEHHHA cancer potency factor for "Nickel and compounds" to such a compound. This ensures that the cancer potency factor is applied only to the fraction of the overall weight of the emissions that are associated with health effects of the metal. In other cases, the Hot Spots metals are already reported as the metal atom equivalent (e.g., CAS 7440-02-0, "Nickel"), and these cases do not use any further molecular weight adjustment. (Refer to Note [7] in Appendix A,

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List of Substances in the EICG Report for further information on how the emissions of various Hot Spots metal compounds are reported.)

The appropriate molecular weight adjustment factors (MWAFF) to be used along with the OEHHA cancer potency factors for Hot Spots metals can be found in the MWAFF column¹ of the table containing OEHHA/ARB Approved Health Values For Use In Hot Spots Facility Risk Assessments that is in Appendix L of this document.

As an example, the compound “Nickel hydroxide” has a molecular formula of H_2NiO_2 . The atomic weight of each of the elements in this compound, and the fraction they represent of the total weight, are therefore as follows:

<u>Element</u>	<u>Atomic Weight</u>	<u>Fraction of Total Weight = MWAF</u>
1 x Nickel (Ni) 1 x	58.70	58.70 / 92.714 = 0.6332 (MWAF for Nickel)
2 x Oxygen (O)	2 x 15.999	
2 x Hydrogen (H)	2 x 1.008	

Total Molecular		
Weight of H ₂ NiO ₂ :	92.714	

So, for example, assume that 100 pounds of “Nickel hydroxide” emissions are reported under CAS number 12054-48-7. To get the Nickel atom equivalent of these emissions, multiply by the listed MWAFF (0.6332) for Nickel hydroxide:

- 100 pounds x 0.6332 = 63.32 pounds of Nickel atom equivalent.

This step should be completed prior to applying the OEHHA cancer potency factor for “Nickel and compounds” in a calculation for a prioritization score or risk assessment calculation. **Note, however, that the HARP software automatically applies the appropriate MWAFF for each Hot Spots chemical (by CAS number), so the emissions should not be manually adjusted when using HARP. Therefore, if using HARP, you would use 100 pounds for Nickel hydroxide and HARP will make the MWAFF adjustment for you.**

4.2.1.2 Release Parameters

In order to use air dispersion models, release parameters (e.g., stack height and inside diameter, stack gas exit velocity, release temperature, and emission source location in actual UTM coordinates) need to be reported. The EICG Report specifies that the release parameters must be reported for each

¹ The value listed in the MWAFF column for Asbestos is not a molecular weight adjustment. This is a conversion factor for adjusting mass and fibers or structures. See Appendix C for more information on Asbestos or the EICG report for reporting guidance.

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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 air dispersion modeling guidelines or specific user's manuals. This information should also be included in the air dispersion portion of the HRA. This information must be presented in tables included in the HRA. Note that some dimensional units needed for the dispersion model may require conversion from the units reported in the Inventory Report (e.g., degrees K vs. degrees F). Chapter 9 provides an outline that specifies the content and recommended format of HRA results.

4.2.1.3 *Operation Schedule*

The HRA should include a discussion of the facility operation schedule and daily emission patterns. Special weekly or seasonal emission patterns may vary and should be discussed. This is especially important in a refined HRA. Diurnal emission patterns should match the diurnal dispersion characteristics of the ambient air. Hourly emission scalars are needed to best represent emissions from facilities, especially for diurnal pattern. Air dispersion models, such as ISCST3, readily accept hourly emissions scalars and these scalars are fully functional in the HARP software with ISCST3. In addition, for the purposes of exposure adjustment for an off-site work receptor the emission schedule and exposure schedule should corroborate any exposure adjustment factors. (For example, no exposure adjustment factor should be made when an off-site receptor and the emissions are on a coincident schedule.) Some fugitive emission patterns may be continuous. Additionally, these data are used for adjustments in a screening air dispersion analysis (see Appendix H for further details). A table should be included with the emission schedule on an hourly, weekly and yearly basis. Chapter 9 provides an outline that specifies the content and recommended format of HRA results.

4.2.1.4 *Emission Controls*

The HRA 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 EICG Report requires 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). Contact the District for guidance with control equipment adjustments. Recommended default deposition rates that are used when calculating potential noninhalation health impacts are listed in Section 8.2.4. Chapter 9 provides an outline that specifies the content and recommended format of HRA results.

4.2.2 *Landfill Emissions*

Emission estimates for landfill sites should be based on testing required under Health and Safety Code, Section (HSC) 41805.5 (AB 3374, Calderon) and any supplemental AB 2588 source tests or emission estimates used 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

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HRA. The Hot Spots Program HRA 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 internal combustion engines, flares, evaporation ponds, composting operations, boilers, and gasoline dispensing systems.

4.3 *Source Characterization*

The types of sources and quantity of sources at a facility need to be characterized in order to select an appropriate air dispersion model.

4.3.1 *Classification According to Source Type*

Air dispersion models can be classified according to the type of source that they are designed to simulate, including, but not limited to, point, line, area, and volume sources. Several models have the capability to simulate more than one type of source.

4.3.1.1 *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 from buildings and exhaust stacks from facility processes.

4.3.1.2 *Line Sources*

In practical terms, line sources are 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. A roadway is a unique line source. Models designed to simulate the enhanced mixing due to motor vehicle movements have been developed (i.e., CALINE4 and CAL3QHCR).

4.3.1.3 *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}, PM₁₀, 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 at the same elevation 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.

4.3.1.4 *Volume Sources*

Non-point sources with emissions containing 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 or passive ventilation, and line sources such as conveyor belts and rail lines.

4.3.2 *Classification According to Quantity of Sources*

The selection of an air dispersion model also requires the consideration of the number of distinct sources. Some dispersion models are capable of simulating only one source at a time, and therefore are referred to as single-source models (e.g., SCREEN3).

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:

1. 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 the shortest distance from the receptor to the nearest stack).

2. Run the model separately for each individual source and superimposing the results.

Superposition of results from each source is the approach used 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).

4.4 *Terrain Characterization*

Two types of terrain characterizations are required to select the appropriate model. One classification is made according to land type and another one according to terrain topography.

4.4.1 Land Type Classification

Most air dispersion models use different dispersion coefficients (sigmas) depending on the land use over which the pollutants are being transported. The type of land use 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. AERMOD does not depend on the dispersion coefficients used by models such as ISCST3. Therefore AERMOD does not need to classify the land type into urban or rural. When AERMOD becomes adopted as a Guideline model and is more widely used, these recommendations on land use classifications will need to be modified. Until that time, the following recommendations are relevant.

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 (e.g., on the coast) the District should be consulted concerning the classification. The District may require a classification that biases estimated concentrations towards over-prediction. As an alternative, the District may require that receptors be grouped according to the terrain between source and receptor.

4.4.1.1 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 4.1.
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.

4.4.1.2 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 4.6.2 and 4.6.3.).

2. If p is greater than 750 people/km² use urban dispersion coefficients; otherwise, use appropriate rural dispersion coefficients.

Table 4.1 Identification and classification of land use types (Auer, 1978).

Type	Use and Structures	Vegetation
I1	<i>Heavy Industrial</i> Major chemical, steel and fabrication industries; generally 3-5 story buildings, flat roofs	Grass and tree growth extremely rare; <5% vegetation
I2	<i>Light-moderate industrial</i> 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	<i>Commercial</i> Office and apartment buildings, hotels; >10 story heights, flat roofs	Limited grass and trees; <15% vegetation
R1	<i>Common residential</i> Single family dwelling with normal easements; generally one story, pitched roof structures; frequent driveways	Abundant grass lawns and light-moderately wooded; >70% vegetation
R2	<i>Compact residential</i> 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	<i>Compact residential</i> Old multi-family dwellings with close (<2 m) lateral separation; generally 2 story, flat roof structures; garages (via alley) and ash pits, no driveways	Limited lawn sizes, old established shade trees; <35% vegetation
R4	<i>Estate residential</i> Expansive family dwelling on multi-acre tracts	Abundant grass lawns and lightly wooded; >80% vegetation
A1	<i>Metropolitan natural</i> Major municipal, state, or federal parks, golf courses, cemeteries, campuses; occasional single story structures	Nearly total grass and lightly wooded; >95% vegetation
A2	<i>Agricultural rural</i>	Local crops (e.g., corn, soybean); >95% vegetation
A3	<i>Undeveloped</i> Uncultivated; wasteland	Mostly wild grasses and weeds, lightly wooded; >90% vegetation
A4	<i>Undeveloped rural</i>	Heavily wooded; >95% vegetation
A5	<i>Water surfaces</i> Rivers, lakes	

4.4.2 Terrain Topography Classification

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 various models differ in their needs to adjust for these variables.

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. The ISCST3 model uses a screening approach to complex terrain. AERMOD also provides algorithms for complex terrain.

Topography can be classified according to the following sections.

4.4.2.1 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.

4.4.2.2 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.

4.5 Level of Detail: Screening vs. Refined Analysis

Air dispersion models can be classified as “screening” or “refined” according to the level of detail that is used in the assessment of the concentration estimates. Refined air dispersion models use more robust algorithms that are 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 concentrations 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). The HARP software addresses these situations by incorporating the capability of using either representative meteorological data or the default meteorological conditions from the SCREEN3 model as inputs to the ISCST3 air dispersion model.

It is acceptable to use a refined air dispersion model in a “screening” mode for this program’s HRAs. In this case, worst-case hourly meteorological data are used to estimate the maximum 1-hour concentration with the ISCST3 model. Conservative conversion factors are used to estimate longer term averaging periods based on the maximum 1-hour concentration. (See Table 4.3 and Appendix H for guidance on the use of the conversion factors.)

4.6 *Population Exposure*

Population exposure can be assessed by determining the number of people at a particular cancer risk level such as 1×10^{-5} or 1×10^{-6} . For noncancer risk it can be the number of people exposed to the Hazard Index over a certain level such as one or five. The traditional way of estimating population exposure for cancer has been the cancer burden or the number of excess cancer cases in the exposed population.

The 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 or reviewing authority should be consulted before beginning the population exposure estimates. 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, the HARP software can provide population exposure estimates as cancer burden or as the number of persons exposed to a selected potential (user identified) health risk/impact level. Information on obtaining the HARP software can be found under the Hot Spots Program on the ARB’s web site at www.arb.ca.gov. Chapter 9 provides an outline that specifies the content and recommended format of HRA results.

4.6.1 *Zone of Impact*

The first step of population exposure estimate in an HRA is to define the zone of impact. The zone of impact is the area around the facility that is affected by the facility’s emissions. This zone is commonly defined as the area surrounding the facility where receptors have a potential multipathway (inhalation and noninhalation exposure) cancer risk greater than 10^{-6} (one in a million), an acute (inhalation) hazard index (HI) of 1.0, and/or a chronic multipathway HI of 1.0. Some Districts may prefer to use a cancer risk of 10^{-7} or an HI of 0.5 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, the District should be consulted. The District may specify limits on the area of the zone of impact. Ideally, these preferences would be discussed with the District before being presented in the modeling protocol and HRA.

Note that when depicting the HRA results, potential cancer and noncancer isopleths must present the total cancer and noncancer health impacts from both inhalation and noninhalation pathways, when appropriate. The zone of impact should be clearly shown on a map with geographic markers of adequate resolution (see Section 4.6.3.1). The text below discusses methodology for defining the zone

of impact and has format recommendations. Chapter 9 provides an outline that specifies the content and recommended format of all HRA results.

The zone of impact can be defined once the exposure assessment (air dispersion modeling) process has determined the pollutant concentrations at each designated off-site receptor and a risk analysis (see Chapter 8) has been performed. For clarity, the cancer and noncancer zone(s) of impact should be presented on separate maps. A map illustrating the carcinogenic zone of impact is required. The District may at their discretion ask for the map illustrating the potential carcinogenic zone of impact to identify the zone of impact for the minimum exposure pathways (inhalation, soil, dermal, and mothers milk) and the zone of impact for all applicable pathways of exposure (minimum pathways plus site/route dependent pathways). Two maps may be needed to accomplish this. The legend of these maps should state the level(s) used for the zone of impact and identify the exposure pathways that were included in the assessment.

The noncancer maps should also clearly identify the noncancer zones of impact. These include the acute (inhalation) zone of impact and the chronic (including both inhalation, multipathway) zone of impact. The District may at its discretion require separate chronic inhalation and chronic multipathway zones of impact maps. For clarity, presentation of the two chronic zones of impact may also require two or more maps. The legend of these maps should state the level(s) used for the zone of impact and identify the exposure pathways (and target organs) that were included in the assessment. Further information regarding the methods for determination of hazard indices and cancer risk are discussed in Chapter 8 and Appendices I.

4.6.2 Screening Population Estimates for Risk Assessments

Not all HRAs require refined population exposure assessments and at times a screening estimate may be appropriate. A screening population estimate should include an estimate of the maximum exposed population. 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 HRA 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 to be used for screening purposes. Guidance for one screening method is presented here.

1. Use a screening dispersion model (e.g., SCREEN3) 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 that 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.

2. Calculate the potential cancer risk and hazard index for each receptor location by using the methods provided in the risk characterization sections of this document (Chapter 8).
3. Find the distance where the potential cancer risk is equal to District specified levels (e.g., 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} . This exercise should be repeated for the noncancer health impacts.
4. Calculate cancer burden by estimating the number of people in the grid and stipulate that all are exposed at the highest level.

4.6.3 Refined Population Estimates for Risk Assessments

The refined HRA requires a more detailed analysis of the population distribution that is exposed to emissions from the facility. These populations can include exposure estimates for workers and residents through the use of land use maps. 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 at which 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. Census tracts, which the facility could significantly impact, should be identified (see Section 4.6.3.1). A census tract should 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 or they may prefer the census information to be evaluated using smaller blocks. 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., when the census tracts making up a city are combined) is appropriate for receptors that are considerable distances from the facility.

If a facility must also comply with the RCRA/CERCLA HRA 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 some cases it may be appropriate to evaluate risks to on-site receptors. The district should be consulted about special cases for which evaluation of on-site receptors is appropriate, such as facilities frequented by the public or where people may reside (e.g., military facilities).

4.6.3.1 *Census Tracts*

For a refined HRA, the boundaries of census tracts can be used to define the geographic area to be included in the population exposure analysis. Maps showing census tract boundaries and numbers can be obtained from “The Thomas Guide® - Census Tract Edition”. Statistics for each census tract can be obtained from the U.S. Census Bureau. 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 K.

The two basic steps in defining the area under analysis are:

1. Identify the “zone of impact” (as defined previously in Section 4.6.1) 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 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 K.
2. Identify all census tracts within the zone of impact using a U.S. Bureau of Census or equivalent map (e.g., Thomas Brothers®). If only a portion of the census tract lies within the zone of impact, the population used in the burden calculation should include the proportion of the population in that isopleth zone. 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. Each receptor located on the Cartesian grid must be identified with actual UTM coordinates. This process may be computerized and minimizes manual mapping of centroids and census tracts. The HARP software can provide population exposure estimates as cancer burden or as the number of persons exposed at the block level to a selected potential (user identified) health risk/impact level.

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.

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.

It is necessary to limit the size of the detailed analysis area because inclusion of all subcensus tracts would greatly increase the resource requirements of the analysis. For example, an urban area of 100,000 persons would involve approximately 25 census tracts, approximately 100 to 150 block groups, and approximately 1,000 to 1,400 blocks. Furthermore, a high degree of resolution at large distances from a source would not significantly affect the analysis because the concentration gradient at these distances is generally small. Thus, the detailed analysis of census tracts within several kilometers of a facility should be sufficient. The District should be consulted to determine the area that requires detailed analysis.

The District should also be consulted to determine the degree of resolution required. In some cases, resolution of residential populations to the BG/ED level may be sufficient. However, resolution to the block level may also be required for those BG/EDs closest to the facility or those having maximum concentration impacts. The identified employment subareas should be resolved to a similar degree of resolution as the residential population. For each subarea analyzed, the number of residents and/or workers exposed should be estimated.

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 HRAs. 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.

4.6.4 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, nursing homes, residential care facilities, daycare centers,

hospitals). The HRA should state what the District requirements are regarding identification of sensitive receptor locations.

Although sensitive individuals are protected by general assumptions made in the dose response assessment, their identification may be useful to assure the public that such individuals are being considered in the analysis. For cancer and noncancer effects, the identification of sensitive receptor locations may be crucial in evaluating the potential impact of the toxic effect.

4.7 *Receptor Siting*

4.7.1 *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 impact 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 worker receptor (MEIW). Note, however, some situations may require that on-site receptor (worker or residential) locations be evaluated. Some examples where the health impacts of on-site receptors may be appropriate could be military base housing, prisons, universities, or locations where the public may have regular access for the appropriate exposure period (e.g., a lunch time café or museum for acute exposures). The risk assessor should contact the District for guidance if on-site exposure situations are present at the emitting facility. These on-site locations should be included in the HRA. All of these locations (i.e., PMI, MEIR, and MEIW) must be identified for potential multipathway carcinogenic and noncarcinogenic effects. Some facilities will not have off-site workers in the vicinity of the facility and will not need to evaluate worker exposure. The approval to omit the MEIW receptor should be verified in writing with the District or reviewing authority and included in the HRA.

Other sensitive receptor locations may also be of interest and required to be included in the HRA. The District or reviewing authority should be consulted to determine which sensitive receptor locations must be included. It is possible that the estimated PMI, MEIR, and MEIW risk for carcinogenic, chronic noncarcinogenic, and acute noncarcinogenic health effects occur at different locations. Methods used to determine dose are provided in Chapter 5 and methods for calculating potential health impacts are included in Chapter 8 and Appendix I .

The results from a screening model (if available) can be used to identify the area(s) where the maximum concentrations are likely to occur. Receptor points should also be located at the population centroids (see Section 4.7.2) and sensitive receptor locations (see Section 4.6.4). The exact configuration of the receptor array used in an analysis will depend on the topography, population distribution patterns, and other site-specific factors. All receptor locations should be identified in the HRA using actual UTM (Universal Transverse Mercator) coordinates and receptor number. The receptor numbers in the summary tables should match receptor numbers in the computer output. In addition to actual UTM coordinates, the block/street locations (i.e., north side of 3,000 block of Smith

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Street) should be provided for the PMI, MEIR, and MEIW for carcinogenic and noncarcinogenic health effects. Chapter 9 provides an outline that specifies the content and recommended format of HRA results.

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 to represent the breathing zone, or direct inhalation, of a person may need to be considered when the source to receptor distance is less than a few hundred meters. Consideration must also be given to the multipathway analysis, which requires the deposition at ground level. 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 lies with the District.

4.7.2 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. Where population is not uniformly distributed, a population-weighted centroid is needed. Another alternative could be to use the concentration at the point of maximum impact (PMI) within that census tract as the concentration to which the entire population of that census tract is exposed.

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 census tracts maps and street maps to determine the centroid location. At the block level, a geographic centroid is sufficient.

4.8 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) in 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 HRA 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. The argument that “this is the nearest available meteorological data” does not justify that the data are

representative. If no representative meteorological data are available, screening procedures should be used as indicated in Section 4.10.

The analyst should acquire enough meteorological data to ensure that the worst-case meteorological conditions are represented in the model results. The period of record, recommended for use in the air dispersion model, is five years. If it is desired to use a single year to represent long-term averages (i.e., chronic exposure), then the worst-case year should be used. The worst-case year should be the year that yields the greatest maximum chronic off-site risk. If the only adverse health effects associated with all emitted pollutants from a given facility are acute, the worst-case year should be the year that yields the greatest maximum acute off-site risk. With the increasing speeds of today's desktop computers, processing five years of data should be relatively fast. Therefore, we strongly encourage the use of five years of meteorological data when available. However, the District may determine that one year of representative meteorological data is sufficient to adequately characterize the facility's impact.

Otherwise, to determine annual average concentrations for analysis of chronic health effects, the data can be averaged, if a minimum of three years of meteorological data is available. For calculation of the one-hour maximum concentrations needed to evaluate acute effects, the worst-case year should be used in conjunction with the maximum hourly emission rate. For example, the annual average concentration and one-hour maximum concentration at a single receptor for five years of meteorological data are calculated below:

Year	Annual Average ($\mu\text{g}/\text{m}^3$)	Maximum One-Hour ($\mu\text{g}/\text{m}^3$)
1	7	100
2	5	80
3	9	90
4	8	110
5	6	90
5-year average	7	

In the above example, the long-term average concentration over five years is $7.0 \mu\text{g}/\text{m}^3$. Therefore, $7 \mu\text{g}/\text{m}^3$ should be used to evaluate carcinogenic and chronic effects (i.e., annual average concentration). The one-hour maximum concentration is the highest one-hour concentration in the five-year period. Therefore, $110 \mu\text{g}/\text{m}^3$ is the peak one-hour concentration that should be used to evaluate acute effects.

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

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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.

More information on sources of meteorological data, as well as representativeness and completeness of meteorological data, can be found in Chapter 2 of the Part IV TSD.

4.9 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 is in the process of adding new models to the preferred list of models: ISC-PRIME, AERMOD, AERMOD-PRIME, and CalPuff. The latest version of the U.S. EPA recommended models can be found at the SCRAM Bulletin Board located at 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. New models placed on U.S. EPA's preferred list of models (i.e., ISC-PRIME, AERMOD, AERMOD-PRIME, and CalPuff) can be considered at that time. All air dispersion models used to estimate pollutant concentrations for HRA 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 4.4). 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. There are a few pollutants that require averaging times up to 7 hours; these can be found in Table 6.1.

4.9.1 Recommended Models

Recommended air dispersion models to estimate concentrations for HRA analyses are shown in Table 4.2. Currently, SCREEN3 and ISCST3 are the two preferred models for HRAs. This could change when the U.S. EPA places ISC-PRIME, AERMOD, AERMOD-PRIME, and CalPuff on the preferred list. Some of the names of the air dispersion models reflect the version number at the time of the writing of this document. The most current version of the models should be used for the HRA analysis. More than one model may be necessary in some situations, for example, when modeling scenarios have receptors in simple and complex terrain. Some facilities may also require models capable of handling special circumstances such as building downwash, dispersion near coastal areas, etc. See Chapter 2 of the Part IV TSD for more information on modeling special cases and for specific information including inputs and default option settings for most of the models presented in Table 4.2.

To further facilitate the model selection, the District should be consulted for additional recommendations on the appropriate model(s) or a protocol can be submitted for District review and approval (see Chapter 9). A brief description of the preferred screening model, SCREEN 3, and the preferred refined model, ISCST3, are discussed below.

4.9.2 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 shown in Table 4.2. For more information on the applicability of alternative models refer to the following documents:

- U.S. EPA (1986) *Guideline on Air Quality Models (Revised)*
- U.S. EPA (1992a) *Protocol for Determining the Best Performing Model*
- U.S. EPA (1985a) *Interim Procedures for Evaluating Air Quality Models – Experience with Implementation*
- U.S. EPA (1984) *Interim Procedures for Evaluating Air Quality Models (Revised)*

TABLE 4.2 Recommended Air Dispersion Models

	AVERAGING PERIOD	TERRAIN TYPE	SINGLE SOURCE		MULTIPLE SOURCE	
			RURAL	URBAN	RURAL	URBAN
REFINED MODELS	SHORT TERM (1-24 hour avg)	SIMPLE	ISCST3	RAM ISCST3	ISCST3	RAM ISCST3
		COMPLEX	CTDMPLUS	CTDMPLUS	CTDMPLUS	CTDMPLUS
	LONG TERM (Monthly-Annual)	SIMPLE	ISCST3 ISCLT3	RAM ISCST3 ISCLT3	ISCST3 ISCLT3	CDM20 / RAM ISCST3 ISCLT3
		COMPLEX	CTDMPLUS	CTDMPLUS	CTDMPLUS	CTDMPLUS
SCREENING MODELS	SHORT TERM (1-24 hour avg)	SIMPLE	SCREEN3	SCREEN3	SCREEN3	SCREEN3
		COMPLEX	ISCST3 RTDM, CTSCREEN VALLEY SCRNM	SHORTZ CTSCREEN VALLEY SCRNM	ISCST3 CTSCREEN* VALLEY SCRNM	SHORTZ CTSCREEN* VALLEY SCRNM
	LONG TERM (Monthly-Annual)	SIMPLE	SCREEN3	SCREEN3	SCREEN3	SCREEN3
		COMPLEX	ISCST3 RTDM	LONGZ	ISCST3	LONGZ
	Generally speaking, ISCST3 and SCREEN3 are the models that are used in most cases in the Hot Spots Program. Other models in this list may be considered on a case-by-case basis. Additionally, newer models (e.g., ISC-PRIME, AERMOD, AERMOD-PRIME, and/or CalPuff) may be added to this list at a future date.					

4.10 Screening Air Dispersion Models

A screening model may be used to estimate 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 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. Maximum 1-hour concentration averages can be converted to other averaging periods through consultation and approval by the District. Appendix H describes the use of the conversion factors. Because of variations in local meteorology and source types, the exact factor selected may vary from one district to another. Table 4.3 provides guidance on the range and typical values applied. The conversion factors are designed to bias predicted longer-term averaging periods towards overestimation.

Table 4.3. Recommended Factors to Convert Maximum 1-hour Avg. Concentrations to Other Averaging Periods (U.S. EPA, 1995a; ARB, 1994).

Averaging Time	Range	Typical Recommended
3 hours	0.8 - 1.0	0.9
8 hours	0.5 - 0.9	0.7
24 hours	0.2 - 0.6	0.4
30 days	0.2 - 0.3	0.3
Annual	0.06 - 0.1	0.08

4.10.1 SCREEN3

The SCREEN3 model is among the most widely used model primarily because it has been periodically updated to reflect changes in air dispersion modeling practices and theories. The SCREEN3 model represents a good balance between ease of use and the capabilities and flexibility of the algorithms. In addition, the calculations performed by the model are very well documented (U.S. EPA, 1995a). The SCREEN3 User's Guide (U.S. EPA, 1995d) also presents technical information and provides references to other support documents. The dispersion algorithms used in SCREEN3 are consistent with ISCST3. (With the implementation of AERMOD, which is expected in the future, SCREEN3 may need to be superseded with a model that is compatible with AERMOD.)

The most important difference between the SCREEN3 model and refined models such as ISCST3 is the meteorological data used to estimate pollutant concentrations. The SCREEN3 model can assume worst-case meteorology, which greatly simplifies the resources and time normally

associated with obtaining meteorological data. Consequently, more conservative (higher concentration) estimates are normally obtained. Alternatively, a single stability class and wind speed may also be entered.

Number of Sources and Type

SCREEN3 was designed to simulate only a single source at a time. However, more than one source may be modeled by consolidating the emissions into one emission point or by individually running each point source and adding the results. SCREEN3 can be used to model point sources, flare releases, and simple area and volume sources. Input parameters required for various source-types are shown in Tables 4.4 (point), 4.5 (flare release), 4.6 (area), and 4.7 (volume).

Table 4.4. Required Input Parameters to Model a Point Source Using SCREEN3.

Emission Rate (g/s)	
Stack Height (m)	
Stack Inside Diameter (m)	
Stack Gas Exit Velocity (m/s) or Volumetric Flow Rate (ACFM, m ³ /s)	
Stack Gas Temperature (K)	
Ambient Temperature (K)	
Receptor Height Above Ground (m)	
Receptor Distance from the Source (m)	[discrete distance or automated array]
Land Type	[urban or rural]
Meteorology	[option "1" (full meteorology) is normally selected]
<i>In Addition, for building downwash calculations</i>	
Building Height (m)	
Minimum Horizontal Dimension (m)	
Maximum Horizontal Dimension (m)	

Table 4.5. Required Input Parameters to Model a Flare Using SCREEN3.

Emission Rate (g/s)	
Flare Stack Height (m)	
Total Heat Release (cal/s)	
Receptor Height Above Ground (m)	
Receptor Distance from the Source (m)	
Land Type	[urban or rural]
Meteorology	[option “1” (full meteorology) is normally selected]
<i>In Addition, for building downwash calculations</i>	
Building Height (m)	
Minimum Horizontal Dimension (m)	
Maximum Horizontal Dimension (m)	

Table 4.6. Required Input Parameters to Model an Area Source Using SCREEN3.

Emission Rate (g/s-m ²)	
Source Release Height (m)	
Length of Larger Side of the Rectangular Area (m)	
Length of Smaller Side of the Rectangular Area (m)	
Receptor Height Above Ground (m)	
Receptor Distance from the Source (m)	
Land Type	[urban or rural]
Meteorology	[option “1” (full meteorology) is normally selected] [wind direction optional]

Table 4.7. Required Input Parameters to Model a Volume Source Using SCREEN3.

Emission Rate (g/s)	
Source Release Height (m)	
Initial Lateral Dimension of Volume (m)	
Initial Vertical Dimension of Volume (m)	
Receptor Height Above Ground (m)	
Receptor Distance from the Source (m)	
Land Type	[urban or rural]
Meteorology	[option "1" (full meteorology) is normally selected]

Regulatory Options

SCREEN3 algorithms contain all regulatory options internally coded including stack-tip downwash and buoyancy-induced dispersion. These regulatory options are the default settings of the parameters so the user does not need to set any switches during a run.

Special Cases

SCREEN3 has the capability to model several special cases by setting switches in the input file or by responding to on-screen questions (if run interactively). The special cases include:

- simple elevated terrain
- plume impaction in complex terrain using VALLEY model 24-hr screening procedure
- building downwash (only for flat and simple elevated terrain)
- cavity region concentrations (The PRIME algorithms included with ISCST3-PRIME should be used for estimates in the cavity zone)
- inversion break-up fumigation (only for rural inland sites with stack heights greater than or equal to 10 m and flat terrain)
- shoreline fumigation (for sources within 3,000 m from a large body of water)
- plume rise for flare releases

4.11 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. For more information regarding general aspects of model selection see Section 4.9.

4.11.1 ISCST3

The ISCST3 model (U.S. EPA, 1995b; 1995c) is a steady-state Gaussian plume model, which can be used to assess pollutant concentrations from a wide variety of sources associated with an industrial source complex. The ISCST3 model can be used for multiple sources in urban or rural terrain. The model includes the algorithms of the complex terrain model COMPLEX I. The user can specify if calculations are to be made for simple terrain, complex terrain, or both. However since COMPLEX 1 is a screening model, the ISCST3 model is only a screening tool for receptors in complex terrain. The ISCST3 model can calculate concentration averages for 1-hour or for the entire meteorological data period (e.g., annual or intermediate time periods such as 24-hour averages). A summary of basic input parameters needed to model a point source is shown in Table 4.8. Guidance on additional input requirements (e.g., for area and volume sources) may be found in the ISC Users Guide. (ISCST3 may be replaced with AERMOD in the future pending promulgation by the U.S. EPA.)

Table 4.8. Basic Input Parameters Required to Model a Point Source Using ISCST3.

Land Use	Urban or Rural
Averaging Period	
Emission Rate (g/s)	
Stack Height (m)	
Stack Gas Exit Temperature (K)	
Stack Gas Exit Velocity (m/s)	
Stack Diameter (m)	
Receptor Locations (x,y) coordinates (m)	discrete points; polar array; Cartesian array;
Meteorology	may be supplied by preprocessor, e.g., PCRAMMET
Anemometer Height (m)	

4.11.1.1 Regulatory Options

Regulatory application of the ISCST3 model 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 regulatory options, automatically selected when the DFAULT keyword is used, are:

- Stack-tip downwash (except for Schulman-Scire downwash)
- Buoyancy-induced dispersion (except for Schulman-Scire downwash)
- Final plume rise (except for building downwash)
- Treatment of calms
- Default values for wind profile exponents

- Default values for vertical potential temperature gradients
- Use upper-bound concentration estimates for sources influenced by building downwash from super-squat buildings

4.11.1.2 *Special Cases*

a. Building Downwash

The ISC models automatically determine if the plume is affected by the wake region of buildings when their dimensions are given. Including building dimensions in the model input does not necessarily mean that there will be downwash. See Chapter 2 of the Part IV TSD for guidance on how to determine when downwash is likely to occur.

b. Area Sources

The area source algorithms in ISCST3 use an integration technique that allows placement of receptors within the area source. Additionally, initial dispersion in the vertical can be included to simulate sources with vertical extent.

c. Volume Sources

The volume source algorithms in ISCST3 require an estimate of the initial distribution of the emission source in the horizontal and the vertical. Tables that provide information on how to estimate the initial distribution for different sources are given in the ISC3 User's Guide (U.S. EPA, 1995b; 1995c).

d. Intermediate Terrain

When simple and complex terrain algorithms are selected by the user, ISCST3 will select the higher impact from the two algorithms on an hour-by-hour, source-by-source, and receptor-by-receptor basis for all receptors located in intermediate terrain (U.S. EPA, 1995b).

Alternatively, the pollution concentrations in the receptor field may be generated separately from HARP using other approved air dispersion models. HARP has the flexibility to generate a summary of the risk data necessary for an HRA by either approach: ISCST3 internal to HARP or the use of other approved models outside of HARP.

In addition, the HARP software also incorporates the capability of using either user supplied representative meteorological data or the worst-case meteorological conditions from the SCREEN3 model as inputs to the ISCST3 air dispersion model. Information on obtaining the HARP software can be found on the ARB's web site at www.arb.ca.gov. Chapter 9 provides an outline that specifies the content and recommended format of HRA results.

e. Deposition

The ISC models contain algorithms to model settling and deposition and require additional information such as the particle size distribution. For more information consult the ISC3 User's Guide (U.S. EPA, 1995b). Note that, when performing the HRA modeling, a deposition rate will be requested and used for the noninhalation pathway exposure (see Section 8.2.5.A).

4.11.1.3 HARP Dispersion Analysis

It is highly recommended that air dispersion analysis be performed using the HARP software. HARP can perform refined dispersion analysis by utilizing the U.S. EPA standard program ISCST3 (Industrial Source Complex – Short Term 3). In addition, HARP directly links the ISCST3 outputs with risk assessment modules eliminating the need for intermediate processing by the user.

4.12 Modeling Special Cases; Specialized Models

Special situations arise in modeling some sources that require considerable professional judgment; these include building down-wash effects, wet and dry deposition, short term emissions (i.e., significantly less than 1-hour), fumigation effects, rain-cap on stack, and landfill sites. Details for these special modeling situations and specific models can be found in Chapter 2 of the Part IV TSD. It is recommended that the reader consider retaining professional consultation services if the procedures are unfamiliar. 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.

4.13 Interaction with the District

The risk assessor must contact the District to determine if there are any specific modeling requirements. Examples of such requirements may include specific receptor location guidance, specific usage of meteorological data, and specific report format (input and output). See Chapter 9 for information on the format and content of modeling protocols and HRAs.

5. *Exposure Assessment - Estimation of Concentration and Dose*

5.1 *Introduction*

This chapter provides a summary of how toxicant ground level air concentrations estimated from air dispersion modeling or monitoring results are used to determine dose at receptors of interest. This chapter includes all the algorithms and data (e.g., point-estimates, distributions, and transfer factors) that are needed to determine the substance-specific concentration in exposure media and the dose at a receptor of interest. The determination of exposure concentrations and dose precede the calculations of potential health impacts. See Chapter 8 and Appendix I for information on calculating potential health impacts.

At minimum, three receptors are evaluated in Hot Spots health risk assessments (HRA) (see Section 4.7);, these are:

- 1) the Point of Maximum Impact (PMI),
- 2) the Maximally Exposed Individual Resident (MEIR), and
- 3) the Maximally Exposed Individual Worker (MEIW).

The PMI is defined as the receptor point(s) with the highest acute, chronic, or cancer health impacts outside the facility boundary. The facility boundary is defined as the property line. Often the fence is on the property line. The MEIR is defined as the existing off-site residence(s) (e.g., house or apartment) with the highest acute, chronic, or cancer health impacts. The MEIW is defined as the highest acute, chronic, or cancer health impacts at an existing off-site workplace. Note, however, that occasionally some situations may require that on-site receptor (worker or residential) locations be evaluated. Some examples where the health impacts of on-site receptors may be appropriate could be military base housing, prisons, universities, or locations where the public may have regular access for the appropriate exposure period (e.g., a lunch time café or museum for acute exposures). The risk assessor should contact the Air Pollution Control or Air Quality Management District (District) for guidance if on-site exposure situations exist at the emitting facility. These on-site locations should be included in the health risk assessment (HRA).

If the facility emits multiple substances from two or more stacks, the acute, chronic, and cancer health impacts at the PMI may be located at different physical locations. The MEIR or MEIW cancer, acute, and chronic receptors may also be at different locations. In addition, it may be necessary to determine risks at sensitive receptors (e.g., schools, daycare, eldercare, and hospitals). The District or reviewing authority should be consulted in order to determine the appropriate sensitive receptors for evaluation.

The process for determining dose at the receptor location, and ultimately potential health impacts, will likely include air dispersion modeling, and, with less frequency, air monitoring data. Air dispersion modeling combines the facility emissions and release parameters and uses default or site-specific meteorological conditions to estimate downwind, ground-level concentrations at various (user-defined) receptor locations. Air dispersion modeling is described in Chapter 4 and is presented in detail in the *Air Toxics Hot Spots Program Risk Assessment*

Guidelines; Part IV; Technical Support Document for Exposure Assessment and Stochastic Analysis (OEHHA, 2000b) (Part IV TSD).

In summary, the process of using air dispersion modeling results as the basis of an HRA follows these four steps.

- Air dispersion modeling is used to estimate an annual-average and maximum one, four, six, and seven-hour ground level concentrations. The air dispersion modeling results are expressed as an air concentration or in terms of (Chi over Q) for each receptor point. (Chi over Q) is the modeled downwind air concentration based on an emission rate of one gram per second. (Chi over Q) is expressed in units of micrograms per cubic meter per gram per second, or $(\mu\text{g}/\text{m}^3)/(\text{g}/\text{s})$. (Chi over Q) is sometimes written as (χ/Q) and is sometimes referred to as the dilution factor.
- When multiple substances are evaluated, the χ/Q is normally utilized since it is based on an emission rate of one gram per second. The χ/Q at the receptor point of interest is multiplied by the substance-specific emission rate (in g/s) to yield the substance-specific ground-level concentration (GLC) in units of $\mu\text{g}/\text{m}^3$. The following equations illustrate this point.

$$GLC = \left(\chi/Q \right) (Q_{\text{substance}})$$
$$\chi/Q = (\text{Chi over } Q) \text{ in } \left(\frac{\mu\text{g}/\text{m}^3}{\text{g}/\text{s}} \right), \text{ from model results with unit emission rate}$$

$$Q_{\text{substance}} = \text{substance specific emission rate} \left(\frac{\text{g}}{\text{s}} \right)$$

- The applicable exposure pathways (e.g., inhalation, soil, fish) are identified for the emitted substances and the receptor locations are identified. This determines which exposure algorithms in this chapter are ultimately used to estimate dose. After the exposure pathways are identified, the fate and transport algorithms described in this chapter are used to estimate concentrations in the applicable exposure media (e.g., soil or water) and the exposure algorithms are used to determine the substance-specific dose.
- The dose is used with cancer and noncancer health values to calculate the potential health impacts for the receptor (Chapter 8). An example calculation using the high-end point-estimates for the inhalation (breathing) exposure pathway can be found in Appendix I.

The algorithms in this chapter are also used to calculate media concentrations and dose in the rare instance for the Hot Spots program when monitoring equipment were used rather than air dispersion modeling to obtain a receptor's substance-specific GLC. One situation that is specific to monitored data is the treatment of results below the sampling method level of detection (LOD). In short, it is standard risk assessment practice when monitoring results are reported both above and below the LOD to use one-half of the LOD for those sample

concentrations reported below the LOD. If all testing or monitoring results fall below the LOD, then assessors should contact the District for appropriate procedures. For more information about reporting emissions under the Hot Spots Program, see the ARB's *Emission Inventory Criteria and Guidelines Regulations (Title 17, California Code of Regulations, Sections 93300-93300.5)*, and the *Emission Inventory Criteria and Guidelines Report (EICG Report)*, which is incorporated by reference therein (ARB, 1997).

The HARP software is the recommended model for calculating and presenting HRA results for the Hot Spots Program. A contractor, through consultation with OEHHA, Air Resources Board (ARB), and District representatives, developed the HARP software. Information on obtaining the HARP software can be found on the ARB's web site at www.arb.ca.gov under the Hot Spots Program.

5.2 Criteria for Exposure Pathway Evaluation

In order to determine total dose to the receptor the applicable pathways of exposure need to be identified. The inhalation pathway must be evaluated for all Hot Spots substances emitted by the facility. A small subset of Hot Spots substances is subject to deposition on to the soil, plants, and water bodies. These substances need to be evaluated by the appropriate noninhalation pathways, as well as by the inhalation pathway, and the results must be presented in all HRAs. These substances include semi-volatile organic chemicals and heavy metals. Such substances are referred to as multipathway substances. Two steps are used to determine if a substance should be evaluated for multipathway impacts:

- Step one is to see if the substance or its group (e.g., dioxins, PAHs) is listed in Table 5.1.
- Step two is to determine if the substance has an oral reference exposure level (REL) listed in Table 6.3, or if it has an oral cancer slope factor listed in Table 7.1. Oral or noninhalation exposure pathways include the ingestion of soil, fisher caught fish, drinking water from surface waters, mother's milk, homegrown produce, beef, pork, chicken, eggs and cow's milk. The dermal pathway is also evaluated via contact with contaminated soil.

For all multipathway substances, the minimum exposure pathways that must be evaluated at every residential site (in addition to inhalation) are soil ingestion and dermal exposure. If dioxins, furans, or PCBs are emitted, then the breast-milk consumption pathway also becomes mandatory. The other exposure pathways (e.g., the ingestion of homegrown produce or fish) are evaluated on a site-by-site basis. If the resident can be exposed through an impacted exposure pathway, then it must be included in the HRA. However, if there were no vegetable gardens or fruit trees within the zone of impact for a facility, for example, then the produce pathways would not be evaluated. Note that on-site residential receptors are potentially subject to inhalation and noninhalation exposure pathways. Table 8.2 identifies the residential and worker receptor exposure pathways that are mandatory and those that are dependent on the site-specific decisions. While residents can be exposed through several exposure pathways, worker receptors are only evaluated for inhalation, soil ingestion, and dermal exposure using single point-estimates.

Table 5.1 shows the multipathway substances that, based on available scientific data, can be considered for each noninhalation exposure pathway. The exposure pathways that are evaluated for a substance depend on two factors: 1) whether the substance is considered a multipathway substance for the Hot Spots Program (Table 5.1), and 2) what the site-specific conditions are. A multipathway substance may be excluded from a particular exposure pathway because its physical-chemical properties can preclude significant exposure via the pathway. For example, some water-soluble chemicals do not appreciably bioaccumulate in fish; therefore, the fish pathway is not appropriate. In addition, if a particular exposure pathway is not impacted by the facility or is not present at the receptor site, then the pathway is not evaluated. For example, if surface waters are not impacted by the facility, or the water source is impacted but never used for drinking water, then the drinking water pathway is not evaluated.

Table 5.1 Specific Pathways to be Analyzed for each Multipathway Substance

Substance	Soil Ingestion	Dermal	Meat, Milk & Egg Ingestion	Fish Ingestion	Exposed Vegetable Ingestion	Leafy Vegetable Ingestion	Protected Vegetable Ingestion	Root Vegetable Ingestion	Water Ingestion	Breast Milk Ingestion
4,4'-Methylene dianiline	X	X		X	X	X	X	X	X	
Creosotes	X	X	X	X	X	X			X	
Diethylhexylphthalate	X	X		X	X	X	X	X	X	
Hexachlorocyclohexanes	X	X		X	X	X			X	
PAHs	X	X	X	X	X	X			X	
PCBs	X	X	X	X	X	X			X	X
Cadmium & compounds	X	X	X	X	X	X	X	X	X	
Chromium VI & compounds	X	X	X	X	X	X	X	X	X	
Inorganic arsenic & compounds	X	X	X	X	X	X	X	X	X	
Beryllium & compounds	X	X	X	X	X	X	X	X	X	
Lead & compounds	X	X	X	X	X	X	X	X	X	
Mercury & compounds	X	X	X	X	X	X	X	X	X	
Nickel	X	X	X		X	X	X	X	X	
Fluorides (Including hydrogen fluoride)	To be determined									
Dioxins & furans	X	X	X	X	X	X			X	X

5.3 *Estimation of Concentrations in Air, Soil, and Water*

Once emissions exit the source, the substances will be dispersed in the air. The substances in the exhaust gas with high vapor pressures will remain largely in the vapor phase, and substances with lower vapor pressures will tend to adsorb to fly ash or other particulate matter. The emission plume may contain both vapor phase substances and particulates. A single semivolatile organic toxicant can partition as a vapor and into a particulate. Particulates will deposit at a rate that is dependent on the particle size. The substances will deposit on vegetation, on soil, and in water. Use the 0.02 m/s factor for emission sources that have verifiable particulate matter control devices or for emission sources that may be uncontrolled but only emit particulate matter that is less than 2.5 microns (e.g., internal combustion engines powered by compressed natural gas). The following algorithms are used to estimate concentrations in environmental media including air, soil, water, vegetation, and animal products.

5.3.1 *Air*

The concentration of the substance in air at ground level (GLC) is a function of the facility emission rate and the dilution factor (χ/Q) at the points under evaluation.

a. Formula 5.3.1 A:

$$GLC = E\text{-rate} * \chi/Q \quad (\text{EQ 5.3.1 A})$$

- 1> GLC = Ground-level concentration ($\mu\text{g}/\text{m}^3$)
- 2> E-rate = Substance emission rate (g/sec)
- 3> χ/Q = Dilution factor provided by dispersion modeling ($\mu\text{g}/\text{m}^3/\text{g}/\text{sec}$)

b. Recommended values for EQ 5.3.1 A:

- 1> E-rate = Facility specific, substance emission rate
- 2> χ/Q = For point of interest, site specific, from dispersion modeling

c. Assumptions for EQ 5.3.1 A:

- 1> No plume depletion
- 2> Emission rate is constant, i.e., assumes steady state

5.3.2 *Soil*

The average concentration of the substance in soil (C_s) is a function of the deposition, accumulation period, chemical specific soil half-life, mixing depth, and soil bulk density.

a. Formula 5.3.2 A:

$$C_s = \text{Dep} * X / (K_s * SD * BD * T_t) \quad (\text{EQ 5.3.2 A})$$

- 1> C_s = Average soil concentration over the evaluation period ($\mu\text{g}/\text{kg}$)
- 2> Dep = Deposition on the affected soil area per day ($\mu\text{g}/\text{m}^2/\text{d}$)

a> Formula 5.3.2 B:

$$\text{Dep} = \text{GLC} * \text{Dep-rate} * 86,400 \quad (\text{EQ 5.3.2 B})$$

- 1: GLC = Ground-level concentration ($\mu\text{g}/\text{m}^3$)
- 2: Dep-rate = Vertical rate of deposition (m/sec)
- 3: 86,400 = Seconds per day conversion factor (sec/d)

b> Recommended default values for EQ 5.3.2 B:

- 1: GLC = Calculated above in EQ 5.3.1 A
- 2: Dep-rate = Use 0.02 meters/second for controlled or 0.05 meters/second for uncontrolled sources.

c> Assumptions for EQ 5.3.2 B:

- 1: Deposition rate remains constant

3> $X =$ Integral function

a> Formula 5.3.2 C:

$$X = [\{e^{-K_s * T_f} - e^{-K_s * T_0}\} / K_s] + T_t \quad (\text{EQ 5.3.2 C})$$

- 1: $e = 2.718$
- 2: K_s = Soil elimination constant
- 3: T_f = End of evaluation period (d)
- 4: T_0 = Beginning of evaluation period (d)
- 5: T_t = Total days of exposure period $T_f - T_0$ (d)

a: Formula 5.3.2 D:

$$K_s = 0.693 / t_{1/2} \quad (\text{EQ 5.3.2 D})$$

- 1) 0.693 = Natural log of 2
- 2) $t_{1/2}$ = Chemical specific soil half-life (d)

b: Recommended default values for EQ 5.3.2 D:

- 1) $t_{1/2}$ = See Table 5.3

b> Recommended default values for EQ 5.3.2 C:

- 1: K_s = Calculated above in EQ 5.3.2 D
- 2: T_f = 25,550 (d) = 70 yr (for 9, 30 and 70 years). Identifies the total number of days of soil deposition.

= 9,490 (d) = 26 years for nursing mother in mother's milk pathway
- 3: T_0 = 0 (d) The initial time (start period) of exposure to all receptors that are impacted by the soil pathway. Used for direct soil exposure to a worker, residential adults (9, 30, and 70-years), and children. Also used as the initial time for

determining the concentration in soil that is used for estimating the dose from the ingestion of breast milk.

- 4> SD = Soil mixing depth (m)
- 5> BD = Soil bulk density (kg/m³)

b. Recommended default values for EQ 5.3.2 A:

- 1> Dep = Calculated above in EQ 5.3.2 B
- 2> X = Calculated above in EQ 5.3.2 C
- 3> K_s = Calculated above in EQ 5.3.2 D
- 4> SD = 0.01 (m) for playground setting (soil ingestion and dermal pathways) and 0.15 (m) for agricultural setting (produce and meat pathways).
- 5> BD = 1,333 (kg/m³)
- 6> T_t = 25,550 (d) = 70 (yr) for 9, 30 and 70 year exposure durations and mother's milk pathway
= 25,550 (d) for adult in mother's milk pathway

c. Assumptions for EQ 5.3.2 A:

- 1> Substances are uniformly mixed in soil.
- 2> Substances are not leached or washed away, except where evidence exists to the contrary.
- 3> For a receptor ingesting mother's milk, the mother is exposed for 26 years, the child receives milk for one year (the last year of maternal exposure), and then is exposed to all other pathways for 9, 30 or 70 years.
- 4> It is assumed that toxicants accumulate in the soil for 70 years from deposition.

5.3.3 In Water

The average concentration of the substance in water (C_w) is a function of direct deposition and material carried in by surface run-off. However, only the contribution from direct deposition will be considered at this time.

a. Formula 5.3.3 A:

$$C_w = C_{\text{depw}} \quad (\text{EQ 5.3.3 A})$$

- 1> C_w = Average concentration in water (µg/kg)
- 2> C_{depw} = Contribution due to direct deposition (µg/kg)

a> Formula 5.3.3 B:

$$C_{\text{depw}} = \text{Dep} * \text{SA} * 365 / (\text{WV} * \text{VC}) \quad (\text{EQ 5.3.3 B})$$

- 1: Dep = Deposition on water body per day (µg/m²/d)
- 2: SA = Water surface area (m²)
- 3: 365 = Days per year (d/yr)

- 4: WV = Water volume (kg)
- 5: VC = Number of volume changes per year

b> Recommended default values for EQ 5.3.3 B:

- 1: Dep = Calculated above in EQ 5.3.2 B
- 2: SA = Site specific water surface area (m²)
- 3: WV = Site specific water volume in (kg)
- 4: VC = Site specific number of volume changes per year
(SA, WV, and VC values can be acquired from the applicable Department of Water Resources (DWR) Regional office)

c> Assumptions for EQ 5.3.3 B:

- 1: All material deposited into the water remains suspended or dissolved in the water column and is available for bioconcentration in fish.

5.3.4 Estimation of Concentrations in Vegetation and Animal Products

Estimates of the concentration of the substance in vegetation and animals require the use of the results of the air, water, and soil environmental fate evaluation. Plants and animals will be exposed to the substances at the concentrations previously calculated in Section 5.31 to 5.33 above.

1. Vegetation

The average concentration of a substance in and on vegetation (C_f) is a function of direct deposition of the substance onto the vegetation and of root translocation or uptake from soil contaminated by the substance.

a. Formula 5.3.4.1 A:

$$C_v = C_{\text{depv}} * \text{GRAF} + C_{\text{trans}} \quad (\text{EQ 5.3.4.1 A})$$

- 1> C_v = Average concentration in and on specific types of vegetation (µg/kg)
- 2> C_{depv} = Concentration due to direct deposition (µg/kg)
- 3> GRAF = Gastrointestinal Relative Absorption Fraction

a> Formula 5.3.4.1 B:

$$C_{\text{depv}} = [\text{Dep} * \text{IF} / (k * Y)] * (1 - e^{-kT}) \quad (\text{EQ 5.3.4.1 B})$$

- 1: Dep = Deposition on affected vegetation per day (µg/m²/d)
- 2: IF = Interception fraction
- 3: k = Weathering constant (d⁻¹)
- 4: Y = Yield (kg/m²)
- 5: e = Base of natural logarithm (2.718)

6: T = Growth period (d)

b> Recommended default values for EQ 5.3.4.1 B:

- 1: Dep = Calculated above in EQ 5.3.2 B
- 2: IF = Crop specific
 - a: Root crops = 0
 - b: Leafy crops = 0.2
 - c: Protected crops = 0
 - d: Exposed crops = 0.1
- 3: k = $0.1 \text{ (d}^{-1}\text{)}$
- 4: Y = $2 \text{ (kg/m}^2\text{)}$ for root, leafy, protected, exposed and pasture [CA Department of Food and Agriculture dot maps]
- 5: T = 45 (d) for leafy crops
 T = 90 (d) for exposed crops

c> Assumptions for EQ 5.3.4.1 B:

- 1: No deposition on root or protected crops
- 3> $GRAF$ = Gastrointestinal Relative Absorption Fraction
 0.43 for dioxins; 1.0 for all other chemicals

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, i.e., soil, then $GRAF = 1$. 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. In most instances, the GRAF will be 1 (Table 5.3).

- 4> C_{trans} = Concentration due to root translocation or uptake ($\mu\text{g/kg}$)

a> Formula 5.3.4.1 C: $C_{trans} = C_s * UF_2$ (EQ 5.3.4.1 C)

- 1: C_s = Average soil concentration ($\mu\text{g/kg}$)
- 2: UF_2 = Uptake factor based on soil concentration

b> Recommended default values for EQ 5.3.4.1 C:

- 1: C_s = Calculated above in EQ 5.3.2 A
- 2: UF_2 = Inorganic compounds--see Table 5.3

1) Formula 5.3.4.1 D: (for organic compounds)

$$UF_2 = [(0.03 * K_{ow}^{0.77}) + 0.82] / [(K_{oc})(F_{oc})] \quad (EQ\ 5.3.4.1\ D)$$

- a) 0.03 = Empirical constant
- b) K_{ow} = Octanol: water partition factor
- c) 0.77 = Empirical constant
- d) 0.82 = Empirical constant
- e) K_{oc} = Organic carbon partition coefficient
- f) F_{oc} = Fraction organic carbon in soil

2) Recommended default values for EQ 5.3.4.1 D:

- a) K_{ow} = Chemical specific, see Table 5.3
- b) K_{oc} = Chemical specific, see Table 5.3
- c) F_{oc} = 0.1

2. Animal Products

The average concentration of the substance in animal products (C_{fa}) depends on which routes of exposure exist for the animals. Animal exposure routes include inhalation, soil ingestion, ingestion of contaminated feed and pasture, and ingestion of contaminated water.

a. Formula EQ 5.3.4.2 E:

$$C_{fa} = (\text{Inhalation} + \text{Water ingestion} + \text{Feed ingestion} + \text{Pasture/Grazing ingestion} + \text{Soil ingestion}) * T_{co} \quad (EQ\ 5.3.4.2\ E)$$

- 1> C_{fa} = Average concentration in farm animals and their products ($\mu\text{g/kg}$)
- 2> **Inhalation** = Dose through inhalation ($\mu\text{g/d}$)

a> Formula 5.3.4.2 F: **Inhalation = $BR_A * GLC$ (EQ 5.3.4.2 F)**

- 1: BR_A = Inhalation rate for animal (m^3/d)
- 2: GLC = Ground-level concentration ($\mu\text{g}/\text{m}^3$)

b> Recommended default values for EQ 5.3.4.2 F:

- 1: BR_A = See Table 5.2
- 2: GLC = Calculated above in EQ 5.3.1 A

c> Assumptions for EQ 5.3.4.2 F:

- 1: All material inhaled is 100% absorbed

3> **Water ingestion** = Dose through water ingestion (µg/d)

a> Formula EQ 5.3.4.2 G:

$$\text{Water ingestion} = \text{WIR}_a * \text{FSW} * C_w \quad (\text{EQ 5.3.4.2 G})$$

- 1: WIR_a = Water ingestion for animal (kg/d)
- 2: FSW = Fraction of water ingested from a contaminated body of water
- 3: C_w = Average concentration in water (µg/kg)
For water 1 kg = 1 L

b>Recommended default values for EQ 5.3.4.2 G:

- 1: WIR_a = See Table 5.2
- 2: FSW = Site specific, need to survey, fraction of water ingestion practices in affected area
- 3: C_w = Calculated above in EQ 5.3.3 A

Table 5.2 *Point Estimates for Animal Pathway**

Parameter	Beef Cattle	Lactating Dairy Cattle	Pigs	Poultry
BW (body weight) (kg)	500	500	60	2
BR _A (inhalation rate) (m ³ /d)	100	100	7	0.4
WIR _a (water ingestion) (kg/d)**	40	80	8	0.2
FIR (feed ingestion) (kg/d)	8	16	2	0.1
FS _f (soil fraction of feed)	0.01	0.01	NA	NA
FSp (soil fraction of pasture)	0.05	0.05	0.04	0.02

Beef and dairy cattle food from pasture grazing is assumed to be leafy vegetation (grass) and account for 0.5 of the cattle's diet. For pigs, the default assumes a pig's diet consists of equal portions of all plant types exposed, leafy, protected and root. The default assumption is that 0.1 of the diet is homegrown. The default assumption for chickens is that pasture is composed of equal proportions all plant types with 0.05 homegrown.

Agricultural mixing depth should be used for calculating soil concentration for feed and pasture contamination.

NA Not applicable. Assume F S_f is equal to zero.

* See Section 7 of *Technical Support Document for Exposure Assessment and Stochastic Analysis (OEHHA, 2000b)* for source of these values.

** 1 kg=1 L for water

4> **Feed ingestion** = Dose through the ingestion of feed (µg/d) that is harvested after it is impacted by source emissions

a> Formula EQ 5.3.4.2 H:

$$\text{Feed ingestion} = (1 - \text{FG}) * \text{FIR} * L * C_f \quad (\text{EQ 5.3.4.2 H})$$

- 1: FG = Fraction of Diet provided by grazing
- 2: FIR = Feed ingestion rate (kg/d)
- 3: L = fraction of locally grown (source impacted) feed that is not pasture
- 4: C_f = Concentration in feed ($\mu\text{g/kg}$)

b> Recommended default values EQ 5.3.4.2 H:

- 1: FG = Site specific fraction of diet provided by grazing (need to survey)
- 2: FIR = See Table 5.2
- 3: L = Site specific, fraction of locally grown (source impacted) feed that is not pasture
- 4: C_f = As calculated above in EQ 5.3.4.1 A

5> **Pasture/Grazing ingestion** = Dose through pasture/grazing ($\mu\text{g/d}$)

a> Formula EQ 5.3.4.2 I:

$\text{Pasture/Grazing ingestion} = \text{FG} * C_v * \text{FIR} \text{ (EQ 5.3.4.2 I)}$

- 1: FG = Fraction of Diet provided by grazing
- 2: C_v = Concentration in pasture/grazing material ($\mu\text{g/kg}$)
- 3: FIR = Feed ingestion rate (kg/d)

b> Recommended default values EQ 5.3.4.2 J:

- 1: FG = Site specific fraction of diet provided by grazing (need to survey)
- 2: C_v = As calculated above in EQ 5.3.4.1 A
- 3: FIR = See Table 5.2

6> **Soil ingestion**= Dose through soil ingestion ($\mu\text{g/kg}$)

a> Formula EQ 5.3.4.2 K:

$\text{Soil ingestion} = \text{SI}_a * C_s \text{ (EQ 5.3.4.2 K)}$

- 1: SI_a = Soil ingestion rate for animal (kg/d)

a: Formula EQ 5.3.4.2 L:

$\text{SI}_a = [(1 - \text{FG}) * \text{FS}_f * \text{FIR}] + [\text{FG} * \text{FS}_p * \text{FIR}] \text{ (EQ 5.3.4.2 L)}$

- 1) FG = Fraction of diet provided by grazing
- 2) FS_f = Soil ingested as a fraction of feed ingested
- 3) FIR = Feed ingestion rate (kg/d)

- 4) FS_p = Soil ingested as a fraction of pasture ingested

b: Recommended default values for EQ 5.3.4.2 L:

- 1) FG = Site specific fraction of diet provided by grazing
2) FS_f = See Table 5.2
3) FIR = See Table 5.2
4) FS_p = See Table 5.2

- 2: C_s = Average soil concentration ($\mu\text{g/kg}$)

b> Recommended default values for EQ 5.3.4.2 K:

- 1: SI_a = Calculated above
2: C_s = Calculated above in EQ 5.3.2 A

- 7> Tco = Transfer coefficient of contaminant from diet to animal product (d/kg)

a> Recommended default values:

- 1: TCO = SEE TABLE 5.3

b> Recommended default values EQ 5.3.4.2 J:

- 1: FG = Site specific fraction of diet provided by grazing (need to survey)
2: C_f = As calculated above in EQ 5.3.4.1 A
3: FIR = See Table 5.2

Table 5.3 Substance Specific Default Values for Multipathway Substances⁽¹⁾

				Feed to meat, milk, eggs Transfer Coefficients ³ [Tco (d/kg)]			Root Uptake Factors (for inorganic compounds)					
Multipathway Substance	Log K _{oc} ²	Log K _{ow} ²	Fish Biocon. Factor	Tco Meat	Tco Milk	Tco ³ Egg	Root	Leafy	Exposed & Protected	GRAF ⁴	Dermal ⁵ Absorp. Fact.(ABS)	Soil Half Life (days)
Arsenic (inorganic)	NA ⁶	NA	4.0 x 10 ⁺⁰	2.0 x 10 ⁻³	6.2 x 10 ⁻⁵	2.0 x 10 ⁻³	4.0 x 10 ⁻⁴	4.0 x 10 ⁻³	9.0 x 10 ⁻⁴	1.0	0.04	1.0 x 10 ⁺⁸
Beryllium & Compounds	NA	NA	1.9 x 10 ⁺¹	1.0 x 10 ⁻³	9.1 x 10 ⁻⁷	1.0 x 10 ⁻³	2.0 x 10 ⁻³	1.0 x 10 ⁻³	2.0 x 10 ⁻⁴	1.0	0.01	1.0 x 10 ⁺⁸
Cadmium & Compounds	NA	NA	3.66 x 10 ⁺²	5.5 x 10 ⁻⁴	1.0 x 10 ⁻³	5.5 x 10 ⁻⁴	4.0 x 10 ⁻²	6.0 x 10 ⁻²	2.0 x 10 ⁻²	1.0	0.001	1.0 x 10 ⁺⁸
Creosotes	NA	NA	5.83 x 10 ⁺²	3.4 x 10 ⁻²	1.6 x 10 ⁻²	3.4 x 10 ⁻²	NA	NA	NA	1.0	0.13	5.7 x 10 ⁺²
Chromium VI & Cmpds	NA	NA	2.0 x 10 ⁺⁰	9.2 x 10 ⁻³	1.0 x 10 ⁻⁵	9.2 x 10 ⁻³	1.0 x 10 ⁻³	8.0 x 10 ⁻⁴	7.0 x 10 ⁻⁴	1.0	0.01	1.0 x 10 ⁺⁸
Diethylhexylphthalate	4.72	5.11	4.83 x 10 ⁺²	NA	NA	NA	NA	NA	NA	1.0	0.10	2.3 x 10 ⁺¹
Dioxins and Furans	NA	NA	1.9 x 10 ⁺⁴	4.0 x 10 ⁻¹	4.0 x 10 ⁻²	4.0 x 10 ⁻¹	NA	NA	NA	0.43	0.02	4.72 x 10 ⁺³
Hexachlorocyclohexanes	NA	NA	4.56 x 10 ⁺²	NA	NA	NA	NA	NA	NA	1.0	0.10	6.7 x 10 ⁺¹
Lead & Compounds (inorganic)	NA	NA	1.55 x 10 ⁺²	4.0 x 10 ⁻⁴	2.6 x 10 ⁻⁴	4.0 x 10 ⁻⁴	2.0 x 10 ⁻³	5.0 x 10 ⁻³	1.0 x 10 ⁻³	1.0	0.01	1.0 x 10 ⁺⁸
Mercury (inorganic)	NA	NA	5.0 x 10 ⁺³	2.7 x 10 ⁻²	9.7 x 10 ⁻⁶	2.7 x 10 ⁻²	5.0 x 10 ⁻²	9.0 x 10 ⁻²	3.0 x 10 ⁻²	1.0	0.10	1.0 x 10 ⁺⁸
Nickel and compounds	NA	NA	NA	2.0 x 10 ⁻³	1.0 x 10 ⁻³	2.0 x 10 ⁻³	2.0 x 10 ⁻²	6.0 x 10 ⁻³	9.0 x 10 ⁻³	1.0	0.04	1.0 x 10 ⁺⁸
4,4'-Methylene dianiline	2.24	1.59	1.11 x 10 ⁺¹	NA	NA	NA	NA	NA	NA	1.0	0.10	4.0 x 10 ⁺⁰
PAH as Benzo(a)pyrene	NA	NA	5.83 x 10 ⁺²	3.4 x 10 ⁻²	1.6 x 10 ⁻²	3.4 x 10 ⁻²	NA	NA	NA	1.0	0.13	5.7 x 10 ⁺²
Polychlorinated Biphenyls	NA	NA	9.97 x 10 ⁺⁴	5.0 x 10 ⁻²	1.0 x 10 ⁻²	5.0 x 10 ⁻²	NA	NA	NA	1.0	0.14	9.4 x 10 ⁺²

(1) Values based on South Coast AQMD Multi-Pathway Assessment Input Parameters Guidance Document as adapted and modified by OEHHA.

(2) See Tables 5.17 and 5.18 for derivation and references for Kow and Koc values.

(3) Values for the Egg Transfer Coefficients have not been developed but are assumed to be similar to meat transfer coefficients cited in the SCAQMD document.

(4) GRAF (Gastrointestinal Relative Absorption Factor). The guidelines allow for adjusting for bioavailability where the evidence warrants. For example, there are good data which indicate that dioxin is not as available to an organism when bound to soil or fly ash matrices relative to when it is in solution or in food. Therefore, a bioavailability factor is incorporated into the model to account for this difference. When information becomes available for other chemicals of concern, this type of bioavailability will be incorporated into the model.

(5) Dermal absorption of many compounds is limited. The guidelines have incorporated dermal absorption factors to account for the decreased absorption relative to other routes of exposure, for estimates of dermal dose used to assess both cancer and noncancer health hazards. The dermal absorption values come from literature describing absorption of chemicals across the skin. In some cases, there are good data available for specific compounds. In other cases, an absorption fraction is inferred from data for similar chemicals. In a few cases the effects of adsorption to a soil or fly ash matrix on dermal bioavailability have been studied. In these rare instances, the dermal absorption factor used in the guidelines accounts for this decreased bioavailability (e.g., the dermal absorption value for dioxins/furans accounts for decreased bioavailability).

NA - Data Not Available or Not Applicable.

b> Assumptions:

- 1: The transfer coefficient is the same for all exposure routes.
- 2: The transfer coefficient for all meat is the same.
- 3: The transfer coefficient for eggs is the same as for meat.

3. Fish Products

The average concentration in fish (C_f) is based on the concentration in water and a bioconcentration factor.

a. Formula EQ 5.3.4.3 M: $C_f = C_w * BCF$ (EQ 5.3.4.3 M)

- 1> C_f = Concentration in fish ($\mu\text{g/kg}$)
- 2> C_w = Concentration in water ($\mu\text{g/kg}$)
- 3> BCF = Bioconcentration factor

b. Recommended default values for EQ 5.3.4.3 M:

- 1> C_w = Calculated above in EQ 5.3.3 A
- 2> BCF = See Table 5.3

c. Assumptions for EQ 5.3.4.3 M:

- 1> All contaminants in water are available for bioconcentration.
- 2> Contaminant is present in a soil or fly ash matrix.
Contaminant concentrations are uniform in water based on dispersion.
- 4> Only bioconcentration is currently considered. Bioaccumulation from the food chain is not considered.

5.4 Estimation of Dose

Once the concentrations of substances are estimated in air, soil, water, plants, and animal products, they are used to evaluate estimated exposure to people. Exposure is evaluated by calculating the lifetime average daily dose (LADD). The following algorithms calculate this dose for exposure through inhalation, dermal absorption, and ingestion pathways. This section contains average and high-end point-estimates and data distributions for adults and children for many exposure pathways. The point-estimates and data distributions that should be used for children are listed under the nine-year exposure duration. The point-estimates and data distributions that should be used for adults are listed under the 30 and 70-year exposure duration. Workers are addressed as adults using single point-estimates for three exposure pathways. Point-estimates for workers are listed under “worker (single value).” OEHHA has not generated or endorsed distributions for worker exposure. Therefore there is no Tier 3 stochastic approach for offsite worker cancer risk assessment.

5.4.1 Estimation of Exposure Through Inhalation

Exposure through inhalation (Dose-inh) is a function of the respiration rate and the concentration of a substance in the air.

1. Formula EQ 5.4.1 A:

$$\text{Dose-inh} = \frac{C_{\text{air}} * \{DBR\} * A * EF * ED * 10^{-6}}{AT} \quad (\text{EQ 5.4.1 A})$$

where:

- Dose-inh = Dose through inhalation (mg/kg/d)
- 10^{-6} = Micrograms to milligrams conversion, Liters to cubic meters conversion
- C_{air} = Concentration in air ($\mu\text{g}/\text{m}^3$)
- {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, in days (e.g., 25,550 d for 70 yr for cancer risk)

2. Recommended default values for EQ 5.4.1 A:

- a. EF = 350 d/y
- b. ED = 9; 30; or 70 yr
- c. AT = 25,550 days
- d. A = 1
- e. {DBR} 9, 30 & 70 year exposure = see Table 5.4
- f. {DBR} 30 and 70 year exposure = see Table 5. 5 for parametric models (distributions for Tier 3 stochastic risk assessment)

Table 5.4 Point Estimates for Daily Breathing Rate for 9, 30, and 70-year Exposure Durations (DBR) (L/kg BW * Day)

9-Year Exposure Duration		30 & 70-Year Exposure Duration		Off-site ¹ Worker
Average	High End	Average	High End	(Single Value)
452	581	271	393	149

¹This value corresponds to a 70 kg worker breathing 1.3 m³/hour for an eight hour day. 1.3 m³/hr is the breathing rate recommended by U.S.EPA, (1997a) as an hourly average for outdoor workers.

Table 5.5 Breathing Rate Distributions for 9, 30, and 70-Year Exposure Durations for Stochastic Analysis (L/kg BW * Day)

	9-Year Exposure Duration	30 & 70-Year Exposure Duration
Distribution Type	Gamma	Gamma
Location	301.67	193.99
Scale	29.59	31.27
Shape	5.06	2.46

3. Assumption for EQ 5.4.1 A:

- a. The fraction of chemical absorbed (A) is the same fraction absorbed in the study on which the cancer potency or Reference Exposure Level is based.

5.4.2 Estimation of Exposure Through Dermal Absorption

Exposure through dermal absorption (Dose-dermal) is a function of the soil or dust loading of the exposed skin surface, the amount of skin surface area exposed, and the concentration and availability of the substance. Distributions are not available for stochastic analysis. Tier III stochastic risk assessments should include the dermal pathway as a high end point estimate.

1. Formula EQ 5.4.2 A:

$$\text{Dose-dermal} = C_s * SA * SL * Ef * ABS * 10^{-9} * ED / BW * AT (\text{EQ 5.4.2 A})$$

Where:

Dose-dermal	= Exposure dose through dermal absorption (mg/kg/d)
C_s	= Average soil concentration ($\mu\text{g/kg}$)
SA	= Surface area of exposed skin (cm^2)
SL	= Soil loading on skin ($\text{mg/cm}^2\text{-d}$)
ABS	= Fraction absorbed across skin
BW	= Body weight (kg)
10^{-9}	= Micrograms to kilogram conversion factor ($\mu\text{g/kg}$)
EF	= (EF defined in Table 5.6) (days/year)
AT	= 25,550 days (70 years)
ED	= Exposure Duration (years)

2. Recommended default values for EQ 5.4.2 A:

- a. C_s = Calculated above in EQ 5.3.2 A
- b. SA = See Table 5.6
- c. SL = See Table 5.6
- d. ABS = See Table 5.3
- e. BW = See Table 5.6
- f. f = See Table 5.6

Table 5.6 Recommended Point Estimate Values for Dermal Pathway for 9, 30, and 70 Year Exposure Durations and Worker¹

	9 Year ¹ Exposure Duration		30 & 70 Year Exposure Duration		Worker ² (Single Value)
BW Body Weight (kg)	18		63		70
	Average	High End	Average	High End	
SL Soil Loading (mg/cm ² -day) ³	0.2	1.0	0.2	1.0	1.0
EF Exposure Frequency (d/yr)	228	350	121	350	245
SA Surface Area Exposed (cm ²)	2,778	3,044	4,700	5,500	5,800

1. OEHHA, 2000b, page 6-10 contains surface area exposed and exposure frequency recommended values for children (1- 6) and adults (>6). For the 9 year average surface area exposed, a time weighted average value for ages 0-9 was derived with following formula $(5/9 \times 2000) + (3/9 \times 5000) = 2,778 \text{ cm}^2$. For the 9 year high-end surface area exposed, $(5/9 \times 2000) + (3/9 \times 5800) = 3,044 \text{ cm}^2$. It is assumed that dermal exposure to outdoor soil does not occur the first year of life. For exposure frequency the same approach was used: $(5/9 \times 350) + (3/9 \times 100) = 228 \text{ (d/yr)}$ for average.

2. Worker values for surface area exposed and soil loading are the high end adult values from page 6-10, OEHHA, 2000b. The exposure frequency assumes that the worker works 49 weeks per year, 5 days per week and that he or she is exposed everyday at work.

3. For Hot Spots risk assessments it is assumed that one event occurs per day.

5.4.3 Estimation of Exposure Through Ingestion

Exposure through ingestion is a function of the concentration of the substance in the substance ingested (soil, water, and food), the gastrointestinal absorption of the substance in a soil or fly ash matrix, and the amount ingested.

1. Exposure through Ingestion of Soil

There are no distributions for soil ingestion currently recommended. Tier III stochastic risk assessments should include a high-end point estimate of soil ingestion, soil loading , exposure frequency and soil area. The dose from inadvertent soil ingestion can be estimated by the point estimate approach using the following general equation:

$$\text{Dose} = \frac{C_{\text{soil}} \times \text{GRAF} \times \text{SIR} \times \text{EF} \times \text{ED} \times 10^{-9}}{\text{AT}} \quad (\text{EQ 5.4.3.1 A})$$

where:

Dose = dose from soil ingestion (mg/kg BW *day)

10^{-9} = conversion factor (mg/μg) (kg/mg)

C_{soil} = concentration of contaminant in soil (μg/g)

GRAF = gastrointestinal relative absorption fraction, unitless; chemical-specific (see Table 5.3)
 SIR = soil ingestion rate (mg/kg BW * day) (see Table 5.7)
 EF = exposure frequency (days/year)
 ED = exposure duration (years)
 AT = averaging time, period of time over which exposure is averaged (days); for noncancer endpoints, AT = ED x 365 d/yr; for cancer risk estimates, AT = 70 yr x 365 d/yr = 25,550 days

b. Recommended default values for EQ 5.4.3.1 A:

- a. GRAF = Table 5.3
- b. SIR = Table 5.7
- c. EF = 350 d/year resident, 245 d/year worker
- d. ED = 9, 30, or 70 yr
- e. AT = 25,550 days

Table 5.7 Soil Ingestion Rates (SIR) for 9, 30 and 70-Year Exposure Durations and Off-site Worker.

	9-Year Exposure Duration	30 & 70-Year Exposure Duration	Off-site ¹ Worker
Soil Ingestion Rate (mg/kg BW *Day)	8.7	1.7	1.4

1. The soil ingestion rate of 1.4 (mg/kg BW * day) corresponds to the OEHHA, 2000b recommendation of 100 mg/day for a 70 kg adult.

In this approach, it is assumed that the soil ingested contains a representative concentration of the contaminant(s) and the concentration is constant over the exposure period.

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, i.e., soil, then 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. In most instances, the GRAF will be 1.

2. Exposure through Ingestion of Water

a. Formula EQ 5.4.3.2 B:

$\text{Dose-w} = C_w * \text{WIR} * \text{AB}_{\text{ing}} * \text{F}_{\text{dw}} * \text{EF} * \text{ED} * 10^{-6} / \text{AT} \quad (\text{EQ 5.4.3.2 B})$

where:

Dose-w = Exposure dose through ingestion of water (mg/kg/d)
 C_w = Water concentration ($\mu\text{g/kg}$)
WIR = Water ingestion rate (ml/kg BW/day)
 AB_{ing} = Gastrointestinal absorption factor
 F_{dw} = Fraction of drinking water from contaminated source
EF = Exposure frequency (days/year)
ED = Exposure duration (years)
 10^{-6} = Conversion factor ($\mu\text{g/mg}$)(L/ml)

b. Recommended default values for EQ 5.4.3.2 B:

1> C_w = Calculated above 5.3.3 A
2> WIR = See Tables 5.8 and 5.9
3> AB_{ing} = Default set to 1
4> EF = 350 d/yr
5> ED = 9, 30, or 70 yrs
6> AT = 25,550 days

Table 5.8

Point Estimate Water Consumption Ingestion Rates (WIR) for 9, 30, and 70-Year Exposure Durations (ml/kg BW * day)

9-Year Exposure Duration		30 and 70-Year Exposure Duration	
Average	High End	Average	High End
40	81	24	54

Table 5.9

Water Ingestion Lognormal Distributions for 9, 30, and 70-Year Exposure Durations (ml/kg BW * day) (Stochastic Analysis)

Distribution Type	9-Year Exposure Duration		30 & 70-Year Exposure Duration	
	Mean $\pm$ S.D.	$\mu \pm \sigma$	Mean $\pm$ S.D.	$\mu \pm \sigma$
Lognormal	40.03 $\pm$ 21.45	3.57 $\pm$ 0.50	24.2 $\pm$ 17.0	2.99 $\pm$ 0.63

3. Exposure through Ingestion of Food

The exposure through food ingestion can be through ingestion of plant products, animal products (including fish), and mother's milk.

a. Plant products

Exposure through ingesting plants (Dose-p) is a function of the type of plant, gastrointestinal absorption factor, bioavailability and the fraction of plants ingested that are homegrown. The calculation is done for each type of plant, then summed to get total dose for this pathway.

1> Formula EQ 5.4.3.3.a C:

$$\text{Dose-p} = (C_f * IP * \text{GRAF} * L * EF * ED * 10^{-6}) / AT \text{ (EQ 5.4.3.3.a C)}$$

- a> Dose-p = Exposure dose through ingestion of plant products (mg/kg/d)
- b> C_f = Concentration in plant type ($\mu\text{g/kg}$)
- c> IP = Consumption of exposed, leafy, protected, or root produce (g/kg*day)
- d> GRAF = Gastrointestinal relative absorption factor
- e> L = Fraction of exposed, leafy, protected, or root produce homegrown
- f> EF = Exposure frequency (days/year)
- g> ED = Exposure duration (years)
- h> 10^{-6} = Conversion factor ($\mu\text{g/kg}$ to mg/g)
- i> AT = Averaging time, period over which exposure is averaged (days)

2> Recommended default values for EQ 5.4.3.3.a C:

- a> C_f = Calculated above in EQ 5.3.4.1 A
- b> IP = See Tables 5.10 to 5.12
- c> GRAF = See Table 5.3
- d> L = Site specific fraction of produce homegrown or locally produced. For nonurban sites 0.15 may be used as a default. For urban sites 0.052 may be used (USEPA, 1997b).
- e> EF = 350 d/yr
- f> ED = 70 yrs
- g> AT = 25,550 days

Table 5.10
Point Estimates for Per Capita Food
Consumption Rates (g/Kg BW * Day)

	9-Year Exposure Duration		30 & 70-Year Exposure Durations	
	Average	High End	Average	High End
Produce				
Exposed	4.16	15.7	3.56	12.1
Leafy	2.92	10.9	2.90	10.6
Protected	1.63	6.66	1.39	4.88
Root	4.08	14.9	3.16	10.5
Meat				
Beef	2.24	7.97	2.25	6.97
Chicken	1.80	4.77	1.46	5.02
Pork	1.31	5.10	1.39	4.59
Dairy	12.0	51.9	5.46	17.4
Eggs	3.21	10.3	1.80	5.39

Table 5.11
Parametric Models for Ages 0-9 Food Consumption
Distributions (g/kg BW * Day) (Stochastic Analysis)

Food Category	Distribution Type	Mean	Std. Dev.	Location	Scale	Shape	$\mu \pm \sigma$
Produce							
Exposed	Lognormal	3.93	5.49				exp(0.83±1.04)
Leafy	Lognormal	2.83	3.89				exp(0.43±1.03)
Protected	Weibull			0.13	1.21	0.71	
Root	Lognormal	4.08	5.91				exp(0.84±1.06)
Meat							
Beef	Weibull			0.24	1.72	0.77	
Chicken	Gamma			0.25	2.94	0.53	
Pork	Weibull			0.18	0.97	0.78	
Dairy	Lognormal	11.32	18.3				exp(1.78±1.13)
Eggs	Weibull			0.26	2.67	0.82	

Table 5.12
Parametric Models for Ages 0-70 Food Consumption Distributions
(g/kg BW * Day) (Stochastic Analysis)

Category of Food	Mean	Standard Deviation	Distribution Type	$\mu \pm \sigma$
Produce				
Exposed	3.43	6.16	Lognormal	Exp (0.51±1.20)
Leafy	2.97	4.95	Lognormal	Exp (0.42±1.15)
Protected	1.39	2.43	Lognormal	Exp (-0.37±1.18)
Root	3.07	5.23	Lognormal	Exp (0.44±1.17)
Meat				
Beef	2.32	3.50	Lognormal	Exp (0.25±1.09)
Chicken	1.44	2.19	Lognormal	Exp (-0.23±1.09)
Pork	1.42	2.30	Lognormal	Exp (-0.29±1.13)
Dairy	5.57	10.5	Lognormal	Exp (0.96±1.23)
Eggs	1.84	2.60	Lognormal	Exp (0.061±1.05)

Table 5.13
Default Values for Fisher-caught Fish Consumption (g/kg BW * Day)

	9, 30, & 70-Year Exposure Scenario
Average	0.48
High-End	1.35

Table 5.14
Parametric Model for Fisher-caught Fish Consumption Distribution for 9, 30 and 70-Year Exposure Scenarios (g/kg BW *Day) (stochastic analysis).

Mean	Standard Deviation	Distribution Type	$\mu \pm \sigma$
0.48	0.71	Lognormal	exp(-1.31 ± 1.08)

b. Animal Products (Including Fisher-caught Fish)

Exposure through animal product ingestion (Dose-ap) is a function of what type of meat and/or fish is ingested, as well as animal milk products and eggs. The calculation is done for each type and then summed to get the total dose for this pathway.

1> Formula 5.4.3.3.b D:

Dose-ap = $C_{fa} * If * GI * L * EF * ED * 10^{-6} / AT$	(EQ 5.4.3.3.b D)

- a> Dose-ap = Exposure dose through ingestion of animal or fish products (mg/kg BW * day)
- b> C_{fa} = Concentration in animal product (µg/kg)
- c> If = Consumption of animal product (g/kg BW per day), e.g, beef, chicken, pork, dairy, eggs, fish
- d> GI = Gastrointestinal absorption factor
- e> L = Fraction of animal product homegrown
- f> EF = Exposure frequency (days/year)
- g> ED = Exposure duration (years)
- h> AT = Averaging time (days)
- i> 10^{-6} = Conversion factor (µg/kg to mg/g) for C_f term

2> Recommended default values for EQ 5.4.3.3.b D:

- a> C_{fa} = Calculated above in EQ 5.3.4.2 E
- b> If = See Tables 5.10, 5.11, and 5.12. For fish ingestion rates see Table 5.13. For distributions (parametric models) for Tier 3 risk assessments see Tables 5.11, 5.12, and 5.14.
- c> GI = Default set to 1.
- d> L = Site specific fraction of product locally produced.
- e> EF = 350 d/yr
- f> ED = 70 yrs
- G> AT = 25,550 DAYS

c. Mother's Milk

Exposure through mother's milk ingestion (Dose-Im) 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 the equations on pages 20-26.

1> Formula 5.4.3.3.c E:

$$\text{Dose-Im} = C_m * \text{BMI}_{\text{bw}} * F * \text{yr} / 25,550 \text{ (EQ 5.4.3.3.c E)}$$

- a> Dose-Im = Exposure dose through ingestion of mother's milk (mg/kg BW/d)
- b> 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/g milk)

1: Formula 5.4.3.3.c F:

$$C_m = E_{\text{mi}} * t_{1/2} * f_1 * f_3 * 10^{-3} / (f_2 * 0.693) \text{ (EQ 5.4.3.3.c F)}$$

- a: E_{mi} = Average daily maternal intake of contaminant from all routes (mg/kg/d)
- b: $t_{1/2}$ = Half-life of contaminant in mother (d)
- c: f_1 = Fraction of contaminant that partitions to mother's fat
- d: f_3 = Fraction of fat of mother's milk (kg fat/kg milk)
- e: f_2 = Fraction of mother's weight that is fat(kg fat/kg bw)
- f: 10^{-3} = Conversion factor (g to kg milk)
- g: 0.693 = Natural log of 2

2: Recommended default values for EQ 5.4.3.3.c F:

- a: E_{mi} = Sum of doses
- b: $t_{1/2}$ = 2,117 (d) for PCDDs/PCDFs = 5.8 yr
1,460 (d) for both PCBs
- c: f_1 = 0.8
- d: f_3 = 0.04 (kg fat/kg milk)
- e: f_2 = 0.33 (kg fat/kg BW)
- c> BMI_{bw} = Daily breast-milk ingestion rate (g/kg BW*day)
- d> F = Frequency of exposure (d/yr)
- e> yr = Breast-feeding period (yr)
- f> 25,550 = Exposure period (d)

2> Recommended default values for EQ 5.4.3.3.c E:

- a> BMI_{bw} = see Table 5.15
For distribution (parametric model) for Tier 3 stochastic

risk assessments see Table 5.16
 b> F = 365 (d)
 c> yr = 1(yr)

3> Assumptions for EQ 5.4.3.3.c E:

- a> For the MEIR, mother is exposed for 25 years, the child receives milk for another year, and then the nursing infant is exposed for 9, 30, or 70 years.
- b> For the 9, 30, and 70 year exposure duration scenarios, the total toxicant dose from the breast-feeding in the first year of life is assumed to be spread over 70 years in order to calculate an average daily dose.

Table 5.15
Point Estimate Values for Breast Milk Consumption Rate
(g/kg BW *day)

	9, 30, and 70-Year Exposure Durations
Average	102
High End	138

Table 5.16
Parametric Model for Breast Milk Consumption Rate for
9, 30, and 70 Year Exposure Durations (Stochastic Analysis) (g/kg BW *day)

Distribution Type	Mean $\pm$ S.D.
Normal	102 $\pm$ 21.8

5.5 References for Kow and Koc Values in Table 5.3

Table 5.17 References for Kow Values

Compound	Notes	Reference
Diethylhexylphthalate	Level 1 calculation	Mackay <i>et al.</i> (1995)
4,4'-Methylene dianiline	Measured	Hansch <i>et al.</i> (1985)

Table 5.18 References for Koc Values

Compound	Notes	Reference
Diethylhexylphthalate	Level 1 calculation	Mackay <i>et al.</i> (1995)
4,4'-Methylene dianiline	Estimated according to methodology of Lyman <i>et al.</i> (1990)	Lyman <i>et al.</i> (1990)

6. Dose-Response Assessment for Noncarcinogenic Endpoints

6.1 Derivation of Toxicity Criteria

Dose-response assessment describes the quantitative relationship between the amount of exposure to a substance (the dose) and the incidence or occurrence of an adverse health impact (the response). For noncarcinogens, dose-response information is presented in the form of Reference Exposure Levels (RELs). RELs are concentrations or doses at or below which adverse effects are not likely to occur following specified exposure conditions. The methodology for developing chronic RELs is fundamentally the same as that used by U.S. EPA in developing the inhalation Reference Concentrations (RfCs) and oral Reference Doses (RfDs).

Acute and chronic RELs are frequently calculated by dividing the no observed adverse effect level (NOAEL) or lowest observed adverse effect levels (LOAEL) in human or animal studies by uncertainty factors. Uncertainty factors are applied to account for interspecies extrapolation, intraspecies variability, the use of subchronic studies to extrapolate to chronic effects, and use of a LOAEL instead of a NOAEL. Total uncertainty factors range from one to three thousand for current RELs. Haber's equation is used, where needed, to adjust studies with different exposure times to the one-hour period needed for most acute RELs. Currently, there are eight acute RELs with reproductive health endpoints, which have exposure time periods different from one-hour; these alternative exposure periods include four, six, and seven hours. The most sensitive toxicological end point is selected as the basis for the REL when there are multiple adverse health effects. A slightly more complicated methodology, the Benchmark Concentration approach, is described in OEHHA, 1999a. The selection of the most sensitive endpoint as the basis for a REL helps ensure that the REL is protective for all health effects. The use of uncertainty factors helps ensure that the REL is protective for nearly all individuals, including sensitive subpopulations, within the limitations of current scientific knowledge.

It should be emphasized that exceeding the acute or chronic REL does not necessarily indicate that an adverse health impact will occur. However, levels of exposure above the REL have an increasing but undefined probability of resulting in an adverse health impact, particularly in sensitive individuals (e.g., depending on the toxicant, the very young, the elderly, pregnant women, and those with acute or chronic illnesses). The significance of exceeding the REL is dependent on the seriousness of the health endpoint, the strength and interpretation of the health studies, the magnitude of combined safety factors, and other considerations. In addition, there is a possibility that an REL may not be protective of certain small, unusually sensitive human subpopulations. Such subpopulations can be difficult to identify and study because of their small numbers, lack of knowledge about toxic mechanisms, and other factors. It may be useful to consult OEHHA staff when an REL is exceeded (hazard quotient or hazard index is greater than 1.0). Chapter 8 discusses the methods used for determining potential noncancer health impacts and Appendix I presents example calculations used to determine a hazard quotient (HQ) and hazard indices (HI). For detailed information on the methodology and derivations for acute RELs, see the *Air Toxics Hot Spots Program Risk Assessment Guidelines; Part I; The Determination of Acute Reference Exposure Levels for Airborne Toxicants (OEHHA 1999a)* (Part I TSD). For information on chronic RELs see the *Air Toxics Hot Spots Program*

Risk Assessment Guidelines; Part III; Technical Support Document for the Determination of Chronic Reference Exposure Levels (OEHHA 2000a) (Part III TSD).

Tables 6.1 and 6.2 list the currently adopted acute and chronic inhalation RELs. Some substances that pose a chronic inhalation hazard may also present a chronic hazard via non-inhalation (oral) routes of exposure. The oral RELs for these substances are presented in Table 6.3. Appendix L provides a consolidated listing of all the acute and chronic RELs and target organs that are approved for use by OEHHA and ARB for the Hot Spots Program. Periodically, new or updated RELs are adopted by OEHHA and these guidelines will be updated to reflect those changes. See OEHHA's web site at www.oehha.ca.gov (look under "Air", then select "Hot Spots Guidelines") to determine if any new or updated RELs have been adopted since the last guideline update.

6.2 Description of Acute Reference Exposure Levels

OEHHA developed acute RELs for assessing potential noncancer health impacts for short-term, generally one-hour peak exposures to facility emissions. (A few RELs are for 4 to 7-hour peak exposures.) By definition, an acute REL is an exposure that is not likely to cause adverse health effects in a human population, including sensitive subgroups, exposed to that concentration (in units of micrograms per cubic meter or $\mu\text{g}/\text{m}^3$) for the specified exposure duration on an intermittent basis. Many acute RELs are based on mild adverse effects, such as mild irritation of the eyes, nose, or throat, or may result in other mild adverse physiological changes. For most individuals, it is expected that the mild irritation and other adverse physiological changes will not persist after exposure ceases. Some acute RELs are based on reproductive/developmental endpoints, such as teratogenicity or fetotoxicity, which are considered severe adverse effects. The RELs, target organ systems, and the averaging time for substances that can present a potential acute hazard from inhalation are presented in Table 6.1. Unlike the chronic RELs discussed in the following section, there are no acute noninhalation RELs. Chapter 8 discusses the methods used for determining noncancer acute health impacts. Appendix I presents an example calculation used to determine an HQ and HI.

Table 6.1 Acute Reference Exposure Levels and Target Organ Systems Impacted				
Substance	Chemical Abstract Service Number (CAS)	Acute Inhalation REL ($\mu\text{g}/\text{m}^3$)	Averaging ^a Time (hour)	Acute Hazard Index Target Organ Systems(s)
Acrolein	107-02-8	1.9×10^{-1}	1	Eyes; Respiratory System
Acrylic Acid	79-10-7	$6.0 \times 10^{+3}$	1	Eyes; Respiratory System
Ammonia	7664-41-7	$3.2 \times 10^{+3}$	1	Eyes; Respiratory System
Arsenic and Inorganic Arsenic Compounds	7440-38-2	1.9×10^{-1}	4	Reproductive/Developmental
Arsine	7784-42-1	$1.6 \times 10^{+2}$	1	Hematologic System
Benzene	71-43-2	$1.3 \times 10^{+3}$	6	Hematologic System; Immune System; Reproductive/Developmental
Benzyl Chloride	100-44-7	$2.4 \times 10^{+2}$	1	Eyes; Respiratory System
Carbon Disulfide	75-15-0	$6.2 \times 10^{+3}$	6	Nervous System; Reproductive/Developmental
Carbon Monoxide ^b	630-08-0	$2.3 \times 10^{+4}$	1	Cardiovascular System
Carbon Tetrachloride	56-23-5	$1.9 \times 10^{+3}$	7	Alimentary Tract; Nervous System; Reproductive/Developmental
Chlorine	7782-50-5	$2.1 \times 10^{+2}$	1	Eyes; Respiratory System
Chloroform	67-66-3	$1.5 \times 10^{+2}$	7	Nervous System; Reproductive/Developmental
Chloropicrin	76-06-2	$2.9 \times 10^{+1}$	1	Eyes; Respiratory System
Copper and Compounds	7440-50-8	$1.0 \times 10^{+2}$	1	Respiratory System
1,4-Dioxane	123-91-1	$3.0 \times 10^{+3}$	1	Eyes; Respiratory System
Epichlorohydrin	106-89-8	$1.3 \times 10^{+3}$	1	Eyes; Respiratory System
Ethylene Glycol Monobutyl Ether	111-76-2	$1.4 \times 10^{+4}$	1	Eyes; Respiratory System
Ethylene Glycol Monoethyl Ether	110-80-5	$3.7 \times 10^{+2}$	6	Reproductive/Developmental
Ethylene Glycol Monoethyl Ether Acetate	111-15-9	$1.4 \times 10^{+2}$	6	Nervous System; Reproductive/Developmental
Ethylene Glycol Monomethyl Ether	109-86-4	$9.3 \times 10^{+1}$	6	Reproductive/Developmental
Formaldehyde	50-00-0	$9.4 \times 10^{+1}$	1	Eyes; Immune System; Respiratory
Hydrogen Chloride	7647-01-0	$2.1 \times 10^{+3}$	1	Eyes; Respiratory System
Hydrogen Cyanide	74-90-8	$3.4 \times 10^{+2}$	1	Nervous System
Hydrogen Fluoride	7664-39-3	$2.4 \times 10^{+2}$	1	Eyes; Respiratory System
Hydrogen Selenide	7783-07-5	$5.0 \times 10^{+0}$	1	Eyes; Respiratory System
Hydrogen Sulfide ^b	7783-06-4	$4.2 \times 10^{+1}$	1	Nervous System
Isopropyl Alcohol	67-63-0	$3.2 \times 10^{+3}$	1	Eyes; Respiratory System
Mercury (Inorganic)	7439-97-6	$1.8 \times 10^{+0}$	1	Reproductive/Developmental
Methanol	67-56-1	$2.8 \times 10^{+4}$	1	Nervous System

Table 6.1 Acute Reference Exposure Levels and Target Organ Systems Impacted				
Substance	Chemical Abstract Service Number (CAS)	Acute Inhalation REL ($\mu\text{g}/\text{m}^3$)	Averaging ^a Time (hour)	Acute Hazard Index Target Organ Systems(s)
Methyl Bromide	74-83-9	$3.9 \times 10^{+3}$	1	Nervous System; Respiratory Irritation; Reproductive/Developmental
Methyl Chloroform	71-55-6	$6.8 \times 10^{+4}$	1	Nervous System
Methyl Ethyl Ketone	78-93-3	$1.3 \times 10^{+4}$	1	Eyes; Respiratory System
Methylene Chloride	75-09-2	$1.4 \times 10^{+4}$	1	Nervous System
Nickel and Nickel Compounds	7440-02-0	$6.0 \times 10^{+0}$	1	Immune System; Respiratory System
Nitric Acid	7697-37-2	$8.6 \times 10^{+1}$	1	Respiratory System
Nitrogen Dioxide ^b	10102-44-0	$4.7 \times 10^{+2}$	1	Respiratory System
Ozone ^b	10028-15-6	$1.8 \times 10^{+2}$	1	Eyes; Respiratory System
Perchloroethylene	127-18-4	$2.0 \times 10^{+4}$	1	Eyes; Nervous System; Respiratory System
Phenol	108-95-2	$5.8 \times 10^{+3}$	1	Eyes; Respiratory System
Phosgene	75-44-5	$4.0 \times 10^{+0}$	1	Respiratory System
Propylene Oxide	75-56-9	$3.1 \times 10^{+3}$	1	Eyes; Respiratory System; Reproductive/Developmental
Sodium Hydroxide	1310-73-2	$8.0 \times 10^{+0}$	1	Eyes; Skin; Respiratory System
Styrene	100-42-5	$2.1 \times 10^{+4}$	1	Eyes; Respiratory System
Sulfates ^b	N/A	$1.2 \times 10^{+2}$	1	Respiratory System
Sulfur Dioxide ^b	7446-09-5	$6.6 \times 10^{+2}$	1	Respiratory System
Sulfuric Acid and Oleum	7664-93-9 8014-95-7	$1.2 \times 10^{+2}$	1	Respiratory System
Toluene	108-88-3	$3.7 \times 10^{+4}$	1	Nervous System; Eyes; Respiratory System; Reproductive/Developmental
Triethylamine	121-44-8	$2.8 \times 10^{+3}$	1	Nervous System; Eyes
Vanadium Pentoxide	1314-62-1	$3.0 \times 10^{+1}$	1	Eyes; Respiratory System
Vinyl Chloride	75-01-4	$1.8 \times 10^{+5}$	1	Nervous System; Eyes; Respiratory System
Xylenes (m,o,p-isomers)	1330-20-7	$2.2 \times 10^{+4}$	1	Eyes; Respiratory System

a. The averaging period of noncancer acute RELs is generally a one-hour exposure. However, some are based on several hour exposure for reproductive/developmental endpoints (see section 1.6 of the Part I TSD). The RELs for the following substances must be compared to modeled emission concentrations of the same duration rather than maximum one-hour concentrations (e.g., a 4-hour REL should be compared to the maximum 4-hour average concentration from the air dispersion model).

b. California Ambient Air Quality Standard

6.3 *Description of Chronic Reference Exposure Levels*

OEHHA has developed chronic RELs for assessing noncancer health impacts from long-term exposure. (See the Part III TSD for detailed information on the development of noncancer chronic inhalation and oral RELs.) A chronic REL is a concentration level (that is expressed in units of micrograms per cubic meter ($\mu\text{g}/\text{m}^3$) for inhalation exposure and in a dose expressed in units of milligram per kilogram-day ($\text{mg}/\text{kg}\text{-day}$) for oral exposures), at or below which no adverse health effects are anticipated following long-term exposure. Long-term exposure for these purposes has been defined as 12% of a lifetime, or about eight years for humans. Table 6.2 lists the chronic noncancer RELs that should be used in the assessment of chronic health effects from inhalation exposure. Appendix L provides a consolidated listing of all the acute and chronic RELs and target organs that are approved for use by OEHHA and ARB for the Hot Spots Program. Periodically, new or updated RELs are adopted by OEHHA and these guidelines will be updated to reflect those changes. See OEHHA's web site at www.oehha.ca.gov (look under "Air", then select "Hot Spots Guidelines") to determine if any new or updated RELs have been adopted since the last guideline update.

The most sensitive organ system(s) associated with each chronic REL are also presented in Table 6.2. Chapter 8 discusses the methods used for determining potential noncancer health impacts and Appendix I presents example calculations used to determine a HQ and HI.

**Table 6.2 Chronic Inhalation Reference Exposure Levels (RELs)
And Chronic Hazard Index Target Organ System(s)**

Substance	Chemical Abstract Service Number (CAS)	Chronic Inhalation REL (µg/m³)	Chronic Inhalation Hazard Index Target Organ System(s)
Acetaldehyde ^a	75-07-0	9.0 x 10 ⁺⁰	Respiratory System
Acrolein	107-02-8	6.0 x 10 ⁻²	Eyes; Respiratory System
Acrylonitrile	107-13-1	5.0 x 10 ⁺⁰	Respiratory System
Ammonia	7664-41-7	2.0 x 10 ⁺²	Respiratory System
Arsenic & Inorganic Arsenic Compounds	7440-38-2	3.0 x 10 ⁻²	Cardiovascular System; Developmental; Nervous System
Benzene	71-43-2	6.0 x 10 ⁺¹	Developmental; Hematopoietic System; Nervous System
Beryllium and Beryllium Compounds	7440-41-7	7.0 x 10 ⁻³	Immune System; Respiratory System
Butadiene	106-99-0	2.0 x 10 ⁺¹	Reproductive System
Cadmium and Cadmium Compounds	7440-43-9	2.0 x 10 ⁻²	Kidney; Respiratory System
Carbon Disulfide	75-15-0	8.0 x 10 ⁺²	Nervous System; Reproductive System
Carbon Tetrachloride	56-23-5	4.0 x 10 ⁺¹	Alimentary System; Developmental; Nervous System
Chlorine	7782-50-5	2.0 x 10 ⁻¹	Respiratory System
Chlorine Dioxide	10049-04-4	6.0 x 10 ⁻¹	Respiratory System
Chlorinated Dibenzo- <i>p</i> -dioxins ^b			
2,3,7,8-Tetrachlorodibenzo- <i>p</i> -dioxin ^b	1746-01-6	4.0 x 10 ⁻⁵	Alimentary System; Developmental; Endocrine System; Hematopoietic System; Reproductive System; Respiratory System
1,2,3,7,8-Pentachlorodibenzo- <i>p</i> -dioxin ^b	40321-76-4	4.0 x 10 ⁻⁵	
1,2,3,4,7,8-Hexachlorodibenzo- <i>p</i> -dioxin ^b	39227-28-6	4.0 x 10 ⁻⁴	
1,2,3,6,7,8-Hexachlorodibenzo- <i>p</i> -dioxin ^b	57653-85-7	4.0 x 10 ⁻⁴	
1,2,3,7,8,9-Hexachlorodibenzo- <i>p</i> -dioxin ^b	19408-74-3	4.0 x 10 ⁻⁴	
1,2,3,4,6,7,8-Heptachlorodibenzo- <i>p</i> -dioxin ^b	35822-46-9	4.0 x 10 ⁻³	
1,2,3,4,6,7,8,9-Octachlorodibenzo- <i>p</i> -dioxin ^b	3268-87-9	4.0 x 10 ⁻¹	
Chlorinated Dibenzofurans ^b			
2,3,7,8-Tetrachlorodibenzofuran ^b	5120-73-19	4.0 x 10 ⁻⁴	Alimentary System; Developmental; Endocrine System; Hematopoietic System; Reproductive System; Respiratory System
1,2,3,7,8-Pentachlorodibenzofuran ^b	57117-41-6	8.0 x 10 ⁻⁴	
2,3,4,7,8-Pentachlorodibenzofuran ^b	57117-31-4	8.0 x 10 ⁻⁵	
1,2,3,4,7,8-Hexachlorodibenzofuran ^b	70648-26-9	4.0 x 10 ⁻⁴	
1,2,3,6,7,8-Hexachlorodibenzofuran ^b	57117-44-9	4.0 x 10 ⁻⁴	

**Table 6.2 Chronic Inhalation Reference Exposure Levels (RELs)
And Chronic Hazard Index Target Organ System(s)**

Substance	Chemical Abstract Service Number (CAS)	Chronic Inhalation REL ($\mu\text{g}/\text{m}^3$)	Chronic Inhalation Hazard Index Target Organ System(s)
1,2,3,7,8,9-Hexachlorodibenzofuran ^b	72918-21-9	4.0×10^{-4}	Alimentary System; Developmental; Endocrine System; Hematopoietic System; Reproductive System; Respiratory System
2,3,4,6,7,8-Hexachlorodibenzofuran ^b	60851-34-5	4.0×10^{-4}	
1,2,3,4,6,7,8-Heptachlorodibenzofuran ^b	67562-39-4	4.0×10^{-3}	
1,2,3,4,7,8,9-Heptachlorodibenzofuran ^b	55673-89-7	4.0×10^{-3}	
1,2,3,4,6,7,8,9-Octachlorodibenzofuran ^b	39001-02-0	4.0×10^{-1}	
Chlorobenzene	108-90-7	$1.0 \times 10^{+3}$	Alimentary System; Kidney; Reproductive System
Chloroform	67-66-3	$3.0 \times 10^{+2}$	Alimentary System; Developmental; Kidney
Chloropicrin	76-06-2	4.0×10^{-1}	Respiratory System
Chromium VI & Soluble Chromium VI Compounds (except chromic trioxide)	18540-29-9	2.0×10^{-1}	Respiratory System
Chromic Trioxide (as chromic acid mist)	1333-82-0	2.0×10^{-3}	Respiratory System
Cresol Mixtures	1319-77-3	$6.0 \times 10^{+2}$	Nervous System
1,4-Dichlorobenzene	106-46-7	$8.0 \times 10^{+2}$	Alimentary System; Kidney; Nervous System; Respiratory System;
1,1-Dichloroethylene (Vinylidene Chloride)	75-35-4	$7.0 \times 10^{+1}$	Alimentary System
Diesel Exhaust ^a	N/A	$5.0 \times 10^{+0}$	Respiratory System
Diethanolamine	111-42-2	$3.0 \times 10^{+0}$	Cardiovascular System; Nervous System
N,N-Dimethylformamide	68-12-2	$8.0 \times 10^{+1}$	Alimentary System; Respiratory System
1,4-Dioxane	123-91-1	$3.0 \times 10^{+3}$	Alimentary System; Cardiovascular System; Kidney
Epichlorohydrin	106-89-8	$3.0 \times 10^{+0}$	Eyes; Respiratory System
1,2-Epoxybutane	106-88-7	$2.0 \times 10^{+1}$	Cardiovascular System; Respiratory System
Ethylbenzene	100-41-4	$2.0 \times 10^{+3}$	Alimentary System (Liver); Developmental; Endocrine System; Kidney
Ethyl Chloride	75-00-3	$3.0 \times 10^{+4}$	Alimentary System; Developmental
Ethylene Dibromide	106-93-4	8.0×10^{-1}	Reproductive
Ethylene Dichloride	107-06-2	$4.0 \times 10^{+2}$	Alimentary System (Liver)
Ethylene Glycol	107-21-1	$4.0 \times 10^{+2}$	Developmental; Kidney; Respiratory System
Ethylene Glycol Monoethyl Ether	110-80-5	$7.0 \times 10^{+1}$	Hematopoietic System; Reproductive System
Ethylene Glycol Monoethyl Ether Acetate	111-15-9	$3.0 \times 10^{+2}$	Developmental

**Table 6.2 Chronic Inhalation Reference Exposure Levels (RELs)
And Chronic Hazard Index Target Organ System(s)**

Substance	Chemical Abstract Service Number (CAS)	Chronic Inhalation REL ($\mu\text{g}/\text{m}^3$)	Chronic Inhalation Hazard Index Target Organ System(s)
Ethylene Glycol Monomethyl Ether	109-86-4	$6.0 \times 10^{+1}$	Reproductive System
Ethylene Glycol Monomethyl Ether Acetate	110-49-6	$9.0 \times 10^{+1}$	Reproductive System
Ethylene Oxide	75-21-8	$3.0 \times 10^{+1}$	Nervous System
Formaldehyde	50-00-0	$3.0 \times 10^{+0}$	Eyes; Respiratory System
Fluorides		$1.3 \times 10^{+1}$	Bone and Teeth, Respiratory System
Glutaraldehyde	111-30-8	8.0×10^{-2}	Respiratory System
Hexane (n-)	110-54-3	$7.0 \times 10^{+3}$	Nervous System
Hydrazine	302-01-2	2.0×10^{-1}	Alimentary System; Endocrine System
Hydrogen Chloride	7647-01-0	$9.0 \times 10^{+0}$	Respiratory System
Hydrogen Cyanide	74-90-8	$9.0 \times 10^{+0}$	Cardiovascular System; Endocrine System; Nervous System
Hydrogen Fluoride	7664-39-3	$1.4 \times 10^{+1}$	Bone and Teeth, Respiratory System
Hydrogen Sulfide	7783-06-4	$1.0 \times 10^{+1}$	Respiratory System
Isophorone	78-59-1	$2.0 \times 10^{+3}$	Alimentary System; Developmental
Isopropanol	67-63-0	$7.0 \times 10^{+3}$	Developmental; Kidney
Maleic Anhydride	108-31-6	7.0×10^{-1}	Respiratory System
Manganese & Manganese Compounds	7439-96-5	2.0×10^{-1}	Nervous System
Mercury & Mercury Compounds (inorganic)	7439-97-6	9.0×10^{-2}	Nervous System
Methanol	67-56-1	$4.0 \times 10^{+3}$	Developmental
Methyl Bromide	74-83-9	$5.0 \times 10^{+0}$	Developmental; Nervous System; Respiratory System
Methyl tertiary-Butyl Ether	1634-04-4	$8.0 \times 10^{+3}$	Alimentary System; Eyes; Kidney
Methyl Chloroform	71-55-6	$1.0 \times 10^{+3}$	Nervous System
Methyl Isocyanate	624-83-9	$1.0 \times 10^{+0}$	Reproductive; Respiratory System
Methylene Chloride	75-09-2	$4.0 \times 10^{+2}$	Cardiovascular System; Nervous System
4,4'-Methylene Dianiline (and its dichloride)	101-77-9	$2.0 \times 10^{+1}$	Alimentary System; Eyes
Methylene Diphenyl Isocyanate	101-68-8	7.0×10^{-1}	Respiratory System
Naphthalene	91-20-3	$9.0 \times 10^{+0}$	Respiratory System
Nickel & Nickel Compounds (except nickel oxide)	7440-02-0	5.0×10^{-2}	Hematopoietic System; Respiratory System

Table 6.2 Chronic Inhalation Reference Exposure Levels (RELs) And Chronic Hazard Index Target Organ System(s)			
Substance	Chemical Abstract Service Number (CAS)	Chronic Inhalation REL ($\mu\text{g}/\text{m}^3$)	Chronic Inhalation Hazard Index Target Organ System(s)
Nickel Oxide	1313-99-1	1.0×10^{-1}	Hematopoietic System; Respiratory System
Phenol	108-95-2	$2.0 \times 10^{+2}$	Alimentary System; Cardiovascular System; Kidney; Nervous System
Phosphine	7803-51-2	8.0×10^{-1}	Alimentary System; Hematopoietic System; Kidney; Nervous System; Respiratory System
Phosphoric Acid	7664-38-2	$7.0 \times 10^{+0}$	Respiratory System
Phthalic Anhydride	85-44-9	$2.0 \times 10^{+1}$	Respiratory System
<i>Polychlorinated biphenyls^{P4} (PCBs) (speciated)^b</i>			
3,3',4,4'-Tetrachlorobiphenyl (77) ^b	35298-13-3	4.0×10^{-1}	Alimentary System; Developmental; Endocrine System; Hematopoietic System; Reproductive System; Respiratory System
3,4,4',5-Tetrachlorobiphenyl (81) ^b	70362-50-4	4.0×10^{-1}	
2,3,3',4,4'- Pentachlorobiphenyl (105) ^b	32598-14-4	4.0×10^{-1}	
2,3,4,4'5- Pentachlorobiphenyl (114) ^b	74472-37-0	8.0×10^{-2}	
2,3'4,4',5- Pentachlorobiphenyl (118) ^b	31508-00-6	4.0×10^{-1}	
2',3,4,4',5- Pentachlorobiphenyl (123) ^b	65510-44-3	4.0×10^{-1}	
3,3',4,4',5- Pentachlorobiphenyl (126) ^b	57465-28-8	4.0×10^{-4}	
2,3,3',4,4',5-Hexachlorobiphenyl (156) ^b	38380-08-4	8.0×10^{-2}	
2,3,3',4,4',5'-Hexachlorobiphenyl (157) ^b	69782-90-7	8.0×10^{-2}	
2,3',4,4',5,5'-Hexachlorobiphenyl (167) ^b	52663-72-6	4.0×10^{-0}	
3,3',4,4'5,5'- Hexachlorobiphenyl (169) ^b	32774-16-6	4.0×10^{-3}	
2,3,3'4,4',5,5'- Heptachlorobiphenyl (189) ^b	39635-31-9	4.0×10^{-1}	
Propylene	115-07-1	$3.0 \times 10^{+3}$	Respiratory System
Propylene Glycol Monomethyl Ether	107-98-2	$7.0 \times 10^{+3}$	Alimentary System
Propylene Oxide	75-56-9	$3.0 \times 10^{+1}$	Respiratory System
Selenium and Selenium compounds (other than Hydrogen Selenide)	7782-49-2	$2.0 \times 10^{+1}$	Alimentary System; Cardiovascular System; Nervous System
Styrene	100-42-5	$9.0 \times 10^{+2}$	Nervous System
Sulfuric Acid	7664-93-9	$1.0 \times 10^{+0}$	Respiratory System
Tetrachloroethylene ^a (Perchloroethylene)	127-18-4	$3.5 \times 10^{+1}$	Alimentary System; Kidney

**Table 6.2 Chronic Inhalation Reference Exposure Levels (RELs)
And Chronic Hazard Index Target Organ System(s)**

Substance	Chemical Abstract Service Number (CAS)	Chronic Inhalation REL ($\mu\text{g}/\text{m}^3$)	Chronic Inhalation Hazard Index Target Organ System(s)
Toluene	108-88-3	3.0×10^{-2}	Developmental; Nervous System; Respiratory System
2,4-Toluene Diisocyanate	584-84-9	7.0×10^{-2}	Respiratory System
2,6-Toluene Diisocyanate	91-08-7	7.0×10^{-2}	Respiratory System
Trichloroethylene ^a	79-01-6	6.0×10^{-2}	Eyes; Nervous System
Triethylamine	121-44-8	2.0×10^{-2}	Eyes
Vinyl Acetate	108-05-4	2.0×10^{-2}	Respiratory System
Xylenes (m, o, p-isomers)	1330-20-7	7.0×10^{-2}	Nervous System; Respiratory System

a These peer-reviewed values were developed under the Toxic Air Contaminant (TAC) Program mandated by AB1807 (California Health and Safety Code Sec. 39650 *et seq.*).

N/A Not Applicable

b The OEHHA has adopted the World Health Organization 1997 Toxicity Equivalency Factor (WHO₉₇-TEF) scheme for evaluating the cancer risk and noncancer risk due to exposure to samples containing mixtures of polychlorinated dibenzo-*p*-dioxins (PCDD) (also referred to as chlorinated dioxins and dibenzofurans), polychlorinated dibenzofurans (PCDF) and polychlorinated biphenyls (PCBs). See Appendix E for more information about the scheme and for the methodology for calculating 2,3,7,8-equivalents for PCDD and PCDFs. For convenience, OEHHA has calculated chronic REL values for speciated PCDDs, PCDFs and PCBs based on the WHO₉₇ TEF values and the chronic REL for 2,3,7,8-tetrachlorodibenzo-*p*-dioxin using the procedure discussed in Appendix E. The chronic REL values can be used to calculate a hazard index when the mixtures are speciated from individual congener ground level concentrations.

6.4 Description of Chronic Oral (Noninhalation) Reference Exposure Levels

As specified throughout the guidelines, estimates of long-term exposure resulting from facility air emissions of specific compounds must be analyzed for both inhalation and noninhalation (multipathway) pathways of exposure for humans. Facilities often emit substances under high temperature and pressure in the presence of particulate matter. While some of these substances are expected to remain in the vapor phase, other substances such as metals and semi-volatile organics can be either emitted as particles, form particles after emission from the facility, or adhere to existing particles. Some substances will partition between vapor and particulate phases. Substances in the particulate phase can be removed from the atmosphere by settling and, thus, potentially present a significant hazard via noninhalation pathways.

Particulate-associated chemicals can be deposited directly onto soil, onto the leaves or fruits of crops, or onto surface waters. Exposure via the oral route is the predominant noninhalation pathway, resulting in the noninhalation RELs being referred to as ‘oral RELs’ in this document. The oral RELs are expressed as doses in milligrams of substance (consumed and dermally absorbed) per kilogram body weight per day (mg/kg-day).

Table 6.3 lists the chronic noncancer RELs to be used in the assessment of chronic health effects from noninhalation pathways of exposure. Appendix L provides a consolidated listing of all chronic RELs and target organs that are approved for use by OEHHA and ARB for the Hot Spots Program. Periodically, new or updated RELs are adopted by OEHHA and these guidelines will be updated to reflect those changes. See OEHHA’s web site at www.oehha.ca.gov (look under “Air”, then select “Hot Spots Guidelines”) to determine if any new or updated RELs have been adopted since the last guideline update. Chapter 8 discusses the methods used for determining potential noncancer health impacts and Appendix I presents example calculations used to determine a HQ and HI.

**Table 6.3 Chronic Noninhalation ‘Oral’ Reference Exposure Levels (RELs)
And Chronic Hazard Index Target Organ System(s)**

Substance	Chemical Abstract Service Number (CAS)	Chronic Oral REL (mg/kg-day)	Chronic Oral Hazard Index Target Organ System(s)
Arsenic & Inorganic Arsenic Compounds	7440-38-2	3.0 x 10 ⁻⁴	Cardiovascular System; Skin
Beryllium and Beryllium Compounds	7440-41-7	2.0 x 10 ⁻³	Alimentary System
Cadmium and Cadmium Compounds	7440-43-9	5.0 x 10 ⁻⁴	Kidney
Chlorinated Dibenzo- <i>p</i> -dioxins ^a			
2,3,7,8-Tetrachlorodibenzo- <i>p</i> -dioxin ^a	1746-01-6	1.0 x 10 ⁻⁸	Alimentary System; Developmental; Endocrine System; Hematopoietic System; Reproductive System; Respiratory System
1,2,3,7,8-Pentachlorodibenzo- <i>p</i> -dioxin ^a	40321-76-4	1.0 x 10 ⁻⁸	
1,2,3,4,7,8-Hexachlorodibenzo- <i>p</i> -dioxin ^a	39227-28-6	1.0 x 10 ⁻⁷	
1,2,3,6,7,8-Hexachlorodibenzo- <i>p</i> -dioxin ^a	57653-85-7	1.0 x 10 ⁻⁷	
1,2,3,7,8,9-Hexachlorodibenzo- <i>p</i> -dioxin ^a	19408-74-3	1.0 x 10 ⁻⁷	
1,2,3,4,6,7,8-Heptachlorodibenzo- <i>p</i> -dioxin ^a	35822-46-9	1.0 x 10 ⁻⁶	
1,2,3,4,6,7,8,9-Octachlorodibenzo- <i>p</i> -dioxin ^a	3268-87-9	1.0 x 10 ⁻⁴	
Chlorinated Dibenzofurans ^a			
2,3,7,8-Tetrachlorodibenzofuran ^a	5120-73-19	1.0 x 10 ⁻⁷	Alimentary System; Developmental; Endocrine System; Hematopoietic System; Reproductive System; Respiratory System
1,2,3,7,8-Pentachlorodibenzofuran ^a	57117-41-6	5.0 x 10 ⁻⁷	
2,3,4,7,8-Pentachlorodibenzofuran ^a	57117-31-4	5.0 x 10 ⁻⁸	
1,2,3,4,7,8-Hexachlorodibenzofuran ^a	70648-26-9	1.0 x 10 ⁻⁷	
1,2,3,6,7,8-Hexachlorodibenzofuran ^a	57117-44-9	1.0 x 10 ⁻⁷	
1,2,3,7,8,9-Hexachlorodibenzofuran ^a	72918-21-9	1.0 x 10 ⁻⁷	
2,3,4,6,7,8-Hexachlorodibenzofuran ^a	60851-34-5	1.0 x 10 ⁻⁷	
1,2,3,4,6,7,8-Heptachlorodibenzofuran ^a	67562-39-4	1.0 x 10 ⁻⁶	
1,2,3,4,7,8,9-Heptachlorodibenzofuran ^a	55673-89-7	1.0 x 10 ⁻⁶	
1,2,3,4,6,7,8,9-Octachlorodibenzofuran ^a	39001-02-0	1.0 x 10 ⁻⁴	
Chromium VI & Soluble Chromium VI Compounds (except chromic trioxide)	18540-29-9	2.0 x 10 ⁻²	Hematologic
Fluorides (including hydrogen fluoride)		4.0 x 10 ⁻²	Bones and Teeth
Mercury & Mercury Compounds (inorganic)	7439-97-6	3.0 x 10 ⁻⁴	Immune System; Kidney
Nickel & Nickel Compounds (except nickel oxide)	7440-02-0	5.0 x 10 ⁻²	Alimentary System
Nickel Oxide	1313-99-1	5.0 x 10 ⁻²	Alimentary System
Polychlorinated biphenyls ^{P4} (PCBs) (speciated) ^b			Alimentary System; Developmental; Endocrine System; Hematopoietic System; Reproductive System; Respiratory System
3,3',4,4'-Tetrachlorobiphenyl (77) ^b	35298-13-3	1.0 x 10 ⁻⁴	
3,4,4',5-Tetrachlorobiphenyl (81) ^b	70362-50-4	1.0 x 10 ⁻⁴	
2,3,3',4,4'- Pentachlorobiphenyl (105) ^b	32598-14-4	1.0 x 10 ⁻⁴	

**Table 6.3 Chronic Noninhalation ‘Oral’ Reference Exposure Levels (RELs)
And Chronic Hazard Index Target Organ System(s)**

Substance	Chemical Abstract Service Number (CAS)	Chronic Oral REL (mg/kg-day)	Chronic Oral Hazard Index Target Organ System(s)
2,3,4,4'- Pentachlorobiphenyl (114) ^b	74472-37-0	2.0 x 10 ⁻⁵	Alimentary System; Developmental; Endocrine System; Hematopoietic System; Reproductive System; Respiratory System
2,3',4,4',5- Pentachlorobiphenyl (118) ^b	31508-00-6	1.0 x 10 ⁻⁴	
2',3,4,4',5- Pentachlorobiphenyl (123) ^b	65510-44-3	1.0 x 10 ⁻⁴	
3,3',4,4',5- Pentachlorobiphenyl (126) ^b	57465-28-8	1.0 x 10 ⁻⁷	
2,3,3',4,4',5-Hexachlorobiphenyl (156) ^b	38380-08-4	2.0 x 10 ⁻⁵	
2,3,3',4,4',5'-Hexachlorobiphenyl (157) ^b	69782-90-7	2.0 x 10 ⁻⁵	
2,3',4,4',5,5'-Hexachlorobiphenyl (167) ^b	52663-72-6	1.0 x 10 ⁻³	
3,3',4,4',5,5'- Hexachlorobiphenyl (169) ^b	32774-16-6	1.0 x 10 ⁻⁶	
2,3,3',4,4',5,5'- Heptachlorobiphenyl (189) ^b	39635-31-9	1.0 x 10 ⁻⁴	

- a** The OEHHA has adopted the World Health Organization 1997 Toxicity Equivalency Factor (WHO₉₇-TEF) scheme for evaluating the cancer risk due to exposure to samples containing mixtures of polychlorinated dibenzo-*p*-dioxins (PCDD) (also referred to as chlorinated dioxins and dibenzofurans), polychlorinated dibenzofurans (PCDF) and polychlorinated biphenyls (PCBs). For convenience, OEHHA has calculated chronic REL values for speciated PCDDs, PCDFs and PCBs based on the WHO97 TEF values and the chronic REL for 2,3,7,8-tetrachlorodibenzo-*p*-dioxin using the procedure discussed in Appendix E. See Appendix E for more information about the scheme and for the methodology for calculating 2,3,7,8-equivalents for PCDD, PCDFs and PCBs. The oral chronic RELs for these compounds may be used if the mixtures are speciated to calculate a hazard index from individual congener doses.

7. Dose-Response Assessment for Carcinogens

7.1 Introduction

Dose-response assessment describes the quantitative relationship between the amount of exposure to a substance (the dose) and the incidence or occurrence of injury (the response). The process often involves establishing a toxicity value or criterion to use in assessing potential health risk. The toxicity criterion, or health guidance value, for carcinogens is the cancer potency slope (potency factor), which describes the potential risk of developing cancer per unit of average daily dose over a 70-year lifetime. Cancer inhalation and oral potency factors have been determined by the Office of Environmental Health Hazard Assessment (OEHHA) or by the United States Environmental Protection Agency (U.S. EPA) and endorsed by OEHHA. They are available for many of the substances listed in Appendix A (List of Substances) as carcinogens. Table 7.1 and Appendix L list the inhalation and oral cancer potency factors that should be used in multipathway health risk assessments (HRAs) for the Hot Spots Program.

The details on the methodology of dose-response assessment for carcinogens are provided in the 1985 California Department of Health Services publication *Guidelines for Chemical Carcinogen Risk Assessments and their Scientific Rationale* (CDHS, 1985). Substance-by-substance information is presented in OEHHA's document entitled, *The Air Toxics Hot Spots Program Risk Assessment Guidelines; Part II; Technical Support Document for Describing Available Cancer Potency Factors* (OEHHA 1999b) (Part II TSD).

7.2 Definition of Carcinogenic Potency

Cancer potency factors are expressed as the upper bound probability of developing cancer assuming continuous lifetime exposure to a substance at a dose of one milligram per kilogram of body weight, and are expressed in units of inverse dose as a potency slope [i.e., $(\text{mg/kg/day})^{-1}$]. Another common potency expression is in units of inverse concentration [$(\mu\text{g}/\text{m}^3)^{-1}$] when the slope is based on exposure concentration rather than dose; this is termed the unit risk factor. It is assumed in cancer risk assessments that risk is directly proportional to dose and that there is no threshold for carcinogenesis. The derivation of carcinogenic inhalation and oral cancer potency factors takes into account the available information on pharmacokinetics and on the mechanism of carcinogenic action. These values are generally the 95% upper confidence limits (UCL) on the dose-response slope. Table 7.1 and Appendix L list inhalation and oral cancer potency factors that should be used in risk assessments for the Hot Spots Program. Chapter 8 describes procedures for use of potency factors in estimating potential cancer risk.

7.2.1 Description of the Inhalation Cancer Potency Factor

Under the new risk assessment methodology and algorithms presented in Chapters 5 and 8, inhalation cancer slope factors must be expressed in units of inverse dose (i.e., $(\text{mg/kg/day})^{-1}$). Unit

risk factors, in the units of inverse concentration as micrograms per cubic meter (i.e., $(\mu\text{g}/\text{m}^3)^{-1}$), which have been used in previous guidelines for the Hot Spots program, can also be used for assessing cancer inhalation risk directly from air concentrations. However, breathing rates, expressed in units of liters per kilogram of body weight-day ($\text{L}/\text{kg}\cdot\text{BW}\text{-day}$ or $\text{L}/\text{kg}\text{-day}$), can be coupled with the air concentrations to estimate dose in $\text{mg}/\text{kg}\text{-day}$. This allows estimation of average, high-end, and distributions of cancer risk. Therefore for the Hot Spots Program, inhalation cancer potency factors are now recommended for determining cancer risk instead of unit risk factors. Unit risk factors are still listed in the Part II TSD and may prove useful in other risk assessment applications.

Multiplication of the average daily inhalation dose over 70 years ($\text{mg}/\text{kg}\text{-day}$) with the cancer potency factor ($\text{mg}/\text{kg}\text{-day}$)⁻¹ will give inhalation cancer risk (unitless). A more complete description of how cancer risk is calculated from the exposure dose and cancer potency factors is provided in Chapter 8. Appendix I presents an example calculation for determining potential (inhalation) cancer risk. A list of current inhalation potency factors is provided in Table 7.1. Periodically, new or revised cancer potency factors will be peer reviewed by the State's Scientific Review Panel on Toxic Air Contaminants and adopted by the Director of OEHHA. At that time, these guidelines will be updated to reflect those changes. However, in the interim between the adoption of new or updated numbers and a guideline update, consult the OEHHA web site at www.oehha.ca.gov (look under "Air", then select "Hot Spots Guidelines") to determine if any new or updated cancer potency factors have been adopted since the last guideline update. If so, these too should be used in the HRA.

7.2.2 Description of the Oral Cancer Potency Factor

Under the Hot Spots Program, a few substances are considered multipathway substances. Multipathway substances have the potential to impact a receptor through inhalation and noninhalation (oral) exposure routes. These substances include heavy metals and semi-volatile organic substances such as dioxins, furans, and polycyclic aromatic hydrocarbons (PAHs). These substances commonly exist in the particle phase or partially in the particle phase when emitted into the air. They can therefore be deposited onto soil, vegetation, and water. Noninhalation exposure pathways considered under the Hot Spots Program include the ingestion of soil, homegrown produce, meat, milk, surface water, breast milk, and fish as well as dermal exposure to contaminants deposited in the soil. See Table 5.1 for a list of substances that must be evaluated for multipathway exposure.

Table 7.1 and Appendix L list oral cancer potency factors in units of ($\text{mg}/\text{kg}\text{-day}$)⁻¹ that should be used for assessing the potential cancer risk for these substances through noninhalation exposure pathways. The cancer risk from these individual pathways is calculated by multiplying the dose ($\text{mg}/\text{kg}\text{-day}$) times the oral cancer potency factor ($\text{mg}/\text{kg}\text{-day}$)⁻¹ to yield oral potential cancer risk (unitless). Chapter 5 provides all of the algorithms to calculate exposure dose through all of the individual exposure pathways. Appendix I provides a sample calculation for dose and cancer risk using the inhalation exposure pathway.

Four carcinogens (cadmium, hexavalent chromium, beryllium, and nickel), although subject to deposition, are only treated as carcinogenic by the inhalation route and not by the oral route. Therefore,

there are no oral cancer potency factors for these substances. However, the oral doses of these substances need to be estimated because of their noncancer toxicity. See Chapters 6 and 8, and Appendices I, J, and L for dose-response factors, and calculations to address these substances.

Table 7.1 Inhalation and Oral Cancer Potency Factors

Substance	Chemical Abstract Service Number (CAS)	Inhalation Potency Factor (mg/kg-day) ⁻¹	Oral Slope Factor (mg/kg-day) ⁻¹
Acetaldehyde	75-07-0	1.0 x 10 ⁻²	
Acetamide	60-35-5	7.0 x 10 ⁻²	
Acrylamide	79-06-1	4.5 x 10 ⁺⁰	
Acrylonitrile	107-13-1	1.0 x 10 ⁺⁰	
Allyl chloride	107-05-1	2.1 x 10 ⁻²	
2-Aminoanthraquinone	117-79-3	3.3 x 10 ⁻²	
Aniline	62-53-3	5.7 x 10 ⁻³	
Arsenic (inorganic)	7440-38-2	1.2 x 10 ⁺¹	1.5 x 10 ⁺⁰
Asbestos [#]	1332-21-4	1.9 x 10 ^{-4 #}	
Benz[<i>a</i>]anthracene ^{BaP}	56-55-3	3.9 x 10 ⁻¹	1.2 x 10 ⁺⁰
Benzene	71-43-2	1.0 x 10 ⁻¹	
Benzidine	92-87-5	5.0 x 10 ⁺²	
Benzo[<i>a</i>]pyrene	50-32-8	3.9 x 10 ⁺⁰	1.2 x 10 ⁺¹
Benzo[<i>b</i>]fluoranthrene ^{BaP}	205-99-2	3.9 x 10 ⁻¹	1.2 x 10 ⁺⁰
Benzo[<i>j</i>]fluoranthrene ^{BaP}	205-82-3	3.9 x 10 ⁻¹	1.2 x 10 ⁺⁰
Benzo[<i>k</i>]fluoranthrene ^{BaP}	207-08-9	3.9 x 10 ⁻¹	1.2 x 10 ⁺⁰
Benzyl chloride	100-44-7	1.7 x 10 ⁻¹	
Beryllium	7440-41-7	8.4 x 10 ⁺⁰	
Bis(2-chloroethyl) ether	111-44-4	2.5 x 10 ⁺⁰	
Bis(chloromethyl)ether	542-88-1	4.6 x 10 ⁺⁺¹	
1,3-Butadiene	106-99-0	6.0 x 10 ⁻¹	
Cadmium (and compounds)	7440-43-9	1.5 x 10 ⁺¹	
Carbon tetrachloride	56-23-5	1.5 x 10 ⁻¹	
Chlorinated Dibenzo- <i>p</i> -dioxins ^A			
2,3,7,8-Tetrachlorodibenzo- <i>p</i> -dioxin	1746-01-6	1.3 x 10 ⁺⁵	1.3 x 10 ⁺⁵
1,2,3,7,8-Pentachlorodibenzo- <i>p</i> -dioxin	40321-76-4	1.3 x 10 ⁺⁵	1.3 x 10 ⁺⁵
1,2,3,4,7,8-Hexachlorodibenzo- <i>p</i> -dioxin	39227-28-6	1.3 x 10 ⁺⁴	1.3 x 10 ⁺⁴
1,2,3,6,7,8-Hexachlorodibenzo- <i>p</i> -dioxin	57653-85-7	1.3 x 10 ⁺⁴	1.3 x 10 ⁺⁴
1,2,3,7,8,9-Hexachlorodibenzo- <i>p</i> -dioxin	19408-74-3	1.3 x 10 ⁺⁴	1.3 x 10 ⁺⁴
1,2,3,4,6,7,8-Heptachlorodibenzo- <i>p</i> -dioxin	35822-46-9	1.3 x 10 ⁺³	1.3 x 10 ⁺³
1,2,3,4,6,7,8,9-Octachlorodibenzo- <i>p</i> -dioxin	3268-87-9	1.3 x 10 ⁺¹	1.3 x 10 ⁺¹
Chlorinated Dibenzofurans ^A			
2,3,7,8-Tetrachlorodibenzofuran	5120-73-19	1.3 x 10 ⁺⁴	1.3 x 10 ⁺⁴

Table 7.1 Inhalation and Oral Cancer Potency Factors

Substance	Chemical Abstract Service Number (CAS)	Inhalation Potency Factor (mg/kg-day) ⁻¹	Oral Slope Factor (mg/kg-day) ⁻¹
1,2,3,7,8-Pentachlorodibenzofuran	57117-41-6	6.5 x 10 ⁺³	6.5 x 10 ⁺³
2,3,4,7,8-Pentachlorodibenzofuran	57117-31-4	6.5 x 10 ⁺⁴	6.5 x 10 ⁺⁴
1,2,3,4,7,8-Hexachlorodibenzofuran	70648-26-9	1.3 x 10 ⁺⁴	1.3 x 10 ⁺⁴
1,2,3,6,7,8-Hexachlorodibenzofuran	57117-44-9	1.3 x 10 ⁺⁴	1.3 x 10 ⁺⁴
1,2,3,7,8,9-Hexachlorodibenzofuran	72918-21-9	1.3 x 10 ⁺⁴	1.3 x 10 ⁺⁴
2,3,4,6,7,8-Hexachlorodibenzofuran	60851-34-5	1.3 x 10 ⁺⁴	1.3 x 10 ⁺⁴
1,2,3,4,6,7,8-Heptachlorodibenzofuran	67562-39-4	1.3 x 10 ⁺³	1.3 x 10 ⁺³
1,2,3,4,7,8,9-Heptachlorodibenzofuran	55673-89-7	1.3 x 10 ⁺³	1.3 x 10 ⁺³
1,2,3,4,6,7,8,9-Octachlorodibenzofuran	39001-02-0	1.3 x 10 ⁺¹	1.3 x 10 ⁺¹
Chlorinated paraffins	108171-26-2	8.9 x 10 ⁻²	
Chloroform	67-66-3	1.9 x 10 ⁻²	
4-Chloro- <i>o</i> -phenylenediamine	95-83-0	1.6 x 10 ⁻²	
<i>p</i> -Chloro- <i>o</i> -toluidine	95-69-2	2.7 x 10 ⁻¹	
Chromium (hexavalent)	18540-29-9	5.1 x 10 ⁺²	
Chrysene ^{BaP}	218-01-9	3.9 x 10 ⁻²	1.2 x 10 ⁻¹
Creosote	8001-58-9	*	
<i>p</i> -Cresidine	120-71-8	1.5 x 10 ⁻¹	
Cupferron	135-20-6	2.2 x 10 ⁻¹	
2,4-Diaminoanisole	615-05-4	2.3 x 10 ⁻²	
2,4-Diaminotoluene	95-80-7	4.0 x 10 ⁺⁰	
Dibenz[<i>a,h</i>]acridine ^{BaP}	226-36-8	3.9 x 10 ⁻¹	1.2 x 10 ⁺⁰
Dibenz[<i>a,j</i>]acridine ^{BaP}	224-42-0	3.9 x 10 ⁻¹	1.2 x 10 ⁺⁰
Dibenz[<i>a,h</i>]anthracene ^{BaP}	53-70-3	4.1 x 10 ⁺⁰	4.1 x 10 ⁺⁰
Dibenzo[<i>a,e</i>]pyrene ^{BaP}	192-65-4	3.9 x 10 ⁺⁰	1.2 x 10 ⁺¹
Dibenzo[<i>a,h</i>]pyrene ^{BaP}	189-64-0	3.9 x 10 ⁺¹	1.2 x 10 ⁺²
Dibenzo[<i>a,l</i>]pyrene ^{BaP}	189-55-9	3.9 x 10 ⁺¹	1.2 x 10 ⁺²
Dibenzo[<i>a,l</i>]pyrene ^{BaP}	191-30-0	3.9 x 10 ⁺¹	1.2 x 10 ⁺²
7H-Dibenzo[<i>c,g</i>]carbazole ^{BaP}	194-59-2	3.9 x 10 ⁺⁰	1.2 x 10 ⁺¹
1,2-Dibromo-3-chloropropane	96-12-8	7.0 x 10 ⁺⁰	
1,4-Dichlorobenzene	106-46-7	4.0 x 10 ⁻²	
3,3'-Dichlorobenzidine	91-94-1	1.2 x 10 ⁺⁰	
1,1-Dichloroethane	75-34-3	5.7 x 10 ⁻³	
Diesel exhaust ^B	NA	1.1 x 10 ⁺⁰	
Diethylhexylphthalate	117-81-7	8.4 x 10 ⁻³	8.4 x 10 ⁻³
<i>p</i> -Dimethylaminoazobenzene	60-11-7	4.6 x 10 ⁺⁰	
7,12-Dimethylbenz[<i>a</i>]anthracene ^{BaP}	57-97-6	2.5 x 10 ⁺²	2.5 x 10 ⁺²

Table 7.1 Inhalation and Oral Cancer Potency Factors

Substance	Chemical Abstract Service Number (CAS)	Inhalation Potency Factor (mg/kg-day) ⁻¹	Oral Slope Factor (mg/kg-day) ⁻¹
1,6-Dinitropyrene ^{BaP}	42397-64-8	3.9 x 10 ⁺¹	1.2 x 10 ⁺²
1,8-Dinitropyrene ^{BaP}	42397-65-9	3.9 x 10 ⁺⁰	1.2 x 10 ⁺¹
2,4-Dinitrotoluene	121-14-2	3.1 x 10 ⁻¹	
1,4-Dioxane	123-91-1	2.7 x 10 ⁻²	
Epichlorohydrin	106-89-8	8.0 x 10 ⁻²	
Ethylene dibromide	106-93-4	2.5 x 10 ⁻¹	
Ethylene dichloride	107-06-2	7.2 x 10 ⁻²	
Ethylene oxide	75-21-8	3.1 x 10 ⁻¹	
Ethylene thiourea	96-45-7	4.5 x 10 ⁻²	
Formaldehyde	50-00-0	2.1 x 10 ⁻²	
Hexachlorobenzene	118-74-1	1.8 x 10 ⁺⁰	
Hexachlorocyclohexanes (technical grade)	608-73-1	4.0 x 10 ⁺⁰	4.0 x 10 ⁺⁰
Hydrazine	302-01-2	1.7 x 10 ⁺¹	
Indeno[1,2,3- <i>cd</i>]pyrene ^{BaP}	193-39-5	3.9 x 10 ⁻¹	1.2 x 10 ⁺⁰
Lead and lead compounds	7439-92-1	4.2 x 10 ⁻²	8.5 x 10 ⁻³
Lindane	58-89-9	1.1 x 10 ⁺⁰	
Methyl tertiary-butyl ether	1634-04-4	1.8 x 10 ⁻³	
3-Methylcholanthrene ^{BaP}	56-49-5	2.2 x 10 ⁺¹	2.2 x 10 ⁺¹
5-Methylchrysene ^{BaP}	3697-24-3	3.9 x 10 ⁺⁰	1.2 x 10 ⁺¹
4, 4'-Methylene bis(2-chloroaniline) (MOCA)	101-14-4	1.5 x 10 ⁺⁰	
Methylene chloride	75-09-2	3.5 x 10 ⁻³	
4,4'-Methylenedianiline	101-77-9	1.6 x 10 ⁺⁰	1.6 x 10 ⁺⁰
Michler's ketone	90-94-8	8.6 x 10 ⁻¹	
Nickel (and compounds)	7440-02-0	9.1 x 10 ⁻¹	
5-Nitroacenaphthene ^{BaP}	602-87-9	1.3 x 10 ⁻¹	1.3 x 10 ⁻¹
6-Nitrochrysene ^{BaP}	7496-02-8	3.9 x 10 ⁺¹	1.2 x 10 ⁺²
2-Nitrofluorene ^{BaP}	607-57-8	3.9 x 10 ⁻²	1.2 x 10 ⁻¹
1-Nitropyrene ^{BaP}	5522-43-0	3.9 x 10 ⁻¹	1.2 x 10 ⁺⁰
4-Nitropyrene ^{BaP}	57835-92-4	3.9 x 10 ⁻¹	1.2 x 10 ⁺⁰
N-Nitroso-n-butylamine	924-16-3	1.1 x 10 ⁺¹	
N-Nitroso-N-methylethylamine	10595-95-6	3.7 x 10 ⁰	
N-Nitrosodi-n-propylamine	621-64-7	7.0 x 10 ⁺⁰	
N-Nitrosodiethylamine	55-18-5	3.6 x 10 ⁺¹	
N-Nitrosodimethylamine	62-75-9	1.6 x 10 ⁺¹	
N-Nitrosodiphenylamine	86-30-6	9.0 x 10 ⁻³	
p-Nitrosodiphenylamine	156-10-5	2.2 x 10 ⁻²	
N-Nitrosomorpholine	59-89-2	6.7 x 10 ⁺⁰	

Table 7.1 Inhalation and Oral Cancer Potency Factors

Substance	Chemical Abstract Service Number (CAS)	Inhalation Potency Factor (mg/kg-day) ⁻¹	Oral Slope Factor (mg/kg-day) ⁻¹
N-Nitrosopiperidine	100-75-4	9.4 x 10 ⁺⁰	
N-Nitrosopyrrolidine	930-55-2	2.1 x 10 ⁺⁰	
Pentachlorophenol	87-86-5	1.8 x 10 ⁻²	
Perchloroethylene	127-18-4	2.1 x 10 ⁻²	
Polychlorinated biphenyls (PCBs) (unspeciated mixture)	1336-36-3		
(high risk) ^{P1}		2.0 x 10 ⁺⁰	2.0 x 10 ⁺⁰
(medium/low risk) ^{P2}		4.0 x 10 ⁻¹	4.0 x 10 ⁻¹
(lowest risk) ^{P3}		7.0 x 10 ⁻²	7.0 x 10 ⁻²
Polychlorinated biphenyls ^{P4} (PCBs) (speciated)			
3,3',4,4' -Tetrachlorobiphenyl (77)	35298-13-3	1.3 x 10 ⁺¹	1.3 x 10 ⁺¹
3,4,4',5-Tetrachlorobiphenyl (81)	70362-50-4	1.3 x 10 ⁺¹	1.3 x 10 ⁺¹
2,3,3',4,4' - Pentachlorobiphenyl (105)	32598-14-4	1.3 x 10 ⁺¹	1.3 x 10 ⁺¹
2,3,4,4',5- Pentachlorobiphenyl (114)	74472-37-0	6.5 x 10 ⁺¹	6.5 x 10 ⁺¹
2,3',4,4',5- Pentachlorobiphenyl (118)	31508-00-6	1.3 x 10 ⁺¹	1.3 x 10 ⁺¹
2',3,4,4',5- Pentachlorobiphenyl (123)	65510-44-3	1.3 x 10 ⁺¹	1.3 x 10 ⁺¹
3,3',4,4',5- Pentachlorobiphenyl (126)	57465-28-8	1.3 x 10 ⁺⁴	1.3 x 10 ⁺⁴
2,3,3',4,4',5-Hexachlorobiphenyl (156)	38380-08-4	6.5 x 10 ⁺¹	6.5 x 10 ⁺¹
2,3,3',4,4',5' -Hexachlorobiphenyl (157)	69782-90-7	6.5 x 10 ⁺¹	6.5 x 10 ⁺¹
2,3',4,4',5,5' -Hexachlorobiphenyl (167)	52663-72-6	1.3 x 10 ⁺⁰	1.3 x 10 ⁺⁰
3,3',4,4',5,5' - Hexachlorobiphenyl (169)	32774-16-6	1.3 x 10 ⁺³	1.3 x 10 ⁺³
2,3,3',4,4',5,5' - Heptachlorobiphenyl (189)	39635-31-9	1.3 x 10 ⁺¹	1.3 x 10 ⁺¹
Potassium bromate	7758-01-2	4.9 x 10 ⁻¹	
1,3-Propane sultone	1120-71-4	2.4 x 10 ⁺⁰	
Propylene oxide	75-56-9	1.3 x 10 ⁻²	
1,1,2,2-Tetrachloroethane	79-34-5	2.0 x 10 ⁻¹	
Thioacetamide	62-55-5	6.1 x 10 ⁺⁰	
2,4-Toluene diisocyanate	584-84-9	3.9 x 10 ⁻²	
2,6-Toluene diisocyanate	91-08-7	3.9 x 10 ⁻²	
1,1,2-Trichloroethane (vinyl trichloride)	79-00-5	5.7 x 10 ⁻²	
Trichloroethylene	79-01-6	7.0 x 10 ⁻³	
2,4,6-Trichlorophenol	88-06-2	7.0 x 10 ⁻²	
Urethane	51-79-6	1.0 x 10 ⁺⁰	
Vinyl chloride	75-01-4	2.7 x 10 ⁻¹	

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- # Asbestos: $[100 \text{ PCM fibers/m}^3]^{-1}$ A unit risk factor of $2.7 \times 10^{-6} (\mu\text{g/m}^3)^{-1}$ and an inhalation cancer potency factor of $2.2 \times 10^{-2} (\text{mg/kg BW} \cdot \text{day})^{-1}$ are available (see Appendix C for explanation).
- BaP PAHs and PAH Derivatives: Many have potency equivalency factors relative to benzo[a]pyrene (see Appendix G).
- A Polychlorinated Dibenzo-*p*-dioxins and Polychlorinated Dibenzofurans: The World Health Organization 1997 (WHO-97) Toxicity Equivalency Factors are used for polychlorinated dibenzo-*p*-dioxins, polychlorinated dibenzofurans and polychlorinated biphenyls. (see Appendix E). For convenience, OEHHA has calculated cancer potency factors for speciated poly chlorinated biphenyls congeners using the procedure in Appendix E.
- B Diesel Exhaust is listed as a Toxic Air Contaminant by the Air Resources Board as "Particulate Matter from Diesel-Fueled Engines". (See Appendix D)
- * Creosote: Can be calculated using Potency Equivalency Factors contained in the benzo[a]pyrene Toxic Air Contaminant document and in Appendix G of these guidelines.
- P1 Polychlorinated Biphenyls (PCBs): High Risk is for use in cases where congeners with more than four chlorines do not comprise less (are greater) than one-half percent of total PCBs. The high risk number is the default for Polychlorinated Biphenyls (PCBs).
- P2 The low risk number is generally not applicable to the Hot Spots program. The Hot Spots program addresses PCBs emitted by stationary facilities. It cannot be assumed that such emissions would occur by simple evaporation. There is a dermal absorption factor applied in evaluation of the dermal pathway for PCBs so the medium risk would not apply to dermal exposure. The water pathway does not include an assumption that PCB isomers are water soluble, so the medium number would not apply to the water pathway.
- P3 Polychlorinated Biphenyls (PCBs): Lowest Risk is for use in cases where congeners with more than four chlorines comprise less than one-half percent of total PCBs. In order for the low number to be used, scientific justification needs to be presented.
- P4 Number in parentheses is the IUPAC #, the PCB nomenclature is IUPAC.

8. *Risk Characterization for Carcinogens and Noncarcinogens and the Requirements for Hot Spots Risk Assessments*

8.1 *Introduction*

Risk characterization is the final step of the health risk assessment (HRA). In this step, information developed through the exposure assessment (e.g., monitored or modeled concentrations, inhalation or oral doses, and exposure pathway information) is combined with cancer potency factors and Reference Exposure Levels (RELs) to quantify the cancer risk and noncancer health impacts, respectively. Under the Air Toxics Hot Spots (Hot Spots) Act, comprehensive risk assessments should quantify both individual and population-wide health risks (Health and Safety Code Section (HSC) 44306). Persons preparing HRAs for the Hot Spots Program should consult the local Air Pollution Control or Air Quality Management District (District) to determine if the District has special guidelines to assist with HRA format or other requirements of the Hot Spots Program. Note that, for the Hot Spots Program, the 70-year exposure duration should continue to be used as the basis for estimating risk.

This chapter provides guidance on how to evaluate the risk characterization components required by the Hot Spots Program. A general summary of the HRA components includes the following items or information. This information should be clearly presented in cross-referenced text, tables, figures, and/or maps.

- The location and potential acute noncancer, and multipathway (inhalation and noninhalation) cancer and noncancer chronic health impacts at the point of maximum impact (PMI), at the maximum exposed individual resident (MEIR), at the maximum exposed individual worker (MEIW), and at specified (contact District or reviewing authority) sensitive receptors (e.g., schools, hospitals, daycare, or eldercare facilities).
- Estimates of population exposure for potential cancer risk and noncancer acute and chronic health impacts.

To perform the HRA and create the information listed above, OEHHA recommends using a tiered approach to risk assessment. The tiered approach provides a risk assessor with flexibility and allows consideration of site-specific differences. Furthermore, risk assessors can tailor the level of effort and refinement of an HRA by using the point-estimate exposure assumptions or the stochastic treatment of exposure factor distributions. Tier-1 evaluations are required for all HRAs prepared for the Hot Spots Program. Persons preparing an HRA using Tier-2 through Tier-4 evaluations must also include the results of a Tier-1 evaluation in the HRA. The four-tiered approach to risk assessment is intended to primarily apply to residential cancer risk assessment, both for inhalation and noninhalation pathways. OEHHA is not recommending a stochastic approach (Tier-3) for worker exposure, or noncancer inhalation chronic evaluations. A Tier-2 evaluation could be used for off-site worker risk assessments.

