# GUIDANCE TO ADDRESS THE FRIANT RANCH RULING FOR CEQA PROJECTS IN THE SAC METRO AIR DISTRICT

## SACRAMENTO METROPOLITAN
## AIR QUALITY MANAGEMENT DISTRICT
## SACRAMENTO, CALIFORNIA

Prepared for
**Sacramento Metropolitan Air Quality Management District**
**Sacramento, California**

Prepared by
**Ramboll US Corporation**
**San Francisco, California**

Project Number
**1690012674**

Date
**Final October 2020**

# CONTENTS

## Tables

## Figures

## APPENDICES

# ACRONYMS AND ABBREVIATIONS

| | |
|---|---|
| AAQS: | Ambient Air Quality Standards |
| APCA: | Anthropogenic Precursor Culpability Assessment |
| AQMDs: | Air Quality Management Districts |
| AQTSD: | Air Quality Technical Support Document |
| ARB: | California Air Resources Board |
| BAAQMD: | Bay Area Air Quality Management District |
| BenMAP: | Benefits Mapping and Analysis Program |
| CAMx: | Comprehensive Air Quality Model with Extensions |
| CCOS: | Central California Ozone Study |
| CEQA: | California Environmental Quality Act |
| CMAQ: | Community Multiscale Air Quality |
| CO: | Carbon Monoxide |
| C-R: | Concentration-Response |
| CSAPR: | Cross-State Air Pollution Rule |
| DDM: | Decoupled Direct Method |
| DPM: | Diesel Particulate Matter |
| EC: | Elemental Carbon |
| EIR: | Environmental Impact Report |
| EMFAC: | Emissions Factor (ARB’s on-road mobile source emissions model) |
| EPA: | United States Environmental Protection Agency |
| FF10: | Flat File 2010 |
| FPRM: | Fine Particulate Matter |
| GHGs: | Greenhouse Gases |
| GIS: | Geographical Information System |
| HDDM: | Higher Order Decoupled Direct Method |
| ISAM: | Integrated Source Apportionment Method |
| ISORROPIA: | Aerosol Thermodynamic Module |
| MERPs: | Modeled Emission Rate Precursors |
| MRGUAM: | Gridded merge program |
| NAAQS: | National Ambient Air Quality Standard |
| $NH_4$: | Ammonium |

| | |
|---|---|
| $NH_4NO_3$: | Ammonium Nitrate |
| $NO_2$: | Nitrogen Dioxide |
| $NO_3$: | Nitrate |
| $NO_X$: | Oxides of Nitrogen |
| $O_3$: | Ozone |
| OA: | Organic Aerosol |
| OC: | Organic Carbon |
| OSAT: | Ozone Source Apportionment Technology |
| PGM: | Photochemical Grid Model |
| PM: | Particulate Matter |
| $PM_{2.5}$: | Particulate Matter 2.5 micrometers or less in diameter |
| $PM_{10}$: | Particulate Matter 10 micrometers or less in diameter |
| POA: | Primary Organic Aerosol |
| Project: | CEQA project |
| PSAT: | Particulate Source Apportionment Technology |
| QA: | Quality Assurance |
| QC: | Quality Control |
| ROG: | Reactive Organic Gases |
| Sac Metro Air District: | Sacramento Metropolitan Air Quality Management District |
| SCC: | Source Classification Code |
| SFNA: | Sacramento Federal Ozone Nonattainment Area |
| SIPs: | State Implementation Plans |
| SMOKE: | Sparse Matrix Operator Kerner Emissions |
| SOx: | Oxides of Sulfur |
| $SO_2$: | Sulfur Dioxide |
| $SO_4$: | Sulfate |
| TOS: | Thresholds of Significance |
| USEPA: | United States Environmental Protection Agency |
| VOCs: | Volatile Organic Compounds |

This page intentionally left blank.

# 1. INTRODUCTION

The California Environmental Quality Act (CEQA) is a state statute that requires state and local agencies to identify the significant environmental impacts of their actions and to avoid or mitigate those impacts, if feasible. A public agency must comply with CEQA when it undertakes an activity defined by CEQA as a "project." A project is an activity carried out by a public agency or a private activity that must receive some discretionary approval (meaning that the agency has the authority to deny the requested permit or approval) from a government agency, and that may cause either a direct physical change in the environment or a reasonably foreseeable indirect change in the environment. Air quality impacts of a proposed project are one of the environmental factors that are required to be evaluated under CEQA, and require mitigation unless the impacts can be shown to be insignificant. Air quality impacts typically include increases in criteria pollutants [e.g., ozone ($O_3$), nitrogen dioxide ($NO_2$), sulfur dioxide ($SO_2$), carbon monoxide (CO) and particulate matter ($PM_{10}$ and $PM_{2.5}$)], greenhouse gases (GHGs), air toxics (e.g., diesel particulate matter, DPM), and the resultant health effects of increases in air pollutants.

The California Supreme Court, in the case of *Sierra Club v. County of Fresno* (2018) 6 Cal. 5th 502, determined that the air quality analysis in the environmental impact report (EIR) prepared under CEQA for the Friant Ranch Project was inadequate because it did not make "a reasonable effort to substantively connect the project's air quality impacts to likely health consequences." The Court determined that "the EIR should be revised to relate the expected adverse air quality impacts to likely health consequences or explain in meaningful detail why it is not feasible at the time of drafting to provide such an analysis."

Lead agencies and practitioners preparing documents to comply with CEQA have requested guidance from the Sacramento Metropolitan Air Quality Management District (Sac Metro Air District) on implementing the Friant Ranch decision in the review and analysis of proposed projects in Sacramento County. On April 25, 2019, the Sac Metro Air District published an Interim Recommendation for addressing the Friant Ranch decision. The Interim Recommendation stated that agencies should follow the Court's advice to explain in meaningful detail why an analysis of likely health consequences resulting from a development project is not yet feasible. This explanation should describe the background underlying air regulations, the regional nature of the regulatory approach, and why the approach is not amenable to project-level assessments.

The Interim Recommendation stated that an expanded discussion of health impacts resulting from specific air pollutants may also be warranted for projects with emissions exceeding the Sac Metro Air District's thresholds of significance. The Interim Recommendation was put in place to assist lead agencies and practitioners with CEQA document preparation until the Sac Metro Air District developed a methodology that would provide a consistent, reliable and meaningful analysis to address the Court's direction on correlating health impacts to a project's emissions.

# 2. PURPOSE AND AUTHORITY

The Sac Metro Air District is one of 35 air districts in California responsible for local air quality planning, monitoring, and stationary source permitting. Sac Metro Air District covers Sacramento County, including the cities of Sacramento, Citrus Heights, Folsom, Rancho Cordova, Elk Grove, Galt, and Isleton.

Under the CEQA review process, Sac Metro Air District may serve as the lead agency, a responsible agency with limited discretionary authority, or a reviewing agency providing comment on the air quality impacts of a proposed project or plan. CEQA requires that lead agencies identify significant environmental impacts and to avoid or mitigate those impacts if feasible. Lead agencies in the Sacramento Federal Nonattainment Area (SFNA) often look to the Sac Metro Air District for guidance on CEQA-related topics. In addition, the Sac Metro Air District partners on regional issues with nearby air districts including the following:

- Yolo-Solano Air Quality Management District;
- Placer County Air Pollution Control District;
- El Dorado County Air Quality Management District; and
- Feather River Air Quality Management District.

Sac Metro Air District staff has developed this guidance with input from the other SFNA air districts since they share air quality issues and use the same growth assumptions, mobile source emissions, and modeling efforts to support ozone and PM attainment plans. The geographic area covered by the Sac Metro Air District and the four other neighboring Air Districts listed above is referred to as the Five-Air-District Region.

This guidance is intended for use in the Sac Metro Air District, however it contains information that can be used by the partner agencies to set guidance.

This guidance document:

1. Replaces the Interim Recommendation.
2. Provides insight on the health effects that may result from a project emitting at the maximum thresholds of significance (TOS) levels in the Five-Air-District Region for oxides of nitrogen ($NO_X$), volatile organic compounds (VOCs), and PM, in addition to levels of CO and oxides of sulfur ($SO_X$) calculated proportional to $NO_X$ (as described in **Section 4.1**). This information can be used in environmental documents to provide a conservative estimate of the health effects of criteria pollutant emissions at the significance thresholds or below.
3. Provides look-up tables for estimating health effects for strategic areas where growth exceeding thresholds of significance is anticipated.
4. Provides modeling guidance for CEQA projects that have emissions in excess of the significance thresholds and are located outside the strategic areas modeled.
5. Provides information on disclosing health effects in an overall health context in a CEQA document.

# 3. ORGANIZATION OF GUIDANCE

This guidance document provides an overview of the Friant Ranch screening analyses, methods and results. **Section 4** describes the screening analysis approach and methods for projects with emissions at or below the thresholds of significance. **Section 5** describes the screening methods for projects located in strategic areas with emissions above the thresholds of significance. **Section 6** provides a general description of the recommended analysis methods for projects above the thresholds of significance suitable for planners and the public should the screening methods in **Section 4** and **Section 5** not be applicable. **Section 7** provides information on incorporating health effects information into a CEQA document and discussing overall health context. **Appendix A** provides, for practitioners skilled in the art of photochemical grid modeling and health effects analyses, recommended procedures for conducting a health effects analysis that would be expected for larger projects and for projects that do not fit the requirements described for using the screening analyses. The procedures used in conducting the health effects screening analysis for small projects are discussed in **Appendix B**. **Appendix C** discusses the screening analysis for strategic area projects. The treatment of $SO_2$ and CO emissions that do not have significant emissions levels in the screening analysis and procedures for speciating ROG and PM emissions is discussed in **Appendix D**. **Appendix E** provides a list of commonly used Source Classification Codes (SCC) for source types from typical CEQA projects. **Appendices F and G** provide health effects output for the minor project and strategic area project screening modeling.

# 4. GUIDANCE FOR SCREENING HEALTH EFFECTS ANALYSIS

## 4.1 Thresholds of Significance

The Sac Metro Air District and neighboring air districts have established thresholds of significance (TOS) for certain criteria air pollutants and their precursors. If a proposed project has an emissions rate for a pollutant that exceeds one of the TOS, then the project would be considered to have a significant air quality impact and the proponent must evaluate and implement mitigation where feasible. **Table 1** displays the TOS for the Sac Metro Air District and neighboring air districts.

**Table 1. Operational thresholds of significance for the Sac Metro Air District and neighboring air districts**

| Pollutants in lbs./day | | | | |
|---|---|---|---|---|
| **Air District** | **$NO_X$** | **ROG** | **$PM_{10}$** | **$PM_{2.5}$** |
| Sacramento | 65 | 65 | 80 | **82** |
| Placer | 55 | 55 | **82** | Not established |
| El Dorado | **82** | **82** | Cause or contribute to an exceedance of Ambient Air Quality Standards (AAQS) | Cause or contribute to an exceedance of AAQS |
| Feather River | 25 | 25 | 80 | Not established |
| Yolo Solano | 55[a] | 55[a] | 80 | Not established |

[a] 55 lbs./day is equivalent to the 10 tons/year adopted threshold.
**Red** indicates the highest emission rate among the five districts

Ramboll conducted a screening analysis to estimate the level of health effects for a proposed CEQA project that has emissions at the maximum TOS levels. In addition to the pollutants with thresholds, project emissions also included $SO_2$ and CO. $SO_2$ is a precursor to secondary $PM_{2.5}$ and CO plays a small role in the formation of ozone.

Lead agencies and CEQA practitioners can use this screening analysis to provide a conservative estimate of health effects for projects with emissions at the TOS or below.

## 4.2 Overview of Health Effects Analysis

This section presents a general overview of the procedures for conducting a health effects analysis of a project that satisfies the requirements of the Friant Ranch court decision to disclose adverse health effects resulting from a CEQA project. The first step in the process is to run a photochemical grid model (PGM) to assess the increases in ambient air concentrations of pollutants that the project emissions may cause. PGMs require a database of information, including meteorology and the spatial and temporal allocation of emissions in the area to be modeled. This includes both existing emissions and the emissions of the particular project being evaluated. The next step is to put the increases in concentrations from the PGM that result from the project's emissions into the Benefits Mapping and Analysis Program (BenMAP), a U.S. Environmental Protection Agency (USEPA) tool that estimates health impacts from ozone and $PM_{2.5}$. More discussion of the procedures to conduct a health effects analysis are provided in **Section 6** of this guidance, with technical details provided in **Appendix A**.

## 4.3 Screening Analysis for Projects at or Below Thresholds Levels

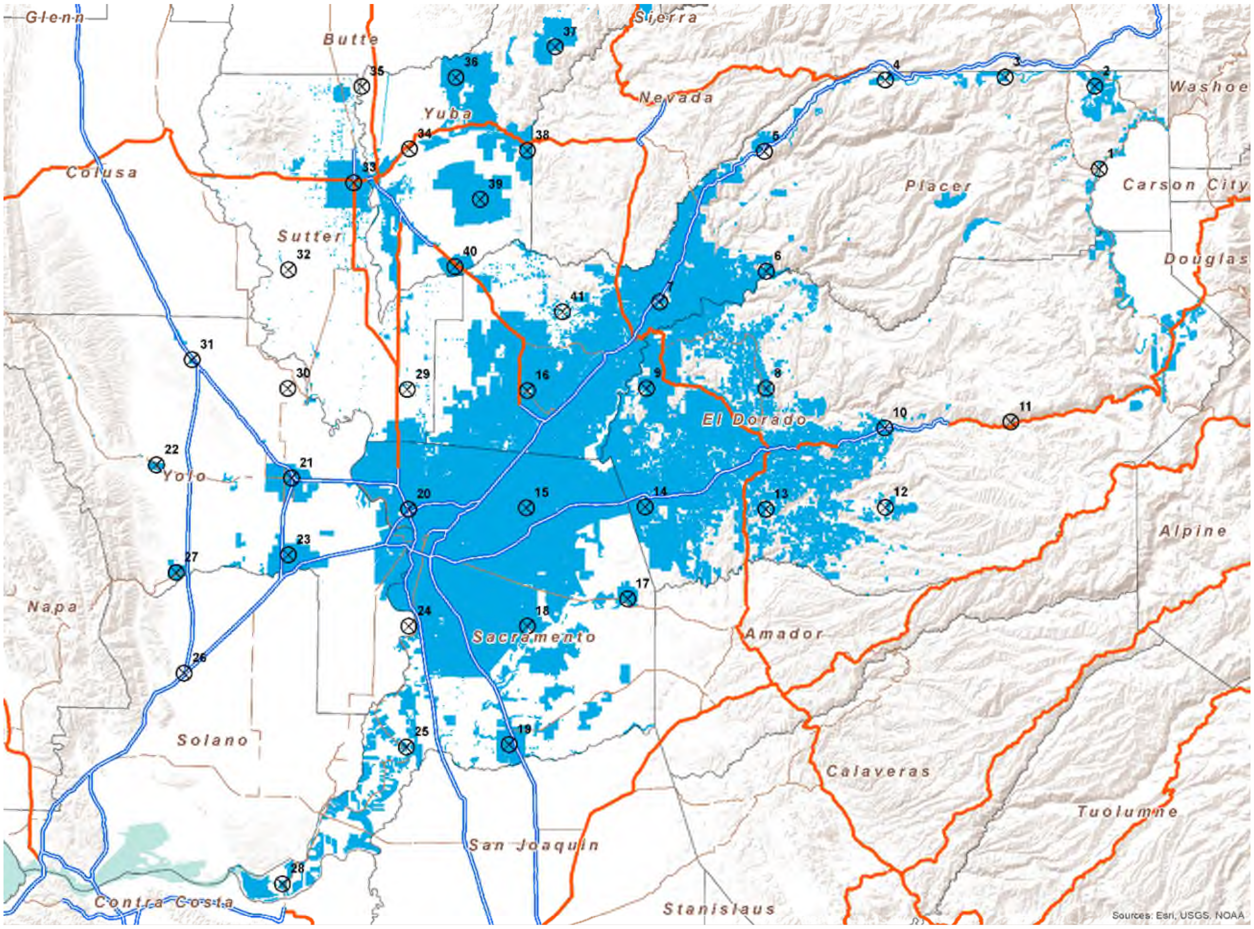
A health effects screening analysis was conducted for hypothetical sources within the Sac Metro Air District and neighboring air districts (i.e., the Five-Air-District Region) using emission rates at the thresholds of significance (noted in **Table 1**). The hypothetical source locations were intended to be proxy locations for where real projects may be located.

### 4.3.1 Definition of Hypothetical Project Sources for Screening Analysis

Each hypothetical source was assumed to have an emission rate for each pollutant at the threshold of significance, indicated by the red numbers in **Table 1**. This resulted in an emission rate of 82 lbs./day for $NO_X$, ROG, $PM_{2.5}$ and $PM_{10}$. The hypothetical sources also included emission rates of CO and $SO_2$ that were based on an analysis of the ratios of the emission rates of $SO_2$ to $NO_X$ and CO to $NO_X$ for six recent CEQA projects in Sacramento County. This analysis is described in **Appendix D**.

**Figure 1** shows the geographic areas in which the Sac Metro Air District expects CEQA projects to be located in Sacramento and neighboring counties (shaded blue), along with the locations of the 41 hypothetical projects. These expected growth areas are consistent with the Sacramento Area Council of Government's 2050 Blueprint growth map. The 41 hypothetical projects were distributed across the potential growth areas to capture the differences in the dispersion regimes of the mountain/valley flow systems, photochemical regimes, areas which include high and low emissions levels, urban and rural atmospheres, and population densities of the urban versus remote areas.

**Figure 1. Potential CEQA project locations (blue shading) in the five-air-district region along with locations of the 41 hypothetical project locations used in the screening modeling.**



## 4.3.2 Screening Analysis Health Effects Modeling

For the screening analysis, the Comprehensive Air Quality Model with Extensions (CAMx) PGM was used with a 2012 annual 4-km grid resolution meteorological and emissions database for a domain covering Sacramento and nearby counties. The 2035 future year anthropogenic (i.e., human-made) emissions were used as the baseline. The ozone and PM impacts were estimated from each of the 41 hypothetical sources whose emissions were set at the 82 lbs./day TOS level for ROG, $PM_{2.5}$ and $NO_X$ and corresponding levels of CO and $SO_2$. Health effects were estimated for each of the 41 hypothetical sources using a simulator of USEPA's BenMAP health effects model with the concentration-response (C-R) functions, 2035 population, and procedures described in **Appendix A** (see **Tables A-1** and **A-2**). This guidance recommends assessing mortality (all causes), hospital admissions (respiratory, asthma, cardiovascular), emergency room visits (asthma), and acute myocardial infarction (non-fatal) health effects for $PM_{2.5,}$ and assessing mortality, emergency room visits (respiratory) and hospital admissions (respiratory) health effects for ozone, consistent with the USEPA's approach when establishing the National Ambient Air Quality Standards (NAAQS)[1].

As an example, **Table 2** displays the health effects for PM and ozone increases resulting from hypothetical source location number 20 (see **Figure 1** for location map). The analysis estimates that a project at hypothetical source location number 20, emitting 82 lbs./day of $NO_X$, ROG and PM and corresponding levels of CO and $SO_2$, would have 2.3 premature deaths (mortality, all causes) per year across the modeling domain (see Appendix A, Table A-1 and Appendix B, Figure B-2 for the Reduced Sacramento 4-km Modeling Domain specifications and map) and 2.1 premature deaths per year within the Five-Air-District Region due to its increases in PM concentrations. To put this health effect into context, **Table 2** also includes the increase over the background health incidence rate of each health effect endpoint within the Five-Air-District Region. For hypothetical source location number 20, the 2.1 premature deaths per year within the Five-Air-District Region due to the project's PM impacts would result in a very small (0.005%) increase over the background incidence of premature deaths due to PM concentrations within the Five-Air-District Region, which is 44,766 deaths per year.

The PM and ozone health effects due to emissions from each of the 41 hypothetical source locations are provided in **Appendix F**.

---

[1] https://www3.epa.gov/ttn/naaqs/standards/pm/data/PM_RA_FINAL_June_2010.pdf.

**Table 2. Health effects for hypothetical project number 20 produced by EPA's BenMAP program (see Appendix F for health effects of all 41 hypothetical projects).**

| BenMAP | | | | | |
|---|---|---|---|---|---|
| **Run with PopGrid populations - Source 20** | | | | | |
| **PM$_{2.5}$ Health Endpoint** | **Age Range*** | **Incidences Across the Reduced Sacramento 4-km Modeling Domain Resulting from Project Emissions (per year)** | **Incidences Across the 5-Air-District Region Resulting from Project Emissions (per year)** | **Percent of Background Health Incidences Across the 5-Air-District Region**** | **Total Number of Health Incidences Across the 5-Air-District Region (per year)**** |
| | | **(Mean)** | **(Mean)** | | |
| Emergency Room Visits, Asthma | 0 - 99 | 1.45 | 1.36 | 0.0074 | 18419 |
| Mortality, All Cause | 30 - 99 | 2.29 | 2.06 | 0.0046 | 44766 |
| Hospital Admissions, Asthma | 0 - 64 | 0.097 | 0.092 | 0.0050 | 1846 |
| Hospital Admissions, All Cardiovascular (less Myocardial Infarctions) | 65 - 99 | 0.19 | 0.17 | 0.00071 | 24037 |
| Hospital Admissions, All Respiratory | 65 - 99 | 0.34 | 0.30 | 0.0015 | 19644 |
| Acute Myocardial Infarction, Nonfatal | 18 - 24 | 0.00013 | 0.00012 | 0.0032 | 4 |
| Acute Myocardial Infarction, Nonfatal | 25 - 44 | 0.012 | 0.012 | 0.0038 | 308 |
| Acute Myocardial Infarction, Nonfatal | 45 - 54 | 0.025 | 0.024 | 0.0032 | 741 |
| Acute Myocardial Infarction, Nonfatal | 55 - 64 | 0.040 | 0.038 | 0.0031 | 1239 |
| Acute Myocardial Infarction, Nonfatal | 65 - 99 | 0.12 | 0.11 | 0.0022 | 5052 |

| | | | | | |
|---|---|---|---|---|---|
| **Ozone Health Endpoint** | **Age Range*** | **Incidences Across the Reduced Sacramento 4-km Modeling Domain Resulting from Project Emissions (per year)** | **Incidences Across the 5-Air-District Region Resulting from Project Emissions (per year)** | **Percent of Background Health Incidences Across the 5-Air-District Region**** | **Total Number of Health Incidences Across the 5-Air- District Region (per year)**** |
| | | **(Mean)** | **(Mean)** | | |
| Hospital Admissions, All Respiratory | 65 - 99 | 0.085 | 0.065 | 0.00033 | 19644 |
| Mortality, Non-Accidental | 0 - 99 | 0.053 | 0.043 | 0.00014 | 30386 |
| Emergency Room Visits, Asthma | 0 - 17 | 0.46 | 0.39 | 0.0066 | 5859 |
| Emergency Room Visits, Asthma | 18 - 99 | 0.72 | 0.61 | 0.0049 | 12560 |

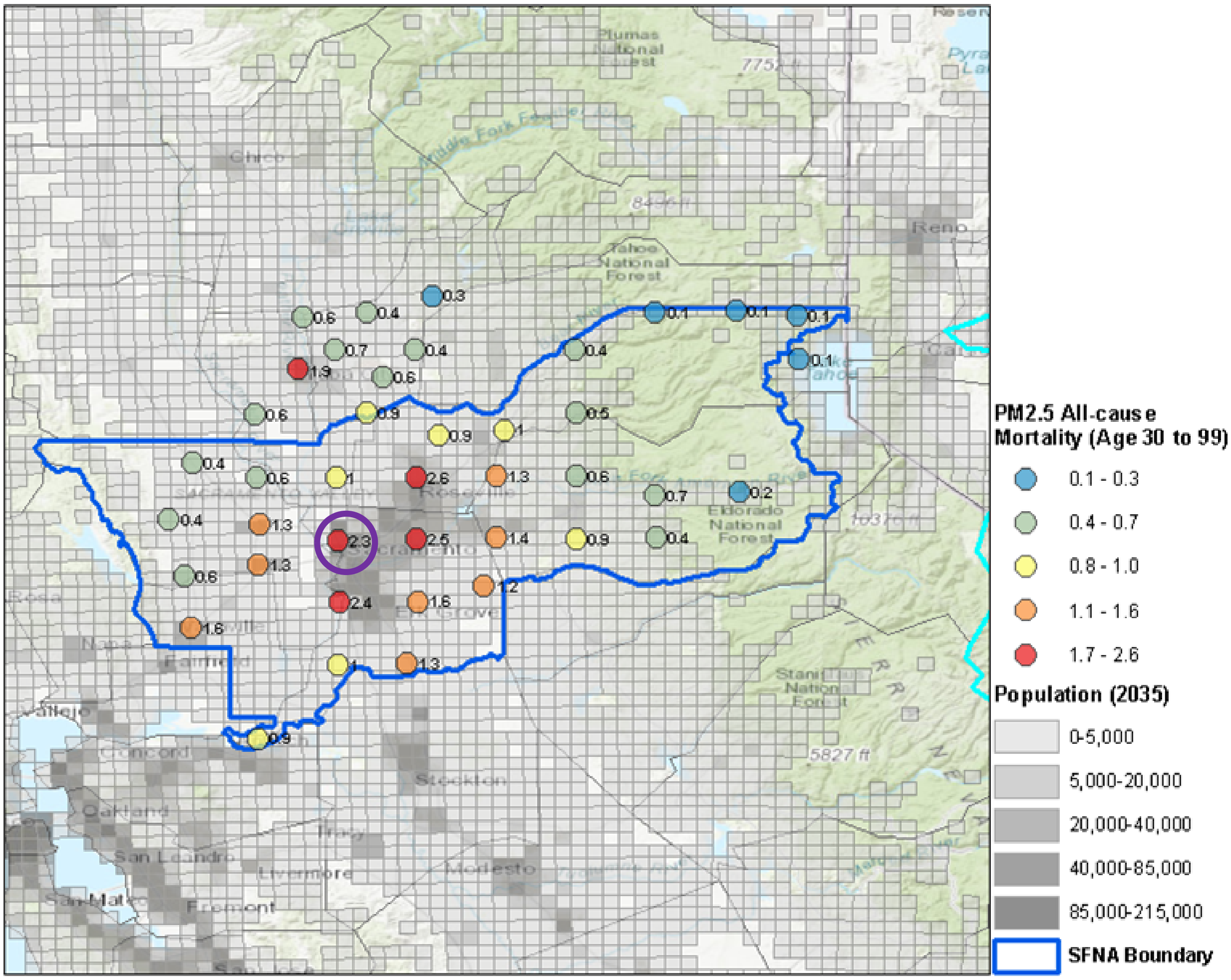
* Other age ranges are available, but the studies shown here are the ones used by the EPA in its health assessments. The age ranges are consistent with each epidemiological study that is the basis of the health function.

** The percent of background health incidence uses the mean incidence. The background health incidence is an estimate of the average number of people that are affected by the health endpoint in a given population over a given period of time. In this case, these background incidence rates cover the Five-Air-District Region. Health incidence rates and other health data are typically collected by the government as well as by the World Health Organization. The background incidence rates used here are obtained from BenMAP.

**Figure 2** is a map that displays the estimated number of premature deaths across the modeling domain that may result from increases in PM concentrations from the $NO_X$, $PM_{2.5}$ and $SO_2$ emissions at each of the 41 hypothetical project locations. The estimated PM premature deaths range from 0.1 to 2.6. Also shown in **Figure 2** are the gridded population amounts in 2035 used in the health effect estimates. Premature death and other health effects are greatest for those sources located near high population areas. For example, there are three hypothetical sources in Sacramento County that have estimated PM premature deaths greater than 2, whereas all of the other hypothetical source estimated PM premature deaths are less than 2. The three Sacramento County hypothetical sources include source number 20 in the northwestern portion of Sacramento County (near Interstate 5 and Interstate 80), used for the example results shown in **Table 2**.

For a project with emissions below the thresholds of significance, the health effects will be lower than presented here.

**Figure 2. Premature deaths resulting from PM at 41 hypothetical project locations on a population base map with SFNA boundary outline. Location of hypothetical source number 20, whose results were presented in Table 2, is shown by the purple circle.**



### 4.3.3 Minor Project Health Effects Screening Tool

The health effects of the 41 hypothetical sources were interpolated to the 4-km modeling domain and imported into an interactive spreadsheet into which the user can input the project location and obtain the estimated health effects information for a source with TOS emission rates at that location. Projects with emissions lower than the TOS would have lower estimated health effects.

The Minor Project Health Effects Screening Tool is available on the Sac Metro Air District's CEQA Guidance & Tools website.

# 5. TREATMENT OF PROJECTS THAT EXCEED THRESHOLDS IN STRATEGIC AREAS

To estimate the health effects of potential projects with emissions greater than the thresholds of significance emission rates and located in strategic areas, additional health effects screening modeling was conducted, and the results were used to develop a Strategic Area Health Effects Screening Tool. This screening analysis is discussed briefly below, with details provided in **Appendix C**.

## 5.1 Strategic Area Project Screening Modeling

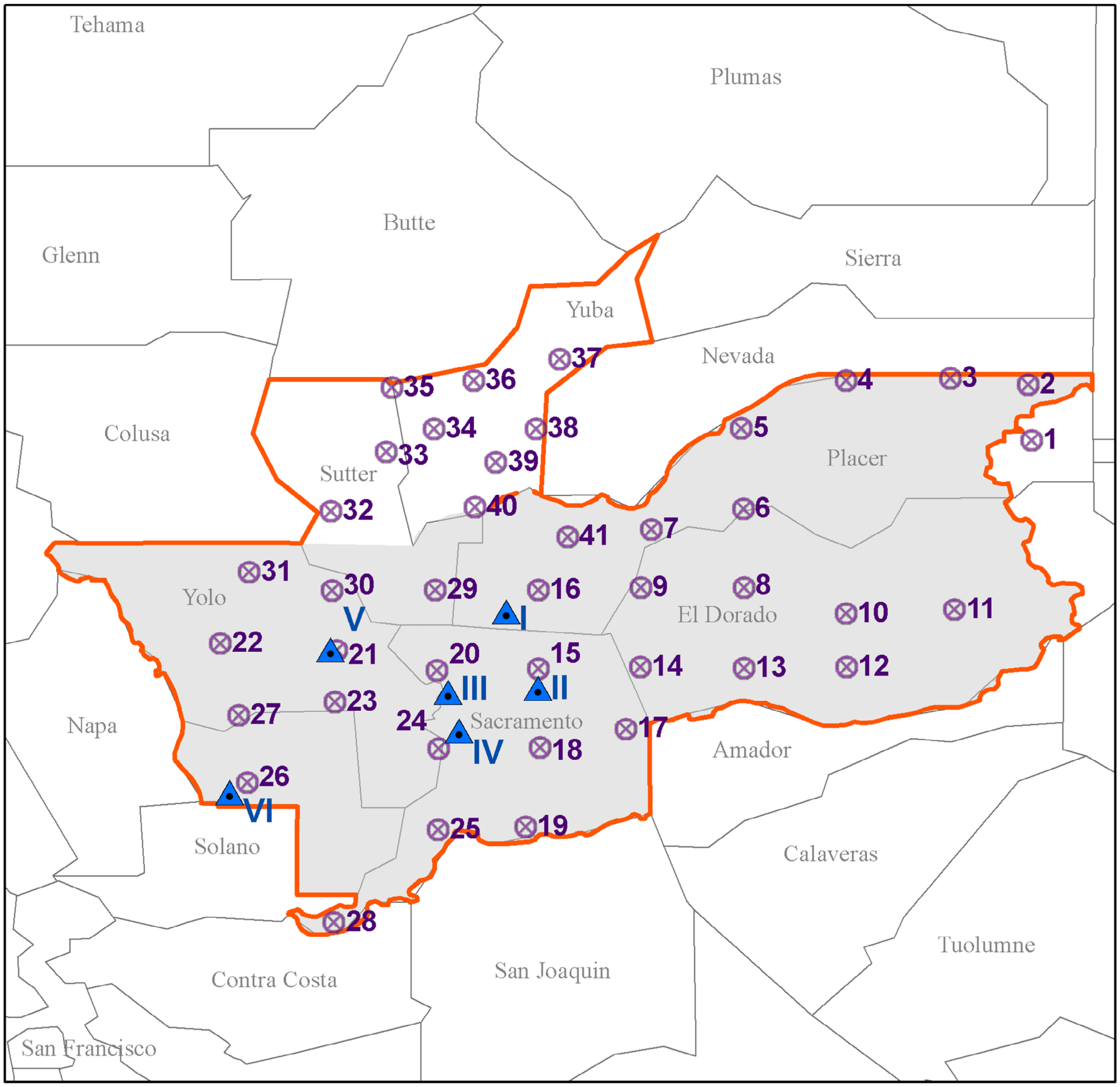
The Sac Metro Air District provided six potential strategic area project locations for use in the health effects screening modeling. These six locations are intended to be used as proxy locations for nearby projects exceeding the thresholds of significance. The six locations are listed in **Table 3** and shown in **Figure 3**.

**Table 3. Coordinates for 6 hypothetical strategic area projects.**

| ID | Name | Latitude | Longitude | Location |
|---|---|---|---|---|
| I | West Roseville | 38.765833 | -121.359299 | Fiddyment Road & Pleasant Grove Boulevard |
| II | Rancho Cordova | 38.588080 | -121.286765 | Zinfandel Drive & White Rock Road |
| III | Downtown Sacramento | 38.579336 | -121.494119 | 10th Street & K Street |
| IV | South Sacramento | 38.490489 | -121.468468 | Florin Road & Franklin Boulevard |
| V | Woodland | 38.677388 | -121.765759 | Main Street & East Street |
| VI | Vacaville | 38.347954 | -121.998058 | Merchant Street & Lincoln Highway |

**IMPORTANT NOTE:** Prior to using the Strategic Area Project Health Screening Tool, project proponents should confirm with Sac Metro Air District staff that one of the strategic area project locations is appropriate for use as a proxy. If a project is located outside of Sacramento County, the project proponent should check with the applicable air district.

**Figure 3. Locations of six strategic area Projects I-VI used in the screening modeling, along with the 41 hypothetical projects used in the minor project analysis with boundary of the Five-Air-District Region (red) and the SFNA shaded grey.**



The screening modeling addressed hypothetical sources at each of the six strategic area project locations at emission levels that were two times (2x) and 8 times (8x) the maximum threshold of significance level (see **Table 1**). The strategic area projects also included CO and $SO_2$ emissions and speciated ROG and PM emissions using the same approach as used in the 41 hypothetical minor project analysis (see **Appendix D**). The strategic area project screening modeling emissions rates used are shown in **Table 4**.

**Table 4. Levels of emissions proposed for evaluating strategic area projects that are 2 and 8 times the maximum threshold of significance**

| Pollutant | Emissions (lbs./day) | |
|---|---|---|
| | 2xTOS | 8xTOS |
| $NO_X$ | 164 | 656 |
| $PM_{2.5}$ | 164 | 656 |
| ROG | 164 | 656 |
| $SO_2$ | 1.96 | 7.84 |
| CO | 524 | 2096 |

Two annual CAMx ozone and PM source apportionment model simulations were conducted for the 2012 calendar year; 2035 future year anthropogenic (i.e., human-made) emissions were used as the baseline emissions. The following future-year anthropogenic emissions were used: (1) six projects at 2xTOS emissions; and (2) six projects at 8xTOS emissions. Emissions from each of the six projects were tagged for treatment by the CAMx ozone and PM source apportionment tool. The incremental ozone and $PM_{2.5}$ contributions of each of the six projects at the two levels of emissions were used with the BenMAP tool to estimate health effects, with results shown in **Appendix G**. BenMAP was run to obtain ozone and $PM_{2.5}$ health effects from each of the precursor emissions (i.e., $NO_X$, ROG and PM) separately, which allows the user to obtain only the health results associated with the pollutant with emissions above the threshold.

## 5.2 Strategic Area Project Health Effects Screening Tool

The strategic area project screening modeling health effects were used to develop a Strategic Area Projects Health Effects Screening Tool spreadsheet that can be used to estimate health effects for potential projects with emissions below the 8xTOS level. The Strategic Area Project Health Effects Screening Tool has two interactive components that need to be specified by the user:

1. Project Location: The user selects one of the six strategic area project locations (see **Table 3** and **Figure 3**) from a dropdown menu so that the spreadsheet uses the strategic area project health effects screening modeling results for that location.
2. Project Emissions: The user inputs the $NO_X$, ROG and $PM_{2.5}$ emissions in pounds/day for the potential project. The tool linearly interpolates the ozone and PM health effects for the selected project location from the 2xTOS and 8xTOS CAMx/BenMAP modeling.

If the user inputs any one of the $NO_X$, ROG or PM emissions below the 2xTOS emissions rate, then the health effects for the 2xTOS emissions level for that precursor is used to provide a conservative estimate of health effects. If the user inputs one or more emission rates above the 8xTOS level, the tool outputs an error message that one or more of the emission rates provided is too high to use the tool.

The Strategic Area Project Health Effects Screening Tool can be obtained on the Sac Metro Air District's CEQA Guidance & Tools website.

### 5.3 Recommendations for Using the Strategic Area Projects Health Effects Screening Tool

The Strategic Area Health Effects Screening Tool can provide an estimate of the health effects for a CEQA project within the Sac Metro Air District and the 5-Air-District Region with 656 lbs/day or less of NOx, ROG and $PM_{2.5}$ emissions. If the proposed CEQA project is within close proximity (e.g., within one 4-km grid cell) of one of the six strategic area source locations, a project proponent can discuss using the health effects from the Tool at that strategic area location with concurrence from the Sac Metro Air District, or applicable air district if the project is located outside of Sacramento County. If the project is located within the Sac Metro Air District, but is not in close proximity to one of the six strategic area source locations, then the project proponent may use the health effects results from the South Sacramento strategic area location as that will provide a conservative (i.e., upper bound) estimate of the potential health effects of the project, since the South Sacramento strategic area is located in the highest population area in the 5-Air-District Region. If a project is located outside of Sacramento County, the project proponent should confirm this approach with the applicable air district. Alternatively, the project proponent can conduct explicit photochemical grid and health effects modeling following the procedures in section 6 and Appendix A of this guidance.

# 6. ANALYSIS OF INDIVIDUAL PROJECTS

For a practitioner skilled in the art of photochemical grid modeling and health effects analysis, **Appendix A** provides detailed guidance on how to conduct a health effects analysis for an individual project in Sacramento County, and potentially in the Five-Air-District Region, with input from the applicable air district**.** This section provides a layperson's description of this approach. While the approach outlined in this section can be used for any project, this guidance document allows a screening approach for projects within Sacramento County and the Five-Air-District Region in which emissions of VOC, $NO_X$ and PM are equal to the maximum thresholds of significance or lower, and provides look-up tables for larger projects in designated strategic areas. Therefore, this individual project modeling guidance should only be used for larger projects outside the designated strategic areas to prepare a site-specific health effects analysis.

In order to estimate the health effects of the increases of criteria pollutants from a proposed project, practitioners should apply a photochemical grid model (PGM) to estimate the increases in concentrations of ozone and $PM_{2.5}$ in the region as a result of the emissions of criteria and precursor pollutants from a project. Next, apply the U.S. Environmental Protection Agency (USEPA)-authored program, the Benefits Mapping and Analysis Program (BenMAP[2]), to estimate the resulting health effects from the increases in concentration. This process is described further below.

## 6.1 Pollutants Evaluated

This analysis estimates the health effects of criteria pollutants and their precursors, specifically those health effects that are evaluated by the USEPA in rulemaking setting the NAAQS: $NO_X$, VOC [also known as reactive organic gases, or ROG, which are virtually the same as VOC with some slight differences][3], CO, ozone, $SO_2$, $PM_{2.5}$ and $PM_{10}$. USEPA's default health effects functions in BenMAP for PM use $PM_{2.5}$ as the causal PM agent, so the health effects of $PM_{10}$ are represented using $PM_{2.5}$ as a surrogate. $NO_X$ and VOC are not criteria air pollutants but, in the presence of sunlight, they form ozone and contribute to the formation of secondary $PM_{2.5}$ and thus are analyzed here. As a conservative measure, $SO_2$ and CO are evaluated due to their small contribution to the formation of secondary $PM_{2.5}$ and ozone, respectively.

This guidance recommends that the health effects from ozone and $PM_{2.5}$ be evaluated, because the USEPA has determined that these criteria pollutants would have the greatest effect on human health. While ozone is not commonly emitted directly, some $PM_{2.5}$ is emitted directly. Ozone and secondary $PM_{2.5}$ are formed by the emissions of other pollutants to the atmosphere, including VOC, $NO_X$, CO and $SO_2$.

Additionally, $SO_2$, $NO_2$ and CO concentration changes due to a project are not evaluated individually. Each of these pollutants has NAAQS against which the presence or absence of health effects can be measured, and none of these pollutants are typically considered to be formed in the atmosphere as secondary pollutants, as are ozone and $PM_{2.5}$. NAAQS are health-based thresholds and thus a direct comparison with them allows evaluation of

---

[2] https://www.epa.gov/benmap/benmap-ce-manual-and-appendices.

[3] ROG emissions are quantified and modeled as VOCs in this assessment. ROG means total organic gases minus ARB's "exempt" compounds (e.g., methane, ethane, CFCs, etc.). ROG is similar, but not identical, to USEPA's term "VOC", which is based on USEPA's exempt list, which is slightly different from ARB's list.

potential health effects. $NO_2$ concentration changes are not individually evaluated as there are currently no $NO_2$ non-attainment areas in the United States, even now that the 1-hour standard has been implemented. Similarly, $SO_2$ concentration changes are also not individually evaluated as there are no current $SO_2$ non-attainment areas in the state of California. Sac Metro Air District has been in attainment of the NAAQS and State CO standards since the early 1990s. Even so, as noted above, contributions of $NO_X$, CO, and $SO_2$ continue to be evaluated for their contributions to the formation of ozone and secondary $PM_{2.5}$, the two criteria pollutants the USEPA has determined to have the greatest effect on human health.

## 6.2 Technical Analysis

The first step in the technical analysis is to run the PGM with appropriate information to assess the increases in ambient air concentrations of pollutants that the project's emissions may cause. PGMs require a database of information, including meteorological fields and how emissions are distributed in the area to be modeled. This includes both existing emissions and project emissions. The latest publicly-available PGM database for Northern California should be used in this analysis.

The USEPA's air quality modeling guidelines (Appendix W[4]) and ozone and $PM_{2.5}$ modeling guidance[5] recommend using a PGM to estimate ozone and secondary $PM_{2.5}$ concentrations. The USEPA's modeling guidance does not recommend specific PGMs but provides procedures for determining an appropriate PGM on a case-by-case basis. Both the modeling guidelines and guidance note that the CAMx[6] and the Community Multiscale Air Quality (CMAQ)[7] PGMs have been used extensively in the past and would be acceptable PGMs. The USEPA has prepared a memorandum[8] documenting the suitability of using CAMx and CMAQ for ozone and secondary $PM_{2.5}$ modeling of a single-source or small group of sources.

To estimate the potential outcome of a proposed project's emissions on ambient pollutant concentrations, add the project's mitigated emissions to the existing emissions in the PGM database. Ensure that the project emissions that are analyzed present a maximum year. Construction emissions could be included in the analysis if the lead agency determines the size, intensity, and duration of construction warrant review and disclosure. These maxima may occur in different years but may be conservatively analyzed in a single-year assessment. Consider when the maximum emissions year will have the greatest impact. It is recommended that maximum 24-hour emission rates be used, as some of the C-R health effects functions use daily concentration estimates. Account for seasonal changes in maximum 24-hour emissions when appropriate, such as when wood stoves or fireplaces are used for home heating in the cold months.

Each project's emissions should be spatially distributed across the modeling area in a manner that reflects the actual distribution, considering where mobile source emissions may occur. Operational emissions may include area sources (architectural coatings, VOCs in

---

[4] https://www3.epa.gov/ttn/scram/appendix_w/2016/AppendixW_2017.pdf.

[5] https://www3.epa.gov/ttn/scram/guidance/guide/O3-PM-RH-Modeling_Guidance-2018.pdf.

[6] http://www.camx.com/.

[7] https://www.epa.gov/cmaq.

[8] https://www3.epa.gov/ttn/scram/guidance/clarification/20170804-Photochemical_Grid_Model_Clarification_Memo.pdf.

consumer products, and landscaping equipment), emergency generators, off-road equipment, and emissions associated with motor vehicle use. Construction emissions may include off-road equipment, paving, architectural coatings, fugitive dust, and emissions associated with hauling, vendor, and worker activity.

Following completion of the PGM modeling, use USEPA's BenMAP[9, 10] program to estimate the potential health effects of the project's contribution to ozone and $PM_{2.5}$ concentrations. BenMAP uses the concentration estimates produced by the PGM along with population and health effect C-R functions to estimate various health effects of the concentration increases. BenMAP has a wide history of applications by the USEPA and others, including for local-scale analyses[11] as needed to assess the health effects of a project's emissions. Use the USEPA default BenMAP health effects C-R functions that are typically used in national rulemaking, such as the health effects assessment[12] for the 2012 $PM_{2.5}$ NAAQS. The guidance recommends assessing the following health effects for $PM_{2.5:}$ mortality (all causes), hospital admissions (respiratory, asthma, cardiovascular), emergency room visits (asthma), and acute myocardial infarction (non-fatal). For ozone, the guidance recommends the following endpoints: mortality, emergency room visits (respiratory) and hospital admissions (respiratory).

The procedures outlined in **Appendix A** are designed to provide guidance to a practitioner with experience in PGM modeling to conduct a health effects analysis that satisfies the requirements of the Friant Ranch court decision. Consequently, the guidance assumes a level of knowledge of PGM and health effects modeling and is not designed for those not familiar with PGM and health effects modeling.

---

[9] https://www.epa.gov/benmap/how-benmap-ce-estimates-health-and-economic-effects-air-pollution.

[10] https://www.epa.gov/sites/production/files/2015-04/documents/benmap-ce_user_manual_march_2015.pdf.

[11] https://www.epa.gov/benmap/benmap-ce-applications-articles-and-presentations#local.

[12] https://www3.epa.gov/ttn/naaqs/standards/pm/data/PM_RA_FINAL_June_2010.pdf.

# 7. DISCLOSING MODELING RESULTS IN A PROJECT CEQA DOCUMENT

Now that photochemical grid modeling and BenMAP analyses have been conducted for minor projects at the maximum threshold levels at 41 locations in the five-air-district area, and for projects greater than threshold levels (2x and 8x) for 5 strategic growth areas, an analysis of the results must be developed for disclosure in a project CEQA document. Only the health effects of ozone and $PM_{2.5}$ are addressed in this guidance, as those are the pollutants that USEPA uses in BenMAP to estimate the health effects of emissions of NOx, VOCs, CO, $SO_2$, and $PM_{2.5}$. Ozone and $PM_{2.5}$ have the most critical health effects and thus are the emissions evaluated to determine the CEQA project's health effects. A CEQA analysis should report the results generated by the Minor Project Health Effects Screening Tool, Strategic Area Project Health Effects Screening Tool (example output in **Table 2**), or project specific modeling, and qualitatively discuss how the health effects tool provides an average estimate across all populations. Note that CEQA "does not require technical perfection in an EIR, but rather adequacy, completeness, and a good-faith effort at full disclosure."[13] To this end, the environmental document will be improved in its sufficiency as an informational document if it includes a *qualitative* discussion of influences on the outcomes of modeling the health effects of projects. These factors may apply *universally* to the health effects on the total population or be *limited in application* to population subgroups.

## 7.1 Discussing Health Effects on the Total Population

Present the applicable screening table for the project and **frame the model's outputs in terms of the wider context of current population health**. Provide this wider context for the results by describing overall health conditions in the county. This can be done by using other data sources, which might include:

- Be Healthy Sacramento[14], which provides a search of and comparisons of local health indicators.
- The California Department of Public Health, which provides County Health Status Profiles.[15]
- The California Air Resources Board's lists of health tracking websites, which provide community health trends.[16]

As an example of how to use this data, Sacramento County's Health Status Profile for 2019 reported an annual average of 11,551 deaths from all causes (2015-2017) in Sacramento County. This can be compared to a project with emissions at or below the thresholds of significance for which the screening tool indicates that the potential increase in mortality incidence is less than 3 in the Five-Air-District Region.

---

[13] *2020 CEQA Statute & Guidelines Handbook* https://www.califaep.org/statute_and_guidelines.php, Association of Environmental Professionals, CEQA Guidelines Section 15003, Policy (i), p. 136. Accessed 4/28/20

[14] *Be Healthy Sacramento,* Sacramento County, 2020, www.behealthysacramento.org. Accessed 3/9/2020

[15] *Vital Records Data and Statistics*, California Department of Public Health, 2020, https://www.cdph.ca.gov/Programs/CHSI/Pages/County-Health-Status-Profiles.aspx. Accessed 3/9/2020

[16] *Understanding the Health of Our Communities,* California Air Resources Board, 2020, https://ww2.arb.ca.gov/resources/documents/understanding-health-our-communities. Accessed 3/13/2020

Also consider that overall, **each model generates *conservative* estimates of health effects**, for two reasons:

- **The tools' outputs are based on the simulation of a *full year* of exposure at the maximum daily average** of the increases in air pollution concentrations. As a result, actual project-related health effects may be *less* than the estimates calculated by the tool. For more information on how the CAMx modeling was prepared to estimate ozone and $PM_{2.5}$ emission concentration changes due to a project's emissions, and the resulting conservative nature of the health effects modeling using the BenMAP model, please see Section A.4 of **Appendix A**.
- **The health effects are calculated for emissions levels that are very high**. For the Minor Projects Health Effects Tool, described in Section 4, emissions are assumed to be *at* the threshold of significance levels. The Minor Projects Health Effects Screening Tool estimates the mean incidence of health outcomes such as mortality, hospital admissions, emergency room visits and heart attacks (acute myocardial infarction) in the Five-Air-District Region that may result from emissions from a new project that emits 82 pounds/day of NOx, ROG or PM. For the Strategic Area Project Health Effects Tool, described in Section 5, inputted emissions are between *two times* and *eight times* the threshold of significance (up to 656 pounds/day). The Strategic Area Project Health Effects Screening Tool focuses the analysis in six locations where growth is expected from projects with emissions above thresholds levels. Most projects, except for large plans such as specific plans, will not have emissions at these high levels.

**However, even with these conservative factors built in, the models' outputs indicate low overall health effects.** The mean health incidence for a project emitting at the threshold of significance levels at all 41 locations was less than 3 per year for mortality and less than 1.5 per year for other health outcomes evaluated. The modeling results support a conclusion that any one proposed project in the Five-Air-District Region with emissions at or below the maximum threshold levels does not on its own lead to sizeable health effects. At the strategic area locations, as expected, mean health incidences are higher than the Minor Projects Health Effects Screening Tool. The maximum reported mortality rate is 22 incidences per year and all other health outcomes evaluated are under 9 per year from a project emitting 656 pounds/day of NOx, ROG, and PM at the downtown Sacramento location.

**On the other hand, projects may produce other health effects that are not evaluated in the models.** These can be discussed as well.

- **The models' outputs include only the effects that have been researched sufficiently so as to be quantifiable**. Research has identified other health effects for both $PM_{2.5}$ and ozone than those indicated in the models.
  - For $PM_{2.5}$, modeled health outcomes include respiratory effects, cardiovascular effects, and premature mortality. But $PM_{2.5}$ through various modes of action can alter not only respiratory and cardiovascular systems, but also metabolism, affecting weight gain and increasing diabetes rates; the nervous system, leading to cognitive decline, brain inflammation, and reduced brain volume; and gestation, resulting in

low birthweight and preterm birth.[17] These other effects have been documented but not been studied sufficiently to identify a dose-response relationship.

- For ozone, the health consequences reported by these models include respiratory effects and premature mortality. In the screening models, project health effects resulting from ozone are considerably smaller than those of $PM_{2.5}$. Ozone is primarily a respiratory system irritant, but at sufficient doses, ozone can increase lung permeability, increasing their susceptibility to toxins and microorganisms.[18] Long-term exposure to ozone may cause permanent lung damage, such as abnormal lung development in children, and has also been linked to cardiovascular effects, but less is known than for $PM_{2.5}$ about the concentrations at which these effects occur.[19]

## 7.2 Discussing Health Effects in Population Subgroups

The models estimate increases in the incidence of health effects in the entire population of the Five-Air-District Region. The model outputs are derived from the numbers of people who would be affected by a project due to their geographic proximity and based on an *average population* throughout the Five-Air-District Region. **The models do not take into account population subgroups with greater vulnerabilities to air pollution, except for ages for certain endpoints.** The health effects of increased air pollution emissions may occur disproportionately in areas where the population is more susceptible to health effects from air pollution.

The Centers for Disease Control and Prevention (CDC)[20] reports human health being influenced by five main determinants: genetics, behavior, environmental and physical influences, medical care, and social factors. These five determinants of health are seen in **Figure 4**. BenMAP estimates the potential health effects from a change in air pollution concentrations, but does not fully account for other factors impacting health such as access to medical care, genetics, income levels, behavioral choices such as diet and exercise, and underlying health conditions. As an environmental factor, air pollutants have been linked to multiple health effects, with greater impacts on vulnerable populations.[21] Vulnerable populations are those defined by environmental sensitivity factors such as age, race/ethnicity, levels of education and income, and linguistic isolation.[22]

---

[17] *Particulate Matter: Spotlight on Health Protection. Symposium Summary: Health Effects and Exposures and Risk. October 29, 2019*. Bay Area Air Quality Management District. https://www.baaqmd.gov/~/media/files/board-of-directors/advisory-council/2019/20191028-pm-symposium-summary-final-03062020-pdf.pdf?la=en. Accessed 4/28/20.

[18] *Facts About Ozone and Health,* California Air Resources Board, 2016, https://ww3.arb.ca.gov/research/aaqs/caaqs/ozone/ozone-fs.pdf Accessed 4/17/20

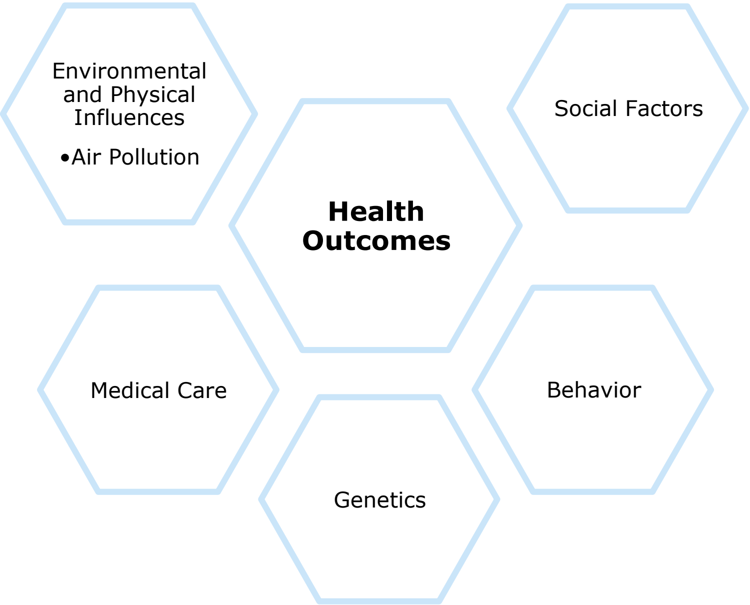
[19] *Ozone and Oxidants,* Health Effects Institute, https://www.healtheffects.org/air-pollution/ozone-and-oxidants, 2020. Accessed 4/9/2020

[20] *NCHHSTP Social Determinants of Health*, U.S. Centers for Disease Control and Prevention, 2019, https://www.cdc.gov/nchhstp/socialdeterminants/faq.html#what-are-social-determinants . Accessed 4/13/2020

[21] *People at Risk,* California Air Resources Board, 2020, https://ww2.arb.ca.gov/our-work/programs/people-risk/about. Accessed 4/14/2020

[22] *Climate Change and Health Vulnerability Indicators for California,* California Department of Public Health, April 2020. https://www.cdph.ca.gov/Programs/OHE/Pages/CC-Health-Vulnerability-Indicators.aspx. Accessed 4/29/20

**Figure 4. Five main determinants that affect human health (Source: CDC).**



The CDC has made it a priority nationally to achieve health equity, eliminate disparities, and improve the health of all groups.[23] One of the health disparities observable in the effects of air pollution is that increases in $PM_{2.5}$ and ozone concentrations lead to a *greater risk of death for racial minorities and people with low income* than for the rest of the population, even when the concentrations are lower than the national standards.[24] Communities that are home to high numbers of low-income and minority populations are often *environmental justice* (EJ) areas where a history of unfavorable decisions has led to greater concentrations of air pollution and other negative environmental factors than in higher-income areas. In EJ areas, not only are the residents exposed to higher levels of negative environmental factors, but because of the chronic stressors inherent in a life with limited resources and other factors that increase their susceptibility, they are less resilient to environmental influences on health. As a result, emissions from a new project will be experienced more severely in low-income and minority communities than in wealthier areas. The tool outputs health effects in regional averages. The number of health incidences that result from an increase in air pollution will not likely be higher than what the model estimates, but the incidences may disproportionately occur in the areas where the population is more susceptible.

It will be especially important to discuss this in the environmental document if a project emits $PM_{2.5}$ in the community. Both ozone and $PM_{2.5}$ contribute to regional health impacts, but ozone is primarily a regional pollutant, and its effects are experienced throughout the

---

[23] *NCHHSTP Social Determinants of Health*, U.S. Centers for Disease Control and Prevention, 2019, https://www.cdc.gov/nchhstp/socialdeterminants/faq.html#what-are-social-determinants. Accessed 4/13/2020

[24] Quan Di, MS et al: "Air Pollution and Mortality in the Medicare Population," N Engl J Med 2017; 376:2513-2522, June 29, 2017, https://www.nejm.org/doi/full/10.1056/NEJMoa1702747.

community. On the other hand, primary $PM_{2.5}$ emissions are more locally concentrated. For example, the people who experience the most health effects from roadway pollutant emissions are those who live within 1,000 feet of a freeway or major roadway.[25] Projects that emit a great deal of $PM_{2.5}$ are likely to have more impact locally in vulnerable communities than in communities more representative of the average population of the region.

## 7.3 Identifying Vulnerable Populations

To identify and discuss the population characteristics near a project site that may lead to increased risk of health effects from a project, a useful tool is the Healthy Places Index[26] created by the Public Health Alliance of Southern California and derived from federal, state and local government data. The Healthy Places Index (HPI) offers indicators of local community conditions in California that contribute to life expectancy and a mapping tool for comparisons of selected areas with other areas across the region or the state. The HPI mapping tool can be used to compare *specific characteristics* of the population in the area of the proposed project – such as the proportion of the population living below 200% Federal Poverty Level – with other census tracts, cities, counties, Congressional districts, elementary school districts, or other geographic units in the area. It can also be used to compare the *overall relative health vulnerability* (the combined indicators) with those of other geographic units. The HPI mapping tool allows the user to compare local factors down to the census tract level, a degree of resolution that is useful for assessing project health effects. A geographic area that appears in a shade of blue on the HPI mapping tool has *lower* levels of health-promoting community conditions and could be reported in the CEQA analysis as likely to experience a *disproportionate rate of health effects* from a project than a community that appears in a shade of green. The HPI mapping tool provides *comparisons* only, showing how an area compares to other areas in the state or to other geographic regions selected, and not raw numbers.

## 7.4 Consideration of Incidental Health Effects

While this guidance is focused on the health effects of air pollution emitted by a single project, it should be considered that a project may influence health in other ways. New development creates changes in the built environment that can affect health through various pathways. A complete analysis might include a qualitative discussion of how the project's changes to the built environment could have incidental health effects, and whether those incidental health effects will be experienced by *project users* and the *broader community*. The following topics could be considered.

*Vehicle Miles Traveled*: Increasing vehicle miles traveled per capita (VMT/capita) in a region creates acute health impacts (injuries and deaths due to vehicle collisions) as well as chronic health impacts (obesity, hypertension, diabetes, and heart disease due to increased sedentary behaviors, such as driving).[27] Conversely, reducing VMT/capita by increasing

---

[25] *Strategies to Reduce Air Pollution Exposure Near High Volume Roadways,* California Air Resources Board, Technical Advisory April 2017. P. 12. https://ww2.arb.ca.gov/sites/default/files/2017-10/rd_technical_advisory_final.pdf. Accessed 4/28/20.

[26] https://healthyplacesindex.org/

[27] *Cutting Greenhouse Gas Emissions is Only the Beginning: A Literature Review of the Co-Benefits of Reducing Vehicle Miles Traveled*, UC Davis National Center for Sustainable Transportation, 2017,

density and land use mix, especially when combined with sidewalks or trails and public transit infrastructure, enables more people to live closer to daily destinations, making it practical to walk and bike instead of drive. This increases physical activity and reduces obesity, diabetes, high blood pressure, heart disease, and other chronic conditions associated with a sedentary lifestyle. Infill development provides support for transit operations, which offer people more options for accessing health-supportive services such as grocery stores, pharmacies, and medical facilities. Building housing near transit encourages people to walk to transit to get to where they need to go, and provides linkages to jobs, food, and health services for the one-third of adults who do not drive. More compact, connected street networks with fewer lanes on major roads are correlated with lower levels of obesity, diabetes, high blood pressure, and heart disease, as well as with the lowest levels of traffic deaths.[28]

*Urban Greening*: Greater neighborhood tree canopy has been correlated to improvement of overall human health, primarily healthier weight, social cohesion, and mental health.[29] People make more walking trips to task destinations such as stores or coffee shops when they perceive that there are many natural features along the route, including street trees. New trees planted on roadsides and medians and along sidewalks reduce crash rates on both urban arterial and highway sites.[30] Trees and shrubs in thick vegetative barriers along freeway edges can also absorb and disperse traffic emissions and thus reduce exposure to pollutants for nearby populations. Shade trees on streets, in parking lots, and near driveways reduce emissions of volatile organic compounds from parked cars.

*Heat Exposure*: By the end of the century, average daily temperatures will increase by 10° F in the Sacramento region, with as many as 36 added days of extreme heat (greater than 103.9° F) per year in some areas. Extreme heat can lead to heat-related illnesses such as heat rash, heat exhaustion, and heatstroke. If left untreated, heat-related conditions can lead to death.[31] The built environment can increase or decrease incidence of extreme heat and heat exposure. Projects that convert natural or agricultural lands to areas covered with concrete, asphalt, and rooftops increase the amount of solar radiation that is absorbed and re-radiated into the surrounding environment, creating an urban heat island effect. Projects that increase tree canopy and utilize high-albedo surfaces such as cool roofs and cool pavements can lower local temperatures and contribute to regional reductions. Combining these vegetation and cool-surface measures provides the greatest effect.[32]

*Allostatic Load*: Defined as the cost of chronic exposure to elevated or fluctuating stress-hormone or neural responses resulting from chronic or repeated challenges that the

---

https://ncst.ucdavis.edu/research-product/cutting-greenhouse-gas-emissions-only-beginning-literature-review-co-benefits.

[28] Marshall WE et al (2014) Community design, street networks, and public health. *J Transport and Health* 1 (4), p. 326-340. Dec 2014. https://doi.org/10.1016/j.jth.2014.06.002

[29] Ulmer JM et al. Multiple health benefits of urban tree canopy: The mounting evidence for a green prescription, *Health and Place* 42, 54-62. November 2016. https://doi.org/10.1016/j.healthplace.2016.08.011

[30] Mok, J., et al. (2006) Landscape Improvement Impacts on Roadside Safety in Texas. *Landscape and Urban Planning*, Vol. 78, No. 3, pp 263-274. http://www.naturewithin.info/Roadside/RdsdSftyTexas_L&UP.pdf

[31] Capital Region Climate Readiness Collaborative, *Capital Region Transportation Sector Urban Heat Island Reduction Plan,* May 2020. pp. 9-10. https://urbanheat-smaqmd.hub.arcgis.com/

[32] Capital Region Climate Readiness Collaborative, *Capital Region Transportation Sector Urban Heat Island Reduction Plan Summary Report,* May 2020, p. 16. https://urbanheat-smaqmd.hub.arcgis.com/

individual experiences as stressful, allostatic load can lead to development of heart disease, diabetes, chronic pain, fatigue, and other conditions.[33] The built environment can increase or decrease the allostatic burden placed on individuals. Projects that expose people to chronic noise or odors increase the burden. Allostatic load also increases if people have difficulty fulfilling daily needs. Projects that support individuals of all incomes and ages and that include a mix of uses or amenities to facilitate daily life will reduce the sense of stress in peoples' lives. Infill and compact development projects can increase community connectivity and social cohesion (trust), reducing stress and improving health resilience. Allostatic load is also decreased by projects that provide ample access to safe physical activity, whether through sidewalks and bike lanes that lead to daily destinations or networks of walking and biking trails. Projects that incorporate social cohesion can increase perceived safety, which also reduces stress and encourages use of active modes.

Once the health effects of a project are fully reviewed and described, including disclosure of outputs from one of the screening tools or project-specific modeling results and discussion of health effects in context, the lead agency can make an informed decision on a project with health effects information that meets the intent of the Friant ruling.

---

[33] *Allostatic Load,* ScienceDirect, 2020. https://www.sciencedirect.com/topics/neuroscience/allostatic-load

# APPENDIX A

# GUIDANCE FOR CONDUCTING A SITE-SPECIFIC HEALTH EFFECTS ANALYSIS

This Appendix provides documentation on how to conduct a site-specific health effects analysis for a project in Sacramento County (and potentially the Five-Air-District Region with input from the applicable air district) that does not qualify to use the minor project screening approach, or the larger project strategic area approach provided in this guidance.

The procedures outlined in this Appendix are designed to provide guidance to practitioners with experience in PGM modeling in conducting health effects analyses that satisfy the requirements of the Friant Ranch court decision. Consequently, this guidance assumes a level of knowledge related to PGM modeling and is not designed for those not familiar with PGM modeling.

## A.1 OVERVIEW OF TECHNICAL APPROACH

The first step in this process is to run a photochemical grid model (PGM) with appropriate information to assess the increases in ambient air concentrations of pollutants caused by the project's emissions. PGMs require a database of information, including meteorological fields and the spatial allocation of emissions in the area to be modeled, including both base (background/existing) emissions and emissions for the project being evaluated. A recommended modeling plan for conducting such a photochemical modeling study is provided in **Section A.2.**

Project emissions include oxides of nitrogen ($NO_X$), respirable ($PM_{10}$) and fine ($PM_{2.5}$) primary particulate matter (PM), sulfur dioxide ($SO_2$), carbon monoxide (CO) and volatile organic compounds (VOC, also called ROG). $NO_X$ and VOC are precursors to ozone and, along with $SO_2$, are also precursors to secondary $PM_{2.5}$. CO also plays a smaller role in the formation of ozone and should be considered for evaluation if emissions information is available.

To estimate the potential outcome of a proposed project's emissions on ambient air concentrations, a project's emissions are added to the 4-km annual PGM modeling database.[34] For use in PGMs, each project emissions source must be spatially distributed across the modeling grid cells so that they can be incorporated into the gridded emission inventory. For projects with on-road mobile source emissions, the emissions will need to be spread across the roadway network.