There is only a Tier-1 option for determining acute noncancer risks since calculating the hazard quotient only involves the acute REL and short-term maximum ground level air concentrations. There is only a Tier-1 option for evaluating inhalation noncancer chronic risks since calculating the chronic hazard quotient only involves the chronic Reference Exposure Level and the annual average concentration (not exposure parameter distributions). Chronic noninhalation noncancer risks involve a calculation of dose from oral pathways. It is possible that site-specific intake variates (e.g., fish consumption) could be appropriate for a particular site and therefore a Tier-2 analysis could be useful. See the *Air Toxics Hot Spots Program Risk Assessment Guidelines; Part IV; Technical Support Document for Exposure Assessment and Stochastic Analysis (OEHHA, 2000b)* (Part IV TSD) for a detailed discussion of the tiered approach. Table 8.1 summarizes OEHHA's recommendations for the four Tiers.

Table 8.1 Tiers for Cancer and Noncancer Hot Spots Risk Assessments

Tier	Cancer		Chronic Non Cancer		Acute
	Inhalation	Noninhalation	Inhalation	Noninhalation	Inhalation
Tier-1	X	X	X	X	X
Tier-2	X	X		X	
Tier-3	X	X			
Tier-4	X	X			

Cancer risk assessment as currently practiced involves estimating exposure to carcinogenic chemicals and multiplying the dose times the cancer potency factor. There are often questions regarding the validity of applying the cancer potency factors to less than lifetime exposures. The cancer potency or unit risk factors are estimated from long-term animal studies approaching lifetime, or from worker epidemiological studies involving long term exposure usually over decades.

8.2 Risk Characterization for Cancer Health Effects

8.2.1 Calculating Inhalation Cancer Risk

A 70-year inhalation cancer risk evaluation is required for all carcinogenic risk assessments (see Sections 8.2.2 and 8.2.3 for exposure duration information). There are two pieces of information needed to assess inhalation cancer risk. These are the inhalation cancer potency for the substance, expressed in units of inverse dose as a potency slope (i.e., $(\text{mg/kg/day})^{-1}$) from Table 7.1, and an estimate of average daily inhalation dose in units of milligram per kilogram-day (mg/kg-day) (see Chapters 4 and 5). Cancer risk is calculated by multiplying the inhalation dose by the inhalation cancer potency factor to yield the potential inhalation excess cancer risk. The following equation illustrates the formula for calculating cancer risk. See Appendix I for an example calculation.

$$(\text{Inhalation Dose (mg/kg-day)}) \times (\text{Cancer Potency (mg/kg-day)}^{-1}) = \text{Cancer Risk}$$

To convert this to chances per million of developing cancer, multiply the potential cancer risk by 10^6 . This result is useful as a risk communication tool.

Tier-1 is a standard point-estimate approach that uses the recommended exposure pathway (e.g., breathing rate) point-estimates presented in this document. A Tier-1 evaluation must use the high-end point-estimate for the inhalation pathway to present the inhalation cancer risk. For the Hot Spots Program, the 70-year exposure duration should be used as the basis for public notification and risk reduction audits and plans. Sections 8.2.2 and 8.2.3 describe the use of exposure duration adjustment factors for residential and worker receptors. As supplemental information, the assessor may wish to evaluate the cancer risk by using the average point-estimate to provide a range of cancer risk to the risk manager. The assessor may also decide to further supplement the HRA by performing a Tier-3 evaluation using the daily breathing rate data distribution in a stochastic analysis. See Chapter 5 for the algorithms and exposure information used for all exposure pathways for Tier-1 and Tier-3 evaluations. The HARP software will perform all of these analyses. Specifically, the required high-end, 70-year inhalation cancer risk evaluation can be performed in HARP by selecting either the high-end point-estimate/cancer risk analysis or by selecting the derived/70-year cancer risk analysis.

The risk assessment guidelines require the use of the 95th percentile (i.e., high end) breathing rate for all assessments of cancer risk by the inhalation route in Tier-1 risk assessments in order to avoid underestimating risk to the public, including children. In general, the risk management of facilities in the Air Toxics Hot Spots program is based on the 70-year risk at the highest exposed receptor point using high-end estimates of breathing rate. Some facilities subject to the Air Toxics Hot Spots Act (e.g., some in the industry-wide categories) have very small zones of impact. In some of these instances, there will be very few receptors within the zone of impact. It isn't possible to develop special recommendations for all possible exposure scenarios. Alternative breathing rates (point estimates or distributions) may be used as part of Tier-2 or Tier-4 risk assessments. Thus, the risk manager should take this into account during any risk management decisions. OEHHA is willing to work with risk managers at ARB and the Districts on this issue. Further examination of the issue is warranted.

8.2.2 Calculating Cancer Risk Using Different Exposure Durations

A. Residential

OEHHA recommends the 70-year exposure duration (ED) be used for determining residential cancer risks. For the Hot Spots Program, the 70-year exposure duration should be used as the basis for public notification and risk reduction audits and plans. This will ensure that a person residing in the vicinity of a facility for a lifetime will be included in the evaluation of risk posed by that facility. Exposure durations of 9-years and 30-years may also be evaluated as supplemental information to show the range of cancer risk based on residency periods. Lifetime or 70-year exposure is the historical benchmark for comparing facility impacts on receptors and for evaluating the effectiveness of air pollution control measures. Although it is not likely that most 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 of another facility at the next residence. 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, if a facility is notifying the public regarding cancer risk, it is useful information for a person who has resided in his current residence for less than 70 years to know that the calculated estimate of his or her cancer risk is less than that calculated for a 70-year risk.

Cancer risk assessment as currently practiced involves estimating exposure to carcinogenic chemicals and multiplying the dose times the cancer potency factor. There are often questions regarding the validity of applying the cancer potency factors to less than lifetime exposures. The cancer potency or unit risk factors are estimated from long-term animal studies approaching lifetime, or from worker epidemiological studies involving long term exposure usually over decades.

OEHHA has presented in this document exposure variates for estimating 9, 30 and 70-year exposures. These exposures are chosen to coincide with U.S. EPA's estimates of the average (9 years), high-end estimates (30-years) of residence time, and a typical lifetime (70 years). We support the use of cancer potency factors for estimating cancer risk for these exposure durations. However, as the exposure duration decreases the uncertainties introduced by applying cancer potency factors derived from very long term studies increases. Short-term high exposures are not necessarily equivalent to longer-term lower exposures even when the total dose is the same. OEHHA therefore does not support the use of current cancer potency factor to evaluate cancer risk for exposures of less than 9 years. If such risk must be evaluated, we recommend assuming that average daily dose for short-term exposure is assumed to last for a minimum of 9 years. OEHHA is evaluating cancer risk assessment methodologies over the next several years to address a number of issues including methods to evaluate short-term exposures to carcinogens.

If children younger than age 9 can be exposed to the emissions of a short term project, then the point estimates for a child should be used for an exposure period of 9 years to calculate a child's potential cancer risk. OEHHA is evaluating cancer risk assessment methodologies over the next several years to address a number of issues including methods to evaluate short-term exposures to carcinogens.

As presented in Chapter 5 and explained in the Part IV TSD, the 9-year (child) exposure duration is intended to represent the first 9-years of life. Children, for physiological as well as behavioral reasons, have higher rates of exposure (mg/kg-day) than adults. Therefore, the daily point-estimate (e.g., inhalation rate, soil ingestion rates) for the 9-year exposure duration is higher than for the 30 and 70-year (adult) exposure durations. When assessing the impacts specifically for children, the 9-year point-estimates and exposure factor distributions should be used. If a 9-year adult exposure duration is desired, then the 30 and 70-year point-estimates could be used and the cancer risk is adjusted using a factor of 9/70.

The 30 and 70-year exposure durations are intended to represent the first 30 and first 70 years of life, respectively. However, in the interest of simplicity, the 30-year exposure duration scenario uses the same exposure point-estimates and data distributions as the 70-year exposure duration scenario. This assumption to use the 70-year exposure point-estimate for both 30 and 70-year exposures probably results in a small underestimation of dose for the 30-year exposure scenario, since the exposure parameters for earlier years are higher than years spent as an adult.

The mother's milk pathway is unlike other pathways because the (entire) dose to the breastfed infant is received in the first year of life. In evaluating risk from the pathway for 9, 30 and 70 years, it is assumed that the cancer risk from the one-year exposure to contaminants in mother's milk is equally spread over 70 years to obtain a lifetime risk. If an assessor wants to calculate the multipathway risk for a 9-year exposure duration, then the cancer risk for this exposure pathway is adjusted using a $9/70^{\text{th}}$ factor.

B. Worker

The general approach for estimating the potential health impacts to an offsite worker (e.g., MEIW) includes estimating the concentration at the receptor and identifying the duration of that exposure. The best way to determine potential impacts for a worker is to use the algorithms and exposure information in Chapter 5 and the HARP software.

There are three factors that affect worker exposure for cancer risk determination. The first is the offsite worker's schedule. For example, some workers such as teachers have three months off during the summer and some workers work throughout the year except for weekends, holidays and vacation. The second factor is the operating schedule of the emitting facility under consideration. This is important because the ISCST-3 air dispersion computer model, or other models typically calculate an annual average air concentration based on actual operating conditions. For example, the facility may operate 365 days a year, 24 hours a day or may operate eight hours a day, five days a week. The third factor is the coincidence of the offsite worker's schedule with the time that the facility is emitting. For example, if the facility emits during the day, five days a week, and the offsite worker is working only at night, then no inhalation exposure would occur.

If an adjustment needs to be made for the time that the worker is present (coincident with the emissions), then the standard default assumption is the worker is present for 5 days per week, 49 weeks per year, for 40 years. The 40-year working lifetime is the same assumption used under the Proposition 65 Regulation. The worker is assumed to breathe $149 \text{ L/kg BW}^* \text{ day}$ for an 8-hour workday. Other adjustments may be appropriate, such as for teachers or other workers. If the offsite worker only works part time, for example 4 hours per day, a factor of 0.5 ($4/8$) may be used to adjust the daily inhalation exposure proportionally.

If the annual average concentration of pollutants from the emitting facility (determined by the air model) is different than the air concentration that the worker breathes when present at the site, then the

annual average concentration for the worker inhalation pathway will need to be adjusted. For example, if the offsite worker and emitting facility are on concurrent schedules (i.e., the worker has a standard working schedule of eight hours per day, 5 days a week, and the facility emits 5 days a week, 8 hours per day), then the annual average air concentrations for the worker inhalation pathway would need be approximated by adjusting it upward using a factor of 4.2 ($7/5 \times 24/8$). The annual average determined by the air modeling program is a 24 hour per day, 7 days per week, 365 days per year regardless of the actual operating schedule of the facility. The adjustment simply reflects the air concentration that the worker breathes. If the worker is only present some of the time that the facility is operating, then the average concentration that the worker breathes over his or her working day may be used.

For the chemicals where noninhalation pathways (e.g., soil ingestion and dermal exposure) need to be evaluated for workers, the annual average concentration should not be adjusted to account for the operating schedule of the emitting facility or the worker schedule (even if the facility emits only 5 days per week 8 hours per day while the offsite worker is present). The pollutant will be deposited and accumulate in the soil in the absence or presence of the worker; therefore, the total deposition and soil concentration will be dependent on the annual average air concentration.

If the calculation for determining a MEIW inhalation risk are not able to be performed using the original algorithms or the HARP software, then the adjustment factors in Table 8.2 may be of use for inhalation assessments only. The algorithms and assumptions in Chapter 5 must be used to determine multipathway impacts to a worker receptor.

Table 8.2: Adjustment Factors to Convert Inhalation Based Cancer Risk Estimates for a Residential Receptor to a Worker Receptor

Worker Receptor Type (Hrs/Days/Weeks/Years)	Facility Operating Schedule (Hrs/Days/Weeks/Years)	Adjustment Factor	
		(High End)*	(Average)*
Worker (8/5/49/40)	Continuous (24/7/52/70)	0.1516	0.2199
Worker (8/5/49/40)	Standard (8/5/52/70)	0.6366	0.9234
Teacher (8/5/36 ^T /40)	Continuous (24/7/52/70)	0.1114	0.1616
Teacher (8/5/36 ^T /40)	Standard (8/5/52/70)	0.4679	0.6787

* High End adjustment factors convert the residential receptor risk based on the high-end breathing rate point-estimate to a worker receptor risk. Average adjustment factors convert the residential receptor risk based on the average breathing rate point-estimate to a worker receptor risk.

T Number of weeks is based on school days per year reported by school district representatives.

C. Uses of Exposure Duration Adjustments for On-site Receptors

On-site workers are protected by CAL OSHA and do not have to be evaluated under the Hot Spots program, unless the worker also lives on the facility site, or property. Occasionally, facilities like

prisons, military bases, and universities have worker housing within the facility. In these situations the evaluation of on-site cancer risks, and/or acute and chronic noncancer hazard indices is appropriate under the Hot Spots program.

If the receptor lives and works on the facility, site, or property, then they should be evaluated under both scenarios and the one that is most health protective should be used.

The cancer risk estimates for the onsite residents may be done using the 70-year exposure variates and 40-year exposure duration. The use of the 70 year exposure variates will overestimate exposure to adult workers to a small extent because higher inhalation rates, etc., during the portion of a 70 year lifetime that a person is a child are incorporated. If the on-site resident under evaluation can be exposed through an impacted exposure pathway (other than inhalation), then that exposure pathway must be included. Other situations that may require on-site receptor assessment include the presence of locations where the public may have regular access for the appropriate exposure period (e.g., a lunchtime café, store, or museum for acute exposures). No exposure adjustments apply to acute exposure analyses. The District may be consulted on the appropriate evaluations for the risk assessment.

8.2.3 Speciation for Specific Classes of Compounds: Polycyclic Aromatic Hydrocarbons (PAHs), Polychlorinated Dibenzo-*p*-dioxins (PCDDs) and Dibenzofurans (PCDFs), and Polychlorinated Biphenyls (PCBs)

Health values and potency equivalency factors (PEFs) have been developed for approximately 26 PAHs (see Appendix G). When speciation of PAHs has been performed on facility emissions, these health values and PEFs should be used. In those cases where speciation of PAHs has not been performed, then benzo(a)pyrene or B(a)P serves as the surrogate carcinogen for all PAH emissions. A similar method has been developed for PCDDs and PCDFs, and PCBs known as toxicity equivalency factors (WHO TEFs), based on the number of chlorines and their position on the molecule (see Appendix E). Where speciation of PCDDs and PCDFs, and PCBs has been performed on facility emissions, the WHO TEFs should be used. In those cases where speciation of PCDDs and PCDFs has not been performed, then 2,3,7,8-tetrachlorodibenzo-*p*-dioxin (TCDD) serves as the surrogate for PCDD and PCDF emissions. Similarly, where only total PCBs are available, then the cancer potency factor for PCBs should be applied.

When using the HARP software, the emission contribution of speciated PAHs and PCDDs/PCDFs that have health values can be entered into the software. Unknown contributions of the PAH or PCDD/PCDF mixtures, or PAHs without a health value, should be assigned the appropriate surrogate. If a surrogate substance is used in the report, the facility-emitted substance (PAH mixture or PCDDs/PCDF mixture) must also be clearly indicated in the risk assessment as the actual substance emitted.

Since the surrogates for total PAH (B(a)P) and total PCDD/PCDF (2,3,7,8-tetrachlorodibenzo-*p*-dioxin) are the most or nearly-the-most potent carcinogens in the class, use of the cancer potency factors for these with total emissions will overestimate the risk.

Given that speciation data on these classes of compounds can result in significant capital investment, it may be reasonable to run a screening estimate of risk on the unknown mixture using the appropriate surrogate compound to represent the class. If the resulting risk estimate is deemed significant enough to trigger health concerns, it would then be advisable to speciate the mixture and run a screening estimate using the speciated data.

8.2.4 Determination of Noninhalation (Oral) Cancer Risk

A small subset of Hot Spots substances is subject to deposition onto the soil, plants, and water bodies. These substances need to be evaluated by the appropriate noninhalation pathways, as well as by the inhalation pathway, and the results must be presented in all HRAs. These substances include semi-volatile organic chemicals and heavy metals.

For all multipathway substances, the minimum exposure pathways that must be evaluated at every residential site (in addition to inhalation) are soil ingestion and dermal exposure. If dioxins, furans, or PCBs are emitted, then the breast-milk consumption pathway becomes mandatory. The other exposure pathways (e.g., ingestion of homegrown produce or fish) are only evaluated if the facility impacts that exposure medium and the receptor under evaluation can be exposed to that medium or pathway. For example, if the facility does not impact a fishable body of water within the isopleth of the facility, or the impacted water body does not sustain fish, then the fish pathway will not be considered for that facility or receptor. Table 5.1 lists the multipathway substances and the pathways that can be considered for each substance. Table 8.3 identifies the residential receptor exposure pathways that are mandatory and those that are dependent on the available routes of exposure. Table 8.3 also identifies the three exposure pathways that are appropriate for a worker receptor.

Table 8.3 Mandatory and Site/Route Dependant Exposure Pathways

Mandatory Exposure Pathways	Site/Route Dependent Exposure Pathways
• Inhalation^w • Soil Ingestion^w • Dermal Exposure^w • Breast-Milk or Mother's Milk Consumption*	• Homegrown Produce Ingestion • Fish Ingestion • Drinking Water Ingestion • Dairy (Cow's) Milk Ingestion • Meat (Beef, Pork, Chicken, and Egg) Ingestion

(*) If dioxins, furans, or PCBs are emitted, then the breast-milk consumption pathway becomes mandatory.

(w) Identifies the only appropriate exposure pathways that should be evaluated for a worker. These pathways are

inhalation, dermal exposure, and the soil ingestion pathways.

The oral cancer risk is calculated using the same steps as inhalation cancer risk described in Section 8.2.1. The only difference is that the inhalation dose is replaced by a noninhalation pathway dose (e.g., soil ingestion) and consideration is given to determining the dominant exposure pathways for the proper use of point-estimates (see Section 8.2.5).

In summary, an oral dose (see Chapters 4 and 5) from the pathway under evaluation (e.g., soil ingestion) is multiplied by the substance-specific oral slope factor, expressed in units of inverse dose as a potency slope (i.e., $(\text{mg/kg/day})^{-1}$) from Table 7.1 or Appendix L, to yield the soil ingestion cancer risk. The following equation illustrates the formula for calculating cancer risk. Details (data, algorithms, and guidance) for each exposure pathway are presented in Chapter 5 and the Part IV TSD. See the discussion of Tier-1 in Section 8.2.6 or the Part IV TSD for the method used to determine the multipathway cancer risk. See Appendix I for an example calculation for the inhalation exposure pathway.

$$\left(\text{Oral Dose} \frac{\text{mg}}{\text{kg} - \text{day}} \right) \left(\text{Oral Slope Factor} \frac{\text{kg} - \text{day}}{\text{mg}} \right) = \text{Potential Cancer Risk}$$

To convert this to chances per million of developing cancer, multiply the cancer risk by 10^6 . This result is useful as a risk communication tool.

$$\text{Cancer risk} \times 10^6 = \text{chances per million}$$

8.2.5 Evaluation of Multipathway (Inhalation and Noninhalation) Cancer Risk

A. Deposition Rate

A deposition rate must be used when determining potential noninhalation health impacts. In the absence of facility specific information on the size of the emitted particles, the default values for deposition rate should be used. Currently, the default value of 0.02 meters per second is used for emission sources that have verifiable particulate matter control devices or for emission sources that may be uncontrolled but only emit particulate matter that is less than 2.5 microns (e.g., internal combustion engines powered by compressed natural gas). The 0.05 meters per second default value is used for risk assessment if the emissions are uncontrolled. If other deposition rate factors are used, sufficient support documentation must be included with the HRA.

B. Use of Air Dispersion Modeling Results for Pastures and Water Bodies in Risk Assessment and the HARP Software

The substance or pollutant deposition to a drinking or pasture water body source and pastureland will be evaluated if an HRA includes the drinking water, fish ingestion, and cow's milk or meat (beef) exposure pathways. Two approaches are recommended for determining the deposition impacts to water bodies and pastureland. A simple approach is to select the results from a single receptor point on the grid laid over the area covered by the water body or pasture and assume that the modeled concentration at that grid-point is uniform across the water or pasture area. To make this first approach health protective, the grid-point within the area of the water body or pastureland with the highest modeled concentration should be used. A more refined approach is to average the air dispersion modeling results for all of the grid-points covering the area of the pasture or water body.

C. Summary of the Tiered Approach to Risk Assessment

The tiered approach for risk assessment that is presented in detail in the Part IV TSD and summarized here should be reviewed prior to estimating multipathway cancer risk. The tiered approach to risk assessment and the evaluation described here are included in the HARP software. The HARP software is the recommended model for calculating HRA results for the Hot Spots Program. Information on obtaining the HARP software can be found under the Air Toxics Program on the ARB's web site at www.arb.ca.gov.

Tier-1 is a standard point-estimate approach that uses the recommended exposure variate (e.g., breathing or water ingestion rate) point-estimates presented in this document. If an HRA cancer risk assessment involves multipathway residential exposures, then the risk assessor needs to first calculate the cancer risk from each pathway using the high-end exposure variates for all pathways. Then a second calculation is performed in which the pathways with the two highest cancer risks are added to the cancer risks from the rest of the pathways (if any) calculated with the average exposure variates. Dominant pathways are defined as the two exposure pathways that contribute the most to the total cancer risk estimate when using high-end point-estimates for all the exposure pathways under consideration. The final cancer risk calculation using a combination of high end and average exposure variates is referred to as derived risk in the HARP software and applies only to the residential receptor. There are only single values for exposure variates for the worker for the three pathways considered.

A similar procedure is used to determine the hazard index for the noncancer noninhalation pathways. The doses from all pathways (noninhalation) are calculated using the high-end exposure variate. The dose is used to calculate the hazard quotient for all noninhalation pathways. The hazard quotient for the inhalation pathway is calculated from the ground level concentration and the chronic REL. The three pathways with the highest hazard quotient are the dominant pathways. The remaining noninhalation pathways (if any) hazard quotients may be recalculated using the average exposure variates. The total hazard quotient for the chemical may be calculated by adding the

individual hazard quotients from the dominant pathways and those calculated with the average exposure variates.

Using the derived estimate of dose and risk will lessen the issue of compounding high-end exposure estimates, while retaining a health-protective approach for the more important exposure pathway(s). It is unlikely that an individual receptor would be on the high-end of exposure for all the intake variates (exposure pathways). Usually, inhalation is the dominant pathway posing the most cancer risk and noncancer chronic health impacts in the HRAs prepared for the Hot Spots Program. Occasionally, risks from other exposure pathways may also be dominant for lipophilic (fat-loving) compounds or metals. Therefore, for many facilities emitting volatile and multipathway chemicals, the inhalation pathway will be at least one of the two exposure pathways for which cancer risks are assessed using a high-end estimate (see Section 8.2.1).

The relatively health-protective assumptions incorporated into the Tier-1 risk assessment (e.g., 70-year exposure duration (for cancer) and the 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 use a more resource-intensive stochastic modeling effort described in Tier-3 and Tier-4. While further evaluation may provide more information to the risk manager on which to base decisions, the Tier-1 evaluation is useful in comparing risks among a large number of facilities and must be included in all HRAs.

Tier-2 analysis allows the use of available site-specific information to develop point-estimates that are more appropriate to use in the site-specific HRA than the recommended point-estimates. In Tier-3, a stochastic approach to exposure assessment is taken using the exposure factor distributions presented in the Part IV TSD and in Chapter 5. The Part IV TSD exposure factor distributions apply only to a residential receptor and are used only for the determination of cancer risk. Tier-4 is also a stochastic approach but allows for utilization of site-specific distributions if they are justifiable and more appropriate for the site under evaluation than those recommended in this document.

Tier-3 and Tier-4 analyses show a distribution of cancer risk indicating the percent of the population exposed to various levels of risk. This type of analysis provides an illustration of population risk. The results from this type of analysis can also be used to show what percentage of the population would be protected with various risk management options.

OEHHA is not recommending a stochastic approach (Tier-3) for worker exposure, or noncancer inhalation chronic evaluations. A Tier-2 evaluation could be used for off-site worker risk assessments. There is only a Tier-1 option for determining acute noncancer risks since calculating the hazard quotient only involves the acute REL and short-term maximum ground level air concentrations. In addition, no exposure duration adjustment should be made for noncancer assessments.

D. Multipathway Cancer Risk Methodology

In order to characterize total substance risk for a single multipathway substance the inhalation risk is calculated by multiplying the inhalation dose (mg/kg-day) times the inhalation cancer potency factor to give the inhalation cancer risk (Section 8.2.1). Using Tier-1, the dermal and oral dose from each relevant exposure pathway is multiplied times the substance-specific oral potency factor to give the oral (noninhalation) cancer risk (see Sections 8.2.4 and 8.2.5). The inhalation cancer risk and oral cancer risk are then summed to give the multipathway cancer risk for that substance. Many facilities will emit multiple carcinogenic substances. If multiple substances are emitted, the cancer risk from each of the individual substances (including multipathway and volatile, inhalation-only substances) is summed to give the (total) multipathway cancer risk for the entire facility at the receptor location.

Cancer risks from different substances are treated additively in the Hot Spots Program in part because many carcinogens act through the common mechanism of DNA damage. However, this assumption fails to take into account the limited information on substance interactions. However, the overall uncertainty in the cancer potency factors and the variability in the human population is probably far greater than the uncertainty from the assumption of additivity. In addition, cancers are life threatening serious diseases so it is not unreasonable to consider total additive risk. Therefore, the additive assumption is reasonable from a public health point of view. Other possible interactions of multiple carcinogens include synergism (effects are greater than additive) or antagonism (effects are less than additive). The type of interaction is substance dependent and can be dose dependent. All three types of interactions have been demonstrated scientifically.

8.2.6 Risk Characterization for Stochastic Risk Assessment.

Risk characterization for a stochastic risk assessment is similar to that described for the point-estimate approach. However, the results of the stochastic risk assessment is a distribution of risk which accounts for some of the variability in cancer risk that results from natural variability in exposure, such as breathing rates or water intake. The cancer risk distribution for inhalation cancer risk, for example, is generated by multiplying random values from the breathing rate distribution times the ground level air concentration, and the cancer potency factor. A variation of the Monte Carlo method called Latin hypercube sampling is the method by which the values from the breathing rate distribution are selected. If noninhalation pathways need to be evaluated, the same process is followed for each pathway and the risk is summed to give an overall inhalation and noninhalation cancer risk distribution. Distributions are only available for some of the exposure variates and none are currently recommended for the fate and transport algorithms. As more data become available for exposure variates and fate and transport variates, OEHHA will expand the number of distributions in our model to better capture the variability in exposure and risk.

The HARP software will perform an HRA using either OEHHA or user-provided data distributions using a Monte Carlo analysis and include the statistics on the distributions. The 70-year

exposure duration should be used as the basis for public notification and risk reduction audits and plans. If an assessor would prefer to evaluate 9 or 30-year exposure durations, then a cancer risk distribution for 9 or 30-year exposure duration would be presented in addition to the 70-year exposure duration. An adult's analysis would use the 30 and 70-year data distributions. If a stochastic analysis is performed for a child, then the child's (9-year) distribution must be used. A stochastic approach for acute and chronic health impacts and worker (MEIW) exposures are not currently recommended. Information on obtaining the HARP software can be found under the Air Toxics Program on the ARB's web site at www.arb.ca.gov.

8.3 Risk Characterization for Noncarcinogens

Noncancer impacts are determined for acute (inhalation) exposure and for both inhalation and oral chronic exposure. Estimates of health impacts for noncancer endpoints are expressed as a hazard quotient (for individual substances) or a hazard index (for multiple substances). In addition, all hazard quotients (HQ) and hazard indices (HI) must be determined by target organ system. An HQ of one or less indicates that adverse health effects are not expected to result from exposure to emissions of that substance. As the HQ increases above one, the probability of human health effects increases by an undefined amount. However, it should be noted that a hazard index above 1 is not necessarily indicative of health impacts due to the application of uncertainty factors in deriving the Reference Exposure Levels. There are limitations to this method of assessing cumulative noncancer chronic health impacts. The impact on organ systems may not be additive if health effects occur by different mechanisms. However, the impact on organ systems could also be synergistic. An analysis by a trained health professional familiar with the substance's toxicological literature is usually needed to determine the public health significance of an HQ or HI above one. It is recommended that the Air District contact OEHHHA if this situation presents itself. For assessing the noncancer health impacts of lead, different procedures are used; please see Appendix F.

There is only one approach to calculating the acute HI because the calculation is based on the highest short-term ground level air concentrations and the acute Reference Exposure Level. Likewise the chronic inhalation HI calculation is performed using the annual average ground level concentration and the chronic REL. Therefore no Tier-2, Tier-3 or Tier-4 options are available for acute or chronic noncancer inhalation hazard evaluation. However, there may be cases in which site specific fate and transport variates or exposure variates may be more appropriate to determine dose (mg/kg-day) for the noninhalation chronic HI; therefore, in some cases a Tier-2 evaluation may be appropriate for the noninhalation pathways.

Generally, the inhalation pathway is the largest contributor to the total dose. However, there are situations where a noninhalation pathway of exposure contributes substantially to a noncancer chronic HI. In these cases, the high-end point-estimate of dose is appropriate to use for the three dominant pathways and the average point-estimate for the non-dominant pathways. Dominant pathways are defined as the three pathways that contribute the most to the total hazard quotient for a chemical noncancer HI result when using high-end point-estimates for all the exposure pathways under

consideration. Typically inhalation would be one of these three pathways. In addition, no exposure duration adjustment (e.g., 9/70 or 30/70) should be made for noncancer assessments. See the Part IV TSD for a detailed discussion of the tiered approach, or Section 8.2.5 for a short overview of each tier.

Information contained in the following locations is needed to evaluate noncancer health impacts. Chapter 4 describes air dispersion modeling and both Chapter 6 and Appendix L list all the needed dose-response information. Appendix I presents sample calculations for determining chronic multipathway noncancer HQs and HIs and acute (inhalation) HQs and HIs. Chapter 9 provides an outline of information required for risk characterization. The HARP software is the recommended model for calculating and presenting HRA results for the Hot Spots Program. Information on obtaining the HARP software can be found under the Air Toxics Program on the ARB's web site at www.arb.ca.gov.

A. Evaluation of Background Criteria Pollutants

The District should be contacted to determine if the contribution of background criteria pollutants to respiratory health effects is required to be included in an HRA for the Hot Spots Program. If inclusion is required, the method for calculating the health impact from both acute and chronic exposure (respiratory endpoint) is the standard HI approach (see Sections 8.3.1 and 8.3.4). The background criteria pollutant contribution should be calculated if the HI from the facility's emissions exceeds 0.5 in either the acute or chronic assessment for the respiratory endpoint.

The most recent criteria pollutant concentration data should be obtained from the ARB's ambient air monitoring network and can be found in the *California Almanac of Emissions and Air Quality* on their web site at www.arb.ca.gov. For determining the criteria pollutant contribution in both the chronic and acute HI calculations, annual average concentration data should be taken from a monitoring site near the facility. If background contributions are unavailable, the District may direct the risk assessor to make an alternative assumption. The criteria pollutants that should be included in both the acute and chronic assessments for the respiratory endpoint are ozone, nitrogen dioxide, sulfur dioxide, sulfates, and hydrogen sulfide.

8.3.1 Noncancer Chronic Inhalation Health Impacts

All substances in the Hot Spots Program must be evaluated through the inhalation pathway. Noncancer chronic inhalation health impacts are calculated by dividing the substance-specific annual average air concentration in micrograms per cubic meter ($\mu\text{g}/\text{m}^3$) by the chronic inhalation REL ($\mu\text{g}/\text{m}^3$) (Table 6.2). An REL is used as an indicator of potential noncancer health impacts and is defined as the concentration at which no adverse noncancer health effects are anticipated. If this calculation is performed for a single substance, then it is called the hazard quotient (HQ). The following equation illustrates how to calculate the HQ for chronic inhalation exposure.

$$\text{Hazard Quotient} = \frac{\text{Annual Average Concentration (mg/m}^3\text{)}}{\text{Chronic Reference Exposure Level (mg/m}^3\text{)}}$$

The risk characterization of cumulative noncancer chronic health impacts from the emissions of multiple substances by the inhalation route is accomplished by determining the HI. The HI is calculated by summing the HQs from all of the substances that affect the same organ system. Note, do not add the HQs or HIs for different target organs together (e.g., do not add the impacts for the eye to the cardiovascular system). Table 6.2 and Appendix L have a list of the organ systems affected by each substance. No exposure duration adjustment (e.g., 9/70) should be made for noncancer assessments. The following equation illustrates how to calculate the HI for chronic exposure for the eye (target organ) from two substances. See Appendix I for an example calculation.

$$\text{Hazard Index (HI}_{\text{eye}}) = \text{HQ}_{\text{substance 1(eye)}} + \text{HQ}_{\text{substance 2(eye)}}$$

8.3.2 Noncancer Chronic Health Impacts from the Oral Route

Risk characterization for chronic health effects from exposure via the oral route is also conducted using the hazard index approach. The hazard quotient is obtained by dividing the oral dose (derived from the annual average concentration) in milligrams per kilogram-day (mg/kg-day) by the oral chronic REL, expressed in units of (mg/kg-day) (Table 6.3). The point-estimates and algorithms for calculating the oral dose for all applicable exposure pathways and receptors (e.g., workers or residents) are explained in Chapter 5.

The high-end point-estimates are used for all exposure pathways to determine which exposure pathways are dominant. Once the dominant exposure pathways are decided, the assessor uses the high-end point-estimates for the two dominant noninhalation pathways and the average point estimates for the rest of the non-dominant exposure pathways to determine the dose and chronic health impacts at the residential receptor. The 70-year exposure duration point-estimates are used for residential receptors and the worker (single) point-estimates are used for the MEIW in this calculation. No exposure duration adjustment (e.g., 9/70) should be made for noncancer assessments. The oral HQ is calculated by dividing the oral dose by the oral chronic REL. The significance of oral HQs greater or less than one are the same as explained for the chronic inhalation chronic HQ in Section 8.3.1. The following equation illustrates how to calculate the HQ for chronic noninhalation exposure. To estimate the hazard index from noninhalation exposures when multiple pollutants impact the same target organ, the oral HQ's are summed (See Section 8.3.3 below).

$$\text{Hazard Quotient}_{\text{oral}} = \frac{\text{Exposure Pathway Dose (mg/kg - day)}}{\text{Chronic (oral) Reference Exposure Level (mg/kg - day)}}$$

8.3.3 Evaluation of Chronic Noncancer Multipathway Hazard Quotients and Hazard Indices

To determine multipathway chronic noncancer health impacts, it is necessary to calculate the total hazard index from both inhalation and noninhalation exposures. First, the inhalation HQ is calculated (Section 8.3.1). Second, if the substance has an oral REL, then the oral HQ is calculated (see Sections 8.2.5, 8.3, and 8.3.2). For a residential receptor, the oral HQ is calculated using the 70-year high-end point-estimates for the two dominant noninhalation pathways and the average point-estimates for the rest of the pertinent exposure pathways. If a worker is under evaluation, then the worker single point-estimates are used for the soil and dermal pathways. The third step is to add the HQs together for each exposure pathway to give the substance's total multipathway HQ by target organ. If there is only one substance, then the multipathway HQ is the same as the HI.

- If there are multiple substances emitted, then the fourth step is to total the HQs for all the individual substances by each target organ. For example, add the HQs for all substances that impact the respiratory system, then repeat this step for the next target organ system (e.g., cardiovascular system). This step is repeated until all target organs (for the substances emitted) are individually totaled. These impacts by target organ are now referred to as the HI. Note, do not add the HQs or HIs for different target organ together (e.g., do not add the impacts for the respiratory system to the cardiovascular system). No exposure duration adjustment (e.g., 9/70) should be made for noncancer assessments. See Appendix I for an example calculation.
- For respiratory irritants, do not add in an oral contribution to the HI for the respiratory system for chemicals with both inhalation and oral RELs.

8.3.4 Noncancer Acute Health Impacts

Risk characterization for acute health effects uses the same principles (HQ, for an individual substance, and HI, for multiple substances) as the chronic noncancer inhalation methodology (see Section 8.3.1). All acute substances are evaluated through the inhalation pathway only.

- Noncancer acute health impacts are calculated by dividing the substance-specific short-term maximum concentration in micrograms per cubic meter ($\mu\text{g}/\text{m}^3$) by the acute REL (also in units of $\mu\text{g}/\text{m}^3$) (Table 6.1) for each substance. If this calculation is performed for a single substance, then it is called the HQ. The HQ should be applied to all appropriate target organs for a given substance.
- If multiple substances are emitted, then the next step is to total the individual substance's HQs by each target organ. For example, add the HQs for all substances that impact the respiratory system, then repeat this step for the next target organ system. This step is repeated until all target organs (for the substances emitted) are individually totaled. These impacts by target organ are now referred to as the HI. Note, do not add the

HQs or HIs for different target organs together (e.g., do not add the impacts for the respiratory system to immune system).

There are no oral acute RELs since it is anticipated that health effects from such a brief exposure via the oral route would be insignificant relative to the inhalation route. No exposure duration adjustment should be made for noncancer assessments. See Appendix I for an example calculation. HQs calculated using one, four, six, and seven hour exposure duration RELs may be added together for calculation of an acute HI. This would only occur in evaluating reproductive and developmental toxicants, since all other endpoints have only one hour acute RELs.

The HARP software incorporates two procedures for determining an acute HI. Both procedures use the calculations for HQ and HI described above. These two procedures make a difference when a facility has two or more separated emission points or for HRAs involving multiple facilities. The first procedure is a more simplistic approach (consistent with previous CAPCOA HRA methods) where the maximum concentrations from each emission source are superimposed to impact receptors at the same time, irrespective of wind direction and/ or atmospheric stability. This procedure is a simple, health protective approach to assess acute impacts. The second procedure is more refined than the first and improves on previous HRA methods. This second procedure takes into account meteorology and relative source positions by superimposing results from multiple sources with concurrent wind direction and atmospheric conditions, thereby computing a more refined maximum impact by hour at each receptor. This refined HI procedure may decrease the concentrations at many receptor locations when compared to the simplistic approach, but should not underestimate potential health impacts (i.e., HQs or HIs). This dual procedure approach is another way the new HRA guidelines are building flexibility into the HRA methods.

8.4 *Population-Level Risk Estimates*

8.4.1 *Carcinogenic Risk*

There are basically two ways to provide population-level risk estimates, namely cancer burden estimates and estimates of the number of people exposed at specific cancer risk levels.

1. The cancer burden is calculated by multiplying the number of people exposed (census information) by the cancer risk at either the MEIR or the population centroid of each census block. The result of this calculation is an estimate of the number of cancer cases expected from a 70-year exposure to current estimated facility emissions.
2. An estimate of the number of people exposed at various cancer risk levels can provide perspective on the magnitude of the potential public health threat posed by a facility. This approach is intended as a replacement for the cancer burden calculation used by some Districts in the past. The new approach provides a much easier way to interpret results when compared to cancer burden estimates. A facility in a sparsely populated

area can have a public health impact different from the same facility in a highly populated area. Such information can be useful in risk management decisions. The level of detail required for the population 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. Some suggested approaches and methods for handling the breakdown of population and performance of a screening or refined population exposure analyses are provided in Section 4.6.

The population estimates should be based on the latest available census results. The population of the census block may be assumed to be equally distributed over the census block, unless for some reason more refined information is available. The population in census blocks cut by two or more risk isopleths can thus be apportioned based on the area in each isopleth. The isopleths needed should be drawn using the smallest practical grid size. The Districts may ask facilities to use the new procedure or the cancer burden approach. The District or reviewing authority should be consulted before beginning the population exposure estimates and, as results are generated, further consultation may be necessary.

A fundamental first step in estimating the number of people at risk from facility emissions is to define the zones of impact (see Section 4.6.1). This zone is commonly defined as the area within the isopleth surrounding the facility where receptors have a multipathway cancer risk greater than 10^{-6} . Some Districts may prefer to use a cancer risk of 10^{-7} to define the carcinogenic zone of impact. The total number of persons exposed to a series of potential risk levels can be presented to aid risk managers in understanding the magnitude of the potential public health impacts. See Table 8.3 for an example of data summarizing population exposure estimates for cancer risk.

Table 8.3 Example of Estimates of Population Risk

Estimated Number of Persons Exposed	Cancer Risk^N (chances per million)
X	1 to 10
Y	10 to 100
Z	>100

(N) Column would be titled to reflect acute or chronic noncancer health impacts.

The HARP software can provide population-level risk estimates as cancer burden or as the number of persons exposed to a selected (user-identified) cancer risk level at block level centroids. Information on obtaining the HARP software can be found under the Air Toxics Program on the ARB's web site at www.arb.ca.gov. Chapter 9 provides an outline that specifies the content and recommended format of HRA results.

8.4.2 Population Estimates of Noncancer Health Impacts

A noncancer chronic and acute population estimate of the number of people exposed to acute and chronic HQs or HIs exceeding 0.5 or 1.0, in increments of 1.0, should also be presented. For example, a facility with a maximum chronic HI of 4.0 would present the number of people exposed to a chronic HI of 0.5, 1.0, 2.0, 3.0, and 4.0. The isopleths used in this determination should be drawn using the smallest feasible grid size. The same methods that are described in Chapter 4 and Section 8.4.1 (for the population exposure estimate for cancer risk) should be used in the chronic and acute population estimates. Population estimates for acute and chronic health impacts should be presented separately and in a format consistent with Table 8.3.

9. *Summary of the Requirements for a Modeling Protocol and a Health Risk Assessment Report*

The purpose of this chapter is to clarify the type of information that is expected to be included in modeling protocols and health risk assessments (HRAs). These outlines are intended to promote transparent, consistent presentation and efficient review of these products. It is possible that protocols and HRAs that do not include all the information presented in these outlines may be considered deficient by the reviewing authority. We recommend that persons preparing these products consult with the local Air Pollution Control or Air Quality Management District (District) to determine if the District has modeling or HRA guidelines that supercede these outlines. If the District does not have guidelines for these products, then we recommend Section 9.1 be used for modeling protocols and Section 9.2 be used for the presentation of HRAs. Persons preparing modeling protocols and HRAs should specify the guidelines that were used to prepare their products.

9.1 *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 and risk assessment process. We encourage people who are preparing protocols to take advantage of the protocol step and fully discuss anticipated methodologies for any portion of your project that may need special consideration. Below, we have provided 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.**

I. Introduction

- Include the facility name, address, and a brief overview describing the facility's operations.
- Provide a description of the terrain and topography surrounding the facility and potential receptors.
- Indicate the format in which data will be provided. Ideally, the report and summary of data will be on paper and all data and model input and output files will be provided electronically (e.g., compact disk or CD).
- Identify the guidelines used to prepare the protocol.

II. Emissions

- For each pollutant and process whose emissions are required to be quantified in the HRA, list the annual average emissions (pounds/year and grams/second) and maximum one-hour emissions (pounds/hour and grams/second)*.
- Identify the reference and method(s) used to determine emissions (e.g., source tests, emission factors, etc.). Clearly indicate any emission data that are not reflected in the previously submitted emission inventory report. In this event, a revised emission inventory report will need to be submitted to the District.

III. Models / Modeling Assumptions

- Identify the model(s) to be used, including the version number.
- Identify the model options that will be used in the analysis.
- Indicate complex terrain options that may be used, if applicable.
- Identify the source type(s) that will be used to represent the facility's operations (e.g., point, area, or volume sources, flare options or other).
- Indicate the preliminary source characteristics (e.g., stack height, gas temperature, exit velocity, dimensions of volume source, etc.).
- Identify and support the use of urban or rural dispersion coefficients for those models that require dispersion coefficients. For other models, identify and support the parameters required to characterize the atmospheric dispersion due to land characteristics (e.g., surface roughness, Monin-Obukhov length).

IV. Meteorological Data

- Specify the type, source, and year(s) of hourly meteorological data (e.g., hourly surface data, upper air mixing height information).
- State how the data are representative for the facility site.
- Describe QA/QC procedures.
- Identify any gaps in the data; if gaps exist, describe how the data gaps are filled.

*Except radionuclides, for which annual and hourly emissions are reported in Curies/year and millicuries/hour, respectively.

V. *Deposition*

- Specify the method to calculate deposition (if applicable).

VI. *Receptors*

- Identify the method that will be used to determine the location of sensitive receptors, the point of maximum impact (PMI), and the maximum exposed individual residential (MEIR) and worker (MEIW) receptors (e.g., fine receptor spacing of 20 meters at the fenceline and centered on the maximum impacts; coarse receptor spacing of 100 meters out to 2,000 meters; extra coarse spacing of 1,000 meters out to 20,000 meters).
- Identify the method that will be used to evaluate potential cancer risk in the vicinity of the facility for purposes of calculating cancer burden or population impact estimates. Clarify the same information for the presentation of noncancer impacts (e.g., centroids of the census tracts in the area within the zone of impact).
- Specify that actual UTM coordinates and the block/street locations (i.e., north side of 3,000 block of Smith Street), where possible, will be provided for specified receptor locations.
- Identify and support the use of any exposure adjustments.
- Identify if sensitive receptors are present and which receptors will be evaluated in the HRA.

VII. *Maps*

- Indicate which cancer risk isopleths will be plotted for the cancer zone of impact (e.g., 10^{-7} , 10^{-6} see Section 4.6.1).
- Indicate the hazard quotients or hazard indices to be plotted for the noncancer acute and chronic zones of impact (e.g., 0.5, 1.0, etc.).

9.2 *Outline for a Health Risk Assessment Report*

The purpose of this section is to provide an outline to assist with the preparation and review of health risk assessments (HRAs). This outline specifies the key components that should be included in HRAs. All information used for the report must be presented in the HRA. Ideally, the HRA report and

a summary of data used in the HRA will be on paper and all data and model input and output files will be provided electronically (e.g., CD). Persons preparing HRAs for the Hot Spots Program should consult the District to determine if HRA guidelines or special formats are to be followed when preparing and presenting the HRA's results. If District guidelines or formats do not exist that supersede this outline, then the HRA should follow the format presented here. If the HRA is prepared for other programs, the reviewing authority should be consulted for clarification of format and content. We recommend that those persons preparing HRAs specify the guidelines that were used to prepare their product. The HRA may be considered deficient by the reviewing authority if components that are listed here are not included.

I. Table of Contents

- Section headings with page numbers indicated.
- Tables and figures with page numbers indicated.
- Appendices with page numbers indicated.

II. Executive Summary

- Name of the facility including the complete address.
- Facility identifier number (consult the District).
- Description of facility operations and a list identifying emitted substances including table of maximum 1-hour and annual average emissions.
- Provide a brief definition of acute, chronic, and cancer health impacts and multipathway substances.
- Text presenting overview of dispersion modeling and exposure assessment.
- Text defining dose-response assessment for cancer and noncancer health impacts and a table showing target organ systems by substance for noncancer impacts.
- Summary of results, including:
 - Location block/street location; e.g., north side of 3,000 block of Smith Street) and description of the off-site point of maximum impact (PMI), maximum exposed individual resident (MEIR), and maximum exposed individual worker (MEIW).
 - Location block/street location; e.g., north side of 3,000 block of Smith Street) and description of any on-site receptors that were evaluated at the facility (consult District or agency).
 - Location (block/street location; e.g., north side of 3,000 block of Smith Street) and description of any sensitive receptors that are required by the district or reviewing authorities (consult District or agency).

NOTE: When presenting the following information, potential cancer risk should be presented for a 70-year, Tier-1 analysis. Results of other exposure assumptions or tier evaluations can be presented, but must be clearly labeled. For the Hot Spots Program, the 70-year exposure duration should be used as the basis for public notification and risk reduction audits and plans.

- Text presenting an overview of the (total) potential multipathway cancer risk at the PMI, MEIR, MEIW, and sensitive receptors. Provide a table of cancer risk by substance for the MEIR and MEIW (if applicable). Include a statement indicating which of the substances appear to contribute most to (drive) the potential health impacts. In addition, identify the exposure pathways evaluated in the HRA.
- Provide a map of the facility and surroundings and identify the location of the MEIR, MEIW, and PMI.
- Provide a map of 70-year lifetime cancer risk zone of impact, if applicable.
- Text presenting an overview of the acute and chronic noncancer hazard quotients or the (total) hazard indices for the PMI, MEIR, MEIW, and sensitive receptors. Include separate statements (for acute and chronic exposures) indicating which of the substances appear to drive the potential health impacts. In addition, clearly identify the primary target organ(s) that are impacted from acute and chronic exposures.
- Identify any subpopulations (e.g., subsistence fishers) of concern.
- Table and text presenting an overview of estimates of population exposure (e.g., cancer burden or population estimates from HARP) (consult District or agency) (see Section 8.4).
- Version of the Risk Assessment Guidelines and computer program(s) used to prepare the risk assessment.

III. Risk Assessment Procedures

A. Hazard identification

- Table and text identifying all substances emitted from the facility, plus any other substances required by the District or reviewing authority. Include the CAS number of the substance and the physical form of the substance if possible. [The Hot Spots substances are listed in Appendix A, and also in the ARB's *Emission Inventory Criteria and Guidelines Regulations (Title 17, California Code of Regulations,*

Sections 93300-93300.5), and the Emission Inventory Criteria and Guidelines Report (EICG Report), which is incorporated by reference therein (ARB, 1997)].

- Table and text identifying all substances that are evaluated for cancer risk and/or noncancer acute and chronic health impacts. In addition, identify any substances that present a potential cancer risk or chronic noncancer hazard via noninhalation routes of exposure.
- Describe the types and amounts of continuous or intermittent *predictable* emissions from the facility that occurred during the reporting year. As required by statute, releases from a facility include spilling, leaking, pumping, pouring, emitting, emptying, discharging, injecting, escaping (fugitive), leaching, dumping, or disposing of a substance into ambient air. Include the substance(s) released and a description of the processes that resulted in long-term and continuous releases.

B. Exposure assessment

This section describes the information related to the air dispersion modeling process that should be reported in the risk assessment. In addition, doses calculated by pathway of exposure for each substance should be included in this section. The District may have specific requirements regarding format and content (see Section 4.13). **Sample calculations may need to be provided (in an appendix) for each step to indicate how the reported emissions data were used, if software other than HARP is used. The educated reader should be able to reproduce the risk assessment without the need for clarification. The location of any information that is presented in appendices, on electronic media, or attached documents that supports information presented in this section, must be clearly identified by title and page number in this section's text and in the document's table of contents.**

1. Information on the Facility and its Surroundings

- Report the following information regarding the facility and its surroundings:
 - Facility name
 - Facility identifier number (consult the District).
 - Location (use actual UTM coordinates and street address)
 - Land use type (see Section 4.4)
 - Local topography.
 - Facility plot plan identifying[†]
 - emission source locations
 - property line
 - horizontal scale
 - building heights and dimensions
 - complex terrain if applicable

- Description of the site/route dependent exposure pathways. Provide a summary of the site-specific inputs used for each pathway (e.g., water or grazing intake assumptions). This information may be presented in the appendix with the information clearly presented and cross-referenced to the text.

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 actual UTM coordinates (m)
 - Source base elevation (m)
 - 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)

(See Appendix K for an example.)

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)

(See Appendix K for an example.)

Emission Control Equipment and Efficiency

- Report emission control equipment and efficiency by source and by substance. The description should be brief.

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 (see Appendix K):
 - Source name
 - Source identification number
 - Substance name and CAS number (Emittent ID from Inventory Guidelines)
 - Annual average emissions for each substance (lb/yr & g/s)*
 - Maximum one-hour emissions for each substance (lb/hr & g/s)*

*Except radionuclides, for which annual and hourly emissions are reported in Curies/year and millicuries/hour, respectively.

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 (see Appendix K):
 - Substance name and CAS number (Emittent ID from Inventory Guidelines)
 - Annual average emissions for each substance (lb/yr & g/s)
 - Maximum one-hour emissions for each substance (lb/hr & g/s)

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.

3. Meteorological Data

- The HRA should indicate the source and time period of the meteorological data used. Include the meteorological data (electronically) with the HRA.
- Include proper justification for using this data including information regarding appropriateness and quality assurance/quality control.

- Identify any gaps in the data; if gaps exist, describe how the data gaps are filled.
- Provide a wind rose for a minimum of the entire time period of the meteorological data used, and time period coincident with operating schedule. (Other wind roses may be useful as well, such as a stability rose or a day/night wind rose.)
- The HRA should indicate if the District required the use of a specified representative meteorological data set or the use of default meteorological conditions from SCREEN3. All memos indicating the District's approval of meteorological data should be attached in an appendix.

4. 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 model used, the level of detail (screening or refined analysis) and the rationale behind the selection.
- Table and text that specifies the following information for each air dispersion model used:
 - version number
 - selected options and parameters
 - receptor grid spacing

5. Air Dispersion Modeling Results

- All information used for the report must be presented in the HRA. Ideally, a summary of data used in the HRA will be on paper and all data and model input and output (e.g., the ISCST3 input file containing the regulatory options and emission parameters, receptor locations, meteorology, etc) files will be provided electronically (e.g., CD).
- For the PMI, MEIR, MEIW, and any sensitive receptors required by the District, include tables that summarize the annual average concentrations that are calculated for all the substances at each site. We recommend the use of tables to present the relative contribution of each emission point to the receptor concentration. (These tables should have clear reference to the computer model that generated the data. It should be made clear to any reader how data from the computer output was transferred to these tables).

- For the PMI, MEIR, MEIW, and any sensitive receptors required by the District, include tables that summarize the maximum one-hour; four, six, or seven-hour (for those substance with RELs based on those averaging periods); and 30-day average (lead only[†]) concentrations. (These tables should have clear reference to the computer model that generated the data. It should be made clear to any reader how data from the computer output was transferred to these tables).
- If proprietary software is used, all algorithms and parameters should be included with the HRA in a clear, easy to use format.

C. Dose-Response

- Provide tables of the inhalation and oral RELs and cancer potency factors for each substance that is quantified in the HRA.
- Identify the guidelines (title and date) that were used to obtain these factors.
- Provide a table of target organ systems for each noncancer substance, including chronic inhalation, chronic oral (if applicable), and acute.

D. Risk Characterization

The Hot Spots Analysis and Reporting Program (HARP) will generate the risk characterization data needed for the outline below. Any data needed to support the risk characterization findings should be clearly presented and referenced in the text and appendices. A listing of HARP output files that meet these HRA requirements are provided in this outline under the section entitled “Appendices”. **All HARP files should be included in the HRA. Ideally, the HRA report and a summary of data used in the HRA will be on paper and all data and model input and output files will be provided electronically (e.g., CD). Information on obtaining copies of HARP is available on the California Air Resources Board’s Internet web site under the Air Toxics Program at www.arb.ca.gov.**

NOTE: The potential cancer risk for the PMI, MEIR and sensitive receptors of interest must be presented in the HRA’s text, tables, and maps using a (lifetime) 70-year exposure period. MEIW location should use appropriate exposure periods. For the Hot Spots Program, the 70-year exposure duration should be used as the basis for residential public notification and risk reduction audits and plans. All HRAs must include the results of a Tier-1 exposure assessment (see Chapter 2 and 8, or Part IV TSD). If the reviewing authority specifies that additional exposure periods should be presented, or if persons preparing the HRA would like to present additional information (i.e., exposure duration adjustments or the inclusions of risk

characterizations using Tier-2 through Tier-4 exposure data), then this information should be presented in separate, clearly titled, sections, tables, and text.

The following information should be presented in this section of the HRA. If not fully presented here, then by topic, clearly identify the section(s) and pages within the HRA where this information is presented.

- Description of receptors to be quantified.
- Table and text providing the location [UTM coordinates and the block/street address (e.g., north side of 3,000 block of Smith Street)] and description of the PMI, MEIR, and MEIW for both cancer and noncancer risks.
- Table and text providing description of the PMI and MEIR for 9- and 30-year cancer risk.
- Table and text providing the location [UTM coordinates and the block/street address (e.g., north side of 3,000 block of Smith Street)] and description of any sensitive receptors that are of interest to the District or reviewing authorities (consult District or agency).
- Provide any exposure information that is used for risk characterization (e.g., concentrations at receptors, emissions information, census information, figures, zone of impact maps, etc.). Identify the site/route dependent exposure pathways (e.g., water ingestion) for the receptor(s), where appropriate (e.g., MEIR). Provide a summary of the site-specific inputs used for each exposure pathway (e.g., water or grazing intake assumptions). This information may be presented in the appendix with the information clearly presented and cross-referenced to the text. In addition, provide reference to the appendix (section and page number) that contains the modeling (i.e., HARP/dispersion modeling) files that show the same information.
- If any exposure parameters were used other than those provided in the *Air Toxics Risk Assessment Guidelines; Part IV; Technical Support Document for Exposure Assessment and Stochastic Analysis (2000b)* (Part IV TSD), they must be presented in detail. The derivation and data used must be presented so that it is clear to the reviewer. The justification for using site-specific exposure parameters must be clearly presented.
- Include tables of the estimated dose for each substance by each exposure pathway at the PMI, MEIR, MEIW, and at any sensitive receptor locations (required by the District).

- Table and text presenting the potential multipathway cancer risk by substance, by pathway, and total, at the PMI, MEIR, MEIW, and sensitive receptor locations (required by the District).
- Table and text presenting the acute (inhalation) and chronic noncancer (inhalation and oral) hazard quotients (by substance, exposure pathways, and target organs) and the (total) hazard indices by substance and target organs for the PMI, MEIR, MEIW, and sensitive receptors. Note: chronic noncancer results should be shown with inhalation and oral contributions (shown separately) and for the combined (multipathway) impact.
- Identify any subpopulations (e.g., subsistence fishers) of concern.
- Table and text presenting estimates of population exposure (e.g., population exposure estimates or cancer burden from HARP) (consult District or agency). Tables should indicate the number of persons exposed to a (total) cancer risk greater than 10^{-7} , 10^{-6} , 10^{-5} , 10^{-4} , etc., and total hazard quotient or hazard index greater than 0.5, 1.0, 2.0, and 3.0, etc. Provide a table that shows excess cancer burden for each population unit and the total excess cancer burden, if cancer burden calculation is required.
- Provide maps that illustrate the HRA results for the three bullet points below. These maps should be an actual street map of the area impacted by the facility with elevation contours and actual UTM coordinates, and the facility boundaries clearly labeled. In some cases the elevation contours will make the map too crowded and should therefore not appear. 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 are usually the most appropriate choice (see Section 4.6). Note that the HARP program contains a mapping feature.
 - The facility (emission points and boundaries), the locations of the PMI, MEIR, MEIW, and sensitive receptors.

- Maps of the cancer zone of impacts (e.g., 10^{-6} or 10^{-7} levels - consult District or Agency). The map should clearly identify the zone of impact for the minimum exposure pathways (inhalation, soil ingestion, dermal exposure, and breast-milk consumption) and the zone of impact for all the applicable exposure pathways (minimum exposure pathways plus additional site/route specific pathways). Two maps may be needed to accomplish this. The legend of these maps should state the level(s) used for the zone of impact and identify the exposure pathways that were included in the assessment.
 - Maps of the noncancer hazard index (HI) zone of impacts (e.g., 0.5 or 1.0 - consult District or Agency). The noncancer maps should clearly identify the noncancer zones of impact. These include the acute (inhalation), chronic (inhalation), and chronic (multipathway) zones of impact. For clarity, presentation of the noncancer zones of impact may require two or more maps. The legend of these maps should state the level(s) used for the zone of impact and identify the exposure pathways.
-
- The risk assessor may want to include a discussion of the strengths and weaknesses of the risk analyses and associated uncertainty directly related to the facility HRA.
 - If appropriate, comment on the possible alternatives for control or remedial measures. How do the risks compare?
 - If possible, identify any community concerns that influence public perception of risk.
 - Sample calculations may be needed for all analyses in the HRA if proprietary software other than HARP was used. The District should be consulted. These calculations should be clearly presented and referenced to the findings they are supporting in the HRA text.
 - Version of the Risk Assessment Guidelines and computer program used to prepare the risk assessment.
 - If software other than HARP is used for the health assessment modeling, all supporting material must be included with the HRA (e.g., all algorithms and parameters used in a clear, easy to review format).

E. References

F. Appendices

The appendices should contain all data, sample calculations, assumptions, and all modeling and risk assessment files that are needed to reproduce the HRA results. Ideally, a summary of data used in the HRA will be on paper and all data and model input and output files will be provided electronically (e.g., CD), unless otherwise specified by the district or reviewing

authority. All appendices and the information they contain should be referenced, clearly titled, and paginated. The HARP program (input and output) files will include many of the items listed below.

- **Potential Appendix Topics (if not presented elsewhere in the HRA report):**
 - List of all receptors locations (UTM coordinates and the block/street address (e.g., north side of 3,000 block of Smith Street)) for the PMI, MEIR, MEIW, and sensitive receptors.
 - List of all emitted substances.
 - All emissions files.
 - List of dose-response factors.
 - All air dispersion modeling input and output files. Detailed discussions of meteorological data, regulatory options, emission parameters, receptor locations, etc.
 - Census data.
 - Maps.
 - Identify the site/route dependent exposure pathways for the receptor(s), where appropriate (e.g., MEIR). Provide a summary of the site-specific inputs used for each pathway (e.g., water or grazing intake assumptions) and the data to support them.
 - All calculations used to determine emissions, concentrations, and potential health impacts at the PMI, MEIR, MEIW, and sensitive receptors.
 - All HRA model input and output (HARP) files for receptors of concern.
 - (Total) cancer and noncancer impacts by receptor, substance, and exposure pathway (by endpoint for noncancer) at all receptors.
 - Presentation of alternate risk assessment methods (e.g., alternate exposure durations, or Tier-2 to Tier-4 evaluations with supporting information).
- **List of HARP files that meet the Submittal Requirements**
 - ISC workbook file with all ISC parameters (filename.ISC).
 - ISC input file generated by HARP when ISC is run (filename.INP)
 - ISC output file generated by HARP when ISC is run (filename.OUT)
 - ISC binary output file; holds χ/Q for data for each hour (filename.BIN)
 - List of error messages generated by ISC (filename.ERR)
 - Sources receptor file; contains list of sources and receptors for the ISC run; generated by HARP when you set up ISC (filename.SRC)
 - Point estimate risk values generated by HARP; this file is updated automatically each time you perform one of the point estimate risk analysis functions (filename.RSK)
 - Average and maximum χ/Q values for each source-receptor combination; generated by ISC (filename.XOQ)
 - Plot file generated by ISC (filename.PLT)

- Representative meteorological data used for the facility air dispersion modeling (filename.MET)
- Site-specific parameters used for all receptor risk modeling (filename.SIT)
- Map file used to overlay facility and receptors (filename.DEB)

(†) Health and Safety Code (HSC) Section 44346 authorizes facility operators to designate certain Hot Spots information as trade secret. HSC Section 44361(a) requires Districts to make health risk assessments available for public review upon request. HSC 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.

(‡) Please see Appendix F or contact the Office of Environmental Health Hazard Assessment for information on calculating and presenting chronic lead results.

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Appendix A

Air Toxics Hot Spots Program

List Of Substances*

*The List of Substances presented in Appendix A is periodically updated by the California Air Resources Board. The last update was July 1, 1997.

Appendix A-I

Substances For Which Emissions Must Be Quantified

July 1, 1997

The Air Toxics Hot Spots Program Guidance Manual for Preparation of Health Risk Assessments.
August 2003.

APPENDIX A-I
Substances For Which Emissions Must Be Quantified

Emittent ID Other (Note [1]) Notes(s)	Substance Name (Note [2])	Add Date (Note [3])	Carcinogen (Note [4])	Applicable Degree of Accuracy (lb/yr) (Note [5])	Source List(s) (Note [6])
75070	Acetaldehyde		c	20.	1 2 3 4
60355	Acetamide		c	2.	1 2 3 4
75058	Acetonitrile	06/91		200.	1 2
98862	Acetophenone	06/91		100.	1 2
53963	2-Acetylaminofluorene [PAH-Derivative, POM]		c	100.	1 2 4 5
107028	Acrolein			0.05	1 2
79061	Acrylamide		c	0.01	1 2 3 4
79107	Acrylic acid	06/91		5.	1 2
107131	Acrylonitrile		c	0.1	1 2 3 4 5
107051	Allyl chloride		c	5.	1 2 4
7429905	Aluminum	06/91		100.	1
1344281	Aluminum oxide (fibrous forms)	06/91		100.	7
117793	2-Aminoanthraquinone [PAH-Derivative, POM]		c	5.	1 2 4 5
92671	4-Aminobiphenyl [POM]		c	100.	1 2 3 4 5
61825	Amitrole		c	0.1	3 4 5
7664417	Ammonia			200.	1 2
6484522	Ammonium nitrate	06/91		100.	1
7783202	Ammonium sulfate	06/91		100.	1
62533	Aniline	09/90	c	5.	1 2 4
90040	o-Anisidine		c	100.	1 2 3 4 5
-	Anthracene [PAH, POM], (see PAH)				
7440360	Antimony	06/91		1.	7
* [7]	Antimony compounds	06/91		1.	1 2
	including but not limited to:				
1309644	Antimony trioxide	09/90	c	1.	1 2 3 4
[7]					
7440382	Arsenic		c	0.01	1 2 3 4 5
1016	Arsenic compounds (inorganic)		c	0.01	1 2 3 4 5
[7]					
	including but not limited to:				
7784421	Arsine			0.01	1 2 7
[7]					
1017	Arsenic compounds (other than inorganic)	06/91		0.1	1
[7]					
7440393	Barium	06/91		1.	7
* [7]	Barium compounds	06/91		1.	1
-	Benz[a]anthracene [PAH, POM], (see PAH)				
71432	Benzene		c	2.	1 2 3 4 5

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92875	Benzidine (and its salts) [POM]		c	0.0001	1 2 3 4 5
1020	Benzidine-based dyes [POM]		c	0.0001	1 2 3
	including but not limited to:				
1937377	Direct Black 38 [PAH-Derivative, POM]		c	0.0001	1 2 4 5
2602462	Direct Blue 6 [PAH-Derivative, POM]		c	0.0001	1 2 4 5
16071866	Direct Brown 95 (technical grade) [POM]	09/89	c	0.0001	1 2 4
-	Benzo[a]pyrene [PAH, POM], (see PAH)				
-	Benzo[b]fluoranthene [PAH, POM], (see PAH)				
271896	Benzofuran	06/91	c	100.	4

APPENDIX A-I
Substances For Which Emissions Must Be Quantified

Emittent ID Other (Note [1]) Notes(s)	Substance Name (Note [2])	Add Date (Note [3])	Carcinogen (Note [4])	Applicable Degree of Accuracy (lb/yr) (Note [5])	Source List(s) (Note [6])
98077	Benzoic trichloride {Benzotrichloride}		c	10.	1 2 4 5
-	Benzo[j]fluoranthene [PAH, POM], (see PAH)				
-	Benzo[k]fluoranthene [PAH, POM], (see PAH)				
98884	Benzoyl chloride	06/91		100.	1
94360	Benzoyl peroxide	06/91		100.	7
100447	Benzyl chloride		c	50.	1 2 4
7440417	Beryllium		c	0.001	1 2 3 4 5
*	Beryllium compounds	09/89	c	0.001	1 2 3 4 5
[7]					
92524	Biphenyl [POM]	06/91		0.5	1 2
111444	Bis(2-chloroethyl) ether {DCEE}	09/89	c	0.05	1 2 4
542881	Bis(chloromethyl) ether		c	0.001	1 2 3 4 5
103231	Bis(2-ethylhexyl) adipate	06/91		100.	1
7726956	Bromine			0.5	2
*	Bromine compounds (inorganic)			100.	1 2
[7]					
	including but not limited to:				
7758012	Potassium bromate			0.1	1 3 4
[7]					
75252	Bromoform	06/91		100.	1 2 4
106990	1,3-Butadiene		c	0.1	1 2 3 4 5
141322	Butyl acrylate	06/91		100.	1
71363	n-Butyl alcohol	06/91		100.	1
78922	sec-Butyl alcohol	06/91		100.	1
75650	tert-Butyl alcohol	06/91		100.	1
85687	Butyl benzyl phthalate	06/91		100.	1
7440439	Cadmium		c	0.01	1 2 3 4 5
*	Cadmium compounds		c	0.01	1 2 3 4 5
[7]					
156627	Calcium cyanamide	06/91		100.	1 2
105602	Caprolactam	06/91		100.	1 2
2425061	Captafol	09/89	c	100.	4
133062	Captan	09/90	c	100.	1 2 4
63252	Carbaryl [PAH-Derivative, POM]	06/91		100.	1 2
1050	Carbon black extracts		c	2.	1 3 4
75150	Carbon disulfide	09/89		200.	1 2 4
56235	Carbon tetrachloride		c	1.	1 2 3 4 5
463581	Carbonyl sulfide	06/91		100.	1 2
1055	Carrageenan (degraded)		c	100.	3 4
120809	Catechol	06/91		100.	1 2

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133904	Chloramben	06/91		100.	1	2		
57749	Chlordane	09/89	c	10.	1	2	4	
108171262	Chlorinated paraffins (average chain length, C12; approximately 60% chlorine by weight)	09/89	c	2.			3	4 5
7782505	Chlorine			0.5	1	2		
10049044	Chlorine dioxide	06/91		1.	1			
79118	Chloroacetic acid	06/91		100.	1	2		
532274	2-Chloroacetophenone	06/91		0.1	1	2		
106478	p-Chloroaniline	07/96		100.			4	7

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1058	Chlorobenzenes including but not limited to:	06/91		100.	1
108907	Chlorobenzene			200.	1 2
25321226	Dichlorobenzenes (mixed isomers) including:	06/91		100.	1 7
95501	1,2-Dichlorobenzene	06/91		200.	1 7
541731	1,3-Dichlorobenzene	06/91		100.	1 7
106467	p-Dichlorobenzene {1,4-Dichlorobenzene}		c	5.	1 2 3 5
120821	1,2,4-Trichlorobenzene	06/91		200.	1 2
510156	Chlorobenzilate [POM] {Ethyl-4,4'- dichlorobenzilate}	09/90	c	100.	1 2 4
67663	Chloroform		c	10.	1 2 3 4 5
107302	Chloromethyl methyl ether (technical grade)		c	100.	1 2 4 5
1060	Chlorophenols including but not limited to:		c	100.	1 3
120832	2,4-Dichlorophenol	06/91	c	100.	1 7
87865	Pentachlorophenol	09/90	c	10.	1 2 4
58902	2,3,4,6-Tetrachlorophenol	07/96	c	100.	1 7
95954	2,4,5-Trichlorophenol	06/91	c	100.	1 2
88062	2,4,6-Trichlorophenol		c	2.	1 2 4
95830	4-Chloro-o-phenylenediamine		c	10.	3 4 5
76062	Chloropicrin			2.	7
126998	Chloroprene			5.	1 2
95692	p-Chloro-o-toluidine		c	0.5	3 4
7440473	Chromium	06/91		0.001	7
*	Chromium compounds (other than hexavalent)	06/91		0.001	1 2
[7]					
18540299	Chromium, hexavalent (and compounds)		c	0.0001	1 2 3 4 5
[7]					
10294403	Barium chromate including but not limited to:	06/91	c	0.001	1 2 5
[7]					
13765190	Calcium chromate	06/91	c	0.001	1 2 5
[7]					
1333820	Chromium trioxide	06/91	c	0.0001	1 2 5
[7]					
7758976	Lead chromate	06/91	c	0.001	1 2 5
[7]					

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10588019	Sodium dichromate	06/91	c	0.0001	1 2	5
[7]						
7789062	Strontium chromate	06/91	c	0.001	1 2	5
[7]						
-	Chrysene [PAH, POM], (see PAH)					
7440484	Cobalt	06/91		0.5		7
*	Cobalt compounds	06/91		0.5	1 2	
[7]						
1066	Coke oven emissions		c	0.05	1 2 3 4 5	
7440508	Copper			0.1	2	
*	Copper compounds	09/89		0.1	1 2	
[7]						
1070	Creosotes		c	0.05	1 3 4	
120718	p-Cresidine		c	1.	3 4 5	
1319773	Cresols (mixtures of) {Cresylic acid}			5.	1 2	
	including:					
108394	m-Cresol	06/91		5.	1 2	
95487	o-Cresol	06/91		5.	1 2	
106445	p-Cresol	06/91		5.	1 2	
4170303	Crotonaldehyde	07/96	c	50.		7

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98828	Cumene	06/91		200.	1 2
80159	Cumene hydroperoxide	06/91		100.	1
135206	Cupferron		c	0.5	4 5
1073	Cyanide compounds	06/91		0.05	1 2
[8]	including but not limited to:				
74908	Hydrocyanic acid			10.	2
110827	Cyclohexane	06/91		200.	1
108930	Cyclohexanol	07/96		200.	7
66819	Cycloheximide			2.	6
1163195	Decabromodiphenyl oxide [POM]	06/91		100.	1 2
1075	Dialkylnitrosamines			0.001	1
	including but not limited to:				
924163	N-Nitrosodi-n-butylamine		c	0.0001	1 3 4 5
1116547	N-Nitrosodiethanolamine		c	100.	1 3 4 5
55185	N-Nitrosodiethylamine		c	0.001	1 3 4 5
62759	N-Nitrosodimethylamine		c	0.01	1 2 3 4 5
621647	N-Nitrosodi-n-propylamine		c	0.01	1 3 4 5
10595956	N-Nitrosomethylethylamine		c	0.001	1 3 4
615054	2,4-Diaminoanisole		c	5.	3 4
1078	Diaminotoluenes (mixed isomers)	09/90	c	100.	1 4
	including but not limited to:				
95807	2,4-Diaminotoluene {2,4-Toluenediamine}		c	0.05	1 2 3 4 5
334883	Diazomethane	06/91	c	5.	1 2
226368	Dibenz[a,h]acridine [POM]		c	0.5	1 2 3 4 5
224420	Dibenz[a,j]acridine [POM]		c	0.5	1 2 3 4 5
-	Dibenz[a,h]anthracene [PAH, POM], (see PAH)				
194592	7H-Dibenzo[c,g]carbazole		c	0.05	1 2 3 4 5
-	Dibenzo[a,e]pyrene [PAH, POM], (see PAH)				
-	Dibenzo[a,h]pyrene [PAH, POM], (see PAH)				
-	Dibenzo[a,i]pyrene [PAH, POM], (see PAH)				
-	Dibenzo[a,l]pyrene [PAH, POM], (see PAH)				
132649	Dibenzofuran [POM]	06/91		100.	1 2
-	Dibenzofurans (chlorinated) (see Polychlorinated dibenzofurans) [POM]				
96128	1,2-Dibromo-3-chloropropane {DBCP}		c	0.01	1 2 3 4 5
96139	2,3-Dibromo-1-propanol	07/96	c	50.	4
84742	Dibutyl phthalate	06/91		100.	1 2
-	p-Dichlorobenzene {1,4-Dichlorobenzene} (see Chlorobenzenes)				

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91941	3,3'-Dichlorobenzidine [POM]		c	0.1	1 2 3 4 5
72559	Dichlorodiphenyldichloroethylene {DDE} [POM]	09/89	c	100.	1 2 4
75343	1,1-Dichloroethane {Ethylidene dichloride}	09/90	c	20.	1 2 4
94757	Dichlorophenoxyacetic acid, salts and esters {2,4-D}	06/91		100.	1 2
78875	1,2-Dichloropropane {Propylene dichloride}	09/90	c	20.	1 2 4
542756	1,3-Dichloropropene		c	10.	1 2 3 4 5
62737	Dichlorovos {DDVP}	09/89	c	0.5	1 2 4
115322	Dicofol [POM]	06/91		100.	1 2

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- -	Diesel engine exhaust	09/90	c		1 3 4
[9]					
9901	Diesel engine exhaust, particulate matter	09/90	c	10.	1 3 4
[9]					
9902	Diesel engine exhaust, total organic gas	09/90	c	10.	1 3 4
[9]					
#	Diesel fuel (marine)	06/91	c		
111422	Diethanolamine	06/91		20.	1 2
117817	Di(2-ethylhexyl) phthalate {DEHP}		c	20.	1 2 3 4 5
64675	Diethyl sulfate		c	100.	1 2 3 4 5
119904	3,3'-Dimethoxybenzidine [POM]		c	100.	1 2 3 4 5
60117	4-Dimethylaminoazobenzene [POM]		c	0.01	1 2 3 4 5
121697	N,N-Dimethylaniline	06/91		200.	1 2
57976	7,12-Dimethylbenz[a]anthracene [PAH-Derivative, POM]	09/90	c	0.0001	1 2 4
119937	3,3'-Dimethylbenzidine {o-Tolidine} [POM]		c	10.	1 2 3 4 5
79447	Dimethyl carbamoyl chloride		c	100.	1 2 3 4 5
68122	Dimethyl formamide	09/90	c	100.	1 2 3
57147	1,1-Dimethylhydrazine		c	0.1	1 2 3 4 5
131113	Dimethyl phthalate	06/91		50.	1 2
77781	Dimethyl sulfate		c	0.01	1 2 3 4 5
534521	4,6-Dinitro-o-cresol (and salts)	06/91		100.	1 2
51285	2,4-Dinitrophenol	06/91		100.	1 2
42397648	1,6-Dinitropyrene [PAH-Derivative, POM]	06/91	c	0.001	1 2 3 4
42397659	1,8-Dinitropyrene [PAH-Derivative, POM]	06/91	c	0.05	1 2 3 4
25321146	Dinitrotoluenes (mixed isomers) including but not limited to:	06/91		100.	7
121142	2,4-Dinitrotoluene	09/89	c	0.5	1 2 4
606202	2,6-Dinitrotoluene	06/91		100.	7
123911	1,4-Dioxane		c	5.	1 2 3 4 5
-	Dioxins (Chlorinated dibenzodioxins) (see Polychlorinated dibenzo-p-dioxins) [POM]				
630933	Diphenylhydantoin [POM]		c	100.	1 2 4
122667	1,2-Diphenylhydrazine {Hydrazobenzene} [POM]		c	100.	1 2 4 5
1090	Environmental Tobacco Smoke		c	2.	1 3 4
106898	Epichlorohydrin		c	2.	1 2 3 4 5
106887	1,2-Epoxybutane	06/91		100.	1 2
1091	Epoxy resins	09/89		100.	
140885	Ethyl acrylate		c	200.	1 2 3 4 5
100414	Ethyl benzene	06/91		200.	1 2

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75003	Ethyl chloride {Chloroethane}			200.	1	2	4	
-	Ethyl-4,4'-dichlorobenzilate (see Chlorobenzilate)							
74851	Ethylene	06/91		200.				7
106934	Ethylene dibromide {1,2-Dibromoethane}		c	0.5	1	3	4	5 6
107062	Ethylene dichloride {1,2-Dichloroethane}		c	2.	1	2	3	4 5
107211	Ethylene glycol	06/91		200.	1	2		
151564	Ethyleneimine {Aziridine}	06/91		100.	1	2		
75218	Ethylene oxide		c	0.5	1	2	3	4 5 6
96457	Ethylene thiourea		c	2.	1	2	3	4 5

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1101	Fluorides and compounds including but not limited to:	09/89		100.	2
7664393	Hydrogen fluoride			50.	1 2 7
1103	Fluorocarbons (brominated)			200.	6
[10] 1104	Fluorocarbons (chlorinated)			200.	1 6
[10]	including but not limited to:				
76131	Chlorinated fluorocarbon {CFC-113}			200.	1 2 6
	{1,1,2-Trichloro-1,2,2-trifluoroethane}				
75456	Chlorodifluoromethane {Freon 22}	07/96		200.	1 6 7
75434	Dichlorofluoromethane {Freon 12}	07/96		200.	1 6 7
75694	Trichlorofluoromethane {Freon 11}	07/96		200.	1 6 7
50000	Formaldehyde		c	5.	1 2 3 4 5 6
110009	Furan	07/96	c	5.	4
- -	Gasoline engine exhaust	09/90	c		3
[9]	including but not limited to:				
- -	Gasoline engine exhaust (condensates & extracts)	06/91	c		4
[9]					
9910	Gasoline engine exhaust, particulate matter	09/90	c	100.	3 4
[9]					
9911	Gasoline engine exhaust, total organic gas	09/90	c	100.	3 4
[9]					
1110	Gasoline vapors		c	200.	1 2 3 4
[11]					
111308	Glutaraldehyde			0.1	1 6
1115	Glycol ethers and their acetates			100.	1 2 6
	including but not limited to:				
111466	Diethylene glycol	09/90		100.	1 6
111966	Diethylene glycol dimethyl ether	09/90		100.	1 2 6
112345	Diethylene glycol monobutyl ether	09/90		100.	1 2 6
111900	Diethylene glycol monoethyl ether	09/90		100.	1 2 6
111773	Diethylene glycol monomethyl ether	09/90		100.	1 2 6
25265718	Dipropylene glycol	09/90		100.	1 6
34590948	Dipropylene glycol monomethyl ether	09/90		100.	1 6
629141	Ethylene glycol diethyl ether	09/90		100.	1 2 6
110714	Ethylene glycol dimethyl ether	09/90		100.	1 2 6
111762	Ethylene glycol monobutyl ether	09/90		200.	1 2 6

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110805	Ethylene glycol monoethyl ether	09/89		50.	1	2	6			
111159	Ethylene glycol monoethyl ether acetate	09/90		100.	1	2	6			
109864	Ethylene glycol monomethyl ether	09/89		10.	1	2	6			
110496	Ethylene glycol monomethyl ether acetate	09/90		200.	1	2	6			
2807309	Ethylene glycol monopropyl ether	09/90		100.	1	2	6			
107982	Propylene glycol monomethyl ether	09/90		200.	1		6			
108656	Propylene glycol monomethyl ether acetate	09/90		100.	1		6			
112492	Triethylene glycol dimethyl ether	09/90		100.	1	2	6			
76448	Heptachlor	09/89	c	100.	1	2	4			
118741	Hexachlorobenzene		c	0.1	1	2	3	5		
87683	Hexachlorobutadiene	06/91		0.1	1	2				
1120	Hexachlorocyclohexanes(mixed or technical grade)		c	0.05	1		3	4	5	
	including but not limited to:									
319846	alpha-Hexachlorocyclohexane	07/96	c	0.1	1		3	4	5	7
319857	beta-Hexachlorocyclohexane	07/96	c	0.1	1		3	4	5	7
58899	Lindane {gamma-Hexachlorocyclohexane}	09/90	c	0.1	1	2		4		

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77474	Hexachlorocyclopentadiene			2.	1 2
67721	Hexachloroethane	09/90	c	200.	1 2 4
680319	Hexamethylphosphoramide		c	100.	1 2 3 4 5
110543	Hexane	06/91		200.	1 2
302012	Hydrazine		c	0.01	1 2 3 4 5
7647010	Hydrochloric acid			20.	1 2
-	Hydrocyanic acid (see Cyanide compounds)				
7783064	Hydrogen sulfide			5.	1 2
123319	Hydroquinone	06/91		100.	1 2
-	Indeno[1,2,3-cd]pyrene [PAH, POM], (see PAH)				
13463406	Iron pentacarbonyl	07/96		5.	7
1125	Isocyanates			0.05	6
	including but not limited to:				
822060	Hexamethylene-1,6-diisocyanate	06/91		0.05	1 2
101688	Methylene diphenyl diisocyanate {MDI} [POM]	06/91		0.1	1 2
624839	Methyl isocyanate			1.	1 2
-	Toluene-2,4-diisocyanate (see Toluene diisocyanates)				
-	Toluene-2,6-diisocyanate (see Toluene diisocyanates)				
78591	Isophorone	06/91		200.	1 2
78795	Isoprene, except from vegetative emission sources	07/96	c	200.	3
67630	Isopropyl alcohol	06/91		200.	1
80057	4,4'-Isopropylidenediphenol [POM]	06/91		100.	1 2
7439921	Lead		c	0.5	1 4 6
1128	Lead compounds (inorganic)		c	0.5	1 3
[7]					
	including but not limited to:				
301042	Lead acetate		c	1.	1 2 4 5
[7] [12]					
-	Lead chromate (see Chromium, hexavalent)				
7446277	Lead phosphate		c	2.	1 4 5
[7]					
1335326	Lead subacetate	09/90	c	2.	1 2 4
[7] [12]					
1129	Lead compounds (other than inorganic)	06/91		5.	1 2
[7]					
108316	Maleic anhydride			0.5	1 2
7439965	Manganese			0.1	1 2

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[7]	* Manganese compounds	09/89		0.1	1	2		
7439976	Mercury			1.	1	2	4	6
[7]	* Mercury compounds	09/89		1.	1	2	4	
	including but not limited to:							
7487947	Mercuric chloride			1.		2		
[7]								
593748	Methyl mercury {Dimethylmercury}			1.		2		
[7]								
67561	Methanol			200.	1	2		
72435	Methoxychlor [POM]	06/91		100.	1	2		
75558	2-Methylaziridine {1,2-Propyleneimine}		c	100.	1	2	3	4
74839	Methyl bromide {Bromomethane}			20.	1	2		6
74873	Methyl chloride {Chloromethane}	06/91		20.	1	2		
71556	Methyl chloroform {1,1,1-Trichloroethane}			200.	1	2		6
56495	3-Methylcholanthrene [PAH-Derivative, POM]	09/90	c	0.001	1	2	4	
3697243	5-Methylchrysene [PAH-Derivative, POM]		c	0.05	1	2	3	4

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101144	4,4'-Methylene bis(2-chloroaniline) {MOCA} [POM]		c	0.1	1 2 3 4 5
75092	Methylene chloride {Dichloromethane}		c	50.	1 2 3 4 5 6
101779	4,4'-Methylenedianiline (and its dichloride) [POM]		c	0.1	1 2 3 4 5
78933	Methyl ethyl ketone {2-Butanone}	06/91		200.	1 2
60344	Methyl hydrazine	06/91		100.	1 2
74884	Methyl iodide {Iodomethane}		c	100.	1 2 4 5
108101	Methyl isobutyl ketone {Hexone}	06/91		20.	1 2
75865	2-Methylactonitrile {Acetone cyanohydrin}	07/96		50.	7
80626	Methyl methacrylate			200.	1 2 6
109068	2-Methylpyridine	07/96		100.	7
1634044	Methyl tert-butyl ether	06/91		200.	1 2
90948	Michler's ketone [POM]		c	0.1	1 2 4 5
1136	Mineral fibers (fine, manmade) (fine mineral fibers which are manmade and are airborne particles of a respirable size greater than 5 microns in length, less than or equal to 3.5 microns in diameter, with a length to diameter ratio of 3:1) including but not limited to:	06/91	c	100.	1 2 7
1056	Ceramic fibers	09/89	c	100.	1 2 3 4
1111	Glasswool fibers	09/89	c	100.	1 2 3 4
1168	Rockwool fibers	09/89	c	100.	1 2 3
1181	Slagwool fibers	09/89	c	100.	1 2 3
1135	Mineral fibers (other than manmade) including but not limited to:			100.	2 7
1332214	Asbestos		c	0.0001	1 2 3 4 5
12510428	Erionite		c	100.	2 3 4
1190	Talc containing asbestiform fibers		c	100.	2 3 4
1313275	Molybdenum trioxide	06/91		100.	1
-	Naphthalene [PAH, POM], (see PAH)				
7440020	Nickel		c	0.1	1 2 3 4 5
*	Nickel compounds		c	1.	1 2 3 4 5
[7]	including but not limited to:				
373024	Nickel acetate	06/91	c	0.1	1 2 5
[7]					
3333393	Nickel carbonate	06/91	c	0.1	1 2 5
[7]					
13463393	Nickel carbonyl		c	0.1	1 2 4 5
[7]					

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12054487	Nickel hydroxide	06/91	c	0.1	1 2	5
[7]						
1271289	Nickelocene	06/91	c	0.1	1 2	5
[7]						
1313991	Nickel oxide	06/91	c	0.1	1 2	5
[7]						
12035722	Nickel subsulfide		c	0.1	1 2	4 5
[7]						
1146	Nickel refinery dust from the pyrometallurgical process	09/89	c	0.1		4
7697372	Nitric acid	06/91		50.	1	
139139	Nitrilotriacetic acid		c	100.	1	4 5
98953	Nitrobenzene			0.5	1 2	
92933	4-Nitrobiphenyl [POM]	09/89	c	100.	1 2	4
7496028	6-Nitrochrysene [PAH-Derivative, POM]	06/91	c	0.001	1 2 3	4
607578	2-Nitrofluorene [PAH-Derivative, POM]	06/91	c	5.	1 2 3	4

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302705	Nitrogen mustard N-oxide		c	0.05	3 4
100027	4-Nitrophenol	06/91		100.	1 2
79469	2-Nitropropane		c	0.01	1 2 3 4 5
5522430	1-Nitropyrene [PAH-Derivative, POM]	06/91	c	0.5	1 2 3 4
156105	p-Nitrosodiphenylamine [POM]		c	5.	1 2 4 5
684935	N-Nitroso-N-methylurea		c	100.	1 2 4 5
59892	N-Nitrosomorpholine		c	0.01	1 2 3 4 5
100754	N-Nitrosopiperidine		c	200.	3 4 5
930552	N-Nitrosopyrrolidine		c	0.05	3 4 5
- -	PAHs (Polycyclic aromatic hydrocarbons) [POM]				1 2
[13]	including but not limited to:				
1151	PAHs, total, w/o individ. components reported			50.	1 2
1150	PAHs, total, with individ. components also reported			50.	1 2
83329	Acenaphthene [PAH, POM]	07/96		50.	1
208968	Acenaphthylene [PAH, POM]	07/96		50.	1
120127	Anthracene [PAH, POM]	06/91		50.	1 2 7
56553	Benz[a]anthracene [PAH, POM]		c	0.5	1 2 3 4 5
50328	Benzo[a]pyrene [PAH, POM]		c	0.05	1 2 3 4 5
205992	Benzo[b]fluoranthene [PAH, POM]		c	0.5	1 2 3 4 5
192972	Benzo[e]pyrene [PAH, POM]	07/96		0.5	1
191242	Benzo[g,h,i]perylene [PAH, POM]	07/96		0.5	1
205823	Benzo[j]fluoranthene [PAH, POM]		c	0.5	1 2 3 4 5
207089	Benzo[k]fluoranthene [PAH, POM]		c	0.5	1 2 3 4 5
218019	Chrysene [PAH, POM]	09/90	c	5.	1 2 4
53703	Dibenz[a,h]anthracene [PAH, POM]		c	0.1	1 2 3 4 5
192654	Dibenzo[a,e]pyrene [PAH, POM]		c	0.05	1 2 3 4 5
189640	Dibenzo[a,h]pyrene [PAH, POM]		c	0.001	1 2 3 4 5
189559	Dibenzo[a,i]pyrene [PAH, POM]		c	0.001	1 2 3 4 5
191300	Dibenzo[a,l]pyrene [PAH, POM]		c	0.001	1 2 3 4 5
206440	Fluoranthene [PAH, POM]	07/96		0.5	1
86737	Fluorene [PAH, POM]	07/96		0.5	1
193395	Indeno[1,2,3-cd]pyrene [PAH, POM]		c	0.5	1 2 3 4 5
91576	2-Methyl naphthalene [PAH, POM]	07/96		50.	1
91203	Naphthalene [PAH, POM]			50.	1 2
198550	Perylene [PAH, POM]	07/96		0.5	1
85018	Phenanthrene [PAH, POM]	07/96		0.5	1
129000	Pyrene [PAH, POM]	07/96		0.5	1

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[14]	#	PAH-Derivatives (Polycyclic aromatic hydrocarbon	06/91			
		derivatives) [POM]				
		(including but not limited to those substances				
		listed in Appendix A with the bracketed				
		designation [PAH-Derivative, POM])				
56382		Parathion	06/91		100.	1 2
1336363		PCBs (Polychlorinated biphenyls) [POM]		c	0.01	1 2 3 4 5 6
82688		Pentachloronitrobenzene {Quintobenzene}	06/91		100.	1 2
79210		Peracetic acid	06/91		100.	1
127184		Perchloroethylene {Tetrachloroethene}		c	5.	1 2 3 4 5 6

APPENDIX A-I
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Emittent ID Other (Note [1]) Notes(s)	Substance Name (Note [2])	Add Date (Note [3])	Carcinogen (Note [4])	Applicable Degree of Accuracy (lb/yr) (Note [5])	Source List(s) (Note [6])
108952	Phenol			200.	1 2
106503	p-Phenylenediamine	06/91		100.	1 2
90437	2-Phenylphenol [POM]	06/91		100.	1 2
75445	Phosgene			2.	1 2
7723140	Phosphorus			0.1	1 2
- -	Phosphorus compounds:	09/89			2
7803512	Phosphine			0.01	1 2 7
7664382	Phosphoric acid	09/89		50.	1 2
10025873	Phosphorus oxychloride	09/89		0.1	2
10026138	Phosphorus pentachloride	09/89		0.1	2
1314563	Phosphorus pentoxide	09/89		0.1	2
7719122	Phosphorus trichloride	09/89		0.1	2
126738	Tributyl phosphate	09/89		100.	2
78400	Triethyl phosphine	09/89		100.	2
512561	Trimethyl phosphate	09/89		100.	2
78308	Triorthocresyl phosphate [POM]	09/89		0.5	1 2
115866	Triphenyl phosphate [POM]	09/89		100.	1 2
101020	Triphenyl phosphite [POM]	09/89		100.	1 2
85449	Phthalic anhydride			0.01	1 2
- -	Polychlorinated dibenzo-p-dioxins {PCDDs or Dioxins} [POM]		c		1 2
	including but not limited to:				
1086	Dioxins, total, w/o individ. isomers reported {PCDDs}		c	0.00002	1 2
1085	Dioxins, total, with individ. isomers also reported {PCDDs}		c	0.00002	1 2
1746016	2,3,7,8-Tetrachlorodibenzo-p-dioxin {TCDD} [POM]		c	0.000001	1 2 3 4 5
40321764	1,2,3,7,8-Pentachlorodibenzo-p-dioxin [POM]		c	0.000001	1 2
39227286	1,2,3,4,7,8-Hexachlorodibenzo-p-dioxin [POM]		c	0.000001	1 2 4
57653857	1,2,3,6,7,8-Hexachlorodibenzo-p-dioxin [POM]		c	0.000001	1 2
19408743	1,2,3,7,8,9-Hexachlorodibenzo-p-dioxin [POM]		c	0.000001	1 2
35822469	1,2,3,4,6,7,8-Heptachlorodibenzo-p-dioxin [POM]		c	0.000001	1 2
3268879	1,2,3,4,5,6,7,8-Octachlorodibenzo-p-dioxin [POM]	07/96	c	0.000001	1 2
41903575	Total Tetrachlorodibenzo-p-dioxin [POM]	07/96	c	0.000001	1 2
36088229	Total Pentachlorodibenzo-p-dioxin [POM]	07/96	c	0.000001	1 2
34465468	Total Hexachlorodibenzo-p-dioxin [POM]	07/96	c	0.000001	1 2
37871004	Total Heptachlorodibenzo-p-dioxin [POM]	07/96	c	0.000001	1 2

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Emittent ID Other (Note [1]) Notes(s)	Substance Name (Note [2])	Add Date (Note [3])	Carcinogen (Note [4])	Applicable Degree of Accuracy (lb/yr) (Note [5])	Source List(s) (Note [6])
- -	Polychlorinated dibenzofurans {PCDFs or Dibenzofurans} [POM] including but not limited to:		c		1 2
1080	Dibenzofurans (Polychlorinated dibenzofurans) {PCDFs} [POM]		c	0.00002	1 2
51207319	2,3,7,8-Tetrachlorodibenzofuran [POM]		c	0.000001	1 2
57117416	1,2,3,7,8-Pentachlorodibenzofuran [POM]		c	0.000001	1 2
57117314	2,3,4,7,8-Pentachlorodibenzofuran [POM]		c	0.000001	1 2
70648269	1,2,3,4,7,8-Hexachlorodibenzofuran [POM]		c	0.000001	1 2
57117449	1,2,3,6,7,8-Hexachlorodibenzofuran [POM]		c	0.000001	1 2
72918219	1,2,3,7,8,9-Hexachlorodibenzofuran [POM]		c	0.000001	1 2
60851345	2,3,4,6,7,8-Hexachlorodibenzofuran [POM]		c	0.000001	1 2
67562394	1,2,3,4,6,7,8-Heptachlorodibenzofuran [POM]		c	0.000001	1 2
55673897	1,2,3,4,7,8,9-Heptachlorodibenzofuran [POM]		c	0.000001	1 2
39001020	1,2,3,4,5,6,7,8-Octachlorodibenzofuran [POM]	07/96	c	0.000001	1 2
55722275	Total Tetrachlorodibenzofuran [POM]	07/96	c	0.000001	1 2
30402154	Total Pentachlorodibenzofuran [POM]	07/96	c	0.000001	1 2
55684941	Total Hexachlorodibenzofuran [POM]	07/96	c	0.000001	1 2
38998753	Total Heptachlorodibenzofuran [POM]	07/96	c	0.000001	1 2
#	POM (Polycyclic organic matter)	09/89			1 2
[15]	(including but not limited to those substances listed in Appendix A with the bracketed designation of [POM], [PAH, POM], or [PAH-Derivative, POM])				
1120714	1,3-Propane sultone		c	0.05	1 2 3 4 5
57578	beta-Propiolactone		c	10.	1 2 3 4 5
123386	Propionaldehyde	06/91		200.	1 2
114261	Propoxur {Baygon}	06/91		100.	1 2
115071	Propylene			200.	1 2
75569	Propylene oxide		c	10.	1 2 3 4 5
-	1,2-Propyleneimine (see 2-Methylaziridine)				
110861	Pyridine	06/91		100.	7
91225	Quinoline	06/91		100.	1 2
106514	Quinone	06/91		100.	1 2
1165	Radionuclides		c	100.	1 2 4
[16]	including but not limited to:				
24267569	Iodine-131	09/89	c	100.	1 2 4
1166	Radon and its decay products	09/89	c	100.	1 4

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50555	Reserpine [POM]		c	100.	1	2	4	5
#	Residual (heavy) fuel oils	06/91	c					
7782492	Selenium			0.5		2		
*	Selenium compounds			0.5	1	2		
[7]								
	including but not limited to:							
7446346	Selenium sulfide	09/90	c	0.1		2	4	5
[7]								
1175	Silica, crystalline		c	0.1	1		3	4
7440224	Silver	06/91		2.				7
*	Silver compounds	06/91		2.	1			
[7]								

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Substances For Which Emissions Must Be Quantified

Emittent ID Other (Note [1]) Notes(s)	Substance Name (Note [2])	Add Date (Note [3])	Carcinogen (Note [4])	Applicable Degree of Accuracy (lb/yr) (Note [5])	Source List(s) (Note [6])
1310732	Sodium hydroxide			2.	1 2
100425	Styrene		c	100.	1 2 3 6
96093	Styrene oxide		c	100.	1 2 3 4
7664939	Sulfuric acid	06/91		2.	1
100210	Terephthalic acid	06/91		100.	1
79345	1,1,2,2-Tetrachloroethane	09/90	c	1.	1 2 4
7440280	Thallium	06/91		100.	7
*	Thallium compounds	06/91		100.	7
[7]					
62555	Thioacetamide		c	0.01	3 4 5
62566	Thiourea		c	0.1	1 3 4 5
7550450	Titanium tetrachloride	06/91		100.	1 2
108883	Toluene			200.	1 2 4 6
-	2,4-Toluenediamine (see 2,4-Diaminotoluene)				
1204	Toluene diisocyanates including but not limited to:	06/91	c	0.1	1 3
584849	Toluene-2,4-diisocyanate		c	0.1	1 2 3 5
91087	Toluene-2,6-diisocyanate		c	0.1	1 2 3 5
95534	o-Toluidine		c	10.	1 2 3 4 5
8001352	Toxaphene {Polychlorinated camphenes}		c	100.	1 2 3 4 5
79005	1,1,2-Trichloroethane {Vinyl trichloride}	06/91	c	50.	1 2 4
-	1,1,1-Trichloroethane (see Methyl chloroform)				
79016	Trichloroethylene		c	20.	1 2 4
-	2,4,6-Trichlorophenol (see Chlorophenols)				
96184	1,2,3-Trichloropropane	07/96	c	200.	3 4 7
121448	Triethylamine	06/91		20.	1 2
1582098	Trifluralin	06/91		100.	1 2
95636	1,2,4-Trimethylbenzene	06/91		5.	1
540841	2,2,4-Trimethylpentane	06/91		100.	1 2
51796	Urethane {Ethyl carbamate}		c	0.1	1 2 3 4 5
7440622	Vanadium (fume or dust)	06/91		10.	7
[17]					
108054	Vinyl acetate	06/91		200.	1 2
593602	Vinyl bromide		c	20.	1 2 3 4
75014	Vinyl chloride		c	0.5	1 2 3 4 5
100403	4-Vinylcyclohexene	07/96	c	5.	3
75025	Vinyl fluoride	07/96	c	200.	3
75354	Vinylidene chloride			20.	1 2
1206	Wood preservatives (containing arsenic and chromate)	09/89		100.	6

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1210	Xylenes (mixed xylenes)		200.	1 2	6
	including:				
108383	m-Xylene	06/91	200.	1 2	
95476	o-Xylene	06/91	200.	1 2	
106423	p-Xylene	06/91	200.	1 2	
7440666	Zinc		2.	2	
*	Zinc compounds	09/89	2.	1 2	
[7]					
	including but not limited to:				
1314132	Zinc oxide		2.	2	
[7]					

Appendix A-II

Substances For Which Production, Use, Or Other Presence Must Be Reported

July 1, 1997

APPENDIX A-II
Substances For Which Production, Use, Or Other Presence Must Be Reported

Emittent ID (Note [1])	Substance Name (Note [2])	Add Date (Note [3])	Carcinogen (Note [4])	Source List(s) (Note [6])	Other Notes(s)
26148685	A-alpha-C {2-Amino-9H-pyrido[2,3-b]indole}	09/89	c	3 4	[18]
34256821	Acetochlor	09/89	c	4	
62476599	Acifluorfen [POM]	09/90	c	1 2 4	
3688537	AF-2		c	3 4	
1000	Aflatoxins		c	3 4 5	
15972608	Alachlor	09/89	c	4	
309002	Aldrin	09/89	c	4	
107186	Allyl alcohol	06/91			7
60093	p-Aminoazobenzene {4-Aminoazobenzene} [POM]		c	1 2 3 4	
97563	o-Aminoazotoluene [POM]		c	1 2 3 4 5	
6109973	3-Amino-9-ethylcarbazole hydrochloride [POM]	09/89	c	1 2 4 5	
125848	Aminoglutethimide	09/90		4	
82280	1-Amino-2-methylantraquinone [PAH-Derivative, POM]		c	1 2 4 5	
68006837	2-Amino-3-methyl-9H-pyrido(2,3-b) indole {MeA- alpha-C}	09/89	c	3 4	
712685	2-Amino-5-(5-nitro-2-furyl)-1,3,4-thiadiazole		c	3 4	
-	2-Amino-9H-pyrido(2,3-b)indole (see A-alpha-C)				
134292	o-Anisidine hydrochloride		c	4 5	
104949	p-Anisidine	06/91			7
140578	Aramite		c	3 4	
492808	Auramine [POM]		c	1 2 3 4 5	
446866	Azathioprine		c	3 4 5	
103333	Azobenzene [POM]	09/90	c	1 2 4	
98873	Benzal chloride	06/91			7
55210	Benzamide	06/91			7
1694093	Benzyl violet 4B [POM]		c	1 2 3 4	
1025	Betel quid with tobacco		c	3 4	
494031	N-N-Bis(2-chloroethyl)-2-naphthylamine {Chlornaphazine} [PAH-Derivative, POM]		c	1 2 3 4 5	
108601	Bis(2-chloro-1-methylethyl) ether	06/91			7
1030	Bitumens, extracts of steam-refined and air- refined bitumens		c	3 4	
1035	Bleomycins		c	3	
75274	Bromodichloromethane	09/90	c	4	
1689845	Bromoxynil	06/91		4	
25013165	Butylated hydroxyanisole {BHA}		c	3 4	
123728	Butyraldehyde	06/91			7
3068880	beta-Butyrolactone		c	3 4	
630080	Carbon monoxide	09/89		4	
143500	Chlordecone {Kepone}		c	3 4	
6164983	Chlordimeform	09/89	c	4	
115286	Chlorendic acid	09/89	c	3 4 5	
124481	Chlorodibromomethane	09/90	c	4	

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563473	3-Chloro-2-methylpropene	09/89	c	4 5
1065	Chlorophenoxy herbicides		c	3
1897456	Chlorothalonil	09/89	c	4
1059	p-Chloro-o-toluidine (strong acid salts)	06/91	c	3

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Emittent ID (Note [1])	Substance Name (Note [2])	Add Date (Note [3])	Carcinogen (Note [4])	Source List(s) (Note [6])	Other Notes(s)
4680788	C. I. Acid Green 3 [POM]	06/91		1 2 7	
569642	C. I. Basic Green 4 [POM]	06/91		1 2 7	
989388	C. I. Basic Red 1 [POM]	06/91		1 2 7	
569619	C. I. Basic Red 9 monohydrochloride [POM]	09/89	c	1 2 4 5	
2832408	C. I. Disperse Yellow 3 [POM] (NOTE: "C. I." means "color index")	06/91		1 2 7	
87296	Cinnamyl anthranilate [POM]	09/89	c	1 2 4 5	
6358538	Citrus Red No. 2 [POM]		c	1 2 3 4	
8007452	Coal tars	09/89	c	3 4 5	
21725462	Cyanazine	09/90		4	
14901087	Cycasin		c	3 4	
13121705	Cyhexatin	09/89		4	
3468631	D and C Orange No. 17 [PAH-Derivative, POM]	09/90	c	1 2 4	
81889	D and C Red No. 19 [POM]	09/90	c	1 2 4	
2092560	D and C Red No. 8 [PAH-Derivative, POM]	06/91	c	1 2 4	
5160021	D and C Red No. 9 [PAH-Derivative, POM]	09/90	c	1 2 4	
1596845	Daminozide	09/90	c	4	
50293	DDT {1,1,1-Trichloro-2,2-bis(p-chlorophenyl)ethane} [POM]		c	1 2 3 4 5	
613354	N,N'-Diacetylbenzidine [POM]		c	1 2 3 4	
2303164	Diallate	06/91			7
39156417	2,4-Diaminoanisole sulfate		c	4 5	
101804	4,4'-Diaminodiphenyl ether [POM]		c	1 2 3 4 5	
764410	1,4-Dichloro-2-butene	09/90	c	4	
28434868	3,3'-Dichloro-4,4'-diaminodiphenyl ether [POM]	09/89	c	1 2 3 4	
72548	Dichlorodiphenyldichloroethane {DDD} [POM]	09/89	c	1 2 4	
540590	1,2-Dichloroethylene	06/91			7
78886	2,3-Dichloropropene	06/91			7
60571	Dieldrin	09/89	c	4	
1464535	Diepoxybutane		c	3 4 5	
1615801	1,2-Diethylhydrazine		c	3 4	
84662	Diethyl phthalate	06/91			7
101906	Diglycidyl resorcinol ether {DGRE}		c	3 4 5	
94586	Dihydrosafrole		c	3 4	
20325400	3,3'-Dimethoxybenzidine dihydrochloride [POM]	06/91	c	1 2 4	
55738540	trans-2-[(Dimethylamino)methylimino]-5-[2-(5-nitro-2-furyl)vinyl]-1,3,4-oxadiazol		c	3 4	
540738	1,2-Dimethylhydrazine		c	3 4	
105679	2,4-Dimethylphenol {2,4-Xylenol}	06/91			7
513371	Dimethylvinylchloride {DMVC}	09/89	c	4 5	
25154545	Dinitrobenzenes (mixtures of) including:	09/90		4	7
99650	m-Dinitrobenzene	06/91			7
528290	o-Dinitrobenzene	06/91			7

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100254	p-Dinitrobenzene	06/91		7
39300453	Dinocap	09/90	4	
88857	Dinoseb	09/89	4	
117840	n-Dioctyl phthalate	06/91		7

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2475458	Disperse Blue 1 [PAH-Derivative, POM]	06/91	c	1 2 3 4	
541413	Ethyl chloroformate	06/91			7
62500	Ethyl methanesulfonate		c	3 4	
2164172	Fluometuron	06/91			7
133073	Folpet	09/89	c	4	
3570750	2-(2-Formylhydrazino)-4-(5-nitro-2-furyl)thiazole		c	3 4	
60568050	Furmecyclo	09/90	c	4	
67730114	Glu-P-1 {2-Amino-6-methyldipyrido[1,2-a:3',2'-d]imidazole}		c	3 4	
67730103	Glu-P-2 {2-Aminodipyrido[1,2-a:3',2'-d]imidazole}		c	3 4	
765344	Glycidaldehyde		c	3 4	
556525	Glycidol	09/90	c	4	
16568028	Gyromitrin {Acetaldehyde methylformylhydrazone}		c	4	
2784943	HC Blue 1	09/89	c	4 5	
1024573	Heptachlor epoxide	09/89	c	4	
1335871	Hexachloronaphthalene [PAH-Derivative, POM]	06/91		1 2	7
10034932	Hydrazine sulfate		c	4 5	
76180966	IQ {2-Amino-3-methylimidazo[4,5-f]quinoline}		c	3 4	
78842	Isobutyraldehyde	06/91			7
120581	Isosafrole	09/90	c	4	
4759482	Isotretinoin			4	
77501634	Lactofen [POM]	09/89	c	1 2 4	
1131	Lubricant base oils and derived products, specifically vacuum distillates, acid treated oils, aromatic oils, mildly solvent-refined oils, mildly hydrotreated-oils and used engine oils.	09/89	c	3 4 5	
8018017	Mancozeb	09/90	c	4	
12427382	Maneb	09/90	c	4	
59052	Methotrexate	09/89		4	
96333	Methyl acrylate	06/91			7
590965	Methylazoxymethanol	09/90	c	4	
592621	Methylazoxymethanol acetate	09/89	c	3 4	
101611	4,4'-Methylene bis (N,N-dimethyl) benzenamine [POM]		c	1 2 4 5	
838880	4,4'-Methylene bis(2-methylaniline) [POM]	09/89	c	1 2 3 4	
74953	Methylene bromide	06/91			7
66273	Methyl methanesulfonate		c	3 4	
129157	2-Methyl-1-nitroanthraquinone (uncertain purity) [PAH-Derivative, POM]		c	1 2 3 4	
70257	N-Methyl-N'-nitro-N-nitrosoguanidine		c	3 4	
-	N-Methyl-N-nitrosourethane (see N-Nitroso-N- methylurethane)				
924425	N-Methyloacrylamide	09/90	c	4	

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9006422	Metiram	09/90		4
1140	Mineral oils (untreated and mildly treated oils; and those used in occupations such as mulespinning, metal machining, and jute processing).	c	3	4 5

APPENDIX A-II
Substances For Which Production, Use, Or Other Presence Must Be Reported

Emittent ID (Note [1])	Substance Name (Note [2])	Add Date (Note [3])	Carcinogen (Note [4])	Source List(s) (Note [6])	Other Notes(s)
2385855	Mirex		c	3 4 5	
315220	Monocrotaline		c	3 4	
505602	Mustard gas {Sulfur mustard}		c	3 4 5	
134327	1-Naphthylamine [PAH-Derivative, POM]	09/90	c	1 2 4	
91598	2-Naphthylamine [PAH-Derivative, POM]		c	1 2 3 4 5	
54115	Nicotine	09/90		4	
1148	Nitrilotriacetic acid (salts) including but not limited to:	06/91	c	3	
18662538	Nitrilotriacetic acid, trisodium salt monohydrate	06/91	c	4	
602879	5-Nitroacenaphthene [PAH-Derivative, POM]		c	1 2 3 4	
99592	5-Nitro-o-anisidine		c	4 5	
1836755	Nitrofen (technical grade)		c	3 4 5	
51752	Nitrogen mustard {Mechlorethamine}		c	3 4 5	
55867	Nitrogen mustard hydrochloride	09/89	c	4 5	
55630	Nitroglycerin	06/91			7
88755	2-Nitrophenol	06/91			7
57835924	4-Nitropyrene [PAH-Derivative, POM]	06/91	c	1 2 3 4	
86306	N-Nitrosodiphenylamine [POM]	09/89	c	1 2 4	
759739	N-Nitroso-N-ethylurea		c	4 5	
60153493	3-(N-Nitrosomethylamino)propionitrile	09/89	c	3 4	
64091914	4-(N-Nitrosomethylamino)-1-(3-pyridyl)-1-butanone {NNK}	09/89	c	3 4	
615532	N-Nitroso-N-methylurethane {N-Methyl-N-nitrosourethane}		c	3 4	
4549400	N-Nitrosomethylvinylamine		c	3 4 5	
16543558	N-Nitrosornicotine		c	3 4 5	
13256229	N-Nitrososarcosine		c	3 4 5	
303479	Ochratoxin A [POM]	09/90	c	1 2 4	
2234131	Octachloronaphthalene [PAH-Derivative, POM]	06/91		1 2	7
2646175	Oil Orange SS [PAH-Derivative, POM]		c	1 2 3 4	
20816120	Osmium tetroxide	06/91			7
794934	Panfuran S {Dihydroxymethylfuratrizine}		c	3 4	
122601	Phenyl glycidyl ether	09/90	c	3 4	
57410	Phenytoin [POM]		c	1 2 3 4 5	
88891	Picric acid	06/91			7
1155	Polybrominated biphenyls {PBBs} [POM]		c	1 2 3 4 5	
53973981	Polygeenan	09/89	c	4	
3761533	Ponceau MX [PAH-Derivative, POM]		c	1 2 3 4	
3564098	Ponceau 3R [PAH-Derivative, POM]		c	1 2 3 4	
36791045	Ribavirin	09/90		4	
94597	Safrole		c	3 4 5	
1180	Shale oils		c	3 4	
132274	Sodium o-phenylphenate [POM]		c	1 2 3 4	

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128449	Sodium saccharin	09/89	c	4
1185	Soots		c	3 4
10048132	Sterigmatocystin [POM]		c	1 2 3 4

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Substances For Which Production, Use, Or Other Presence Must Be Reported

Emittent ID (Note [1])	Substance Name (Note [2])	Add Date (Note [3])	Carcinogen (Note [4])	Source List(s) (Note [6])	Other Notes(s)
95067	Sulfallate		c	3 4 5	
5216251	p-alpha,alpha,alpha-Tetrachlorotoluene	09/90	c	4	
961115	Tetrachlorvinphos	06/91			7
509148	Tetranitromethane	09/90	c	4	
139651	4,4'-Thiodianiline [POM]		c	1 2 3 4	
1314201	Thorium dioxide		c	4 5	
1200	Tobacco products, smokeless		c	3 4	
1205	alpha-chlorinated Toluenes		c	3	
636215	o-Toluidine hydrochloride		c	4 5	
106490	p-Toluidine	09/90	c	4	
52686	Trichlorfon	06/91			7
68768	Tris(aziridinyl)-p-benzoquinone {Triaziquone}	09/90	c	4	
52244	Tris(1-aziridinyl) phosphine sulfide {Thiotepa}		c	3 4 5	
126727	Tris(2,3-dibromopropyl)phosphate	09/89	c	4	
62450060	Trp-P-1 {3-Amino-1,4-dimethyl-5H-pyrido[4,3-b]indole}		c	3 4	
62450071	Trp-P-2 {3-Amino-1-methyl-5H-pyrido[4,3-b]indole}		c	3 4	
72571	Trypan blue [PAH-Derivative, POM]		c	1 2 3 4	
106876	4-Vinyl-1-cyclohexene diepoxide {Vinyl cyclohexene dioxide}	09/90	c	4	
81812	Warfarin [POM]			1 2 4	
87627	2,6-Xylidene	06/91		4	
12122677	Zineb	09/90	c	4	

Appendix A-III

Substances Which Need Not Be Reported

Unless Manufactured By The Facility

July 1, 1997

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APPENDIX A-III
Substances Which Need Not Be Reported Unless Manufactured By the Facility

Emittent ID (Note [1])	Substance Name (Note [2])	Add Date (Note [3])	Carcinogen (Note [4])	Source List(s) (Note [6])	Other Notes(s)
546883	Acetohydroxamic acid	09/90		4	
50760	Actinomycin D	09/90	c	4	
23214928	Adriamycin [PAH-Derivative, POM]		c	1 2 3 4 5	
28981977	Alprazolam [POM]	09/90		1 2 4	
39831555	Amikacin sulfate	09/90		4	
54626	Aminopterin			4	
1005	Analgesic mixtures containing phenacetin		c	3 4 5	
1010	Androgenic (anabolic) steroids including but not limited to:		c	3 4	
58184	Methyltestosterone	09/90		4	
434071	Oxymetholone		c	4 5	
58220	Testosterone and its esters including but not limited to:	09/89		4	
315377	Testosterone enanthate	09/90		4	
50782	Aspirin	06/91		4	
115026	Azaserine		c	3 4	
5411223	Benzphetamine hydrochloride [POM]	09/90		1 2 4	
154938	Bischloroethyl nitrosourea		c	3 4	
55981	1,4-Butanediol dimethanesulfonate {Busulfen/ Myleran}		c	3 4 5	
41575944	Carboplatin	09/90		4	
474259	Chenodiol	09/90		4	
305033	Chlorambucil		c	3 4 5	
56757	Chloramphenicol		c	3 4	
1620219	Chlorcyclizine hydrochloride [POM]			1 2 4	
13010474	1-(2-Chloroethyl)-3-cyclohexyl-1-nitrosourea {CCNU}		c	3 4 5	
13909096	1-(2-Chloroethyl)-3-(4-methylcyclohexyl)-1- nitrosourea {Methyl CCNU}		c	3	
15663271	Cisplatin		c	3 4	
50419	Clomiphene citrate [POM]	09/90		1 2 4	
50180	Cyclophosphamide		c	3 4	
147944	Cytarabine	09/89		4	
4342034	Dacarbazine		c	3 4 5	
17230885	Danazol	09/90		4	
20830813	Daunomycin [PAH-Derivative, POM]		c	1 2 3 4	
23541506	Daunorubicin hydrochloride [PAH-Derivative, POM]	09/90		1 2 4	
84173	Dienestrol [POM]	09/90	c	1 2 4	
564250	Doxycycline	09/90		4	
379793	Ergotamine tartrate [POM]	09/90		1 2 4	
1095	Estrogens, non-steroidal including but not limited to:		c	3 5	
56531	Diethylstilbestrol [POM]		c	1 2 3 4 5	
1100	Estrogens, steroidal		c	3 5	

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including but not limited to:

1068	Conjugated estrogens	09/90	c	4
50282	Estradiol 17 beta		c	4 5
53167	Estrone		c	4 5

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Substances Which Need Not Be Reported Unless Manufactured By the Facility

Emittent ID (Note [1])	Substance Name (Note [2])	Add Date (Note [3])	Carcinogen (Note [4])	Source List(s) (Note [6])	Other Notes(s)
57636	Ethinyl estradiol		c	4 5	
72333	Mestranol		c	3 4 5	
33419420	Etoposide [POM]	09/90		2	
54350480	Etretinate			4	
51218	Fluorouracil	09/89		4	
76437	Fluoxymesterone	09/90		4	
13311847	Flutamide	09/90		4	
67458	Furazolidone	09/90	c	4	
126078	Griseofulvin		c	3 4	
23092173	Halazepam [POM]	09/90		1 2 4	
3778732	Ifosfamide	09/90		4	
9004664	Iron dextran complex		c	3 4 5	
303344	Lasiocarpine	09/89	c	3 4	
554132	Lithium carbonate	06/91		4	
919164	Lithium citrate	06/91		4	
846491	Lorazepam [POM]	09/90		1 2 4	
595335	Megestrol acetate	06/91		4	
148823	Melphalan		c	3 4 5	
9002680	Menotropins	09/90		4	
6112761	Mercaptopurine	09/90		4	
531760	Merphalan	09/89	c	4	
3963959	Methacycline hydrochloride	06/91		4	
60560	Methimazole	09/90		4	
15475566	Methotrexate sodium	09/90		4	
484208	5-Methoxypsoralen		c	3	
56042	Methylthiouracil		c	3 4	
443481	Metronidazole		c	3 4 5	
59467968	Midazolam hydrochloride [POM]	09/90		1 2 4	
62015398	Misoprostol	09/90		4	
50077	Mitomycin C		c	3 4	
70476823	Mitoxantrone hydrochloride [PAH-Derivative, POM]	09/90		1 2 4	
139913	5-(Morpholinomethyl)-3-[(5-nitrofurfurylidene)amino]-2-oxazolidinone		c	3 4	
86220420	Nafarelin acetate [PAH-Derivative, POM]	09/90		1 2 4	
3771195	Nafenopin [POM]		c	1 2 3 4	
1405103	Neomycin sulfate	09/90		4	
56391572	Netilmicin sulfate	09/90		4	
61574	Niridazole		c	3 4	
67209	Nitrofurantoin	06/91	c	4	
59870	Nitrofurazone	09/90	c	4	
555840	1-[(5-Nitrofurfurylidene)amino]-2-imidazolidinone		c	3 4	
531828	N-[4-(5-Nitro-2-furyl)-2-thiazolyl]acetamide		c	3 4	
6533002	Norgestrel	09/90		4	
79572	Oxytetracycline	06/91		4	

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115673	Paramethadione	09/90	4
52675	Penicillamine	06/91	4

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Substances Which Need Not Be Reported Unless Manufactured By the Facility

Emittent ID (Note [1])	Substance Name (Note [2])	Add Date (Note [3])	Carcinogen (Note [4])	Source List(s) (Note [6])	Other Notes(s)
57330	Pentobarbital sodium	09/90		4	
63989	Phenacetamide	09/90		4	
62442	Phenacetin		c	3 4 5	
94780	Phenazopyridine hydrochloride		c	3 4 5	
3546109	Phenesterin	09/89	c	4 5	
50066	Phenobarbital		c	3 4	
59961	Phenoxybenzamine [POM]	09/89	c	1 2 4	
63923	Phenoxybenzamine hydrochloride [POM]	09/90	c	1 2 3 4 5	
54911	Pipobroman	09/90		4	
18378897	Plicamycin [PAH-Derivative, POM]	09/90		1 2 4	
366701	Procarbazine hydrochloride		c	3 4 5	
57830	Progesterone		c	3 4 5	
1160	Progestins		c	3	
	including but not limited to:				
71589	Medroxyprogesterone acetate		c	3 4	
68224	Norethisterone		c	4 5	
51525	Propylthiouracil		c	3 4 5	
302794	all-trans-Retinoic acid	09/89		4	
1167	Retinol/retinyl esters	09/89	c	4	
81072	Saccharin		c	3 4 5	
3810740	Streptomycin sulfate	06/91		4	
18883664	Streptozotocin		c	3 4 5	
54965241	Tamoxifen citrate [POM]	09/90		1 2 4	
846504	Temazepam [POM]	09/90		1 2 4	
64755	Tetracycline hydrochloride	06/91		4	
50351	Thalidomide			4	
154427	Thioguanine	09/90		4	
49842071	Tobramycin sulfate	09/90		4	
299752	Treosulfan		c	3 4	
28911015	Triazolam [POM]	09/90		1 2 4	
13647353	Trilostane	09/90		4	
127480	Trimethadione	06/91		4	
66751	Uracil mustard		c	3 4	
26995915	Urofollitropin	09/90		4	
99661	Valproate			4	
143679	Vinblastine sulfate [POM]	09/90		1 2 4	
2068782	Vincristine sulfate [POM]	09/90		1 2 4	

NOTES TO APPENDIX A

Note	Text of Note

[1]	Emittent ID (the emittent identification number) is the Chemical Abstract Service (CAS) number where available, or an ARB-assigned 4-digit emittent ID code. A dash ("-") is shown for the Emittent ID for substances which are alphabetized under a group header or synonym elsewhere on the list. Refer to the cross reference indicated in parenthesis, "()". A double dash ("- -") is shown for the Emittent ID to indicate that the entry is a non-reportable group header for the substances immediately following it. An asterisk ("*") is shown for the Emittent ID to indicate that the emissions of unspecified metal compounds shall be reported as the metal atom equivalent. See Note [7]. A pound sign ("#") is shown for the Emittent ID to indicate that the individual, component listed substances must be reported for this mixture or group.
[2]	Individual substances listed under a group heading must be reported individually. Other, unspecified substances in the group must be summed and reported using the emittent ID of the group heading. The square bracket designation, "[]", indicates that the substance is a component of the chemical group heading(s) within the brackets. The braces designation, "{ }", indicates a synonym for the substance listed.
[3]	The date the Board approved addition of the substance to the original list. The original list was approved by the Board in July 1988.
[4]	The letter "c" indicates that for purposes of this section the substance shall be treated as a human carcinogen or potential human carcinogen.
[5]	Applicable degree of accuracy (in lbs/year except where noted). Radionuclides must be reported in Curie units, and the accuracy must be considered accordingly. Refer to Section VII.E. and Appendix B.

Note Text of Note

- [6] Substances are required to be included on the Hot Spots list based on the following lists cited in Health & Safety Code Section 44321:

1 = California Air Resources Board (44321(c));	2 = Environmental Protection Agency (44321(e));
3 = International Agency for Research on Cancer; (44321(a); Labor Code section 6382(b)(1))	4 = Governor's List of Carcinogens and Reproductive Toxicants; (44321(b); HSC Section 25249.8)
5 = National Toxicology Program (44321(a));	6 = Hazard Evaluation System and Information Service (44321(d))
7 = Added pursuant to HSC Section 44321 (f).	

- [7] Emissions of unspecified metal compounds shall be reported as the amount of the metal atom equivalent, using the metal emittent identification number for the metal itself (or the emittent identification number indicated on the table, such as for reporting inorganic versus other-than-inorganic arsenic compounds).

For unspecified metal compounds which contain two or more listed metals (e.g., zinc chromate), each component metal shall be reported as the amount of the appropriate metal atom equivalent (i.e., the zinc portion of the weight as zinc equivalent and the chromate portion as hexavalent chromium equivalent).

For specific, individually listed metal compounds (e.g., Lead chromate), emissions shall be reported for the compound (as pounds of whole compound), using the emittent identification number for that compound.

- [8] Compounds of the form "X-CN", where formal dissociation can occur. Report as the amount of Cyanide equivalent in the compound using an emittent identification code of 1073.

- [9] Emissions of these mixtures shall be reported as emissions of total particulate matter and total organic gas, using the following emittent identification numbers:

9901 Diesel exhaust, particulate matter	9910 Gasoline exhaust, particulate matter
9902 Diesel exhaust, total organic gas	9911 Gasoline exhaust, total organic gas

Individually listed substances from diesel and gasoline exhaust must also be reported.

[10]	The emittent identification number 1105 has been discontinued for all facilities reporting for the first time and for all updates. Use the listed replacement emittent identification codes 1103 and 1104.
[11]	Emissions of the individual, component listed substances must be reported in addition to the total gasoline vapors emissions.
[12]	These lead compounds are listed here so that the inorganic lead fraction will be quantified and reported if these individual compounds cannot be quantified.
[13]	PAH: (Polycyclic Aromatic Hydrocarbon) - An organic compound consisting of a fused ring structure containing at least two (2) benzene rings, and which may also contain additional fused rings not restricted exclusively to hexagonal rings. The structure does not include any heteroatoms or substituent groups. The structure includes only carbon and hydrogen. PAHs are a subgroup of POM and have a boiling point of greater than or equal to 100 C.
[14]	PAH-DERIVATIVE: (Polycyclic Aromatic Hydrocarbon Derivative) - An organic compound consisting of a fused ring structure containing at least two (2) benzene rings, and which may also contain additional fused rings not restricted exclusively to hexagonal rings. The fused ring structure does not contain heteroatoms. The structure does contain one or more substituent groups. PAH-Derivatives are a subgroup of POM and have a boiling point of greater than or equal to 100 C.
[15]	POM: (Polycyclic Organic Matter) - Includes organic compounds with more than one benzene ring, and which have a boiling point of greater than or equal to 100 C.
[16]	Radionuclides and other radioactive substances shall be reported in units of Curies per year (for annual average emissions) and in units of milliCuries per hour (for maximum hourly emissions).
[17]	Emissions of Vanadium (fume or dust) shall be reported as the amount of the vanadium atom equivalent, using the identification number 7440622.
[18]	The emittent identification number 1001 has been replaced with the CAS number 26148685.

Appendix B

Health And Safety Code Related to the

Air Toxics Hot Spots Program

Appendix B

Health And Safety Code Related To The Air Toxics Hot Spots Program¹

PART 6. AIR TOXICS "HOT SPOTS" INFORMATION AND ASSESSMENT
(Part 6 added by Stats. 1987, Ch. 1252, Sec. 1. Operative July 1, 1988, pursuant to Section 44384. Note: Sections 44380 and 44384 became operative Jan. 1, 1988.)

CHAPTER 1. LEGISLATIVE FINDINGS AND DEFINITIONS
(Chapter 1 added by Stats. 1987, Ch. 1252, Sec. 1. Operative July 1, 1988, pursuant to Section 44384.)

44300. This part shall be known and may be cited as the Air Toxics "Hot Spots" Information and Assessment Act of 1987. (Added by Stats. 1987, Ch. 1252, Sec. 1. Operative July 1, 1988, pursuant to Section 44384.)

44301. The Legislature finds and declares all of the following:

- (a) In the wake of recent publicity surrounding planned and unplanned releases of toxic chemicals into the atmosphere, the public has become increasingly concerned about toxics in the air.
- (b) The Congressional Research Service of the Library of Congress has concluded that 75 percent of the United States population lives in proximity to at least one facility that manufactures chemicals. An incomplete 1985 survey of large chemical companies conducted by the Congressional Research Service documented that nearly every chemical plant studied routinely releases into the surrounding air significant levels of substances proven to be or potentially hazardous to public health.
- (c) Generalized emissions inventories compiled by air pollution control districts and air quality management districts in California confirm the findings of the Congressional Research Service survey as well as reveal that many other facilities and businesses which do not actually manufacture chemicals do use hazardous substances in sufficient quantities to expose, or in a manner that exposes, surrounding populations to toxic air releases.
- (d) These releases may create localized concentrations or air toxics "hot spots" where emissions from specific sources may expose individuals and population groups to elevated risks of adverse health effects, including, but not limited to, cancer and contribute to the cumulative health risks of emissions from other sources in the area. In some cases where large populations may not be significantly affected by adverse health risks, individuals may be exposed to significant risks.

¹ AB564 Passed in the 1996 legislative session. The text will be added when the code is revised.

- (e) Little data is currently available to accurately assess the amounts, types, and health impacts of routine toxic chemical releases into the air. As a result, there exists significant uncertainty about the amounts of potentially hazardous air pollutants which are released, the location of those releases, and the concentrations to which the public is exposed.
- (f) The State of California has begun to implement a long-term program to identify, assess, and control ambient levels of hazardous air pollutants, but additional legislation is needed to provide for the collection and evaluation of information concerning the amounts, exposures, and short- and long-term health effects of hazardous substances regularly released to the surrounding atmosphere from specific sources of hazardous releases.
- (g) In order to more effectively implement control strategies for those materials posing an unacceptable risk to the public health, additional information on the sources of potentially hazardous air pollutants is necessary.
- (h) It is in the public interest to ascertain and measure the amounts and types of hazardous releases and potentially hazardous releases from specific sources that may be exposing people to those releases, and to assess the health risks to those who are exposed. (Added by Stats. 1987, Ch. 1252, Sec. 1. Operative July 1, 1988, pursuant to Section 44384.)

44302. The definitions set forth in this chapter govern the construction of this part. (Added by Stats. 1987, Ch. 1252, Sec. 1. Operative July 1, 1988, pursuant to Section 44384.)

44303. "Air release" or "release" means any activity that may cause the issuance of air contaminants, including the actual or potential spilling, leaking, pumping, pouring, emitting, emptying, discharging, injecting, escaping, leaching, dumping, or disposing of a substance into the ambient air and that results from the routine operation of a facility or that is predictable, including, but not limited to, continuous and intermittent releases and predictable process upsets or leaks. (Added by Stats. 1987, Ch. 1252, Sec. 1. Operative July 1, 1988, pursuant to Section 44384.)

44304. "Facility" means every structure, appurtenance, installation, and improvement on land which is associated with a source of air releases or potential air releases of a hazardous material. (Added by Stats. 1987, Ch. 1252, Sec. 1. Operative July 1, 1988, pursuant to Section 44384.)

44306. "Health risk assessment" means a detailed comprehensive analysis prepared pursuant to Section 44361 to evaluate and predict the dispersion of hazardous substances in the environment and the potential for exposure of human populations and to assess and quantify both the individual and population wide health risks associated with those levels of exposure. (Added by Stats. 1987, Ch. 1252, Sec. 1. Operative July 1, 1988, pursuant to Section 44384.)

44307. "Operator" means the person who owns or operates a facility or part of a facility. (Added by Stats. 1987, Ch. 1252, Sec. 1. Operative July 1, 1988, pursuant to Section 44384.)

44308. "Plan" means the emissions inventory plan which meets the conditions specified in Section 44342. (Added by Stats. 1987, Ch. 1252, Sec. 1. Operative July 1, 1988, pursuant to Section 44384.)

44309. "Report" means the emissions inventory report specified in Section 44341. (Added by Stats. 1987, Ch. 1252, Sec. 1. Operative July 1, 1988, pursuant to Section 44384.)

CHAPTER 2. FACILITIES SUBJECT TO THIS PART
(Chapter 2 added by Stats. 1987, Ch. 1252, Sec. 1. Operative July 1, 1988,
pursuant to Section 44384.)

44320. This part applies to the following:

- (a) Any facility which manufactures, formulates, uses, or releases any of the substances listed pursuant to Section 44321 or any other substance which reacts to form a substance listed in Section 44321 and which releases or has the potential to release total organic gases, particulates, or oxides of nitrogen or sulfur in the amounts specified in Section 44322.
- (b) Except as provided in Section 44323, any facility which is listed in any current toxics use or toxics air emission survey, inventory, or report released or compiled by a district. A district may, with the concurrence of the state board, waive the application of this part pursuant to this subdivision for any facility which the district determines will not release any substance listed pursuant to Section 44321 due to a shutdown or a process change. (Amended by Stats. 1989, Ch. 1254, Sec. 7). References at the time of publication (see page iii): Regulations: 17, CCR, sections 90700-90703, 90704, 93303, 93306

44321. For the purposes of Section 44320, the state board shall compile and maintain a list of substances that contains, but is not limited to, all of the following:

- (a) Substances identified by reference in paragraph (1) of subdivision (b) of Section 6382 of the Labor Code and substances placed on the list prepared by the National Toxicology Program issued by the United States Secretary of Health and Human Services pursuant to paragraph (4) of Section 262 of Public Law 95-622 of 1978. For the purposes of this subdivision, the state board may remove from the list any substance which meets both of the following criteria:
 - (1) No evidence exists that it has been detected in air.
 - (2) The substance is not manufactured or used in California, or, if manufactured or used in California, because of the physical or chemical characteristics of the substance or the manner in which it is manufactured or used, there is no possibility that it will become airborne.
- (b) Carcinogens and reproductive toxins referenced in or compiled pursuant to Section 25249.8, except those which meet both of the criteria identified in subdivision (a).
- (c) The candidate list of potential toxic air contaminants and the list of designated toxic air contaminants prepared by the state board pursuant to Article 2 (commencing with Section 39660) of Chapter 3.5 of Part 2, including, but not limited to, all substances currently under review and scheduled or nominated for review and substances identified and listed for which health effects information is limited.

- (d) Substances for which an information or hazard alert has been issued by the repository of current data established pursuant to Section 147.2 of the Labor Code.
- (e) Substances reviewed, under review, or scheduled for review as air toxics or potential air toxics by the Office of Air Quality Planning and Standards of the Environmental Protection Agency, including substances evaluated in all of the following categories or their equivalent: preliminary health and source screening, detailed assessment, intent to list, decision not to regulate, listed, standard proposed, and standard promulgated.
- (f) Any additional substances recognized by the state board as presenting a chronic or acute threat to public health when present in the ambient air, including, but not limited to, any neurotoxins or chronic respiratory toxins not included within subdivision (a), (b), (c), (d), or (e). (Added by Stats. 1987, Ch. 1252, Sec. 1. Operative July 1, 1988, pursuant to Section 44384.)

44322. This part applies to facilities specified in subdivision (a) of Section 44320 in accordance with the following schedule:

- (a) For those facilities that release, or have the potential to release, 25 tons per year or greater of total organic gases, particulates, or oxides of nitrogen or sulfur, this part becomes effective on July 1, 1988.
- (b) For those facilities that release, or have the potential to release, more than 10 but less than 25 tons per year of total organic gases, particulates, or oxides of nitrogen or sulfur, this part becomes effective July 1, 1989.
- (c) For those facilities that release, or have the potential to release, less than 10 tons per year of total organic gases, particulates, or oxides of nitrogen or sulfur, the state board shall, on or before July 1, 1990, prepare and submit a report to the Legislature identifying the classes of those facilities to be included in this part and specifying a timetable for their inclusion. (Amended by Stats. 1989, Ch. 1254, Sec. 8.)

44323. A district may prepare an industrywide emissions inventory and health risk assessment for facilities specified in subdivision (b) of Section 44320 and subdivisions (a) and (b) of Section 44322, and shall prepare an industrywide emissions inventory for the facilities specified in subdivision (c) of Section 44322, in compliance with this part for any class of facilities that the district finds and determines meets all of the following conditions:

- (a) All facilities in the class fall within one four-digit Standard Industrial Classification Code.
- (b) Individual compliance with this part would impose severe economic hardships on the majority of the facilities within the class.
- (c) The majority of the class is composed of small businesses.
- (d) Releases from individual facilities in the class can easily and generically be characterized and calculated. (Amended by Stats. 1989, Ch. 1254, Sec. 9.)

44324. This part does not apply to any facility where economic poisons are employed in their pesticidal use, unless that facility was subject to district permit requirements on or before August 1, 1987. As used in this section, "pesticidal use" does not include the manufacture or formulation of pesticides. (Added by Stats. 1981, Ch. 1252, Sec. 1. Operative July 1, 1988, pursuant to Section 44384.)

44325. Any solid waste disposal facility in compliance with Section 41805.5 is in compliance with the emissions inventory requirements of this part. (Added by Stats. 1987, Ch. 1252, Sec. 1. Operative July 1, 1988, pursuant to Section 44384.)

CHAPTER 3. AIR TOXICS EMISSION INVENTORIES
(Chapter 3 added by Stats. 1987, Ch. 1252, Sec. 1. Operative July 1, 1988,
pursuant to Section 44384.)

44340. (a) The operator of each facility subject to this part shall prepare and submit to the district a proposed comprehensive emissions inventory plan in accordance with the criteria and guidelines adopted by the state board pursuant to Section 44342.
- (b) The proposed plan shall be submitted to the district on or before August 1, 1989, except that, for any facility to which subdivision (b) of Section 44322 applies, the proposed plan shall be submitted to the district on or before August 1, 1990. The district shall approve, modify, and approve as modified, or return for revision and resubmission, the plan within 120 days of receipt.
- (c) The district shall not approve a plan unless all of the following conditions are met:
- (1) The plan meets the requirements established by the state board pursuant to Section 44342.
 - (2) The plan is designed to produce, from the list compiled and maintained pursuant to Section 44321, a comprehensive characterization of the full range of hazardous materials that are released, or that may be released, to the surrounding air from the facility. Air release data shall be collected at, or calculated for, the primary locations of actual and potential release for each hazardous material. Data shall be collected or calculated for all continuous, intermittent, and predictable air releases.
 - (3) The measurement technologies and estimation methods proposed provide state-of-the-art effectiveness and are sufficient to produce a true representation of the types and quantities of air releases from the facility.
 - (4) Source testing or other measurement techniques are employed wherever necessary to verify emission estimates, as determined by the state board and to the extent technologically feasible. All testing devices shall be appropriately located, as determined by the state board.
 - (5) Data are collected or calculated for the relevant exposure rate or rates of each hazardous material according to its characteristic toxicity and for the emission rate necessary to ensure a characterization of risk associated with exposure to releases of the hazardous material that meets the requirements of Section 44361. The source of all emissions shall be displayed or described. (Added by Stats. 1987, Ch. 1252, Sec. 1. Operative July 1, 1988, pursuant to Section 44384.)

44341. Within 180 days after approval of a plan by the district, the operator shall implement the plan and prepare and submit a report to the district in accordance with the plan. The district shall transmit all monitoring data contained in the approved report to the state board. (Added by Stats. 1987, Ch. 1252, Sec. 1. Operative July 1, 1988, pursuant to Section 44384.)

44342. The state board shall, on or before May 1, 1989, in consultation with the districts, develop criteria and guidelines for site-specific air toxics emissions inventory plans which shall be designed to comply with the conditions specified in Section 44340 and which shall include at least all of the following:

- (a) For each class of facility, a designation of the hazardous materials for which emissions are to be quantified and an identification of the likely source types within that class of facility. The hazardous materials for quantification shall be chosen from among, and may include all or part of, the list specified in Section 44321.
- (b) Requirements for a facility diagram identifying each actual or potential discrete emission point and the general locations where fugitive emissions may occur. The facility diagram shall include any nonpermitted and nonprocess sources of emissions and shall provide the necessary data to identify emission characteristics. An existing facility diagram which meets the requirements of this section may be submitted.
- (c) Requirements for source testing and measurement. The guidelines may specify appropriate uses of estimation techniques including, but not limited to, emissions factors, modeling, mass balance analysis, and projections, except that source testing shall be required wherever necessary to verify emission estimates to the extent technologically feasible. The guidelines shall specify conditions and locations where source testing, fence-line monitoring, or other measurement techniques are to be required and the frequency of that testing and measurement.
- (d) Appropriate testing methods, equipment, and procedures, including quality assurance criteria.
- (e) Specifications for acceptable emissions factors, including, but not limited to, those which are acceptable for substantially similar facilities or equipment, and specification of procedures for other estimation techniques and for the appropriate use of available data.
- (f) Specification of the reporting period required for each hazardous material for which emissions will be inventoried.
- (g) Specifications for the collection of useful data to identify toxic air contaminants pursuant to Article 2 (commencing with Section 39660) of Chapter 3.5 of Part 2.
- (h) Standardized format for preparation of reports and presentation of data.
- (i) A program to coordinate and eliminate any possible overlap between the requirements of this chapter and the requirements of Section 313 of the Superfund Amendment and Reauthorization Act of 1986 (Public Law 99-499). The state board shall design the guidelines and criteria to ensure that, in collecting data to be used for emissions inventories, actual measurement is utilized whenever necessary to verify the accuracy of emission estimates, to the extent technologically feasible. (Added by Stats. 1987, Ch. 1252, Sec. 1. Operative July 1, 1988, pursuant to Section 44384.)

44343. The district shall review the reports submitted pursuant to Section 44341 and shall, within 90 days, review each report, obtain corrections and clarifications of the data, and notify the Office of Environmental Health Hazard Assessment, the Department of Industrial Relations, and the city or county health department of its findings and determinations as a result of its review of the report. (Added by Stats. 1987, Ch. 1252, Sec. 1. Operative July 1, 1988, pursuant to Section 44384. Amended by Governor's Reorganization Plan No. 1 of 1991, §142.)

44344. Except as provided in Section 44391, emissions inventories developed pursuant to this chapter shall be updated every four years, in accordance with the procedures established by the state board. Those updates shall take into consideration improvements in measurement techniques and advancing knowledge concerning the types and toxicity of hazardous material released or potentially released. (Amended by Stats. 1993, Ch. 1041, Sec. 1. Effective January 1, 1994.)

44344.3.

- (a) A facility shall be granted an exemption by a district from further compliance with this part after meeting all of the following criteria:
 - (1) The facility was required to comply with this part only as a result of its particulate matter emissions.
 - (2) The facility has participated in, utilized data derived from, or is eligible to utilize data derived from, approved pooled source testing.
 - (3) The facility has submitted an emissions inventory plan and report that was subsequently accepted and approved.
 - (4) The facility has been designated by the district as a low priority facility under the guidelines set forth pursuant to this part for facility prioritization, and facility emissions do not present a significant health risk as specified in subdivision (b) of Section 44362.
 - (5) The facility handles, processes, stores, or distributes bulk agricultural commodities or handles, feeds, or rears livestock. (b) Subdivision (a) does not apply to a facility that, because of information provided pursuant to Section 44344.7, is reclassified as an intermediate or high priority facility by the district.
- (c) The operator of a facility that has been granted an exemption pursuant to this section shall biennially submit a statement to the district for the district's review, with a copy of the most recent emissions inventory for the facility, indicating that, except as to matters for which an emissions inventory update has been or will be submitted pursuant to Section 44344.7, there has been no significant change in facility operations or activities. The district shall not impose any fee upon the operator with regard to the submission of the statement. (Added by Stats. 1993, Ch. 1037, Sec. 1. Effective January 1, 1994.)

44344.5. The operator of any new facility that previously has not been subject to this part shall prepare and submit an emissions inventory plan and report. (Added by Stats. 1993, Ch. 1037, Sec. 2. Effective January 1, 1994.)

44344.7. The operator of a facility exempted pursuant to subdivision (a) of Section 44344.3 shall submit an emissions inventory update for those sources and substances for which a change in activities or operations has occurred, as follows:

- (a) The facility emits a newly listed substance.
- (b) A sensitive receptor has been established or constructed on or after January 1, 1994, within 500 meters of the facility.
- (c) The facility emits a substance for which the potency factor has increased.

- (d) The facility has begun emission of a listed substance not included in the previous emissions inventory. (Added by Stats. 1993, Ch. 1037, Sec. 3. Effective January 1, 1994.)
44345. (a) On or before July 1, 1989, the state board shall develop a program to compile and make available to other state and local public agencies and the public all data collected pursuant to this chapter.
- (b) In addition, the state board, on or before March 1, 1990, shall compile, by district, emissions inventory data for mobile sources and area sources not subject to district permit requirements, and data on natural source emissions, and shall incorporate these data into data compiled and released pursuant to this chapter. (Added by Stats. 1987, Ch. 1252, Sec. 1. Operative July 1, 1988, pursuant to Section 44384.)
44346. (a) If an operator believes that any information required in the facility diagram specified pursuant to subdivision (b) of Section 44342 involves the release of a trade secret, the operator shall nevertheless make the disclosure to the district, and shall notify the district in writing of that belief in the report.
- (b) Subject to this section, the district shall protect from disclosure any trade secret designated as such by the operator, if that trade secret is not a public record.
- (c) Upon receipt of a request for the release of information to the public which includes information which the operator has notified the district is a trade secret and which is not a public record, the following procedure applies:
- (1) The district shall notify the operator of the request in writing by certified mail, return receipt requested.
 - (2) The district shall release the information to the public, but not earlier than 30 days after the date of mailing the notice of the request for information, unless, prior to the expiration of the 30-day period, the operator obtains an action in an appropriate court for a declaratory judgment that the information is subject to protection under this section or for a preliminary injunction prohibiting disclosure of the information to the public and promptly notifies the district of that action.
- (d) This section does not permit an operator to refuse to disclose the information required pursuant to this part to the district.
- (e) Any information determined by a court to be a trade secret, and not a public record pursuant to this section, shall not be disclosed to anyone except an officer or employee of the district, the state, or the United States, in connection with the official duties of that officer or employee under any law for the protection of health, or to contractors with the district or the state and its employees if, in the opinion of the district or the state, disclosure is necessary and required for the satisfactory performance of a contract, for performance of work, or to protect the health and safety of the employees of the contractor.
- (f) Any officer or employee of the district or former officer or employee who, by virtue of that employment or official position, has possession of, or has access to, any trade secret subject to this section, and who, knowing that disclosure of the information to the general public is prohibited by this section, knowingly and willfully discloses the information in any manner to any person not entitled to receive it is guilty of a

misdemeanor. Any contractor of the district and any employee of the contractor, who has been furnished information as authorized by this section, shall be considered an employee of the district for purposes of this section.

- (g) Information certified by appropriate officials of the United States as necessary to be kept secret for national defense purposes shall be accorded the full protections against disclosure as specified by those officials or in accordance with the laws of the United States
- (h) As used in this section, "trade secret" and "public record" have the meanings and protections given to them by Section 6254.7 of the Government Code and Section 1060 of the Evidence Code. All information collected pursuant to this chapter, except for data used to calculate emissions data required in the facility diagram, shall be considered "air pollution emission data," for the purposes of this section. (Added by Stats. 1987, Ch. 1252, Sec. 1. Operative July 1, 1988, pursuant to Section 44384.)

CHAPTER 4. RISK ASSESSMENT

(Chapter 4 added by Stats. 1987, Ch. 1252, Sec. 1. Operative July 1, 1988, pursuant to Section 44384.)

44360. (a) Within 90 days of completion of the review of all emissions inventory data for facilities specified in subdivision (a) of Section 44322, but not later than December 1, 1990, the district shall, based on examination of the emissions inventory data and in consultation with the state board and the State Department of Health Services, prioritize and then categorize those facilities for the purposes of health risk assessment. The district shall designate high, intermediate, and low priority categories and shall include each facility within the appropriate category based on its individual priority. In establishing priorities pursuant to this section, the district shall consider the potency, toxicity, quantity, and volume of hazardous materials released from the facility, the proximity of the facility to potential receptors, including, but not limited to, hospitals, schools, day care centers, worksites, and residences, and any other factors that the district finds and determines may indicate that the facility may pose a significant risk to receptors. The district shall hold a public hearing prior to the final establishment of priorities and categories pursuant to this section.
- (b) (1) Within 150 days of the designation of priorities and categories pursuant to subdivision (a), the operator of every facility that has been included within the highest priority category shall prepare and submit to the district a health risk assessment pursuant to Section 44361. The district may, at its discretion, grant a 30-day extension for submittal of the health risk assessment.
 - (2) Health risk assessments required by this chapter shall be prepared in accordance with guidelines established by the Office of Environmental Health Hazard Assessment. The office shall prepare draft guidelines which shall be circulated to the public and the regulated community and shall adopt risk assessment guidelines after consulting with the state board and the Risk Assessment Committee of the California Air Pollution Control Officers Association and after conducting at least two public workshops, one in the northern and one in the southern part of the state. The adoption of the guidelines is not subject to

Chapter 3.5 (commencing with Section 11340) of Part 1 of Division 3 of Title 2 of the Government Code. The scientific review panel established pursuant to Section 39670 shall evaluate the guidelines adopted under this paragraph and shall recommend changes and additional criteria to reflect new scientific data or empirical studies.

- (3) The guidelines established pursuant to paragraph (2) shall impose only those requirements on facilities subject to this subdivision that are necessary to ensure that a required risk assessment is accurate and complete and shall specify the type of site-specific factors that districts may take into account in determining when a single health risk assessment may be allowed under subdivision (d). The guidelines shall, in addition, allow the operator of a facility, at the operator's option, and to the extent that valid and reliable data are available, to include for consideration by the district in the health risk assessment any or all of the following supplemental information:
 - (a) Information concerning the scientific basis for selecting risk parameter values that are different than those required by the guidelines and the likelihood distributions that result when alternative values are used.
 - (b) Data from dispersion models, microenvironment characteristics, and population distributions that may be used to estimate maximum actual exposure.
 - (c) Risk expressions that show the likelihood that any given risk estimate is the correct risk value.
 - (d) A description of the incremental reductions in risk that occur when exposure is reduced.
- (4) To ensure consistency in the use of the supplemental information authorized by subparagraphs (A), (B), (C), and (D) of paragraph (3), the guidelines established pursuant to paragraph (2) shall include guidance for use by the districts in considering the supplemental information when it is included in the health risk assessment. (c) Upon submission of emissions inventory data for facilities specified in subdivisions (b) and (c) of Section 44322, the district shall designate facilities for inclusion within the highest priority category, as appropriate, and any facility so designated shall be subject to subdivision (b). In addition, the district may require the operator of any facility to prepare and submit health risk assessments, in accordance with the priorities developed pursuant to subdivision (a).
- (e) The district shall, except where site specific factors may affect the results, allow the use of a single health risk assessment for two or more substantially identical facilities operated by the same person.
- (f) Nothing contained in this section, Section 44380.5, or Chapter 6 (commencing with Section 44390) shall be interpreted as requiring a facility operator to prepare a new or revised health risk assessment using the guidelines established pursuant to paragraph (2) of subdivision (a) of this section if the facility operator is required by the district to begin the preparation of a health risk assessment before those guidelines are established. (Amended by Stats. 1992, Ch. 1162, Sec. 1. Effective January 1, 1993.)

44361. (a) Each health risk assessment shall be submitted to the district. The district shall make the health risk assessment available for public review, upon request. After preliminary review of the emissions impact and modeling data, the district shall submit the health risk assessment to the Office of Environmental Health Hazard Assessment for review and, within 180 days of receiving the health risk assessment, the office shall submit to the district its comments on the data and findings relating to health effects. The district shall consult with the state board as necessary to adequately evaluate the emissions impact and modeling data contained within the risk assessment.
- (b) For the purposes of complying with this section, the Office of Environmental Health Hazard Assessment may select a qualified independent contractor to review the data and findings relating to health effects. The office shall not select an independent contractor to review a specific health risk assessment who may have a conflict of interest with regard to the review of that health risk assessment. Any review by an independent contractor shall comply with the following requirements:
- (1) Be performed in a manner consistent with guidelines provided by the office.
 - (2) Be reviewed by the office for accuracy and completeness.
 - (3) Be submitted by the office to the district in accordance with this section.
- (c) The district shall reimburse the Office of Environmental Health Hazard Assessment or the qualified independent contractor designated by the office pursuant to subdivision (b), within 45 days of its request, for its actual costs incurred in reviewing a health risk assessment pursuant to this section.
- (d) If a district requests the Office of Environmental Health Hazard Assessment to consult with the district concerning any requirement of this part, the district shall reimburse the office, within 45 days of its request, for the costs incurred in the consultation.
- (e) Upon designation of the high priority facilities, as specified in subdivision (a) of Section 44360, the Office of Environmental Health Hazard Assessment shall evaluate the staffing requirements of this section and may submit recommendations to the Legislature, as appropriate, concerning the maximum number of health risk assessments to be reviewed each year pursuant to this section. (Added by Stats. 1987, Ch. 1252, Sec. 1. Operative July 1, 1988, pursuant to Section

44384. Amended by Governor's Reorganization Plan No. 1 of 1991, §144.)

44362. (a) Taking the comments of the Office of Environmental Health Hazard Assessment into account, the district shall approve or return for revision and resubmission and then approve, the health risk assessment within 180 days of receipt. If the health risk assessment has not been revised and resubmitted within 60 days of the district's request of the operator to do so, the district may modify the health risk assessment and approve it as modified.
- (b) Upon approval of the health risk assessment, the operator of the facility shall provide notice to all exposed persons regarding the results of the health risk assessment prepared pursuant to Section 44361 if, in the judgment of the district, the health risk assessment indicates there is a significant health risk associated with emissions from the facility. If notice is required under this subdivision, the notice shall include only

information concerning significant health risks attributable to the specific facility for which the notice is required. Any notice shall be made in accordance with procedures specified by the district. (Added by Stats. 1981, Ch. 1252, Sec. 1. Operative July 1, 1988, pursuant to Section 44384. Amended by Governor's Reorganization Plan No. 1 of 1991, 145.)

44363. (a) Commencing July 1, 1991, each district shall prepare and publish an annual report which does all of the following:
- (1) Describes the priorities and categories designated pursuant to Section 44360 and summarizes the results and progress of the health risk assessment program undertaken pursuant to this part.
 - (2) Ranks and identifies facilities according to the degree of cancer risk posed both to individuals and to the exposed population.
 - (3) Identifies facilities which expose individuals or populations to any noncancer health risks.
 - (4) Describes the status of the development of control measures to reduce emissions of toxic air contaminants, if any.
- (b) The district shall disseminate the annual report to county boards of supervisors, city councils, and local health officers and the district board shall hold one or more public hearings to present the report and discuss its content and significance. (Added by Stats. 1987, Ch. 1252, Sec. 1. Operative July 1, 1988, pursuant to Section 44384.)
44364. The state board shall utilize the reports and assessments developed pursuant to this part for the purposes of identifying, establishing priorities for, and controlling toxic air contaminants pursuant to Chapter 3.5 (commencing with Section 39650) of Part 2. (Added by Stats. 1987, Ch. 1252, Sec. 1. Operative July 1, 1988, pursuant to Section 44384.)
44365. (a) If the state board finds and determines that a district's actions pursuant to this part do not meet the requirements of this part, the state board may exercise the authority of the district pursuant to this part to approve emissions inventory plans and require the preparation of health risk assessments.
- (b) This part does not prevent any district from establishing more stringent criteria and requirements than are specified in this part for approval of emissions inventories and requiring the preparation and submission of health risk assessments. Nothing in this part limits the authority of a district under any other provision of law to assess and regulate releases of hazardous substances. (Added by Stats. 1987, Ch. 1252, Sec. 1. Operative July 1, 1988, pursuant to Section 44384.)
44366. (a) In order to verify the accuracy of any information submitted by facilities pursuant to this part, a district or the state board may proceed in accordance with Section 41510. (Added by Stats. 1987, Ch. 1252, Sec. 1. Operative July 1, 1988, pursuant to Section 44384.)

CHAPTER 5. FEES AND REGULATIONS

(Chapter 5 added by Stats. 1987, Ch. 1252, Sec. 1. Operative July 1, 1988, pursuant to Section 44384.)

44380. (a) The state board shall adopt a regulation which does all of the following:
- (1) Sets forth the amount of revenue which the district must collect to recover the reasonable anticipated cost which will be incurred by the state board and the Office of Environmental Health Hazard Assessment to implement and administer this part.
 - (2) Requires each district to adopt a fee schedule which recovers the costs of the district and which assesses a fee upon the operator of every facility subject to this part. A district may request the state board to adopt a fee schedule for the district if the district's program costs are approved by the district board and transmitted to the state board by April 1 of the year in which the request is made.
 - (3) Requires any district that has an approved toxics emissions inventory compiled pursuant to this part by August 1 of the preceding year to adopt a fee schedule, as described in paragraph (2), which imposes on facility operators fees which are, to the maximum extent practicable, proportionate to the extent of the releases identified in the toxics emissions inventory and the level of priority assigned to that source by the district pursuant to Section 44360.
- (b) Commencing August 1, 1992, and annually thereafter, the state board shall review and may amend the fee regulation.
- (c) The district shall notify each person who is subject to the fee of the obligation to pay the fee. If a person fails to pay the fee within 60 days after receipt of this notice, the district, unless otherwise provided by district rules, shall require the person to pay an additional administrative civil penalty. The district shall fix the penalty at not more than 100 percent of the assessed fee, but in an amount sufficient in its determination, to pay the district's additional expenses incurred by the person's noncompliance. If a person fails to pay the fee within 120 days after receipt of this notice, the district may initiate permit revocation proceedings. If any permit is revoked, it shall be reinstated only upon full payment of the overdue fee plus any late penalty, and a reinstatement fee to cover administrative costs of reinstating the permit.
- (d) Each district shall collect the fees assessed pursuant to subdivision (a). After deducting the costs to the district to implement and administer this part, the district shall transmit the remainder to the Controller for deposit in the Air Toxics Inventory and Assessment Account, which is hereby created in the General Fund. The money in the account is available, upon appropriation by the Legislature, to the state board and the Office of Environmental Health Hazard Assessment for the purposes of administering this part. (Amended by Stats. 1992, Ch. 375, Sec. 1. Effective January 1, 1993.)

44380.1. A facility shall be granted an exemption by a district from paying a fee in accordance with Section 44380 if all of the following criteria are met:

- (a) The facility primarily handles, processes, stores, or distributes bulk agricultural commodities or handles, feeds, or rears livestock.
- (b) The facility was required to comply with this part only as a result of its particulate matter emissions.

- (c) The fee schedule adopted by the district or the state board for these types of facilities is not solely based on toxic emissions weighted for potency or toxicity. (Added by Stats. 1993, Ch. 1037, Sec. 4. Effective January 1, 1994.)

44380.5. In addition to the fee assessed pursuant to Section 44380, a supplemental fee may be assessed by the district, the state board, or the Office of Environmental Health Hazard Assessment upon the operator of a facility that, at the operator's option, includes supplemental information authorized by paragraph (3) of subdivision (b) of Section 44360 in a health risk assessment, if the review of that supplemental information substantially increases the costs of reviewing the health risk assessment by the district, the state board, or the office. The supplemental fee shall be set by the state board in the regulation required by subdivision (a) of Section 44380 and shall be set in an amount sufficient to cover the direct costs to review the information supplied by an operator pursuant to paragraph (3) of subdivision (b) of Section 44360. (Added by Stats. 1992, Ch. 1162, Sec. 2. Effective January 1, 1993.)

- 44381. (a) Any person who fails to submit any information, reports, or statements required by this part, or who fails to comply with this part or with any permit, rule, regulation, or requirement issued or adopted pursuant to this part, is subject to a civil penalty of not less than five hundred dollars (\$500) or more than ten thousand dollars (\$10,000) for each day that the information, report, or statement is not submitted, or that the violation continues.
- (b) Any person who knowingly submits any false statement or representation in any application, report, statement, or other document filed, maintained, or used for the purposes of compliance with this part is subject to a civil penalty of not less than one thousand dollars (\$1,000) or more than twenty-five thousand dollars (\$25,000) per day for each day that the information remains uncorrected. (Added by Stats. 1987, Ch. 1252, Sec. 1. Operative July 1988, pursuant to Section 44384.)

44382. Every district shall, by regulation, adopt the requirements of this part as a condition of every permit issued pursuant to Chapter 4 (commencing with Section 42300) of Part 4 for all new and modified facilities. (Added by Stats. 1987, Ch. 1252, Sec. 1. Operative July 1, 1988, pursuant to Section 44384.)

44384. Except for Section 44380 and this section, all provisions of this part shall become operative on July 1, 1988. (Added by Stats. 1987, Ch. 1252, Sec. 1. Operative January 1, 1988, by its own provisions.)

CHAPTER 6. FACILITY TOXIC AIR CONTAMINANT RISK REDUCTION AUDIT AND PLAN

(Chapter 6 added by Stats. 1992, Ch. 1162, Sec. 3. Effective January 1, 1993.)

44390. For purposes of this chapter, the following definitions apply:

- (a) "Airborne toxic risk reduction measure" or "ATRRM" means those in-plant changes in production processes or feedstocks that reduce or eliminate toxic air emissions subject to this part. ATRRM's may include:
 - (1) Feedstock modification.

- (2) Product reformulations.
 - (3) Production system modifications.
 - (4) System enclosure, emissions control, capture, or conversion.
 - (5) Operational standards and practices modification.
- (b) Airborne toxic risk reduction measures do not include measures that will increase risk from exposure to the chemical in another media or that increase the risk to workers or consumers.
- (c) "Airborne toxic risk reduction audit and plan" or "audit and plan" means the audit and plan specified in Section 44392. (Added by Stats. 1992, Ch. 1162, Sec. 3. Effective January 1, 1993.)
44391. (a) Whenever a health risk assessment approved pursuant to Chapter 4 (commencing with Section 44360) indicates, in the judgment of the district, that there is a significant risk associated with the emissions from a facility, the facility operator shall conduct an airborne toxic risk reduction audit and develop a plan to implement airborne toxic risk reduction measures that will result in the reduction of emissions from the facility to a level below the significant risk level within five years of the date the plan is submitted to the district. The facility operator shall implement measures set forth in the plan in accordance with this chapter.
- (b) The period to implement the plan required by subdivision (a) may be shortened by the district if it finds that it is technically feasible and economically practicable to implement the plan to reduce emissions below the significant risk level more quickly or if it finds that the emissions from the facility pose an unreasonable health risk.
- (c) A district may lengthen the period to implement the plan required by subdivision (a) by up to an additional five years if it finds that a period longer than five years will not result in an unreasonable risk to public health and that requiring implementation of the plan within five years places an unreasonable economic burden on the facility operator or is not technically feasible.
- (d) (1) The state board and districts shall provide assistance to smaller businesses that have inadequate technical and financial resources for obtaining information, assessing risk reduction methods, and developing and applying risk reduction techniques.
- (2) Risk reduction audits and plans for any industry subject to this chapter which is comprised mainly of small businesses using substantially similar technology may be completed by a self-conducted audit and checklist developed by the state board. The state board, in coordination with the districts, shall provide a copy of the audit and checklist to small businesses within those industries to assist them to meet the requirements of this chapter.
- (e) The audit and plan shall contain all the information required by Section 44392.
- (f) The plan shall be submitted to the district, within six months of a district's determination of significant risk, for review of completeness. Operators of facilities that have been notified prior to January 1, 1993, that there is a significant risk associated with emissions from the facility shall submit the plan by July 1, 1993. The district's review of completeness shall include a substantive analysis of the emission reduction measures included in the plan, and the ability of those measures to achieve

emission reduction goals as quickly as feasible as provided in subdivisions (a) and (b).

- (g) The district shall find the audit and plan to be satisfactory within three months if it meets the requirements of this chapter, including, but not limited to, subdivision (f). If the district determines that the audit and plan does not meet those requirements, the district shall remand the audit and plan to the facility specifying the deficiencies identified by the district. A facility operator shall submit a revised audit and plan addressing the deficiencies identified by the district within 90 days of receipt of a deficiency notice.
- (h) Progress on the emission reductions achieved by the plan shall be reported to the district in emissions inventory updates. Emissions inventory updates shall be prepared as required by the audit and plan found to be satisfactory by the district pursuant to subdivision (g).
- (i) If new information becomes available after the initial risk reduction audit and plan, on air toxics risks posed by a facility, or emission reduction technologies that may be used by a facility that would significantly impact risks to exposed persons, the district may require the plan to be updated and resubmitted to the district.
- (j) This section does not authorize the emission of a toxic air contaminant in violation of an airborne toxic control measure adopted pursuant to Chapter 3.5 (commencing with Section 39650) or in violation of Section 41700. (Amended by Stats. 1993, Ch. 1041, Sec. 2. Effective January 1, 1994.)

44392. A facility operator subject to this chapter shall conduct an airborne toxic risk reduction audit and develop a plan which shall include at a minimum all of the following:

- (a) The name and location of the facility.
- (b) The SIC code for the facility.
- (c) The chemical name and the generic classification of the chemical.
- (d) An evaluation of the ATRRM's available to the operator.
- (e) The specification of, and rationale for, the ATRRMs that will be implemented by the operator. The audit and plan shall document the rationale for rejecting ATRRMs that are identified as infeasible or too costly.
- (f) A schedule for implementing the ATRRMs. The schedule shall meet the time requirements of subdivision (a) of Section 44391 or the time period for implementing the plan set by the district pursuant to subdivision (b) or (c) of Section 44391, whichever is applicable.
- (g) The audit and plan shall be reviewed and certified as meeting this chapter by an engineer who is registered as a professional engineer pursuant to Section 6762 of the Business and Professions Code, by an individual who is responsible for the processes and operations of the site, or by an environmental assessor registered pursuant to Section 25570.3. (Added by Stats. 1992, Ch. 1162, Sec. 3. Effective January 1, 1993.)

44393. The plan prepared pursuant to Section 44391 shall not be considered to be the equivalent of a pollution prevention program or a source reduction program, except insofar as the audit and plan elements are consistent with source reduction, as defined in Section 25244.14, or

subsequent statutory definitions of pollution prevention. (Added by Stats. 1992, Ch. 1162, Sec. 3. Effective January 1, 1993.)

44394. Any facility operator who does not submit a complete airborne toxic risk reduction audit and plan or fails to implement the measures set forth in the plan as set forth in this chapter is subject to the civil penalty specified in subdivision (a) of Section 44381, and any facility operator who, in connection with the audit or plan, knowingly submits any false statement or representation is subject to the civil penalty specified in subdivision (b) of Section 44381. (Added by Stats. 1992, Ch. 1162, Sec. 3. Effective January 1, 1993.)

Appendix C

Asbestos Quantity Conversion Factors

Appendix C

Asbestos Quantity Conversion Factors

A. “PCM” versus “TEM”

Two main analytical methods have been used for the analysis of asbestos samples: phase contrast microscopy (PCM), the primary method used historically to analyze asbestos samples, and transmission electron microscopy (TEM), the current state-of-the-art method.

PCM analysis has been preferred in the past over TEM because it can be done more quickly and it is less expensive. One major limitation of PCM analysis, however, especially in outdoor environments, is that the analyst cannot distinguish asbestos from non-asbestos fibers, such as cellulose, talc, or gypsum. Also, PCM cannot detect fibers that have a diameter of about 0.3 microns or less, which could substantially underestimate the asbestos fiber concentrations. These limitations make PCM impractical for the analysis of ambient asbestos samples.

Transmission electron microscopy (TEM) is the preferred analytical method for outdoor asbestos samples because of its ability to detect small fibers (greater than or equal to 0.0002 microns in diameter) and to distinguish between asbestos fibers and non-asbestos fibers. The term “TEM structures” is often used to describe asbestos fibers detected by this method. TEM is the method recommended by the Office of Environmental Health Hazard Assessment (OEHHA). TEM measurements cannot be directly related to the risk potency factors, however, because the studies upon which OEHHA’s risk assessment was based used the less expensive PCM analysis. The TEM measurements must be converted to PCM-equivalent units, using the following equation (ARB, 1990):

$$1 \text{ PCM fiber} = 320 \text{ TEM structures}$$

B. Asbestos Inhalation Cancer Potency Factor

The unit risk factor for asbestos fibers is 1.9×10^{-4} in units of $(100 \text{ PCM fibers/m}^3)^{-1}$ and the unit risk factor is 6.3×10^{-2} in units of $(\mu\text{g/m}^3)^{-1}$. The unit risk factor is based on epidemiological studies in which PCM fiber measurements were used. These unit risk factors are listed in Chapter 7 and in the Asbestos Toxic Air Contaminant (TAC) identification document (CDHS, 1986) and in OEHHA, 1999b. These asbestos cancer potency factors are for mesothelioma. Since these cancer potency factors are in units of concentration or dose, complications arise when the emitted asbestos quantities are reported in mass units (pounds/year and maximum pounds/hour) for the Air Toxics Hot Spots Program (Hot Spots).

The TAC inhalation cancer potency factor has been converted from mass to concentration using a factor of 0.003 μg asbestos = 100 asbestos PCM fibers. This conversion has been derived from information published by the United States Environmental Protection Agency (U.S. EPA) (U.S. EPA, 1986). The number of asbestos PCM fibers associated with a given mass of asbestos can vary appreciably. Also, U.S. EPA has stated that this conversion factor is the geometric mean of measured relationships between optical fiber counts and mass airborne chrysotile in several published studies, that the range of the conversion factor between the different studies is large (0.0005 - 0.015 μg asbestos/100 asbestos PCM fibers), and that the factor carries with it an appreciable uncertainty.

The current recommendation for Hot Spots risk assessments uses a default breathing rate of 393 L/day-kg body weight for a 70 year exposure duration. A dose is calculated from the ground level concentration using the following equation:

$$X (\mu\text{g}/\text{m}^3) \times 393 \text{ L/day-kg body weight} \times 10^{-6} = \text{dose (mg/kg-day)}$$

The 10^{-6} term converts the L in the breathing rate to m^3 and the μg in the air concentration term to mg.

In order to obtain cancer risk the dose is subsequently multiplied times the cancer potency factor as follows:

$$\text{Dose (mg/kg-body weight)} \times \text{cancer potency factor (mg/kg-body weight)} = \text{Cancer risk (unitless)}$$

For risk communication purposes cancer risk may be converted into chances per million of developing cancer. This terminology is often more clearly understood by the public than cancer risk.

$$\text{Cancer risk} \times (1 \times 10^6) = \text{chances per million of developing cancer}$$

The cancer potency factor $(\text{mg/kg body weight})^{-1}$ may be calculated from the fiber cancer potency factor using the relationship of 0.003 μg = 100 fibers PCM, 70 kg body weight, 20 m^3 breathed per day, and a factor of 1000 to convert μg asbestos into mg:

$$1.9 \times 10^{-4} (100 \text{ PCM fibers} / \text{m}^3)^{-1} \times \frac{70 \text{ kg}}{20 \text{ m}^3} \times \frac{1000}{0.003 \text{ mg} / 100 \text{ fibers}} = 2.2 \times 10^{-2} (\text{mg} / \text{kg body weight})^{-1}$$

The ISCST3 air dispersion modeling program estimates concentrations in units of $\mu\text{g}/\text{m}^3$ based on emission estimates in lb/yr. If the ground level concentrations are derived from PCM fiber measurements, then no additional uncertainty is introduced by the conversion to μg using the factor of 0.003. This is because the factor is effectively cancelled out by its use to derive the cancer potency factor in $(\text{mg/kg body weight})^{-1}$. There is a slight rounding error that may be introduced.

The Air Toxics Hot Spots Program Guidance Manual for Preparation of Health Risk Assessments. August 2003.

References

ARB, 1990. Proposed Control Measure for Asbestos-Containing Serpentine Rock in Surfacing Applications, Technical Support Document, Air Resources Board, February 1990.

CDHS, (1986) California Department of Health Services (CDHS) 1986. Report to the Air Resources Board on Asbestos. Part B. Health Effects of Asbestos. Epidemiological Studies Section, Berkeley, CA.

OEHHA. (1999b). Air Toxics Hot Spots Program Risk Assessment Guidelines. Part II. Technical Support Document for Describing Available Cancer Potency Factors. Available online at <http://www.oehha.ca.gov>

USEPA, 1986. Airborne Asbestos Health Assessment Update. EPA/600/8-84/003F, Office of Health and Environmental Assessment, Washington, DC.

Appendix D

Risk Assessment Procedures to Evaluate Particulate Emissions from Diesel-Fueled Engines

Appendix D

Risk Assessment Procedures to Evaluate Particulate Emissions from Diesel-Fueled Engines

A. Introduction

The objective of this appendix is to discuss procedures for estimating potential cancer and noncancer health risk from exposure to particulate matter (PM) emissions from diesel-fueled engines (diesel exhaust). It will also clarify the requirements and recommendations for acute noncancer and multipathway cancer and chronic risk assessment for diesel PM. In addition to the notification and risk reduction requirements under the Hot Spots Program, this appendix should facilitate the use of the *Risk Reduction Plan to Reduce Particulate Matter Emissions from Diesel-Fueled Engines and Vehicles* (ARB, 2000) (Diesel Guidelines). The Diesel Guidelines were developed by the Air Resources Board (ARB) with assistance from the Office of Environmental Health Hazard Assessment (OEHHA) in October 2000. The Diesel Guidelines are intended to assist local Air Pollution Control and Air Quality Management Districts (Districts) and sources of diesel PM emissions in making consistent risk management decisions.

In advance of performing a health risk assessment (HRA), it is recommended that the District and the stationary source of diesel emissions reach a consensus on the HRA approach for estimating health impacts from diesel exhaust. See Chapter 9 for an outline of a modeling protocol.

B. Calculations/Risk Assessment Procedures

In August 1998, the ARB identified diesel exhaust as a toxic air contaminant (TAC) (ARB, 1998). In the identification report, OEHHA provided an inhalation noncancer chronic reference exposure level (REL) of 5 micrograms per cubic meter ($\mu\text{g}/\text{m}^3$) and a range of inhalation cancer potency factors of 1.3×10^{-4} to 2.4×10^{-3} ($\mu\text{g}/\text{m}^3$)⁻¹. The Scientific Review Panel on Toxic Air Contaminants recommended a “reasonable estimate” inhalation unit risk factor of 3.0×10^{-4} ($\mu\text{g}/\text{m}^3$)⁻¹. From the unit risk factor an inhalation cancer potency factor of 1.1 (mg/kg-day)⁻¹ may be calculated. These noncancer and cancer health factors were developed based on whole (gas and particulate matter) diesel exhaust. The surrogate for whole diesel exhaust is diesel PM. PM₁₀ (particulate matter, ten microns or less in size) is the basis for the potential risk calculations.

Cancer

When conducting an HRA, the potential cancer risk from inhalation exposure to diesel PM will outweigh the potential noncancer health impacts. Therefore, inhalation cancer risk is required for every HRA. (The methods for calculating inhalation cancer risk can be found in Chapters 5, 7, and 8.) When comparing whole diesel exhaust to speciated diesel exhaust (e.g., PAHs, metals), potential cancer risk from inhalation exposure to whole diesel exhaust will

outweigh the multipathway cancer risk from the speciated components. For this reason, there will be few situations where an analysis of multipathway risk is necessary.

The District may elect to require a multipathway analysis if reliable data are available and the District decides that it is necessary. If the District elects to require a multipathway analysis, the components of the diesel exhaust will need to be speciated since there is not an oral cancer potency factor for diesel PM. It is recommended that the District be consulted on the procedures for conducting a multipathway analysis for diesel exhaust. The District may wish to use speciation data from the ARB. If so, a resource for speciation data is available on the ARB's website at www.arb.ca.gov/emisinv/speciate/speciate.htm.

If a multipathway analysis is required, the speciated data should be compared with the substances in Table 5.1. Any substances in the speciation profile that are listed in Table 5.1 and have an oral cancer potency factor in Table 7.1 should be included in the multipathway analysis. Potential multipathway cancer risks are estimated following the procedures in Chapters 5 and 8 of this document. These procedures require summing the potential cancer risk from each carcinogen to estimate the total facility cancer risk.

Noncancer Chronic

To determine noncancer chronic inhalation health impacts from exposure to diesel exhaust use the methods described in Chapters 6 and 8.

In most situations, noncancer health impacts from inhalation exposure to whole diesel exhaust will outweigh the noncancer multipathway health impacts to the speciated components of diesel exhaust. However, there may be situations when the multipathway impacts need to be investigated.

Therefore, the District may elect to require a multipathway analysis if reliable data is available and they feel it is necessary. If the District elects to require a multipathway analysis, the components of the diesel exhaust will need to be speciated since there is not an oral reference exposure level for diesel PM. A resource for speciation data at the ARB is identified above. It is recommended that the District be consulted on the procedures for conducting a multipathway analysis. If a multipathway analysis is required, the speciated data should be compared with the substances in Table 5.1. Any substances in the speciation profile that are listed in Table 5.1 and have an oral chronic REL in Table 6.3 should be included in the multipathway analysis. Potential multipathway chronic risks are estimated following the procedures in Chapters 5 and 8 of this document.

Noncancer Acute

As stated above, potential cancer risk is usually the driving health impact for diesel exhaust. However, there may be certain unusual situations where an evaluation of the acute health effects may be warranted. One possible situation is when a nearby receptor is located above the emission release point (e.g. on a hillside or in a multistory apartment building). Since there is no acute REL for diesel exhaust, the components of the exhaust will need to be speciated to determine the potential acute health impacts. It is recommended that the District be consulted on the procedures for conducting an acute analysis. If an acute analysis is required, the speciated

data should be compared with the substances in Table 6.1. Any substances in the speciation profile that are listed in Table 6.1 should be included in the acute analysis. A resource for speciation data at the ARB is identified above. Potential acute risks are estimated following the procedures in Chapters 6 and 8 of this document.

References:

ARB 1998. Air Resources Board, "Proposed Identification of Diesel Exhaust as a Toxic Air Contaminant, Appendix III, Part A, Exposure Assessment," April 1998.

ARB 2000. Air Resources Board, "Risk Reduction Plan to Reduce Particulate Matter Emissions from Diesel-Fueled Engines and Vehicles," October 2000.

Appendix E

Toxicity Equivalency Factors for

Polychlorinated Dibenzo-*p*-Dioxins Dibenzofurans

And Polychlorinated Biphenyls

Appendix E

Toxicity Equivalency Factors for Polychlorinated Dibenzo-*p*-Dioxins Dibenzofurans and Polychlorinated Biphenyls

Introduction

Dioxins and furans vary considerably in their potency for causing both cancer and noncancer health impacts. A facility may choose to speciate dioxin and furan emissions in order to obtain a more accurate picture of the risks. A scheme, based on both cancer and noncancer toxicity studies, has been developed to relate the potency of various dioxin and furan congeners to the potency of 2,3,7,8-tetrachlorodibenzo-*p*-dioxin. A detailed explanation of the World Health Organization's 1997 Toxicity Equivalents Factor (WHO₉₇-TEF) (van den Berg, 1998) scheme, the latest scheme adopted by OEHHA, is available in OEHHA (2003).

The individually calculated inhalation or oral doses of each dioxin or furan congener may be multiplied times the oral or inhalation cancer potency for each individual congener listed in Table 7.1. In order to determine the inhalation chronic hazard index, the ground level concentration of each congener may be divided by the chronic REL for each congener in Table 6.2 and the hazard quotients may be summed to give the hazard index for dioxins and furans. The oral chronic hazard quotient may be calculated by determining the oral dose of each congener and dividing by the individual chronic oral REL for each congener. The oral hazard quotients may be summed to give the hazard quotient for oral noncancer dioxin risks and may then be added to the inhalation hazard index to give the combined inhalation and oral chronic hazard quotient for dioxins.

A second equivalent procedure may also be used to calculate the cancer risk of a mixture of dioxin and furan congeners. The concentration of each congener listed in Table E-1 is multiplied by the WHO₉₇-TEF for that congener. For example, for 1,2,3,4,7,8-hexachlorodibenzodioxin the concentration ($\mu\text{g}/\text{m}^3$) may be multiplied by 0.1 to give the concentration equivalent to 2,3,7,8-tetrachlorodibenzo-*p*-dioxin. 2,4,7,8-tetrachlorodibenzodioxin would be multiplied by zero indicating no cancer or noncancer toxicity. The 2,3,7,8-tetrachlorodibenzo-*p*-dioxin equivalent concentrations may be summed and treated as if the total concentration were 2,3,7,8-tetrachlorodibenzo-*p*-dioxin for the purposes of calculating cancer and noncancer risks. Thus, the potency adjusted ground level concentration can be multiplied by the breathing rate to give dose (see equation 5.4.1), and then multiplied times the cancer potency factor for 2,3,7,8-tetrachlorodibenzo-*p*-dioxin (Table 7.1) to give cancer risk for the entire mixture. If a noncancer chronic hazard index needs to be calculated the potency adjusted ground level concentration can be divided by the chronic reference exposure level for 2,3,7,8-tetrachlorodibenzo-*p*-dioxin to give a hazard index for the entire mixture. The TEF may be multiplied times the individual congener dose calculated for the inhalation and oral cancer risk calculation, and the oral chronic hazard index determination.

The most recent TEF scheme adopted by OEHHA includes TEF for individual PCB congeners (see Table E-1) (OEHHA, 2003). These are the congeners that have dioxin-like biological effects. The same procedures as described above may be used to calculate the concentration or dose of these congeners. Where data are available on individual PCB congeners emitted by a facility, then these TEFs are to be used. If Table E1 is used to adjust the dose or concentration of the individual PCB congeners, the 2,3,7,8-tetrachlorodibenzo-*p*-dioxin oral and inhalation cancer potency factors should be used to determine cancer risk. The chronic inhalation and oral REL for 2,3,7,8-tetrachlorodibenzo-*p*-dioxin should be used to determine the noncancer chronic hazard index. If only total PCB data are available, then the PCB slope factors provided in Table 7.1 can be used for cancer risk determination.

Table E1. WHO/97 Toxic equivalency factors (TEFs)

Congener	TEF _{WHO-97}
PCDDs	
2,3,7,8-TCDD	1
1,2,3,7,8-PeCDD	1
1,2,3,4,7,8-HxCDD	0.1
1,2,3,7,8,9-HxCDD	0.1
1,2,3,6,7,8-HxCDD	0.1
1,2,3,4,6,7,8-HpCDD	0.01
1,2,3,4,6,7,8,9-OCDD	0.0001
PCDFs	
2,3,7,8-TCDF	0.1
1,2,3,7,8-PeCDF	0.05
2,3,4,7,8-PeCDF	0.5
1,2,3,4,7,8-HxCDF	0.1
1,2,3,7,8,9-HxCDF	0.1
1,2,3,6,7,8-HxCDF	0.1
2,3,4,6,7,8-HxCDF	0.1
1,2,3,4,6,7,8-HpCDF	0.01
1,2,3,4,7,8,9-HpCDF	0.01
1,2,3,4,6,7,8,9-OCDF	0.0001
PCBs (IUPAC #, Structure)	
77 3,3',4,4'-TCB	0.0001
81 3,4,4',5-TCB	0.0001
105 2,3,3',4,4'-PeCB	0.0001
114 2,3,4,4',5-PeCB	0.0005
118 2,3',4,4',5-PeCB	0.0001
123 2',3,4,4',5-PeCB	0.0001
126 3,3',4,4',5-PeCB	0.1
156 2,3,3',4,4',5-HxCB	0.0005
157 2,3,3',4,4',5'-HxCB	0.0005
167 2,3',4,4',5,5'-HxCB	0.00001
169 3,3',4,4',5,5'-HxCB	0.01
189 2,3,3',4,4',5,5'-HpCB	0.0001

References

OEHHA, 2003. Technical Support Document for Describing Available Cancer Potency Factors, Appendix A (revised August, 2003) : Use of the Revised Toxicity Equivalency Factor (TEF_{WHO-97}) Scheme for Estimating Toxicity of Mixtures of Dioxin-Like Chemicals, September 2003. Available at www.oehha.ca.gov.

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Appendix F

Overview of the Lead Risk Assessment Procedures

Appendix F

Overview of the Lead Risk Assessment Procedures

I. Introduction

The objective of this appendix is to provide a method for estimating potential cancer and noncancer health effects due to airborne lead exposure. This appendix should facilitate the use of the *Risk Management Guidelines for New, Modified, and Existing Sources of Lead* (Lead RM Guidelines) (ARB, 2001) for analysis of lead exposure. The Lead RM Guidelines were developed by the Air Resources Board (ARB) with assistance from Office of Environmental Health Hazard Assessment (OEHHA) and Department of Health Services (DHS) in March 2001 to assist local air districts and sources of lead in making consistent risk management decisions for new, modified, and existing sources of lead.

In April 1997, the ARB identified inorganic lead as a toxic air contaminant (TAC) (ARB, 1997). Lead is unique among other TACs identified by ARB in several ways. First, infants and children are particularly susceptible to the health effects of lead, and the risk assessment is based on health effects in children. Second, the chronic noncancer effects are related to blood lead levels (BLLs) as opposed to ambient air concentrations. These BLLs reflect current and past exposure from a number of sources; air emissions may only be a small part of the total exposure. Third, based on recommendations of the OEHHA and the Scientific Review Panel on Toxic Air Contaminants (SRP), the ARB did not identify a threshold level for chronic noncancer health effects due to lead exposure. Threshold levels are levels below which no adverse health effects are expected to occur. Since acute or chronic Reference Exposure Levels (RELs) are based on threshold levels, none were developed for lead. Thus, a hazard index approach is not used for lead. Instead, air concentrations are compared to defined air lead levels associated with specified percentages of children with BLL ≥ 10 $\mu\text{g/dL}$. Acceptable risk is based on minimizing the number of children at or above a BLL of 10 $\mu\text{g/dL}$.

II. Methods for Estimation of Health Risk Effects

Methods for estimating site-specific noncancer and cancer potential health impacts from exposure to lead emissions are given in the Lead RM Guidelines. The noncancer health effects pose greater public health significance than the cancer health effects. Minimizing noncancer health effects of lead will therefore also minimize cancer health effects.

Chronic noncancer health risks are estimated based on neurodevelopmental health risks to children and would also be protective of adults. These health effects can be evaluated using a tiered approach based on blood lead level distribution in the population.

Potential multipathway cancer risks are estimated following the procedures in Chapters 5 and 8 of this document. These procedures require summing individual cancer risk from each carcinogen to estimate the total facility cancer risk.

In advance of performing a health risk assessment (HRA), it is recommended that the Air Pollution Control or Air Quality Management District (District) and the stationary source of lead air emissions reach a consensus on the HRA approach for estimating chronic noncancer and cancer health risks. See Chapter 9 for an outline of a modeling protocol.

A. Tiered Approach for Estimating Noncancer Risks due to Lead Exposure

The Lead Risk Management Guidelines provide three tiers of analysis to determine baseline BLL distributions for estimating risk. Although there is a simple risk management option provided in the Lead RM Guidelines, in a risk assessment for the Air Toxics Hot Spots program one of the following tiers must be used to report estimates of the percent of children estimated to be above 10 µg/dL blood lead. The tiered approach is based on an assessment of neurodevelopmental risk, with the BLL distribution in the population as the most significant factor. The BLL distribution consists of two components: 1) the baseline BLL distribution due to all sources of exposure; and 2) the exposure due to emissions from a facility.

Tier I is a default approach that requires minimal site-specific information on concentrations of lead in environmental media other than air. Tier I uses two default BLL distributions, one for a high exposure scenario and one for an average exposure scenario. The exposure scenario is determined using the median age of the homes in the census tract and the ratio of area income to the poverty level. The default baseline BLL distribution for each of the exposure scenarios is based on a review of neighborhood and community blood lead studies. The assessor determines the 30-day average lead concentration due to the facility averaged over the 1 square kilometer area centered on the Maximum Offsite Concentration (MOC). The percentage of children with BLLs greater than or equal to 10 micrograms per deciliter (≥ 10 µg/dL) is determined using Table F-1 (also found on page 17 in the Lead RM Guidelines), the air lead concentration, and the determined exposure scenario. The 10 µg/dL threshold level has been identified by the Centers for Disease Control and Prevention (CDC) as a level where potential health effects may occur. The public health goal of management practices should be to implement procedures/practices to prevent BLLs at or above this level. The estimated percentage of children with BLLs ≥ 10 µg/dL is then used with risk management levels given in Chapter III, Section D of the Lead RM Guidelines to assist in making risk management decisions.

Table F-1 Percentage of Children with Blood Lead Levels ≥ 10 $\mu\text{g/dl}$ for Various Air Lead Concentrations at Two Exposure Scenarios

Air Lead Concentration in the Maximum Exposure Area (30-day average) [$\mu\text{g/m}^3$]	Percent ≥ 10 $\mu\text{g/dL}$	
	High Exposure Scenario	Average Exposure Scenario
Baseline*	5.1	1.2
0.02	5.4	1.4
0.06	6.1	1.7
0.10	6.8	2.2
0.20	8.9	3.4
0.25	9.8	4.1
0.50	15.9	8.9
0.75	22.4	15.4
1.0	29.1	23.0
1.5	42.5	39.0

* The baseline represents BLLs due to lead in soil, dust, water, food, and background air lead concentrations.

Tier II requires the development of site-specific baseline BLL distributions within the impacted population using site-specific estimates of lead levels in environmental media, including soil, dust, water, and/or food, using the U.S. EPA Integrated Exposure Uptake Biokinetic (IEUBK) model. The IEUBK model calculates the probability of an individual exceeding a specific BLL based on site-specific information. The aggregate of the individual BLLs is used to estimate the neurodevelopmental risk in the maximum exposure area. A detailed discussion of this tier is beyond the scope of this overview; see Appendix D in the Lead RM Guidelines for a discussion of the IEUBK model and its use.

Tier III involves actual blood lead sampling of the population impacted by the facility to define the baseline BLLs. In Tier III, the facility is responsible for conducting BLL testing to establish a site-specific BLL distribution. The Lead RM Guidelines recommend the neurodevelopmental risk be calculated as the probability of children in an affected exposure area having a BLL ≥ 10 $\mu\text{g/dL}$ using the results of the blood lead sampling. It is highly unlikely that this option would be used due to the cost incurred and the fact that the sampled population must consent to the sampling and an appropriate sampling strategy must be developed to adequately characterize the blood lead levels of the impacted population.

For further information on the tiered approach using the Tier I, Tier II, or Tier III, please see Chapter II of the *ARB Risk Management Guidelines for New, Modified, and Existing Sources of Lead* (ARB, 2001). This document can be downloaded from the ARB web site at <http://www.arb.ca.gov/toxics/lead/lead.htm> or can be requested by calling (916) 323-4327.

B. Methods for Estimating Potential Cancer Risks due to Lead

While lead has a unique noncancer assessment methodology, the determination of potential multipathway cancer risk is the same as other carcinogens. Chapters 5, 7, and 8, and Appendices I and L provide all the needed information for calculating potential cancer risk. The health risk assessment should report the multipathway cancer risks from lead emissions.

Chapter III in the Lead RM Guidelines provides methods for determining risk management of lead exposure, using the results from the cancer risk calculation, and the local District's defined significance levels.

III. References

ARB, 1997. Proposed Identification Inorganic Lead as a Toxic Air Contaminant, Parts A, B, C. California Air Resources Board. April, 1997.

ARB, 2001. ARB Risk Management Guidelines for New, Modified, and Existing Sources of Lead. California Air Resources Board. March 2001

APPENDIX G

PAH Potency Factors and Selection of Potency Equivalency Factors (PEF) for PAHs Based on Benzo[A]Pyrene Potency

Appendix G

PAH Potency Factors and Selection of Potency Equivalency Factors (PEF) for PAHs based on Benzo(a)pyrene Potency

Benzo(a)pyrene (BaP) was chosen as the primary representative of the class of polycyclic aromatic hydrocarbons (PAHs) because of (1) the large amount of toxicological data available on BaP (versus the relatively incomplete database for other PAHs), (2) the availability of monitoring techniques for BaP, and (3) the significant exposure expected (and found). The Office of Environmental Health Hazard Assessment (OEHHA) has developed a Potency Equivalency Factor (PEF) procedure to assess the relative potencies of PAHs and PAH derivatives as a group. This procedure can address the impact of carcinogenic PAHs in ambient air since they are usually present together. This procedure was approved by the Scientific Review Panel (SRP) on Toxic Air Contaminants (TAC) as part of the Health Effects Assessment of Benzo(a)pyrene during the TAC identification process (OEHHA, 1993).

Due to the variety of data available on the carcinogenicity and mutagenicity of PAHs, an order of preference for the use of available data in assessing relative potency was developed. If a health effects evaluation and quantitative risk assessment leading to a cancer potency value had been conducted on a specific PAH, then those values were given the highest preference. Cancer potency values for PAHs developed by this process are shown in Table G-1.

Table G-1: Potencies of PAHs and derivatives¹

Chemicals	Cancer potency factors (mg/kg-day) ⁻¹	Unit risks (µg/m ³) ⁻¹
benzo[a]pyrene	11.5	1.1×10^{-3}
dibenz[a,h]anthracene	4.1	1.2×10^{-4}
7,12-dimethylbenzanthracene	250	7.1×10^{-2}
3-methylcholanthrene	22	6.3×10^{-3}
5-nitroacenaphthene	0.13	3.7×10^{-5}

1. Source: (OEHHA 1993; Collins *et al.*, 1998). It is assumed that unit risks for inhalation have the same relative activities as cancer potencies for oral intake.

If potency values have not been developed for specific compounds, a carcinogenic activity relative to BaP, rather than a true potency, can be developed. These relative activity values are referred to as Potency Equivalency Factors or PEFs. For air contaminants, the relative potency to BaP based on data from inhalation studies would be optimal. Otherwise, intrapulmonary or intratracheal administration studies would be most relevant, since such studies are in the target organ of interest. Next in order of

preference is information on activity by the oral route and skin painting. Intraperitoneal and subcutaneous administration rank at the bottom of the *in vivo* tests considered useful for PEF development because of their lack of relevance to environmental exposures. Next, in decreasing order of preference, are genotoxicity data, which exist for a large number of compounds. In many cases genotoxicity information is restricted to mutagenicity data. Finally, there are data on structure-activity relationships among PAH compounds. Structure-activity considerations may help identify a PAH as carcinogenic, but at this time have not been established as predictors of carcinogenic potency.

Using this order of preference, PEFs were derived for 21 PAHs and are presented in Table G-2 (OEHHA, 1993; Collins *et al.*, 1998).

Table G-2. OEHHA PEF weighting scheme for PAHs and their resulting cancer potency values.

PAH or derivative	PEF	Unit Risk (mg/m^3) ⁻¹	Inhalation Slope Factor ($\text{mg}/\text{kg}\cdot\text{day}$) ⁻¹	Oral Slope Factor ($\text{mg}/\text{kg}\cdot\text{day}$) ⁻¹
benzo[a]pyrene (index compound)	1.0	1.1E-3	3.9E+0	1.2E+1
benz[a]anthracene	0.1	1.1E-4	3.9E-1	1.2E+0
benzo[b]fluoranthene	0.1	1.1E-4	3.9E-1	1.2E+0
benzo[j]fluoranthene	0.1	1.1E-4	3.9E-1	1.2E+0
benzo[k]fluoranthene	0.1	1.1E-4	3.9E-1	1.2E+0
dibenz[a,j]acridine	0.1	1.1E-4	3.9E-1	1.2E+0
dibenz[a,h]acridine	0.1	1.1E-4	3.9E-1	1.2E+0
7H-dibenzo[c,g]carbazole	1.0	1.1E-3	3.9E+0	1.2E+1
dibenzo[a,e]pyrene	1.0	1.1E-3	3.9E+0	1.2E+1
dibenzo[a,h]pyrene	10	1.1E-2	3.9E+1	1.2E+2
dibenzo[a,i]pyrene	10	1.1E-2	3.9E+1	1.2E+2
dibenzo[a,l]pyrene	10	1.1E-2	3.9E+1	1.2E+2
indeno[1,2,3-cd]pyrene	0.1	1.1E-4	3.9E-1	1.2E+0
5-methylchrysene	1.0	1.1E-3	3.9E+0	1.2E+1
1-nitropyrene	0.1	1.1E-4	3.9E-1	1.2E+0
4-nitropyrene	0.1	1.1E-4	3.9E-1	1.2E+0
1,6-dinitropyrene	10	1.1E-2	3.9E+1	1.2E+2
1,8-dinitropyrene	1.0	1.1E-3	3.9E+0	1.2E+1
6-nitrochrysene	10	1.1E-2	3.9E+1	1.2E+2
2-nitrofluorene	0.01	1.1E-5	3.9E-2	1.2E-1
chrysene	0.01	1.1E-5	3.9E-2	1.2E-1

1. Source: OEHHA (1993)

The cancer potency comparisons show that some PAHs are more potent than BaP, while other PAHs analyzed were less or much less potent. These comparisons indicated that considering all PAHs to be equivalent in potency to BaP would likely overestimate the cancer potency of a PAH mixture, but such an assumption would be health protective and likely to be helpful in a screening estimate of PAH risks (OEHHA, 1993). If one

The Air Toxics Hot Spots Program Guidance Manual for Preparation of Health Risk Assessments. August 2003.

assumes that PAHs are as carcinogenic as they are genotoxic, then their hazard relative to BaP would be dependent on their concentration in the environment. In light of the limited information available on other PAHs, BaP remains an important representative or surrogate for this group of air pollutants.

Detailed descriptions on the criteria used for developing individual PEFs can be found in (OEHHA, 1999b). Currently, OEHHA is undertaking a review of all recent literature pertaining to the carcinogenicity and mutagenicity of PAHs. New cancer potency values for PAHs may be developed if an adequate health effects evaluation and quantitative risk assessment can be performed. Also, some current PEFs may be modified based on new data. Any changes to the potency values and PEFs for PAHs will be reflected in the HARP program when they occur. It is incumbent on the risk assessor to access the most recent version of the HARP program to ensure that the most up-to-date PAH potency values are used.

References

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Appendix H

Recommendations for Estimating Concentrations of Longer Averaging Periods from the Maximum One-Hour Concentration for Screening Purposes

Appendix H

Recommendations for Estimating Concentrations of Longer Averaging Periods from the Maximum One-Hour Concentration for Screening Purposes

A. Introduction

The U.S. Environmental Protection Agency (U.S. EPA) SCREEN3 air dispersion model is frequently used to estimate the maximum one-hour concentration downwind due to emissions from a point source to assess impacts from a source. The SCREEN3 model results (or ISCST3 with screening meteorological data), in conjunction with the U.S. EPA screening factors, are frequently used to estimate concentrations for longer averaging periods, such as the maximum annual average concentration. In addition, it is permissible to use the ISCST3 air dispersion model in a screening mode with identical meteorological conditions as used in the SCREEN3 model to superimpose results from multiple sources.

This method to assess short-term and long-term impacts may be used as a first-level screening indicator to determine if a more refined analysis is necessary. In the event that representative meteorological data are not available, the screening assessment may be the only computer modeling method available to assess source impacts.

In California, this standard procedure will generally bias concentrations towards over prediction in most cases when the source is a continuous release. However, in the case when a source is not continuous, these screening factors may not be biased towards over prediction. In this case, we recommend an alternative procedure for estimating screening value concentrations for longer averaging periods than one-hour for intermittent releases.

B. Current Procedures

The current screening factors used to estimate longer term averages (i.e., 3-hour, 8-hour, 24-hour, 30-day, and annual averages) from maximum one-hour concentrations in California are shown in Table H.1 and Figure H.1. The factors are U.S. EPA recommended values with the exception of the 30-day factor. The 30-day factor is an ARB recommended value (ARB, 1994). The maximum and minimum values are recommended limits to which one may diverge from the general (Rec.) case, (U.S. EPA, 1992). Diverging from the general case should only be done on a case by case basis with prior approval from the reviewing agency.

C. Non-Standard Averaging Periods with a Continuous Release

The following is the ARB recommendation for estimating screening concentrations for non-standard averaging periods that are not listed in Table H.1 or Figure H.1. Specifically, the recommendation is for estimating screening concentrations for 4-hour, 6-hour, and 7-hour averaging periods.

The current U.S. EPA screening factors applicable to standard averaging periods should be used for non-standard averaging periods. Specifically for the 4-hour, 6-hour, and 7-hour averaging periods, we recommend that the 3-hour screening factor of (0.9 ± 0.1) be used. The following illustrates the method to estimate a 6-hour average concentration from a continuous release from a single point source:

1. determine the maximum 1-hour concentration according to standard screening procedures ($C_{\text{max1-hr}}$),
2. scale the maximum 1-hour concentration by (0.9 ± 0.1) , and
3. the result is the maximum 6-hour concentration
 $(C_{\text{max6-hr}} = C_{\text{max1-hr}} * (0.9 \pm 0.1))$.

In the case for the 6-hour and 7-hour average concentration estimates, the user may wish to take the lower bound of (0.9 ± 0.1) , or 0.8. For the 4-hour average estimate, we recommend the user to use the 3-hour factor as is, 0.9.

Figure H.1
Screening Factors to Convert
1-hr Max. to Longer Avg. Periods

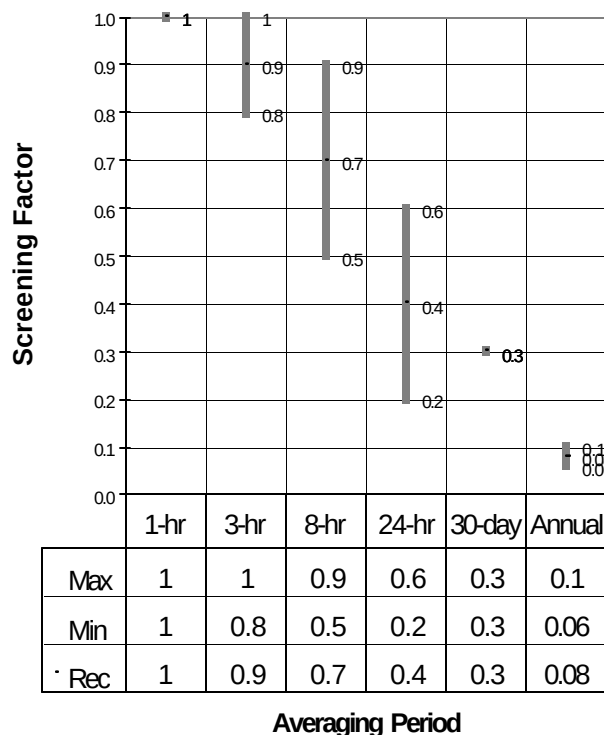


Table H.1 Recommended Factors to Convert Maximum 1-hour Avg. Concentrations to Other Averaging Periods (U.S. EPA, 1992; ARB, 1994).

Averaging Time	Range	Typical Recommended
3 hours	0.8 - 1.0	0.9
8 hours	0.5 - 0.9	0.7
24 hours	0.2 - 0.6	0.4
30 days	0.2 - 0.3	0.3
Annual	0.06 - 0.1	0.08

Table H.2 summarizes these recommendations for the non-standard averaging periods.

Table H.2 Recommended Factors to Convert Maximum 1-hour Avg. Concentrations to Non-Standard Averaging Periods.

Averaging Time	Range	Typical Recommended
4 hours	0.8 - 1.0	0.9
6 hours	0.8 – 1.0	0.8
7 hours	0.8 – 1.0	0.8

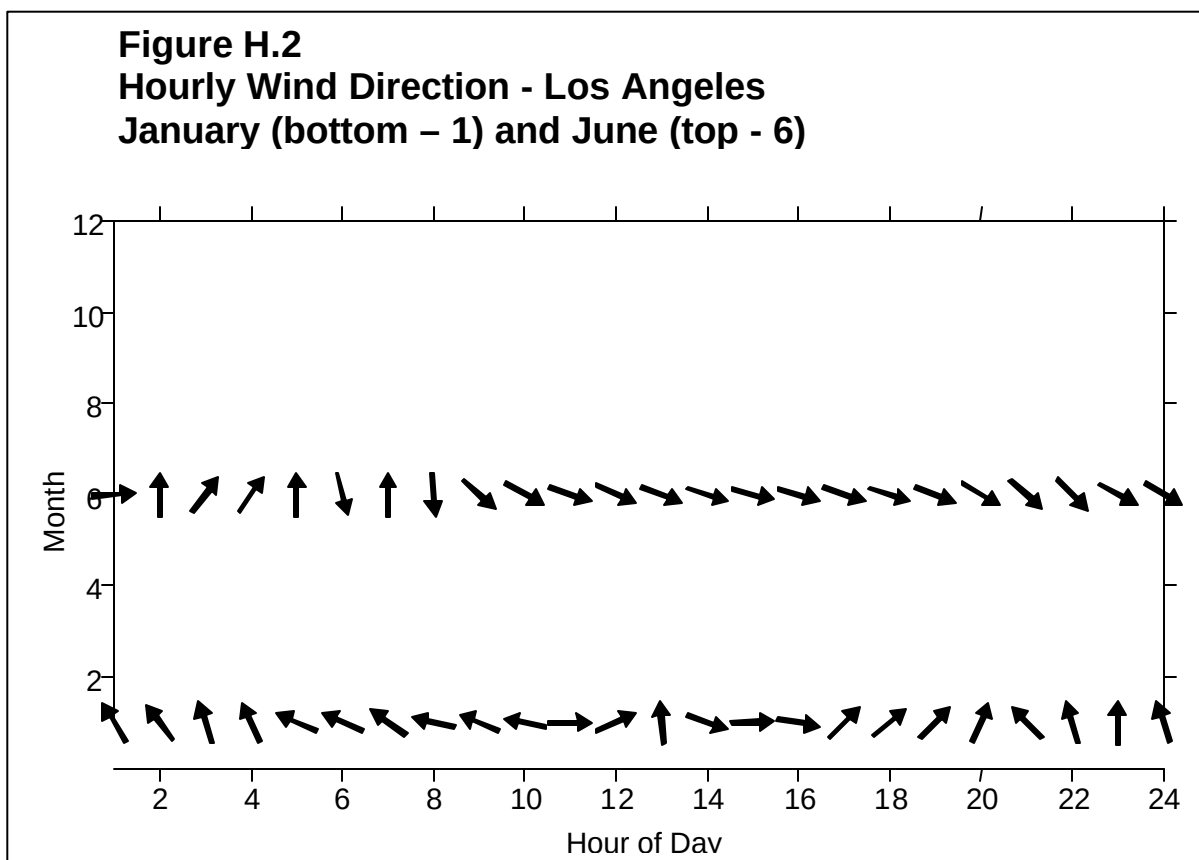
D. Definitions

It is convenient to define the following terms relating to sources with respect to the duration of the release.

- Continuous Release – this is a release that is continuous over the duration of a year. An example of this type of release would be fugitive emissions from a 24-hour per day, 7-day per week operation or an operation that is nearly continuous.
- Intermittent Release – many emissions fall under this category. These are emission types that are not continuous over the year. Any operation that has normal business hours (e.g., 8 am to 6 pm) would fall into this category.
- Systematic Release – these are intermittent releases that occur at a specific time of the day. As an example, these type of releases can occur when a process requires clean out at the end of the work day. Thereby releasing emissions only at the end of the workday systematically. Systematic releases are similar to intermittent releases with a shorter duration during the normal operating schedule.
- Random Release – these are intermittent releases that can occur any time during the operating schedule. An example of this type of release would be of the type that depends on batch processing. For example, a brake shop may emit pollutants only when the brakes are cleaned which happens randomly throughout the normal business hours.

E. Screening Factors

The U.S. EPA screening factors, as shown in Table H.1, compensate for the effects of varying conditions of wind speed, wind direction, ambient temperature, atmospheric stability, and mixing height over longer averaging periods, even though it is not explicitly indicated in the U.S. EPA Guidance (U.S. EPA, 1992). Figure H.2 shows the variability in wind direction over a 24-hour period. The data are averaged for two seven-day periods from data collected at Los Angeles International Airport (LAX). Figure H.2 was compiled for data collected in 1989 for January 1 to January 7 and June 1 through June 7, 1989. The ordinate in Figure H.2 shows the months of the year. Only two months are plotted. The abscissa shows the hour of the day.



As seen in Figure H.2, the wind direction changes throughout all hours of the day. In addition, the wind direction for LAX, in the overnight and early morning hours, can vary from January to June. During the afternoon hours of 1400 – 1600, the wind direction is similar in both months of January and June.

The standard U.S. EPA screening factor to estimate the maximum 24-hour concentration from the maximum 1-hour concentration is 0.4, as seen in Table H.1. Figure H.2 shows that for 15 of 24 hours the wind blows from the west-northwest during June. A 24-hour screening factor could be 0.6 ($0.6 \approx 15\text{hrs}/24\text{hrs}$) based on wind direction alone. This is consistent with the upper bound of the adjustment factors shown in Table H.1. Including the variability for wind speed, ambient temperature, and atmospheric stability could further reduce the estimated scaling factor of 0.6 closer towards the U.S. EPA recommended value of 0.4.

F. Intermittent Release

Support for the U.S. EPA screening factor is demonstrated for a continuous release (i.e., 24 hours per day) in the description above. It is important to be cautious when applying the U.S. EPA screening factors to an intermittent source for the purposes of estimating an annual average concentration (e.g., a business that may only emit during normal operating hours of 8 am to 6 pm).

Intermittent emissions, such as those from burning barrels, testing a standby diesel generator, or any normal business hour operation (e.g., 8am to 6pm Monday through Friday), could have the effect of eliminating some of the annual variability of meteorological conditions. For example, emissions only during the daytime could eliminate the variability of a drainage flow pattern in mountainous terrain. Guidance for estimating long-term averages for a screening approach and intermittent emissions is not available.

For a source located in the LAX meteorological domain, an emission pattern confined to the hours of 1400 to 1600 would eliminate any variability associated with the wind direction. In this case, estimating a 24-hour average with the U.S. EPA scaling factor of 0.4 would be incorrect.

In the event the emissions are intermittent but randomly distributed throughout the day, the scaling factor of 0.4 may be appropriate because the natural diurnal variability of meteorological conditions are concurrent with emissions. An additional pro-rating of the concentration, when estimating a 24-hour concentration, would be required to discount due to the intermittent nature of the emissions.

We recommend the following steps to estimate a screening based estimate of annual average concentrations from intermittent emissions.

1. Estimate the maximum one-hour concentration ($c_{1\text{-hr}}$) based on the SCREEN3 model approach (or similar, e.g., ISCST3 with screening meteorological data) for possible meteorological conditions consistent with the operating conditions and the actual hourly emission rate. It is acceptable to estimate downwind concentrations using all meteorological combinations available to SCREEN3. However, it is possible to be selective for the choices of meteorological conditions and still be conservative. For example, daytime only emissions need not be evaluated for nighttime stable atmospheric conditions (Pasquill-Gifford classes A through D are unstable and neutral atmospheric conditions applicable during the day. Classes D through F are neutral and stable atmospheric conditions applicable during the night.)
2. Estimate the concentration for the longest averaging period applicable based on the length of time of the systematic or randomly distributed emissions and the factors in Table H.1. For example, the longest averaging period concentration that may be estimated with the U.S. EPA scaling factors is an 8-hour concentration ($c_{8\text{-hr}}$) for emissions that are systematically released for 12 hours. Scaling factors between 8-hours and 12-hours are not available. In the case of the 8-hour concentration, the U.S. EPA screening factor of 0.7 ± 0.2 to estimate the maximum 8-hour concentration is appropriate.

The U.S. EPA Screening Guidance allows for deviation from the suggested conversion factor on a case-by-case basis. We recommend the lower end of the range for the conversion factor (i.e., 0.5 for the 8-hour average) when estimating an annual average concentration. This is because variability associated with seasonal differences in wind speed, wind direction, and atmospheric stability would not be addressed otherwise. As seen in Figure H.2, there are seasonal differences in the wind direction.

For example, if X is the length of time of systematic or randomly distributed emissions, the following scalars can apply.

- $X \leq 2$ hrs; Scalar = 1.0 to estimate a 1-hour average
- $3 \text{ hrs} \leq X \leq 7$ hrs; Scalar = 0.8 to estimate a 3-hour average
- $8 \text{ hrs} \leq X \leq 20$ hrs; Scalar = 0.5 to estimate an 8-hour average (the selection of 20 hours is arbitrary)
- $21 \text{ hrs} \leq X \leq 24$ hrs; this may be a continuous release, use standard screening procedures.

3. Estimate the annual average concentration (c_{annual}) by assuming the longer averaging period estimated above is persistent for the entire year. In the above example the 8-hour concentration is assumed to be persistent for an entire year to estimate an annual average concentration (i.e., the annual average concentration is assumed to be equal to the 8-hour concentration).

In addition, the annual average concentration should be pro-rated over the final averaging period based on the pro-rated emissions (i.e., the calculation should include the fact that for some hours over the year, the emission rate is zero).

For example, if Y is the number of operating hours in the year (e.g., $Y = X * 365$), the following may apply.

$$(c_{\text{annual}}) = (c_{1\text{-hr}}) (\text{Scalar}) (Y/8760\text{hrs/yr})$$

4. The hourly emission rate should be calculated based on the assumed operating schedule in the steps above. An example for a facility operating Y hours per year follows.

$$(q_{\text{hourly}}) = (Q_{\text{yearly}})/(Y \text{ hrs/yr})$$

5. The annual average concentration (or ground level concentration GLC) can be estimated as follows.

$$\begin{aligned} \text{GLC} &= (c_{\text{annual}}) (q_{\text{hourly}}) \\ &= (c_{1\text{-hr}})(\text{Scalar}) (Y\text{hrs}/8760\text{hrs}) (Q_{\text{yearly}})/(Y \text{ hrs/yr}) \\ &= (c_{1\text{-hr}})(\text{Scalar}) (Q_{\text{yearly}})/(8760 \text{ hrs/yr}) \end{aligned}$$

Practically speaking, the above five steps condense down to determining three values. The first value is the maximum 1-hour concentration. The second value is the Scalar (either 1.0, 0.8, or 0.5). And the third value is the hourly emission rate estimated by uniformly distributed over the entire year (8760 hours). The operating hours per year drops out of the calculations for an annual average concentration provided the emissions are based on an annual inventory (See step 5).

In the event that the acute averaging period is required and the emissions are based on an annual inventory, then the annual operating hours are required.

Below are four examples using the steps as outlined above. In each case, the annual average concentration is the desired value for use in risk assessment calculations. A fifth example is also included to demonstrate the need for the operating hours per year for an acute analysis when the inventory is provided on an annual basis.

Example 1 - Fugitive Gasoline Station Emissions

Emissions are **continuous** for 24 hours per day and 365 days per year.

1. Estimate the maximum 1-hour concentration with the Screen3 model (or similar screening modeling approach), $c_{1\text{-hr}}$.
2. Estimate the annual average concentration, c_{annual} , with the U.S. EPA screening factor of 0.08.
$$(c_{\text{annual}}) = (c_{1\text{-hr}})(0.08)$$
3. The hourly emission rate, q_{hourly} , for the annual average concentration is based on 24 hours per day and 365 days per year (8760 hours per year).
$$(q_{\text{hourly}}) = (Q_{\text{yearly}})/(8760 \text{ hrs/yr})$$
4. The annual average concentration (or ground level concentration GLC) can be estimated as follows.
$$\text{GLC} = (c_{\text{annual}}) (q_{\text{hourly}})$$
$$\text{GLC} = (c_{1\text{-hr}})(0.08) (Q_{\text{yearly}})/(8760 \text{ hrs/yr})$$

Example 2 - Dry Cleaner Emissions

Emissions are **intermittent** over the year but **systematic** for 10 hours per day, 5 days per week and 50 weeks per year.

1. Estimate the maximum 1-hour concentration with the Screen3 model (or similar screening modeling approach), $c_{1\text{-hr}}$.
2. Estimate the maximum 8-hour average concentration, $c_{8\text{-hr}}$, with the U.S. EPA screening factor of 0.7 ± 0.2 as the longest averaging period of continuous release. The averaging period would need to be less than 10 hours. Use the lower range of the screening factor, 0.5, because the annual average is the final product and variability due to seasonal differences are not accounted for otherwise.
$$(c_{8\text{-hr}}) = (c_{1\text{-hr}})(0.5)$$
3. Assume the worst-case 8-hour concentration is persistent throughout the year and pro-rate the concentration based on emissions over the year. For this dry cleaner, there are 2500 hours of operating condition emissions. Therefore the annual average is calculated as follows.
$$(c_{\text{annual}}) = (c_{8\text{-hr}}) (2500\text{hrs}/8760\text{hrs})$$
$$= (c_{1\text{-hr}})(0.5) (2500\text{hrs}/8760\text{hrs})$$

4. The hourly emission rate, q_{hourly} , for the annual average concentration is based on 2500 hours per year.

$$(q_{\text{hourly}}) = (Q_{\text{yearly}})/(2500 \text{ hrs/yr})$$
5. The annual average concentration (or ground level concentration GLC) can be estimated as follows.

$$\begin{aligned} \text{GLC} &= (c_{\text{annual}}) (q_{\text{hourly}}) \\ &= (c_{1\text{-hr}})(0.5) (2500\text{hrs}/8760\text{hrs}) (Q_{\text{yearly}})/(2500 \text{ hrs/yr}) \\ &= (c_{1\text{-hr}})(0.5) (Q_{\text{yearly}})/(8760 \text{ hrs/yr}) \end{aligned}$$

Example 3 - Burning Barrel Emissions

Emissions are **intermittent** over the year and **random** during daylight hours for two hours per burn, two burns per week, and 52 weeks per year.

1. Estimate the maximum 1-hour concentration with the Screen3 model (or similar screening modeling approach), $c_{1\text{-hr}}$. Meteorological combinations may be restricted to daytime conditions for this screening analysis. Pasquill-Gifford stability classes A, B, C, and D are unstable and neutral conditions for daytime conditions.
2. Estimate the maximum 8-hour average concentration, $c_{8\text{-hr}}$, with the U.S. EPA screening factor of 0.7 ± 0.2 as the longest averaging period where the emissions have the potential to be randomly distributed. Depending on the day of the year and latitude of the emissions, the daylight hours can vary. For this example, we assume the daylight hours can be as short as 10 hours per day to as long as 14 hours per day. Since the emissions are randomly distributed throughout the daylight hours, the longest averaging period we can scale with U.S. EPA scaling factors is a 10 hour average. In this case, the averaging period becomes the 8-hour average and the scaling factor becomes 0.7 ± 0.2 . Again since this is for an annual average, we use the lower end of the range, 0.5.

$$(c_{8\text{-hr}}) = (c_{1\text{-hr}})(0.5)$$
3. Assume the worst-case 8-hour concentration is persistent throughout the year and pro-rate the concentration based on the emissions over the year. For the burning barrels there are 208 hours of operating condition emissions ($208 \text{ hrs} = (2\text{hrs/burn})(2\text{burns/wk})(52\text{wk/yr})$). Therefore the annual average concentration is calculated as follows.

$$\begin{aligned} (c_{\text{annual}}) &= (c_{8\text{-hr}}) (208\text{hrs}/8760\text{hrs}) \\ &= (c_{1\text{-hr}})(0.5) (208\text{hrs}/8760\text{hrs}) \end{aligned}$$
4. The hourly emission rate, q_{hourly} , for the annual average concentration is based on 208 hours per year.

$$(q_{\text{hourly}}) = (Q_{\text{yearly}})/(208 \text{ hrs/yr})$$
5. The annual average concentration (or ground level concentration GLC) can be estimated as follows.

$$\begin{aligned}\text{GLC} &= (c_{\text{annual}}) (q_{\text{hourly}}) \\ &= (c_{1\text{-hr}})(0.5) (208\text{hrs}/8760\text{hrs}) (Q_{\text{yearly}})/(208 \text{ hrs/yr}) \\ &= (c_{1\text{-hr}})(0.5) (Q_{\text{yearly}})/(8760 \text{ hrs/yr})\end{aligned}$$

Example 4 - Standby Diesel Engine Testing

Emissions are **intermittent** over the year and **systematic** for two hours per week and 50 weeks per year. The engine testing is conducted at 2 pm on Fridays.

1. Estimate the maximum 1-hour concentration with the Screen3 model (or similar screening modeling approach), $c_{1\text{-hr}}$. Meteorological combinations may be restricted to daytime conditions in this screening analysis because the engine test is conducted at 2 pm. Pasquill-Gifford stability classes A, B, C, and D are unstable and neutral conditions for daytime conditions.
2. In this case, the emission schedule is systematically fixed over a two hour period. Therefore, the longest averaging period which is applicable for the U.S. EPA screening factors is one-hour because a two-hour conversion factor is not available. Therefore, we assume the maximum 1-hour concentration is persistent for the entire year. We still prorate the concentration based on the emissions. There are 100 hours of engine testing per year. Therefore the annual average concentration becomes.
 $(c_{\text{annual}}) = (c_{1\text{-hr}}) (100\text{hrs}/8760\text{hrs})$

3. The hourly emission rate, q_{hourly} , for the annual average concentration is based on 100 hours per year.
 $(q_{\text{hourly}}) = (Q_{\text{yearly}})/(100 \text{ hrs/yr})$

4. The annual average concentration (or ground level concentration GLC) can be estimated as follows.

$$\begin{aligned}\text{GLC} &= (c_{\text{annual}}) (q_{\text{hourly}}) \\ &= (c_{1\text{-hr}}) (100\text{hrs}/8760\text{hrs}) (Q_{\text{yearly}})/(100 \text{ hrs/yr}) \\ &= (c_{1\text{-hr}}) (Q_{\text{yearly}})/(8760 \text{ hrs/yr})\end{aligned}$$

Below is an example using the steps above to estimate an acute concentration longer than a 1-hour averaging period. This case is similar to Example 3 above with the exception of the averaging period.

Example 5 - Burning Barrel Emissions – Acute REL

Emissions are **intermittent** over the year and **random** during daylight hours for two **continuous** hours per burn, two burns per week, and 52 weeks per year. The arsenic acute REL is for a 4-hour averaging period. The steps below are used to estimate the acute concentration, 4-hour REL, for arsenic.

1. Estimate the maximum 1-hour concentration with the Screen3 model (or similar screening modeling approach), $c_{1\text{-hr}}$. Meteorological combinations may be restricted

to daytime conditions for this screening analysis. Pasquill-Gifford stability classes A, B, C, and D are unstable and neutral conditions for daytime conditions.

2. The maximum 1-hour concentration is used as is without screening adjustment factors listed in Tables H.1 or H.2. The emissions are **continuous** through a 2-hour event within a 4-hour window. The adjustments in Table H.2 would only be used if the emissions were continuous for a 4-hour event or **randomly** distributed through a 4-hour event.
3. Assume the worst-case 1-hour concentration is persistent for the 4-hour averaging period and pro-rate the concentration based on the emissions over the 4-hour window. For the burning barrels there are 2 hours of operating condition emissions (2hrs/burn). Therefore the 4-hour average concentration is calculated as follows.
$$(C_{4\text{-hr}}) = (C_{1\text{-hr}}) (2\text{hrs}/4\text{hrs})$$
4. The hourly emission rate, q_{hourly} , for the annual average concentration is based on 208 hours per year (208 hrs = (2hrs/burn)(2burns/wk)(52wk/yr)).
$$(q_{\text{hourly}}) = (Q_{\text{yearly}})/(208 \text{ hrs/yr})$$
5. The 4-hr average concentration (or ground level concentration $GLC_{4\text{-hr}}$) can be estimated as follows.
$$\begin{aligned} GLC_{4\text{-hr}} &= (C_{4\text{-hr}}) (q_{\text{hourly}}) \\ &= (C_{1\text{-hr}}) (2\text{hrs}/4\text{hrs}) (Q_{\text{yearly}})/(208 \text{ hrs/yr}) \end{aligned}$$

This step of Example 5 differs from the previous Examples because the number of operating hours per year does not drop out of the calculation as seen above.

The above methods were used in a recent modeling evaluation for emissions from a burning barrel (example 3 above) (ARB, 2002). Table H.3, below, shows results from the modeling evaluation. Shown in Table H.3 are the maximum annual average concentration based on the screening approach outlined above as well as a refined approach with site specific meteorological data from four locations, Alturas, Bishop, San Benito, and Escondido. As seen in Table H.3, the screening evaluation as described in the example overestimates the values calculated based on the refined analysis. This is the desired outcome of a screening approach.

Table H.3 Maximum Annual Average Concentration (c/q) Above Ambient Conditions - Burning Barrel Emissions					
Met. City	Alturas	Bishop	San Benito	Escondido	SCREENING
D (m)	(mg/m ³)/(g/s)	(mg/m ³)/(g/s)	(mg/m ³)/(g/s)	(mg/m ³)/(g/s)	(mg/m ³)/(g/s)
20	44.	61.	85.	110.	590.
50	12.	16.	22.	30.	230.
100	4.	5.	7.	9.	85.
Notes: (a) Annual χ/q is based on 208 hours of emissions at 1 g/s. (b) χ/q is the concentration in $\mu\text{g}/\text{m}^3$ based on an hourly emission rate of 1 g/s.					

G. Implementation

The approach outlined above has been implemented in the HARP program. Appendix J provides example output files from the Hot Spot Analysis and Reporting Program (HARP). The HARP software has been developed by a contractor through consultation with OEHHA, Air Resources Board (ARB), and District representatives. The HARP software is the recommended model for calculating and presenting HRA results for the Hot Spots Program. Information on obtaining the HARP software can be found on the ARB's web site at www.arb.ca.gov. Note, since the HARP software is a tool that uses the methods specified in this document, the software will be available after these guidelines have undergone public and peer review, been endorsed by the state's Scientific Review Panel (SRP) on Toxic Air Contaminants, and adopted by OEHHA.

References

- ARB (1994). ARB memorandum dated 4/11/94 from A. Ranzieri to J. Brooks on the subject, "One-hour to Thirty-day Average Screening Factor."
- ARB (2002). Staff Report: Initial Statement of Reasons for the Proposed Airborne Toxic Control Measure to Reduce Emissions of Toxic Air Contaminants from Outdoor Residential Waste Burning, January 2002. California Air Resources Board.
- U.S. EPA (1992). Screening Procedures for Estimating the Air Quality Impact of Stationary Sources, Revised, October 1992, EPA-454/R-92-019. U.S. Environmental Protection Agency, Research Triangle Park, NC.

Appendix I

Calculation Examples for

Estimating Potential Health Impacts

Appendix I

Calculation Examples for Estimating Potential Health Impacts

This appendix provides three example calculations to illustrate the procedures to estimate potential health impacts from a facility. The examples provided are intended to assist the risk assessor in understanding the steps associated with conducting the final step of risk assessment, risk characterization. The three examples provided in this appendix evaluate the inhalation cancer risk, the noncancer acute hazard quotient (HQ) and hazard index (HI), and the multipathway (inhalation and oral) noncancer chronic HQ and HI for seven compounds. Specific requirements for health risk assessment (HRA) under the Hot Spots Program are presented in Chapter 8. The HARP software will perform the calculations that are presented here and required in Chapters 8 and 9. See the ARB's website at www.arb.ca.gov for more information on HARP.

A. Sample Calculation for Inhalation Cancer Health Risk Assessment

The following example illustrates the steps for calculating cancer risk at the maximum exposed individual resident (MEIR) using the high-end point-estimate for the inhalation exposure pathway. This example does not cover the steps for completing a noninhalation or multipathway HRA. Algorithms to estimate point-estimate and stochastic multipathway exposure can be found in Chapter 5. For simplicity, it is recommended that the risk assessor use HARP to conduct a multipathway risk assessment or stochastic risk assessment.

Step one - Determine the annual average concentration at the MEIR and inhalation cancer potency factor for each emitted compound.

The risk assessor would obtain the annual average concentrations from the air dispersion modeling results. This step has been completed for this example. Table I.1 presents the annual average concentrations at our hypothetical facility. In addition, Table I.1 also presents inhalation cancer potency factors for each substance, which also can be found in Chapter 7 and Appendix L. Note that where no inhalation cancer potency has been developed for a substance, the tables in this example have been annotated with dashes, since it will not be possible to conduct a quantitative risk assessment for these compounds. As previously stated, this example does not take into account multipathway effects for the compounds listed in Table I.1. It is recommended that the risk assessor use HARP for conducting such an analysis.

Table I.1 Annual Average Concentrations at the MEIR and Inhalation Cancer Potency Factors

Substance	Annual Average Concentrations (mg/m ³)	Inhalation Cancer Potency Factor (mg/kg-d) ⁻¹
Ammonia	--	--
Arsenic	0.0015	12
Benzene	5	0.10
Chlorine	--	--
Chlorobenzene	--	--
2,3,7,8-TCDD (dioxin)	0.000004	130,000
Nickel	0.02	0.91

Step two - Determine the inhalation dose for each compound.

Once you have determined the annual average concentration for the emitted substance, the equation below is used to calculate the inhalation dose for each substance. This equation is listed in Section 5.4.1 of this document, and is also listed in the *Air Toxics Hot Spots Risk Assessment Guidelines; Part IV; Exposure Assessment and Stochastic Analysis Technical Support Document (OEHHA, 2000b)* (Part IV TSD).

$$\text{dose} - \text{inh} = \frac{(\text{C}_{\text{air}})(\text{DBR})(A)(\text{EF})(\text{ED})(1 \times 10^{-6})}{\text{AT}}$$

Where:

- dose-inh = Dose through inhalation (mg/kg/d)
- 1×10^{-6} = Micrograms to milligrams conversion (10^{-3} mg/ μ g), liters to cubic meters conversion (10^{-3} m³/l)
- C_{air} = Concentration in air (μ g/m³)
- DBR = Daily breathing rate (L/kg body weight-day or L/kg-day)
- A = Inhalation absorption factor
- EF = Exposure frequency (days/year)
- ED = Exposure duration (years)
- AT = Averaging time period over which exposure is averaged, in days (e.g., 25,550 days for 70 year cancer risk)

A summary of the exposure point-estimates and data distributions for use in risk assessment can be found in Chapter 5 of this document. For more detail on point-estimates and data distributions see the Part IV TSD. The recommended default values presented in Table I.2 can be used when site-specific information is not available.

Table I.2 Recommended Default Values

Variable	Recommended Default Value
EF	350 days/year
ED	9; 30; or 70 years
AT	70 years (25,550 days)
DBR (used in this example) 30 and 70 year-exposure	271 (mean); 393 (95 th percentile) L/kg body weight – day (For other DBRs see Table 5.4, Chapter 5)
A	1 (currently used for all substances included in the Hot Spots program)

The following equation shows the calculation for the inhalation dose of arsenic by using the annual average concentration for arsenic (Table I.1) and the recommended default values in Table I.2. Note that the high-end (95th percentile) 70-year daily breathing rate of 393 liters/kg - day was used in this example.

$$\text{arsenic (dose - inh)} = \frac{\left(\frac{0.0015 \text{ mg}}{\text{m}^3} \right) \left(\frac{393 \text{ liters}}{\text{kg} - \text{day}} \right) \left(1 \right) \left(\frac{350 \text{ days}}{\text{year}} \right) (70 \text{ years}) \left(\frac{1 \times 10^{-3} \text{ mg}}{1 \text{ mg}} \right) \left(\frac{1 \times 10^{-3} \text{ m}^3}{\text{liters}} \right)}{25,550 \text{ days}}$$

$$\text{arsenic (dose - inh)} = 5.7 \times 10^{-7} \text{ mg / kg - day}$$

This calculation would be repeated for each substance under evaluation using their respective annual average concentrations. For our hypothetical facility, we have calculated each inhalation dose for each substance. Table I.3 shows the results from our analysis.

Table I.3 Calculated Doses for Substances

Compound	Calculated Dose
Ammonia	--
Arsenic	5.7 x 10 ⁻⁷
Benzene	1.9 x 10 ⁻³
Chlorine	--
Chlorobenzene	--
2,3,7,8-TCDD (dioxin)	1.5 x 10 ⁻⁹
Nickel	7.5 x 10 ⁻⁶

Step three – Determine potential inhalation cancer risk for the MEIR.

Once you have calculated the inhalation dose, multiply the dose by the inhalation cancer potency factor as shown below. Use a factor of 1×10^6 to express cancer risk in chances per million.

$$\left(\text{Inhalation Dose} \frac{\text{mg}}{\text{kg} - \text{day}} \right) \left(\text{Cancer Potency} \frac{\text{kg} - \text{day}}{\text{mg}} \right) (1 \times 10^6) = \text{Cancer Risk (chances per million)}$$

For our hypothetical facility, the equation below shows the calculation for the inhalation cancer risk of arsenic. For this example, the inhalation cancer potency factor for arsenic is $12 (\text{mg/kg-d})^{-1}$ taken from Table I.1.

$$\left(5.7 \times 10^{-7} \frac{\text{mg}}{\text{kg} - \text{day}} \right) \left(12 \frac{\text{kg} - \text{day}}{\text{mg}} \right) (1 \times 10^6) = 6.8 \text{ chances per million}$$

Use the substance-specific inhalation dose and inhalation cancer potency factor to determine the cancer risk for each compound by repeating this step. Finally, sum the individual substance cancer risks to give you the total facility (inhalation) cancer risk. Table I.4 shows the individual substance and total facility potential (inhalation) cancer risk. In this example, our hypothetical facility poses a (inhalation) cancer risk of 399 chances per million at the MEIR. Note, although not presented here, a facility emitting arsenic or dioxins should also evaluate cancer risk from noninhalation exposure pathways.

Table I.4 Hypothetical Facility Inhalation Cancer Risk

Compound	Cancer risk (per million)
Ammonia	--
Arsenic	6.8
Benzene	190
Chlorine	--
Chlorobenzene	--
2,3,7,8-TCDD (dioxin)	195
Nickel	6.8
Total Facility Inhalation Cancer Risk	399

While this example illustrates the steps used to calculate cancer risk using the inhalation dose algorithm, steps one through three can also be used to calculate noninhalation cancer risk and ultimately multipathway (inhalation and noninhalation pathway) cancer risk. To determine noninhalation cancer risk, an assessor should use the appropriate exposure pathway algorithm presented in Chapter 5. For example, equation 5.4.3.1.A (Chapter 5) would be used to determine

dose for the soil ingestion pathway. Once the assessor has determined the ingestion dose, the cancer risk for that pathway is calculated using the substance-specific oral slope factor. Oral slope factors can be found in Appendix L and Chapter 7. To calculate multipathway cancer risk, the cancer risks for all substances and exposure pathways are summed. See Chapter 8 for further discussion.

B. Sample Calculation of Noncancer Acute Hazard Indices

Risk characterization for noncancer health impacts are expressed as a hazard quotient (for individual substances) or a hazard index (for multiple substances). In addition, all hazard quotients (HQ) and hazard indices (HI) must be determined by target organ system. The example below illustrates the approach for calculating a noncancer acute HQ and HI at the MEIR. As discussed in Chapter 8, the following example is provided to assist the risk assessor in understanding how to calculate an acute HQ and HI. Using HARP, both the acute HQ and HI will be automatically calculated at each receptor. No exposure duration adjustment should be made for noncancer assessments. Specific requirements for risk assessment under the Hot Spots Program can be found in Chapters 8 and 9.

Step one - Determine the 1-hour maximum concentrations at the MEIR and acute reference exposure levels (RELs) for each emitted substance.

The risk assessor would obtain the 1-hour maximum (or 4, 6, or 7-hour, if required) concentrations from the air dispersion modeling results. This step has been completed for this example. Table I.5 presents the maximum 1, 4, 6, or 7-hour concentrations, target organ systems, and acute RELs for seven substances. Note that where an acute REL has not been developed for a substance, the tables in this example have been annotated with dashes. In this

Table I.5 Concentrations, Acute RELs, and Target Organ System(s) for Substances at the MEIR

Substance	1, 4, 6 or 7-hour Maximum Concentration (mg/m ³)	Acute REL (mg/m ³)	Target Organ System(s)
Ammonia	1900	3200	Respiratory system; Eye
Arsenic	0.03	0.19	Reproductive/developmental
Benzene	20	1300	Reproductive/developmental; Immune system; Hematologic system
Chlorine	40	210	Respiratory system; Eye
Chlorobenzene	--	--	--
2,3,7,8-TCDD (dioxin)	--	--	--
Nickel	1.8	6	Respiratory system; Immune system

example, chlorobenzene and 2,3,7,8-TCDD (dioxin) do not have acute REL values. The acute RELs and their corresponding target organ system(s) can be found in Table 6.1 (Chapter 6) and also in Appendix L.

Step two - Determine the hazard quotient for each compound.

The hazard quotients for each compound are calculated by taking the acute maximum 1, 4, 6, or 7-hour concentration and dividing by the substance-specific acute REL. The following equation shows how to calculate the hazard quotient for ammonia.

$$\text{Acute Hazard Quotient} = \frac{\left(\text{Maximum 1, 4, 6, or 7-hr Concentration} \right)}{\left(\text{Acute REL} \right)} \Rightarrow \text{Acute Hazard Quotient}_{(\text{ammonia})} = \frac{\left(1900 \text{ mg} / \text{m}^3 \right)}{\left(3200 \text{ mg} / \text{m}^3 \right)} = 0.6$$

Step three – Determine the HI for all emitted substances.

The acute HI is calculated by summing each hazard quotient for each substance by target organ system(s). For example, add the HQs for all substances that impact the respiratory system, then repeat this step for the next target organ system (e.g., reproductive/developmental system). This step is repeated until all target organs (for the substances emitted) are individually totaled. See Table 6.1 for target organ system information. Note, never add together the HQs or HIs for different target organ systems (e.g., do not add the impacts for the respiratory system to the reproductive/developmental system). Table I.6 shows individual hazard quotients for each substance and total hazard index. {Bob, adding benzene (6-hr) and arsenic (4-hr) below OK?}

Table I.6 Individual Hazard Quotients and Total Hazard Index

Substance	Immune System	Reproductive/ Developmental	Hematologic System	Respiratory System	Eye
Ammonia				0.6	0.6
Arsenic		0.2			
Benzene	0.02	0.02	0.02		
Chlorine				0.2	0.2
Chlorobenzene					
2,3,7,8-TCDD (dioxin)					
Nickel	0.3			0.3	
Total Hazard Index	0.32	0.22	0.02	1.1	0.8

In this example, an HQ of one was not equaled or exceeded for any individual substance. However, an HI (the sum of the hazard quotients for each target organ) of one was exceeded for the respiratory system. Exceeding a hazard index of one may indicate that there is the potential for adverse acute health impacts at this receptor location. Therefore, there is increased concern that exposed individuals may experience respiratory system irritation, particularly among sensitive individuals. The District and OEHHA should be consulted when a hazard index exceeds one (see Section 8.3).

C. Sample Calculation of Noncancer Chronic Hazard Indices

The example below illustrates the approach for calculating a noncancer chronic HQ and HI at the MEIR. An HQ expresses the noncancer health impacts for an individual substance and an HI expresses the potential impacts for multiple substances. As discussed in Chapter 8, the following example is provided to assist the risk assessor in understanding the calculation of a chronic HQ and HI. Using the HARP software, both the chronic HQ and HI will be automatically calculated at each receptor. No exposure duration adjustment (e.g., 9/70) should be made for noncancer assessments. Specific requirements for risk assessment under the Hot Spots Program can be found in Chapters 8 and 9.

Step one - Determine the annual average concentrations at the MEIR and inhalation and oral chronic RELs for each emitted substance.

The risk assessor would obtain the substance-specific annual average concentrations from the air dispersion modeling results. This step has been completed for this example. Table I.7 presents the annual average concentrations, target organ systems, and chronic RELs for seven substances. All of the substances have a chronic REL value associated with them. In addition, arsenic, dioxins, and nickel are multipathway substances; therefore, oral and dermal exposure must be included as potential exposure pathways. The chronic RELs and their corresponding target organ system(s) can be found in Tables 6.2 and 6.3 (Chapter 6) and also in Appendix L.

Table I.7 Annual Average Concentrations, Chronic RELs, and Target Organ Systems for Substances at the MEIR.

Substance	Annual Average Conc. (mg/m ³)	Chronic REI (inhalation) (mg/m ³)	Target Organ System(s) (inhalation)	Chronic Oral REL (mg/kg-day)	Target Organ System(s) (oral/dermal)
Ammonia	160	200	Respiratory System	-	-
Arsenic	0.0015	0.03	Development; Cardiovascular System; Nervous System	0.0003	Cardiovascular system; skin
Benzene	5	60	Hematopoietic System; Development; Nervous System	-	-
Chlorine	0.08	0.2	Respiratory System	-	-
Chlorobenzene	20	1000	Alimentary System; Kidney; Reproductive System	-	-
2,3,7,8-TCDD (dioxin)	0.000004	0.00004	Alimentary System (Liver); Reproductive System; Development; Endocrine System; Respiratory System; Hematopoietic System	0.00000001 (10 pg/kg-day)	Alimentary System (Liver); Reproductive System; Development; Endocrine System; Respiratory System; Hematopoietic System
Nickel	0.02	0.05	Respiratory System; Hematopoietic System	0.05	Alimentary System

Step two – Determine the inhalation chronic hazard quotient for each substance.

For inhalation exposure, the individual hazard quotients for each substance are calculated by taking the annual average concentration and dividing by its corresponding chronic inhalation REL. Using the information contained in Table I.7, the equation below is used to calculate the inhalation hazard quotient for arsenic.

$$\text{Chronic Hazard Quotient} = \frac{\left(\text{Annual } ^\circ \text{avg. Concentration} \right)}{\left(\text{Chronic REL} \right)} \Rightarrow \text{Chronic Hazard Quotient}_{(\text{arsenic})} = \frac{(0.0015 \text{ mg} / \text{m}^3)}{(0.03 \text{ mg} / \text{m}^3)} = 0.05$$

Step three – Determine the noninhalation hazard quotient for each substance.

For the substances that are subject to deposition, noninhalation (i.e., oral and dermal) exposure pathways need to be considered in the chronic hazard quotient evaluation. The point-estimates and algorithms for calculating the oral dose for all of the applicable exposure

pathways and receptors (e.g., workers or residents) are explained in Chapter 5. Note, the HARP software uses the appropriate information and performs all the steps discussed in these examples.

As discussed in Sections 8.2.5 and 8.3, Tier-1 of the tiered approach to risk assessment states that the high-end point-estimates are used for the two dominant noninhalation exposure pathways and the non-dominant exposure pathways use the average point-estimates to determine the dose and chronic health impacts at a residential receptor. To determine which exposure pathways are the two dominant ones, high-end point-estimates are used for all applicable exposure pathways to see which two pathways provide the highest impacts for each substance. Once the two dominant noninhalation pathways are determined for each substance, the doses for the remaining noninhalation exposure pathway for that substance are recalculated using the average point-estimates. The 70-year exposure duration point-estimates are used for residential receptors and the worker (single) point-estimates are used for the maximum exposed worker (see Chapter 5). No exposure duration adjustment (e.g., 9/70) should be made for noncancer assessments.

This example shows how to combine the impacts from multiple exposure pathways to obtain an oral (noninhalation) hazard quotient for a single substance. For each substance, the impacts for a specific exposure pathway are assessed by dividing the oral dose (derived from the annual average concentration) in milligrams per kilogram-day (mg/kg-day) by the oral chronic REL, expressed in units of (mg/kg-day) (Table 6.3). The next equation shows the HQ calculation for arsenic through the soil ingestion (SI) exposure pathway.

Note, prior to this point in this calculation, we are assuming several steps have taken place. These steps include: 1) the completion of air dispersion modeling to obtain the ground-level annual-average air concentration; 2) identification of the existing exposure pathways at the receptor location; 3) calculation of the concentration in the exposure media (e.g., for soil - Equation 5.3.2.A); 4) determination of the dominant noninhalation exposure pathway(s) for the substance; and 5) the calculation of the substance-specific dose for that exposure pathway (e.g., Equation 5.4.3.1.A is used to calculate the dose from soil ingestion). See Chapter 5 for the algorithms for calculating the oral dose for all of the applicable exposure pathways and receptors. For this example, the calculated dose for arsenic from soil ingestion is assumed to be 0.000015 mg/kg-day.

$$\begin{array}{l} \text{Chronic} \\ \text{Oral Hazard} \\ \text{Quotient} \end{array} = \frac{SI \text{ dose}}{\left(\begin{array}{l} \text{Chronic} \\ \text{Oral REL} \end{array} \right)} \Rightarrow \begin{array}{l} \text{Chronic} \\ \text{Oral Hazard} \\ \text{Quotient} \end{array} = \frac{(0.000015 \text{ mg / kg - day})}{(0.0003 \text{ mg / kg - day})} = 0.05$$

(SI arsenic)

For each substance, this step is repeated for each applicable noninhalation exposure pathway. As illustrated below, the (total) oral HQ for a substance is calculated by summing the HQs for all applicable exposure pathways. In this example, the chronic oral HQ is assumed to equal 0.1.

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$$\begin{array}{l} \text{Chronic Oral} \\ \text{Hazard} \\ \text{Quotient}^*_{(\text{arsenic})} \end{array} = [\text{HQ}_{(\text{SI})} + \text{HQ}_{(\text{D})} + \text{HQ}_{(\text{DW})} + \text{HQ}_{(\text{MI})} + \text{HQ}_{(\text{FI})} + \text{HQ}_{(\text{HV})}]$$

$$\begin{array}{l} \text{Chronic Oral} \\ \text{Hazard} \\ \text{Quotient}^*_{(\text{arsenic})} \end{array} = 0.1$$

* Noninhalation pathways:

SI = soil ingestion

FI = fisher-caught fish

DW = drinking water

HV= homegrown vegetables

D = dermal absorption

BM= breast milk (not applicable for arsenic exposure)

MI = meat, milk & egg

Step four – Determine the chronic HI

The chronic HI is calculated by summing each hazard quotient (inhalation and noninhalation) for each substance by the target organ system(s). For example, add the HQs for all substances that impact the respiratory system, then repeat this step for the next target organ

Table I.8 Substance-Specific Inhalation and Noninhalation Hazard Quotients and the Hazard Index by Target Organ System

Substance	Respiratory System	Hematopoietic System	Alimentary System	Endocrine System	Development	Reproductive System	Kidney	Nervous System	Cardiovascular System	Skin
Ammonia	0.8									
Arsenic					0.05(i)			0.05(i)	0.05(i) 0.1(ni)	0.1(ni)
Benzene		0.08			0.08			0.08		
Chlorine	0.04									
Chlorobenzene			0.02			0.02	0.02			
2,3,7,8-TCDD (dioxin)	0.1(i) 0.2(ni)	0.1(i) 0.2(ni)	0.1(i) 0.2(ni)	0.1(i) 0.2(ni)	0.1(i) 0.2(ni)	0.1(i) 0.2(ni)				
Nickel	0.4(i)	0.4(i)	0.1(ni)							
Hazard Index	1.54	0.78	0.32	0.3	0.43	0.32	0.02	0.13	0.15	0.1

i = inhalation pathway contribution

ni = noninhalation pathway contribution

system (e.g., cardiovascular system). This step is repeated until all target organs (for the substances emitted) are individually totaled. See Tables 6.2 and 6.3 for target organ system information. Note, never add together the HQs or HIs for different target organ systems (e.g., do not add the impacts for the respiratory system to the cardiovascular system). No exposure duration adjustment (e.g., 9/70) should be made for noncancer assessments. Table I.8 shows individual hazard quotients (inhalation and noninhalation) for each substance and the hazard index by target organ system. In this table, arsenic is highlighted in bold to identify how the information calculated above is presented and used.

In this example, an HQ of one was not equaled or exceeded for any individual substance. However, an HI (the sum of the hazard quotients for each target organ) of one was exceeded for the respiratory system. Exceeding a hazard index of one may indicate that there is the potential for adverse chronic health impacts at this receptor location. Therefore, there is increased concern that exposed individuals may experience respiratory system irritation or injury, particularly among sensitive individuals. The District and OEHHHA should be consulted when a hazard index exceeds one (see Section 8.3).

Appendix J

Glossary Of Acronyms and Definition of Selected Terms

Glossary of Acronyms and Definitions of Selected Terms

Acute Exposure: One or a series of short-term exposures generally lasting less than 24 hours.

Acute Health Effects: A health effect that occurs over a relatively short period of time (e.g., minutes or hours). The term is used to describe brief exposures and effects which appear promptly after exposure.

Adverse Health Effect: A health effect from exposure to air contaminants that may range from relatively mild temporary conditions, such as eye or throat irritation, shortness of breath, or headaches, to permanent and serious conditions, such as birth defects, cancer or damage to lungs, nerves, liver, heart, or other organs.

AERMOD: a proposed (by U.S. EPA) steady-state, plume-based air dispersion model for estimating near-field impacts from a variety of industrial source types (designed to provide reasonable concentration estimates over a wide range of conditions with minimal discontinuities, to be easily implemented with reasonable input requirements and computer resource needs, to be based on up-to-date science that captures the essential physical processes while remaining simple, and to be easily revised as the science evolves). To the extent practicable, the structure of the input or the control file for AERMOD is the same as that for ISCST3.

Air Dispersion Modeling: Algorithms, usually performed with a computer, that relate a mass emission rate, source configuration, and meteorological information to calculate ambient air concentrations.

Air District: The Air Pollution Control and Air Quality Management Districts are the political bodies responsible for managing air quality on a regional or county basis. California is currently divided into 35 air districts.

Air monitoring: The periodic or continuous sampling and analysis of air pollutants in ambient air or from individual pollutant sources.

Air Toxics Hot Spots Act Emission Inventory Reports: Documents that contain information regarding emission sources, emitted substances, emission rates and release parameters, prepared under the Emission Inventory Criteria and Guidelines (also referred to as “Inventory Reports”).

Air Toxics Hot Spots Information and Assessment Act of 1987 (AB 2588): (Health and Safety Code, Section 44300-44394) - A state law which established the “Hot Spots” Program to develop a statewide inventory of site-specific air toxic emissions, to assess the risk to public health from exposure to these emissions, to notify the public of any significant health risks and to reduce emissions below the significant risk levels.

Algorithm: a set of rules for solving a problem in a finite number of steps

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California Air Resources Board (ARB): The State's lead air quality management agency consisting of an eleven-member board appointed by the Governor. The ARB is responsible for attainment and maintenance of the state and federal air quality standards, and is fully responsible for motor vehicle pollution control. It oversees county and regional air pollution management programs.

Asthma: A chronic inflammatory disorder of the lungs characterized by wheezing, breathlessness, chest tightness, and cough.

Atmospheric half-life: The time required for the concentration of a pollutant or reactant to fall to one-half of its initial value.

Benchmark Dose: That dose derived from linear regression of one or more dose-response curves associated with a specific response rate (such as 1, 5, or 10%) in the test population. This is the starting dose to which uncertainty factors are applied to determine a reference exposure level (REL) using the benchmark dose approach.

Urban Block Groups (BGs): A geographical unit smaller than a census tract used for reporting census data. BGs contain roughly 1,100 persons.

Bioaccumulation: the concentration of a substance in a body or part of a body or other living tissue in a concentration higher than that of the surrounding environment

Bioconcentrate: The process of increasing contaminant concentration in biota up the food chain as contaminants are ingested and concentrated in tissues of organisms higher up in the chain.

Cancer burden: The estimated number of theoretical cancer cases in a defined population resulting from lifetime exposure to pollutants emitted from a facility.

Cancer potency factor (CPF): The theoretical upper bound probability of extra cancer cases occurring in an exposed population assuming a lifetime exposure to the chemical when the chemical dose is expressed in exposure units of milligrams/kilogram-day (mg/kg-d).

California Air Pollution Control Officers Association (CAPCOA): A non-profit association of the air pollution control officers from all 35 air quality districts throughout California. CAPCOA was formed in 1975 to promote clean air and to provide a forum for sharing knowledge, experience, and information among the air quality regulatory agencies around the state.

Cal/EPA: In July 1991, the California Environmental Protection Agency (Cal/EPA) was created to coordinate the State's environmental quality programs and assure that there is a cabinet level voice for environmental protection.

Chemical Abstract Services Registry Number (CAS): The Chemical Abstracts Service Registry Number (CAS) is a numeric designation assigned by the American Chemical Society's Chemical Abstracts Service and uniquely identifies a specific chemical compound. This entry allows one to conclusively identify a material regardless of the name or naming system used.

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CCR: California Code of Regulations

CERCLA: Comprehensive Environmental Response, Compensation and Liability Act (Superfund), a federal regulation providing direction and financial support for the clean-up of major hazardous waste sites

Centroid Locations: The location at which calculated ambient concentration is assumed to represent the entire subarea, typically the geometric centroid of an area, but possibly the population-weighted centroid of the area.

Census Tract: A physical area used by the U.S. Census Bureau to compile population and other statistical data.

Chronic Exposure: Long-term exposure, usually lasting one year to a lifetime.

Chronic Health Effect: An adverse non-cancer health effect that develops and persists (e.g., months or years) over time after long-term exposure to a substance

Criteria Air Pollutant: a pollutant or precursor to a pollutant for which the U.S. Environmental Protection Agency or the Air Resources Board has established an Ambient Air Quality Standard (AAQS). Examples include ozone, carbon monoxide, nitrogen dioxide, sulfur dioxide, lead, and PM₁₀ and PM_{2.5}.

Default: A value used when specific information that applies to a specific situation is not available.

Developmental toxicity: Adverse effects on the developing organism that may result from exposure prior to conception (either parent), during prenatal development, or postnatally to the time of sexual maturation. Adverse developmental effects may be detected at any point in the life span of the organism. Major manifestations of developmental toxicity include: death of the developing organism; induction of structural birth defects; altered growth; and functional deficiency.

Dilution factor (c/Q): a site-specific quantity defined as a ratio of the ground level concentration in $\mu\text{g}/\text{m}^3$ to the mass emission rate in g/s and represented by c/Q .

Dose: A calculated amount of a substance estimated to be received by the subject, whether human or animal, as a result of exposure. Doses are generally expressed in terms of amount of chemical per unit body weight; typical units are mg/kg-day.

Dose-response assessment: The process of characterizing the relationship between the exposure to an agent and the incidence of an adverse health effect in exposed populations.

DTSC: California Department of Toxic Substances Control

ED: Rural Enumeration District. A geographical unit smaller than a census tract used to report census data. EDs contain roughly 1,100 persons.

The Air Toxics Hot Spots Program Guidance Manual for Preparation of Health Risk Assessments. August 2003.

Emission Inventory Criteria and Guidelines: Regulation and Report adopted by the California Air Resources Board specifying criteria and procedures for the preparation of Air Toxics Hot Spots Act Emission Inventory Reports (Title 17, California Code of Regulations, Sections 93300-93300.5)

Endpoint: An observable or measurable biological or biochemical event including cancer used as an index of the effect of a chemical on a cell, tissue, organ, organism, etc.

Epidemiology: The study of the occurrence and distribution of a disease or physiological condition in human populations and of the factors that influence this distribution.

Exposure: Contact of an organism with a chemical, physical, or biological agent. Exposure is quantified as the amount of the agent available at the exchange boundaries of the organism (e.g., skin, lungs, digestive tract) and available for absorption.

Exposure Pathway: A route of exposure by which xenobiotics enter the human body, (e.g., inhalation, ingestion, dermal absorption).

Fugitive Dust: Dust particles that are introduced into the air through certain activities such as soil cultivation, or vehicles operating on open fields or dirt roadways. A subset of fugitive emissions.

Fugitive Emissions: Emissions not caught by a capture system which are often due to equipment leaks, evaporative processes, and windblown disturbances.

Gaussian Model: An air dispersion model based on the assumption that the time-averaged concentration of a species emitted from a point source has a Gaussian distribution about the mean centerline.

Genotoxic: having an adverse effect on the genetic material (DNA) resulting in a mutation or in chromosome damage

GLC: Estimated ground level concentration, usually for a specified averaging time (e.g., annual average, 1 hour, etc.)

Hot Spots Analysis and Reporting Program (HARP): A single integrated software package designed to promote statewide consistency, efficiency, and cost-effective implementation of health risk assessments and the Hot Spots Program. The HARP software package consists of three modules that include: 1) the Emissions Inventory Database Module, 2) the Air Dispersion Modeling Module, and 3) the Risk Analysis and Mapping Module.

Health Risk Assessment (HRA): the name of a computer program developed by the ARB, the OEHHA, and the University of California which was designed to aid in the computation of risk in the Hot Spots program

HSC: Health and Safety Code of the State of California

The Air Toxics Hot Spots Program Guidance Manual for Preparation of Health Risk Assessments. August 2003.

Haber's Law: The product of the concentration (C) and time of exposure (t) required to produce a specific physiologic effect is equal to a constant level or severity of response (K), or $C * t = K$

Hazard identification: The process of determining whether exposure to an agent can cause an increase in the incidence of an adverse health effect including cancer

Health Risk Assessment: A health risk assessment (HRA) is an evaluation or report that a risk assessor (e.g., Air Resources Board, district, consultant, or facility operator) develops to describe the potential a person or population may have of developing adverse health effects from exposure to a facility's emissions. Some health effects that are evaluated could include cancer, developmental effects, or respiratory illness. The pathways that can be included in an HRA depend on the toxic air pollutants that a person (receptor) may be exposed to, and can include breathing, the ingestion of soil, water, crops, fish, meat, milk, and eggs, and dermal exposure.

Health Risk Guidance Value (HRGV): A numerical value with which to compare an exposure level in order to determine the probability of occurrence of an adverse health effect. In the Hot Spots program the toxicity criteria or toxicity values are known as Reference Exposure Levels (RELs) for noncancer effects and as inhalation unit risk factors and cancer potency values for cancer effects.

Hazard Index (HI): The sum of individual acute or chronic hazard quotients (HQs) for each substance affecting a particular toxicological endpoint.

Hazard Quotient (HQ): The estimated ground level concentration divided by the reference exposure level for a single substance and a particular endpoint. For an acute HQ the one hour maximum concentration is divided by the acute Reference Exposure Level for the substance. For a chronic HQ, the annual concentration is divided by the chronic Reference Exposure level.

Hot Spot: A location where emissions from specific sources may expose individuals and population groups to elevated risks of adverse health effects, including but not limited to cancer, and contribute to the cumulative health risks of emissions from other sources in the area.

Individual Excess Cancer Risk: The theoretical probability of an individual person developing cancer as a result of lifetime exposure to carcinogenic substances. The Individual Excess Cancer Risk is calculated by summing the potential cancer risks due to both inhalation and noninhalation routes of exposure.

Inhalation (Breathing) Rate: The amount of air inhaled in a specified time period (e.g., per minute, per hour, per day, etc.); also called breathing rate and ventilation rate. This is an example of a variate.

Inhalation unit risk factor: The theoretical upper bound probability of extra cancer cases occurring in the exposed population assuming a lifetime exposure to the chemical when the air concentration is expressed in exposure units of per microgram/cubic meter $(\mu\text{g}/\text{m}^3)^{-1}$.

The Air Toxics Hot Spots Program Guidance Manual for Preparation of Health Risk Assessments. August 2003.

Initiator carcinogen: A substance which causes the first stage of carcinogenesis, the conversion of a normal cell to a neoplastic cell. Initiation is considered to be a rapid, irreversible change often involving a change in the DNA caused by the initiator.

Interspecies: Between different species.

Intraspecies: Within the same species.

Industrial Source Complex Dispersion model (ISC3): Air modeling software that incorporates three previous programs into a single program. These are the short-term model (ISCST), the long term model (ISCLT), and the complex terrain model (COMPLEX).

Isopleth: A line on a map connecting points of equal value (e.g., risk, concentration, etc.).

Lowest-observed adverse effect level (LOAEL): The lowest dose or exposure level of a chemical in a study at which there is a statistically or biologically significant increase in the frequency or severity of an adverse effect in the exposed population as compared with an appropriate, unexposed control group.

Margin of safety: The ratio of the no-observed-adverse-effect level (NOAEL) to the estimated human exposure.

Mean: The arithmetic average.

MEI: Maximum exposed individual (theoretical)

MEIR: Maximum exposed individual resident (actual)

MEIW: Maximum exposed individual worker (actual)

Meteorology: The science that deals with the phenomena of the atmosphere especially weather and weather conditions. In the area of air dispersion modeling, *meteorology* is used to refer to climatological data needed to run an air dispersion model including: wind speed, wind direction, stability class and ambient temperature.

Milligram: One one-thousandth (10^{-3}) of a gram.

Molecular formula: The formula which identifies the atoms and the number of each kind in the molecules of a compound. Elements in the molecular formula are listed according to the Hill convention (C, H, then other elements in alphabetical order).

Molecular weight: The sum of the atomic weights of the atoms in a molecule. For example, methane (CH_4) is 16.043, the atomic weights being carbon = 12.011, hydrogen = 1.008.

Monte Carlo simulation: Application of random sampling to obtain an approximate value of an expression.

The Air Toxics Hot Spots Program Guidance Manual for Preparation of Health Risk Assessments. August 2003.

Multipathway substance: A substance or chemical that once airborne from an emission source can, under environmental conditions, be taken into a human receptor by inhalation and by other exposure routes such as after deposition on skin or after ingestion of soil contaminated by the emission

No Observed Adverse Effect Level (NOAEL): The highest experimental dose at which there is no statistically or biologically significant increase in frequency or severity of adverse health effects in the exposed population compared with an appropriate, unexposed population. Effects may be produced at this level, but they are not considered to be adverse. Substances are generally considered to not have a NOAEL for the cancer endpoint.

Noncarcinogenic Effects: Noncancer health effects which may include birth defects, organ damage, morbidity, and death.

Office of Environmental Health Hazard Assessment (OEHHA): An office within the California Environmental Protection Agency that is responsible for evaluating chemicals for adverse health impacts and establishing safe exposure levels. OEHHA also assists in performing health risk assessments and developing risk assessment procedures for air quality management purposes.

PM₁₀, PM_{2.5}: PM₁₀ is particulate matter less than 10 µm in diameter; PM_{2.5} is particulate matter less than 2.5 µm in diameter.

PMI: Off-site point of maximum impact. A location, with or without people currently present, at which the total cancer risk, or the total noncancer risk, has the highest numerical value.

Point Estimate: A single value estimate for a given variate

Potency: Essentially the relative effectiveness, or risk, of a standard amount of a substance to cause a toxic response.

Potency Slope: Used to calculate the probability or risk of cancer associated with an estimated exposure, based on the assumption in cancer risk assessments that risk is directly proportional to dose and that there is no threshold for carcinogenesis. It is the slope of the dose-response curve estimated at low exposures.

Proposition 65: Safe Drinking Water and Toxic Enforcement Act of 1986, also known as Proposition 65. This Act is codified in California Health and Safety Code Section 25249.5, et seq. No person in the course of doing business shall knowingly discharge or release a chemical known to the state to cause cancer or reproductive toxicity into water or into land where such chemical passes or probably will pass into any source of drinking water, without first giving clear and reasonable warning to such individual.

Resource Conservation and Recovery Act (RCRA) of 1976: A federal law regulating disposal of hazardous waste

Receptor: A location with or without people present at which the ground level concentration of an emitted chemical can be estimated

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Refined Models: Air dispersion models designed to provide more representative concentration estimates than screening models taking into account actual meteorological conditions.

Reference Concentration (RfC): An estimate, derived by the U.S. EPA (with an uncertainty spanning perhaps an order of magnitude) of a daily exposure to the human population, (including sensitive subgroups) that is likely to be without appreciable risk of deleterious effects during a lifetime of exposure. The RfC is derived from a no or lowest observed adverse effect level from human or animal exposures, to which uncertainty or "safety" factors are applied.

Reference Dose (RfD): An estimate delivered by the U.S. EPA (with uncertainty spanning perhaps an order of magnitude) of the daily exposure to the human population (including sensitive subpopulations) that is likely to be without deleterious effects during a lifetime. The RfD is reported in units of mg of substance/kg body weight/day for oral exposures.

Reference exposure level (REL): expressed in units of $\mu\text{g}/\text{m}^3$ for inhalation exposures and of mg/kg-d for noninhalation exposures. The REL is an exposure level at or below which no noncancer adverse health effect is anticipated to occur in a human population exposed for a specific duration. An REL is virtually the same as the terms Reference Concentration (RfC) for inhalation or Reference Dose (RfD) used by U.S. EPA, only it may be for varying amounts of time rather than lifetime only. It has been given a different name so that the values estimated by the State Office of Environmental Health Hazard Assessment can easily be distinguished from those developed by the U.S. EPA. RELs are used to evaluate toxicity endpoints other than cancer.

Reproductive toxicity: Harmful effects on fertility, gestation, or offspring, caused by exposure of either parent to a substance.

Risk: The (characterization of the) probability of potentially adverse effects to human health, in this instance from the exposure to environmental hazards.

Risk Assessment: The characterization (in the present context) of the probability of potentially adverse health effects to people from exposure to environmental chemical hazards.

Risk Management: An evaluation of the need for and feasibility of reducing risk. It includes consideration of magnitude of risk, available control technologies, and economic feasibility.

Risk Management and Prevention Program (RMPP): A program administered by the Office of Emergency Services (OES) and local agencies to reduce the frequency and severity of accidental releases of toxic materials

Scientific Review Panel on Toxic Air Contaminants or SRP: A nine-member panel appointed to advise the Air Resources Board and the Department of Pesticide Regulation in their evaluation of the adverse health effects toxicity of substances being evaluated as Toxic Air Contaminants.

Screening Models: Dispersion models used to provide a maximum concentration that is likely to overestimate public exposure.

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Sensitive Receptor: A location such as a hospital or daycare center where the human occupants are considered to be more sensitive to pollutants than “average”.

Severity Level: The (acute) discomfort or mild effect level; the concentration of an airborne substance at or below which exposure for one hour may result in some odors, tastes, visual cues, and sensations but which will cause no adverse health effects in essentially all of the population. Exposure to concentrations above this level, depending on the chemical, may result in minor health effects, such as mild eye and respiratory irritation, skin irritation, minor histologic effects, and headaches.

Severity Level II: The (acute) disability or serious effect level. Exposure for one hour to an airborne substance above this level may lead individuals to seek assistance. Exposures above this level, depending on the chemical, may result in serious health effects such as severe eye irritation, severe respiratory irritation, bronchospasm, shortness of breath, disorientation, blurred vision, vomiting, cardiac arrhythmia and adverse outcomes of an existing or subsequent pregnancy.

Stationary source: A non-mobile source of air pollutants which can be either a point or area source.

Stochastic: A process that involves random variation

Synergism: A pharmacologic or toxicologic interaction in which the combined effect of two or more chemicals is greater than the sum of the effects of each chemical alone.

Subcensus Tract: Smaller population unit within a census tract.

Surrogate: As used in this document refers to a single substance category used to represent a family of related chemical compounds, e.g., gasoline vapors or POM (polycyclic organic matter) in place of benzo(a)pyrene.

Threshold, Nonthreshold: A threshold dose is the minimally effective dose of any chemical that is observed to produce a response (e.g., enzyme change, liver toxicity, death). For most toxic effects, except carcinogenesis, there appear to be threshold doses. Nonthreshold substances are those substances, including nearly all carcinogens, that are known or assumed to have some risk of response at any dose above zero.

Toxic air contaminant (TAC): As defined by California Health and Safety Code, Section 39655 (a): an air pollutant which may cause or contribute to an increase in mortality or in serious illness, or which may pose a present or potential hazard to human health. Substances, which have been identified by the United States Environmental Protection Agency as hazardous air pollutants (e.g. benzene, asbestos), shall be identified by the Board as toxic air contaminants.

Toxicology: The multidisciplinary study of toxicants, their harmful effects on biological systems, and the conditions under which these harmful effects occur. The mechanisms of action, detection, and treatment of the conditions produced by toxicants are studied.

Uncertainty: True uncertainty is that which is not known about a factor that influences its value.

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URF: See inhalation unit risk factor

UTM Coordinates: Universal Transfer Mercator Coordinates. Coordinates used to define a specific location by means of two values (i.e., easting and northing coordinates).

United States Environmental Protection Agency (U.S. EPA): The Federal agency charged with setting policy and guidelines, carrying out legal mandates, for the protection, and national interests in environmental resources.

Vapor: The gaseous phase of liquids or solids at atmospheric temperature and pressure.

Vapor Pressure: The pressure exerted by a chemical vapor in equilibrium with its liquid or solid phase at any given temperature, used to calculate the rate of evaporation of a substance.

Variability: Ability to have different numerical values of a parameter, such as height or weight

Variate: A variable quantity associated with a probability distribution (e.g. inhalation rate)

Volatile: Chemicals that rapidly pass off from the liquid state in the form of vapors.

Xenobiotic: A toxic agent; a relatively small (MW<1000), non-nutritive chemical that is foreign to the species being studied

Zone of impact: The area in the vicinity of the facility in which an individual is exposed to a specified cancer risk, usually one in a million or greater.

Appendix K

HRA Forms and Maps Used With Air Dispersion Modeling

- Example of Census Tract Map**
- Example of 7.5 minute Series Map**
- Examples of Tables for Emissions Reporting**

Figure 1
Census Tracts, View 1

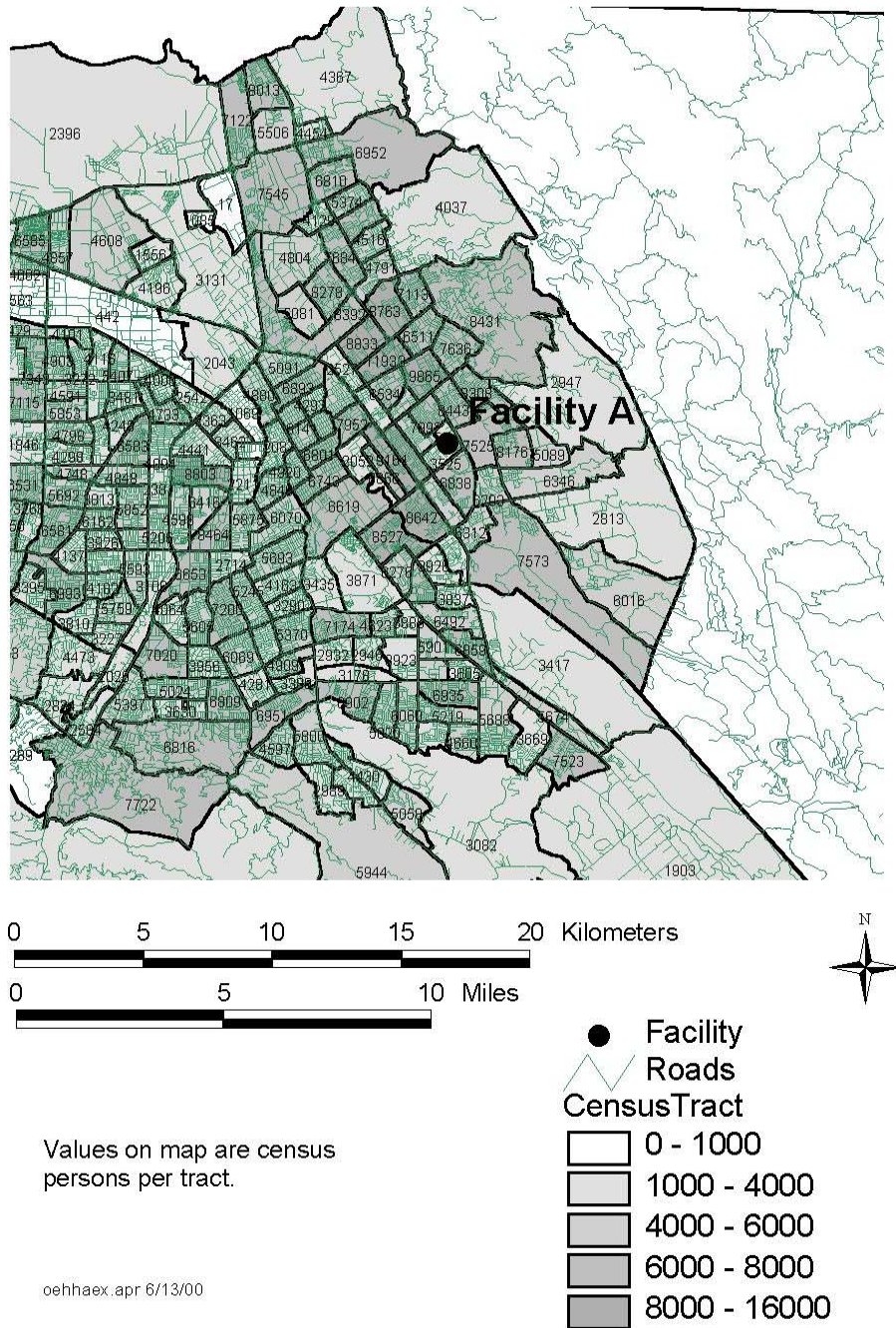


Figure 2
Census Tracts, View 2

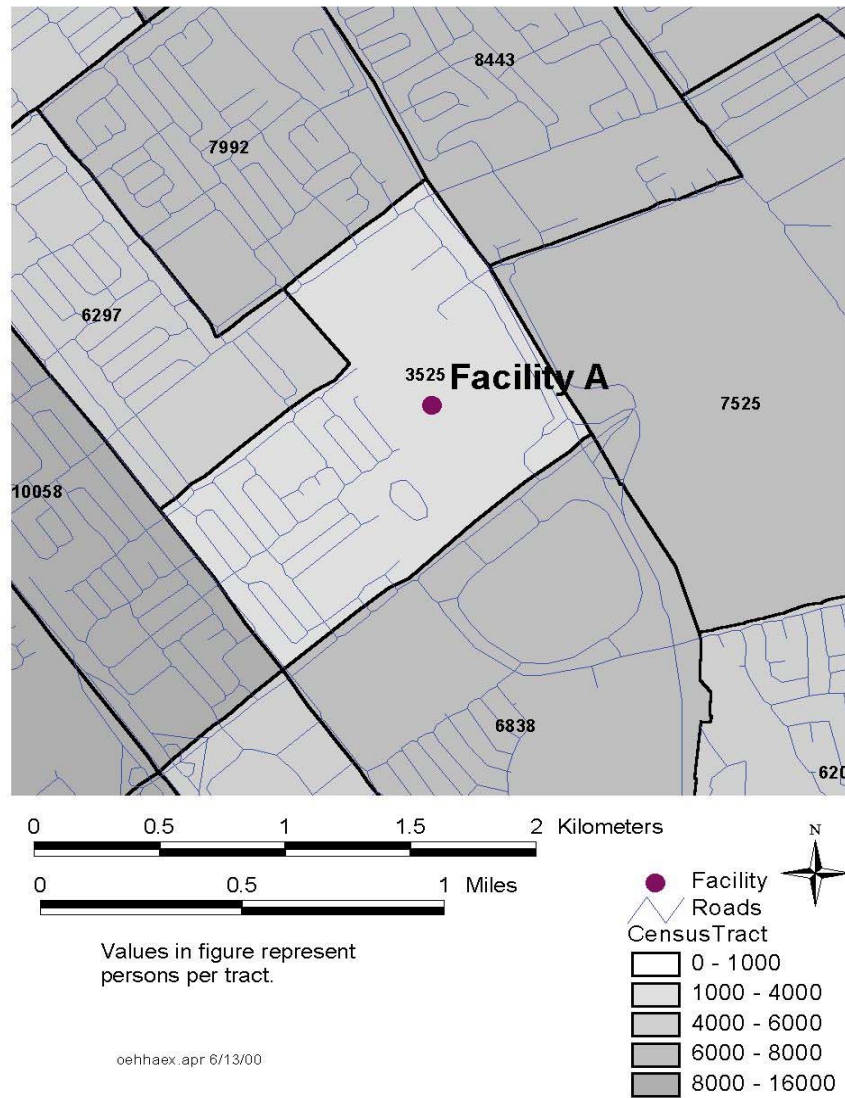
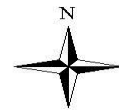
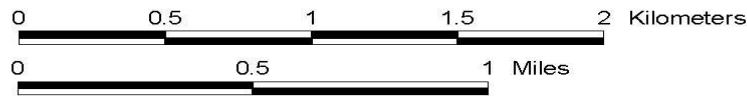
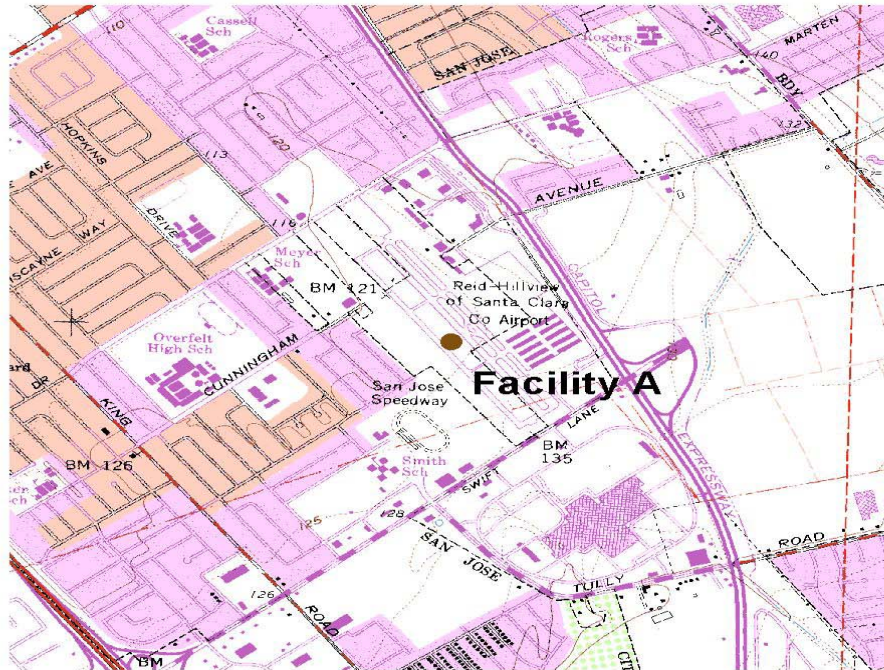


Figure 4
USGS 7.5 Minute Topographic Map



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HEALTH RISK ASSESSMENT

EMISSION RATE BY SUBSTANCE AND SOURCE RAG-001

FACILITY NAME / FACILITY ADDRESS / SITE ID#:

SOURCE ID No.	SOURCE NAME	SUBSTANCE NAME	CAS No.	1-HOUR MAXIMUM (lb/hr)	1-HOUR MAXIMUM (g/s)	ANNUAL AVERAGE (lb/yr)	ANNUAL AVERAGE (g/s)

HEALTH RISK ASSESSMENT

EMISSION RATE BY SUBSTANCE – TOTALS – RAG-002

FACILITY NAME / FACILITY ADDRESS / SITE ID#

SUBSTANCE NAME	CAS No.	1-HOUR MAXIMUM (lb/hr)	1-HOUR MAXIMUM (g/s)	ANNUAL AVERAGE (lb/yr)	ANNUAL AVERAGE (g/s)

HEALTH RISK ASSESSMENT

SOURCE PARAMETERS – STACKS – RAG-003

FACILITY NAME / FACILITY ADDRESS / SITE ID#

SOURCE ID No.	STACK NAME	UTM Easting	UTM Northing	HEIGHT (m)	DIAMETER (m)	TEMP. (F) (K)		FLOW RATE (ACFM)	EXIT VEL. (m/s)

HEALTH RISK ASSESSMENT

SOURCE OPERATING HOURS – RAG-004

FACILITY NAME / FACILITY ADDRESS / SITE ID#

SOURCE ID No.	STACK NAME	AVERAGE OPERATING HOURS		MAXIMUM OPERATING HOURS	
		(hr/day)	(days/year)	(hr/day)	(days/year)

Appendix L

OEHHA/ARB Approved Health Values for Use in Hot Spot Facility Risk Assessments

Purpose of the Appendix L Tables:

The purpose of the following reference tables is to provide a quick list of all health values that have been approved by the Office of Environmental Health Hazard Assessment (OEHHA) and the Air Resources Board (ARB) for use in facility health risk assessments conducted for the AB 2588 Air Toxics Hot Spots Program. The OEHHA has developed and adopted new risk assessment guidelines that update and replace the California Air Pollution Control Officers Association's (CAPCOA) *Air Toxics "Hot Spots" Program Revised 1992 Risk Assessment Guidelines*, October 1993.

The following tables list the OEHHA adopted inhalation and oral cancer slope factors, noncancer acute Reference Exposure Levels (RELs), and inhalation and oral noncancer chronic RELs. In addition, these tables list the substances in Appendix A-I (*Substances For Which Emissions Must Be Quantified*) and Appendix F (*Criteria For Inputs For Risk Assessment Using Screening Air Dispersion Modeling*) of the ARB's *Hot Spots Emission Inventory Criteria and Guidelines (EICG)*. OEHHA is still in the process of adopting new noncancer chronic RELs. Therefore, new health values will periodically be added to, or deleted from, these tables. Users of these tables are advised to monitor the OEHHA website (www.oehha.ca.gov) for any updates to the health values.

Substances written in *italics* do not have explicit OEHHA approved health values, but are included in this table to clarify applicability of OEHHA adopted health effects values to individual or grouped substances listed in the *Hot Spots Emission Inventory Criteria and Guidelines*, Appendix A-I list of "*Substances For Which Emissions Must Be Quantified*."

The "Date Value Reviewed" column lists the date that the health value was last reviewed by OEHHA and the Scientific Review Panel, and/or approved for use in the AB 2588 Air Toxics Hot Spots Program. This information is useful to tell where the number came from. If the health value is unchanged since it was first approved for use in the Hot Spots Program, then the date that the value was first approved for use by CAPCOA is listed within the brackets [].

- April 1999 is listed for the cancer potency values and noncancer acute RELs, which have been adopted by the OEHHA as part of the AB 2588 "Hot Spots" Risk Assessment Guidelines.
- February 2000, April 2000, January 2001, and December 2001 are listed for the first set of 22, the second set of 16, the third set of 22, and the fourth set of 12 noncancer chronic RELs, respectively.
- October 2000 is listed for the oral chronic RELs and oral cancer slope factors. 1996 is listed for the U.S. EPA Reference Concentrations. Dates of 1990-1992 and 1996 are listed for CAPCOA chronic RELs that may eventually be dropped or replaced.
- For the substances identified as Toxic Air Contaminants, the Air Resources Board hearing date is listed. The dates for acetaldehyde, benzo[a]pyrene, and methyl tertiary-butyl ether represent the dates the values were approved by the Scientific Review Panel.