Once project emissions are allocated to grid cells, emission estimates from the project are spatially gridded, temporally allocated (e.g., adjustments to account for season/month, day-of-week and hour-of-day), and chemically speciated to be used for the PGM using the Sparse Matrix Operator Kerner Emissions (SMOKE[35]) emissions modeling system supported by the USEPA. More details on how to work with the emissions inventory, spatial allocation, and SMOKE inputs and outputs are described in **Section A.3.**

In order to be conservative, we recommend that future year emissions be used for the modeling database. Future years will feature larger populations and lower background emissions, which usually results in higher ozone and secondary PM from the incremental project emissions. Accordingly, the future year database provides the most conservative estimate of health effects. More details on preparing inputs for the PGM modeling are included in **Section A.3.**

Following completion of the PGM modeling, the USEPA's BenMAP[36, 37] program is used to estimate the potential health effects of the project's contribution to ozone and $PM_{2.5}$ concentrations. USEPA's default health effect functions in BenMAP for PM use fine particulate ($PM_{2.5}$) as the causal PM agent, so the health effects of $PM_{10}$ are represented using $PM_{2.5}$ as a surrogate. BenMAP uses the concentration

---

[34] In this guidance we recommend that the currently available BAAQMD 2012 PGM modeling database be used for the CCOS Northern California domain or a reduced size domain that is focused on the SFNA. BAAQMD performed Weather Research and Forecasting (WRF) meteorological modeling for the 4-km domain and 2012 calendar year that has been processed by MCIP and WRFCAMx to generate CMAQ and CAMx 2012 4-km meteorological inputs for the domain. BAAQMD prepared 2012 emissions for the CMAQ model that have been converted to the format used by CAMx using the CMAQ2CAMx processor.

[35] https://www.cmascenter.org/smoke/

[36] https://www.epa.gov/benmap/how-benmap-ce-estimates-health-and-economic-effects-air-pollution.

[37] https://www.epa.gov/sites/production/files/2015-04/documents/benmap-ce_user_manual_march_2015.pdf.

estimates produced by CAMx, along with population and health effect concentration-response (C-R) functions, to estimate the various health effects of the concentration increases. BenMAP has a wide history of applications by the USEPA and others, including for local-scale analysis[38] as needed for assessing the health effects of a project's emissions. This guidance recommends using USEPA-default BenMAP health effects C-R functions that are typically used in national rulemaking, such as the health effects assessment[39] for the 2012 $PM_{2.5}$ NAAQS. The health effects for $PM_{2.5}$ include mortality (all causes), hospital admissions (respiratory, asthma, cardiovascular), emergency room visits (asthma), and acute myocardial infarction (non-fatal). For ozone, the endpoints are mortality, emergency room visits (respiratory) and hospital admissions (respiratory). Details on the BenMAP inputs and outputs and definitions for the health effects are shown in **Section A.4.**

---

[38] https://www.epa.gov/benmap/benmap-ce-applications-articles-and-presentations#local.

[39] https://www3.epa.gov/ttn/naaqs/standards/pm/data/PM_RA_FINAL_June_2010.pdf.

# A.2 MODELING PLAN

Estimating the potential health impacts of criteria pollutants due to emissions from a proposed CEQA project involves the following activities:

- Selection of an air quality model and air quality modeling database for use in the analysis.
- Estimating the ozone and PM precursor emissions for the proposed CEQA project.
- Processing of the CEQA project emissions for use in the selected air quality model.
- Air quality modeling of the proposed CEQA project emissions to obtain the incremental ozone and PM concentrations due to the project's emissions.
- Processing of the incremental ozone and PM concentrations due to the project's emissions by a health effects model to estimate the mortality, morbidity and other health effects.
- Documenting the health effects modeling and results with enough detail that the results could be duplicated.

## A.2.1 Selection of an Air Quality Model

Proposed CEQA project emissions typically include, but are not limited to $NO_X$, $PM_{10}$, $PM_{2.5}$, $SO_2$, CO and VOC. $NO_X$ and VOCs are not criteria air pollutants[40] but, in the presence of sunlight, they form ozone and contribute to the formation of secondary $PM_{2.5}$ and thus are analyzed here. If $SO_2$ and CO emissions are otherwise quantified in the environmental document, these can be conservatively included as they have contributions to the formation of secondary $PM_{2.5}$ and/or ozone.

EPA's air quality modeling guidelines (Appendix W[41]) and ozone and $PM_{2.5}$ modeling guidance[42] recommend using a photochemical model to estimate ozone and secondary $PM_{2.5}$ concentrations. Most photochemical models for modeling ozone and secondary PM are photochemical grid models (PGMs). EPA's modeling guidance does not recommend specific PGMs but provides procedures for determining an appropriate PGM on a case-by-case basis. EPA's air quality modeling guidelines and guidance does note that both the Comprehensive Air-quality Model with extensions (CAMx[43]) and the Community Multiscale Air Quality (CMAQ[44]) PGMs have been used extensively in the past and if applied correctly would be acceptable PGMs. In fact, EPA has prepared a Memorandum[45] documenting the suitability of using CAMx and CMAQ for ozone and secondary $PM_{2.5}$ modeling of single-sources or a small groups of sources.

---

[40] The six criteria air pollutants are ozone ($O_3$), particulate matter (PM), nitrogen dioxide ($NO_2$), sulfur dioxide ($SO_2$), carbon monoxide (CO) and lead (Pb).

[41] https://www3.epa.gov/ttn/scram/appendix_w/2016/AppendixW_2017.pdf.

[42] https://www3.epa.gov/ttn/scram/guidance/guide/O3-PM-RH-Modeling_Guidance-2018.pdf.

[43] http://www.camx.com/.

[44] https://www.epa.gov/cmaq.

[45] https://www3.epa.gov/ttn/scram/guidance/clarification/20170804-Photochemical_Grid_Model_Clarification_Memo.pdf.

Thus, for the Sac Metro Air District Friant Ranch analysis of the health effects of criteria pollutants from a proposed CEQA project, either the CAMx or CMAQ PGMs would be acceptable.

### A.2.2 Selection of an Air Quality Modeling Platform

Because some of the health effect Concentration-Response (C-R) functions require annual PM concentrations, an annual PGM modeling platform is required. The development of an all-new annual PGM modeling platform from scratch is quite resource-intensive. Thus, it is more cost-effective to use an appropriate existing PGM modeling platform. The California Air Resources Board (ARB) and several air districts in California routinely develop PGM modeling databases to address ozone and $PM_{2.5}$ attainment as part of State Implementation Plans (SIPs). We propose to use the latest publicly-available PGM database for Northern California, developed by the Bay Area Air Quality Management District (BAAQMD), and to adapt it for this analysis. The BAAQMD PGM database is tailored for California using California-specific input tools [e.g., the Emissions Factor (EMFAC[46]) mobile source emissions model] and uses a high-resolution 4-km horizontal grid resolution to better simulate meteorology and air quality in the complex terrain and coastal environment of California. This contrasts with EPA's national modeling platforms[47] used for national rulemakings [e.g., transport rules such as Cross-State Air Pollution Rule (CSAPR[48]) or defining new NAAQS] that use a coarser 12-km horizontal grid resolution. The BAAQMD 2012 annual PGM modeling database that uses the Central California Ozone Study (CCOS) modeling domain depicted in **Figure A-1** would be appropriate for this analysis. For the hypothetical project screening analysis discussed in **Appendix B**, the BAAQMD 2012 annual CCOS domain PGM database was adapted for a reduced 4-km grid resolution domain covering the Sacramento and neighboring counties shown in **Figure B-2** that would also be appropriate for this analysis. The CCOS and reduced 4-km PGM modeling domains use a Lambert Conformal Conic (LCC) projection with the domain definitions given in **Table A-1**. BAAQMD performed WRF meteorological and SMOKE emissions modeling for the CCOS 4-km domain and 2012 calendar year in generating the 2012 CCOS domain PGM modeling database. The 2012 CCOS PGM modeling database was originally developed for the CMAQ PGM but has been extended for the CAMx PGM as well. Descriptions of the WRF meteorological, SMOKE emissions and CMAQ and CAMx PGM models are available on the BAAQMD's Research and Modeling website.[49]

---

[46] https://www.arb.ca.gov/emfac/

[47] https://www.epa.gov/air-emissions-modeling/2014-2016-version-7-air-emissions-modeling-platforms

[48] https://www.epa.gov/csapr

[49] http://www.baaqmd.gov/about-air-quality/research-and-data/research-and-modeling

**Table A-1. Definitions of the Northern California CCOS (Figure A-1) and reduced Sacramento (Figure B-2) 4-km grid resolution PGM modeling domains**

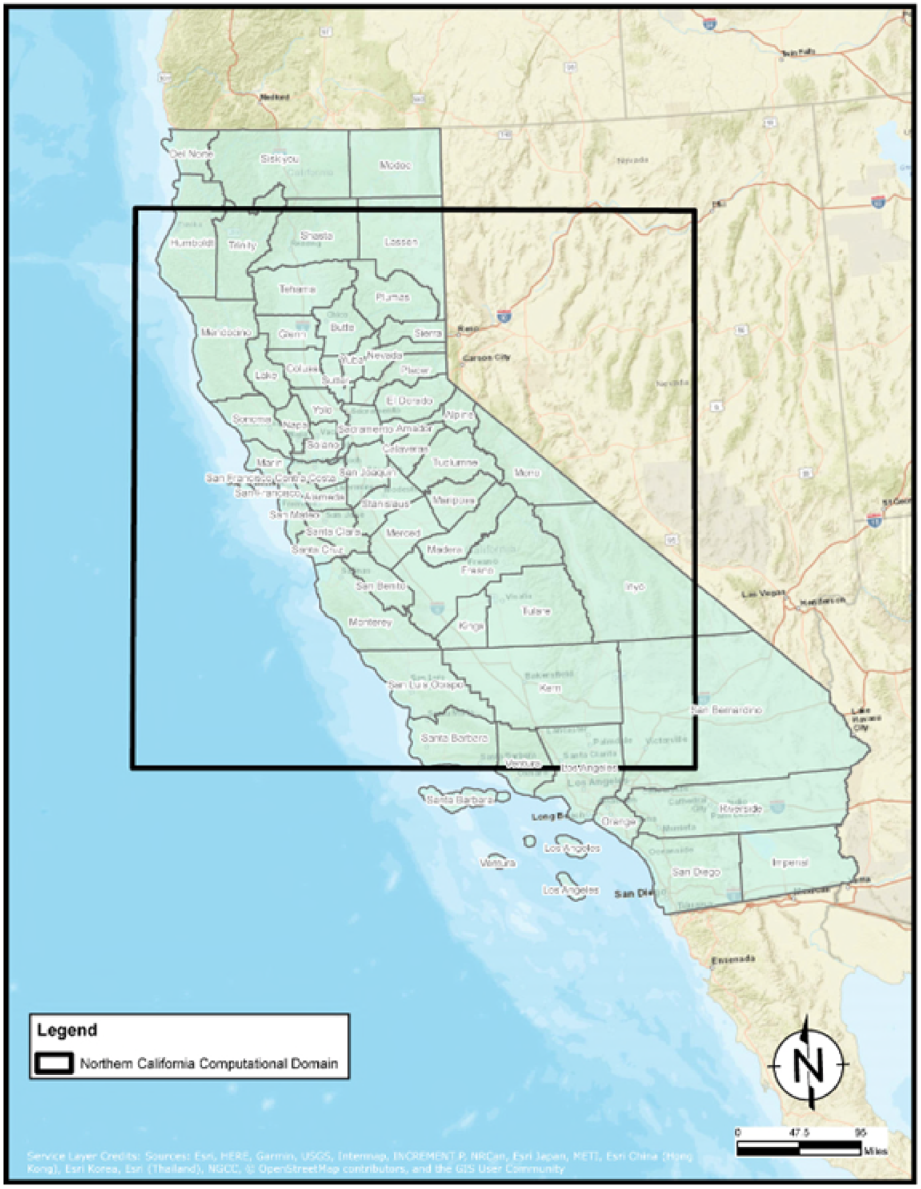
<table>
<tr><th>Parameter</th><th colspan="4">Value</th></tr>
<tr><td>Projection</td><td colspan="4">Lambert-Conformal Conic</td></tr>
<tr><td>1st True Latitude</td><td colspan="4">30 degrees N</td></tr>
<tr><td>2nd True Latitude</td><td colspan="4">60 degrees N</td></tr>
<tr><td>Central Longitude</td><td colspan="4">-120.5 degrees W</td></tr>
<tr><td>Central Latitude</td><td colspan="4">37 degrees N</td></tr>
<tr><th>Domain</th><th>NX</th><th>NY</th><th>X-Offset Origin (km)</th><th>Y-Offset Origin (km)</th></tr>
<tr><td>CCOS (NCA)</td><td>185</td><td>185</td><td>-376</td><td>-292</td></tr>
<tr><td>Reduced (Sacramento)</td><td>78</td><td>106</td><td>-224</td><td>8</td></tr>
</table>

Future-year emission scenarios can be developed as far out as the 2035 year using ARB's county-level emissions by species and source category that are available on the ARB CEPAM webpage[50] and that can be used to project the 2012 emissions to a future year. A project's contribution to ozone and PM concentrations should be evaluated for the most appropriate future year(s) based on the characteristics of the project.

---

[50] https://www.arb.ca.gov/app/emsinv/fcemssumcat/fcemssumcat2016.php

**Figure A-1. CCOS 4 km modeling domain for Northern California PGM modeling**



## A.2.3 Approaches for Estimating Incremental Project Contributions

PGMs simulate emissions concentrations due to all sources, including all anthropogenic and natural emissions and transport from all upwind sources. There are several techniques that can be used to isolate the incremental contributions of emissions from a proposed CEQA project to ozone and PM concentrations:

1. Brute Force Method: In the Brute Force Method, the PGM is applied for a base case and a case where the project's emissions are added to the base case and the project's ozone and PM incremental impacts are obtained from the differences in the two simulations.

2. Source Apportionment Tools: Some PGMs (including CAMx and CMAQ) come instrumented with a source apportionment tool that uses tagged species (reactive tracers) that run in parallel to the host model and keeps track of the ozone and PM contributions due to user-selected source groups (e.g., emission from a CEQA Project).
3. Sensitivity Tools: Some PGMs also come with sensitivity tools that can track the sensitivity of ozone and PM to user-selected source groups that can be post-processed to get the source contributions.

The Brute Force Method can be used with any air quality model and could be a viable method for obtaining the ozone and PM contributions from a proposed CEQA project. However, because the project's incremental concentrations are obtained by calculating the difference between two PGM simulations, there is the potential to introduce model noise. Model noise in this case are changes in the two PGM simulations concentration estimates that are due to numerical artifacts not associated with the project's emissions. The aerosol thermodynamic module (ISORROPIA) used in CAMx and CMAQ is particularly prone to producing model noise in particle ammonium nitrate ($NH_4NO_3$) concentrations due to its complicated parameterization that includes branching. Given the small concentrations expected from CEQA projects, model noise could be a significant issue.

Source Apportionment methods alleviate the problem of model noise because only one simulation is performed. The CAMx Ozone and Particulate Source Apportionment Technology (OSAT/PSAT) tools have been used extensively by EPA and others, including in EPA's CSAPR (CSAPR Update[51]), which estimated upwind state contributions to downwind state nonattainment with details on the CSAPR CAMx source apportionment modeling contained in the CSAPR Air Quality Technical Support Document (AQTSD).[52] CAMx was also used by EPA to develop single-source or facility-level ozone and secondary $PM_{2.5}$ Modeled Emission Rate Precursors (MERPs[53]) significance threshold emission rates, a use similar to modeling a CEQA project's emissions ozone and $PM_{2.5}$ impacts. The CMAQ has the Integrated Source Apportionment Method (ISAM[54]) source apportionment tool for ozone and PM.

Both CAMx and CMAQ have the Decoupled Direct Method (DDM) sensitivity tool. DDM operates similarly to the source apportionment tools, providing sensitivity coefficients only for user-selected source groups. However, DDM is much more computationally extensive than source apportionment. And for a single project, the Brute Force Method, which is another sensitivity method, is also more efficient. Thus, we do not recommend using DDM for this analysis.

Either the Brute Force or Source Apportionment methods are viable tools for estimating the incremental ozone and PM impacts due to emissions of a proposed CEQA project's emissions. Given that it is difficult to determine whether model noise will be a problem, the Source Apportionment method is a safer pathway so it is recommended in this guidance. If using CAMx, the Anthropogenic Precursor Culpability Assessment (APCA) version of the ozone source apportionment tool should be used.

---

[51] https://www.govinfo.gov/content/pkg/FR-2016-10-26/pdf/2016-22240.pdf.

[52] https://www.epa.gov/sites/production/files/2017-05/documents/aq_modeling_tsd_final_csapr_update.pdf.

[53] https://www3.epa.gov/ttn/scram/appendix_w/2016/MERPs_WebinarPresentation_01192017.pdf.

[54] https://github.com/USEPA/CMAQ/blob/master/DOCS/Users_Guide/CMAQ_UG_ch11_ISAM.md

# A.3 EMISSIONS AND AIR QUALITY MODELING

The following sections describe how the CEQA project emissions are processed and the air quality modeling conducted using either the BAAQMD Northern California CCOS 4-km modeling domain or the Sacramento reduced 4-km modeling domain in the 2012 PGM modeling database.

## A.3.1 Project Emissions

For most projects, the maximum daily emissions of criteria pollutants and their precursors from operation and construction should be used. In cases where there are projects with large seasonal variations in maximum daily emissions (e.g., wood stoves or fireplace use), the seasonal variation in the maximum daily emissions should be accounted for. If maximum daily emissions are not otherwise quantified in the environmental document, average daily emissions should be provided. At a minimum, emissions of $NO_X$, VOC, and $PM_{2.5}$ are required, unless one or more of these did not increase due to the project. If quantified and available, project emissions for CO and $SO_2$ should be provided as well. The development of detailed emissions inventories is an important component of any CEQA project analysis. However, for PGM modeling, the project emissions inventories need to be converted into the hourly gridded speciated emission inputs in the format used by the PGM. This is typically accomplished using the Sparse Matrix Kernel Emissions (SMOKE[55]) modeling system.

## A.3.2 SMOKE Emissions Modeling of Project Emissions

The first step in the SMOKE emissions processing is to convert the project emission inventory into the Flat File 2010 (FF10) format for input to SMOKE. The emissions for each process of the project's emissions need to be assigned an appropriate Source Classification Code (SCC[56]) that is used to cross-reference to that particular source sector's typical chemical speciation and temporal allocation profile. SCCs are a 10-digit numerical code that represents a hierarchical classification of the source sectors emissions type. In this case, chemical speciation is performed for the SAPRC07 chemical mechanism used in the 2012 4-km PGM modeling database. Temporal allocation takes annual emissions or maximum daily emissions and distributes them to month of year, day of week, and hour of day using typical temporal profiles for each source sector as defined by the SCC. In some cases, there are source sectors that only operate during part of a year (e.g., residential wood combustion, home heating using wood stoves and fireplaces). In this case, separate SMOKE modeling using the maximum daily emissions for the different seasons is appropriate. EPA has a detailed website describing SCCs[57], although not all possible SCCs have a cross-reference to chemical speciation and temporal profiles in SMOKE. **Appendix E** presents several SCCs that are typically used to characterize source types in CEQA project emissions that are included in SMOKE's cross-reference file and can be used in populating the FF10 SMOKE input files.

As part of the analysis, the project source emissions need to be spatially allocated to appropriate geographic locations (i.e., 4-km grid cells). The emissions can be allocated to modeling grid cells using gridding surrogates. To process the project emissions, a project area-based spatial surrogate needs to be developed. For many project sources the emission sources (e.g., construction) are allocated to the

---

[55] https://www.cmascenter.org/smoke/

[56] https://ofmpub.epa.gov/sccwebservices/sccsearch/docs/SCC-IntroToSCCs.pdf

[57] https://ofmpub.epa.gov/sccwebservices/sccsearch/

grid cell(s) containing the project. For more geographically complex project emission source categories (e.g., mobile source emissions associated with the project), the surrogate distributions can be developed using the USEPA's Spatial Allocation Tool,[58] which combines geographical information system (GIS)-based data (shapefiles) and modeling domain definitions to generate the appropriate gridded surrogate data set. In SMOKE, the project sources are assigned specific surrogates for gridding by cross-referencing the SCCs. All on-site project emissions are distributed in the modeling grid cell(s) where the project is located. On-road mobile sources are typically spatially distributed in the site's grid cells and surrounding grid cells based on roadway locations that can be defined using GIS shapefiles and the EPA surrogate tool. In some cases, CEQA projects have used transportation models to characterize the project's effects on mobile sources and to define the extent of the mobile source emissions spatial distribution.

The SMOKE system is then used to process emissions for the modeling domain, for example the CCOS 4-km modeling grid shown in **Figure A-1**. A representative week from each month (seven days a week for each month) is typically used to represent the entire month's emissions and obtain the correct day-of-week emissions. Holidays are typically modeled separately as if they were a Sunday. SMOKE should be applied to perform the following tasks:

1. Chemical Speciation: Emissions estimates of criteria pollutant precursors should be speciated for the SAPRC07 photochemical and AERO6 aerosol chemical mechanisms employed by the PGM in SMOKE processing. The speciation profiles compatible with the SAPRC07-AERO6 mechanism for $PM_{2.5}$ should be used to be consistent with the emissions used in the BAAQMD's modeling system used in this analysis. SMOKE outputs PGM emission inputs in the CMAQ PGM format that can be converted into CAMx-ready formats using CMAQ2CAMx conversion program and species mapping if CAMx is the PGM used.
2. Temporal Allocation: SMOKE resolves the annual emissions to a monthly, day-of-week and hour-of-day timescale for PGM modeling. These allocations are determined from the particular source category specified by the SCC. Monthly, weekly, and diurnal profiles are cross-referenced to SCC in the SMOKE processing to provide the appropriate temporal resolution.
3. Spatial Allocation: The project emissions estimates should be spatially resolved to the grid cells for modeling using spatial surrogates, as described above.

Standard quality assurance/quality control (QA/QC) of the emissions developed and SMOKE processing need to be conducted during all aspects of the SMOKE emissions processing. These steps should follow the approach recommended in the USEPA modeling guidance (USEPA, 2007). SMOKE includes quality assurance and reporting features to keep track of the adjustments at each processing stage and to ensure that data integrity is not compromised. The SMOKE log files should be carefully reviewed for error messages and ensured that appropriate source profiles were used.  All error records reported during processing should be reviewed and any discrepancies resolved. This is important to ensure that source categories are correctly characterized. A key step in the QA/QC of the SMOKE emissions modeling is to compare SMOKE input and output emissions and to ensure that no emissions are dropped or added in the processing. As part of the documentation, summary tables of emissions should be generated to compare input inventory totals against model-ready output totals and to confirm

---

[58] https://www.cmascenter.org/sa-tools/documentation/4.2/html/srgtool/SurrogateToolUserGuide_4_2.pdf

consistency. Spatial plots should be generated to visually verify correct spatial allocation of the emissions.

The final step in the emissions processing is to merge the project's gridded emissions with other regional components through the gridded merge program (MRGUAM) for CAMx. The daily emissions for CAMx should be merged in the time format required by CAMx. If CAMx v7.0 or newer is used, then the individual "pre-merged" emission inputs can be provided separately in the CAMx inputs, so the final merge is not necessary. CMAQ can also take separate emission file inputs, so it also does not need a final merged step.

### A.3.3 PGM Modeling of Project Emissions

PGM modeling is conducted for a future-year emissions scenario to isolate the contributions of the project's emissions to ozone and PM concentrations. As noted above, either the CAMx or CMAQ PGM models would be acceptable and the project's contributions could be obtained in either model using either the Brute Force or Source Apportionment approaches, but this guidance recommends that the Source Apportionment approach be used to isolate the project's ozone and $PM_{2.5}$ contributions, as the Brute Force method can be susceptible to model noise.

With CAMx, the Anthropogenic Precursor Culpability Assessment (APCA) ozone and PSAT PM source apportionment tools should be used. For CMAQ, the ISAM ozone and PM source apportionment tool should be used. The project emissions need to be separately tagged for tracking by the CAMx APCA/PSAT or CMAQ ISAM source apportionment tools. The CAMx user's guide[59] describes how to tag sources for treatment by and how to invoke the APCA/PSAT source apportionment tools. A CAMx APCA/PSAT source apportionment simulation will generate two hourly average concentration files: (1) the standard model output of hourly gridded total surface layer concentrations; and (2) an hourly output file of surface layer gridded concentrations for each APCA/PSAT source group. The standard output file with elimination (subtraction) of the APCA/PSAT concentration contributions from the project source group is defined as the Base Case, and the standard output that includes the contributions of the project's emissions is defined as the Project Case. Documentation on the CMAQ ISAM source apportionment tool is available on the CMAQ website.[60]

The PGM Base Case and Project Case gridded hourly concentration outputs are processed to generate annual (365 days) gridded files for the following two species and averaging times:

- Daily average total $PM_{2.5}$ concentrations; and
- Maximum daily average 8-hour (MDA8) ozone concentrations.

It is recommended that spatial maps of the incremental $PM_{2.5}$ and ozone concentrations due to project's emissions be examined and reported as part of the QA/QC of the PGM modeling. At a minimum, the annual average and highest 24-hour average $PM_{2.5}$ and highest MDA8 ozone incremental concentrations due to the project's emissions be reported. **Figures B-3, B-4 and B-5** show examples of these types of displays for source 20 from the hypothetical minor source screening modeling discussed in **Appendix B**. The PGM gridded daily $PM_{2.5}$ and MDA8 ozone concentrations are used as inputs to BenMAP to obtain the incremental health effects due to the emissions of the project, as described in the next section.

---

[59] http://www.camx.com/files/camxusersguide_v6-50.pdf

[60] https://www.airqualitymodeling.org/index.php/CMAQv5.0.2_Integrated_Source_Apportionment

# A.4 ESTIMATION OF HEALTH EFFECT IMPACTS

The potential health effects of ozone and $PM_{2.5}$ concentrations due to the project's emissions should be estimated using the Environmental Benefits Mapping and Analysis Program (BenMAP), Community Edition v1.5 (March 2019).[61] BenMAP, originally developed by the USEPA, is a powerful and flexible tool that helps users estimate human health effects and economic benefits resulting from changes in air quality. BenMAP outputs include PM- and ozone-related health endpoints such as premature mortality, hospital admissions, and emergency room visits. BenMAP uses the following simplified formula to express changes in ambient air pollution to certain health endpoints (AAI, 2018)[62]:

$$\text{Health Effect} = \text{Air Quality Change} \times \text{Health Effect Estimate} \times \text{Exposed Population} \times \text{Background Health Incidence}$$

- Air Quality Change: The difference between the starting air pollution concentration level (the Base Case) and the air pollution concentration level after some change, such as a new source (e.g., emissions from a proposed CEQA project in the Project Case).
- Health Effect Estimate: An estimate of the percentage change in an adverse health effect due to a one-unit change in ambient air pollution. Effect estimates, also referred to as concentration-response (C-R) functions, are obtained from epidemiological studies.
- Exposed Population: The number of people affected by the air quality change. The government census office is a good source for this information. As noted below, we recommend the use of data from PopGrid, which is an add-on program to BenMAP that allocates the block-level U.S. Census population to a user-defined grid.[63] As new census data is collected, USEPA updates the BenMAP tool.
- Background Health Incidence: An estimate of the average number of people that die (or suffer from some adverse health effect) in a given population over a given period of time. For example, the health incidence rate might be the probability that a person will die in a given year. Health incidence rates and other health data are typically collected by the government as well as by the World Health Organization. The background incidence rates used here are obtained from BenMAP. Age-, cause-, and county-specific mortality rates are calculated by BenMAP using data from the Centers for Disease Control (CDC) WONDER database[64]. Hospitalization rates and emergency room visits are calculated using data from the Healthcare Cost and Utilization Project (HCUP). The relationship between short-term PM exposure and heart attacks have been determined using epidemiological studies.

## A.4.1 Application of BenMAP

The PGM output data are processed to generate aggregated daily average $PM_{2.5}$ and MDA8 ozone concentrations appropriate for various health endpoints as described above. The PGM concentrations for a Base Case (i.e., without the project emissions) and a Project Case (i.e., the Base Case plus the contributions of the project emissions) are used as inputs to BenMAP, which internally takes the

---

[61] http://www.epa.gov/air/benmap/

[62] The common function used for calculating health effects is the following log-linear function: Health Effect = Background Health Incidence x [1 – exponential (Health Effect Estimate * Air Quality Change)] x Exposed Population

[63] https://www.epa.gov/benmap/benmap-community-edition

[64] http://wonder.cdc.gov

difference between the Base and Project Cases in order to obtain the incremental ozone and PM contributions due to the project. The PGM simulation results from the full year (January to December) are used to estimate the health effects of $PM_{2.5}$ and ozone. BenMAP translates increases in the pollutant concentrations due to the project emissions to changes in the incidence rate for each health effect using a C-R function derived from previously published epidemiological studies. BenMAP provides multiple C-R functions based on different epidemiological studies for a given health endpoint. We recommend using the USEPA default C-R functions that are used in national rulemaking when evaluating health effects. We also recommend using more refined population data that uses population data from PopGrid, which allocates the census population to each modeled 4x4 kilometer (km) grid cell (e.g., **Figure A-1**).

The population used for both the quantified health effects and the calculation of background health incidence presented here is usually calculated for a future year that has maximum project emissions.[65]

Although there are a large number of potential health endpoints that could be included in the analysis, we recommend using the key health endpoints that have been the focus of recent USEPA risk assessments (e.g., USEPA, 2010; USEPA, 2014). For example, the USEPA notes that health endpoints were selected based on consideration of at-risk populations (e.g. people with asthma), endpoints that have public health significance, and endpoints for which information is sufficient to support a quantitative concentration-response relationship (USEPA, 2014).

The $PM_{2.5}$ health endpoints and associated C-R functions that we recommend for use in this BenMAP analysis are presented in **Table A-2**. Each C-R function is based on a certain age range for the given health endpoint depending on the underlying epidemiological study on which it is based.

The increases in the BenMAP-estimated health effect incidences and the background and percent of background health incidence due to the project emissions should be presented for each health endpoint in **Table A-2.** These values reflect the total health effects across the modeling domain (e.g., CCOS domain in **Figure A-1** or reduced 4-km Sacramento domain in **Figure B-1**) or across the Five-Air-District Region. Reporting the percent increase in each of the health effect endpoints across the Five-Air-District Region or other geographic region puts into context the incremental increase in health effects due to the project emissions.

---

[65] For background incidence rates, BenMAP projects likely mortality rates for future years, but for other health effects, incidence rates are based on population changes only and may not reflect rates for future years.

**Table A-2. Summary of recommended $PM_{2.5}$ health endpoints**

| Health Endpoint | Age Range[2] | Daily Metric | Seasonal Metric | Annual Metric | C-R Function Selected[1] |
|---|---|---|---|---|---|
| Emergency Room Visits, Asthma | 0-99 | 24-hr mean | | | Mar et al., 2010 |
| Mortality, All Cause | 30-99 | 24-hr mean | Quarterly mean | Mean | Krewski et al., 2009 |
| Hospital Admissions, Asthma | 0-64 | 24-hr mean | - | - | Sheppard, 2003 |
| Hospital Admissions, All Cardiovascular (excluding Myocardial Infarctions) | 65-99 | 24-hr mean | - | - | Bell, 2012 |
| Hospital Admissions, All Respiratory | 65-99 | 24-hr mean | - | - | Zanobetti et al., 2009 |
| Acute Myocardial Infarction, Nonfatal | 18-24 | 24-hr mean | - | - | Zanobetti et al., 2009 |
| Acute Myocardial Infarction, Nonfatal | 25-44 | 24-hr mean | - | - | |
| Acute Myocardial Infarction, Nonfatal | 45-54 | 24-hr mean | - | - | |
| Acute Myocardial Infarction, Nonfatal | 55-64 | 24-hr mean | - | - | |
| Acute Myocardial Infarction, Nonfatal | 65-99 | 24-hr mean | - | - | |

[1] C-R functions available in BenMAP (AAI, 2018)

[2] Other age ranges are available, but the studies shown here are the ones used by the EPA in its health assessments. The age ranges are consistent with each epidemiological study that is the basis of the health function.

As noted above, although a larger number of health endpoints could be evaluated, we recommend selecting the ozone health endpoints based on recent USEPA risk assessments (USEPA, 2010; USEPA, 2014). The health endpoints and associated C-R functions for ozone are presented in **Table A-3.** Each ozone C-R function is associated with a certain age range for the given health endpoint, depending on the epidemiological study on which it is based. Increases in the BenMAP-estimated health effects incidences and percent of background health incidence due to the project emissions across the Five-Air-District Region should be presented for each health endpoint. In addition, health incidences and percent of background health incidence due to project emissions can be reported for other geographic areas with justification.

**Table A-3. Summary of recommended ozone health endpoints**

| Health Endpoint | Age Range[3] | Daily Metric[2] | Seasonal Metric | Annual Metric | C-R Function Selected[1] |
|---|---|---|---|---|---|
| Hospital Admissions, All Respiratory | 65 - 99 | MDA8 | - | - | Katsouyanni et al., 2009 |
| Mortality, Non-Accidental | 0 - 99 | MDA8 | - | - | Smith et al., 2009 |
| Emergency Room Visits, Asthma | 0 - 17 | MDA8 | - | - | Mar and Koenig, 2009 |
| Emergency Room Visits, Asthma | 18 - 99 | MDA8 | - | - | Mar and Koenig, 2009 |

1. C-R function available in BenMAP (AAI, 2018)
2. MDA8 = Maximum daily average 8-hour ozone concentration
3. Other age ranges are available, but the studies shown here are the ones used by the EPA in its health assessments. The age ranges are consistent with each epidemiological study conducted that is the basis of the health function.