Substance ☼	Chemical Abstract Service Number (CAS) ▼	Noncancer Effects						Cancer Risk				
		Acute Inhalation REL (µg/m ³)	Date ♦ Value Reviewed [Added]	Chronic Inhalation REL (µg/m ³)	Date ♦ Value Reviewed [Added]	Chronic Oral REL (mg/kg/d)	Date ♦ Value Reviewed [Added]	Inhalation Cancer Potency Factor (mg/kg-d) ⁻¹	Date ♦ Value Reviewed [Added]	Oral Slope Factor (mg/kg-d) ⁻¹	Date ♦ Value Reviewed [Added]	M ♦ W A F
ACETALDEHYDE	75-07-0			9.0 ^E +00	5/93			1.0E-02	4/99 [5/93]			1
ACETAMIDE	60-35-5							7.0E-02	4/99			1
ACROLEIN	107-02-8	1.9E-01	4/99	6.0E-02	1/01							--
ACRYLAMIDE	79-06-1							4.5E+00	4/99 [7/90]			1
ACRYLIC ACID	79-10-7	6.0E+03	4/99									--
ACRYLONITRILE	107-13-1			5.0E+00	12/01			1.0E+00	4/99 [1/91]			1
ALLYL CHLORIDE	107-05-1							2.1E-02	4/99			1
2-AMINOANTHRAQUINONE	117-79-3							3.3E-02	4/99			1
AMMONIA	7664-41-7	3.2E+03	4/99	2.0E+02	2/00							--
ANILINE	62-53-3							5.7E-03	4/99			1
Antimony Compounds	7440-36-0											--
ANTIMONY TRIOXIDE	1309-64-4											--
ARSENIC AND COMPOUNDS (INORGANIC) ^{TAC} ♣	7440-38-2 1016 [1015]	1.9E-01 AveP	4/99	3.0E-02	1/01	3.0E-04	10/00	1.2E+01 TAC	7/90	1.5E+00	10/00	1
ARSINE	7784-42-1	1.6E+02	4/99									--
ASBESTOS ^{TAC} ⚡	1332-21-4							1.9E-04 TAC⚡	3/86			333.33 ⚡
BENZENE ^{TAC}	71-43-2	1.3E+03 AveP	4/99	6.0E+01	2/00			1.0E-01 TAC	1/85			1
BENZIDINE (AND ITS SALTS) values also apply to:	92-87-5							5.0E+02	4/99 [1/91]			1
Benzidine based dyes	1020							5.0E+02	4/99 [1/91]			1
Direct Black 38	1937-37-7							5.0E+02	4/99 [1/91]			1
Direct Blue 6	2602-46-2							5.0E+02	4/99 [1/91]			1
Direct Brown 95 (technical grade)	16071-86-6							5.0E+02	4/99 [1/91]			1
BENZYL CHLORIDE	100-44-7	4E+02	4/99					1.7E-01	4/99			1
BERYLLIUM AND COMPOUNDS ♣	7440-41-7 [1021]			7.0 ^E -03	12/01	2.0E-03	12/01	8.4E+00	4/99 [7/90]			1
BIS(2-CHLOROETHYL)ETHER (Dichloroethyl ether)	111-44-4							2.5E+00	4/99			1
BIS(CHLOROMETHYL)ETHER	542-88-1							4.6E+01	4/99 [1/91]			1
1,3-BUTADIENE ^{TAC}	106-99-0			2.0E+01	1/01			6.0E-01 TAC	7/92			1

APPENDIX L - TABLE 1
OEHHA/ARB APPROVED HEALTH VALUES FOR USE IN HOT SPOT FACILITY RISK ASSESSMENTS [⊕]

Substance [⊕]	Chemical Abstract Service Number (CAS)	Noncancer Effects						Cancer Risk				
		Acute Inhalation REL (µg/m ³)	Date [♦] Value Reviewed [Added]	Chronic Inhalation REL (µg/m ³)	Date [♦] Value Reviewed [Added]	Chronic Oral REL (mg/kg/d)	Date [♦] Value Reviewed [Added]	Inhalation Cancer Potency Factor (mg/kg-d) ⁻¹	Date [♦] Value Reviewed [Added]	Oral Slope Factor (mg/kg-d) ⁻¹	Date [♦] Value Reviewed [Added]	M ⁺ W A F
CADMIUM AND COMPOUNDS ^{TAC} [⬆]	7440-43-9 [1045]			2.0 ^E -02	1/01	5.0E-04	10/00	1.5E+01 TAC	1/87			1
CARBON DISULFIDE	75-15-0	6.2E+03 AveP	4/99	8.0E+02 RfC								--
CARBON MONOXIDE	630-08-0	2.3E+04	4/99									--
CARBON TETRACHLORIDE ^{TAC} (Tetrachloromethane)	56-23-5	1.9E+03 AveP	4/99	4.0 ^E +01	1/01			1.5E-01 TAC	9/87			1
CHLORINATED PARAFFINS	108171-26-2							8.9E-02	4/99			1
CHLORINE	7782-50-5	2.1E+02	4/99	2.0 ^E -01	2/00							--
CHLORINE DIOXIDE	10049-04-4			6.0E-01	1/01							--
4-CHLORO-O-PHENYLENEDIAMINE	95-83-0							1.6E-02	4/99			1
CHLOROBENZENE	108-90-7			1.0E+03	1/01							--
CHLORODIFLUOROMETHANE ... (see Fluorocarbons)												
CHLOROFORM ^{TAC}	67-66-3	1.5E+02 AveP	4/99	3.0E+02	4/00			1.9E-02 TAC	12/90			1
<i>Chlorophenols</i>	<i>1060</i>											--
PENTACHLOROPHENOL	87-86-5							1.8E-02	4/99			1
2,4,6-TRICHLOROPHENOL	88-06-2							7.0E-02	4/99 [1/91]			1
CHLOROPICRIN	76-06-2	2.9E+01	4/99	4.0E-01	12/01							--
CHLOROPRENE	126-99-8											--
p-CHLORO-o-TOLUIDINE	95-69-2							2.7E-01	4/99			1
CHROMIUM 6+ ^{TAC} [⬆] <i>values also apply to:</i>	18540-29-9			2.0E-01	1/01	2.0E-02	10/00	5.1E+02 TAC	1/86			1
<i>Barium chromate[⬆]</i>	<i>10294-40-3</i>			<i>2.0E-01</i>	<i>1/01</i>	<i>2.0E-02</i>	<i>10/00</i>	<i>5.1E+02</i> TAC	<i>1/86</i>			<i>0.2053</i>
<i>Calcium chromate[⬆]</i>	<i>13765-19-0</i>			<i>2.0E-01</i>	<i>1/01</i>	<i>2.0E-02</i>	<i>10/00</i>	<i>5.1E+02</i> TAC	<i>1/86</i>			<i>0.3332</i>
<i>Lead chromate[⬆]</i>	<i>7758-97-6</i>			<i>2.0E-01</i>	<i>1/01</i>	<i>2.0E-02</i>	<i>10/00</i>	<i>5.1E+02</i> TAC	<i>1/86</i>			<i>0.1609</i>
<i>Sodium dichromate[⬆]</i>	<i>10588-01-9</i>			<i>2.0E-01</i>	<i>1/01</i>	<i>2.0E-02</i>	<i>10/00</i>	<i>5.1E+02</i> TAC	<i>1/86</i>			<i>0.397</i>
<i>Strontium chromate[⬆]</i>	<i>7789-06-2</i>			<i>2.0E-01</i>	<i>1/01</i>	<i>2.0E-02</i>	<i>10/00</i>	<i>5.1E+02</i> TAC	<i>1/86</i>			<i>0.2554</i>
CHROMIUM TRIOXIDE [⬆] (as chromic acid mist)	1333-82-0			2.0E-03	1/01	2.0E-02	10/00	5.1E+02 TAC	1/86			0.52
COPPER AND COMPOUNDS	7440-50-8 [1067]	1.0E+02	4/99									--
p-CRESIDINE	120-71-8							1.5E-01	4/99			1
CRESOLS (mixtures of)	1319-77-3			6.0E+02	1/01							--
m-CRESOL	108-39-4			6.0E+02	1/01							--

APPENDIX L - TABLE 1
OEHHA/ARB APPROVED HEALTH VALUES FOR USE IN HOT SPOT FACILITY RISK ASSESSMENTS [®]

Substance [®]	Chemical Abstract Service Number (CAS)	Noncancer Effects						Cancer Risk				
		Acute Inhalation REL (µg/m ³)	Date [♦] Value Reviewed [Added]	Chronic Inhalation REL (µg/m ³)	Date [♦] Value Reviewed [Added]	Chronic Oral REL (mg/kg/d)	Date [♦] Value Reviewed [Added]	Inhalation Cancer Potency Factor (mg/kg-d) ⁻¹	Date [♦] Value Reviewed [Added]	Oral Slope Factor (mg/kg-d) ⁻¹	Date [♦] Value Reviewed [Added]	M [♦] W A F
o-CRESOL	95-48-7			6.0E+02	1/01							--
p-CRESOL	106-44-5			6.0E+02	1/01							--
CUPFERRON	135-20-6							2.2E-01	4/99			1
Cyanide Compounds (inorganic)	57-12-5 1073	3.4E+02	4/99	9.0E+00	4/00							--
HYDROGEN CYANIDE (Hydrocyanic acid)	74-90-8	3.4E+02	4/99	9.0E+00	4/00							--
2,4-DIAMINOANISOLE	615-05-4							2.3E-02	4/99			1
2,4-DIAMINOTOLUENE	95-80-7							4.0E+00	4/99			1
1,2-DIBROMO-3-CHLOROPROPANE (DBCP)	96-12-8							7.0E+00	4/99 [1/92]			1
p-DICHLOROBENZENE	106-46-7			8.0E+02	1/01			4.0E-02	4/99 [1/91]			1
3,3-DICHLOROBENZIDINE	91-94-1							1.2E+00	4/99 [1/91]			1
1,1-DICHLOROETHANE (Ethylidene dichloride)	75-34-3							5.7E-03	4/99			1
1,1-DICHLOROETHYLENE ... (see Vinylidene Chloride)												
DI(2-ETHYLHEXYL)PHTHALATE (DEHP)	117-81-7							8.4E-03	4/99 [1/92]	8.4E-03	10/00	1
DIESEL EXHAUST ... (see Particulate Emissions from Diesel-Fueled Engines)												
DIETHANOLAMINE	111-42-2			3.0E+00	12/01							--
DIMETHYLAMINE	124-40-3											--
p-DIMETHYLAMINOAZOBENZENE	60-11-7							4.6E+00	4/99			1
N,N-DIMETHYL FORMAMIDE	68-12-2			8.0E+01	1/01							--
2,4-DINITROTOLUENE	121-14-2							3.1E-01	4/99			1
1,4-DIOXANE (1,4-Diethylene dioxide)	123-91-1	3.0E+03	4/99	3.0E+03	4/00			2.7E-02	4/99 [1/91]			1
EPICHLOROHYDRIN (1-Chloro-2,3-epoxypropane)	106-89-8	1.3E+03	4/99	3.0E+00	1/01			8.0E-02	4/99 [1/92]			1
1,2-EPOXYBUTANE	106-88-7			2.0E+01	1/01							--
ETHYL ACRYLATE	140-88-5											--
ETHYL BENZENE	100-41-4			2.0E+03	2/00							--
ETHYL CHLORIDE (Chloroethane)	75-00-3			3.0E+04	4/00							--
ETHYLENE DIBROMIDE ^{1AL} (1,2-Dibromoethane)	106-93-4			8.0E-01	12/01			2.5E-01 TAC	7/85			1

APPENDIX L - TABLE 1
OEHHHA/ARB APPROVED HEALTH VALUES FOR USE IN HOT SPOT FACILITY RISK ASSESSMENTS [⊕]

Substance [⊕]	Chemical Abstract Service Number (CAS)	Noncancer Effects						Cancer Risk				
		Acute Inhalation REL (µg/m ³)	Date [♦] Value Reviewed [Added]	Chronic Inhalation REL (µg/m ³)	Date [♦] Value Reviewed [Added]	Chronic Oral REL (mg/kg/d)	Date [♦] Value Reviewed [Added]	Inhalation Cancer Potency Factor (mg/kg-d) ⁻¹	Date [♦] Value Reviewed [Added]	Oral Slope Factor (mg/kg-d) ⁻¹	Date [♦] Value Reviewed [Added]	M ⁺ W A F
ETHYLENE DICHLORIDE ^{TAC} (1,2-Dichloroethane)	107-06-2			4.0E+02	1/01			7.2E-02 ^{TAC}	9/85			1
ETHYLENE GLYCOL	107-21-1			4.0E+02	4/00							--
ETHYLENE GLYCOL BUTYL ETHER ... (see Glycol ethers)												
ETHYLENE OXIDE ^{TAC} (1,2-Epoxyethane)	75-21-8			3.0E+01	1/01			3.1E-01 ^{TAC}	11/87			1
ETHYLENE THIOUREA	96-45-7							4.5E-02	4/99			1
Fluorides	1101	2.4E+02	4/99	1.3E+01	8/03	4.0E-2	8/03					--
HYDROGEN FLUORIDE (Hydrofluoric acid)	7664-39-3	2.4E+02	4/99	1.4E+01	8/031	4.0E-2						--
FORMALDEHYDE ^{TAC}	50-00-0	9.4E+01	4/99	3.0E+00	2/00			2.1E-02 ^{TAC}	3/92			1
GASOLINE VAPORS	1110											--
GLUTARALDEHYDE	111-30-8			8.0E-02	1/01							--
GLYCOL ETHERS	1115											
ETHYLENE GLYCOL MONOBUTYL ETHER – EGBE	111-76-2	1.4E+04	4/99									--
ETHYLENE GLYCOL MONOETHYL ETHER – EGEE	110-80-5	3.7E+02 ^{AveP}	4/99[1/92]	7.0E+01	2/00							--
ETHYLENE GLYCOL MONOETHYL ETHER ACETATE – EGEEA	111-15-9	1.4E+02 ^{AveP}	4/99	3.0E+02	2/00							--
ETHYLENE GLYCOL MONOMETHYL ETHER – EGME	109-86-4	9.3E+01 ^{AveP}	4/99	6.0E+01	2/00							--
ETHYLENE GLYCOL MONOMETHYL ETHER ACETATE – EGMEA	110-49-6			9.0E+01	2/00							--
HEXACHLOROBENZENE	118-74-1							1.8E+00	4/99 [1/91]			1
HEXACHLOROCYCLOHEXANES (mixed or technical grade)	608-73-1 1120							4.0E+00	4/99 [1/91]	4.0E+00	10/00 [1/92]	1
Alpha- HEXACHLOROCYCLOHEXANE	319-84-6							4.0E+00	4/99 [1/91]	4.0E+00	10/00 [1/92]	1
beta- HEXACHLOROCYCLOHEXANE	319-85-7							4.0E+00	4/99 [1/91]	4.0E+00	10/00 [1/92]	1
Gamma- HEXACHLOROCYCLOHEXANE (Lindane)	58-89-9							1.1E+00	4/99	1.1E+00	10/00	1

APPENDIX L - TABLE 1
OEHHA/ARB APPROVED HEALTH VALUES FOR USE IN HOT SPOT FACILITY RISK ASSESSMENTS [⊕]

Substance [⊕]	Chemical Abstract Service Number (CAS)	Noncancer Effects						Cancer Risk				
		Acute Inhalation REL (µg/m ³)	Date [♦] Value Reviewed [Added]	Chronic Inhalation REL (µg/m ³)	Date [♦] Value Reviewed [Added]	Chronic Oral REL (mg/kg/d)	Date [♦] Value Reviewed [Added]	Inhalation Cancer Potency Factor (mg/kg-d) ⁻¹	Date [♦] Value Reviewed [Added]	Oral Slope Factor (mg/kg-d) ⁻¹	Date [♦] Value Reviewed [Added]	M [⊕] W A F
n-HEXANE	110-54-3			7.0E+03	4/00							--
HYDRAZINE	302-01-2			2.0E-01	1/01			1.7E+01	4/99 [7/90]			1
HYDROCHLORIC ACID (Hydrogen chloride)	7647-01-0	2.1E+03	4/99	9.0E+00	2/00							--
HYDROGEN BROMIDE ... (see Bromine & Compounds)												
HYDROGEN CYANIDE ... (see Cyanide & Compounds)												
HYDROGEN FLUORIDE ... (see Fluorides)												
HYDROGEN SELENIDE ... (see Selenium & Compounds)												
HYDROGEN SULFIDE	7783-06-4	4.2E+01	4/99[7/90]	1.0E+01	4/00							--
ISOPHORONE	78-59-1			2.0E+03	12/01							--
ISOPROPYL ALCOHOL (Isopropanol)	67-63-0	3.2E+03	4/99	7.0E+03	2/00							--
LEAD AND COMPOUNDS ^{TAC} * [⊕] (inorganic) <i>values also apply to:</i>	7439-92-1 1128 [1130]							4.2E-02 TAC	4/97	8.5E-03	10/00	1
<i>Lead acetate</i> [⊕]	301-04-2							4.2E-02 TAC	4/97	8.5E-03	10/00	0.637
<i>Lead phosphate</i> [⊕]	7446-27-7							4.2E-02 TAC	4/97	8.5E-03	10/00	0.7659
<i>Lead subacetate</i> [⊕]	1335-32-6							4.2E-02 TAC	4/97	8.5E-03	10/00	0.7696
LINDANE ... (see gamma-Hexachlorocyclohexane)												
MALEIC ANHYDRIDE	108-31-6			7.0E-01	12/01							--
MANGANESE AND COMPOUNDS	7439-96-5 [1132]			2.0E-01	4/00							--
MERCURY AND COMPOUNDS (INORGANIC)	7439-97-6 [1133]	1.8E+00	4/99	9.0E-02	2/00	3.0E-04	10/00 [1/92]					--
<i>Mercuric chloride</i>	7487-94-7	1.8E+00	4/99	9.0E-02	2/00	3.0E-04	10/00 [1/92]					--
MERCURY AND COMPOUNDS (ORGANIC) <i>values also apply to:</i>	N/A											
METHYL MERCURY	593-74-8											--
METHANOL	67-56-1	2.8E+04	4/99	4.0E+03	4/00							--
METHYL BROMIDE (Bromomethane)	74-83-9	3.9E+03	4/99	5.0E+00	2/00							--
METHYL tertiary-BUTYL ETHER	1634-04-4			8.0E+03	2/00			9.1E-04	11/99			1
METHYL CHLOROFORM (1,1,1-Trichloroethane)	71-55-6	6.8E+04	4/99	1.0E+03	2/00							--

APPENDIX L - TABLE 1
OEHHA/ARB APPROVED HEALTH VALUES FOR USE IN HOT SPOT FACILITY RISK ASSESSMENTS [⊕]

Substance [⊕]	Chemical Abstract Service Number (CAS)	Noncancer Effects						Cancer Risk				
		Acute Inhalation REL (µg/m ³)	Date [♦] Value Reviewed [Added]	Chronic Inhalation REL (µg/m ³)	Date [♦] Value Reviewed [Added]	Chronic Oral REL (mg/kg/d)	Date [♦] Value Reviewed [Added]	Inhalation Cancer Potency Factor (mg/kg-d) ⁻¹	Date [♦] Value Reviewed [Added]	Oral Slope Factor (mg/kg-d) ⁻¹	Date [♦] Value Reviewed [Added]	M [⊕] W A F
METHYL ETHYL KETONE (2-Butanone)	78-93-3	1.3E+04	4/99									--
METHYL ISOCYANATE	624-83-9			1.0E+00	12/01							--
METHYL MERCURY ... (see Mercury & Compounds)												
METHYL METHACRYLATE	80-62-6											--
4,4'-METHYLENE BIS (2-CHLOROANILINE) (MOCA)	101-14-4							1.5E+00	4/99			1
METHYLENE CHLORIDE ^{TAC} (Dichloromethane)	75-09-2	1.4E+04	4/99	4.0 ^E +02	2/00			3.5E-03 ^{TAC}	7/89			1
4,4'-METHYLENE DIANILINE (AND ITS DICHLORIDE)	101-77-9			2.0 ^E +01	12/01			1.6E+00	4/99	1.6E+00	10/00	1
METHYLENE DIPHENYL ISOCYANATE	101-68-8			7.0E-01	1/01							--
MICHLER'S KETONE (4,4' -Bis(dimethylamino)benzophenone)	90-94-8							8.6E-01	4/99			1
N-NITROSO-n-BUTYLAMINE	924-16-3							1.1E+01	4/99 [1/92]			1
N-NITROSODI-n-PROPYLAMINE	621-64-7							7.0E+00	4/99 [1/91]			1
N-NITROSODIETHYLAMINE	55-18-5							3.6E+01	4/99 [1/91]			1
N-NITROSODIMETHYLAMINE	62-75-9							1.6E+01	4/99 [1/91]			1
N-NITROSODIPHENYLAMINE	86-30-6							9.0E-03	4/99			1
N-NITROSO-N-METHYLETHYLAMINE	10595-95-6							2.2E+01	4/99 [7/90]			1
N-NITROSOMORPHOLINE	59-89-2							6.7E+00	4/99 [7/92]			1
N-NITROSOPIPERIDINE	100-75-4							9.4E+00	4/99 [7/92]			1
N-NITROSOPYRROLIDINE	930-55-2							2.1E+00	4/99 [7/90]			1
NAPHTHALENE ... (see Polycyclic aromatic hydrocarbons)												
NICKEL AND COMPOUNDS ^{TAC} [⊕] values also apply to:	7440-02-0 [1145]	6.0E+00	4/99	5.0E-02	2/00	5.0E-02	10/00	9.1E-01 ^{TAC}	8/91			1
Nickel acetate [⊕]	373-02-4	6.0E+00	4/99	5.0E-02	2/00	5.0E-02	10/00	9.1E-01 ^{TAC}	8/91			0.3321
Nickel carbonate [⊕]	3333-39-3	6.0E+00	4/99	5.0E-02	2/00	5.0E-02	10/00	9.1E-01 ^{TAC}	8/91			0.4945
Nickel carbonyl [⊕]	13463-39-3	6.0E+00	4/99	5.0E-02	2/00	5.0E-02	10/00	9.1E-01 ^{TAC}	8/91			0.3438
Nickel hydroxide [⊕]	12054-48-7	6.0E+00	4/99	5.0E-02	2/00	5.0E-02	10/00	9.1E-01 ^{TAC}	8/91			0.6332

APPENDIX L - TABLE 1
OEHHA/ARB APPROVED HEALTH VALUES FOR USE IN HOT SPOT FACILITY RISK ASSESSMENTS [⊕]

Substance [⊕]	Chemical Abstract Service Number (CAS) ▼	Noncancer Effects						Cancer Risk				
		Acute Inhalation REL (µg/m ³)	Date [♦] Value Reviewed [Added]	Chronic Inhalation REL (µg/m ³)	Date [♦] Value Reviewed [Added]	Chronic Oral REL (mg/kg/d)	Date [♦] Value Reviewed [Added]	Inhalation Cancer Potency Factor (mg/kg-d) ⁻¹	Date [♦] Value Reviewed [Added]	Oral Slope Factor (mg/kg-d) ⁻¹	Date [♦] Value Reviewed [Added]	M [⊕] W A F
Nickelocene [⊕]	1271-28-9	6.0E+00	4/99	5.0E-02	2/00	5.0E-02	10/00	9.1E-01 TAC	8/91			0.4937
NICKEL OXIDE [⊕]	1313-99-1	6.0E+00	4/99	1.0E-01	2/00	5.0E-02	10/00	9.1E-01 TAC	8/91			0.7859
Nickel refinery dust from the pyrometallurgical process	1146	6.0E+00	4/99	5.0E-02	2/00	5.0E-02	10/00	9.1E-01 TAC	8/91			1
Nickel subsulfide [⊕]	12035-72-2	6.0E+00	4/99	5.0E-02	2/00	5.0E-02	10/00	9.1E-01 TAC	8/91			0.2443
NITRIC ACID	7697-37-2	8.6E+01	4/99									--
NITROGEN DIOXIDE	10102-44-0	4.7E+02	4/99[1/92]									--
2-NITROPROPANE	79-46-9											--
p-NITROSODIPHENYLAMINE	156-10-5							2.2E-02	4/99			1
OZONE	10028-15-6	1.8E+02	4/99[1/92]									--
PARTICULATE EMISSIONS FROM DIESEL-FUELED ENGINES ^{TAC} ■	9901			5.0E+00 TAC	8/98			1.1E+00 TAC	8/98			1
PENTACHLOROPHENOL ... (see Chlorophenols)												
PERCHLOROETHYLENE ^{TAC} (Tetrachloroethylene)	127-18-4	2.0E+04	4/99	3.5E+01 TAC	10/91			2.1E-02 TAC	10/91			1
PHENOL	108-95-2	5.8E+03	4/99	2.0E+02	4/00							--
PHOSGENE	75-44-5	4.0E+00	4/99									--
PHOSPHINE	7803-51-2			8.0E-01	9/02							--
PHOSPHORIC ACID	7664-38-2			7.0E+00	2/00							--
PHTHALIC ANHYDRIDE	85-44-9			2.0E+01	1/01							--
PCB (POLYCHLORINATED BIPHENYLS-unspeiated mixture) [lowest risk] [★]	1336-36-3							7.0E-02	2/02	7.0E-02	2/02	1
PCB (POLYCHLORINATED BIPHENYLS-unspeiated mixture) [low risk] [★]	1336-36-3							4.0E-01	2/02	4.0E-01	2/02	1
PCB (POLYCHLORINATED BIPHENYLS - unspeiated mixture) [high risk] [★]	1336-36-3							2.0E+00	2/02	2.0E+00	2/02	1
PCB (POLYCHLORINATED BIPHENYLS (speiated) [∇]												
3,3',4,4' -TETRACHLOROBIPHENYL (77)	35298-13-3			4.0E-01	8/03	1.0E -04	8/03	1.3E +01	8/03	1.3E +01	8/03	
3,4,4',5-TETRACHLOROBIPHENYL (81)	70362-50-4			4.0E-01	8/03	1.0E -04	8/03	1.3E +01	8/03	1.3E +01	8/03	
2,3,3',4,4' - PENTACHLOROBIPHENYL (105)	32598-14-4			4.0E-01	8/03	1.0E -04	8/03	1.3E +01	8/03	1.3E +01	8/03	
2,3,4,4'5- PENTACHLOROBIPHENYL (114)	74472-37-0			8.0E-02	8/03	2.0E -05	8/03	6.5E +01	8/03	6.5E +01	8/03	
2,3'4,4',5- PENTACHLOROBIPHENYL (118)	31508-00-6			4.0E-01	8/03	1.0E -04	8/03	1.3E +01	8/03	1.3E +01	8/03	

APPENDIX L - TABLE 1
OEHH/ARB APPROVED HEALTH VALUES FOR USE IN HOT SPOT FACILITY RISK ASSESSMENTS *

Substance *	Chemical Abstract Service Number (CAS)	Noncancer Effects						Cancer Risk				
		Acute Inhalation REL (µg/m ³)	Date * Value Reviewed [Added]	Chronic Inhalation REL (µg/m ³)	Date * Value Reviewed [Added]	Chronic Oral REL (mg/kg/d)	Date * Value Reviewed [Added]	Inhalation Cancer Potency Factor (mg/kg-d) ⁻¹	Date * Value Reviewed [Added]	Oral Slope Factor (mg/kg-d) ⁻¹	Date * Value Reviewed [Added]	M* W A F
2',3,4,4',5- PENTACHLOROBIPHENYL (123)	65510-44-3			4.0E-01	8/03	1.0E -04	8/03	1.3E +01	8/03	1.3E +01	8/03	
3,3',4,4',5- PENTACHLOROBIPHENYL (126)	57465-28-8			4.0E-04	8/03	1.0E -07	8/03	1.3E +04	8/03	1.3E +04	8/03	
2,3,3',4,4',5-HEXACHLOROBIPHENYL (156)	38380-08-4			8.0E-02	8/03	2.0E -05	8/03	6.5E +01	8/03	6.5E +01	8/03	
2,3,3',4,4',5'-HEXACHLOROBIPHENYL (157)	69782-90-7			8.0E-02	8/03	2.0E -05	8/03	6.5E +01	8/03	6.5E +01	8/03	
2,3',4,4',5,5'-HEXACHLOROBIPHENYL (167)	52663-72-6			4.0E-00	8/03	1.0E -03	8/03	1.3E +00	8/03	1.3E +00	8/03	
3,3',4,4',5,5' - HEXACHLOROBIPHENYL (169)	32774-16-6			4.0E-03	8/03	1.0E -06	8/03	1.3E +03	8/03	1.3E +03	8/03	
2,3,3',4,4',5,5' - HEPTACHLOROBIPHENYL (189)	39635-31-9			4.0E-01	8/03	1.0 E-04	8/03	1.3E +01	8/03	1.3E +01	8/03	
POLYCHLORINATED DIBENZO-P-DIOXINS (PCDD) (AS 2,3,7,8-PCDD EQUIVALENT) ^{TAC} *	1085 1086											
2,3,7,8-TETRACHLORODIBENZO-P-DIOXIN ^{TAC}	1746-01-6			4.0E-05	2/00	1.0E-08	10/00	1.3E+05 TAC	8/86	1.3E+05 TAC	8/86	1
1,2,3,7,8-PENTACHLORODIBENZO-P-DIOXIN	40321-76-4			8.0E-05	2/00	2.0E-08	10/00	1.3E+05	4/99	1.3E+05	10/00	1
1,2,3,4,7,8-HEXACHLORODIBENZO-P-DIOXIN	39227-28-6			4.0E-04	2/00	1.0E-07	10/00	1.3E+04	4/99	1.3E+04	10/00	1
1,2,3,6,7,8-HEXACHLORODIBENZO-P-DIOXIN	57653-85-7			4.0E-04	2/00	1.0E-07	10/00	1.3E+04	4/99	1.3E+04	10/00	1
1,2,3,7,8,9-HEXACHLORODIBENZO-P-DIOXIN	19408-74-3			4.0E-04	2/00	1.0E-07	10/00	1.3E+04	4/99	1.3E+04	10/00	1
1,2,3,4,6,7,8-HEPTACHLORODIBENZO-P-DIOXIN	35822-46-9			4.0E-03	2/00	1.0E-06	10/00	1.3E+03	4/99	1.3E+03	10/00	1
1,2,3,4,6,7,8,9-OCTACHLORODIBENZO-P-DIOXIN	3268-87-9			4.0E-02	2/00	1.0E-05	10/00	1.3E+01	4/99	1.3E+01	10/00	1
POLYCHLORINATED DIBENZOFURANS (AS 2,3,7,8-PCDD EQUIVALENT) (PCDF) ^{TAC} *	1080											
2,3,7,8-TETRACHLORODIBENZOFURAN	5120-73-19			4.0E-04	2/00	1.0E-07	10/00	1.3E+04	4/99	1.3E+04	10/00	1
1,2,3,7,8-PENTACHLORODIBENZOFURAN	57117-41-6			8.0E-04	2/00	2.0E-07	10/00	6.5E+03	4/99	6.5E+03	10/00	1
2,3,4,7,8-PENTACHLORODIBENZOFURAN	57117-31-4			8.0E-05	2/00	2.0E-08	10/00	6.5E+04	4/99	6.5E+04	10/00	1
1,2,3,4,7,8-HEXACHLORODIBENZOFURAN	70648-26-9			4.0E-04	2/00	1.0E-07	10/00	1.3E+04	4/99	1.3E+04	10/00	1

APPENDIX L - TABLE 1
OEHHA/ARB APPROVED HEALTH VALUES FOR USE IN HOT SPOT FACILITY RISK ASSESSMENTS *

Substance *	Chemical Abstract Service Number (CAS)	Noncancer Effects						Cancer Risk				
		Acute Inhalation REL (µg/m ³)	Date * Value Reviewed [Added]	Chronic Inhalation REL (µg/m ³)	Date * Value Reviewed [Added]	Chronic Oral REL (mg/kg/d)	Date * Value Reviewed [Added]	Inhalation Cancer Potency Factor (mg/kg-d) ⁻¹	Date * Value Reviewed [Added]	Oral Slope Factor (mg/kg-d) ⁻¹	Date * Value Reviewed [Added]	M* W A F
1,2,3,6,7,8- HEXACHLORODIBENZOFURAN	57117-44-9			4.0E-04	2/00	1.0E-07	10/00	1.3E+04	4/99	1.3E+04	10/00	1
1,2,3,7,8,9- HEXACHLORODIBENZOFURAN	72918-21-9			4.0E-04	2/00	1.0E-07	10/00	1.3E+04	4/99	1.3E+04	10/00	1
2,3,4,6,7,8- HEXACHLORODIBENZOFURAN	60851-34-5			4.0E-04	2/00	1.0E-07	10/00	1.3E+04	4/99	1.3E+04	10/00	1
1,2,3,4,6,7,8- HEPTACHLORODIBENZOFURAN	67562-39-4			4.0E-03	2/00	1.0E-06	10/00	1.3E+03	4/99	1.3E+03	10/00	1
1,2,3,4,7,8,9- HEPTACHLORODIBENZOFURAN	55673-89-7			4.0E-03	2/00	1.0E-06	10/00	1.3E+03	4/99	1.3E+03	10/00	1
1,2,3,4,6,7,8,9- OCTACHLORODIBENZOFURAN	39001-02-0			4.0E-02	2/00	1.0E-05	10/00	1.3E+01	4/99	1.3E+01	10/00	1
POLYCYCLIC AROMATIC HYDROCARBON (PAH)	1150 1151											
BENZ(A)ANTHRACENE *	56-55-3							3.9E-01	4/99 [4/94]	1.2E+00	10/00 [4/94]	1
BENZO(A)PYRENE *	50-32-8							3.9E+00	4/99 [4/94]	1.2E+01	10/00 [4/94]	1
BENZO(B)FLUORANTHENE *	205-99-2							3.9E-01	4/99 [4/94]	1.2E+00	10/00 [4/94]	1
BENZO(J)FLUORANTHENE *	205-82-3							3.9E-01	4/99 [4/94]	1.2E+00	10/00 [4/94]	1
BENZO(K)FLUORANTHENE *	207-08-9							3.9E-01	4/99 [4/94]	1.2E+00	10/00 [4/94]	1
CHRYSENE *	218-01-9							3.9E-02	4/99 [4/94]	1.2E-01	10/00 [4/94]	1
DIBENZ(A,H)ACRIDINE *	226-36-8							3.9E-01	4/99 [4/94]	1.2E+00	10/00 [4/94]	1
DIBENZ(A,H)ANTHRACENE *	53-70-3							4.1E+00	4/99 [4/94]	4.1E+00	10/00 [4/94]	1
DIBENZ(A,J)ACRIDINE *	224-42-0							3.9E-01	4/99 [4/94]	1.2E+00	10/00 [4/94]	1
DIBENZO(A,E)PYRENE *	192-65-4							3.9E+00	4/99 [4/94]	1.2E+01	10/00 [4/94]	1
DIBENZO(A,H)PYRENE *	189-64-0							3.9E+01	4/99 [4/94]	1.2E+02	10/00 [4/94]	1

APPENDIX L - TABLE 1
OEHHA/ARB APPROVED HEALTH VALUES FOR USE IN HOT SPOT FACILITY RISK ASSESSMENTS *

Substance *	Chemical Abstract Service Number (CAS) ▼	Noncancer Effects						Cancer Risk				
		Acute Inhalation REL (µg/m ³)	Date * Value Reviewed [Added]	Chronic Inhalation REL (µg/m ³)	Date * Value Reviewed [Added]	Chronic Oral REL (mg/kg/d)	Date * Value Reviewed [Added]	Inhalation Cancer Potency Factor (mg/kg-d) ⁻¹	Date * Value Reviewed [Added]	Oral Slope Factor (mg/kg-d) ⁻¹	Date * Value Reviewed [Added]	M* W A F
DIBENZO(A,I)PYRENE *	189-55-9							3.9E+01	4/99 [4/94]	1.2E+02	10/00 [4/94]	1
DIBENZO(A,L)PYRENE *	191-30-0							3.9E+01	4/99 [4/94]	1.2E+02	10/00 [4/94]	1
7H-DIBENZO(C,G)CARBAZOLE *	194-59-2							3.9E+00	4/99 [4/94]	1.2E+01	10/00 [4/94]	1
7,12-DIMETHYLBENZ(A)ANTHRACENE *	57-97-6							2.5E+02	4/99 [4/94]	2.5E+02	10/00 [4/94]	1
1,6-DINITROPYRENE *	42397-64-8							3.9E+01	4/99 [4/94]	1.2E+02	10/00 [4/94]	1
1,8-DINITROPYRENE *	42397-65-9							3.9E+00	4/99 [4/94]	1.2E+01	10/00 [4/94]	1
INDENO(1,2,3-C,D)PYRENE *	193-39-5							3.9E-01	4/99 [4/94]	1.2E+00	10/00 [4/94]	1
3-METHYLCHOLANTHRENE *	56-49-5							2.2E+01	4/99 [4/94]	2.2E+01	10/00 [4/94]	1
5-METHYLCHRYSENE *	3697-24-3							3.9E+00	4/99 [4/94]	1.2E+01	10/00 [4/94]	1
NAPHTHALENE	91-20-3			9.0E+00	4/00							--
5-NITROACENAPHTHENE *	602-87-9							1.3E-01	4/99 [4/94]	1.3E-01	10/00 [4/94]	1
6-NITROCHRYSENE *	7496-02-8							3.9E+01	4/99 [4/94]	1.2E+02	10/00 [4/94]	1
2-NITROFLUORENE *	607-57-8							3.9E-02	4/99 [4/94]	1.2E-01	10/00 [4/94]	1
1-NITROPYRENE *	5522-43-0							3.9E-01	4/99 [4/94]	1.2E+00	10/00 [4/94]	1
4-NITROPYRENE *	57835-92-4							3.9E-01	4/99 [4/94]	1.2E+00	10/00 [4/94]	1
POTASSIUM BROMATE.... ... (see Bromine & Compounds)												
1,3-PROPANE SULTONE	1120-71-4							2.4E+00	4/99			1
PROPYLENE (PROPENE)	115-07-1			3.0E+03	4/00							--
PROPYLENE GLYCOL MONOMETHYL ETHER	107-98-2			7.0E+03	2/00							--
PROPYLENE OXIDE	75-56-9	3.1E+03	4/99	3.0E+01	2/00			1.3E-02	4/99 [7/90]			1
SELENIUM AND COMPOUNDS	7782-49-2 [1170]			2.0E+01	12/01							--
HYDROGEN SELENIDE	7783-07-5	5.0E+00	4/99									--
<i>Selenium sulfide</i>	7446-34-6			2.0E+01	12/01							--
SODIUM HYDROXIDE	1310-73-2	8.0E+00	4/99	4.8E+00	7/90							--

APPENDIX L - TABLE 1
OEHHA/ARB APPROVED HEALTH VALUES FOR USE IN HOT SPOT FACILITY RISK ASSESSMENTS [⊕]

Substance [⊕]	Chemical Abstract Service Number (CAS)	Noncancer Effects						Cancer Risk				
		Acute Inhalation REL (µg/m ³)	Date [♦] Value Reviewed [Added]	Chronic Inhalation REL (µg/m ³)	Date [♦] Value Reviewed [Added]	Chronic Oral REL (mg/kg/d)	Date [♦] Value Reviewed [Added]	Inhalation Cancer Potency Factor (mg/kg-d) ⁻¹	Date [♦] Value Reviewed [Added]	Oral Slope Factor (mg/kg-d) ⁻¹	Date [♦] Value Reviewed [Added]	M ⁺ W A F
STYRENE	100-42-5	2.1E+04	4/99	9.0E+02	4/00							--
SULFATES	9960	1.2E+02	4/99	2.5E+01	1/92							--
SULFUR DIOXIDE	7446-09-5	6.6E+02	4/99[1/92]	6.6E+02	1/92							--
SULFURIC ACID AND OLEUM	7664-93-9	1.2E+02	4/99	1.0E+00	12/01							--
SULFURIC ACID	7664-93-9	1.2E+02	4/99	1.0E+00	12/01							--
SULFUR TRIOXIDE	7446-71-9	1.2E+02	4/99									--
OLEUM	8014-95-7	1.2E+02	4/99	1.0E+00	12/01							--
1,1,2,2-TETRACHLOROETHANE	79-34-5							2.0E-01	4/99			1
TETRACHLOROPHENOLS ... (see Chlorophenols)												
2,4,5-TRICHLOROPHENOL ... (see Chlorophenols)												
2,4,6-TRICHLOROPHENOL ... (see Chlorophenols)												
THIOACETAMIDE	62-55-5							6.1E+00	4/99			1
TOLUENE	108-88-3	3.7E+04	4/99	3.0E+02	4/00							--
<i>Toluene diisocyanates</i>	26471-62-5 1204			7.0E-02	1/01			3.9E-02	4/99			1
TOLUENE-2,4-DIISOCYANATE	584-84-9			7.0E-02	1/01			3.9E-02	4/99			1
TOLUENE-2,6-DIISOCYANATE	91-08-7			7.0E-02	1/01			3.9E-02	4/99			1
1,1,2-TRICHLOROETHANE (Vinyl trichloride)	79-00-5							5.7E-02	4/99			1
TRICHLOROETHYLENE ^{TAC}	79-01-6			6.0E+02	4/00			7.0E-03 TAC	10/90			1
TRIETHYLAMINE	121-44-8	2.8E+03	4/99	2.0 ^E +02	9/02							--
URETHANE (Ethyl carbamate)	51-79-6							1.0E+00	4/99 [7/90]			1
<i>Vanadium Compounds</i>	N/A											
<i>Vanadium (fume or dust)</i>	7440-62-2	3.0E+01	4/99									--
VANADIUM PENTOXIDE	1314-62-1	3.0E+01	4/99									--
VINYL ACETATE	108-05-4			2.0E+02	12/01							--
VINYL CHLORIDE ^{TAC} (Chloroethylene)	75-01-4	1.8E+05	4/99					2.7E-01 TAC	12/90			1
VINYLDENE CHLORIDE (1,1-Dichloroethylene)	75-35-4			7.0E+01	1/01							--

APPENDIX L - TABLE 1
OEHHA/ARB APPROVED HEALTH VALUES FOR USE IN HOT SPOT FACILITY RISK ASSESSMENTS [⊕]

Substance [⊕]	Chemical Abstract Service Number (CAS)	Noncancer Effects						Cancer Risk				
		Acute Inhalation REL (µg/m ³)	Date [♦] Value Reviewed [Added]	Chronic Inhalation REL (µg/m ³)	Date [♦] Value Reviewed [Added]	Chronic Oral REL (mg/kg/d)	Date [♦] Value Reviewed [Added]	Inhalation Cancer Potency Factor (mg/kg-d) ⁻¹	Date [♦] Value Reviewed [Added]	Oral Slope Factor (mg/kg-d) ⁻¹	Date [♦] Value Reviewed [Added]	M ⁺ W A F
XYLENES (mixed isomers)	1330-20-7 1210	2.2E+04	4/99	7.0E+02	4/00							--
m-XYLENE	108-38-3	2.2E+04	4/99	7.0E+02	4/00							--
o-XYLENE	95-47-6	2.2E+04	4/99	7.0E+02	4/00							--
p-XYLENE	106-42-3	2.2E+04	4/99	7.0E+02	4/00							--

APPENDIX L - TABLE 1
OEHHA/ARB APPROVED HEALTH VALUES FOR USE IN HOT SPOT FACILITY RISK ASSESSMENTS *

Purpose:	The purpose of this reference table is to provide a quick list of all health values that have been approved by the Office of Environmental Health Hazard Assessment (OEHHA) and the Air Resources Board (ARB) for use in facility health risk assessments conducted for the AB 2588 Air Toxics Hot Spots Program. The OEHHA has developed and adopted new risk assessment guidelines that update and replace the California Air Pollution Control Officers Association's (CAPCOA) <i>Air Toxics "Hot Spots" Program Revised 1992 Risk Assessment Guidelines, October 1993</i>. The OEHHA has adopted five technical support documents for these guidelines. This table lists the OEHHA adopted inhalation and oral cancer slope factors, noncancer acute Reference Exposure Levels (RELs), and inhalation and oral noncancer chronic RELs. In addition, it lists the substances in Appendix A-I (<i>Substances For Which Emissions Must Be Quantified</i>) and Appendix F (<i>Criteria For Inputs For Risk Assessment Using Screening Air Dispersion Modeling</i>) of the ARB's <i>Air Toxics "Hot Spots" Emission Inventory Criteria and Guidelines (EICG)</i>. OEHHA is still in the process of adopting new noncancer chronic RELs. Therefore, new health values will periodically be added to, or deleted from, this table. Users of this table are advised to monitor the OEHHA website (www.oehha.ca.gov) for any updates to the health values.
☼	Substances written in <i>italics</i> do not have explicit OEHHA approved health values, but are included in this table to clarify applicability of OEHHA adopted health effects values to individual or grouped substances listed in the <i>Air Toxics "Hot Spots" Emission Inventory Criteria and Guidelines</i>, Appendix A-I list of "<i>Substances For Which Emissions Must Be Quantified</i>".
▼	Chemical Abstract Service Number (CAS): For chemical groupings and mixtures where a CAS number is not applicable, the 4-digit code used in the <i>Air Toxics "Hot Spots" Emission Inventory Criteria and Guidelines (EICG) Report</i> is listed. The 4-digit codes enclosed in brackets [] are codes that have been phased out, but may still appear on previously reported Hot Spots emissions. For information on the origin and use of the 4-digit code, see the EICG report.
◆	Date Value Reviewed [Added]: These columns list the date that the health value was last reviewed by OEHHA and the Scientific Review Panel, and/or approved for use in the AB 2588 Air Toxics Hot Spots Program. If the health value is unchanged since it was first approved for use in the Hot Spots Program, then the date that the value was first approved for use by CAPCOA is listed within the brackets []. - April 1999 is listed for the cancer potency values and noncancer acute RELs, which have been adopted by the OEHHA as part of the AB 2588 "Hot Spot" Risk Assessment Guidelines. - February 2000, April 2000, January 2001, and December 2001 are listed for the first set of 22, the second set of 16, the third set of 22, and the fourth set of 12 noncancer chronic RELs, respectively. - October 2000 is listed for the oral chronic RELs and oral cancer slope factors. 1996 is listed for the U.S. EPA Reference Concentrations. Dates of 1990-1992 and 1996 are listed for CAPCOA chronic RELs, which may eventually be dropped or replaced. - For the substances identified as Toxic Air Contaminants, the Air Resources Board hearing date is listed. The dates for acetaldehyde, benzo[a]pyrene, and methyl tertiary-butyl ether represent the dates the values were approved by the Scientific Review Panel.
♣	Molecular Weight Adjustment Factor: Molecular weight adjustment factors (MWAF) are only to be used when a toxic metal has a cancer potency factor. For most of the Hot Spots toxic metals, the OEHHA cancer potency factor applies to the weight of the toxic metal atom contained in the overall compound. Some of the Hot Spots compounds contain various elements along with the toxic metal atom (e.g., "Nickel hydroxide", CAS number 12054-48-7, has a formula of H_2NiO_2). Therefore, an adjustment to the reported pounds of the overall compound is needed before applying the OEHHA cancer potency factor for "Nickel and compounds" to such a compound. This ensures that the cancer potency factor is applied only to the fraction of the overall weight of the emissions that are associated with health effects of the metal. In other cases, the Hot Spots metals are already reported as the metal atom equivalent (e.g., CAS 7440-02-0, "Nickel"), and these cases do not use any further molecular weight adjustment. (Refer to Note [7] in Appendix A, List of Substances in the EICG Report for further information on how the emissions of various Hot Spots metal compounds are reported.) The appropriate molecular weight adjustment factors (MWAF) to be used along with the OEHHA cancer potency factors for Hot Spots metals can be found in the MWAF column of this table. A double dash (--) was entered into the column if the substance does not currently have a cancer potency factor. So, for example, assume 100 pounds of "Nickel hydroxide" emissions are reported under CAS number 12054-48-7. To get the Nickel atom equivalent of these emissions, multiply by the listed MWAF (0.6332) for Nickel hydroxide: 100 pounds x 0.6332 = 63.32 pounds of Nickel atom equivalent <i>This step should be completed prior to applying the OEHHA cancer potency factor for "Nickel and compounds" in a calculation for a prioritization score or risk assessment calculation.</i> (For more information see Chapter 4 and Appendix H of OEHHA's <i>The Air Toxics Hot Spots Program Risk Assessment Guidelines; Part V; Technical Support Document; Guidance Manual for Preparation of Health Risk Assessments</i>.) Note: The value listed in the MWAF column for Asbestos is not a molecular weight adjustment. This is a conversion factor for adjusting mass to fibers or structures. See Appendix C of OEHHA's <i>The Air Toxics Hot Spots Program Risk Assessment Guidelines; Part V; Technical Support Document; Guidance Manual for Preparation of Health Risk Assessments</i> for more information on Asbestos, or see the EICG report for reporting guidance. Also see the Asbestos footnote (designated by the symbol ☿)
N/A	Not Applicable
Ñ	Values calculated using WHO TEF procedure in OEHHA, 2003
TAC	Toxic Air Contaminant: The Air Resources Board has identified this substance as a Toxic Air Contaminant.

APPENDIX L - TABLE 1
OEHHA/ARB APPROVED HEALTH VALUES FOR USE IN HOT SPOT FACILITY RISK ASSESSMENTS *

AveP	The averaging period of noncancer acute RELs is generally a one-hour exposure. However, some are based on several hour exposure for reproductive/developmental endpoints (see section 1.6 of OEHHA's technical support document for <i>The Determination of Acute Reference Exposure Levels for Airborne Toxicants, March 1999</i>). Typically the RELs for the following substances are compared to modeled emission concentrations of the same duration rather than maximum one-hour concentrations (e.g., a 4-hour REL should be compared to the maximum 4-hour average concentration from the air dispersion model). 4-Hour: Arsenic and Inorganic Arsenic Compounds 6-Hour: Benzene, Carbon disulfide, Ethylene glycol monoethyl ether, Ethylene glycol monoethyl ether acetate, Ethylene glycol monomethyl ether 7-Hour: Carbon tetrachloride, Chloroform
☒	Asbestos: The units for the Inhalation Cancer Potency factor for asbestos are $(100 \text{ PCM fibers/m}^3)^{-1}$. A conversion factor of 100 fibers/0.003 μg can be multiplied by a receptor concentration of asbestos expressed in $\mu\text{g/m}^3$. Unless other information necessary to estimate the concentration (fibers/m^3) of asbestos at receptors of interest is available. A unit risk factor of $2.7 \times 10^{-6} (\mu\text{g/m}^3)^{-1}$ and an inhalation cancer potency factor of $2.2 \times 10^{-12} (\text{mg/kg BW} \cdot \text{day})^{-1}$ are available. For more information on asbestos quantity conversion factors, see Appendix C of OEHHA's <i>The Air Toxics Hot Spots Program Risk Assessment Guidelines; Part II; Technical Support Document for Describing Available Cancer Potency Factors</i>, and Appendix C of OEHHA's <i>The Air Toxics Hot Spots Program Risk Assessment Guidelines; Part V; Technical Support Document; Guidance Manual for Preparation of Health Risk Assessments</i>.
✱	Inorganic Lead: Inorganic Lead was identified by the Air Resources Board as a Toxic Air Contaminant in April 1997. Since information on noncancer health effects show no identified threshold, no Reference Exposure Level has been developed. The document, <i>Risk Management Guidelines for New, Modified, and Existing Sources of Lead, March 2001</i>, has been developed by ARB and OEHHA staff for assessing noncancer health impacts from sources of lead. See Appendix F of OEHHA's <i>The Air Toxics Hot Spots Program Risk Assessment Guidelines; Part V; Technical Support Document; Guidance Manual for Preparation of Health Risk Assessments</i> for an overview of how to evaluate noncancer impacts from exposure to lead using these risk management guidelines.
❖	Polycyclic Aromatic Hydrocarbons (PAHs): These substances are PAH or PAH-derivatives that have OEHHA-developed Potency Equivalency Factors (PEFs) which were approved by the Scientific Review Panel in April 1994 (see ARB document entitled <i>Benzo [a]pyrene as a Toxic Air Contaminant</i>). PAH inhalation slope factors listed here have been adjusted by the PEFs. See Appendix G of OEHHA's <i>The Air Toxics Hot Spots Program Risk Assessment Guidelines; Part V; Technical Support Document; Guidance Manual for Preparation of Health Risk Assessments</i> for more information.
★	Polychlorinated Biphenyls: (unspeciated mixtures) Lowest Risk: For use in cases where congeners with more than four chlorines comprise less than one-half percent of total polychlorinated biphenyls. High Risk: For use in cases where congeners with more than four chlorines do not comprise less than one-half percent of total polychlorinated biphenyls. The Low Risk: This number would not ordinarily be used in the Hot Spots program.
•	Polychlorinated Dibenzo-<i>p</i>-dioxins and Polychlorinated Dibenzofurans (also referred to as chlorinated dioxins and dibenzofurans): The OEHHA has adopted the World Health Organization 1997 (WHO-97) Toxicity Equivalency Factor) scheme for evaluating the cancer and noncancer risk due to exposure to samples containing speciated mixtures of polychlorinated dibenzo-<i>p</i>-dioxins (PCDD) and polychlorinated dibenzofurans (PCDF). See Appendix A of OEHHA's <i>Technical Support Document For Describing Available Cancer Potency Factors</i> for more information about the scheme. See Appendix E of OEHHA's <i>The Air Toxics Hot Spots Program Risk Assessment Guidelines; Part V; Technical Support Document; Guidance Manual for Preparation of Health Risk Assessments</i> for the methodology for calculating 2,3,7,8-equivalents for PCDD and PCDFs.
■	Particulate Emissions from Diesel-Fueled Engines: The inhalation cancer potency factor and chronic REL were derived from whole diesel exhaust and should be used only for impacts from the inhalation pathway. The inhalation impacts from speciated emissions from diesel-fueled engines are already accounted for in the inhalation cancer potency factor and REL. However, at the discretion of the risk assessor, speciated emissions from diesel-fueled engines may be used to estimate acute noncancer health impacts or the contribution to cancer risk or chronic noncancer health impacts for the non-inhalation exposure pathway. See Appendix D of OEHHA's <i>The Air Toxics Hot Spots Program Risk Assessment Guidelines; Part V; Technical Support Document; Guidance Manual for Preparation of Health Risk Assessments</i> for more information.

Table last updated: August, 2003

APPENDIX L - TABLE 2 OEHHA/ARB ACUTE REFERENCE EXPOSURE LEVELS AND TARGET ORGANS[®]

Substance [®]	Chemical [▼] Abstract Service Number (CAS)	Acute REL (µg/m ³)	Date [♦] Value Reviewed	Target Organs									
				Alimentary Tract	Cardiovascular	Developmental	Eye	Hematologic	Immune	Nervous	Reproductive	Respiratory	Skin
ACROLEIN	107-02-8	1.9E-01	4/99				X					X	
ACRYLIC ACID	79-10-7	6.0E+03	4/99				X					X	
AMMONIA	7664-41-7	3.2E+03	4/99				X					X	
ARSENIC AND COMPOUNDS (INORGANIC) ^{TAC}	7440-38-2 1016 [1015]	1.9E-01 ^{AveP}	4/99			X					X		
ARSINE	7784-42-1	1.6E+02	4/99					X					
BENZENE ^{TAC}	71-43-2	1.3E+03 ^{AveP}	4/99			X		X	X		X		
BENZYL CHLORIDE	100-44-7	2.4E+02	4/99				X					X	
CARBON DISULFIDE	75-15-0	6.2E+03 ^{AveP}	4/99			X				X	X		
CARBON MONOXIDE	630-08-0	2.3E+04	4/99		X								
CARBON TETRACHLORIDE ^{TAC} (Tetrachloromethane)	56-23-5	1.9E+03 ^{AveP}	4/99	X		X				X	X		
CHLORINE	7782-50-5	2.1E+02	4/99				X					X	
CHLOROFORM ^{TAC}	67-66-3	1.5E+02 ^{AveP}	4/99			X				X	X		
CHLOROPICRIN	76-06-2	2.9E+01	4/99				X					X	
COPPER AND COMPOUNDS	7440-50-8 [1067]	1.0E+02	4/99									X	
Cyanide Compounds (inorganic)	57-12-5 1073	3.4E+02	4/99							✓			
HYDROGEN CYANIDE (Hydrocyanic acid)	74-90-8	3.4E+02	4/99							X			
1,4-DIOXANE ⁺ (1,4-Diethylene dioxide)	123-91-1	3.0E+03	4/99				X					X	
EPICHLOROHYDRIN (1-Chloro-2,3-epoxypropane)	106-89-8	1.3E+03	4/99				X					X	
Fluorides and Compounds	1101	2.4E+02	4/99				✓					✓	
HYDROGEN FLUORIDE (Hydrofluoric acid)	7664-39-3	2.4E+02	4/99				X					X	
FORMALDEHYDE ^{TAC}	50-00-0	9.4E+01	4/99				X		X			X	
GLYCOL ETHERS	1115												
ETHYLENE GLYCOL BUTYL ETHER – EGBE	111-76-2	1.4E+04	4/99				X					X	
ETHYLENE GLYCOL ETHYL ETHER – EGEE	110-80-5	3.7E+02 ^{AveP}	4/99 [1/92]			X					X		
ETHYLENE GLYCOL ETHYL ETHER ACETATE - EGEEA	111-15-9	1.4E+02 ^{AveP}	4/99			X				X	X		
ETHYLENE GLYCOL METHYL ETHER – EGME	109-86-4	9.3E+01 ^{AveP}	4/99			X					X		

APPENDIX L - TABLE 2 OEHHA/ARB ACUTE REFERENCE EXPOSURE LEVELS AND TARGET ORGANS [®]

Substance [⊛]	Chemical [▼] Abstract Service Number (CAS)	Acute REL (µg/m ³)	Date [♦] Value Reviewed	Target Organs									
				Alimentary Tract	Cardiovascular	Developmental	Eye	Hematologic	Immune	Nervous	Reproductive	Respiratory	Skin
HYDROCHLORIC ACID (Hydrogen chloride)	7647-01-0	2.1E+03	4/99				X					X	
HYDROGEN CYANIDE (Hydrocyanic acid) ... (see Cyanide Compounds)													
HYDROGEN FLUORIDE (Hydrofluoric acid) ... (see Fluorides & Compounds)													
HYDROGEN SELENIDE ... (see Selenium & Compounds)													
HYDROGEN SULFIDE	7783-06-4	4.2E+01	4/99 [7/90]							X			
ISOPROPYL ALCOHOL (Isopropanol)	67-63-0	3.2E+03	4/99				X					X	
MERCURY AND COMPOUNDS (INORGANIC)	7439-97-6 [1133]	1.8E+00	4/99			X					X		
<i>Mercuric chloride</i>	7487-94-7	1.8E+00	4/99			✓					✓		
METHANOL	67-56-1	2.8E+04	4/99							X			
METHYL BROMIDE (Bromomethane)	74-83-9	3.9E+03	4/99			X				X	X	X	
METHYL CHLOROFORM (1,1,1-Trichloroethane)	71-55-6	6.8E+04	4/99							X			
METHYL ETHYL KETONE (2-Butanone)	78-93-3	1.3E+04	4/99				X					X	
METHYLENE CHLORIDE ^{TAC} (Dichloromethane)	75-09-2	1.4E+04	4/99							X			
NICKEL AND COMPOUNDS ^{TAC}	7440-02-0 [1145]	6.0E+00	4/99						X			X	
<i>Nickel acetate,</i>	373-02-4	6.0E+00	4/99						✓			✓	
<i>Nickel carbonate</i>	3333-39-3	6.0E+00	4/99						✓			✓	
<i>Nickel carbonyl</i>	13463-39-3	6.0E+00	4/99						✓			✓	
<i>Nickel hydroxide</i>	12054-48-7	6.0E+00	4/99						✓			✓	
<i>Nickelocene</i>	1271-28-9	6.0E+00	4/99						✓			✓	
NICKEL OXIDE	1313-99-1	6.0E+00	4/99						X			X	
<i>Nickel refinery dust from the pyrometallurgical process</i>	1146	6.0E+00	4/99						✓			✓	
<i>Nickel subsulfide</i>	12035-72-2	6.0E+00	4/99						✓			✓	
NITRIC ACID	7697-37-2	8.6E+01	4/99									X	
NITROGEN DIOXIDE	10102-44-0	4.7E+02	4/99 [1/92]									X	
OZONE	10028-15-6	1.8E+02	4/99 [1/92]				X					X	
PERCHLOROETHYLENE ^{TAC} (Tetrachloroethylene)	127-18-4	2.0E+04	4/99				X			X		X	
PHENOL	108-95-2	5.8E+03	4/99				X					X	

APPENDIX L - TABLE 2 OEHHA/ARB ACUTE REFERENCE EXPOSURE LEVELS AND TARGET ORGANS [®]

Substance [®]	Chemical Abstract Service Number (CAS)	Acute REL (µg/m ³)	Date [♦] Value Reviewed	Target Organs									
				Alimentary Tract	Cardiovascular	Developmental	Eye	Hematologic	Immune	Nervous	Reproductive	Respiratory	Skin
PHOSGENE	75-44-5	4.0E+00	4/99									X	
PROPYLENE OXIDE	75-56-9	3.1E+03	4/99			X	X				X	X	
<i>Selenium and Compounds</i>	7782-49-2 [1170]												
HYDROGEN SELENIDE	7783-07-5	5.0E+00	4/99				X					X	
SODIUM HYDROXIDE	1310-73-2	8.0E+00	4/99				X					X	X
STYRENE	100-42-5	2.1E+04	4/99				X					X	
SULFATES	9960	1.2E+02	4/99									X	
SULFUR DIOXIDE	7446-09-5	6.6E+02	4/99 [1/92]									X	
SULFURIC ACID AND OLEUM	7664-93-9	1.2E+02	4/99									X	
<i>SULFURIC ACID</i>	7664-93-9	1.2E+02	4/99									✓	
<i>SULFUR TRIOXIDE</i>	7446-71-9	1.2E+02	4/99									✓	
<i>OLEUM</i>	8014-95-7	1.2E+02	4/99									✓	
TOLUENE	108-88-3	3.7E+04	4/99			X	X			X	X	X	
TRIETHYLAMINE	121-44-8	2.8E+03	4/99				X			X			
<i>Vanadium Compounds</i>	N/A												
<i>Vanadium (fume or dust)</i>	7440-62-2	3.0E+01	4/99				✓					✓	
VANADIUM PENTOXIDE	1314-62-1	3.0E+01	4/99				X					X	
VINYL CHLORIDE ^{TAC} (Chloroethylene)	75-01-4	1.8E+05	4/99				X			X		X	
XYLENES (mixed isomers)	1330-20-7 1210	2.2E+04	4/99				X					X	
m-Xylene	108-38-3	2.2E+04	4/99				X					X	
o-Xylene	95-47-6	2.2E+04	4/99				X					X	
p-Xylene	106-42-3	2.2E+04	4/99				X					X	

APPENDIX L - TABLE 2 OEHHA/ARB ACUTE REFERENCE EXPOSURE LEVELS AND TARGET ORGANS [®]

Purpose:	The purpose of this reference table is to provide a quick list of all health values that have been approved by the Office of Environmental Health Hazard Assessment (OEHHA) and the Air Resources Board (ARB) for use in facility health risk assessments conducted for the AB 2588 Air Toxics Hot Spots Program. The OEHHA has developed and adopted new risk assessment guidelines that update and replace the California Air Pollution Control Officers Association's (CAPCOA) <i>Air Toxics "Hot Spots" Program Revised 1992 Risk Assessment Guidelines, October 1993</i>. The OEHHA has adopted five technical support documents for these guidelines. This table lists the OEHHA adopted noncancer acute Reference Exposure Levels (RELs). In addition, it lists the substances in Appendix A-I (<i>Substances For Which Emissions Must Be Quantified</i>) and Appendix F (<i>Criteria For Inputs For Risk Assessment Using Screening Air Dispersion Modeling</i>) of the ARB's <i>Air Toxics "Hot Spots" Emission Inventory Criteria and Guidelines (EICG)</i>. Users of this table are advised to monitor the OEHHA website (www.oehha.ca.gov) for any updates to the health values.
☼	Substances written in <i>italics</i> and with a ✓ do not have explicit OEHHA approved health values, but are included in this table to clarify applicability of OEHHA adopted health effects values to individual or grouped substances listed in the <i>Air Toxics "Hot Spots" Emission Inventory Criteria and Guidelines</i>, Appendix A-I list of "<i>Substances For Which Emissions Must Be Quantified</i>".
▼	Chemical Abstract Service Number (CAS): For chemical groupings and mixtures where a CAS number is not applicable, the 4-digit code used in the <i>Air Toxics "Hot Spots" Emission Inventory Criteria and Guidelines (EICG) Report</i> is listed. The 4-digit codes enclosed in brackets [] are codes that have been phased out, but may still appear on previously reported Hot Spots emissions. For information on the origin and use of the 4-digit code, see the EICG report.
◆	Date Value Reviewed [Added]: This column lists the date that the health value was last reviewed by OEHHA and the Scientific Review Panel, and/or approved for use in the AB 2588 Air Toxics "Hot Spots" Program. If the health value is unchanged since it was first approved for use in the "Hot Spots" Program, then the date that the value was first approved for use by CAPCOA is listed within the brackets []. April 1999 is listed for the noncancer acute RELs which have been adopted by the OEHHA as part of the AB 2588 "Hot Spot" Risk Assessment Guidelines.
TAC	Toxic Air Contaminant: The Air Resources Board has identified this substance as a Toxic Air Contaminant.
AveP	The averaging period of noncancer acute RELs is generally a one-hour exposure. However, some are based on several hour exposure for reproductive/developmental endpoints (see section 1.6 of OEHHA's technical support document for <i>The Determination of Acute Reference Exposure Levels for Airborne Toxicants, March 1999</i>). Typically the RELs for the following substances are compared to modeled emission concentrations of the same duration rather than maximum one-hour concentrations (e.g., a 4-hour REL should be compared to the maximum 4-hour average concentration from the air dispersion model). 4-Hour: Arsenic and Inorganic Arsenic Compounds 6-Hour: Benzene, Carbon disulfide, Ethylene glycol ethyl ether, Ethylene glycol ethyl ether acetate, Ethylene glycol methyl ether 7-Hour: Carbon tetrachloride, Chloroform

Table last updated: August 2003

APPENDIX L - TABLE 3 OEHHA/ARB CHRONIC INHALATION AND ORAL REFERENCE EXPOSURE LEVELS AND TARGET ORGANS [®]

Substance [®]	Chemical [▼] Abstract Service Number (CAS)	Chronic Inhalation REL (µg/m ³)	Chronic Oral REL	Date [♦] Value Reviewed [Added]	Target Organs												
					Alimentary	Bone	Cardiovascular	Developmental	Endocrine	Eye	Hematologic	Immune	Kidney	Nervous	Reproductive	Respiratory	Skin
ACETALDEHYDE	75-07-0	9.0E+00		5/93												X	
ACROLEIN	107-02-8	6.0E-02		1/01						X						X	
ACRYLONITRILE	107-13-1	5.0E+00		12/01												X	
AMMONIA	7664-41-7	2.0E+02		2/00												X	
ARSENIC AND COMPOUNDS (INORGANIC) ^{TAC}	7440-38-2 1016 [1015]	3.0E-02		1/01			X	X						X			
			3.0 ^E -04	10/00			X										X
BENZENE ^{TAC}	71-43-2	6.0E+01		2/00				X			X			X			
BERYLLIUM AND COMPOUNDS	7440-41-7 [1021]	7.0E-03		12/01								X				X	
			2.0 ^E -03	12/01	X												
1,3-BUTADIENE ^{TAC}	106-99-0	2.0E+01		1/01											X		
CADMIUM AND COMPOUNDS ^{T7AC}	7440-43-9 [1045]	2.0E-02		1/01									X			X	
			5.0 ^E -04	10/00									X				
CARBON DISULFIDE	75-15-0	8.0E+02		11/01										X	X		
CARBON TETRACHLORIDE ^{TAC} (Tetrachloromethane)	56-23-5	4.0E+01		1/01	X			X						X			
CHLORINE	7782-50-5	2.0E-01		2/00												X	
CHLORINE DIOXIDE	10049-04-4	6.0E-01		1/01												X	
CHLOROBENZENE	108-90-7	1.0E+03		1/01	X								X		X		
CHLOROFORM ^{TAC}	67-66-3	3.0E+02		4/00	X			X					X				
CHLOROPICRIN	76-06-2	4.0E-01		12/01												X	
CHROMIUM 6+ ^{TAC}	18540-29-9	2.0E-01		1/01												X	
			2.0E-02	10/00							X						
<i>Barium chromate</i>	10294-40-3	2.0E-01		1/01												✓	
			2.0E-02	10/00							✓						
<i>Calcium chromate</i>	13765-19-0	2.0E-01		1/01												✓	
			2.0E-02	10/00							✓						
<i>Lead chromate</i>	7758-97-6	2.0E-01		1/01												✓	
			2.0E-02	10/00							✓						

APPENDIX L - TABLE 3 OEHHA/ARB CHRONIC INHALATION AND ORAL REFERENCE EXPOSURE LEVELS AND TARGET ORGANS [®]

Substance [®]	Chemical Abstract Service Number (CAS) [▼]	Chronic Inhalation REL (µg/m ³)	Chronic Oral REL	Date Value Reviewed [Added] [♦]	Target Organs												
					Alimentary	Bone	Cardiovascular	Developmental	Endocrine	Eye	Hematologic	Immune	Kidney	Nervous	Reproductive	Respiratory	Skin
Sodium dichromate	10588-01-9	2.0E-01		1/01												✓	
			2.0E-02	10/00							✓						
Strontium chromate	7789-06-2	2.0E-01		1/01												✓	
			2.0E-02	10/00							✓						
CHROMIUM TRIOXIDE (as chromic acid mist)	1333-82-0	2.0E-03		1/01												X	
			2.0E-02	10/00							✓						
CRESOLS (mixtures of)	1319-77-3	6.0E+02		1/01										X			
m-CRESOL	108-39-4	6.0E+02		1/01										X			
o-CRESOL	95-48-7	6.0E+02		1/01										X			
p-CRESOL	106-44-5	6.0E+02		1/01										X			
Cyanide Compounds (inorganic)	57-12-5 1073	9.0E+00		4/00			✓		✓					✓			
HYDROGEN CYANIDE (Hydrocyanic acid)	74-90-8	9.0E+00		4/00			X		X					X			
p-DICHLOROBENZENE	106-46-7	8.0E+02		1/01	X								X	X		X	
1,1-DICHLOROETHYLENE ... (see Vinylidene Chloride)																	
DIESEL EXHAUST ... (see Particulate Emissions from Diesel-Fueled Engines)																	
DIETHANOLAMINE	111-42-2	3.0E+00		12/01			X							X			
N,N-DIMETHYL FORMAMIDE	68-12-2	8.0E+01		1/01	X											X	
1,4-DIOXANE [♦] (1,4-Diethylene dioxide)	123-91-1	3.0E+03		4/00	X		X						X				
EPICHLOROHYDRIN (1-Chloro-2,3-epoxypropane)	106-89-8	3.0E+00		1/01						X						X	
1,2-EPOXYBUTANE	106-88-7	2.0E+01		1/01			X									X	
ETHYL BENZENE	100-41-4	2.0E+03		2/00	X			X	X				X				
ETHYL CHLORIDE (Chlorethane)	75-00-3	3.0E+04		4/00	X			X									
ETHYLENE DIBROMIDE ^{TAC} (1,2-Dibromoethane)	106-93-4	8.0E-01		12/01											X		
ETHYLENE DICHLORIDE ^{TAC} (1,2-Dichloroethane)	107-06-2	4.0E+02		1/01	X												
ETHYLENE GLYCOL	107-21-1	4.0E+02		4/00				X					X			X	
ETHYLENE OXIDE ^{TAC} (1,2-Epoxyethane)	75-21-8	3.0E+01		1/01										X			

APPENDIX L - TABLE 3 OEHHA/ARB CHRONIC INHALATION AND ORAL REFERENCE EXPOSURE LEVELS AND TARGET ORGANS [®]

Substance [⚠]	Chemical [▼] Abstract Service Number (CAS)	Chronic Inhalation REL (µg/m ³)	Chronic Oral REL	Date [◆] Value Reviewed [Added]	Target Organs													
					Alimentary	Bone	Cardiovascular	Developmental	Endocrine	Eye	Hematologic	Immune	Kidney	Nervous	Reproductive	Respiratory	Skin	
Fluorides	1101	1.3E+1	4.0E-2	8/03		X					✓*						✓	✓*
HYDROGEN FLUORIDE (Hydrofluoric acid)	7664-39-3	1.4E+1	4.0E-2	8/03		X					X*						X	X*
FORMALDEHYDE ^{TAC}	50-00-0	3.0E+00		2/00							X						X	
GLUTARALDEHYDE	111-30-8	8.0E-02		1/01													X	
GLYCOL ETHERS	1115																	
ETHYLENE GLYCOL ETHYL ETHER – EGEE	110-80-5	7.0E+01		2/00								X				X		
ETHYLENE GLYCOL ETHYL ETHER ACETATE - EGEEA	111-15-9	3.0E+02		2/00					X									
ETHYLENE GLYCOL METHYL ETHER – EGME	109-86-4	6.0E+01		2/00												X		
ETHYLENE GLYCOL METHYL ETHER ACETATE – EGMEA	110-49-6	9.0E+01		2/00												X		
n-HEXANE	110-54-3	7.0E+03		4/00											X			
HYDRAZINE	302-01-2	2.0E-01		1/01	X					X								
HYDROCHLORIC ACID (Hydrogen chloride)	7647-01-0	9.0E+00		2/00													X	
HYDROGEN CYANIDE (Hydrocyanic acid) (see Cyanide Compounds)																		
HYDROGEN FLUORIDE (Hydrofluoric acid) (see Fluorides & Compounds)																		
HYDROGEN SULFIDE	7783-06-4	1.0E+01		4/00													X	
ISOPHORONE	78-59-1	2.0E+03		12/01	X				X									
ISOPROPYL ALCOHOL (Isopropanol)	67-63-0	7.0E+03		2/00					X					X				
MALEIC ANHYDRIDE	108-31-6	7.0E-01		12/01													X	
MANGANESE AND COMPOUNDS	7439-96-5 [1132]	2.0E-01		4/00											X			
MERCURY AND COMPOUNDS (INORGANIC)	7439-97-6 [1133]	9.0E-02		2/00											X			
			3.0 ^E -04	10/00 [1/92]								X	X					
<i>Mercuric chloride</i>	7487-94-7	9.0E-02		2/00											✓			
			3.0E-04	10/00 [1/92]								✓	✓					
MERCURY AND COMPOUNDS (ORGANIC)	N/A																	
METHANOL	67-56-1	4.0E+03		4/00					X									
METHYL BROMIDE (Bromomethane)	74-83-9	5.0E+00		2/00					X					X			X	
METHYL tertiary-BUTYL ETHER	1634-04-4	8.0E+03		2/00	X						X			X				

APPENDIX L - TABLE 3 OEHHA/ARB CHRONIC INHALATION AND ORAL REFERENCE EXPOSURE LEVELS AND TARGET ORGANS [®]

Substance [®]	Chemical [▼] Abstract Service Number (CAS)	Chronic Inhalation REL (µg/m ³)	Chronic Oral REL	Date [◆] Value Reviewed [Added]	Target Organs												
					Alimentary	Bone	Cardiovascular	Developmental	Endocrine	Eye	Hematologic	Immune	Kidney	Nervous	Reproductive	Respiratory	Skin
METHYL CHLOROFORM (1,1,1-Trichloroethane)	71-55-6	1.0E+03		2/00										X			
METHYL ISOCYANATE	624-83-9	1.0E+00		12/01											X	X	
METHYLENE CHLORIDE ^{TAC} (Dichloromethane)	75-09-2	4.0E+02		2/00			X							X			
4,4'-METHYLENE DIANILINE (AND ITS DICHLORIDE)	101-77-9	2.0E+01		12/01	X					X							
METHYLENE DIPHENYL ISOCYANATE	101-68-8	7.0E-01		1/01												X	
NAPHTHALENE	91-20-3	9.0E+00		4/00												X	
NICKEL AND COMPOUNDS ^{TAC}	7440-02-0 [1145]	5.0E-02		2/00							X					X	
			5.0E-02	10/00	X												
<i>Nickel acetate</i>	373-02-4	5.0E-02		2/00							✓					✓	
			5.0E-02	10/00	✓												
<i>Nickel carbonate</i>	3333-39-3	5.0E-02		2/00							✓					✓	
			5.0E-02	10/00	✓												
<i>Nickel carbonyl</i>	13463-39-3	5.0E-02		2/00							✓					✓	
			5.0E-02	10/00	✓												
<i>Nickel hydroxide</i>	12054-48-7	5.0E-02		2/00							✓					✓	
			5.0E-02	10/00	✓												
<i>Nickelocene</i>	1271-28-9	5.0E-02		2/00							✓					✓	
			5.0E-02	10/00	✓												
NICKEL OXIDE	1313-99-1	1.0E-01		2/00							X					X	
			5.0E-02	10/00	X												
<i>Nickel refinery dust from pyrometallurgical process</i>	1146	5.0E-02		2/00							✓					✓	
			5.0E-02	10/00	✓												
<i>Nickel subsulfide</i>	12035-72-2	5.0E-02		2/00							✓					✓	
			5.0E-02	10/00	✓												
PCB (POLYCHLORINATED BIPHENYLS (speciated) [▼]																	
3,3',4,4'-TETRACHLOROBIPHENYL (77)	35298-13-3	4.0E-01		8/03	X			X	X		X				X	X	
			1.0E-04	8/03	X			X	X		X				X	X	
3,4,4',5-TETRACHLOROBIPHENYL (81)	70362-50-4	4.0E-01		8/03	X			X	X		X				X	X	
			1.0E-04	8/03	X			X	X		X				X	X	

APPENDIX L - TABLE 3 OEHHA/ARB CHRONIC INHALATION AND ORAL REFERENCE EXPOSURE LEVELS AND TARGET ORGANS [®]

Substance [®]	Chemical [▼] Abstract Service Number (CAS)	Chronic Inhalation REL (µg/m ³)	Chronic Oral REL	Date [♦] Value Reviewed [Added]	Target Organs												
					Alimentary	Bone	Cardiovascular	Developmental	Endocrine	Eye	Hematologic	Immune	Kidney	Nervous	Reproductive	Respiratory	Skin
2,3,3',4,4' - PENTACHLOROBIPHENYL (105)	32598-14-4	4.0E-01		8/03	X			X	X		X				X	X	
			1.0E -04	8/03	X			X	X		X				X	X	
2,3,4,4'5- PENTACHLOROBIPHENYL (114)	74472-37-0	8.0E-02		8/03	X			X	X		X				X	X	
			2.0E -05	8/03	X			X	X		X				X	X	
2,3'4,4',5- PENTACHLOROBIPHENYL (118)	31508-00-6	4.0E-01		8/03	X			X	X		X				X	X	
			1.0E -04	8/03	X			X	X		X				X	X	
2',3,4,4',5- PENTACHLOROBIPHENYL (123)	65510-44-3	4.0E-01		8/03	X			X	X		X				X	X	
			1.0E -04	8/03	X			X	X		X				X	X	
3,3',4,4',5- PENTACHLOROBIPHENYL (126)	57465-28-8	4.0E-04		8/03	X			X	X		X				X	X	
			1.0E -07	8/03	X			X	X		X				X	X	
2,3,3',4,4',5-HEXACHLOROBIPHENYL (156)	38380-08-4	8.0E-02		8/03	X			X	X		X				X	X	
			2.0E -05	8/03	X			X	X		X				X	X	
2,3,3',4,4',5'-HEXACHLOROBIPHENYL (157)	69782-90-7	8.0E-02		8/03	X			X	X		X				X	X	
			2.0E -05	8/03	X			X	X		X				X	X	
2,3',4,4',5,5'-HEXACHLOROBIPHENYL (167)	52663-72-6	4.0E-00		8/03	X			X	X		X				X	X	
			1.0E -03	8/03	X			X	X		X				X	X	
3,3',4,4'5,5' - HEXACHLOROBIPHENYL (169)	32774-16-6	4.0E-03		8/03	X			X	X		X				X	X	
			1.0E -06	8/03	X			X	X		X				X	X	
2,3,3'4,4',5,5' - HEPTACHLOROBIPHENYL (189)	39635-31-9	4.0E-01		8/03	X			X	X		X				X	X	
			1.0 E-04	8/03	X			X	X		X				X	X	
PARTICULATE EMISSIONS FROM DIESEL-FUELED ENGINES ^{TAC} ■	9901	5.0E+00 ^{TAC}		8/98												X	
PERCHLOROETHYLENE ^{TAC} (Tetrachloroethylene)	127-18-4	3.5E+01 ^{TAC}		10/91	X								X				
PHENOL	108-95-2	2.0E+02		4/00	X		X						X	X			
PHOSPHINE	7803-51-2	8.0E-1		9/02	X									X		X	
PHOSPHORIC ACID	7664-38-2	7.0E+00		2/00												X	
PHTHALIC ANHYDRIDE	85-44-9	2.0E+01		1/01												X	
POLYCHLORINATED DIBENZO-P-DIOXINS (PCDD)	1085																
(AS 2,3,7,8-EQUIV) ^{TAC} ♦	1086																

APPENDIX L - TABLE 3 OEHHA/ARB CHRONIC INHALATION AND ORAL REFERENCE EXPOSURE LEVELS AND TARGET ORGANS [®]

Substance [®]	Chemical Abstract Service Number (CAS)	Chronic Inhalation REL (µg/m ³)	Chronic Oral REL	Date [♦] Value Reviewed [Added]	Target Organs												
					Alimentary	Bone	Cardiovascular	Developmental	Endocrine	Eye	Hematologic	Immune	Kidney	Nervous	Reproductive	Respiratory	Skin
2,3,7,8-TETRACHLORODIBENZO- <i>P</i> -DIOXIN ^{TAC}	1746-01-6	4.0E-05		2/00	X			X	X		X				X	X	
			1.0E-08	10/00	X			X	X		X				X	X	
1,2,3,7,8-PENTACHLORODIBENZO- <i>P</i> -DIOXIN	40321-76-4	4.0E-05		2/00	X			X	X		X				X	X	
			1.0E-08	10/00	X			X	X		X				X	X	
1,2,3,4,7,8-HEXACHLORODIBENZO- <i>P</i> -DIOXIN	39227-28-6	4.0E-04		2/00	X			X	X		X				X	X	
			1.0E-07	10/00	X			X	X		X				X	X	
1,2,3,6,7,8-HEXACHLORODIBENZO- <i>P</i> -DIOXIN	57653-85-7	4.0E-04		2/00	X			X	X		X				X	X	
			1.0E-07	10/00	X			X	X		X				X	X	
1,2,3,7,8,9-HEXACHLORODIBENZO- <i>P</i> -DIOXIN	19408-74-3	4.0E-04		2/00	X			X	X		X				X	X	
			1.0E-07	10/00	X			X	X		X				X	X	
1,2,3,4,6,7,8-HEPTACHLORODIBENZO- <i>P</i> -DIOXIN	35822-46-9	4.0E-03		2/00	X			X	X		X				X	X	
			1.0E-06	10/00	X			X	X		X				X	X	
1,2,3,4,6,7,8,9-OCTACHLORODIBENZO- <i>P</i> -DIOXIN	3268-87-9	4.0E-01		2/00	X			X	X		X				X	X	
			1.0E-04	10/00	X			X	X		X				X	X	
POLYCHLORINATED DIBENZOFURANS (PCDF) (AS 2,3,7,8-EQUIV) ^{TAC ♦}	1080																
2,3,7,8-TETRACHLORODIBENZOFURAN	5120-73-19	4.0E-04		2/00	X			X	X		X				X	X	
			1.0E-07	10/00	X			X	X		X				X	X	
1,2,3,7,8-PENTACHLORODIBENZOFURAN	57117-41-6	8.0E-04		2/00	X			X	X		X				X	X	
			2.0E-07	10/00	X			X	X		X				X	X	
2,3,4,7,8-PENTACHLORODIBENZOFURN	57117-31-4	8.0E-05		2/00	X			X	X		X				X	X	
			2.0E-08	10/00	X			X	X		X				X	X	
1,2,3,4,7,8-HEXACHLORODIBENZOFURAN	70648-26-9	4.0E-04		2/00	X			X	X		X				X	X	
			1.0E-07	10/00	X			X	X		X				X	X	
1,2,3,6,7,8-HEXACHLORODIBENZOFURAN	57117-44-9	4.0E-04		2/00	X			X	X		X				X	X	
			1.0E-07	10/00	X			X	X		X				X	X	
1,2,3,7,8,9-HEXACHLORODIBENZOFURAN	72918-21-9	4.0E-04		2/00	X			X	X		X				X	X	
			1.0E-07	10/00	X			X	X		X				X	X	
2,3,4,6,7,8-HEXACHLORODIBENZOFURAN	60851-34-5	4.0E-04		2/00	X			X	X		X				X	X	
			1.0E-07	10/00	X			X	X		X				X	X	

APPENDIX L - TABLE 3 OEHHA/ARB CHRONIC INHALATION AND ORAL REFERENCE EXPOSURE LEVELS AND TARGET ORGANS *

Substance *	Chemical Abstract Service Number (CAS) ▼	Chronic Inhalation REL (µg/m ³)	Chronic Oral REL	Date ♦ Value Reviewed [Added]	Target Organs												
					Alimentary	Bone	Cardiovascular	Developmental	Endocrine	Eye	Hematologic	Immune	Kidney	Nervous	Reproductive	Respiratory	Skin
1,2,3,4,6,7,8-HEPTACHLORODIBENZOFURAN	67562-39-4	4.0E-03		2/00	X			X	X		X				X	X	
			1.0E-06	10/00	X			X	X		X				X	X	
1,2,3,4,7,8,9-HEPTACHLORODIBENZOFURAN	55673-89-7	4.0E-03		2/00	X			X	X		X				X	X	
			1.0E-06	10/00	X			X	X		X				X	X	
1,2,3,4,6,7,8,9-OCTACHLORODIBENZOFURAN	39001-02-0	4.0E-01		2/00	X			X	X		X				X	X	
			1.0E-04	10/00	X			X	X		X				X	X	
PROPYLENE (PROPENE)	115-07-1	3.0E+03		4/00												X	
PROPYLENE GLYCOL MONOMETHYL ETHER	107-98-2	7.0E+03		2/00	X												
PROPYLENE OXIDE	75-56-9	3.0E+01		2/00												X	
SELENIUM AND COMPOUNDS (other than hydrogen selenide)	7782-49-2 [1170]	2.0E+01		12/01	X		X							X			
STYRENE	100-42-5	9.0E+02		4/00										X			
SULFURIC ACID	7664-93-9	1.0E+00		12/01												X	
<i>Sulfuric Acid and Oleum</i>	7664-93-9	1.0E+00		12/01												✓	
<i>Sulfuric Trioxide</i>	7446-71-9	1.0E+00		12/01												✓	
<i>Oleum</i>	8014-95-7	1.0E+00		12/01												✓	
TOLUENE	108-88-3	3.0E+02		4/00				X						X		X	
<i>Toluene diisocyanates</i>	26471-62-5 1204	7.0E-02		1/01												✓	
TOLUENE-2,4-DIISOCYANATE	584-84-9	7.0E-02		1/01												X	
TOLUENE-2,6-DIISOCYANATE	91-08-7	7.0E-02		1/01												X	
TRICHLOROETHYLENE ^{TAC}	79-01-6	6.0E+02		4/00						X				X			
TRIETHYLAMINE	121-44-8	2.0E+02		9/02						X		X				X	
VINYL ACETATE	108-05-4	2.0E+02		12/01												X	
VINYLDENE CHLORIDE (1,1,-Dichloroethylene)	75-35-4	7.0E+01		1/01	X												
XYLENES (mixed isomers)	1330-20-7 1210	7.0E+02		4/00										X		X	
m-XYLENE	108-38-3	7.0E+0 2		4/00										X		X	
o-XYLENE	95-47-6	7.0E+02		4/00										X		X	
p-XYLENE	106-42-3	7.0E+02		4/00										X		X	

Purpose:	The purpose of this reference table is to provide a quick list of all health values that have been approved by the Office of Environmental Health Hazard Assessment (OEHHA) and the Air Resources Board (ARB) for use in facility health risk assessments conducted for the AB 2588 Air Toxics Hot Spots Program. The OEHHA has developed and adopted new risk assessment guidelines that update and replace the California Air Pollution Control Officers Association's (CAPCOA) <i>Air Toxics "Hot Spots" Program Revised 1992 Risk Assessment Guidelines, October 1993</i>. The OEHHA has adopted five technical support documents for these guidelines. This table lists the OEHHA adopted inhalation and oral noncancer chronic RELs. In addition, it lists the substances in Appendix A-I (<i>Substances For Which Emissions Must Be Quantified</i>) and Appendix F (<i>Criteria For Inputs For Risk Assessment Using Screening Air Dispersion Modeling</i>) of the ARB's <i>Air Toxics "Hot Spots" Emission Inventory Criteria and Guidelines (EICG)</i>. OEHHA is still in the process of adopting new noncancer chronic RELs. Therefore, new health values will periodically be added to, or deleted from, this table. Users of this table are advised to monitor the OEHHA website (www.oehha.ca.gov) for any updates to the health values.
☼	Substances written in <i>italics</i> and with a ✓ do not have explicit OEHHA approved health values, but are included in this table to clarify applicability of OEHHA adopted health effects values to individual or grouped substances listed in the <i>Air Toxics "Hot Spots" Emission Inventory Criteria and Guidelines</i>, Appendix A-I list of "<i>Substances For Which Emissions Must Be Quantified</i>".
▼	Chemical Abstract Service Number (CAS): For chemical groupings and mixtures where a CAS number is not applicable, the 4-digit code used in the <i>Air Toxics "Hot Spots" Emission Inventory Criteria and Guidelines (EICG) Report</i> is listed. The 4-digit codes enclosed in brackets [] are codes that have been phased out, but may still appear on previously reported Hot Spots emissions. For information on the origin and use of the 4-digit code, see the EICG report.
◆	Date Value Reviewed [Added]: This column lists the date that the health value was last reviewed by OEHHA and the Scientific Review Panel, and/or approved for use in the AB 2588 Air Toxics "Hot Spots" Program. If the health value is unchanged since it was first approved for use in the "Hot Spots" Program, then the date that the value was first approved for use by CAPCOA is listed within the brackets []. - February 2000, April 2000, January 2001, and December 2001 are listed for the first set of 22, the second set of 16, the third set of 22, and the fourth set of 12 noncancer chronic RELs, respectively. - October 2000 is listed for the oral chronic RELs. The chronic REL for carbon disulfide was adopted in May 2002. Chronic RELs for phosphine and triethylamine were adopted in September 2002. Chronic RELs for fluorides including hydrogen fluoride were adopted August 2003. - For the substances identified as Toxic Air Contaminants, the Air Resources Board hearing date is listed. The date for acetaldehyde represents the date the value was approved by the Scientific Review Panel.
TAC	Toxic Air Contaminant: The Air Resources Board has identified this substance as a Toxic Air Contaminant.
★	Polychlorinated Biphenyls: Chronic Oral: The chronic oral value is U.S. EPA's 1996 oral Reference Dose for Aroclor-1254.
•	Polychlorinated Dibenzo-<i>p</i>-dioxins and Polychlorinated Dibenzofurans (also referred to as chlorinated dioxins and dibenzofurans): The OEHHA has adopted the World Health Organization 1997 (WHO-97) Toxicity Equivalency Factor scheme for evaluating the cancer risk due to exposure to samples containing mixtures of polychlorinated dibenzo-<i>p</i>-dioxins (PCDD) and polychlorinated dibenzofurans (PCDF) and determining cancer risks for a number of specific PCB congeners. See Appendix A of OEHHA's <i>Technical Support Document For Describing Available Cancer Potency Factors</i> for more information about the scheme. See Appendix E of OEHHA's <i>The Air Toxics Hot Spots Program Risk Assessment Guidelines; Part V; Technical Support Document; Guidance Manual for Preparation of Health Risk Assessments</i> for the methodology for calculating 2,3,7,8-equivalents for PCDD, PCDFs and a number of specific PCB congeners.
■	Particulate Emissions from Diesel-Fueled Engines: The unit risk factor and chronic REL were derived from whole diesel exhaust and should be used only for impacts from the inhalation pathway. The inhalation impacts from speciated emissions from diesel-fueled engines are already accounted for in the unit risk factor and REL. However, at the discretion of the risk assessor, speciated emissions from diesel-fueled engines may be used to estimate acute noncancer health impacts or the contribution to cancer risk or chronic noncancer health impacts for the non-inhalation exposure pathway. See Appendix D of OEHHA's <i>The Air Toxics Hot Spots Program Risk Assessment Guidelines; Part V; Technical Support Document; Guidance Manual for Preparation of Health Risk Assessments</i> for more information.

Table last updated: August 2003



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Chapter 9: Air Quality Element

Introduction

“

Air quality attainment goals established by the South Coast Air Quality Management District have been more than met despite the substantial growth in the region in the last 20 years. Most of this is a result of significantly improved engine technology and the replacement of more polluting vehicles. However, local initiatives that expanded transit options, concentrated development more efficiently, and increased local employment opportunities have also contributed to air quality improvement.

”

– RCIP Vision

WHY IS AIR QUALITY IMPORTANT?

The quality of the air we breathe directly affects our health, environment, economy and our quality of life. Because the inside of our bodies are in constant contact with the outside world through the oxygen we inhale, air pollutants make their way to our lungs and into our blood stream. An overabundance of pollutants in the air can cause mild to severe health effects, including increased hospitalization and emergency room visits, respiratory illnesses, increased risk of developing cancer, decreased breathing capacity, lung inflammation, difficulty in exercising and even a reduction in life-span.

Just as we are affected by air pollution, so too are plants and animals. Animals must breathe the same air and are subject to the same types of negative health effects. Certain plants and trees may absorb air pollutants which can stunt their development or cause premature death. There are also numerous impacts to our economy including lost work days due to illness, a desire on the part of business to locate in areas with a healthy environment, and increased expenses from medical costs. Pollutants may also lower visibility and cause damage to property. Certain air pollutants are responsible for discoloring painted surfaces, eating away at stones used in buildings, dissolving the mortar that holds bricks together, and cracking tires and other items made from rubber.

WHAT CAN WE DO ABOUT AIR QUALITY?

Air quality is a regional issue, effecting and affected by every city and county. Although Riverside County generates the lowest emissions of any county in the South Coast Air Basin, air quality in the County is among the Basin's worst due to onshore winds transporting vast amounts of pollutants from Los Angeles and Orange Counties into the Inland Empire.

While the County and the region have made great strides in reducing air pollution, it is committed to meeting state and federal air quality guidelines. Policies and programs addressed in this element will focus on the two main sources of air pollutant emissions: mobile sources and stationary sources. Mobile sources include automobiles, motorcycles, trucks and airplanes. Motor vehicles constitute the largest generator of air pollutant emissions in Riverside County. Stationary sources produce significant amounts of pollutants and include electrical power-generating facilities, manufacturing, fabrication, miscellaneous industrial processes and combustion of natural gas.



County of Riverside General Plan

Air Quality Element



Ambient Air - Outside air, any portion of the atmosphere not contained by walls and a roof.

It is an intent of this Air Quality Element to provide background information on the physical and regulatory environment affecting air quality in the County. This element also identifies goals, policies and programs that are meant to balance the County's actions regarding land use, circulation and other issues with their potential effects on air quality. This element in conjunction with local and regional air quality planning efforts addresses ambient air quality standards set forth by the Federal Environmental Protection Agency and the California Air Resources Board (CARB).



The Setting

Riverside County is located within three air basins, as can be seen on Figure AQ-1, Riverside County Air Quality Basins. They are the South Coast Air Basin (SOCAB), Salton Sea Air Basin (SSAB) and the Mojave Desert Air Basin (MDAB). Air quality within each basin is not only affected by various emissions sources (mobile, industry, etc.), but also by atmospheric conditions such as wind speed, wind direction, temperature and rainfall. The following provides a description of each air basin and its relevant climate and meteorological conditions affecting air pollution.

SOUTH COAST AIR BASIN

Western Riverside County (west of the San Geronio Pass) is located within the South Coast Air Basin (SOCAB), which includes all of Orange County and the non-desert portions of Los Angeles, Riverside and San Bernardino Counties. Air quality conditions in the SOCAB are under the jurisdiction of the South Coast Air Quality Management District (SCAQMD).



Santa Ana Winds - Santa Ana winds are generally defined as warm, dry winds that blow from the east or northeast (offshore) occurring predominantly between the months of December and February. The winds develop when a region of high pressure builds over the Great Basin (the high plateau east of the Sierra Mountains and west of the Rocky Mountains including most of Nevada and Utah) and move locally across the Mojave Desert and then over and through passes in the San Gabriel, San Bernardino and San Jacinto Mountains.

According to the Air Quality Management Plan (AQMP), the worst air quality problem in the nation occurs in the South Coast Air Basin. With very light average wind speeds, the basin atmosphere has a limited capability to disperse air contaminants horizontally. The dominant daily wind pattern is a daytime sea breeze (onshore breeze) and a nighttime land breeze (offshore breeze), broken only occasionally by winter storms and infrequent strong Santa Ana winds from the Great Basin, Mojave, and deserts to the north.

On virtually all spring and early summer days, most of the pollution produced during an individual day is moved out of the basin through mountain passes, or is lifted by the warm, vertical currents produced by the heating of mountain slopes. In those seasons, the basin can be “flushed” of pollutants by a transport of ocean air during the afternoon. From late summer through the winter months, the flushing is less pronounced because of lower wind speeds and the earlier appearance of offshore winds. With extremely stagnant wind flows, the drainage winds may begin near the mountains by late afternoon. Remaining pollutants are trapped and begin to accumulate during the night and the following morning. A low average morning wind speed in pollution source areas is an important indicator of air stagnation potential.



Inversion layer - A layer of warm air that traps the cooler air and any pollutants it carries below.

The vertical dispersion of air pollutants in the South Coast Air Basin is hampered by the presence of a temperature inversion in the layers of the atmosphere near the surface of the Earth. In a normal situation, as temperatures decrease with altitude, air continues to rise as it remains warmer than the surrounding air. With an inversion layer, air cannot continue to expand upwards, as it is trapped by the warmer air above.

However, as the day progresses and the sun warms the ground, the surface layer of air approaches a temperature equal to that of the inversion layer. When these temperatures become equal, the inversion layer begins to erode at its lower edge. If enough warming takes place, the inversion layer becomes weaker and weaker and finally “breaks.” The surface air layers can then mix upward without limit.



This phenomenon is frequently observed in the middle of late afternoon on hot summer days when the smog appears to clear up suddenly. Winter inversions frequently break by mid-morning, thereby preventing contaminant build-up.

The combination of low wind speeds and low level inversions produces the greatest concentration of pollutants. On high wind days other air pollutants including particulate matter such as dust and soil are swept and carried in the air. On days of no inversion or on days of winds averaging over 15 miles per hour, there will be no important smog effects, during either summer or winter.



Smog - A combination of smoke, ozone, hydrocarbons, nitrogen oxides, and other chemically reactive compounds which, under certain conditions of weather and sunlight, may result in a murky brown haze that causes adverse health effects. The primary source of smog in California is motor vehicles.

In the winter, the greatest pollution problems are carbon monoxide and oxides of nitrogen because of extremely low level inversions and air stagnation during the night and early morning hours. Smog levels are much lower during this season due to the lack of strong inversion during the daylight hours and the lack of intense sunlight which is needed to produce photochemical reactions.

In the summer, the longer daylight hours and the brighter sunshine combine to cause a reaction between hydrocarbons and oxides of nitrogen to form more smog. Carbon monoxide is not as great a problem in summer because inversions are not as low and intense in the surface boundary layer (within 100 feet of the ground) as in winter and because horizontal ventilation is better in summer.

The basin-wide average occurrence of inversion at the ground surface is 11 days per month; the averages vary from two days in June to 22 days in December and January. The potential for high concentration varies seasonally for many contaminants. During late spring, summer and early fall, light winds, low mixing heights and brilliant sunshine combine to produce conditions favorable for the maximum production of photochemical oxidants, mainly ozone. During the spring and summer, when fairly deep marine layers are frequently found in the Basin, sulfate concentrations are at their peak.

SALTON SEA AIR BASIN



Subtropical High Cell - An area of atmospheric high pressure located at approximately 30 degrees north and south latitude. Air tends to sink near high-pressure centers, which inhibits precipitation and cloud formation. This is why high-pressure systems tend to bring bright, sunny days with calm weather.

The middle part of Riverside County (between San Geronio Pass and Joshua Tree National Monument), belongs in the Salton Sea Air Basin (SSAB), along with Imperial County. Air quality conditions in this portion of the County, although in the SSAB, are also administered by the SCAQMD. The SCAQMD is responsible for the development of the regional Air Quality Management Plan and efforts to regulate pollutant emissions from a variety of sources.

The SSAB portion of Riverside County is separated from the SOCAB region by the San Jacinto Mountains and from the Mojave Desert Air Basin to the east by the Little San Bernardino Mountains. During the summer, the SSAB is generally influenced by a Pacific Subtropical High Cell that sits off the coast, inhibiting cloud formation and encouraging daytime solar heating. The SSAB is rarely influenced by cold air masses moving south from Canada and Alaska, as these systems are weak and diffuse by the time they reach the desert. Most desert moisture arrives from infrequent warm, moist and unstable air masses from the south. The SSAB averages between three and seven inches of precipitation per year.



Figure AQ- 1 Riverside County Air Quality Basins



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MOJAVE DESERT AIR BASIN

The Mojave Desert Air Basin (MDAB), comprised of 21,000 square miles, encompasses the eastern portion of Riverside County consisting of the Palo Verde Valley along with portions of Los Angeles, Kern and San Bernardino Counties. Air quality conditions in the Riverside County MDAB are partly under the jurisdiction of the SCAQMD and partly under the jurisdiction of the Mojave Desert Air Quality Management District (MDAQMD).

The MDAB consists of an assemblage of mountain ranges interspersed with long broad valleys that often contain dry lakes. Many of the lower mountains that dot the vast terrain rise from 1,000 to 4,000 feet above the valley floor. Prevailing winds in the MDAB are out of the west and southwest. These prevailing winds are due to the proximity of the MDAB to coastal and central regions and the presence of the Sierra Nevada mountains, which pose as a natural barrier to the north; air masses pushed onshore in southern California by differential heating are channeled through the MDAB. The MDAB is separated from the southern California coastal and central California valley regions by mountains whose passes form the main channels for these air masses.

During the summer months, the MDAB is generally influenced by a Pacific Subtropical High Cell that sits off the coast, inhibiting cloud formation and encouraging daytime solar heating. The MDAB is rarely influenced by cold air masses moving south from Canada and Alaska, with desert moisture arriving from infrequent warm, moist and unstable air masses from the south. The MDAB averages between three and seven inches of precipitation per year.



County of Riverside General Plan

Air Quality Element

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Regulatory Restrictions

The combination of geographical features and high levels of pollutants produced in the region have resulted in the Environmental Protection Agency (EPA) designating the air basins in Riverside County as non-attainment areas (Table AQ-2). This means that due to the high level of pollutants in the region, the area is not expected to meet National Ambient Air Quality Standards in the near future.

The Federal Clean Air Act (1977 Amendments) requires that designated agencies in any region of the nation not meeting national clean air standards must prepare a plan demonstrating the steps that would bring the area into compliance with all national standards by December 31, 1987. In response, the Governor of California designated agencies to develop these plans.

For the South Coast Air Basin and the Salton Sea Air Basin, the agencies designated to develop regional air quality plans are the South Coast Air Quality Management District (SCAQMD) and the Southern California Association of Governments (SCAG). The two agencies first adopted an Air Quality Management Plan (AQMP) in 1979 and have revised it several times subsequently, as earlier attainment forecasts were shown to be overly optimistic. Equivalent regional air quality plans were created for the Mojave Desert Air Basin by the Mojave Desert Air Quality Management Basin (MDAQMD) in conjunction with SCAG.

In 1998, the California Legislature enacted the California Clean Air Act (CCAA). The CCAA requires regional emissions to be reduced by 5% per year, averaged over a 3-year period, until attainment can be demonstrated. Each region that did not meet a national or state air quality standard was required to prepare a plan which demonstrated how the 5% reductions were to be achieved. In response, the SCAQMD and MDAQMD revised their air quality plans to meet CCAA requirements.

The latest AQMP, approved in 1997, was designed to meet both federal and state air quality planning guidelines. Strategies for controlling air pollutant emissions in the AQMP are grouped into three "tiers," based on their anticipated timing for implementation. Tier I consists of the implementation of best available current technology and management practices that can be adopted within five years. Tier II is based on anticipated advancement in current technology and vigorous regulatory action, while Tier III controls consist of implementation measures which first require the development of new technologies.

The MDAQMD adopted its Air Quality Attainment Plan in 1995 to meet state ozone standards and the Attainment Demonstration Plan in 1996 to meet federal ozone standards. While the Mojave Desert Air Basin is classified by the state as a non-attainment area for PM₁₀ (coarse particles larger than 2.5 but smaller than 10 micrometers), state law does not require an air quality plan to meet this standard, and as such, no plan has been adopted.



County of Riverside General Plan

Air Quality Element



Indirect Source – A facility, building, structure, installation, property, road, or highway which attracts, or may attract, mobile sources of pollution such as cars and trucks.

To achieve the goals and objectives of the air quality plans at the local level, all cities and counties must adopt air quality elements or other elements/plans that fully address air quality as well as implement these plans to achieve compliance with state and federal standards. Local responsibilities for achieving compliance primarily focus on measures that control “Indirect Sources” such as facilities, buildings, structures, installations, real property, roads or highways that attract mobile sources of pollution.



Issues and Policies

AIR QUALITY

“

Air quality is viewed as such an important factor in the quality of life that its measurements are used as a major factor in evaluating the Plan's performance.

”

– RCIP Vision

Six criteria air pollutants have been established for every air basin within the State of California. These are pollutants for which acceptable levels of exposure can be determined and for which an ambient air quality standard has been set. As shown in Table AQ-1, Ambient Air Quality Standards, federal and state standards have been developed for ozone, carbon monoxide, nitrogen dioxide, sulfur dioxide and PM₁₀. Federal primary standards for air pollutants have been established to protect the public health, while secondary standards protect the public welfare by preventing impairment of visibility and damage to vegetation and property.

Table AQ-1
Ambient Air Quality Standards

Pollutant	Averaging Time	State	Federal	
			Primary	Secondary
Ozone	1 Hour	0.09 ppm	0.12 ppm	Same as Primary Standard
	8 Hour	0.08 ppm	0.08 ppm	
Nitrogen Dioxide	Annual Average	0.053 ppm	0.053 ppm	Same as Primary Standard
	1 Hour	0.25 ppm	–	
Carbon Monoxide	8 Hour	9.0 ppm	9.0 ppm	–
	1 Hour	20.0 ppm	35.0 ppm	–
Suspended Particulate Matter (PM ₁₀ & PM _{2.5})	Annual Geometric Mean	30 µg/m ³	65 µg/m ³ (PM _{2.5})	–
	24 Hour	50 µg/m ³	150 µg/m ³ (PM ₁₀) 15 µg/m ³ (PM _{2.5})	Same as Primary Standard
	Annual Arithmetic Mean	--	50 µg/m ³	
Sulfur Dioxide	Annual Average	--	0.03 ppm	Same as Primary Standard
	24 Hour	0.04 ppm	0.14 ppm	
	3 Hour	--	--	0.5 ppm
	1 Hour	0.25 ppm	–	–
Lead	30 Day Average	1.5 µg/m ³	--	--
	Calendar Quarter	--	1.5 µg/m ³	Same as Primary Standard

Notes: ppm = parts per million; µg/m³ = micrograms per cubic meter of air
Source: California Air Resources Board Fact Sheet 39, 1998.



Riverside County has made great strides in achieving state and federal air quality standards. The following provides a description of the six criteria air pollutants and their attainment status in each of the three Riverside County air basins.

Ozone

Ozone is a pungent, colorless gas typical of southern California smog. Elevated ozone concentrations result in reduced lung function, particularly during vigorous physical activity. Ozone levels peak during the summer and early fall months.

The SOCAB is designated as a non-attainment area for both federal and state ozone standards, meaning that air quality standards are being exceeded. The Environmental Protection Agency (EPA) has classified the entire Southern California Association of Governments region as an “extreme” non-attainment area, and has mandated that the South Coast Air Quality Basin achieve attainment by 2010. The SSAB and MDAB are both designated as non-attainment areas for federal and state ozone standards.

Carbon Monoxide

Carbon monoxide (CO) is formed by the incomplete combustion of fossil fuels, almost entirely from automobiles. It is a colorless, odorless gas that can cause dizziness, fatigue and impairments to central nervous system functions.

The SOCAB is designated as a non-attainment area for federal CO standards. However, the Riverside County area of SOCAB has not exceeded either federal or state CO standards in the past five years. The SSAB and MDAB have both been designated as attainment areas for federal and state Carbon Monoxide standards.

Nitrogen Oxides

Nitrogen dioxide (NO₂), a reddish brown gas, and nitric oxide (NO), a colorless odorless gas, are jointly referred to as nitrogen oxides or NO_x. NO_x is a primary component of smog and also contributes to other pollution problems such as high concentration of fine particulate matter, poor visibility, and acid deposition. NO₂ decreases lung function and may reduce resistance to infection.

The SOCAB has not exceeded either federal or state standards for nitrogen dioxides in the past five years. It is designated as a maintenance area (an area that was once classified as non-attainment but has recently shown achievement of air quality standards) under federal standards and as an attainment area under state standards. The SSAB and MDAB are designated as attainment areas for both federal and state NO₂ standards.

Sulfur Dioxide

Sulfur dioxide (SO₂) is a colorless irritating gas created mainly by industrial facilities. SO₂ irritates the respiratory tract, injures lung tissue when combined with fine particulate matter and reduces visibility and the level of sunlight.

The SOCAB, SSAB and MDAB are all designated as attainment areas for both federal and state sulfur dioxide standards.



Fugitive Dust - Dust particles that are introduced into the air through certain activities such as soil cultivation, off-road vehicles, or any vehicles operating on open fields or dirt roadways.

Lead

Lead is a gray-white metal that is soft, malleable, and resistant to corrosion. Sources of lead resulting in concentrations in the air include industrial sources and weathering of soils, followed by fugitive dust emissions. Health effects from exposure to lead include brain and kidney damage, learning disabilities, seizures and death. Fetuses, infants and children are more sensitive than others to the adverse effects of lead exposure. Exposure to low levels of lead can adversely affect the development and function of the central nervous system, leading to learning disorders, distractibility, inability to follow simple commands and a lower intelligence quotient.

The SOCAB, SSAB and MDAB are all designated as attainment areas for both federal and state lead standards.

Particulate Matter

Particulate matter is the term used for a mixture of solid particles and liquid droplets found in the air. Coarse particles (larger than 2.5 but smaller than 10 micrometers, or PM_{10}) come from a variety of sources, including windblown dust and grinding operations. Fine particles (less than 2.5 micrometers, or $PM_{2.5}$) often come from fuel combustion, power plants and diesel buses and trucks. Fine particles can also be formed in the atmosphere through chemical reactions. PM_{10} and its health affects are discussed in greater detail later in the Particulate Matter section of this Element.

The SOCAB and SSAB are designated as non-attainment areas for both state and federal PM_{10} . The MDAB is designated as a non-attainment area for state PM_{10} standards, but as an attainment unclassified area for Federal standards (after meeting attainment standards, the MDAQMD discontinued monitoring efforts; consequently it cannot be given full attainment status).

The following table summarizes the attainment status for these six pollutants within each of the three air quality basins covering Riverside County.



Table AQ-2
Attainment of State and Federal Criteria Air Pollutant Standards

Air Basin	Ozone	Carbon Monoxide	Nitrogen Oxides	Sulfur Dioxide	Lead	Particulate Matter
SCAQMD	Non-attainment (State and Federal)	Non-attainment (Federal) Has not exceeded State standards in 5 years	Maintenance Area ¹	Attainment (State and Federal)	Attainment (State and Federal)	Non-attainment (State and Federal)
SSAB	Non-attainment (State and Federal)	Attainment (State and Federal)	Attainment (State and Federal)	Attainment (State and Federal)	Attainment (State and Federal)	Non-attainment (State and Federal)
MDAQMD	Non-attainment (State and Federal)	Attainment (State and Federal)	Attainment (State and Federal)	Attainment (State and Federal)	Attainment (State and Federal)	Non-attainment (Federal) Attainment Unclassified ² (State)

Notes:

1. An area once classified as non-attainment but has recently shown achievement of air quality standards.
2. After meeting attainment standards, the MDAQMD discontinued monitoring efforts; consequently it cannot be given full attainment status.

Source: Southern California Air Quality Management District and the Mojave Desert Air Quality Management Basin



The General Plan policy

and implementation item reference system:

Identifies which element contains the Policy, in this case the Land Use Element, and the sequential number.

LU 1.3

Neighborhood
Commercial uses should be located near residential uses.

(AI 1 and AI 4)

Reference to the relevant Action Items contained in the implementation Program

Multi-jurisdictional Cooperation

Air pollutants are not limited to jurisdictional boundaries. Local land use patterns, emission sources, and airflow patterns throughout southern California contribute to the air quality of Riverside County. While the County can enact policies that limit emissions within its boundaries, it is necessary to support efforts to decrease region-wide pollution emissions as surrounding jurisdictions significantly impact Riverside County's air quality. The following policies are designed to establish a regional basis for improving air quality.

Policies:

- AQ 1.1 Promote and participate with regional and local agencies, both public and private, to protect and improve air quality. (AI 111)
- AQ 1.2 Support the Southern California Association of Government's (SCAG) Regional Growth Management Plan by developing intergovernmental agreements with appropriate governmental entities such as the Western Riverside Council of Governments (WRCOG), the Coachella Valley Association of Governments (CVAG), sanitation districts, water districts, and those subregional entities identified in the Regional Growth Management Plan. (AI 111)
- AQ 1.3 Participate in the development and update of those regional air quality management plans required under federal and state law, and meet all standards established for clean air in these plans. (AI 110)



- AQ 1.4 Coordinate with the SCAQMD and MDAQMD to ensure that all elements of air quality plans regarding reduction of air pollutant emissions are being enforced. (AI 111)
- AQ 1.5 Establish and implement air quality, land use and circulation measures that improve not only the County's environment but the entire region's. (AI 111)
- AQ 1.6 Establish a level playing field by working with local jurisdictions to simultaneously adopt policies similar to those in this Air Quality Element
- AQ 1.7 Support legislation which promotes cleaner industry, clean fuel vehicles and more efficient burning engines and fuels. (AI 113)
- AQ 1.8 Support the introduction of federal, state or regional enabling legislation to permit the County to promote inventive air quality programs, which otherwise could not be implemented. (AI 113)
- AQ 1.9 Encourage, publicly recognize and reward innovative approaches that improve air quality. (AI 113)
- AQ 1.10 Work with regional and local agencies to evaluate the feasibility of implementing a system of charges (e.g., pollution charges, user fees, congestion pricing and toll roads) that requires individuals who undertake polluting activities to bear the economic cost of their actions where possible. (AI 111)
- AQ 1.11 Involve environmental groups, the business community, special interests, and the general public in the formulation and implementation of programs that effectively reduce airborne pollutants.

Sensitive Receptors



Children may suffer from asthma or other chronic diseases as a result of exposure to polluted air.

Sensitive receptors refer to those segments of the population most susceptible to poor air quality (i.e. children, elderly and the sick) and to certain at-risk sensitive land uses such as schools, hospitals, parks, or residential communities. The intent of the following policies is to reduce the negative impacts of poor air quality on the County's sensitive receptors.

Policies:

- AQ 2.1 The County land use planning efforts shall assure that sensitive receptors are separated and protected from polluting point sources to the greatest extent possible. (AI 114)
- AQ 2.2 Require site plan designs to protect people and land uses sensitive to air pollution through the use of barriers and/or distance from emissions sources when possible. (AI 114)



- AQ 2.3 Encourage the use of pollution control measures such as landscaping, vegetation and other materials, which trap particulate matter or control pollution. (AI 114)
- AQ 2.4 Consider creating a program to plant urban trees on an Area Plan basis that removes pollutants from the air, provides shade and decreases the negative impacts of heat on the air. (AI 114)

Mobile Pollution Sources

Mobile sources are subdivided into two categories: on-road (generally motorized vehicles like automobiles, motorcycles and trucks) and non-road sources (trains, boats, jet skis and all-terrain vehicles). The County's land use distribution, proximity to Orange and Los Angeles Counties, and subsequent auto-generated traffic have had a tremendously detrimental impact on air quality. Vehicle miles traveled (VMT) have doubled over the past 20 years, with mobile pollution sources constituting approximately 60% of air pollution in the region.



Transportation Management Associations - Non Profit organizations formed so that employers, developers, building owners, local government representatives, and others can work together and collectively establish policies, programs, and services to address local transportation problems.

Policies:

- AQ 3.1 Allow the market place, as much as possible, to determine the most economical approach to relieve congestion and cut emissions.
- AQ 3.2 Seek new cooperative relationships between employers and employees to reduce vehicle miles traveled.
- AQ 3.3 Encourage large employers and commercial/industrial complexes to create Transportation Management Associations. (AI 115)
- AQ 3.4 Encourage employee rideshare and transit incentives for employers with more than 25 employees at a single location.

Stationary Pollution Sources

Stationary pollution sources are generally divided into two subcategories for analysis: point sources (such as power plants and refinery boilers) and area sources (including small emission sources such as residential water heaters and architectural coatings). Agricultural and industrial land uses are generally the main stationary pollution sources in Riverside County, though most urbanized land areas and their associated activities also contribute to poor air quality in the region. While industrial sources are addressed here, agricultural source impacts, due to their primary emissions of PM₁₀, are addressed in the Particulate Matter section of this element.

Policies:

- AQ 4.1 Encourage the use of building materials/methods which reduce emissions.
- AQ 4.2 Encourage the use of efficient heating equipment and other appliances, such as water heaters, swimming pool heaters, cooking equipment, refrigerators, furnaces and boiler units.



- AQ 4.3 Encourage centrally heated facilities to utilize automated time clocks or occupant sensors to control heating.
-  AQ 4.4 Require residential building construction to comply with energy use guidelines detailed in Title 24 of the California Administrative Code.
- AQ 4.5 Require stationary pollution sources to minimize the release of toxic pollutants through:
- Design features;
 - Operating procedures;
 - Preventive maintenance;
 - Operator training; and
 - Emergency response planning
- AQ 4.6 Require stationary air pollution sources to comply with applicable air district rules and control measures.
- AQ 4.7 To the greatest extent possible, require every project to mitigate any of its anticipated emissions which exceed allowable emissions as established by the SCAQMD, MDAQMD, SOCAB, the Environmental Protection Agency and the California Air Resources Board.
-  AQ 4.8 Expand, as appropriate, measures contained in the County's Fugitive Dust Reduction Program for the Coachella Valley to the entire County.
-  AQ 4.9 Require compliance with SCAQMD Rules 403 and 403.1, and support appropriate future measures to reduce fugitive dust emanating from construction sites.
- AQ 4.10 Coordinate with the SCAQMD and MDAQMD to create a communications plan to alert those conducting grading operations in the County of first, second, and third stage smog alerts, and when wind speeds exceed 25 miles per hour. During these instances all grading operations should be suspended. (AI 111)

Energy Efficiency and Conservation

Recycling and conservation efforts established and encouraged by the County can reduce the amount of pollutants emitted within the County. Efforts to recycle wastes can reduce the amount of pollutants emitted from the production of new materials while preserving raw materials. Conservation measures minimize the impacts of not only the consumption of, but also the production of energy sources.

Policies

- AQ 5.1 Utilize source reduction, recycling and other appropriate measures to reduce the amount of solid waste disposed of in landfills.
- AQ 5.2 Adopt incentives and/or regulations to enact energy conservation requirements for private and public developments. (AI 62)



- AQ 5.3 Update, when necessary, the County's Policy Manual for Energy Conservation to reflect revisions to the County Energy Conservation Program.
- AQ 5.4 Encourage the incorporation of energy-efficient design elements, including appropriate site orientation and the use of shade and windbreak trees to reduce fuel consumption for heating and cooling.

JOBS AND HOUSING

Imagine commuting in the morning and driving only a few short miles to work. There would be no commutes over an hour, no crowded freeways that resemble parking lots and no fighting traffic. This is the life of people who live near work. And as more residents are able to live and work within the County, this will be the commuting pattern of most residents. This will save fuel, ease congestion, speed traffic, cut emissions and improve air quality. However, if nothing is done, the risks are great. SCAG predicts that by the year 2010 commutes between Riverside County and Los Angeles County may increase by 600% over 2000 levels.

Part of the solution to the region's air quality problems is a better jobs-to-housing ratio. The objective of the jobs to housing ratio concept is to reduce Vehicle Miles Traveled (VMT) by locating jobs and housing closer together. In the ideal situation, the appropriate number of housing units in various income categories are provided to house the County's workforce. While this does not ensure that residents will live and work within Riverside County, the likelihood of it occurring does increase.

As stated in the General Plan Housing Element, traffic patterns on the major east-west transportation routes indicate that Riverside County serves as a bedroom community that supplies approximately 18% of the labor pool for the Los Angeles-Orange County metropolitan area (Table AQ-3, Home County by Work County). Statistics for 1990 to 2000 show that Riverside County's jobs-household ratio is slowly improving, however, from 0.80 jobs per household in 1990 to 0.90 in 1997 and 0.94 in 2000. The unincorporated area shows a severe shortage of jobs, however, with only 0.48 jobs per household in the western County and 0.26 jobs per household in the eastern County in 1997. This is the reverse of the jobs to housing ratio experienced in Los Angeles and Orange Counties where there were approximately 1.46 and 1.52 jobs per household respectively in the year 2000.



A "household" consists of all the people occupying a dwelling unit, whether or not they are related.

Whenever possible, the County should offer incentives to businesses and individuals to control emissions and implement the AQMP. In job-poor areas, the County should stress job creation and reductions in vehicle miles traveled to improve air quality over other less efficient methods. Among the positive approaches available to the County to encourage job creation in job-poor areas are: education; job training and placement services; technical assistance to incoming businesses; reducing regulation and paperwork on businesses; fast-tracking and fee waivers; and low interest loans.



**Table AQ-3
Home County by Work County**

Home County						
Work County	Los Angeles	Orange	Riverside	San Bernardino	Ventura	Imperial
Los Angeles	90%	17%	8%	16%	18%	0%
Orange	6	79	10	7	0	0
Riverside	0	0	68	9	0	1
San Bernardino	2	2	8	68	0	0
Ventura	2	0	1	0	80	1
San Diego	0	1	4	0	1	1
Imperial	0	0	1	0	0	97

Source: 1999 SCAG State of the Commute Report

Education and Job Training

To stay competitive, the business community requires an educated and trained work force. While County residents are among the most talented and skilled in southern California, job training and education programs should be provided as an incentive for businesses to locate within the County. This will help ensure residents are trained and qualified to meet the specific needs of the business community.

Policies:

- AQ 6.1 Assist small businesses by developing education and job training programs, especially in job-poor areas. (AI 124)
- AQ 6.2 Collaborate with local colleges and universities to develop appropriate educational programs to assist residents in obtaining job skills to meet market demands.

Business Development

To the extent possible, the Air Quality Element will be an economic development program designed to enhance employment opportunities in Riverside County. Attempts to improve air quality should not prevent business development, especially within job-poor areas. In fact, business development should be identified as a critical factor in increasing air quality. Increasing employment opportunities within the County will allow residents to obtain jobs locally and decrease commute times. Decreased commute times mean less time spent in air polluting vehicles.



Policies:

- AQ 7.1 Provide incentives to encourage new firms to locate within the County and existing firms to expand operations. (AI 18)
- AQ 7.2 Work with SCAQMD and MDAQMD to develop a means to encourage the location of new commercial and industrial development in those localities where jobs are most needed. (AI 18)
- AQ 7.3 Create a loan program to encourage small businesses to locate within the County. (AI 18)
- AQ 7.4 Offer incentives to businesses to control emissions and implement the AQMP. (AI 18)
- AQ 7.5 Reduce regulations on small businesses wherever possible and thereby encourage small business development and job creation. The County shall set performance standards as well as design standards, thus giving small business owners as many options as possible to comply with County regulations. (AI 18)
- AQ 7.6 Adopt policies freeing small businesses from unnecessary and duplicative paperwork. (AI 18)
- AQ 7.7 Assemble information collected from County agencies and departments concerning the business community to develop programs that better serve their needs. (AI 18)

Jobs-to-Housing Ratio

One of the challenges facing the County is to provide the appropriate quantity of residential and employment-generating uses within close proximity to each other in order to reduce the amount of vehicle miles traveled and minimize impacts on air quality. In addition to providing incentives for businesses to locate within Riverside County, it is important to consider the jobs-to-housing ratio when approving the construction of new developments, including the use of mixed-use land patterns and the placement of new public facilities.

Policies:

- AQ 8.1 Locate new public facilities in job-poor areas of the County. (AI 18)
- AQ 8.2 Emphasize job creation and reductions in vehicle miles traveled in job-poor areas to improve air quality over other less efficient methods. (AI 18)
- AQ 8.3 Time and locate public facilities and services so that they further enhance job creation opportunities. (AI 18)
- AQ 8.4 Support new mixed-use land use patterns and community centers which encourage community self-sufficiency and containment, and discourage automobile dependency. (AI 14)



Please see the General

Plan Land Use Element Land Use Designation Policies section and Appendix J, Community Center Guidelines for additional information.

- AQ 8.5 Develop community centers in conformance with policies contained in the Land Use Element. (AI 14)
- AQ 8.6 Encourage employment centers in close proximity to residential uses. (AI 14)
- AQ 8.7 Implement zoning code provisions which encourage community centers, telecommuting and home-based businesses. (AI 1)
- AQ 8.8 Promote land use patterns which reduce the number and length of motor vehicle trips. (AI 26)
- AQ 8.9 Promote land use patterns that promote alternative modes of travel. (AI 26)



Please see the General

Plan Circulation Element Planned Circulation Systems section for further policies regarding alternative modes of travel.

Multi-jurisdictional Coordination

The County of Riverside recognizes the regional context of the policies it creates. Because air pollutants do not recognize political boundaries, often the policies of one community may adversely impact residents of another. This is particularly true with respect to pollutants emitted by motor vehicles, which underscores the importance of regional and subregional cooperation.

Policies:

- AQ 9.1 Cooperate with local, regional, state and federal jurisdictions to reduce vehicle miles traveled and motor vehicle emissions through job creation. (AI 18)
- AQ 9.2 Attain performance goals and/or VMT reductions which are consistent with SCAG's Growth Management Plan. (AI 26)

TRANSPORTATION DEMAND MANAGEMENT



Please see the General

Plan Circulation Element Transportation Demand Management section for additional information.

Vehicles are an essential part of life in California. People use them to go to work, run errands and transport goods all across the state and nation. However, while they serve a valuable function, many streets and freeways are increasingly overburdened with traffic. Everyday, cars and trucks jam onto the freeway at the beginning and end of each workday. Inching along the average twenty-two mile commute for Riverside County residents, automobiles spew pollutants into the air, while long sunny days change these pollutants into other noxious compounds. Most cars carry a single occupant, adding to the congestion and smog. When traffic does move, accidents often involving large trucks bring traffic to a grinding halt.

The good news is that our commute times and distance traveled to and from work have been stable over the last decade. The bad news is that Riverside County residents drive the furthest distance and have some of the longest commute times in all of southern California (Tables AQ-4, AQ-5 and AQ-6).

Table AQ-4
Commute Distance by Home County



County of Riverside General Plan

Air Quality Element

Home County	1992	1993	1994	1996	1998	1999
Los Angeles	15.8 miles	13.3 miles	15.3 miles	14.6 miles	15.3 miles	14.9 miles
Orange	14.9	14	15.8	15.7	14.2	16.1
Riverside	20.9	22.8	22.2	24.1	21	21.6
San Bernardino	20.4	20	21.3	25	22.4	21.3
Ventura	17.7	15.4	16.2	17.8	15.9	16.3
Imperial*	NA	NA	NA	11.8	12.1	14.5

* Imperial County was included for the first time in the 1996 study.
Source: 1999 SCAG State of the Commute Report

Table AQ-5
Commuting Time for Trip to Work by Home County

Home County	1992	1993	1994	1996	1998	1999
Los Angeles	37 minutes	33 minutes	30 minutes	33 minutes	31 minutes	34 minutes
Orange	32	29	30	30	31	33
Riverside	38	37	36	38	36	37
San Bernardino	35	36	36	38	37	35
Ventura	28	26	28	28	26	27
Imperial	NA	NA	NA	20	23	24

* Imperial County was included for the first time in the 1996 study.
Source: 1999 SCAG State of the Commute Report

Table AQ-6
Commuting Time for Return Trip Home by Home County

Home County	1992	1993	1994	1996	1998	1999
Los Angeles	42 minutes	36 minutes	34 minutes	36 minutes	38 minutes	41 minutes
Orange	35	34	38	37	34	41
Riverside	41	43	43	46	40	38
San Bernardino	42	39	42	47	39	41
Ventura	32	30	31	32	30	33
Imperial	NA	NA	NA	21	24	23

* Imperial County was included for the first time in the 1996 study.
Source: 1999 SCAG State of the Commute Report



Transportation Demand Management (TDM) - Low-cost ways to reduce demand by automobiles on transportation systems, such as programs to promote telecommuting, flextime and ridesharing.

Transportation Demand Management (TDM) can help unclog freeways and reduce commute times, thereby improving air quality. However, it means planning driving patterns to reduce the number of cars and trucks using the roads at any one time. This is the essence of TDM.

As stated in the Circulation Element, TDM strategies help reduce work-related trips by encouraging individuals who now drive alone to form carpools and vanpools, and to take the bus or light rail. Alternatively, workers may work longer hours and so eliminate a trip to the office once or twice a week. Two



other TDM strategies that eliminate work trips are telecommuting and work-at-home programs. When individuals must drive, TDM calls for changes in their work schedules to avoid peak traffic periods. A similar TDM strategy encourages large trucks to operate at night. Because traffic at night is lighter, accidents are less likely, and when they do occur, they may not tie up the freeway for hours as they would during the day.

TDM strategies for reducing trips that are not work related are also important. Among these are merchant transportation incentives, such as discounts to customers who use public transit and free bus passes. Some measures reduce both work and non-work related trips. For example, by pricing parking spaces and providing convenient parking for people who rideshare, parking management encourages the use of carpools, vanpools and public transit. It also eliminates on-street parking which adds to congestion.

TDM alone, however, is not the answer. Transit improvements and facility development must accompany these changes. Efforts to encouraging a shift to transit will fail unless transit operators make convenient, safe and reliable transit service available. Similarly, a lack of work centers now blocks the development of telecommuting. The County can take steps to foster the development of such work centers. Changing transportation demand will also require facility development, such as park-n-ride lots, bus turnouts, off-site parking, and facilities for bicycles and pedestrians.

The County's Transportation Demand Management Ordinance for new developments, designed to meet the requirements of the Riverside County Congestion Management Program and the Air Quality Management Plan, promotes the development of TDM strategies early in the development review process. The ordinance sets goals for reducing vehicle trips generated by new developments, a minimum road level-of-service for all new development projects and a reduction in overall vehicle trips emanating from the County. This ordinance also establishes potential TDM measures to be used where appropriate including off-site telecommunications facilities, carpooling, alternative work schedules, transit ridership incentives, and an enhanced pedestrian and bikeway circulation system.

Trip Reduction

As the automobile is the major source of air pollution in the region, the County recognizes the importance of reducing the number of vehicle trips and miles traveled. Policies in this section are not intended to create additional regulation, but to create incentives to reduce vehicle trips, encourage alternative schedules and conform to policies created by regional governments.

Policies:

- AQ 10.1 Encourage trip reduction plans to promote alternative work schedules, ridesharing, telecommuting and work-at-home programs, employee education and preferential parking. (AI 47)



- AQ 10.2 Use incentives, regulations and Transportation Demand Management in cooperation with surrounding jurisdictions when possible to eliminate vehicle trips which would otherwise be made. (AI 47)
- AQ 10.3 Assist merchants in encouraging their customers to shift from single occupancy vehicles to transit, carpools, bicycles, or foot. (AI 48)
- AQ 10.4 Continue to enforce the County's Transportation Demand Management Ordinance and update as necessary.

Special Events

Temporary special events provide recreational and retail opportunities for residents. However, these events may also result in traffic congestion on roadways adjacent to the event. The following policies are designed to alleviate traffic congestion and the accompanying pollution caused by excess vehicle travel times.

Policies:

- AQ 11.1 Establish requirements for special event centers to provide off-site parking and park-n-ride facilities at remote locations. Remote parking should be as close to practicable to the event site and the operator should supply shuttle services. (AI 116)
- AQ 11.2 Promote the use of peripheral parking by increasing on-site parking rates and offering reduced rates to peripheral parking with tickets sold for non-ridesharing patrons. (AI 116)
- AQ 11.3 Encourage special event center operators to advertise and offer discounted transit passes with event tickets (AI 116)
- AQ 11.4 Encourage special event center operators to advertise and offer discount parking incentives to carpooling patrons, with two or more persons per vehicle, for on-site parking facilities. (AI 116)

TRANSPORTATION SYSTEMS MANAGEMENT

Transportation systems management improves traffic flow through modification in the operation of existing transit facilities and fleets. This increases mobility and thereby improves air quality. Commerce, industry and public welfare require adequate mobility. Poor transportation systems management, on the other hand, creates congested highways, perpetuates poorly maintained and polluting fleets, weakens the County's economy and diminishes its citizens' health and well-being.

The County's rapidly growing population combined with unsynchronized traffic signals, delays at grade-level rail crossings, non-uniform street widths, inadequate roadway maintenance and poor emergency response, has resulted in increased congestion. Increased congestion means stop-and-go traffic and longer travel and idling time for cars, buses and trucks. Congestion increases



An at-grade railroad crossing is one where the street and the rail line form an intersection, and physically cross one-another.



transportation costs and vehicle emissions, and frays nerves. Moreover, a lack of fleets using alternative fuels adds to poor air quality.

Because transportation systems management provides an important weapon for relieving congestion, improving mobility, and enhancing air quality, the County should use it extensively in its fight for cleaner air.

Traffic Flow

It is a goal of the County to manage its transportation systems in a manner in which mobility and efficiency are enhanced. Improving the flow of traffic promotes mobility on our streets, resulting in decreased impacts on air quality.

Policies:

- AQ 12.1 Manage traffic flow through signal synchronization, while coordinating with and permitting the free flow of mass transit vehicles, when possible. (AI 117)
- AQ 12.2 Synchronize signals throughout the County with those of its cities, adjoining counties and the California Department of Transportation. (AI 117)
- AQ 12.3 Construct and improve traffic signals with channelization and Automated Traffic Surveillance and Control systems at appropriate intersections (AI 117)
- AQ 12.4 Eliminate traffic hazards and delays through highway maintenance, rapid emergency response, debris removal, and elimination of at-grade railroad crossings, when possible. (AI 119)
- AQ 12.5 Encourage business owners to schedule deliveries at off-peak traffic periods.



Channelization - Involves the separation or regulation of conflicting traffic movements into definite paths of travel by traffic islands or pavement markings, to facilitate the safe and orderly movement of vehicles and pedestrians.



High Occupancy Vehicles (HOV) Lanes -Carpools, vanpools, buses and motorcycles are the only vehicles allowed to use HOV lanes. Generally, HOV lanes require two-person carpools, though there are some roadways that require a minimum of three (with the exception of super-ultra-low-emission vehicles, which may use HOV lanes with only a single occupant).

Transportation System Management Improvements

Proper management and oversight of the County-owned fleet can provide a highly effective tool for reducing direct and indirect impacts on air quality. It is therefore a goal of the County to continually improve its own transportation system and cooperate with officials in all levels of government to enhance regional efforts to improve transportation systems management.

Policies:

- AQ 13.1 Manage the County of Riverside transportation fleet fueling standards to achieve an appropriate alternate fuel fleet mix. (AI 118)
- AQ 13.2 Cooperate with local, regional, state, and federal jurisdictions to better manage transportation facilities and fleets.



- AQ 13.3 Encourage the construction of high-occupancy-vehicle (HOV) lanes whenever possible to relieve congestion, safety hazards and air pollution as described in the AQMP.

TRANSPORTATION FACILITY DEVELOPMENT



Please see the General

Plan Circulation Element, Planned Circulation Systems section for additional information and policies.

Regionally, transportation facility development means increasing capacity through the expansion of highway and transit systems to meet population and land use demand. Though major construction projects often require massive capital investment, mobility and capacity are increased. These projects include: major highways in high growth regions, construction of high occupancy vehicle (HOV) lanes where severe traffic problems occur, and the construction of rapid transit corridors and facilities. Unfortunately, this strategy responds slowly to changing demands on the transportation system and may burden the region with debt.

Estimates for the development of additional facilities and systems over the next twenty years call for billions of dollars in investment. While federal government spending will account for a large portion of the funding required, additional revenues will have to be raised through a variety of means, including the gas tax, sales tax, user fees, tolls and bonds.

The costs of regional transportation projects also include growth in population, housing and services, and their impact on the transportation system. This raises traffic volume to or above the system's designed capacity while decaying air quality. When major transit corridors become congested, for example, daily commuters take alternate routes to avoid traffic delays. Once a new route becomes operational, commuters abandon these alternative routes for the new or improved systems until they too become congested. However, trying to build out of this situation does not solve the problem because it fuels an unbridled cycle of more growth, traffic, transportation facility development and smog. Continued transportation facility development results in increased growth, higher taxes, and minimal net gains in mobility for each dollar spent. All of this only lessens the chances for good air quality.

Just as there is a need regionally, capital improvements are also required locally to keep traffic moving and reduce emissions. It is the intent of the County to continue such improvements. However, the County recognizes that large construction projects are not always the best option for meeting transportation demands and that other, less expensive alternatives, are sometimes available. These alternatives include demand management, transportation systems management, and strategies to improve the job/housing ratio. While the County cannot meet all of its mobility and air pollution challenges using these alternatives, they may supplement needed capital improvements to help meet the County's transportation demands.

The transportation facility development required must improve mobility by encouraging multiple-occupancy vehicle use and alternative travel modes for both short and long trips. Therefore, the County must emphasize construction projects such as single purpose, high occupancy vehicle lanes, park-n-ride lots, light rail and bus routes. It should also give priority to bicycle paths and trails,



pedestrian overpasses, and bus turnouts. These projects improve mobility and air quality by encouraging efficient transportation use.

Policies:

- AQ 14.1 Emphasize the use of high occupancy vehicle lanes, light rail and bus routes, and pedestrian and bicycle facilities when using transportation facility development to improve mobility and air quality.
- AQ 14.2 When developing new capital facility improvement plans, also consider measures such as Transportation Demand Management, Transportation Systems Management, or job/housing balance strategies.
- AQ 14.3 Monitor traffic and congestion to determine when and where the County needs new transportation facilities to achieve increased mobility efficiency.
- AQ 14.4 Preserve transportation corridors with the potential of high demand or of regional significance for future expansion to meet project demand. (AI 53)

PARTICULATE MATTER

The Environmental Protection Agency (EPA) defines particulate matter (PM) as either airborne photochemical precipitates or windborne dust. Consisting of tiny solid or liquid particles of soot, dust, smoke, fumes, and aerosols, common sources of PM are manufacturing and power plants, agriculture, diesel trucks and other vehicles, construction sites, fire and windblown dust. Generally PM settles from atmospheric suspension as either particulate or acid rain and fog that has the potential to damage health, crops, and property. Particulate of 2.5 microns or smaller (2.5 microns is approximately equal to .000098 inches) may stay suspended in the air for longer periods of time and when inhaled can penetrate deep into the lungs. Among the health effects related to PM_{2.5} are premature death, decreased lung function and exacerbation of asthma and other respiratory tract illnesses.

Particulate sized between 2.5 and 10 microns (10 microns is approximately equal to .0004 inches), known as PM₁₀ also pose a great risk to human health. PM₁₀ can easily enter the air sacs in the lungs where they may be deposited, resulting in an increased risk of developing cancer, potentially changing lung function and structure, and possibly exacerbating preexisting respiratory and cardiovascular diseases. It can also irritate the eyes, damage sensitive tissues, sometimes carry disease, and may even cause premature death. PM_{2.5} and PM₁₀ are especially hazardous to the old, young and infirm.

Although it produces less than 10% of the South Coast Air Basin's particulate matter, western Riverside County, which is part of the SOCAB, exceeds federal standards more than any other urban area in the nation, and has the highest particulate concentration in the SOCAB. These high levels of particulate matter are largely imported from the urbanized portions of Los Angeles and Orange Counties. This imported particulate is generally composed of photochemical



precipitates rather than dust, smoke or soot. Riverside County is also responsible for generating large amounts of particulate matter from sources such as agriculture, warehousing operations, and truck traffic.

While Riverside County is dedicated to implementing policies to control particulate matter produced within its own boundaries, it has no control over particulate imported from beyond its boundaries. The solution to the problem of imported particulate matter in western Riverside County is the adoption of adequate control measures by those responsible jurisdictions in Los Angeles and Orange Counties. By adhering to the control measures contained in the AQMP, these jurisdictions can have a positive impact on particulate matter pollution in the SOCAB portion of Riverside County.

The air quality concerns in the Salton Sea Air Basin (SSAB) portions of the County differ somewhat from those in western Riverside County. Unlike the SOCAB region, particulates in SSAB are primarily dust, smoke and soot. While in 1993 and 1994, PM_{10} concentrations were under the federal standard, concentrations in 1995 were slightly above federal limits. The maximum annual average PM_{10} concentration in 1995 was recorded at 4% above the federal standard; however, the measurement included one day with high winds without which the SSAB would have been under the federal standard. The far more stringent state standards were exceeded on 44% of the days in 1995.

The Mojave Desert Air Basin (MDAB), like the SOCAB and SSAB, is designated as a non-attainment area for PM_{10} . Particulates in the MDAB are primarily fugitive caused by high winds or vehicle travel on unpaved roads. Particulates in the area are generally not caused by exhaust stacks or primary emission points.

While sources and severity of particulate pollution differ in subareas of the County, it is the County's objective to control particulate matter throughout all of Riverside County. However, where necessary, the County shall tailor its control measures and implementation procedures to best address the unique situations found in each area. One example of such an area is the Mira Loma community, where particulate pollutant levels are among the worst in the nation. In such an area, strong measures must be taken immediately to protect the health and welfare of residents, especially children, the elderly and those with respiratory illnesses.

Monitoring

Air quality monitoring stations are located throughout Riverside County (Figure AQ-2). However, at times it may be necessary to locate additional monitors in those areas of the County suspected of producing excessively high levels of particulates. This more localized data may then assist control and law enforcement efforts in reducing and minimizing particulate matter levels.

Policies:

AQ 15.1 Identify and monitor sources, enforce existing regulations, and promote stronger controls to reduce particulate matter.

County of Riverside General Plan

Air Quality Element



Figure AQ- 2 South Coast Air Quality Management District and California Air Resources Board Air Monitoring Network In Riverside County



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Multi-jurisdictional Cooperation

Particulate matter concentrations are a regional issue. In addition to those created in Riverside County, particulates originating in surrounding cities and counties are transported into Riverside County by prevailing winds. Therefore, any meaningful attempt to decrease particulate concentrations in the County will involve cooperation with local and regional governments and a tightening of state and federal standards.

Policies:

- AQ 16.1 Cooperate with local, regional, state and federal jurisdictions to better control particulate matter.
- AQ 16.2 Encourage stricter state and federal legislation on bias belted tires, smoking vehicles, and vehicles that spill debris on streets and highways, to better control particulate matter. (AI 113)
- AQ 16.3 Collaborate with the SCAQMD and MDAQMD to require and/or encourage the adoption of regulations or incentives to limit the amount of time trucks may idle. (AI 120)
- AQ 16.4 Collaborate with the EPA, SCAQMD, MDAQMD, and warehouse owners and operators to create regulations and programs to reduce the amount of diesel fumes released due to warehousing operations. (AI 121)

Control Measures

Riverside County can implement simple control measures to reduce the amount of particulates produced within its borders. Strict enforcement of these and current regulations can then lead to a substantial decrease in particulate concentrations in the County and neighboring areas.

Policies:

- AQ 17.1 Reduce particulate matter from agriculture, construction, demolition, debris hauling, street cleaning, utility maintenance, railroad rights-of-way, and off-road vehicles to the extent possible. (AI 123)
- AQ 17.2 Enforce regulations against illegal fires.
- AQ 17.3 Identify and create a control plan for areas within the County prone to wind erosion of soil.
- AQ 17.4 Adopt incentives, regulations and/or procedures to manage paved and unpaved roads and parking lots so they produce the minimum practicable level of particulates (AI 111)
- AQ 17.5 Adopt incentives and/or procedures to limit dust from agricultural lands and operations, where applicable. (AI 123)



County of Riverside General Plan

Air Quality Element

- AQ 17.6 Reduce emissions from building materials and methods that generate excessive pollutants, through incentives and/or regulations.
- AQ 17.7 Separate trucks from other vehicles in industrial areas of the County with the creation of truck-only access lanes to promote the free flow of traffic. (AI 43)
- AQ 17.8 Adopt regulations and programs necessary to meet state and federal guidelines for diesel emissions. (AI 121)
- AQ 17.9 Encourage the installation and use of electric service units at truck stops and distribution centers for heating and cooling truck cabs, and particularly for powering refrigeration trucks in lieu of idling of engines for power. (AI 120)
- AQ 17.10 Promote and encourage the use of natural gas and electric vehicles in distribution centers.
- AQ 17.11 Create and implement street-sweeping plans, as appropriate, in areas of the County disproportionately affected by particulate matter pollution.

SOUTH COAST AIR QUALITY MANAGEMENT DISTRICT

THE HEALTH EFFECTS OF AIR POLLUTION ON CHILDREN

Fall 2000

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Introduction

Air pollution has many effects on the health of both adults and children. The purpose of this article will be to examine what is known about how air pollution affects health, especially children's.

Over the past several years the incidence of a number of diseases has increased greatly. Asthma is perhaps the most important disease with an increasing incidence, but other diseases, such as allergic reactions, bronchitis and respiratory infections also have been increasing. The cause of these increases may be due at least in part to the effects of air pollution. This review will address the following questions:

1. Why are children more susceptible to the effects of air pollution than adults?
2. Which air pollutants have the greatest impact on the health of children and adults?
3. What can be done to reduce the effects of air pollution on children's health?

Why are Children More Susceptible to Air Pollution Than Adults?

In many health effects research studies, children are considered as if they were small adults. This is not really true. There are many differences between children and adults in the ways that they respond to air pollution. For example, children take in more air per unit body weight at a given level of exertion than do adults. When a child is exercising at maximum levels, such as during a soccer game or other sports event, they may take in 20 percent to 50 percent more air -- and more air pollution -- than would an adult in comparable activity.

Another important difference is that children do not necessarily respond to air pollution in the same way as adults. Adults exposed to low levels of the pollutant ozone will experience symptoms such as coughing, soreness in their chests, sore throats, and sometimes headaches. Children, on the other hand, may not feel the same symptoms, or at least they do not acknowledge them when asked by researchers. It is currently not known if children actually do not feel the symptoms or if they ignore them while preoccupied with play activities.

This probably does not mean that children are less sensitive to air pollution than adults. There are several good studies that show children to have losses in lung functions even when they don't cough or feel discomfort. This is important because symptoms are often warning signals and can be used to trigger protective behavior. Children may not perceive these warning signals and might not reduce their activities on smoggy days.

Children also spend more time outside than adults. The average adult, except for those who work mostly outdoors, spends most of their time indoors -- at home, work, or even at the gym. Children spend more time outside, and are often outdoors during periods when air pollution is at its highest.

The typical adult spends 85 percent to 95 percent of their time indoors, while children may spend less than 80 percent of their time indoors. Children may also exert themselves harder than adults when playing outside.

Perhaps the most important difference between adults and children is that children are growing and developing. Along with their increased body size, children's lungs are growing and changing, too.

The Lung's Important Role in Health

The lung is an extremely complex organ. While most organs in your body are made up of a few different types of cells, the lung contains more than 40 different kinds of cells. Each of these cells is important to health and maintaining the body's fitness.

Air pollution can change the cells in the lung by damaging those that are most susceptible. If the cells that are damaged are important in the development of new functional parts of the lung, then the lung may not achieve its full growth and function as a child matures to adulthood. Although very little research has been conducted to address this extremely important issue, this review will discuss the information that is available.

USC Children's Health Study

Recent results from the Children's Health Study, conducted by investigators at the University of Southern California, suggest that children with asthma are at much greater risk of increased asthma symptoms when they live in communities with higher levels of ozone and particles and participate in three or more competitive sports. Having said all this, the purpose of this review is not to discourage children or adults from normal daily activities and outdoor exercise. Exercise has very important, beneficial outcomes. Appropriate exercise and prudent exposures of children and adults should be encouraged even in an environment that may always contain some amount of air pollution.

Which Air Pollutants Have the Greatest Impact on the Health of Children and Adults?

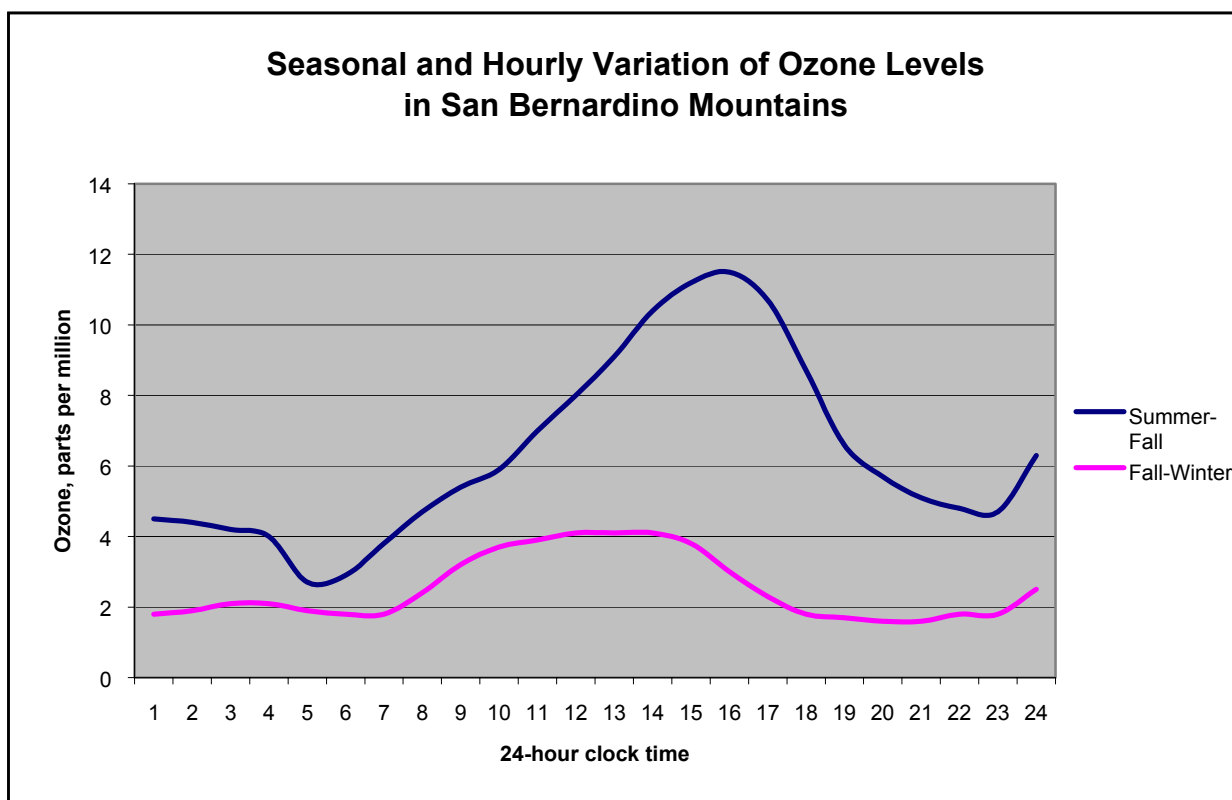
Ozone

Ozone is one of the most important air pollutants affecting human health in regions like Southern California.

Ozone (O₃) is a molecule built of three atoms of oxygen linked together in a very energetic combination. When ozone comes into contact with a surface it rapidly releases this extra force in the form of chemical energy. When this happens in biological systems, such as the respiratory tract, this energy can cause damage to sensitive tissues in the upper and lower airways.

Ozone formation

Because ozone forms as a product of solar energy and photochemical reactions of pollutants, it is not surprising that the highest concentrations of ozone in the atmosphere occur when sunlight is most intense. Thus, ozone generally reaches peak levels during the middle of the day in the summer months. These types of air pollution patterns are called diurnal and seasonal variations. The following graph shows that ozone levels in the San Bernardino Mountains are highest in the summer and fall, and peak in the late afternoon.



Ozone Air Quality Standards

Federal and state agencies have set air quality standards for ozone. An ozone level greater than 0.08 parts per million (ppm) averaged over eight hours is considered unhealthy. This level has been set because both laboratory and community studies have demonstrated measurable effects of ozone at or above that threshold.

The effects of ozone on people include:

- irritation of the nose and throat;
- increased mucus production and tendency to cough;
- eye irritation and headaches for some; and
- during severe episodes, chest pain and difficulty taking a deep breath without coughing.

How Ozone Damages Lungs

What happens when you breathe air that is contaminated with ozone? Like oxygen, ozone is soluble in the fluids that line the respiratory tract. Therefore some ozone can penetrate into the gas-exchange, or alveolar, region of the deep lung.

The following photos show how ozone affects the sensitive tissue in the deep lung. The pictures are from the lungs of rats exposed to ozone in a laboratory under carefully controlled conditions. The human lung is similar --although not identical -- to the rat's lung in terms of the types of cells and the overall structure of the alveolar region.



Figure 1

Figure 1 shows a magnified view of the structure of the normal gas-exchange region of the lung. It is called the gas-exchange region because oxygen inhaled from the air is transferred to the hemoglobin in blood in small blood vessels located inside the thin walls separating the alveolar air spaces.

At the same time, carbon dioxide, produced by normal metabolism and dissolved in the blood, is excreted into the air and expired when you breathe out.

The walls of a normal alveolus are very thin. There are only two layers of cells and a thin interstitial matrix separating the air in the alveolar space, or lumen, from the fluid inside the blood vessels. The cells that line the healthy alveoli are mostly very broad and very thin, and are called Type I lung cells or Type I pneumocytes. This provides a very large surface area across which gases can be efficiently transported.

Figure 2 shows the effects of breathing 0.2 ppm ozone for 4 hours. In Southern California air pollution levels can approach 0.2 ppm -- a Stage 1 ozone alert -- during the smoggiest summer days. The photo shows evidence of additional cells, called macrophages, and some material that may be fragments of ozone-injured alveolar wall cells inside the alveolar space.

Macrophages are immune system cells that respond to the injury of the delicate cells that line the alveolar lumen. These macrophages play important roles in protecting the lungs from inhaled bacteria,

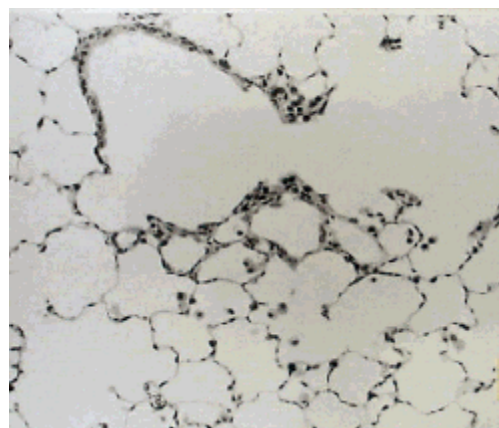


Figure 2

fungi and viruses, and are also important in helping to repair lung tissue injury caused by inhaled pollutants.

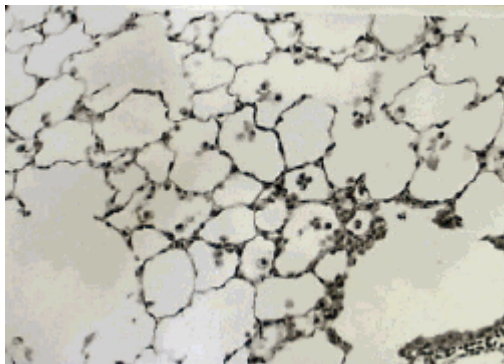


Figure 3

Figure 3 shows more extensive damage following exposure a higher concentration of ozone, 0.6 ppm. The alveolar walls are thicker and there is evidence of cells infiltrating within the walls. There are more macrophages in the alveolar spaces and the thin, Type I cells have been damaged and replaced with thicker Type II, almost cube-shaped cells that are more resistant to the toxic effects of ozone. All of these changes occurred within 48 hours after exposure. If exposure continues for more than three days, the evidence of cell injury seems to be reduced, except for the continuing presence of the Type II cells.

Is Ozone-Related Lung Damage Permanent?

People actually report that the symptoms they feel when first exposed to ozone seem to go away, even though their exposure continues.

Following ozone injury, if the lung is not exposed to ozone for approximately five to seven days, it can for the most part repair itself provided the injury is not too extensive. However, long-term studies with laboratory animals have shown that there may be residual and in some cases permanent damage. This damage might be thought of as accelerated aging of the lung. Thus, frequent exposures to ozone can cause transient damage. The lung's defenses can repair most but probably not all of that damage within a relatively short time in most healthy individuals.

Research and Air Quality Standards

Health scientists probably know more about the effects of ozone on human health than about any other pollutants. This is because ozone is pervasive in the environment. Also there are excellent methods of measuring ozone so the pollutant can be studied using epidemiological methods. The findings of these epidemiological studies can be verified using well-controlled laboratory studies with human volunteers and laboratory animals. Thousands of scientific papers on the health effects of ozone have been published and these have been critically reviewed in documents that provide the scientific basis for National and State Ambient Air Quality Standards. (Ambient refers to outdoor air.)

These so-called Criteria Documents are important because they are extensively reviewed by scientists, public agencies, industry representatives, environmental groups such as the American Lung Association and the Natural Resources Defense Council,

and the public. National and state ambient air quality standards set the goals for healthy air quality in Southern California and across the country.

Based upon the most recent studies, it is now apparent that ozone plays an important role in causing acute health effects, such as heightening asthma symptoms and developing bronchitis symptoms.

The role of ozone in producing long-term or chronic effects is less clear, at least from the available epidemiological studies. However, laboratory animal studies suggest that there can be long-term consequences.

How to Reduce Ozone Exposure

The U.S. Environmental Protection Agency (EPA) has recommended that ozone should not exceed 0.08 ppm averaged over an 8-hr period. When ozone exceeds this level, active children and adults, those with respiratory disease such as asthma, and other people with unusual susceptibility to ozone should limit prolonged outdoor exposure.

Incidentally, personal tobacco smoking during periods of high ozone exposure doubled the risk of asthmatic individuals needing to go to the emergency room for treatment of asthma symptoms.

Carbon Monoxide

Carbon monoxide (CO), a colorless, odorless gas, is a byproduct of combustion.

When inhaled, carbon monoxide reacts very rapidly with hemoglobin in the blood, preventing uptake and transport of oxygen. Because carbon monoxide readily and firmly attaches to hemoglobin, it stays in the blood for a relatively long time. Thus, during an exposure carbon monoxide concentrations in blood can rise in a matter of minutes, then stay high for hours.

Who is Most Sensitive to the Health Effects of Carbon Monoxide?

Most of the health effects directly associated with carbon monoxide are most likely due to decreases in oxygen delivery to vital organs such as the heart and the brain.

People with heart disease may be especially sensitive to the effects of carbon monoxide. In addition, people with lung diseases that limit efficient use of inhaled oxygen, such as asthma and emphysema, may also be susceptible. Even in people without heart or lung diseases, reduced delivery of oxygen to skeletal muscles, especially during exercise, can reduce the ability to perform strenuous work.

At high levels of carbon monoxide exposure, impaired delivery of oxygen to the central nervous system can reduce the ability to respond quickly to external stimuli. After exposures that convert 5 percent to 10 percent of the circulating hemoglobin to carboxyhemoglobin (COHb), people's ability to recognize and react to flashes of light in a test system are reduced. At 10 percent to 30 percent carboxyhemoglobin, nausea,

headaches, unconsciousness, and sometimes death can result. The severity of symptoms increases with the concentration of carboxyhemoglobin.

Air Quality Standards for Carbon Monoxide

Both the EPA and the State of California have set air quality standards for carbon monoxide based on the results of epidemiological and laboratory findings. Ambient levels of carbon monoxide should not exceed 9 ppm, when averaged over an 8-hour interval, and should not exceed 20 ppm in any one-hour period. (The USEPA has a slightly higher 1-hour standard of 35 ppm).

Sources of Carbon Monoxide

The major sources of carbon monoxide pollution are automotive exhaust and emissions from large industrial combustion sources such as electrical power plants. Because these sources produce many contaminants in addition to carbon monoxide -- such as fine particles and nitrogen oxides -- it is often difficult to isolate the health effects of ambient carbon monoxide from those of other pollutants.

In addition to carbon monoxide generated outside, there are also important indoor sources of the pollutant. The most important of these are combustion sources such as gas ovens, gas burners, water heaters, and heating systems. However, in most cases emissions from well-maintained and vented gas appliances are small.

Tobacco smoking is a more significant source of carbon monoxide. Tobacco smoke can contain very high concentrations of carbon monoxide (1,000 ppm to 50,000 ppm). Carbon monoxide levels in the homes of children whose relatives smoke tobacco products can be higher than the carbon monoxide levels outdoors.

Health Effects of Carbon Monoxide

There are hundreds of cases per year of deaths or severe illness due to carbon monoxide poisoning from faulty appliances, indoor emissions of automobile exhaust and industrial exposures. These cases show that carbon monoxide poisoning causes symptoms very similar to those of the flu. In fact, the true number of cases is not really known because many people may have been poisoned slightly and thought that they were just fighting off a cold or the flu. Thus it is very important to make sure that home appliances are well-maintained and that all combustion sources are properly vented to the outdoors.

Epidemiological studies have shown significant association between several health effects and carbon monoxide, although as mentioned earlier it is difficult to completely isolate carbon monoxide's effects from those of other air pollutants.

For example, asthmatic children in Taiwan who were exposed to high levels of traffic-related air pollution -- using carbon monoxide and nitrogen dioxide as marker compounds-- reported more respiratory symptoms than children with lower exposures.

A study of physician office visits in London showed associations between air pollution and doctor visits for asthma and other lower respiratory disease. For children, levels of nitrogen dioxide, carbon monoxide, and sulfur dioxide were associated with increased numbers of medical consultations. However, in adults, the only consistent association was with levels of airborne particles. This suggests that children and adults might respond differently to pollution exposures.

Prenatal Effects of Carbon Monoxide

Carbon monoxide may also have prenatal effects. Pregnant women who were exposed to high levels of ambient carbon monoxide (5 ppm to 6 ppm) were at increased risk of having low birth-weight babies. It has long been known that women who smoke cigarettes during pregnancy have low birth-weight babies, but this is the first study of similar findings in women exposed to environmental carbon monoxide.

Babies exposed to carbon monoxide during the maturation of their organs may suffer permanent changes to those organs. Studies using newborn rats showed that carbon monoxide exposure could cause changes in the heart muscle tissue. This in turn could increase the severity of effects of artery constrictions when they became adults. Other animal studies have shown that long-term carbon monoxide exposure can contribute to a disease called ventricular hypertrophy, in which the cells of the heart's ventricle chambers are enlarged and possibly weakened.

Airborne Particles

Particles, including nitrates, sulfates, carbon¹ and acid aerosols² are a complex group of pollutants.

Unlike ozone, which has a specific chemical composition, airborne particles vary in size and composition depending on time and location. Although the components of particles may have common sources, the types and amounts of particles collected at any one time and location may be unique.

To add to the problem, gaseous pollutants including ozone, sulfur dioxide, nitrogen dioxide and carbon monoxide often are present in the atmosphere at the same time as are particles. It is not always possible to clearly differentiate between the health effects of the gases, the particles, and possibly the combination of particles and gases. This complexity presents a tremendous challenge to the scientific community and to public in trying to understand how inhaled particles affect human health.

The Challenge of Measuring Particle Pollution

Precisely measuring particulate pollution is more difficult and labor intensive than measuring gaseous pollutants such as ozone. For this reason, particle concentrations are not measured on a daily basis in most communities. Frequently, they are measured once every six days.

¹ Both elemental and organic. Elemental carbon is pure carbon from combustion sources, including diesel particulate. Organic carbon is a semi-volatile hydrocarbon from combustion and some evaporative sources.

² Aerosol is the scientific term used to describe particles suspended in a fluid, such as air.

Particle samples are collected on filters that are then weighed. Particle concentrations are reported in terms of micrograms of particles per cubic meter ($\mu\text{g}/\text{m}^3$) of collected air.

Originally, the particle samples were relatively indiscriminate with respect to particle size and often contained very large particles. These large particles contributed a great deal to the weighed particle mass, but might not have been very important with respect to lung health. This is because most of the particles were too large to penetrate through the nasal and head airways to reach the lung. A more health-related sample was needed.

After a great deal of scientific consideration it was decided that particulate matter with aerodynamic diameters³ less than or equal to 10 microns (μm) should be collected. Ambient air quality standards were developed for this material, which is called PM_{10} .

Sources of Particle Pollution

Researchers noted that the sources of relatively large-size particles (greater than 3 microns in aerodynamic diameter) were quite distinct from the sources of particles less than 1 micron in diameter.

The larger, so-called "coarse" particles are mostly produced by mechanical processes, such as automobile tire wear on the road, industrial cutting, grinding and pulverizing processes and re-suspension of particles from the ground or other surfaces by wind and human activities. The chemical composition of coarse particles may be somewhat similar to the chemical composition of soil in that area, along with industrial compounds from activities such as mining or smelting operations. The coarse fraction of urban aerosols also contains bits of plants, molds, spores and some bacteria. Thus the characteristics of the coarse particles may vary greatly in different communities.

In contrast, the smaller or so-called "fine" particles in the urban aerosol come from combustion sources, such as power plants, automobile, truck, bus and other vehicle exhaust or from the reactions that transform some of the pollutant gases into solid or liquid particles. These distinctions may be important because the current air pollution health effects literature suggests, although not with certainty, that for some key health effects the fine particles are more important than the coarse particles. These findings have led EPA to propose a new nationwide $\text{PM}_{2.5}$ standard that would reduce exposure to particles that are 2.5 microns or less in diameter.

Historic Air Pollution Disasters

Epidemiological studies have consistently associated adverse health effects with exposures to particulate air pollution. Early studies implicated particulate and sulfur dioxide pollution in the acute illnesses and premature deaths associated with extremely

³ Aerodynamic diameter is used to define particles' size. Particle deposition on a surface, or in the lung, depends on the particle's aerodynamic and diffusion characteristics. A particle's aerodynamic characteristics depend on its density, shape, actual size, and velocity while its diffusion characteristics are functions of its size and the density of the air in which it is suspended.

severe pollution episodes in Donora, Penn., London, and New York in the 1940s, 1950s, and 1960s. The particle levels in a four-week pollution disaster in London in 1955 were more than 50 times higher than the California standard.⁴ Twenty percent of that aerosol was composed of acid sulfates -- probably sulfuric acid. The number of people hospitalized for lung or heart-related diseases was extraordinarily high, but more importantly there were more than 4,000 premature, or "excess," deaths in the London population.

Fortunately, major efforts by government agencies, the public, and industries have made it very unlikely there will ever be a similar episode in modern urban communities. However, the lessons learned from these disasters are still relevant. Despite the fact that our levels of airborne particles are much lower than those that occurred during the disasters, EPA estimates that there are still more than 6,000 excess deaths in the United States that could be associated with inhaled particles.

Health Effects of Particulate Pollution

Current ambient levels of PM₁₀ -- 30 to 150 micrograms per cubic meter -- are associated with increases in the numbers of people that die daily from heart or lung failure. Most of these deaths are among the elderly. However there is a strong body of evidence that some children are also adversely affected by particulate matter.

The American Thoracic Society's Environmental and Occupational Health Assembly reviewed current health effects literature. They report that daily fluctuations in PM₁₀ levels have been related to:

- acute respiratory hospital admissions in children;
- school and kindergarten absences;
- decreases in peak lung air flow rates in normal children; and
- increased medication use in children and adults with asthma.

The USC Children's Health Study suggests that children with asthma living in a community with high particle concentrations may have suppressed lung growth. After children moved into cleaner cities their lung growth returned to the normal rate, but they did not recover the lost potential growth, according to John Peters, the study's principle investigator.

It is difficult to positively assign a quantitative risk associated with particulate matter because nearly all studies of its health effects find other pollutants present that may account for some of the effects.

Part of the problem is due to the nature of the data being collected. The levels of particulate matter vary during the course of the day and peak values can be quite high. Few studies have evaluated the effect of these short-term "spikes." However, at least one epidemiological study of children with asthma suggested that changes in symptoms

⁴ The California standard for particulate matter (PM₁₀) is 50 micrograms per cubic meter averaged over 24 hours

and lung function correlate more strongly with 1-hour peaks than with 24-hour average concentrations.

Other studies, primarily with laboratory animals, suggest that the chemical composition⁵ and surface areas of the particles may be more important than particle mass. Scientists are continuing to study the health effects of particles and are developing better methods for measuring the important constituents. It may be possible in the near future to more accurately assess the effects of inhaled particles on human health.

Nitrogen Oxides

Nitrogen oxides are produced during most combustion processes. Mobile sources and power plants are the major contributors in Southern California.

About 80 percent of the immediately released nitrogen oxide is in the form nitric oxide (NO). Small amounts of nitrous oxide (N₂O) are also produced. Nitrous oxide is a "greenhouse" gas that is suspected of playing an important role in global warming.

Nitric oxide reacts with oxygen in the air to produce nitrogen dioxide (NO₂). Further oxidation during the day causes the nitrogen dioxide to form nitric acid and nitrate particles. In the dark, nitrogen dioxide can react with ozone and form a very reactive free radical. The free radical then can react with organic compounds in the air to form nitrogenated organic compounds, some of which have been shown to be mutagenic and carcinogenic.

Health Effects of Nitrogen Dioxide

Nitrogen dioxide is the most important nitrogen oxide compound with respect to acute adverse health effects. Under most chemical conditions it is an oxidant, as is ozone. However, it takes about 10 times more nitrogen dioxide than ozone to cause significant lung irritation and inflammation.

Nitrogen dioxide differs from ozone in that it suppresses the immune system to a much greater degree. As discussed below, some epidemiological studies have shown that children exposed to high levels of ambient nitrogen dioxide may be at increased risk of respiratory infections. Studies with laboratory animals have indeed shown that if mice are exposed first to nitrogen dioxide and later to bacteria at a level that would not infect a healthy control animal, their normal lung defense mechanisms are suppressed and the bacteria are able to infect the host.

⁵ The idea that all particles are equally toxic is not scientifically justified. There are many good examples that can be taken from studies of particles in the workplace. For example, certain types of particles that contain quartz -- a natural mineral composed of silicon dioxide but with a specific crystal structure -- are very potent lung irritants. Repeated exposures to this material can lead to a serious, permanent lung disease called lung fibrosis. Other mineral particles that are fibrous, such as specific forms of asbestos, can cause lung cancer. Other particles such as titanium dioxide do not seem to cause occupational diseases.

Average levels of nitrogen dioxide in the United States range from 0.02 to 0.04 ppm. Levels in major urban areas in Southern California may be higher, but the region has not exceeded the federal standard⁶ for nitrogen dioxide since 1991.

During the 1970s, one of the first studies relating respiratory illnesses and changes in lung function to ambient nitrogen dioxide concentrations reported that children living in areas with high nitrogen dioxide concentrations had greater incidences of lung-related illness than children living in areas with lower concentrations. Since then, other epidemiological studies have suggested that children with asthma are more likely than children without asthma to have reduced lung function and symptoms of respiratory irritation, such as cough and sore throat, when outdoor average nitrogen dioxide concentrations exceed about 0.02 ppm.

Some studies also have suggested that children younger than five years old may be more severely affected by nitrogen dioxide than older children. Several epidemiological studies have suggested that for children, the most important effect of ambient exposure to nitrogen dioxide might be increased susceptibility to respiratory infections and increased severity of responses to inhaled allergens.

Although many epidemiological studies show significant associations between outdoor nitrogen dioxide concentrations and adverse health outcomes, some studies do not corroborate these effects. In part, this is because it is often difficult to fully account for the influences of indoor sources of nitrogen dioxide.

Improvements in Nitrogen Dioxide Measurements

More recent studies have used special devices, called passive dosimeters, that can be worn by children to collect nitrogen dioxide for later analysis. These measurements give epidemiologists the ability to better assess a child's total nitrogen dioxide exposure over the course of the day. These studies show that there can be a great deal of individual variation in exposures, even for children living in the same communities. Thus, it is not surprising that epidemiological studies that do not estimate a nitrogen dioxide dose may reach different conclusions.