The uncertainties in the CEQA project health effects analysis should be discussed, along with assumptions made, to ensure that the analysis is conservative (i.e., tending toward overstating the project's health effects). Many of these uncertainties are discussed below.

Due to the uncertainties in the health effects analysis, the CEQA Friant Ranch health effects analysis approach and methodology should be conducted in a fashion to ensure that the uncertainty is of a conservative nature. In addition to the conservative assumptions noted above that should be built into the emissions quantities (e.g., using maximum 24-hour emissions and year with maximum emissions), there are a number of assumptions that are built into the application of C-R functions in BenMAP that may lead to an overestimation of health effects. For example, for all-cause mortality health effects from $PM_{2.5}$, the estimates are based on a single epidemiological study that found an association between $PM_{2.5}$ concentrations and mortality. While similar studies suggest that such an association exists, there remains uncertainty regarding a clear causal link. This uncertainty stems from the limitations of epidemiological studies, such as inadequate exposure estimates and the inability to control for many factors that could explain the association between $PM_{2.5}$ and mortality, such as lifestyle factors like smoking. Several reviews have evaluated the scientific evidence of health effects from specific particulate components (e.g., Rohr and Wyzga 2012; Lippmann and Chen, 2009; Kelly and Fussell, 2007). These reviews indicate that the evidence is strongest for combustion-derived components of PM including elemental carbon (EC), organic carbon (OC) and various metals (e.g., nickel and vanadium). However, there are still no definitive data that point to any particular component of PM as being more toxic than other components. The USEPA has also stated that results from various studies have shown the importance of considering particle size, composition, and particle source in determining the health effects of PM (USEPA, 2009). Further, the USEPA (2009) found that studies have reported that particles from industrial sources and from coal combustion appear to be the most significant contributors to PM-related mortality, consistent with the findings by Rohr and Wyzga (2012) and others. This is particularly important to note here, as in many projects a large portion of primary PM emissions are from entrained roadway dust and not from combustion.

For both the $PM_{2.5}$ and ozone health effects calculated, each of the pollutants may be a confounder of the other. Thus, while the C-R functions are derived from studies that evaluated the effects for each pollutant individually, both air pollutants could contribute to the health effect outcomes evaluated, and thus the overall impacts may be overstated.

Another uncertainty highlighted by the USEPA (2012) that applies to potential health effects from both $PM_{2.5}$ and ozone is the assumption of a log-linear response between exposure and health effects, without consideration for a threshold below which effects may not be measurable. The issue of a threshold for $PM_{2.5}$ and ozone is highly debatable and can have significant implications for health effects analyses as it requires consideration of current air pollution levels and calculating effects only for areas that exceed threshold levels. Without consideration of a threshold, any incremental contribution to existing ambient air pollution levels, whether below or above the applicable threshold for a given criteria pollutant, is assumed to adversely affect health. Although the USEPA traditionally does not consider thresholds in its cost-benefit analyses, the NAAQS itself is a health-based threshold level that the USEPA has developed, based on evaluating the most current evidence of health effects.

As noted above, the health effects estimation using this method presumes that effects seen at large concentration differences can be linearly scaled down to (i.e., correspond to) small increases in concentration, with no consideration of potential thresholds below which health effects may not occur. This methodology of linearly scaling health effects is broadly accepted for use in regulatory evaluations and is considered as being health protective (USEPA, 2010), but potentially overstates the potential health effects. In summary, health effects presented using the procedures in this guidance are conservatively estimated, and the actual effects may be zero.

### A.4.2 Documentation of Results

The results of the health effects assessment should be documented in a brief technical report in plain English that clearly describes how the project’s emissions of air pollutants are correlated to health effects. The report should include sufficient detail to enable those who are skilled in the art (and who did not participate in its preparation) to understand the procedures that were used and to consider meaningfully the issues the proposed project raises.

The technical reports should include the following sections: Introduction, Technical Approach, and Results. The technical report should include details on how the PGM was selected and the source of the database used in its operation. It should include details on the emissions used in the PGM as well as a rationale that includes information on the geographical distribution of emissions within the modeling domain. This is particularly important if offsite traffic comprises a significant part of the emissions. The technical report should include details on the speciation of emissions and how the individual emissions were allocated among various source groups. The technical report should include details on how the PGM was operated as well as the important technical choices made and include QA/QC procedures and displays (e.g., spatial maps like in **Figures B-3, B-4 and B-5**). While not recommended unless there is ample evidence to justify it, the user may have some rationale for using C-R responses that are different from the defaults found in BenMAP. Should those be used, the technical report should contain the justification for departure from default C-R responses, as well as details on the C-R responses that were used. The technical report should also contain information on uncertainties in the various steps of the process.

The report should put the health effects into context by comparing them to background rates in the population at large, expressing them as a percent of the background health effects. This comparison can be done using data from the BenMAP model. For perspective, previous evaluations of large developments have shown that the estimated increases in those health effect incidences are fairly minor compared to the background values.

The report should also note that the health effects estimation using BenMAP presumes that effects seen at large concentration differences can be linearly scaled down to small increases in concentration. Accordingly, the report should note that the health effects are conservatively estimated.

Section 7 of the guidance provides additional health context and resources that should be included in the results documentation.

## A.5 REFERENCES

Abt Associates Inc. (AAI). "BenMAP Environmental Benefits Mapping and Analysis Program – Community Edition User's Manual." Prepared for US Environmental Protection Agency, 2018, Cambridge, MA.

Coats, C.J. Jr. *High-performance Algorithms in the Sparse Matrix Operator Kernel Emissions (SMOKE) Modeling System*. Proc. Ninth AMS Joint Conference of Air & Waste Management Association/American Meteorological Society, Atlanta, GA, 1996, pp. 584-588.

Coats, C.J. Jr., and M.R. Houyoux. *Fast Emissions Modeling with the Sparse Matrix Operator Kernel Emissions (SMOKE) Modeling System*. Air & Waste Management Association Conference, New Orleans, LA, 1996.

Kelly, Frank J., and J.C. Fussell. "Particulate Toxicity Ranking Report: Report Number 2/07." Environmental Research Group, Kings College, London, 2007.

Lippmann, M., and L.C. Chen. "Health Effects of Concentrated Ambient Air Particulate Matter (CAPs) and Its Components." *Critical Reviews in Toxicology*, vol. 39, no. 10, 2009, pp. 865-913.

Rohr, Annette C., and Ronald E. Wyzga. "Attributing Health Effects to Individual Particulate Matter Constituents." *Atmospheric Environment*, vol. 62, Dec 2012, pp. 130-152, doi:10.1016/j.atmosenv.07.036.

U.S. Environmental Protection Agency (USEPA). "Guidance on the Use of Models and Other Analyses for Demonstrating Attainment of Air Quality Goals for Ozone, PM2.5 and Regional Haze." Office of Air Quality Planning and Standards, EPA-454/B-07-002, 2007, Research Triangle Park, NC.

U.S. Environmental Protection Agency (USEPA). "Integrated Science Assessment (ISA) for Particulate Matter: Final Report." EPA/600/R-08/139F, Dec, 2009, Washington, DC, https://cfpub.epa.gov/ncea/isa/recordisplay.cfm?deid=216546

U.S. Environmental Protection Agency (USEPA). "Quantitative Health Risk Assessment for Particulate Matter." Office of Air Quality Planning and Standards, EPA-452/R-10-005m, June 2010, www3.epa.gov/ttn/naaqs/standards/pm/data/PM_RA_FINAL_June_2010.pdf

U.S. Environmental Protection Agency (USEPA). "Regulatory Impact Analysis for the Final Revisions to the National Ambient Air Quality Standards for Particulate Matter." EPA-452/R-12-005, 2012, Washington, DC, www3.epa.gov/ttn/ecas/docs/ria/naaqs-pm_ria_final_2012-12.pdf.

U.S. Environmental Protection Agency (USEPA). "Health Risk and Exposure Assessment for Ozone Final Report." Risk and Benefits Group, Health and Environmental Impacts Division, Office of Air Quality Planning and Standards, EPA-452/R-14-004a, 2014.

# APPENDIX B
# SCREENING LEVEL HEATH EFFECTS ANALYSIS

# B.1 INTRODUCTION

A screening analysis using PGM and BenMAP modeling of hypothetical projects within the Sac Metro Air District and neighboring areas was conducted. The screening level health effects analysis was conducted by first identifying locations where potential new projects may be located within the Five-Air-District Region that also includes the entire Sacramento Federal Nonattainment Area (SFNA): Sacramento, Placer, El Dorado, Feather River and Yolo Solano air districts.

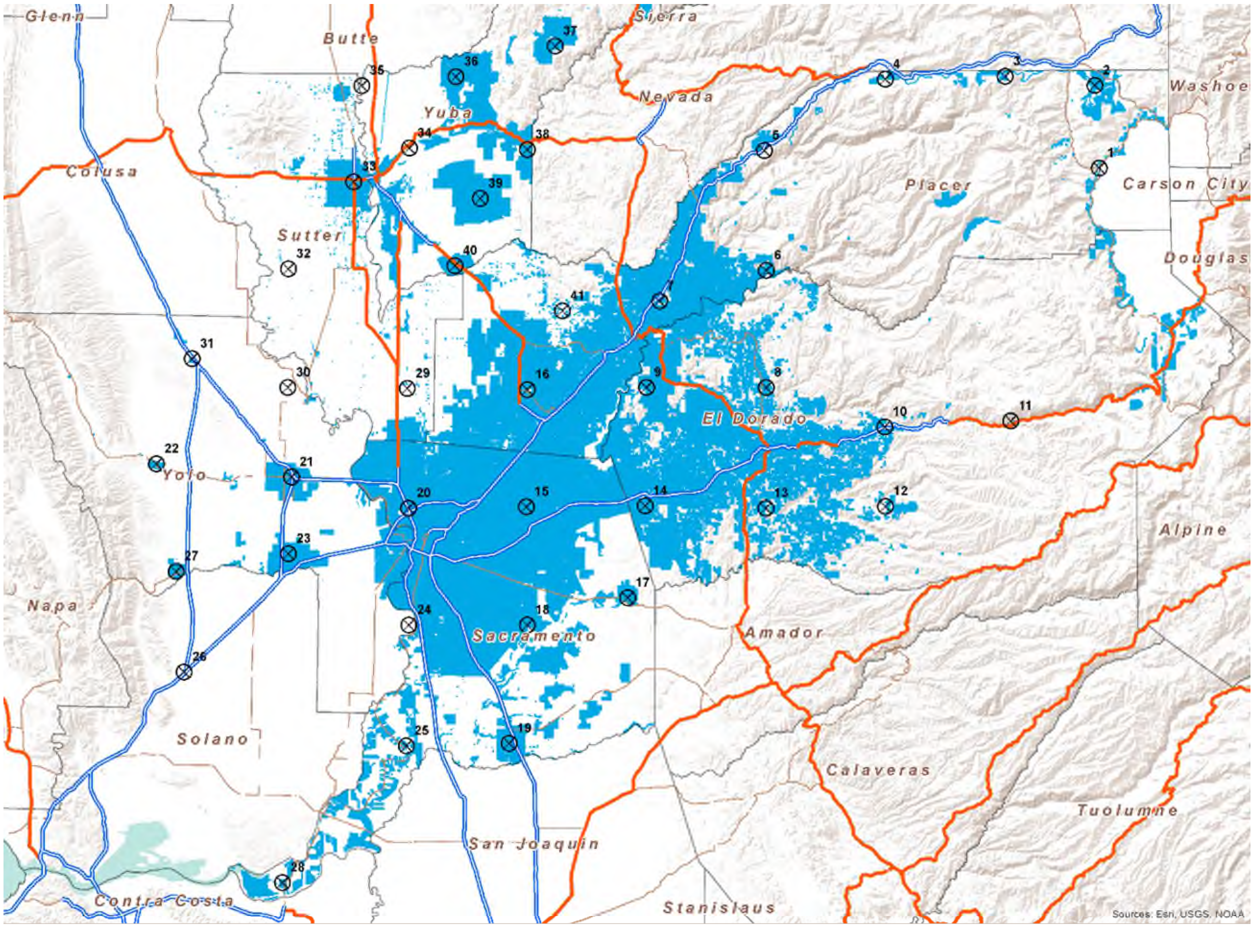
Using the methods described in **Appendix A**, emissions equal to the CEQA thresholds of significance were assumed to occur in 41 representative project locations. The PGM modeling results were then put into BenMAP in order to estimate the health effects that may result from development in each of these locations. The resulting screening level health effects for each of the 41 hypothetical project locations were generated. In addition, Ramboll developed an interactive Minor Project Health Effects Screening Tool in an Excel spreadsheet that allows the user to input a specific proposed project location and the resultant health effects for a project at the maximum TOS emission rates are interpolated from the 41 representative project locations to the point of the proposed project location. This tool is further described in this section.

# B.2 HYPOTHETICAL PROJECT DEFINITIONS

## B.2.1 Hypothetical Project Locations

The potential project locations for the screening-level health effects analysis were determined by overlaying the 2050 Sacramento Area Council of Governments estimate of potential project development in the Five-Air-District Region on the 4-km gridded domain area, as shown in the blue shaded area in **Figure B-1**. A sufficient number of hypothetical project locations were selected in order to represent the different meteorological and transport conditions across the region, but not so many that the computational burden of the air quality model simulation became prohibitive. Based on this information, 41 hypothetical project source locations were chosen, shown in **Figure B-1**. Each hypothetical project site represents a source of precursor emissions for $PM_{2.5}$ and ozone.

**Figure B-1 Potential CEQA project locations (blue shading) in the 5-Air-District Region along with locations of the 41 hypothetical project sources used in the screening modeling.**



Sources: Esri, USGS, NOAA

### B.2.2 Emissions for Each Hypothetical Project Source

The screening methodology is intended to provide preparers of environmental documentation a conservative estimate of health effects for projects at any location within the Five-Air-District Region that has emissions at or lower than the significance thresholds for all pollutants. Each of the five air districts within the SFNA has its own thresholds of significance for emissions of air pollutants, as shown in **Table B-1**. The highest threshold of significance for any district within the SFNA is 82 lbs./day each for $NO_X$, ROG, $PM_{2.5}$ and $PM_{10}$. Therefore, 82 lbs./day each of $NO_X$, ROG and $PM_{2.5}$ was chosen as the emission rate for each of these hypothetical project sources. Although $SO_2$ and CO aren't pollutants with thresholds of significance levels in the five air districts that comprise the SFNA, they are often associated with projects and they do impact ozone and secondary particulate formation.

In order to characterize the appropriate emission levels of $SO_2$ and CO, the emissions inventories for six projects from Sacramento County were reviewed and compared to the emissions of NOx. Based on the ratios of the emissions of $SO_2$ to NOx and CO to NOx, the relative $SO_2$ and CO emissions rates for a project where its NOx emissions were at the threshold of significance were calculated to be 0.98 lbs./day and 262 lbs./day, respectively. These emissions rates are therefore representative of $SO_2$ and CO emissions from residential and commercial projects relative to the emissions of $NO_X$ at the threshold of significance levels of 82 lbs./day. This calculation is further discussed in **Appendix D**.

The health effects from any project with emissions below the thresholds of significance will be lower than the health effects presented in this screening analysis.

**Table B-1. Thresholds of significance**

| Pollutants in lbs./day (with some exceptions, noted) | | | | |
|---|---|---|---|---|
| **Air District** | **NOX** | **ROG** | **PM10** | **PM2.5** |
| Sacramento | 65 | 65 | 80 | **82** |
| Placer | 55 | 55 | **82** | Not established |
| El Dorado | **82** | **82** | Cause or contribute to an exceedance of ambient air quality standards (AAQS) | Cause or contribute to an exceedance of ambient air quality standards (AAQS) |
| Feather River | 25 | 25 | 80 | Not established |
| Yolo Solano | 55[a] | 55[a] | 80 | Not established |

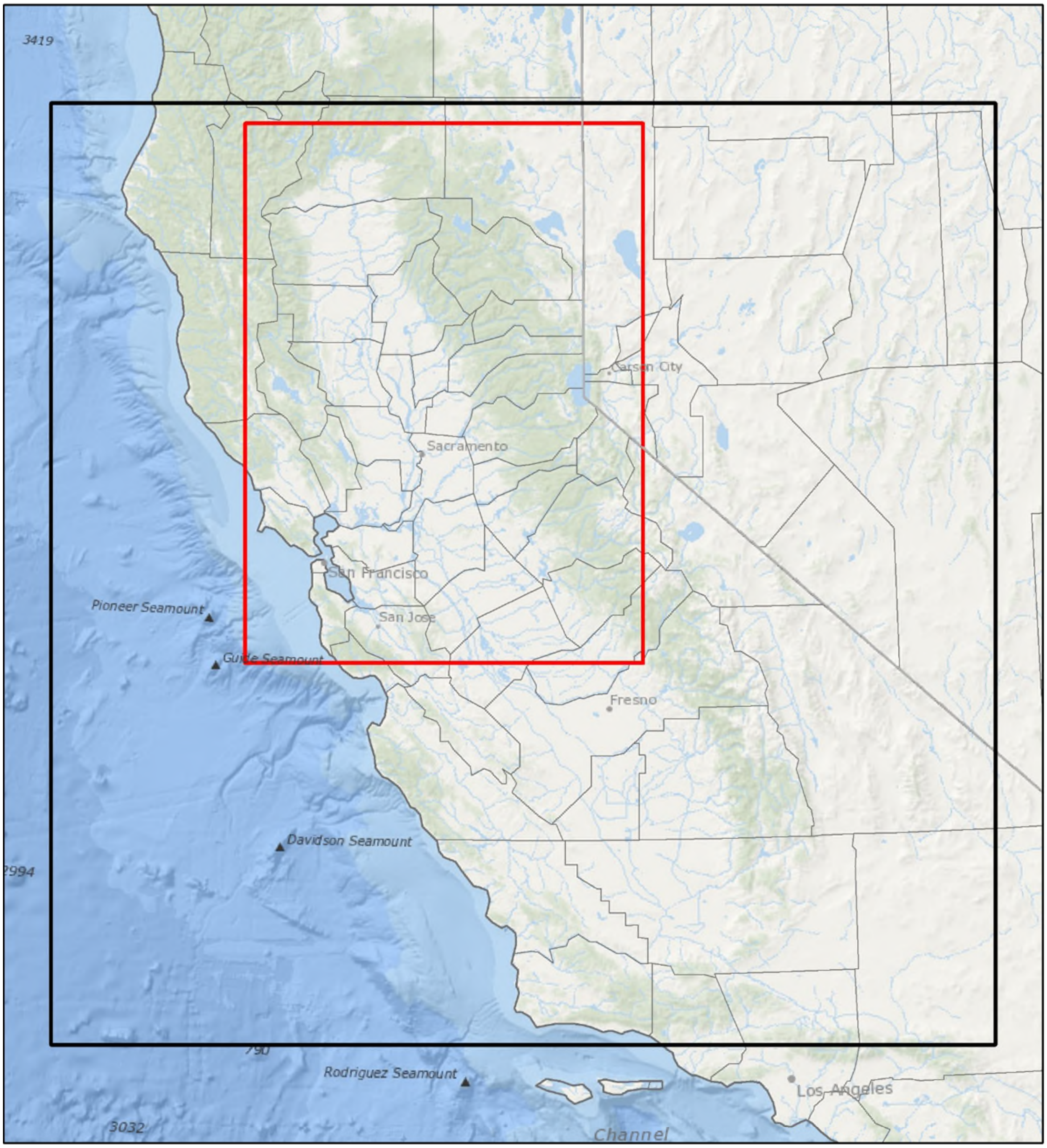
[a] 55 lbs./day is equivalent to 10 tons/year adopted threshold
[b] **Red** indicates the highest emission rate among the five districts

## B.3 PGM SCREENING MODELING

### B.3.1 Reduced 4-km Modeling Domain

The 2012 BAAQMD modeling platform for the CCOS domain shown in **Figure A-1** was adapted for the health effects screening analysis. The CCOS domain covers large portions of northern California and western Nevada where we would expect there to be no significant health effects due to a CEQA project within the Five-Air-District Region. Thus, we reduced the size of the CCOS domain to the red domain embedded in the CCOS domain shown in **Figure B-2**. The boundary conditions for the smaller 4-km domain in **Figure B-2** were based on a CAMx simulation of the larger CCOS domain (**Figure A-1**). As QA for the new 2012 reduced Sacramento modeling domain database, we performed a CAMx base case simulation using the reduced domain and found that it produced essentially the same ozone and PM results as the CAMx full CCOS domain simulation.

**Figure B-2. Sac Metro Air District CAMx 4-km domain (red box) used in the screening analysis embedded in the 4-km CCOS domain (black box) covering northern California.**



### B.3.2 Emissions used in the Screening Analysis

The 2035 anthropogenic emissions for the reduced 4-km modeling domain **(Figure B-2)** were obtained by projecting the BAAQMD 2012 anthropogenic emissions to 2035 using the ARB CEPAM[66] emission projections.

As discussed in **Section B.1.2**, each of the 41 hypothetical projects were assumed to have $NO_X$, ROG and $PM_{2.5}$ emissions of 82 lbs./day with $SO_2$ and CO emissions of 0.98 lbs./day and 262 lbs./day, respectively. The hypothetical project ROG (also known as VOC) emissions were speciated into the VOC species used in the SAPRC07 chemical mechanism that is used by CAMx with speciation profiles based on the typical mix of sources types in a CEQA project as described in **Appendix D**. The emissions were assumed to be released near the surface (i.e., in layer 1), which is also typical for CEQA projects in the region.

### B.3.3 PGM Modeling

The CAMx PGM was used to simulate the incremental ozone and PM concentrations due to emissions from each of the 41 hypothetical project sources. Emissions from each of the 41 hypothetical sources were separately tagged for treatment by the CAMx APCA/PSAT ozone/PM source apportionment tools. The CAMx standard and source apportionment output was processed to generate Base Case concentrations that consisted of CAMx standard model output minus the contributions of all 41 hypothetical sources. Then, the contributions of each individual hypothetical project were separately added to the Base Case for each Project Case. The PGM estimated gridded daily 24-hour average $PM_{2.5}$ and MDA8 ozone concentrations for the Base Case and Project Case that were then used in the health effects modeling.

**Figures B-3, B-4 and B-5** display the incremental $PM_{2.5}$ and ozone concentrations due to hypothetical source number 20, which is located near the intersection of I-80 and I-5 (see **Figure B-1**). For annual average $PM_{2.5}$ concentrations, the maximum contribution due to hypothetical source 20 is 0.44 $\mu g/m^3$ and occurs close to the source location (**Figure B-3**). The highest daily $PM_{2.5}$ (**Figure B-4**) and MDA8 ozone (**Figure B-5**) concentrations due to hypothetical source 20 are, respectively, 1.69 $\mu g/m^3$ and 0.38 ppb, and also occur close to the location of source 20.

---

[66] https://www.arb.ca.gov/app/emsinv/fcemssumcat/fcemssumcat2016.php

**Figure B-3. Map of the incremental annual average $PM_{2.5}$ concentrations (µg/m$^3$) due to emissions from hypothetical source 20.**

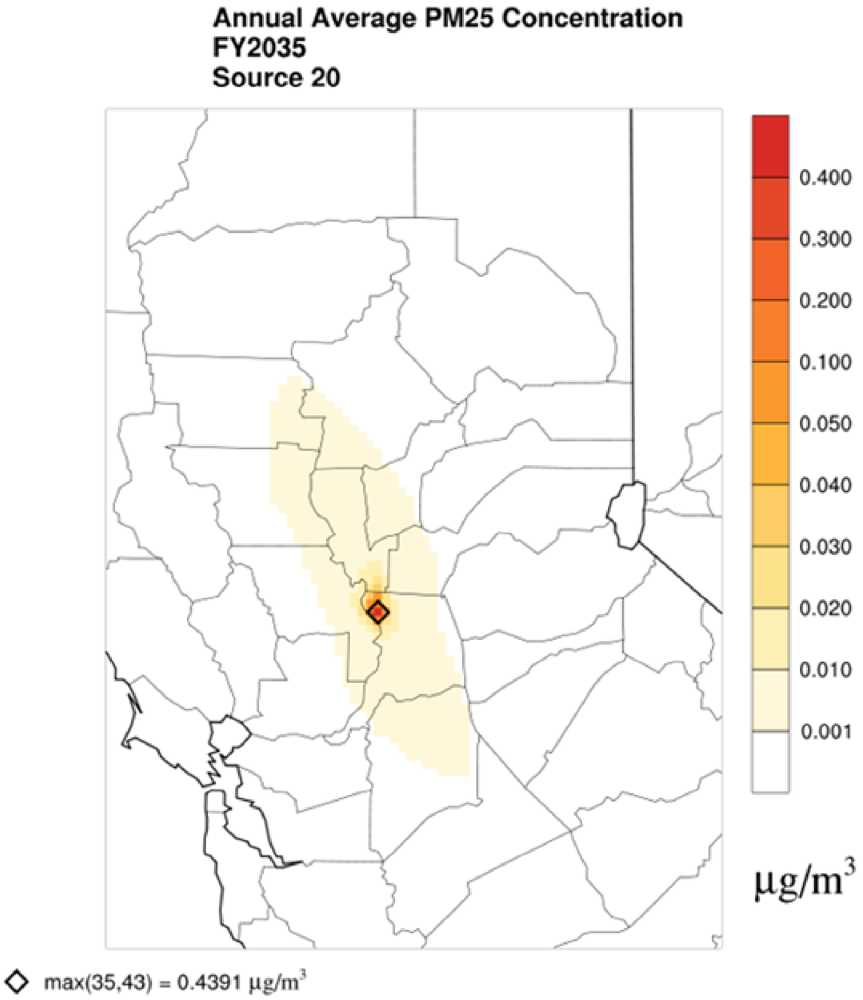


**Figure B-4. Map of the incremental maximum 24-hour average $PM_{2.5}$ concentrations ($\mu g/m^3$) due to emissions from hypothetical source 20.**

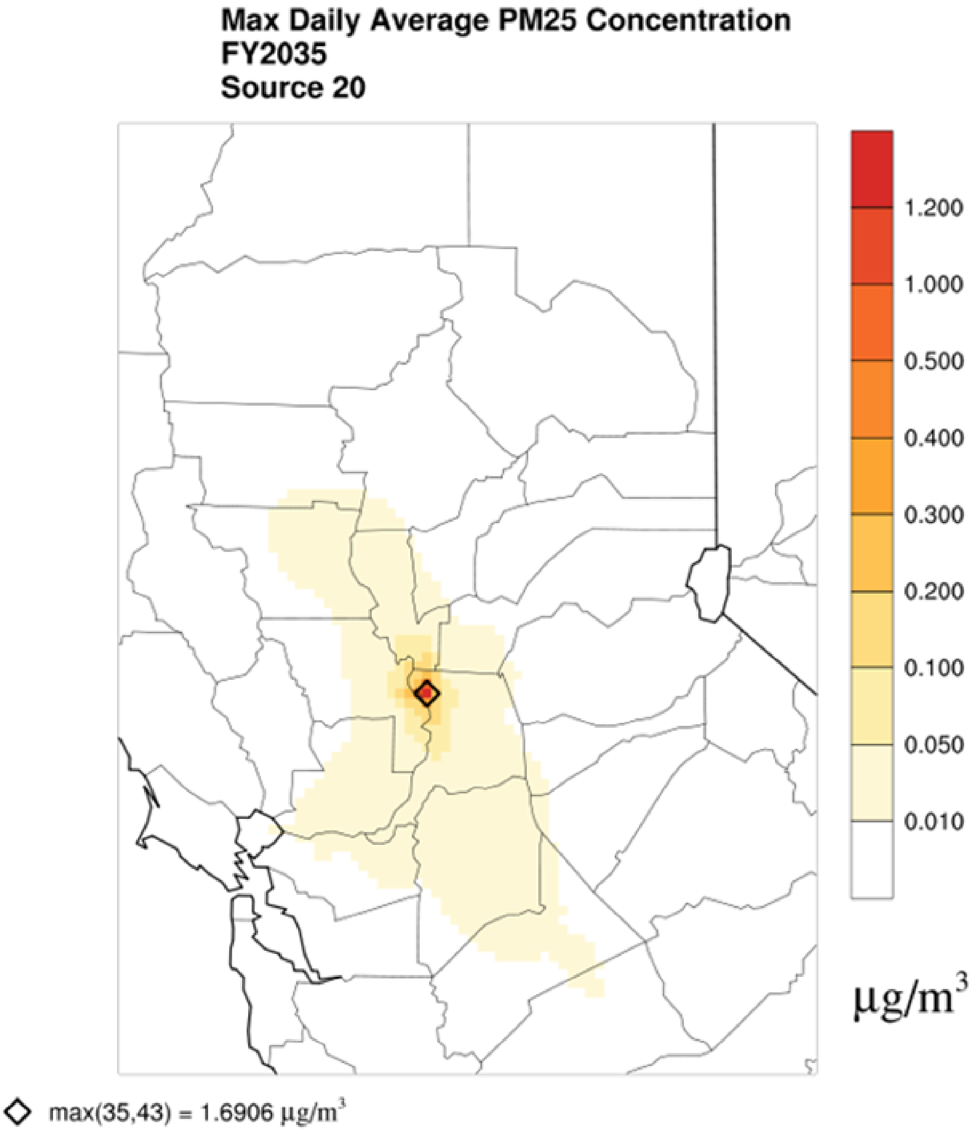
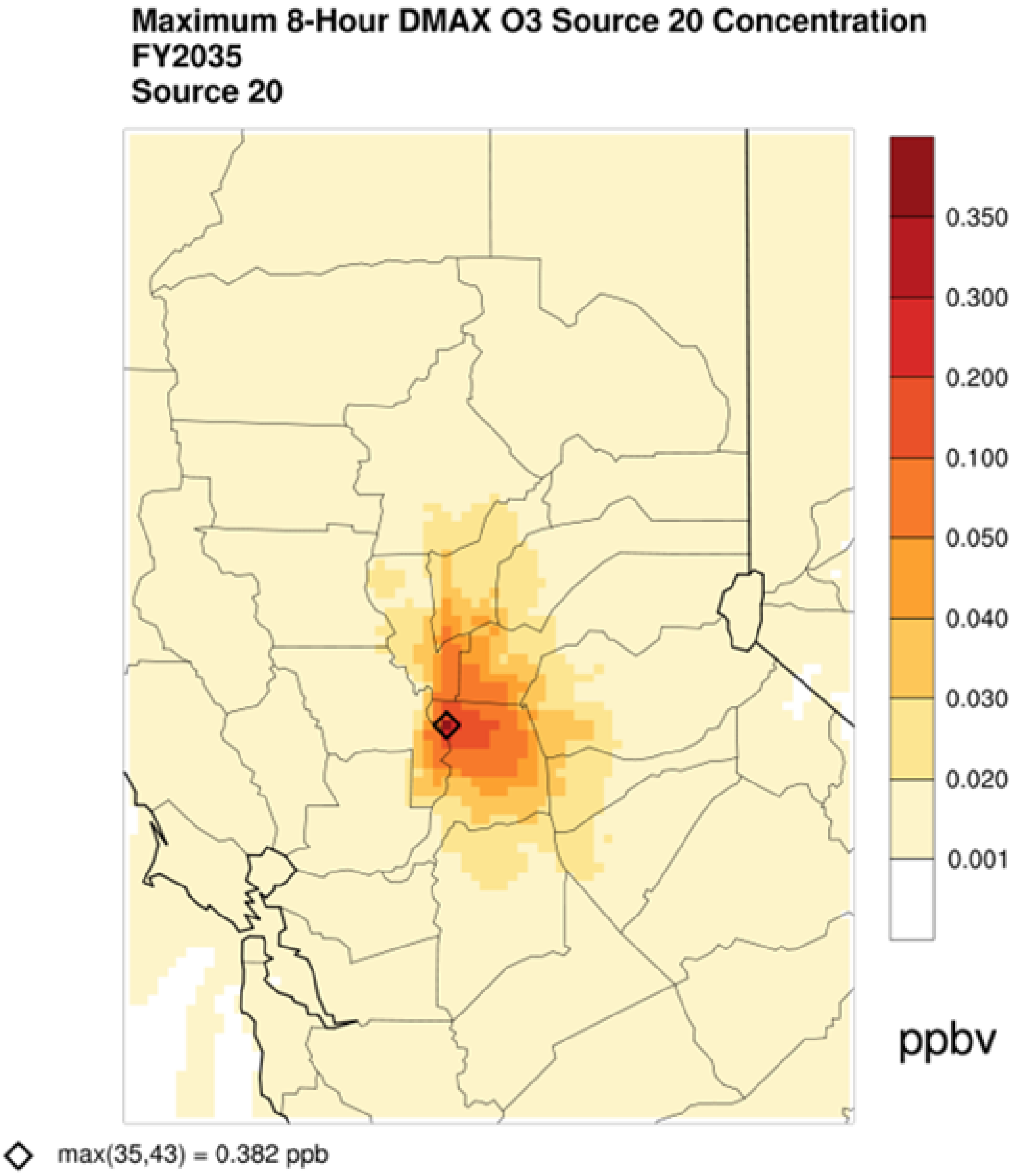


**Figure B-5. Map of the incremental highest MDA8 ozone concentrations (ppb) due to emissions from hypothetical source 20.**



# B.4 HEALTH EFFECTS MODELING

## B.4.1 BenMAP Simulator

EPA's BenMAP air pollution health effects tool is a Windows-based program with the flexibility to use several alternative Concentration-Response (C-R) functions. The application of BenMAP for the 41 hypothetical projects would be quite time-consuming. Thus, a Python-based BenMAP simulator was developed that could efficiently estimate the health effect impacts of the 41 hypothetical projects using the CAMx source apportionment modeling results. The specific default C-R functions identified in **Appendix A** (**Tables A-2** and **A-3**) were implemented in the Python-based BenMAP simulator.