However, laboratory studies involving controlled exposures of human volunteers and laboratory animals have demonstrated plausible effects of nitrogen dioxide on human health. For example, if one exposes rats or other animals to nitrogen dioxide, and then examines their respiratory tract tissues, it is very evident that the pollutant can cause short-term injury similar to that seen after ozone exposure.

Long-term exposures to high concentrations of nitrogen dioxide can produce chronic damage to respiratory tract tissue that resembles the lung disease emphysema.

The pollutant's suppression of immune system functions reduces the ability of the host to fight off bacterial and viral infections. Human volunteers who inhaled weakened

⁶ 0.053 ppm as an annual average

influenza virus after being exposed to nitrogen dioxide in laboratories were more susceptible to the infection than a control group that did not inhale nitrogen dioxide.

Other studies show that nitrogen dioxide decreases the body's ability to generate antibodies when challenged by pathogens, and may reduce the ability of the respiratory system to remove foreign particles such as bacteria and viruses from the lung.

Lead

People can be exposed to lead (Pb) through air, food and water. Lead is a toxic heavy metal that causes nerve damage and impairs the body's ability to make hemoglobin, leading to a form of anemia.

Sources of Lead Pollution

Large amounts of lead were emitted to the atmosphere when it was used as a gasoline additive.⁷ The emitted lead could be inhaled. In addition, lead fallout from the air caused widespread contamination of soil, plants, food products, and water.

Lead is often measured in children's blood as an index of environmental exposure. Even low levels⁸ of lead in the blood of children aged 6 to 7 are linked to measurable changes in intelligence quotient and certain perceptual-motor skills. Higher levels of lead exposure can also result in kidney damage and may be related to high blood pressure in adults.

Sulfur Oxides

Most manmade emissions of the gas sulfur dioxide (SO₂) come primarily from the combustion of fossil fuels such as coal, oil, and diesel fuel.

Most of the sulfur in fossil fuel is converted sulfur dioxide, but a small amount is also converted to sulfuric acid. In the atmosphere, gaseous sulfur dioxide can also be converted to sulfuric acid and sulfate-containing particles. Thus, atmospheric concentrations of sulfur dioxide are often highly associated with acidic particles, sulfuric acid particles and sulfate particle concentrations.

The current National Ambient Air Quality Standards for sulfur dioxide are 18 micrograms per cubic meter averaged annually, and 365 micrograms per cubic meter averaged over 24 hours. Southern California does not exceed the national air quality standard because its industries primarily burn low-sulfur fuels such as natural gas. Much of the sulfur oxide air pollution in Southern California is likely to be associated with diesel emissions.

⁷ Lead in the form of tetraethyl lead was added to gasoline in the United States in large amounts from the 1950s until it was banned in the mid-1970s.

⁸ 10 to 30 micrograms per 100 milliliters

Sulfur dioxide is a very water-soluble gas and therefore most of the sulfur dioxide that is inhaled is absorbed in the upper respiratory tract and does not reach the lung's airways. However, the small amount of sulfur dioxide that does penetrate into the airways can provoke important health effects, primarily in individuals with asthma.

For those with asthma, even relatively short-term, low-level exposures to sulfur dioxide can result in airway constriction leading to difficulty in breathing and possibly contribute to the severity of an asthmatic attack.

A number of epidemiological studies have shown associations between ambient sulfur dioxide and rates of mortality (death) and morbidity (illness). However, because sulfur dioxide is often strongly correlated with fine particles and especially sulfate-containing particles, it is difficult to separate the effects of sulfur dioxide from those of the particle compounds.

A study in France found an increase of 2.9 visits to the emergency room for every 20 micrograms per cubic meter increase in atmospheric sulfur dioxide. The results pertained to days when the average sulfur dioxide levels were above 68 micrograms per cubic meter but below the U.S. health standard.

In London, asthma and other lower respiratory diseases in children were most significantly associated with exposures to nitrogen dioxide, carbon monoxide, and sulfur dioxide. In adults the only consistent association was with particulate matter.

Hospital admissions for children with asthma may increase by 20 percent following acute exposure to ozone peaks and possibly with sulfur dioxide. Chronic exposure to increased levels of fine particles, sulfur dioxide, and nitrogen dioxide may be associated with up to threefold increase in nonspecific respiratory symptoms. Thus, recent literature suggests that sulfur dioxide affects adults and children differently and that chronic and acute effects may also be different.

Diesel Emissions

Diesel fuel is burned to power buses, trucks, road-building equipment, trains, boats and ships and electricity-generating equipment. When diesel fuel is burned, the exhaust includes both particles and gases. Diesel emissions are important constituents of ambient air pollution.

What's in Diesel?

Diesel particles consist mainly of elemental carbon and other carbon-containing compounds. Hundreds of compounds have been identified as constituents of diesel particles. These include polycyclic aromatic hydrocarbons (PAHs) and other compounds that have been associated with tumor formation and cancer. In 1998, the California Air Resources Board designated diesel particulate a cancer-causing toxic air contaminant.

Diesel particles are microscopic. More than 90 percent of them are less than 1 micron in diameter. Due to their minute size, diesel particles can penetrate deeply into the lung. There is evidence that once in the lung, diesel particles may stay there for a long time.

In addition to particles, diesel exhaust contains several gaseous compounds including carbon monoxide, nitrogen oxides, sulfur dioxide and organic vapors, for example formaldehyde and 1,3-butadiene. Formaldehyde and 1,3-butadiene have been classified as toxic and hazardous air pollutants. Both have been shown to cause tumors in animal studies and there is evidence that exposure to high levels of 1,3-butadiene can cause cancer in humans.

AQMD's recent landmark research project, the Multiple Air Toxics Exposure Study II, found that diesel particulate is responsible for about 70 percent of the total cancer risk from all toxic air pollution in the greater Los Angeles metropolitan area.

Diesel emissions may also be a problem for asthmatics. Some studies suggest that children with asthma who live near roadways with high amounts of diesel truck traffic have more asthma attacks and use more asthma medication.

Some human volunteers, exposed to diesel exhaust in carefully controlled laboratory studies, reported symptoms such as eye and throat irritation, coughing, phlegm production, difficulty breathing, headache, lightheadedness, nausea and perception of unpleasant odors. Another laboratory study, in which volunteers were exposed to relatively high levels of diesel particles for about an hour, showed that such exposures could cause lung inflammation.

Thus current epidemiological and laboratory evidence suggests that at typical urban concentrations, diesel exhaust may contribute significantly to the health effects of air pollution.

What Can Be Done to Reduce the Effects of Air Pollution on Children's Health?

After reviewing the literature on how children's exposures differ from those of adults, it is evident that:

- children are outdoors more hours per day than most adults;
- they exert themselves to a greater degree while they are outside than most adults; and
- they participate in more organized activities than adults.

There are definite health benefits to having children participate in outdoor activities. However, scientific evidence also suggests that air pollution exposures can injure children's lungs and other organs.

Air quality information in the form of health reports and air quality advisories are now a regular part of life in California. One logical step is to reduce strenuous activities during pollution episodes and try to take advantage of those hours when airborne pollutant levels are lower.

At the public level there is a long-standing commitment to improve air quality. When you look at the air pollution levels in California today you can see that a great deal of progress has been made. There has been a cost for this progress. For instance, some products are more expensive. In return, the lower levels of pollutant exposure compared to 20 years ago should decrease the adverse effect of air pollution on the long-term health of our developing children.

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(Amended July 9, 1993) (Amended February 14, 1997)
(Amended December 11, 1998)(Amended April 2, 2004)
(Amended June 3, 2005)

RULE 403. FUGITIVE DUST

(a) Purpose

The purpose of this Rule is to reduce the amount of particulate matter entrained in the ambient air as a result of anthropogenic (man-made) fugitive dust sources by requiring actions to prevent, reduce or mitigate fugitive dust emissions.

(b) Applicability

The provisions of this Rule shall apply to any activity or man-made condition capable of generating fugitive dust.

(c) Definitions

- (1) ACTIVE OPERATIONS means any source capable of generating fugitive dust, including, but not limited to, earth-moving activities, construction/demolition activities, disturbed surface area, or heavy- and light-duty vehicular movement.
- (2) AGGREGATE-RELATED PLANTS are defined as facilities that produce and / or mix sand and gravel and crushed stone.
- (3) AGRICULTURAL HANDBOOK means the region-specific guidance document that has been approved by the Governing Board or hereafter approved by the Executive Officer and the U.S. EPA. For the South Coast Air Basin, the Board-approved region-specific guidance document is the Rule 403 Agricultural Handbook dated December 1998. For the Coachella Valley, the Board-approved region-specific guidance document is the Rule 403 Coachella Valley Agricultural Handbook dated April 2, 2004.
- (4) ANEMOMETERS are devices used to measure wind speed and direction in accordance with the performance standards, and maintenance and calibration criteria as contained in the most recent Rule 403 Implementation Handbook.
- (5) BEST AVAILABLE CONTROL MEASURES means fugitive dust control actions that are set forth in Table 1 of this Rule.

- (6) BULK MATERIAL is sand, gravel, soil, aggregate material less than two inches in length or diameter, and other organic or inorganic particulate matter.
- (7) CEMENT MANUFACTURING FACILITY is any facility that has a cement kiln at the facility.
- (8) CHEMICAL STABILIZERS are any non-toxic chemical dust suppressant which must not be used if prohibited for use by the Regional Water Quality Control Boards, the California Air Resources Board, the U.S. Environmental Protection Agency (U.S. EPA), or any applicable law, rule or regulation. The chemical stabilizers shall meet any specifications, criteria, or tests required by any federal, state, or local water agency. Unless otherwise indicated, the use of a non-toxic chemical stabilizer shall be of sufficient concentration and application frequency to maintain a stabilized surface.
- (9) COMMERCIAL POULTRY RANCH means any building, structure, enclosure, or premises where more than 100 fowl are kept or maintained for the primary purpose of producing eggs or meat for sale or other distribution.
- (10) CONFINED ANIMAL FACILITY means a source or group of sources of air pollution at an agricultural source for the raising of 3,360 or more fowl or 50 or more animals, including but not limited to, any structure, building, installation, farm, corral, coop, feed storage area, milking parlor, or system for the collection, storage, or distribution of solid and liquid manure; if domesticated animals, including horses, sheep, goats, swine, beef cattle, rabbits, chickens, turkeys, or ducks are corralled, penned, or otherwise caused to remain in restricted areas for commercial agricultural purposes and feeding is by means other than grazing.
- (11) CONSTRUCTION/DEMOLITION ACTIVITIES means any on-site mechanical activities conducted in preparation of, or related to, the building, alteration, rehabilitation, demolition or improvement of property, including, but not limited to the following activities: grading, excavation, loading, crushing, cutting, planing, shaping or ground breaking.
- (12) CONTRACTOR means any person who has a contractual arrangement to conduct an active operation for another person.
- (13) DAIRY FARM is an operation on a property, or set of properties that are contiguous or separated only by a public right-of-way, that raises cows or

produces milk from cows for the purpose of making a profit or for a livelihood. Heifer and calf farms are dairy farms.

- (14) **DISTURBED SURFACE AREA** means a portion of the earth's surface which has been physically moved, uncovered, destabilized, or otherwise modified from its undisturbed natural soil condition, thereby increasing the potential for emission of fugitive dust. This definition excludes those areas which have:
 - (A) been restored to a natural state, such that the vegetative ground cover and soil characteristics are similar to adjacent or nearby natural conditions;
 - (B) been paved or otherwise covered by a permanent structure; or
 - (C) sustained a vegetative ground cover of at least 70 percent of the native cover for a particular area for at least 30 days.
- (15) **DUST SUPPRESSANTS** are water, hygroscopic materials, or non-toxic chemical stabilizers used as a treatment material to reduce fugitive dust emissions.
- (16) **EARTH-MOVING ACTIVITIES** means the use of any equipment for any activity where soil is being moved or uncovered, and shall include, but not be limited to the following: grading, earth cutting and filling operations, loading or unloading of dirt or bulk materials, adding to or removing from open storage piles of bulk materials, landfill operations, weed abatement through disking, and soil mulching.
- (17) **DUST CONTROL SUPERVISOR** means a person with the authority to expeditiously employ sufficient dust mitigation measures to ensure compliance with all Rule 403 requirements at an active operation.
- (18) **FUGITIVE DUST** means any solid particulate matter that becomes airborne, other than that emitted from an exhaust stack, directly or indirectly as a result of the activities of any person.
- (19) **HIGH WIND CONDITIONS** means that instantaneous wind speeds exceed 25 miles per hour.
- (20) **INACTIVE DISTURBED SURFACE AREA** means any disturbed surface area upon which active operations have not occurred or are not expected to occur for a period of 20 consecutive days.
- (21) **LARGE OPERATIONS** means any active operations on property which contains 50 or more acres of disturbed surface area; or any earth-moving operation with a daily earth-moving or throughput volume of 3,850 cubic

meters (5,000 cubic yards) or more three times during the most recent 365-day period.

- (22) OPEN STORAGE PILE is any accumulation of bulk material, which is not fully enclosed, covered or chemically stabilized, and which attains a height of three feet or more and a total surface area of 150 or more square feet.
- (23) PARTICULATE MATTER means any material, except uncombined water, which exists in a finely divided form as a liquid or solid at standard conditions.
- (24) PAVED ROAD means a public or private improved street, highway, alley, public way, or easement that is covered by typical roadway materials, but excluding access roadways that connect a facility with a public paved roadway and are not open to through traffic. Public paved roads are those open to public access and that are owned by any federal, state, county, municipal or any other governmental or quasi-governmental agencies. Private paved roads are any paved roads not defined as public.
- (25) PM₁₀ means particulate matter with an aerodynamic diameter smaller than or equal to 10 microns as measured by the applicable State and Federal reference test methods.
- (26) PROPERTY LINE means the boundaries of an area in which either a person causing the emission or a person allowing the emission has the legal use or possession of the property. Where such property is divided into one or more sub-tenancies, the property line(s) shall refer to the boundaries dividing the areas of all sub-tenancies.
- (27) RULE 403 IMPLEMENTATION HANDBOOK means a guidance document that has been approved by the Governing Board on April 2, 2004 or hereafter approved by the Executive Officer and the U.S. EPA.
- (28) SERVICE ROADS are paved or unpaved roads that are used by one or more public agencies for inspection or maintenance of infrastructure and which are not typically used for construction-related activity.
- (29) SIMULTANEOUS SAMPLING means the operation of two PM₁₀ samplers in such a manner that one sampler is started within five minutes of the other, and each sampler is operated for a consecutive period which must be not less than 290 minutes and not more than 310 minutes.
- (30) SOUTH COAST AIR BASIN means the non-desert portions of Los Angeles, Riverside, and San Bernardino counties and all of Orange

County as defined in California Code of Regulations, Title 17, Section 60104. The area is bounded on the west by the Pacific Ocean, on the north and east by the San Gabriel, San Bernardino, and San Jacinto Mountains, and on the south by the San Diego county line.

- (31) **STABILIZED SURFACE** means any previously disturbed surface area or open storage pile which, through the application of dust suppressants, shows visual or other evidence of surface crusting and is resistant to wind-driven fugitive dust and is demonstrated to be stabilized. Stabilization can be demonstrated by one or more of the applicable test methods contained in the Rule 403 Implementation Handbook.
 - (32) **TRACK-OUT** means any bulk material that adheres to and agglomerates on the exterior surface of motor vehicles, haul trucks, and equipment (including tires) that have been released onto a paved road and can be removed by a vacuum sweeper or a broom sweeper under normal operating conditions.
 - (33) **TYPICAL ROADWAY MATERIALS** means concrete, asphaltic concrete, recycled asphalt, asphalt, or any other material of equivalent performance as determined by the Executive Officer, and the U.S. EPA.
 - (34) **UNPAVED ROADS** means any unsealed or unpaved roads, equipment paths, or travel ways that are not covered by typical roadway materials. Public unpaved roads are any unpaved roadway owned by federal, state, county, municipal or other governmental or quasi-governmental agencies. Private unpaved roads are all other unpaved roadways not defined as public.
 - (35) **VISIBLE ROADWAY DUST** means any sand, soil, dirt, or other solid particulate matter which is visible upon paved road surfaces and which can be removed by a vacuum sweeper or a broom sweeper under normal operating conditions.
 - (36) **WIND-DRIVEN FUGITIVE DUST** means visible emissions from any disturbed surface area which is generated by wind action alone.
 - (37) **WIND GUST** is the maximum instantaneous wind speed as measured by an anemometer.
- (d) **Requirements**
- (1) No person shall cause or allow the emissions of fugitive dust from any active operation, open storage pile, or disturbed surface area such that:

- (A) the dust remains visible in the atmosphere beyond the property line of the emission source; or
 - (B) the dust emission exceeds 20 percent opacity (as determined by the appropriate test method included in the Rule 403 Implementation Handbook), if the dust emission is the result of movement of a motorized vehicle.
- (2) No person shall conduct active operations without utilizing the applicable best available control measures included in Table 1 of this Rule to minimize fugitive dust emissions from each fugitive dust source type within the active operation.
- (3) No person shall cause or allow PM₁₀ levels to exceed 50 micrograms per cubic meter when determined, by simultaneous sampling, as the difference between upwind and downwind samples collected on high-volume particulate matter samplers or other U.S. EPA-approved equivalent method for PM₁₀ monitoring. If sampling is conducted, samplers shall be:
 - (A) Operated, maintained, and calibrated in accordance with 40 Code of Federal Regulations (CFR), Part 50, Appendix J, or appropriate U.S. EPA-published documents for U.S. EPA-approved equivalent method(s) for PM₁₀.
 - (B) Reasonably placed upwind and downwind of key activity areas and as close to the property line as feasible, such that other sources of fugitive dust between the sampler and the property line are minimized.
- (4) No person shall allow track-out to extend 25 feet or more in cumulative length from the point of origin from an active operation. Notwithstanding the preceding, all track-out from an active operation shall be removed at the conclusion of each workday or evening shift.
- (5) No person shall conduct an active operation with a disturbed surface area of five or more acres, or with a daily import or export of 100 cubic yards or more of bulk material without utilizing at least one of the measures listed in subparagraphs (d)(5)(A) through (d)(5)(E) at each vehicle egress from the site to a paved public road.
 - (A) Install a pad consisting of washed gravel (minimum-size: one inch) maintained in a clean condition to a depth of at least six inches and extending at least 30 feet wide and at least 50 feet long.

- (B) Pave the surface extending at least 100 feet and at least 20 feet wide.
 - (C) Utilize a wheel shaker/wheel spreading device consisting of raised dividers (rails, pipe, or grates) at least 24 feet long and 10 feet wide to remove bulk material from tires and vehicle undercarriages before vehicles exit the site.
 - (D) Install and utilize a wheel washing system to remove bulk material from tires and vehicle undercarriages before vehicles exit the site.
 - (E) Any other control measures approved by the Executive Officer and the U.S. EPA as equivalent to the actions specified in subparagraphs (d)(5)(A) through (d)(5)(D).
- (6) Beginning January 1, 2006, any person who operates or authorizes the operation of a confined animal facility subject to this Rule shall implement the applicable conservation management practices specified in Table 4 of this Rule.
- (e) Additional Requirements for Large Operations
- (1) Any person who conducts or authorizes the conducting of a large operation subject to this Rule shall implement the applicable actions specified in Table 2 of this Rule at all times and shall implement the applicable actions specified in Table 3 of this Rule when the applicable performance standards can not be met through use of Table 2 actions; and shall:
 - (A) submit a fully executed Large Operation Notification (Form 403 N) to the Executive Officer within 7 days of qualifying as a large operation;
 - (B) include, as part of the notification, the name(s), address(es), and phone number(s) of the person(s) responsible for the submittal, and a description of the operation(s), including a map depicting the location of the site;
 - (C) maintain daily records to document the specific dust control actions taken, maintain such records for a period of not less than three years; and make such records available to the Executive Officer upon request;

- (D) install and maintain project signage with project contact signage that meets the minimum standards of the Rule 403 Implementation Handbook, prior to initiating any earthmoving activities;
 - (E) identify a dust control supervisor that:
 - (i) is employed by or contracted with the property owner or developer;
 - (ii) is on the site or available on-site within 30 minutes during working hours;
 - (iii) has the authority to expeditiously employ sufficient dust mitigation measures to ensure compliance with all Rule requirements;
 - (iv) has completed the AQMD Fugitive Dust Control Class and has been issued a valid Certificate of Completion for the class; and
 - (F) notify the Executive Officer in writing within 30 days after the site no longer qualifies as a large operation as defined by paragraph (c)(18).
- (2) Any Large Operation Notification submitted to the Executive Officer or AQMD-approved dust control plan shall be valid for a period of one year from the date of written acceptance by the Executive Officer. Any Large Operation Notification accepted pursuant to paragraph (e)(1), excluding those submitted by aggregate-related plants and cement manufacturing facilities must be resubmitted annually by the person who conducts or authorizes the conducting of a large operation, at least 30 days prior to the expiration date, or the submittal shall no longer be valid as of the expiration date. If all fugitive dust sources and corresponding control measures or special circumstances remain identical to those identified in the previously accepted submittal or in an AQMD-approved dust control plan, the resubmittal may be a simple statement of no-change (Form 403NC).
- (f) **Compliance Schedule**
The newly amended provisions of this Rule shall become effective upon adoption. Pursuant to subdivision (e), any existing site that qualifies as a large operation will have 60 days from the date of Rule adoption to comply with the notification and recordkeeping requirements for large operations. Any Large Operation

Notification or AQMD-approved dust control plan which has been accepted prior to the date of adoption of these amendments shall remain in effect and the Large Operation Notification or AQMD-approved dust control plan annual resubmittal date shall be one year from adoption of this Rule amendment.

(g) Exemptions

(1) The provisions of this Rule shall not apply to:

- (A) Dairy farms.
- (B) Confined animal facilities provided that the combined disturbed surface area within one continuous property line is one acre or less.
- (C) Agricultural vegetative crop operations provided that the combined disturbed surface area within one continuous property line and not separated by a paved public road is 10 acres or less.
- (D) Agricultural vegetative crop operations within the South Coast Air Basin, whose combined disturbed surface area includes more than 10 acres provided that the person responsible for such operations:
 - (i) voluntarily implements the conservation management practices contained in the Rule 403 Agricultural Handbook;
 - (ii) completes and maintains the self-monitoring form documenting sufficient conservation management practices, as described in the Rule 403 Agricultural Handbook; and
 - (iii) makes the completed self-monitoring form available to the Executive Officer upon request.
- (E) Agricultural vegetative crop operations outside the South Coast Air Basin whose combined disturbed surface area includes more than 10 acres provided that the person responsible for such operations:
 - (i) voluntarily implements the conservation management practices contained in the Rule 403 Coachella Valley Agricultural Handbook; and
 - (ii) completes and maintains the self-monitoring form documenting sufficient conservation management practices, as described in the Rule 403 Coachella Valley Agricultural Handbook; and
 - (iii) makes the completed self-monitoring form available to the Executive Officer upon request.

- (F) Active operations conducted during emergency life-threatening situations, or in conjunction with any officially declared disaster or state of emergency.
 - (G) Active operations conducted by essential service utilities to provide electricity, natural gas, telephone, water and sewer during periods of service outages and emergency disruptions.
 - (H) Any contractor subsequent to the time the contract ends, provided that such contractor implemented the required control measures during the contractual period.
 - (I) Any grading contractor, for a phase of active operations, subsequent to the contractual completion of that phase of earth-moving activities, provided that the required control measures have been implemented during the entire phase of earth-moving activities, through and including five days after the final grading inspection.
 - (J) Weed abatement operations ordered by a county agricultural commissioner or any state, county, or municipal fire department, provided that:
 - (i) mowing, cutting or other similar process is used which maintains weed stubble at least three inches above the soil; and
 - (ii) any discing or similar operation which cuts into and disturbs the soil, where watering is used prior to initiation of these activities, and a determination is made by the agency issuing the weed abatement order that, due to fire hazard conditions, rocks, or other physical obstructions, it is not practical to meet the conditions specified in clause (g)(1)(H)(i). The provisions this clause shall not exempt the owner of any property from stabilizing, in accordance with paragraph (d)(2), disturbed surface areas which have been created as a result of the weed abatement actions.
 - (K) sandblasting operations.
- (2) The provisions of paragraphs (d)(1) and (d)(3) shall not apply:
- (A) When wind gusts exceed 25 miles per hour, provided that:

- (i) The required Table 3 contingency measures in this Rule are implemented for each applicable fugitive dust source type, and;
 - (ii) records are maintained in accordance with subparagraph (e)(1)(C).
 - (B) To unpaved roads, provided such roads:
 - (i) are used solely for the maintenance of wind-generating equipment; or
 - (ii) are unpaved public alleys as defined in Rule 1186; or
 - (iii) are service roads that meet all of the following criteria:
 - (a) are less than 50 feet in width at all points along the road;
 - (b) are within 25 feet of the property line; and
 - (c) have a traffic volume less than 20 vehicle-trips per day.
 - (C) To any active operation, open storage pile, or disturbed surface area for which necessary fugitive dust preventive or mitigative actions are in conflict with the federal Endangered Species Act, as determined in writing by the State or federal agency responsible for making such determinations.
- (3) The provisions of (d)(2) shall not apply to any aggregate-related plant or cement manufacturing facility that implements the applicable actions specified in Table 2 of this Rule at all times and shall implement the applicable actions specified in Table 3 of this Rule when the applicable performance standards of paragraphs (d)(1) and (d)(3) can not be met through use of Table 2 actions.
 - (4) The provisions of paragraphs (d)(1), (d)(2), and (d)(3) shall not apply to:
 - (A) Blasting operations which have been permitted by the California Division of Industrial Safety; and
 - (B) Motion picture, television, and video production activities when dust emissions are required for visual effects. In order to obtain this exemption, the Executive Officer must receive notification in writing at least 72 hours in advance of any such activity and no nuisance results from such activity.
 - (5) The provisions of paragraph (d)(3) shall not apply if the dust control actions, as specified in Table 2, are implemented on a routine basis for

each applicable fugitive dust source type. To qualify for this exemption, a person must maintain records in accordance with subparagraph (e)(1)(C).

- (6) The provisions of paragraph (d)(4) shall not apply to earth coverings of public paved roadways where such coverings are approved by a local government agency for the protection of the roadway, and where such coverings are used as roadway crossings for haul vehicles provided that such roadway is closed to through traffic and visible roadway dust is removed within one day following the cessation of activities.
- (7) The provisions of subdivision (e) shall not apply to:
 - (A) officially-designated public parks and recreational areas, including national parks, national monuments, national forests, state parks, state recreational areas, and county regional parks.
 - (B) any large operation which is required to submit a dust control plan to any city or county government which has adopted a District-approved dust control ordinance.
 - (C) any large operation subject to Rule 1158, which has an approved dust control plan pursuant to Rule 1158, provided that all sources of fugitive dust are included in the Rule 1158 plan.
- (8) The provisions of subparagraph (e)(1)(A) through (e)(1)(C) shall not apply to any large operation with an AQMD-approved fugitive dust control plan provided that there is no change to the sources and controls as identified in the AQMD-approved fugitive dust control plan.

(h) Fees

Any person conducting active operations for which the Executive Officer conducts upwind/downwind monitoring for PM₁₀ pursuant to paragraph (d)(3) shall be assessed applicable Ambient Air Analysis Fees pursuant to Rule 304.1. Applicable fees shall be waived for any facility which is exempted from paragraph (d)(3) or meets the requirements of paragraph (d)(3).

TABLE 1
BEST AVAILABLE CONTROL MEASURES
(Applicable to All Construction Activity Sources)

Source Category	Control Measure	Guidance
Backfilling	01-1 Stabilize backfill material when not actively handling; and 01-2 Stabilize backfill material during handling; and 01-3 Stabilize soil at completion of activity.	✓ Mix backfill soil with water prior to moving ✓ Dedicate water truck or high capacity hose to backfilling equipment ✓ Empty loader bucket slowly so that no dust plumes are generated ✓ Minimize drop height from loader bucket
Clearing and grubbing	02-1 Maintain stability of soil through pre-watering of site prior to clearing and grubbing; and 02-2 Stabilize soil during clearing and grubbing activities; and 02-3 Stabilize soil immediately after clearing and grubbing activities.	✓ Maintain live perennial vegetation where possible ✓ Apply water in sufficient quantity to prevent generation of dust plumes
Clearing forms	03-1 Use water spray to clear forms; or 03-2 Use sweeping and water spray to clear forms; or 03-3 Use vacuum system to clear forms.	✓ Use of high pressure air to clear forms may cause exceedance of Rule requirements
Crushing	04-1 Stabilize surface soils prior to operation of support equipment; and 04-2 Stabilize material after crushing.	✓ Follow permit conditions for crushing equipment ✓ Pre-water material prior to loading into crusher ✓ Monitor crusher emissions opacity ✓ Apply water to crushed material to prevent dust plumes

TABLE 1
BEST AVAILABLE CONTROL MEASURES
(Applicable to All Construction Activity Sources)

Source Category	Control Measure	Guidance
Cut and fill	05-1 Pre-water soils prior to cut and fill activities; and 05-2 Stabilize soil during and after cut and fill activities.	✓ For large sites, pre-water with sprinklers or water trucks and allow time for penetration ✓ Use water trucks/pulls to water soils to depth of cut prior to subsequent cuts
Demolition – mechanical/manual	06-1 Stabilize wind erodible surfaces to reduce dust; and 06-2 Stabilize surface soil where support equipment and vehicles will operate; and 06-3 Stabilize loose soil and demolition debris; and 06-4 Comply with AQMD Rule 1403.	✓ Apply water in sufficient quantities to prevent the generation of visible dust plumes
Disturbed soil	07-1 Stabilize disturbed soil throughout the construction site; and 07-2 Stabilize disturbed soil between structures	✓ Limit vehicular traffic and disturbances on soils where possible ✓ If interior block walls are planned, install as early as possible ✓ Apply water or a stabilizing agent in sufficient quantities to prevent the generation of visible dust plumes
Earth-moving activities	08-1 Pre-apply water to depth of proposed cuts; and 08-2 Re-apply water as necessary to maintain soils in a damp condition and to ensure that visible emissions do not exceed 100 feet in any direction; and 08-3 Stabilize soils once earth-moving activities are complete.	✓ Grade each project phase separately, timed to coincide with construction phase ✓ Upwind fencing can prevent material movement on site ✓ Apply water or a stabilizing agent in sufficient quantities to prevent the generation of visible dust plumes

TABLE 1
BEST AVAILABLE CONTROL MEASURES
(Applicable to All Construction Activity Sources)

Source Category	Control Measure	Guidance
Importing/exporting of bulk materials	09-1 Stabilize material while loading to reduce fugitive dust emissions; and 09-2 Maintain at least six inches of freeboard on haul vehicles; and 09-3 Stabilize material while transporting to reduce fugitive dust emissions; and 09-4 Stabilize material while unloading to reduce fugitive dust emissions; and 09-5 Comply with Vehicle Code Section 23114.	✓ Use tarps or other suitable enclosures on haul trucks ✓ Check belly-dump truck seals regularly and remove any trapped rocks to prevent spillage ✓ Comply with track-out prevention/mitigation requirements ✓ Provide water while loading and unloading to reduce visible dust plumes
Landscaping	10-1 Stabilize soils, materials, slopes	✓ Apply water to materials to stabilize ✓ Maintain materials in a crusted condition ✓ Maintain effective cover over materials ✓ Stabilize sloping surfaces using soil binders until vegetation or ground cover can effectively stabilize the slopes ✓ Hydroseed prior to rain season
Road shoulder maintenance	11-1 Apply water to unpaved shoulders prior to clearing; and 11-2 Apply chemical dust suppressants and/or washed gravel to maintain a stabilized surface after completing road shoulder maintenance.	✓ Installation of curbing and/or paving of road shoulders can reduce recurring maintenance costs ✓ Use of chemical dust suppressants can inhibit vegetation growth and reduce future road shoulder maintenance costs

TABLE 1
BEST AVAILABLE CONTROL MEASURES
(Applicable to All Construction Activity Sources)

Source Category	Control Measure	Guidance
Screening	12-1 Pre-water material prior to screening; and 12-2 Limit fugitive dust emissions to opacity and plume length standards; and 12-3 Stabilize material immediately after screening.	✓ Dedicate water truck or high capacity hose to screening operation ✓ Drop material through the screen slowly and minimize drop height ✓ Install wind barrier with a porosity of no more than 50% upwind of screen to the height of the drop point
Staging areas	13-1 Stabilize staging areas during use; and 13-2 Stabilize staging area soils at project completion.	✓ Limit size of staging area ✓ Limit vehicle speeds to 15 miles per hour ✓ Limit number and size of staging area entrances/exits
Stockpiles/ Bulk Material Handling	14-1 Stabilize stockpiled materials. 14-2 Stockpiles within 100 yards of off-site occupied buildings must not be greater than eight feet in height; or must have a road bladed to the top to allow water truck access or must have an operational water irrigation system that is capable of complete stockpile coverage.	✓ Add or remove material from the downwind portion of the storage pile ✓ Maintain storage piles to avoid steep sides or faces

TABLE 1
BEST AVAILABLE CONTROL MEASURES
(Applicable to All Construction Activity Sources)

Source Category	Control Measure	Guidance
Traffic areas for construction activities	15-1 Stabilize all off-road traffic and parking areas; and 15-2 Stabilize all haul routes; and 15-3 Direct construction traffic over established haul routes.	✓ Apply gravel/paving to all haul routes as soon as possible to all future roadway areas ✓ Barriers can be used to ensure vehicles are only used on established parking areas/haul routes
Trenching	16-1 Stabilize surface soils where trencher or excavator and support equipment will operate; and 16-2 Stabilize soils at the completion of trenching activities.	✓ Pre-watering of soils prior to trenching is an effective preventive measure. For deep trenching activities, pre-trench to 18 inches soak soils via the pre-trench and resuming trenching ✓ Washing mud and soils from equipment at the conclusion of trenching activities can prevent crusting and drying of soil on equipment
Truck loading	17-1 Pre-water material prior to loading; and 17-2 Ensure that freeboard exceeds six inches (CVC 23114)	✓ Empty loader bucket such that no visible dust plumes are created ✓ Ensure that the loader bucket is close to the truck to minimize drop height while loading
Turf Overseeding	18-1 Apply sufficient water immediately prior to conducting turf vacuuming activities to meet opacity and plume length standards; and 18-2 Cover haul vehicles prior to exiting the site.	✓ Haul waste material immediately off-site

TABLE 1
BEST AVAILABLE CONTROL MEASURES
(Applicable to All Construction Activity Sources)

Source Category	Control Measure	Guidance
Unpaved roads/parking lots	19-1 Stabilize soils to meet the applicable performance standards; and 19-2 Limit vehicular travel to established unpaved roads (haul routes) and unpaved parking lots.	✓ Restricting vehicular access to established unpaved travel paths and parking lots can reduce stabilization requirements
Vacant land	20-1 In instances where vacant lots are 0.10 acre or larger and have a cumulative area of 500 square feet or more that are driven over and/or used by motor vehicles and/or off-road vehicles, prevent motor vehicle and/or off-road vehicle trespassing, parking and/or access by installing barriers, curbs, fences, gates, posts, signs, shrubs, trees or other effective control measures.	

Table 2
DUST CONTROL MEASURES FOR LARGE OPERATIONS

FUGITIVE DUST SOURCE CATEGORY	CONTROL ACTIONS
Earth-moving (except construction cutting and filling areas, and mining operations)	(1a) Maintain soil moisture content at a minimum of 12 percent, as determined by ASTM method D-2216, or other equivalent method approved by the Executive Officer, the California Air Resources Board, and the U.S. EPA. Two soil moisture evaluations must be conducted during the first three hours of active operations during a calendar day, and two such evaluations each subsequent four-hour period of active operations; OR (1a-1) For any earth-moving which is more than 100 feet from all property lines, conduct watering as necessary to prevent visible dust emissions from exceeding 100 feet in length in any direction.
Earth-moving: Construction fill areas:	(1b) Maintain soil moisture content at a minimum of 12 percent, as determined by ASTM method D-2216, or other equivalent method approved by the Executive Officer, the California Air Resources Board, and the U.S. EPA. For areas which have an optimum moisture content for compaction of less than 12 percent, as determined by ASTM Method 1557 or other equivalent method approved by the Executive Officer and the California Air Resources Board and the U.S. EPA, complete the compaction process as expeditiously as possible after achieving at least 70 percent of the optimum soil moisture content. Two soil moisture evaluations must be conducted during the first three hours of active operations during a calendar day, and two such evaluations during each subsequent four-hour period of active operations.

Table 2 (Continued)

FUGITIVE DUST SOURCE CATEGORY	CONTROL ACTIONS
Earth-moving: Construction cut areas and mining operations:	(1c) Conduct watering as necessary to prevent visible emissions from extending more than 100 feet beyond the active cut or mining area unless the area is inaccessible to watering vehicles due to slope conditions or other safety factors.
Disturbed surface areas (except completed grading areas)	(2a/b) Apply dust suppression in sufficient quantity and frequency to maintain a stabilized surface. Any areas which cannot be stabilized, as evidenced by wind driven fugitive dust must have an application of water at least twice per day to at least 80 percent of the unstabilized area.
Disturbed surface areas: Completed grading areas	(2c) Apply chemical stabilizers within five working days of grading completion; OR (2d) Take actions (3a) or (3c) specified for inactive disturbed surface areas.
Inactive disturbed surface areas	(3a) Apply water to at least 80 percent of all inactive disturbed surface areas on a daily basis when there is evidence of wind driven fugitive dust, excluding any areas which are inaccessible to watering vehicles due to excessive slope or other safety conditions; OR (3b) Apply dust suppressants in sufficient quantity and frequency to maintain a stabilized surface; OR (3c) Establish a vegetative ground cover within 21 days after active operations have ceased. Ground cover must be of sufficient density to expose less than 30 percent of unstabilized ground within 90 days of planting, and at all times thereafter; OR (3d) Utilize any combination of control actions (3a), (3b), and (3c) such that, in total, these actions apply to all inactive disturbed surface areas.

Table 2 (Continued)

FUGITIVE DUST SOURCE CATEGORY	CONTROL ACTIONS
Unpaved Roads	(4a) Water all roads used for any vehicular traffic at least once per every two hours of active operations [3 times per normal 8 hour work day]; OR (4b) Water all roads used for any vehicular traffic once daily and restrict vehicle speeds to 15 miles per hour; OR (4c) Apply a chemical stabilizer to all unpaved road surfaces in sufficient quantity and frequency to maintain a stabilized surface.
Open storage piles	(5a) Apply chemical stabilizers; OR (5b) Apply water to at least 80 percent of the surface area of all open storage piles on a daily basis when there is evidence of wind driven fugitive dust; OR (5c) Install temporary coverings; OR (5d) Install a three-sided enclosure with walls with no more than 50 percent porosity which extend, at a minimum, to the top of the pile. This option may only be used at aggregate-related plants or at cement manufacturing facilities.
All Categories	(6a) Any other control measures approved by the Executive Officer and the U.S. EPA as equivalent to the methods specified in Table 2 may be used.

TABLE 3
CONTINGENCY CONTROL MEASURES FOR LARGE OPERATIONS

FUGITIVE DUST SOURCE CATEGORY	CONTROL MEASURES
Earth-moving	(1A) Cease all active operations; OR (2A) Apply water to soil not more than 15 minutes prior to moving such soil.
Disturbed surface areas	(0B) On the last day of active operations prior to a weekend, holiday, or any other period when active operations will not occur for not more than four consecutive days: apply water with a mixture of chemical stabilizer diluted to not less than 1/20 of the concentration required to maintain a stabilized surface for a period of six months; OR (1B) Apply chemical stabilizers prior to wind event; OR (2B) Apply water to all unstabilized disturbed areas 3 times per day. If there is any evidence of wind driven fugitive dust, watering frequency is increased to a minimum of four times per day; OR (3B) Take the actions specified in Table 2, Item (3c); OR (4B) Utilize any combination of control actions (1B), (2B), and (3B) such that, in total, these actions apply to all disturbed surface areas.
Unpaved roads	(1C) Apply chemical stabilizers prior to wind event; OR (2C) Apply water twice per hour during active operation; OR (3C) Stop all vehicular traffic.
Open storage piles	(1D) Apply water twice per hour; OR (2D) Install temporary coverings.
Paved road track-out	(1E) Cover all haul vehicles; OR (2E) Comply with the vehicle freeboard requirements of Section 23114 of the California Vehicle Code for both public and private roads.
All Categories	(1F) Any other control measures approved by the Executive Officer and the U.S. EPA as equivalent to the methods specified in Table 3 may be used.

Table 4
(Conservation Management Practices for Confined Animal Facilities)

SOURCE CATEGORY	CONSERVATION MANAGEMENT PRACTICES
Manure Handling (Only applicable to Commercial Poultry Ranches)	(1a) Cover manure prior to removing material off-site; AND (1b) Spread the manure before 11:00 AM and when wind conditions are less than 25 miles per hour; AND (1c) Utilize coning and drying manure management by removing manure at laying hen houses at least twice per year and maintain a base of no less than 6 inches of dry manure after clean out; or in lieu of complying with conservation management practice (1c), comply with conservation management practice (1d). (1d) Utilize frequent manure removal by removing the manure from laying hen houses at least every seven days and immediately thin bed dry the material.
Feedstock Handling	(2a) Utilize a sock or boot on the feed truck auger when filling feed storage bins.
Disturbed Surfaces	(3a) Maintain at least 70 percent vegetative cover on vacant portions of the facility; OR (3b) Utilize conservation tillage practices to manage the amount, orientation and distribution of crop and other plant residues on the soil surface year-round, while growing crops (if applicable) in narrow slots or tilled strips; OR (3c) Apply dust suppressants in sufficient concentrations and frequencies to maintain a stabilized surface.
Unpaved Roads	(4a) Restrict access to private unpaved roads either through signage or physical access restrictions and control vehicular speeds to no more than 15 miles per hour through worker notifications, signage, or any other necessary means; OR (4b) Cover frequently traveled unpaved roads with low silt content material (i.e., asphalt, concrete, recycled road base, or gravel to a minimum depth of four inches); OR (4c) Treat unpaved roads with water, mulch, chemical dust suppressants or other cover to maintain a stabilized surface.
Equipment Parking Areas	(5a) Apply dust suppressants in sufficient quantity and frequency to maintain a stabilized surface; OR (5b) Apply material with low silt content (i.e., asphalt, concrete, recycled road base, or gravel to a depth of four inches).

**Table C-1. 2006 – 2008 Thresholds for Construction and Operation with
Gradual Conversion of NO_x to NO₂**

SRA No.	Source Receptor Area	Allowable emissions (lbs/day) as a function of receptor distance (meters) from site boundary									
		1 Acre					2 Acre				
		25	50	100	200	500	25	50	100	200	500
1	Central LA	74	74	82	106	168	108	106	110	126	179
2	Northwest Coastal LA County	103	104	121	156	245	147	143	156	186	262
3	Southwest Coastal LA County	91	93	107	139	218	131	128	139	165	233
4	South Coastal LA County	57	58	68	90	142	82	80	87	106	151
5	Southeast LA County	80	81	94	123	192	114	111	121	145	205
6	West San Fernando Valley	103	104	121	157	245	147	143	156	187	263
7	East San Fernando Valley	80	81	94	122	191	114	111	121	144	204
8	West San Gabriel Valley	69	69	81	104	164	98	95	104	124	175
9	East San Gabriel Valley	89	112	159	251	489	128	151	200	284	513
10	Pomona/Walnut Valley	103	129	185	292	570	149	175	230	330	598
11	South San Gabriel Valley	83	84	96	123	193	121	118	126	147	206
12	South Central LA County	46	46	54	70	109	65	64	69	82	117
13	Santa Clarita Valley	114	115	133	173	273	163	159	172	204	291
15	San Gabriel Mountains	114	115	133	173	273	163	159	172	204	291
16	North Orange County	103	104	121	159	252	147	143	156	186	269
17	Central Orange County	81	83	98	123	192	115	114	125	148	205
18	North Coastal Orange County	92	93	108	140	219	131	128	139	165	235
19	Saddleback Valley	91	93	108	140	218	131	127	139	165	233
20	Central Orange County Coastal	92	93	108	140	219	131	128	139	165	235
21	Capistrano Valley	91	93	108	140	218	131	127	139	165	233
22	Norco/Corona	118	148	211	334	652	170	200	263	378	684
23	Metropolitan Riverside County	118	148	212	335	652	170	200	264	379	684
24	Perris Valley	118	148	212	335	652	170	200	264	379	684
25	Lake Elsinore	162	203	292	460	896	234	275	363	521	941
26	Temecula Valley	162	203	292	460	896	234	275	363	521	941
27	Anza Area	162	203	292	460	896	234	275	363	521	941
28	Hemet/San Jacinto Valley	162	203	292	460	896	234	275	363	521	941
29	Banning Airport	103	131	189	299	585	149	176	234	340	614
30	Coachella Valley	132	166	238	376	733	191	225	296	425	769
31	East Riverside County	132	166	238	376	733	191	225	296	425	769
32	Northwest San Bernardino Valley	118	148	211	334	652	170	200	263	378	684
33	Southwest San Bernardino Valley	118	148	211	334	652	170	200	263	378	684
34	Central San Bernardino Valley	118	148	211	334	652	170	200	263	378	684
35	East San Bernardino Valley	118	148	211	334	651	170	200	263	377	683
36	West San Bernardino Mountains	118	148	211	334	652	170	200	263	378	684
37	Central San Bernardino Mountains	118	148	211	334	652	170	200	263	378	684
38	East San Bernardino Mountains	118	148	211	334	651	170	200	263	377	683

**Table C-1. 2006 – 2008 Thresholds for Construction and Operation with
Gradual Conversion of NO_x to NO₂ (Continued)**

SRA No.	Source Receptor Area	Allowable emissions (lbs/day) as a function of receptor distance (meters) from site boundary				
		5 Acre				
		25	50	100	200	500
1	Central LA	161	157	165	173	212
2	Northwest Coastal LA County	221	212	226	250	312
3	Southwest Coastal LA County	197	189	202	222	277
4	South Coastal LA County	123	118	126	141	179
5	Southeast LA County	172	165	176	194	244
6	West San Fernando Valley	221	212	226	250	313
7	East San Fernando Valley	172	165	176	194	242
8	West San Gabriel Valley	148	141	151	166	208
9	East San Gabriel Valley	203	227	286	368	584
10	Pomona/Walnut Valley	236	265	330	426	681
11	South San Gabriel Valley	183	176	184	202	245
12	South Central LA County	98	94	101	111	139
13	Santa Clarita Valley	246	236	251	275	345
15	San Gabriel Mountains	246	236	251	275	345
16	North Orange County	221	212	226	249	317
17	Central Orange County	183	167	180	202	245
18	North Coastal Orange County	197	190	202	223	278
19	Saddleback Valley	197	189	201	222	278
20	Central Orange County Coastal	197	190	202	223	278
21	Capistrano Valley	197	189	201	222	278
22	Norco/Corona	270	302	378	486	778
23	Metropolitan Riverside County	270	302	378	488	780
24	Perris Valley	270	302	378	488	780
25	Lake Elsinore	371	416	520	672	1,072
26	Temecula Valley	371	416	520	672	1,072
27	Anza Area	371	416	520	672	1,072
28	Hemet/San Jacinto Valley	371	416	520	672	1,072
29	Banning Airport	236	265	333	434	698
30	Coachella Valley	304	340	425	547	875
31	East Riverside County	304	340	425	547	875
32	Northwest San Bernardino Valley	270	303	378	486	778
33	Southwest San Bernardino Valley	270	303	378	486	778
34	Central San Bernardino Valley	270	302	378	486	778
35	East San Bernardino Valley	270	302	378	486	778
36	West San Bernardino Mountains	270	303	378	486	778
37	Central San Bernardino Mountains	270	302	378	486	778
38	East San Bernardino Mountains	270	302	378	486	778

Table C-2. 2006 – 2008 CO Emission Thresholds for Construction and Operation

SRA No.	Source Receptor Area	Allowable emissions (lbs/day) as a function of receptor distance (meters) from site boundary									
		1 Acre					2 Acre				
		25	50	100	200	500	25	50	100	200	500
1	Central LA	680	882	1,259	2,406	7,911	1,048	1,368	1,799	3,016	8,637
2	Northwest Coastal LA County	562	833	1,233	2,367	7,724	827	1,213	1,695	2,961	8,446
3	Southwest Coastal LA County	664	785	1,156	2,228	7,269	967	1,158	1,597	2,783	7,950
4	South Coastal LA County	585	789	1,180	2,296	7,558	842	1,158	1,611	2,869	8,253
5	Southeast LA County	571	735	1,088	2,104	6,854	861	1,082	1,496	2,625	7,500
6	West San Fernando Valley	426	652	1,089	2,096	6,815	644	903	1,497	2,629	7,460
7	East San Fernando Valley	498	732	1,158	2,227	7,267	786	1,068	1,594	2,786	7,947
8	West San Gabriel Valley	535	783	1,158	2,229	7,270	812	1,125	1,594	2,785	7,957
9	East San Gabriel Valley	623	945	1,914	4,803	20,721	953	1,344	2,445	5,658	22,093
10	Pomona/Walnut Valley	612	911	1,741	4,345	18,991	885	1,358	2,298	5,097	20,256
11	South San Gabriel Valley	673	760	1,113	2,110	6,884	1,031	1,143	1,554	2,660	7,530
12	South Central LA County	231	342	632	1,545	5,452	346	515	841	1,817	5,962
13	Santa Clarita Valley	590	879	1,294	2,500	8,174	877	1,256	1,787	3,108	8,933
15	San Gabriel Mountains	590	879	1,294	2,500	8,174	877	1,256	1,787	3,108	8,933
16	North Orange County	522	685	1,014	1,975	6,531	762	1,010	1,395	2,444	7,121
17	Central Orange County	485	753	1,128	2,109	6,841	715	1,041	1,547	2,685	7,493
18	North Coastal Orange County	647	738	1,090	2,096	6,841	962	1,089	1,506	2,615	7,493
19	Saddleback Valley	696	833	1,234	2,376	7,724	993	1,227	1,696	2,965	8,454
20	Central Orange County Coastal	647	738	1,090	2,096	6,841	962	1,089	1,506	2,615	7,493
21	Capistrano Valley	696	833	1,234	2,376	7,724	993	1,227	1,696	2,965	8,454
22	Norco/Corona	674	999	1,853	4,352	17,637	1,007	1,474	2,461	5,183	18,934
23	Metropolitan Riverside County	602	887	1,746	4,359	17,640	883	1,262	2,232	5,136	18,947
24	Perris Valley	602	887	1,746	4,359	17,640	883	1,262	2,232	5,136	18,947
25	Lake Elsinore	750	1,105	2,176	5,501	23,866	1,100	1,572	2,781	6,399	25,412
26	Temecula Valley	750	1,105	2,176	5,501	23,866	1,100	1,572	2,781	6,399	25,412
27	Anza Area	750	1,105	2,176	5,501	23,866	1,100	1,572	2,781	6,399	25,412
28	Hemet/San Jacinto Valley	750	1,105	2,176	5,501	23,866	1,100	1,572	2,781	6,399	25,412
29	Banning Airport	1,000	1,420	2,623	6,154	25,057	1,541	2,049	3,458	7,395	26,890
30	Coachella Valley	878	1,387	2,565	6,021	24,417	1,299	1,931	3,409	7,174	26,212
31	East Riverside County	878	1,387	2,565	6,021	24,417	1,299	1,931	3,409	7,174	26,212
32	Northwest San Bernardino Valley	863	1,328	2,423	5,691	23,065	1,232	1,877	3,218	6,778	24,768
33	Southwest San Bernardino Valley	863	1,328	2,423	5,691	23,065	1,232	1,877	3,218	6,778	24,768
34	Central San Bernardino Valley	667	1,059	2,141	5,356	21,708	972	1,463	2,738	6,346	23,304
35	East San Bernardino Valley	775	1,205	2,279	5,351	21,703	1,174	1,712	3,029	6,375	23,294
36	West San Bernardino Mountains	863	1,328	2,423	5,691	23,065	1,232	1,877	3,218	6,778	24,768
37	Central San Bernardino Mountains	667	1,059	2,141	5,356	21,708	972	1,463	2,738	6,346	23,304
38	East San Bernardino Mountains	775	1,205	2,279	5,351	21,703	1,174	1,712	3,029	6,375	23,294

Table C-2. 2006 – 2008 CO Emission Thresholds for Construction and Operation (Continued)

SRA No.	Source Receptor Area	Allowable emissions (lbs/day) as a function of receptor distance (meters) from site boundary				
		5 Acre				
		25	50	100	200	500
1	Central LA	1,861	2,331	3,030	4,547	10,666
2	Northwest Coastal LA County	1,531	1,985	2,762	4,383	10,467
3	Southwest Coastal LA County	1,796	1,984	2,608	4,119	9,852
4	South Coastal LA County	1,530	1,982	2,613	4,184	10,198
5	Southeast LA County	1,480	1,855	2,437	3,867	9,312
6	West San Fernando Valley	1,158	1,537	2,438	3,871	9,271
7	East San Fernando Valley	1,434	1,872	2,599	4,119	9,848
8	West San Gabriel Valley	1,540	1,921	2,599	4,119	9,857
9	East San Gabriel Valley	1,733	2,299	3,680	7,600	25,558
10	Pomona/Walnut Valley	1,566	2,158	3,691	7,011	23,450
11	South San Gabriel Valley	1,814	1,984	2,549	4,024	9,342
12	South Central LA County	630	879	1,368	2,514	7,389
13	Santa Clarita Valley	1,644	2,095	2,922	4,608	11,049
15	San Gabriel Mountains	1,644	2,095	2,922	4,608	11,049
16	North Orange County	1,311	1,731	2,274	3,605	8,754
17	Central Orange County	1,253	1,734	2,498	4,018	9,336
18	North Coastal Orange County	1,711	1,864	2,455	3,888	9,272
19	Saddleback Valley	1,804	2,102	2,763	4,387	10,507
20	Central Orange County Coastal	1,711	1,864	2,455	3,888	9,272
21	Capistrano Valley	1,804	2,102	2,763	4,387	10,507
22	Norco/Corona	1,700	2,470	3,964	7,350	22,490
23	Metropolitan Riverside County	1,577	2,178	3,437	6,860	22,530
24	Perris Valley	1,577	2,178	3,437	6,860	22,530
25	Lake Elsinore	1,965	2,714	4,282	8,547	29,256
26	Temecula Valley	1,965	2,714	4,282	8,547	29,256
27	Anza Area	1,965	2,714	4,282	8,547	29,256
28	Hemet/San Jacinto Valley	1,965	2,714	4,282	8,547	29,256
29	Banning Airport	2,817	3,575	5,534	10,383	31,903
30	Coachella Valley	2,292	3,237	5,331	10,178	31,115
31	East Riverside County	2,292	3,237	5,331	10,178	31,115
32	Northwest San Bernardino Valley	2,193	2,978	5,188	9,611	29,410
33	Southwest San Bernardino Valley	2,193	2,978	5,188	9,611	29,410
34	Central San Bernardino Valley	1,746	2,396	4,142	8,532	27,680
35	East San Bernardino Valley	2,075	2,890	4,765	9,044	27,650
36	West San Bernardino Mountains	2,193	2,978	5,188	9,611	29,410
37	Central San Bernardino Mountains	1,746	2,396	4,142	8,532	27,680
38	East San Bernardino Mountains	2,075	2,890	4,765	9,044	27,650

Table C-3. PM10 Emission Thresholds for Operation

SRA No.	Source Receptor Area	Significance Threshold of 2.5 mg/m ³ Allowable emissions (lbs/day) as a function of receptor distance (meters) from boundary of site									
		1 Acre					2 Acre				
		25	50	100	200	500	25	50	100	200	500
1	Central LA	2	4	8	17	43	2	6	11	20	46
2	Northwest Coastal LA County	1	3	7	14	36	2	5	9	16	37
3	Southwest Coastal LA County	1	4	7	14	34	2	6	9	16	36
4	South Coastal LA County	1	3	7	15	38	2	5	9	17	40
5	Southeast LA County	1	3	8	16	42	2	5	10	18	44
6	West San Fernando Valley	1	3	7	15	38	2	5	8	16	39
7	East San Fernando Valley	1	3	7	13	33	2	5	9	15	35
8	West San Gabriel Valley	1	3	7	14	37	2	5	9	16	39
9	East San Gabriel Valley	2	4	9	19	48	2	6	11	20	50
10	Pomona/Walnut Valley	1	3	7	14	36	2	5	8	16	38
11	South San Gabriel Valley	1	4	7	15	37	2	6	9	17	39
12	South Central LA County	1	3	7	13	34	2	5	9	15	36
13	Santa Clarita Valley	1	3	6	13	32	2	5	8	15	34
15	San Gabriel Mountains	1	3	6	13	32	2	5	8	15	34
16	North Orange County	1	3	6	13	33	2	4	8	15	35
17	Central Orange County	1	3	7	15	38	2	5	9	17	40
18	North Coastal Orange County	1	4	7	13	33	2	6	9	15	35
19	Saddleback Valley	1	3	6	12	29	2	5	8	14	31
20	Central Orange County Coastal	1	4	7	13	33	2	6	9	15	35
21	Capistrano Valley	1	3	6	12	29	2	5	8	14	31
22	Norco/Corona	1	3	8	18	48	2	5	10	20	50
23	Metropolitan Riverside County	1	3	8	17	43	2	5	10	18	45
24	Perris Valley	1	3	8	17	43	2	5	10	18	45
25	Lake Elsinore	1	3	8	17	43	2	5	10	18	45
26	Temecula Valley	1	3	8	17	43	2	5	10	18	45
27	Anza Area	1	3	8	17	43	2	5	10	18	45
28	Hemet/San Jacinto Valley	1	3	8	17	43	2	5	10	18	45
29	Banning Airport	2	5	14	31	84	3	8	18	38	98
30	Coachella Valley	1	3	9	20	52	2	6	16	36	97
31	East Riverside County	1	3	9	20	52	2	6	16	36	97
32	Northwest San Bernardino Valley	2	4	11	25	68	2	5	9	16	39
33	Southwest San Bernardino Valley	2	4	11	25	68	2	5	9	16	39
34	Central San Bernardino Valley	1	3	8	18	47	2	6	10	20	50
35	East San Bernardino Valley	1	3	9	20	53	2	5	11	22	56
36	West San Bernardino Mountains	2	4	11	25	68	2	5	9	16	39
37	Central San Bernardino Mountains	1	3	8	18	47	2	6	10	20	50
38	East San Bernardino Mountains	1	3	9	20	53	2	5	11	22	56

Table C-3. PM10 Emission Thresholds for Operation (Continued)

SRA No.	Source Receptor Area	Significance Threshold of 2.5 mg/m ³ Allowable emissions (lbs/day) as a function of receptor distance (meters) from boundary of site				
		5 acres				
		25	50	100	200	500
1	Central LA	4	12	17	26	53
2	Northwest Coastal LA County	3	10	13	21	42
3	Southwest Coastal LA County	4	12	15	21	41
4	South Coastal LA County	4	10	14	22	46
5	Southeast LA County	4	10	15	23	49
6	West San Fernando Valley	3	9	13	21	44
7	East San Fernando Valley	4	11	14	21	41
8	West San Gabriel Valley	3	9	13	21	44
9	East San Gabriel Valley	4	11	16	26	55
10	Pomona/Walnut Valley	3	9	13	20	42
11	South San Gabriel Valley	4	11	15	22	45
12	South Central LA County	4	10	14	20	40
13	Santa Clarita Valley	3	10	13	19	39
15	San Gabriel Mountains	3	10	13	19	39
16	North Orange County	3	9	12	19	40
17	Central Orange County	3	10	14	22	45
18	North Coastal Orange County	4	11	14	21	41
19	Saddleback Valley	3	9	12	18	36
20	Central Orange County Coastal	4	11	14	21	41
21	Capistrano Valley	3	9	12	18	36
22	Norco/Corona	3	9	14	25	55
23	Metropolitan Riverside County	4	10	14	23	50
24	Perris Valley	4	10	14	23	50
25	Lake Elsinore	4	10	14	23	50
26	Temecula Valley	4	10	14	23	50
27	Anza Area	4	10	14	23	50
28	Hemet/San Jacinto Valley	4	10	14	23	50
29	Banning Airport	6	16	25	44	98
30	Coachella Valley	4	11	16	27	60
31	East Riverside County	4	11	16	27	60
32	Northwest San Bernardino Valley	4	12	20	34	78
33	Southwest San Bernardino Valley	4	12	20	34	78
34	Central San Bernardino Valley	4	11	16	26	55
35	East San Bernardino Valley	4	11	16	28	62
36	West San Bernardino Mountains	4	12	20	34	78
37	Central San Bernardino Mountains	4	11	16	26	55
38	East San Bernardino Mountains	4	11	16	28	62

Table C-4. PM10 Emission Thresholds for Construction

SRA No.	Source Receptor Area	Significance Threshold of 10.4 mg/m ³ Allowable emissions (lbs/day) as a function of receptor distance (meters) from boundary of site									
		1 Acre					2 Acre				
		25	50	100	200	500	25	50	100	200	500
1	Central LA	5	15	33	70	179	8	25	43	80	190
2	Northwest Coastal LA County	4	12	27	57	146	6	19	34	64	154
3	Southwest Coastal LA County	5	14	28	56	140	8	23	37	65	148
4	South Coastal LA County	4	13	29	61	158	7	21	37	70	167
5	Southeast LA County	4	13	30	66	173	7	21	39	74	182
6	West San Fernando Valley	4	11	27	59	155	6	17	33	66	162
7	East San Fernando Valley	4	13	26	54	136	7	21	34	62	144
8	West San Gabriel Valley	4	11	27	58	152	6	19	34	66	160
9	East San Gabriel Valley	5	14	34	75	199	7	22	42	84	207
10	Pomona/Walnut Valley	4	11	26	57	148	6	18	33	64	156
11	South San Gabriel Valley	5	13	29	60	153	7	22	37	68	162
12	South Central LA County	4	12	26	54	139	7	20	34	62	146
13	Santa Clarita Valley	4	12	25	51	131	6	19	32	59	139
15	San Gabriel Mountains	4	12	25	51	131	6	19	32	59	139
16	North Orange County	4	10	24	53	137	6	17	31	60	145
17	Central Orange County	4	12	28	60	158	6	19	35	68	166
18	North Coastal Orange County	4	13	27	54	135	7	21	35	62	144
19	Saddleback Valley	4	11	24	48	121	6	18	30	55	129
20	Central Orange County Coastal	4	13	27	54	135	7	21	35	62	144
21	Capistrano Valley	4	11	24	48	121	6	18	30	55	129
22	Norco/Corona	4	11	32	73	198	6	18	39	81	206
23	Metropolitan Riverside County	4	12	30	67	178	7	20	38	75	186
24	Perris Valley	4	12	30	67	178	7	20	38	75	186
25	Lake Elsinore	4	12	30	67	178	7	20	38	75	186
26	Temecula Valley	4	12	30	67	178	7	20	38	75	186
27	Anza Area	4	12	30	67	178	7	20	38	75	186
28	Hemet/San Jacinto Valley	4	12	30	67	178	7	20	38	75	186
29	Banning Airport	6	19	55	129	348	10	32	73	157	407
30	Coachella Valley	4	13	35	80	214	7	22	44	89	223
31	East Riverside County	4	13	35	80	214	7	22	44	89	223
32	Northwest San Bernardino Valley	5	14	44	103	280	6	19	34	66	160
33	Southwest San Bernardino Valley	5	14	44	103	280	6	19	34	66	160
34	Central San Bernardino Valley	4	13	33	74	196	7	22	42	83	205
35	East San Bernardino Valley	4	12	36	82	220	7	21	44	90	230
36	West San Bernardino Mountains	5	14	44	103	280	6	19	34	66	160
37	Central San Bernardino Mountains	4	13	33	74	196	7	22	42	83	205
38	East San Bernardino Mountains	4	12	36	82	220	7	21	44	90	230

Table C-4. PM10 Emission Thresholds for Construction (Continued)

SRA No.	Source Receptor Area	Significance Threshold of 10.4 mg/m ³ Allowable emissions (lbs/day) as a function of receptor distance (meters) from boundary of site				
		5 acres				
		25	50	100	200	500
1	Central LA	16	50	69	107	219
2	Northwest Coastal LA County	13	40	55	84	174
3	Southwest Coastal LA County	15	46	60	88	171
4	South Coastal LA County	14	42	58	92	191
5	Southeast LA County	14	42	60	95	203
6	West San Fernando Valley	11	35	51	84	181
7	East San Fernando Valley	14	42	56	84	167
8	West San Gabriel Valley	12	37	53	85	180
9	East San Gabriel Valley	14	43	63	105	229
10	Pomona/Walnut Valley	12	36	51	82	175
11	South San Gabriel Valley	14	43	59	91	186
12	South Central LA County	13	41	55	83	166
13	Santa Clarita Valley	12	38	52	79	161
15	San Gabriel Mountains	12	38	52	79	161
16	North Orange County	11	34	49	78	165
17	Central Orange County	13	39	55	88	188
18	North Coastal Orange County	14	44	57	85	167
19	Saddleback Valley	12	37	49	74	148
20	Central Orange County Coastal	14	44	57	85	167
21	Capistrano Valley	12	37	49	74	148
22	Norco/Corona	12	37	58	101	228
23	Metropolitan Riverside County	13	40	59	96	207
24	Perris Valley	13	40	59	96	207
25	Lake Elsinore	13	40	59	96	207
26	Temecula Valley	13	40	59	96	207
27	Anza Area	13	40	59	96	207
28	Hemet/San Jacinto Valley	13	40	59	96	207
29	Banning Airport	21	67	104	180	405
30	Coachella Valley	14	44	67	112	248
31	East Riverside County	14	44	67	112	248
32	Northwest San Bernardino Valley	16	50	80	140	322
33	Southwest San Bernardino Valley	16	50	80	140	322
34	Central San Bernardino Valley	14	44	65	106	229
35	East San Bernardino Valley	14	42	66	113	255
36	West San Bernardino Mountains	16	50	80	140	322
37	Central San Bernardino Mountains	14	44	65	106	229
38	East San Bernardino Mountains	14	42	66	113	255

Table C-5. PM2.5 Emission Thresholds for Operation

SRA No.	Source Receptor Area	Significance Threshold of 2.5 ug/m ³ Allowable emissions (lbs/day) as a function of receptor distance (meters) from boundary of site									
		1 Acre					2 Acre				
		25	50	100	200	500	25	50	100	200	500
1	Central LA	1	2	3	6	25	2	2	3	7	27
2	Northwest Coastal LA County	1	1	2	5	19	1	2	3	6	20
3	Southwest Coastal LA County	1	2	3	5	18	1	2	3	6	20
4	South Coastal LA County	1	2	3	7	23	1	2	4	8	25
5	Southeast LA County	1	1	2	5	21	1	2	3	6	22
6	West San Fernando Valley	1	1	2	5	19	1	2	2	5	21
7	East San Fernando Valley	1	1	2	5	17	1	2	3	5	18
8	West San Gabriel Valley	1	1	2	5	19	1	2	3	5	20
9	East San Gabriel Valley	1	2	3	6	23	2	2	3	7	25
10	Pomona/Walnut Valley	1	1	2	5	18	1	2	3	5	20
11	South San Gabriel Valley	1	2	3	5	20	2	2	3	6	22
12	South Central LA County	1	1	2	4	17	1	2	3	5	18
13	Santa Clarita Valley	1	1	2	5	18	1	2	2	5	20
15	San Gabriel Mountains	1	1	2	5	18	1	2	2	5	20
16	North Orange County	1	1	3	5	18	1	2	3	6	19
17	Central Orange County	1	1	2	6	21	1	2	3	6	22
18	North Coastal Orange County	1	2	3	6	19	2	2	3	7	20
19	Saddleback Valley	1	1	2	5	17	1	2	3	6	18
20	Central Orange County Coastal	1	2	3	6	19	2	2	3	7	20
21	Capistrano Valley	1	1	2	5	17	1	2	3	6	18
22	Norco/Corona	1	2	3	6	23	2	2	3	6	24
23	Metropolitan Riverside County	1	1	2	5	21	1	2	3	6	22
24	Perris Valley	1	1	2	5	21	1	2	3	6	22
25	Lake Elsinore	1	1	2	5	21	1	2	3	6	22
26	Temecula Valley	1	1	2	5	21	1	2	3	6	22
27	Anza Area	1	1	2	5	21	1	2	3	6	22
28	Hemet/San Jacinto Valley	1	1	2	5	21	1	2	3	6	22
29	Banning Airport	1	2	4	9	38	2	3	5	10	40
30	Coachella Valley	1	2	3	6	26	2	2	3	7	27
31	East Riverside County	1	2	3	6	26	2	2	3	7	27
32	Northwest San Bernardino Valley	1	2	3	8	34	2	2	4	9	36
33	Southwest San Bernardino Valley	1	2	3	8	34	2	2	4	9	36
34	Central San Bernardino Valley	1	2	3	6	24	1	2	3	7	25
35	East San Bernardino Valley	1	2	3	7	27	2	2	4	8	29
36	West San Bernardino Mountains	1	2	3	8	34	2	2	4	9	36
37	Central San Bernardino Mountains	1	2	3	6	24	1	2	3	7	25
38	East San Bernardino Mountains	1	2	3	7	27	2	2	4	8	29

Table C-5. PM2.5 Emission Thresholds for Operation (Continued)

SRA No.	Source Receptor Area	Significance Threshold of 2.5 ug/m3 Allowable emissions (lbs/day) as a function of receptor distance (meters) from boundary of site				
		5 Acre				
		25	50	100	200	500
1	Central LA	2	3	5	9	31
2	Northwest Coastal LA County	2	2	4	7	23
3	Southwest Coastal LA County	2	3	5	9	24
4	South Coastal LA County	2	3	5	10	29
5	Southeast LA County	2	3	4	8	25
6	West San Fernando Valley	2	2	3	7	23
7	East San Fernando Valley	2	3	4	7	21
8	West San Gabriel Valley	2	3	4	7	23
9	East San Gabriel Valley	2	3	5	9	28
10	Pomona/Walnut Valley	2	3	4	7	23
11	South San Gabriel Valley	2	3	5	9	25
12	South Central LA County	2	3	4	7	21
13	Santa Clarita Valley	2	2	3	7	23
15	San Gabriel Mountains	2	2	3	7	23
16	North Orange County	2	3	4	8	23
17	Central Orange County	2	3	4	8	27
18	North Coastal Orange County	2	3	5	9	25
19	Saddleback Valley	2	3	4	8	22
20	Central Orange County Coastal	2	3	5	9	25
21	Capistrano Valley	2	3	4	8	22
22	Norco/Corona	2	3	5	9	28
23	Metropolitan Riverside County	2	3	4	8	26
24	Perris Valley	2	3	4	8	26
25	Lake Elsinore	2	3	4	8	26
26	Temecula Valley	2	3	4	8	26
27	Anza Area	2	3	4	8	26
28	Hemet/San Jacinto Valley	2	3	4	8	26
29	Banning Airport	3	4	6	14	46
30	Coachella Valley	2	3	5	9	31
31	East Riverside County	2	3	5	9	31
32	Northwest San Bernardino Valley	2	3	5	11	41
33	Southwest San Bernardino Valley	2	3	5	11	41
34	Central San Bernardino Valley	2	3	5	9	29
35	East San Bernardino Valley	3	3	5	10	34
36	West San Bernardino Mountains	2	3	5	11	41
37	Central San Bernardino Mountains	2	3	5	9	29
38	East San Bernardino Mountains	3	3	5	10	34

Table C-6. PM2.5 Emission Thresholds for Construction

SRA No.	Source Receptor Area	Significance Threshold of 10.4 ug/m ³ Allowable emissions (lbs/day) as a function of receptor distance (meters) from boundary of site									
		1 Acre					2 Acre				
		25	50	100	200	500	25	50	100	200	500
1	Central LA	3	5	10	24	102	5	7	12	28	110
2	Northwest Coastal LA County	3	4	8	18	77	4	5	10	21	82
3	Southwest Coastal LA County	3	5	9	21	75	5	7	12	25	81
4	South Coastal LA County	3	5	10	26	93	5	7	13	30	101
5	Southeast LA County	3	4	8	19	86	4	6	10	22	92
6	West San Fernando Valley	3	4	7	18	79	4	5	9	21	84
7	East San Fernando Valley	3	4	8	18	68	4	6	10	21	73
8	West San Gabriel Valley	3	4	7	18	77	4	5	9	21	82
9	East San Gabriel Valley	3	5	9	22	94	5	7	12	26	100
10	Pomona/Walnut Valley	3	4	7	18	75	4	6	10	21	80
11	South San Gabriel Valley	4	5	9	20	83	5	8	12	24	89
12	South Central LA County	3	4	7	17	70	4	6	9	19	74
13	Santa Clarita Valley	3	4	7	18	74	4	5	9	20	80
15	San Gabriel Mountains	3	4	7	18	74	4	5	9	20	80
16	North Orange County	3	4	9	20	74	4	6	11	24	79
17	Central Orange County	3	4	9	22	85	4	6	11	25	92
18	North Coastal Orange County	3	5	9	22	76	5	7	12	26	83
19	Saddleback Valley	3	4	8	19	68	4	6	10	22	74
20	Central Orange County Coastal	3	5	9	22	76	5	7	12	26	83
21	Capistrano Valley	3	4	8	19	68	4	6	10	22	74
22	Norco/Corona	3	5	9	22	92	5	7	12	25	98
23	Metropolitan Riverside County	3	4	8	20	86	4	6	10	23	91
24	Perris Valley	3	4	8	20	86	4	6	10	23	91
25	Lake Elsinore	3	4	8	20	86	4	6	10	23	91
26	Temecula Valley	3	4	8	20	86	4	6	10	23	91
27	Anza Area	3	4	8	20	86	4	6	10	23	91
28	Hemet/San Jacinto Valley	3	4	8	20	86	4	6	10	23	91
29	Banning Airport	4	7	14	36	156	6	9	17	41	166
30	Coachella Valley	3	5	10	24	105	5	7	12	28	112
31	East Riverside County	3	5	10	24	105	5	7	12	28	112
32	Northwest San Bernardino Valley	4	6	12	32	141	5	8	14	36	150
33	Southwest San Bernardino Valley	4	6	12	32	141	5	8	14	36	150
34	Central San Bernardino Valley	3	5	9	23	98	4	6	12	26	104
35	East San Bernardino Valley	4	5	10	26	112	5	7	13	30	120
36	West San Bernardino Mountains	4	6	12	32	141	5	8	14	36	150
37	Central San Bernardino Mountains	3	5	9	23	98	4	6	12	26	104
38	East San Bernardino Mountains	4	5	10	26	112	5	7	13	30	120

Table C-6. PM_{2.5} Emission Thresholds for Construction (Continued)

SRA No.	Source Receptor Area	Significance Threshold of 10.4 ug/m ³ Allowable emissions (lbs/day) as a function of receptor distance (meters) from boundary of site				
		5 Acre				
		25	50	100	200	500
1	Central LA	8	11	18	36	126
2	Northwest Coastal LA County	6	8	14	29	95
3	Southwest Coastal LA County	8	11	19	35	96
4	South Coastal LA County	8	10	18	39	120
5	Southeast LA County	7	10	15	30	103
6	West San Fernando Valley	6	8	13	26	96
7	East San Fernando Valley	8	10	15	28	86
8	West San Gabriel Valley	7	9	14	27	93
9	East San Gabriel Valley	8	11	17	35	116
10	Pomona/Walnut Valley	7	9	15	28	93
11	South San Gabriel Valley	9	12	19	34	104
12	South Central LA County	7	10	15	27	86
13	Santa Clarita Valley	6	8	13	26	95
15	San Gabriel Mountains	6	8	13	26	95
16	North Orange County	6	9	15	34	95
17	Central Orange County	7	9	15	32	109
18	North Coastal Orange County	9	11	18	35	101
19	Saddleback Valley	8	11	16	30	90
20	Central Orange County Coastal	9	11	18	35	101
21	Capistrano Valley	8	11	16	30	90
22	Norco/Corona	8	11	18	34	113
23	Metropolitan Riverside County	8	10	16	31	105
24	Perris Valley	8	10	16	31	105
25	Lake Elsinore	8	10	16	31	105
26	Temecula Valley	8	10	16	31	105
27	Anza Area	8	10	16	31	105
28	Hemet/San Jacinto Valley	8	10	16	31	105
29	Banning Airport	11	14	25	55	189
30	Coachella Valley	8	11	19	37	128
31	East Riverside County	8	11	19	37	128
32	Northwest San Bernardino Valley	9	12	21	45	170
33	Southwest San Bernardino Valley	9	12	21	45	170
34	Central San Bernardino Valley	8	10	17	35	120
35	East San Bernardino Valley	9	12	20	40	140
36	West San Bernardino Mountains	9	12	21	45	170
37	Central San Bernardino Mountains	8	10	17	35	120
38	East San Bernardino Mountains	9	12	20	40	140



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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 – 99 th 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/m³ = microgram per cubic meter ≥ = greater than or equal to
MT/yr CO₂eq = metric tons per year of CO₂ equivalents > = greater than

Appendix C Air Quality Calculations

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This appendix describes the procedures used to analyze potential air quality impacts for the Lakeview Substation Project Proponent's Environmental Assessment (PEA).

1.0 ANALYSIS OVERVIEW

The following analyses of potential air quality impacts were conducted:

- Total peak daily emissions of criteria pollutants and precursors (volatile organic compounds [VOC], carbon monoxide [CO], nitrogen oxides [NOx], sulfur oxides [SOx], particulate matter smaller than 10 microns aerodynamic diameter [PM₁₀] and particulate matter smaller than 2.5 microns aerodynamic diameter [PM_{2.5}]) during construction (including construction of the Proposed Substation, distribution facilities, Subtransmission Source Lines, and telecommunication facilities, and demolition of the Nuevo and Model Pole Top substations) and operation of the Proposed Project were calculated and compared with California Environmental Quality Act (CEQA) significance thresholds for regional air quality impacts adopted by the South Coast Air Quality Management District (SCAQMD)
- On-site peak daily emissions of CO, NOx, PM₁₀ and PM_{2.5} during construction and operation of the proposed project were calculated and analyzed to evaluate potential localized impacts
- Total greenhouse gas (GHG) emissions during construction and operation of the Proposed Project were calculated to evaluate potential cumulative impacts from GHG emissions

Section 2 of this appendix describes the emission calculation procedures for the types of activities that are anticipated to generate emissions during construction and operation of the Proposed Project, Section 3 describes the calculation of peak daily emissions, Section 4 describes the calculation of total GHG emissions, and Section 5 describes the analysis of potential localized impacts. References are provided in Section 6. The associated calculations are provided in the attached tables.

2.0 EMISSION CALCULATIONS

2.1 Emission Sources

Construction and operational emissions can be distinguished as either on-site or off-site. On-site emissions principally consist of exhaust emissions (CO, VOC, NOx, SOx, PM₁₀, PM_{2.5} and GHG) from construction equipment and motor vehicles, entrained PM₁₀ and PM_{2.5} from vehicles traveling on paved and unpaved surfaces, fugitive dust (PM₁₀ and PM_{2.5}) from grading and excavation, VOC from asphaltic paving, and GHG from leakage of equipment containing sulfur hexafluoride (SF₆). Off-site emissions during the construction and operation phases consist of exhaust emissions and entrained paved and unpaved road dust from motor vehicles.

2.2 Construction Equipment Exhaust Emission Calculations

The combustion of fuel to provide power for the operation of construction equipment results in the generation of exhaust emissions. The following equation was used to calculate daily exhaust emissions from each type of construction equipment used during each construction phase for the Proposed Project:

$$E_{i,j} = EF_{i,j} \times H_j \times N_j \quad (\text{Eq. 1})$$

where:

$E_{i,j}$ = Emissions of pollutant i from equipment type j [pounds/day]

$EF_{i,j}$ = Emission factor for pollutant i from equipment type j [pounds/operating hour]

H_j = Daily operating time for equipment type j [hours/day]

N_j = Number of pieces of equipment of type j

The exhaust emission factors, $EF_{i,j}$, used for the calculations for diesel-fueled equipment are composite horsepower-based off-road emission factors for 2012, the year construction is anticipated to begin, developed for the SCAQMD by the California Air Resources Board (CARB) from its OFFROAD 2007 Model (SCAQMD, 2008a). The composite off-road emission factors were derived based on equipment type (e.g., tractor, dozer, scraper), and average equipment age and horsepower rating within horsepower ranges for the year.

The emission factors developed by CARB for the SCAQMD are listed in Table 48 in the attached tables. They include emission factors for VOC, CO, NO_x, SO_x and PM₁₀, as well as two GHGs (carbon dioxide [CO₂] and methane [CH₄]). PM_{2.5} emission factors were calculated by multiplying the PM₁₀ emission factors by the PM_{2.5} fraction of PM₁₀ in construction equipment engine exhaust (SCAQMD, 2006).

Aerial lifts and some of the forklifts to be used during construction of the Proposed Project are anticipated to be propane-fueled. Since the emission factors available from the SCAQMD are only for diesel-fueled equipment, AECOM used the CARB OFFROAD 2007 Model to calculate total daily emissions and total daily operating hours for natural gas-fueled¹ aerial lifts and forklifts during 2012 in the SCAQMD's jurisdiction. Total daily emissions by equipment horsepower range were then divided by total daily operating hours to calculate hourly emission factors. The resulting emission factors are listed in Table 48 in the attached tables.

The following equation was used to calculate total GHG emissions from each type of construction equipment during each construction phase:

¹ The OFFROAD 2007 Model does not calculate emissions from propane-fueled equipment. Therefore, emissions from natural gas-fueled equipment were used to estimate emissions from propane-fueled equipment.

$$E_{GHG,j} = (E_{CO2,j} + 21 \times E_{CH4,j}) \times D_j \times 4.536 \times 10^{-4} \quad (\text{Eq. 2})$$

where:

$E_{GHG,j}$ = Total GHG emissions from equipment type j [metric tons (1,000 kilograms) carbon dioxide equivalent]

$E_{CO2,j}$ = Daily CO₂ emissions from equipment type j [pounds/day]

21 = Global warming potential for CH₄ relative to CO₂

$E_{CH4,j}$ = Daily CH₄ emissions from equipment type j [pounds/day]

D_j = Days equipment of type j are used during the construction phase

4.536×10^{-4} = Metric tons per pound unit conversion

Table 3.5, Construction Equipment and Workforce Estimates, in Chapter 3, Project Description, of the PEA provided the types, number, daily operating hours and total operating days for construction equipment anticipated to be used during each construction phase for the Proposed Project. Horsepower ratings for the equipment were estimated from typical horsepower ratings for the types of equipment anticipated to be used. All construction equipment exhaust emissions were anticipated to occur on-site.

Daily VOC, CO, NO_x, SO_x, PM₁₀ and PM_{2.5} and total GHG construction equipment exhaust emissions calculations for each construction phase are provided in Tables 7 through 46 in the attached tables.

2.3 Motor Vehicle Exhaust Emission Calculations

The combustion of fuel in motor vehicle engines results in the generation of exhaust emissions. The following equation was used to calculate daily exhaust emissions from each type of motor vehicle used during each construction phase and during operation of the Proposed Project:

$$E_{i,j} = EF_{i,j} \times VMT_j \times N_j \quad (\text{Eq. 3})$$

where:

$E_{i,j}$ = Emissions of pollutant i from motor vehicle type j [pounds/day]

$EF_{i,j}$ = Emission factor for pollutant i from motor vehicle type j [pounds/vehicle-mile-traveled]

VMT_j = Daily vehicle-miles-traveled (VMT) by motor vehicle type j [miles/day]

N_j = Number of motor vehicles of type j

The SCAQMD (2007a) has derived motor vehicle emission factors using CARB's EMFAC 2007 (v2.3) BURDEN model. The emission factors were derived by dividing the total daily district-wide emissions by total daily vehicle-miles-traveled (VMT) to obtain

emission factors in pounds per mile traveled. Emission factors were derived for gasoline-fueled passenger/light-duty vehicles and diesel-fueled medium-/heavy-duty vehicles by taking the weighted average of vehicle types and simplifying them into two categories - passenger/light-duty and medium-/heavy-duty vehicles (e.g., delivery trucks). Emission factors were also derived for heavy heavy-duty diesel-fueled trucks, which have a vehicle weight ranging between 33,001 and 60,000 pounds.

The emission factors developed by the SCAQMD (2007a) are listed in Tables 49 and 50 in the attached tables. They include emission factors for VOC, CO, NO_x, SO_x, PM₁₀, CO₂ and CH₄. PM_{2.5} emission factors were calculated by multiplying the PM₁₀ emission factors by the PM_{2.5} fraction of PM₁₀ in motor vehicle exhaust (SCAQMD, 2006).

The following equation was used to calculate total GHG emissions from each type of vehicle during each construction phase and during operation of the Proposed Project:

$$E_{GHG,j} = (E_{CO_2,j} + 21 \times E_{CH_4,j}) \times D_j \times 4.536 \times 10^{-4} \quad (\text{Eq. 2})$$

where:

$E_{GHG,j}$ = Total GHG emissions from vehicle type j [metric tons carbon dioxide equivalent]

$E_{CO_2,j}$ = Daily CO₂ emissions from vehicle type j [pounds/day]

21 = Global warming potential for CH₄ relative to CO₂

$E_{CH_4,j}$ = Daily CH₄ emissions from vehicle type j [pounds/day]

D_j = Days vehicles of type j are used during the construction phase

4.536×10^{-4} = Metric tons per pound unit conversion

The types of vehicles, the vehicle categories used to assign emission factors, the number of vehicles used and the basis for estimating the number of vehicles during each construction phase and during operation of the Proposed Project are listed in Table C-1, Motor Vehicle Categories and Numbers. The daily on-site and off-site VMT for each type of vehicle and the basis for the VMT estimates during each construction phase and during operation of the Proposed Project are listed in Table C-2, Motor Vehicle Daily Vehicle-Miles-Traveled. Table C-2 also lists estimated VMT for travel on paved and unpaved roads and surfaces. Although exhaust emissions are independent of the type of surface, entrained fugitive particulate matter emission factors, as discussed in Section 2.4, Motor Vehicle Entrained Particulate Matter Calculations, are different for travel on paved and unpaved surfaces.

Daily motor vehicle exhaust emission calculations are provided in Tables 7 through 47 in the attached tables.

Table C-1 Motor Vehicle Categories and Numbers

Vehicle	Category ¹	Number	Basis for Number ²
Substation Survey			
Survey Truck	Passenger	2	Table 3.5
Worker Commute	Passenger	2	Table 3.5
Substation Grading			
Water Truck	HHDT	1	Table 3.5
Tool Truck	Passenger	1	Table 3.5
Pickup 4x4	Passenger	1	Table 3.5
Dump Truck	HHDT	45	Based on 40,000 CY export/import (Table 3.1) over 90 days and 10 CY/truck: $40,000 / 90 / 10 = 44.4$
Worker Commute	Passenger	15	Table 3.5
Substation Fencing			
Flatbed Truck	Delivery	1	Table 3.5
Crewcab Truck	Delivery	1	Table 3.5
Worker Commute	Passenger	4	Table 3.5
Substation Civil			
Dump Truck	HHDT	1	Based on 450 CY excavated (Table 3.1) over 60 days and 10 CY/truck: $450 / 60 / 10 = 0.8$
Water Truck	HHDT	1	Table 3.5
Tool Truck	Passenger	1	Table 3.5
Concrete Truck	HHDT	9	Based on total of 445 CY concrete poured (Table 3.1) over 5 days and 10 CY/truck: $445 / 5 / 10 = 8.9$
Worker Commute	Passenger	10	Table 3.5
Substation MEER			
Carry-all Truck	Delivery	1	Table 3.5
Stake Truck	Delivery	1	Table 3.5
Worker Commute	Passenger	4	Table 3.5
Substation Electrical			
Crew Truck	Passenger	2	Table 3.5
Worker Commute	Passenger	10	Table 3.5
Substation Wiring			
Worker Commute	Passenger	5	Table 3.5
Substation Transformers			

Vehicle	Category ¹	Number	Basis for Number ²
Crew Truck	Passenger	1	Table 3.5
Low Bed Truck	HHDT	1	Table 3.5
Worker Commute	Passenger	6	Table 3.5
Substation Maintenance Crew Equipment Check			
Maintenance Truck	Passenger	2	Table 3.5
Worker Commute	Passenger	2	Table 3.5
Substation Testing			
Crew Truck	Passenger	1	Table 3.5
Worker Commute	Passenger	2	Table 3.5
Substation Asphaltting			
Stake Truck	HHDT	1	Table 3.5
Dump Truck	HHDT	1	Table 3.5
Crew Truck	Passenger	2	Table 3.5
Asphalt Delivery Truck	HHDT	4	Based on 308 CY (Table 3.1) over 8 days and 10 CY/truck: $308 / 8 / 10 = 3.9$
Aggregate Base Delivery Truck	HHDT	6	Based on 370 CY (Table 3.1) over 7 days and 10 CY/truck: $370 / 7 / 10 = 5.3$
Worker Commute	Passenger	6	Table 3.5
Substation Landscaping			
Dump Truck	HHDT	1	Table 3.5
Crushed Rock Delivery Truck	HHDT	7	Based on 1,050 CY (Table 3.1) over 15 days and 10 CY/truck: $1,050 / 15 / 10 = 7.0$
Worker Commute	Passenger	6	Table 3.5
Substation Irrigation			
Crew Truck	Passenger	1	Table 3.5
Worker Commute	Passenger	7	Table 3.5
Distribution Civil			
Dump Truck	HHDT	4	Based on 315 CY (Table 3.1) over 9 days and 10 CY/truck: $450 / 9 / 10 = 3.5$
Delivery Truck	HHDT	1	Table 3.5
Concrete Truck	Delivery	2	Based on 100 CY (estimate) over 9 days and 10 CY/truck: $100 / 9 / 10 = 1.1$
Worker Commute	Passenger	5	Table 3.5
Distribution Electrical			
Rodder Truck	HHDT	1	Table 3.5
Reel Truck	HHDT	1	Table 3.5

Vehicle	Category¹	Number	Basis for Number²
Line Truck	Delivery	1	Table 3.5
Troubleman Truck	Delivery	1	Table 3.5
Boom Truck	HHDT	1	Table 3.5
Foreman Truck	Passenger	1	Table 3.5
Worker Commute	Passenger	8	Table 3.5
Subtransmission Survey			
1/2-Ton Pick-up Truck, 4x4	Passenger	1	Table 3.5
Worker Commute	Passenger	2	Table 3.5
Subtransmission Marshalling Yard			
1-Ton Crew Cab, 4x4	Delivery	1	Table 3.5
Truck, Semi Tractor	HHDT	1	Table 3.5
Worker Commute	Passenger	4	Table 3.5
Subtransmission Right-of-Way Clearing			
Water Truck	HHDT	4	Based on 16,000 gal/day and 4,000 gal truck: $16,000 / 4,000 = 4$
1-Ton Crew Cab, 4x4	Delivery	1	Table 3.5
Lowboy Truck/Trailer	HHDT	1	Table 3.5
Worker Commute	Passenger ⁵	5	Table 3.5
Subtransmission Roads and Landing Work			
Water Truck	HHDT	8	Based on 32,000 gal/day and 4,000 gal/truck: $32,000 / 4,000 = 8$
1-Ton Crew Cab, 4x4	Delivery	1	Table 3.5
Lowboy Truck/Trailer	HHDT	1	Table 3.5
Aggregate Base Delivery Truck	HHDT	29	Based on 4,000 CY (Section 3.2.3.2) over 14 days and 10 CY/truck: $4,000 / 14 / 10 = 28.6$
Worker Commute	Passenger	5	Table 3.5
Subtransmission Guard Structure Installation			
3/4-Ton Pick-up Truck, 4x4	Delivery	1	Table 3.5
1-Ton Crew Cab Flat Bed, 4x4	Delivery	1	Table 3.5
Extendable Flat Bed Pole Truck	HHDT	1	Table 3.5
Auger Truck	HHDT	1	Table 3.5
30-Ton Crane Truck	HHDT	1	Table 3.5
80ft. Hydraulic Manlift/Bucket Truck	HHDT	1	Table 3.5

Vehicle	Category ¹	Number	Basis for Number ²
Worker Commute	Passenger	6	Table 3.5
Subtransmission Wood Poles Removal			
1-Ton Crew Cab, 4x4	Delivery	1	Table 3.5
Flat Bed Truck/Trailer	HHDT	1	Table 3.5
30-Ton Crane Truck	HHDT	1	Table 3.5
Worker Commute	Passenger	6	Table 3.5
Subtransmission TSP Foundations Installation			
Water Truck	HHDT	1	Table 3.5
1-Ton Crew Cab Flat Bed, 4x4	Delivery	1	Table 3.5
10-CY Dump Truck	HHDT	8	Based on excavating 18' dia. x 40' deep (Table 3.2) = 74.5 CY foundation/day and 10 CY truck: $74.5 / 10 = 7.5$
10-CY Concrete Mixer Truck	HHDT	8	Based on pouring 18' dia. x 40' deep (Table 3.2) = 74.5 CY foundation/day and 10 CY truck: $74.5 / 10 = 7.5$
30-Ton Crane Truck	HHDT	1	Table 3.5
Auger Truck	HHDT	1	Table 3.5
Worker Commute	Passenger	7	Table 3.5
Subtransmission Wood Pole Installation			
3/4-Ton Pick-up Truck, 4x4	Delivery	1	Table 3.5
1-Ton Crew Cab Flat Bed, 4x4	Delivery	1	Table 3.5
Worker Commute	Passenger	8	Table 3.5
Subtransmission Steel Pole Haul			
3/4-Ton Pick-up Truck, 4x4	Delivery	1	Table 3.5
40' Flat Bed Truck/Trailer	HHDT	1	Table 3.5
Worker Commute	Passenger	4	Table 3.5
Subtransmission Steel Pole Assembly			
3/4-Ton Pick-up Truck, 4x4	Delivery	1	Table 3.5
1-Ton Crew Cab Flat Bed, 4x4	Delivery	1	Table 3.5
Worker Commute	Passenger	8	Table 3.5
Subtransmission Steel Pole Erection			
3/4-Ton Pick-up Truck, 4x4	Delivery	1	Table 3.5
1-Ton Crew Cab Flat Bed, 4x4	Delivery	1	Table 3.5

Vehicle	Category¹	Number	Basis for Number²
Worker Commute	Passenger	8	Table 3.5
Subtransmission Conductor Installation			
3/4-Ton Pick-up Truck, 4x4	Delivery	1	Table 3.5
1-Ton Crew Cab Flat Bed, 4x4	Delivery	1	Table 3.5
Wire Truck/Trailer	HHDT	1	Table 3.5
Dump Truck (Trash)	HHDT	1	Table 3.5
Bucket Truck	HHDT	1	Table 3.5
22-Ton Manitex	HHDT	1	Table 3.5
Splicing Rig	Delivery	1	Table 3.5
Splicing Lab	Delivery	1	Table 3.5
3 Drum Straw Line Puller	HHDT	1	Table 3.5
Static Truck/Tensioner	HHDT	1	Table 3.5
Worker Commute	Passenger	16	Table 3.5
Subtransmission Guard Structure Removal			
3/4-Ton Pick-up Truck, 4x4	Delivery	1	Table 3.5
1-Ton Crew Cab Flat Bed, 4x4	Delivery	1	Table 3.5
Extendable Flat Bed Pole Truck	HHDT	1	Table 3.5
30-Ton Crane Truck	HHDT	1	Table 3.5
80-Foot Hydraulic Manlift/Bucket Truck	HHDT	1	Table 3.5
Worker Commute	Passenger	6	Table 3.5
Subtransmission Restoration			
Water Truck	HHDT	1	Table 3.5
1-Ton Crew Cab, 4x4	Delivery	1	Table 3.5
Lowboy Truck/Trailer	HHDT	1	Table 3.5
Worker Commute	Passenger	7	Table 3.5
Telecommunications Control Building			
Van	Passenger	2	Table 3.5
Crew Truck	Delivery	1	Table 3.5
Worker Commute	Passenger	4	Table 3.5
Telecommunications Overhead Installation			
Bucket Truck	Delivery	2	Table 3.5
Splice Lab Truck	Delivery	1	Table 3.5

Vehicle	Category ¹	Number	Basis for Number ²
Crew Truck	Delivery	1	Table 3.5
Worker Commute	Passenger	6	Table 3.5
Telecommunications Underground Facility			
Crew Truck	Delivery	2	Table 3.5
Flatbed Truck	HHDT	1	Table 3.5
Stake Truck	HHDT	1	Table 3.5
Worker Commute	Passenger	6	Table 3.5
Telecommunications Underground Installation			
Reel Truck	HHDT	2	Table 3.5
Crew Truck	Delivery	1	Table 3.5
Splice Lab Truck	Delivery	1	Table 3.5
Worker Commute	Passenger	6	Table 3.5
Telecommunications Systems at Other Locations			
Van	Passenger	6	Table 3.5
Worker Commute	Passenger	6	Table 3.5
Nuevo Substation Demolition Civil			
Dump Truck	HHDT	2	Table 3.5
Water Truck	HHDT	1	Table 3.5
Tool Truck	Passenger	1	Table 3.5
Worker Commute	Passenger	5	Table 3.5
Nuevo Substation Demolition Electrical			
Tool Trailer	Passenger	1	Table 3.5
Crew Truck	Passenger	2	Table 3.5
Worker Commute	Passenger	5	Table 3.5
Nuevo Substation Demolition Equipment Check			
Maintenance Truck	Passenger	1	Table 3.5
Worker Commute	Passenger	2	Table 3.5
Nuevo Substation Demolition Testing			
Crew Truck	Passenger	1	Table 3.5
Worker Commute	Passenger	2	Table 3.5
Model P. T. Substation Demolition Civil			
Dump Truck	HHDT	1	Table 3.5
Flatbed Truck	HHDT	1	Table 3.5
Foreman Truck	Passenger	1	Table 3.5

Vehicle	Category ¹	Number	Basis for Number ²
Worker Commute	Passenger	5	Table 3.5
Model P. T. Substation Demolition Electrical			
Line Truck	Delivery	1	Table 3.5
Troubleman Truck	Delivery	1	Table 3.5
Boom Truck	Delivery	1	Table 3.5
Foreman Truck	Delivery	1	Table 3.5
Flatbed Truck	Delivery	1	Table 3.5
Pumper/Tanker Truck	Delivery	1	Table 3.5
Worker Commute	Passenger	5	Table 3.5
Operations			
Subtransmission Line Inspection	Passenger	1	Section 3.12
Substation Site Visit	Passenger	1	Section 3.12

Notes:

CY = cubic yards; dia = diameter; gal = gallons; MEER = Mechanical and Electrical Equipment Room; TSP = Tubular Steel Poles; ' = feet

¹ Category is used to assign emission factors. 'Passenger' is passenger vehicles in Table 49 in the attached tables, and is used for all gasoline-fueled vehicles. 'Delivery' is delivery vehicles in Table 49 in the attached tables, and is used for diesel-fueled vehicles except for heavy, heavy-duty diesel-fueled trucks (HHDT). 'HHDT' is heavy, heavy-duty diesel-fueled trucks in Table 50 in attached tables.

² Table and section numbers refer to tables and sections in PEA Chapter 3, Project Description.

Table C-2 Motor Vehicle Daily Vehicle-Miles-Traveled

Vehicle	On-Site Daily VMT (mi) ¹	Off-Site Daily VMT (mi)			Notes
		P ²	U ²	T ²	
Substation Survey					
Survey Truck	1	60	0	60	Survey company assumed to be within 30 mi. of substation
Worker Commute	0	60	0	60	Workers assumed to be located within 30 mi.
Substation Grading					
Water Truck	2	10	0	10	Water supply within 5 mi.
Tool Truck	1	14	0	14	Travel from Meniffee Service Center
Pickup 4x4	1	14	0	14	Travel from Meniffee Service Center
Dump Truck	0.2	60	0	60	Borrow/disposal sites within 30 mi.
Worker Commute	0	60	0	60	Workers assumed to be located within 30 mi.

Vehicle	On-Site Daily VMT (mi) ¹	Off-Site Daily VMT (mi)			Notes
		P ²	U ²	T ²	
Substation Fencing					
Flatbed Truck	2	14	0	14	Travel from Menifee Service Center
Crewcab Truck	1	14	0	14	Travel from Menifee Service Center
Worker Commute	0	60	0	60	Workers assumed to be located within 30 mi.
Substation Civil					
Dump Truck	1	0	0	0	Dump truck stays on-site
Water Truck	1	10	0	10	Water supply assumed to be within 5 mi. of substation
Tool Truck	1	14	0	14	Travel from Menifee Service Center
Concrete Truck	0.1	60	0	60	Concrete supplier within 30 mi.
Worker Commute	0	60	0	60	Workers assumed to be located within 30 mi.
Substation MEER					
Carry-all Truck	1	14	0	14	Travel from Menifee Service Center
Stake Truck	1	14	0	14	Travel from Menifee Service Center
Worker Commute	0	60	0	60	Workers assumed to be located within 30 mi.
Substation Electrical					
Crew Truck	1	14	0	14	Travel from Menifee Service Center
Worker Commute	0	60	0	60	Workers assumed to be located within 30 mi.
Substation Wiring					
Worker Commute	0	60	0	60	Workers assumed to be located within 30 mi.
Substation Transformers					
Crew Truck	1	14	0	14	Travel from Menifee Service Center
Low Bed Truck	1	0	0	0	Low bed truck stays on-site
Worker Commute	0	60	0	60	Workers assumed to be located within 30 mi.
Substation Maintenance Crew Equipment Check					
Maintenance Truck	0.5	14	0	14	Travel from Menifee Service Center
Worker Commute	0	60	0	60	Workers assumed to be located within 30 mi.
Substation Testing					
Crew Truck	0.5	14	0	14	Travel from Menifee Service Center
Worker Commute	0	60	0	60	Workers assumed to be located within 30 mi.
Substation Asphalting					

Vehicle	On-Site Daily VMT (mi) ¹	Off-Site Daily VMT (mi)			Notes
		P ²	U ²	T ²	
Stake Truck	1	0	0	0	Stake truck stays on-site
Dump Truck	1	0	0	0	Dump truck stays on-site
Crew Truck	2	14	0	14	Travel from Menifee Service Center
Asphalt Delivery Truck	0.1	60	0	60	Asphalt supplier within 30 mi.
Aggregate Base Delivery Truck	0.1	60	0	60	Aggregate supply within 30 mi.
Worker Commute	0	60	0	60	Workers assumed to be located within 30 mi.
Substation Landscaping					
Dump Truck	1	0	0	0	Dump truck stays on-site
Crushed Rock Delivery Truck	0.1	60	0	60	Crushed rock supply within 30 mi.
Worker Commute	0	60	0	60	Workers assumed to be located within 30 mi.
Substation Irrigation					
Crew Truck	0.5	14	0	14	Travel from Menifee Service Center
Worker Commute	0	60	0	60	Workers assumed to be located within 30 mi.
Distribution Civil					
Dump Truck	0	60	0	60	Disposal site within 30 mi.
Delivery Truck	0	60	0	60	Equipment supplier within 30 mi.
Concrete Truck	0	60	0	60	Concrete supplier within 30 mi.
Worker Commute	0	60	0	60	Workers assumed to be located within 30 mi.
Distribution Electrical					
Rodder Truck	0	14	0	14	Travel from Menifee Service Center
Reel Truck	0	14	0	14	Travel from Menifee Service Center
Line Truck	0	14	0	14	Travel from Menifee Service Center
Troubleman Truck	0	14	0	14	Travel from Menifee Service Center
Boom Truck	0	14	0	14	Travel from Menifee Service Center
Foreman Truck	0	14	0	14	Travel from Menifee Service Center
Worker Commute	0	60	0	60	Workers assumed to be located within 30 mi.
Subtransmission Survey					
1/2-Ton Pick-up Truck, 4x4	0	14	4	18	Travel from Menifee Service Center (paved); roundtrip along Subtransmission Source Line ROW (unpaved)

Vehicle	On-Site Daily VMT (mi) ¹	Off-Site Daily VMT (mi)			Notes
		P ²	U ²	T ²	
Worker Commute	0	60	0	0	Workers assumed to be located within 30 mi.
Subtransmission Marshalling Yard					
1-Ton Crew Cab, 4x4	5	0	0	0	Traveling on-site 25% of 2 hr/day at 10 mph
Truck, Semi Tractor	2.5	0	0	0	Traveling on-site 25% of 1 hr/day at 10 mph
Worker Commute	0	60	0	60	Workers assumed to be located within 30 mi.
Subtransmission Right-of-Way Clearing					
Water Truck	1	10	3	13	Water supply within 5 mi. of Subtransmission Source Line Route (paved); roundtrip along 1.5 mi. of Subtransmission Source Line Route (unpaved)
1-Ton Crew Cab, 4x4	0	14	4	18	Travel from Menifee Service Center (paved); roundtrip along Subtransmission Source Line ROW (unpaved)
Lowboy Truck/Trailer	0	14	4	18	Travel from Menifee Service Center (paved); roundtrip along Subtransmission Source Line ROW (unpaved)
Worker Commute	0	60	0	60	Workers assumed to be located within 30 mi.
Subtransmission Roads and Landing Work					
Water Truck	1	10	3	13	Water supply within 5 mi. of Subtransmission Source Line Route (paved); roundtrip along 1.5 mi. of Subtransmission Source Line Route (unpaved)
1-Ton Crew Cab, 4x4	0	14	4	18	Travel from Menifee Service Center (paved); roundtrip along Subtransmission Source Line ROW (unpaved)
Lowboy Truck/Trailer	0	14	4	18	Travel from Menifee Service Center (paved); roundtrip along Subtransmission Source Line ROW (unpaved)
Aggregate Base Delivery Truck	0	60	4	64	Aggregate supply within 30 mi. of Subtransmission Source Line Route (paved); roundtrip along Subtransmission Source Line Route (unpaved)
Worker Commute	0	60	0	60	Workers assumed to be located within 30 mi.
Subtransmission Guard Structure Installation					
3/4-Ton Pick-up Truck, 4x4	0	14	4	18	Travel from Menifee Service Center (paved); roundtrip along Subtransmission Source Line ROW (unpaved)

Vehicle	On-Site Daily VMT (mi) ¹	Off-Site Daily VMT (mi)			Notes
		P ²	U ²	T ²	
1-Ton Crew Cab Flat Bed, 4x4	0	14	4	18	Travel from Menifee Service Center (paved); roundtrip along Subtransmission Source Line ROW (unpaved)
Extendable Flat Bed Pole Truck	0	14	4	18	Travel from Menifee Service Center (paved); roundtrip along Subtransmission Source Line ROW (unpaved)
Auger Truck	0	14	4	18	Travel from Menifee Service Center (paved); roundtrip along Subtransmission Source Line ROW (unpaved)
30-Ton Crane Truck	0	14	4	18	Travel from Menifee Service Center (paved); roundtrip along Subtransmission Source Line ROW (unpaved)
80-Foot Hydraulic Manlift/Bucket Truck	0	14	4	18	Travel from Menifee Service Center (paved); roundtrip along Subtransmission Source Line ROW (unpaved)
Worker Commute	0	60	0	60	Workers assumed to be located within 30 mi.
Subtransmission Wood Poles Removal					
1-Ton Crew Cab, 4x4	0	14	4	18	Travel from Menifee Service Center (paved); roundtrip along Subtransmission Source Line ROW (unpaved)
Flat Bed Truck/Trailer	0	14	4	18	Travel from Menifee Service Center (paved); roundtrip along Subtransmission Source Line ROW (unpaved)
30-Ton Crane Truck	0	14	4	18	Travel from Menifee Service Center (paved); roundtrip along Subtransmission Source Line ROW (unpaved)
Worker Commute	0	60	0	60	Workers assumed to be located within 30 mi.
Subtransmission TSP Foundations Installation					
Water Truck	0	10	4	14	Travel from Menifee Service Center (paved); roundtrip along Subtransmission Source Line ROW (unpaved)
1-Ton Crew Cab Flat Bed, 4x4	0	14	4	18	Travel from Menifee Service Center (paved); roundtrip along Subtransmission Source Line ROW (unpaved)
10-cu. yd. Dump Truck	0	60	4	64	Disposal site within 30 mi. of Subtransmission Source Line Route (paved); roundtrip along Subtransmission Source Line Route (unpaved)
10-cu. yd. Concrete Mixer Truck	0	60	4	64	Concrete supply within 30 mi. of Subtransmission Source Line Route (paved); roundtrip along Subtransmission Source Line Route (unpaved)

Vehicle	On-Site Daily VMT (mi) ¹	Off-Site Daily VMT (mi)			Notes
		P ²	U ²	T ²	
30-Ton Crane Truck	0	14	4	18	Travel from Menifee Service Center (paved); roundtrip along Subtransmission Source Line ROW (unpaved)
Auger Truck	0	14	4	18	Travel from Menifee Service Center (paved); roundtrip along Subtransmission Source Line ROW (unpaved)
Worker Commute	0	60	0	60	Workers assumed to be located within 30 mi.
Subtransmission Wood Pole Installation					
3/4-Ton Pick-up Truck, 4x4	0	14	4	18	Travel from Menifee Service Center (paved); roundtrip along Subtransmission Source Line ROW (unpaved)
1-Ton Crew Cab Flat Bed, 4x4	0	14	4	18	Travel from Menifee Service Center (paved); roundtrip along Subtransmission Source Line ROW (unpaved)
Worker Commute	0	60	0	60	Workers assumed to be located within 30 mi.
Subtransmission Steel Pole Haul					
3/4-Ton Pick-up Truck, 4x4	0	14	4	18	Travel from Menifee Service Center (paved); roundtrip along Subtransmission Source Line ROW (unpaved)
40' Flat Bed Truck/Trailer	0	14	4	18	Travel from Menifee Service Center (paved); roundtrip along Subtransmission Source Line ROW (unpaved)
Worker Commute	0	60	0	60	Workers assumed to be located within 30 mi.
Subtransmission Steel Pole Assembly					
3/4-Ton Pick-up Truck, 4x4	0	14	4	18	Travel from Menifee Service Center (paved); roundtrip along Subtransmission Source Line ROW (unpaved)
1-Ton Crew Cab Flat Bed, 4x4	0	14	4	18	Travel from Menifee Service Center (paved); roundtrip along Subtransmission Source Line ROW (unpaved)
Worker Commute	0	60	0	60	Workers assumed to be located within 30 mi.
Subtransmission Steel Pole Erection					
3/4-Ton Pick-up Truck, 4x4	0	14	4	18	Travel from Menifee Service Center (paved); roundtrip along Subtransmission Source Line ROW (unpaved)
1-Ton Crew Cab Flat Bed, 4x4	0	14	4	18	Travel from Menifee Service Center (paved); roundtrip along Subtransmission Source Line ROW (unpaved)

Vehicle	On-Site Daily VMT (mi) ¹	Off-Site Daily VMT (mi)			Notes
		P ²	U ²	T ²	
Worker Commute	0	60	0	60	Workers assumed to be located within 30 mi.
Subtransmission Conductor Installation					
3/4-Ton Pick-up Truck, 4x4	0	14	4	18	Travel from Meniffee Service Center (paved); roundtrip along Subtransmission Source Line ROW (unpaved)
1-Ton Crew Cab Flat Bed, 4x4	0	14	4	18	Travel from Meniffee Service Center (paved); roundtrip along Subtransmission Source Line ROW (unpaved)
Wire Truck/Trailer	0	14	4	18	Travel from Meniffee Service Center (paved); roundtrip along Subtransmission Source Line ROW (unpaved)
Dump Truck (Trash)	0	60	4	64	Disposal site within 30 mi. of Subtransmission Source Line Route (paved); roundtrip along Subtransmission Source Line Route (unpaved)
Bucket Truck	0	14	4	18	Travel from Meniffee Service Center (paved); roundtrip along Subtransmission Source Line ROW (unpaved)
22-Ton Manitex	0	14	4	18	Travel from Meniffee Service Center (paved); roundtrip along Subtransmission Source Line ROW (unpaved)
Splicing Rig	0	14	4	18	Travel from Meniffee Service Center (paved); roundtrip along Subtransmission Source Line ROW (unpaved)
Splicing Lab	0	14	4	18	Travel from Meniffee Service Center (paved); roundtrip along Subtransmission Source Line ROW (unpaved)
3 Drum Straw Line Puller	0	14	4	18	Travel from Meniffee Service Center (paved); roundtrip along Subtransmission Source Line ROW (unpaved)
Static Truck/Tensioner	0	14	4	18	Travel from Meniffee Service Center (paved); roundtrip along Subtransmission Source Line ROW (unpaved)
Worker Commute	0	60	0	60	Workers assumed to be located within 30 mi.
Subtransmission Guard Structure Removal					
3/4-Ton Pick-up Truck, 4x4	0	14	4	18	Travel from Meniffee Service Center (paved); roundtrip along Subtransmission Source Line ROW (unpaved)
1-Ton Crew Cab Flat Bed, 4x4	0	14	4	18	Travel from Meniffee Service Center (paved); roundtrip along Subtransmission Source Line ROW (unpaved)

Vehicle	On-Site Daily VMT (mi) ¹	Off-Site Daily VMT (mi)			Notes
		P ²	U ²	T ²	
Extendable Flat Bed Pole Truck	0	14	4	18	Travel from Menifee Service Center (paved); roundtrip along Subtransmission Source Line ROW (unpaved)
30-Ton Crane Truck	0	14	4	18	Travel from Menifee Service Center (paved); roundtrip along Subtransmission Source Line ROW (unpaved)
80-Foot Hydraulic Manlift/Bucket Truck	0	14	4	18	Travel from Menifee Service Center (paved); roundtrip along Subtransmission Source Line ROW (unpaved)
Worker Commute	0	60	0	60	Workers assumed to be located within 30 mi.
Subtransmission Restoration					
Water Truck	3	10	3	13	Travel from Menifee Service Center (paved); 1.5 mi. roundtrip along Subtransmission Source Line ROW (unpaved)
1-Ton Crew Cab, 4x4	3	14	4	18	Travel from Menifee Service Center (paved); roundtrip along Subtransmission Source Line ROW (unpaved)
Lowboy Truck/Trailer	0	14	4	18	Travel from Menifee Service Center (paved); roundtrip along Subtransmission Source Line ROW (unpaved)
Worker Commute	0	60	0	60	Workers assumed to be located within 30 mi.
Telecommunications Control Building					
Van	0	14	0	14	Travel from Menifee Service Center
Crew Truck	0	14	0	14	Travel from Menifee Service Center
Worker Commute	0	60	0	60	Workers assumed to be located within 30 mi.
Telecommunications Overhead Installation					
Bucket Truck	0	0	21	21	Roundtrip along Subtransmission Source Line ROW (4 mi.) plus travel along ROW from new Subtransmission Source Line ROW to Moval Substation (17 mi.)
Splice Lab Truck	0	0	21	21	Roundtrip along Subtransmission Source Line ROW (4 mi.) plus travel along ROW from new Subtransmission Source Line ROW to Moval Substation (17 mi.)
Crew Truck	0	0	21	21	Roundtrip along Subtransmission Source Line ROW (4 mi.) plus travel along ROW from new Subtransmission Source Line ROW to Moval Substation (17 mi.)

Vehicle	On-Site Daily VMT (mi) ¹	Off-Site Daily VMT (mi)			Notes
		P ²	U ²	T ²	
Worker Commute	0	60	0	60	Workers assumed to be located within 30 mi.
Telecommunications Underground Facility					
Crew Truck	0	1	0	1	Worksite within 0.5 mi. from nearest substation
Flatbed Truck	0	1	0	1	Worksite within 0.5 mi. from nearest substation
Stake Truck	0	1	0	1	Worksite within 0.5 mi. from nearest substation
Worker Commute	0	60	0	60	Workers assumed to be located within 30 mi.
Telecommunications Underground Installation					
Reel Truck	0	1	0	1	Worksite within 0.5 mi. from nearest substation
Crew Truck	0	1	0	1	Worksite within 0.5 mi. from nearest substation
Splice Lab Truck	0	1	0	1	Worksite within 0.5 mi. from nearest substation
Worker Commute	0	60	0	60	Workers assumed to be located within 30 mi.
Telecommunications Systems at Other Locations					
Van	0	60	0	60	Other substations assumed within 30 mi.
Worker Commute	0	60	0	60	Workers assumed to be located within 30 mi.
Nuevo Substation Demolition Civil					
Dump Truck	1	60	0	60	Disposal site within 30 mi.
Water Truck	1	10	0	10	Water supply within 5 mi.
Tool Truck	1	0	0	0	Tool truck stays on-site
Worker Commute	0	60	0	60	Workers assumed to be located within 30 mi.
Nuevo Substation Demolition Electrical					
Tool Trailer	1	0	0	0	Tool trailer stays on-site
Crew Truck	1	12	0	12	Travel from Meniffee Service Center
Worker Commute	0	60	0	60	Workers assumed to be located within 30 mi.
Nuevo Substation Demolition Equipment Check					
Maintenance Truck	0.5	12	0	12	Travel from Meniffee Service Center
Worker Commute	0	60	0	60	Workers assumed to be located within 30 mi.
Nuevo Substation Demolition Testing					
Crew Truck	0.5	12	0	12	Travel from Meniffee Service Center
Worker Commute	0	60	0	60	Workers assumed to be located within 30 mi.
Model P. T. Substation Demolition Civil					
Dump Truck	1	60	0	60	Disposal site within 30 mi.

Vehicle	On-Site Daily VMT (mi) ¹	Off-Site Daily VMT (mi)			Notes
		P ²	U ²	T ²	
Flatbed Truck	1	12	0	12	Travel from Menifee Service Center
Foreman Truck	1	12	0	12	Travel from Menifee Service Center
Worker Commute	0	60	0	60	Workers assumed to be located within 30 mi.
Model P. T. Substation Demolition Electrical					
Line Truck	0.5	12	0	12	Travel from Menifee Service Center
Troubleman Truck	0.5	12	0	12	Travel from Menifee Service Center
Boom Truck	0.5	12	0	12	Travel from Menifee Service Center
Foreman Truck	0.5	12	0	12	Travel from Menifee Service Center
Flatbed Truck	0.5	12	0	12	Travel from Menifee Service Center
Pumper/Tanker Truck	0.5	12	0	12	Travel from Menifee Service Center
Worker Commute	0	60	0	60	Workers assumed to be located within 30 mi.
Operations					
Subtransmission Line Inspection	0	60	7	67	Trip origin within 30 mi.; roundtrip along entire Subtransmission Source Line Route (unpaved)
Substation Site Visit	0	60	0	60	Trip origin within 30 mi.

Notes:

CY = cubic yards; hr/day = hours per day; MEER = Mechanical and Electrical Equipment Room; mi = miles; mph = miles per hour; ROW = rights-of-way; TSP = Tubular Steel Poles; ' = feet

¹ On-site travel estimated from site dimensions. All on-site travel is unpaved, except for marshalling yard and Nuevo and Model Pole Top substations.

² P = off-site paved road/surface VMT; U = off-site unpaved road/surface VMT; T = total off-site VMT

2.4 Motor Vehicle Entrained Particulate Matter Emission Calculations

Motor vehicles entrain particulate matter from the surfaces on which they travel. The following equation was used to calculate daily entrained particulate matter emissions from each type of motor vehicle used during each construction phase and during operation for the Proposed Project:

$$E_{i,j,k} = EF_{i,j,k} \times VMT_{j,k} \times N_j \text{ (Eq. 4)}$$

where:

$E_{i,j,k}$ = Emissions of pollutant i (PM₁₀ or PM_{2.5}) from motor vehicle type j traveling on surface type k (paved or unpaved) [pounds/day]

$EF_{i,j,k}$ = Emission factor for pollutant i from motor vehicle type j on surface type k [pounds/VMT]

$VM_{T,j,k}$ = Daily VMT by motor vehicle type j on surface type k [miles/day]

N_j = Number of motor vehicles of type j

The following equation (EPA, 2006a) was used to calculate the emission factors for motor vehicles traveling on paved roads and surfaces:

$$EF_{i,j,P} = k_{i,p} \times (sL / 2)^{0.65} \times (W_j/3)^{1.5} - C \quad (\text{Eq. 5})$$

where:

$EF_{i,j,P}$ = Emission factor for pollutant i (PM_{10} or $PM_{2.5}$) from motor vehicle type j traveling on paved surfaces [pounds/VMT]

$k_{i,P}$ = Particle size multiplier for pollutant i

= 0.016 for PM_{10}

= 0.0024 for $PM_{2.5}$

sL = Surface silt loading [grams/square meter]

W_j = Average weight of vehicles traveling on the paved surface [tons]

C = Exhaust, brake wear and tire wear adjustment [pounds/VMT]

= 0.0047 for PM_{10}

= 0.00036 for $PM_{2.5}$

The paved road silt loading of 0.035 grams/square meter and the average on-road vehicle weight of 3.2 tons in Riverside County from CARB (1997) were used for the calculations.

The following equation (EPA, 2006b) was used to calculate the emission factors for motor vehicles traveling on unpaved roads and surfaces:

$$EF_{i,j,U} = k_{i,u} \times (s / 12)^{0.9} \times (W_j/3)^{0.45} \times (1 - CE_U / 100) \quad (\text{Eq. 6})$$

where:

$EF_{i,j,U}$ = Emission factor for pollutant i (PM_{10} or $PM_{2.5}$) from motor vehicle type j traveling on unpaved surfaces [pounds/VMT]

$k_{i,u}$ = Particle size multiplier for pollutant i

= 1.5 for PM_{10}

= 0.15 for $PM_{2.5}$

s = Silt content of the unpaved surface [percent by weight]

W_j = Average weight of vehicles traveling on the unpaved surface [tons]

CE_U = Control efficiency for entrained particulate matter emissions from unpaved surfaces [percent]

The unpaved road silt content of 7.5 percent for overburden from the SCAQMD CEQA Handbook, (SCAQMD, 1993), Table A9-9-E-1, was used. Vehicle weights were estimated from the type of vehicle. The control efficiency of 57 percent from limiting speeds on unpaved roads to 15 miles per hour (mph) (SCAQMD, 2007b) was used for the calculations.

Entrained particulate matter emission factors by type of vehicle and surface are provided in Table 51 in the attached tables. Estimated daily VMT on paved and unpaved surfaces by type of vehicle during each construction phase and during operation of the Proposed Project are listed in Table C-2, Motor Vehicle Daily Vehicle-Miles-Traveled.

Motor vehicle entrained particulate matter emission calculations are provided in Tables 7 through 47 in the attached tables.

2.5 Earthwork Fugitive Particulate Matter Emission Calculations

Handling soil during excavation and grading generates fugitive particulate matter from soil dropping during transfers, wind erosion of temporary storage piles, and bulldozing, scraping and grading.

The following equation was used to calculate daily emissions from soil dropping during construction of the Proposed Project:

$$E_i = EF_i \times V_s \quad (\text{Eq. 7})$$

where:

E_i = Emissions of pollutant i (PM_{10} or $PM_{2.5}$) from soil dropping [pounds/day]

EF_i = Emission factor for pollutant i from soil dropping [pounds/cubic yard]

V_s = Volume of soil dropped [cubic yards/day]

The following equation (EPA, 2006c) was used to calculate the emission factor for fugitive particulate matter emissions from soil dropping:

$$EF_i = f_i \times 0.011 \times (WS / 5)^{1.3} / (M / 2)^{1.4} \times N_s \times D_s \quad (\text{Eq. 8})$$

where:

EF_i = Emission factor for fugitive particulate matter emissions from soil dropping

f_i = Mass fraction of pollutant i (PM_{10} or $PM_{2.5}$) in PM_{10} emissions from soil dropping

= 1 for PM_{10}

= 0.208 for $PM_{2.5}$ from SCAQMD (2006)

WS = Mean wind speed [miles/hour]

= 12 miles/hour from SCAQMD CEQA Air Quality Handbook (1993), Table 9-9-G

M = Soil moisture content [percent by weight]

= 10.6 percent average of near-surface soil samples from Proposed Substation Site preliminary geotechnical investigation

N_s = Number of times each cubic yard is dropped [number/day]

= 4 (assumption)

D_s = Soil density [tons/cubic yard]

= 1.47 tons/cubic yard average of near-surface soil samples from Proposed Substation Site preliminary geotechnical investigation

The following equation was used to calculate daily emissions from storage pile wind erosion during construction of the Proposed Project:

$$E_i = EF_i \times A_s \quad (\text{Eq. 9})$$

where:

E_i = Emissions of pollutant i (PM_{10} or $PM_{2.5}$) from storage pile wind erosion [pounds/day]

EF_i = Emission factor for pollutant i from storage pile wind erosion [pounds/acre-day]

A_s = Exposed storage pile surface area [acres]

The following equation from the SCAQMD CEQA Air Quality Handbook (SCAQMD, 1993), Table 9-9-E, was used to calculate the emission factor for fugitive particulate matter emissions from storage pile wind erosion:

$$EF_i = f_i \times 0.85 \times (s / 1.5) \times (365 / 235) \times (P_w / 15) \times (1 - CE / 100) \quad (\text{Eq. 10})$$

where:

EF_i = Emission factor for fugitive particulate matter emissions from storage pile wind erosion

- f_i = Mass fraction of pollutant i (PM_{10} or $PM_{2.5}$) in PM_{10} emissions from storage pile wind erosion
- = 1 for PM_{10}
- = 0.208 for $PM_{2.5}$ from SCAQMD (2006)
- s = Storage pile silt content [weight percent]
- = 26.7 percent average of near-surface soil samples from Proposed Substation Site preliminary geotechnical investigation
- P_w = Percent of time unobstructed wind speed exceeds 12 miles/hour
- = 100 percent (conservative assumption)
- CE = Control efficiency [percent]
- = 90 percent from watering storage pile by hand at a rate of 1.4 gallons/hour-square yard (SCAQMD, 2007b)

The following equation was used to calculate daily emissions from bulldozing, scraping and grading during construction of the Proposed Project:

$$E_i = EF_i \times H_G \quad (\text{Eq. 11})$$

where:

- E_i = Emissions of pollutant i (PM_{10} or $PM_{2.5}$) from bulldozing, scraping and grading [pounds/day]
- EF_i = Emission factor for pollutant i from bulldozing, scraping and grading [pounds/hour]
- H_G = Daily bulldozing, scraping and grading duration [hours/day]

The following equation (EPA, 1998) was used to calculate the emission factor for fugitive particulate matter emissions from bulldozing, scraping and grading:

$$EF_i = f_i \times 0.75 \times s^{1.5} / M^{1.4} \times (1 - CE / 100) \quad (\text{Eq. 12})$$

where:

- EF_i = Emission factor for fugitive particulate matter emissions from bulldozing, scraping and grading
- f_i = Mass fraction of pollutant i (PM_{10} or $PM_{2.5}$) in PM_{10} emissions from bulldozing, scraping and grading
- = 1 for PM_{10}
- = 0.208 for $PM_{2.5}$ from SCAQMD (2006)

- s = Material silt content [weight percent]
 = 26.7 percent average of near-surface soil samples from Proposed Substation Site preliminary geotechnical investigation
- M = Material moisture content [weight percent]
 = 10.6 percent average of near-surface soil samples from Proposed Substation Site preliminary geotechnical investigation
- CE = Control efficiency [percent]
 = 61 percent from watering three times per day from SCAQMD (2007c)

The emission factor calculations are presented in Table 52 in the attached tables.

The daily hours of bulldozing, scraping and grading were calculated from the construction equipment usage estimates provided in Table 3.5, Construction Equipment and Workforce Estimates, in Chapter 3, Project Description, of the PEA. Estimated daily volumes of soil handled and storage pile surface areas during construction phases that involve soil handling and temporary storage piles are listed in Table C-3, Estimated Soil Handling and Storage Pile Surface Areas by Construction Phase.

Earthwork fugitive particulate matter emission calculations are provided in Tables 7 through 47 in the attached tables.

Table C-3 Estimated Soil Handling and Storage Pile Surface Areas by Construction Phase

Construction Phase	Type	Daily Amount	Basis ¹
Substation Grading	Soil Dropping	450 CY	40,000 CY total (Table 3.1) over 90 days: $40,000 / 90 = 444$
	Storage Piles	0.13 acres	450 CY total in two conical piles 7' tall x 58' diameter
Substation Civil	Soil Dropping	8 CY	450 CY total (Table 3.1) over 60 days: $450 / 60 = 7.5$
Distribution Civil	Soil Dropping	50 CY	450 CY total (Table 3.1) over 9 days: $450 / 9 = 50$
Subtransmission ROW Clearing	Soil Handling	200 CY	Clearing 10,800' long x 14' wide x 6" depth (Section 3.2.3.2) over 14 days: $10,800 \times 14 \times 0.5 / 27 / 14 = 200$
Subtransmission Roads and Landings	Soil Handling	2,800	Cut and fill 8 acres (Table 3.4) x 18" depth (Section 3.2.3.2) over 14 days: $8 \times 43,560 \times 1.5 / 27 \times 2 / 14 = 2,766$
	Storage Piles	0.6 acres	8 acres (Table 3.4) over 14 days: $8 / 14 = 0.57$
Subtransmission TSP	Soil	75 CY	Excavate 8' diameter x 40' deep (Table 3.2)

Construction Phase	Type	Daily Amount	Basis ¹
Foundations Installation	handling		per day = $\pi \times 8^2 / 4 \times 40 / 27 = 74.5$
Subtransmission Wood Pole Installation	Soil Handling	12 CY	Excavate 73 poles, 3' diameter x 11' deep (Table 3.2) over 19 days: $73 \times \pi \times 3^2 / 4 \times 11 / 27 / 19 = 11.1$
Telecommunications Underground Facility	Soil Handling	34 CY	Excavate duct banks, 3,950' long (Table 3.4) x 1.5' wide x 3' deep (Section 3.2.4) plus pull boxes and manholes, two 3' x 5' x 3' and three 4' x 4' x 5' (Section 3.2.4) over 20 days: $(3,950 \times 1.5 \times 3 + 2 \times 3 \times 5 \times 3 + 3 \times 4 \times 4 \times 5) / 27 / 20 = 33.5$
Model Pole Top Substation Decommissioning Civil	Soil Handling	130 CY	Excavate total of 260 CY over 2 days
	Storage Pile	0.04 acres	130 CY in one conical pile 7' tall x 22' diameter

Note:

CY = cubic yards; hr/day = hours per day; ROW = rights-of-way; TSP = Tubular Steel Poles; ' = feet; " = inches

¹ Table and section numbers refer to PEA Chapter 3, Project Description

2.6 Asphaltic Paving VOC Emission Calculations

Asphaltic paving generates VOC emissions as the asphalt cures. The following equation was used to calculate daily VOC emissions from asphaltic paving:

$$E = EF \times A_p \quad (\text{Eq. 13})$$

where:

E = VOC emissions from asphaltic paving [pounds/day]

EF = Emission factor for VOC from asphaltic paving [pounds/acre]

= 2.62 pounds/acre from URBEMIS 2007 User's Guide, Appendix A (URBEMIS, 2007)

A_p = Area paved [acres/day]

The maximum surface area paved in a single day would be 11,200 square feet (0.26 acres) for the Proposed Substation external driveway (see PEA Chapter 3, Project Description, Table 3.1, Substation Ground Improvements and Material Volumes). VOC emissions from asphaltic paving are calculated in Table 17 in the attached tables.

2.7 Equipment SF₆ Leakage GHG Emission Calculations

New circuit breakers installed at the Proposed Substation would be insulated with SF₆, which is a GHG. Leakage of SF₆ from the circuit breakers during operation of the Proposed Project would generate GHG emissions. The following equation was used to calculate GHG emissions from SF₆ leakage:

$$E = L / 100 \times M_{\text{SF}_6} \times 23,200 \times 4.536 \times 10^{-4} \quad (\text{Eq. 14})$$

where:

E = GHG emissions from SF₆ leakage [metric tons CO₂ equivalent/year]

L = SF₆ leakage rate [percent/year]

= 0.5 percent/year estimated by SCE

M_{SF6} = SF₆ in new circuit breakers [pounds]

= 378 pounds, estimated by SCE

23,200 = SF₆ global warming potential

4.536 x 10⁻⁴ = Metric tons/pound conversion factor

GHG emissions from SF₆ leakage are calculated in Table 47 in the attached tables.

3.0 PEAK DAILY EMISSIONS CALCULATIONS

Peak daily emissions of VOC, CO, NO_x, SO_x, PM₁₀ and PM_{2.5} during construction and operation of the Proposed Project were calculated for comparison with the SCAQMD's CEQA mass emissions CEQA significance thresholds.

2.1 Peak Daily Construction Emission Calculations

The following steps were used to estimate peak daily emissions during construction of the Proposed Project:

- Daily emissions during each of the construction phases in Table 3.5, Construction Equipment and Workforce Estimates, in Chapter 3, Project Description, of the PEA were calculated using the procedures in Section 2, Emission Calculations. The calculations are provided in Tables 7 through 46 in the attached tables, and total daily emissions for each construction phase are listed in Table 1 in the attached tables.
- The maximum daily emissions that may occur during construction of each component of the Proposed Project (Substation, distribution facilities, Subtransmission Source Lines and telecommunication facilities and during demolition of the Nuevo Substation and the Model Pole Top Substation) were estimated as follows:

- o Daily emissions during the construction phases for each component of the Proposed Project that may overlap were added together to estimate daily emissions during overlapping construction phases. Construction phases that may overlap are listed in Table C-4, Possible Overlapping Construction Phases.
- o The highest daily emissions among the overlapping and non-overlapping construction phases for each component of the Proposed Project were then determined.
- Construction of the Proposed Substation, distribution facilities, Subtransmission Source Lines and telecommunication facilities may all occur at the same time. Therefore, maximum daily emissions during simultaneous construction of these project components were estimated by adding together the maximum daily emissions during construction of the individual components estimated in the previous step.
- Demolition of the Nuevo and Model Pole Top substations may occur at the same time but would not commence until construction of the other Proposed Project components is completed. Therefore, the maximum daily emissions during the demolition activities for the two substations were added together to estimate maximum daily emissions during demolition.
- Peak daily construction emissions were the higher of the maximum daily emissions during construction of the new Proposed Project components and during demolition of the two existing substations.

The peak daily construction emissions calculations are provided in Table 2 in the attached tables.

Table C-4 Possible Overlapping Construction Phases

Project Component	Overlapping Construction Phases
Substation Construction	Grading
	Civil and Fencing
	MEER, Electrical, Wiring, Transformers, Equipment Check, Testing, Asphaltting, Landscaping, Irrigation
Distribution Facilities Construction	All Phases
Subtransmission Source Line Construction	All Phases
Telecommunications Construction	Marshalling Yard, Right-of-Way Clearing, Roads and Landing Work
	Marshalling Yard, Tubular Steel Pole Foundations Installation, Steel Pole Haul, Steel Pole Assembly, Steel Pole Erection, Wood Pole Installation
	Marshalling Yard, Steel Pole Erection, Wood Pole Installation, Guard Structure Installation

Project Component	Overlapping Construction Phases
	Marshalling Yard, Existing Wood Poles Removal, Guard Structure Installation
	Marshalling Yard, Conductor Installation
	Marshalling Yard, Guard Structure Removal
	Marshalling Yard, Restoration
	Marshalling Yard, Right-of-Way Clearing, Roads and Landing Work
Nuevo Substation Demolition	Civil
	Electrical
	Maintenance Crew Equipment Check
	Testing
Model Pole Top Substation Demolition	Civil
	Electrical

2.2 Peak Daily Operational Emission Calculations

During operation of the Proposed Project, motor vehicle exhaust and entrained paved road particulate matter emissions would be generated by motor vehicle travel for inspections of the Proposed Substation and Subtransmission Source Lines. Emissions from these activities were calculated using the procedures described in Section 2.2, Construction Equipment Exhaust Emission Calculations, and Section 2.3, Motor Vehicle Exhaust Emission Calculations. The calculations of peak daily emissions considered visits to inspect both the Proposed Substation and the Subtransmission Source Lines on the same day, to ensure that emissions were not underestimated. The peak daily operational emission calculations are provided in Table 47 in the attached tables.

4.0 TOTAL GREENHOUSE GAS EMISSION CALCULATIONS

GHG emissions during each construction phase and during operation of the Proposed Project were calculated using the procedures described in Section 2.2, Construction Equipment Exhaust Emission Calculations, Section 2.3, Motor Vehicle Exhaust Emission Calculations, and Section 2.7, Equipment SF₆ Leakage GHG Emission Calculations. The calculations are provided in Tables 7 through 47 in the attached tables. Total GHG emissions during construction and during each construction phase are listed in Table 6 in the attached Tables, and GHG emissions during project operation are in Table 47.

5.0 LOCALIZED IMPACTS ANALYSIS

The SCAQMD (2008b) has developed look-up tables that can be used to evaluate the potential for construction emissions to cause localized exceedances of the ambient air quality CEQA significance thresholds. This localized significance thresholds (LST) analysis consists of comparing maximum daily on-site CO, NO_x, PM₁₀, and PM_{2.5}

emissions at individual locations with maximum allowable emissions obtained from the look-up tables. The maximum allowable emissions in the tables depend on the location within the South Coast Air Basin, the size (disturbed area) of the construction activities, and the distance from the construction site boundary to the nearest receptor. Receptors for the analysis include residences for PM₁₀ and PM_{2.5} and either residences or commercial locations for CO and NOx.

Daily on-site emissions during each construction phase were calculated using the procedures described in Section 2, Emission Calculations, for use in the LST analysis for impacts during construction of the Proposed Project. All construction equipment usage and fugitive particulate matter emissions from earthwork were assumed to occur on-site. On-site motor vehicle travel estimates to calculate on-site vehicle exhaust and entrained particulate matter emissions are listed in Table C-2, Motor Vehicle Daily Vehicle-Miles-Traveled. Daily on-site construction emissions calculations are provided in Tables 7 through 46 in the attached tables, and total daily on-site emissions are listed by construction phase in Table 3 in the attached tables.

Maximum daily on-site emissions that could occur at a single location during construction of each of the components of the Proposed Project were used in the LST analysis. On-site emissions during construction of the Proposed Substation, distribution facilities and telecommunication facilities and during demolition of the Nuevo and Model Pole Top substations were assumed to occur at a single location each day. On-site emissions during construction of the Proposed Subtransmission Source Line Route were divided by the number of separate locations at which construction activities for that phase of construction would occur during one day to calculate the emissions used in the analyses. The following information was used for this analysis:

- Guard Structure Installation: 4 structures per day (4 locations)
- Existing Wood Poles Removal: 10 poles per day (10 locations)
- Tubular Steel Pole Foundations Installation: 1 foundation per day (1 location)
- Wood Pole Installation: 4 poles per day (1 location)
- Steel Pole Haul: 4 locations per day (4 locations)
- Steel Pole Assembly: 3 poles per day (3 locations)
- Steel Pole Erection: 3 poles per day (3 locations)
- Conductor Installation: 1 pull, 1 tension and 1 splicing site per day (3 locations)
- Guard Structure Removal: 4 structures per day (4 locations)

Emissions generated during Proposed Subtransmission Source Line Route rights-of-way (ROW) clearing, roads and landing work, and restoration were not included in the analyses, since these emissions would occur over distances of approximately one mile each day, rather than at fixed locations. Daily on-site emissions at a single location for each construction phase and maximum daily on-site emissions during construction of each Proposed Project component are listed in Table 4 in the attached tables.

The SCAQMD look-up tables for the LST analysis list maximum daily allowable on-site emissions that will not cause LSTs to be exceeded for 1-, 2- and 5-acre construction sites and for receptor distances from the boundary of 25, 50, 100, 200 and 500 meters. The values for a 5-acre site were used for the analyses for the Proposed Substation construction, and the values for a 1-acre site were used for construction of the other Proposed Project components. Linear interpolation of the emissions in the look-up tables was used to calculate the maximum allowable emissions corresponding to the actual receptor distances. The analyses are shown in Table 5 in the attached tables.

Emissions during operation of the Proposed Project would be solely from motor vehicle travel to visit the Proposed Substation Site and to inspect the Proposed Subtransmission Source Lines. Since these emissions would not occur at a single location each day, they would not cause the localized significance thresholds to be exceeded.

6.0 REFERENCES

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Table 1
Construction Emissions Summary
Total Daily Criteria Pollutant Emissions by Construction Phase

Phase	VOC (lb/day)	CO (lb/day)	NOX (lb/day)	SOX (lb/day)	PM10 (lb/day)	PM2.5 (lb/day)
Substation Construction						
Survey	0.19	1.85	0.19	0.00	1.08	0.10
Grading	11.63	52.09	117.60	0.16	33.18	9.46
Fencing	0.65	4.53	3.55	0.01	2.86	0.48
Civil	3.78	26.62	32.41	0.05	5.50	2.00
Substation MEER	0.26	2.30	0.71	0.00	2.10	0.21
Electrical	0.96	41.64	3.94	0.01	1.87	0.37
Wiring	0.27	11.14	0.48	0.00	0.29	0.04
Transformers	0.99	14.35	6.32	0.01	2.64	0.50
Maintenance Crew Equipment Check	0.12	1.14	0.12	0.00	0.86	0.08
Testing	0.11	1.03	0.10	0.00	0.39	0.03
Asphalting	4.82	16.58	28.54	0.04	4.80	1.68
Landscaping	1.96	9.05	15.14	0.02	3.02	0.87
Irrigation	2.15	8.53	5.09	0.01	1.10	0.46
Distribution Construction						
Civil	4.27	16.34	41.78	0.06	2.26	1.47
Electrical	3.43	14.15	26.75	0.04	1.53	0.97
Subtransmission Source Line Construction						
Survey	0.11	1.06	0.11	0.00	1.86	0.18
Marshalling Yard	0.83	3.90	6.35	0.01	0.43	0.21
Right-of-Way Clearing	4.66	18.07	41.67	0.06	40.55	7.27
Roads and Landing Work	10.70	41.75	111.05	0.15	177.53	24.43
Guard Structure Installation	5.29	20.79	46.19	0.07	20.86	3.57
Existing Wood Poles Removal	3.60	14.07	30.02	0.05	11.11	2.12
Tubular Steel Pole Foundations Installation	6.00	24.73	62.29	0.10	76.11	9.56
Wood Pole Installation	2.65	11.54	20.55	0.03	5.20	1.21
Steel Pole Haul	1.26	5.71	10.25	0.01	6.05	0.91
Steel Pole Assembly	1.89	9.29	12.86	0.02	4.93	0.98
Steel Pole Erection	1.89	9.29	12.86	0.02	4.93	0.98
Conductor Installation	5.54	25.36	52.62	0.08	36.36	5.06
Guard Structure Removal	3.62	14.62	32.34	0.04	16.61	2.71
Restoration	5.46	21.03	48.99	0.07	31.32	6.51
Telecommunications Construction						
Control Building Communications Room	0.24	2.27	0.45	0.00	0.26	0.02
Overhead Cable Installation	2.74	12.72	29.52	0.04	66.39	7.38
Underground Facility Installation	1.14	6.33	5.54	0.01	0.80	0.42
Underground Cable Installation	2.95	12.25	28.20	0.05	1.28	0.90
Optical Systems Installation at Other Locations	0.57	5.51	0.56	0.01	0.64	0.04
Nuevo Substation Demolition						
Civil	1.47	8.17	10.40	0.02	0.99	0.67
Electrical	0.80	30.96	4.29	0.01	0.56	0.27
Maintenance Crew Equipment Check	0.11	1.01	0.10	0.00	0.12	0.01
Testing	0.11	1.01	0.10	0.00	0.38	0.03
Model P.T. Substation Demolition						
Civil	1.04	6.00	6.46	0.01	0.73	0.43
Electrical	3.47	14.63	30.57	0.04	1.53	1.42

Notes:

VOC = volatile organic compounds

CO = carbon monoxide

NOX = nitrogen oxides

SOX = sulfur oxides

PM10 = suspended particulate matter measuring less than 10 microns

PM2.5 = suspended particulate matter measuring less than 2.5 micron

lb/day = pounds per day

MEER = mechanical and electrical equipment room

Table 2
Construction Emissions Summary
Total Daily Criteria Pollutant Emissions for Overlapping Construction Phases

Group ^a	VOC (lb/day)	CO (lb/day)	NOX (lb/day)	SOX (lb/day)	PM10 (lb/day)	PM2.5 (lb/day)
Substation Construction						
Survey	0.19	1.85	0.19	0.00	1.08	0.10
Grading	11.63	52.09	117.60	0.16	33.18	9.46
Civil, Fencing	4.43	31.15	35.96	0.06	8.36	2.48
MEER, Electrical, Wiring, Transformers, Equipment Check, Testing, Asphaltting, Landscaping, Irrigation	9.48	97.23	55.35	0.09	15.97	3.80
Maximum	11.63	97.23	117.60	0.16	33.18	9.46
Distribution Construction						
All	7.70	30.49	68.54	0.11	3.79	2.45
Maximum	7.70	30.49	68.54	0.11	3.79	2.45
Subtransmission Source Line Construction						
Marshalling Yard, Survey	0.94	4.95	6.46	0.01	2.29	0.39
Marshalling Yard, Right-of-Way Clearing, Roads and Landing Work	16.19	63.72	159.07	0.22	218.51	31.90
Marshalling Yard, Tubular Steel Pole Foundations Installation, Steel Pole Haul, Steel Pole Assembly, Steel Pole Erection, Wood Pole Installation	14.52	64.47	125.15	0.19	97.65	13.84
Marshalling Yard, Steel Pole Erection, Wood Pole Installation, Guard Structure Installation	10.66	45.52	85.94	0.14	31.42	5.97
Marshalling Yard, Existing Wood Poles Removal, Guard Structure Installation	9.73	38.76	82.56	0.13	32.40	5.90
Marshalling Yard, Conductor Installation	6.38	29.26	58.97	0.09	36.80	5.27
Marshalling Yard, Guard Structure Removal	4.45	18.52	38.70	0.06	17.05	2.92
Marshalling Yard, Restoration	6.30	24.93	55.34	0.08	31.76	6.72
Maximum	16.19	64.47	159.07	0.22	218.51	31.90
Telecommunications Construction						
All	7.40	36.81	63.82	0.11	69.11	8.74
Maximum	7.40	36.81	63.82	0.11	69.11	8.74
CONSTRUCTION MAXIMUM DAILY^b	42.91	229.00	409.03	0.59	324.60	52.55
Nuevo Substation Demolition						
Civil	1.47	8.17	10.40	0.02	0.99	0.67
Electrical	0.80	30.96	4.29	0.01	0.56	0.27
Maintenance Crew Equipment Check	0.11	1.01	0.10	0.00	0.12	0.01
Testing	0.11	1.01	0.10	0.00	0.38	0.03
Maximum	1.47	30.96	10.40	0.02	0.99	0.67
Model P.T. Substation Demolition						
Civil	1.04	6.00	6.46	0.01	0.73	0.43
Electrical	3.47	14.63	30.57	0.04	1.53	1.42
Maximum	3.47	14.63	30.57	0.04	1.53	1.42
DEMOLITION MAXIMUM DAILY^c	3.47	30.96	30.57	0.04	1.53	1.42
PEAK DAILY^d	42.91	229.00	409.03	0.59	324.60	52.55

^a The construction phases within a group could all occur at the same time.

^b Construction maximum daily emissions are the sum of the maximum daily emissions during construction of the substation, the distribution facilities, the subtransmission source lines and the telecommunications facilities, since construction of all of these components could occur at the same time.

^c Demolition maximum daily emissions are the maximum daily emissions during demolition of the Nuevo Substation or the Model P.T. Substation.

^d Peak daily emissions are the greater of the maximum daily emissions during construction and during demolition, since demolition would occur after construction is completed.

Table 3
Construction Emissions Summary
Onsite Daily Criteria Pollutant Emissions by Construction Phase

Phase	VOC (lb/day)	CO (lb/day)	NOX (lb/day)	SOX (lb/day)	PM10 (lb/day)	PM2.5 (lb/day)
Substation Construction						
Survey	0.00	0.02	0.00	0.00	0.87	0.09
Grading	4.04	17.30	33.07	0.04	26.13	5.90
Fencing	0.39	2.26	2.88	0.00	2.61	0.45
Civil	1.90	16.30	14.92	0.02	4.14	1.25
Substation MEER	0.00	0.03	0.03	0.00	1.85	0.19
Electrical	0.46	36.83	3.45	0.00	1.31	0.34
Wiring	0.03	8.84	0.24	0.00	0.03	0.02
Transformers	0.68	11.38	6.02	0.01	2.29	0.48
Maintenance Crew Equipment Check	0.00	0.01	0.00	0.00	0.73	0.07
Testing	0.00	0.00	0.00	0.00	0.27	0.03
Asphalting	2.99	7.49	9.69	0.01	3.08	0.89
Landscaping	0.61	2.00	1.87	0.00	1.73	0.31
Irrigation	1.80	5.21	4.75	0.01	0.71	0.43
Distribution Construction						
Civil	2.99	9.44	29.38	0.04	1.08	0.96
Electrical	2.86	9.51	24.58	0.03	0.95	0.88
Subtransmission Source Line Construction						
Survey	0.00	0.00	0.00	0.00	0.00	0.00
Marshalling Yard	0.64	2.06	6.17	0.01	0.22	0.20
Right-of-Way Clearing	4.21	14.78	38.96	0.05	23.22	5.46
Roads and Landing Work	5.45	18.42	50.75	0.07	37.97	8.42
Guard Structure Installation	4.74	16.75	43.06	0.07	1.71	1.58
Existing Wood Poles Removal	3.19	10.67	28.32	0.04	1.18	1.09
Tubular Steel Pole Foundations Installation	2.91	10.27	28.44	0.05	1.09	0.92
Wood Pole Installation	2.19	7.31	19.55	0.02	0.86	0.78
Steel Pole Haul	0.98	3.41	9.20	0.01	0.34	0.32
Steel Pole Assembly	1.43	5.06	11.86	0.01	0.59	0.54
Steel Pole Erection	1.43	5.06	11.86	0.01	0.59	0.54
Conductor Installation	4.23	15.33	45.87	0.06	1.53	1.41
Guard Structure Removal	3.11	10.75	29.77	0.04	1.20	1.10
Restoration	5.01	17.22	47.39	0.06	22.28	5.57
Telecommunications Construction						
Control Building Communications Room	0.00	0.00	0.00	0.00	0.00	0.00
Overhead Cable Installation	2.26	8.67	27.79	0.04	0.86	0.79
Underground Facility Installation	0.84	3.53	5.17	0.01	0.47	0.40
Underground Cable Installation	2.65	9.44	27.82	0.04	0.95	0.87
Optical Systems Installation at Other Locations	0.00	0.00	0.00	0.00	0.00	0.00
Nuevo Substation Demolition						
Civil	0.91	4.55	6.14	0.01	0.52	0.48
Electrical	0.54	28.48	4.04	0.00	0.27	0.25
Maintenance Crew Equipment Check	0.00	0.00	0.00	0.00	0.00	0.00
Testing	0.00	0.00	0.00	0.00	0.27	0.03
Model P.T. Substation Demolition						
Civil	0.61	2.87	3.99	0.00	0.35	0.32
Electrical	3.07	11.22	29.09	0.04	1.16	1.07

Table 4
Construction Emissions Summary
Total Daily Onsite Criteria Pollutant Emissions for Overlapping Construction Phases

Group^a	VOC (lb/day)	CO (lb/day)	NOX (lb/day)	SOX (lb/day)	PM10 (lb/day)	PM2.5 (lb/day)
Substation Construction						
Survey	0.00	0.02	0.00	0.00	0.87	0.09
Grading	4.04	17.30	33.07	0.04	26.13	5.90
Civil, Fencing	2.30	18.56	17.80	0.02	6.75	1.70
MEER, Electrical, Wiring, Transformers, Equipment Check, Testing, Asphalt, Landscaping, Irrigation	6.58	71.79	26.06	0.03	11.99	2.75
Maximum Substation Construction	6.58	71.79	33.07	0.04	26.13	5.90
Distribution Construction						
Civil	2.99	9.44	29.38	0.04	1.08	0.96
Electrical	2.86	9.51	24.58	0.03	0.95	0.88
Maximum	2.99	9.51	29.38	0.04	1.08	0.96
Subtransmission Source Line Construction^b						
Survey	0.00	0.00	0.00	0.00	0.00	0.00
Marshalling Yard	0.64	2.06	6.17	0.01	0.22	0.20
Guard Structure Installation	1.19	4.19	10.76	0.02	0.43	0.39
Existing Wood Poles Removal	0.32	1.07	2.83	0.00	0.12	0.11
Tubular Steel Pole Foundations Installation	2.91	10.27	28.44	0.05	1.09	0.92
Wood Pole Installation	0.55	1.83	4.89	0.01	0.21	0.19
Steel Pole Haul	0.25	0.85	2.30	0.00	0.09	0.08
Steel Pole Assembly	0.48	1.69	3.95	0.00	0.20	0.18
Steel Pole Erection	0.48	1.69	3.95	0.00	0.20	0.18
Conductor Installation	1.41	5.11	15.29	0.02	0.51	0.47
Guard Structure Removal	0.78	2.69	7.44	0.01	0.30	0.28
Maximum	2.91	10.27	28.44	0.05	1.09	0.92
Telecommunications Construction						
Control Building Communications Room	0.00	0.00	0.00	0.00	0.00	0.00
Overhead Cable Installation	2.26	8.67	27.79	0.04	0.86	0.79
Underground Facility Installation	0.84	3.53	5.17	0.01	0.47	0.40
Underground Cable Installation	2.65	9.44	27.82	0.04	0.95	0.87
Optical Systems Installation at Other Locations	0.00	0.00	0.00	0.00	0.00	0.00
Maximum	2.65	9.44	27.82	0.04	0.95	0.87
Nuevo Substation Demolition						
Civil	0.91	4.55	6.14	0.01	0.52	0.48
Electrical	0.54	28.48	4.04	0.00	0.27	0.25
Maintenance Crew Equipment Check	0.00	0.00	0.00	0.00	0.00	0.00
Testing	0.00	0.00	0.00	0.00	0.27	0.03
Maximum	0.91	28.48	6.14	0.01	0.52	0.48
Model P.T. Substation Demolition						
Civil	0.61	2.87	3.99	0.00	0.35	0.32
Electrical	3.07	11.22	29.09	0.04	1.16	1.07
Maximum	3.07	11.22	29.09	0.04	1.16	1.07

^a The construction phases within a group could all occur at the same time at the same location.

The following Subtransmission Source Line construction activity emissions were divided by the following number of working locations per day:

- Guard Structure Installation: 4 structures per day
- Existing Wood Poles Removal: 10 poles per day
- Tubular Steel Pole Foundations Installation: 1 foundation per day
- Wood Pole Installation: 4 poles per day
- Steel Pole Haul: 4 locations per day
- Steel Pole Assembly: 3 poles per day
- Steel Pole Erection: 3 poles per day
- Conductor Installation: 1 pull, 1 tension and 1 splicing site per day
- Guard Structure Removal: 4 structures per day

^b Right-of-way clearing, roads and landing work, and restoration were excluded from the LST analysis because these activities would occur over a distance of approximately 1 mile along the Proposed Subtransmission Source Line Route, instead of at a single location, each day.

Table 5
Construction Emissions
Localized Significance Threshold Analysis

Pollutant	Daily Onsite Emissions (lb/day)	Receptor Distance (m)	Allowable Emissions Interpolation ^a					Allowable Exceeded?
			Distance 1 (m)	Emissions 1 (lb/day)	Distance 2 (m)	Emissions 2 (lb/day)	Interpolated Emissions (lb/day) ^b	
Substation Construction ^c								
CO	72	40	25	1,577	50	2,178	1,938	No
NOx	33	40	25	270	50	302	289	No
PM10	26	40	25	13	50	40	29	No
PM2.5	6	40	25	8	50	10	9	No
Distribution Construction ^d								
CO	10	40	25	602	50	887	773	No
NOx	29	40	25	118	50	148	136	No
PM10	1	40	25	4	50	12	9	No
PM2.5	1	40	25	3	50	4	4	No
Subtransmission Source Line Construction ^d								
CO	10	25	25	602	50	887	602	No
NOx	28	25	25	118	50	148	118	No
PM10	1	25	25	4	50	12	4	No
PM2.5	1	25	25	3	50	4	3	No
Telecommunications Construction ^d								
CO	9	40	25	602	50	887	773	No
NOx	28	40	25	118	50	148	136	No
PM10	1	40	25	4	50	12	9	No
PM2.5	1	40	25	3	50	4	4	No
Nuevo Substation Demolition ^d								
CO	28	60	50	887	100	1,746	1,059	No
NOx	6	60	50	148	100	212	161	No
PM10	1	60	50	12	100	30	16	No
PM2.5	0	60	50	4	100	8	5	No
Model P.T. Substation Demolition ^d								
CO	11	60	50	887	100	1,746	1,059	No
NOx	29	60	50	148	100	212	161	No
PM10	1	60	50	12	100	30	16	No
PM2.5	1	60	50	4	100	8	5	No

^a Allowable emissions are from Appendix C to Final Localized Significance Methodology, SCAQMD, revised October 2009, downloaded from <http://www.aqmd.gov/ceqa/handbook/LST/LST.html>

^b Interpolated emissions = Emissions 1 + (Receptor distance - Distance 1) x (Emissions 2 - Emissions 1) / (Distance 2 - Distance 1)

^c Closest receptor is a residence. Allowable emissions are for a 5 acre site

^d Closest receptor is a residence. Allowable emissions are for a 1 acre site.

Table 6
Construction Emissions Summary
Total Greenhouse Gas Emissions by Construction Phase

Phase	CO2e (MT)
Substation Construction	
Survey	1.21
Grading	652.98
Fencing	3.15
Civil	72.97
Substation MEER	3.16
Electrical	37.09
Wiring	4.41
Transformers	15.09
Maintenance Crew Equipment Check	2.24
Testing	5.38
Asphalting	26.24
Landscaping	16.05
Irrigation	8.62
Distribution Construction	
Civil	41.77
Electrical	76.99
Subtransmission Source Line Construction	
Survey	0.35
Marshalling Yard	171.54
Right-of-Way Clearing	36.21
Roads and Landing Work	96.37
Guard Structure Installation	6.52
Existing Wood Poles Removal	1.97
Tubular Steel Pole Foundations Installation	151.36
Wood Pole Installation	25.67
Steel Pole Haul	3.34
Steel Pole Assembly	5.30
Steel Pole Erection	5.30
Conductor Installation	37.04
Guard Structure Removal	3.93
Restoration	11.95
Telecommunications Construction	
Control Building Communications Room	1.36
Overhead Cable Installation	83.44
Underground Facility Installation	8.77
Underground Cable Installation	12.59
Optical Systems Installation at Other Locations	4.32
Nuevo Substation Demolition	
Civil	3.55
Electrical	2.72
Maintenance Crew Equipment Check	0.13
Testing	0.13
Model P.T. Substation Demolition	
Civil	1.95
Electrical	41.92
Total	1,685.07

Table 7
Substation Construction Emissions
Survey

Emissions Summary

Source	VOC (lb/day)	CO (lb/day)	NOX (lb/day)	SOX (lb/day)	PM10 (lb/day)	PM2.5 (lb/day)	CO2e (MT)
Construction Equipment Exhaust	0.00	0.00	0.00	0.00	0.00	0.00	0.0
Onsite Motor Vehicle Exhaust	0.00	0.02	0.00	0.00	0.00	0.00	0.0
Onsite Motor Vehicle Fugitive PM	--	--	--	--	0.87	0.09	
Earthwork Fugitive PM	--	--	--	--	0.00	0.00	
Onsite Total	0.00	0.02	0.00	0.00	0.87	0.09	0.0
Offsite Motor Vehicle Exhaust	0.19	1.84	0.19	0.00	0.02	0.01	1.2
Offsite Motor Vehicle Fugitive PM	--	--	--	--	0.19	0.00	
Offsite Total	0.19	1.84	0.19	0.00	0.21	0.01	1.2
Total	0.19	1.85	0.19	0.00	1.08	0.10	1.2

Construction Equipment Summary

Equipment	Horse-power	Number	Days Used	Hours Used/Day
None				

Construction Equipment Exhaust Emission Factors

Equipment	Horse-power	VOC (lb/hr) ^a	CO (lb/hr) ^a	NOX (lb/hr) ^a	SOX (lb/hr) ^a	PM10 (lb/hr) ^a	PM2.5 (lb/hr) ^b	CO2 (lb/hr) ^a	CH4 (lb/hr) ^a
None		0.000	0.000	0.000	0.000	0.000	0.000	0.000	0.000

^a From Table 48

^b Diesel PM2.5 emission factor [lb/hr] = PM10 emission factor [lb/hr] x PM2.5 fraction of PM10

PM2.5 Fraction= 0.920

From Appendix A, Final--Methodology to Calculate Particulate Matter (PM) 2.5

and PM 2.5 Significance Thresholds, SCAQMD, October 2006,

http://www.aqmd.gov/ceqa/handbook/PM2_5/PM2_5.html

Construction Equipment Daily Criteria Pollutant Exhaust Emissions

Equipment	VOC (lb/day) ^a	CO (lb/day) ^a	NOX (lb/day) ^a	SOX (lb/day) ^a	PM10 (lb/day) ^a	PM2.5 (lb/day) ^a
None	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

^a Emissions [lb/day] = number x hours/day x emission factor [lb/hr]

Construction Equipment Total Greenhouse Gas Emissions

Equipment	CO2 (MT) ^a	CH4 (MT) ^a	CO2e (MT) ^b
None	0.0	0.0	0.0
Total	0.0	0.0	0.0

^a Emissions [metric tons, MT] = emission factor [lb/hr] x hours/day x Number x days used x 453.6 [g/lb] / 1,000,000 [g/MT]

Emission factors are in Table 48

^b CO₂-equivalent (CO₂e) emission factors are CO₂ emissions plus 21 x CH₄ emissions, based on Table C.1 from California Climate Action

Registry General Reporting Protocol, Version 3.0, April 2008, http://www.climateregistry.org/resources/docs/protocols/grp/GRP_V3_April2008_FINAL.pdf

Motor Vehicle Usage

Vehicle	Number	Days Used	Hours Used/Day	Miles/Day/Veh.
Onsite				
Survey Truck	2	10	N/A	1
Offsite				
Survey Truck	2	10	N/A	60
Worker Commute	2	10	N/A	60

Motor Vehicle Exhaust Emission Factors

Vehicle	Category	VOC (lb/mi) ^a	CO (lb/mi) ^a	NOX (lb/mi) ^a	SOX (lb/mi) ^a	PM10 (lb/mi) ^a	PM2.5 (lb/mi) ^b	CO2 (lb/mi) ^a	CH4 (lb/mi) ^a
Onsite									

Table 7
Substation Construction Emissions
Survey

Survey Truck	Passenger	7.96E-04	7.65E-03	7.76E-04	1.07E-05	8.98E-05	5.75E-05	1.10E+00	7.17E-05
Offsite									
Survey Truck	Passenger	7.96E-04	7.65E-03	7.76E-04	1.07E-05	8.98E-05	5.75E-05	1.10E+00	7.17E-05
Worker Commute	Passenger	7.96E-04	7.65E-03	7.76E-04	1.07E-05	8.98E-05	5.75E-05	1.10E+00	7.17E-05

a From Table 49 or Table 50

Motor Vehicle Daily Criteria Pollutant Exhaust Emissions

Vehicle	VOC (lb/day) ^a	CO (lb/day) ^a	NOX (lb/day) ^a	SOX (lb/day) ^a	PM10 (lb/day) ^a	PM2.5 (lb/day) ^a
Onsite						
Survey Truck	0.00	0.02	0.00	0.00	0.00	0.00
Onsite Total	0.00	0.02	0.00	0.00	0.00	0.00
Offsite						
Survey Truck	0.10	0.92	0.09	0.00	0.01	0.01
Worker Commute	0.10	0.92	0.09	0.00	0.01	0.01
Offsite Total	0.19	1.84	0.19	0.00	0.02	0.01
Total	0.19	1.85	0.19	0.00	0.02	0.01

^a Emissions [lb/day] = number x miles/day x emission factor [lb/mi]

Motor Vehicle Total Greenhouse Gas Emissions

Vehicle	CO2 (MT) ^a	CH4 (MT) ^a	CO2e (MT) ^b
Onsite			
Survey Truck	0.0	0.0	0.0
Onsite Total	0.0	0.0	0.0
Offsite			
Survey Truck	0.6	0.0	0.6
Worker Commute	0.6	0.0	0.6
Offsite Total	1.2	0.0	1.2
Total	1.2	0.0	1.2

^a Emissions [metric tons, MT] = emission factor [lb/hr] x miles/day x Number x days used x 453.6 [g/lb] / 1,000,000 [g/MT]

Emission factors are in Table 49 and Table 50

^b CO₂-equivalent (CO₂e) emission factors are CO₂ emissions plus 21 x CH₄ emissions, based on Table C.1 from California Climate Action Registry General Reporting Protocol, Version 3.0, April 2008, http://www.climateregistry.org/resources/docs/protocols/grp/GRP_V3_April2008_FINAL.pdf

Motor Vehicle Fugitive Particulate Matter Emissions

Vehicle	Number	Road Type	Miles/Day/ Vehicle	PM10 Emission Factor (lb/mi) ^a	PM2.5 Emission Factor (lb/mi) ^a	PM10 Emissions (lb/day) ^b	PM2.5 Emissions (lb/day) ^b
Onsite							
Survey Truck	2	Unpaved	1	0.435	0.043	0.87	0.09
Onsite Total						0.87	0.09
Offsite							
Survey Truck	2	Paved	60	0.001	0.000	0.10	0.00
Worker Commute	2	Paved	60	0.001	0.000	0.10	0.00
Offsite Total						0.19	0.00
Total						1.06	0.09

a From Table 51

^b Emissions [lb/day] = number x miles/day x emission factor [lb/mi]

Earthwork Fugitive Particulate Matter Emissions

Activity	Activity Units	Activity Level	PM10 Emission Factor ^a	PM2.5 Emission Factor ^a	PM10 (lb/day) ^b	PM2.5 (lb/day) ^b
Soil Handling	CY/day		1.62E-03	3.36E-04	0.00	0.00
Bulldozing, Scraping and Grading	hr/day		1.481	0.308	0.00	0.00
Storage Pile Wind Erosion	acres		15.7	3.26	0.00	0.00
Total					0.00	0.00

a From Table 52

^b Emissions [lb/day] = Emission factor [lb/activity unit] x Activity unit [units/day]

Table 8
Substation Construction Emissions
Grading

Emissions Summary

Source	VOC (lb/day)	CO (lb/day)	NOX (lb/day)	SOX (lb/day)	PM10 (lb/day)	PM2.5 (lb/day)	CO2e (MT)
Construction Equipment Exhaust	4.02	17.22	32.87	0.04	1.69	1.55	143.3
Onsite Motor Vehicle Exhaust	0.02	0.08	0.20	0.00	0.01	0.01	1.2
Onsite Motor Vehicle Fugitive PM	--	--	--	--	6.86	0.69	
Earthwork Fugitive PM	--	--	--	--	17.57	3.65	
Onsite Total	4.04	17.30	33.07	0.04	26.13	5.90	144.5
Offsite Motor Vehicle Exhaust	7.59	34.79	84.52	0.12	4.14	3.56	508.5
Offsite Motor Vehicle Fugitive PM	--	--	--	--	2.91	0.00	
Offsite Total	7.59	34.79	84.52	0.12	7.05	3.56	508.5
Total	11.63	52.09	117.60	0.16	33.18	9.46	653.0

Construction Equipment Summary

Equipment	Horse-power	Number	Days Used	Hours Used/Day
Dozer	305	1	90	4
Loader	147	2	90	4
Scraper	267	1	90	3
Grader	110	1	90	3
4x4 Backhoe	79	2	90	2
4x4 Tamper	174	1	90	2

Construction Equipment Exhaust Emission Factors

Equipment	Horse-power	VOC (lb/hr) ^a	CO (lb/hr) ^a	NOX (lb/hr) ^a	SOX (lb/hr) ^a	PM10 (lb/hr) ^a	PM2.5 (lb/hr) ^b	CO2 (lb/hr) ^a	CH4 (lb/hr) ^a	Category
Dozer	305	0.266	1.022	2.391	0.003	0.094	0.087	259.229	0.024	Crawler Tractors
Loader	147	0.131	0.629	1.013	0.001	0.058	0.054	106.315	0.012	Rubber Tired Loaders
Scraper	267	0.333	1.300	3.016	0.003	0.119	0.110	321.429	0.030	Scrapers
Grader	110	0.135	0.536	0.822	0.001	0.074	0.068	74.965	0.012	Graders
4x4 Backhoe	79	0.076	0.356	0.491	0.001	0.043	0.040	51.728	0.007	Tractors/Loaders/Backhoes
4x4 Tamper	174	0.101	0.588	0.860	0.001	0.047	0.043	106.516	0.009	Other Construction Equipment

^a From Table 48

^b Diesel PM2.5 emission factor [lb/hr] = PM10 emission factor [lb/hr] x PM2.5 fraction of PM10

PM2.5 Fraction= 0.920

From Appendix A, Final-Methodology to Calculate Particulate Matter (PM) 2.5

and PM 2.5 Significance Thresholds, SCAQMD, October 2006,

http://www.aqmd.gov/ceqa/handbook/PM2_5/PM2_5.html

Construction Equipment Daily Criteria Pollutant Exhaust Emissions

Equipment	VOC (lb/day) ^a	CO (lb/day) ^a	NOX (lb/day) ^a	SOX (lb/day) ^a	PM10 (lb/day) ^a	PM2.5 (lb/day) ^a
Dozer	1.06	4.09	9.57	0.01	0.38	0.35
Loader	1.05	5.03	8.11	0.01	0.47	0.43
Scraper	1.00	3.90	9.05	0.01	0.36	0.33
Grader	0.40	1.61	2.47	0.00	0.22	0.20
4x4 Backhoe	0.30	1.42	1.96	0.00	0.17	0.16
4x4 Tamper	0.20	1.18	1.72	0.00	0.09	0.09
Total	4.02	17.22	32.87	0.04	1.69	1.55

^a Emissions [lb/day] = number x hours/day x emission factor [lb/hr]

Construction Equipment Total Greenhouse Gas Emissions

Equipment	CO2 (MT) ^a	CH4 (MT) ^a	CO2e (MT) ^b
Dozer	42.3	0.0	42.4
Loader	34.7	0.0	34.8
Scraper	39.4	0.0	39.4
Grader	9.2	0.0	9.2
4x4 Backhoe	17.4	0.0	17.4
4x4 Tamper	0.0	0.0	0.0
Total	143.0	0.0	143.3

^a Emissions [metric tons, MT] = emission factor [lb/hr] x hours/day x Number x

days used x 453.6 [g/lb] / 1,000,000 [g/MT]

Emission factors are in Table 48

^b CO₂-equivalent (CO₂e) emission factors are CO₂ emissions plus 21 x CH₄ emissions, based on Table C.1 from California Climate Action

Registry General Reporting Protocol, Version 3.0, April 2008, http://www.climateregistry.org/resources/docs/protocols/grp/GRP_V3_April2008_FINAL.pdf

Motor Vehicle Usage

Vehicle	Number ^a	Days Used	Hours Used/Day	Miles/Day/Veh.
Onsite				
Water Truck	1	90	N/A	2
Tool Truck	1	90	N/A	1
Pickup 4x4	1	90	N/A	1
Dump Truck	45	90	N/A	0.1
Offsite				
Water Truck	1	90	N/A	10
Tool Truck	1	90	N/A	14

Table 8
Substation Construction Emissions
Grading

Pickup 4x4	1	90	N/A	14
Dump Truck	45	90	N/A	60
Worker Commute	15	90	N/A	60

^a Dump trucks based on 40,000 CY import/export over 90 days and 10 CY/truck = 40,000 / 90 / 10 = 44.4

Motor Vehicle Exhaust Emission Factors

Vehicle	Category	VOC (lb/mi) ^a	CO (lb/mi) ^a	NOX (lb/mi) ^a	SOX (lb/mi) ^a	PM10 (lb/mi) ^a	PM2.5 (lb/mi) ^b	CO2 (lb/mi) ^a	CH4 (lb/mi) ^a
Onsite									
Water Truck	HHDT	2.53E-03	1.02E-02	3.09E-02	4.04E-05	1.50E-03	1.29E-03	4.22E+00	1.17E-04
Tool Truck	Passenger	7.96E-04	7.65E-03	7.76E-04	1.07E-05	8.98E-05	5.75E-05	1.10E+00	7.17E-05
Pickup 4x4	Passenger	7.96E-04	7.65E-03	7.76E-04	1.07E-05	8.98E-05	5.75E-05	1.10E+00	7.17E-05
Dump Truck	HHDT	2.53E-03	1.02E-02	3.09E-02	4.04E-05	1.50E-03	1.29E-03	4.22E+00	1.17E-04
Offsite									
Water Truck	HHDT	2.53E-03	1.02E-02	3.09E-02	4.04E-05	1.50E-03	1.29E-03	4.22E+00	1.17E-04
Tool Truck	Passenger	7.96E-04	7.65E-03	7.76E-04	1.07E-05	8.98E-05	5.75E-05	1.10E+00	7.17E-05
Dump Truck	HHDT	2.53E-03	1.02E-02	3.09E-02	4.04E-05	1.50E-03	1.29E-03	4.22E+00	1.17E-04
Worker Commute	Passenger	7.96E-04	7.65E-03	7.76E-04	1.07E-05	8.98E-05	5.75E-05	1.10E+00	7.17E-05

^a From Table 49 or Table 50

Motor Vehicle Daily Criteria Pollutant Exhaust Emissions

Vehicle	VOC (lb/day) ^a	CO (lb/day) ^a	NOX (lb/day) ^a	SOX (lb/day) ^a	PM10 (lb/day) ^a	PM2.5 (lb/day) ^a
Onsite						
Water Truck	0.01	0.02	0.06	0.00	0.00	0.00
Tool Truck	0.00	0.01	0.00	0.00	0.00	0.00
Pickup 4x4	0.00	0.01	0.00	0.00	0.00	0.00
Dump Truck	0.01	0.05	0.14	0.00	0.01	0.01
Onsite Total	0.02	0.08	0.20	0.00	0.01	0.01
Offsite						
Water Truck	0.03	0.10	0.31	0.00	0.01	0.01
Tool Truck	0.01	0.11	0.01	0.00	0.00	0.00
Pickup 4x4	0.01	0.11	0.01	0.00	0.00	0.00
Dump Truck	6.82	27.58	83.49	0.11	4.04	3.49
Worker Commute	0.72	6.89	0.70	0.01	0.08	0.05
Offsite Total	7.59	34.79	84.52	0.12	4.14	3.56
Total	7.61	34.87	84.73	0.12	4.15	3.57

^a Emissions [lb/day] = number x miles/day x emission factor [lb/mi]

Motor Vehicle Total Greenhouse Gas Emissions

Vehicle	CO2 (MT) ^a	CH4 (MT) ^a	CO2e (MT) ^b
Onsite			
Water Truck	0.3	0.0	0.3
Tool Truck	0.0	0.0	0.0
Pickup 4x4	0.0	0.0	0.0
Dump Truck	0.8	0.0	0.8
Onsite Total	1.2	0.0	1.2
Offsite			
Water Truck	1.7	0.0	1.7
Tool Truck	0.6	0.0	0.6
Pickup 4x4	0.6	0.0	0.6
Dump Truck	464.7	0.0	465.0
Worker Commute	40.5	0.0	40.5
Offsite Total	508.1	0.0	508.5
Total	509.4	0.0	509.7

^a Emissions [metric tons, MT] = emission factor [lb/hr] x miles/day x Number x

days used x 453.6 [g/lb] / 1,000,000 [g/MT]

Emission factors are in Table 49 and Table 50

^b CO₂-equivalent (CO₂e) emission factors are CO₂ emissions plus 21 x CH₄ emissions, based on Table C.1 from California Climate Action

Registry General Reporting Protocol, Version 3.0, April 2008, http://www.climateregistry.org/resources/docs/protocols/grp/GRP_V3_April2008_FINAL.pdf

Motor Vehicle Fugitive Particulate Matter Emissions

Vehicle	Number	Road Type	Miles/ Day/ Vehicle	PM10 Emission Factor (lb/mi) ^a	PM2.5 Emission Factor (lb/mi) ^a	PM10 Emissions (lb/day) ^b	PM2.5 Emissions (lb/day) ^b
Onsite							
Water Truck	1	Unpaved	2	0.922	0.092	1.84	0.18
Tool Truck	1	Unpaved	1	0.435	0.043	0.43	0.04
Pickup 4x4	1	Unpaved	1	0.435	0.043	0.43	0.04
Dump Truck	45	Unpaved	0.1	0.922	0.092	4.15	0.42
Onsite Total						6.86	0.69
Offsite							
Water Truck	1	Paved	10	0.001	0.000	0.01	0.00
Tool Truck	1	Paved	14	0.001	0.000	0.01	0.00
Pickup 4x4	1	Paved	14	0.001	0.000	0.01	0.00
Dump Truck	45	Paved	60	0.001	0.000	2.16	0.00
Worker Commute	15	Paved	60	0.001	0.000	0.72	0.00
Offsite Total						2.91	0.00

Table 8
Substation Construction Emissions
Grading

Total						9.78	0.69

a From Table 51

b Emissions [lb/day] = number x miles/day x emission factor [lb/mi]

Earthwork Fugitive Particulate Matter Emissions

Activity	Activity Units	Activity Level	PM10 Emission Factor^a	PM2.5 Emission Factor^a	PM10 (lb/day)^b	PM2.5 (lb/day)^b
Soil Handling ^c	CY/day	450	1.62E-03	3.36E-04	0.73	0.15
Bulldozing, Scraping and Grading	hr/day	10	1.481	0.308	14.81	3.08
Storage Pile Wind Erosion ^d	acres	0.13	15.7	3.26	2.04	0.42
Total					17.57	3.65

a From Table 52

b Emissions [lb/day] = Emission factor [lb/activity unit] x Activity unit [units/day]

c Peak daily estimated from total of 40,000 CY over 90 days

d Based on 225 CY in each of two cones 7 ft. tall x 58 ft. diameter

Table 9
Substation Construction Emissions
Fencing

Emissions Summary

Source	VOC (lb/day)	CO (lb/day)	NOX (lb/day)	SOX (lb/day)	PM10 (lb/day)	PM2.5 (lb/day)	CO2e (MT)
Construction Equipment Exhaust	0.39	2.22	2.83	0.00	0.23	0.21	1.6
Onsite Motor Vehicle Exhaust	0.01	0.05	0.05	0.00	0.00	0.00	0.0
Onsite Motor Vehicle Fugitive PM	--	--	--	--	2.38	0.24	
Earthwork Fugitive PM	--	--	--	--	0.00	0.00	
Onsite Total	0.39	2.26	2.88	0.00	2.61	0.45	1.6
Offsite Motor Vehicle Exhaust	0.25	2.27	0.67	0.00	0.04	0.03	1.6
Offsite Motor Vehicle Fugitive PM	--	--	--	--	0.21	0.00	
Offsite Total	0.25	2.27	0.67	0.00	0.25	0.03	1.6
Total	0.65	4.53	3.55	0.01	2.86	0.48	3.1

Construction Equipment Summary

Equipment	Horse-power	Number	Days Used	Hours Used/Day
Bobcat	75	1	10	8

Construction Equipment Exhaust Emission Factors

Equipment	Horse-power	VOC (lb/hr) ^a	CO (lb/hr) ^a	NOX (lb/hr) ^a	SOX (lb/hr) ^a	PM10 (lb/hr) ^a	PM2.5 (lb/hr) ^b	CO2 (lb/hr) ^a	CH4 (lb/hr) ^a	Category
Bobcat	75	0.048	0.277	0.354	0.001	0.029	0.026	42.762	0.004	Skid Steer Loaders

^a From Table 48

^b Diesel PM2.5 emission factor [lb/hr] = PM10 emission factor [lb/hr] x PM2.5 fraction of PM10

PM2.5 Fraction= 0.920

From Appendix A, Final-Methodology to Calculate Particulate Matter (PM) 2.5

and PM 2.5 Significance Thresholds, SCAQMD, October 2006,

http://www.aqmd.gov/ceqa/handbook/PM2_5/PM2_5.html

Construction Equipment Daily Criteria Pollutant Exhaust Emissions

Equipment	VOC (lb/day) ^a	CO (lb/day) ^a	NOX (lb/day) ^a	SOX (lb/day) ^a	PM10 (lb/day) ^a	PM2.5 (lb/day) ^a
Bobcat	0.39	2.22	2.83	0.00	0.23	0.21
Total	0.39	2.22	2.83	0.00	0.23	0.21

^a Emissions [lb/day] = number x hours/day x emission factor [lb/hr]

Construction Equipment Total Greenhouse Gas Emissions

Equipment	CO2 (MT) ^a	CH4 (MT) ^a	CO2e (MT) ^b
Bobcat	1.6	0.0	1.6
Total	1.6	0.0	1.6

^a Emissions [metric tons, MT] = emission factor [lb/hr] x hours/day x Number x

days used x 453.6 [g/lb] / 1,000,000 [g/MT]

Emission factors are in Table 48

^b CO₂-equivalent (CO₂e) emission factors are CO₂ emissions plus 21 x CH₄ emissions, based on Table C.1 from California Climate Action

Registry General Reporting Protocol, Version 3.0, April 2008, http://www.climateaction.org/resources/docs/protocols/grp/GRP_V3_April2008_FINAL.pdf

Motor Vehicle Usage

Vehicle	Number	Days Used	Hours Used/Day	Miles/Day/Veh.
Onsite				
Flatbed Truck	1	10	N/A	2
Crewcab Truck	1	10	N/A	1
Offsite				
Flatbed Truck	1	10	N/A	14
Crewcab Truck	1	10	N/A	14
Worker Commute	4	10	N/A	60

Motor Vehicle Exhaust Emission Factors

Vehicle	Category	VOC (lb/mi) ^a	CO (lb/mi) ^a	NOX (lb/mi) ^a	SOX (lb/mi) ^a	PM10 (lb/mi) ^a	PM2.5 (lb/mi) ^b	CO2 (lb/mi) ^a	CH4 (lb/mi) ^a
Onsite									
Flatbed Truck	Delivery	2.24E-03	1.55E-02	1.73E-02	2.67E-05	6.50E-04	5.50E-04	2.77E+00	1.07E-04
Crewcab Truck	Delivery	2.24E-03	1.55E-02	1.73E-02	2.67E-05	6.50E-04	5.50E-04	2.77E+00	1.07E-04
Offsite									
Flatbed Truck	Delivery	2.24E-03	1.55E-02	1.73E-02	2.67E-05	6.50E-04	5.50E-04	2.77E+00	1.07E-04
Crewcab Truck	Delivery	2.24E-03	1.55E-02	1.73E-02	2.67E-05	6.50E-04	5.50E-04	2.77E+00	1.07E-04
Worker Commute	Passenger	7.96E-04	7.65E-03	7.76E-04	1.07E-05	8.98E-05	5.75E-05	1.10E+00	7.17E-05

^a From Table 49 or Table 50

Motor Vehicle Daily Criteria Pollutant Exhaust Emissions

Vehicle	VOC (lb/day) ^a	CO (lb/day) ^a	NOX (lb/day) ^a	SOX (lb/day) ^a	PM10 (lb/day) ^a	PM2.5 (lb/day) ^a
Onsite						
Flatbed Truck	0.00	0.03	0.03	0.00	0.00	0.00

Table 9
Substation Construction Emissions
Fencing

Crewcab Truck	0.00	0.02	0.02	0.00	0.00	0.00
Onsite Total	0.01	0.05	0.05	0.00	0.00	0.00
Offsite						
Flatbed Truck	0.03	0.22	0.24	0.00	0.01	0.01
Crewcab Truck	0.03	0.22	0.24	0.00	0.01	0.01
Worker Commute	0.19	1.84	0.19	0.00	0.02	0.01
Offsite Total	0.25	2.27	0.67	0.00	0.04	0.03
Total	0.26	2.32	0.72	0.00	0.04	0.03

^a Emissions [lb/day] = number x miles/day x emission factor [lb/mi]

Motor Vehicle Total Greenhouse Gas Emissions

Vehicle	CO2 (MT) ^a	CH4 (MT) ^a	CO2e (MT) ^b
Onsite			
Flatbed Truck	0.0	0.0	0.0
Crewcab Truck	0.0	0.0	0.0
Onsite Total	0.0	0.0	0.0
Offsite			
Flatbed Truck	0.2	0.0	0.2
Crewcab Truck	0.2	0.0	0.2
Worker Commute	1.2	0.0	1.2
Offsite Total	1.6	0.0	1.6
Total	1.6	0.0	1.6

^a Emissions [metric tons, MT] = emission factor [lb/hr] x miles/day x Number x days used x 453.6 [g/lb] / 1,000,000 [g/MT]

Emission factors are in Table 49 and Table 50

^b CO₂-equivalent (CO₂e) emission factors are CO₂ emissions plus 21 x CH₄ emissions, based on Table C.1 from California Climate Action Registry General Reporting Protocol, Version 3.0, April 2008, http://www.climateregistry.org/resources/docs/protocols/grp/GRP_V3_April2008_FINAL.pdf

Motor Vehicle Fugitive Particulate Matter Emissions

Vehicle	Number	Road Type	Miles/ Day/ Vehicle	PM10 Emission Factor (lb/mi) ^a	PM2.5 Emission Factor (lb/mi) ^a	PM10 Emissions (lb/day) ^b	PM2.5 Emissions (lb/day) ^b
Onsite							
Flatbed Truck	1	Unpaved	2	0.922	0.092	1.84	0.18
Crewcab Truck	1	Unpaved	1	0.532	0.053	0.53	0.05
Onsite Total						2.38	0.24
Offsite							
Flatbed Truck	1	Paved	14	0.001	0.000	0.01	0.00
Crewcab Truck	1	Paved	14	0.001	0.000	0.01	0.00
Worker Commute	4	Paved	60	0.001	0.000	0.19	0.00
Offsite Total						0.21	0.00
Total						2.59	0.24

^a From Table 51

^b Emissions [lb/day] = number x miles/day x emission factor [lb/mi]

Earthwork Fugitive Particulate Matter Emissions

Activity	Activity Units	Activity Level	PM10 Emission Factor ^a	PM2.5 Emission Factor ^a	PM10 (lb/day) ^b	PM2.5 (lb/day) ^b
Soil Handling	CY/day		1.62E-03	3.36E-04	0.00	0.00
Bulldozing, Scraping and Grading	hr/day		1.481	0.308	0.00	0.00
Storage Pile Wind Erosion	acres		15.7	3.26	0.00	0.00
Total					0.00	0.00

^a From Table 52

^b Emissions [lb/day] = Emission factor [lb/activity unit] x Activity unit [units/day]

Table 10
Substation Construction Emissions
Civil

Emissions Summary

Source	VOC (lb/day)	CO (lb/day)	NOX (lb/day)	SOX (lb/day)	PM10 (lb/day)	PM2.5 (lb/day)	CO2e (MT)
Construction Equipment Exhaust	1.90	16.26	14.83	0.02	1.02	0.93	47.9
Onsite Motor Vehicle Exhaust	0.01	0.04	0.09	0.00	0.00	0.00	0.3
Onsite Motor Vehicle Fugitive PM	--	--	--	--	3.11	0.31	
Earthwork Fugitive PM	--	--	--	--	0.01	0.00	
Onsite Total	1.90	16.30	14.92	0.02	4.14	1.25	48.2
Offsite Motor Vehicle Exhaust	1.88	10.32	17.48	0.03	0.88	0.75	24.7
Offsite Motor Vehicle Fugitive PM	--	--	--	--	0.48	0.00	
Offsite Total	1.88	10.32	17.48	0.03	1.36	0.75	24.7
Total	3.78	26.62	32.41	0.05	5.50	2.00	73.0

Construction Equipment Summary

Equipment	Horse-power	Number	Days Used	Hours Used/Day
Excavator	152	1	60	4
Foundation Auger	79	1	60	5
Backhoe	79	2	60	3
Skip Loader	75	1	60	3
Bobcat Skid Steer	75	2	60	3
Forklift	83	1	60	4
17-Ton Crane	125	1	45	2

Construction Equipment Exhaust Emission Factors

Equipment	Horse-power	VOC (lb/hr) ^a	CO (lb/hr) ^a	NOX (lb/hr) ^a	SOX (lb/hr) ^a	PM10 (lb/hr) ^a	PM2.5 (lb/hr) ^b	CO2 (lb/hr) ^a	CH4 (lb/hr) ^a	Category
Excavator	152	0.129	0.668	0.961	0.001	0.057	0.052	112.222	0.012	Excavators
Foundation Auger	79	0.051	0.472	0.503	0.001	0.033	0.030	77.122	0.005	Bore/Drill Rigs
Backhoe	79	0.076	0.356	0.491	0.001	0.043	0.040	51.728	0.007	Tractors/Loaders/Backhoes
Skip Loader	75	0.048	0.277	0.354	0.001	0.029	0.026	42.762	0.004	Skid Steer Loaders
Bobcat Skid Steer	75	0.048	0.277	0.354	0.001	0.029	0.026	42.762	0.004	Skid Steer Loaders
Forklift	83	0.004	1.408	0.172	0.000	0.003	0.003	31.235	0.033	Forklifts-Propane
17-Ton Crane	125	0.109	0.484	0.826	0.001	0.048	0.044	80.345	0.010	Cranes

^a From Table 48

^b Diesel PM2.5 emission factor [lb/hr] = PM10 emission factor [lb/hr] x PM2.5 fraction of PM10

PM2.5 Fraction= 0.920

From Appendix A, Final-Methodology to Calculate Particulate Matter (PM) 2.5

and PM 2.5 Significance Thresholds, SCAQMD, October 2006,

http://www.aqmd.gov/ceqa/handbook/PM2_5/PM2_5.html

Construction Equipment Daily Criteria Pollutant Exhaust Emissions

Equipment	VOC (lb/day) ^a	CO (lb/day) ^a	NOX (lb/day) ^a	SOX (lb/day) ^a	PM10 (lb/day) ^a	PM2.5 (lb/day) ^a
Excavator	0.52	2.67	3.85	0.01	0.23	0.21
Foundation Auger	0.26	2.36	2.51	0.00	0.16	0.15
Backhoe	0.46	2.13	2.95	0.00	0.26	0.24
Skip Loader	0.14	0.83	1.06	0.00	0.09	0.08
Bobcat Skid Steer	0.29	1.66	2.12	0.00	0.17	0.16
Forklift	0.02	5.63	0.69	0.00	0.01	0.01
17-Ton Crane	0.22	0.97	1.65	0.00	0.10	0.09
Total	1.90	16.26	14.83	0.02	1.02	0.93

^a Emissions [lb/day] = number x hours/day x emission factor [lb/hr]

Construction Equipment Total Greenhouse Gas Emissions

Equipment	CO2 (MT) ^a	CH4 (MT) ^a	CO2e (MT) ^b
Excavator	12.2	0.0	12.2
Foundation Auger	10.5	0.0	10.5
Backhoe	8.4	0.0	8.5
Skip Loader	3.5	0.0	3.5
Bobcat Skid Steer	13.1	0.0	13.2
Forklift	0.0	0.0	0.0
17-Ton Crane	0.0	0.0	0.0
Total	47.8	0.0	47.9

^a Emissions [metric tons, MT] = emission factor [lb/hr] x hours/day x Number x

days used x 453.6 [g/lb] / 1,000,000 [g/MT]

Emission factors are in Table 48

^b CO₂-equivalent (CO₂e) emission factors are CO₂ emissions plus 21 x CH₄ emissions, based on Table C.1 from California Climate Action

Registry General Reporting Protocol, Version 3.0, April 2008, http://www.climateregistry.org/resources/docs/protocols/grp/GRP_V3_April2008_FINAL.pdf

Motor Vehicle Usage

Vehicle	Number ^a	Days Used	Hours Used/Day	Miles/Day/Veh.
Onsite				
Dump Truck	1	60	N/A	1

Table 10
Substation Construction Emissions
Civil

Water Truck	1	60	N/A	1
Tool Truck	1	60	N/A	1
Concrete Truck	9	5	N/A	0.1
Offsite				
Water Truck	1	60	N/A	10
Concrete Truck	9	5	N/A	60
Tool Truck	1	60	N/A	14
Worker Commute	10	60	N/A	60

^a Concrete trucks based on 445 CY over 5 days and 10 CY/truck = 445 / 5 / 10 = 8.9

Motor Vehicle Exhaust Emission Factors

Vehicle	Category	VOC (lb/mi) ^a	CO (lb/mi) ^a	NOX (lb/mi) ^a	SOX (lb/mi) ^a	PM10 (lb/mi) ^a	PM2.5 (lb/mi) ^b	CO2 (lb/mi) ^a	CH4 (lb/mi) ^a
Onsite									
Dump Truck	HHDT	2.53E-03	1.02E-02	3.09E-02	4.04E-05	1.50E-03	1.29E-03	4.22E+00	1.17E-04
Water Truck	HHDT	2.53E-03	1.02E-02	3.09E-02	4.04E-05	1.50E-03	1.29E-03	4.22E+00	1.17E-04
Tool Truck	HHDT	2.53E-03	1.02E-02	3.09E-02	4.04E-05	1.50E-03	1.29E-03	4.22E+00	1.17E-04
Concrete Truck	Passenger	7.96E-04	7.65E-03	7.76E-04	1.07E-05	8.98E-05	5.75E-05	1.10E+00	7.17E-05
Offsite									
Water Truck	HHDT	2.53E-03	1.02E-02	3.09E-02	4.04E-05	1.50E-03	1.29E-03	4.22E+00	1.17E-04
Concrete Truck	HHDT	2.53E-03	1.02E-02	3.09E-02	4.04E-05	1.50E-03	1.29E-03	4.22E+00	1.17E-04
Tool Truck	Passenger	7.96E-04	7.65E-03	7.76E-04	1.07E-05	8.98E-05	5.75E-05	1.10E+00	7.17E-05
Worker Commute	Passenger	7.96E-04	7.65E-03	7.76E-04	1.07E-05	8.98E-05	5.75E-05	1.10E+00	7.17E-05

a From Table 49 or Table 50

Motor Vehicle Daily Criteria Pollutant Exhaust Emissions

Vehicle	VOC (lb/day) ^a	CO (lb/day) ^a	NOX (lb/day) ^a	SOX (lb/day) ^a	PM10 (lb/day) ^a	PM2.5 (lb/day) ^a
Onsite						
Dump Truck	0.00	0.01	0.03	0.00	0.00	0.00
Water Truck	0.00	0.01	0.03	0.00	0.00	0.00
Tool Truck	0.00	0.01	0.03	0.00	0.00	0.00
Concrete Truck	0.00	0.01	0.00	0.00	0.00	0.00
Onsite Total	0.01	0.04	0.09	0.00	0.00	0.00
Offsite						
Water Truck	0.03	0.10	0.31	0.00	0.01	0.01
Concrete Truck	1.36	5.52	16.70	0.02	0.81	0.70
Tool Truck	0.01	0.11	0.01	0.00	0.00	0.00
Worker Commute	0.48	4.59	0.47	0.01	0.05	0.03
Offsite Total	1.88	10.32	17.48	0.03	0.88	0.75
Total	1.89	10.36	17.58	0.03	0.88	0.75

^a Emissions [lb/day] = number x miles/day x emission factor [lb/mi]

Motor Vehicle Total Greenhouse Gas Emissions

Vehicle	CO2 (MT) ^a	CH4 (MT) ^a	CO2e (MT) ^b
Onsite			
Dump Truck	0.1	0.0	0.1
Water Truck	0.1	0.0	0.1
Tool Truck	0.1	0.0	0.1
Concrete Truck	0.0	0.0	0.0
Onsite Total	0.3	0.0	0.3
Offsite			
Water Truck	1.1	0.0	1.1
Concrete Truck	5.2	0.0	5.2
Tool Truck	0.4	0.0	0.4
Worker Commute	18.0	0.0	18.0
Offsite Total	24.7	0.0	24.7
Total	25.1	0.0	25.1

^a Emissions [metric tons, MT] = emission factor [lb/hr] x miles/day x Number x days used x 453.6 [g/lb] / 1,000,000 [g/MT]

Emission factors are in Table 49 and Table 50

^b CO₂-equivalent (CO₂e) emission factors are CO₂ emissions plus 21 x CH₄ emissions, based on Table C.1 from California Climate Action Registry General Reporting Protocol, Version 3.0, April 2008, http://www.climateregistry.org/resources/docs/protocols/grp/GRP_V3_April2008_FINAL.pdf

Motor Vehicle Fugitive Particulate Matter Emissions

Vehicle	Number	Road Type	Miles/Day/Vehicle	PM10 Emission Factor (lb/mi) ^a	PM2.5 Emission Factor (lb/mi) ^a	PM10 Emissions (lb/day) ^b	PM2.5 Emissions (lb/day) ^b
Onsite							
Dump Truck	1	Unpaved	1	0.922	0.092	0.92	0.09
Water Truck	1	Unpaved	1	0.922	0.092	0.92	0.09
Tool Truck	1	Unpaved	1	0.435	0.043	0.43	0.04
Concrete Truck	9	Unpaved	0.1	0.922	0.092	0.83	0.08
Onsite Total						3.11	0.31
Offsite							
Water Truck	1	Paved	10	0.001	0.000	0.01	0.00

Table 10
Substation Construction Emissions
Civil

Concrete Truck	9	Paved	60	0.001	0.000	0.43	0.00
Tool Truck	1	Paved	14	0.001	0.000	0.01	0.00
Worker Commute	10	Paved	60	0.001	0.000	0.48	0.00
Offsite Total						0.48	0.00
Total						3.59	0.31

a From Table 51

b Emissions [lb/day] = number x miles/day x emission factor [lb/mi]

Earthwork Fugitive Particulate Matter Emissions

Activity	Activity Units	Activity Level	PM10 Emission Factor ^a	PM2.5 Emission Factor ^a	PM10 (lb/day) ^b	PM2.5 (lb/day) ^b
Soil Handling ^c	CY/day	8	1.62E-03	3.36E-04	0.01	0.00
Bulldozing, Scraping and Grading	hr/day		1.481	0.308	0.00	0.00
Storage Pile Wind Erosion	acres		15.7	3.26	0.00	0.00
Total					0.01	0.00

a From Table 52

b Emissions [lb/day] = Emission factor [lb/activity unit] x Activity unit [units/day]

c Peak daily estimated from total of 450 CY over 60 days

Table 11
Substation Construction Emissions
Substation MEER

Emissions Summary

Source	VOC (lb/day)	CO (lb/day)	NOX (lb/day)	SOX (lb/day)	PM10 (lb/day)	PM2.5 (lb/day)	CO2e (MT)
Construction Equipment Exhaust	0.00	0.00	0.00	0.00	0.00	0.00	0.0
Onsite Motor Vehicle Exhaust	0.00	0.03	0.03	0.00	0.00	0.00	0.1
Onsite Motor Vehicle Fugitive PM	--	--	--	--	1.84	0.18	
Earthwork Fugitive PM	--	--	--	--	0.00	0.00	
Onsite Total	0.00	0.03	0.03	0.00	1.85	0.19	0.1
Offsite Motor Vehicle Exhaust	0.25	2.27	0.67	0.00	0.04	0.03	3.1
Offsite Motor Vehicle Fugitive PM	--	--	--	--	0.21	0.00	
Offsite Total	0.25	2.27	0.67	0.00	0.25	0.03	3.1
Total	0.26	2.30	0.71	0.00	2.10	0.21	3.2

Construction Equipment Summary

Equipment	Horse-power	Number	Days Used	Hours Used/Day
None				

Construction Equipment Exhaust Emission Factors

Equipment	Horse-power	VOC (lb/hr) ^a	CO (lb/hr) ^a	NOX (lb/hr) ^a	SOX (lb/hr) ^a	PM10 (lb/hr) ^a	PM2.5 (lb/hr) ^b	CO2 (lb/hr) ^a	CH4 (lb/hr) ^a
None		0.000	0.000	0.000	0.000	0.000	0.000	0.000	0.000

^a From Table 48

^b Diesel PM2.5 emission factor [lb/hr] = PM10 emission factor [lb/hr] x PM2.5 fraction of PM10

PM2.5 Fraction= 0.920

From Appendix A, Final--Methodology to Calculate Particulate Matter (PM) 2.5

and PM 2.5 Significance Thresholds, SCAQMD, October 2006,

http://www.aqmd.gov/ceqa/handbook/PM2_5/PM2_5.html

Construction Equipment Daily Criteria Pollutant Exhaust Emissions

Equipment	VOC (lb/day) ^a	CO (lb/day) ^a	NOX (lb/day) ^a	SOX (lb/day) ^a	PM10 (lb/day) ^a	PM2.5 (lb/day) ^a
None	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

^a Emissions [lb/day] = number x hours/day x emission factor [lb/hr]

Construction Equipment Total Greenhouse Gas Emissions

Equipment	CO2 (MT) ^a	CH4 (MT) ^a	CO2e (MT) ^b
None	0.0	0.0	0.0
Total	0.0	0.0	0.0

^a Emissions [metric tons, MT] = emission factor [lb/hr] x hours/day x Number x days used x 453.6 [g/lb] / 1,000,000 [g/MT]

Emission factors are in Table 48

^b CO₂-equivalent (CO₂e) emission factors are CO₂ emissions plus 21 x CH₄ emissions, based on Table C.1 from California Climate Action

Registry General Reporting Protocol, Version 3.0, April 2008, http://www.climateregistry.org/resources/docs/protocols/grp/GRP_V3_April2008_FINAL.pdf

Motor Vehicle Usage

Vehicle	Number	Days Used	Hours Used/Day	Miles/Day/Veh.
Onsite				
Carry-all Truck	1	20	N/A	1
Stake Truck	1	20	N/A	1
Offsite				
Carry-all Truck	1	20	N/A	14
Stake Truck	1	20	N/A	14
Worker Commute	4	20	N/A	60

Motor Vehicle Exhaust Emission Factors

Vehicle	Category	VOC (lb/mi) ^a	CO (lb/mi) ^a	NOX (lb/mi) ^a	SOX (lb/mi) ^a	PM10 (lb/mi) ^a	PM2.5 (lb/mi) ^b	CO2 (lb/mi) ^a	CH4 (lb/mi) ^a

Table 11
Substation Construction Emissions
Substation MEER

Onsite									
Carry-all Truck	Delivery	2.24E-03	1.55E-02	1.73E-02	2.67E-05	6.50E-04	5.50E-04	2.77E+00	1.07E-04
Stake Truck	Delivery	2.24E-03	1.55E-02	1.73E-02	2.67E-05	6.50E-04	5.50E-04	2.77E+00	1.07E-04
Offsite									
Carry-all Truck	Delivery	2.24E-03	1.55E-02	1.73E-02	2.67E-05	6.50E-04	5.50E-04	2.77E+00	1.07E-04
Stake Truck	Delivery	2.24E-03	1.55E-02	1.73E-02	2.67E-05	6.50E-04	5.50E-04	2.77E+00	1.07E-04
Worker Commute	Passenger	7.96E-04	7.65E-03	7.76E-04	1.07E-05	8.98E-05	5.75E-05	1.10E+00	7.17E-05

a From Table 49 or Table 50

Motor Vehicle Daily Criteria Pollutant Exhaust Emissions

Vehicle	VOC (lb/day) ^a	CO (lb/day) ^a	NOX (lb/day) ^a	SOX (lb/day) ^a	PM10 (lb/day) ^a	PM2.5 (lb/day) ^a
Onsite						
Carry-all Truck	0.00	0.02	0.02	0.00	0.00	0.00
Stake Truck	0.00	0.02	0.02	0.00	0.00	0.00
Onsite Total	0.00	0.03	0.03	0.00	0.00	0.00
Offsite						
Carry-all Truck	0.03	0.22	0.24	0.00	0.01	0.01
Stake Truck	0.03	0.22	0.24	0.00	0.01	0.01
Worker Commute	0.19	1.84	0.19	0.00	0.02	0.01
Offsite Total	0.25	2.27	0.67	0.00	0.04	0.03
Total	0.26	2.30	0.71	0.00	0.04	0.03

^a Emissions [lb/day] = number x miles/day x emission factor [lb/mi]

Motor Vehicle Total Greenhouse Gas Emissions

Vehicle	CO2 (MT) ^a	CH4 (MT) ^a	CO2e (MT) ^b
Onsite			
Carry-all Truck	0.0	0.0	0.0
Stake Truck	0.0	0.0	0.0
Onsite Total	0.1	0.0	0.1
Offsite			
Carry-all Truck	0.4	0.0	0.4
Stake Truck	0.4	0.0	0.4
Worker Commute	2.4	0.0	2.4
Offsite Total	3.1	0.0	3.1
Total	3.2	0.0	3.2

^a Emissions [metric tons, MT] = emission factor [lb/hr] x miles/day x Number x days used x 453.6 [g/lb] / 1,000,000 [g/MT]

Emission factors are in Table 49 and Table 50

^b CO₂-equivalent (CO₂e) emission factors are CO₂ emissions plus 21 x CH₄ emissions, based on Table C.1 from California Climate Action Registry General Reporting Protocol, Version 3.0, April 2008, http://www.climateregistry.org/resources/docs/protocols/grp/GRP_V3_April2008_FINAL.pdf

Motor Vehicle Fugitive Particulate Matter Emissions

Vehicle	Number	Road Type	Miles/Day/ Vehicle	PM10 Emission Factor (lb/mi) ^a	PM2.5 Emission Factor (lb/mi) ^a	PM10 Emissions (lb/day) ^b	PM2.5 Emissions (lb/day) ^b
Onsite							
Carry-all Truck	1	Unpaved	1	0.922	0.092	0.92	0.09
Stake Truck	1	Unpaved	1	0.922	0.092	0.92	0.09
Onsite Total						1.84	0.18
Offsite							
Carry-all Truck	1	Paved	14	0.001	0.000	0.01	0.00
Stake Truck	1	Paved	14	0.001	0.000	0.01	0.00
Worker Commute	4	Paved	60	0.001	0.000	0.19	0.00
Offsite Total						0.21	0.00
Total						2.06	0.18

a From Table 51

^b Emissions [lb/day] = number x miles/day x emission factor [lb/mi]

Earthwork Fugitive Particulate Matter Emissions

Table 11
Substation Construction Emissions
Substation MEER

Activity	Activity Units	Activity Level	PM10 Emission Factor ^a	PM2.5 Emission Factor ^a	PM10 (lb/day) ^b	PM2.5 (lb/day) ^b
Soil Handling	CY/day		1.62E-03	3.36E-04	0.00	0.00
Bulldozing, Scraping and Grading	hr/day		1.481	0.308	0.00	0.00
Storage Pile Wind Erosion	acres		15.7	3.26	0.00	0.00
Total					0.00	0.00

^a From Table 52

^b Emissions [lb/day] = Emission factor [lb/activity unit] x Activity unit [units/day]

Table 12
Substation Construction Emissions
Electrical

Emissions Summary

Source	VOC (lb/day)	CO (lb/day)	NOX (lb/day)	SOX (lb/day)	PM10 (lb/day)	PM2.5 (lb/day)	CO2e (MT)
Construction Equipment Exhaust	0.46	36.82	3.45	0.00	0.25	0.23	15.0
Onsite Motor Vehicle Exhaust	0.00	0.02	0.00	0.00	0.00	0.00	0.1
Onsite Motor Vehicle Fugitive PM	--	--	--	--	1.06	0.11	
Earthwork Fugitive PM	--	--	--	--	0.00	0.00	
Onsite Total	0.46	36.83	3.45	0.00	1.31	0.34	15.1
Offsite Motor Vehicle Exhaust	0.50	4.81	0.49	0.01	0.06	0.04	22.0
Offsite Motor Vehicle Fugitive PM	--	--	--	--	0.50	0.00	
Offsite Total	0.50	4.81	0.49	0.01	0.56	0.04	22.0
Total	0.96	41.64	3.94	0.01	1.87	0.37	37.1

Construction Equipment Summary

Equipment	Horse-power	Number	Days Used	Hours Used/Day
Scissor Lift	25	2	70	3
Manlift	25	2	70	3
Reach Manlift	25	1	70	4
15-Ton Crane	125	1	70	3

Construction Equipment Exhaust Emission Factors

Equipment	Horse-power	VOC (lb/hr) ^a	CO (lb/hr) ^a	NOX (lb/hr) ^a	SOX (lb/hr) ^a	PM10 (lb/hr) ^a	PM2.5 (lb/hr) ^b	CO2 (lb/hr) ^a	CH4 (lb/hr) ^a	Category
Scissor Lift	25	0.008	2.210	0.061	0.000	0.007	0.006	13.000	0.070	Aerial Lifts-Propane
Manlift	25	0.008	2.210	0.061	0.000	0.007	0.006	13.000	0.070	Aerial Lifts-Propane
Reach Manlift	25	0.008	2.210	0.061	0.000	0.007	0.006	13.000	0.070	Aerial Lifts-Propane
15-Ton Crane	125	0.109	0.484	0.826	0.001	0.048	0.044	80.345	0.010	Cranes

^a From Table 48

^b Diesel PM2.5 emission factor [lb/hr] = PM10 emission factor [lb/hr] x PM2.5 fraction of PM10

PM2.5 Fraction= 0.920

From Appendix A, Final-Methodology to Calculate Particulate Matter (PM) 2.5

and PM 2.5 Significance Thresholds, SCAQMD, October 2006,

http://www.aqmd.gov/ceqa/handbook/PM2_5/PM2_5.html

Construction Equipment Daily Criteria Pollutant Exhaust Emissions

Equipment	VOC (lb/day) ^a	CO (lb/day) ^a	NOX (lb/day) ^a	SOX (lb/day) ^a	PM10 (lb/day) ^a	PM2.5 (lb/day) ^a
Scissor Lift	0.05	13.26	0.36	0.00	0.04	0.04
Manlift	0.05	13.26	0.36	0.00	0.04	0.04
Reach Manlift	0.03	8.84	0.24	0.00	0.03	0.02
15-Ton Crane	0.33	1.45	2.48	0.00	0.14	0.13
Total	0.46	36.82	3.45	0.00	0.25	0.23

^a Emissions [lb/day] = number x hours/day x emission factor [lb/hr]

Construction Equipment Total Greenhouse Gas Emissions

Equipment	CO2 (MT) ^a	CH4 (MT) ^a	CO2e (MT) ^b
Scissor Lift	2.5	0.0	2.8
Manlift	2.5	0.0	2.8
Reach Manlift	1.7	0.0	1.8
15-Ton Crane	7.7	0.0	7.7
Total	14.3	0.0	15.0

^a Emissions [metric tons, MT] = emission factor [lb/hr] x hours/day x Number x

days used x 453.6 [g/lb] / 1,000,000 [g/MT]

Emission factors are in Table 48

^b CO₂-equivalent (CO₂e) emission factors are CO₂ emissions plus 21 x CH₄ emissions, based on Table C.1 from California Climate Action

Registry General Reporting Protocol, Version 3.0, April 2008, http://www.climateregistry.org/resources/docs/protocols/grp/GRP_V3_April2008_FINAL.pdf

Motor Vehicle Usage

Vehicle	Number	Days Used	Hours Used/Day	Miles/Day/Veh.
Onsite				
Crew Truck	2	70	N/A	1
Offsite				
Crew Truck	2	70	N/A	14
Worker Commute	10	70	N/A	60

Motor Vehicle Exhaust Emission Factors

Vehicle	Category	VOC (lb/mi) ^a	CO (lb/mi) ^a	NOX (lb/mi) ^a	SOX (lb/mi) ^a	PM10 (lb/mi) ^a	PM2.5 (lb/mi) ^b	CO2 (lb/mi) ^a	CH4 (lb/mi) ^a
Onsite									
Crew Truck	Passenger	7.96E-04	7.65E-03	7.76E-04	1.07E-05	8.98E-05	5.75E-05	1.10E+00	7.17E-05
Offsite									
Crew Truck	Passenger	7.96E-04	7.65E-03	7.76E-04	1.07E-05	8.98E-05	5.75E-05	1.10E+00	7.17E-05
Worker Commute	Passenger	7.96E-04	7.65E-03	7.76E-04	1.07E-05	8.98E-05	5.75E-05	1.10E+00	7.17E-05

^a From Table 49 or Table 50

Table 12
Substation Construction Emissions
Electrical

Motor Vehicle Daily Criteria Pollutant Exhaust Emissions

Vehicle	VOC (lb/day) ^a	CO (lb/day) ^a	NOX (lb/day) ^a	SOX (lb/day) ^a	PM10 (lb/day) ^a	PM2.5 (lb/day) ^a
Onsite						
Crew Truck	0.00	0.02	0.00	0.00	0.00	0.00
Onsite Total	0.00	0.02	0.00	0.00	0.00	0.00
Offsite						
Crew Truck	0.02	0.21	0.02	0.00	0.00	0.00
Worker Commute	0.48	4.59	0.47	0.01	0.05	0.03
Offsite Total	0.50	4.81	0.49	0.01	0.06	0.04
Total	0.50	4.82	0.49	0.01	0.06	0.04

^a Emissions [lb/day] = number x miles/day x emission factor [lb/mi]

Motor Vehicle Total Greenhouse Gas Emissions

Vehicle	CO2 (MT) ^a	CH4 (MT) ^a	CO2e (MT) ^b
Onsite			
Crew Truck	0.1	0.0	0.1
Onsite Total	0.1	0.0	0.1
Offsite			
Crew Truck	1.0	0.0	1.0
Worker Commute	21.0	0.0	21.0
Offsite Total	22.0	0.0	22.0
Total	22.0	0.0	22.1

^a Emissions [metric tons, MT] = emission factor [lb/hr] x miles/day x Number x days used x 453.6 [g/lb] / 1,000,000 [g/MT]

Emission factors are in Table 49 and Table 50

^b CO₂-equivalent (CO₂e) emission factors are CO₂ emissions plus 21 x CH₄ emissions, based on Table C.1 from California Climate Action Registry General Reporting Protocol, Version 3.0, April 2008, http://www.climateregistry.org/resources/docs/protocols/grp/GRP_V3_April2008_FINAL.pdf

Motor Vehicle Fugitive Particulate Matter Emissions

Vehicle	Number	Road Type	Miles/Day/Vehicle	PM10 Emission Factor (lb/mi) ^a	PM2.5 Emission Factor (lb/mi) ^a	PM10 Emissions (lb/day) ^b	PM2.5 Emissions (lb/day) ^b
Onsite							
Crew Truck	2	Unpaved	1	0.532	0.053	1.06	0.11
Onsite Total						1.06	0.11
Offsite							
Crew Truck	2	Paved	14	0.001	0.000	0.02	0.00
Worker Commute	10	Paved	60	0.001	0.000	0.48	0.00
Offsite Total						0.50	0.00
Total						1.57	0.11

^a From Table 51

^b Emissions [lb/day] = number x miles/day x emission factor [lb/mi]

Earthwork Fugitive Particulate Matter Emissions

Activity	Activity Units	Activity Level	PM10 Emission Factor ^a	PM2.5 Emission Factor ^a	PM10 (lb/day) ^b	PM2.5 (lb/day) ^b
Soil Handling	CY/day		1.62E-03	3.36E-04	0.00	0.00
Bulldozing, Scraping and Grading	hr/day		1.481	0.308	0.00	0.00
Storage Pile Wind Erosion	acres		15.7	3.26	0.00	0.00
Total					0.00	0.00

^a From Table 52

^b Emissions [lb/day] = Emission factor [lb/activity unit] x Activity unit [units/day]

Table 13
Substation Construction Emissions
Wiring

Emissions Summary

Source	VOC (lb/day)	CO (lb/day)	NOX (lb/day)	SOX (lb/day)	PM10 (lb/day)	PM2.5 (lb/day)	CO2e (MT)
Construction Equipment Exhaust	0.03	8.84	0.24	0.00	0.03	0.02	0.7
Onsite Motor Vehicle Exhaust	0.00	0.00	0.00	0.00	0.00	0.00	0.0
Onsite Motor Vehicle Fugitive PM	--	--	--	--	0.00	0.00	
Earthwork Fugitive PM	--	--	--	--	0.00	0.00	
Onsite Total	0.03	8.84	0.24	0.00	0.03	0.02	0.7
Offsite Motor Vehicle Exhaust	0.24	2.30	0.23	0.00	0.03	0.02	3.8
Offsite Motor Vehicle Fugitive PM	--	--	--	--	0.24	0.00	
Offsite Total	0.24	2.30	0.23	0.00	0.27	0.02	3.8
Total	0.27	11.14	0.48	0.00	0.29	0.04	4.4

Construction Equipment Summary

Equipment	Horse-power	Number	Days Used	Hours Used/Day
Manlift	25	1	25	4

Construction Equipment Exhaust Emission Factors

Equipment	Horse-power	VOC (lb/hr) ^a	CO (lb/hr) ^a	NOX (lb/hr) ^a	SOX (lb/hr) ^a	PM10 (lb/hr) ^a	PM2.5 (lb/hr) ^b	CO2 (lb/hr) ^a	CH4 (lb/hr) ^a	Category
Manlift	25	0.008	2.210	0.061	0.000	0.007	0.006	13.000	0.070	Aerial Lifts-Propane

^a From Table 48

^b Diesel PM2.5 emission factor [lb/hr] = PM10 emission factor [lb/hr] x PM2.5 fraction of PM10

PM2.5 Fraction= 0.920

From Appendix A, Final-Methodology to Calculate Particulate Matter (PM) 2.5

and PM 2.5 Significance Thresholds, SCAQMD, October 2006,

http://www.aqmd.gov/ceqa/handbook/PM2_5/PM2_5.html

Construction Equipment Daily Criteria Pollutant Exhaust Emissions

Equipment	VOC (lb/day) ^a	CO (lb/day) ^a	NOX (lb/day) ^a	SOX (lb/day) ^a	PM10 (lb/day) ^a	PM2.5 (lb/day) ^a
Manlift	0.03	8.84	0.24	0.00	0.03	0.02
Total	0.03	8.84	0.24	0.00	0.03	0.02

^a Emissions [lb/day] = number x hours/day x emission factor [lb/hr]

Construction Equipment Total Greenhouse Gas Emissions

Equipment	CO2 (MT) ^a	CH4 (MT) ^a	CO2e (MT) ^b
Manlift	0.6	0.0	0.7
Total	0.6	0.0	0.7

^a Emissions [metric tons, MT] = emission factor [lb/hr] x hours/day x Number x

days used x 453.6 [g/lb] / 1,000,000 [g/MT]

Emission factors are in Table 48

^b CO₂-equivalent (CO₂e) emission factors are CO₂ emissions plus 21 x CH₄ emissions, based on Table C.1 from California Climate Action

Registry General Reporting Protocol, Version 3.0, April 2008, http://www.climateregistry.org/resources/docs/protocols/grp/GRP_V3_April2008_FINAL.pdf

Motor Vehicle Usage

Vehicle	Number	Days Used	Hours Used/Day	Miles/Day/Veh.
Onsite				
None				
Offsite				
Worker Commute	5	25	N/A	60

Motor Vehicle Exhaust Emission Factors

Vehicle	Category	VOC (lb/mi) ^a	CO (lb/mi) ^a	NOX (lb/mi) ^a	SOX (lb/mi) ^a	PM10 (lb/mi) ^a	PM2.5 (lb/mi) ^b	CO2 (lb/mi) ^a	CH4 (lb/mi) ^a
Onsite									
None									
Offsite									
Worker Commute	Passenger	7.96E-04	7.65E-03	7.76E-04	1.07E-05	8.98E-05	5.75E-05	1.10E+00	7.17E-05

^a From Table 49 or Table 50

Motor Vehicle Daily Criteria Pollutant Exhaust Emissions

Vehicle	VOC (lb/day) ^a	CO (lb/day) ^a	NOX (lb/day) ^a	SOX (lb/day) ^a	PM10 (lb/day) ^a	PM2.5 (lb/day) ^a
Onsite						
None	0.00	0.00	0.00	0.00	0.00	0.00
Onsite Total	0.00	0.00	0.00	0.00	0.00	0.00
Offsite						
Worker Commute	0.24	2.30	0.23	0.00	0.03	0.02
Offsite Total	0.24	2.30	0.23	0.00	0.03	0.02
Total	0.24	2.30	0.23	0.00	0.03	0.02

^a Emissions [lb/day] = number x miles/day x emission factor [lb/mi]

Motor Vehicle Total Greenhouse Gas Emissions

Table 13
Substation Construction Emissions
Wiring

Vehicle	CO2 (MT) ^a	CH4 (MT) ^a	CO2e (MT) ^b
Onsite			
None	0.0	0.0	0.0
Onsite Total	0.0	0.0	0.0
Offsite			
Worker Commute	3.7	0.0	3.8
Offsite Total	3.7	0.0	3.8
Total	3.7	0.0	3.8

^a Emissions [metric tons, MT] = emission factor [lb/hr] x miles/day x Number x

days used x 453.6 [g/lb] / 1,000,000 [g/MT]

Emission factors are in Table 49 and Table 50

^b CO₂-equivalent (CO₂e) emission factors are CO₂ emissions plus 21 x CH₄ emissions, based on Table C.1 from California Climate Action

Registry General Reporting Protocol, Version 3.0, April 2008, http://www.climateregistry.org/resources/docs/protocols/grp/GRP_V3_April2008_FINAL.pdf

Motor Vehicle Fugitive Particulate Matter Emissions

Vehicle	Number	Road Type	Miles/ Day/ Vehicle	PM10 Emission Factor (lb/mi) ^a	PM2.5 Emission Factor (lb/mi) ^a	PM10 Emissions (lb/day) ^b	PM2.5 Emissions (lb/day) ^b
Onsite							
None							
Onsite Total						0.00	0.00
Offsite							
Worker Commute	5	Paved	60	0.001	0.000	0.24	0.00
Offsite Total						0.24	0.00
Total						0.24	0.00

^a From Table 51

^b Emissions [lb/day] = number x miles/day x emission factor [lb/mi]

Earthwork Fugitive Particulate Matter Emissions

Activity	Activity Units	Activity Level	PM10 Emission Factor ^a	PM2.5 Emission Factor ^a	PM10 (lb/day) ^b	PM2.5 (lb/day) ^b
Soil Handling	CY/day		1.62E-03	3.36E-04	0.00	0.00
Bulldozing, Scraping and Grading	hr/day		1.481	0.308	0.00	0.00
Storage Pile Wind Erosion	acres		15.7	3.26	0.00	0.00
Total					0.00	0.00

^a From Table 52

^b Emissions [lb/day] = Emission factor [lb/activity unit] x Activity unit [units/day]

Table 14
Substation Construction Emissions
Transformers

Emissions Summary

Source	VOC (lb/day)	CO (lb/day)	NOX (lb/day)	SOX (lb/day)	PM10 (lb/day)	PM2.5 (lb/day)	CO2e (MT)
Construction Equipment Exhaust	0.68	11.35	5.99	0.01	0.30	0.28	9.2
Onsite Motor Vehicle Exhaust	0.00	0.03	0.03	0.00	0.00	0.00	0.1
Onsite Motor Vehicle Fugitive PM	--	--	--	--	1.99	0.20	
Earthwork Fugitive PM	--	--	--	--	0.00	0.00	
Onsite Total	0.68	11.38	6.02	0.01	2.29	0.48	9.3
Offsite Motor Vehicle Exhaust	0.31	2.97	0.30	0.00	0.03	0.02	5.8
Offsite Motor Vehicle Fugitive PM	--	--	--	--	0.31	0.00	
Offsite Total	0.31	2.97	0.30	0.00	0.35	0.02	5.8
Total	0.99	14.35	6.32	0.01	2.64	0.50	15.1

Construction Equipment Summary

Equipment	Horse-power	Number	Days Used	Hours Used/Day
Crane	125	1	30	6
Forklift	25	1	30	6

Construction Equipment Exhaust Emission Factors

Equipment	Horse-power	VOC (lb/hr) ^a	CO (lb/hr) ^a	NOX (lb/hr) ^a	SOX (lb/hr) ^a	PM10 (lb/hr) ^a	PM2.5 (lb/hr) ^b	CO2 (lb/hr) ^a	CH4 (lb/hr) ^a	Category
Crane	125	0.109	0.484	0.826	0.001	0.048	0.044	80.345	0.010	Cranes
Forklift	83	0.004	1.408	0.172	0.000	0.003	0.003	31.235	0.033	Forklifts-Propane

^a From Table 48

^b Diesel PM2.5 emission factor [lb/hr] = PM10 emission factor [lb/hr] x PM2.5 fraction of PM10

PM2.5 Fraction= 0.920

From Appendix A, Final-Methodology to Calculate Particulate Matter (PM) 2.5

and PM 2.5 Significance Thresholds, SCAQMD, October 2006,

http://www.aqmd.gov/ceqa/handbook/PM2_5/PM2_5.html

Construction Equipment Daily Criteria Pollutant Exhaust Emissions

Equipment	VOC (lb/day) ^a	CO (lb/day) ^a	NOX (lb/day) ^a	SOX (lb/day) ^a	PM10 (lb/day) ^a	PM2.5 (lb/day) ^a
Crane	0.65	2.90	4.96	0.01	0.29	0.26
Forklift	0.02	8.45	1.03	0.00	0.02	0.02
Total	0.68	11.35	5.99	0.01	0.30	0.28

^a Emissions [lb/day] = number x hours/day x emission factor [lb/hr]

Construction Equipment Total Greenhouse Gas Emissions

Equipment	CO2 (MT) ^a	CH4 (MT) ^a	CO2e (MT) ^b
Crane	6.6	0.0	6.6
Forklift	2.6	0.0	2.6
Total	9.1	0.0	9.2

^a Emissions [metric tons, MT] = emission factor [lb/hr] x hours/day x Number x

days used x 453.6 [g/lb] / 1,000,000 [g/MT]

Emission factors are in Table 48

^b CO₂-equivalent (CO₂e) emission factors are CO₂ emissions plus 21 x CH₄ emissions, based on Table C.1 from California Climate Action

Registry General Reporting Protocol, Version 3.0, April 2008, http://www.climateregistry.org/resources/docs/protocols/grp/GRP_V3_April2008_FINAL.pdf

Motor Vehicle Usage

Vehicle	Number	Days Used	Hours Used/Day	Miles/Day/Veh.
Onsite				
Crew Truck	2	30	N/A	1
Low Bed Truck	1	30	N/A	1
Offsite				
Crew Truck	2	30	N/A	14
Worker Commute	6	30	N/A	60

Motor Vehicle Exhaust Emission Factors

Vehicle	Category	VOC (lb/mi) ^a	CO (lb/mi) ^a	NOX (lb/mi) ^a	SOX (lb/mi) ^a	PM10 (lb/mi) ^a	PM2.5 (lb/mi) ^b	CO2 (lb/mi) ^a	CH4 (lb/mi) ^a
Onsite									
Crew Truck	Passenger	7.96E-04	7.65E-03	7.76E-04	1.07E-05	8.98E-05	5.75E-05	1.10E+00	7.17E-05
Low Bed Truck	HDDT	2.53E-03	1.02E-02	3.09E-02	4.04E-05	1.50E-03	1.29E-03	4.22E+00	1.17E-04
Offsite									
Crew Truck	Passenger	7.96E-04	7.65E-03	7.76E-04	1.07E-05	8.98E-05	5.75E-05	1.10E+00	7.17E-05
Worker Commute	Passenger	7.96E-04	7.65E-03	7.76E-04	1.07E-05	8.98E-05	5.75E-05	1.10E+00	7.17E-05

^a From Table 49 or Table 50

Motor Vehicle Daily Criteria Pollutant Exhaust Emissions

Vehicle	VOC (lb/day) ^a	CO (lb/day) ^a	NOX (lb/day) ^a	SOX (lb/day) ^a	PM10 (lb/day) ^a	PM2.5 (lb/day) ^a

Table 14
Substation Construction Emissions
Transformers

Onsite						
Crew Truck	0.00	0.02	0.00	0.00	0.00	0.00
Low Bed Truck	0.00	0.01	0.03	0.00	0.00	0.00
Onsite Total	0.00	0.03	0.03	0.00	0.00	0.00
Offsite						
Crew Truck	0.02	0.21	0.02	0.00	0.00	0.00
Worker Commute	0.29	2.76	0.28	0.00	0.03	0.02
Offsite Total	0.31	2.97	0.30	0.00	0.03	0.02
Total	0.31	3.00	0.33	0.00	0.04	0.02

^a Emissions [lb/day] = number x miles/day x emission factor [lb/mi]

Motor Vehicle Total Greenhouse Gas Emissions

Vehicle	CO2 (MT)^a	CH4 (MT)^a	CO2e (MT)^b
Onsite			
Crew Truck	0.0	0.0	0.0
Low Bed Truck	0.1	0.0	0.1
Onsite Total	0.1	0.0	0.1
Offsite			
Crew Truck	0.4	0.0	0.4
Worker Commute	5.4	0.0	5.4
Offsite Total	5.8	0.0	5.8
Total	5.9	0.0	5.9

^a Emissions [metric tons, MT] = emission factor [lb/hr] x miles/day x Number x days used x 453.6 [g/lb] / 1,000,000 [g/MT]

Emission factors are in Table 49 and Table 50

^b CO₂-equivalent (CO₂e) emission factors are CO₂ emissions plus 21 x CH₄ emissions, based on Table C.1 from California Climate Action Registry General Reporting Protocol, Version 3.0, April 2008, http://www.climateregistry.org/resources/docs/protocols/grp/GRP_V3_April2008_FINAL.pdf

Motor Vehicle Fugitive Particulate Matter Emissions

Vehicle	Number	Road Type	Miles/Day/Vehicle	PM10 Emission Factor (lb/mi)^a	PM2.5 Emission Factor (lb/mi)^a	PM10 Emissions (lb/day)^b	PM2.5 Emissions (lb/day)^b
Onsite							
Crew Truck	2	Unpaved	1	0.532	0.053	1.06	0.11
Low Bed Truck	1	Unpaved	1	0.922	0.092	0.92	0.09
Onsite Total						1.99	0.20
Offsite							
Crew Truck	2	Paved	14	0.001	0.000	0.02	0.00
Worker Commute	6	Paved	60	0.001	0.000	0.29	0.00
Offsite Total						0.31	0.00
Total						2.30	0.20

^a From Table 51

^b Emissions [lb/day] = number x miles/day x emission factor [lb/mi]

Earthwork Fugitive Particulate Matter Emissions

Activity	Activity Units	Activity Level	PM10 Emission Factor^a	PM2.5 Emission Factor^a	PM10 (lb/day)^b	PM2.5 (lb/day)^b
Soil Handling	CY/day		1.62E-03	3.36E-04	0.00	0.00
Bulldozing, Scraping and Grading	hr/day		1.481	0.308	0.00	0.00
Storage Pile Wind Erosion	acres		15.7	3.26	0.00	0.00
Total					0.00	0.00

^a From Table 52

^b Emissions [lb/day] = Emission factor [lb/activity unit] x Activity unit [units/day]

Table 15
Substation Construction Emissions
Maintenance Crew Equipment Check

Emissions Summary

Source	VOC (lb/day)	CO (lb/day)	NOX (lb/day)	SOX (lb/day)	PM10 (lb/day)	PM2.5 (lb/day)	CO2e (MT)
Construction Equipment Exhaust	0.00	0.00	0.00	0.00	0.00	0.00	0.0
Onsite Motor Vehicle Exhaust	0.00	0.01	0.00	0.00	0.00	0.00	0.0
Onsite Motor Vehicle Fugitive PM	--	--	--	--	0.73	0.07	
Earthwork Fugitive PM	--	--	--	--	0.00	0.00	
Onsite Total	0.00	0.01	0.00	0.00	0.73	0.07	0.0
Offsite Motor Vehicle Exhaust	0.12	1.13	0.11	0.00	0.01	0.01	2.2
Offsite Motor Vehicle Fugitive PM	--	--	--	--	0.12	0.00	
Offsite Total	0.12	1.13	0.11	0.00	0.13	0.01	2.2
Total	0.12	1.14	0.12	0.00	0.86	0.08	2.2

Construction Equipment Summary

Equipment	Horse-power	Number	Days Used	Hours Used/Day
None				

Construction Equipment Exhaust Emission Factors

Equipment	Horse-power	VOC (lb/hr) ^a	CO (lb/hr) ^a	NOX (lb/hr) ^a	SOX (lb/hr) ^a	PM10 (lb/hr) ^a	PM2.5 (lb/hr) ^b	CO2 (lb/hr) ^a	CH4 (lb/hr) ^a	Category
None										

^a From Table 48

^b Diesel PM2.5 emission factor [lb/hr] = PM10 emission factor [lb/hr] x PM2.5 fraction of PM10

PM2.5 Fraction= 0.920

From Appendix A, Final-Methodology to Calculate Particulate Matter (PM) 2.5

and PM 2.5 Significance Thresholds, SCAQMD, October 2006,

http://www.aqmd.gov/ceqa/handbook/PM2_5/PM2_5.html

Construction Equipment Daily Criteria Pollutant Exhaust Emissions

Equipment	VOC (lb/day) ^a	CO (lb/day) ^a	NOX (lb/day) ^a	SOX (lb/day) ^a	PM10 (lb/day) ^a	PM2.5 (lb/day) ^a
None	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

^a Emissions [lb/day] = number x hours/day x emission factor [lb/hr]

Construction Equipment Total Greenhouse Gas Emissions

Equipment	CO2 (MT) ^a	CH4 (MT) ^a	CO2e (MT) ^b
None	0.0	0.0	0.0
Total	0.0	0.0	0.0

^a Emissions [metric tons, MT] = emission factor [lb/hr] x hours/day x Number x

days used x 453.6 [g/lb] / 1,000,000 [g/MT]

Emission factors are in Table 48

^b CO₂-equivalent (CO₂e) emission factors are CO₂ emissions plus 21 x CH₄ emissions, based on Table C.1 from California Climate Action

Registry General Reporting Protocol, Version 3.0, April 2008, http://www.climateregistry.org/resources/docs/protocols/grp/GRP_V3_April2008_FINAL.pdf

Motor Vehicle Usage

Vehicle	Number	Days Used	Hours Used/Day	Miles/Day/Veh.
Onsite				
Maintenance Truck	2	30	N/A	0.5
Offsite				
Maintenance Truck	2	30	N/A	14
Worker Commute	2	30	N/A	60

Motor Vehicle Exhaust Emission Factors

Vehicle	Category	VOC (lb/mi) ^a	CO (lb/mi) ^a	NOX (lb/mi) ^a	SOX (lb/mi) ^a	PM10 (lb/mi) ^a	PM2.5 (lb/mi) ^b	CO2 (lb/mi) ^a	CH4 (lb/mi) ^a
Onsite									
Maintenance Truck	Passenger	7.96E-04	7.65E-03	7.76E-04	1.07E-05	8.98E-05	5.75E-05	1.10E+00	7.17E-05
Offsite									
Maintenance Truck	Passenger	7.96E-04	7.65E-03	7.76E-04	1.07E-05	8.98E-05	5.75E-05	1.10E+00	7.17E-05
Worker Commute	Passenger	7.96E-04	7.65E-03	7.76E-04	1.07E-05	8.98E-05	5.75E-05	1.10E+00	7.17E-05

^a From Table 49 or Table 50

Motor Vehicle Daily Criteria Pollutant Exhaust Emissions

Vehicle	VOC (lb/day) ^a	CO (lb/day) ^a	NOX (lb/day) ^a	SOX (lb/day) ^a	PM10 (lb/day) ^a	PM2.5 (lb/day) ^a
Onsite						
Maintenance Truck	0.00	0.01	0.00	0.00	0.00	0.00
Onsite Total	0.00	0.01	0.00	0.00	0.00	0.00
Offsite						
Maintenance Truck	0.02	0.21	0.02	0.00	0.00	0.00
Worker Commute	0.10	0.92	0.09	0.00	0.01	0.01

Table 15
Substation Construction Emissions
Maintenance Crew Equipment Check

Offsite Total	0.12	1.13	0.11	0.00	0.01	0.01
Total	0.12	1.14	0.12	0.00	0.01	0.01

^a Emissions [lb/day] = number x miles/day x emission factor [lb/mi]

Motor Vehicle Total Greenhouse Gas Emissions

Vehicle	CO2 (MT) ^a	CH4 (MT) ^a	CO2e (MT) ^b
Onsite			
Maintenance Truck	0.0	0.0	0.0
Onsite Total	0.0	0.0	0.0
Offsite			
Maintenance Truck	0.4	0.0	0.4
Worker Commute	1.8	0.0	1.8
Offsite Total	2.2	0.0	2.2
Total	2.2	0.0	2.2

^a Emissions [metric tons, MT] = emission factor [lb/hr] x miles/day x Number x days used x 453.6 [g/lb] / 1,000,000 [g/MT]

Emission factors are in Table 49 and Table 50

^b CO₂-equivalent (CO₂e) emission factors are CO₂ emissions plus 21 x CH₄ emissions, based on Table C.1 from California Climate Action

Registry General Reporting Protocol, Version 3.0, April 2008, http://www.climateregistry.org/resources/docs/protocols/grp/GRP_V3_April2008_FINAL.pdf

Motor Vehicle Fugitive Particulate Matter Emissions

Vehicle	Number	Road Type	Miles/Day/ Vehicle	PM10 Emission Factor (lb/mi) ^a	PM2.5 Emission Factor (lb/mi) ^a	PM10 Emissions (lb/day) ^b	PM2.5 Emissions (lb/day) ^b
Onsite							
Maintenance Truck	2	Unpaved	0.5	0.726	0.073	0.73	0.07
Onsite Total						0.73	0.07
Offsite							
Maintenance Truck	2	Paved	14	0.001	0.000	0.02	0.00
Worker Commute	2	Paved	60	0.001	0.000	0.10	0.00
Offsite Total						0.12	0.00
Total						0.84	0.07

^a From Table 51

^b Emissions [lb/day] = number x miles/day x emission factor [lb/mi]

Earthwork Fugitive Particulate Matter Emissions

Activity	Activity Units	Activity Level	PM10 Emission Factor ^a	PM2.5 Emission Factor ^a	PM10 (lb/day) ^b	PM2.5 (lb/day) ^b
Soil Handling	CY/day		1.62E-03	3.36E-04	0.00	0.00
Bulldozing, Scraping and Grading	hr/day		1.481	0.308	0.00	0.00
Storage Pile Wind Erosion	acres		15.7	3.26	0.00	0.00
Total					0.00	0.00

^a From Table 52

^b Emissions [lb/day] = Emission factor [lb/activity unit] x Activity unit [units/day]

Table 16
Substation Construction Emissions
Testing

Emissions Summary

Source	VOC (lb/day)	CO (lb/day)	NOX (lb/day)	SOX (lb/day)	PM10 (lb/day)	PM2.5 (lb/day)	CO2e (MT)
Construction Equipment Exhaust	0.00	0.00	0.00	0.00	0.00	0.00	0.0
Onsite Motor Vehicle Exhaust	0.00	0.00	0.00	0.00	0.00	0.00	0.0
Onsite Motor Vehicle Fugitive PM	--	--	--	--	0.27	0.03	
Earthwork Fugitive PM	--	--	--	--	0.00	0.00	
Onsite Total	0.00	0.00	0.00	0.00	0.27	0.03	0.0
Offsite Motor Vehicle Exhaust	0.11	1.03	0.10	0.00	0.01	0.01	5.4
Offsite Motor Vehicle Fugitive PM	--	--	--	--	0.11	0.00	
Offsite Total	0.11	1.03	0.10	0.00	0.12	0.01	5.4
Total	0.11	1.03	0.10	0.00	0.39	0.03	5.4

Construction Equipment Summary

Equipment	Horse-power	Number	Days Used	Hours Used/Day
None				

Construction Equipment Exhaust Emission Factors

Equipment	Horse-power	VOC (lb/hr) ^a	CO (lb/hr) ^a	NOX (lb/hr) ^a	SOX (lb/hr) ^a	PM10 (lb/hr) ^a	PM2.5 (lb/hr) ^b	CO2 (lb/hr) ^a	CH4 (lb/hr) ^a	Category
None										

^a From Table 48

^b Diesel PM2.5 emission factor [lb/hr] = PM10 emission factor [lb/hr] x PM2.5 fraction of PM10

PM2.5 Fraction= 0.920

From Appendix A, Final-Methodology to Calculate Particulate Matter (PM) 2.5

and PM 2.5 Significance Thresholds, SCAQMD, October 2006,

http://www.aqmd.gov/ceqa/handbook/PM2_5/PM2_5.html

Construction Equipment Daily Criteria Pollutant Exhaust Emissions

Equipment	VOC (lb/day) ^a	CO (lb/day) ^a	NOX (lb/day) ^a	SOX (lb/day) ^a	PM10 (lb/day) ^a	PM2.5 (lb/day) ^a
None	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

^a Emissions [lb/day] = number x hours/day x emission factor [lb/hr]

Construction Equipment Total Greenhouse Gas Emissions

Equipment	CO2 (MT) ^a	CH4 (MT) ^a	CO2e (MT) ^b
None	0.0	0.0	0.0
Total	0.0	0.0	0.0

^a Emissions [metric tons, MT] = emission factor [lb/hr] x hours/day x Number x

days used x 453.6 [g/lb] / 1,000,000 [g/MT]

Emission factors are in Table 48

^b CO₂-equivalent (CO₂e) emission factors are CO₂ emissions plus 21 x CH₄ emissions, based on Table C.1 from California Climate Action

Registry General Reporting Protocol, Version 3.0, April 2008, http://www.climateaction.org/resources/docs/protocols/grp/GRP_V3_April2008_FINAL.pdf

Motor Vehicle Usage

Vehicle	Number	Days Used	Hours Used/Day	Miles/Day/Veh. ^a
Onsite				
Crew Truck	1	80	N/A	0.5
Offsite				
Crew Truck	1	80	N/A	14
Worker Commute	2	80	N/A	60

Motor Vehicle Exhaust Emission Factors

Vehicle	Category	VOC (lb/mi) ^a	CO (lb/mi) ^a	NOX (lb/mi) ^a	SOX (lb/mi) ^a	PM10 (lb/mi) ^a	PM2.5 (lb/mi) ^b	CO2 (lb/mi) ^a	CH4 (lb/mi) ^a
Onsite									
Crew Truck	Passenger	7.96E-04	7.65E-03	7.76E-04	1.07E-05	8.98E-05	5.75E-05	1.10E+00	7.17E-05
Offsite									
Crew Truck	Passenger	7.96E-04	7.65E-03	7.76E-04	1.07E-05	8.98E-05	5.75E-05	1.10E+00	7.17E-05
Worker Commute	Passenger	7.96E-04	7.65E-03	7.76E-04	1.07E-05	8.98E-05	5.75E-05	1.10E+00	7.17E-05

^a From Table 49 or Table 50

Motor Vehicle Daily Criteria Pollutant Exhaust Emissions

Vehicle	VOC (lb/day) ^a	CO (lb/day) ^a	NOX (lb/day) ^a	SOX (lb/day) ^a	PM10 (lb/day) ^a	PM2.5 (lb/day) ^a
Onsite						
Crew Truck	0.00	0.00	0.00	0.00	0.00	0.00
Onsite Total	0.00	0.00	0.00	0.00	0.00	0.00
Offsite						
Crew Truck	0.01	0.11	0.01	0.00	0.00	0.00
Worker Commute	0.10	0.92	0.09	0.00	0.01	0.01

Table 16
Substation Construction Emissions
Testing

Offsite Total	0.11	1.03	0.10	0.00	0.01	0.01
Total	0.11	1.03	0.10	0.00	0.01	0.01

^a Emissions [lb/day] = number x miles/day x emission factor [lb/mi]

Motor Vehicle Total Greenhouse Gas Emissions

Vehicle	CO2 (MT)^a	CH4 (MT)^a	CO2e (MT)^b
Onsite			
Crew Truck	0.0	0.0	0.0
Onsite Total	0.0	0.0	0.0
Offsite			
Crew Truck	0.6	0.0	0.6
Worker Commute	4.8	0.0	4.8
Offsite Total	5.4	0.0	5.4
Total	5.4	0.0	5.4

^a Emissions [metric tons, MT] = emission factor [lb/hr] x miles/day x Number x days used x 453.6 [g/lb] / 1,000,000 [g/MT]

Emission factors are in Table 49 and Table 50

^b CO₂-equivalent (CO₂e) emission factors are CO₂ emissions plus 21 x CH₄ emissions, based on Table C.1 from California Climate Action

Registry General Reporting Protocol, Version 3.0, April 2008, http://www.climateregistry.org/resources/docs/protocols/grp/GRP_V3_April2008_FINAL.pdf

Motor Vehicle Fugitive Particulate Matter Emissions

Vehicle	Number	Road Type	Miles/ Day/ Vehicle	PM10 Emission Factor (lb/mi)^a	PM2.5 Emission Factor (lb/mi)^a	PM10 Emissions (lb/day)^b	PM2.5 Emissions (lb/day)^b
Onsite							
Crew Truck	1	Unpaved	0.5	0.532	0.053	0.27	0.03
Onsite Total						0.27	0.03
Offsite							
Crew Truck	1	Paved	14	0.001	0.000	0.01	0.00
Worker Commute	2	Paved	60	0.001	0.000	0.10	0.00
Offsite Total						0.11	0.00
Total						0.37	0.03

^a From Table 51

^b Emissions [lb/day] = number x miles/day x emission factor [lb/mi]

Earthwork Fugitive Particulate Matter Emissions

Activity	Activity Units	Activity Level	PM10 Emission Factor^a	PM2.5 Emission Factor^a	PM10 (lb/day)^b	PM2.5 (lb/day)^b
Soil Handling	CY/day		1.62E-03	3.36E-04	0.00	0.00
Bulldozing, Scraping and Grading	hr/day		1.481	0.308	0.00	0.00
Storage Pile Wind Erosion	acres		15.7	3.26	0.00	0.00
Total					0.00	0.00

^a From Table 52

^b Emissions [lb/day] = Emission factor [lb/activity unit] x Activity unit [units/day]

Table 17
Substation Construction Emissions
Asphalting

Emissions Summary

Source	VOC (lb/day)	CO (lb/day)	NOX (lb/day)	SOX (lb/day)	PM10 (lb/day)	PM2.5 (lb/day)	CO2e (MT)
Construction Equipment Exhaust	2.30	7.46	9.63	0.01	0.70	0.65	6.0
Onsite Motor Vehicle Exhaust	0.01	0.03	0.06	0.00	0.00	0.00	0.1
Onsite Motor Vehicle Fugitive PM	--	--	--	--	2.38	0.24	
Earthwork Fugitive PM	--	--	--	--	0.00	0.00	
Asphaltic Paving VOC	0.7	--	--	--	--	--	--
Onsite Total	2.99	7.49	9.69	0.01	3.08	0.89	6.1
Offsite Motor Vehicle Exhaust	1.83	9.10	18.86	0.03	0.93	0.80	20.1
Offsite Motor Vehicle Fugitive PM	--	--	--	--	0.79	0.00	
Offsite Total	1.83	9.10	18.86	0.03	1.72	0.80	20.1
Total	4.82	16.58	28.54	0.04	4.80	1.68	26.2

Construction Equipment Summary

Equipment	Horse-power	Number	Days Used	Hours Used/Day
Paving Roller	46	2	15	4
Asphalt Paver	152	1	15	4
Tractor	45	1	15	3
Asphalt Curb Machine	35	1	15	3

Construction Equipment Exhaust Emission Factors

Equipment	Horse-power	VOC (lb/hr) ^a	CO (lb/hr) ^a	NOX (lb/hr) ^a	SOX (lb/hr) ^a	PM10 (lb/hr) ^a	PM2.5 (lb/hr) ^b	CO2 (lb/hr) ^a	CH4 (lb/hr) ^a	Category
Paving Roller	46	0.110	0.299	0.268	0.000	0.026	0.024	25.983	0.010	Rollers
Asphalt Paver	152	0.186	0.783	1.449	0.001	0.082	0.075	128.285	0.017	Pavers
Tractor	45	0.101	0.330	0.303	0.000	0.027	0.025	30.347	0.009	Tractors/Loaders/Backhoes
Asphalt Curb Machine	35	0.124	0.312	0.259	0.000	0.028	0.026	23.927	0.011	Paving Equipment

^a From Table 48

^b Diesel PM2.5 emission factor [lb/hr] = PM10 emission factor [lb/hr] x PM2.5 fraction of PM10

PM2.5 Fraction= 0.920

From Appendix A, Final-Methodology to Calculate Particulate Matter (PM) 2.5

and PM 2.5 Significance Thresholds, SCAQMD, October 2006,

http://www.aqmd.gov/ceqa/handbook/PM2_5/PM2_5.html

Construction Equipment Daily Criteria Pollutant Exhaust Emissions

Equipment	VOC (lb/day) ^a	CO (lb/day) ^a	NOX (lb/day) ^a	SOX (lb/day) ^a	PM10 (lb/day) ^a	PM2.5 (lb/day) ^a
Paving Roller	0.88	2.40	2.14	0.00	0.21	0.19
Asphalt Paver	0.75	3.13	5.80	0.01	0.33	0.30
Tractor	0.30	0.99	0.91	0.00	0.08	0.07
Asphalt Curb Machine	0.37	0.94	0.78	0.00	0.08	0.08
Total	2.30	7.46	9.63	0.01	0.70	0.65

^a Emissions [lb/day] = number x hours/day x emission factor [lb/hr]

Construction Equipment Total Greenhouse Gas Emissions

Equipment	CO2 (MT) ^a	CH4 (MT) ^a	CO2e (MT) ^b
Paving Roller	1.4	0.0	1.4
Asphalt Paver	3.5	0.0	3.5
Tractor	0.6	0.0	0.6
Asphalt Curb Machine	0.5	0.0	0.5
Total	6.0	0.0	6.0

^a Emissions [metric tons, MT] = emission factor [lb/hr] x hours/day x Number x

days used x 453.6 [g/lb] / 1,000,000 [g/MT]

Emission factors are in Table 48

^b CO₂-equivalent (CO₂e) emission factors are CO₂ emissions plus 21 x CH₄ emissions, based on Table C.1 from California Climate Action

Registry General Reporting Protocol, Version 3.0, April 2008, http://www.climateregistry.org/resources/docs/protocols/grp/GRP_V3_April2008_FINAL.pdf

Motor Vehicle Usage

Vehicle	Number ^b	Days Used	Hours Used/Day	Miles/Day/Veh. ^a
Onsite				
Stake Truck	1	15	N/A	0.5
Dump Truck	1	15	N/A	0.5
Crew Truck	2	15	N/A	0.5
Asphalt Delivery Truck	4	15	N/A	0.1
Aggregate Base Delivery Truck	6	15	N/A	0.1
Offsite				
Crew Truck	2	15	N/A	14
Asphalt Delivery Truck	4	15	N/A	60
Aggregate Base Delivery Truck	6	15	N/A	60
Worker Commute	6	15	N/A	60

^a Onsite travel based on 25% use at 10 mph average speed

^b Asphalt delivery trucks based on 308 CY over 8 days and 10 CY/truck = 308 / 8 / 10 = 3.9

Table 17
Substation Construction Emissions
Asphalting

Aggregate base delivery trucks based on 370 CY over 7 days and 10 CY/truck = 370 / 7 / 10 = 5.3

Motor Vehicle Exhaust Emission Factors

Vehicle	Category	VOC (lb/mi) ^a	CO (lb/mi) ^a	NOX (lb/mi) ^a	SOX (lb/mi) ^a	PM10 (lb/mi) ^a	PM2.5 (lb/mi) ^b	CO2 (lb/mi) ^a	CH4 (lb/mi) ^a
Onsite									
Stake Truck	HHDT	2.53E-03	1.02E-02	3.09E-02	4.04E-05	1.50E-03	1.29E-03	4.22E+00	1.17E-04
Dump Truck	HHDT	2.53E-03	1.02E-02	3.09E-02	4.04E-05	1.50E-03	1.29E-03	4.22E+00	1.17E-04
Crew Truck	Passenger	7.96E-04	7.65E-03	7.76E-04	1.07E-05	8.98E-05	5.75E-05	1.10E+00	7.17E-05
Asphalt Delivery Truck	HHDT	2.53E-03	1.02E-02	3.09E-02	4.04E-05	1.50E-03	1.29E-03	4.22E+00	1.17E-04
Aggregate Base Delivery Truck	HHDT	2.53E-03	1.02E-02	3.09E-02	4.04E-05	1.50E-03	1.29E-03	4.22E+00	1.17E-04
Offsite									
Crew Truck	Passenger	7.96E-04	7.65E-03	7.76E-04	1.07E-05	8.98E-05	5.75E-05	1.10E+00	7.17E-05
Asphalt Delivery Truck	HHDT	2.53E-03	1.02E-02	3.09E-02	4.04E-05	1.50E-03	1.29E-03	4.22E+00	1.17E-04
Aggregate Base Delivery Truck	HHDT	2.53E-03	1.02E-02	3.09E-02	4.04E-05	1.50E-03	1.29E-03	4.22E+00	1.17E-04
Worker Commute	Passenger	7.96E-04	7.65E-03	7.76E-04	1.07E-05	8.98E-05	5.75E-05	1.10E+00	7.17E-05

a From Table 49 or Table 50

Motor Vehicle Daily Criteria Pollutant Exhaust Emissions

Vehicle	VOC (lb/day) ^a	CO (lb/day) ^a	NOX (lb/day) ^a	SOX (lb/day) ^a	PM10 (lb/day) ^a	PM2.5 (lb/day) ^a
Onsite						
Stake Truck	0.00	0.01	0.02	0.00	0.00	0.00
Dump Truck	0.00	0.01	0.02	0.00	0.00	0.00
Crew Truck	0.00	0.01	0.00	0.00	0.00	0.00
Asphalt Delivery Truck	0.00	0.00	0.01	0.00	0.00	0.00
Aggregate Base Delivery Truck	0.00	0.01	0.02	0.00	0.00	0.00
Onsite Total	0.01	0.03	0.06	0.00	0.00	0.00
Offsite						
Crew Truck	0.02	0.21	0.02	0.00	0.00	0.00
Asphalt Delivery Truck	0.61	2.45	7.42	0.01	0.36	0.31
Aggregate Base Delivery Truck	0.91	3.68	11.13	0.01	0.54	0.47
Worker Commute	0.29	2.76	0.28	0.00	0.03	0.02
Offsite Total	1.83	9.10	18.86	0.03	0.93	0.80
Total	1.83	9.13	18.92	0.03	0.94	0.80

^a Emissions [lb/day] = number x miles/day x emission factor [lb/mi]

Motor Vehicle Total Greenhouse Gas Emissions

Vehicle	CO2 (MT) ^a	CH4 (MT) ^a	CO2e (MT) ^b
Onsite			
Stake Truck	0.0	0.0	0.0
Dump Truck	0.0	0.0	0.0
Crew Truck	0.0	0.0	0.0
Asphalt Delivery Truck	0.0	0.0	0.0
Aggregate Base Delivery Truck	0.0	0.0	0.0
Onsite Total	0.1	0.0	0.1
Offsite			
Crew Truck	0.2	0.0	0.2
Asphalt Delivery Truck	6.9	0.0	6.9
Aggregate Base Delivery Truck	10.3	0.0	10.3
Worker Commute	2.7	0.0	2.7
Offsite Total	20.1	0.0	20.1
Total	20.2	0.0	20.2

^a Emissions [metric tons, MT] = emission factor [lb/hr] x miles/day x Number x days used x 453.6 [g/lb] / 1,000,000 [g/MT]

Emission factors are in Table 49 and Table 50

^b CO₂-equivalent (CO₂e) emission factors are CO₂ emissions plus 21 x CH₄ emissions, based on Table C.1 from California Climate Action

Registry General Reporting Protocol, Version 3.0, April 2008, http://www.climateregistry.org/resources/docs/protocols/grp/GRP_V3_April2008_FINAL.pdf

Motor Vehicle Fugitive Particulate Matter Emissions

Vehicle	Number	Road Type	Miles/Day/Vehicle	PM10 Emission Factor (lb/mi) ^a	PM2.5 Emission Factor (lb/mi) ^a	PM10 Emissions (lb/day) ^b	PM2.5 Emissions (lb/day) ^b
Onsite							
Stake Truck	1	Unpaved	0.5	0.922	0.092	0.46	0.05
Dump Truck	1	Unpaved	0.5	0.922	0.092	0.46	0.05
Crew Truck	2	Unpaved	0.5	0.532	0.053	0.53	0.05
Asphalt Delivery Truck	4	Unpaved	0.1	0.922	0.092	0.37	0.04
Aggregate Base Delivery Truck	6	Unpaved	0.1	0.922	0.092	0.55	0.06
Onsite Total						2.38	0.24
Offsite							
Crew Truck	2	Paved	14	0.001	0.000	0.02	0.00
Asphalt Delivery Truck	4	Paved	60	0.001	0.000	0.19	0.00
Aggregate Base Delivery Truck	6	Paved	60	0.001	0.000	0.29	0.00
Worker Commute	6	Paved	60	0.001	0.000	0.29	0.00
Offsite Total						0.79	0.00

Table 17
Substation Construction Emissions
Asphalting

Total						3.17	0.24

a From Table 51

b Emissions [lb/day] = number x miles/day x emission factor [lb/mi]

Earthwork Fugitive Particulate Matter Emissions

Activity	Activity Units	Activity Level	PM10 Emission Factor^a	PM2.5 Emission Factor^a	PM10 (lb/day)^b	PM2.5 (lb/day)^b
Soil Handling	CY/day		1.62E-03	3.36E-04	0.00	0.00
Bulldozing, Scraping and Grading	hr/day		1.481	0.308	0.00	0.00
Storage Pile Wind Erosion	acres		15.7	3.26	0.00	0.00
Total					0.00	0.00

a From Table 52

b Emissions [lb/day] = Emission factor [lb/activity unit] x Activity unit [units/day]

Asphaltic Paving VOC Emissions

Area Paved (acre/day)^a	Emission Factor (lb/acre)^b	VOC (lb/day)^c
0.26	2.62	0.7

a Assumed 11,200 sq. ft. external driveway paved in one day

b From URBEMISS 2007 User's Guide, Appendix A,

<http://www.urbemis.com/software/download.html>

c Emissions [lb/day] = Emission factor [lb/acre] x Area paved [acre/day]

Table 18
Substation Construction Emissions
Landscaping

Emissions Summary

Source	VOC (lb/day)	CO (lb/day)	NOX (lb/day)	SOX (lb/day)	PM10 (lb/day)	PM2.5 (lb/day)	CO2e (MT)
Construction Equipment Exhaust	0.60	1.98	1.82	0.00	0.16	0.15	1.2
Onsite Motor Vehicle Exhaust	0.00	0.02	0.05	0.00	0.00	0.00	0.0
Onsite Motor Vehicle Fugitive PM	--	--	--	--	1.57	0.16	
Earthwork Fugitive PM	--	--	--	--	0.00	0.00	
Onsite Total	0.61	2.00	1.87	0.00	1.73	0.31	1.3
Offsite Motor Vehicle Exhaust	1.35	7.05	13.27	0.02	0.66	0.56	14.8
Offsite Motor Vehicle Fugitive PM	--	--	--	--	0.62	0.00	
Offsite Total	1.35	7.05	13.27	0.02	1.29	0.56	14.8
Total	1.96	9.05	15.14	0.02	3.02	0.87	16.1

Construction Equipment Summary

Equipment	Horse-power	Number	Days Used	Hours Used/Day
Tractor	45	1	15	6

Construction Equipment Exhaust Emission Factors

Equipment	Horse-power	VOC (lb/hr) ^a	CO (lb/hr) ^a	NOX (lb/hr) ^a	SOX (lb/hr) ^a	PM10 (lb/hr) ^a	PM2.5 (lb/hr) ^b	CO2 (lb/hr) ^a	CH4 (lb/hr) ^a	Category
Tractor	45	0.101	0.330	0.303	0.000	0.027	0.025	30.347	0.009	Tractors/Loaders/Backhoes

^a From Table 48

^b Diesel PM2.5 emission factor [lb/hr] = PM10 emission factor [lb/hr] x PM2.5 fraction of PM10

PM2.5 Fraction= 0.920

From Appendix A, Final-Methodology to Calculate Particulate Matter (PM) 2.5

and PM 2.5 Significance Thresholds, SCAQMD, October 2006,

http://www.aqmd.gov/ceqa/handbook/PM2_5/PM2_5.html

Construction Equipment Daily Criteria Pollutant Exhaust Emissions

Equipment	VOC (lb/day) ^a	CO (lb/day) ^a	NOX (lb/day) ^a	SOX (lb/day) ^a	PM10 (lb/day) ^a	PM2.5 (lb/day) ^a
Tractor	0.60	1.98	1.82	0.00	0.16	0.15
Total	0.60	1.98	1.82	0.00	0.16	0.15

^a Emissions [lb/day] = number x hours/day x emission factor [lb/hr]

Construction Equipment Total Greenhouse Gas Emissions

Equipment	CO2 (MT) ^a	CH4 (MT) ^a	CO2e (MT) ^b
Tractor	1.2	0.0	1.2
Total	1.2	0.0	1.2

^a Emissions [metric tons, MT] = emission factor [lb/hr] x hours/day x Number x

days used x 453.6 [g/lb] / 1,000,000 [g/MT]

Emission factors are in Table 48

^b CO₂-equivalent (CO₂e) emission factors are CO₂ emissions plus 21 x CH₄ emissions, based on Table C.1 from California Climate Action

Registry General Reporting Protocol, Version 3.0, April 2008, http://www.climateregistry.org/resources/docs/protocols/grp/GRP_V3_April2008_FINAL.pdf

Motor Vehicle Usage

Vehicle	Number ^a	Days Used	Hours Used/Day	Miles/Day/Veh.
Onsite				
Dump Truck	1	15	N/A	1
Crushed Rock Delivery Truck	7	15	N/A	0.1
Offsite				
Crushed Rock Delivery Truck	7	15	N/A	60
Worker Commute	6	15	N/A	60

^a Crushed rock delivery trucks based on 1,050 CY over 15 days and 10 CY/truck = 1,050 / 15 / 10 = 7

Motor Vehicle Exhaust Emission Factors

Vehicle	Category	VOC (lb/mi) ^a	CO (lb/mi) ^a	NOX (lb/mi) ^a	SOX (lb/mi) ^a	PM10 (lb/mi) ^a	PM2.5 (lb/mi) ^b	CO2 (lb/mi) ^a	CH4 (lb/mi) ^a
Onsite									
Dump Truck	HHDT	2.53E-03	1.02E-02	3.09E-02	4.04E-05	1.50E-03	1.29E-03	4.22E+00	1.17E-04
Crushed Rock Delivery Truck	HHDT	2.53E-03	1.02E-02	3.09E-02	4.04E-05	1.50E-03	1.29E-03	4.22E+00	1.17E-04
Offsite									
Crushed Rock Delivery Truck	HHDT	2.53E-03	1.02E-02	3.09E-02	4.04E-05	1.50E-03	1.29E-03	4.22E+00	1.17E-04
Worker Commute	Passenger	7.96E-04	7.65E-03	7.76E-04	1.07E-05	8.98E-05	5.75E-05	1.10E+00	7.17E-05

^a From Table 49 or Table 50

Motor Vehicle Daily Criteria Pollutant Exhaust Emissions

Vehicle	VOC (lb/day) ^a	CO (lb/day) ^a	NOX (lb/day) ^a	SOX (lb/day) ^a	PM10 (lb/day) ^a	PM2.5 (lb/day) ^a
Onsite						
Dump Truck	0.00	0.01	0.03	0.00	0.00	0.00
Crushed Rock Delivery Truck	0.00	0.01	0.02	0.00	0.00	0.00

Table 18
Substation Construction Emissions
Landscaping

Onsite Total	0.00	0.02	0.05	0.00	0.00	0.00
Offsite						
Crushed Rock Delivery Truck	1.06	4.29	12.99	0.02	0.63	0.54
Worker Commute	0.29	2.76	0.28	0.00	0.03	0.02
Offsite Total	1.35	7.05	13.27	0.02	0.66	0.56
Total	1.35	7.06	13.32	0.02	0.66	0.57

^a Emissions [lb/day] = number x miles/day x emission factor [lb/mi]

Motor Vehicle Total Greenhouse Gas Emissions

Vehicle	CO₂ (MT)^a	CH₄ (MT)^a	CO₂e (MT)^b
Onsite			
Dump Truck	0.0	0.0	0.0
Crushed Rock Delivery Truck	0.0	0.0	0.0
Onsite Total	0.0	0.0	0.0
Offsite			
Crushed Rock Delivery Truck	12.0	0.0	12.1
Worker Commute	2.7	0.0	2.7
Offsite Total	14.7	0.0	14.8
Total	14.8	0.0	14.8

^a Emissions [metric tons, MT] = emission factor [lb/hr] x miles/day x Number x days used x 453.6 [g/lb] / 1,000,000 [g/MT]

Emission factors are in Table 49 and Table 50

^b CO₂-equivalent (CO₂e) emission factors are CO₂ emissions plus 21 x CH₄ emissions, based on Table C.1 from California Climate Action Registry General Reporting Protocol, Version 3.0, April 2008, http://www.climateregistry.org/resources/docs/protocols/grp/GRP_V3_April2008_FINAL.pdf

Motor Vehicle Fugitive Particulate Matter Emissions

Vehicle	Number	Road Type	Miles/Day/Vehicle	PM₁₀ Emission Factor (lb/mi)^a	PM_{2.5} Emission Factor (lb/mi)^a	PM₁₀ Emissions (lb/day)^b	PM_{2.5} Emissions (lb/day)^b
Onsite							
Dump Truck	1	Unpaved	1	0.922	0.092	0.92	0.09
Crushed Rock Delivery Truck	7	Unpaved	0.1	0.922	0.092	0.65	0.06
Onsite Total						1.57	0.16
Offsite							
Crushed Rock Delivery Truck	7	Paved	60	0.001	0.000	0.34	0.00
Worker Commute	6	Paved	60	0.001	0.000	0.29	0.00
Offsite Total						0.62	0.00
Total						2.19	0.16

^a From Table 51

^b Emissions [lb/day] = number x miles/day x emission factor [lb/mi]

Earthwork Fugitive Particulate Matter Emissions

Activity	Activity Units	Activity Level	PM₁₀ Emission Factor^a	PM_{2.5} Emission Factor^a	PM₁₀ (lb/day)^b	PM_{2.5} (lb/day)^b
Soil Handling	CY/day		1.62E-03	3.36E-04	0.00	0.00
Bulldozing, Scraping and Grading	hr/day		1.481	0.308	0.00	0.00
Storage Pile Wind Erosion	acres		15.7	3.26	0.00	0.00
Total					0.00	0.00

^a From Table 52

^b Emissions [lb/day] = Emission factor [lb/activity unit] x Activity unit [units/day]

Table 19
Substation Construction Emissions
Irrigation

Emissions Summary

Source	VOC (lb/day)	CO (lb/day)	NOX (lb/day)	SOX (lb/day)	PM10 (lb/day)	PM2.5 (lb/day)	CO2e (MT)
Construction Equipment Exhaust	1.80	5.21	4.75	0.01	0.44	0.41	4.3
Onsite Motor Vehicle Exhaust	0.00	0.00	0.00	0.00	0.00	0.00	0.0
Onsite Motor Vehicle Fugitive PM	--	--	--	--	0.27	0.03	
Earthwork Fugitive PM	--	--	--	--	0.00	0.00	
Onsite Total	1.80	5.21	4.75	0.01	0.71	0.43	4.3
Offsite Motor Vehicle Exhaust	0.35	3.32	0.34	0.00	0.04	0.02	4.3
Offsite Motor Vehicle Fugitive PM	--	--	--	--	0.35	0.00	
Offsite Total	0.35	3.32	0.34	0.00	0.39	0.02	4.3
Total	2.15	8.53	5.09	0.01	1.10	0.46	8.6

Construction Equipment Summary

Equipment	Horse-power	Number	Days Used	Hours Used/Day
Bobcat	45	1	20	8
Trencher	33	1	20	8

Construction Equipment Exhaust Emission Factors

Equipment	Horse-power	VOC (lb/hr) ^a	CO (lb/hr) ^a	NOX (lb/hr) ^a	SOX (lb/hr) ^a	PM10 (lb/hr) ^a	PM2.5 (lb/hr) ^b	CO2 (lb/hr) ^a	CH4 (lb/hr) ^a	Category
Bobcat	45	0.060	0.233	0.240	0.000	0.018	0.017	25.519	0.005	Skid Steer Loaders
Trencher	33	0.166	0.418	0.354	0.000	0.037	0.034	32.918	0.015	Trenchers

^a From Table 48

^b Diesel PM2.5 emission factor [lb/hr] = PM10 emission factor [lb/hr] x PM2.5 fraction of PM10

PM2.5 Fraction= 0.920

From Appendix A, Final-Methodology to Calculate Particulate Matter (PM) 2.5

and PM 2.5 Significance Thresholds, SCAQMD, October 2006,

http://www.aqmd.gov/ceqa/handbook/PM2_5/PM2_5.html

Construction Equipment Daily Criteria Pollutant Exhaust Emissions

Equipment	VOC (lb/day) ^a	CO (lb/day) ^a	NOX (lb/day) ^a	SOX (lb/day) ^a	PM10 (lb/day) ^a	PM2.5 (lb/day) ^a
Bobcat	0.48	1.87	1.92	0.00	0.14	0.13
Trencher	1.32	3.34	2.83	0.00	0.30	0.27
Total	1.80	5.21	4.75	0.01	0.44	0.41

^a Emissions [lb/day] = number x hours/day x emission factor [lb/hr]

Construction Equipment Total Greenhouse Gas Emissions

Equipment	CO2 (MT) ^a	CH4 (MT) ^a	CO2e (MT) ^b
Bobcat	1.9	0.0	1.9
Trencher	2.4	0.0	2.4
Total	4.2	0.0	4.3

^a Emissions [metric tons, MT] = emission factor [lb/hr] x hours/day x Number x

days used x 453.6 [g/lb] / 1,000,000 [g/MT]

Emission factors are in Table 48

^b CO₂-equivalent (CO₂e) emission factors are CO₂ emissions plus 21 x CH₄ emissions, based on Table C.1 from California Climate Action

Registry General Reporting Protocol, Version 3.0, April 2008, http://www.climateregistry.org/resources/docs/protocols/grp/GRP_V3_April2008_FINAL.pdf

Motor Vehicle Usage

Vehicle	Number ^b	Days Used	Hours Used/Day	Miles/Day/Veh.
Onsite				
Crew Truck	1	20	N/A	0.5
Offsite				
Crew Truck	1	20	N/A	14
Worker Commute	7	20	N/A	60

Motor Vehicle Exhaust Emission Factors

Vehicle	Category	VOC (lb/mi) ^a	CO (lb/mi) ^a	NOX (lb/mi) ^a	SOX (lb/mi) ^a	PM10 (lb/mi) ^a	PM2.5 (lb/mi) ^b	CO2 (lb/mi) ^a	CH4 (lb/mi) ^a
Onsite									
Crew Truck	Passenger	7.96E-04	7.65E-03	7.76E-04	1.07E-05	8.98E-05	5.75E-05	1.10E+00	7.17E-05
Offsite									
Crew Truck	Passenger	7.96E-04	7.65E-03	7.76E-04	1.07E-05	8.98E-05	5.75E-05	1.10E+00	7.17E-05
Worker Commute	Passenger	7.96E-04	7.65E-03	7.76E-04	1.07E-05	8.98E-05	5.75E-05	1.10E+00	7.17E-05

^a From Table 49 or Table 50

Motor Vehicle Daily Criteria Pollutant Exhaust Emissions

Vehicle	VOC (lb/day) ^a	CO (lb/day) ^a	NOX (lb/day) ^a	SOX (lb/day) ^a	PM10 (lb/day) ^a	PM2.5 (lb/day) ^a
Onsite						
Crew Truck	0.00	0.00	0.00	0.00	0.00	0.00

Table 19
Substation Construction Emissions
Irrigation

Onsite Total	0.00	0.00	0.00	0.00	0.00	0.00
Offsite						
Crew Truck	0.01	0.11	0.01	0.00	0.00	0.00
Worker Commute	0.33	3.21	0.33	0.00	0.04	0.02
Offsite Total	0.35	3.32	0.34	0.00	0.04	0.02
Total	0.35	3.33	0.34	0.00	0.04	0.02

^a Emissions [lb/day] = number x miles/day x emission factor [lb/mi]

Motor Vehicle Total Greenhouse Gas Emissions

Vehicle	CO₂ (MT)^a	CH₄ (MT)^a	CO₂e (MT)^b
Onsite			
Crew Truck	0.0	0.0	0.0
Onsite Total	0.0	0.0	0.0
Offsite			
Crew Truck	0.1	0.0	0.1
Worker Commute	4.2	0.0	4.2
Offsite Total	4.3	0.0	4.3
Total	4.3	0.0	4.3

^a Emissions [metric tons, MT] = emission factor [lb/hr] x miles/day x Number x days used x 453.6 [g/lb] / 1,000,000 [g/MT]

Emission factors are in Table 49 and Table 50

^b CO₂-equivalent (CO₂e) emission factors are CO₂ emissions plus 21 x CH₄ emissions, based on Table C.1 from California Climate Action Registry General Reporting Protocol, Version 3.0, April 2008, http://www.climateregistry.org/resources/docs/protocols/grp/GRP_V3_April2008_FINAL.pdf

Motor Vehicle Fugitive Particulate Matter Emissions

Vehicle	Number	Road Type	Miles/Day/ Vehicle	PM₁₀ Emission Factor (lb/mi)^a	PM_{2.5} Emission Factor (lb/mi)^a	PM₁₀ Emissions (lb/day)^b	PM_{2.5} Emissions (lb/day)^b
Onsite							
Crew Truck	1	Unpaved	0.5	0.532	0.053	0.27	0.03
Onsite Total						0.27	0.03
Offsite							
Crew Truck	1	Paved	14	0.001	0.000	0.01	0.00
Worker Commute	7	Paved	60	0.001	0.000	0.34	0.00
Offsite Total						0.35	0.00
Total						0.61	0.03

^a From Table 51

^b Emissions [lb/day] = number x miles/day x emission factor [lb/mi]

Earthwork Fugitive Particulate Matter Emissions

Activity	Activity Units	Activity Level	PM₁₀ Emission Factor^a	PM_{2.5} Emission Factor^a	PM₁₀ (lb/day)^b	PM_{2.5} (lb/day)^b
Soil Handling	CY/day		1.62E-03	3.36E-04	0.00	0.00
Bulldozing, Scraping and Grading	hr/day		1.481	0.308	0.00	0.00
Storage Pile Wind Erosion	acres		15.7	3.26	0.00	0.00
Total					0.00	0.00

^a From Table 52

^b Emissions [lb/day] = Emission factor [lb/activity unit] x Activity unit [units/day]

Table 20
Distribution Construction Emissions
Civil

Emissions Summary

Source	VOC (lb/day)	CO (lb/day)	NOX (lb/day)	SOX (lb/day)	PM10 (lb/day)	PM2.5 (lb/day)	CO2e (MT)
Construction Equipment Exhaust	2.99	9.44	29.38	0.04	1.03	0.94	32.6
Onsite Motor Vehicle Exhaust	0.00	0.00	0.00	0.00	0.00	0.00	0.0
Onsite Motor Vehicle Fugitive PM	--	--	--	--	0.00	0.00	
Earthwork Fugitive PM	--	--	--	--	0.06	0.01	
Onsite Total	2.99	9.44	29.38	0.04	1.08	0.96	32.6
Offsite Motor Vehicle Exhaust	1.28	6.90	12.40	0.02	0.60	0.52	9.2
Offsite Motor Vehicle Fugitive PM	--	--	--	--	0.58	0.00	
Offsite Total	1.28	6.90	12.40	0.02	1.18	0.52	9.2
Total	4.27	16.34	41.78	0.06	2.26	1.47	41.8

Construction Equipment Summary

Equipment	Horse-power	Number	Days Used	Hours Used/Day
Backhoe	350	1	18	8
Roller	250	1	18	8

Construction Equipment Exhaust Emission Factors

Equipment	Horse-power	VOC (lb/hr) ^a	CO (lb/hr) ^a	NOX (lb/hr) ^a	SOX (lb/hr) ^a	PM10 (lb/hr) ^a	PM2.5 (lb/hr) ^b	CO2 (lb/hr) ^a	CH4 (lb/hr) ^a	Category
Backhoe	350	0.239	0.771	2.262	0.004	0.078	0.072	344.854	0.022	Tractors/Loaders/Backhoes
Roller	250	0.135	0.408	1.410	0.002	0.050	0.046	153.090	0.012	Rollers

^a From Table 48

^b Diesel PM2.5 emission factor [lb/hr] = PM10 emission factor [lb/hr] x PM2.5 fraction of PM10

PM2.5 Fraction = 0.920

From Appendix A, Final-Methodology to Calculate Particulate Matter (PM) 2.5

and PM 2.5 Significance Thresholds, SCAQMD, October 2006,

http://www.aqmd.gov/ceqa/handbook/PM2_5/PM2_5.html

Construction Equipment Daily Criteria Pollutant Exhaust Emissions

Equipment	VOC (lb/day) ^a	CO (lb/day) ^a	NOX (lb/day) ^a	SOX (lb/day) ^a	PM10 (lb/day) ^a	PM2.5 (lb/day) ^a
Backhoe	1.91	6.17	18.10	0.03	0.63	0.58
Roller	1.08	3.27	11.28	0.01	0.40	0.37
Total	2.99	9.44	29.38	0.04	1.03	0.94

^a Emissions [lb/day] = number x hours/day x emission factor [lb/hr]

Construction Equipment Total Greenhouse Gas Emissions

Equipment	CO2 (MT) ^a	CH4 (MT) ^a	CO2e (MT) ^b
Backhoe	22.5	0.0	22.6
Roller	10.0	0.0	10.0
Total	32.5	0.0	32.6

^a Emissions [metric tons, MT] = emission factor [lb/hr] x hours/day x Number x

days used x 453.6 [g/lb] / 1,000,000 [g/MT]

Emission factors are in Table 48

^b CO₂-equivalent (CO₂e) emission factors are CO₂ emissions plus 21 x CH₄ emissions, based on Table C.1 from California Climate Action

Registry General Reporting Protocol, Version 3.0, April 2008, http://www.climateregistry.org/resources/docs/protocols/grp/GRP_V3_April2008_FINAL.pdf

Motor Vehicle Usage

Vehicle	Number ^a	Days Used	Hours Used/Day	Miles/Day/Veh.
Onsite				
None				
Offsite				
Dump Truck	4	9	N/A	60
Delivery Truck	1	4	N/A	60
Concrete Truck	2	9	N/A	60
Worker Commute	5	18	N/A	60

^a Dump truck based on 315 CY over 9 days and 10 CY/truck = 315 / 9 / 10 = 3.5

Concrete trucks based on 100 CY over 9 days and 10 CY/truck = 100 / 9 / 10 = 1.1

Motor Vehicle Exhaust Emission Factors

Vehicle	Category	VOC (lb/mi) ^a	CO (lb/mi) ^a	NOX (lb/mi) ^a	SOX (lb/mi) ^a	PM10 (lb/mi) ^a	PM2.5 (lb/mi) ^b	CO2 (lb/mi) ^a	CH4 (lb/mi) ^a
Onsite									
None		0.00E+00	0.00E+00	0.00E+00	0.00E+00	0.00E+00	0.00E+00	0.00E+00	0.00E+00
Offsite									
Dump Truck	HHDT	2.53E-03	1.02E-02	3.09E-02	4.04E-05	1.50E-03	1.29E-03	4.22E+00	1.17E-04
Delivery Truck	Delivery	2.24E-03	1.55E-02	1.73E-02	2.67E-05	6.50E-04	5.50E-04	2.77E+00	1.07E-04
Concrete Truck	HHDT	2.53E-03	1.02E-02	3.09E-02	4.04E-05	1.50E-03	1.29E-03	4.22E+00	1.17E-04
Worker Commute	Passenger	7.96E-04	7.65E-03	7.76E-04	1.07E-05	8.98E-05	5.75E-05	1.10E+00	7.17E-05

^a From Table 49 or Table 50

Table 20
Distribution Construction Emissions
Civil

Motor Vehicle Daily Criteria Pollutant Exhaust Emissions

Vehicle	VOC (lb/day) ^a	CO (lb/day) ^a	NOX (lb/day) ^a	SOX (lb/day) ^a	PM10 (lb/day) ^a	PM2.5 (lb/day) ^a
Onsite						
None	0.00	0.00	0.00	0.00	0.00	0.00
Onsite Total	0.00	0.00	0.00	0.00	0.00	0.00
Offsite						
Dump Truck	0.61	2.45	7.42	0.01	0.36	0.31
Delivery Truck	0.13	0.93	1.04	0.00	0.04	0.03
Concrete Truck	0.30	1.23	3.71	0.00	0.18	0.16
Worker Commute	0.24	2.30	0.23	0.00	0.03	0.02
Offsite Total	1.28	6.90	12.40	0.02	0.60	0.52
Total	1.28	6.90	12.40	0.02	0.60	0.52

^a Emissions [lb/day] = number x miles/day x emission factor [lb/mi]

Motor Vehicle Total Greenhouse Gas Emissions

Vehicle	CO2 (MT) ^a	CH4 (MT) ^a	CO2e (MT) ^b
Onsite			
None	0.0	0.0	0.0
Onsite Total	0.0	0.0	0.0
Offsite			
Dump Truck	4.1	0.0	4.1
Delivery Truck	0.3	0.0	0.3
Concrete Truck	2.1	0.0	2.1
Worker Commute	2.7	0.0	2.7
Offsite Total	9.2	0.0	9.2
Total	9.2	0.0	9.2

^a Emissions [metric tons, MT] = emission factor [lb/hr] x miles/day x Number x days used x 453.6 [g/lb] / 1,000,000 [g/MT]
Emission factors are in Table 49 and Table 50

^b CO₂-equivalent (CO₂e) emission factors are CO₂ emissions plus 21 x CH₄ emissions, based on Table C.1 from California Climate Action Registry General Reporting Protocol, Version 3.0, April 2008, http://www.climateregistry.org/resources/docs/protocols/grp/GRP_V3_April2008_FINAL.pdf

Motor Vehicle Fugitive Particulate Matter Emissions

Vehicle	Number	Road Type	Miles/Day/Vehicle	PM10 Emission Factor (lb/mi) ^a	PM2.5 Emission Factor (lb/mi) ^a	PM10 Emissions (lb/day) ^b	PM2.5 Emissions (lb/day) ^b
Onsite							
None						0.00	0.00
Onsite Total						0.00	0.00
Offsite							
Dump Truck	4	Paved	60	0.001	0.000	0.19	0.00
Delivery Truck	1	Paved	60	0.001	0.000	0.05	0.00
Concrete Truck	2	Paved	60	0.001	0.000	0.10	0.00
Worker Commute	5	Paved	60	0.001	0.000	0.24	0.00
Offsite Total						0.58	0.00
Total						0.58	0.00

^a From Table 51

^b Emissions [lb/day] = number x miles/day x emission factor [lb/mi]

Earthwork Fugitive Particulate Matter Emissions

Activity	Activity Units	Activity Level	PM10 Emission Factor ^a	PM2.5 Emission Factor ^a	PM10 (lb/day) ^b	PM2.5 (lb/day) ^b
Soil Handling ^c	CY/day	35	1.62E-03	3.36E-04	0.06	0.01
Bulldozing, Scraping and Grading	hr/day		1.481	0.308	0.00	0.00
Storage Pile Wind Erosion	acres		15.7	3.26	0.00	0.00
Total					0.06	0.01

^a From Table 52

^b Emissions [lb/day] = Emission factor [lb/activity unit] x Activity unit [units/day]

^c Based on 315 CY over 9 days

Table 21
Distribution Construction Emissions
Electrical

Emissions Summary

Source	VOC (lb/day)	CO (lb/day)	NOX (lb/day)	SOX (lb/day)	PM10 (lb/day)	PM2.5 (lb/day)	CO2e (MT)
Construction Equipment Exhaust	2.86	9.51	24.58	0.03	0.95	0.88	61.8
Onsite Motor Vehicle Exhaust	0.00	0.00	0.00	0.00	0.00	0.00	0.0
Onsite Motor Vehicle Fugitive PM	--	--	--	--	0.00	0.00	
Earthwork Fugitive PM	--	--	--	--	0.00	0.00	
Onsite Total	2.86	9.51	24.58	0.03	0.95	0.88	61.8
Offsite Motor Vehicle Exhaust	0.56	4.64	2.17	0.01	0.13	0.10	15.2
Offsite Motor Vehicle Fugitive PM	--	--	--	--	0.45	0.00	
Offsite Total	0.56	4.64	2.17	0.01	0.58	0.10	15.2
Total	3.43	14.15	26.75	0.04	1.53	0.97	77.0

Construction Equipment Summary

Equipment	Horse-power	Number	Days Used	Hours Used/Day
Rodder Truck	35	1	42	8
Cable Dolly	9	1	42	8
Reel Truck	210	1	42	8
Boom Truck	235	1	42	8

Construction Equipment Exhaust Emission Factors

Equipment	Horse-power	VOC (lb/hr) ^a	CO (lb/hr) ^a	NOX (lb/hr) ^a	SOX (lb/hr) ^a	PM10 (lb/hr) ^a	PM2.5 (lb/hr) ^b	CO2 (lb/hr) ^a	CH4 (lb/hr) ^a	Category
Rodder Truck	35	0.084	0.274	0.271	0.000	0.023	0.021	27.990	0.008	Other Construction Equipment
Cable Dolly	9	0.012	0.062	0.074	0.000	0.003	0.003	10.107	0.001	Other Construction Equipment
Reel Truck	210	0.152	0.543	1.657	0.002	0.055	0.050	254.238	0.014	Other Construction Equipment
Boom Truck	235	0.110	0.310	1.071	0.001	0.039	0.036	112.159	0.010	Cranes

^a From Table 48

^b Diesel PM2.5 emission factor [lb/hr] = PM10 emission factor [lb/hr] x PM2.5 fraction of PM10

PM2.5 Fraction= 0.920

From Appendix A, Final-Methodology to Calculate Particulate Matter (PM) 2.5

and PM 2.5 Significance Thresholds, SCAQMD, October 2006,

http://www.aqmd.gov/ceqa/handbook/PM2_5/PM2_5.html

Construction Equipment Daily Criteria Pollutant Exhaust Emissions

Equipment	VOC (lb/day) ^a	CO (lb/day) ^a	NOX (lb/day) ^a	SOX (lb/day) ^a	PM10 (lb/day) ^a	PM2.5 (lb/day) ^a
Rodder Truck	0.67	2.19	2.17	0.00	0.18	0.17
Cable Dolly	0.09	0.49	0.59	0.00	0.02	0.02
Reel Truck	1.21	4.34	13.26	0.02	0.44	0.40
Boom Truck	0.88	2.48	8.57	0.01	0.31	0.29
Total	2.86	9.51	24.58	0.03	0.95	0.88

^a Emissions [lb/day] = number x hours/day x emission factor [lb/hr]

Construction Equipment Total Greenhouse Gas Emissions

Equipment	CO2 (MT) ^a	CH4 (MT) ^a	CO2e (MT) ^b
Rodder Truck	4.3	0.0	4.3
Cable Dolly	1.5	0.0	1.5
Reel Truck	38.7	0.0	38.8
Boom Truck	17.1	0.0	17.1
Total	61.6	0.0	61.8

^a Emissions [metric tons, MT] = emission factor [lb/hr] x hours/day x Number x

days used x 453.6 [g/lb] / 1,000,000 [g/MT]

Emission factors are in Table 48

^b CO₂-equivalent (CO₂e) emission factors are CO₂ emissions plus 21 x CH₄ emissions, based on Table C.1 from California Climate Action

Registry General Reporting Protocol, Version 3.0, April 2008, http://www.climateregistry.org/resources/docs/protocols/grp/GRP_V3_April2008_FINAL.pdf

Motor Vehicle Usage

Vehicle	Number	Days Used	Hours Used/Day	Miles/Day/Veh.
Onsite				
None				0
Offsite				
Rodder Truck	1	42	N/A	14
Reel Truck	1	42	N/A	14
Line Truck	1	42	N/A	14
Troubleman Truck	1	42	N/A	14
Boom Truck	1	42	N/A	14
Foreman Truck	1	42	N/A	14
Worker Commute	8	42	N/A	60

Motor Vehicle Exhaust Emission Factors

Vehicle	Category	VOC (lb/mi) ^a	CO (lb/mi) ^a	NOX (lb/mi) ^a	SOX (lb/mi) ^a	PM10 (lb/mi) ^a	PM2.5 (lb/mi) ^b	CO2 (lb/mi) ^a	CH4 (lb/mi) ^a

Table 21
Distribution Construction Emissions
Electrical

Onsite									
None		0.00E+00	0.00E+00	0.00E+00	0.00E+00	0.00E+00	0.00E+00	0.00E+00	0.00E+00
Offsite									
Rodder Truck	HHDT	2.53E-03	1.02E-02	3.09E-02	4.04E-05	1.50E-03	1.29E-03	4.22E+00	1.17E-04
Reel Truck	HHDT	2.53E-03	1.02E-02	3.09E-02	4.04E-05	1.50E-03	1.29E-03	4.22E+00	1.17E-04
Line Truck	Delivery	2.24E-03	1.55E-02	1.73E-02	2.67E-05	6.50E-04	5.50E-04	2.77E+00	1.07E-04
Troubleman Truck	Delivery	2.24E-03	1.55E-02	1.73E-02	2.67E-05	6.50E-04	5.50E-04	2.77E+00	1.07E-04
Boom Truck	HHDT	2.53E-03	1.02E-02	3.09E-02	4.04E-05	1.50E-03	1.29E-03	4.22E+00	1.17E-04
Foreman Truck	Passenger	7.96E-04	7.65E-03	7.76E-04	1.07E-05	8.98E-05	5.75E-05	1.10E+00	7.17E-05
Worker Commute	Passenger	7.96E-04	7.65E-03	7.76E-04	1.07E-05	8.98E-05	5.75E-05	1.10E+00	7.17E-05

a From Table 49 or Table 50

Motor Vehicle Daily Criteria Pollutant Exhaust Emissions

Vehicle	VOC (lb/day) ^a	CO (lb/day) ^a	NOX (lb/day) ^a	SOX (lb/day) ^a	PM10 (lb/day) ^a	PM2.5 (lb/day) ^a
Onsite						
None	0.00	0.00	0.00	0.00	0.00	0.00
Onsite Total	0.00	0.00	0.00	0.00	0.00	0.00
Offsite						
Rodder Truck	0.04	0.14	0.43	0.00	0.02	0.02
Reel Truck	0.04	0.14	0.43	0.00	0.02	0.02
Line Truck	0.03	0.22	0.24	0.00	0.01	0.01
Troubleman Truck	0.03	0.22	0.24	0.00	0.01	0.01
Boom Truck	0.04	0.14	0.43	0.00	0.02	0.02
Foreman Truck	0.01	0.11	0.01	0.00	0.00	0.00
Worker Commute	0.38	3.67	0.37	0.01	0.04	0.03
Offsite Total	0.56	4.64	2.17	0.01	0.13	0.10
Total	0.56	4.64	2.17	0.01	0.13	0.10

^a Emissions [lb/day] = number x miles/day x emission factor [lb/mi]

Motor Vehicle Total Greenhouse Gas Emissions

Vehicle	CO2 (MT) ^a	CH4 (MT) ^a	CO2e (MT) ^b
Onsite			
None	0.0	0.0	0.0
Onsite Total	0.0	0.0	0.0
Offsite			
Rodder Truck	1.1	0.0	1.1
Reel Truck	1.1	0.0	1.1
Line Truck	0.7	0.0	0.7
Troubleman Truck	0.7	0.0	0.7
Boom Truck	1.1	0.0	1.1
Foreman Truck	0.3	0.0	0.3
Worker Commute	10.1	0.0	10.1
Offsite Total	15.2	0.0	15.2
Total	15.2	0.0	15.2

^a Emissions [metric tons, MT] = emission factor [lb/hr] x miles/day x Number x days used x 453.6 [g/lb] / 1,000,000 [g/MT]

Emission factors are in Table 49 and Table 50

^b CO₂-equivalent (CO₂e) emission factors are CO₂ emissions plus 21 x CH₄ emissions, based on Table C.1 from California Climate Action

Registry General Reporting Protocol, Version 3.0, April 2008, http://www.climateregistry.org/resources/docs/protocols/grp/GRP_V3_April2008_FINAL.pdf

Motor Vehicle Fugitive Particulate Matter Emissions

Vehicle	Number	Road Type	Miles/Day/Vehicle	PM10 Emission Factor (lb/mi) ^a	PM2.5 Emission Factor (lb/mi) ^a	PM10 Emissions (lb/day) ^b	PM2.5 Emissions (lb/day) ^b
Onsite							
None						0.00	0.00
Onsite Total						0.00	0.00
Offsite							
Rodder Truck	1	Paved	14	0.001	0.000	0.01	0.00
Reel Truck	1	Paved	14	0.001	0.000	0.01	0.00
Line Truck	1	Paved	14	0.001	0.000	0.01	0.00
Troubleman Truck	1	Paved	14	0.001	0.000	0.01	0.00
Boom Truck	1	Paved	14	0.001	0.000	0.01	0.00
Foreman Truck	1	Paved	14	0.001	0.000	0.01	0.00
Worker Commute	8	Paved	60	0.001	0.000	0.38	0.00
Offsite Total						0.45	0.00
Total						0.45	0.00

a From Table 51

^b Emissions [lb/day] = number x miles/day x emission factor [lb/mi]

Earthwork Fugitive Particulate Matter Emissions

Activity	Activity Units	Activity Level	PM10 Emission Factor ^a	PM2.5 Emission Factor ^a	PM10 (lb/day) ^b	PM2.5 (lb/day) ^b
Soil Handling	CY/day		1.62E-03	3.36E-04	0.00	0.00

Table 21
Distribution Construction Emissions
Electrical

Bulldozing, Scraping and Grading	hr/day		1.481	0.308	0.00	0.00
Storage Pile Wind Erosion	acres		15.7	3.26	0.00	0.00
Total					0.00	0.00

a From Table 52

b Emissions [lb/day] = Emission factor [lb/activity unit] x Activity unit [units/day]

Table 22
Subtransmission Source Line Construction Emissions
Survey

Emissions Summary

Source	VOC (lb/day)	CO (lb/day)	NOX (lb/day)	SOX (lb/day)	PM10 (lb/day)	PM2.5 (lb/day)	CO2e (MT)
Construction Equipment Exhaust	0.00	0.00	0.00	0.00	0.00	0.00	0.0
Onsite Motor Vehicle Exhaust	0.00	0.00	0.00	0.00	0.00	0.00	0.0
Onsite Motor Vehicle Fugitive PM	--	--	--	--	0.00	0.00	
Earthwork Fugitive PM	--	--	--	--	0.00	0.00	
Onsite Total	0.00	0.00	0.00	0.00	0.00	0.00	0.0
Offsite Motor Vehicle Exhaust	0.11	1.06	0.11	0.00	0.01	0.01	0.3
Offsite Motor Vehicle Fugitive PM	--	--	--	--	1.85	0.17	
Offsite Total	0.11	1.06	0.11	0.00	1.86	0.18	0.3
Total	0.11	1.06	0.11	0.00	1.86	0.18	0.3

Construction Equipment Summary

Equipment	Horse-power	Number	Days Used	Hours Used/Day
None				

Construction Equipment Exhaust Emission Factors

Equipment	Horse-power	VOC (lb/hr) ^a	CO (lb/hr) ^a	NOX (lb/hr) ^a	SOX (lb/hr) ^a	PM10 (lb/hr) ^a	PM2.5 (lb/hr) ^b	CO2 (lb/hr) ^a	CH4 (lb/hr) ^a	Category
None		0.000	0.000	0.000	0.000	0.000	0.000	0.000	0.000	

^a From Table 48

^b Diesel PM2.5 emission factor [lb/hr] = PM10 emission factor [lb/hr] x PM2.5 fraction of PM10

PM2.5 Fraction= 0.920

From Appendix A, Final-Methodology to Calculate Particulate Matter (PM) 2.5

and PM 2.5 Significance Thresholds, SCAQMD, October 2006,

http://www.aqmd.gov/ceqa/handbook/PM2_5/PM2_5.html

Construction Equipment Daily Criteria Pollutant Exhaust Emissions

Equipment	VOC (lb/day) ^a	CO (lb/day) ^a	NOX (lb/day) ^a	SOX (lb/day) ^a	PM10 (lb/day) ^a	PM2.5 (lb/day) ^a
None	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

^a Emissions [lb/day] = number x hours/day x emission factor [lb/hr]

Construction Equipment Total Greenhouse Gas Emissions

Equipment	CO2 (MT) ^a	CH4 (MT) ^a	CO2e (MT) ^b
None	0.0	0.0	0.0
Total	0.0	0.0	0.0

^a Emissions [metric tons, MT] = emission factor [lb/hr] x hours/day x Number x

days used x 453.6 [g/lb] / 1,000,000 [g/MT]

Emission factors are in Table 48

^b CO₂-equivalent (CO₂e) emission factors are CO₂ emissions plus 21 x CH₄ emissions, based on Table C.1 from California Climate Action

Registry General Reporting Protocol, Version 3.0, April 2008, http://www.climateregistry.org/resources/docs/protocols/grp/GRP_V3_April2008_FINAL.pdf

Motor Vehicle Usage

Vehicle	Number	Days Used	Hours Used/Day	Miles/Day/Veh.
Onsite				
None				
Offsite				
1/2-Ton Pick-up Truck, 4x4	1	5	N/A	18
Worker Commute	2	5	N/A	60

Motor Vehicle Exhaust Emission Factors

Vehicle	Category	VOC (lb/mi) ^a	CO (lb/mi) ^a	NOX (lb/mi) ^a	SOX (lb/mi) ^a	PM10 (lb/mi) ^a	PM2.5 (lb/mi) ^b	CO2 (lb/mi) ^a	CH4 (lb/mi) ^a
Onsite									
None		0.00E+00	0.00E+00	0.00E+00	0.00E+00	0.00E+00	0.00E+00	0.00E+00	0.00E+00
Offsite									
1/2-Ton Pick-up Truck, 4x4	Passenger	7.96E-04	7.65E-03	7.76E-04	1.07E-05	8.98E-05	5.75E-05	1.10E+00	7.17E-05
Worker Commute	Passenger	7.96E-04	7.65E-03	7.76E-04	1.07E-05	8.98E-05	5.75E-05	1.10E+00	7.17E-05

^a From Table 49 or Table 50

Motor Vehicle Daily Criteria Pollutant Exhaust Emissions

Vehicle	VOC (lb/day) ^a	CO (lb/day) ^a	NOX (lb/day) ^a	SOX (lb/day) ^a	PM10 (lb/day) ^a	PM2.5 (lb/day) ^a
Onsite						
None	0.00	0.00	0.00	0.00	0.00	0.00
Onsite Total	0.00	0.00	0.00	0.00	0.00	0.00
Offsite						
1/2-Ton Pick-up Truck, 4x4	0.01	0.14	0.01	0.00	0.00	0.00
Worker Commute	0.10	0.92	0.09	0.00	0.01	0.01
Offsite Total	0.11	1.06	0.11	0.00	0.01	0.01
Total	0.11	1.06	0.11	0.00	0.01	0.01

^a Emissions [lb/day] = number x miles/day x emission factor [lb/mi]

Table 22
Subtransmission Source Line Construction Emissions
Survey

Motor Vehicle Total Greenhouse Gas Emissions

Vehicle	CO ₂ (MT) ^a	CH ₄ (MT) ^a	CO ₂ e (MT) ^b
Onsite			
None	0.0	0.0	0.0
Onsite Total	0.0	0.0	0.0
Offsite			
1/2-Ton Pick-up Truck, 4x4	0.0	0.0	0.0
Worker Commute	0.3	0.0	0.3
Offsite Total	0.3	0.0	0.3
Total	0.3	0.0	0.3

^a Emissions [metric tons, MT] = emission factor [lb/hr] x miles/day x Number x days used x 453.6 [g/lb] / 1,000,000 [g/MT]

Emission factors are in Table 49 and Table 50

^b CO₂-equivalent (CO₂e) emission factors are CO₂ emissions plus 21 x CH₄ emissions, based on Table C.1 from California Climate Action

Registry General Reporting Protocol, Version 3.0, April 2008, http://www.climateregistry.org/resources/docs/protocols/grp/GRP_V3_April2008_FINAL.pdf

Motor Vehicle Fugitive Particulate Matter Emissions

Vehicle	Number	Road Type	Miles/Day/Vehicle	PM ₁₀ Emission Factor (lb/mi) ^a	PM _{2.5} Emission Factor (lb/mi) ^a	PM ₁₀ Emissions (lb/day) ^b	PM _{2.5} Emissions (lb/day) ^b
Onsite							
None							
Onsite Total						0.00	0.00
Offsite							
1/2-Ton Pick-up Truck, 4x4	1	Paved	14	0.001	0.000	0.01	0.00
1/2-Ton Pick-up Truck, 4x4	1	Unpaved	4	0.435	0.043	1.74	0.17
Worker Commute	2	Paved	60	0.001	0.000	0.10	0.00
Offsite Total						1.85	0.17
Total						1.85	0.17

^a From Table 51

^b Emissions [lb/day] = number x miles/day x emission factor [lb/mi]

Earthwork Fugitive Particulate Matter Emissions

Activity	Activity Units	Activity Level	PM ₁₀ Emission Factor ^a	PM _{2.5} Emission Factor ^a	PM ₁₀ (lb/day) ^b	PM _{2.5} (lb/day) ^b
Soil Handling	CY/day		1.62E-03	3.36E-04	0.00	0.00
Bulldozing, Scraping and Grading	hr/day		1.481	0.308	0.00	0.00
Storage Pile Wind Erosion	acres		15.7	3.26	0.00	0.00
Total					0.00	0.00

^a From Table 52

^b Emissions [lb/day] = Emission factor [lb/activity unit] x Activity unit [units/day]

Table 23
Subtransmission Source Line Construction Emissions
Marshalling Yard

Emissions Summary

Source	VOC (lb/day)	CO (lb/day)	NOX (lb/day)	SOX (lb/day)	PM10 (lb/day)	PM2.5 (lb/day)	CO2e (MT)
Construction Equipment Exhaust	0.62	1.96	6.00	0.01	0.21	0.19	123.7
Onsite Motor Vehicle Exhaust	0.02	0.10	0.16	0.00	0.01	0.01	4.0
Onsite Motor Vehicle Fugitive PM	--	--	--	--	0.01	0.00	
Earthwork Fugitive PM	--	--	--	--	0.00	0.00	
Onsite Total	0.64	2.06	6.17	0.01	0.22	0.20	127.7
Offsite Motor Vehicle Exhaust	0.19	1.84	0.19	0.00	0.02	0.01	43.8
Offsite Motor Vehicle Fugitive PM	--	--	--	--	0.19	0.00	
Offsite Total	0.19	1.84	0.19	0.00	0.21	0.01	43.8
Total	0.83	3.90	6.35	0.01	0.43	0.21	171.5

Construction Equipment Summary

Equipment	Horse-power	Number	Days Used	Hours Used/Day
30-Ton Crane Truck	300	1	365	2
10,000 lb Rough Terrain Forklift	200	1	365	5

Construction Equipment Exhaust Emission Factors

Equipment	Horse-power	VOC (lb/hr) ^a	CO (lb/hr) ^a	NOX (lb/hr) ^a	SOX (lb/hr) ^a	PM10 (lb/hr) ^a	PM2.5 (lb/hr) ^b	CO2 (lb/hr) ^a	CH4 (lb/hr) ^a	Category
30-Ton Crane Truck	300	0.163	0.569	1.533	0.002	0.057	0.053	180.101	0.015	Cranes
10,000 lb Rough Terrain Forklift	200	0.059	0.164	0.587	0.001	0.019	0.017	77.122	0.005	Forklifts