The Python-based BenMAP simulator was run for the 41 hypothetical project locations shown in **Figure B-1** using the CAMx Base Case and Project Case modeling results. We then ran BenMAP using the CAMx 2035 annual source apportionment modeling results for hypothetical project number 20, which, because it is in the City of Sacramento, represents one of the hypothetical sources with relatively higher health effects than others. **Tables B-2** and **B-3** display the resultant $PM_{2.5}$ and ozone health effects from running the EPA BenMAP and Python-based BenMAP simulator on the CAMx source apportionment modeling results for hypothetical source number 20. To three significant digits, the results are identical. Because the Python-based simulator uses higher precision than BenMAP, the results are not identical when looking out to more significant decimal places. For example, to four significant digits the premature mortality due to PM across the entire modeling domain for hypothetical project number 20 is 2.289 per year using BenMAP and 2.287 per year using the Python-based BenMAP simulator. These less-than-0.1% differences do not change any aspects of the health effects assessment. Summaries of the potential health effects across the modeling, like those presented in Tables **B-2** and **B-3** for hypothetical source 20, are provided for each one of the 41 hypothetical sources in **Appendix F**. Note that in addition to the project's incremental health effects, the percent increase of the health effects over the background health effects should also be presented. For example, for hypothetical source 20, the increase of 2.06 premature mortalities per year within the Five-Air-District Region that is due to increased PM concentrations from the project's emissions represents a 0.005% increase over the background value of the Five-Air-District Region; thus, this is a very small increase.

**Table B-2. Health effects for hypothetical project number 20 produced by EPA's BenMAP program.**

| **BenMAP** | | | | | |
|---|---|---|---|---|---|
| **Run with PopGrid populations - Source 20** | | | | | |
| **$PM_{2.5}$ Health Endpoint** | **Age Range*** | **Incidences Across the Reduced Sacramento 4-km Modeling Domain Resulting from Project Emissions (per year)** | **Incidences Across the 5-Air District Region Resulting from Project Emissions (per year)** | **Percent of Background Health Incidences Across the 5-Air District Region**** | **Total Number of Health Incidences Across the 5-Air District Region (per year)**** |
| | | **(Mean)** | **(Mean)** | | |
| Emergency Room Visits, Asthma | 0 - 99 | 1.45 | 1.36 | 0.0074 | 18419 |
| Mortality, All Cause | 30 - 99 | 2.29 | 2.06 | 0.0046 | 44766 |
| Hospital Admissions, Asthma | 0 - 64 | 0.097 | 0.092 | 0.0050 | 1846 |
| Hospital Admissions, All Cardiovascular (less Myocardial Infarctions) | 65 - 99 | 0.19 | 0.17 | 0.00071 | 24037 |
| Hospital Admissions, All Respiratory | 65 - 99 | 0.34 | 0.30 | 0.0015 | 19644 |
| Acute Myocardial Infarction, Nonfatal | 18 - 24 | 0.00013 | 0.00012 | 0.0032 | 4 |
| Acute Myocardial Infarction, Nonfatal | 25 - 44 | 0.012 | 0.012 | 0.0038 | 308 |
| Acute Myocardial Infarction, Nonfatal | 45 - 54 | 0.025 | 0.024 | 0.0032 | 741 |
| Acute Myocardial Infarction, Nonfatal | 55 - 64 | 0.040 | 0.038 | 0.0031 | 1239 |
| Acute Myocardial Infarction, Nonfatal | 65 - 99 | 0.12 | 0.11 | 0.0022 | 5052 |

| | | | | | |
|---|---|---|---|---|---|
| **Ozone Health Endpoint** | **Age Range*** | **Incidences Across the Reduced Sacramento 4-km Modeling Domain Resulting from Project Emissions (per year)** | **Incidences Across the 5-Air-District Region Resulting from Project Emissions (per year)** | **Percent of Background Health Incidences Across the 5-Air-District Region**** | **Total Number of Health Incidences Across the 5-Air-District Region (per year)**** |
| | | **(Mean)** | **(Mean)** | | |
| Hospital Admissions, All Respiratory | 65 - 99 | 0.085 | 0.065 | 0.00033 | 19644 |
| Mortality, Non-Accidental | 0 - 99 | 0.053 | 0.043 | 0.00014 | 30386 |
| Emergency Room Visits, Asthma | 0 - 17 | 0.46 | 0.39 | 0.0066 | 5859 |
| Emergency Room Visits, Asthma | 18 - 99 | 0.72 | 0.61 | 0.0049 | 12560 |

* Other age ranges are available, but the studies shown here are the ones used by the EPA in their health assessments. The age ranges are consistent with each epidemiological study that is the basis of the health function.

** The percent of background health incidence uses the mean incidence. The background health incidence is an estimate of the average number of people that are affected by the health endpoint in a given population over a given period of time. In this case, these background incidence rates cover the Five-Air-District domain. Health incidence rates and other health data are typically collected by the government as well as the World Health Organization. The background incidence rates used here are obtained from BenMAP.

**Table B-3. Health effects for hypothetical project number 20 produced by the Python-based BenMAP simulator.**

| BenMAP-Python | | | | | |
|---|---|---|---|---|---|
| **Run with PopGrid populations - Source 20** | | | | | |
| **$PM_{2.5}$ Health Endpoint** | **Age Range*** | **Incidences Across the Reduced Sacramento 4-km Modeling Domain Resulting from Project Emissions (per year)** | **Incidences Across the 5-Air-District Region Resulting from Project Emissions (per year)** | **Percent of Background Health Incidences Across the 5-Air-District Region**** | **Total Number of Health Incidences Across the 5-Air-District Region (per year)**** |
| | | **(Mean)** | **(Mean)** | | |
| Emergency Room Visits, Asthma | 0 - 99 | 1.46 | 1.37 | 0.0074 | 18419 |
| Mortality, All Cause | 30 - 99 | 2.29 | 2.06 | 0.0046 | 44766 |
| Hospital Admissions, Asthma | 0 - 64 | 0.097 | 0.092 | 0.0050 | 1846 |
| Hospital Admissions, All Cardiovascular (less Myocardial Infarctions) | 65 - 99 | 0.19 | 0.17 | 0.00071 | 24037 |
| Hospital Admissions, All Respiratory | 65 - 99 | 0.34 | 0.30 | 0.0015 | 19644 |
| Acute Myocardial Infarction, Nonfatal | 18 - 24 | 0.00013 | 0.00012 | 0.0032 | 4 |
| Acute Myocardial Infarction, Nonfatal | 25 - 44 | 0.012 | 0.012 | 0.0038 | 308 |
| Acute Myocardial Infarction, Nonfatal | 45 - 54 | 0.025 | 0.024 | 0.0032 | 741 |
| Acute Myocardial Infarction, Nonfatal | 55 - 64 | 0.0398 | 0.038 | 0.0031 | 1239 |
| Acute Myocardial Infarction, Nonfatal | 65 - 99 | 0.12 | 0.11 | 0.0022 | 5052 |

| | | | | | |
|---|---|---|---|---|---|
| **Ozone Health Endpoint** | **Age Range*** | **Incidences Across the Reduced Sacramento 4-km Modeling Domain Resulting from Project Emissions (per year)** | **Incidences Across the 5-Air-District Region Resulting from Project Emissions (per year)** | **Percent of Background Health Incidences Across the 5-Air-District Region**** | **Total Number of Health Incidences Across the 5-Air-District Region (per year)**** |
| | | **(Mean)** | **(Mean)** | | |
| Hospital Admissions, All Respiratory | 65 - 99 | 0.085 | 0.065 | 0.00033 | 19644 |
| Mortality, Non-Accidental | 0 - 99 | 0.053 | 0.043 | 0.00014 | 30386 |
| Emergency Room Visits, Asthma | 0 - 17 | 0.46 | 0.39 | 0.0067 | 5859 |
| Emergency Room Visits, Asthma | 18 - 99 | 0.72 | 0.61 | 0.0049 | 12560 |

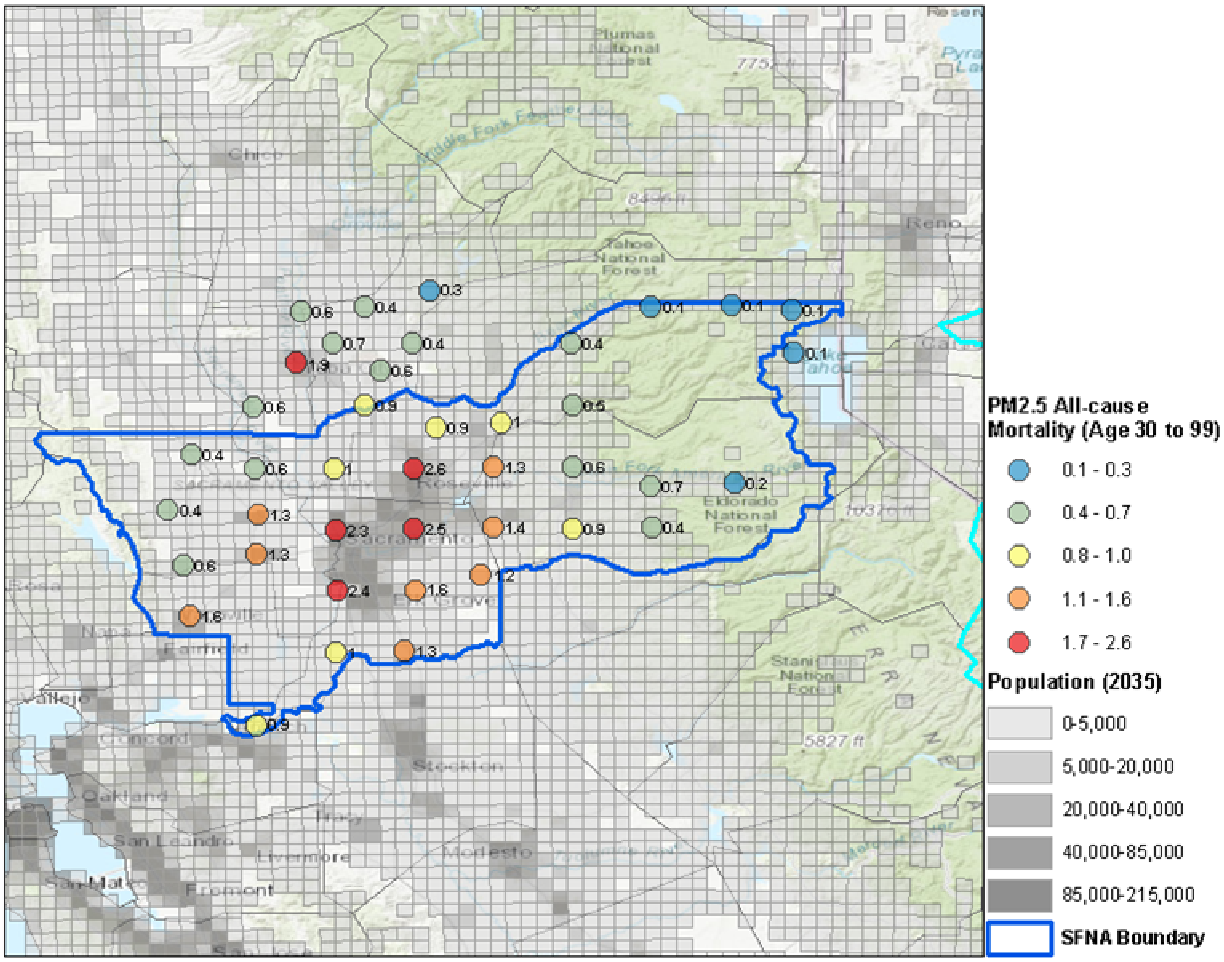
* Other age ranges are available, but the studies shown here are the ones used by the EPA in its health assessments. The age ranges are consistent with each epidemiological study that is the basis of the health function.

** The percent of background health incidence uses the mean incidence. The background health incidence is an estimate of the average number of people that are affected by the health endpoint in a given population over a given period of time. In this case, these background incidence rates cover the Five-Air-District domain. Health incidence rates and other health data are typically collected by the government as well as the World Health Organization. The background incidence rates used here are obtained from BenMAP.

### B.4.2 Screening Modeling Health Effects Results

The estimated health effects due to a change in $PM_{2.5}$ and ozone concentrations resulting from emissions for each of the 41 hypothetical project sources are provided in **Appendix F. Figure B-6** displays a map of the total PM mortality health effects results of all 41 hypothetical projects. Even though all 41 hypothetical projects have the same emissions, their health effects can vary by over an order of magnitude (e.g., from 0.1 to 2.6). Atmospheric chemistry and dispersion can play a role in the differences in a hypothetical source’s concentrations and resulting health effects in different locations, but the primary difference in a hypothetical project’s health effects is the source’s proximity to population centers. For example, the hypothetical sources located in the City of Sacramento have greater health effects than those in the Sierra Nevada mountains.

**Figure B-6. Hypothetical project PM mortality health effects superimposed on population density with SFNA boundary outline.**



### B.4.3 Minor Project Health Effects Screening Tool

A simple screening health effects spreadsheet tool was developed by interpolating the health effects from the 41 hypothetical source locations to each 4-km grid in the Sac Metro Air District and neighboring air districts. The spatial interpolation was performed using python's SciPy implementation of the radial basis function interpolation.[67] Multiple basis functions were tested, but the linear function was selected because it provides higher values for the interpolated health effects and therefore was considered more conservative for the purposes of the screening tool implementation. The user can input the latitude/longitude location of a proposed project and the spreadsheet will generate a table of health effects corresponding to the threshold of significance emissions rate at the proposed project location.

---

[67] https://docs.scipy.org/doc/scipy/reference/generated/scipy.interpolate.Rbf.html

# APPENDIX C
# STRATEGIC AREA PROJECT HEALTH EFFECTS ANALYSIS

# C.1 STRATEGIC AREA HEALTH EFFECTS RESULTS

This Appendix describes the Friant Ranch strategic area health effects screening modeling analysis for potential projects in the Sac Metro Air District and neighboring air districts.

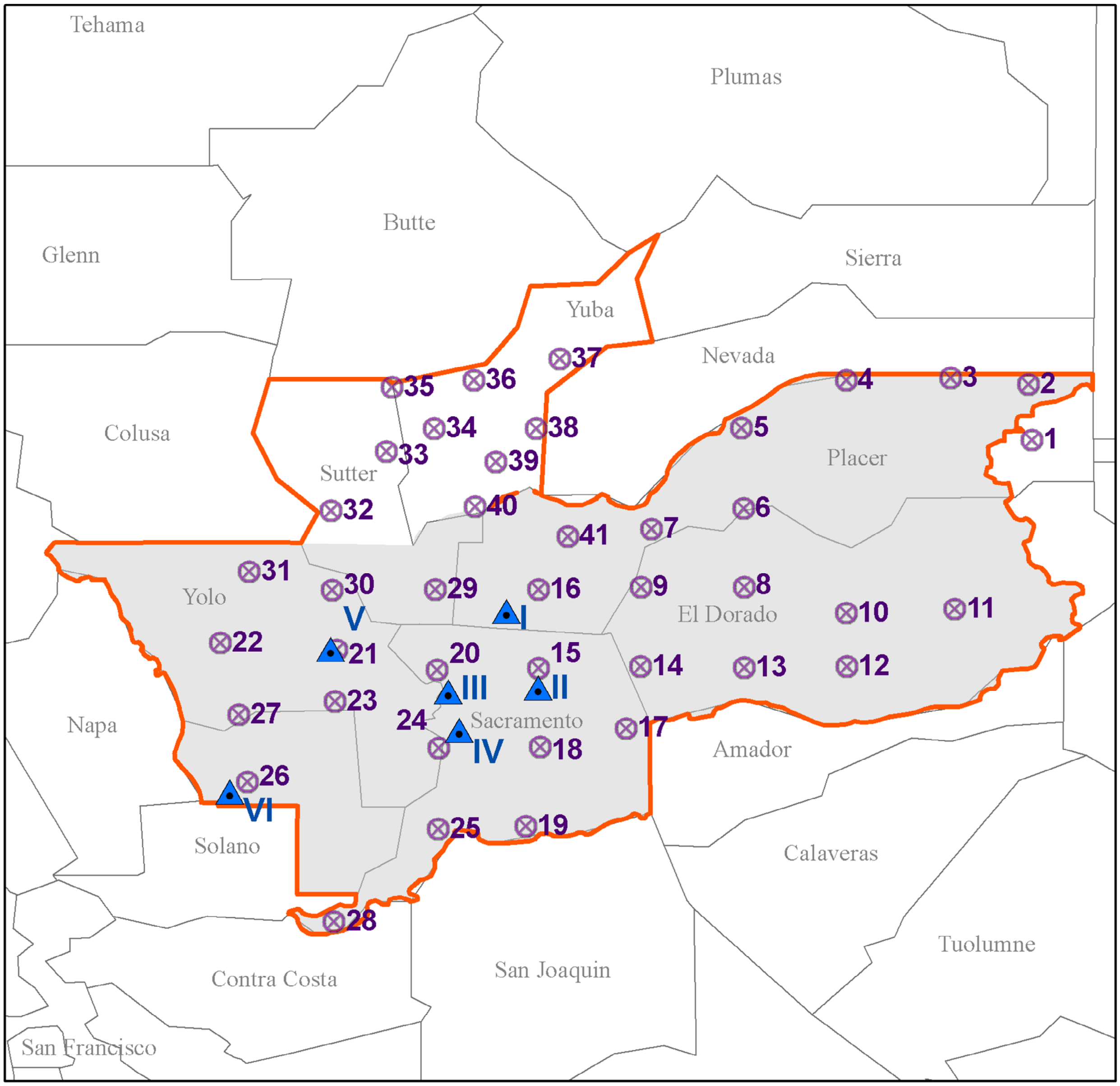
## C.1.1 Strategic Area Project Screening Modeling

The Sac Metro Air District provided six locations for potential projects that represent the general areas in which projects exceeding thresholds of significance levels would be expected to occur. The six potential locations are listed in **Table C-1** and shown in **Figure C-1**.

Table C-1. Coordinates for 6 hypothetical strategic area projects.

| ID | Name | Latitude | Longitude | Location |
|---|---|---|---|---|
| I | West Roseville | 38.765833 | -121.359299 | Fiddyment Road & Pleasant Grove Boulevard |
| II | Rancho Cordova | 38.588080 | -121.286765 | Zinfandel Drive & White Rock Road |
| III | Downtown Sacramento | 38.579336 | -121.494119 | 10th Street & K Street |
| IV | South Sacramento | 38.490489 | -121.468468 | Florin Road & Franklin Boulevard |
| V | Woodland | 38.677388 | -121.765759 | Main Street & East Street |
| VI | Vacaville | 38.347954 | -121.998058 | Merchant Street & Lincoln Highway |

**Figure C-1. Locations of six projects I-VI used in the strategic area screening modeling, along with the 41 hypothetical Projects used in the minor project analysis and boundary of the Five-Air-District Region (red) with the SFNA shaded grey.**



The project screening modeling was run at each of the six locations at two levels of emissions, corresponding to two times (2x) and 8 times (8x) the threshold of significance level, which is 82 lbs./day for $NO_X$, ROG, $PM_{2.5}$ and $PM_{10}$ (see **Table 1**). The six projects also included CO and $SO_2$ emissions using the same approach as used for the 41 hypothetical minor project analysis (see **Appendices B and D**). The ROG and PM emissions for the six projects were also speciated following the same approach as the hypothetical minor project modeling (see **Appendix D**). **Table C-2** displays the project emissions for the two levels of emissions used. Two levels of emissions were modeled in the project screening modeling to account for non-linear effects of ozone and secondary PM formation as a function of $NO_X$, ROG, $SO_2$ and CO emissions.

**Table C-2. Emissions levels used for modeling strategic area projects at the six locations that are 2 and 8 times the threshold of significance.**

| Pollutant | Emissions (lbs./day) | |
|---|---|---|
| | 2xTOS | 8xTOS |
| $NO_X$ | 164 | 656 |
| $PM_{2.5}$ | 164 | 656 |
| ROG | 164 | 656 |
| $SO_2$ | 1.96 | 7.84 |
| CO | 524 | 2096 |

The ultimate goal of the strategic area screening analysis is to develop an interactive spreadsheet in which the user selects one of the six project locations and inputs the project total $NO_X$, $PM_{2.5}$ and VOC emissions. The spreadsheet internally interpolates the health effects from the CAMx/BenMAP modeling for each pollutant, and outputs a health effects summary table. If a user inputs any emissions value above the maximum emissions analyzed (see 8xTOS values in **Table C-2**), then the spreadsheet will output an error message. If the user inputs emissions below the minimum emissions analyzed (see 2xTOS values in **Table C-2**), then the spreadsheet will output the health effects corresponding to the 2xTOS scenario as a conservative estimate of the health effects.

Two annual CAMx ozone and PM source apportionment model simulations were conducted for the 2012 calendar year using 2035 future year anthropogenic emissions: (1) six strategic area projects at 2xTOS emissions; and (2) six strategic area projects at 8xTOS emissions. Emissions from each of the six projects were tagged for treatment by the CAMx ozone (APCA) and PM (PSAT) source apportionment tool.

The CAMx source apportionment ozone and $PM_{2.5}$ contributions of each of the six projects at the two levels of emissions were input into BenMAP to obtain health effects, with results shown in **Appendix G**. BenMAP was run separately to obtain the ozone and $PM_{2.5}$ health effects from the project $NO_X$, ROG and PM emissions. For ozone, the following species mappings were used to attribute ozone ($O_3$) health effects to $NO_X$, ROG and PM precursor emissions.

- Ozone($NO_X$) = O3N (ozone formed under NOx-limited conditions)
- Ozone(ROG) = O3V (ozone formed under VOC/ROG-limited conditions)
- Ozone(PM) = 0.0

For particulate matter, the following species mappings were used to attribute $PM_{2.5}$ health effects to $NO_X$, ROG and PM emissions:

- $PM_{2.5}$(NOx) = Nitrate (NO3) + Ammonium (NH4) + Sulfate (SO4)
- $PM_{2.5}$(ROG) = 0.0
- $PM_{2.5}$(PM) = Elemental Carbon (EC) + Primary Organic Aerosol (POA) + Other Fine Particulate (FPRM) + Fine Crustal Particulate (FCRS)

Note that the $PM_{2.5}$ associated with $SO_4$ is assigned to the project $NO_X$ precursor emissions because the project $SO_2$ emissions were derived as a ratio to the $NO_X$ emissions (see **Appendix D**). Particulate sulfate is expected to be a small component, as the $SO_2$ emissions in the six projects are only 1.2% of the $NO_X$ emissions (see **Table C-2**).

The BenMAP results of the six strategic area project screening modeling at two emissions levels are provided in **Appendix G**.

### C.1.2 Strategic Area Project Health Effects Screening Tool

The strategic area project screening modeling health effects were used to develop a Strategic Area Projects Health Effects Screening Tool, which is a spreadsheet that can be used to estimate health effects for potential strategic area projects with emissions below the 8xTOS level. The Strategic Area Project Health Effects Screening Tool has two interactive components that need to be defined by the user:

1. Project Location: Select one of the six strategic area project locations (see **Table C-1** and **Figure C-1**) from a dropdown menu, and the spreadsheet uses the strategic area project health effects screening modeling results for that location.
2. Project Emissions: Input the $NO_X$, ROG and $PM_{2.5}$ emissions in pounds/day for the potential strategic area project, and the tool linearly interpolates the ozone and PM health effects for the selected project location from the 2xTOS and 8xTOS CAMx/BenMAP modeling.

Note that if the user inputs $NO_X$, ROG or PM emissions below the 2xTOS emissions rate, then the health effects for the 2xTOS emissions level are used to provide a conservative estimate of health effects. The assumption of linear interpolation of the ozone and PM health effects between the 2xTOS and 8xTOS CAMx/BenMAP modeling results could potentially introduce uncertainties in the results, if the linear assumption is invalid. The health effects concentration-response (C-R) functions used in BenMAP are most frequently expressed in log-linear relationships in concentration, so linear interpolation of the health effects between the 2xTOS and 8xTOS concentrations could introduce uncertainties. However, these are very low levels of concentrations, so the log-linear relationship of the C-R functions can be accurately represented by a linear relationship. The chemistry of ozone and secondary $PM_{2.5}$ formation is non-linear, so the use of linear interpolation of the $NO_X$ and ROG health effects could introduce uncertainties in the results. Again, since we are analyzing very small changes in ozone and secondary $PM_{2.5}$ concentrations, the non-linear terms are negligible and small changes in the non-linear models can be correctly analyzed as linear, consistent with Taylor's theorem.[68] Furthermore, because we are interpolating between the 2xTOS and 8xTOS modeling scenarios (rather than extrapolating from one scenario), any non-linear effects in either the C-R functions or chemistry are bounded.

---

[68] https://mathinsight.org/taylors_theorem_multivariable_introduction

A CEQA project within the Sac Metro Air District or the 5-Air-District Region with 656 lbs/day or less of NOx, ROG and $PM_{2.5}$ emissions may use the Strategic Area Health Effects Screening Tool to provide an estimate of the health effects of the project. If the proposed project is within close proximity (e.g., within one 4-km grid cell) of one of the six strategic area source locations the proponent can discuss using the health effects from the Tool at that location with concurrence from the Sac Metro Air District or other applicable air district in the 5-Air-District Region.

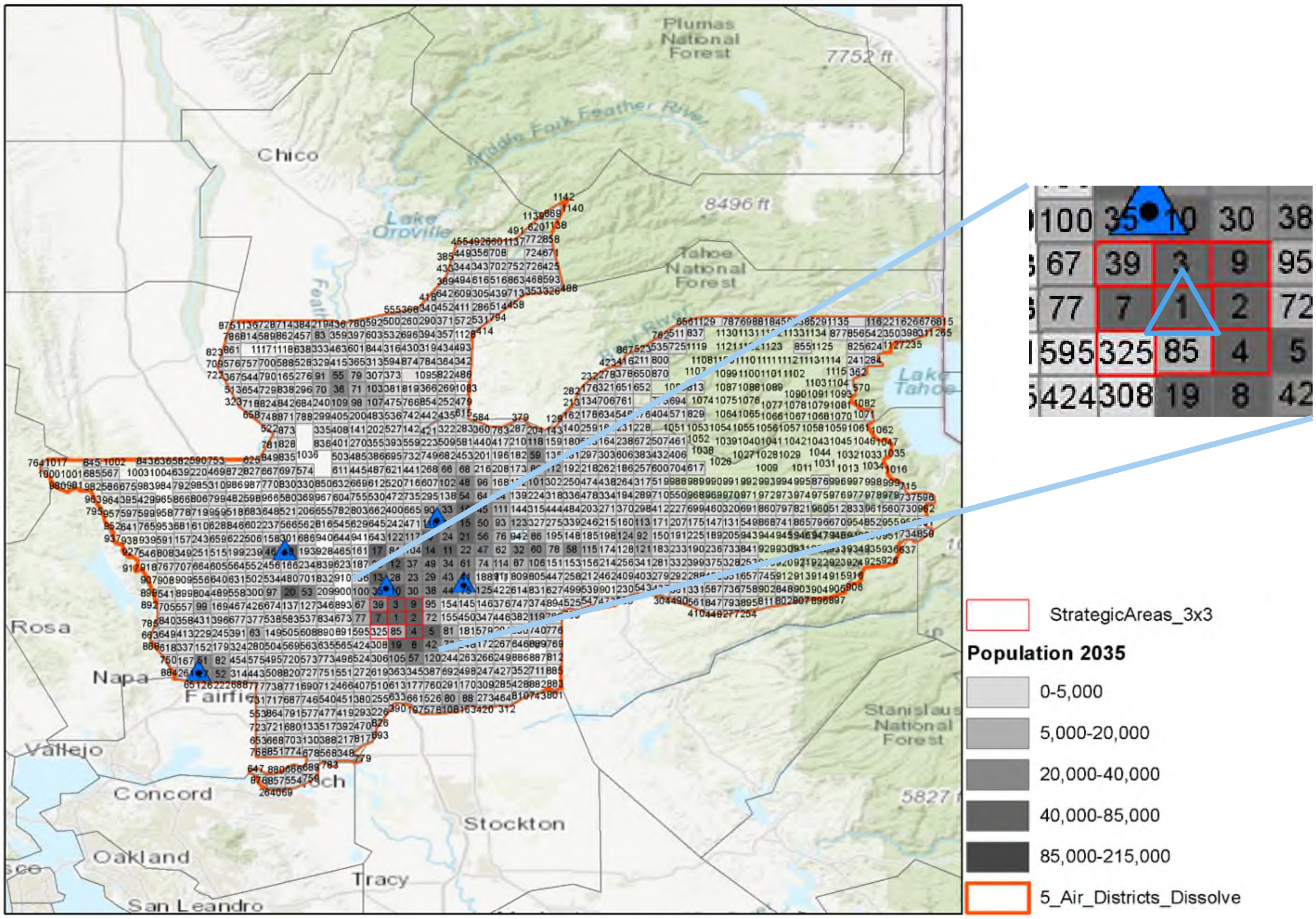
### C.1.3 Using the Strategic Area Projects Health Effects Screening Tool Outside Strategic Areas

The strategic area projects health effects screening tool can be used outside of the strategic areas to provide a conservative (i.e., upper bound) estimate of health effects if the South Sacramento strategic area source is used as a surrogate location. The South Sacramento strategic area source was selected as a surrogate location because it has the highest population density within the 5-Air-District Region. Population density is the strongest driver of health effects. Consequently, the highest population density would be expected to have the largest population exposed and, as a result, the greatest number of health effects. The South Sacramento location is in the 4-km grid cell with the highest population and is also the grid cell centroid of a 3x3 array of 4-km grid cells with the highest population in the 5-Air-District Region; the 9-cells include the 4-km grid cells with the 1st, 2nd 3rd 4th 7th and 9th highest population grid cells in the 5-Air-District Region (see Figure C-2).

Because of the high population density, the South Sacramento location has the highest total health effects of the locations analyzed, out of the six strategic area source locations. For example, for a source with 656 lbs/day of NOx, ROG and $PM_{2.5}$, the premature mortality due to $PM_{2.5}$ across the 5-Air-District Region for the South Sacramento location is 26 deaths compared to 11, 17, 20, 2 and 2 deaths for the West Roseville, Rancho Cordova, Downtown Sacramento, Woodland and Vacaville strategic area locations, respectively.

Alternatively, the project proponent can conduct explicit photochemical grid and health effects modeling following the procedures in section 6 and Appendix A of this guidance.

**Figure C-2. Ranking of population in each 4-km grid cell within the 5-Air-District Region with magnified inset of highest population grid cells where the South Sacramento strategic area source is located.**



# APPENDIX D

# CHARACTERIZATION OF $SO_2$ AND CO EMISSIONS AND ROG CHEMICAL SPECIATION FOR TYPICAL PROJECT EMISSIONS

# D.1 ESTIMATE OF HYPOTHETICAL PROJECT $SO_2$ AND CO EMISSIONS

To characterize the approximate $SO_2$ and CO emissions that may result from emissions at the significance thresholds for $PM_{2.5}$, $NO_X$ and VOCs, we analyzed six historical projects from Sacramento County. The projects were chosen as they represented a diversity of sources and were not dependent on a specific type of source.

To conduct the analysis, the Sac Metro Air District provided criteria pollutant emissions inventory information for the six projects. The information was for the years spanning 2013-2018, and therefore reflected practices and emissions profiles that are current. The emissions inventories were created using CalEEMod to be consistent with past and future projects occurring within the Sac Metro Air District.

Descriptions of these projects can be found in **Table D-1**. Descriptions are from the project description section of the development’s CEQA document, which does not always match the CalEEMod land use inputs, also shown in **Table D-1**.

**Table D-1. Projects used to estimate the $SO_2$ and CO emissions ratios**

| Development | CEQA Project Document Descriptions | CalEEMod Inputs |
|---|---|---|
| **Newbridge** | • 1,095 acre mixed-use development<br>• 3,135 Residential Units<br>• 190,000 sq. ft. Commercial space, 180,000 sq. ft. Office space, 59.6 acres Recreational space, 9.4 acres Educational space | • 297.5 acres modeled<br>• 880 Single Family Homes, 280 unit Low Rise Apartment<br>• 120,000 sq. ft. Regional Shopping Center, 100 acre City Park, 1,000 student Elementary School |
| **Panhandle** | • 490 acre area to be annexed into Sacramento<br>• 2,550 Residential Units and associated infrastructure | • Approx. 483 acres modeled<br>• 2,660 Single Family Homes<br>• 500 student Elementary School, 2800 student Junior High School, 57.8 acre City Park, 101,280 sq. ft. Regional Shopping Center |
| **Richards Boulevard Office Complex** | • 1.375 million GSF complex<br>• Includes 1.225 million GSF workspace plus: lobbies, cafeterias, fitness center, auditorium, retail | • 1.437 million sq. ft. Government Office Building<br>• 1,020 space Enclosed Parking with Elevator<br>• 400 space Parking Lot |
| **The Core** | • 13 acre development<br>• 300 unit luxury apartment complex with parking lot, utilities | • 11.7 acres modeled<br>• 300 unit Mid Rise Apartment |
| **Bilby Ridge** | • Proposed annexation of 480 acre area<br>• Description does not include a proposed new land use | • 17.57 acres modeled<br>• 210,000 sq. ft. General Office Building, 110,000 sq. ft. Elementary School, 2.30 acre City Park, 345,000 sq. ft. Strip Mall |
| **Cardoso** | • 17.46 acre parcel of former agricultural land<br>• 69 Single Family Homes to be built on 16.84 acres, remaining .62 acres for existing home | • 16.84 acres modeled<br>• 69 Single Family Homes |

Overall emissions from the projects are provided in **Table D-2**. The allocated emissions are shown in **Tables D-3a-e**. **Table D-3f** shows the average percentage of emissions of each pollutant for each source type. These tables show that the great majority of $SO_2$ and CO emissions are associated with mobile sources. Accordingly, we chose to estimate $SO_2$ and CO emissions from the ratio of mobile-source $NO_X$ emissions as mobile-source emissions are also the great majority of $NO_X$ emissions.

**Table D-2. Total emissions by project**

| Development | Emissions (tons/yr.) | | | | |
|---|---|---|---|---|---|
| | ROG | NOx | CO | SO2 | PM2.5 |
| Newbridge | 38.73 | 14.09 | 92.93 | 0.24 | 4.50 |
| Panhandle | 29.20 | 25.07 | 84.31 | 0.18 | 5.88 |
| Richards Boulevard Office Complex | 8.50 | 10.63 | 32.38 | 0.12 | 3.18 |
| The Core | 2.20 | 3.39 | 12.16 | 0.03 | 0.68 |
| Bilby Ridge | 8.29 | 19.63 | 50.30 | 0.12 | 2.51 |
| Cardoso | 0.80 | 0.98 | 3.20 | 0.01 | 0.19 |

**Table D-3a. ROG - Percent of mitigated operational emissions attributed to each category by project**

| | Newbridge | Panhandle | Richards Blvd | The Core | Bilby Ridge | Cardoso |
|---|---|---|---|---|---|---|
| | Percentage of Operational Emissions (%) | | | | | |
| **Architectural Coating** | 11.20 | 11.01 | 6.95 | 8.54 | 3.72 | 9.70 |
| **Consumer Products** | 64.78 | 70.43 | 66.46 | 53.30 | 31.34 | 60.55 |
| **Landscaping** | 1.36 | 4.11 | 0.04 | 4.27 | 0.01 | 2.70 |
| **Energy** | 0.47 | 0.11 | 0.85 | 0.72 | 0.41 | 1.20 |
| **Mobile** | 22.18 | 14.34 | 25.54 | 33.17 | 64.52 | 25.85 |
| **Stationary** | 0.00 | 0.00 | 0.16 | 0.00 | 0.00 | 0.00 |
| | | | | | | |
| **Development Total (lbs./day)** | 212.21 | 160.01 | 46.57 | 12.04 | 45.43 | 4.39 |
| **Sac Metro Air District Significance Threshold (lbs./day)** | 65 | | | | | |

### Table D-3b. NOx - Percent of mitigated operational emissions attributed to each category by development

| | Newbridge | Panhandle | Richards Blvd | The Core | Bilby Ridge | Cardoso |
|---|---|---|---|---|---|---|
| | Percentage of Operational Emissions (%) | | | | | |
| **Architectural Coating** | 0.00 | 0.00 | 0.00 | 0.00 | 0.00 | 0.00 |
| **Consumer Products** | 0.00 | 0.00 | 0.00 | 0.00 | 0.00 | 0.00 |
| **Landscaping** | 1.43 | 1.84 | 0.00 | 1.06 | 0.00 | 0.84 |
| **Energy** | 11.20 | 1.16 | 6.21 | 3.98 | 1.58 | 8.35 |
| **Mobile** | 87.37 | 97.00 | 93.23 | 94.97 | 98.42 | 90.81 |
| **Stationary** | 0.00 | 0.00 | 0.56 | 0.00 | 0.00 | 0.00 |
| | | | | | | |
| **Development Total (lbs./day)** | 77.20 | 137.39 | 58.23 | 18.57 | 107.57 | 5.39 |
| **Sac Metro Air District Significance Threshold (lbs./day)** | 65 | | | | | |

### Table D-3c. CO - Percent of mitigated operational emissions attributed to each category by development

| | Newbridge | Panhandle | Richards Blvd | The Core | Bilby Ridge | Cardoso |
|---|---|---|---|---|---|---|
| | Percentage of Operational Emissions (%) | | | | | |
| **Architectural Coating** | 0.00 | 0.00 | 0.00 | 0.00 | 0.00 | 0.00 |
| **Consumer Products** | 0.00 | 0.00 | 0.00 | 0.00 | 0.00 | 0.00 |
| **Landscaping** | 18.82 | 47.41 | 0.11 | 25.49 | 0.02 | 22.26 |
| **Energy** | 0.77 | 0.29 | 1.71 | 0.47 | 0.52 | 1.09 |
| **Mobile** | 80.41 | 52.30 | 98.07 | 74.04 | 99.46 | 76.64 |
| **Stationary** | 0.00 | 0.00 | 0.10 | 0.00 | 0.00 | 0.00 |
| | | | | | | |
| **Development Total (lbs./day)** | 509.21 | 462.00 | 177.43 | 66.65 | 275.60 | 17.55 |
| **Sac Metro Air District Significance Threshold (lbs./day)** | N/A | | | | | |

### Table D-3d. SO2 - Percent of mitigated operational emissions attributed to each category by development

| | Newbridge | Panhandle | Richards Blvd | The Core | Bilby Ridge | Cardoso |
|---|---|---|---|---|---|---|
| | Percentage of Operational Emissions (%) | | | | | |
| **Architectural Coating** | 0.00 | 0.00 | 0.00 | 0.00 | 0.00 | 0.00 |
| **Consumer Products** | 0.00 | 0.00 | 0.00 | 0.00 | 0.00 | 0.00 |
| **Landscaping** | 0.39 | 1.18 | 0.00 | 0.56 | 0.00 | 0.47 |
| **Energy** | 4.19 | 0.97 | 3.22 | 2.98 | 1.59 | 6.07 |
| **Mobile** | 95.42 | 97.85 | 96.73 | 96.46 | 98.41 | 93.47 |
| **Stationary** | 0.00 | 0.00 | 0.05 | 0.00 | 0.00 | 0.00 |
| | | | | | | |
| **Development Total (lbs./day)** | 1.31 | 0.99 | 0.67 | 0.16 | 0.64 | 0.05 |
| **Sac Metro Air District Significance Threshold (lbs./day)** | N/A | | | | | |

### Table D-3e. PM2.5- Percent of mitigated operational emissions attributed to each category by development

| | Newbridge | Panhandle | Richards Blvd | The Core | Bilby Ridge | Cardoso |
|---|---|---|---|---|---|---|
| | Percentage of Operational Emissions (%) | | | | | |
| **Architectural Coating (Total)** | 0.00 | 0.00 | 0.00 | 0.00 | 0.00 | 0.00 |
| **Consumer Products (Total)** | 0.00 | 0.00 | 0.00 | 0.00 | 0.00 | 0.00 |
| **Landscaping (Total)** | 2.15 | 3.78 | 0.00 | 2.50 | 0.00 | 2.12 |
| **Energy (Total)** | 2.83 | 0.38 | 1.58 | 1.59 | 0.94 | 3.58 |
| **Mobile (Fugitive)** | 90.26 | 94.29 | 95.73 | 92.51 | 93.47 | 90.92 |
| **Mobile (Exhaust)** | 4.76 | 1.55 | 2.63 | 3.40 | 5.59 | 3.38 |
| **Stationary (Total)** | 0.00 | 0.00 | 0.06 | 0.00 | 0.00 | 0.00 |
| | | | | | | |
| **Development Total (lbs./day)** | 24.63 | 32.24 | 17.43 | 3.75 | 13.75 | 1.02 |
| **SMAQMD Significance Threshold (lbs./day)** | 82 | | | | | |

**Table D-3f. Emissions summary for all pollutants for all projects with average percentages of emissions**

| | ROG | | | NOx | | | CO | | | SO2 | | | PM2.5 Total | | |
|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|
| | **Avg** | Min | Max | **Avg** | Min | Max | **Avg** | Min | Max | **Avg** | Min | Max | **Avg** | Min | Max |
| | **%** | | | **%** | | | **%** | | | **%** | | | **%** | | |
| **Architectural Coating** | **8.52** | 3.72 | 11.20 | **0.00** | 0.00 | 0.00 | **0.00** | 0.00 | 0.00 | **0.00** | 0.00 | 0.00 | **0.00** | 0.00 | 0.00 |
| **Consumer Products** | **57.81** | 31.34 | 70.43 | **0.00** | 0.00 | 0.00 | **0.00** | 0.00 | 0.00 | **0.00** | 0.00 | 0.00 | **0.00** | 0.00 | 0.00 |
| **Landscaping** | **2.08** | 0.01 | 4.27 | **0.86** | 0.00 | 1.84 | **19.02** | 0.02 | 47.41 | **0.43** | 0.00 | 1.18 | **1.76** | 0.00 | 3.78 |
| **Energy** | **0.63** | 0.11 | 1.20 | **5.41** | 1.16 | 11.20 | **0.81** | 0.29 | 1.71 | **3.17** | 0.97 | 6.07 | **1.82** | 0.38 | 3.58 |
| **Mobile (Total)** | **30.93** | 14.34 | 64.52 | **93.63** | 87.37 | 98.42 | **80.15** | 52.30 | 99.46 | **96.39** | 93.47 | 98.41 | -- | -- | -- |
| Mobile (Fugitive) | **--** | -- | -- | -- | -- | -- | -- | -- | -- | -- | -- | -- | **92.86** | 90.26 | 95.73 |
| Mobile (Exhaust) | -- | -- | -- | -- | -- | -- | -- | -- | -- | -- | -- | -- | **3.55** | 1.55 | 5.59 |
| **Stationary** | **0.03** | 0.00 | 0.16 | **0.09** | 0.00 | 0.56 | **0.02** | 0.00 | 0.10 | **0.01** | 0.00 | 0.05 | **0.01** | 0.00 | 0.06 |

The ratios of emissions of $SO_2$ and CO to $NO_X$ is shown in **Table D-4**, below.

**Table D-4. Ratio of CO/NOx and SO2/NOx**

| **Source Category** | **Newbridge** | | **Panhandle** | | **Richards Boulevard** | | **The Core** | | **Bilby Ridge** | | **Cardoso** | |
|---|---|---|---|---|---|---|---|---|---|---|---|---|
| | **CO/NOx** | **SO2/NOx** | **CO/NOx** | **SO2/NOx** | **CO/NOx** | **SO2/NOx** | **CO/NOx** | **SO2/NOx** | **CO/NOx** | **SO2/NOx** | **CO/NOx** | **SO2/NOx** |
| | **Unitless (ratio)** | | | | | | | | | | | |
| **Architectural Coating** | -- | -- | -- | -- | -- | -- | -- | -- | -- | -- | -- | -- |
| **Consumer Products** | -- | -- | -- | -- | -- | -- | -- | -- | -- | -- | -- | -- |
| **Landscaping** | 86.7711 | 0.0046 | 86.7080 | 0.0046 | 110.3030 | 0.0000 | 86.6061 | 0.0045 | 107.5000 | 0.0000 | 86.6464 | 0.0049 |
| **Energy** | 0.4515 | 0.0064 | 0.8400 | 0.0060 | 0.8400 | 0.0060 | 0.4251 | 0.0064 | 0.8401 | 0.0060 | 0.4263 | 0.0063 |
| **Mobile** | 6.0703 | 0.0185 | 1.8130 | 0.0072 | 3.2051 | 0.0120 | 2.7985 | 0.0086 | 2.5892 | 0.0059 | 2.7488 | 0.0090 |
| **Stationary** | -- | -- | -- | -- | 0.5702 | 0.0010 | -- | -- | -- | -- | -- | -- |
| **Total** | 6.5958 | 0.0170 | 3.3626 | 0.0072 | 3.0469 | 0.0116 | 3.5894 | 0.0085 | 2.5620 | 0.0059 | 3.2571 | 0.0087 |

The ratio of CO to $NO_X$ for mobile sources varied from a high of 6.07 to a low of 1.81, with many clustered between 2.5 and 3.2. We chose a ratio of 3.2 to be conservative and decided on a default value of 3.2 x 82, or 262 lbs. CO/day. The ratio of $SO_2$ to $NO_X$ varies for mobile sources from a high of 0.0185 to a low of 0.0059, with most between 0.072 to 0.0090. We chose the second highest value of 0.012 to be conservative and decided on a default value of 0.012 times 82, or 0.98 lbs. $SO_2$/day.

## D.2 CHEMICAL SPECIATION FOR HYPOTHETICAL PROJECT ROG AND PM EMISSIONS

In addition to specifying the hypothetical project primary $PM_{2.5}$, $PM_{10}$ and ROG emissions, the user needs to chemically speciate these emissions into the individual components used in the CAMx chemical mechanism. Primary $PM_{2.5}$ and $PM_{10}$ are chemically inert, and the concentration-response functions selected for use in the BenMAP health effects model use only the total $PM_{2.5}$ mass concentrations and don't differentiate health effects across different PM species (e.g., elemental carbon, organic aerosol and other fine particulate). Thus, it doesn't matter how the hypothetical project PM emissions are speciated, and for this reason, all the hypothetical project $PM_{2.5}$ emissions were speciated as the CAMx fine particulate matter (FPRM) species.

The speciation of the hypothetical project ROG emissions, however, is important, as the different ROG individual species in the SAPRC07 chemical mechanism used in the BAAQMD CAMx 2012 modeling database have different chemical reactivities and ozone formation potentials. The hypothetical project ROG emissions are speciated into the SAPRC07 chemical mechanism using the SMOKE emissions model that allocates the ROG emissions to SAPRC07 species using chemical speciation profiles from EPA's SPECIATE database[69]. SMOKE cross-references SPECIATE chemical speciation profiles to source emission types using SCCs. To determine the types of sources with ROG emissions for a typical CEQA project in the Sac Metro Air District planning area, we examined the percent contribution of ROG emissions for the same six projects that are discussed above and shown in **Table D-3a**. Ignoring the Bilby Ridge Project, which is an outlier among the six projects, we found that the following three source categories contributed 95-99% of the ROG emissions, so we assumed the following ROG contributions for these three source categories, with the SCCs in parenthesis and the ranges across the five projects in brackets:

- Consumer Products (2460000000) = 65% [53% - 70%]
- Mobile Sources (220110111B) = 25% [14% - 33%]
- Architectural Coatings (241001000) = 10% [7% - 11%]

The SMOKE emissions model was used with the SCC codes listed above to chemically speciate the hypothetical project ROG emissions into the SAPRC07 chemical species.

---

[69] https://www.epa.gov/air-emissions-modeling/speciate

# APPENDIX E
# SAMPLE SCC CODES TYPICALLY USED IN CEQA PROJECTS

# E.1 APPENDIX E

**Table E-1. Example SCCs frequently used to characterize CEQA Project emission source types**

| Emission Source | SCC | SCC Description |
|---|---|---|
| Architectural Coatings | 2401001000 | Solvent Utilization; Surface Coating; Architectural Coatings; Total: All Solvent Types |
| Construction Off-road Equipment | 2270002000 | Mobile Sources; Off-highway Vehicle Diesel; Construction and Mining Equipment; Total |
| Consumer Products | 2460000000 | Solvent Utilization; Miscellaneous Non-industrial: Consumer and Commercial; All Processes; Total: All Solvent Types |
| Consumer Products | 2460100000 | Solvent Utilization; Miscellaneous Non-industrial: Consumer and Commercial; All Personal Care Products; Total: All Solvent Types |
| Consumer Products | 2460200000 | Solvent Utilization; Miscellaneous Non-industrial: Consumer and Commercial; All Household Products; Total: All Solvent Types |
| Consumer Products | 2460400000 | Solvent Utilization; Miscellaneous Non-industrial: Consumer and Commercial; All Automotive Aftermarket Products; Total: All Solvent Types |
| Consumer Products | 2460500000 | Solvent Utilization; Miscellaneous Non-industrial: Consumer and Commercial; All Coatings and Related Products; Total: All Solvent Types |
| Consumer Products | 2460600000 | Solvent Utilization; Miscellaneous Non-industrial: Consumer and Commercial; All Adhesives and Sealants; Total: All Solvent Types |
| Consumer Products | 2460800000 | Solvent Utilization; Miscellaneous Non-industrial: Consumer and Commercial; All FIFRA Related Products; Total: All Solvent Types |
| Consumer Products | 2460900000 | Solvent Utilization; Miscellaneous Non-industrial: Consumer and Commercial; Miscellaneous Products (Not Otherwise Covered); Total: All Solvent Types |
| Energy (Stationary Engines) | 20200102 | Internal Combustion Engines; Industrial; Distillate Oil (Diesel);Reciprocating |
| Energy (Natural Gas) | 2102006000 | Stationary Source Fuel Combustion; Industrial; Natural Gas; Total: Boilers and IC Engines |
| Marine Vessels (Ferries) | 2280002010 | Mobile Sources; Marine Vessels, Commercial; Diesel; Ocean-going Vessels |
| Mobile | 220100111B | Mobile Sources; Highway Vehicles - Gasoline; Light Duty Gasoline Vehicles (LDGV);Rural[70] Interstate: Brake Wear |
| Mobile | 220100111R | Mobile Sources; Highway Vehicles - Gasoline; Light Duty Gasoline Vehicles (LDGV); Rural Interstate: Resting Loss |

---

[70] Rural and Urban mobile designations provide equivalent chemical speciation and temporal distributions, as the EMFAC mobile emissions model does not distinguish between the two.

**Table E-1. Example SCCs frequently used to characterize CEQA Project emission source types**

| Emission Source | SCC | SCC Description |
|---|---|---|
| Mobile | 220100111S | Mobile Sources; Highway Vehicles - Gasoline; Light Duty Gasoline Vehicles (LDGV); Rural Interstate: Start |
| Mobile | 220100111T | Mobile Sources; Highway Vehicles - Gasoline; Light Duty Gasoline Vehicles (LDGV);Rural Interstate: Tire Wear |
| Mobile | 220100111V | Mobile Sources; Highway Vehicles - Gasoline; Light Duty Gasoline Vehicles (LDGV);Rural Interstate: Evap (except Refueling) |
| Mobile | 220100111X | Mobile Sources; Highway Vehicles - Gasoline; Light Duty Gasoline Vehicles (LDGV); Rural Interstate: Exhaust |
| Mobile | 220102011B | Mobile Sources; Highway Vehicles - Gasoline; Light Duty Gasoline Trucks 1 & 2 (M6) = LDGT1 (M5); Rural Interstate: Brake Wear |
| Mobile | 220102011R | Mobile Sources; Highway Vehicles - Gasoline; Light Duty Gasoline Trucks 1 & 2 (M6) = LDGT1 (M5); Rural Interstate: Resting Loss |
| Mobile | 220102011S | Mobile Sources; Highway Vehicles - Gasoline; Light Duty Gasoline Trucks 1 & 2 (M6) = LDGT1 (M5); Rural Interstate: Start |
| Mobile | 220102011T | Mobile Sources; Highway Vehicles - Gasoline; Light Duty Gasoline Trucks 1 & 2 (M6) = LDGT1 (M5); Rural Interstate: Tire Wear |
| Mobile | 220102011V | Mobile Sources; Highway Vehicles - Gasoline; Light Duty Gasoline Trucks 1 & 2 (M6) = LDGT1 (M5); Rural Interstate: Evap (except Refueling) |
| Mobile | 220102011X | Mobile Sources; Highway Vehicles - Gasoline; Light Duty Gasoline Trucks 1 & 2 (M6) = LDGT1 (M5); Rural Interstate: Exhaust |
| Mobile | 2201070110 | Mobile Sources; Highway Vehicles - Gasoline; Heavy Duty Gasoline Vehicles 2B thru 8B & Buses (HDGV);Rural Interstate: Total |
| Mobile | 220107011B | Mobile Sources; Highway Vehicles - Gasoline; Heavy Duty Gasoline Vehicles 2B thru 8B & Buses (HDGV); Rural Interstate: Brake Wear |
| Mobile | 220107011I | Mobile Sources; Highway Vehicles - Diesel; Heavy Duty Diesel Vehicles (HDDV) Class 2B; Rural Interstate: Idling |
| Mobile | 220107011R | Mobile Sources; Highway Vehicles - Gasoline; Heavy Duty Gasoline Vehicles 2B thru 8B & Buses (HDGV); Rural Interstate: Resting Loss |
| Mobile | 220107011S | Mobile Sources; Highway Vehicles - Gasoline; Heavy Duty Gasoline Vehicles 2B thru 8B & Buses (HDGV); Rural Interstate: Start |
| Mobile | 220107011T | Mobile Sources; Highway Vehicles - Gasoline; Heavy Duty Gasoline Vehicles 2B thru 8B & Buses (HDGV); Rural Interstate: Tire Wear |
| Mobile | 220107011V | Mobile Sources; Highway Vehicles - Gasoline; Heavy Duty Gasoline Vehicles 2B thru 8B & Buses (HDGV); Rural Interstate: Evap (except Refueling) |
| Mobile | 220107011X | Mobile Sources; Highway Vehicles - Gasoline; Heavy Duty Gasoline Vehicles 2B thru 8B & Buses (HDGV); Rural Interstate: Exhaust |
| Mobile | 2201070130 | Mobile Sources; Highway Vehicles - Gasoline; Heavy Duty Gasoline Vehicles 2B thru 8B & Buses (HDGV); Rural Other Principal Arterial: Total |

### Table E-1. Example SCCs frequently used to characterize CEQA Project emission source types

| Emission Source | SCC | SCC Description |
|---|---|---|
| Mobile | 220107013B | Mobile Sources; Highway Vehicles - Gasoline; Heavy Duty Gasoline Vehicles 2B thru 8B & Buses (HDGV); Rural Other Principal Arterial: Brake Wear |
| Mobile | 220107013I | Mobile Sources; Highway Vehicles - Gasoline; Heavy Duty Gasoline Vehicles 2B thru 8B & Buses (HDGV); Rural Other Principal Arterial: Idling |
| Mobile | 220107013R | Mobile Sources; Highway Vehicles - Gasoline; Heavy Duty Gasoline Vehicles 2B thru 8B & Buses (HDGV); Rural Other Principal Arterial: Resting Loss |
| Mobile | 220107013S | Mobile Sources; Highway Vehicles - Gasoline; Heavy Duty Gasoline Vehicles 2B thru 8B & Buses (HDGV); Rural Other Principal Arterial: Start |
| Mobile | 220107013T | Mobile Sources; Highway Vehicles - Gasoline; Heavy Duty Gasoline Vehicles 2B thru 8B & Buses (HDGV); Rural Other Principal Arterial: Tire Wear |
| Mobile | 220107013V | Mobile Sources; Highway Vehicles - Gasoline; Heavy Duty Gasoline Vehicles 2B thru 8B & Buses (HDGV); Rural Other Principal Arterial: Evap (except Refueling) |
| Mobile | 220107013X | Mobile Sources; Highway Vehicles - Gasoline; Heavy Duty Gasoline Vehicles 2B thru 8B & Buses (HDGV); Rural Other Principal Arterial: Exhaust |
| Mobile | 220108011B | Mobile Sources; Highway Vehicles - Gasoline; Motorcycles (MC); Rural Interstate: Brake Wear |
| Mobile | 220108011R | Mobile Sources; Highway Vehicles - Gasoline; Motorcycles (MC); Rural Interstate: Resting Loss |
| Mobile | 220108011S | Mobile Sources; Highway Vehicles - Gasoline; Motorcycles (MC); Rural Interstate: Start |
| Mobile | 220108011T | Mobile Sources; Highway Vehicles - Gasoline; Motorcycles (MC); Rural Interstate: Tire Wear |
| Mobile | 220108011V | Mobile Sources; Highway Vehicles - Gasoline; Motorcycles (MC); Rural Interstate: Evap (except Refueling) |
| Mobile | 220108011X | Mobile Sources; Highway Vehicles - Gasoline; Motorcycles (MC); Rural Interstate: Exhaust |
| Mobile | 223000111B | Mobile Sources; Highway Vehicles - Diesel; Light Duty Diesel Vehicles (LDDV); Rural Interstate: Brake Wear |
| Mobile | 223000111T | Mobile Sources; Highway Vehicles - Diesel; Light Duty Diesel Vehicles (LDDV); Rural Interstate: Tire Wear |
| Mobile | 223000111X | Mobile Sources; Highway Vehicles - Diesel; Light Duty Diesel Vehicles (LDDV); Rural Interstate: Exhaust |
| Mobile | 223006011B | Mobile Sources; Highway Vehicles - Diesel; Light Duty Diesel Trucks 1 thru 4 (M6) (LDDT); Rural Interstate: Brake Wear |
| Mobile | 223006011T | Mobile Sources; Highway Vehicles - Diesel; Light Duty Diesel Trucks 1 thru 4 (M6) (LDDT); Rural Interstate: Tire Wear |

### Table E-1. Example SCCs frequently used to characterize CEQA Project emission source types

| Emission Source | SCC | SCC Description |
|---|---|---|
| Mobile | 223006011X | Mobile Sources; Highway Vehicles - Diesel; Light Duty Diesel Trucks 1 thru 4 (M6) (LDDT); Rural Interstate: Exhaust |
| Mobile | 223007111B | Mobile Sources; Highway Vehicles - Diesel; Heavy Duty Diesel Vehicles (HDDV) Class 2B; Rural Interstate: Brake Wear |
| Mobile | 223007111I | Mobile Sources; Highway Vehicles – Diesel; Heavy Duty Diesel Vehicles (HDDV) Class 2B; Rural Interstate: Idling |
| Mobile | 223007111T | Mobile Sources; Highway Vehicles - Diesel; Heavy Duty Diesel Vehicles (HDDV) Class 2B; Rural Interstate: Tire Wear |
| Mobile | 223007111X | Mobile Sources; Highway Vehicles - Diesel; Heavy Duty Diesel Vehicles (HDDV) Class 2B; Rural Interstate: Exhaust |
| Mobile | 2230072110 | Mobile Sources; Highway Vehicles - Diesel; Heavy Duty Diesel Vehicles (HDDV) Class 3, 4, & 5; Rural Interstate: Total |
| Mobile | 223007211B | Mobile Sources; Highway Vehicles - Diesel; Heavy Duty Diesel Vehicles (HDDV) Class 3, 4, & 5; Rural Interstate: Brake Wear |
| Mobile | 223007211I | Mobile Sources; Highway Vehicles - Diesel; Heavy Duty Diesel Vehicles (HDDV) Class 3, 4, & 5; Rural Interstate: Idling |
| Mobile | 223007211T | Mobile Sources; Highway Vehicles - Diesel; Heavy Duty Diesel Vehicles (HDDV) Class 3, 4, & 5; Rural Interstate: Tire Wear |
| Mobile | 223007211X | Mobile Sources; Highway Vehicles - Diesel; Heavy Duty Diesel Vehicles (HDDV) Class 3, 4, & 5; Rural Interstate: Exhaust |
| Mobile | 223007311B | Mobile Sources; Highway Vehicles - Diesel; Heavy Duty Diesel Vehicles (HDDV) Class 6 & 7; Rural Interstate: Brake Wear |
| Mobile | 223007311I | Mobile Sources; Highway Vehicles - Diesel; Heavy Duty Diesel Vehicles (HDDV) Class 6 & 7; Rural Interstate: Idling |
| Mobile | 223007311S | Mobile Sources; Highway Vehicles - Diesel; Heavy Duty Diesel Vehicles (HDDV) Class 6 & 7; Rural Interstate: Start |
| Mobile | 223007311T | Mobile Sources; Highway Vehicles - Diesel; Heavy Duty Diesel Vehicles (HDDV) Class 6 & 7; Rural Interstate: Tire Wear |
| Mobile | 223007311X | Mobile Sources; Highway Vehicles - Diesel; Heavy Duty Diesel Vehicles (HDDV) Class 6 & 7; Rural Interstate: Exhaust |
| Mobile | 223007513B | Mobile Sources; Highway Vehicles - Diesel; Heavy Duty Diesel Buses (School & Transit); Rural Other Principal Arterial: Brake Wear |
| Mobile | 223007513I | Mobile Sources; Highway Vehicles - Diesel; Heavy Duty Diesel Buses (School & Transit); Rural Other Principal Arterial: Idling |
| Mobile | 223007513S | Mobile Sources; Highway Vehicles - Diesel; Heavy Duty Diesel Buses (School & Transit); Rural Other Principal Arterial: Start |
| Mobile | 223007513T | Mobile Sources; Highway Vehicles - Diesel; Heavy Duty Diesel Buses (School & Transit); Rural Other Principal Arterial: Tire Wear |

**Table E-1. Example SCCs frequently used to characterize CEQA Project emission source types**

| Emission Source | SCC | SCC Description |
|---|---|---|
| Mobile | 223007513X | Mobile Sources; Highway Vehicles - Diesel; Heavy Duty Diesel Buses (School & Transit); Rural Other Principal Arterial: Exhaust |
| Mobile | 2294000000 | Mobile Sources; Paved Roads; All Paved Roads; Total: Fugitives |
| Waste Water Treatment Plant | 2630010000 | Waste Disposal, Treatment, and Recovery; Wastewater Treatment; Industrial; Total Processed |