^a From Table 48

^b Diesel PM2.5 emission factor [lb/hr] = PM10 emission factor [lb/hr] x PM2.5 fraction of PM10

PM2.5 Fraction= 0.920

From Appendix A, Final-Methodology to Calculate Particulate Matter (PM) 2.5

and PM 2.5 Significance Thresholds, SCAQMD, October 2006,

http://www.aqmd.gov/ceqa/handbook/PM2_5/PM2_5.html

Construction Equipment Daily Criteria Pollutant Exhaust Emissions

Equipment	VOC (lb/day) ^a	CO (lb/day) ^a	NOX (lb/day) ^a	SOX (lb/day) ^a	PM10 (lb/day) ^a	PM2.5 (lb/day) ^a
30-Ton Crane Truck	0.33	1.14	3.07	0.00	0.11	0.11
10,000 lb Rough Terrain Forklift	0.30	0.82	2.94	0.00	0.09	0.09
Total	0.62	1.96	6.00	0.01	0.21	0.19

^a Emissions [lb/day] = number x hours/day x emission factor [lb/hr]

Construction Equipment Total Greenhouse Gas Emissions

Equipment	CO2 (MT) ^a	CH4 (MT) ^a	CO2e (MT) ^b
30-Ton Crane Truck	59.6	0.0	59.7
10,000 lb Rough Terrain Forklift	63.8	0.0	63.9
Total	123.5	0.0	123.7

^a Emissions [metric tons, MT] = emission factor [lb/hr] x hours/day x Number x

days used x 453.6 [g/lb] / 1,000,000 [g/MT]

Emission factors are in Table 48

^b CO₂-equivalent (CO₂e) emission factors are CO₂ emissions plus 21 x CH₄ emissions, based on Table C.1 from California Climate Action

Registry General Reporting Protocol, Version 3.0, April 2008, http://www.climateregistry.org/resources/docs/protocols/grp/GRP_V3_April2008_FINAL.pdf

Motor Vehicle Usage

Vehicle	Number	Days Used	Hours Used/Day	Miles/Day/ Veh. ^a
Onsite				
1-Ton Crew Cab, 4x4	1	365	2	5
Truck, Semi Tractor	1	365	1	2.5
Offsite				
Worker Commute	4	365	N/A	60

^a Onsite travel based on 25% use at 10 mph average speed

Motor Vehicle Exhaust Emission Factors

Vehicle	Category	VOC (lb/mi) ^a	CO (lb/mi) ^a	NOX (lb/mi) ^a	SOX (lb/mi) ^a	PM10 (lb/mi) ^a	PM2.5 (lb/mi) ^b	CO2 (lb/mi) ^a	CH4 (lb/mi) ^a
Onsite									
1-Ton Crew Cab, 4x4	Delivery	2.24E-03	1.55E-02	1.73E-02	2.67E-05	6.50E-04	5.50E-04	2.77E+00	1.07E-04
Truck, Semi Tractor	HHDT	2.53E-03	1.02E-02	3.09E-02	4.04E-05	1.50E-03	1.29E-03	4.22E+00	1.17E-04
Offsite									
Worker Commute	Passenger	7.96E-04	7.65E-03	7.76E-04	1.07E-05	8.98E-05	5.75E-05	1.10E+00	7.17E-05

^a From Table 49 or Table 50

Motor Vehicle Daily Criteria Pollutant Exhaust Emissions

Vehicle	VOC (lb/day) ^a	CO (lb/day) ^a	NOX (lb/day) ^a	SOX (lb/day) ^a	PM10 (lb/day) ^a	PM2.5 (lb/day) ^a
Onsite						

Table 23
Subtransmission Source Line Construction Emissions
Marshalling Yard

1-Ton Crew Cab, 4x4	0.01	0.08	0.09	0.00	0.00	0.00
Truck, Semi Tractor	0.01	0.03	0.08	0.00	0.00	0.00
Onsite Total	0.02	0.10	0.16	0.00	0.01	0.01
Offsite						
Worker Commute	0.19	1.84	0.19	0.00	0.02	0.01
Offsite Total	0.19	1.84	0.19	0.00	0.02	0.01
Total	0.21	1.94	0.35	0.00	0.03	0.02

^a Emissions [lb/day] = number x miles/day x emission factor [lb/mi]

Motor Vehicle Total Greenhouse Gas Emissions

Vehicle	CO ₂ (MT) ^a	CH ₄ (MT) ^a	CO ₂ e (MT) ^b
Onsite			
1-Ton Crew Cab, 4x4	2.3	0.0	2.3
Truck, Semi Tractor	1.7	0.0	1.7
Onsite Total	4.0	0.0	4.0
Offsite			
Worker Commute	43.8	0.0	43.8
Offsite Total	43.8	0.0	43.8
Total	47.8	0.0	47.9

^a Emissions [metric tons, MT] = emission factor [lb/hr] x miles/day x Number x days used x 453.6 [g/lb] / 1,000,000 [g/MT]

Emission factors are in Table 49 and Table 50

^b CO₂-equivalent (CO₂e) emission factors are CO₂ emissions plus 21 x CH₄ emissions, based on Table C.1 from California Climate Action Registry General Reporting Protocol, Version 3.0, April 2008, http://www.climateregistry.org/resources/docs/protocols/grp/GRP_V3_April2008_FINAL.pdf

Motor Vehicle Fugitive Particulate Matter Emissions

Vehicle	Number	Road Type	Miles/Day/Vehicle	PM ₁₀ Emission Factor (lb/mi) ^a	PM _{2.5} Emission Factor (lb/mi) ^a	PM ₁₀ Emissions (lb/day) ^b	PM _{2.5} Emissions (lb/day) ^b
Onsite							
1-Ton Crew Cab, 4x4	1	Paved	5	0.001	0.000	0.00	0.00
Truck, Semi Tractor	1	Paved	2.5	0.001	0.000	0.00	0.00
Onsite Total						0.01	0.00
Offsite							
Worker Commute	4	Paved	60	0.001	0.000	0.19	0.00
Offsite Total						0.19	0.00
Total						0.20	0.00

^a From Table 51

^b Emissions [lb/day] = number x miles/day x emission factor [lb/mi]

Earthwork Fugitive Particulate Matter Emissions

Activity	Activity Units	Activity Level	PM ₁₀ Emission Factor ^a	PM _{2.5} Emission Factor ^a	PM ₁₀ (lb/day) ^b	PM _{2.5} (lb/day) ^b
Soil Handling	CY/day		1.62E-03	3.36E-04	0.00	0.00
Bulldozing, Scraping and Grading	hr/day		1.481	0.308	0.00	0.00
Storage Pile Wind Erosion	acres		15.7	3.26	0.00	0.00
Total					0.00	0.00

^a From Table 52

^b Emissions [lb/day] = Emission factor [lb/activity unit] x Activity unit [units/day]

Table 24
Subtransmission Source Line Construction Emissions
Right-of-Way Clearing

Emissions Summary

Source	VOC (lb/day)	CO (lb/day)	NOX (lb/day)	SOX (lb/day)	PM10 (lb/day)	PM2.5 (lb/day)	CO2e (MT)
Construction Equipment Exhaust	4.20	14.74	38.84	0.05	1.44	1.32	31.8
Onsite Motor Vehicle Exhaust	0.01	0.04	0.12	0.00	0.01	0.01	0.1
Onsite Motor Vehicle Fugitive PM	--	--	--	--	3.69	0.37	
Earthwork Fugitive PM	--	--	--	--	18.09	3.76	
Onsite Total	4.21	14.78	38.96	0.05	23.22	5.46	31.9
Offsite Motor Vehicle Exhaust	0.46	3.29	2.71	0.01	0.14	0.12	4.3
Offsite Motor Vehicle Fugitive PM	--	--	--	--	17.18	1.69	
Offsite Total	0.46	3.29	2.71	0.01	17.32	1.81	4.3
Total	4.66	18.07	41.67	0.06	40.55	7.27	36.2

Construction Equipment Summary

Equipment	Horse-power	Number	Days Used	Hours Used/Day
Road Grader	350	1	14	6
Backhoe/Front Loader	350	1	14	6
Track Type Dozer	350	1	14	6

Construction Equipment Exhaust Emission Factors

Equipment	Horse-power	VOC (lb/hr) ^a	CO (lb/hr) ^a	NOX (lb/hr) ^a	SOX (lb/hr) ^a	PM10 (lb/hr) ^a	PM2.5 (lb/hr) ^b	CO2 (lb/hr) ^a	CH4 (lb/hr) ^a	Category
Road Grader	350	0.195	0.664	1.819	0.002	0.067	0.062	229.484	0.018	Graders
Backhoe/Front Loader	350	0.239	0.771	2.262	0.004	0.078	0.072	344.854	0.022	Tractors/Loaders/Backhoes
Track Type Dozer	350	0.266	1.022	2.391	0.003	0.094	0.087	259.229	0.024	Crawler Tractors

^a From Table 48

^b Diesel PM2.5 emission factor [lb/hr] = PM10 emission factor [lb/hr] x PM2.5 fraction of PM10

PM2.5 Fraction= 0.920

From Appendix A, Final-Methodology to Calculate Particulate Matter (PM) 2.5

and PM 2.5 Significance Thresholds, SCAQMD, October 2006,

http://www.aqmd.gov/ceqa/handbook/PM2_5/PM2_5.html

Construction Equipment Daily Criteria Pollutant Exhaust Emissions

Equipment	VOC (lb/day) ^a	CO (lb/day) ^a	NOX (lb/day) ^a	SOX (lb/day) ^a	PM10 (lb/day) ^a	PM2.5 (lb/day) ^a
Road Grader	1.17	3.98	10.92	0.01	0.40	0.37
Backhoe/Front Loader	1.43	4.63	13.57	0.02	0.47	0.43
Track Type Dozer	1.60	6.13	14.35	0.02	0.57	0.52
Total	4.20	14.74	38.84	0.05	1.44	1.32

^a Emissions [lb/day] = number x hours/day x emission factor [lb/hr]

Construction Equipment Total Greenhouse Gas Emissions

Equipment	CO2 (MT) ^a	CH4 (MT) ^a	CO2e (MT) ^b
Road Grader	8.7	0.0	8.8
Backhoe/Front Loader	13.1	0.0	13.2
Track Type Dozer	9.9	0.0	9.9
Total	31.8	0.0	31.8

^a Emissions [metric tons, MT] = emission factor [lb/hr] x hours/day x Number x

days used x 453.6 [g/lb] / 1,000,000 [g/MT]

Emission factors are in Table 48

^b CO₂-equivalent (CO₂e) emission factors are CO₂ emissions plus 21 x CH₄ emissions, based on Table C.1 from California Climate Action

Registry General Reporting Protocol, Version 3.0, April 2008, http://www.climateregistry.org/resources/docs/protocols/grp/GRP_V3_April2008_FINAL.pdf

Motor Vehicle Usage

Vehicle	Number ^a	Days Used	Hours Used/Day	Miles/Day/Veh.
Onsite				
Water Truck	4	14	N/A	1
Offsite				
Water Truck	4	14	N/A	13
1-Ton Crew Cab, 4x4	1	14	N/A	18
Lowboy Truck/Trailer	1	14	N/A	18
Worker Commute	5	14	N/A	60

^a Water trucks based on 16,000 gal water per day and 4,000 gal/truck = 16,000 / 4,000 = 4

Motor Vehicle Exhaust Emission Factors

Vehicle	Category	VOC (lb/mi) ^a	CO (lb/mi) ^a	NOX (lb/mi) ^a	SOX (lb/mi) ^a	PM10 (lb/mi) ^a	PM2.5 (lb/mi) ^b	CO2 (lb/mi) ^a	CH4 (lb/mi) ^a
Onsite									
Water Truck	HHDT	2.53E-03	1.02E-02	3.09E-02	4.04E-05	1.50E-03	1.29E-03	4.22E+00	1.17E-04
Offsite									
Water Truck	HHDT	2.53E-03	1.02E-02	3.09E-02	4.04E-05	1.50E-03	1.29E-03	4.22E+00	1.17E-04
1-Ton Crew Cab, 4x4	Delivery	2.24E-03	1.55E-02	1.73E-02	2.67E-05	6.50E-04	5.50E-04	2.77E+00	1.07E-04
Lowboy Truck/Trailer	HHDT	2.53E-03	1.02E-02	3.09E-02	4.04E-05	1.50E-03	1.29E-03	4.22E+00	1.17E-04
Worker Commute	Passenger	7.96E-04	7.65E-03	7.76E-04	1.07E-05	8.98E-05	5.75E-05	1.10E+00	7.17E-05

Table 24
Subtransmission Source Line Construction Emissions
Right-of-Way Clearing

a From Table 49 or Table 50

Motor Vehicle Daily Criteria Pollutant Exhaust Emissions

Vehicle	VOC (lb/day) ^a	CO (lb/day) ^a	NOX (lb/day) ^a	SOX (lb/day) ^a	PM10 (lb/day) ^a	PM2.5 (lb/day) ^a
Onsite						
Water Truck	0.01	0.04	0.12	0.00	0.01	0.01
Onsite Total	0.01	0.04	0.12	0.00	0.01	0.01
Offsite						
Water Truck	0.13	0.53	1.61	0.00	0.08	0.07
1-Ton Crew Cab, 4x4	0.04	0.28	0.31	0.00	0.01	0.01
Lowboy Truck/Trailer	0.05	0.18	0.56	0.00	0.03	0.02
Worker Commute	0.24	2.30	0.23	0.00	0.03	0.02
Offsite Total	0.46	3.29	2.71	0.01	0.14	0.12
Total	0.47	3.33	2.83	0.01	0.15	0.12

^a Emissions [lb/day] = number x miles/day x emission factor [lb/mi]

Motor Vehicle Total Greenhouse Gas Emissions

Vehicle	CO2 (MT) ^a	CH4 (MT) ^a	CO2e (MT) ^b
Onsite			
Water Truck	0.1	0.0	0.1
Onsite Total	0.1	0.0	0.1
Offsite			
Water Truck	1.4	0.0	1.4
1-Ton Crew Cab, 4x4	0.3	0.0	0.3
Lowboy Truck/Trailer	0.5	0.0	0.5
Worker Commute	2.1	0.0	2.1
Offsite Total	4.3	0.0	4.3
Total	4.4	0.0	4.4

^a Emissions [metric tons, MT] = emission factor [lb/hr] x miles/day x Number x days used x 453.6 [g/lb] / 1,000,000 [g/MT]

Emission factors are in Table 49 and Table 50

^b CO₂-equivalent (CO₂e) emission factors are CO₂ emissions plus 21 x CH₄ emissions, based on Table C.1 from California Climate Action Registry General Reporting Protocol, Version 3.0, April 2008, http://www.climateregistry.org/resources/docs/protocols/grp/GRP_V3_April2008_FINAL.pdf

Motor Vehicle Fugitive Particulate Matter Emissions

Vehicle	Number	Road Type	Miles/Day/ Vehicle	PM10 Emission Factor (lb/mi) ^a	PM2.5 Emission Factor (lb/mi) ^a	PM10 Emissions (lb/day) ^b	PM2.5 Emissions (lb/day) ^b
Onsite							
Water Truck	4	Unpaved	1	0.922	0.092	3.69	0.37
Onsite Total						3.69	0.37
Offsite							
Water Truck	4	Paved	10	0.001	0.000	0.03	0.00
1-Ton Crew Cab, 4x4	1	Paved	14	0.001	0.000	0.01	0.00
Lowboy Truck/Trailer	1	Paved	14	0.001	0.000	0.01	0.00
Water Truck	4	Unpaved	3	0.922	0.092	11.07	1.11
1-Ton Crew Cab, 4x4	1	Unpaved	4	0.532	0.053	2.13	0.21
Lowboy Truck/Trailer	1	Unpaved	4	0.922	0.092	3.69	0.37
Worker Commute	5	Paved	60	0.001	0.000	0.24	0.00
Offsite Total						17.18	1.69
Total						20.87	2.06

a From Table 51

^b Emissions [lb/day] = number x miles/day x emission factor [lb/mi]

Earthwork Fugitive Particulate Matter Emissions

Activity	Activity Units	Activity Level	PM10 Emission Factor ^a	PM2.5 Emission Factor ^a	PM10 (lb/day) ^b	PM2.5 (lb/day) ^b
Soil Handling ^c	CY/day	200	1.62E-03	3.36E-04	0.32	0.07
Bulldozing, Scraping and Grading	hr/day	12	1.481	0.308	17.77	3.70
Storage Pile Wind Erosion	acres		15.7	3.26	0.00	0.00
Total					18.09	3.76

a From Table 52

^b Emissions [lb/day] = Emission factor [lb/activity unit] x Activity unit [units/day]

^c Based on clearing 10,800 ft. long x 14' wide x 6" deep = 2,800 CY over 14 days

Table 25
Subtransmission Source Line Construction Emissions
Roads and Landing Work

Emissions Summary

Source	VOC (lb/day)	CO (lb/day)	NOX (lb/day)	SOX (lb/day)	PM10 (lb/day)	PM2.5 (lb/day)	CO2e (MT)
Construction Equipment Exhaust	5.43	18.34	50.51	0.07	1.85	1.70	41.7
Onsite Motor Vehicle Exhaust	0.02	0.08	0.25	0.00	0.01	0.01	0.2
Onsite Motor Vehicle Fugitive PM	--	--	--	--	7.38	0.74	
Earthwork Fugitive PM	--	--	--	--	28.73	5.98	
Onsite Total	5.45	18.42	50.75	0.07	37.97	8.42	41.9
Offsite Motor Vehicle Exhaust	5.25	23.33	60.30	0.08	2.91	2.51	54.4
Offsite Motor Vehicle Fugitive PM	--	--	--	--	136.65	13.49	
Offsite Total	5.25	23.33	60.30	0.08	139.56	16.00	54.4
Total	10.70	41.75	111.05	0.15	177.53	24.43	96.4

Construction Equipment Summary

Equipment	Horse-power	Number	Days Used	Hours Used/Day
Road Grader	350	1	14	4
Backhoe/Front Loader	350	1	14	6
Drum Type Compactor	250	1	14	4
Track Type Dozer	350	1	14	6
Excavator	300	1	14	6

Construction Equipment Exhaust Emission Factors

Equipment	Horse-power	VOC (lb/hr) ^a	CO (lb/hr) ^a	NOX (lb/hr) ^a	SOX (lb/hr) ^a	PM10 (lb/hr) ^a	PM2.5 (lb/hr) ^b	CO2 (lb/hr) ^a	CH4 (lb/hr) ^a	Category
Road Grader	350	0.195	0.664	1.819	0.002	0.067	0.062	229.484	0.018	Graders
Backhoe/Front Loader	350	0.239	0.771	2.262	0.004	0.078	0.072	344.854	0.022	Tractors/Loaders/Backhoes
Drum Type Compactor	250	0.135	0.408	1.410	0.002	0.050	0.046	153.090	0.012	Rollers
Track Type Dozer	350	0.266	1.022	2.391	0.003	0.094	0.087	259.229	0.024	Crawler Tractors
Excavator	300	0.180	0.549	1.611	0.002	0.057	0.053	233.735	0.016	Excavators

^a From Table 48

^b Diesel PM2.5 emission factor [lb/hr] = PM10 emission factor [lb/hr] x PM2.5 fraction of PM10

PM2.5 Fraction=

0.920

From Appendix A, Final--Methodology to Calculate Particulate Matter (PM) 2.5

and PM 2.5 Significance Thresholds, SCAQMD, October 2006,

http://www.aqmd.gov/ceqa/handbook/PM2_5/PM2_5.html

Construction Equipment Daily Criteria Pollutant Exhaust Emissions

Equipment	VOC (lb/day) ^a	CO (lb/day) ^a	NOX (lb/day) ^a	SOX (lb/day) ^a	PM10 (lb/day) ^a	PM2.5 (lb/day) ^a
Road Grader	0.78	2.66	7.28	0.01	0.27	0.25
Backhoe/Front Loader	1.43	4.63	13.57	0.02	0.47	0.43
Drum Type Compactor	0.54	1.63	5.64	0.01	0.20	0.18
Track Type Dozer	1.60	6.13	14.35	0.02	0.57	0.52
Excavator	1.08	3.30	9.67	0.01	0.34	0.32
Total	5.43	18.34	50.51	0.07	1.85	1.70

^a Emissions [lb/day] = number x hours/day x emission factor [lb/hr]

Construction Equipment Total Greenhouse Gas Emissions

Equipment	CO2 (MT) ^a	CH4 (MT) ^a	CO2e (MT) ^b
Road Grader	5.8	0.0	5.8
Backhoe/Front Loader	13.1	0.0	13.2
Drum Type Compactor	3.9	0.0	3.9
Track Type Dozer	9.9	0.0	9.9
Excavator	8.9	0.0	8.9
Total	41.6	0.0	41.7

^a Emissions [metric tons, MT] = emission factor [lb/hr] x hours/day x Number x

days used x 453.6 [g/lb] / 1,000,000 [g/MT]

Emission factors are in Table 48

^b CO₂-equivalent (CO₂e) emission factors are CO₂ emissions plus 21 x CH₄ emissions, based on Table C.1 from California Climate Action

Registry General Reporting Protocol, Version 3.0, April 2008, http://www.climateregistry.org/resources/docs/protocols/grp/GRP_V3_April2008_FINAL.pdf

Motor Vehicle Usage

Vehicle	Number ^a	Days Used	Hours Used/Day	Miles/Day/Veh.
Onsite				
Water Truck	8	14	N/A	1
Offsite				
Water Truck	8	14	N/A	13
1-Ton Crew Cab, 4x4	1	14	N/A	18
Lowboy Truck/Trailer	1	14	N/A	18
Aggregate Base Delivery Truck	29	14	N/A	64
Worker Commute	5	14	N/A	60

^a Water trucks based on 32,000 gal water per day and 4,000 gal/truck = 32,000 / 4,000 = 8

Table 25
Subtransmission Source Line Construction Emissions
Roads and Landing Work

Aggregate base delivery trucks based on 4,000 CY over 14 days and 10 CY/truck = 4,000 / 14 / 10 = 28.6

Motor Vehicle Exhaust Emission Factors

Vehicle	Category	VOC (lb/mi) ^a	CO (lb/mi) ^a	NOX (lb/mi) ^a	SOX (lb/mi) ^a	PM10 (lb/mi) ^a	PM2.5 (lb/mi) ^b	CO2 (lb/mi) ^a	CH4 (lb/mi) ^a
Onsite									
Water Truck	HHDT	2.53E-03	1.02E-02	3.09E-02	4.04E-05	1.50E-03	1.29E-03	4.22E+00	1.17E-04
Offsite									
Water Truck	Delivery	2.24E-03	1.55E-02	1.73E-02	2.67E-05	6.50E-04	5.50E-04	2.77E+00	1.07E-04
1-Ton Crew Cab, 4x4	Delivery	2.24E-03	1.55E-02	1.73E-02	2.67E-05	6.50E-04	5.50E-04	2.77E+00	1.07E-04
Lowboy Truck/Trailer	HHDT	2.53E-03	1.02E-02	3.09E-02	4.04E-05	1.50E-03	1.29E-03	4.22E+00	1.17E-04
Aggregate Base Delivery Truck	HHDT	2.53E-03	1.02E-02	3.09E-02	4.04E-05	1.50E-03	1.29E-03	4.22E+00	1.17E-04
Worker Commute	Passenger	7.96E-04	7.65E-03	7.76E-04	1.07E-05	8.98E-05	5.75E-05	1.10E+00	7.17E-05

a From Table 49 or Table 50

Motor Vehicle Daily Criteria Pollutant Exhaust Emissions

Vehicle	VOC (lb/day) ^a	CO (lb/day) ^a	NOX (lb/day) ^a	SOX (lb/day) ^a	PM10 (lb/day) ^a	PM2.5 (lb/day) ^a
Onsite						
Water Truck	0.02	0.08	0.25	0.00	0.01	0.01
Onsite Total	0.02	0.08	0.25	0.00	0.01	0.01
Offsite						
Water Truck	0.23	1.61	1.80	0.00	0.07	0.06
1-Ton Crew Cab, 4x4	0.04	0.28	0.31	0.00	0.01	0.01
Lowboy Truck/Trailer	0.05	0.18	0.56	0.00	0.03	0.02
Aggregate Base Delivery Truck	4.69	18.96	57.39	0.08	2.78	2.40
Worker Commute	0.24	2.30	0.23	0.00	0.03	0.02
Offsite Total	5.25	23.33	60.30	0.08	2.91	2.51
Total	5.27	23.41	60.54	0.08	2.92	2.52

^a Emissions [lb/day] = number x miles/day x emission factor [lb/mi]

Motor Vehicle Total Greenhouse Gas Emissions

Vehicle	CO2 (MT) ^a	CH4 (MT) ^a	CO2e (MT) ^b
Onsite			
Water Truck	0.2	0.0	0.2
Onsite Total	0.2	0.0	0.2
Offsite			
Water Truck	1.8	0.0	1.8
1-Ton Crew Cab, 4x4	0.3	0.0	0.3
Lowboy Truck/Trailer	0.5	0.0	0.5
Aggregate Base Delivery Truck	49.7	0.0	49.7
Worker Commute	2.1	0.0	2.1
Offsite Total	54.4	0.0	54.4
Total	54.6	0.0	54.7

^a Emissions [metric tons, MT] = emission factor [lb/hr] x miles/day x Number x days used x 453.6 [g/lb] / 1,000,000 [g/MT]

Emission factors are in Table 49 and Table 50

^b CO₂-equivalent (CO₂e) emission factors are CO₂ emissions plus 21 x CH₄ emissions, based on Table C.1 from California Climate Action

Registry General Reporting Protocol, Version 3.0, April 2008, http://www.climateregistry.org/resources/docs/protocols/grp/GRP_V3_April2008_FINAL.pdf

Motor Vehicle Fugitive Particulate Matter Emissions

Vehicle	Number	Road Type	Miles/Day/Vehicle	PM10 Emission Factor (lb/mi) ^a	PM2.5 Emission Factor (lb/mi) ^a	PM10 Emissions (lb/day) ^b	PM2.5 Emissions (lb/day) ^b
Onsite							
Water Truck	8	Unpaved	1	0.922	0.092	7.38	0.74
Onsite Total						7.38	0.74
Offsite							
Water Truck	8	Paved	10	0.001	0.000	0.06	0.00
1-Ton Crew Cab, 4x4	1	Paved	14	0.001	0.000	0.01	0.00
Lowboy Truck/Trailer	1	Paved	14	0.001	0.000	0.01	0.00
Aggregate Base Delivery Truck	29	Paved	60	0.001	0.000	1.39	0.00
Water Truck	8	Unpaved	3	0.922	0.092	22.13	2.21
1-Ton Crew Cab, 4x4	1	Unpaved	4	0.532	0.053	2.13	0.21
Lowboy Truck/Trailer	1	Unpaved	4	0.922	0.092	3.69	0.37
Aggregate Base Delivery Truck	29	Unpaved	4	0.922	0.092	106.98	10.70
Worker Commute	5	Paved	60	0.001	0.000	0.24	0.00
Offsite Total						136.65	13.49
Total						144.03	14.23

a From Table 51

^b Emissions [lb/day] = number x miles/day x emission factor [lb/mi]

Earthwork Fugitive Particulate Matter Emissions

Table 25
Subtransmission Source Line Construction Emissions
Roads and Landing Work

Activity	Activity Units	Activity Level	PM10 Emission Factor ^a	PM2.5 Emission Factor ^a	PM10 (lb/day) ^b	PM2.5 (lb/day) ^b
Soil Handling ^c	CY/day	2,800	1.62E-03	3.36E-04	4.52	0.94
Bulldozing, Scraping and Grading	hr/day	10	1.481	0.308	14.81	3.08
Storage Pile Wind Erosion ^d	acres	0.6	15.7	3.26	9.40	1.96
Total					28.73	5.98

a From Table 52
b Emissions [lb/day] = Emission factor [lb/activity unit] x Activity unit [units/day]
c Based on excavating and backfilling 8.0 acres to 1.5' depth over 14 days
d Based on 8.0 acres total over 14 days

Table 26
Subtransmission Source Line Construction Emissions
Guard Structure Installation

Emissions Summary

Source	VOC (lb/day)	CO (lb/day)	NOX (lb/day)	SOX (lb/day)	PM10 (lb/day)	PM2.5 (lb/day)	CO2e (MT)
Construction Equipment Exhaust	4.74	16.75	43.06	0.07	1.71	1.58	5.8
Onsite Motor Vehicle Exhaust	0.00	0.00	0.00	0.00	0.00	0.00	0.0
Onsite Motor Vehicle Fugitive PM	--	--	--	--	0.00	0.00	
Earthwork Fugitive PM	--	--	--	--	0.00	0.00	
Onsite Total	4.74	16.75	43.06	0.07	1.71	1.58	5.8
Offsite Motor Vehicle Exhaust	0.55	4.05	3.13	0.01	0.16	0.13	0.7
Offsite Motor Vehicle Fugitive PM	--	--	--	--	18.98	1.86	
Offsite Total	0.55	4.05	3.13	0.01	19.14	2.00	0.7
Total	5.29	20.79	46.19	0.07	20.86	3.57	6.5

Construction Equipment Summary

Equipment	Horse-power	Number	Days Used	Hours Used/Day
Compressor Trailer	120	1	2	6
Auger Truck	500	1	2	6
30-Ton Crane Truck	300	1	2	8
80ft. Hydraulic Manlift/Bucket Truck	350	1	2	4
Backhoe/Front Loader	350	1	2	6

Construction Equipment Exhaust Emission Factors

Equipment	Horse-power	VOC (lb/hr) ^a	CO (lb/hr) ^a	NOX (lb/hr) ^a	SOX (lb/hr) ^a	PM10 (lb/hr) ^a	PM2.5 (lb/hr) ^b	CO2 (lb/hr) ^a	CH4 (lb/hr) ^a	Category
Compressor Trailer	120	0.089	0.329	0.533	0.001	0.049	0.045	46.950	0.008	Air Compressors
Auger Truck	500	0.135	0.553	1.315	0.003	0.044	0.040	311.309	0.012	Bore/Drill Rigs
30-Ton Crane Truck	300	0.163	0.569	1.533	0.002	0.057	0.053	180.101	0.015	Cranes
80ft. Hydraulic Manlift/Bucket Truck	350	0.163	0.569	1.533	0.002	0.057	0.053	180.101	0.015	Cranes
Backhoe/Front Loader	350	0.239	0.771	2.262	0.004	0.078	0.072	344.854	0.022	Tractors/Loaders/Backhoes

^a From Table 48

^b Diesel PM2.5 emission factor [lb/hr] = PM10 emission factor [lb/hr] x PM2.5 fraction of PM10

PM2.5 Fraction= 0.920

From Appendix A, Final--Methodology to Calculate Particulate Matter (PM) 2.5

and PM 2.5 Significance Thresholds, SCAQMD, October 2006,

http://www.aqmd.gov/ceqa/handbook/PM2_5/PM2_5.html

Construction Equipment Daily Criteria Pollutant Exhaust Emissions

Equipment	VOC (lb/day) ^a	CO (lb/day) ^a	NOX (lb/day) ^a	SOX (lb/day) ^a	PM10 (lb/day) ^a	PM2.5 (lb/day) ^a
Compressor Trailer	0.53	1.97	3.20	0.00	0.30	0.27
Auger Truck	0.81	3.32	7.89	0.02	0.26	0.24
30-Ton Crane Truck	1.31	4.55	12.26	0.01	0.46	0.42
80ft. Hydraulic Manlift/Bucket Truck	0.65	2.28	6.13	0.01	0.23	0.21
Backhoe/Front Loader	1.43	4.63	13.57	0.02	0.47	0.43
Total	4.74	16.75	43.06	0.07	1.71	1.58

^a Emissions [lb/day] = number x hours/day x emission factor [lb/hr]

Construction Equipment Total Greenhouse Gas Emissions

Equipment	CO2 (MT) ^a	CH4 (MT) ^a	CO2e (MT) ^b
Compressor Trailer	0.3	0.0	0.3
Auger Truck	1.7	0.0	1.7
30-Ton Crane Truck	1.3	0.0	1.3
80ft. Hydraulic Manlift/Bucket Truck	0.7	0.0	0.7
Backhoe/Front Loader	1.9	0.0	1.9
Total	5.8	0.0	5.8

^a Emissions [metric tons, MT] = emission factor [lb/hr] x hours/day x Number x

days used x 453.6 [g/lb] / 1,000,000 [g/MT]

Emission factors are in Table 48

^b CO₂-equivalent (CO₂e) emission factors are CO₂ emissions plus 21 x CH₄ emissions, based on Table C.1 from California Climate Action

Registry General Reporting Protocol, Version 3.0, April 2008, http://www.climateaction.org/resources/docs/protocols/grp/GRP_V3_April2008_FINAL.pdf

Motor Vehicle Usage

Vehicle	Number	Days Used	Hours Used/Day	Miles/Day/Veh.
Onsite				
None				
Offsite				
3/4-Ton Pick-up Truck, 4x4	1	2	N/A	18
1-Ton Crew Cab Flat Bed, 4x4	1	2	N/A	18
Extendable Flat Bed Pole Truck	1	2	N/A	18
Auger Truck	1	2	N/A	18
30-Ton Crane Truck	1	2	N/A	18
80ft. Hydraulic Manlift/Bucket Truck	1	2	N/A	18
Worker Commute	6	2	N/A	60

Table 26
Subtransmission Source Line Construction Emissions
Guard Structure Installation

Motor Vehicle Exhaust Emission Factors

Vehicle	Category	VOC (lb/mi) ^a	CO (lb/mi) ^a	NOX (lb/mi) ^a	SOX (lb/mi) ^a	PM10 (lb/mi) ^a	PM2.5 (lb/mi) ^b	CO2 (lb/mi) ^a	CH4 (lb/mi) ^a
Onsite									
None		0.00E+00	0.00E+00	0.00E+00	0.00E+00	0.00E+00	0.00E+00	0.00E+00	0.00E+00
Offsite									
3/4-Ton Pick-up Truck, 4x4	Delivery	2.24E-03	1.55E-02	1.73E-02	2.67E-05	6.50E-04	5.50E-04	2.77E+00	1.07E-04
1-Ton Crew Cab Flat Bed, 4x4	Delivery	2.24E-03	1.55E-02	1.73E-02	2.67E-05	6.50E-04	5.50E-04	2.77E+00	1.07E-04
Extendable Flat Bed Pole Truck	HHDT	2.53E-03	1.02E-02	3.09E-02	4.04E-05	1.50E-03	1.29E-03	4.22E+00	1.17E-04
Auger Truck	HHDT	2.53E-03	1.02E-02	3.09E-02	4.04E-05	1.50E-03	1.29E-03	4.22E+00	1.17E-04
30-Ton Crane Truck	HHDT	2.53E-03	1.02E-02	3.09E-02	4.04E-05	1.50E-03	1.29E-03	4.22E+00	1.17E-04
80ft. Hydraulic Manlift/Bucket Truck	HHDT	2.53E-03	1.02E-02	3.09E-02	4.04E-05	1.50E-03	1.29E-03	4.22E+00	1.17E-04
Worker Commute	Passenger	7.96E-04	7.65E-03	7.76E-04	1.07E-05	8.98E-05	5.75E-05	1.10E+00	7.17E-05

a From Table 49 or Table 50

Motor Vehicle Daily Criteria Pollutant Exhaust Emissions

Vehicle	VOC (lb/day) ^a	CO (lb/day) ^a	NOX (lb/day) ^a	SOX (lb/day) ^a	PM10 (lb/day) ^a	PM2.5 (lb/day) ^a
Onsite						
None	0.00	0.00	0.00	0.00	0.00	0.00
Onsite Total	0.00	0.00	0.00	0.00	0.00	0.00
Offsite						
3/4-Ton Pick-up Truck, 4x4	0.04	0.28	0.31	0.00	0.01	0.01
1-Ton Crew Cab Flat Bed, 4x4	0.04	0.28	0.31	0.00	0.01	0.01
Extendable Flat Bed Pole Truck	0.05	0.18	0.56	0.00	0.03	0.02
Auger Truck	0.05	0.18	0.56	0.00	0.03	0.02
30-Ton Crane Truck	0.05	0.18	0.56	0.00	0.03	0.02
80ft. Hydraulic Manlift/Bucket Truck	0.05	0.18	0.56	0.00	0.03	0.02
Worker Commute	0.29	2.76	0.28	0.00	0.03	0.02
Offsite Total	0.55	4.05	3.13	0.01	0.16	0.13
Total	0.55	4.05	3.13	0.01	0.16	0.13

^a Emissions [lb/day] = number x miles/day x emission factor [lb/mi]

Motor Vehicle Total Greenhouse Gas Emissions

Vehicle	CO2 (MT) ^a	CH4 (MT) ^a	CO2e (MT) ^b
Onsite			
None	0.0	0.0	0.0
Onsite Total	0.0	0.0	0.0
Offsite			
3/4-Ton Pick-up Truck, 4x4	0.0	0.0	0.0
1-Ton Crew Cab Flat Bed, 4x4	0.0	0.0	0.0
Extendable Flat Bed Pole Truck	0.1	0.0	0.1
Auger Truck	0.1	0.0	0.1
30-Ton Crane Truck	0.1	0.0	0.1
80ft. Hydraulic Manlift/Bucket Truck	0.1	0.0	0.1
Worker Commute	0.4	0.0	0.4
Offsite Total	0.7	0.0	0.7
Total	0.7	0.0	0.7

^a Emissions [metric tons, MT] = emission factor [lb/hr] x miles/day x Number x days used x 453.6 [g/lb] / 1,000,000 [g/MT]

Emission factors are in Table 49 and Table 50

^b CO₂-equivalent (CO₂e) emission factors are CO₂ emissions plus 21 x CH₄ emissions, based on Table C.1 from California Climate Action Registry General Reporting Protocol, Version 3.0, April 2008, http://www.climate registry.org/resources/docs/protocols/grp/GRP_V3_April2008_FINAL.pdf

Motor Vehicle Fugitive Particulate Matter Emissions

Vehicle	Number	Road Type	Miles/Day/Vehicle	PM10 Emission Factor (lb/mi) ^a	PM2.5 Emission Factor (lb/mi) ^a	PM10 Emissions (lb/day) ^b	PM2.5 Emissions (lb/day) ^b
Onsite							
None							
Onsite Total						0.00	0.00
Offsite							
3/4-Ton Pick-up Truck, 4x4	1	Paved	14	0.001	0.000	0.01	0.00
1-Ton Crew Cab Flat Bed, 4x4	1	Paved	14	0.001	0.000	0.01	0.00
Extendable Flat Bed Pole Truck	1	Paved	14	0.001	0.000	0.01	0.00
Auger Truck	1	Paved	14	0.001	0.000	0.01	0.00
30-Ton Crane Truck	1	Paved	14	0.001	0.000	0.01	0.00
80ft. Hydraulic Manlift/Bucket Truck	1	Paved	14	0.001	0.000	0.01	0.00
3/4-Ton Pick-up Truck, 4x4	1	Unpaved	4	0.435	0.043	1.74	0.17
1-Ton Crew Cab Flat Bed, 4x4	1	Unpaved	4	0.532	0.053	2.13	0.21
Extendable Flat Bed Pole Truck	1	Unpaved	4	0.922	0.092	3.69	0.37
Auger Truck	1	Unpaved	4	0.922	0.092	3.69	0.37
30-Ton Crane Truck	1	Unpaved	4	0.922	0.092	3.69	0.37
80ft. Hydraulic Manlift/Bucket Truck	1	Unpaved	4	0.922	0.092	3.69	0.37
Worker Commute	6	Paved	60	0.001	0.000	0.29	0.00

Table 26
Subtransmission Source Line Construction Emissions
Guard Structure Installation

Offsite Total						18.98	1.86
Total						18.98	1.86

a From Table 51

b Emissions [lb/day] = number x miles/day x emission factor [lb/mi]

Earthwork Fugitive Particulate Matter Emissions

Activity	Activity Units	Activity Level	PM10 Emission Factor^a	PM2.5 Emission Factor^a	PM10 (lb/day)^b	PM2.5 (lb/day)^b
Soil Handling	CY/day		1.62E-03	3.36E-04	0.00	0.00
Bulldozing, Scraping and Grading	hr/day		1.481	0.308	0.00	0.00
Storage Pile Wind Erosion	acres		15.7	3.26	0.00	0.00
Total					0.00	0.00

a From Table 52

b Emissions [lb/day] = Emission factor [lb/activity unit] x Activity unit [units/day]

Table 27
Subtransmission Source Line Construction Emissions
Existing Wood Poles Removal

Emissions Summary

Source	VOC (lb/day)	CO (lb/day)	NOX (lb/day)	SOX (lb/day)	PM10 (lb/day)	PM2.5 (lb/day)	CO2e (MT)
Construction Equipment Exhaust	3.19	10.67	28.32	0.04	1.18	1.09	1.7
Onsite Motor Vehicle Exhaust	0.00	0.00	0.00	0.00	0.00	0.00	0.0
Onsite Motor Vehicle Fugitive PM	--	--	--	--	0.00	0.00	
Earthwork Fugitive PM	--	--	--	--	0.00	0.00	
Onsite Total	3.19	10.67	28.32	0.04	1.18	1.09	1.7
Offsite Motor Vehicle Exhaust	0.42	3.40	1.70	0.01	0.10	0.08	0.3
Offsite Motor Vehicle Fugitive PM	--	--	--	--	9.83	0.95	
Offsite Total	0.42	3.40	1.70	0.01	9.92	1.03	0.3
Total	3.60	14.07	30.02	0.05	11.11	2.12	2.0

Construction Equipment Summary

Equipment	Horse-power	Number	Days Used	Hours Used/Day
10-000 lb. Rough Terrain Forklift	200	1	1	4
30-Ton Crane Truck	300	1	1	6
Compressor Trailer	120	1	1	6
Backhoe/Front Loader	350	1	1	6

Construction Equipment Exhaust Emission Factors

Equipment	Horse-power	VOC (lb/hr) ^a	CO (lb/hr) ^a	NOX (lb/hr) ^a	SOX (lb/hr) ^a	PM10 (lb/hr) ^a	PM2.5 (lb/hr) ^b	CO2 (lb/hr) ^a	CH4 (lb/hr) ^a	Category
10-000 lb. Rough Terrain Forklift	200	0.059	0.164	0.587	0.001	0.019	0.017	77.122	0.005	Forklifts
30-Ton Crane Truck	300	0.163	0.569	1.533	0.002	0.057	0.053	180.101	0.015	Cranes
Compressor Trailer	120	0.089	0.329	0.533	0.001	0.049	0.045	46.950	0.008	Air Compressors
Backhoe/Front Loader	350	0.239	0.771	2.262	0.004	0.078	0.072	344.854	0.022	Tractors/Loaders/Backhoes

^a From Table 48

^b Diesel PM2.5 emission factor [lb/hr] = PM10 emission factor [lb/hr] x PM2.5 fraction of PM10

PM2.5 Fraction= 0.920

From Appendix A, Final-Methodology to Calculate Particulate Matter (PM) 2.5

and PM 2.5 Significance Thresholds, SCAQMD, October 2006,

http://www.aqmd.gov/ceqa/handbook/PM2_5/PM2_5.html

Construction Equipment Daily Criteria Pollutant Exhaust Emissions

Equipment	VOC (lb/day) ^a	CO (lb/day) ^a	NOX (lb/day) ^a	SOX (lb/day) ^a	PM10 (lb/day) ^a	PM2.5 (lb/day) ^a
10-000 lb. Rough Terrain Forklift	0.24	0.66	2.35	0.00	0.07	0.07
30-Ton Crane Truck	0.98	3.41	9.20	0.01	0.34	0.32
Compressor Trailer	0.53	1.97	3.20	0.00	0.30	0.27
Backhoe/Front Loader	1.43	4.63	13.57	0.02	0.47	0.43
Total	3.19	10.67	28.32	0.04	1.18	1.09

^a Emissions [lb/day] = number x hours/day x emission factor [lb/hr]

Construction Equipment Total Greenhouse Gas Emissions

Equipment	CO2 (MT) ^a	CH4 (MT) ^a	CO2e (MT) ^b
10-000 lb. Rough Terrain Forklift	0.1	0.0	0.1
30-Ton Crane Truck	0.5	0.0	0.5
Compressor Trailer	0.1	0.0	0.1
Backhoe/Front Loader	0.9	0.0	0.9
Total	1.7	0.0	1.7

^a Emissions [metric tons, MT] = emission factor [lb/hr] x hours/day x Number x

days used x 453.6 [g/lb] / 1,000,000 [g/MT]

Emission factors are in Table 48

^b CO₂-equivalent (CO₂e) emission factors are CO₂ emissions plus 21 x CH₄ emissions, based on Table C.1 from California Climate Action

Registry General Reporting Protocol, Version 3.0, April 2008, http://www.climateregistry.org/resources/docs/protocols/grp/GRP_V3_April2008_FINAL.pdf

Motor Vehicle Usage

Vehicle	Number	Days Used	Hours Used/Day	Miles/Day/Veh.
Onsite				
None				
Offsite				
1-Ton Crew Cab, 4x4	1	1	N/A	18
Flat Bed Truck/Trailer	1	1	N/A	18
30-Ton Crane Truck	1	1	N/A	18
Worker Commute	6	1	N/A	60

Motor Vehicle Exhaust Emission Factors

Vehicle	Category	VOC (lb/mi) ^a	CO (lb/mi) ^a	NOX (lb/mi) ^a	SOX (lb/mi) ^a	PM10 (lb/mi) ^a	PM2.5 (lb/mi) ^b	CO2 (lb/mi) ^a	CH4 (lb/mi) ^a
Onsite									
None		0.00E+00	0.00E+00	0.00E+00	0.00E+00	0.00E+00	0.00E+00	0.00E+00	0.00E+00
Offsite									

Table 27
Subtransmission Source Line Construction Emissions
Existing Wood Poles Removal

1-Ton Crew Cab, 4x4	Delivery	2.24E-03	1.55E-02	1.73E-02	2.67E-05	6.50E-04	5.50E-04	2.77E+00	1.07E-04
Flat Bed Truck/Trailer	HHDT	2.53E-03	1.02E-02	3.09E-02	4.04E-05	1.50E-03	1.29E-03	4.22E+00	1.17E-04
30-Ton Crane Truck	HHDT	2.53E-03	1.02E-02	3.09E-02	4.04E-05	1.50E-03	1.29E-03	4.22E+00	1.17E-04
Worker Commute	Passenger	7.96E-04	7.65E-03	7.76E-04	1.07E-05	8.98E-05	5.75E-05	1.10E+00	7.17E-05

a From Table 49 or Table 50

Motor Vehicle Daily Criteria Pollutant Exhaust Emissions

Vehicle	VOC (lb/day) ^a	CO (lb/day) ^a	NOX (lb/day) ^a	SOX (lb/day) ^a	PM10 (lb/day) ^a	PM2.5 (lb/day) ^a
Onsite						
None	0.00	0.00	0.00	0.00	0.00	0.00
Onsite Total	0.00	0.00	0.00	0.00	0.00	0.00
Offsite						
1-Ton Crew Cab, 4x4	0.04	0.28	0.31	0.00	0.01	0.01
Flat Bed Truck/Trailer	0.05	0.18	0.56	0.00	0.03	0.02
30-Ton Crane Truck	0.05	0.18	0.56	0.00	0.03	0.02
Worker Commute	0.29	2.76	0.28	0.00	0.03	0.02
Offsite Total	0.42	3.40	1.70	0.01	0.10	0.08
Total	0.42	3.40	1.70	0.01	0.10	0.08

^a Emissions [lb/day] = number x miles/day x emission factor [lb/mi]

Motor Vehicle Total Greenhouse Gas Emissions

Vehicle	CO2 (MT) ^a	CH4 (MT) ^a	CO2e (MT) ^b
Onsite			
None	0.0	0.0	0.0
Onsite Total	0.0	0.0	0.0
Offsite			
1-Ton Crew Cab, 4x4	0.0	0.0	0.0
Flat Bed Truck/Trailer	0.0	0.0	0.0
30-Ton Crane Truck	0.0	0.0	0.0
Worker Commute	0.2	0.0	0.2
Offsite Total	0.3	0.0	0.3
Total	0.3	0.0	0.3

^a Emissions [metric tons, MT] = emission factor [lb/hr] x miles/day x Number x days used x 453.6 [g/lb] / 1,000,000 [g/MT]

Emission factors are in Table 49 and Table 50

^b CO₂-equivalent (CO₂e) emission factors are CO₂ emissions plus 21 x CH₄ emissions, based on Table C.1 from California Climate Action

Registry General Reporting Protocol, Version 3.0, April 2008, http://www.climateregistry.org/resources/docs/protocols/grp/GRP_V3_April2008_FINAL.pdf

Motor Vehicle Fugitive Particulate Matter Emissions

Vehicle	Number	Road Type	Miles/Day/ Vehicle	PM10 Emission Factor (lb/mi) ^a	PM2.5 Emission Factor (lb/mi) ^a	PM10 Emissions (lb/day) ^b	PM2.5 Emissions (lb/day) ^b
Onsite							
None							
Onsite Total						0.00	0.00
Offsite							
1-Ton Crew Cab, 4x4	1	Paved	14	0.001	0.000	0.01	0.00
Flat Bed Truck/Trailer	1	Paved	14	0.001	0.000	0.01	0.00
30-Ton Crane Truck	1	Paved	14	0.001	0.000	0.01	0.00
1-Ton Crew Cab, 4x4	1	Unpaved	4	0.532	0.053	2.13	0.21
Flat Bed Truck/Trailer	1	Unpaved	4	0.922	0.092	3.69	0.37
30-Ton Crane Truck	1	Unpaved	4	0.922	0.092	3.69	0.37
Worker Commute	6	Paved	60	0.001	0.000	0.29	0.00
Offsite Total						9.83	0.95
Total						9.83	0.95

a From Table 51

^b Emissions [lb/day] = number x miles/day x emission factor [lb/mi]

Earthwork Fugitive Particulate Matter Emissions

Activity	Activity Units	Activity Level	PM10 Emission Factor ^a	PM2.5 Emission Factor ^a	PM10 (lb/day) ^b	PM2.5 (lb/day) ^b
Soil Handling	CY/day		1.62E-03	3.36E-04	0.00	0.00
Bulldozing, Scraping and Grading	hr/day		1.481	0.308	0.00	0.00
Storage Pile Wind Erosion	acres		15.7	3.26	0.00	0.00
Total					0.00	0.00

a From Table 52

^b Emissions [lb/day] = Emission factor [lb/activity unit] x Activity unit [units/day]

Table 28
Subtransmission Source Line Construction Emissions
Tubular Steel Pole Foundations Installation

Emissions Summary

Source	VOC (lb/day)	CO (lb/day)	NOX (lb/day)	SOX (lb/day)	PM10 (lb/day)	PM2.5 (lb/day)	CO2e (MT)
Construction Equipment Exhaust	2.91	10.27	28.44	0.05	0.97	0.89	73.6
Onsite Motor Vehicle Exhaust	0.00	0.00	0.00	0.00	0.00	0.00	0.0
Onsite Motor Vehicle Fugitive PM	--	--	--	--	0.00	0.00	
Earthwork Fugitive PM	--	--	--	--	0.12	0.03	
Onsite Total	2.91	10.27	28.44	0.05	1.09	0.92	73.6
Offsite Motor Vehicle Exhaust	3.09	14.46	33.85	0.05	1.66	1.42	77.8
Offsite Motor Vehicle Fugitive PM	--	--	--	--	73.36	7.22	
Offsite Total	3.09	14.46	33.85	0.05	75.02	8.65	77.8
Total	6.00	24.73	62.29	0.10	76.11	9.56	151.4

Construction Equipment Summary

Equipment	Horse-power	Number	Days Used	Hours Used/Day
30-Ton Crane Truck	300	1	34	5
Backhoe/Front Loader	200	1	34	8
Auger Truck	500	1	34	8

Construction Equipment Exhaust Emission Factors

Equipment	Horse-power	VOC (lb/hr) ^a	CO (lb/hr) ^a	NOX (lb/hr) ^a	SOX (lb/hr) ^a	PM10 (lb/hr) ^a	PM2.5 (lb/hr) ^b	CO2 (lb/hr) ^a	CH4 (lb/hr) ^a	Category
30-Ton Crane Truck	300	0.163	0.569	1.533	0.002	0.057	0.053	180.101	0.015	Cranes
Backhoe/Front Loader	200	0.126	0.375	1.281	0.002	0.042	0.038	171.737	0.011	Tractors/Loaders/Backhoes
Auger Truck	500	0.135	0.553	1.315	0.003	0.044	0.040	311.309	0.012	Bore/Drill Rigs

^a From Table 48

^b Diesel PM2.5 emission factor [lb/hr] = PM10 emission factor [lb/hr] x PM2.5 fraction of PM10

PM2.5 Fraction= 0.920

From Appendix A, Final--Methodology to Calculate Particulate Matter (PM) 2.5

and PM 2.5 Significance Thresholds, SCAQMD, October 2006,

http://www.aqmd.gov/ceqa/handbook/PM2_5/PM2_5.html

Construction Equipment Daily Criteria Pollutant Exhaust Emissions

Equipment	VOC (lb/day) ^a	CO (lb/day) ^a	NOX (lb/day) ^a	SOX (lb/day) ^a	PM10 (lb/day) ^a	PM2.5 (lb/day) ^a
30-Ton Crane Truck	0.82	2.85	7.66	0.01	0.29	0.26
Backhoe/Front Loader	1.01	3.00	10.25	0.02	0.33	0.31
Auger Truck	1.08	4.42	10.52	0.02	0.35	0.32
Total	2.91	10.27	28.44	0.05	0.97	0.89

^a Emissions [lb/day] = number x hours/day x emission factor [lb/hr]

Construction Equipment Total Greenhouse Gas Emissions

Equipment	CO2 (MT) ^a	CH4 (MT) ^a	CO2e (MT) ^b
30-Ton Crane Truck	13.9	0.0	13.9
Backhoe/Front Loader	21.2	0.0	21.2
Auger Truck	38.4	0.0	38.4
Total	73.5	0.0	73.6

^a Emissions [metric tons, MT] = emission factor [lb/hr] x hours/day x Number x

days used x 453.6 [g/lb] / 1,000,000 [g/MT]

Emission factors are in Table 48

^b CO₂-equivalent (CO₂e) emission factors are CO₂ emissions plus 21 x CH₄ emissions, based on Table C.1 from California Climate Action

Registry General Reporting Protocol, Version 3.0, April 2008, http://www.climateaction.org/resources/docs/protocols/grp/GRP_V3_April2008_FINAL.pdf

Motor Vehicle Usage

Vehicle	Number ^a	Days Used	Hours Used/Day	Miles/Day/Veh.
Onsite				
None				
Offsite				
Water Truck	1	34	N/A	14
1-Ton Crew Cab Flat Bed, 4x4	1	34	N/A	18
10-cu. yd. Dump Truck	8	34	N/A	64
10-cu. yd. Concrete Mixer Truck	8	34	N/A	64
30-Ton Crane Truck	1	34	N/A	18
Auger Truck	1	34	N/A	18
Worker Commute	7	34	N/A	60

^a Concrete mixer and dump trucks based on 74.5 CY per foundation and 10 CY/truck = 74.5 / 10 = 7.5

Motor Vehicle Exhaust Emission Factors

Vehicle	Category	VOC (lb/mi) ^a	CO (lb/mi) ^a	NOX (lb/mi) ^a	SOX (lb/mi) ^a	PM10 (lb/mi) ^a	PM2.5 (lb/mi) ^b	CO2 (lb/mi) ^a	CH4 (lb/mi) ^a
Onsite									
None		0.00E+00	0.00E+00	0.00E+00	0.00E+00	0.00E+00	0.00E+00	0.00E+00	0.00E+00
Offsite									

Table 28
Subtransmission Source Line Construction Emissions
Tubular Steel Pole Foundations Installation

Water Truck	HHDT	2.53E-03	1.02E-02	3.09E-02	4.04E-05	1.50E-03	1.29E-03	4.22E+00	1.17E-04
1-Ton Crew Cab Flat Bed, 4x4	Delivery	2.24E-03	1.55E-02	1.73E-02	2.67E-05	6.50E-04	5.50E-04	2.77E+00	1.07E-04
10-cu. yd. Dump Truck	HHDT	2.53E-03	1.02E-02	3.09E-02	4.04E-05	1.50E-03	1.29E-03	4.22E+00	1.17E-04
10-cu. yd. Concrete Mixer Truck	HHDT	2.53E-03	1.02E-02	3.09E-02	4.04E-05	1.50E-03	1.29E-03	4.22E+00	1.17E-04
30-Ton Crane Truck	HHDT	2.53E-03	1.02E-02	3.09E-02	4.04E-05	1.50E-03	1.29E-03	4.22E+00	1.17E-04
Auger Truck	HHDT	2.53E-03	1.02E-02	3.09E-02	4.04E-05	1.50E-03	1.29E-03	4.22E+00	1.17E-04
Worker Commute	Passenger	7.96E-04	7.65E-03	7.76E-04	1.07E-05	8.98E-05	5.75E-05	1.10E+00	7.17E-05

a From Table 49 or Table 50

Motor Vehicle Daily Criteria Pollutant Exhaust Emissions

Vehicle	VOC (lb/day) ^a	CO (lb/day) ^a	NOX (lb/day) ^a	SOX (lb/day) ^a	PM10 (lb/day) ^a	PM2.5 (lb/day) ^a
Onsite						
None	0.00	0.00	0.00	0.00	0.00	0.00
Onsite Total	0.00	0.00	0.00	0.00	0.00	0.00
Offsite						
Water Truck	0.04	0.14	0.43	0.00	0.02	0.02
1-Ton Crew Cab Flat Bed, 4x4	0.04	0.28	0.31	0.00	0.01	0.01
10-cu. yd. Dump Truck	1.29	5.23	15.83	0.02	0.77	0.66
10-cu. yd. Concrete Mixer Truck	1.29	5.23	15.83	0.02	0.77	0.66
30-Ton Crane Truck	0.05	0.18	0.56	0.00	0.03	0.02
Auger Truck	0.05	0.18	0.56	0.00	0.03	0.02
Worker Commute	0.33	3.21	0.33	0.00	0.04	0.02
Offsite Total	3.09	14.46	33.85	0.05	1.66	1.42
Total	3.09	14.46	33.85	0.05	1.66	1.42

^a Emissions [lb/day] = number x miles/day x emission factor [lb/mi]

Motor Vehicle Total Greenhouse Gas Emissions

Vehicle	CO2 (MT) ^a	CH4 (MT) ^a	CO2e (MT) ^b
Onsite			
None	0.0	0.0	0.0
Onsite Total	0.0	0.0	0.0
Offsite			
Water Truck	0.9	0.0	0.9
1-Ton Crew Cab Flat Bed, 4x4	0.8	0.0	0.8
10-cu. yd. Dump Truck	33.3	0.0	33.3
10-cu. yd. Concrete Mixer Truck	33.3	0.0	33.3
30-Ton Crane Truck	1.2	0.0	1.2
Auger Truck	1.2	0.0	1.2
Worker Commute	7.1	0.0	7.1
Offsite Total	77.7	0.0	77.8
Total	77.7	0.0	77.8

^a Emissions [metric tons, MT] = emission factor [lb/hr] x miles/day x Number x days used x 453.6 [g/lb] / 1,000,000 [g/MT]

Emission factors are in Table 49 and Table 50

^b CO₂-equivalent (CO₂e) emission factors are CO₂ emissions plus 21 x CH₄ emissions, based on Table C.1 from California Climate Action

Registry General Reporting Protocol, Version 3.0, April 2008, http://www.climate registry.org/resources/docs/protocols/grp/GRP_V3_April2008_FINAL.pdf

Motor Vehicle Fugitive Particulate Matter Emissions

Vehicle	Number	Road Type	Miles/Day/ Vehicle	PM10 Emission Factor (lb/mi) ^a	PM2.5 Emission Factor (lb/mi) ^a	PM10 Emissions (lb/day) ^b	PM2.5 Emissions (lb/day) ^b
Onsite							
None							
Onsite Total						0.00	0.00
Offsite							
Water Truck	1	Paved	10	0.001	0.000	0.01	0.00
1-Ton Crew Cab Flat Bed, 4x4	1	Paved	14	0.001	0.000	0.01	0.00
10-cu. yd. Dump Truck	8	Paved	60	0.001	0.000	0.38	0.00
10-cu. yd. Concrete Mixer Truck	8	Paved	60	0.001	0.000	0.38	0.00
30-Ton Crane Truck	1	Paved	14	0.001	0.000	0.01	0.00
Auger Truck	1	Paved	14	0.001	0.000	0.01	0.00
Water Truck	1	Unpaved	4	0.922	0.092	3.69	0.37
1-Ton Crew Cab Flat Bed, 4x4	1	Unpaved	4	0.532	0.053	2.13	0.21
10-cu. yd. Dump Truck	8	Unpaved	4	0.922	0.092	29.51	2.95
10-cu. yd. Concrete Mixer Truck	8	Unpaved	4	0.922	0.092	29.51	2.95
30-Ton Crane Truck	1	Unpaved	4	0.922	0.092	3.69	0.37
Auger Truck	1	Unpaved	4	0.922	0.092	3.69	0.37
Worker Commute	7	Paved	60	0.001	0.000	0.34	0.00
Offsite Total						73.36	7.22
Total						73.36	7.22

a From Table 51

^b Emissions [lb/day] = number x miles/day x emission factor [lb/mi]

Earthwork Fugitive Particulate Matter Emissions

Table 28
Subtransmission Source Line Construction Emissions
Tubular Steel Pole Foundations Installation

Activity	Activity Units	Activity Level	PM10 Emission Factor ^a	PM2.5 Emission Factor ^a	PM10 (lb/day) ^b	PM2.5 (lb/day) ^b
Soil Handling ^c	CY/day	75	1.62E-03	3.36E-04	0.12	0.03
Bulldozing, Scraping and Grading	hr/day		1.481	0.308	0.00	0.00
Storage Pile Wind Erosion	acres		15.7	3.26	0.00	0.00
Total					0.12	0.03

a From Table 52
b Emissions [lb/day] = Emission factor [lb/activity unit] x Activity unit [units/day]
c Based on excavating 8 ft. diameter x 40 ft. deep per foundation and one foundation per day

Table 29
Subtransmission Source Line Construction Emissions
Wood Pole Installation

Emissions Summary

Source	VOC (lb/day)	CO (lb/day)	NOX (lb/day)	SOX (lb/day)	PM10 (lb/day)	PM2.5 (lb/day)	CO2e (MT)
Construction Equipment Exhaust	2.19	7.31	19.55	0.02	0.84	0.77	20.3
Onsite Motor Vehicle Exhaust	0.00	0.00	0.00	0.00	0.00	0.00	0.0
Onsite Motor Vehicle Fugitive PM	--	--	--	--	0.00	0.00	
Earthwork Fugitive PM	--	--	--	--	0.02	0.00	
Onsite Total	2.19	7.31	19.55	0.02	0.86	0.78	20.3
Offsite Motor Vehicle Exhaust	0.46	4.23	1.00	0.01	0.07	0.05	5.4
Offsite Motor Vehicle Fugitive PM	--	--	--	--	4.27	0.39	
Offsite Total	0.46	4.23	1.00	0.01	4.34	0.43	5.4
Total	2.65	11.54	20.55	0.03	5.20	1.21	25.7

Construction Equipment Summary

Equipment	Horse-power	Number	Days Used	Hours Used/Day
Compressor Trailer	120	1	19	5
80-Ton Rough Terrain Crane	350	1	19	6
Backhoe/Front Loader	200	1	19	6

Construction Equipment Exhaust Emission Factors

Equipment	Horse-power	VOC (lb/hr) ^a	CO (lb/hr) ^a	NOX (lb/hr) ^a	SOX (lb/hr) ^a	PM10 (lb/hr) ^a	PM2.5 (lb/hr) ^b	CO2 (lb/hr) ^a	CH4 (lb/hr) ^a	Category
Compressor Trailer	120	0.089	0.329	0.533	0.001	0.049	0.045	46.950	0.008	Air Compressors
80-Ton Rough Terrain Crane	350	0.163	0.569	1.533	0.002	0.057	0.053	180.101	0.015	Cranes
Backhoe/Front Loader	200	0.126	0.375	1.281	0.002	0.042	0.038	171.737	0.011	Tractors/Loaders/Backhoes

^a From Table 48

^b Diesel PM2.5 emission factor [lb/hr] = PM10 emission factor [lb/hr] x PM2.5 fraction of PM10

PM2.5 Fraction= 0.920

From Appendix A, Final-Methodology to Calculate Particulate Matter (PM) 2.5

and PM 2.5 Significance Thresholds, SCAQMD, October 2006,

http://www.aqmd.gov/ceqa/handbook/PM2_5/PM2_5.html

Construction Equipment Daily Criteria Pollutant Exhaust Emissions

Equipment	VOC (lb/day) ^a	CO (lb/day) ^a	NOX (lb/day) ^a	SOX (lb/day) ^a	PM10 (lb/day) ^a	PM2.5 (lb/day) ^a
Compressor Trailer	0.45	1.64	2.67	0.00	0.25	0.23
80-Ton Rough Terrain Crane	0.98	3.41	9.20	0.01	0.34	0.32
Backhoe/Front Loader	0.76	2.25	7.69	0.01	0.25	0.23
Total	2.19	7.31	19.55	0.02	0.84	0.77

^a Emissions [lb/day] = number x hours/day x emission factor [lb/hr]

Construction Equipment Total Greenhouse Gas Emissions

Equipment	CO2 (MT) ^a	CH4 (MT) ^a	CO2e (MT) ^b
Compressor Trailer	2.0	0.0	2.0
80-Ton Rough Terrain Crane	9.3	0.0	9.3
Backhoe/Front Loader	8.9	0.0	8.9
Total	20.2	0.0	20.3

^a Emissions [metric tons, MT] = emission factor [lb/hr] x hours/day x Number x

days used x 453.6 [g/lb] / 1,000,000 [g/MT]

Emission factors are in Table 48

^b CO₂-equivalent (CO₂e) emission factors are CO₂ emissions plus 21 x CH₄ emissions, based on Table C.1 from California Climate Action

Registry General Reporting Protocol, Version 3.0, April 2008, http://www.climateregistry.org/resources/docs/protocols/grp/GRP_V3_April2008_FINAL.pdf

Motor Vehicle Usage

Vehicle	Number	Days Used	Hours Used/Day	Miles/Day/Veh.
Onsite				
None				0
Offsite				
3/4-Ton Pick-up Truck, 4x4	1	19	N/A	18
1-Ton Crew Cab Flat Bed, 4x4	1	19	N/A	18
Worker Commute	8	19	N/A	60

Motor Vehicle Exhaust Emission Factors

Vehicle	Category	VOC (lb/mi) ^a	CO (lb/mi) ^a	NOX (lb/mi) ^a	SOX (lb/mi) ^a	PM10 (lb/mi) ^a	PM2.5 (lb/mi) ^b	CO2 (lb/mi) ^a	CH4 (lb/mi) ^a
Onsite									
None		0.00E+00	0.00E+00	0.00E+00	0.00E+00	0.00E+00	0.00E+00	0.00E+00	0.00E+00
Offsite									
3/4-Ton Pick-up Truck, 4x4	Delivery	2.24E-03	1.55E-02	1.73E-02	2.67E-05	6.50E-04	5.50E-04	2.77E+00	1.07E-04
1-Ton Crew Cab Flat Bed, 4x4	Delivery	2.24E-03	1.55E-02	1.73E-02	2.67E-05	6.50E-04	5.50E-04	2.77E+00	1.07E-04
Worker Commute	Passenger	7.96E-04	7.65E-03	7.76E-04	1.07E-05	8.98E-05	5.75E-05	1.10E+00	7.17E-05

^a From Table 49 or Table 50

Motor Vehicle Daily Criteria Pollutant Exhaust Emissions

Table 29
Subtransmission Source Line Construction Emissions
Wood Pole Installation

Vehicle	VOC (lb/day) ^a	CO (lb/day) ^a	NOX (lb/day) ^a	SOX (lb/day) ^a	PM10 (lb/day) ^a	PM2.5 (lb/day) ^a
Onsite						
None	0.00	0.00	0.00	0.00	0.00	0.00
Onsite Total	0.00	0.00	0.00	0.00	0.00	0.00
Offsite						
3/4-Ton Pick-up Truck, 4x4	0.04	0.28	0.31	0.00	0.01	0.01
1-Ton Crew Cab Flat Bed, 4x4	0.04	0.28	0.31	0.00	0.01	0.01
Worker Commute	0.38	3.67	0.37	0.01	0.04	0.03
Offsite Total	0.46	4.23	1.00	0.01	0.07	0.05
Total	0.46	4.23	1.00	0.01	0.07	0.05

^a Emissions [lb/day] = number x miles/day x emission factor [lb/mi]

Motor Vehicle Total Greenhouse Gas Emissions

Vehicle	CO2 (MT) ^a	CH4 (MT) ^a	CO2e (MT) ^b
Onsite			
None	0.0	0.0	0.0
Onsite Total	0.0	0.0	0.0
Offsite			
3/4-Ton Pick-up Truck, 4x4	0.4	0.0	0.4
1-Ton Crew Cab Flat Bed, 4x4	0.4	0.0	0.4
Worker Commute	4.6	0.0	4.6
Offsite Total	5.4	0.0	5.4
Total	5.4	0.0	5.4

^a Emissions [metric tons, MT] = emission factor [lb/hr] x miles/day x Number x days used x 453.6 [g/lb] / 1,000,000 [g/MT]

Emission factors are in Table 49 and Table 50

^b CO₂-equivalent (CO₂e) emission factors are CO₂ emissions plus 21 x CH₄ emissions, based on Table C.1 from California Climate Action Registry General Reporting Protocol, Version 3.0, April 2008, http://www.climateregistry.org/resources/docs/protocols/grp/GRP_V3_April2008_FINAL.pdf

Motor Vehicle Fugitive Particulate Matter Emissions

Vehicle	Number	Road Type	Miles/Day/ Vehicle	PM10 Emission Factor (lb/mi) ^a	PM2.5 Emission Factor (lb/mi) ^a	PM10 Emissions (lb/day) ^b	PM2.5 Emissions (lb/day) ^b
Onsite							
None	0						
Onsite Total						0.00	0.00
Offsite							
3/4-Ton Pick-up Truck, 4x4	1	Paved	14	0.001	0.000	0.01	0.00
1-Ton Crew Cab Flat Bed, 4x4	1	Paved	14	0.001	0.000	0.01	0.00
3/4-Ton Pick-up Truck, 4x4	1	Unpaved	4	0.435	0.043	1.74	0.17
1-Ton Crew Cab Flat Bed, 4x4	1	Unpaved	4	0.532	0.053	2.13	0.21
Worker Commute	8	Paved	60	0.001	0.000	0.38	0.00
Offsite Total						4.27	0.39
Total						4.27	0.39

^a From Table 51

^b Emissions [lb/day] = number x miles/day x emission factor [lb/mi]

Earthwork Fugitive Particulate Matter Emissions

Activity	Activity Units	Activity Level	PM10 Emission Factor ^a	PM2.5 Emission Factor ^a	PM10 (lb/day) ^b	PM2.5 (lb/day) ^b
Soil Handling ^c	CY/day	12	1.62E-03	3.36E-04	0.02	0.00
Bulldozing, Scraping and Grading	hr/day		1.481	0.308	0.00	0.00
Storage Pile Wind Erosion	acres		15.7	3.26	0.00	0.00
Total					0.02	0.00

^a From Table 52

^b Emissions [lb/day] = Emission factor [lb/activity unit] x Activity unit [units/day]

^c Based on excavating 3 ft. diameter x 11 ft. deep per pole x 4 poles per day

Table 30
Subtransmission Source Line Construction Emissions
Steel Pole Haul

Emissions Summary

Source	VOC (lb/day)	CO (lb/day)	NOX (lb/day)	SOX (lb/day)	PM10 (lb/day)	PM2.5 (lb/day)	CO2e (MT)
Construction Equipment Exhaust	0.98	3.41	9.20	0.01	0.34	0.32	2.5
Onsite Motor Vehicle Exhaust	0.00	0.00	0.00	0.00	0.00	0.00	0.0
Onsite Motor Vehicle Fugitive PM	--	--	--	--	0.00	0.00	
Earthwork Fugitive PM	--	--	--	--	0.00	0.00	
Onsite Total	0.98	3.41	9.20	0.01	0.34	0.32	2.5
Offsite Motor Vehicle Exhaust	0.28	2.30	1.05	0.00	0.06	0.05	0.9
Offsite Motor Vehicle Fugitive PM	--	--	--	--	5.64	0.54	
Offsite Total	0.28	2.30	1.05	0.00	5.70	0.59	0.9
Total	1.26	5.71	10.25	0.01	6.05	0.91	3.3

Construction Equipment Summary

Equipment	Horse-power	Number	Days Used	Hours Used/Day
80-Ton Rough Terrain Crane	350	1	5	6

Construction Equipment Exhaust Emission Factors

Equipment	Horse-power	VOC (lb/hr) ^a	CO (lb/hr) ^a	NOX (lb/hr) ^a	SOX (lb/hr) ^a	PM10 (lb/hr) ^a	PM2.5 (lb/hr) ^b	CO2 (lb/hr) ^a	CH4 (lb/hr) ^a	Category
80-Ton Rough Terrain Crane	350	0.163	0.569	1.533	0.002	0.057	0.053	180.101	0.015	Cranes

^a From Table 48

^b Diesel PM2.5 emission factor [lb/hr] = PM10 emission factor [lb/hr] x PM2.5 fraction of PM10

PM2.5 Fraction= 0.920

From Appendix A, Final-Methodology to Calculate Particulate Matter (PM) 2.5

and PM 2.5 Significance Thresholds, SCAQMD, October 2006,

http://www.aqmd.gov/ceqa/handbook/PM2_5/PM2_5.html

Construction Equipment Daily Criteria Pollutant Exhaust Emissions

Equipment	VOC (lb/day) ^a	CO (lb/day) ^a	NOX (lb/day) ^a	SOX (lb/day) ^a	PM10 (lb/day) ^a	PM2.5 (lb/day) ^a
80-Ton Rough Terrain Crane	0.98	3.41	9.20	0.01	0.34	0.32
Total	0.98	3.41	9.20	0.01	0.34	0.32

^a Emissions [lb/day] = number x hours/day x emission factor [lb/hr]

Construction Equipment Total Greenhouse Gas Emissions

Equipment	CO2 (MT) ^a	CH4 (MT) ^a	CO2e (MT) ^b
80-Ton Rough Terrain Crane	2.5	0.0	2.5
Total	2.5	0.0	2.5

^a Emissions [metric tons, MT] = emission factor [lb/hr] x hours/day x Number x

days used x 453.6 [g/lb] / 1,000,000 [g/MT]

Emission factors are in Table 48

^b CO₂-equivalent (CO₂e) emission factors are CO₂ emissions plus 21 x CH₄ emissions, based on Table C.1 from California Climate Action

Registry General Reporting Protocol, Version 3.0, April 2008, http://www.climateregistry.org/resources/docs/protocols/grp/GRP_V3_April2008_FINAL.pdf

Motor Vehicle Usage

Vehicle	Number	Days Used	Hours Used/Day	Miles/Day/Veh.
Onsite				
None				0
Offsite				
3/4-Ton Pick-up Truck, 4x4	1	5	N/A	18
40' Flat Bed Truck/Trailer	1	5	N/A	18
Worker Commute	4	5	N/A	60

Motor Vehicle Exhaust Emission Factors

Vehicle	Category	VOC (lb/mi) ^a	CO (lb/mi) ^a	NOX (lb/mi) ^a	SOX (lb/mi) ^a	PM10 (lb/mi) ^a	PM2.5 (lb/mi) ^b	CO2 (lb/mi) ^a	CH4 (lb/mi) ^a
Onsite									
None									
Offsite									
3/4-Ton Pick-up Truck, 4x4	Delivery	2.24E-03	1.55E-02	1.73E-02	2.67E-05	6.50E-04	5.50E-04	2.77E+00	1.07E-04
40' Flat Bed Truck/Trailer	HHDT	2.53E-03	1.02E-02	3.09E-02	4.04E-05	1.50E-03	1.29E-03	4.22E+00	1.17E-04
Worker Commute	Passenger	7.96E-04	7.65E-03	7.76E-04	1.07E-05	8.98E-05	5.75E-05	1.10E+00	7.17E-05

^a From Table 49 or Table 50

Motor Vehicle Daily Criteria Pollutant Exhaust Emissions

Vehicle	VOC (lb/day) ^a	CO (lb/day) ^a	NOX (lb/day) ^a	SOX (lb/day) ^a	PM10 (lb/day) ^a	PM2.5 (lb/day) ^a
Onsite						
None	0.00	0.00	0.00	0.00	0.00	0.00
Onsite Total	0.00	0.00	0.00	0.00	0.00	0.00
Offsite						
3/4-Ton Pick-up Truck, 4x4	0.04	0.28	0.31	0.00	0.01	0.01
40' Flat Bed Truck/Trailer	0.05	0.18	0.56	0.00	0.03	0.02
Worker Commute	0.19	1.84	0.19	0.00	0.02	0.01

Table 30
Subtransmission Source Line Construction Emissions
Steel Pole Haul

Offsite Total	0.28	2.30	1.05	0.00	0.06	0.05
Total	0.28	2.30	1.05	0.00	0.06	0.05

^a Emissions [lb/day] = number x miles/day x emission factor [lb/mi]

Motor Vehicle Total Greenhouse Gas Emissions

Vehicle	CO2 (MT) ^a	CH4 (MT) ^a	CO2e (MT) ^b
Onsite			
None	0.0	0.0	0.0
Onsite Total	0.0	0.0	0.0
Offsite			
3/4-Ton Pick-up Truck, 4x4	0.1	0.0	0.1
40' Flat Bed Truck/Trailer	0.2	0.0	0.2
Worker Commute	0.6	0.0	0.6
Offsite Total	0.9	0.0	0.9
Total	0.9	0.0	0.9

^a Emissions [metric tons, MT] = emission factor [lb/hr] x miles/day x Number x days used x 453.6 [g/lb] / 1,000,000 [g/MT]

Emission factors are in Table 49 and Table 50

^b CO₂-equivalent (CO₂e) emission factors are CO₂ emissions plus 21 x CH₄ emissions, based on Table C.1 from California Climate Action Registry General Reporting Protocol, Version 3.0, April 2008, http://www.climateregistry.org/resources/docs/protocols/grp/GRP_V3_April2008_FINAL.pdf

Motor Vehicle Fugitive Particulate Matter Emissions

Vehicle	Number	Road Type	Miles/Day/ Vehicle	PM10 Emission Factor (lb/mi) ^a	PM2.5 Emission Factor (lb/mi) ^a	PM10 Emissions (lb/day) ^b	PM2.5 Emissions (lb/day) ^b
Onsite							
None	0						
Onsite Total						0.00	0.00
Offsite							
3/4-Ton Pick-up Truck, 4x4	1	Paved	14	0.001	0.000	0.01	0.00
40' Flat Bed Truck/Trailer	1	Paved	14	0.001	0.000	0.01	0.00
3/4-Ton Pick-up Truck, 4x4	1	Unpaved	4	0.435	0.043	1.74	0.17
40' Flat Bed Truck/Trailer	1	Unpaved	4	0.922	0.092	3.69	0.37
Worker Commute	4	Paved	60	0.001	0.000	0.19	0.00
Offsite Total						5.64	0.54
Total						5.64	0.54

^a From Table 51

^b Emissions [lb/day] = number x miles/day x emission factor [lb/mi]

Earthwork Fugitive Particulate Matter Emissions

Activity	Activity Units	Activity Level	PM10 Emission Factor ^a	PM2.5 Emission Factor ^a	PM10 (lb/day) ^b	PM2.5 (lb/day) ^b
Soil Handling	CY/day		1.62E-03	3.36E-04	0.00	0.00
Bulldozing, Scraping and Grading	hr/day		1.481	0.308	0.00	0.00
Storage Pile Wind Erosion	acres		15.7	3.26	0.00	0.00
Total					0.00	0.00

^a From Table 52

^b Emissions [lb/day] = Emission factor [lb/activity unit] x Activity unit [units/day]

Table 31
Subtransmission Source Line Construction Emissions
Steel Pole Assembly

Emissions Summary

Source	VOC (lb/day)	CO (lb/day)	NOX (lb/day)	SOX (lb/day)	PM10 (lb/day)	PM2.5 (lb/day)	CO2e (MT)
Construction Equipment Exhaust	1.43	5.06	11.86	0.01	0.59	0.54	3.6
Onsite Motor Vehicle Exhaust	0.00	0.00	0.00	0.00	0.00	0.00	0.0
Onsite Motor Vehicle Fugitive PM	--	--	--	--	0.00	0.00	
Earthwork Fugitive PM	--	--	--	--	0.00	0.00	
Onsite Total	1.43	5.06	11.86	0.01	0.59	0.54	3.6
Offsite Motor Vehicle Exhaust	0.46	4.23	1.00	0.01	0.07	0.05	1.7
Offsite Motor Vehicle Fugitive PM	--	--	--	--	4.27	0.39	
Offsite Total	0.46	4.23	1.00	0.01	4.34	0.43	1.7
Total	1.89	9.29	12.86	0.02	4.93	0.98	5.3

Construction Equipment Summary

Equipment	Horse-power	Number	Days Used	Hours Used/Day
Compressor Trailer	120	1	6	5
80-Ton Rough Terrain Crane	350	1	6	6

Construction Equipment Exhaust Emission Factors

Equipment	Horse-power	VOC (lb/hr) ^a	CO (lb/hr) ^a	NOX (lb/hr) ^a	SOX (lb/hr) ^a	PM10 (lb/hr) ^a	PM2.5 (lb/hr) ^b	CO2 (lb/hr) ^a	CH4 (lb/hr) ^a	Category
Compressor Trailer	120	0.089	0.329	0.533	0.001	0.049	0.045	46.950	0.008	Air Compressors
80-Ton Rough Terrain Crane	350	0.163	0.569	1.533	0.002	0.057	0.053	180.101	0.015	Cranes

^a From Table 48

^b Diesel PM2.5 emission factor [lb/hr] = PM10 emission factor [lb/hr] x PM2.5 fraction of PM10

PM2.5 Fraction = 0.920

From Appendix A, Final-Methodology to Calculate Particulate Matter (PM) 2.5

and PM 2.5 Significance Thresholds, SCAQMD, October 2006,

http://www.aqmd.gov/ceqa/handbook/PM2_5/PM2_5.html

Construction Equipment Daily Criteria Pollutant Exhaust Emissions

Equipment	VOC (lb/day) ^a	CO (lb/day) ^a	NOX (lb/day) ^a	SOX (lb/day) ^a	PM10 (lb/day) ^a	PM2.5 (lb/day) ^a
Compressor Trailer	0.45	1.64	2.67	0.00	0.25	0.23
80-Ton Rough Terrain Crane	0.98	3.41	9.20	0.01	0.34	0.32
Total	1.43	5.06	11.86	0.01	0.59	0.54

^a Emissions [lb/day] = number x hours/day x emission factor [lb/hr]

Construction Equipment Total Greenhouse Gas Emissions

Equipment	CO2 (MT) ^a	CH4 (MT) ^a	CO2e (MT) ^b
Compressor Trailer	0.6	0.0	0.6
80-Ton Rough Terrain Crane	2.9	0.0	2.9
Total	3.6	0.0	3.6

^a Emissions [metric tons, MT] = emission factor [lb/hr] x hours/day x Number x

days used x 453.6 [g/lb] / 1,000,000 [g/MT]

Emission factors are in Table 48

^b CO₂-equivalent (CO₂e) emission factors are CO₂ emissions plus 21 x CH₄ emissions, based on Table C.1 from California Climate Action

Registry General Reporting Protocol, Version 3.0, April 2008, http://www.climateregistry.org/resources/docs/protocols/grp/GRP_V3_April2008_FINAL.pdf

Motor Vehicle Usage

Vehicle	Number	Days Used	Hours Used/Day	Miles/Day/Veh.
Onsite				
None				0
Offsite				
3/4-Ton Pick-up Truck, 4x4	1	6	N/A	18
1-Ton Crew Cab Flat Bed, 4x4	1	6	N/A	18
Worker Commute	8	6	N/A	60

Motor Vehicle Exhaust Emission Factors

Vehicle	Category	VOC (lb/mi) ^a	CO (lb/mi) ^a	NOX (lb/mi) ^a	SOX (lb/mi) ^a	PM10 (lb/mi) ^a	PM2.5 (lb/mi) ^b	CO2 (lb/mi) ^a	CH4 (lb/mi) ^a
Onsite									
None		0.00E+00	0.00E+00	0.00E+00	0.00E+00	0.00E+00	0.00E+00	0.00E+00	0.00E+00
Offsite									
3/4-Ton Pick-up Truck, 4x4	Delivery	2.24E-03	1.55E-02	1.73E-02	2.67E-05	6.50E-04	5.50E-04	2.77E+00	1.07E-04
1-Ton Crew Cab Flat Bed, 4x4	Delivery	2.24E-03	1.55E-02	1.73E-02	2.67E-05	6.50E-04	5.50E-04	2.77E+00	1.07E-04
Worker Commute	Passenger	7.96E-04	7.65E-03	7.76E-04	1.07E-05	8.98E-05	5.75E-05	1.10E+00	7.17E-05

^a From Table 49 or Table 50

Motor Vehicle Daily Criteria Pollutant Exhaust Emissions

Vehicle	VOC (lb/day) ^a	CO (lb/day) ^a	NOX (lb/day) ^a	SOX (lb/day) ^a	PM10 (lb/day) ^a	PM2.5 (lb/day) ^a
Onsite						
None	0.00	0.00	0.00	0.00	0.00	0.00
Onsite Total	0.00	0.00	0.00	0.00	0.00	0.00

Table 31
Subtransmission Source Line Construction Emissions
Steel Pole Assembly

Offsite						
3/4-Ton Pick-up Truck, 4x4	0.04	0.28	0.31	0.00	0.01	0.01
1-Ton Crew Cab Flat Bed, 4x4	0.04	0.28	0.31	0.00	0.01	0.01
Worker Commute	0.38	3.67	0.37	0.01	0.04	0.03
Offsite Total	0.46	4.23	1.00	0.01	0.07	0.05
Total	0.46	4.23	1.00	0.01	0.07	0.05

^a Emissions [lb/day] = number x miles/day x emission factor [lb/mi]

Motor Vehicle Total Greenhouse Gas Emissions

Vehicle	CO ₂ (MT) ^a	CH ₄ (MT) ^a	CO ₂ e (MT) ^b
Onsite			
None	0.0	0.0	0.0
Onsite Total	0.0	0.0	0.0
Offsite			
3/4-Ton Pick-up Truck, 4x4	0.1	0.0	0.1
1-Ton Crew Cab Flat Bed, 4x4	0.1	0.0	0.1
Worker Commute	1.4	0.0	1.4
Offsite Total	1.7	0.0	1.7
Total	1.7	0.0	1.7

^a Emissions [metric tons, MT] = emission factor [lb/hr] x miles/day x Number x days used x 453.6 [g/lb] / 1,000,000 [g/MT]

Emission factors are in Table 49 and Table 50

^b CO₂-equivalent (CO₂e) emission factors are CO₂ emissions plus 21 x CH₄ emissions, based on Table C.1 from California Climate Action Registry General Reporting Protocol, Version 3.0, April 2008, http://www.climateregistry.org/resources/docs/protocols/grp/GRP_V3_April2008_FINAL.pdf

Motor Vehicle Fugitive Particulate Matter Emissions

Vehicle	Number	Road Type	Miles/Day/ Vehicle	PM ₁₀ Emission Factor (lb/mi) ^a	PM _{2.5} Emission Factor (lb/mi) ^a	PM ₁₀ Emissions (lb/day) ^b	PM _{2.5} Emissions (lb/day) ^b
Onsite							
None	0						
Onsite Total						0.00	0.00
Offsite							
3/4-Ton Pick-up Truck, 4x4	1	Paved	14	0.001	0.000	0.01	0.00
1-Ton Crew Cab Flat Bed, 4x4	1	Paved	14	0.001	0.000	0.01	0.00
3/4-Ton Pick-up Truck, 4x4	1	Unpaved	4	0.435	0.043	1.74	0.17
1-Ton Crew Cab Flat Bed, 4x4	1	Unpaved	4	0.532	0.053	2.13	0.21
Worker Commute	8	Paved	60	0.001	0.000	0.38	0.00
Offsite Total						4.27	0.39
Total						4.27	0.39

^a From Table 51

^b Emissions [lb/day] = number x miles/day x emission factor [lb/mi]

Earthwork Fugitive Particulate Matter Emissions

Activity	Activity Units	Activity Level	PM ₁₀ Emission Factor ^a	PM _{2.5} Emission Factor ^a	PM ₁₀ (lb/day) ^b	PM _{2.5} (lb/day) ^b
Soil Handling	CY/day		1.62E-03	3.36E-04	0.00	0.00
Bulldozing, Scraping and Grading	hr/day		1.481	0.308	0.00	0.00
Storage Pile Wind Erosion	acres		15.7	3.26	0.00	0.00
Total					0.00	0.00

^a From Table 52

^b Emissions [lb/day] = Emission factor [lb/activity unit] x Activity unit [units/day]

Table 32
Subtransmission Source Line Construction Emissions
Steel Pole Erection

Emissions Summary

Source	VOC (lb/day)	CO (lb/day)	NOX (lb/day)	SOX (lb/day)	PM10 (lb/day)	PM2.5 (lb/day)	CO2e (MT)
Construction Equipment Exhaust	1.43	5.06	11.86	0.01	0.59	0.54	3.6
Onsite Motor Vehicle Exhaust	0.00	0.00	0.00	0.00	0.00	0.00	0.0
Onsite Motor Vehicle Fugitive PM	--	--	--	--	0.00	0.00	
Earthwork Fugitive PM	--	--	--	--	0.00	0.00	
Onsite Total	1.43	5.06	11.86	0.01	0.59	0.54	3.6
Offsite Motor Vehicle Exhaust	0.46	4.23	1.00	0.01	0.07	0.05	1.7
Offsite Motor Vehicle Fugitive PM	--	--	--	--	4.27	0.39	
Offsite Total	0.46	4.23	1.00	0.01	4.34	0.43	1.7
Total	1.89	9.29	12.86	0.02	4.93	0.98	5.3

Construction Equipment Summary

Equipment	Horse-power	Number	Days Used	Hours Used/Day
Compressor Trailer	120	1	6	5
80-Ton Rough Terrain Crane	350	1	6	6

Construction Equipment Exhaust Emission Factors

Equipment	Horse-power	VOC (lb/hr) ^a	CO (lb/hr) ^a	NOX (lb/hr) ^a	SOX (lb/hr) ^a	PM10 (lb/hr) ^a	PM2.5 (lb/hr) ^b	CO2 (lb/hr) ^a	CH4 (lb/hr) ^a	Category
Compressor Trailer	120	0.089	0.329	0.533	0.001	0.049	0.045	46.950	0.008	Air Compressors
80-Ton Rough Terrain Crane	350	0.163	0.569	1.533	0.002	0.057	0.053	180.101	0.015	Cranes

^a From Table 48

^b Diesel PM2.5 emission factor [lb/hr] = PM10 emission factor [lb/hr] x PM2.5 fraction of PM10

PM2.5 Fraction = 0.920

From Appendix A, Final-Methodology to Calculate Particulate Matter (PM) 2.5

and PM 2.5 Significance Thresholds, SCAQMD, October 2006,

http://www.aqmd.gov/ceqa/handbook/PM2_5/PM2_5.html

Construction Equipment Daily Criteria Pollutant Exhaust Emissions

Equipment	VOC (lb/day) ^a	CO (lb/day) ^a	NOX (lb/day) ^a	SOX (lb/day) ^a	PM10 (lb/day) ^a	PM2.5 (lb/day) ^a
Compressor Trailer	0.45	1.64	2.67	0.00	0.25	0.23
80-Ton Rough Terrain Crane	0.98	3.41	9.20	0.01	0.34	0.32
Total	1.43	5.06	11.86	0.01	0.59	0.54

^a Emissions [lb/day] = number x hours/day x emission factor [lb/hr]

Construction Equipment Total Greenhouse Gas Emissions

Equipment	CO2 (MT) ^a	CH4 (MT) ^a	CO2e (MT) ^b
Compressor Trailer	0.6	0.0	0.6
80-Ton Rough Terrain Crane	2.9	0.0	2.9
Total	3.6	0.0	3.6

^a Emissions [metric tons, MT] = emission factor [lb/hr] x hours/day x Number x

days used x 453.6 [g/lb] / 1,000,000 [g/MT]

Emission factors are in Table 48

^b CO₂-equivalent (CO₂e) emission factors are CO₂ emissions plus 21 x CH₄ emissions, based on Table C.1 from California Climate Action

Registry General Reporting Protocol, Version 3.0, April 2008, http://www.climateregistry.org/resources/docs/protocols/grp/GRP_V3_April2008_FINAL.pdf

Motor Vehicle Usage

Vehicle	Number	Days Used	Hours Used/Day	Miles/Day/Veh.
Onsite				
None				0
Offsite				
3/4-Ton Pick-up Truck, 4x4	1	6	N/A	18
1-Ton Crew Cab Flat Bed, 4x4	1	6	N/A	18
Worker Commute	8	6	N/A	60

Motor Vehicle Exhaust Emission Factors

Vehicle	Category	VOC (lb/mi) ^a	CO (lb/mi) ^a	NOX (lb/mi) ^a	SOX (lb/mi) ^a	PM10 (lb/mi) ^a	PM2.5 (lb/mi) ^b	CO2 (lb/mi) ^a	CH4 (lb/mi) ^a
Onsite									
None		0.00E+00	0.00E+00	0.00E+00	0.00E+00	0.00E+00	0.00E+00	0.00E+00	0.00E+00
Offsite									
3/4-Ton Pick-up Truck, 4x4	Delivery	2.24E-03	1.55E-02	1.73E-02	2.67E-05	6.50E-04	5.50E-04	2.77E+00	1.07E-04
1-Ton Crew Cab Flat Bed, 4x4	Delivery	2.24E-03	1.55E-02	1.73E-02	2.67E-05	6.50E-04	5.50E-04	2.77E+00	1.07E-04
Worker Commute	Passenger	7.96E-04	7.65E-03	7.76E-04	1.07E-05	8.98E-05	5.75E-05	1.10E+00	7.17E-05

^a From Table 49 or Table 50

Motor Vehicle Daily Criteria Pollutant Exhaust Emissions

Vehicle	VOC (lb/day) ^a	CO (lb/day) ^a	NOX (lb/day) ^a	SOX (lb/day) ^a	PM10 (lb/day) ^a	PM2.5 (lb/day) ^a
Onsite						
None	0.00	0.00	0.00	0.00	0.00	0.00
Onsite Total	0.00	0.00	0.00	0.00	0.00	0.00

Table 32
Subtransmission Source Line Construction Emissions
Steel Pole Erection

Offsite						
3/4-Ton Pick-up Truck, 4x4	0.04	0.28	0.31	0.00	0.01	0.01
1-Ton Crew Cab Flat Bed, 4x4	0.04	0.28	0.31	0.00	0.01	0.01
Worker Commute	0.38	3.67	0.37	0.01	0.04	0.03
Offsite Total	0.46	4.23	1.00	0.01	0.07	0.05
Total	0.46	4.23	1.00	0.01	0.07	0.05

^a Emissions [lb/day] = number x miles/day x emission factor [lb/mi]

Motor Vehicle Total Greenhouse Gas Emissions

Vehicle	CO ₂ (MT) ^a	CH ₄ (MT) ^a	CO ₂ e (MT) ^b
Onsite			
None	0.0	0.0	0.0
Onsite Total	0.0	0.0	0.0
Offsite			
3/4-Ton Pick-up Truck, 4x4	0.1	0.0	0.1
1-Ton Crew Cab Flat Bed, 4x4	0.1	0.0	0.1
Worker Commute	1.4	0.0	1.4
Offsite Total	1.7	0.0	1.7
Total	1.7	0.0	1.7

^a Emissions [metric tons, MT] = emission factor [lb/hr] x miles/day x Number x days used x 453.6 [g/lb] / 1,000,000 [g/MT]

Emission factors are in Table 49 and Table 50

^b CO₂-equivalent (CO₂e) emission factors are CO₂ emissions plus 21 x CH₄ emissions, based on Table C.1 from California Climate Action Registry General Reporting Protocol, Version 3.0, April 2008, http://www.climateregistry.org/resources/docs/protocols/grp/GRP_V3_April2008_FINAL.pdf

Motor Vehicle Fugitive Particulate Matter Emissions

Vehicle	Number	Road Type	Miles/Day/ Vehicle	PM ₁₀ Emission Factor (lb/mi) ^a	PM _{2.5} Emission Factor (lb/mi) ^a	PM ₁₀ Emissions (lb/day) ^b	PM _{2.5} Emissions (lb/day) ^b
Onsite							
None	0						
Onsite Total						0.00	0.00
Offsite							
3/4-Ton Pick-up Truck, 4x4	1	Paved	14	0.001	0.000	0.01	0.00
1-Ton Crew Cab Flat Bed, 4x4	1	Paved	14	0.001	0.000	0.01	0.00
3/4-Ton Pick-up Truck, 4x4	1	Unpaved	4	0.435	0.043	1.74	0.17
1-Ton Crew Cab Flat Bed, 4x4	1	Unpaved	4	0.532	0.053	2.13	0.21
Worker Commute	8	Paved	60	0.001	0.000	0.38	0.00
Offsite Total						4.27	0.39
Total						4.27	0.39

^a From Table 51

^b Emissions [lb/day] = number x miles/day x emission factor [lb/mi]

Earthwork Fugitive Particulate Matter Emissions

Activity	Activity Units	Activity Level	PM ₁₀ Emission Factor ^a	PM _{2.5} Emission Factor ^a	PM ₁₀ (lb/day) ^b	PM _{2.5} (lb/day) ^b
Soil Handling	CY/day		1.62E-03	3.36E-04	0.00	0.00
Bulldozing, Scraping and Grading	hr/day		1.481	0.308	0.00	0.00
Storage Pile Wind Erosion	acres		15.7	3.26	0.00	0.00
Total					0.00	0.00

^a From Table 52

^b Emissions [lb/day] = Emission factor [lb/activity unit] x Activity unit [units/day]

Table 33
Subtransmission Source Line Construction Emissions
Conductor Installation

Emissions Summary

Source	VOC (lb/day)	CO (lb/day)	NOX (lb/day)	SOX (lb/day)	PM10 (lb/day)	PM2.5 (lb/day)	CO2e (MT)
Construction Equipment Exhaust	4.23	15.33	45.87	0.06	1.53	1.41	28.4
Onsite Motor Vehicle Exhaust	0.00	0.00	0.00	0.00	0.00	0.00	0.0
Onsite Motor Vehicle Fugitive PM	--	--	--	--	0.00	0.00	
Earthwork Fugitive PM	--	--	--	--	0.00	0.00	
Onsite Total	4.23	15.33	45.87	0.06	1.53	1.41	28.4
Offsite Motor Vehicle Exhaust	1.31	10.03	6.75	0.02	0.36	0.29	8.7
Offsite Motor Vehicle Fugitive PM	--	--	--	--	34.47	3.36	
Offsite Total	1.31	10.03	6.75	0.02	34.83	3.65	8.7
Total	5.54	25.36	52.62	0.08	36.36	5.06	37.0

Construction Equipment Summary

Equipment	Horse-power	Number	Days Used	Hours Used/Day
Bucket Truck	350	1	10	8
22-Ton Manitex	350	1	10	8
Splicing Rig	10	1	10	2
Splicing Lab	16	1	10	2
3 Drum Straw Line Puller	300	1	10	6
Static Truck/Tensioner	350	1	10	6

Construction Equipment Exhaust Emission Factors

Equipment	Horse-power	VOC (lb/hr) ^a	CO (lb/hr) ^a	NOX (lb/hr) ^a	SOX (lb/hr) ^a	PM10 (lb/hr) ^a	PM2.5 (lb/hr) ^b	CO2 (lb/hr) ^a	CH4 (lb/hr) ^a	Category
Bucket Truck	350	0.128	0.494	1.655	0.002	0.049	0.045	212.856	0.012	Aerial Lifts
22-Ton Manitex	350	0.163	0.569	1.533	0.002	0.057	0.053	180.101	0.015	Cranes
Splicing Rig	10	0.012	0.062	0.074	0.000	0.003	0.003	10.107	0.001	Other Construction Equipment
Splicing Lab	16	0.028	0.095	0.163	0.000	0.010	0.009	17.631	0.002	Generator Sets
3 Drum Straw Line Puller	300	0.152	0.543	1.657	0.002	0.055	0.050	254.238	0.014	Other Construction Equipment
Static Truck/Tensioner	350	0.152	0.543	1.657	0.002	0.055	0.050	254.238	0.014	Other Construction Equipment

^a From Table 48

^b Diesel PM2.5 emission factor [lb/hr] = PM10 emission factor [lb/hr] x PM2.5 fraction of PM10

PM2.5 Fraction= 0.920

From Appendix A, Final-Methodology to Calculate Particulate Matter (PM) 2.5
and PM 2.5 Significance Thresholds, SCAQMD, October 2006,
http://www.aqmd.gov/ceqa/handbook/PM2_5/PM2_5.html

Construction Equipment Daily Criteria Pollutant Exhaust Emissions

Equipment	VOC (lb/day) ^a	CO (lb/day) ^a	NOX (lb/day) ^a	SOX (lb/day) ^a	PM10 (lb/day) ^a	PM2.5 (lb/day) ^a
Bucket Truck	1.02	3.95	13.24	0.02	0.39	0.36
22-Ton Manitex	1.31	4.55	12.26	0.01	0.46	0.42
Splicing Rig	0.02	0.12	0.15	0.00	0.01	0.01
Splicing Lab	0.06	0.19	0.33	0.00	0.02	0.02
3 Drum Straw Line Puller	0.91	3.26	9.94	0.01	0.33	0.30
Static Truck/Tensioner	0.91	3.26	9.94	0.01	0.33	0.30
Total	4.23	15.33	45.87	0.06	1.53	1.41

^a Emissions [lb/day] = number x hours/day x emission factor [lb/hr]

Construction Equipment Total Greenhouse Gas Emissions

Equipment	CO2 (MT) ^a	CH4 (MT) ^a	CO2e (MT) ^b
Bucket Truck	7.7	0.0	7.7
22-Ton Manitex	6.5	0.0	6.5
Splicing Rig	0.1	0.0	0.1
Splicing Lab	0.2	0.0	0.2
3 Drum Straw Line Puller	6.9	0.0	6.9
Static Truck/Tensioner	6.9	0.0	6.9
Total	28.3	0.0	28.4

^a Emissions [metric tons, MT] = emission factor [lb/hr] x hours/day x Number x
days used x 453.6 [g/lb] / 1,000,000 [g/MT]

Emission factors are in Table 48

^b CO₂-equivalent (CO₂e) emission factors are CO₂ emissions plus 21 x CH₄ emissions, based on Table C.1 from California Climate Action
Registry General Reporting Protocol, Version 3.0, April 2008, http://www.climateregistry.org/resources/docs/protocols/grp/GRP_V3_April2008_FINAL.pdf

Motor Vehicle Usage

Vehicle	Number	Days Used	Hours Used/Day	Miles/Day/Veh.
Onsite				
None				0
Offsite				
3/4-Ton Pick-up Truck, 4x4	1	10	N/A	18
1-Ton Crew Cab Flat Bed, 4x4	1	10	N/A	18
Wire Truck/Trailer	1	10	N/A	18

Table 33
Subtransmission Source Line Construction Emissions
Conductor Installation

Dump Truck (Trash)	1	10	N/A	64
Bucket Truck	1	10	N/A	18
22-Ton Manitex	1	10	N/A	18
Splicing Rig	1	10	N/A	18
Splicing Lab	1	10	N/A	18
3 Drum Straw Line Puller	1	10	N/A	18
Static Truck/Tensioner	1	10	N/A	18
Worker Commute	16	10	N/A	60

Motor Vehicle Exhaust Emission Factors

Vehicle	Category	VOC (lb/mi) ^a	CO (lb/mi) ^a	NOX (lb/mi) ^a	SOX (lb/mi) ^a	PM10 (lb/mi) ^a	PM2.5 (lb/mi) ^b	CO2 (lb/mi) ^a	CH4 (lb/mi) ^a
Onsite									
None		0.00E+00	0.00E+00	0.00E+00	0.00E+00	0.00E+00	0.00E+00	0.00E+00	0.00E+00
Offsite									
3/4-Ton Pick-up Truck, 4x4	Delivery	2.24E-03	1.55E-02	1.73E-02	2.67E-05	6.50E-04	5.50E-04	2.77E+00	1.07E-04
1-Ton Crew Cab Flat Bed, 4x4	Delivery	2.24E-03	1.55E-02	1.73E-02	2.67E-05	6.50E-04	5.50E-04	2.77E+00	1.07E-04
Wire Truck/Trailer	HHDT	2.53E-03	1.02E-02	3.09E-02	4.04E-05	1.50E-03	1.29E-03	4.22E+00	1.17E-04
Dump Truck (Trash)	HHDT	2.53E-03	1.02E-02	3.09E-02	4.04E-05	1.50E-03	1.29E-03	4.22E+00	1.17E-04
Bucket Truck	HHDT	2.53E-03	1.02E-02	3.09E-02	4.04E-05	1.50E-03	1.29E-03	4.22E+00	1.17E-04
22-Ton Manitex	HHDT	2.53E-03	1.02E-02	3.09E-02	4.04E-05	1.50E-03	1.29E-03	4.22E+00	1.17E-04
Splicing Rig	Delivery	2.24E-03	1.55E-02	1.73E-02	2.67E-05	6.50E-04	5.50E-04	2.77E+00	1.07E-04
Splicing Lab	Delivery	2.24E-03	1.55E-02	1.73E-02	2.67E-05	6.50E-04	5.50E-04	2.77E+00	1.07E-04
3 Drum Straw Line Puller	HHDT	2.53E-03	1.02E-02	3.09E-02	4.04E-05	1.50E-03	1.29E-03	4.22E+00	1.17E-04
Static Truck/Tensioner	HHDT	2.53E-03	1.02E-02	3.09E-02	4.04E-05	1.50E-03	1.29E-03	4.22E+00	1.17E-04
Worker Commute	Passenger	7.96E-04	7.65E-03	7.76E-04	1.07E-05	8.98E-05	5.75E-05	1.10E+00	7.17E-05

a From Table 49 or Table 50

Motor Vehicle Daily Criteria Pollutant Exhaust Emissions

Vehicle	VOC (lb/day) ^a	CO (lb/day) ^a	NOX (lb/day) ^a	SOX (lb/day) ^a	PM10 (lb/day) ^a	PM2.5 (lb/day) ^a
Onsite						
None	0.00	0.00	0.00	0.00	0.00	0.00
Onsite Total	0.00	0.00	0.00	0.00	0.00	0.00
Offsite						
3/4-Ton Pick-up Truck, 4x4	0.04	0.28	0.31	0.00	0.01	0.01
1-Ton Crew Cab Flat Bed, 4x4	0.04	0.28	0.31	0.00	0.01	0.01
Wire Truck/Trailer	0.05	0.18	0.56	0.00	0.03	0.02
Dump Truck (Trash)	0.16	0.65	1.98	0.00	0.10	0.08
Bucket Truck	0.05	0.18	0.56	0.00	0.03	0.02
22-Ton Manitex	0.05	0.18	0.56	0.00	0.03	0.02
Splicing Rig	0.04	0.28	0.31	0.00	0.01	0.01
Splicing Lab	0.04	0.28	0.31	0.00	0.01	0.01
3 Drum Straw Line Puller	0.05	0.18	0.56	0.00	0.03	0.02
Static Truck/Tensioner	0.05	0.18	0.56	0.00	0.03	0.02
Worker Commute	0.76	7.35	0.74	0.01	0.09	0.06
Offsite Total	1.31	10.03	6.75	0.02	0.36	0.29
Total	1.31	10.03	6.75	0.02	0.36	0.29

^a Emissions [lb/day] = number x miles/day x emission factor [lb/mi]

Motor Vehicle Total Greenhouse Gas Emissions

Vehicle	CO2 (MT) ^a	CH4 (MT) ^a	CO2e (MT) ^b
Onsite			
None	0.0	0.0	0.0
Onsite Total	0.0	0.0	0.0
Offsite			
3/4-Ton Pick-up Truck, 4x4	0.2	0.0	0.2
1-Ton Crew Cab Flat Bed, 4x4	0.2	0.0	0.2
Wire Truck/Trailer	0.3	0.0	0.3
Dump Truck (Trash)	1.2	0.0	1.2
Bucket Truck	0.3	0.0	0.3
22-Ton Manitex	0.3	0.0	0.3
Splicing Rig	0.2	0.0	0.2
Splicing Lab	0.2	0.0	0.2
3 Drum Straw Line Puller	0.3	0.0	0.3
Static Truck/Tensioner	0.3	0.0	0.3
Worker Commute	4.8	0.0	4.8
Offsite Total	8.6	0.0	8.7
Total	8.6	0.0	8.7

^a Emissions [metric tons, MT] = emission factor [lb/hr] x miles/day x Number x days used x 453.6 [g/lb] / 1,000,000 [g/MT]

Emission factors are in Table 49 and Table 50

^b CO₂-equivalent (CO₂e) emission factors are CO₂ emissions plus 21 x CH₄ emissions, based on Table C.1 from California Climate Action

Registry General Reporting Protocol, Version 3.0, April 2008, http://www.climateregistry.org/resources/docs/protocols/grp/GRP_V3_April2008_FINAL.pdf

Motor Vehicle Fugitive Particulate Matter Emissions

Table 33
Subtransmission Source Line Construction Emissions
Conductor Installation

Vehicle	Number	Road Type	Miles/ Day/ Vehicle	PM10 Emission Factor (lb/mi) ^a	PM2.5 Emission Factor (lb/mi) ^a	PM10 Emissions (lb/day) ^b	PM2.5 Emissions (lb/day) ^b
Onsite							
None	0						
Onsite Total						0.00	0.00
Offsite							
3/4-Ton Pick-up Truck, 4x4	1	Paved	14	0.001	0.000	0.01	0.00
1-Ton Crew Cab Flat Bed, 4x4	1	Paved	14	0.001	0.000	0.01	0.00
Wire Truck/Trailer	1	Paved	14	0.001	0.000	0.01	0.00
Dump Truck (Trash)	1	Paved	60	0.001	0.000	0.05	0.00
Bucket Truck	1	Paved	14	0.001	0.000	0.01	0.00
22-Ton Manitex	1	Paved	14	0.001	0.000	0.01	0.00
Splicing Rig	1	Paved	14	0.001	0.000	0.01	0.00
Splicing Lab	1	Paved	14	0.001	0.000	0.01	0.00
3 Drum Straw Line Puller	1	Paved	14	0.001	0.000	0.01	0.00
Static Truck/Tensioner	1	Paved	14	0.001	0.000	0.01	0.00
3/4-Ton Pick-up Truck, 4x4	1	Unpaved	4	0.435	0.043	1.74	0.17
1-Ton Crew Cab Flat Bed, 4x4	1	Unpaved	4	0.532	0.053	2.13	0.21
Wire Truck/Trailer	1	Unpaved	4	0.922	0.092	3.69	0.37
Dump Truck (Trash)	1	Unpaved	4	0.922	0.092	3.69	0.37
Bucket Truck	1	Unpaved	4	0.922	0.092	3.69	0.37
22-Ton Manitex	1	Unpaved	4	0.922	0.092	3.69	0.37
Splicing Rig	1	Unpaved	4	0.726	0.073	2.91	0.29
Splicing Lab	1	Unpaved	4	0.726	0.073	2.91	0.29
3 Drum Straw Line Puller	1	Unpaved	4	0.922	0.092	3.69	0.37
Static Truck/Tensioner	1	Unpaved	4	0.922	0.092	3.69	0.37
3/4-Ton Pick-up Truck, 4x4	1	Unpaved	4	0.435	0.043	1.74	0.17
Worker Commute	16	Paved	60	0.001	0.000	0.77	0.00
Offsite Total						34.47	3.36
Total						34.47	3.36

^a From Table 51

^b Emissions [lb/day] = number x miles/day x emission factor [lb/mi]

Earthwork Fugitive Particulate Matter Emissions

Activity	Activity Units	Activity Level	PM10 Emission Factor ^a	PM2.5 Emission Factor ^a	PM10 (lb/day) ^b	PM2.5 (lb/day) ^b
Soil Handling	CY/day		1.62E-03	3.36E-04	0.00	0.00
Bulldozing, Scraping and Grading	hr/day		1.481	0.308	0.00	0.00
Storage Pile Wind Erosion	acres		15.7	3.26	0.00	0.00
Total					0.00	0.00

^a From Table 52

^b Emissions [lb/day] = Emission factor [lb/activity unit] x Activity unit [units/day]

Table 34
Subtransmission Source Line Construction Emissions
Guard Structure Removal

Emissions Summary

Source	VOC (lb/day)	CO (lb/day)	NOX (lb/day)	SOX (lb/day)	PM10 (lb/day)	PM2.5 (lb/day)	CO2e (MT)
Construction Equipment Exhaust	3.11	10.75	29.77	0.04	1.20	1.10	3.3
Onsite Motor Vehicle Exhaust	0.00	0.00	0.00	0.00	0.00	0.00	0.0
Onsite Motor Vehicle Fugitive PM	--	--	--	--	0.00	0.00	
Earthwork Fugitive PM	--	--	--	--	0.00	0.00	
Onsite Total	3.11	10.75	29.77	0.04	1.20	1.10	3.3
Offsite Motor Vehicle Exhaust	0.50	3.86	2.57	0.01	0.14	0.11	0.7
Offsite Motor Vehicle Fugitive PM	--	--	--	--	15.28	1.49	
Offsite Total	0.50	3.86	2.57	0.01	15.41	1.60	0.7
Total	3.62	14.62	32.34	0.04	16.61	2.71	3.9

Construction Equipment Summary

Equipment	Horse-power	Number	Days Used	Hours Used/Day
Compressor Trailer	120	1	2	6
30-Ton Crane Truck	300	1	2	8
80ft. Hydraulic Manlift/Bucket Truck	350	1	2	4
Backhoe/Front Loader	200	1	2	6

Construction Equipment Exhaust Emission Factors

Equipment	Horse-power	VOC (lb/hr) ^a	CO (lb/hr) ^a	NOX (lb/hr) ^a	SOX (lb/hr) ^a	PM10 (lb/hr) ^a	PM2.5 (lb/hr) ^b	CO2 (lb/hr) ^a	CH4 (lb/hr) ^a	Category
Compressor Trailer	120	0.089	0.329	0.533	0.001	0.049	0.045	46.950	0.008	Air Compressors
30-Ton Crane Truck	300	0.163	0.569	1.533	0.002	0.057	0.053	180.101	0.015	Cranes
80ft. Hydraulic Manlift/Bucket Truck	350	0.128	0.494	1.655	0.002	0.049	0.045	212.856	0.012	Aerial Lifts
Backhoe/Front Loader	200	0.126	0.375	1.281	0.002	0.042	0.038	171.737	0.011	Tractors/Loaders/Backhoes

^a From Table 48

^b Diesel PM2.5 emission factor [lb/hr] = PM10 emission factor [lb/hr] x PM2.5 fraction of PM10

PM2.5 Fraction= 0.920

From Appendix A, Final-Methodology to Calculate Particulate Matter (PM) 2.5

and PM 2.5 Significance Thresholds, SCAQMD, October 2006,

http://www.aqmd.gov/ceqa/handbook/PM2_5/PM2_5.html

Construction Equipment Daily Criteria Pollutant Exhaust Emissions

Equipment	VOC (lb/day) ^a	CO (lb/day) ^a	NOX (lb/day) ^a	SOX (lb/day) ^a	PM10 (lb/day) ^a	PM2.5 (lb/day) ^a
Compressor Trailer	0.53	1.97	3.20	0.00	0.30	0.27
30-Ton Crane Truck	1.31	4.55	12.26	0.01	0.46	0.42
80ft. Hydraulic Manlift/Bucket Truck	0.51	1.98	6.62	0.01	0.20	0.18
Backhoe/Front Loader	0.76	2.25	7.69	0.01	0.25	0.23
Total	3.11	10.75	29.77	0.04	1.20	1.10

^a Emissions [lb/day] = number x hours/day x emission factor [lb/hr]

Construction Equipment Total Greenhouse Gas Emissions

Equipment	CO2 (MT) ^a	CH4 (MT) ^a	CO2e (MT) ^b
Compressor Trailer	0.3	0.0	0.3
30-Ton Crane Truck	1.3	0.0	1.3
80ft. Hydraulic Manlift/Bucket Truck	0.8	0.0	0.8
Backhoe/Front Loader	0.9	0.0	0.9
Total	3.3	0.0	3.3

^a Emissions [metric tons, MT] = emission factor [lb/hr] x hours/day x Number x

days used x 453.6 [g/lb] / 1,000,000 [g/MT]

Emission factors are in Table 48

^b CO₂-equivalent (CO₂e) emission factors are CO₂ emissions plus 21 x CH₄ emissions, based on Table C.1 from California Climate Action

Registry General Reporting Protocol, Version 3.0, April 2008, http://www.climateregistry.org/resources/docs/protocols/grp/GRP_V3_April2008_FINAL.pdf

Motor Vehicle Usage

Vehicle	Number	Days Used	Hours Used/Day	Miles/Day/Veh.
Onsite				
None				0
Offsite				
3/4-Ton Pick-up Truck, 4x4	1	2	N/A	18
1-Ton Crew Cab Flat Bed, 4x4	1	2	N/A	18
Extendable Flat Bed Pole Truck	1	2	N/A	18
30-Ton Crane Truck	1	2	N/A	18
80ft. Hydraulic Manlift/Bucket Truck	1	2	N/A	18
Worker Commute	6	2	N/A	60

Motor Vehicle Exhaust Emission Factors

Vehicle	Category	VOC (lb/mi) ^a	CO (lb/mi) ^a	NOX (lb/mi) ^a	SOX (lb/mi) ^a	PM10 (lb/mi) ^a	PM2.5 (lb/mi) ^b	CO2 (lb/mi) ^a	CH4 (lb/mi) ^a
Onsite									

Table 34
Subtransmission Source Line Construction Emissions
Guard Structure Removal

None		0.00E+00	0.00E+00	0.00E+00	0.00E+00	0.00E+00	0.00E+00	0.00E+00	0.00E+00
Offsite									
3/4-Ton Pick-up Truck, 4x4	Delivery	2.24E-03	1.55E-02	1.73E-02	2.67E-05	6.50E-04	5.50E-04	2.77E+00	1.07E-04
1-Ton Crew Cab Flat Bed, 4x4	Delivery	2.24E-03	1.55E-02	1.73E-02	2.67E-05	6.50E-04	5.50E-04	2.77E+00	1.07E-04
Extendable Flat Bed Pole Truck	HHDT	2.53E-03	1.02E-02	3.09E-02	4.04E-05	1.50E-03	1.29E-03	4.22E+00	1.17E-04
30-Ton Crane Truck	HHDT	2.53E-03	1.02E-02	3.09E-02	4.04E-05	1.50E-03	1.29E-03	4.22E+00	1.17E-04
80ft. Hydraulic Manlift/Bucket Truck	HHDT	2.53E-03	1.02E-02	3.09E-02	4.04E-05	1.50E-03	1.29E-03	4.22E+00	1.17E-04
Worker Commute	Passenger	7.96E-04	7.65E-03	7.76E-04	1.07E-05	8.98E-05	5.75E-05	1.10E+00	7.17E-05

a From Table 49 or Table 50

Motor Vehicle Daily Criteria Pollutant Exhaust Emissions

Vehicle	VOC (lb/day) ^a	CO (lb/day) ^a	NOX (lb/day) ^a	SOX (lb/day) ^a	PM10 (lb/day) ^a	PM2.5 (lb/day) ^a
Onsite						
None	0.00	0.00	0.00	0.00	0.00	0.00
Onsite Total	0.00	0.00	0.00	0.00	0.00	0.00
Offsite						
3/4-Ton Pick-up Truck, 4x4	0.04	0.28	0.31	0.00	0.01	0.01
1-Ton Crew Cab Flat Bed, 4x4	0.04	0.28	0.31	0.00	0.01	0.01
Extendable Flat Bed Pole Truck	0.05	0.18	0.56	0.00	0.03	0.02
30-Ton Crane Truck	0.05	0.18	0.56	0.00	0.03	0.02
80ft. Hydraulic Manlift/Bucket Truck	0.05	0.18	0.56	0.00	0.03	0.02
Worker Commute	0.29	2.76	0.28	0.00	0.03	0.02
Offsite Total	0.50	3.86	2.57	0.01	0.14	0.11
Total	0.50	3.86	2.57	0.01	0.14	0.11

^a Emissions [lb/day] = number x miles/day x emission factor [lb/mi]

Motor Vehicle Total Greenhouse Gas Emissions

Vehicle	CO2 (MT) ^a	CH4 (MT) ^a	CO2e (MT) ^b
Onsite			
None	0.0	0.0	0.0
Onsite Total	0.0	0.0	0.0
Offsite			
3/4-Ton Pick-up Truck, 4x4	0.0	0.0	0.0
1-Ton Crew Cab Flat Bed, 4x4	0.0	0.0	0.0
Extendable Flat Bed Pole Truck	0.1	0.0	0.1
30-Ton Crane Truck	0.1	0.0	0.1
80ft. Hydraulic Manlift/Bucket Truck	0.1	0.0	0.1
Worker Commute	0.4	0.0	0.4
Offsite Total	0.7	0.0	0.7
Total	0.7	0.0	0.7

^a Emissions [metric tons, MT] = emission factor [lb/hr] x miles/day x Number x days used x 453.6 [g/lb] / 1,000,000 [g/MT]

Emission factors are in Table 49 and Table 50

^b CO₂-equivalent (CO₂e) emission factors are CO₂ emissions plus 21 x CH₄ emissions, based on Table C.1 from California Climate Action

Registry General Reporting Protocol, Version 3.0, April 2008, http://www.climateregistry.org/resources/docs/protocols/grp/GRP_V3_April2008_FINAL.pdf

Motor Vehicle Fugitive Particulate Matter Emissions

Vehicle	Number	Road Type	Miles/Day/ Vehicle	PM10 Emission Factor (lb/mi) ^a	PM2.5 Emission Factor (lb/mi) ^a	PM10 Emissions (lb/day) ^b	PM2.5 Emissions (lb/day) ^b
Onsite							
None	0						
Onsite Total						0.00	0.00
Offsite							
3/4-Ton Pick-up Truck, 4x4	1	Paved	14	0.001	0.000	0.01	0.00
1-Ton Crew Cab Flat Bed, 4x4	1	Paved	14	0.001	0.000	0.01	0.00
Extendable Flat Bed Pole Truck	1	Paved	14	0.001	0.000	0.01	0.00
30-Ton Crane Truck	1	Paved	14	0.001	0.000	0.01	0.00
80ft. Hydraulic Manlift/Bucket Truck	1	Paved	14	0.001	0.000	0.01	0.00
3/4-Ton Pick-up Truck, 4x4	1	Unpaved	4	0.435	0.043	1.74	0.17
1-Ton Crew Cab Flat Bed, 4x4	1	Unpaved	4	0.532	0.053	2.13	0.21
Extendable Flat Bed Pole Truck	1	Unpaved	4	0.922	0.092	3.69	0.37
30-Ton Crane Truck	1	Unpaved	4	0.922	0.092	3.69	0.37
80ft. Hydraulic Manlift/Bucket Truck	1	Unpaved	4	0.922	0.092	3.69	0.37
Worker Commute	6	Paved	60	0.001	0.000	0.29	0.00
Offsite Total						15.28	1.49
Total						15.28	1.49

a From Table 51

^b Emissions [lb/day] = number x miles/day x emission factor [lb/mi]

Earthwork Fugitive Particulate Matter Emissions

Activity	Activity Units	Activity Level	PM10 Emission Factor ^a	PM2.5 Emission Factor ^a	PM10 (lb/day) ^b	PM2.5 (lb/day) ^b
Soil Handling	CY/day		1.62E-03	3.36E-04	0.00	0.00

Table 34
Subtransmission Source Line Construction Emissions
Guard Structure Removal

Bulldozing, Scraping and Grading	hr/day		1.481	0.308	0.00	0.00
Storage Pile Wind Erosion	acres		15.7	3.26	0.00	0.00
Total					0.00	0.00

a From Table 52
b Emissions [lb/day] = Emission factor [lb/activity unit] x Activity unit [units/day]

Table 35
Subtransmission Source Line Construction Emissions
Restoration

Emissions Summary

Source	VOC (lb/day)	CO (lb/day)	NOX (lb/day)	SOX (lb/day)	PM10 (lb/day)	PM2.5 (lb/day)	CO2e (MT)
Construction Equipment Exhaust	5.00	17.19	47.30	0.06	1.74	1.60	10.8
Onsite Motor Vehicle Exhaust	0.01	0.03	0.09	0.00	0.00	0.00	0.0
Onsite Motor Vehicle Fugitive PM	--	--	--	--	2.77	0.28	
Earthwork Fugitive PM	--	--	--	--	17.77	3.70	
Onsite Total	5.01	17.22	47.39	0.06	22.28	5.57	10.8
Offsite Motor Vehicle Exhaust	0.45	3.81	1.60	0.01	0.10	0.07	1.2
Offsite Motor Vehicle Fugitive PM	--	--	--	--	8.95	0.86	
Offsite Total	0.45	3.81	1.60	0.01	9.05	0.93	1.2
Total	5.46	21.03	48.99	0.07	31.32	6.51	11.9

Construction Equipment Summary

Equipment	Horse-power	Number	Days Used	Hours Used/Day
Road Grader	350	1	4	6
Backhoe/Front Loader	350	1	4	6
Drum Type Compactor	250	1	4	6
Track Type Dozer	350	1	4	6

Construction Equipment Exhaust Emission Factors

Equipment	Horse-power	VOC (lb/hr) ^a	CO (lb/hr) ^a	NOX (lb/hr) ^a	SOX (lb/hr) ^a	PM10 (lb/hr) ^a	PM2.5 (lb/hr) ^b	CO2 (lb/hr) ^a	CH4 (lb/hr) ^a	Category
Road Grader	350	0.195	0.664	1.819	0.002	0.067	0.062	229.484	0.018	Graders
Backhoe/Front Loader	350	0.239	0.771	2.262	0.004	0.078	0.072	344.854	0.022	Tractors/Loaders/Backhoes
Drum Type Compactor	250	0.135	0.408	1.410	0.002	0.050	0.046	153.090	0.012	Rollers
Track Type Dozer	350	0.266	1.022	2.391	0.003	0.094	0.087	259.229	0.024	Crawler Tractors

^a From Table 48

^b Diesel PM2.5 emission factor [lb/hr] = PM10 emission factor [lb/hr] x PM2.5 fraction of PM10

PM2.5 Fraction= 0.920

From Appendix A, Final-Methodology to Calculate Particulate Matter (PM) 2.5

and PM 2.5 Significance Thresholds, SCAQMD, October 2006,

http://www.aqmd.gov/ceqa/handbook/PM2_5/PM2_5.html

Construction Equipment Daily Criteria Pollutant Exhaust Emissions

Equipment	VOC (lb/day) ^a	CO (lb/day) ^a	NOX (lb/day) ^a	SOX (lb/day) ^a	PM10 (lb/day) ^a	PM2.5 (lb/day) ^a
Road Grader	1.17	3.98	10.92	0.01	0.40	0.37
Backhoe/Front Loader	1.43	4.63	13.57	0.02	0.47	0.43
Drum Type Compactor	0.81	2.45	8.46	0.01	0.30	0.28
Track Type Dozer	1.60	6.13	14.35	0.02	0.57	0.52
Total	5.00	17.19	47.30	0.06	1.74	1.60

^a Emissions [lb/day] = number x hours/day x emission factor [lb/hr]

Construction Equipment Total Greenhouse Gas Emissions

Equipment	CO2 (MT) ^a	CH4 (MT) ^a	CO2e (MT) ^b
Road Grader	2.5	0.0	2.5
Backhoe/Front Loader	3.8	0.0	3.8
Drum Type Compactor	1.7	0.0	1.7
Track Type Dozer	2.8	0.0	2.8
Total	10.7	0.0	10.8

^a Emissions [metric tons, MT] = emission factor [lb/hr] x hours/day x Number x

days used x 453.6 [g/lb] / 1,000,000 [g/MT]

Emission factors are in Table 48

^b CO₂-equivalent (CO₂e) emission factors are CO₂ emissions plus 21 x CH₄ emissions, based on Table C.1 from California Climate Action

Registry General Reporting Protocol, Version 3.0, April 2008, http://www.climateregistry.org/resources/docs/protocols/grp/GRP_V3_April2008_FINAL.pdf

Motor Vehicle Usage

Vehicle	Number	Days Used	Hours Used/Day	Miles/Day/Veh.
Onsite				
Water Truck	1	4	N/A	3
Offsite				
Water Truck	1	4	N/A	13
1-Ton Crew Cab, 4x4	1	4	N/A	18
Lowboy Truck/Trailer	1	4	N/A	18
Worker Commute	7	4	N/A	60

Motor Vehicle Exhaust Emission Factors

Vehicle	Category	VOC (lb/mi) ^a	CO (lb/mi) ^a	NOX (lb/mi) ^a	SOX (lb/mi) ^a	PM10 (lb/mi) ^a	PM2.5 (lb/mi) ^b	CO2 (lb/mi) ^a	CH4 (lb/mi) ^a
Onsite									
Water Truck	HHDT	2.53E-03	1.02E-02	3.09E-02	4.04E-05	1.50E-03	1.29E-03	4.22E+00	1.17E-04
Offsite									
Water Truck	HHDT	2.53E-03	1.02E-02	3.09E-02	4.04E-05	1.50E-03	1.29E-03	4.22E+00	1.17E-04
1-Ton Crew Cab, 4x4	Delivery	2.24E-03	1.55E-02	1.73E-02	2.67E-05	6.50E-04	5.50E-04	2.77E+00	1.07E-04

Table 35
Subtransmission Source Line Construction Emissions
Restoration

Lowboy Truck/Trailer	HHDT	2.53E-03	1.02E-02	3.09E-02	4.04E-05	1.50E-03	1.29E-03	4.22E+00	1.17E-04
Worker Commute	Passenger	7.96E-04	7.65E-03	7.76E-04	1.07E-05	8.98E-05	5.75E-05	1.10E+00	7.17E-05

a From Table 49 or Table 50

Motor Vehicle Daily Criteria Pollutant Exhaust Emissions

Vehicle	VOC (lb/day) ^a	CO (lb/day) ^a	NOX (lb/day) ^a	SOX (lb/day) ^a	PM10 (lb/day) ^a	PM2.5 (lb/day) ^a
Onsite						
Water Truck	0.01	0.03	0.09	0.00	0.00	0.00
Onsite Total	0.01	0.03	0.09	0.00	0.00	0.00
Offsite						
Water Truck	0.03	0.13	0.40	0.00	0.02	0.02
1-Ton Crew Cab, 4x4	0.04	0.28	0.31	0.00	0.01	0.01
Lowboy Truck/Trailer	0.05	0.18	0.56	0.00	0.03	0.02
Worker Commute	0.33	3.21	0.33	0.00	0.04	0.02
Offsite Total	0.45	3.81	1.60	0.01	0.10	0.07
Total	0.46	3.84	1.69	0.01	0.10	0.08

^a Emissions [lb/day] = number x miles/day x emission factor [lb/mi]

Motor Vehicle Total Greenhouse Gas Emissions

Vehicle	CO2 (MT) ^a	CH4 (MT) ^a	CO2e (MT) ^b
Onsite			
Water Truck	0.0	0.0	0.0
Onsite Total	0.0	0.0	0.0
Offsite			
Water Truck	0.1	0.0	0.1
1-Ton Crew Cab, 4x4	0.1	0.0	0.1
Lowboy Truck/Trailer	0.1	0.0	0.1
Worker Commute	0.8	0.0	0.8
Offsite Total	1.2	0.0	1.2
Total	1.2	0.0	1.2

^a Emissions [metric tons, MT] = emission factor [lb/hr] x miles/day x Number x

days used x 453.6 [g/lb] / 1,000,000 [g/MT]

Emission factors are in Table 49 and Table 50

^b CO₂-equivalent (CO₂e) emission factors are CO₂ emissions plus 21 x CH₄ emissions, based on Table C.1 from California Climate Action

Registry General Reporting Protocol, Version 3.0, April 2008, http://www.climateregistry.org/resources/docs/protocols/grp/GRP_V3_April2008_FINAL.pdf

Motor Vehicle Fugitive Particulate Matter Emissions

Vehicle	Number	Road Type	Miles/ Day/ Vehicle	PM10 Emission Factor (lb/mi) ^a	PM2.5 Emission Factor (lb/mi) ^a	PM10 Emissions (lb/day) ^b	PM2.5 Emissions (lb/day) ^b
Onsite							
Water Truck	1	Unpaved	3	0.922	0.092	2.77	0.28
Onsite Total						2.77	0.28
Offsite							
Water Truck	1	Paved	10	0.001	0.000	0.01	0.00
1-Ton Crew Cab, 4x4	1	Paved	14	0.001	0.000	0.01	0.00
Lowboy Truck/Trailer	1	Paved	14	0.001	0.000	0.01	0.00
Water Truck	1	Unpaved	3	0.922	0.092	2.77	0.28
1-Ton Crew Cab, 4x4	1	Unpaved	4	0.532	0.053	2.13	0.21
Lowboy Truck/Trailer	1	Unpaved	4	0.922	0.092	3.69	0.37
Worker Commute	7	Paved	60	0.001	0.000	0.34	0.00
Offsite Total						8.95	0.86
Total						11.72	1.13

a From Table 51

^b Emissions [lb/day] = number x miles/day x emission factor [lb/mi]

Earthwork Fugitive Particulate Matter Emissions

Activity	Activity Units	Activity Level	PM10 Emission Factor ^a	PM2.5 Emission Factor ^a	PM10 (lb/day) ^b	PM2.5 (lb/day) ^b
Soil Handling	CY/day		1.62E-03	3.36E-04	0.00	0.00
Bulldozing, Scraping and Grading	hr/day	12	1.481	0.308	17.77	3.70
Storage Pile Wind Erosion	acres		15.7	3.26	0.00	0.00
Total					17.77	3.70

a From Table 52

^b Emissions [lb/day] = Emission factor [lb/activity unit] x Activity unit [units/day]

Table 36
Telecommunications Construction
Control Building Communications Room

Emissions Summary

Source	VOC (lb/day)	CO (lb/day)	NOX (lb/day)	SOX (lb/day)	PM10 (lb/day)	PM2.5 (lb/day)	CO2e (MT)
Construction Equipment Exhaust	0.00	0.00	0.00	0.00	0.00	0.00	0.0
Onsite Motor Vehicle Exhaust	0.00	0.00	0.00	0.00	0.00	0.00	0.0
Onsite Motor Vehicle Fugitive PM	--	--	--	--	0.00	0.00	
Earthwork Fugitive PM	--	--	--	--	0.00	0.00	
Onsite Total	0.00	0.00	0.00	0.00	0.00	0.00	0.0
Offsite Motor Vehicle Exhaust	0.24	2.27	0.45	0.00	0.03	0.02	1.4
Offsite Motor Vehicle Fugitive PM	--	--	--	--	0.23	0.00	
Offsite Total	0.24	2.27	0.45	0.00	0.26	0.02	1.4
Total	0.24	2.27	0.45	0.00	0.26	0.02	1.4

Construction Equipment Summary

Equipment	Horse-power	Number	Days Used	Hours Used/Day
None				

Construction Equipment Exhaust Emission Factors

Equipment	Horse-power	VOC (lb/hr) ^a	CO (lb/hr) ^a	NOX (lb/hr) ^a	SOX (lb/hr) ^a	PM10 (lb/hr) ^a	PM2.5 (lb/hr) ^b	CO2 (lb/hr) ^a	CH4 (lb/hr) ^a	Category
None		0.000	0.000	0.000	0.000	0.000	0.000	0.000	0.000	

^a From Table 48

^b Diesel PM2.5 emission factor [lb/hr] = PM10 emission factor [lb/hr] x PM2.5 fraction of PM10

PM2.5 Fraction= 0.920

From Appendix A, Final-Methodology to Calculate Particulate Matter (PM) 2.5

and PM 2.5 Significance Thresholds, SCAQMD, October 2006,

http://www.aqmd.gov/ceqa/handbook/PM2_5/PM2_5.html

Construction Equipment Daily Criteria Pollutant Exhaust Emissions

Equipment	VOC (lb/day) ^a	CO (lb/day) ^a	NOX (lb/day) ^a	SOX (lb/day) ^a	PM10 (lb/day) ^a	PM2.5 (lb/day) ^a
None	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

^a Emissions [lb/day] = number x hours/day x emission factor [lb/hr]

Construction Equipment Total Greenhouse Gas Emissions

Equipment	CO2 (MT) ^a	CH4 (MT) ^a	CO2e (MT) ^b
None	0.0	0.0	0.0
Total	0.0	0.0	0.0

^a Emissions [metric tons, MT] = emission factor [lb/hr] x hours/day x Number x

days used x 453.6 [g/lb] / 1,000,000 [g/MT]

Emission factors are in Table 48

^b CO₂-equivalent (CO₂e) emission factors are CO₂ emissions plus 21 x CH₄ emissions, based on Table C.1 from California Climate Action

Registry General Reporting Protocol, Version 3.0, April 2008, http://www.climateaction.org/resources/docs/protocols/grp/GRP_V3_April2008_FINAL.pdf

Motor Vehicle Usage

Vehicle	Number	Days Used	Hours Used/Day	Miles/Day/Veh.
Onsite				
None				0
Offsite				
Van	2	10	N/A	14
Crew Truck	1	1	N/A	14
Worker Commute	4	10	N/A	60

Motor Vehicle Exhaust Emission Factors

Vehicle	Category	VOC (lb/mi) ^a	CO (lb/mi) ^a	NOX (lb/mi) ^a	SOX (lb/mi) ^a	PM10 (lb/mi) ^a	PM2.5 (lb/mi) ^b	CO2 (lb/mi) ^a	CH4 (lb/mi) ^a
Onsite									
None		0.00E+00	0.00E+00	0.00E+00	0.00E+00	0.00E+00	0.00E+00	0.00E+00	0.00E+00
Offsite									
Van	Passenger	7.96E-04	7.65E-03	7.76E-04	1.07E-05	8.98E-05	5.75E-05	1.10E+00	7.17E-05
Crew Truck	Delivery	2.24E-03	1.55E-02	1.73E-02	2.67E-05	6.50E-04	5.50E-04	2.77E+00	1.07E-04
Worker Commute	Passenger	7.96E-04	7.65E-03	7.76E-04	1.07E-05	8.98E-05	5.75E-05	1.10E+00	7.17E-05

^a From Table 49 or Table 50

Motor Vehicle Daily Criteria Pollutant Exhaust Emissions

Vehicle	VOC (lb/day) ^a	CO (lb/day) ^a	NOX (lb/day) ^a	SOX (lb/day) ^a	PM10 (lb/day) ^a	PM2.5 (lb/day) ^a
Onsite						
None	0.00	0.00	0.00	0.00	0.00	0.00
Onsite Total	0.00	0.00	0.00	0.00	0.00	0.00
Offsite						

Table 36
Telecommunications Construction
Control Building Communications Room

Van	0.02	0.21	0.02	0.00	0.00	0.00
Crew Truck	0.03	0.22	0.24	0.00	0.01	0.01
Worker Commute	0.19	1.84	0.19	0.00	0.02	0.01
Offsite Total	0.24	2.27	0.45	0.00	0.03	0.02
Total	0.24	2.27	0.45	0.00	0.03	0.02

^a Emissions [lb/day] = number x miles/day x emission factor [lb/mi]

Motor Vehicle Total Greenhouse Gas Emissions

Vehicle	CO ₂ (MT) ^a	CH ₄ (MT) ^a	CO ₂ e (MT) ^b
Onsite			
None	0.0	0.0	0.0
Onsite Total	0.0	0.0	0.0
Offsite			
Van	0.1	0.0	0.1
Crew Truck	0.0	0.0	0.0
Worker Commute	1.2	0.0	1.2
Offsite Total	1.4	0.0	1.4
Total	1.4	0.0	1.4

^a Emissions [metric tons, MT] = emission factor [lb/hr] x miles/day x Number x days used x 453.6 [g/lb] / 1,000,000 [g/MT]

Emission factors are in Table 49 and Table 50

^b CO₂-equivalent (CO₂e) emission factors are CO₂ emissions plus 21 x CH₄ emissions, based on Table C.1 from California Climate Action Registry General Reporting Protocol, Version 3.0, April 2008, http://www.climateactionregistry.org/resources/docs/protocols/grp/GRP_V3_April2008_FINAL.pdf

Motor Vehicle Fugitive Particulate Matter Emissions

Vehicle	Number	Road Type	Miles/Day/ Vehicle	PM10 Emission Factor (lb/mi) ^a	PM2.5 Emission Factor (lb/mi) ^a	PM10 Emissions (lb/day) ^b	PM2.5 Emissions (lb/day) ^b
Onsite							
None	0					0.00	0.00
Onsite Total						0.00	0.00
Offsite							
Van	2	Paved	14	0.001	0.000	0.02	0.00
Crew Truck	1	Paved	14	0.001	0.000	0.01	0.00
Worker Commute	4	Paved	60	0.001	0.000	0.19	0.00
Offsite Total						0.23	0.00
Total						0.23	0.00

^a From Table 51

^b Emissions [lb/day] = number x miles/day x emission factor [lb/mi]

Earthwork Fugitive Particulate Matter Emissions

Activity	Activity Units	Activity Level	PM10 Emission Factor ^a	PM2.5 Emission Factor ^a	PM10 (lb/day) ^b	PM2.5 (lb/day) ^b
Soil Handling	CY/day		1.62E-03	3.36E-04	0.00	0.00
Bulldozing, Scraping and Grading	hr/day		1.481	0.308	0.00	0.00
Storage Pile Wind Erosion	acres		15.7	3.26	0.00	0.00
Total					0.00	0.00

^a From Table 52

^b Emissions [lb/day] = Emission factor [lb/activity unit] x Activity unit [units/day]

Table 37
Telecommunications Construction
Overhead Cable Installation

Emissions Summary

Source	VOC (lb/day)	CO (lb/day)	NOX (lb/day)	SOX (lb/day)	PM10 (lb/day)	PM2.5 (lb/day)	CO2e (MT)
Construction Equipment Exhaust	2.26	8.67	27.79	0.04	0.86	0.79	70.9
Onsite Motor Vehicle Exhaust	0.00	0.00	0.00	0.00	0.00	0.00	0.0
Onsite Motor Vehicle Fugitive PM	--	--	--	--	0.00	0.00	
Earthwork Fugitive PM	--	--	--	--	0.00	0.00	
Onsite Total	2.26	8.67	27.79	0.04	0.86	0.79	70.9
Offsite Motor Vehicle Exhaust	0.47	4.05	1.73	0.01	0.09	0.07	12.6
Offsite Motor Vehicle Fugitive PM	--	--	--	--	65.44	6.52	
Offsite Total	0.47	4.05	1.73	0.01	65.53	6.58	12.6
Total	2.74	12.72	29.52	0.04	66.39	7.38	83.4

Construction Equipment Summary

Equipment	Horse-power	Number	Days Used	Hours Used/Day
Bucket Truck	350	2	44	8
Splice Lab Truck	16	1	44	8

Construction Equipment Exhaust Emission Factors

Equipment	Horse-power	VOC (lb/hr) ^a	CO (lb/hr) ^a	NOX (lb/hr) ^a	SOX (lb/hr) ^a	PM10 (lb/hr) ^a	PM2.5 (lb/hr) ^b	CO2 (lb/hr) ^a	CH4 (lb/hr) ^a	Category
Bucket Truck	350	0.128	0.494	1.655	0.002	0.049	0.045	212.856	0.012	Aerial Lifts
Splice Lab Truck	16	0.028	0.095	0.163	0.000	0.010	0.009	17.631	0.002	Generator Sets

^a From Table 48

^b Diesel PM2.5 emission factor [lb/hr] = PM10 emission factor [lb/hr] x PM2.5 fraction of PM10

PM2.5 Fraction = 0.920

From Appendix A, Final-Methodology to Calculate Particulate Matter (PM) 2.5

and PM 2.5 Significance Thresholds, SCAQMD, October 2006,

http://www.aqmd.gov/ceqa/handbook/PM2_5/PM2_5.html

Construction Equipment Daily Criteria Pollutant Exhaust Emissions

Equipment	VOC (lb/day) ^a	CO (lb/day) ^a	NOX (lb/day) ^a	SOX (lb/day) ^a	PM10 (lb/day) ^a	PM2.5 (lb/day) ^a
Bucket Truck	2.04	7.90	26.48	0.03	0.79	0.72
Splice Lab Truck	0.22	0.76	1.31	0.00	0.08	0.07
Total	2.26	8.67	27.79	0.04	0.86	0.79

^a Emissions [lb/day] = number x hours/day x emission factor [lb/hr]

Construction Equipment Total Greenhouse Gas Emissions

Equipment	CO2 (MT) ^a	CH4 (MT) ^a	CO2e (MT) ^b
Bucket Truck	68.0	0.0	68.0
Splice Lab Truck	2.8	0.0	2.8
Total	70.8	0.0	70.9

^a Emissions [metric tons, MT] = emission factor [lb/hr] x hours/day x Number x

days used x 453.6 [g/lb] / 1,000,000 [g/MT]

Emission factors are in Table 48

^b CO₂-equivalent (CO₂e) emission factors are CO₂ emissions plus 21 x CH₄ emissions, based on Table C.1 from California Climate Action

Registry General Reporting Protocol, Version 3.0, April 2008, http://www.climateregistry.org/resources/docs/protocols/grp/GRP_V3_April2008_FINAL.pdf

Motor Vehicle Usage

Vehicle	Number	Days Used	Hours Used/Day	Miles/Day/Veh.
Onsite				
None				0
Offsite				
Bucket Truck	2	44	N/A	21
Splice Lab Truck	1	44	N/A	21
Crew Truck	1	44	N/A	21
Worker Commute	6	44	N/A	60

Motor Vehicle Exhaust Emission Factors

Vehicle	Category	VOC (lb/mi) ^a	CO (lb/mi) ^a	NOX (lb/mi) ^a	SOX (lb/mi) ^a	PM10 (lb/mi) ^a	PM2.5 (lb/mi) ^b	CO2 (lb/mi) ^a	CH4 (lb/mi) ^a
Onsite									
None		0.00E+00	0.00E+00	0.00E+00	0.00E+00	0.00E+00	0.00E+00	0.00E+00	0.00E+00
Offsite									
Bucket Truck	Delivery	2.24E-03	1.55E-02	1.73E-02	2.67E-05	6.50E-04	5.50E-04	2.77E+00	1.07E-04
Splice Lab Truck	Delivery	2.24E-03	1.55E-02	1.73E-02	2.67E-05	6.50E-04	5.50E-04	2.77E+00	1.07E-04
Crew Truck	Delivery	2.24E-03	1.55E-02	1.73E-02	2.67E-05	6.50E-04	5.50E-04	2.77E+00	1.07E-04
Worker Commute	Passenger	7.96E-04	7.65E-03	7.76E-04	1.07E-05	8.98E-05	5.75E-05	1.10E+00	7.17E-05

^a From Table 49 or Table 50

Motor Vehicle Daily Criteria Pollutant Exhaust Emissions

Vehicle	VOC (lb/day) ^a	CO (lb/day) ^a	NOX (lb/day) ^a	SOX (lb/day) ^a	PM10 (lb/day) ^a	PM2.5 (lb/day) ^a
Onsite						

Table 37
Telecommunications Construction
Overhead Cable Installation

None	0.00	0.00	0.00	0.00	0.00	0.00
Onsite Total	0.00	0.00	0.00	0.00	0.00	0.00
Offsite						
Bucket Truck	0.09	0.65	0.73	0.00	0.03	0.02
Splice Lab Truck	0.05	0.32	0.36	0.00	0.01	0.01
Crew Truck	0.05	0.32	0.36	0.00	0.01	0.01
Worker Commute	0.29	2.76	0.28	0.00	0.03	0.02
Offsite Total	0.47	4.05	1.73	0.01	0.09	0.07
Total	0.47	4.05	1.73	0.01	0.09	0.07

^a Emissions [lb/day] = number x miles/day x emission factor [lb/mi]

Motor Vehicle Total Greenhouse Gas Emissions

Vehicle	CO ₂ (MT) ^a	CH ₄ (MT) ^a	CO ₂ e (MT) ^b
Onsite			
None	0.0	0.0	0.0
Onsite Total	0.0	0.0	0.0
Offsite			
Bucket Truck	2.3	0.0	2.3
Splice Lab Truck	1.2	0.0	1.2
Crew Truck	1.2	0.0	1.2
Worker Commute	7.9	0.0	7.9
Offsite Total	12.6	0.0	12.6
Total	12.6	0.0	12.6

^a Emissions [metric tons, MT] = emission factor [lb/hr] x miles/day x Number x days used x 453.6 [g/lb] / 1,000,000 [g/MT]

Emission factors are in Table 49 and Table 50

^b CO₂-equivalent (CO₂e) emission factors are CO₂ emissions plus 21 x CH₄ emissions, based on Table C.1 from California Climate Action Registry General Reporting Protocol, Version 3.0, April 2008, http://www.climateregistry.org/resources/docs/protocols/grp/GRP_V3_April2008_FINAL.pdf

Motor Vehicle Fugitive Particulate Matter Emissions

Vehicle	Number	Road Type	Miles/Day/Vehicle	PM ₁₀ Emission Factor (lb/mi) ^a	PM _{2.5} Emission Factor (lb/mi) ^a	PM ₁₀ Emissions (lb/day) ^b	PM _{2.5} Emissions (lb/day) ^b
Onsite							
None	0					0.00	0.00
Onsite Total						0.00	0.00
Offsite							
Bucket Truck	2	Unpaved	21	0.922	0.092	38.73	3.87
Splice Lab Truck	1	Unpaved	21	0.726	0.073	15.25	1.53
Crew Truck	1	Unpaved	21	0.532	0.053	11.17	1.12
Worker Commute	6	Paved	60	0.001	0.000	0.29	0.00
Offsite Total						65.44	6.52
Total						65.44	6.52

^a From Table 51

^b Emissions [lb/day] = number x miles/day x emission factor [lb/mi]

Earthwork Fugitive Particulate Matter Emissions

Activity	Activity Units	Activity Level	PM ₁₀ Emission Factor ^a	PM _{2.5} Emission Factor ^a	PM ₁₀ (lb/day) ^b	PM _{2.5} (lb/day) ^b
Soil Handling	CY/day		1.62E-03	3.36E-04	0.00	0.00
Bulldozing, Scraping and Grading	hr/day		1.481	0.308	0.00	0.00
Storage Pile Wind Erosion	acres		15.7	3.26	0.00	0.00
Total					0.00	0.00

^a From Table 52

^b Emissions [lb/day] = Emission factor [lb/activity unit] x Activity unit [units/day]

Table 38
Telecommunications Construction
Underground Facility Installation

Emissions Summary

Source	VOC (lb/day)	CO (lb/day)	NOX (lb/day)	SOX (lb/day)	PM10 (lb/day)	PM2.5 (lb/day)	CO2e (MT)
Construction Equipment Exhaust	0.84	3.53	5.17	0.01	0.42	0.38	5.0
Onsite Motor Vehicle Exhaust	0.00	0.00	0.00	0.00	0.00	0.00	0.0
Onsite Motor Vehicle Fugitive PM	--	--	--	--	0.00	0.00	
Earthwork Fugitive PM	--	--	--	--	0.05	0.01	
Onsite Total	0.84	3.53	5.17	0.01	0.47	0.40	5.0
Offsite Motor Vehicle Exhaust	0.30	2.81	0.38	0.00	0.04	0.02	3.7
Offsite Motor Vehicle Fugitive PM	--	--	--	--	0.29	0.00	
Offsite Total	0.30	2.81	0.38	0.00	0.33	0.02	3.7
Total	1.14	6.33	5.54	0.01	0.80	0.42	8.8