# APPENDIX F
# BENMAP HEALTH EFFECTS RESULTS FOR THE 41 HYPOTHETICAL SOURCES USED IN THE MINOR PROJECTS

# Appendix F: BenMAP Health Effects Results for the 41 Hypothetical Sources used in the Minor Project Screening Modeling in Appendix B

| Source | Pollutant | Health Endpoint | Age Range[1] | Incidences (per year)[2] (Mean) (Reduced Sacramento 4-km Domain) |
|---|---|---|---|---|
| 1 | PM2.5 | Emergency Room Visits, Asthma | 0 - 99 | 3.01E-02 |
| 1 | PM2.5 | Mortality, All Cause | 30 - 99 | 1.10E-01 |
| 1 | PM2.5 | Hospital Admissions, Asthma | 0 - 64 | 2.04E-03 |
| 1 | PM2.5 | Hospital Admissions, All Cardiovascular (less Myocardial Infarctions) | 65 - 99 | 6.65E-03 |
| 1 | PM2.5 | Hospital Admissions, All Respiratory | 65 - 99 | 1.77E-02 |
| 1 | PM2.5 | Acute Myocardial Infarction, Nonfatal | 18 - 24 | 3.01E-06 |
| 1 | PM2.5 | Acute Myocardial Infarction, Nonfatal | 25 - 44 | 2.18E-04 |
| 1 | PM2.5 | Acute Myocardial Infarction, Nonfatal | 45 - 54 | 4.43E-04 |
| 1 | PM2.5 | Acute Myocardial Infarction, Nonfatal | 55 - 64 | 8.35E-04 |
| 1 | PM2.5 | Acute Myocardial Infarction, Nonfatal | 65 - 99 | 3.57E-03 |
| 1 | O3 | Hospital Admissions, All Respiratory | 65 - 99 | 9.91E-03 |
| 1 | O3 | Mortality, Non-Accidental | 0 - 99 | 5.63E-03 |
| 1 | O3 | Emergency Room Visits, Asthma | 0 - 17 | 2.84E-02 |
| 1 | O3 | Emergency Room Visits, Asthma | 18 - 99 | 5.38E-02 |
| 2 | PM2.5 | Emergency Room Visits, Asthma | 0 - 99 | 5.41E-02 |
| 2 | PM2.5 | Mortality, All Cause | 30 - 99 | 1.22E-01 |
| 2 | PM2.5 | Hospital Admissions, Asthma | 0 - 64 | 3.10E-03 |
| 2 | PM2.5 | Hospital Admissions, All Cardiovascular (less Myocardial Infarctions) | 65 - 99 | 7.56E-03 |
| 2 | PM2.5 | Hospital Admissions, All Respiratory | 65 - 99 | 2.06E-02 |
| 2 | PM2.5 | Acute Myocardial Infarction, Nonfatal | 18 - 24 | 5.04E-06 |
| 2 | PM2.5 | Acute Myocardial Infarction, Nonfatal | 25 - 44 | 3.33E-04 |
| 2 | PM2.5 | Acute Myocardial Infarction, Nonfatal | 45 - 54 | 5.67E-04 |
| 2 | PM2.5 | Acute Myocardial Infarction, Nonfatal | 55 - 64 | 8.40E-04 |
| 2 | PM2.5 | Acute Myocardial Infarction, Nonfatal | 65 - 99 | 3.81E-03 |
| 2 | O3 | Hospital Admissions, All Respiratory | 65 - 99 | 1.07E-02 |
| 2 | O3 | Mortality, Non-Accidental | 0 - 99 | 5.90E-03 |
| 2 | O3 | Emergency Room Visits, Asthma | 0 - 17 | 3.53E-02 |

| Source | Pollutant | Health Endpoint | Age Range[1] | Incidences (per year)[2] (Mean) (Reduced Sacramento 4-km Domain) |
|---|---|---|---|---|
| 2 | O3 | Emergency Room Visits, Asthma | 18 - 99 | 6.37E-02 |
| 3 | PM2.5 | Emergency Room Visits, Asthma | 0 - 99 | 3.55E-02 |
| 3 | PM2.5 | Mortality, All Cause | 30 - 99 | 1.01E-01 |
| 3 | PM2.5 | Hospital Admissions, Asthma | 0 - 64 | 2.27E-03 |
| 3 | PM2.5 | Hospital Admissions, All Cardiovascular (less Myocardial Infarctions) | 65 - 99 | 6.53E-03 |
| 3 | PM2.5 | Hospital Admissions, All Respiratory | 65 - 99 | 1.74E-02 |
| 3 | PM2.5 | Acute Myocardial Infarction, Nonfatal | 18 - 24 | 3.14E-06 |
| 3 | PM2.5 | Acute Myocardial Infarction, Nonfatal | 25 - 44 | 2.31E-04 |
| 3 | PM2.5 | Acute Myocardial Infarction, Nonfatal | 45 - 54 | 4.44E-04 |
| 3 | PM2.5 | Acute Myocardial Infarction, Nonfatal | 55 - 64 | 6.97E-04 |
| 3 | PM2.5 | Acute Myocardial Infarction, Nonfatal | 65 - 99 | 3.33E-03 |
| 3 | O3 | Hospital Admissions, All Respiratory | 65 - 99 | 9.96E-03 |
| 3 | O3 | Mortality, Non-Accidental | 0 - 99 | 5.51E-03 |
| 3 | O3 | Emergency Room Visits, Asthma | 0 - 17 | 3.26E-02 |
| 3 | O3 | Emergency Room Visits, Asthma | 18 - 99 | 5.86E-02 |
| 4 | PM2.5 | Emergency Room Visits, Asthma | 0 - 99 | 3.15E-02 |
| 4 | PM2.5 | Mortality, All Cause | 30 - 99 | 1.00E-01 |
| 4 | PM2.5 | Hospital Admissions, Asthma | 0 - 64 | 1.93E-03 |
| 4 | PM2.5 | Hospital Admissions, All Cardiovascular (less Myocardial Infarctions) | 65 - 99 | 7.08E-03 |
| 4 | PM2.5 | Hospital Admissions, All Respiratory | 65 - 99 | 1.79E-02 |
| 4 | PM2.5 | Acute Myocardial Infarction, Nonfatal | 18 - 24 | 2.77E-06 |
| 4 | PM2.5 | Acute Myocardial Infarction, Nonfatal | 25 - 44 | 1.94E-04 |
| 4 | PM2.5 | Acute Myocardial Infarction, Nonfatal | 45 - 54 | 4.53E-04 |
| 4 | PM2.5 | Acute Myocardial Infarction, Nonfatal | 55 - 64 | 7.37E-04 |
| 4 | PM2.5 | Acute Myocardial Infarction, Nonfatal | 65 - 99 | 3.78E-03 |
| 4 | O3 | Hospital Admissions, All Respiratory | 65 - 99 | 9.85E-03 |
| 4 | O3 | Mortality, Non-Accidental | 0 - 99 | 5.43E-03 |
| 4 | O3 | Emergency Room Visits, Asthma | 0 - 17 | 3.36E-02 |
| 4 | O3 | Emergency Room Visits, Asthma | 18 - 99 | 5.82E-02 |

| Source | Pollutant | Health Endpoint | Age Range[1] | Incidences (per year)[2] (Mean) (Reduced Sacramento 4-km Domain) |
|---|---|---|---|---|
| 5 | PM2.5 | Emergency Room Visits, Asthma | 0 - 99 | 9.43E-02 |
| 5 | PM2.5 | Mortality, All Cause | 30 - 99 | 3.59E-01 |
| 5 | PM2.5 | Hospital Admissions, Asthma | 0 - 64 | 4.93E-03 |
| 5 | PM2.5 | Hospital Admissions, All Cardiovascular (less Myocardial Infarctions) | 65 - 99 | 2.39E-02 |
| 5 | PM2.5 | Hospital Admissions, All Respiratory | 65 - 99 | 6.10E-02 |
| 5 | PM2.5 | Acute Myocardial Infarction, Nonfatal | 18 - 24 | 7.99E-06 |
| 5 | PM2.5 | Acute Myocardial Infarction, Nonfatal | 25 - 44 | 4.94E-04 |
| 5 | PM2.5 | Acute Myocardial Infarction, Nonfatal | 45 - 54 | 1.24E-03 |
| 5 | PM2.5 | Acute Myocardial Infarction, Nonfatal | 55 - 64 | 2.16E-03 |
| 5 | PM2.5 | Acute Myocardial Infarction, Nonfatal | 65 - 99 | 1.26E-02 |
| 5 | O3 | Hospital Admissions, All Respiratory | 65 - 99 | 1.84E-02 |
| 5 | O3 | Mortality, Non-Accidental | 0 - 99 | 1.03E-02 |
| 5 | O3 | Emergency Room Visits, Asthma | 0 - 17 | 6.22E-02 |
| 5 | O3 | Emergency Room Visits, Asthma | 18 - 99 | 1.07E-01 |
| 6 | PM2.5 | Emergency Room Visits, Asthma | 0 - 99 | 1.12E-01 |
| 6 | PM2.5 | Mortality, All Cause | 30 - 99 | 4.76E-01 |
| 6 | PM2.5 | Hospital Admissions, Asthma | 0 - 64 | 6.24E-03 |
| 6 | PM2.5 | Hospital Admissions, All Cardiovascular (less Myocardial Infarctions) | 65 - 99 | 2.93E-02 |
| 6 | PM2.5 | Hospital Admissions, All Respiratory | 65 - 99 | 7.41E-02 |
| 6 | PM2.5 | Acute Myocardial Infarction, Nonfatal | 18 - 24 | 1.07E-05 |
| 6 | PM2.5 | Acute Myocardial Infarction, Nonfatal | 25 - 44 | 6.41E-04 |
| 6 | PM2.5 | Acute Myocardial Infarction, Nonfatal | 45 - 54 | 1.67E-03 |
| 6 | PM2.5 | Acute Myocardial Infarction, Nonfatal | 55 - 64 | 2.83E-03 |
| 6 | PM2.5 | Acute Myocardial Infarction, Nonfatal | 65 - 99 | 1.56E-02 |
| 6 | O3 | Hospital Admissions, All Respiratory | 65 - 99 | 2.27E-02 |
| 6 | O3 | Mortality, Non-Accidental | 0 - 99 | 1.31E-02 |
| 6 | O3 | Emergency Room Visits, Asthma | 0 - 17 | 7.54E-02 |
| 6 | O3 | Emergency Room Visits, Asthma | 18 - 99 | 1.30E-01 |
| 7 | PM2.5 | Emergency Room Visits, Asthma | 0 - 99 | 1.98E-01 |
| 7 | PM2.5 | Mortality, All Cause | 30 - 99 | 9.85E-01 |

| Source | Pollutant | Health Endpoint | Age Range[1] | Incidences (per year)[2] (Mean) (Reduced Sacramento 4-km Domain) |
|---|---|---|---|---|
| 7 | PM2.5 | Hospital Admissions, Asthma | 0 - 64 | 1.06E-02 |
| 7 | PM2.5 | Hospital Admissions, All Cardiovascular (less Myocardial Infarctions) | 65 - 99 | 5.76E-02 |
| 7 | PM2.5 | Hospital Admissions, All Respiratory | 65 - 99 | 1.47E-01 |
| 7 | PM2.5 | Acute Myocardial Infarction, Nonfatal | 18 - 24 | 1.92E-05 |
| 7 | PM2.5 | Acute Myocardial Infarction, Nonfatal | 25 - 44 | 1.10E-03 |
| 7 | PM2.5 | Acute Myocardial Infarction, Nonfatal | 45 - 54 | 2.83E-03 |
| 7 | PM2.5 | Acute Myocardial Infarction, Nonfatal | 55 - 64 | 5.19E-03 |
| 7 | PM2.5 | Acute Myocardial Infarction, Nonfatal | 65 - 99 | 3.04E-02 |
| 7 | O3 | Hospital Admissions, All Respiratory | 65 - 99 | 3.72E-02 |
| 7 | O3 | Mortality, Non-Accidental | 0 - 99 | 2.20E-02 |
| 7 | O3 | Emergency Room Visits, Asthma | 0 - 17 | 1.07E-01 |
| 7 | O3 | Emergency Room Visits, Asthma | 18 - 99 | 1.93E-01 |
| 8 | PM2.5 | Emergency Room Visits, Asthma | 0 - 99 | 1.35E-01 |
| 8 | PM2.5 | Mortality, All Cause | 30 - 99 | 5.72E-01 |
| 8 | PM2.5 | Hospital Admissions, Asthma | 0 - 64 | 7.89E-03 |
| 8 | PM2.5 | Hospital Admissions, All Cardiovascular (less Myocardial Infarctions) | 65 - 99 | 3.47E-02 |
| 8 | PM2.5 | Hospital Admissions, All Respiratory | 65 - 99 | 8.63E-02 |
| 8 | PM2.5 | Acute Myocardial Infarction, Nonfatal | 18 - 24 | 1.29E-05 |
| 8 | PM2.5 | Acute Myocardial Infarction, Nonfatal | 25 - 44 | 8.57E-04 |
| 8 | PM2.5 | Acute Myocardial Infarction, Nonfatal | 45 - 54 | 1.95E-03 |
| 8 | PM2.5 | Acute Myocardial Infarction, Nonfatal | 55 - 64 | 3.29E-03 |
| 8 | PM2.5 | Acute Myocardial Infarction, Nonfatal | 65 - 99 | 1.83E-02 |
| 8 | O3 | Hospital Admissions, All Respiratory | 65 - 99 | 2.68E-02 |
| 8 | O3 | Mortality, Non-Accidental | 0 - 99 | 1.60E-02 |
| 8 | O3 | Emergency Room Visits, Asthma | 0 - 17 | 8.34E-02 |
| 8 | O3 | Emergency Room Visits, Asthma | 18 - 99 | 1.45E-01 |
| 9 | PM2.5 | Emergency Room Visits, Asthma | 0 - 99 | 2.94E-01 |
| 9 | PM2.5 | Mortality, All Cause | 30 - 99 | 1.26E+00 |
| 9 | PM2.5 | Hospital Admissions, Asthma | 0 - 64 | 1.64E-02 |

| **Source** | **Pollutant** | **Health Endpoint** | **Age Range[1]** | **Incidences (per year)[2] (Mean) (Reduced Sacramento 4-km Domain)** |
|---|---|---|---|---|
| 9 | PM2.5 | Hospital Admissions, All Cardiovascular (less Myocardial Infarctions) | 65 - 99 | 7.51E-02 |
| 9 | PM2.5 | Hospital Admissions, All Respiratory | 65 - 99 | 1.85E-01 |
| 9 | PM2.5 | Acute Myocardial Infarction, Nonfatal | 18 - 24 | 2.90E-05 |
| 9 | PM2.5 | Acute Myocardial Infarction, Nonfatal | 25 - 44 | 1.84E-03 |
| 9 | PM2.5 | Acute Myocardial Infarction, Nonfatal | 45 - 54 | 4.33E-03 |
| 9 | PM2.5 | Acute Myocardial Infarction, Nonfatal | 55 - 64 | 7.33E-03 |
| 9 | PM2.5 | Acute Myocardial Infarction, Nonfatal | 65 - 99 | 4.05E-02 |
| 9 | O3 | Hospital Admissions, All Respiratory | 65 - 99 | 4.81E-02 |
| 9 | O3 | Mortality, Non-Accidental | 0 - 99 | 2.97E-02 |
| 9 | O3 | Emergency Room Visits, Asthma | 0 - 17 | 1.28E-01 |
| 9 | O3 | Emergency Room Visits, Asthma | 18 - 99 | 2.34E-01 |
| 10 | PM2.5 | Emergency Room Visits, Asthma | 0 - 99 | 1.28E-01 |
| 10 | PM2.5 | Mortality, All Cause | 30 - 99 | 6.45E-01 |
| 10 | PM2.5 | Hospital Admissions, Asthma | 0 - 64 | 7.55E-03 |
| 10 | PM2.5 | Hospital Admissions, All Cardiovascular (less Myocardial Infarctions) | 65 - 99 | 3.64E-02 |
| 10 | PM2.5 | Hospital Admissions, All Respiratory | 65 - 99 | 9.51E-02 |
| 10 | PM2.5 | Acute Myocardial Infarction, Nonfatal | 18 - 24 | 1.25E-05 |
| 10 | PM2.5 | Acute Myocardial Infarction, Nonfatal | 25 - 44 | 8.27E-04 |
| 10 | PM2.5 | Acute Myocardial Infarction, Nonfatal | 45 - 54 | 1.66E-03 |
| 10 | PM2.5 | Acute Myocardial Infarction, Nonfatal | 55 - 64 | 2.74E-03 |
| 10 | PM2.5 | Acute Myocardial Infarction, Nonfatal | 65 - 99 | 1.80E-02 |
| 10 | O3 | Hospital Admissions, All Respiratory | 65 - 99 | 1.94E-02 |
| 10 | O3 | Mortality, Non-Accidental | 0 - 99 | 1.15E-02 |
| 10 | O3 | Emergency Room Visits, Asthma | 0 - 17 | 6.20E-02 |
| 10 | O3 | Emergency Room Visits, Asthma | 18 - 99 | 1.08E-01 |
| 11 | PM2.5 | Emergency Room Visits, Asthma | 0 - 99 | 4.60E-02 |
| 11 | PM2.5 | Mortality, All Cause | 30 - 99 | 1.76E-01 |
| 11 | PM2.5 | Hospital Admissions, Asthma | 0 - 64 | 2.81E-03 |
| 11 | PM2.5 | Hospital Admissions, All Cardiovascular (less Myocardial Infarctions) | 65 - 99 | 1.11E-02 |

| Source | Pollutant | Health Endpoint | Age Range[1] | Incidences (per year)[2] (Mean) (Reduced Sacramento 4-km Domain) |
|---|---|---|---|---|
| 11 | PM2.5 | Hospital Admissions, All Respiratory | 65 - 99 | 2.74E-02 |
| 11 | PM2.5 | Acute Myocardial Infarction, Nonfatal | 18 - 24 | 4.22E-06 |
| 11 | PM2.5 | Acute Myocardial Infarction, Nonfatal | 25 - 44 | 3.00E-04 |
| 11 | PM2.5 | Acute Myocardial Infarction, Nonfatal | 45 - 54 | 6.77E-04 |
| 11 | PM2.5 | Acute Myocardial Infarction, Nonfatal | 55 - 64 | 1.12E-03 |
| 11 | PM2.5 | Acute Myocardial Infarction, Nonfatal | 65 - 99 | 5.92E-03 |
| 11 | O3 | Hospital Admissions, All Respiratory | 65 - 99 | 1.20E-02 |
| 11 | O3 | Mortality, Non-Accidental | 0 - 99 | 6.99E-03 |
| 11 | O3 | Emergency Room Visits, Asthma | 0 - 17 | 3.82E-02 |
| 11 | O3 | Emergency Room Visits, Asthma | 18 - 99 | 6.69E-02 |
| 12 | PM2.5 | Emergency Room Visits, Asthma | 0 - 99 | 1.13E-01 |
| 12 | PM2.5 | Mortality, All Cause | 30 - 99 | 4.23E-01 |
| 12 | PM2.5 | Hospital Admissions, Asthma | 0 - 64 | 6.86E-03 |
| 12 | PM2.5 | Hospital Admissions, All Cardiovascular (less Myocardial Infarctions) | 65 - 99 | 2.68E-02 |
| 12 | PM2.5 | Hospital Admissions, All Respiratory | 65 - 99 | 6.39E-02 |
| 12 | PM2.5 | Acute Myocardial Infarction, Nonfatal | 18 - 24 | 1.01E-05 |
| 12 | PM2.5 | Acute Myocardial Infarction, Nonfatal | 25 - 44 | 7.53E-04 |
| 12 | PM2.5 | Acute Myocardial Infarction, Nonfatal | 45 - 54 | 1.71E-03 |
| 12 | PM2.5 | Acute Myocardial Infarction, Nonfatal | 55 - 64 | 2.81E-03 |
| 12 | PM2.5 | Acute Myocardial Infarction, Nonfatal | 65 - 99 | 1.44E-02 |
| 12 | O3 | Hospital Admissions, All Respiratory | 65 - 99 | 1.94E-02 |
| 12 | O3 | Mortality, Non-Accidental | 0 - 99 | 1.16E-02 |
| 12 | O3 | Emergency Room Visits, Asthma | 0 - 17 | 6.42E-02 |
| 12 | O3 | Emergency Room Visits, Asthma | 18 - 99 | 1.10E-01 |
| 13 | PM2.5 | Emergency Room Visits, Asthma | 0 - 99 | 2.31E-01 |
| 13 | PM2.5 | Mortality, All Cause | 30 - 99 | 9.25E-01 |
| 13 | PM2.5 | Hospital Admissions, Asthma | 0 - 64 | 1.41E-02 |
| 13 | PM2.5 | Hospital Admissions, All Cardiovascular (less Myocardial Infarctions) | 65 - 99 | 5.78E-02 |
| 13 | PM2.5 | Hospital Admissions, All Respiratory | 65 - 99 | 1.36E-01 |
| 13 | PM2.5 | Acute Myocardial Infarction, Nonfatal | 18 - 24 | 2.13E-05 |

| Source | Pollutant | Health Endpoint | Age Range[1] | Incidences (per year)[2] (Mean) (Reduced Sacramento 4-km Domain) |
|---|---|---|---|---|
| 13 | PM2.5 | Acute Myocardial Infarction, Nonfatal | 25 - 44 | 1.59E-03 |
| 13 | PM2.5 | Acute Myocardial Infarction, Nonfatal | 45 - 54 | 3.57E-03 |
| 13 | PM2.5 | Acute Myocardial Infarction, Nonfatal | 55 - 64 | 5.82E-03 |
| 13 | PM2.5 | Acute Myocardial Infarction, Nonfatal | 65 - 99 | 3.08E-02 |
| 13 | O3 | Hospital Admissions, All Respiratory | 65 - 99 | 3.88E-02 |
| 13 | O3 | Mortality, Non-Accidental | 0 - 99 | 2.46E-02 |
| 13 | O3 | Emergency Room Visits, Asthma | 0 - 17 | 1.02E-01 |
| 13 | O3 | Emergency Room Visits, Asthma | 18 - 99 | 1.86E-01 |
| 14 | PM2.5 | Emergency Room Visits, Asthma | 0 - 99 | 4.77E-01 |
| 14 | PM2.5 | Mortality, All Cause | 30 - 99 | 1.38E+00 |
| 14 | PM2.5 | Hospital Admissions, Asthma | 0 - 64 | 3.00E-02 |
| 14 | PM2.5 | Hospital Admissions, All Cardiovascular (less Myocardial Infarctions) | 65 - 99 | 9.63E-02 |
| 14 | PM2.5 | Hospital Admissions, All Respiratory | 65 - 99 | 2.05E-01 |
| 14 | PM2.5 | Acute Myocardial Infarction, Nonfatal | 18 - 24 | 4.05E-05 |
| 14 | PM2.5 | Acute Myocardial Infarction, Nonfatal | 25 - 44 | 3.74E-03 |
| 14 | PM2.5 | Acute Myocardial Infarction, Nonfatal | 45 - 54 | 8.14E-03 |
| 14 | PM2.5 | Acute Myocardial Infarction, Nonfatal | 55 - 64 | 1.26E-02 |
| 14 | PM2.5 | Acute Myocardial Infarction, Nonfatal | 65 - 99 | 5.61E-02 |
| 14 | O3 | Hospital Admissions, All Respiratory | 65 - 99 | 5.29E-02 |
| 14 | O3 | Mortality, Non-Accidental | 0 - 99 | 3.33E-02 |
| 14 | O3 | Emergency Room Visits, Asthma | 0 - 17 | 1.53E-01 |
| 14 | O3 | Emergency Room Visits, Asthma | 18 - 99 | 2.74E-01 |
| 15 | PM2.5 | Emergency Room Visits, Asthma | 0 - 99 | 8.92E-01 |
| 15 | PM2.5 | Mortality, All Cause | 30 - 99 | 2.52E+00 |
| 15 | PM2.5 | Hospital Admissions, Asthma | 0 - 64 | 5.63E-02 |
| 15 | PM2.5 | Hospital Admissions, All Cardiovascular (less Myocardial Infarctions) | 65 - 99 | 2.08E-01 |
| 15 | PM2.5 | Hospital Admissions, All Respiratory | 65 - 99 | 3.81E-01 |
| 15 | PM2.5 | Acute Myocardial Infarction, Nonfatal | 18 - 24 | 7.24E-05 |
| 15 | PM2.5 | Acute Myocardial Infarction, Nonfatal | 25 - 44 | 6.31E-03 |
| 15 | PM2.5 | Acute Myocardial Infarction, Nonfatal | 45 - 54 | 1.69E-02 |

| Source | Pollutant | Health Endpoint | Age Range[1] | Incidences (per year)[2] (Mean) (Reduced Sacramento 4-km Domain) |
|---|---|---|---|---|
| 15 | PM2.5 | Acute Myocardial Infarction, Nonfatal | 55 - 64 | 2.87E-02 |
| 15 | PM2.5 | Acute Myocardial Infarction, Nonfatal | 65 - 99 | 1.31E-01 |
| 15 | O3 | Hospital Admissions, All Respiratory | 65 - 99 | 8.99E-02 |
| 15 | O3 | Mortality, Non-Accidental | 0 - 99 | 5.73E-02 |
| 15 | O3 | Emergency Room Visits, Asthma | 0 - 17 | 3.32E-01 |
| 15 | O3 | Emergency Room Visits, Asthma | 18 - 99 | 5.85E-01 |
| 16 | PM2.5 | Emergency Room Visits, Asthma | 0 - 99 | 6.58E-01 |
| 16 | PM2.5 | Mortality, All Cause | 30 - 99 | 2.61E+00 |
| 16 | PM2.5 | Hospital Admissions, Asthma | 0 - 64 | 3.53E-02 |
| 16 | PM2.5 | Hospital Admissions, All Cardiovascular (less Myocardial Infarctions) | 65 - 99 | 1.50E-01 |
| 16 | PM2.5 | Hospital Admissions, All Respiratory | 65 - 99 | 3.70E-01 |
| 16 | PM2.5 | Acute Myocardial Infarction, Nonfatal | 18 - 24 | 7.02E-05 |
| 16 | PM2.5 | Acute Myocardial Infarction, Nonfatal | 25 - 44 | 4.34E-03 |
| 16 | PM2.5 | Acute Myocardial Infarction, Nonfatal | 45 - 54 | 8.91E-03 |
| 16 | PM2.5 | Acute Myocardial Infarction, Nonfatal | 55 - 64 | 1.41E-02 |
| 16 | PM2.5 | Acute Myocardial Infarction, Nonfatal | 65 - 99 | 8.15E-02 |
| 16 | O3 | Hospital Admissions, All Respiratory | 65 - 99 | 8.04E-02 |
| 16 | O3 | Mortality, Non-Accidental | 0 - 99 | 5.12E-02 |
| 16 | O3 | Emergency Room Visits, Asthma | 0 - 17 | 2.26E-01 |
| 16 | O3 | Emergency Room Visits, Asthma | 18 - 99 | 4.05E-01 |
| 17 | PM2.5 | Emergency Room Visits, Asthma | 0 - 99 | 4.66E-01 |
| 17 | PM2.5 | Mortality, All Cause | 30 - 99 | 1.22E+00 |
| 17 | PM2.5 | Hospital Admissions, Asthma | 0 - 64 | 2.96E-02 |
| 17 | PM2.5 | Hospital Admissions, All Cardiovascular (less Myocardial Infarctions) | 65 - 99 | 1.01E-01 |
| 17 | PM2.5 | Hospital Admissions, All Respiratory | 65 - 99 | 1.91E-01 |
| 17 | PM2.5 | Acute Myocardial Infarction, Nonfatal | 18 - 24 | 3.62E-05 |
| 17 | PM2.5 | Acute Myocardial Infarction, Nonfatal | 25 - 44 | 3.37E-03 |
| 17 | PM2.5 | Acute Myocardial Infarction, Nonfatal | 45 - 54 | 8.43E-03 |
| 17 | PM2.5 | Acute Myocardial Infarction, Nonfatal | 55 - 64 | 1.50E-02 |
| 17 | PM2.5 | Acute Myocardial Infarction, Nonfatal | 65 - 99 | 6.24E-02 |

| Source | Pollutant | Health Endpoint | Age Range[1] | Incidences (per year)[2] (Mean) (Reduced Sacramento 4-km Domain) |
|---|---|---|---|---|
| 17 | O3 | Hospital Admissions, All Respiratory | 65 - 99 | 4.86E-02 |
| 17 | O3 | Mortality, Non-Accidental | 0 - 99 | 3.04E-02 |
| 17 | O3 | Emergency Room Visits, Asthma | 0 - 17 | 1.69E-01 |
| 17 | O3 | Emergency Room Visits, Asthma | 18 - 99 | 2.90E-01 |
| 18 | PM2.5 | Emergency Room Visits, Asthma | 0 - 99 | 7.78E-01 |
| 18 | PM2.5 | Mortality, All Cause | 30 - 99 | 1.60E+00 |
| 18 | PM2.5 | Hospital Admissions, Asthma | 0 - 64 | 5.15E-02 |
| 18 | PM2.5 | Hospital Admissions, All Cardiovascular (less Myocardial Infarctions) | 65 - 99 | 1.32E-01 |
| 18 | PM2.5 | Hospital Admissions, All Respiratory | 65 - 99 | 2.44E-01 |
| 18 | PM2.5 | Acute Myocardial Infarction, Nonfatal | 18 - 24 | 6.50E-05 |
| 18 | PM2.5 | Acute Myocardial Infarction, Nonfatal | 25 - 44 | 5.86E-03 |
| 18 | PM2.5 | Acute Myocardial Infarction, Nonfatal | 45 - 54 | 1.50E-02 |
| 18 | PM2.5 | Acute Myocardial Infarction, Nonfatal | 55 - 64 | 2.35E-02 |
| 18 | PM2.5 | Acute Myocardial Infarction, Nonfatal | 65 - 99 | 8.34E-02 |
| 18 | O3 | Hospital Admissions, All Respiratory | 65 - 99 | 5.29E-02 |
| 18 | O3 | Mortality, Non-Accidental | 0 - 99 | 3.28E-02 |
| 18 | O3 | Emergency Room Visits, Asthma | 0 - 17 | 2.28E-01 |
| 18 | O3 | Emergency Room Visits, Asthma | 18 - 99 | 3.72E-01 |
| 19 | PM2.5 | Emergency Room Visits, Asthma | 0 - 99 | 7.04E-01 |
| 19 | PM2.5 | Mortality, All Cause | 30 - 99 | 1.33E+00 |
| 19 | PM2.5 | Hospital Admissions, Asthma | 0 - 64 | 4.53E-02 |
| 19 | PM2.5 | Hospital Admissions, All Cardiovascular (less Myocardial Infarctions) | 65 - 99 | 1.13E-01 |
| 19 | PM2.5 | Hospital Admissions, All Respiratory | 65 - 99 | 2.19E-01 |
| 19 | PM2.5 | Acute Myocardial Infarction, Nonfatal | 18 - 24 | 5.61E-05 |
| 19 | PM2.5 | Acute Myocardial Infarction, Nonfatal | 25 - 44 | 5.01E-03 |
| 19 | PM2.5 | Acute Myocardial Infarction, Nonfatal | 45 - 54 | 1.23E-02 |
| 19 | PM2.5 | Acute Myocardial Infarction, Nonfatal | 55 - 64 | 1.99E-02 |
| 19 | PM2.5 | Acute Myocardial Infarction, Nonfatal | 65 - 99 | 7.06E-02 |
| 19 | O3 | Hospital Admissions, All Respiratory | 65 - 99 | 3.55E-02 |
| 19 | O3 | Mortality, Non-Accidental | 0 - 99 | 2.06E-02 |

| Source | Pollutant | Health Endpoint | Age Range[1] | Incidences (per year)[2] (Mean) (Reduced Sacramento 4-km Domain) |
|---|---|---|---|---|
| 19 | O3 | Emergency Room Visits, Asthma | 0 - 17 | 1.82E-01 |
| 19 | O3 | Emergency Room Visits, Asthma | 18 - 99 | 2.68E-01 |
| 20 | PM2.5 | Emergency Room Visits, Asthma | 0 - 99 | 1.46E+00 |
| 20 | PM2.5 | Mortality, All Cause | 30 - 99 | 2.29E+00 |
| 20 | PM2.5 | Hospital Admissions, All Cardiovascular (less Myocardial Infarctions) | 65 - 99 | 9.71E-02 |
| 20 | PM2.5 | Hospital Admissions, Asthma | 0 - 64 | 1.86E-01 |
| 20 | PM2.5 | Hospital Admissions, All Respiratory | 65 - 99 | 3.37E-01 |
| 20 | PM2.5 | Acute Myocardial Infarction, Nonfatal | 18 - 24 | 1.31E-04 |
| 20 | PM2.5 | Acute Myocardial Infarction, Nonfatal | 25 - 44 | 1.23E-02 |
| 20 | PM2.5 | Acute Myocardial Infarction, Nonfatal | 45 - 54 | 2.49E-02 |
| 20 | PM2.5 | Acute Myocardial Infarction, Nonfatal | 55 - 64 | 3.98E-02 |
| 20 | PM2.5 | Acute Myocardial Infarction, Nonfatal | 65 - 99 | 1.19E-01 |
| 20 | O3 | Hospital Admissions, All Respiratory | 65 - 99 | 8.52E-02 |
| 20 | O3 | Mortality, Non-Accidental | 0 - 99 | 5.28E-02 |
| 20 | O3 | Emergency Room Visits, Asthma | 0 - 17 | 4.61E-01 |
| 20 | O3 | Emergency Room Visits, Asthma | 18 - 99 | 7.24E-01 |
| 21 | PM2.5 | Emergency Room Visits, Asthma | 0 - 99 | 4.42E-01 |
| 21 | PM2.5 | Mortality, All Cause | 30 - 99 | 1.27E+00 |
| 21 | PM2.5 | Hospital Admissions, Asthma | 0 - 64 | 2.63E-02 |
| 21 | PM2.5 | Hospital Admissions, All Cardiovascular (less Myocardial Infarctions) | 65 - 99 | 5.48E-02 |
| 21 | PM2.5 | Hospital Admissions, All Respiratory | 65 - 99 | 1.59E-01 |
| 21 | PM2.5 | Acute Myocardial Infarction, Nonfatal | 18 - 24 | 6.22E-05 |
| 21 | PM2.5 | Acute Myocardial Infarction, Nonfatal | 25 - 44 | 2.83E-03 |
| 21 | PM2.5 | Acute Myocardial Infarction, Nonfatal | 45 - 54 | 5.19E-03 |
| 21 | PM2.5 | Acute Myocardial Infarction, Nonfatal | 55 - 64 | 7.77E-03 |
| 21 | PM2.5 | Acute Myocardial Infarction, Nonfatal | 65 - 99 | 3.43E-02 |
| 21 | O3 | Hospital Admissions, All Respiratory | 65 - 99 | 5.45E-02 |
| 21 | O3 | Mortality, Non-Accidental | 0 - 99 | 3.38E-02 |
| 21 | O3 | Emergency Room Visits, Asthma | 0 - 17 | 2.80E-01 |

| Source | Pollutant | Health Endpoint | Age Range[1] | Incidences (per year)[2] (Mean) (Reduced Sacramento 4-km Domain) |
|---|---|---|---|---|
| 21 | O3 | Emergency Room Visits, Asthma | 18 - 99 | 4.39E-01 |
| 22 | PM2.5 | Emergency Room Visits, Asthma | 0 - 99 | 1.72E-01 |
| 22 | PM2.5 | Mortality, All Cause | 30 - 99 | 4.25E-01 |
| 22 | PM2.5 | Hospital Admissions, Asthma | 0 - 64 | 1.00E-02 |
| 22 | PM2.5 | Hospital Admissions, All Cardiovascular (less Myocardial Infarctions) | 65 - 99 | 2.60E-02 |
| 22 | PM2.5 | Hospital Admissions, All Respiratory | 65 - 99 | 6.42E-02 |
| 22 | PM2.5 | Acute Myocardial Infarction, Nonfatal | 18 - 24 | 1.86E-05 |
| 22 | PM2.5 | Acute Myocardial Infarction, Nonfatal | 25 - 44 | 9.72E-04 |
| 22 | PM2.5 | Acute Myocardial Infarction, Nonfatal | 45 - 54 | 2.20E-03 |
| 22 | PM2.5 | Acute Myocardial Infarction, Nonfatal | 55 - 64 | 3.51E-03 |
| 22 | PM2.5 | Acute Myocardial Infarction, Nonfatal | 65 - 99 | 1.51E-02 |
| 22 | O3 | Hospital Admissions, All Respiratory | 65 - 99 | 4.21E-02 |
| 22 | O3 | Mortality, Non-Accidental | 0 - 99 | 2.44E-02 |
| 22 | O3 | Emergency Room Visits, Asthma | 0 - 17 | 2.06E-01 |
| 22 | O3 | Emergency Room Visits, Asthma | 18 - 99 | 3.36E-01 |
| 23 | PM2.5 | Emergency Room Visits, Asthma | 0 - 99 | 4.58E-01 |
| 23 | PM2.5 | Mortality, All Cause | 30 - 99 | 1.33E+00 |
| 23 | PM2.5 | Hospital Admissions, Asthma | 0 - 64 | 2.55E-02 |
| 23 | PM2.5 | Hospital Admissions, All Cardiovascular (less Myocardial Infarctions) | 65 - 99 | 5.81E-02 |
| 23 | PM2.5 | Hospital Admissions, All Respiratory | 65 - 99 | 1.69E-01 |
| 23 | PM2.5 | Acute Myocardial Infarction, Nonfatal | 18 - 24 | 1.43E-04 |
| 23 | PM2.5 | Acute Myocardial Infarction, Nonfatal | 25 - 44 | 2.58E-03 |
| 23 | PM2.5 | Acute Myocardial Infarction, Nonfatal | 45 - 54 | 4.87E-03 |
| 23 | PM2.5 | Acute Myocardial Infarction, Nonfatal | 55 - 64 | 7.54E-03 |
| 23 | PM2.5 | Acute Myocardial Infarction, Nonfatal | 65 - 99 | 3.64E-02 |
| 23 | O3 | Hospital Admissions, All Respiratory | 65 - 99 | 5.98E-02 |
| 23 | O3 | Mortality, Non-Accidental | 0 - 99 | 3.73E-02 |
| 23 | O3 | Emergency Room Visits, Asthma | 0 - 17 | 3.06E-01 |
| 23 | O3 | Emergency Room Visits, Asthma | 18 - 99 | 4.87E-01 |