Construction Equipment Summary

Equipment	Horse-power	Number	Days Used	Hours Used/Day
Backhoe	79	1	20	8
Concrete Mixer	120	1	20	8

Construction Equipment Exhaust Emission Factors

Equipment	Horse-power	VOC (lb/hr) ^a	CO (lb/hr) ^a	NOX (lb/hr) ^a	SOX (lb/hr) ^a	PM10 (lb/hr) ^a	PM2.5 (lb/hr) ^b	CO2 (lb/hr) ^a	CH4 (lb/hr) ^a	Category
Backhoe	79	0.076	0.356	0.491	0.001	0.043	0.040	51.728	0.007	Tractors/Loaders/Backhoes
Concrete Mixer	25	0.029	0.085	0.155	0.000	0.009	0.008	17.556	0.003	Cement and Mortar Mixers

^a From Table 48

^b Diesel PM2.5 emission factor [lb/hr] = PM10 emission factor [lb/hr] x PM2.5 fraction of PM10

PM2.5 Fraction= 0.920

From Appendix A, Final-Methodology to Calculate Particulate Matter (PM) 2.5

and PM 2.5 Significance Thresholds, SCAQMD, October 2006,

http://www.aqmd.gov/ceqa/handbook/PM2_5/PM2_5.html

Construction Equipment Daily Criteria Pollutant Exhaust Emissions

Equipment	VOC (lb/day) ^a	CO (lb/day) ^a	NOX (lb/day) ^a	SOX (lb/day) ^a	PM10 (lb/day) ^a	PM2.5 (lb/day) ^a
Backhoe	0.61	2.85	3.93	0.00	0.35	0.32
Concrete Mixer	0.23	0.68	1.24	0.00	0.07	0.07
Total	0.84	3.53	5.17	0.01	0.42	0.38

^a Emissions [lb/day] = number x hours/day x emission factor [lb/hr]

Construction Equipment Total Greenhouse Gas Emissions

Equipment	CO2 (MT) ^a	CH4 (MT) ^a	CO2e (MT) ^b
Backhoe	3.8	0.0	3.8
Concrete Mixer	1.3	0.0	1.3
Total	5.0	0.0	5.0

^a Emissions [metric tons, MT] = emission factor [lb/hr] x hours/day x Number x

days used x 453.6 [g/lb] / 1,000,000 [g/MT]

Emission factors are in Table 48

^b CO₂-equivalent (CO₂e) emission factors are CO₂ emissions plus 21 x CH₄ emissions, based on Table C.1 from California Climate Action

Registry General Reporting Protocol, Version 3.0, April 2008, http://www.climateregistry.org/resources/docs/protocols/grp/GRP_V3_April2008_FINAL.pdf

Motor Vehicle Usage

Vehicle	Number	Days Used	Hours Used/Day	Miles/Day/Veh.
Onsite				
None				0
Offsite				
Crew Truck	2	20	N/A	1
Flatbed Truck	1	20	N/A	1
Stake Truck	1	20	N/A	1
Worker Commute	6	20	N/A	60

Motor Vehicle Exhaust Emission Factors

Vehicle	Category	VOC (lb/mi) ^a	CO (lb/mi) ^a	NOX (lb/mi) ^a	SOX (lb/mi) ^a	PM10 (lb/mi) ^a	PM2.5 (lb/mi) ^b	CO2 (lb/mi) ^a	CH4 (lb/mi) ^a
Onsite									
None		0.00E+00	0.00E+00	0.00E+00	0.00E+00	0.00E+00	0.00E+00	0.00E+00	0.00E+00
Offsite									
Crew Truck	Delivery	2.24E-03	1.55E-02	1.73E-02	2.67E-05	6.50E-04	5.50E-04	2.77E+00	1.07E-04
Flatbed Truck	HHDT	2.53E-03	1.02E-02	3.09E-02	4.04E-05	1.50E-03	1.29E-03	4.22E+00	1.17E-04
Stake Truck	HHDT	2.53E-03	1.02E-02	3.09E-02	4.04E-05	1.50E-03	1.29E-03	4.22E+00	1.17E-04
Worker Commute	Passenger	7.96E-04	7.65E-03	7.76E-04	1.07E-05	8.98E-05	5.75E-05	1.10E+00	7.17E-05

^a From Table 49 or Table 50

Motor Vehicle Daily Criteria Pollutant Exhaust Emissions

Vehicle	VOC (lb/day) ^a	CO (lb/day) ^a	NOX (lb/day) ^a	SOX (lb/day) ^a	PM10 (lb/day) ^a	PM2.5 (lb/day) ^a
Onsite						

Table 38
Telecommunications Construction
Underground Facility Installation

None	0.00	0.00	0.00	0.00	0.00	0.00
Onsite Total	0.00	0.00	0.00	0.00	0.00	0.00
Offsite						
Crew Truck	0.00	0.03	0.03	0.00	0.00	0.00
Flatbed Truck	0.00	0.01	0.03	0.00	0.00	0.00
Stake Truck	0.00	0.01	0.03	0.00	0.00	0.00
Worker Commute	0.29	2.76	0.28	0.00	0.03	0.02
Offsite Total	0.30	2.81	0.38	0.00	0.04	0.02
Total	0.30	2.81	0.38	0.00	0.04	0.02

^a Emissions [lb/day] = number x miles/day x emission factor [lb/mi]

Motor Vehicle Total Greenhouse Gas Emissions

Vehicle	CO2 (MT) ^a	CH4 (MT) ^a	CO2e (MT) ^b
Onsite			
None	0.0	0.0	0.0
Onsite Total	0.0	0.0	0.0
Offsite			
Crew Truck	0.1	0.0	0.1
Flatbed Truck	0.0	0.0	0.0
Stake Truck	0.0	0.0	0.0
Worker Commute	3.6	0.0	3.6
Offsite Total	3.7	0.0	3.7
Total	3.7	0.0	3.7

^a Emissions [metric tons, MT] = emission factor [lb/hr] x miles/day x Number x days used x 453.6 [g/lb] / 1,000,000 [g/MT]

Emission factors are in Table 49 and Table 50

^b CO₂-equivalent (CO₂e) emission factors are CO₂ emissions plus 21 x CH₄ emissions, based on Table C.1 from California Climate Action Registry General Reporting Protocol, Version 3.0, April 2008, http://www.climateregistry.org/resources/docs/protocols/grp/GRP_V3_April2008_FINAL.pdf

Motor Vehicle Fugitive Particulate Matter Emissions

Vehicle	Number	Road Type	Miles/Day/Vehicle	PM10 Emission Factor (lb/mi) ^a	PM2.5 Emission Factor (lb/mi) ^a	PM10 Emissions (lb/day) ^b	PM2.5 Emissions (lb/day) ^b
Onsite							
None	0					0.00	0.00
Onsite Total						0.00	0.00
Offsite							
Crew Truck	2	Paved	1	0.001	0.000	0.00	0.00
Flatbed Truck	1	Paved	1	0.001	0.000	0.00	0.00
Stake Truck	1	Paved	1	0.001	0.000	0.00	0.00
Worker Commute	6	Paved	60	0.001	0.000	0.29	0.00
Offsite Total						0.29	0.00
Total						0.29	0.00

^a From Table 51

^b Emissions [lb/day] = number x miles/day x emission factor [lb/mi]

Earthwork Fugitive Particulate Matter Emissions

Activity	Activity Units	Activity Level	PM10 Emission Factor ^a	PM2.5 Emission Factor ^a	PM10 (lb/day) ^b	PM2.5 (lb/day) ^b
Soil Handling ^c	CY/day	34	1.62E-03	3.36E-04	0.05	0.01
Bulldozing, Scraping and Grading	hr/day		1.481	0.308	0.00	0.00
Storage Pile Wind Erosion	acres		15.7	3.26	0.00	0.00
Total					0.05	0.01

^a From Table 52

^b Emissions [lb/day] = Emission factor [lb/activity unit] x Activity unit [units/day]

^c Based on 671 CY over 20 days

Table 39
Telecommunications Construction
Underground Cable Installation

Emissions Summary

Source	VOC (lb/day)	CO (lb/day)	NOX (lb/day)	SOX (lb/day)	PM10 (lb/day)	PM2.5 (lb/day)	CO2e (MT)
Construction Equipment Exhaust	2.65	9.44	27.82	0.04	0.95	0.87	11.5
Onsite Motor Vehicle Exhaust	0.00	0.00	0.00	0.00	0.00	0.00	0.0
Onsite Motor Vehicle Fugitive PM	--	--	--	--	0.00	0.00	
Earthwork Fugitive PM	--	--	--	--	0.00	0.00	
Onsite Total	2.65	9.44	27.82	0.04	0.95	0.87	11.5
Offsite Motor Vehicle Exhaust	0.30	2.81	0.38	0.00	0.04	0.02	1.1
Offsite Motor Vehicle Fugitive PM	--	--	--	--	0.29	0.00	
Offsite Total	0.30	2.81	0.38	0.00	0.33	0.02	1.1
Total	2.95	12.25	28.20	0.05	1.28	0.90	12.6

Construction Equipment Summary

Equipment	Horse-power	Number	Days Used	Hours Used/Day
Reel Truck	210	2	6	8
Splice Lab Truck	16	1	6	8

Construction Equipment Exhaust Emission Factors

Equipment	Horse-power	VOC (lb/hr) ^a	CO (lb/hr) ^a	NOX (lb/hr) ^a	SOX (lb/hr) ^a	PM10 (lb/hr) ^a	PM2.5 (lb/hr) ^b	CO2 (lb/hr) ^a	CH4 (lb/hr) ^a	Category
Reel Truck	210	0.152	0.543	1.657	0.002	0.055	0.050	254.238	0.014	Other Construction Equipment
Splice Lab Truck	16	0.028	0.095	0.163	0.000	0.010	0.009	17.631	0.002	Generator Sets

^a From Table 48

^b Diesel PM2.5 emission factor [lb/hr] = PM10 emission factor [lb/hr] x PM2.5 fraction of PM10

PM2.5 Fraction = 0.920

From Appendix A, Final-Methodology to Calculate Particulate Matter (PM) 2.5

and PM 2.5 Significance Thresholds, SCAQMD, October 2006,

http://www.aqmd.gov/ceqa/handbook/PM2_5/PM2_5.html

Construction Equipment Daily Criteria Pollutant Exhaust Emissions

Equipment	VOC (lb/day) ^a	CO (lb/day) ^a	NOX (lb/day) ^a	SOX (lb/day) ^a	PM10 (lb/day) ^a	PM2.5 (lb/day) ^a
Reel Truck	2.43	8.68	26.52	0.04	0.87	0.80
Splice Lab Truck	0.22	0.76	1.31	0.00	0.08	0.07
Total	2.65	9.44	27.82	0.04	0.95	0.87

^a Emissions [lb/day] = number x hours/day x emission factor [lb/hr]

Construction Equipment Total Greenhouse Gas Emissions

Equipment	CO2 (MT) ^a	CH4 (MT) ^a	CO2e (MT) ^b
Reel Truck	11.1	0.0	11.1
Splice Lab Truck	0.4	0.0	0.4
Total	11.5	0.0	11.5

^a Emissions [metric tons, MT] = emission factor [lb/hr] x hours/day x Number x

days used x 453.6 [g/lb] / 1,000,000 [g/MT]

Emission factors are in Table 48

^b CO₂-equivalent (CO₂e) emission factors are CO₂ emissions plus 21 x CH₄ emissions, based on Table C.1 from California Climate Action

Registry General Reporting Protocol, Version 3.0, April 2008, http://www.climateregistry.org/resources/docs/protocols/grp/GRP_V3_April2008_FINAL.pdf

Motor Vehicle Usage

Vehicle	Number	Days Used	Hours Used/Day	Miles/Day/Veh. ^a
Onsite				
None				0
Offsite				
Reel Truck	2	6	N/A	1
Crew Truck	1	6	N/A	1
Splice Lab Truck	1	6	N/A	1
Worker Commute	6	6	N/A	60

^a Onsite travel based on 25% use at 10 mph average speed

Motor Vehicle Exhaust Emission Factors

Vehicle	Category	VOC (lb/mi) ^a	CO (lb/mi) ^a	NOX (lb/mi) ^a	SOX (lb/mi) ^a	PM10 (lb/mi) ^a	PM2.5 (lb/mi) ^b	CO2 (lb/mi) ^a	CH4 (lb/mi) ^a
Onsite									
None		0.00E+00	0.00E+00	0.00E+00	0.00E+00	0.00E+00	0.00E+00	0.00E+00	0.00E+00
Offsite									
Reel Truck	HHDT	2.53E-03	1.02E-02	3.09E-02	4.04E-05	1.50E-03	1.29E-03	4.22E+00	1.17E-04
Crew Truck	Delivery	2.24E-03	1.55E-02	1.73E-02	2.67E-05	6.50E-04	5.50E-04	2.77E+00	1.07E-04
Splice Lab Truck	Delivery	2.24E-03	1.55E-02	1.73E-02	2.67E-05	6.50E-04	5.50E-04	2.77E+00	1.07E-04
Worker Commute	Passenger	7.96E-04	7.65E-03	7.76E-04	1.07E-05	8.98E-05	5.75E-05	1.10E+00	7.17E-05

^a From Table 49 or Table 50

Motor Vehicle Daily Criteria Pollutant Exhaust Emissions

Vehicle	VOC (lb/day) ^a	CO (lb/day) ^a	NOX (lb/day) ^a	SOX (lb/day) ^a	PM10 (lb/day) ^a	PM2.5 (lb/day) ^a

Table 39
Telecommunications Construction
Underground Cable Installation

Onsite						
None	0.00	0.00	0.00	0.00	0.00	0.00
Onsite Total	0.00	0.00	0.00	0.00	0.00	0.00
Offsite						
Reel Truck	0.01	0.02	0.06	0.00	0.00	0.00
Crew Truck	0.00	0.02	0.02	0.00	0.00	0.00
Splice Lab Truck	0.00	0.02	0.02	0.00	0.00	0.00
Worker Commute	0.29	2.76	0.28	0.00	0.03	0.02
Offsite Total	0.30	2.81	0.38	0.00	0.04	0.02
Total	0.30	2.81	0.38	0.00	0.04	0.02

^a Emissions [lb/day] = number x miles/day x emission factor [lb/mi]

Motor Vehicle Total Greenhouse Gas Emissions

Vehicle	CO2 (MT) ^a	CH4 (MT) ^a	CO2e (MT) ^b
Onsite			
None	0.0	0.0	0.0
Onsite Total	0.0	0.0	0.0
Offsite			
Reel Truck	0.0	0.0	0.0
Crew Truck	0.0	0.0	0.0
Splice Lab Truck	0.0	0.0	0.0
Worker Commute	1.1	0.0	1.1
Offsite Total	1.1	0.0	1.1
Total	1.1	0.0	1.1

^a Emissions [metric tons, MT] = emission factor [lb/hr] x miles/day x Number x days used x 453.6 [g/lb] / 1,000,000 [g/MT]

Emission factors are in Table 49 and Table 50

^b CO₂-equivalent (CO₂e) emission factors are CO₂ emissions plus 21 x CH₄ emissions, based on Table C.1 from California Climate Action Registry General Reporting Protocol, Version 3.0, April 2008, http://www.climateregistry.org/resources/docs/protocols/grp/GRP_V3_April2008_FINAL.pdf

Motor Vehicle Fugitive Particulate Matter Emissions

Vehicle	Number	Road Type	Miles/Day/Vehicle	PM10 Emission Factor (lb/mi) ^a	PM2.5 Emission Factor (lb/mi) ^a	PM10 Emissions (lb/day) ^b	PM2.5 Emissions (lb/day) ^b
Onsite							
None	0					0.00	0.00
Onsite Total						0.00	0.00
Offsite							
Reel Truck	2	Paved	1	0.001	0.000	0.00	0.00
Crew Truck	1	Paved	1	0.001	0.000	0.00	0.00
Splice Lab Truck	1	Paved	1	0.001	0.000	0.00	0.00
Worker Commute	6	Paved	60	0.001	0.000	0.29	0.00
Offsite Total						0.29	0.00
Total						0.29	0.00

^a From Table 51

^b Emissions [lb/day] = number x miles/day x emission factor [lb/mi]

Earthwork Fugitive Particulate Matter Emissions

Activity	Activity Units	Activity Level	PM10 Emission Factor ^a	PM2.5 Emission Factor ^a	PM10 (lb/day) ^b	PM2.5 (lb/day) ^b
Soil Handling	CY/day		1.62E-03	3.36E-04	0.00	0.00
Bulldozing, Scraping and Grading	hr/day		1.481	0.308	0.00	0.00
Storage Pile Wind Erosion	acres		15.7	3.26	0.00	0.00
Total					0.00	0.00

^a From Table 52

^b Emissions [lb/day] = Emission factor [lb/activity unit] x Activity unit [units/day]

Table 40
Telecommunications Construction
Optical Systems Installation at Other Locations

Emissions Summary

Source	VOC (lb/day)	CO (lb/day)	NOX (lb/day)	SOX (lb/day)	PM10 (lb/day)	PM2.5 (lb/day)	CO2e (MT)
Construction Equipment Exhaust	0.00	0.00	0.00	0.00	0.00	0.00	0.0
Onsite Motor Vehicle Exhaust	0.00	0.00	0.00	0.00	0.00	0.00	0.0
Onsite Motor Vehicle Fugitive PM	--	--	--	--	0.00	0.00	
Earthwork Fugitive PM	--	--	--	--	0.00	0.00	
Onsite Total	0.00	0.00	0.00	0.00	0.00	0.00	0.0
Offsite Motor Vehicle Exhaust	0.57	5.51	0.56	0.01	0.06	0.04	4.3
Offsite Motor Vehicle Fugitive PM	--	--	--	--	0.58	0.00	
Offsite Total	0.57	5.51	0.56	0.01	0.64	0.04	4.3
Total	0.57	5.51	0.56	0.01	0.64	0.04	4.3

Construction Equipment Summary

Equipment	Horse-power	Number	Days Used	Hours Used/Day
None				

Construction Equipment Exhaust Emission Factors

Equipment	Horse-power	VOC (lb/hr) ^a	CO (lb/hr) ^a	NOX (lb/hr) ^a	SOX (lb/hr) ^a	PM10 (lb/hr) ^a	PM2.5 (lb/hr) ^b	CO2 (lb/hr) ^a	CH4 (lb/hr) ^a	Category
None		0.000	0.000	0.000	0.000	0.000	0.000	0.000	0.000	

^a From Table 48

^b Diesel PM2.5 emission factor [lb/hr] = PM10 emission factor [lb/hr] x PM2.5 fraction of PM10

PM2.5 Fraction= 0.920

From Appendix A, Final-Methodology to Calculate Particulate Matter (PM) 2.5

and PM 2.5 Significance Thresholds, SCAQMD, October 2006,

http://www.aqmd.gov/ceqa/handbook/PM2_5/PM2_5.html

Construction Equipment Daily Criteria Pollutant Exhaust Emissions

Equipment	VOC (lb/day) ^a	CO (lb/day) ^a	NOX (lb/day) ^a	SOX (lb/day) ^a	PM10 (lb/day) ^a	PM2.5 (lb/day) ^a
None	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

^a Emissions [lb/day] = number x hours/day x emission factor [lb/hr]

Construction Equipment Total Greenhouse Gas Emissions

Equipment	CO2 (MT) ^a	CH4 (MT) ^a	CO2e (MT) ^b
None	0.0	0.0	0.0
Total	0.0	0.0	0.0

^a Emissions [metric tons, MT] = emission factor [lb/hr] x hours/day x Number x

days used x 453.6 [g/lb] / 1,000,000 [g/MT]

Emission factors are in Table 48

^b CO₂-equivalent (CO₂e) emission factors are CO₂ emissions plus 21 x CH₄ emissions, based on Table C.1 from California Climate Action

Registry General Reporting Protocol, Version 3.0, April 2008, http://www.climateregistry.org/resources/docs/protocols/grp/GRP_V3_April2008_FINAL.pdf

Motor Vehicle Usage

Vehicle	Number	Days Used	Hours Used/Day	Miles/Day/Veh.
Onsite				
None				0
Offsite				
Van	6	12	N/A	60
Worker Commute	6	12	N/A	60

Motor Vehicle Exhaust Emission Factors

Vehicle	Category	VOC (lb/mi) ^a	CO (lb/mi) ^a	NOX (lb/mi) ^a	SOX (lb/mi) ^a	PM10 (lb/mi) ^a	PM2.5 (lb/mi) ^b	CO2 (lb/mi) ^a	CH4 (lb/mi) ^a
Onsite									
None		0.00E+00	0.00E+00	0.00E+00	0.00E+00	0.00E+00	0.00E+00	0.00E+00	0.00E+00
Offsite									
Van	Passenger	7.96E-04	7.65E-03	7.76E-04	1.07E-05	8.98E-05	5.75E-05	1.10E+00	7.17E-05
Worker Commute	Passenger	7.96E-04	7.65E-03	7.76E-04	1.07E-05	8.98E-05	5.75E-05	1.10E+00	7.17E-05

^a From Table 49 or Table 50

Motor Vehicle Daily Criteria Pollutant Exhaust Emissions

Vehicle	VOC (lb/day) ^a	CO (lb/day) ^a	NOX (lb/day) ^a	SOX (lb/day) ^a	PM10 (lb/day) ^a	PM2.5 (lb/day) ^a
Onsite						
None	0.00	0.00	0.00	0.00	0.00	0.00
Onsite Total	0.00	0.00	0.00	0.00	0.00	0.00
Offsite						
Van	0.29	2.76	0.28	0.00	0.03	0.02
Worker Commute	0.29	2.76	0.28	0.00	0.03	0.02
Offsite Total	0.57	5.51	0.56	0.01	0.06	0.04
Total	0.57	5.51	0.56	0.01	0.06	0.04

^a Emissions [lb/day] = number x miles/day x emission factor [lb/mi]

Table 40
Telecommunications Construction
Optical Systems Installation at Other Locations

Motor Vehicle Total Greenhouse Gas Emissions

Vehicle	CO2 (MT) ^a	CH4 (MT) ^a	CO2e (MT) ^b
Onsite			
None	0.0	0.0	0.0
Onsite Total	0.0	0.0	0.0
Offsite			
Van	2.2	0.0	2.2
Worker Commute	2.2	0.0	2.2
Offsite Total	4.3	0.0	4.3
Total	4.3	0.0	4.3

^a Emissions [metric tons, MT] = emission factor [lb/hr] x miles/day x Number x days used x 453.6 [g/lb] / 1,000,000 [g/MT]

Emission factors are in Table 49 and Table 50

^b CO₂-equivalent (CO₂e) emission factors are CO₂ emissions plus 21 x CH₄ emissions, based on Table C.1 from California Climate Action

Registry General Reporting Protocol, Version 3.0, April 2008, http://www.climateregistry.org/resources/docs/protocols/grp/GRP_V3_April2008_FINAL.pdf

Motor Vehicle Fugitive Particulate Matter Emissions

Vehicle	Number	Road Type	Miles/Day/Vehicle	PM10 Emission Factor (lb/mi) ^a	PM2.5 Emission Factor (lb/mi) ^a	PM10 Emissions (lb/day) ^b	PM2.5 Emissions (lb/day) ^b
Onsite							
None	0					0.00	0.00
Onsite Total						0.00	0.00
Offsite							
Van	6	Paved	60	0.001	0.000	0.29	0.00
Worker Commute	6	Paved	60	0.001	0.000	0.29	0.00
Offsite Total						0.58	0.00
Total						0.58	0.00

^a From Table 51

^b Emissions [lb/day] = number x miles/day x emission factor [lb/mi]

Earthwork Fugitive Particulate Matter Emissions

Activity	Activity Units	Activity Level	PM10 Emission Factor ^a	PM2.5 Emission Factor ^a	PM10 (lb/day) ^b	PM2.5 (lb/day) ^b
Soil Handling	CY/day		1.62E-03	3.36E-04	0.00	0.00
Bulldozing, Scraping and Grading	hr/day		1.481	0.308	0.00	0.00
Storage Pile Wind Erosion	acres		15.7	3.26	0.00	0.00
Total					0.00	0.00

^a From Table 52

^b Emissions [lb/day] = Emission factor [lb/activity unit] x Activity unit [units/day]

Table 41
Nuevo Substation Demolition Emissions
Civil

Emissions Summary

Source	VOC (lb/day)	CO (lb/day)	NOX (lb/day)	SOX (lb/day)	PM10 (lb/day)	PM2.5 (lb/day)	CO2e (MT)
Construction Equipment Exhaust	0.90	4.51	6.05	0.01	0.52	0.48	1.5
Onsite Motor Vehicle Exhaust	0.01	0.04	0.09	0.00	0.00	0.00	0.0
Onsite Motor Vehicle Fugitive PM	--	--	--	--	0.00	0.00	
Earthwork Fugitive PM	--	--	--	--	0.00	0.00	
Onsite Total	0.91	4.55	6.14	0.01	0.52	0.48	1.6
Offsite Motor Vehicle Exhaust	0.57	3.62	4.25	0.01	0.22	0.19	2.0
Offsite Motor Vehicle Fugitive PM	--	--	--	--	0.24	0.00	
Offsite Total	0.57	3.62	4.25	0.01	0.46	0.19	2.0
Total	1.47	8.17	10.40	0.02	0.99	0.67	3.5

Construction Equipment Summary

Equipment	Horse-power	Number	Days Used	Hours Used/Day
Backhoe	79	1	5	8
Bobcat Skid Steer	75	1	5	6

Construction Equipment Exhaust Emission Factors

Equipment	Horse-power	VOC (lb/hr) ^a	CO (lb/hr) ^a	NOX (lb/hr) ^a	SOX (lb/hr) ^a	PM10 (lb/hr) ^a	PM2.5 (lb/hr) ^b	CO2 (lb/hr) ^a	CH4 (lb/hr) ^a	Category
Backhoe	79	0.076	0.356	0.491	0.001	0.043	0.040	51.728	0.007	Tractors/Loaders/Backhoes
Bobcat Skid Steer	75	0.048	0.277	0.354	0.001	0.029	0.026	42.762	0.004	Skid Steer Loaders

^a From Table 48

^b Diesel PM2.5 emission factor [lb/hr] = PM10 emission factor [lb/hr] x PM2.5 fraction of PM10

PM2.5 Fraction= 0.920

From Appendix A, Final-Methodology to Calculate Particulate Matter (PM) 2.5

and PM 2.5 Significance Thresholds, SCAQMD, October 2006,

http://www.aqmd.gov/ceqa/handbook/PM2_5/PM2_5.html

Construction Equipment Daily Criteria Pollutant Exhaust Emissions

Equipment	VOC (lb/day) ^a	CO (lb/day) ^a	NOX (lb/day) ^a	SOX (lb/day) ^a	PM10 (lb/day) ^a	PM2.5 (lb/day) ^a
Backhoe	0.61	2.85	3.93	0.00	0.35	0.32
Bobcat Skid Steer	0.29	1.66	2.12	0.00	0.17	0.16
Total	0.90	4.51	6.05	0.01	0.52	0.48

^a Emissions [lb/day] = number x hours/day x emission factor [lb/hr]

Construction Equipment Total Greenhouse Gas Emissions

Equipment	CO2 (MT) ^a	CH4 (MT) ^a	CO2e (MT) ^b
Backhoe	0.9	0.0	0.9
Bobcat Skid Steer	0.6	0.0	0.6
Total	1.5	0.0	1.5

^a Emissions [metric tons, MT] = emission factor [lb/hr] x hours/day x Number x

days used x 453.6 [g/lb] / 1,000,000 [g/MT]

Emission factors are in Table 48

^b CO₂-equivalent (CO₂e) emission factors are CO₂ emissions plus 21 x CH₄ emissions, based on Table C.1 from California Climate Action

Registry General Reporting Protocol, Version 3.0, April 2008, http://www.climateregistry.org/resources/docs/protocols/grp/GRP_V3_April2008_FINAL.pdf

Motor Vehicle Usage

Vehicle	Number ^a	Days Used	Hours Used/Day	Miles/Day/Veh.
Onsite				
Dump Truck	2	5	N/A	1
Water Truck	1	5	N/A	1
Tool Truck	1	5	N/A	1
Offsite				
Dump Truck	2	5	N/A	60
Water Truck	1	5	N/A	10
Worker Commute	5	5	N/A	60

Motor Vehicle Exhaust Emission Factors

Vehicle	Category	VOC (lb/mi) ^a	CO (lb/mi) ^a	NOX (lb/mi) ^a	SOX (lb/mi) ^a	PM10 (lb/mi) ^a	PM2.5 (lb/mi) ^b	CO2 (lb/mi) ^a	CH4 (lb/mi) ^a
Onsite									
Dump Truck	HHDT	2.53E-03	1.02E-02	3.09E-02	4.04E-05	1.50E-03	1.29E-03	4.22E+00	1.17E-04
Water Truck	HHDT	2.53E-03	1.02E-02	3.09E-02	4.04E-05	1.50E-03	1.29E-03	4.22E+00	1.17E-04
Tool Truck	Passenger	7.96E-04	7.65E-03	7.76E-04	1.07E-05	8.98E-05	5.75E-05	1.10E+00	7.17E-05
Offsite									
Dump Truck	HHDT	2.53E-03	1.02E-02	3.09E-02	4.04E-05	1.50E-03	1.29E-03	4.22E+00	1.17E-04
Water Truck	HHDT	2.53E-03	1.02E-02	3.09E-02	4.04E-05	1.50E-03	1.29E-03	4.22E+00	1.17E-04
Worker Commute	Passenger	7.96E-04	7.65E-03	7.76E-04	1.07E-05	8.98E-05	5.75E-05	1.10E+00	7.17E-05

^a From Table 49 or Table 50

Table 41
Nuevo Substation Demolition Emissions
Civil

Motor Vehicle Daily Criteria Pollutant Exhaust Emissions

Vehicle	VOC (lb/day) ^a	CO (lb/day) ^a	NOX (lb/day) ^a	SOX (lb/day) ^a	PM10 (lb/day) ^a	PM2.5 (lb/day) ^a
Onsite						
Dump Truck	0.01	0.02	0.06	0.00	0.00	0.00
Water Truck	0.00	0.01	0.03	0.00	0.00	0.00
Tool Truck	0.00	0.01	0.00	0.00	0.00	0.00
Onsite Total	0.01	0.04	0.09	0.00	0.00	0.00
Offsite						
Dump Truck	0.30	1.23	3.71	0.00	0.18	0.16
Water Truck	0.03	0.10	0.31	0.00	0.01	0.01
Worker Commute	0.24	2.30	0.23	0.00	0.03	0.02
Offsite Total	0.57	3.62	4.25	0.01	0.22	0.19
Total	0.58	3.66	4.35	0.01	0.23	0.19

^a Emissions [lb/day] = number x miles/day x emission factor [lb/mi]

Motor Vehicle Total Greenhouse Gas Emissions

Vehicle	CO2 (MT) ^a	CH4 (MT) ^a	CO2e (MT) ^b
Onsite			
Dump Truck	0.0	0.0	0.0
Water Truck	0.0	0.0	0.0
Tool Truck	0.0	0.0	0.0
Onsite Total	0.0	0.0	0.0
Offsite			
Dump Truck	1.1	0.0	1.1
Water Truck	0.1	0.0	0.1
Worker Commute	0.7	0.0	0.8
Offsite Total	2.0	0.0	2.0
Total	2.0	0.0	2.0

^a Emissions [metric tons, MT] = emission factor [lb/hr] x miles/day x Number x days used x 453.6 [g/lb] / 1,000,000 [g/MT]

Emission factors are in Table 49 and Table 50

^b CO₂-equivalent (CO₂e) emission factors are CO₂ emissions plus 21 x CH₄ emissions, based on Table C.1 from California Climate Action Registry General Reporting Protocol, Version 3.0, April 2008, http://www.climateregistry.org/resources/docs/protocols/grp/GRP_V3_April2008_FINAL.pdf

Motor Vehicle Fugitive Particulate Matter Emissions

Vehicle	Number	Road Type	Miles/Day/Vehicle	PM10 Emission Factor (lb/mi) ^a	PM2.5 Emission Factor (lb/mi) ^a	PM10 Emissions (lb/day) ^b	PM2.5 Emissions (lb/day) ^b
Onsite							
Dump Truck	2	Paved	1	0.001	0.000	0.00	0.00
Water Truck	1	Paved	1	0.001	0.000	0.00	0.00
Tool Truck	1	Paved	1	0.001	0.000	0.00	0.00
Onsite Total						0.00	0.00
Offsite							
Dump Truck	2	Paved	60	0.001	0.000	0.10	0.00
Water Truck	1	Paved	10	0.001	0.000	0.01	0.00
Worker Commute	5	Paved	60	0.001	0.000	0.24	0.00
Offsite Total						0.24	0.00
Total						0.24	0.00

^a From Table 51

^b Emissions [lb/day] = number x miles/day x emission factor [lb/mi]

Earthwork Fugitive Particulate Matter Emissions

Activity	Activity Units	Activity Level	PM10 Emission Factor ^a	PM2.5 Emission Factor ^a	PM10 (lb/day) ^b	PM2.5 (lb/day) ^b
Soil Handling	CY/day		1.62E-03	3.36E-04	0.00	0.00
Bulldozing, Scraping and Grading	hr/day		1.481	0.308	0.00	0.00
Storage Pile Wind Erosion	acres		15.7	3.26	0.00	0.00
Total					0.00	0.00

^a From Table 52

^b Emissions [lb/day] = Emission factor [lb/activity unit] x Activity unit [units/day]

Table 42
Nuevo Substation Demolition Emissions
Electrical

Emissions Summary

Source	VOC (lb/day)	CO (lb/day)	NOX (lb/day)	SOX (lb/day)	PM10 (lb/day)	PM2.5 (lb/day)	CO2e (MT)
Construction Equipment Exhaust	0.54	28.46	4.03	0.00	0.27	0.25	1.6
Onsite Motor Vehicle Exhaust	0.00	0.02	0.00	0.00	0.00	0.00	0.0
Onsite Motor Vehicle Fugitive PM	--	--	--	--	0.00	0.00	
Earthwork Fugitive PM	--	--	--	--	0.00	0.00	
Onsite Total	0.54	28.48	4.04	0.00	0.27	0.25	1.6
Offsite Motor Vehicle Exhaust	0.26	2.48	0.25	0.00	0.03	0.02	1.1
Offsite Motor Vehicle Fugitive PM	--	--	--	--	0.26	0.00	
Offsite Total	0.26	2.48	0.25	0.00	0.29	0.02	1.1
Total	0.80	30.96	4.29	0.01	0.56	0.27	2.7

Construction Equipment Summary

Equipment	Horse-power	Number	Days Used	Hours Used/Day
Manlift	25	2	7	6
15-Ton Crane	125	1	7	4

Construction Equipment Exhaust Emission Factors

Equipment	Horse-power	VOC (lb/hr) ^a	CO (lb/hr) ^a	NOX (lb/hr) ^a	SOX (lb/hr) ^a	PM10 (lb/hr) ^a	PM2.5 (lb/hr) ^b	CO2 (lb/hr) ^a	CH4 (lb/hr) ^a	Category
Manlift	25	0.008	2.210	0.061	0.000	0.007	0.006	13.000	0.070	Aerial Lifts-Propane
15-Ton Crane	125	0.109	0.484	0.826	0.001	0.048	0.044	80.345	0.010	Cranes

^a From Table 48

^b Diesel PM2.5 emission factor [lb/hr] = PM10 emission factor [lb/hr] x PM2.5 fraction of PM10

PM2.5 Fraction= 0.920

From Appendix A, Final-Methodology to Calculate Particulate Matter (PM) 2.5

and PM 2.5 Significance Thresholds, SCAQMD, October 2006,

http://www.aqmd.gov/ceqa/handbook/PM2_5/PM2_5.html

Construction Equipment Daily Criteria Pollutant Exhaust Emissions

Equipment	VOC (lb/day) ^a	CO (lb/day) ^a	NOX (lb/day) ^a	SOX (lb/day) ^a	PM10 (lb/day) ^a	PM2.5 (lb/day) ^a
Manlift	0.10	26.53	0.73	0.00	0.08	0.07
15-Ton Crane	0.44	1.94	3.30	0.00	0.19	0.18
Total	0.54	28.46	4.03	0.00	0.27	0.25

^a Emissions [lb/day] = number x hours/day x emission factor [lb/hr]

Construction Equipment Total Greenhouse Gas Emissions

Equipment	CO2 (MT) ^a	CH4 (MT) ^a	CO2e (MT) ^b
Manlift	0.5	0.0	0.6
15-Ton Crane	1.0	0.0	1.0
Total	1.5	0.0	1.6

^a Emissions [metric tons, MT] = emission factor [lb/hr] x hours/day x Number x

days used x 453.6 [g/lb] / 1,000,000 [g/MT]

Emission factors are in Table 48

^b CO₂-equivalent (CO₂e) emission factors are CO₂ emissions plus 21 x CH₄ emissions, based on Table C.1 from California Climate Action

Registry General Reporting Protocol, Version 3.0, April 2008, http://www.climateregistry.org/resources/docs/protocols/grp/GRP_V3_April2008_FINAL.pdf

Motor Vehicle Usage

Vehicle	Number	Days Used	Hours Used/Day	Miles/Day/Veh.
Onsite				
Tool Trailer	1	7	N/A	1
Crew Truck	2	7	N/A	1
Offsite				
Crew Truck	2	7	N/A	12
Worker Commute	5	7	N/A	60

Motor Vehicle Exhaust Emission Factors

Vehicle	Category	VOC (lb/mi) ^a	CO (lb/mi) ^a	NOX (lb/mi) ^a	SOX (lb/mi) ^a	PM10 (lb/mi) ^a	PM2.5 (lb/mi) ^b	CO2 (lb/mi) ^a	CH4 (lb/mi) ^a
Onsite									
Tool Trailer	Passenger	7.96E-04	7.65E-03	7.76E-04	1.07E-05	8.98E-05	5.75E-05	1.10E+00	7.17E-05
Crew Truck	Passenger	7.96E-04	7.65E-03	7.76E-04	1.07E-05	8.98E-05	5.75E-05	1.10E+00	7.17E-05
Offsite									
Crew Truck	Passenger	7.96E-04	7.65E-03	7.76E-04	1.07E-05	8.98E-05	5.75E-05	1.10E+00	7.17E-05
Worker Commute	Passenger	7.96E-04	7.65E-03	7.76E-04	1.07E-05	8.98E-05	5.75E-05	1.10E+00	7.17E-05

^a From Table 49 or Table 50

Motor Vehicle Daily Criteria Pollutant Exhaust Emissions

Vehicle	VOC (lb/day) ^a	CO (lb/day) ^a	NOX (lb/day) ^a	SOX (lb/day) ^a	PM10 (lb/day) ^a	PM2.5 (lb/day) ^a

Table 42
Nuevo Substation Demolition Emissions
Electrical

Onsite						
Tool Trailer	0.00	0.01	0.00	0.00	0.00	0.00
Crew Truck	0.00	0.02	0.00	0.00	0.00	0.00
Onsite Total	0.00	0.02	0.00	0.00	0.00	0.00
Offsite						
Crew Truck	0.02	0.18	0.02	0.00	0.00	0.00
Worker Commute	0.24	2.30	0.23	0.00	0.03	0.02
Offsite Total	0.26	2.48	0.25	0.00	0.03	0.02
Total	0.26	2.50	0.25	0.00	0.03	0.02

^a Emissions [lb/day] = number x miles/day x emission factor [lb/mi]

Motor Vehicle Total Greenhouse Gas Emissions

Vehicle	CO ₂ (MT) ^a	CH ₄ (MT) ^a	CO ₂ e (MT) ^b
Onsite			
Tool Trailer	0.0	0.0	0.0
Crew Truck	0.0	0.0	0.0
Onsite Total	0.0	0.0	0.0
Offsite			
Crew Truck	0.1	0.0	0.1
Worker Commute	1.0	0.0	1.1
Offsite Total	1.1	0.0	1.1
Total	1.1	0.0	1.1

^a Emissions [metric tons, MT] = emission factor [lb/hr] x miles/day x Number x days used x 453.6 [g/lb] / 1,000,000 [g/MT]

Emission factors are in Table 49 and Table 50

^b CO₂-equivalent (CO₂e) emission factors are CO₂ emissions plus 21 x CH₄ emissions, based on Table C.1 from California Climate Action Registry General Reporting Protocol, Version 3.0, April 2008, http://www.climateregistry.org/resources/docs/protocols/grp/GRP_V3_April2008_FINAL.pdf

Motor Vehicle Fugitive Particulate Matter Emissions

Vehicle	Number	Road Type	Miles/Day/Vehicle	PM10 Emission Factor (lb/mi) ^a	PM2.5 Emission Factor (lb/mi) ^a	PM10 Emissions (lb/day) ^b	PM2.5 Emissions (lb/day) ^b
Onsite							
Tool Trailer	1	Paved	1	0.001	0.000	0.00	0.00
Crew Truck	2	Paved	1	0.001	0.000	0.00	0.00
Onsite Total						0.00	0.00
Offsite							
Crew Truck	2	Paved	12	0.001	0.000	0.02	0.00
Worker Commute	5	Paved	60	0.001	0.000	0.24	0.00
Offsite Total						0.26	0.00
Total						0.26	0.00

^a From Table 51

^b Emissions [lb/day] = number x miles/day x emission factor [lb/mi]

Earthwork Fugitive Particulate Matter Emissions

Activity	Activity Units	Activity Level	PM10 Emission Factor ^a	PM2.5 Emission Factor ^a	PM10 (lb/day) ^b	PM2.5 (lb/day) ^b
Soil Handling	CY/day		1.62E-03	3.36E-04	0.00	0.00
Bulldozing, Scraping and Grading	hr/day		1.481	0.308	0.00	0.00
Storage Pile Wind Erosion	acres		15.7	3.26	0.00	0.00
Total					0.00	0.00

^a From Table 52

^b Emissions [lb/day] = Emission factor [lb/activity unit] x Activity unit [units/day]

Table 43
Nuevo Substation Demolition Emissions
Maintenance Crew Equipment Check

Emissions Summary

Source	VOC (lb/day)	CO (lb/day)	NOX (lb/day)	SOX (lb/day)	PM10 (lb/day)	PM2.5 (lb/day)	CO2e (MT)
Construction Equipment Exhaust	0.00	0.00	0.00	0.00	0.00	0.00	0.0
Onsite Motor Vehicle Exhaust	0.00	0.00	0.00	0.00	0.00	0.00	0.0
Onsite Motor Vehicle Fugitive PM	--	--	--	--	0.00	0.00	
Earthwork Fugitive PM	--	--	--	--	0.00	0.00	
Onsite Total	0.00	0.00	0.00	0.00	0.00	0.00	0.0
Offsite Motor Vehicle Exhaust	0.11	1.01	0.10	0.00	0.01	0.01	0.1
Offsite Motor Vehicle Fugitive PM	--	--	--	--	0.11	0.00	
Offsite Total	0.11	1.01	0.10	0.00	0.12	0.01	0.1
Total	0.11	1.01	0.10	0.00	0.12	0.01	0.1

Construction Equipment Summary

Equipment	Horse-power	Number	Days Used	Hours Used/Day
None				

Construction Equipment Exhaust Emission Factors

Equipment	Horse-power	VOC (lb/hr) ^a	CO (lb/hr) ^a	NOX (lb/hr) ^a	SOX (lb/hr) ^a	PM10 (lb/hr) ^a	PM2.5 (lb/hr) ^b	CO2 (lb/hr) ^a	CH4 (lb/hr) ^a	Category
None										

^a From Table 48

^b Diesel PM2.5 emission factor [lb/hr] = PM10 emission factor [lb/hr] x PM2.5 fraction of PM10

PM2.5 Fraction= 0.920

From Appendix A, Final-Methodology to Calculate Particulate Matter (PM) 2.5

and PM 2.5 Significance Thresholds, SCAQMD, October 2006,

http://www.aqmd.gov/ceqa/handbook/PM2_5/PM2_5.html

Construction Equipment Daily Criteria Pollutant Exhaust Emissions

Equipment	VOC (lb/day) ^a	CO (lb/day) ^a	NOX (lb/day) ^a	SOX (lb/day) ^a	PM10 (lb/day) ^a	PM2.5 (lb/day) ^a
None	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

^a Emissions [lb/day] = number x hours/day x emission factor [lb/hr]

Construction Equipment Total Greenhouse Gas Emissions

Equipment	CO2 (MT) ^a	CH4 (MT) ^a	CO2e (MT) ^b
None	0.0	0.0	0.0
Total	0.0	0.0	0.0

^a Emissions [metric tons, MT] = emission factor [lb/hr] x hours/day x Number x

days used x 453.6 [g/lb] / 1,000,000 [g/MT]

Emission factors are in Table 48

^b CO₂-equivalent (CO₂e) emission factors are CO₂ emissions plus 21 x CH₄ emissions, based on Table C.1 from California Climate Action

Registry General Reporting Protocol, Version 3.0, April 2008, http://www.climateaction.org/resources/docs/protocols/grp/GRP_V3_April2008_FINAL.pdf

Motor Vehicle Usage

Vehicle	Number	Days Used	Hours Used/Day	Miles/Day/Veh.
Onsite				
Maintenance Truck	1	2	N/A	0.5
Offsite				
Maintenance Truck	1	2	N/A	12
Worker Commute	2	2	N/A	60

Motor Vehicle Exhaust Emission Factors

Vehicle	Category	VOC (lb/mi) ^a	CO (lb/mi) ^a	NOX (lb/mi) ^a	SOX (lb/mi) ^a	PM10 (lb/mi) ^a	PM2.5 (lb/mi) ^b	CO2 (lb/mi) ^a	CH4 (lb/mi) ^a
Onsite									
Maintenance Truck	Passenger	7.96E-04	7.65E-03	7.76E-04	1.07E-05	8.98E-05	5.75E-05	1.10E+00	7.17E-05
Offsite									
Maintenance Truck	Passenger	7.96E-04	7.65E-03	7.76E-04	1.07E-05	8.98E-05	5.75E-05	1.10E+00	7.17E-05
Worker Commute	Passenger	7.96E-04	7.65E-03	7.76E-04	1.07E-05	8.98E-05	5.75E-05	1.10E+00	7.17E-05

^a From Table 49 or Table 50

Motor Vehicle Daily Criteria Pollutant Exhaust Emissions

Vehicle	VOC (lb/day) ^a	CO (lb/day) ^a	NOX (lb/day) ^a	SOX (lb/day) ^a	PM10 (lb/day) ^a	PM2.5 (lb/day) ^a
Onsite						
Maintenance Truck	0.00	0.00	0.00	0.00	0.00	0.00
Onsite Total	0.00	0.00	0.00	0.00	0.00	0.00
Offsite						
Maintenance Truck	0.01	0.09	0.01	0.00	0.00	0.00
Worker Commute	0.10	0.92	0.09	0.00	0.01	0.01

Table 43
Nuevo Substation Demolition Emissions
Maintenance Crew Equipment Check

Offsite Total	0.11	1.01	0.10	0.00	0.01	0.01
Total	0.11	1.01	0.10	0.00	0.01	0.01

^a Emissions [lb/day] = number x miles/day x emission factor [lb/mi]

Motor Vehicle Total Greenhouse Gas Emissions

Vehicle	CO2 (MT)^a	CH4 (MT)^a	CO2e (MT)^b
Onsite			
Maintenance Truck	0.0	0.0	0.0
Onsite Total	0.0	0.0	0.0
Offsite			
Maintenance Truck	0.0	0.0	0.0
Worker Commute	0.1	0.0	0.1
Offsite Total	0.1	0.0	0.1
Total	0.1	0.0	0.1

^a Emissions [metric tons, MT] = emission factor [lb/hr] x miles/day x Number x days used x 453.6 [g/lb] / 1,000,000 [g/MT]

Emission factors are in Table 49 and Table 50

^b CO₂-equivalent (CO₂e) emission factors are CO₂ emissions plus 21 x CH₄ emissions, based on Table C.1 from California Climate Action

Registry General Reporting Protocol, Version 3.0, April 2008, http://www.climateregistry.org/resources/docs/protocols/grp/GRP_V3_April2008_FINAL.pdf

Motor Vehicle Fugitive Particulate Matter Emissions

Vehicle	Number	Road Type	Miles/ Day/ Vehicle	PM10 Emission Factor (lb/mi)^a	PM2.5 Emission Factor (lb/mi)^a	PM10 Emissions (lb/day)^b	PM2.5 Emissions (lb/day)^b
Onsite							
Maintenance Truck	1	Paved	0.5	0.001	0.000	0.00	0.00
Onsite Total						0.00	0.00
Offsite							
Maintenance Truck	1	Paved	12	0.001	0.000	0.01	0.00
Worker Commute	2	Paved	60	0.001	0.000	0.10	0.00
Offsite Total						0.11	0.00
Total						0.11	0.00

^a From Table 51

^b Emissions [lb/day] = number x miles/day x emission factor [lb/mi]

Earthwork Fugitive Particulate Matter Emissions

Activity	Activity Units	Activity Level	PM10 Emission Factor^a	PM2.5 Emission Factor^a	PM10 (lb/day)^b	PM2.5 (lb/day)^b
Soil Handling	CY/day		1.62E-03	3.36E-04	0.00	0.00
Bulldozing, Scraping and Grading	hr/day		1.481	0.308	0.00	0.00
Storage Pile Wind Erosion	acres		15.7	3.26	0.00	0.00
Total					0.00	0.00

^a From Table 52

^b Emissions [lb/day] = Emission factor [lb/activity unit] x Activity unit [units/day]

Table 44
Nuevo Substation Demolition Emissions
Testing

Emissions Summary

Source	VOC (lb/day)	CO (lb/day)	NOX (lb/day)	SOX (lb/day)	PM10 (lb/day)	PM2.5 (lb/day)	CO2e (MT)
Construction Equipment Exhaust	0.00	0.00	0.00	0.00	0.00	0.00	0.0
Onsite Motor Vehicle Exhaust	0.00	0.00	0.00	0.00	0.00	0.00	0.0
Onsite Motor Vehicle Fugitive PM	--	--	--	--	0.27	0.03	
Earthwork Fugitive PM	--	--	--	--	0.00	0.00	
Onsite Total	0.00	0.00	0.00	0.00	0.27	0.03	0.0
Offsite Motor Vehicle Exhaust	0.11	1.01	0.10	0.00	0.01	0.01	0.1
Offsite Motor Vehicle Fugitive PM	--	--	--	--	0.11	0.00	
Offsite Total	0.11	1.01	0.10	0.00	0.12	0.01	0.1
Total	0.11	1.01	0.10	0.00	0.38	0.03	0.1

Construction Equipment Summary

Equipment	Horse-power	Number	Days Used	Hours Used/Day
None				

Construction Equipment Exhaust Emission Factors

Equipment	Horse-power	VOC (lb/hr) ^a	CO (lb/hr) ^a	NOX (lb/hr) ^a	SOX (lb/hr) ^a	PM10 (lb/hr) ^a	PM2.5 (lb/hr) ^b	CO2 (lb/hr) ^a	CH4 (lb/hr) ^a	Category
None										

^a From Table 48

^b Diesel PM2.5 emission factor [lb/hr] = PM10 emission factor [lb/hr] x PM2.5 fraction of PM10

PM2.5 Fraction= 0.920

From Appendix A, Final-Methodology to Calculate Particulate Matter (PM) 2.5

and PM 2.5 Significance Thresholds, SCAQMD, October 2006,

http://www.aqmd.gov/ceqa/handbook/PM2_5/PM2_5.html

Construction Equipment Daily Criteria Pollutant Exhaust Emissions

Equipment	VOC (lb/day) ^a	CO (lb/day) ^a	NOX (lb/day) ^a	SOX (lb/day) ^a	PM10 (lb/day) ^a	PM2.5 (lb/day) ^a
None	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

^a Emissions [lb/day] = number x hours/day x emission factor [lb/hr]

Construction Equipment Total Greenhouse Gas Emissions

Equipment	CO2 (MT) ^a	CH4 (MT) ^a	CO2e (MT) ^b
None	0.0	0.0	0.0
Total	0.0	0.0	0.0

^a Emissions [metric tons, MT] = emission factor [lb/hr] x hours/day x Number x

days used x 453.6 [g/lb] / 1,000,000 [g/MT]

Emission factors are in Table 48

^b CO₂-equivalent (CO₂e) emission factors are CO₂ emissions plus 21 x CH₄ emissions, based on Table C.1 from California Climate Action

Registry General Reporting Protocol, Version 3.0, April 2008, http://www.climateaction.org/resources/docs/protocols/grp/GRP_V3_April2008_FINAL.pdf

Motor Vehicle Usage

Vehicle	Number	Days Used	Hours Used/Day	Miles/Day/Veh.
Onsite				
Crew Truck	1	2	N/A	0.5
Offsite				
Crew Truck	1	2	N/A	12
Worker Commute	2	2	N/A	60

Motor Vehicle Exhaust Emission Factors

Vehicle	Category	VOC (lb/mi) ^a	CO (lb/mi) ^a	NOX (lb/mi) ^a	SOX (lb/mi) ^a	PM10 (lb/mi) ^a	PM2.5 (lb/mi) ^b	CO2 (lb/mi) ^a	CH4 (lb/mi) ^a
Onsite									
Crew Truck	Passenger	7.96E-04	7.65E-03	7.76E-04	1.07E-05	8.98E-05	5.75E-05	1.10E+00	7.17E-05
Offsite									
Crew Truck	Passenger	7.96E-04	7.65E-03	7.76E-04	1.07E-05	8.98E-05	5.75E-05	1.10E+00	7.17E-05
Worker Commute	Passenger	7.96E-04	7.65E-03	7.76E-04	1.07E-05	8.98E-05	5.75E-05	1.10E+00	7.17E-05

^a From Table 49 or Table 50

Motor Vehicle Daily Criteria Pollutant Exhaust Emissions

Vehicle	VOC (lb/day) ^a	CO (lb/day) ^a	NOX (lb/day) ^a	SOX (lb/day) ^a	PM10 (lb/day) ^a	PM2.5 (lb/day) ^a
Onsite						
Crew Truck	0.00	0.00	0.00	0.00	0.00	0.00
Onsite Total	0.00	0.00	0.00	0.00	0.00	0.00
Offsite						
Crew Truck	0.01	0.09	0.01	0.00	0.00	0.00
Worker Commute	0.10	0.92	0.09	0.00	0.01	0.01

Table 44
Nuevo Substation Demolition Emissions
Testing

Offsite Total	0.11	1.01	0.10	0.00	0.01	0.01
Total	0.11	1.01	0.10	0.00	0.01	0.01

^a Emissions [lb/day] = number x miles/day x emission factor [lb/mi]

Motor Vehicle Total Greenhouse Gas Emissions

Vehicle	CO2 (MT) ^a	CH4 (MT) ^a	CO2e (MT) ^b
Onsite			
Crew Truck	0.0	0.0	0.0
Onsite Total	0.0	0.0	0.0
Offsite			
Crew Truck	0.0	0.0	0.0
Worker Commute	0.1	0.0	0.1
Offsite Total	0.1	0.0	0.1
Total	0.1	0.0	0.1

^a Emissions [metric tons, MT] = emission factor [lb/hr] x miles/day x Number x days used x 453.6 [g/lb] / 1,000,000 [g/MT]

Emission factors are in Table 49 and Table 50

^b CO₂-equivalent (CO₂e) emission factors are CO₂ emissions plus 21 x CH₄ emissions, based on Table C.1 from California Climate Action

Registry General Reporting Protocol, Version 3.0, April 2008, http://www.climateregistry.org/resources/docs/protocols/grp/GRP_V3_April2008_FINAL.pdf

Motor Vehicle Fugitive Particulate Matter Emissions

Vehicle	Number	Road Type	Miles/Day/ Vehicle	PM10 Emission Factor (lb/mi) ^a	PM2.5 Emission Factor (lb/mi) ^a	PM10 Emissions (lb/day) ^b	PM2.5 Emissions (lb/day) ^b
Onsite							
Crew Truck	1	Unpaved	0.5	0.532	0.053	0.27	0.03
Onsite Total						0.27	0.03
Offsite							
Crew Truck	1	Paved	12	0.001	0.000	0.01	0.00
Worker Commute	2	Paved	60	0.001	0.000	0.10	0.00
Offsite Total						0.11	0.00
Total						0.37	0.03

^a From Table 51

^b Emissions [lb/day] = number x miles/day x emission factor [lb/mi]

Earthwork Fugitive Particulate Matter Emissions

Activity	Activity Units	Activity Level	PM10 Emission Factor ^a	PM2.5 Emission Factor ^a	PM10 (lb/day) ^b	PM2.5 (lb/day) ^b
Soil Handling	CY/day		1.62E-03	3.36E-04	0.00	0.00
Bulldozing, Scraping and Grading	hr/day		1.481	0.308	0.00	0.00
Storage Pile Wind Erosion	acres		15.7	3.26	0.00	0.00
Total					0.00	0.00

^a From Table 52

^b Emissions [lb/day] = Emission factor [lb/activity unit] x Activity unit [units/day]

Table 45
Model P.T. Substation Demolition Emissions
Civil

Emissions Summary

Source	VOC (lb/day)	CO (lb/day)	NOX (lb/day)	SOX (lb/day)	PM10 (lb/day)	PM2.5 (lb/day)	CO2e (MT)
Construction Equipment Exhaust	0.61	2.85	3.93	0.00	0.35	0.32	0.8
Onsite Motor Vehicle Exhaust	0.01	0.03	0.06	0.00	0.00	0.00	0.0
Onsite Motor Vehicle Fugitive PM	--	--	--	--	0.00	0.00	
Earthwork Fugitive PM	--	--	--	--	0.00	0.00	
Onsite Total	0.61	2.87	3.99	0.00	0.35	0.32	0.8
Offsite Motor Vehicle Exhaust	0.43	3.12	2.47	0.01	0.14	0.11	1.2
Offsite Motor Vehicle Fugitive PM	--	--	--	--	0.24	0.00	
Offsite Total	0.43	3.12	2.47	0.01	0.38	0.11	1.2
Total	1.04	6.00	6.46	0.01	0.73	0.43	1.9

Construction Equipment Summary

Equipment	Horse-power	Number	Days Used	Hours Used/Day
Backhoe	79	1	4	8

Construction Equipment Exhaust Emission Factors

Equipment	Horse-power	VOC (lb/hr) ^a	CO (lb/hr) ^a	NOX (lb/hr) ^a	SOX (lb/hr) ^a	PM10 (lb/hr) ^a	PM2.5 (lb/hr) ^b	CO2 (lb/hr) ^a	CH4 (lb/hr) ^a	Category
Backhoe	79	0.076	0.356	0.491	0.001	0.043	0.040	51.728	0.007	Tractors/Loaders/Backhoes

^a From Table 48

^b Diesel PM2.5 emission factor [lb/hr] = PM10 emission factor [lb/hr] x PM2.5 fraction of PM10

PM2.5 Fraction= 0.920

From Appendix A, Final--Methodology to Calculate Particulate Matter (PM) 2.5

and PM 2.5 Significance Thresholds, SCAQMD, October 2006,

http://www.aqmd.gov/ceqa/handbook/PM2_5/PM2_5.html

Construction Equipment Daily Criteria Pollutant Exhaust Emissions

Equipment	VOC (lb/day) ^a	CO (lb/day) ^a	NOX (lb/day) ^a	SOX (lb/day) ^a	PM10 (lb/day) ^a	PM2.5 (lb/day) ^a
Backhoe	0.61	2.85	3.93	0.00	0.35	0.32
Total	0.61	2.85	3.93	0.00	0.35	0.32

^a Emissions [lb/day] = number x hours/day x emission factor [lb/hr]

Construction Equipment Total Greenhouse Gas Emissions

Equipment	CO2 (MT) ^a	CH4 (MT) ^a	CO2e (MT) ^b
Backhoe	0.8	0.0	0.8
Total	0.8	0.0	0.8

^a Emissions [metric tons, MT] = emission factor [lb/hr] x hours/day x Number x

days used x 453.6 [g/lb] / 1,000,000 [g/MT]

Emission factors are in Table 48

^b CO₂-equivalent (CO₂e) emission factors are CO₂ emissions plus 21 x CH₄ emissions, based on Table C.1 from California Climate Action

Registry General Reporting Protocol, Version 3.0, April 2008, http://www.climateregistry.org/resources/docs/protocols/grp/GRP_V3_April2008_FINAL.pdf

Motor Vehicle Usage

Vehicle	Number ^a	Days Used	Hours Used/Day	Miles/Day/Veh.
Onsite				
Dump Truck	1	4	N/A	1
Flatbed Truck	1	4	N/A	1
Foreman Truck	1	4	N/A	1
Offsite				
Dump Truck	1	4	N/A	60
Flatbed Truck	1	4	N/A	12
Foreman Truck	1	4	N/A	12
Worker Commute	5	4	N/A	60

^a Concrete trucks based on 430 CY over 5 days and 10 CY/truck = 430 / 5 / 10 = 8.6

Motor Vehicle Exhaust Emission Factors

Vehicle	Category	VOC (lb/mi) ^a	CO (lb/mi) ^a	NOX (lb/mi) ^a	SOX (lb/mi) ^a	PM10 (lb/mi) ^a	PM2.5 (lb/mi) ^b	CO2 (lb/mi) ^a	CH4 (lb/mi) ^a
Onsite									
Dump Truck	HHDT	2.53E-03	1.02E-02	3.09E-02	4.04E-05	1.50E-03	1.29E-03	4.22E+00	1.17E-04
Flatbed Truck	HHDT	2.53E-03	1.02E-02	3.09E-02	4.04E-05	1.50E-03	1.29E-03	4.22E+00	1.17E-04
Foreman Truck	Passenger	7.96E-04	7.65E-03	7.76E-04	1.07E-05	8.98E-05	5.75E-05	1.10E+00	7.17E-05
Offsite									
Dump Truck	HHDT	2.53E-03	1.02E-02	3.09E-02	4.04E-05	1.50E-03	1.29E-03	4.22E+00	1.17E-04
Flatbed Truck	HHDT	2.53E-03	1.02E-02	3.09E-02	4.04E-05	1.50E-03	1.29E-03	4.22E+00	1.17E-04
Foreman Truck	Passenger	7.96E-04	7.65E-03	7.76E-04	1.07E-05	8.98E-05	5.75E-05	1.10E+00	7.17E-05
Worker Commute	Passenger	7.96E-04	7.65E-03	7.76E-04	1.07E-05	8.98E-05	5.75E-05	1.10E+00	7.17E-05

^a From Table 49 or Table 50

Motor Vehicle Daily Criteria Pollutant Exhaust Emissions

Table 45
Model P.T. Substation Demolition Emissions
Civil

Vehicle	VOC (lb/day) ^a	CO (lb/day) ^a	NOX (lb/day) ^a	SOX (lb/day) ^a	PM10 (lb/day) ^a	PM2.5 (lb/day) ^a
Onsite						
Dump Truck	0.00	0.01	0.03	0.00	0.00	0.00
Flatbed Truck	0.00	0.01	0.03	0.00	0.00	0.00
Foreman Truck	0.00	0.01	0.00	0.00	0.00	0.00
Onsite Total	0.01	0.03	0.06	0.00	0.00	0.00
Offsite						
Dump Truck	0.15	0.61	1.86	0.00	0.09	0.08
Flatbed Truck	0.03	0.12	0.37	0.00	0.02	0.02
Foreman Truck	0.01	0.09	0.01	0.00	0.00	0.00
Worker Commute	0.24	2.30	0.23	0.00	0.03	0.02
Offsite Total	0.43	3.12	2.47	0.01	0.14	0.11
Total	0.44	3.15	2.53	0.01	0.14	0.11

^a Emissions [lb/day] = number x miles/day x emission factor [lb/mi]

Motor Vehicle Total Greenhouse Gas Emissions

Vehicle	CO2 (MT) ^a	CH4 (MT) ^a	CO2e (MT) ^b
Onsite			
Dump Truck	0.0	0.0	0.0
Flatbed Truck	0.0	0.0	0.0
Foreman Truck	0.0	0.0	0.0
Onsite Total	0.0	0.0	0.0
Offsite			
Dump Truck	0.5	0.0	0.5
Flatbed Truck	0.1	0.0	0.1
Foreman Truck	0.0	0.0	0.0
Worker Commute	0.6	0.0	0.6
Offsite Total	1.2	0.0	1.2
Total	1.2	0.0	1.2

^a Emissions [metric tons, MT] = emission factor [lb/hr] x miles/day x Number x days used x 453.6 [g/lb] / 1,000,000 [g/MT]

Emission factors are in Table 49 and Table 50

^b CO₂-equivalent (CO₂e) emission factors are CO₂ emissions plus 21 x CH₄ emissions, based on Table C.1 from California Climate Action

Registry General Reporting Protocol, Version 3.0, April 2008, http://www.climateregistry.org/resources/docs/protocols/grp/GRP_V3_April2008_FINAL.pdf

Motor Vehicle Fugitive Particulate Matter Emissions

Vehicle	Number	Road Type	Miles/Day/Vehicle	PM10 Emission Factor (lb/mi) ^a	PM2.5 Emission Factor (lb/mi) ^a	PM10 Emissions (lb/day) ^b	PM2.5 Emissions (lb/day) ^b
Onsite							
Dump Truck	1	Paved	1	0.001	0.000	0.00	0.00
Flatbed Truck	1	Paved	1	0.001	0.000	0.00	0.00
Foreman Truck	1	Paved	1	0.001	0.000	0.00	0.00
Onsite Total						0.00	0.00
Offsite							
Dump Truck	1	Paved	60	0.001	0.000	0.05	0.00
Flatbed Truck	1	Paved	12	0.001	0.000	0.01	0.00
Foreman Truck	1	Paved	12	0.001	0.000	0.01	0.00
Worker Commute	5	Paved	60	0.001	0.000	0.24	0.00
Offsite Total						0.24	0.00
Total						0.24	0.00

^a From Table 51

^b Emissions [lb/day] = number x miles/day x emission factor [lb/mi]

Earthwork Fugitive Particulate Matter Emissions

Activity	Activity Units	Activity Level	PM10 Emission Factor ^a	PM2.5 Emission Factor ^a	PM10 (lb/day) ^b	PM2.5 (lb/day) ^b
Soil Handling	CY/day		1.62E-03	3.36E-04	0.00	0.00
Bulldozing, Scraping and Grading	hr/day		1.481	0.308	0.00	0.00
Storage Pile Wind Erosion	acres		15.7	3.26	0.00	0.00
Total					0.00	0.00

^a From Table 52

^b Emissions [lb/day] = Emission factor [lb/activity unit] x Activity unit [units/day]

Table 46
Model P.T. Substation Demolition Emissions
Electrical

Emissions Summary

Source	VOC (lb/day)	CO (lb/day)	NOX (lb/day)	SOX (lb/day)	PM10 (lb/day)	PM2.5 (lb/day)	CO2e (MT)
Construction Equipment Exhaust	3.06	11.19	29.03	0.04	1.15	1.06	36.5
Onsite Motor Vehicle Exhaust	0.01	0.03	0.06	0.00	0.00	0.00	0.1
Onsite Motor Vehicle Fugitive PM	--	--	--	--	0.00	0.00	
Earthwork Fugitive PM	--	--	--	--	0.00	0.00	
Onsite Total	3.07	11.22	29.09	0.04	1.16	1.07	36.6
Offsite Motor Vehicle Exhaust	0.40	3.41	1.48	0.01	0.07	0.06	5.3
Offsite Motor Vehicle Fugitive PM	--	--	--	--	0.30	0.30	
Offsite Total	0.40	3.41	1.48	0.01	0.37	0.35	5.3
Total	3.47	14.63	30.57	0.04	1.53	1.42	41.9

Construction Equipment Summary

Equipment	Horse-power	Number	Days Used	Hours Used/Day
Wire Dolly	9	1	22	8
Boom Truck	235	1	22	8
Pumper/Tanker Truck	200	1	22	8
Crane	125	1	22	8

Construction Equipment Exhaust Emission Factors

Equipment	Horse-power	VOC (lb/hr) ^a	CO (lb/hr) ^a	NOX (lb/hr) ^a	SOX (lb/hr) ^a	PM10 (lb/hr) ^a	PM2.5 (lb/hr) ^b	CO2 (lb/hr) ^a	CH4 (lb/hr) ^a	Category
Wire Dolly	9	0.012	0.062	0.074	0.000	0.003	0.003	10.107	0.001	Other Construction Equipment
Boom Truck	235	0.110	0.310	1.071	0.001	0.039	0.036	112.159	0.010	Cranes
Pumper/Tanker Truck	200	0.152	0.543	1.657	0.002	0.055	0.050	254.238	0.014	Other Construction Equipment
Crane	125	0.109	0.484	0.826	0.001	0.048	0.044	80.345	0.010	Cranes

^a From Table 48

^b Diesel PM2.5 emission factor [lb/hr] = PM10 emission factor [lb/hr] x PM2.5 fraction of PM10

PM2.5 Fraction= 0.920

From Appendix A, Final--Methodology to Calculate Particulate Matter (PM) 2.5

and PM 2.5 Significance Thresholds, SCAQMD, October 2006,

http://www.aqmd.gov/ceqa/handbook/PM2_5/PM2_5.html

Construction Equipment Daily Criteria Pollutant Exhaust Emissions

Equipment	VOC (lb/day) ^a	CO (lb/day) ^a	NOX (lb/day) ^a	SOX (lb/day) ^a	PM10 (lb/day) ^a	PM2.5 (lb/day) ^a
Wire Dolly	0.09	0.49	0.59	0.00	0.02	0.02
Boom Truck	0.88	2.48	8.57	0.01	0.31	0.29
Pumper/Tanker Truck	1.21	4.34	13.26	0.02	0.44	0.40
Crane	0.87	3.87	6.61	0.01	0.38	0.35
Total	3.06	11.19	29.03	0.04	1.15	1.06

^a Emissions [lb/day] = number x hours/day x emission factor [lb/hr]

Construction Equipment Total Greenhouse Gas Emissions

Equipment	CO2 (MT) ^a	CH4 (MT) ^a	CO2e (MT) ^b
Wire Dolly	0.8	0.0	0.8
Boom Truck	9.0	0.0	9.0
Pumper/Tanker Truck	20.3	0.0	20.3
Crane	6.4	0.0	6.4
Total	36.5	0.0	36.5

^a Emissions [metric tons, MT] = emission factor [lb/hr] x hours/day x Number x

days used x 453.6 [g/lb] / 1,000,000 [g/MT]

Emission factors are in Table 48

^b CO₂-equivalent (CO₂e) emission factors are CO₂ emissions plus 21 x CH₄ emissions, based on Table C.1 from California Climate Action

Registry General Reporting Protocol, Version 3.0, April 2008, http://www.climateregistry.org/resources/docs/protocols/grp/GRP_V3_April2008_FINAL.pdf

Motor Vehicle Usage

Vehicle	Number	Days Used	Hours Used/Day	Miles/Day/ Veh.
Onsite				
Line Truck	1	22	N/A	0.5
Troubleman Truck	1	22	N/A	0.5
Boom Truck	1	22	N/A	0.5
Foreman Truck	1	22	N/A	0.5
Flatbed Truck	1	22	N/A	0.5
Pumper/Tanker Truck	1	22	N/A	0.5
Offsite				
Line Truck	1	22	N/A	12
Troubleman Truck	1	22	N/A	12

Table 46
Model P.T. Substation Demolition Emissions
Electrical

Boom Truck	1	22	N/A	12
Foreman Truck	1	22	N/A	12
Flatbed Truck	1	22	N/A	12
Pumper/Tanker Truck	1	22	N/A	12
Worker Commute	5	22	N/A	60

Motor Vehicle Exhaust Emission Factors

Vehicle	Category	VOC (lb/mi) ^a	CO (lb/mi) ^a	NOX (lb/mi) ^a	SOX (lb/mi) ^a	PM10 (lb/mi) ^a	PM2.5 (lb/mi) ^b	CO2 (lb/mi) ^a	CH4 (lb/mi) ^a
Onsite									
Line Truck	Delivery	2.24E-03	1.55E-02	1.73E-02	2.67E-05	6.50E-04	5.50E-04	2.77E+00	1.07E-04
Troubleman Truck	Delivery	2.24E-03	1.55E-02	1.73E-02	2.67E-05	6.50E-04	5.50E-04	2.77E+00	1.07E-04
Boom Truck	HHDT	2.53E-03	1.02E-02	3.09E-02	4.04E-05	1.50E-03	1.29E-03	4.22E+00	1.17E-04
Foreman Truck	Passenger	7.96E-04	7.65E-03	7.76E-04	1.07E-05	8.98E-05	5.75E-05	1.10E+00	7.17E-05
Flatbed Truck	HHDT	2.53E-03	1.02E-02	3.09E-02	4.04E-05	1.50E-03	1.29E-03	4.22E+00	1.17E-04
Pumper/Tanker Truck	HHDT	2.53E-03	1.02E-02	3.09E-02	4.04E-05	1.50E-03	1.29E-03	4.22E+00	1.17E-04
Offsite									
Line Truck	Delivery	2.24E-03	1.55E-02	1.73E-02	2.67E-05	6.50E-04	5.50E-04	2.77E+00	1.07E-04
Troubleman Truck	Delivery	2.24E-03	1.55E-02	1.73E-02	2.67E-05	6.50E-04	5.50E-04	2.77E+00	1.07E-04
Boom Truck	Delivery	2.24E-03	1.55E-02	1.73E-02	2.67E-05	6.50E-04	5.50E-04	2.77E+00	1.07E-04
Foreman Truck	Delivery	2.24E-03	1.55E-02	1.73E-02	2.67E-05	6.50E-04	5.50E-04	2.77E+00	1.07E-04
Flatbed Truck	Delivery	2.24E-03	1.55E-02	1.73E-02	2.67E-05	6.50E-04	5.50E-04	2.77E+00	1.07E-04
Pumper/Tanker Truck	Delivery	2.24E-03	1.55E-02	1.73E-02	2.67E-05	6.50E-04	5.50E-04	2.77E+00	1.07E-04
Worker Commute	Passenger	7.96E-04	7.65E-03	7.76E-04	1.07E-05	8.98E-05	5.75E-05	1.10E+00	7.17E-05

^a From Table 49 or Table 50

Motor Vehicle Daily Criteria Pollutant Exhaust Emissions

Vehicle	VOC (lb/day) ^a	CO (lb/day) ^a	NOX (lb/day) ^a	SOX (lb/day) ^a	PM10 (lb/day) ^a	PM2.5 (lb/day) ^a
Onsite						
Line Truck	0.00	0.01	0.01	0.00	0.00	0.00
Troubleman Truck	0.00	0.01	0.01	0.00	0.00	0.00
Boom Truck	0.00	0.01	0.02	0.00	0.00	0.00
Foreman Truck	0.00	0.00	0.00	0.00	0.00	0.00
Flatbed Truck	0.00	0.01	0.02	0.00	0.00	0.00
Pumper/Tanker Truck	0.00	0.01	0.02	0.00	0.00	0.00
Onsite Total	0.01	0.03	0.06	0.00	0.00	0.00
Offsite						
Line Truck	0.03	0.19	0.21	0.00	0.01	0.01
Troubleman Truck	0.03	0.19	0.21	0.00	0.01	0.01
Boom Truck	0.03	0.19	0.21	0.00	0.01	0.01
Foreman Truck	0.03	0.19	0.21	0.00	0.01	0.01
Flatbed Truck	0.03	0.19	0.21	0.00	0.01	0.01
Pumper/Tanker Truck	0.03	0.19	0.21	0.00	0.01	0.01
Worker Commute	0.24	2.30	0.23	0.00	0.03	0.02
Offsite Total	0.40	3.41	1.48	0.01	0.07	0.06
Total	0.41	3.44	1.54	0.01	0.08	0.06

^a Emissions [lb/day] = number x miles/day x emission factor [lb/mi]

Motor Vehicle Total Greenhouse Gas Emissions

Vehicle	CO2 (MT) ^a	CH4 (MT) ^a	CO2e (MT) ^b
Onsite			
Line Truck	0.0	0.0	0.0
Troubleman Truck	0.0	0.0	0.0
Boom Truck	0.0	0.0	0.0
Foreman Truck	0.0	0.0	0.0
Flatbed Truck	0.0	0.0	0.0
Pumper/Tanker Truck	0.0	0.0	0.0
Onsite Total	0.1	0.0	0.1
Offsite			
Line Truck	0.3	0.0	0.3
Troubleman Truck	0.3	0.0	0.3
Boom Truck	0.3	0.0	0.3
Foreman Truck	0.3	0.0	0.3
Flatbed Truck	0.3	0.0	0.3
Pumper/Tanker Truck	0.3	0.0	0.3
Worker Commute	3.3	0.0	3.3
Offsite Total	5.3	0.0	5.3
Total	5.4	0.0	5.4

^a Emissions [metric tons, MT] = emission factor [lb/hr] x miles/day x Number x days used x 453.6 [g/lb] / 1,000,000 [g/MT]

Emission factors are in Table 49 and Table 50

^b CO₂-equivalent (CO₂e) emission factors are CO₂ emissions plus 21 x CH₄ emissions, based on Table C.1 from California Climate Action

Registry General Reporting Protocol, Version 3.0, April 2008, http://www.climateregistry.org/resources/docs/protocols/grp/GRP_V3_April2008_FINAL.pdf

Table 46
Model P.T. Substation Demolition Emissions
Electrical

Motor Vehicle Fugitive Particulate Matter Emissions

Vehicle	Number	Road Type	Miles/Day/ Vehicle	PM10 Emission Factor (lb/mi) ^a	PM2.5 Emission Factor (lb/mi) ^a	PM10 Emissions (lb/day) ^b	PM2.5 Emissions (lb/day) ^b
Onsite							
Line Truck	1	Paved	0.5	0.001	0.001	0.00	0.00
Troubleman Truck	1	Paved	0.5	0.001	0.001	0.00	0.00
Boom Truck	1	Paved	0.5	0.001	0.001	0.00	0.00
Foreman Truck	1	Paved	0.5	0.001	0.001	0.00	0.00
Flatbed Truck	1	Paved	0.5	0.001	0.001	0.00	0.00
Pumper/Tanker Truck	1	Paved	0.5	0.001	0.001	0.00	0.00
Onsite Total						0.00	0.00
Offsite							
Line Truck	1	Paved	12	0.001	0.001	0.01	0.01
Troubleman Truck	1	Paved	12	0.001	0.001	0.01	0.01
Boom Truck	1	Paved	12	0.001	0.001	0.01	0.01
Foreman Truck	1	Paved	12	0.001	0.001	0.01	0.01
Flatbed Truck	1	Paved	12	0.001	0.001	0.01	0.01
Pumper/Tanker Truck	1	Paved	12	0.001	0.001	0.01	0.01
Worker Commute	5	Paved	60	0.001	0.001	0.24	0.24
Offsite Total						0.30	0.30
Total						0.30	0.30

^a From Table 51

^b Emissions [lb/day] = number x miles/day x emission factor [lb/mi]

Earthwork Fugitive Particulate Matter Emissions

Activity	Activity Units	Activity Level	PM10 Emission Factor ^a	PM2.5 Emission Factor ^a	PM10 (lb/day) ^b	PM2.5 (lb/day) ^b
Soil Handling	CY/day		1.62E-03	3.36E-04	0.00	0.00
Bulldozing, Scraping and Grading	hr/day		1.481	0.308	0.00	0.00
Storage Pile Wind Erosion	acres		15.7	3.26	0.00	0.00
Total					0.00	0.00

^a From Table 52

^b Emissions [lb/day] = Emission factor [lb/activity unit] x Activity unit [units/day]

Table 47
Operational Emissions

Emissions Summary

Source	VOC (lb/day)	CO (lb/day)	NOX (lb/day)	SOX (lb/day)	PM10 (lb/day)	PM2.5 (lb/day)	CO2e (MT/yr)
Motor Vehicle Exhaust	0.10	0.97	0.10	0.00	0.01	0.01	1
Motor Vehicle Fugitive PM	--	--	--	--	3.15	0.30	--
SF6 Leakage	--	--	--	--	--	--	20
Total	0.10	0.97	0.10	0.00	3.16	0.31	21

Motor Vehicle Usage

Vehicle	Number	Days Used/ Year	Miles/ Day/ Veh.
Subtransmission Line Inspection	1	1	67
Substation Site Visit	1	48	60

Motor Vehicle Exhaust Emission Factors

Vehicle	Category	VOC (lb/mi) ^a	CO (lb/mi) ^a	NOX (lb/mi) ^a	SOX (lb/mi) ^a	PM10 (lb/mi) ^a	PM2.5 (lb/mi) ^b	CO2 (lb/mi) ^a	CH4 (lb/mi) ^a
Subtransmission Line Inspection	Passenger	7.96E-04	7.65E-03	7.76E-04	1.07E-05	8.98E-05	5.75E-05	1.10E+00	7.17E-05
Substation Site Visit	Passenger	7.96E-04	7.65E-03	7.76E-04	1.07E-05	8.98E-05	5.75E-05	1.10E+00	7.17E-05

^a From Table 49 or Table 50

Motor Vehicle Daily Criteria Pollutant Exhaust Emissions

Vehicle	VOC (lb/day) ^a	CO (lb/day) ^a	NOX (lb/day) ^a	SOX (lb/day) ^a	PM10 (lb/day) ^a	PM2.5 (lb/day) ^a
Subtransmission Line Inspection	0.05	0.51	0.05	0.00	0.01	0.00
Substation Site Visit	0.05	0.46	0.05	0.00	0.01	0.00
Total	0.10	0.97	0.10	0.00	0.01	0.01

^a Emissions [lb/day] = number x miles/day x emission factor [lb/mi]

Motor Vehicle Annual Greenhouse Gas Emissions

Vehicle	CO2 (MT/yr) ^a	CH4 (MT/yr) ^a	CO2e (MT/yr) ^b
Subtransmission Line Inspection	0.0	0.0	0.0
Substation Site Visit	1.4	0.0	1.4
Total	1.5	0.0	1.5

^a Emissions [metric tons, MT] = emission factor [lb/hr] x miles/day x Number x days used x 453.6 [g/lb] / 1,000,000 [g/MT]

Emission factors are in Table 49 and Table 50

^b CO₂-equivalent (CO₂e) emission factors are CO₂ emissions plus 21 x CH₄ emissions, based on Table C.1 from California Climate Action Registry General Reporting Protocol, Version 3.0, April 2008, http://www.climateregistry.org/resources/docs/protocols/grp/GRP_V3_April2008_FINAL.pdf

Motor Vehicle Fugitive Particulate Matter Emissions

Vehicle	Number	Road Type	Miles/ Day/ Vehicle	PM10 Emission Factor (lb/mi) ^a	PM2.5 Emission Factor (lb/mi) ^a	PM10 Emissions (lb/day) ^b	PM2.5 Emissions (lb/day) ^b
Subtransmission Line Inspection	1	Paved	67	0.001	0.000	0.05	0.00
Subtransmission Line Inspection	1	Unpaved	7	0.435	0.043	3.04	0.30
Substation Site Visit	1	Paved	60	0.001	0.000	0.05	0.00
Total						3.15	0.30

^a From Table 51

^b Emissions [lb/day] = number x miles/day x emission factor [lb/mi]

SF6 Leakage Greenhouse Gas Emissions

Item	Value	Units
Total SF6	378	pounds
SF6 Leakage Rate	0.5	%/year
SF6 Emissions	1.89	pounds
SF6 Global Warming Potential ^a	23,200	
CO2e Emissions^b	20	MT/yr

^a Based on Table C.1 from California Climate Action

Table 47
Operational Emissions

Registry General Reporting Protocol, Version 3.0,

April 2008.

http://www.climateregistry.org/resources/docs/protocols/grp/GRP_V3_April2008_FINAL.pdf

^b CO₂e emissions [metric tons] = SF₆ emissions [lb] x

Global warming potential [lb CO₂e/lb SF₆] x 453.6 [g/lb] /

1,000,000 [g/MT]

Table 48
SCAB Fleet Average Emission Factors (Diesel)

2012

Air Basin **SC**

		(lb/hr)	(lb/hr)	(lb/hr)	(lb/hr)	(lb/hr)	(lb/hr)	(lb/hr)
Equipment	MaxHP	ROG	CO	NOX	SOX	PM	CO2	CH4
Aerial Lifts	15	0.0102	0.0528	0.0642	0.0001	0.0030	8.7	0.0009
	25	0.0175	0.0517	0.0957	0.0001	0.0055	11.0	0.0016
	50	0.0650	0.1822	0.1916	0.0003	0.0169	19.6	0.0059
	120	0.0607	0.2451	0.4012	0.0004	0.0324	38.1	0.0055
	500	0.1276	0.4941	1.6553	0.0021	0.0491	213	0.0115
	750	0.2379	0.8930	3.0795	0.0039	0.0903	385	0.0215
Aerial Lifts Composite		0.0576	0.1976	0.3249	0.0004	0.0219	34.7	0.0052
Aerial Lifts-Propane	15	0.0037	1.4362	0.0393	0.0000	0.0041	8.9	0.0311
	25	0.0083	2.2104	0.0608	0.0000	0.0067	13.0	0.0697
Aerial Lifts-Propane Composite								
Air Compressors	15	0.0129	0.0494	0.0768	0.0001	0.0052	7.2	0.0012
	25	0.0286	0.0779	0.1337	0.0002	0.0087	14.4	0.0026
	50	0.1010	0.2646	0.2310	0.0003	0.0239	22.3	0.0091
	120	0.0891	0.3287	0.5333	0.0006	0.0492	47.0	0.0080
	175	0.1135	0.5074	0.8954	0.0010	0.0512	88.5	0.0102
	250	0.1066	0.3052	1.2194	0.0015	0.0379	131	0.0096
	500	0.1709	0.5726	1.9077	0.0023	0.0623	232	0.0154
	750	0.2681	0.8849	3.0371	0.0036	0.0980	358	0.0242
	1000	0.4533	1.5617	5.4098	0.0049	0.1589	486	0.0409
Air Compressors Composite		0.0984	0.3445	0.6494	0.0007	0.0469	63.6	0.0089
Bore/Drill Rigs	15	0.0120	0.0632	0.0754	0.0002	0.0029	10.3	0.0011
	25	0.0194	0.0658	0.1233	0.0002	0.0054	16.0	0.0017
	50	0.0351	0.2335	0.2768	0.0004	0.0149	31.0	0.0032
	120	0.0514	0.4724	0.5026	0.0009	0.0328	77.1	0.0046
	175	0.0750	0.7538	0.7479	0.0016	0.0366	141	0.0068
	250	0.0838	0.3435	0.8722	0.0021	0.0268	188	0.0076
	500	0.1354	0.5526	1.3152	0.0031	0.0437	311	0.0122
	750	0.2685	1.0916	2.6320	0.0062	0.0865	615	0.0242
	1000	0.4491	1.6773	6.6123	0.0093	0.1699	928	0.0405
Bore/Drill Rigs Composite		0.0854	0.5068	0.9013	0.0017	0.0367	165	0.0077
Cement and Mortar Mixers	15	0.0075	0.0386	0.0475	0.0001	0.0023	6.3	0.0007
	25	0.0293	0.0852	0.1548	0.0002	0.0091	17.6	0.0026
Cement and Mortar Mixers Composite		0.0093	0.0425	0.0564	0.0001	0.0029	7.2	0.0008
Concrete/Industrial Saws	25	0.0199	0.0678	0.1261	0.0002	0.0050	16.5	0.0018
	50	0.1047	0.3015	0.2972	0.0004	0.0268	30.2	0.0094
	120	0.1155	0.4880	0.7625	0.0009	0.0639	74.1	0.0104
	175	0.1685	0.8723	1.4507	0.0018	0.0767	160	0.0152
Concrete/Industrial Saws Composite		0.1090	0.4148	0.5910	0.0007	0.0491	58.5	0.0098
Cranes	50	0.1101	0.2979	0.2478	0.0003	0.0258	23.2	0.0099
	120	0.0982	0.3650	0.5844	0.0006	0.0533	50.1	50.1
	175	0.1089	0.4838	0.8259	0.0009	0.0479	80.3	0.0098
	250	0.1103	0.3103	1.0712	0.0013	0.0388	112	0.0100
	500	0.1635	0.5691	1.5327	0.0018	0.0571	180	0.0148
	750	0.2767	0.9554	2.6486	0.0030	0.0974	303	0.0250
	9999	0.9905	3.5715	10.9484	0.0098	0.3384	971	0.0894
Cranes Composite		0.1425	0.4946	1.2753	0.0014	0.0553	129	0.0129
Crawler Tractors	50	0.1262	0.3333	0.2713	0.0003	0.0289	24.9	0.0114
	120	0.1374	0.4906	0.8120	0.0008	0.0729	65.8	0.0124
	175	0.1758	0.7491	1.3245	0.0014	0.0765	121	0.0159
	250	0.1854	0.5225	1.7044	0.0019	0.0667	166	0.0167
	500	0.2659	1.0217	2.3914	0.0025	0.0942	259	0.0240
	750	0.4784	1.8248	4.3817	0.0047	0.1705	465	0.0432
	1000	0.7229	2.8959	7.7626	0.0066	0.2503	658	0.0652
Crawler Tractors Composite		0.1671	0.6051	1.2309	0.0013	0.0752	114	0.0151
Crushing/Proc. Equipment	50	0.1927	0.5215	0.4545	0.0006	0.0462	44.0	0.0174

Table 48
SCAB Fleet Average Emission Factors (Diesel)

2012

Air Basin **SC**

		(lb/hr)	(lb/hr)	(lb/hr)	(lb/hr)	(lb/hr)	(lb/hr)	(lb/hr)
Equipment	MaxHP	ROG	CO	NOX	SOX	PM	CO2	CH4
	120	0.1525	0.5829	0.9172	0.0010	0.0851	83.1	0.0138
	175	0.2088	0.9654	1.6343	0.0019	0.0946	167	0.0188
	250	0.1953	0.5592	2.1896	0.0028	0.0682	245	0.0176
	500	0.2733	0.8961	2.9457	0.0037	0.0972	374	0.0247
	750	0.4361	1.3892	4.8387	0.0059	0.1560	589	0.0394
	9999	1.2112	4.0327	14.2648	0.0131	0.4203	1,308	0.1093
Crushing/Proc. Equipment Composite		0.1872	0.6911	1.2633	0.0015	0.0819	132	0.0169
Dumpers/Tenders	25	0.0100	0.0324	0.0614	0.0001	0.0031	7.6	0.0009
Dumpers/Tenders Composite		0.0100	0.0324	0.0614	0.0001	0.0031	7.6	0.0009
Excavators	25	0.0198	0.0677	0.1253	0.0002	0.0048	16.4	0.0018
	50	0.0912	0.2933	0.2568	0.0003	0.0237	25.0	0.0082
	120	0.1183	0.5220	0.7300	0.0009	0.0657	73.6	0.0107
	175	0.1288	0.6678	0.9613	0.0013	0.0569	112	0.0116
	250	0.1301	0.3630	1.2438	0.0018	0.0415	159	0.0117
	500	0.1805	0.5493	1.6112	0.0023	0.0574	234	0.0163
	750	0.3013	0.9096	2.7605	0.0039	0.0969	387	0.0272
Excavators Composite		0.1300	0.5401	0.9817	0.0013	0.0536	120	0.0117
Forklifts	50	0.0514	0.1682	0.1488	0.0002	0.0136	14.7	0.0046
	120	0.0489	0.2195	0.3017	0.0004	0.0277	31.2	0.0044
	175	0.0624	0.3304	0.4664	0.0006	0.0278	56.1	0.0056
	250	0.0595	0.1638	0.5872	0.0009	0.0187	77.1	0.0054
	500	0.0806	0.2241	0.7257	0.0011	0.0252	111	0.0073
Forklifts Composite		0.0585	0.2257	0.4330	0.0006	0.0231	54.4	0.0053
Forklifts-Propane	25	0.0124	1.9683	0.0550	0.0000	0.0068	10.3	0.1042
	50	0.0023	0.2932	0.0984	0.0000	0.0016	18.3	0.0191
	120	0.0039	1.4083	0.1724	0.0000	0.0028	31.2	0.0330
	175	0.0055	2.2550	0.2663	0.0000	0.0058	65.1	0.0460
Forklifts-Propane Composite								
Generator Sets	15	0.0157	0.0698	0.1063	0.0002	0.0061	10.2	0.0014
	25	0.0276	0.0951	0.1632	0.0002	0.0096	17.6	0.0025
	50	0.0959	0.2734	0.2966	0.0004	0.0255	30.6	0.0087
	120	0.1206	0.4956	0.8099	0.0009	0.0640	77.9	0.0109
	175	0.1460	0.7413	1.3131	0.0016	0.0644	142	0.0132
	250	0.1372	0.4502	1.8047	0.0024	0.0508	213	0.0124
	500	0.1952	0.7617	2.5896	0.0033	0.0756	337	0.0176
	750	0.3257	1.2296	4.3019	0.0055	0.1241	544	0.0294
	9999	0.8673	3.0642	10.8871	0.0105	0.3104	1,049	0.0783
Generator Sets Composite		0.0832	0.3121	0.5779	0.0007	0.0351	61.0	0.0075
Graders	50	0.1182	0.3365	0.2882	0.0004	0.0286	27.5	0.0107
	120	0.1348	0.5355	0.8223	0.0009	0.0740	75.0	0.0122
	175	0.1554	0.7363	1.1931	0.0014	0.0688	124	0.0140
	250	0.1575	0.4508	1.5344	0.0019	0.0547	172	0.0142
	500	0.1947	0.6639	1.8193	0.0023	0.0671	229	0.0176
	750	0.4147	1.4022	3.9602	0.0049	0.1439	486	0.0374
Graders Composite		0.1533	0.6129	1.2503	0.0015	0.0649	133	0.0138
Off-Highway Tractors	120	0.2224	0.7269	1.2964	0.0011	0.1143	93.7	0.0201
	175	0.2135	0.8404	1.6085	0.0015	0.0923	130	0.0193
	250	0.1718	0.4896	1.5282	0.0015	0.0644	130	0.0155
	750	0.6814	3.0883	6.1417	0.0057	0.2515	568	0.0615
	1000	1.0246	4.8137	10.5080	0.0082	0.3620	814	0.0924
Off-Highway Tractors Composite		0.2170	0.7878	1.7969	0.0017	0.0871	151	0.0196
Off-Highway Trucks	175	0.1533	0.7593	1.1072	0.0014	0.0666	125	0.0138
	250	0.1469	0.3944	1.3513	0.0019	0.0461	167	0.0133
	500	0.2263	0.6661	1.9463	0.0027	0.0705	272	0.0204
	750	0.3695	1.0792	3.2612	0.0044	0.1164	442	0.0333

Table 48
SCAB Fleet Average Emission Factors (Diesel)

2012

Air Basin **SC**

		(lb/hr)	(lb/hr)	(lb/hr)	(lb/hr)	(lb/hr)	(lb/hr)	(lb/hr)
Equipment	MaxHP	ROG	CO	NOX	SOX	PM	CO2	CH4
	1000	0.5790	1.7854	6.4025	0.0063	0.1933	625	0.0522
Off-Highway Trucks Composite		0.2241	0.6635	2.0158	0.0027	0.0715	260	0.0202
Other Construction Equipment	15	0.0118	0.0617	0.0737	0.0002	0.0028	10.1	0.0011
	25	0.0160	0.0544	0.1019	0.0002	0.0044	13.2	0.0014
	50	0.0842	0.2740	0.2707	0.0004	0.0228	28.0	0.0076
	120	0.1104	0.5320	0.7540	0.0009	0.0633	80.9	0.0100
	175	0.1008	0.5880	0.8599	0.0012	0.0467	107	0.0091
	500	0.1517	0.5426	1.6573	0.0025	0.0545	254	0.0137
Other Construction Equipment Composite		0.0925	0.3847	0.8599	0.0013	0.0366	123	0.0083
Other General Industrial Equipment	15	0.0066	0.0391	0.0466	0.0001	0.0018	6.4	0.0006
	25	0.0185	0.0632	0.1170	0.0002	0.0045	15.3	0.0017
	50	0.1085	0.2856	0.2332	0.0003	0.0253	21.7	0.0098
	120	0.1274	0.4542	0.7277	0.0007	0.0703	62.0	0.0115
	175	0.1349	0.5757	1.0001	0.0011	0.0599	95.9	0.0122
	250	0.1235	0.3281	1.2983	0.0015	0.0417	136	0.0111
	500	0.2232	0.6772	2.2367	0.0026	0.0758	265	0.0201
	750	0.3707	1.1162	3.8016	0.0044	0.1273	437	0.0334
	1000	0.5621	1.8453	6.4018	0.0056	0.1947	560	0.0507
Other General Industrial Equipment Composite		0.1635	0.5362	1.4520	0.0016	0.0632	152	0.0148
Other Material Handling Equipment	50	0.1506	0.3950	0.3243	0.0004	0.0352	30.3	0.0136
	120	0.1239	0.4423	0.7103	0.0007	0.0684	60.7	0.0112
	175	0.1703	0.7292	1.2706	0.0014	0.0759	122	0.0154
	250	0.1305	0.3496	1.3863	0.0016	0.0443	145	0.0118
	500	0.1590	0.4876	1.6124	0.0019	0.0545	192	0.0143
	9999	0.7467	2.4395	8.4619	0.0073	0.2565	741	0.0674
Other Material Handling Equipment Composite		0.1566	0.5108	1.4125	0.0015	0.0613	141	0.0141
Pavers	25	0.0255	0.0811	0.1531	0.0002	0.0080	18.7	0.0023
	50	0.1451	0.3680	0.3038	0.0004	0.0327	28.0	0.0131
	120	0.1467	0.5107	0.8788	0.0008	0.0776	69.2	0.0132
	175	0.1864	0.7833	1.4495	0.0014	0.0819	128	0.0168
	250	0.2182	0.6365	2.0698	0.0022	0.0818	194	0.0197
	500	0.2383	0.9957	2.2418	0.0023	0.0883	233	0.0215
Pavers Composite		0.1596	0.5445	0.8980	0.0009	0.0642	77.9	0.0144
Paving Equipment	25	0.0153	0.0520	0.0974	0.0002	0.0042	12.6	0.0014
	50	0.1239	0.3124	0.2591	0.0003	0.0279	23.9	0.0112
	120	0.1150	0.3997	0.6897	0.0006	0.0610	54.5	0.0104
	175	0.1455	0.6114	1.1384	0.0011	0.0640	101	0.0131
	250	0.1349	0.3946	1.2976	0.0014	0.0507	122	0.0122
Paving Equipment Composite		0.1204	0.4365	0.8114	0.0008	0.0570	68.9	0.0109
Plate Compactors	15	0.0050	0.0263	0.0314	0.0001	0.0013	4.3	0.0005
Plate Compactors Composite		0.0050	0.0263	0.0314	0.0001	0.0013	4.3	0.0005
Pressure Washers	15	0.0075	0.0334	0.0509	0.0001	0.0029	4.9	0.0007
	25	0.0112	0.0385	0.0662	0.0001	0.0039	7.1	0.0010
	50	0.0349	0.1074	0.1339	0.0002	0.0102	14.3	0.0032
	120	0.0332	0.1458	0.2385	0.0003	0.0172	24.1	0.0030
Pressure Washers Composite		0.0173	0.0635	0.0921	0.0001	0.0063	9.4	0.0016
Pumps	15	0.0133	0.0508	0.0790	0.0001	0.0054	7.4	0.0012
	25	0.0386	0.1051	0.1803	0.0002	0.0117	19.5	0.0035
	50	0.1155	0.3229	0.3362	0.0004	0.0299	34.3	0.0104
	120	0.1250	0.5036	0.8226	0.0009	0.0669	77.9	0.0113
	175	0.1498	0.7431	1.3164	0.0016	0.0664	140	0.0135
	250	0.1357	0.4345	1.7375	0.0023	0.0501	201	0.0122
	500	0.2089	0.8032	2.6861	0.0034	0.0803	345	0.0188
	750	0.3557	1.3279	4.5700	0.0057	0.1350	571	0.0321
	9999	1.1456	4.0641	14.2305	0.0136	0.4081	1,355	0.1034

Table 48
SCAB Fleet Average Emission Factors (Diesel)

2012

Air Basin **SC**

		(lb/hr)	(lb/hr)	(lb/hr)	(lb/hr)	(lb/hr)	(lb/hr)	(lb/hr)
Equipment	MaxHP	ROG	CO	NOX	SOX	PM	CO2	CH4
Pumps Composite		0.0813	0.2983	0.4999	0.0006	0.0351	49.6	0.0073
Rollers	15	0.0074	0.0386	0.0461	0.0001	0.0018	6.3	0.0007
	25	0.0162	0.0549	0.1029	0.0002	0.0045	13.3	0.0015
	50	0.1105	0.2994	0.2677	0.0003	0.0263	26.0	0.0100
	120	0.1054	0.4098	0.6619	0.0007	0.0574	59.0	0.0095
	175	0.1320	0.6220	1.0725	0.0012	0.0591	108	0.0119
	250	0.1347	0.4083	1.4103	0.0017	0.0498	153	0.0122
	500	0.1755	0.6752	1.8093	0.0022	0.0652	219	0.0158
Rollers Composite		0.1038	0.4107	0.6936	0.0008	0.0488	67.1	0.0094
Rough Terrain Forklifts	50	0.1315	0.3910	0.3455	0.0004	0.0330	33.9	0.0119
	120	0.1038	0.4364	0.6425	0.0007	0.0585	62.4	0.0094
	175	0.1444	0.7268	1.1204	0.0014	0.0652	125	0.0130
	250	0.1353	0.3896	1.4082	0.0019	0.0458	171	0.0122
	500	0.1894	0.5985	1.8577	0.0025	0.0642	257	0.0171
Rough Terrain Forklifts Composite		0.1093	0.4680	0.6995	0.0008	0.0587	70.3	0.0099
Rubber Tired Dozers	175	0.2209	0.8528	1.6304	0.0015	0.0945	129	0.0199
	250	0.2545	0.7124	2.1985	0.0021	0.0942	183	0.0230
	500	0.3345	1.5220	2.8822	0.0026	0.1210	265	0.0302
	750	0.5042	2.2809	4.4100	0.0040	0.1832	399	0.0455
	1000	0.7807	3.6654	7.7816	0.0060	0.2729	592	0.0704
Rubber Tired Dozers Composite		0.3114	1.2491	2.6866	0.0025	0.1137	239	0.0281
Rubber Tired Loaders	25	0.0205	0.0697	0.1295	0.0002	0.0052	16.9	0.0018
	50	0.1315	0.3756	0.3242	0.0004	0.0319	31.1	0.0119
	120	0.1045	0.4187	0.6404	0.0007	0.0576	58.9	0.0094
	175	0.1312	0.6288	1.0135	0.0012	0.0583	106	0.0118
	250	0.1330	0.3838	1.3129	0.0017	0.0462	149	0.0120
	500	0.1961	0.6755	1.8555	0.0023	0.0677	237	0.0177
	750	0.4044	1.3812	3.9115	0.0049	0.1408	486	0.0365
	1000	0.5480	1.9543	6.3337	0.0060	0.1909	594	0.0494
Rubber Tired Loaders Composite		0.1272	0.4855	1.0034	0.0012	0.0558	109	0.0115
Scrapers	120	0.1990	0.7011	1.1749	0.0011	0.1054	93.9	0.0180
	175	0.2172	0.9158	1.6429	0.0017	0.0945	148	0.0196
	250	0.2367	0.6699	2.1849	0.0024	0.0859	209	0.0214
	500	0.3333	1.3000	3.0162	0.0032	0.1190	321	0.0301
	750	0.5779	2.2380	5.3231	0.0056	0.2075	555	0.0521
Scrapers Composite		0.2916	1.0984	2.5680	0.0027	0.1087	262	0.0263
Signal Boards	15	0.0072	0.0377	0.0450	0.0001	0.0017	6.2	0.0006
	50	0.1270	0.3587	0.3564	0.0005	0.0324	36.2	0.0115
	120	0.1284	0.5269	0.8360	0.0009	0.0703	80.2	0.0116
	175	0.1661	0.8370	1.4268	0.0017	0.0750	155	0.0150
	250	0.1746	0.5516	2.1599	0.0029	0.0639	255	0.0158
Signal Boards Composite		0.0203	0.0940	0.1470	0.0002	0.0083	16.7	0.0018
Skid Steer Loaders	25	0.0211	0.0635	0.1189	0.0002	0.0067	13.8	0.0019
	50	0.0596	0.2332	0.2402	0.0003	0.0180	25.5	0.0054
	120	0.0482	0.2769	0.3536	0.0005	0.0286	42.8	0.0043
Skid Steer Loaders Composite		0.0534	0.2360	0.2686	0.0004	0.0207	30.3	0.0048
Surfacing Equipment	50	0.0513	0.1441	0.1411	0.0002	0.0128	14.1	0.0046
	120	0.1040	0.4251	0.6895	0.0007	0.0557	63.8	0.0094
	175	0.0950	0.4745	0.8195	0.0010	0.0422	85.8	0.0086
	250	0.1095	0.3526	1.1993	0.0015	0.0413	135	0.0099
	500	0.1631	0.6813	1.7819	0.0022	0.0622	221	0.0147
	750	0.2601	1.0660	2.8642	0.0035	0.0986	347	0.0235
Surfacing Equipment Composite		0.1362	0.5467	1.3678	0.0017	0.0512	166	0.0123
Sweepers/Scrubbers	15	0.0124	0.0729	0.0870	0.0002	0.0034	11.9	0.0011
	25	0.0237	0.0808	0.1501	0.0002	0.0060	19.6	0.0021

Table 48
SCAB Fleet Average Emission Factors (Diesel)

2012

Air Basin **SC**

		(lb/hr)	(lb/hr)	(lb/hr)	(lb/hr)	(lb/hr)	(lb/hr)	(lb/hr)
Equipment	MaxHP	ROG	CO	NOX	SOX	PM	CO2	CH4
	50	0.1195	0.3565	0.3179	0.0004	0.0302	31.6	0.0108
	120	0.1233	0.5204	0.7534	0.0009	0.0706	75.0	0.0111
	175	0.1575	0.8008	1.2212	0.0016	0.0717	139	0.0142
	250	0.1205	0.3447	1.3019	0.0018	0.0402	162	0.0109
Sweepers/Scrubbers Composite		0.1278	0.5215	0.7403	0.0009	0.0576	78.5	0.0115
Tractors/Loaders/Backhoes	25	0.0199	0.0662	0.1250	0.0002	0.0061	15.9	0.0018
	50	0.1006	0.3305	0.3030	0.0004	0.0267	30.3	0.0091
	120	0.0760	0.3557	0.4910	0.0006	0.0432	51.7	0.0069
	175	0.1058	0.5866	0.8294	0.0011	0.0478	101	0.0095
	250	0.1264	0.3755	1.2813	0.0019	0.0415	172	0.0114
	500	0.2386	0.7714	2.2621	0.0039	0.0784	345	0.0215
	750	0.3611	1.1563	3.5105	0.0058	0.1199	517	0.0326
Tractors/Loaders/Backhoes Composite		0.0862	0.3824	0.5816	0.0008	0.0435	66.8	0.0078
Trenchers	15	0.0099	0.0517	0.0617	0.0001	0.0024	8.5	0.0009
	25	0.0398	0.1355	0.2519	0.0004	0.0101	32.9	0.0036
	50	0.1656	0.4176	0.3536	0.0004	0.0374	32.9	0.0149
	120	0.1354	0.4732	0.8257	0.0008	0.0709	64.9	0.0122
	175	0.2050	0.8694	1.6306	0.0016	0.0901	144	0.0185
	250	0.2483	0.7418	2.3854	0.0025	0.0951	223	0.0224
	500	0.3135	1.4011	3.0220	0.0031	0.1190	311	0.0283
	750	0.5949	2.6307	5.8034	0.0059	0.2259	587	0.0537
Trenchers Composite		0.1507	0.4749	0.6995	0.0007	0.0582	58.7	0.0136
Welders	15	0.0111	0.0425	0.0660	0.0001	0.0045	6.2	0.0010
	25	0.0224	0.0609	0.1044	0.0001	0.0068	11.3	0.0020
	50	0.1071	0.2854	0.2637	0.0003	0.0260	26.0	0.0097
	120	0.0708	0.2687	0.4376	0.0005	0.0387	39.5	0.0064
	175	0.1183	0.5475	0.9688	0.0011	0.0531	98.2	0.0107
	250	0.0909	0.2704	1.0791	0.0013	0.0329	119	0.0082
	500	0.1154	0.4072	1.3538	0.0016	0.0431	168	0.0104
Welders Composite		0.0703	0.2150	0.2702	0.0003	0.0243	25.6	0.0063

Source: File offroadEF07_25.xls, downloaded from <http://www.aqmd.gov/ceqa/handbook/offroad/offroad.html>

Table 49
Highest (Most Conservative) EMFAC2007 (version 2.3)
Emission Factors for On-Road Passenger Vehicles & Delivery Trucks
 Projects in the SCAQMD (Scenario Years 2007 - 2026)
 Derived from Peak Emissions Inventory (**Winter**, **Annual**, **Summer**)

Vehicle Class:
Passenger Vehicles (<8500 pounds) & Delivery Trucks (>8500 pounds)

The following emission factors were compiled by running the California Air Resources Board's EMFAC2007 (version 2.3) Burden Model, taking the weighted average of vehicle types and simplifying into two categories:
Passenger Vehicles & Delivery Trucks.

These emission factors can be used to calculate on-road mobile source emissions for the vehicle categories listed in the tables below, by use of the following equation:

$$\text{Emissions (pounds per day)} = N \times TL \times EF$$

where N = number of trips, TL = trip length (miles/day), and EF = emission factor (pounds per mile)

This methodology replaces the old EMFAC emission factors in Tables A-9-5-J-1 through A-9-5-L in Appendix A9 of the current SCAQMD CEQA Handbook. All the emission factors account for the emissions from start, running and idling exhaust. In addition, the ROG emission factors include diurnal, hot soak, running and resting emissions, and the PM10 & PM2.5 emission factors include tire and brake wear.

Scenario Year: **2012**

All model years in the range 1968 to 2012

Passenger Vehicles (pounds/mile)		Delivery Trucks (pounds/mile)	
CO	0.00765475	CO	0.01545741
NOx	0.00077583	NOx	0.01732423
ROG	0.00079628	ROG	0.00223776
SOx	0.00001073	SOx	0.00002667
PM10	0.00008979	PM10	0.00064975
PM2.5	0.00005750	PM2.5	0.00054954
CO2	1.10152540	CO2	2.76628414
CH4	0.00007169	CH4	0.00010668

Source: File onroadEF07_26.xls, downloaded from <http://www.aqmd.gov/ceqa/handbook/onroad/onroad.html>

Table 50
Highest (Most Conservative) EMFAC2007 (version 2.3)
Emission Factors for On-Road Heavy-Heavy-Duty Diesel Trucks
 Projects in the SCAQMD (Scenario Years 2007 - 2026)
 Derived from Peak Emissions Inventory (**Winter**, **Annual**, **Summer**)

Vehicle Class:
Heavy-Heavy-Duty Diesel Trucks (33,001 to 60,000 pounds)

The following emission factors were compiled by running the California Air Resources Board's EMFAC2007 (version 2.3) Burden Model and extracting the **Heavy-Heavy-Duty Diesel Truck (HHDT)** Emission Factors.

These emission factors can be used to calculate on-road mobile source emissions for the vehicle/emission categories listed in the tables below, by use of the following equation:

$$\text{Emissions (pounds per day)} = N \times TL \times EF$$

where N = number of trips, TL = trip length (miles/day), and EF = emission factor (pounds per mile)

The **HHDT-DSL** vehicle/emission category accounts for all emissions from heavy-heavy-duty diesel trucks, including start, running and idling exhaust. In addition, ROG emission factors account for diurnal, hot soak, running and resting emissions, and the PM10 & PM2.5 emission factors account for tire and brake wear.

The **HHDT-DSL, Exh** vehicle/emission category includes only the exhaust portion of PM10 & PM2.5 emissions from heavy-heavy-duty diesel trucks.

Scenario Year: **2012**

All model years in the range 1968 to 2012

HHDT-DSL (pounds/mile)		HHDT-DSL, Exh (pounds/mile)	
CO	0.01021519	PM10	0.00135537
NOx	0.03092379	PM2.5	0.00124837
ROG	0.00252764		
SOx	0.00004042		
PM10	0.00149566		
PM2.5	0.00129354		
CO2	4.21590774		
CH4	0.00011651		

Source: File onroadEFHHDT07_26.xls, downloaded from <http://www.aqmd.gov/ceqa/handbook/onroad/onroad.html>

Table 51
Motor Vehicle Entrained Road Dust Emission Factors

Vehicle Type	Surface	Silt Loading (sL, g/m ²) or Silt Content (s, %) ^a	Average Weight (W) (tons) ^b	Un-controlled PM10 Emission Factor (lb/VMT) ^c	Un-controlled PM2.5 Emission Factor (lb/VMT) ^c	Control Efficiency (%) ^d	Controlled PM10 Emission Factor (lb/VMT) ^e	Controlled PM2.5 Emission Factor (lb/VMT) ^e
1/2-Ton Pick-up Truck, 4x4	Paved	0.035	3.2	8.01E-04	0.00E+00	0%	8.01E-04	0.00E+00
1/2-Ton Pick-up Truck, 4x4	Unpaved	7.5	3.2	1.01E+00	1.01E-01	57%	4.35E-01	4.35E-02
Tool Truck	Paved	0.035	3.2	8.01E-04	0.00E+00	0%	8.01E-04	0.00E+00
Tool Truck	Unpaved	7.5	3.2	1.01E+00	1.01E-01	57%	4.35E-01	4.35E-02
Pickup 4x4	Paved	0.035	3.2	8.01E-04	0.00E+00	0%	8.01E-04	0.00E+00
Pickup 4x4	Unpaved	7.5	3.2	1.01E+00	1.01E-01	57%	4.35E-01	4.35E-02
Survey Truck	Paved	0.035	3.2	8.01E-04	0.00E+00	0%	8.01E-04	0.00E+00
Survey Truck	Unpaved	7.5	3.2	1.01E+00	1.01E-01	57%	4.35E-01	4.35E-02
10-cu. yd. Concrete Mixer Truck	Paved	0.035	3.2	8.01E-04	0.00E+00	0%	8.01E-04	0.00E+00
10-cu. yd. Concrete Mixer Truck	Unpaved	7.5	17	2.14E+00	2.14E-01	57%	9.22E-01	9.22E-02
10-cu. yd. Dump Truck	Paved	0.035	3.2	8.01E-04	0.00E+00	0%	8.01E-04	0.00E+00
10-cu. yd. Dump Truck	Unpaved	7.5	17	2.14E+00	2.14E-01	57%	9.22E-01	9.22E-02
1-Ton Crew Cab Flat Bed, 4x4	Paved	0.035	3.2	8.01E-04	0.00E+00	0%	8.01E-04	0.00E+00
1-Ton Crew Cab Flat Bed, 4x4	Unpaved	7.5	5	1.24E+00	1.24E-01	57%	5.32E-01	5.32E-02
1-Ton Crew Cab, 4x4	Paved	0.035	3.2	8.01E-04	0.00E+00	0%	8.01E-04	0.00E+00
1-Ton Crew Cab, 4x4	Unpaved	7.5	5	1.24E+00	1.24E-01	57%	5.32E-01	5.32E-02
22-Ton ManiteX	Paved	0.035	3.2	8.01E-04	0.00E+00	0%	8.01E-04	0.00E+00
22-Ton ManiteX	Unpaved	7.5	17	2.14E+00	2.14E-01	57%	9.22E-01	9.22E-02
3/4-Ton Pick-up Truck, 4x4	Paved	0.035	3.2	8.01E-04	0.00E+00	0%	8.01E-04	0.00E+00
3/4-Ton Pick-up Truck, 4x4	Unpaved	7.5	3.2	1.01E+00	1.01E-01	57%	4.35E-01	4.35E-02
30-Ton Crane Truck	Paved	0.035	3.2	8.01E-04	0.00E+00	0%	8.01E-04	0.00E+00
30-Ton Crane Truck	Unpaved	7.5	17	2.14E+00	2.14E-01	57%	9.22E-01	9.22E-02
3 Drum Straw Line Puller	Paved	0.035	3.2	8.01E-04	0.00E+00	0%	8.01E-04	0.00E+00
3 Drum Straw Line Puller	Unpaved	7.5	17	2.14E+00	2.14E-01	57%	9.22E-01	9.22E-02
40' Flat Bed Truck/Trailer	Paved	0.035	3.2	8.01E-04	0.00E+00	0%	8.01E-04	0.00E+00
40' Flat Bed Truck/Trailer	Unpaved	7.5	17	2.14E+00	2.14E-01	57%	9.22E-01	9.22E-02
80ft. Hydraulic Manlift/Bucket Truck	Paved	0.035	3.2	8.01E-04	0.00E+00	0%	8.01E-04	0.00E+00
80ft. Hydraulic Manlift/Bucket Truck	Unpaved	7.5	17	2.14E+00	2.14E-01	57%	9.22E-01	9.22E-02
Aggregate Base Delivery Truck	Paved	0.035	3.2	8.01E-04	0.00E+00	0%	8.01E-04	0.00E+00
Aggregate Base Delivery Truck	Unpaved	7.5	17	2.14E+00	2.14E-01	57%	9.22E-01	9.22E-02
Asphalt Delivery Truck	Paved	0.035	3.2	8.01E-04	0.00E+00	0%	8.01E-04	0.00E+00
Asphalt Delivery Truck	Unpaved	7.5	17	2.14E+00	2.14E-01	57%	9.22E-01	9.22E-02
Auger Truck	Paved	0.035	3.2	8.01E-04	0.00E+00	0%	8.01E-04	0.00E+00
Auger Truck	Unpaved	7.5	17	2.14E+00	2.14E-01	57%	9.22E-01	9.22E-02
Boom Truck	Paved	0.035	3.2	8.01E-04	0.00E+00	0%	8.01E-04	0.00E+00
Boom Truck	Unpaved	7.5	17	2.14E+00	2.14E-01	57%	9.22E-01	9.22E-02
Bucket Truck	Paved	0.035	3.2	8.01E-04	0.00E+00	0%	8.01E-04	0.00E+00
Bucket Truck	Unpaved	7.5	17	2.14E+00	2.14E-01	57%	9.22E-01	9.22E-02
Carry-all Truck	Paved	0.035	3.2	8.01E-04	0.00E+00	0%	8.01E-04	0.00E+00
Carry-all Truck	Unpaved	7.5	17	2.14E+00	2.14E-01	57%	9.22E-01	9.22E-02
Concrete Truck	Paved	0.035	3.2	8.01E-04	0.00E+00	0%	8.01E-04	0.00E+00
Concrete Truck	Unpaved	7.5	17	2.14E+00	2.14E-01	57%	9.22E-01	9.22E-02
Crew Truck	Paved	0.035	3.2	8.01E-04	0.00E+00	0%	8.01E-04	0.00E+00
Crew Truck	Unpaved	7.5	5	1.24E+00	1.24E-01	57%	5.32E-01	5.32E-02
Crewcab Truck	Paved	0.035	3.2	8.01E-04	0.00E+00	0%	8.01E-04	0.00E+00
Crewcab Truck	Unpaved	7.5	5	1.24E+00	1.24E-01	57%	5.32E-01	5.32E-02
Crushed Rock Delivery Truck	Paved	0.035	3.2	8.01E-04	0.00E+00	0%	8.01E-04	0.00E+00
Crushed Rock Delivery Truck	Unpaved	7.5	17	2.14E+00	2.14E-01	57%	9.22E-01	9.22E-02
Dump Truck	Paved	0.035	3.2	8.01E-04	0.00E+00	0%	8.01E-04	0.00E+00
Dump Truck	Unpaved	7.5	17	2.14E+00	2.14E-01	57%	9.22E-01	9.22E-02
Delivery Truck	Paved	0.035	3.2	8.01E-04	0.00E+00	0%	8.01E-04	0.00E+00
Delivery Truck	Unpaved	7.5	17	2.14E+00	2.14E-01	57%	9.22E-01	9.22E-02
Dump Truck (Trash)	Paved	0.035	3.2	8.01E-04	0.00E+00	0%	8.01E-04	0.00E+00
Dump Truck (Trash)	Unpaved	7.5	17	2.14E+00	2.14E-01	57%	9.22E-01	9.22E-02

Table 51

Motor Vehicle Entrained Road Dust Emission Factors

Vehicle Type	Surface	Silt Loading (sL, g/m ²) or Silt Content (s, %) ^a	Average Weight (W) (tons) ^b	Un-controlled PM10 Emission Factor (lb/VMT) ^c	Un-controlled PM2.5 Emission Factor (lb/VMT) ^c	Control Efficiency (%) ^d	Controlled PM10 Emission Factor (lb/VMT) ^e	Controlled PM2.5 Emission Factor (lb/VMT) ^e
Extendable Flat Bed Pole Truck	Paved	0.035	3.2	8.01E-04	0.00E+00	0%	8.01E-04	0.00E+00
Extendable Flat Bed Pole Truck	Unpaved	7.5	17	2.14E+00	2.14E-01	57%	9.22E-01	9.22E-02
Flat Bed Truck/Trailer	Paved	0.035	3.2	8.01E-04	0.00E+00	0%	8.01E-04	0.00E+00
Flat Bed Truck/Trailer	Unpaved	7.5	17	2.14E+00	2.14E-01	57%	9.22E-01	9.22E-02
Flatbed Truck	Paved	0.035	3.2	8.01E-04	0.00E+00	0%	8.01E-04	0.00E+00
Flatbed Truck	Unpaved	7.5	17	2.14E+00	2.14E-01	57%	9.22E-01	9.22E-02
Foreman Truck	Paved	0.035	3.2	8.01E-04	0.00E+00	0%	8.01E-04	0.00E+00
Foreman Truck	Unpaved	7.5	5	1.24E+00	1.24E-01	57%	5.32E-01	5.32E-02
Line Truck	Paved	0.035	3.2	8.01E-04	0.00E+00	0%	8.01E-04	0.00E+00
Line Truck	Unpaved	7.5	17	2.14E+00	2.14E-01	57%	9.22E-01	9.22E-02
Low Bed Truck	Paved	0.035	3.2	8.01E-04	0.00E+00	0%	8.01E-04	0.00E+00
Low Bed Truck	Unpaved	7.5	17	2.14E+00	2.14E-01	57%	9.22E-01	9.22E-02
Lowboy Truck/Trailer	Paved	0.035	3.2	8.01E-04	0.00E+00	0%	8.01E-04	0.00E+00
Lowboy Truck/Trailer	Unpaved	7.5	17	2.14E+00	2.14E-01	57%	9.22E-01	9.22E-02
Maintenance Truck	Paved	0.035	3.2	8.01E-04	0.00E+00	0%	8.01E-04	0.00E+00
Maintenance Truck	Unpaved	7.5	10	1.69E+00	1.69E-01	57%	7.26E-01	7.26E-02
Pumper/Tanker Truck	Paved	0.035	3.2	8.01E-04	0.00E+00	0%	8.01E-04	0.00E+00
Pumper/Tanker Truck	Unpaved	7.5	17	2.14E+00	2.14E-01	57%	9.22E-01	9.22E-02
Reel Truck	Paved	0.035	3.2	8.01E-04	0.00E+00	0%	8.01E-04	0.00E+00
Reel Truck	Unpaved	7.5	10	1.69E+00	1.69E-01	57%	7.26E-01	7.26E-02
Rodder Truck	Paved	0.035	3.2	8.01E-04	0.00E+00	0%	8.01E-04	0.00E+00
Rodder Truck	Unpaved	7.5	10	1.69E+00	1.69E-01	57%	7.26E-01	7.26E-02
Splice Lab Truck	Paved	0.035	3.2	8.01E-04	0.00E+00	0%	8.01E-04	0.00E+00
Splice Lab Truck	Unpaved	7.5	10	1.69E+00	1.69E-01	57%	7.26E-01	7.26E-02
Splicing Lab	Paved	0.035	3.2	8.01E-04	0.00E+00	0%	8.01E-04	0.00E+00
Splicing Lab	Unpaved	7.5	10	1.69E+00	1.69E-01	57%	7.26E-01	7.26E-02
Splicing Rig	Paved	0.035	3.2	8.01E-04	0.00E+00	0%	8.01E-04	0.00E+00
Splicing Rig	Unpaved	7.5	10	1.69E+00	1.69E-01	57%	7.26E-01	7.26E-02
Stake Truck	Paved	0.035	3.2	8.01E-04	0.00E+00	0%	8.01E-04	0.00E+00
Stake Truck	Unpaved	7.5	17	2.14E+00	2.14E-01	57%	9.22E-01	9.22E-02
Static Truck/Tensioner	Paved	0.035	3.2	8.01E-04	0.00E+00	0%	8.01E-04	0.00E+00
Static Truck/Tensioner	Unpaved	7.5	17	2.14E+00	2.14E-01	57%	9.22E-01	9.22E-02
Tool Trailer	Paved	0.035	3.2	8.01E-04	0.00E+00	0%	8.01E-04	0.00E+00
Tool Trailer	Unpaved	7.5	3.2	1.01E+00	1.01E-01	57%	4.35E-01	4.35E-02
Troubleman Truck	Paved	0.035	3.2	8.01E-04	0.00E+00	0%	8.01E-04	0.00E+00
Troubleman Truck	Unpaved	7.5	17	2.14E+00	2.14E-01	57%	9.22E-01	9.22E-02
Truck, Semi Tractor	Paved	0.035	3.2	8.01E-04	0.00E+00	0%	8.01E-04	0.00E+00
Truck, Semi Tractor	Unpaved	7.5	17	2.14E+00	2.14E-01	57%	9.22E-01	9.22E-02
Van	Paved	0.035	3.2	8.01E-04	0.00E+00	0%	8.01E-04	0.00E+00
Van	Unpaved	7.5	3.2	1.01E+00	1.01E-01	57%	4.35E-01	4.35E-02
Water Truck	Paved	0.035	3.2	8.01E-04	0.00E+00	0%	8.01E-04	0.00E+00
Water Truck	Unpaved	7.5	17	2.14E+00	2.14E-01	57%	9.22E-01	9.22E-02
Wire Truck/Trailer	Paved	0.035	3.2	8.01E-04	0.00E+00	0%	8.01E-04	0.00E+00
Wire Truck/Trailer	Unpaved	7.5	17	2.14E+00	2.14E-01	57%	9.22E-01	9.22E-02
Worker Commute	Paved	0.035	3.2	8.01E-04	0.00E+00	0%	8.01E-04	0.00E+00
Worker Commute	Unpaved	7.5	3.2	1.01E+00	1.01E-01	57%	4.35E-01	4.35E-02
Subtransmission Line Inspection	Paved	0.035	3.2	8.01E-04	0.00E+00	0%	8.01E-04	0.00E+00
Subtransmission Line Inspection	Unpaved	7.5	3.2	1.01E+00	1.01E-01	57%	4.35E-01	4.35E-02
Substation Site Visit	Paved	0.035	3.2	8.01E-04	0.00E+00	0%	8.01E-04	0.00E+00
Substation Site Visit	Unpaved	7.5	3.2	1.01E+00	1.01E-01	57%	4.35E-01	4.35E-02

^a Paved road silt loading from ARB Emission Inventory Methodology 7.9, Entrained Paved Road Dust (1997) for collector roads,<http://www.arb.ca.gov/ei/areasrc/fullpdf/full7-9.pdf>

Unpaved road silt content from SCAQMD CEQA Handbook, (1993) Table A9-9-E-1 for overburden

^b Average paved on-road vehicle weight in Riverside County from ARB Emission Inventory Methodology 7.9, Entrained Paved Road Dust (1997)

Table 51
Motor Vehicle Entrained Road Dust Emission Factors

Vehicle Type	Surface	Silt Loading (sL, g/m2) or Silt Content (s, %) ^a	Average Weight (W) (tons) ^b	Un-controlled PM10 Emission Factor (lb/VMT) ^c	Un-controlled PM2.5 Emission Factor (lb/VMT) ^c	Control Efficiency (%) ^d	Controlled PM10 Emission Factor (lb/VMT) ^e	Controlled PM2.5 Emission Factor (lb/VMT) ^e

Unpaved worker commuting weight on access road assumed to be same as paved road weight

Unpaved weight for other trucks is based on upper limit of 33,000 lbs for medium heavy-duty trucks.

^c Equations:

$$EF(\text{paved}) = k_p (sL/2)^{0.65} (W/3)^{1.5} - C$$

Ref: AP-42, Section 13.2.1, "Paved Roads," November 2006

$$EF(\text{unpaved}) = k_u (s/12)^a (W/3)^b$$

Ref: AP-42, Section 13.2.2, "Unpaved Roads," November 2006

Constants:

k_p =	0.016	(Particle size multiplier for PM10)
	0.0024	(Particle size multiplier for PM2.5)
C =	0.00047	(Exhaust, brake wear and tire wear adjustment, PM10)
	0.00036	(Exhaust, brake wear and tire wear adjustment, PM2.5)
k_u =	1.5	(Particle size multiplier for PM)
	0.15	(Particle size multiplier for PM2.5)
a =	0.9	for PM10
	0.9	for PM2.5
b =	0.45	for PM10
	0.45	for PM2.5

^d Control efficiency from limiting speeds on unpaved roads to 15 mph, from Table XI-A, Mitigation Measure Examples,

Fugitive Dust from Construction & Demolition, http://www.aqmd.gov/ceqa/handbook/mitigation/fugitive/MM_fugitive.html

^e Controlled emission factor [lb/mi] = Uncontrolled emission factor [lb/mi] x (1 - Control efficiency [%] / 100)

Table 52
Fugitive Dust Emission Factors
Soil Dropping During Excavation

Emission Factor [lb/cu. yd] = $0.0011 \times (\text{mean wind speed [mi/hr]} / 5)^{1.3} / (\text{moisture [\%]} / 2)^{1.4} \times (\text{number drops per ton}) \times (\text{density [ton/cu. yd]})$
Reference: AP-42, Equation (1), Section 13.2.4, November 2006

Parameter	Value	Basis
Mean Wind Speed	12	SCAQMD CEQA Air Quality Handbook (1993), Table 9-9-G, default
Moisture	10.6	Preliminary geotechnical investigation of substation site
Number Drops	4	Assumption
Soil Density	1.215	Table 2.46, Handbook of Solid Waste Management

PM10 Emission Factor (Uncontrolled) 1.62E-03 lb/cu. yd
Reduction from Watering Twice/Day^b 0%
Controlled PM10 Emission Factor 1.62E-03 lb/cu. yd
Controlled PM2.5 Emission Factor^a 3.36E-04 lb/cu. yd

^a PM2.5 emission factor [lb/hr] = PM10 emission factor [lb/hr] x PM2.5 fraction of PM10

PM2.5 Fraction of PM10 in Construction Dust = 0.208 from Appendix A, Final–Methodology to Calculate Particulate Matter (PM) 2.5 and PM 2.5 Significance Thresholds, SCAQMD, October 2006

^b Watering is assumed to be used to maintain moist conditions, so no further reduction from watering is included.

Emissions [pounds per day] = Controlled emission factor [pounds per cubic yard] x Volume soil handled [cubic yards per day]

Storage Pile Wind Erosion

Emission Factor [lb/day-acre] = $0.85 \times (\text{silt content [\%]} / 1.5) \times (365 / 235) \times (\text{percentage of time unobstructed wind exceeds 12 mph} / 15)$
Reference: SCAQMD CEQA Air Quality Handbook (1993), Table 9-9-E

Parameter	Value	Basis
Silt Content	26.7	Preliminary geotechnical investigation of substation site
Pct. time wind > 12 mph	100	Worst-case assumption

PM10 Emission Factor (Uncontrolled) 156.7 lb/day-acre
Reduction from Watering Twice/Day 90% Control efficiency from watering storage pile by hand at a rate of 1.4 gallons/hour-yard², Table XI-B, Mitigation Measure Examples, Fugitive Dust from Materials Handling, http://www.aqmd.gov/ceqa/handbook/mitigation/fugitive/MM_fugitive.html
Controlled PM10 Emission Factor 15.7 lb/day-acre
Controlled PM2.5 Emission Factor^a 3.3 lb/day-acre

^a PM2.5 emission factor [lb/hr] = PM10 emission factor [lb/hr] x PM2.5 fraction of PM10

PM2.5 Fraction of PM10 in Construction Dust = 0.208 from Appendix A, Final–Methodology to Calculate Particulate Matter (PM) 2.5 and PM 2.5 Significance Thresholds, SCAQMD, October 2006

Emissions [pounds per day] = Controlled emission factor [pounds per acre-day] x Storage pile surface area [acres]

Bulldozing, Scraping and Grading

Emission Factor [lb/hr] = $0.75 \times (\text{silt content [\%]})^{1.5} / (\text{moisture})^{1.4}$
Reference: AP-42, Table 11.9-1, July 1998

Parameter	Value	Basis
Silt Content	26.7	Preliminary geotechnical investigation of substation site
Moisture	10.6	Preliminary geotechnical investigation of substation site

PM10 Emission Factor (Uncontrolled) 3.797 lb/hr
Reduction from Watering Twice/Day 61% Control efficiency from watering three times per day, Table XI-A, Mitigation Measure Examples, Fugitive Dust from Construction & Demolition, http://www.aqmd.gov/ceqa/handbook/mitigation/fugitive/MM_fugitive.html
Controlled PM10 Emission Factor 1.481 lb/hr
Controlled PM2.5 Emission Factor^a 0.308 lb/hr

^a PM2.5 emission factor [lb/hr] = PM10 emission factor [lb/hr] x PM2.5 fraction of PM10

PM2.5 Fraction of PM10 in Construction Dust = 0.208 from Appendix A, Final–Methodology to Calculate Particulate Matter (PM) 2.5 and PM 2.5 Significance Thresholds, SCAQMD, October 2006

^b Watering is assumed to be used to maintain moist conditions, so no further reduction from watering is included.

Emissions [pounds per day] = Controlled emission factor [pounds per hour] x Bulldozing, scraping or grading time [hours/day]

Table 2
Alternative 2 with Road Dust Mitigation
Construction Emissions Summary
Total Daily Criteria Pollutant Emissions for Overlapping Construction Phases

Group^a	VOC (lb/day)	CO (lb/day)	NOX (lb/day)	SOX (lb/day)	PM10 (lb/day)	PM2.5 (lb/day)
Substation Construction						
Survey	0.19	1.85	0.19	0.00	0.62	0.05
Grading	11.63	52.09	117.60	0.16	29.51	9.10
Civil, Fencing	4.43	31.15	35.96	0.06	5.43	2.18
MEER, Electrical, Wiring, Transformers, Equipment Check, Testing, Asphaltting, Landscaping, Irrigation	11.63	105.76	60.43	0.10	11.66	3.72
Maximum	11.63	105.76	117.60	0.16	29.51	9.10
Distribution Construction						
All	7.70	30.49	68.54	0.11	3.79	2.45
Maximum	7.70	30.49	68.54	0.11	3.79	2.45
Subtransmission Source Line Construction						
Marshalling Yard, Survey	1.21	7.53	7.37	0.01	1.63	0.41
Marshalling Yard, Right-of-Way Clearing, Roads and Landing Work	16.66	70.63	170.32	0.23	185.46	30.68
Marshalling Yard, Tubular Steel Pole Foundations Installation	5.82	27.28	57.30	0.09	37.53	5.72
Marshalling Yard, Steel Pole Haul	2.29	11.32	17.96	0.03	3.75	0.95
Marshalling Yard, Steel Pole Assembly	3.42	16.91	24.79	0.04	6.84	1.59
Marshalling Yard, Steel Pole Erection	3.24	16.26	23.72	0.04	6.74	1.50
Marshalling Yard, Wood Pole Haul	2.29	11.32	17.96	0.03	3.75	0.95
Marshalling Yard, Wood Pole Assembly	3.42	16.91	24.79	0.04	6.84	1.59
Marshalling Yard, Wood Pole Installation	4.42	21.73	38.98	0.06	9.88	2.24
Marshalling Yard, Existing Wood Poles Removal, Guard Structure Installation	5.88	26.84	48.83	0.07	17.49	3.37
Marshalling Yard, Conductor Installation	11.11	49.60	114.40	0.17	29.79	6.07
Marshalling Yard, Guard Structure Removal	3.34	15.99	27.67	0.04	8.56	1.78
Marshalling Yard, Restoration	3.28	16.23	24.32	0.04	16.61	3.53
Maximum	16.66	70.63	170.32	0.23	185.46	30.68
Telecommunications Construction						
Roads and Landing Work	3.64	15.28	28.58	0.04	43.70	7.59
Control Building Communications Room, Overhead Cable Installation, Underground Facility Installation, Underground Cable Installation, Optical Systems Installation at Other Locations	7.64	39.08	64.27	0.11	34.52	5.27
Maximum	7.64	39.08	64.27	0.11	43.70	7.59
CONSTRUCTION MAXIMUM DAILY^b	43.63	245.97	420.73	0.60	262.47	49.81
Nuevo Substation Demolition						
Civil	1.47	8.17	10.40	0.02	0.99	0.67
Electrical	0.80	30.96	4.29	0.01	0.56	0.27
Maintenance Crew Equipment Check	0.11	1.01	0.10	0.00	0.12	0.01
Testing	0.11	1.01	0.10	0.00	0.24	0.02
Maximum	1.47	30.96	10.40	0.02	0.99	0.67
Model P.T. Substation Demolition						
Civil	1.04	6.00	6.46	0.01	0.73	0.43
Electrical	3.47	14.63	30.57	0.04	1.53	1.42
Maximum	3.47	14.63	30.57	0.04	1.53	1.42
DEMOLITION MAXIMUM DAILY^c	3.47	30.96	30.57	0.04	1.53	1.42
PEAK DAILY^d	43.63	245.97	420.73	0.60	262.47	49.81
SCAQMD Significance Threshold	75	555	100	150	150	55

^a The construction phases within a group could all occur at the same time.

^b Construction maximum daily emissions are the sum of the maximum daily emissions during construction of the substation, the distribution facilities, the subtransmission source lines and the telecommunications facilities, since construction of all of these components could occur at the same time.

^c Demolition maximum daily emissions are the maximum daily emissions during demolition of the Nuevo Substation or the Model P.T. Substation.

^d Peak daily emissions are the greater of the maximum daily emissions during construction and during demolition, since demolition would occur after construction is completed.

Table 1
Alternative 2 with Road Dust Mitigation
Construction Emissions Summary
Total Daily Criteria Pollutant Emissions by Component

Phase	VOC (lb/day)	CO (lb/day)	NOX (lb/day)	SOX (lb/day)	PM10 (lb/day)	PM2.5 (lb/day)
Substation Construction						
Survey	0.19	1.85	0.19	0.00	0.62	0.05
Grading	11.63	52.09	117.60	0.16	29.51	9.10
Fencing	0.65	4.53	3.55	0.01	1.59	0.35
Civil	3.78	26.62	32.41	0.05	3.84	1.83
Substation MEER	0.26	2.30	0.71	0.00	1.11	0.12
Electrical	0.96	41.64	3.94	0.01	1.31	0.32
Wiring	0.27	11.14	0.48	0.00	0.29	0.04
Transformers	0.99	14.35	6.32	0.01	1.58	0.40
Maintenance Crew Equipment Check	0.12	1.14	0.12	0.00	0.47	0.04
Testing	0.11	1.03	0.10	0.00	0.24	0.02
Asphalting	4.82	16.58	28.54	0.04	3.53	1.56
Landscaping	1.96	9.05	15.14	0.02	2.18	0.79
Irrigation	2.15	8.53	5.09	0.01	0.95	0.45
Distribution Construction						
Civil	4.27	16.34	41.78	0.06	2.26	1.47
Electrical	3.43	14.15	26.75	0.04	1.53	0.97
Subtransmission Source Line Construction						
Survey	0.22	2.11	0.21	0.00	1.05	0.10
Marshalling Yard	0.99	5.42	7.15	0.01	0.58	0.32
Right-of-Way Clearing	3.10	14.05	24.96	0.03	29.23	5.86
Roads and Landing Work	12.57	51.16	138.21	0.18	155.66	24.50
Guard Structure Installation	2.73	12.13	24.57	0.04	9.84	1.76
Existing Wood Poles Removal	2.16	9.30	17.11	0.02	7.07	1.30
Tubular Steel Pole Foundations Installation	4.83	21.86	50.14	0.07	36.96	5.41
Wood Pole Haul	1.30	5.90	10.81	0.02	3.17	0.64
Wood Pole Assembly	2.43	11.50	17.64	0.03	6.26	1.28
Wood Pole Installation	3.43	16.31	31.82	0.05	9.30	1.92
Steel Pole Haul	1.30	5.90	10.81	0.02	3.17	0.64
Steel Pole Assembly	2.43	11.50	17.64	0.03	6.26	1.28
Steel Pole Erection	2.25	10.84	16.57	0.02	6.16	1.19
Conductor Installation	10.12	44.18	107.25	0.15	29.21	5.75
Guard Structure Removal	2.35	10.57	20.52	0.03	7.98	1.46
Restoration	2.29	10.81	17.17	0.03	16.03	3.22
Telecommunications Construction						
Control Building Communications Room	0.24	2.27	0.45	0.00	0.26	0.02
Roads and Landing Work	3.64	15.28	28.58	0.04	43.70	7.59
Overhead Cable Installation	2.74	12.72	29.52	0.04	31.54	3.89
Underground Facility Installation	1.14	6.33	5.54	0.01	0.80	0.42
Underground Cable Installation	2.95	12.25	28.20	0.05	1.28	0.90
Optical Systems Installation at Other Locations	0.57	5.51	0.56	0.01	0.64	0.04
Nuevo Substation Demolition						
Civil	1.47	8.17	10.40	0.02	0.99	0.67
Electrical	0.80	30.96	4.29	0.01	0.56	0.27
Maintenance Crew Equipment Check	0.11	1.01	0.10	0.00	0.12	0.01
Testing	0.11	1.01	0.10	0.00	0.24	0.02
Model P.T. Substation Demolition						
Civil	1.04	6.00	6.46	0.01	0.73	0.43
Electrical	3.47	14.63	30.57	0.04	1.53	1.42

Notes:

VOC = volatile organic compounds

CO = carbon monoxide

NOX = nitrogen oxides

SOX = sulfur oxides

PM10 = suspended particulate matter measuring less than 10 microns

PM2.5 = suspended particulate matter measuring less than 2.5 micron

lb/day = pounds per day

MEER = mechanical and electrical equipment room

Table 1
Alternative 2 with Road Dust Mitigation
Construction Emissions Summary
Total Daily Criteria Pollutant Emissions by Component

Phase	VOC (lb/day)	CO (lb/day)	NOX (lb/day)	SOX (lb/day)	PM10 (lb/day)	PM2.5 (lb/day)
Substation Construction						
Survey	0.19	1.85	0.19	0.00	0.62	0.05
Grading	11.63	52.09	117.60	0.16	29.51	9.10
Fencing	0.65	4.53	3.55	0.01	1.59	0.35
Civil	3.78	26.62	32.41	0.05	3.84	1.83
Substation MEER	0.26	2.30	0.71	0.00	1.11	0.12
Electrical	0.96	41.64	3.94	0.01	1.31	0.32
Wiring	0.27	11.14	0.48	0.00	0.29	0.04
Transformers	0.99	14.35	6.32	0.01	1.58	0.40
Maintenance Crew Equipment Check	0.12	1.14	0.12	0.00	0.47	0.04
Testing	0.11	1.03	0.10	0.00	0.24	0.02
Asphalting	4.82	16.58	28.54	0.04	3.53	1.56
Landscaping	1.96	9.05	15.14	0.02	2.18	0.79
Irrigation	2.15	8.53	5.09	0.01	0.95	0.45
Distribution Construction						
Civil	4.27	16.34	41.78	0.06	2.26	1.47
Electrical	3.43	14.15	26.75	0.04	1.53	0.97
Subtransmission Source Line Construction						
Survey	0.22	2.11	0.21	0.00	1.05	0.10
Marshalling Yard	0.99	5.42	7.15	0.01	0.58	0.32
Right-of-Way Clearing	3.10	14.05	24.96	0.03	29.23	5.86
Roads and Landing Work	12.57	51.16	138.21	0.18	155.66	24.50
Guard Structure Installation	2.73	12.13	24.57	0.04	9.84	1.76
Existing Wood Poles Removal	2.16	9.30	17.11	0.02	7.07	1.30
Tubular Steel Pole Foundations Installation	4.83	21.86	50.14	0.07	36.96	5.41
Wood Pole Haul	1.30	5.90	10.81	0.02	3.17	0.64
Wood Pole Assembly	2.43	11.50	17.64	0.03	6.26	1.28
Wood Pole Installation	3.43	16.31	31.82	0.05	9.30	1.92
Steel Pole Haul	1.30	5.90	10.81	0.02	3.17	0.64
Steel Pole Assembly	2.43	11.50	17.64	0.03	6.26	1.28
Steel Pole Erection	2.25	10.84	16.57	0.02	6.16	1.19
Conductor Installation	10.12	44.18	107.25	0.15	29.21	5.75
Guard Structure Removal	2.35	10.57	20.52	0.03	7.98	1.46
Restoration	2.29	10.81	17.17	0.03	16.03	3.22
Telecommunications Construction						
Control Building Communications Room	0.24	2.27	0.45	0.00	0.26	0.02
Roads and Landing Work	3.64	15.28	28.58	0.04	43.70	7.59
Overhead Cable Installation	2.74	12.72	29.52	0.04	31.54	3.89
Underground Facility Installation	1.14	6.33	5.54	0.01	0.80	0.42
Underground Cable Installation	2.95	12.25	28.20	0.05	1.28	0.90
Optical Systems Installation at Other Locations	0.57	5.51	0.56	0.01	0.64	0.04
Nuevo Substation Demolition						
Civil	1.47	8.17	10.40	0.02	0.99	0.67
Electrical	0.80	30.96	4.29	0.01	0.56	0.27
Maintenance Crew Equipment Check	0.11	1.01	0.10	0.00	0.12	0.01
Testing	0.11	1.01	0.10	0.00	0.24	0.02
Model P.T. Substation Demolition						
Civil	1.04	6.00	6.46	0.01	0.73	0.43
Electrical	3.47	14.63	30.57	0.04	1.53	1.42

Notes:

VOC = volatile organic compounds

CO = carbon monoxide

NOX = nitrogen oxides

SOX = sulfur oxides

PM10 = suspended particulate matter measuring less than 10 microns

PM2.5 = suspended particulate matter measuring less than 2.5 micron

lb/day = pounds per day

MEER = mechanical and electrical equipment room

Table 2
Alternative 2 with Road Dust Mitigation
Construction Emissions Summary
Total Daily Criteria Pollutant Emissions for Overlapping Construction Phases

Group^a	VOC (lb/day)	CO (lb/day)	NOX (lb/day)	SOX (lb/day)	PM10 (lb/day)	PM2.5 (lb/day)
Substation Construction						
Survey	0.19	1.85	0.19	0.00	0.62	0.05
Grading	11.63	52.09	117.60	0.16	29.51	9.10
Civil, Fencing	4.43	31.15	35.96	0.06	5.43	2.18
MEER, Electrical, Wiring, Transformers, Equipment Check, Testing, Asphaltting, Landscaping, Irrigation	11.63	105.76	60.43	0.10	11.66	3.72
Maximum	11.63	105.76	117.60	0.16	29.51	9.10
Distribution Construction						
All	7.70	30.49	68.54	0.11	3.79	2.45
Maximum	7.70	30.49	68.54	0.11	3.79	2.45
Subtransmission Source Line Construction						
Marshalling Yard, Survey	1.21	7.53	7.37	0.01	1.63	0.41
Marshalling Yard, Right-of-Way Clearing, Roads and Landing Work	16.66	70.63	170.32	0.23	185.46	30.68
Marshalling Yard, Tubular Steel Pole Foundations Installation	5.82	27.28	57.30	0.09	37.53	5.72
Marshalling Yard, Steel Pole Haul	2.29	11.32	17.96	0.03	3.75	0.95
Marshalling Yard, Steel Pole Assembly	3.42	16.91	24.79	0.04	6.84	1.59
Marshalling Yard, Steel Pole Erection	3.24	16.26	23.72	0.04	6.74	1.50
Marshalling Yard, Wood Pole Haul	2.29	11.32	17.96	0.03	3.75	0.95
Marshalling Yard, Wood Pole Assembly	3.42	16.91	24.79	0.04	6.84	1.59
Marshalling Yard, Wood Pole Installation	4.42	21.73	38.98	0.06	9.88	2.24
Marshalling Yard, Existing Wood Poles Removal, Guard Structure Installation	5.88	26.84	48.83	0.07	17.49	3.37
Marshalling Yard, Conductor Installation	11.11	49.60	114.40	0.17	29.79	6.07
Marshalling Yard, Guard Structure Removal	3.34	15.99	27.67	0.04	8.56	1.78
Marshalling Yard, Restoration	3.28	16.23	24.32	0.04	16.61	3.53
Maximum	16.66	70.63	170.32	0.23	185.46	30.68
Telecommunications Construction						
Roads and Landing Work	3.64	15.28	28.58	0.04	43.70	7.59
Control Building Communications Room, Overhead Cable Installation, Underground Facility Installation, Underground Cable Installation, Optical Systems Installation at Other Locations	7.64	39.08	64.27	0.11	34.52	5.27
Maximum	7.64	39.08	64.27	0.11	43.70	7.59
CONSTRUCTION MAXIMUM DAILY^b	43.63	245.97	420.73	0.60	262.47	49.81
Nuevo Substation Demolition						
Civil	1.47	8.17	10.40	0.02	0.99	0.67
Electrical	0.80	30.96	4.29	0.01	0.56	0.27
Maintenance Crew Equipment Check	0.11	1.01	0.10	0.00	0.12	0.01
Testing	0.11	1.01	0.10	0.00	0.24	0.02
Maximum	1.47	30.96	10.40	0.02	0.99	0.67
Model P.T. Substation Demolition						
Civil	1.04	6.00	6.46	0.01	0.73	0.43
Electrical	3.47	14.63	30.57	0.04	1.53	1.42
Maximum	3.47	14.63	30.57	0.04	1.53	1.42
DEMOLITION MAXIMUM DAILY^c	3.47	30.96	30.57	0.04	1.53	1.42
PEAK DAILY^d	43.63	245.97	420.73	0.60	262.47	49.81
SCAQMD Significance Threshold	75	555	100	150	150	55

^a The construction phases within a group could all occur at the same time.

^b Construction maximum daily emissions are the sum of the maximum daily emissions during construction of the substation, the distribution facilities, the subtransmission source lines and the telecommunications facilities, since construction of all of these components could occur at the same time.

^c Demolition maximum daily emissions are the maximum daily emissions during demolition of the Nuevo Substation or the Model P.T. Substation.

^d Peak daily emissions are the greater of the maximum daily emissions during construction and during demolition, since demolition would occur after construction is completed.

SUN CITY, CALIFORNIA (048655)

Period of Record Monthly Climate Summary

Period of Record : 5/ 1/1973 to 1/31/2006

	Jan	Feb	Mar	Apr	May	Jun	Jul	Aug	Sep	Oct	Nov	Dec	Annual
Average Max. Temperature (F)	66.1	68.4	69.6	76.7	82.1	91.9	97.4	98.0	92.6	84.2	73.8	67.6	80.7
Average Min. Temperature (F)	36.3	38.7	41.1	44.4	49.6	54.0	58.9	59.4	57.5	49.2	39.8	34.5	46.9
Average Total Precipitation (in.)	2.66	3.25	1.96	0.66	0.31	0.05	0.03	0.24	0.15	0.25	0.66	1.02	11.22
Average Total SnowFall (in.)	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0
Average Snow Depth (in.)	0	0	0	0	0	0	0	0	0	0	0	0	0

Percent of possible observations for period of record.

Max. Temp.: 92.2% Min. Temp.: 91.6% Precipitation: 94.4% Snowfall: 95.1% Snow Depth: 95%

Check [Station Metadata](#) or [Metadata graphics](#) for more detail about data completeness.

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