| Source | Pollutant | Health Endpoint | Age Range[1] | Incidences (per year)[2] (Mean) (Reduced Sacramento 4-km Domain) |
|---|---|---|---|---|
| 24 | PM2.5 | Emergency Room Visits, Asthma | 0 - 99 | 1.09E+00 |
| 24 | PM2.5 | Mortality, All Cause | 30 - 99 | 2.38E+00 |
| 24 | PM2.5 | Hospital Admissions, Asthma | 0 - 64 | 7.13E-02 |
| 24 | PM2.5 | Hospital Admissions, All Cardiovascular (less Myocardial Infarctions) | 65 - 99 | 1.94E-01 |
| 24 | PM2.5 | Hospital Admissions, All Respiratory | 65 - 99 | 3.57E-01 |
| 24 | PM2.5 | Acute Myocardial Infarction, Nonfatal | 18 - 24 | 9.32E-05 |
| 24 | PM2.5 | Acute Myocardial Infarction, Nonfatal | 25 - 44 | 7.90E-03 |
| 24 | PM2.5 | Acute Myocardial Infarction, Nonfatal | 45 - 54 | 2.02E-02 |
| 24 | PM2.5 | Acute Myocardial Infarction, Nonfatal | 55 - 64 | 3.35E-02 |
| 24 | PM2.5 | Acute Myocardial Infarction, Nonfatal | 65 - 99 | 1.24E-01 |
| 24 | O3 | Hospital Admissions, All Respiratory | 65 - 99 | 9.10E-02 |
| 24 | O3 | Mortality, Non-Accidental | 0 - 99 | 5.68E-02 |
| 24 | O3 | Emergency Room Visits, Asthma | 0 - 17 | 5.11E-01 |
| 24 | O3 | Emergency Room Visits, Asthma | 18 - 99 | 7.88E-01 |
| 25 | PM2.5 | Emergency Room Visits, Asthma | 0 - 99 | 4.82E-01 |
| 25 | PM2.5 | Mortality, All Cause | 30 - 99 | 9.72E-01 |
| 25 | PM2.5 | Hospital Admissions, Asthma | 0 - 64 | 2.99E-02 |
| 25 | PM2.5 | Hospital Admissions, All Cardiovascular (less Myocardial Infarctions) | 65 - 99 | 7.84E-02 |
| 25 | PM2.5 | Hospital Admissions, All Respiratory | 65 - 99 | 1.62E-01 |
| 25 | PM2.5 | Acute Myocardial Infarction, Nonfatal | 18 - 24 | 4.01E-05 |
| 25 | PM2.5 | Acute Myocardial Infarction, Nonfatal | 25 - 44 | 3.29E-03 |
| 25 | PM2.5 | Acute Myocardial Infarction, Nonfatal | 45 - 54 | 7.92E-03 |
| 25 | PM2.5 | Acute Myocardial Infarction, Nonfatal | 55 - 64 | 1.28E-02 |
| 25 | PM2.5 | Acute Myocardial Infarction, Nonfatal | 65 - 99 | 4.75E-02 |
| 25 | O3 | Hospital Admissions, All Respiratory | 65 - 99 | 4.78E-02 |
| 25 | O3 | Mortality, Non-Accidental | 0 - 99 | 2.68E-02 |
| 25 | O3 | Emergency Room Visits, Asthma | 0 - 17 | 2.54E-01 |
| 25 | O3 | Emergency Room Visits, Asthma | 18 - 99 | 3.77E-01 |
| 26 | PM2.5 | Emergency Room Visits, Asthma | 0 - 99 | 5.51E-01 |
| 26 | PM2.5 | Mortality, All Cause | 30 - 99 | 1.60E+00 |

| Source | Pollutant | Health Endpoint | Age Range[1] | Incidences (per year)[2] (Mean) (Reduced Sacramento 4-km Domain) |
|---|---|---|---|---|
| 26 | PM2.5 | Hospital Admissions, Asthma | 0 - 64 | 2.15E-02 |
| 26 | PM2.5 | Hospital Admissions, All Cardiovascular (less Myocardial Infarctions) | 65 - 99 | 1.05E-01 |
| 26 | PM2.5 | Hospital Admissions, All Respiratory | 65 - 99 | 2.53E-01 |
| 26 | PM2.5 | Acute Myocardial Infarction, Nonfatal | 18 - 24 | 4.13E-05 |
| 26 | PM2.5 | Acute Myocardial Infarction, Nonfatal | 25 - 44 | 2.07E-03 |
| 26 | PM2.5 | Acute Myocardial Infarction, Nonfatal | 45 - 54 | 5.50E-03 |
| 26 | PM2.5 | Acute Myocardial Infarction, Nonfatal | 55 - 64 | 8.73E-03 |
| 26 | PM2.5 | Acute Myocardial Infarction, Nonfatal | 65 - 99 | 5.63E-02 |
| 26 | O3 | Hospital Admissions, All Respiratory | 65 - 99 | 6.61E-02 |
| 26 | O3 | Mortality, Non-Accidental | 0 - 99 | 4.00E-02 |
| 26 | O3 | Emergency Room Visits, Asthma | 0 - 17 | 3.26E-01 |
| 26 | O3 | Emergency Room Visits, Asthma | 18 - 99 | 5.39E-01 |
| 27 | PM2.5 | Emergency Room Visits, Asthma | 0 - 99 | 2.57E-01 |
| 27 | PM2.5 | Mortality, All Cause | 30 - 99 | 6.27E-01 |
| 27 | PM2.5 | Hospital Admissions, Asthma | 0 - 64 | 1.37E-02 |
| 27 | PM2.5 | Hospital Admissions, All Cardiovascular (less Myocardial Infarctions) | 65 - 99 | 3.65E-02 |
| 27 | PM2.5 | Hospital Admissions, All Respiratory | 65 - 99 | 9.16E-02 |
| 27 | PM2.5 | Acute Myocardial Infarction, Nonfatal | 18 - 24 | 2.81E-05 |
| 27 | PM2.5 | Acute Myocardial Infarction, Nonfatal | 25 - 44 | 1.33E-03 |
| 27 | PM2.5 | Acute Myocardial Infarction, Nonfatal | 45 - 54 | 3.07E-03 |
| 27 | PM2.5 | Acute Myocardial Infarction, Nonfatal | 55 - 64 | 4.76E-03 |
| 27 | PM2.5 | Acute Myocardial Infarction, Nonfatal | 65 - 99 | 2.10E-02 |
| 27 | O3 | Hospital Admissions, All Respiratory | 65 - 99 | 5.24E-02 |
| 27 | O3 | Mortality, Non-Accidental | 0 - 99 | 3.13E-02 |
| 27 | O3 | Emergency Room Visits, Asthma | 0 - 17 | 2.61E-01 |
| 27 | O3 | Emergency Room Visits, Asthma | 18 - 99 | 4.29E-01 |
| 28 | PM2.5 | Emergency Room Visits, Asthma | 0 - 99 | 5.44E-01 |
| 28 | PM2.5 | Mortality, All Cause | 30 - 99 | 9.03E-01 |
| 28 | PM2.5 | Hospital Admissions, Asthma | 0 - 64 | 3.04E-02 |

| Source | Pollutant | Health Endpoint | Age Range[1] | Incidences (per year)[2] (Mean) (Reduced Sacramento 4-km Domain) |
|---|---|---|---|---|
| 28 | PM2.5 | Hospital Admissions, All Cardiovascular (less Myocardial Infarctions) | 65 - 99 | 7.24E-02 |
| 28 | PM2.5 | Hospital Admissions, All Respiratory | 65 - 99 | 1.72E-01 |
| 28 | PM2.5 | Acute Myocardial Infarction, Nonfatal | 18 - 24 | 4.16E-05 |
| 28 | PM2.5 | Acute Myocardial Infarction, Nonfatal | 25 - 44 | 2.80E-03 |
| 28 | PM2.5 | Acute Myocardial Infarction, Nonfatal | 45 - 54 | 6.45E-03 |
| 28 | PM2.5 | Acute Myocardial Infarction, Nonfatal | 55 - 64 | 1.07E-02 |
| 28 | PM2.5 | Acute Myocardial Infarction, Nonfatal | 65 - 99 | 4.05E-02 |
| 28 | O3 | Hospital Admissions, All Respiratory | 65 - 99 | 4.34E-02 |
| 28 | O3 | Mortality, Non-Accidental | 0 - 99 | 2.14E-02 |
| 28 | O3 | Emergency Room Visits, Asthma | 0 - 17 | 2.64E-01 |
| 28 | O3 | Emergency Room Visits, Asthma | 18 - 99 | 3.79E-01 |
| 29 | PM2.5 | Emergency Room Visits, Asthma | 0 - 99 | 4.39E-01 |
| 29 | PM2.5 | Mortality, All Cause | 30 - 99 | 1.03E+00 |
| 29 | PM2.5 | Hospital Admissions, Asthma | 0 - 64 | 2.76E-02 |
| 29 | PM2.5 | Hospital Admissions, All Cardiovascular (less Myocardial Infarctions) | 65 - 99 | 7.88E-02 |
| 29 | PM2.5 | Hospital Admissions, All Respiratory | 65 - 99 | 1.63E-01 |
| 29 | PM2.5 | Acute Myocardial Infarction, Nonfatal | 18 - 24 | 4.00E-05 |
| 29 | PM2.5 | Acute Myocardial Infarction, Nonfatal | 25 - 44 | 3.10E-03 |
| 29 | PM2.5 | Acute Myocardial Infarction, Nonfatal | 45 - 54 | 7.52E-03 |
| 29 | PM2.5 | Acute Myocardial Infarction, Nonfatal | 55 - 64 | 1.22E-02 |
| 29 | PM2.5 | Acute Myocardial Infarction, Nonfatal | 65 - 99 | 4.83E-02 |
| 29 | O3 | Hospital Admissions, All Respiratory | 65 - 99 | 8.76E-02 |
| 29 | O3 | Mortality, Non-Accidental | 0 - 99 | 5.30E-02 |
| 29 | O3 | Emergency Room Visits, Asthma | 0 - 17 | 3.72E-01 |
| 29 | O3 | Emergency Room Visits, Asthma | 18 - 99 | 6.06E-01 |
| 30 | PM2.5 | Emergency Room Visits, Asthma | 0 - 99 | 2.69E-01 |
| 30 | PM2.5 | Mortality, All Cause | 30 - 99 | 6.13E-01 |
| 30 | PM2.5 | Hospital Admissions, Asthma | 0 - 64 | 1.66E-02 |
| 30 | PM2.5 | Hospital Admissions, All Cardiovascular (less Myocardial Infarctions) | 65 - 99 | 4.29E-02 |

| **Source** | **Pollutant** | **Health Endpoint** | **Age Range**[1] | **Incidences (per year)**[2] **(Mean) (Reduced Sacramento 4-km Domain)** |
|---|---|---|---|---|
| 30 | PM2.5 | Hospital Admissions, All Respiratory | 65 - 99 | 9.46E-02 |
| 30 | PM2.5 | Acute Myocardial Infarction, Nonfatal | 18 - 24 | 2.74E-05 |
| 30 | PM2.5 | Acute Myocardial Infarction, Nonfatal | 25 - 44 | 1.77E-03 |
| 30 | PM2.5 | Acute Myocardial Infarction, Nonfatal | 45 - 54 | 4.08E-03 |
| 30 | PM2.5 | Acute Myocardial Infarction, Nonfatal | 55 - 64 | 6.64E-03 |
| 30 | PM2.5 | Acute Myocardial Infarction, Nonfatal | 65 - 99 | 2.61E-02 |
| 30 | O3 | Hospital Admissions, All Respiratory | 65 - 99 | 5.13E-02 |
| 30 | O3 | Mortality, Non-Accidental | 0 - 99 | 3.13E-02 |
| 30 | O3 | Emergency Room Visits, Asthma | 0 - 17 | 2.62E-01 |
| 30 | O3 | Emergency Room Visits, Asthma | 18 - 99 | 4.14E-01 |
| 31 | PM2.5 | Emergency Room Visits, Asthma | 0 - 99 | 1.79E-01 |
| 31 | PM2.5 | Mortality, All Cause | 30 - 99 | 4.31E-01 |
| 31 | PM2.5 | Hospital Admissions, Asthma | 0 - 64 | 1.07E-02 |
| 31 | PM2.5 | Hospital Admissions, All Cardiovascular (less Myocardial Infarctions) | 65 - 99 | 2.88E-02 |
| 31 | PM2.5 | Hospital Admissions, All Respiratory | 65 - 99 | 6.80E-02 |
| 31 | PM2.5 | Acute Myocardial Infarction, Nonfatal | 18 - 24 | 1.79E-05 |
| 31 | PM2.5 | Acute Myocardial Infarction, Nonfatal | 25 - 44 | 1.06E-03 |
| 31 | PM2.5 | Acute Myocardial Infarction, Nonfatal | 45 - 54 | 2.48E-03 |
| 31 | PM2.5 | Acute Myocardial Infarction, Nonfatal | 55 - 64 | 4.07E-03 |
| 31 | PM2.5 | Acute Myocardial Infarction, Nonfatal | 65 - 99 | 1.69E-02 |
| 31 | O3 | Hospital Admissions, All Respiratory | 65 - 99 | 3.95E-02 |
| 31 | O3 | Mortality, Non-Accidental | 0 - 99 | 2.31E-02 |
| 31 | O3 | Emergency Room Visits, Asthma | 0 - 17 | 1.95E-01 |
| 31 | O3 | Emergency Room Visits, Asthma | 18 - 99 | 3.12E-01 |
| 32 | PM2.5 | Emergency Room Visits, Asthma | 0 - 99 | 2.43E-01 |
| 32 | PM2.5 | Mortality, All Cause | 30 - 99 | 5.58E-01 |
| 32 | PM2.5 | Hospital Admissions, Asthma | 0 - 64 | 1.52E-02 |
| 32 | PM2.5 | Hospital Admissions, All Cardiovascular (less Myocardial Infarctions) | 65 - 99 | 4.11E-02 |
| 32 | PM2.5 | Hospital Admissions, All Respiratory | 65 - 99 | 8.88E-02 |
| 32 | PM2.5 | Acute Myocardial Infarction, Nonfatal | 18 - 24 | 2.33E-05 |

| Source | Pollutant | Health Endpoint | Age Range[1] | Incidences (per year)[2] (Mean) (Reduced Sacramento 4-km Domain) |
|---|---|---|---|---|
| 32 | PM2.5 | Acute Myocardial Infarction, Nonfatal | 25 - 44 | 1.61E-03 |
| 32 | PM2.5 | Acute Myocardial Infarction, Nonfatal | 45 - 54 | 3.86E-03 |
| 32 | PM2.5 | Acute Myocardial Infarction, Nonfatal | 55 - 64 | 6.27E-03 |
| 32 | PM2.5 | Acute Myocardial Infarction, Nonfatal | 65 - 99 | 2.50E-02 |
| 32 | O3 | Hospital Admissions, All Respiratory | 65 - 99 | 5.02E-02 |
| 32 | O3 | Mortality, Non-Accidental | 0 - 99 | 2.97E-02 |
| 32 | O3 | Emergency Room Visits, Asthma | 0 - 17 | 2.38E-01 |
| 32 | O3 | Emergency Room Visits, Asthma | 18 - 99 | 3.84E-01 |
| 33 | PM2.5 | Emergency Room Visits, Asthma | 0 - 99 | 5.59E-01 |
| 33 | PM2.5 | Mortality, All Cause | 30 - 99 | 1.90E+00 |
| 33 | PM2.5 | Hospital Admissions, Asthma | 0 - 64 | 3.40E-02 |
| 33 | PM2.5 | Hospital Admissions, All Cardiovascular (less Myocardial Infarctions) | 65 - 99 | 1.19E-01 |
| 33 | PM2.5 | Hospital Admissions, All Respiratory | 65 - 99 | 3.17E-01 |
| 33 | PM2.5 | Acute Myocardial Infarction, Nonfatal | 18 - 24 | 7.34E-05 |
| 33 | PM2.5 | Acute Myocardial Infarction, Nonfatal | 25 - 44 | 3.16E-03 |
| 33 | PM2.5 | Acute Myocardial Infarction, Nonfatal | 45 - 54 | 9.15E-03 |
| 33 | PM2.5 | Acute Myocardial Infarction, Nonfatal | 55 - 64 | 1.45E-02 |
| 33 | PM2.5 | Acute Myocardial Infarction, Nonfatal | 65 - 99 | 7.54E-02 |
| 33 | O3 | Hospital Admissions, All Respiratory | 65 - 99 | 6.42E-02 |
| 33 | O3 | Mortality, Non-Accidental | 0 - 99 | 3.22E-02 |
| 33 | O3 | Emergency Room Visits, Asthma | 0 - 17 | 2.22E-01 |
| 33 | O3 | Emergency Room Visits, Asthma | 18 - 99 | 3.79E-01 |
| 34 | PM2.5 | Emergency Room Visits, Asthma | 0 - 99 | 2.76E-01 |
| 34 | PM2.5 | Mortality, All Cause | 30 - 99 | 6.93E-01 |
| 34 | PM2.5 | Hospital Admissions, Asthma | 0 - 64 | 1.62E-02 |
| 34 | PM2.5 | Hospital Admissions, All Cardiovascular (less Myocardial Infarctions) | 65 - 99 | 6.11E-02 |
| 34 | PM2.5 | Hospital Admissions, All Respiratory | 65 - 99 | 1.56E-01 |
| 34 | PM2.5 | Acute Myocardial Infarction, Nonfatal | 18 - 24 | 2.69E-05 |
| 34 | PM2.5 | Acute Myocardial Infarction, Nonfatal | 25 - 44 | 1.57E-03 |
| 34 | PM2.5 | Acute Myocardial Infarction, Nonfatal | 45 - 54 | 5.10E-03 |

| Source | Pollutant | Health Endpoint | Age Range[1] | Incidences (per year)[2] (Mean) (Reduced Sacramento 4-km Domain) |
|---|---|---|---|---|
| 34 | PM2.5 | Acute Myocardial Infarction, Nonfatal | 55 - 64 | 7.87E-03 |
| 34 | PM2.5 | Acute Myocardial Infarction, Nonfatal | 65 - 99 | 3.57E-02 |
| 34 | O3 | Hospital Admissions, All Respiratory | 65 - 99 | 6.01E-02 |
| 34 | O3 | Mortality, Non-Accidental | 0 - 99 | 2.88E-02 |
| 34 | O3 | Emergency Room Visits, Asthma | 0 - 17 | 1.86E-01 |
| 34 | O3 | Emergency Room Visits, Asthma | 18 - 99 | 3.21E-01 |
| 35 | PM2.5 | Emergency Room Visits, Asthma | 0 - 99 | 2.36E-01 |
| 35 | PM2.5 | Mortality, All Cause | 30 - 99 | 6.00E-01 |
| 35 | PM2.5 | Hospital Admissions, Asthma | 0 - 64 | 1.46E-02 |
| 35 | PM2.5 | Hospital Admissions, All Cardiovascular (less Myocardial Infarctions) | 65 - 99 | 4.82E-02 |
| 35 | PM2.5 | Hospital Admissions, All Respiratory | 65 - 99 | 1.19E-01 |
| 35 | PM2.5 | Acute Myocardial Infarction, Nonfatal | 18 - 24 | 2.32E-05 |
| 35 | PM2.5 | Acute Myocardial Infarction, Nonfatal | 25 - 44 | 1.62E-03 |
| 35 | PM2.5 | Acute Myocardial Infarction, Nonfatal | 45 - 54 | 4.03E-03 |
| 35 | PM2.5 | Acute Myocardial Infarction, Nonfatal | 55 - 64 | 6.01E-03 |
| 35 | PM2.5 | Acute Myocardial Infarction, Nonfatal | 65 - 99 | 2.82E-02 |
| 35 | O3 | Hospital Admissions, All Respiratory | 65 - 99 | 6.09E-02 |
| 35 | O3 | Mortality, Non-Accidental | 0 - 99 | 2.84E-02 |
| 35 | O3 | Emergency Room Visits, Asthma | 0 - 17 | 2.02E-01 |
| 35 | O3 | Emergency Room Visits, Asthma | 18 - 99 | 3.40E-01 |
| 36 | PM2.5 | Emergency Room Visits, Asthma | 0 - 99 | 1.61E-01 |
| 36 | PM2.5 | Mortality, All Cause | 30 - 99 | 4.23E-01 |
| 36 | PM2.5 | Hospital Admissions, Asthma | 0 - 64 | 9.77E-03 |
| 36 | PM2.5 | Hospital Admissions, All Cardiovascular (less Myocardial Infarctions) | 65 - 99 | 3.77E-02 |
| 36 | PM2.5 | Hospital Admissions, All Respiratory | 65 - 99 | 9.61E-02 |
| 36 | PM2.5 | Acute Myocardial Infarction, Nonfatal | 18 - 24 | 1.44E-05 |
| 36 | PM2.5 | Acute Myocardial Infarction, Nonfatal | 25 - 44 | 1.00E-03 |
| 36 | PM2.5 | Acute Myocardial Infarction, Nonfatal | 45 - 54 | 2.93E-03 |
| 36 | PM2.5 | Acute Myocardial Infarction, Nonfatal | 55 - 64 | 4.56E-03 |
| 36 | PM2.5 | Acute Myocardial Infarction, Nonfatal | 65 - 99 | 2.15E-02 |

| Source | Pollutant | Health Endpoint | Age Range[1] | Incidences (per year)[2] (Mean) (Reduced Sacramento 4-km Domain) |
|---|---|---|---|---|
| 36 | O3 | Hospital Admissions, All Respiratory | 65 - 99 | 4.81E-02 |
| 36 | O3 | Mortality, Non-Accidental | 0 - 99 | 2.29E-02 |
| 36 | O3 | Emergency Room Visits, Asthma | 0 - 17 | 1.40E-01 |
| 36 | O3 | Emergency Room Visits, Asthma | 18 - 99 | 2.46E-01 |
| 37 | PM2.5 | Emergency Room Visits, Asthma | 0 - 99 | 1.16E-01 |
| 37 | PM2.5 | Mortality, All Cause | 30 - 99 | 3.08E-01 |
| 37 | PM2.5 | Hospital Admissions, Asthma | 0 - 64 | 7.21E-03 |
| 37 | PM2.5 | Hospital Admissions, All Cardiovascular (less Myocardial Infarctions) | 65 - 99 | 2.74E-02 |
| 37 | PM2.5 | Hospital Admissions, All Respiratory | 65 - 99 | 7.08E-02 |
| 37 | PM2.5 | Acute Myocardial Infarction, Nonfatal | 18 - 24 | 1.00E-05 |
| 37 | PM2.5 | Acute Myocardial Infarction, Nonfatal | 25 - 44 | 6.75E-04 |
| 37 | PM2.5 | Acute Myocardial Infarction, Nonfatal | 45 - 54 | 2.11E-03 |
| 37 | PM2.5 | Acute Myocardial Infarction, Nonfatal | 55 - 64 | 3.76E-03 |
| 37 | PM2.5 | Acute Myocardial Infarction, Nonfatal | 65 - 99 | 1.55E-02 |
| 37 | O3 | Hospital Admissions, All Respiratory | 65 - 99 | 3.29E-02 |
| 37 | O3 | Mortality, Non-Accidental | 0 - 99 | 1.65E-02 |
| 37 | O3 | Emergency Room Visits, Asthma | 0 - 17 | 1.04E-01 |
| 37 | O3 | Emergency Room Visits, Asthma | 18 - 99 | 1.81E-01 |
| 38 | PM2.5 | Emergency Room Visits, Asthma | 0 - 99 | 1.57E-01 |
| 38 | PM2.5 | Mortality, All Cause | 30 - 99 | 4.37E-01 |
| 38 | PM2.5 | Hospital Admissions, Asthma | 0 - 64 | 9.00E-03 |
| 38 | PM2.5 | Hospital Admissions, All Cardiovascular (less Myocardial Infarctions) | 65 - 99 | 3.52E-02 |
| 38 | PM2.5 | Hospital Admissions, All Respiratory | 65 - 99 | 8.87E-02 |
| 38 | PM2.5 | Acute Myocardial Infarction, Nonfatal | 18 - 24 | 1.44E-05 |
| 38 | PM2.5 | Acute Myocardial Infarction, Nonfatal | 25 - 44 | 8.92E-04 |
| 38 | PM2.5 | Acute Myocardial Infarction, Nonfatal | 45 - 54 | 2.61E-03 |
| 38 | PM2.5 | Acute Myocardial Infarction, Nonfatal | 55 - 64 | 4.17E-03 |
| 38 | PM2.5 | Acute Myocardial Infarction, Nonfatal | 65 - 99 | 1.99E-02 |
| 38 | O3 | Hospital Admissions, All Respiratory | 65 - 99 | 4.94E-02 |
| 38 | O3 | Mortality, Non-Accidental | 0 - 99 | 2.62E-02 |

| Source | Pollutant | Health Endpoint | Age Range[1] | Incidences (per year)[2] (Mean) (Reduced Sacramento 4-km Domain) |
|---|---|---|---|---|
| 38 | O3 | Emergency Room Visits, Asthma | 0 - 17 | 1.38E-01 |
| 38 | O3 | Emergency Room Visits, Asthma | 18 - 99 | 2.49E-01 |
| 39 | PM2.5 | Emergency Room Visits, Asthma | 0 - 99 | 2.19E-01 |
| 39 | PM2.5 | Mortality, All Cause | 30 - 99 | 5.68E-01 |
| 39 | PM2.5 | Hospital Admissions, Asthma | 0 - 64 | 1.25E-02 |
| 39 | PM2.5 | Hospital Admissions, All Cardiovascular (less Myocardial Infarctions) | 65 - 99 | 4.56E-02 |
| 39 | PM2.5 | Hospital Admissions, All Respiratory | 65 - 99 | 1.13E-01 |
| 39 | PM2.5 | Acute Myocardial Infarction, Nonfatal | 18 - 24 | 2.42E-05 |
| 39 | PM2.5 | Acute Myocardial Infarction, Nonfatal | 25 - 44 | 1.25E-03 |
| 39 | PM2.5 | Acute Myocardial Infarction, Nonfatal | 45 - 54 | 3.72E-03 |
| 39 | PM2.5 | Acute Myocardial Infarction, Nonfatal | 55 - 64 | 5.83E-03 |
| 39 | PM2.5 | Acute Myocardial Infarction, Nonfatal | 65 - 99 | 2.64E-02 |
| 39 | O3 | Hospital Admissions, All Respiratory | 65 - 99 | 5.25E-02 |
| 39 | O3 | Mortality, Non-Accidental | 0 - 99 | 2.84E-02 |
| 39 | O3 | Emergency Room Visits, Asthma | 0 - 17 | 1.57E-01 |
| 39 | O3 | Emergency Room Visits, Asthma | 18 - 99 | 2.78E-01 |
| 40 | PM2.5 | Emergency Room Visits, Asthma | 0 - 99 | 3.63E-01 |
| 40 | PM2.5 | Mortality, All Cause | 30 - 99 | 9.09E-01 |
| 40 | PM2.5 | Hospital Admissions, Asthma | 0 - 64 | 2.04E-02 |
| 40 | PM2.5 | Hospital Admissions, All Cardiovascular (less Myocardial Infarctions) | 65 - 99 | 8.14E-02 |
| 40 | PM2.5 | Hospital Admissions, All Respiratory | 65 - 99 | 2.07E-01 |
| 40 | PM2.5 | Acute Myocardial Infarction, Nonfatal | 18 - 24 | 3.34E-05 |
| 40 | PM2.5 | Acute Myocardial Infarction, Nonfatal | 25 - 44 | 1.98E-03 |
| 40 | PM2.5 | Acute Myocardial Infarction, Nonfatal | 45 - 54 | 6.84E-03 |
| 40 | PM2.5 | Acute Myocardial Infarction, Nonfatal | 55 - 64 | 1.03E-02 |
| 40 | PM2.5 | Acute Myocardial Infarction, Nonfatal | 65 - 99 | 4.72E-02 |
| 40 | O3 | Hospital Admissions, All Respiratory | 65 - 99 | 6.78E-02 |
| 40 | O3 | Mortality, Non-Accidental | 0 - 99 | 3.68E-02 |
| 40 | O3 | Emergency Room Visits, Asthma | 0 - 17 | 2.09E-01 |

| Source | Pollutant | Health Endpoint | Age Range[1] | Incidences (per year)[2] (Mean) (Reduced Sacramento 4-km Domain) |
|---|---|---|---|---|
| 40 | O3 | Emergency Room Visits, Asthma | 18 - 99 | 3.64E-01 |
| 41 | PM2.5 | Emergency Room Visits, Asthma | 0 - 99 | 2.42E-01 |
| 41 | PM2.5 | Mortality, All Cause | 30 - 99 | 9.07E-01 |
| 41 | PM2.5 | Hospital Admissions, Asthma | 0 - 64 | 1.37E-02 |
| 41 | PM2.5 | Hospital Admissions, All Cardiovascular (less Myocardial Infarctions) | 65 - 99 | 5.85E-02 |
| 41 | PM2.5 | Hospital Admissions, All Respiratory | 65 - 99 | 1.42E-01 |
| 41 | PM2.5 | Acute Myocardial Infarction, Nonfatal | 18 - 24 | 2.32E-05 |
| 41 | PM2.5 | Acute Myocardial Infarction, Nonfatal | 25 - 44 | 1.48E-03 |
| 41 | PM2.5 | Acute Myocardial Infarction, Nonfatal | 45 - 54 | 3.72E-03 |
| 41 | PM2.5 | Acute Myocardial Infarction, Nonfatal | 55 - 64 | 6.30E-03 |
| 41 | PM2.5 | Acute Myocardial Infarction, Nonfatal | 65 - 99 | 3.24E-02 |
| 41 | O3 | Hospital Admissions, All Respiratory | 65 - 99 | 6.34E-02 |
| 41 | O3 | Mortality, Non-Accidental | 0 - 99 | 3.89E-02 |
| 41 | O3 | Emergency Room Visits, Asthma | 0 - 17 | 1.62E-01 |
| 41 | O3 | Emergency Room Visits, Asthma | 18 - 99 | 3.00E-01 |

1. Affected age ranges are shown . Other age ranges are available, but the endpoints and age ranges shown here are the ones used by the USEPA in its health assessments. The age ranges are consistent with the epidemiological study that is the basis of the health function.
2. Health effects are shown in terms of incidences of each health endpoint and how it compares to the base (2035 base year health effect incidences, or “background health incidence”) values. Health effects and background health incidences are across the Sacramento reduced 4-km model domain.

# APPENDIX G
# BENMAP HEALTH EFFECTS RESULTS FOR SIX STRATEGIC AREA PROJECTS

# Appendix G: BenMAP health effects results for the six sources used in the Strategic Area Project Screening Modeling in Appendix C, in which BenMAP was run separately to get ozone and $PM_{2.5}$ health effects for the three major precursors (NOx, VOC and PM) emissions at the higher 8xTOS (high_8x) and lower 2xTOS (low_2x) emission rates.

| Six Strategic Area Project Identifications and Locations | | | | |
|---|---|---|---|---|
| **ID** | **Name** | **Latitude** | **Longitude** | **Location** |
| I | West Roseville | 38.765833 | -121.359299 | Fiddyment Road & Pleasant Grove Boulevard |
| II | Rancho Cordova | 38.588080 | -121.286765 | Zinfandel Drive & White Rock Road |
| III | Downtown Sacramento | 38.579336 | -121.494119 | 10th Street & K Street |
| IV | South Sacramento | 38.490489 | -121.468468 | Florin Road & Franklin Boulevard |
| V | Woodland | 38.677388 | -121.765759 | Main Street & East Street |
| VI | Vacaville | 38.347954 | -121.998058 | Merchant Street & Lincoln Highway |

| Strategic area Src | Emissions | Species-Precursor | Health Endpoint | Age Range[1] | Incidences per year[2] (Mean) (Reduced Sacramento 4-km Domain) |
|---|---|---|---|---|---|
| I | high_8x | O3-NOx | Hospital Admissions, All Respiratory | 65 - 99 | 6.89E-01 |
| I | high_8x | O3-NOx | Mortality, Non-Accidental | 0 - 99 | 4.42E-01 |
| I | high_8x | O3-NOx | Emergency Room Visits, Asthma | 18 - 99 | 4.30E+00 |
| I | high_8x | O3-NOx | Emergency Room Visits, Asthma | 0 - 17 | 2.55E+00 |
| II | high_8x | O3-NOx | Hospital Admissions, All Respiratory | 65 - 99 | 5.52E-01 |
| II | high_8x | O3-NOx | Mortality, Non-Accidental | 0 - 99 | 3.49E-01 |
| II | high_8x | O3-NOx | Emergency Room Visits, Asthma | 18 - 99 | 3.64E+00 |
| II | high_8x | O3-NOx | Emergency Room Visits, Asthma | 0 - 17 | 2.12E+00 |
| III | high_8x | O3-NOx | Hospital Admissions, All Respiratory | 65 - 99 | 4.88E-01 |
| III | high_8x | O3-NOx | Mortality, Non-Accidental | 0 - 99 | 3.02E-01 |
| III | high_8x | O3-NOx | Emergency Room Visits, Asthma | 18 - 99 | 3.90E+00 |
| III | high_8x | O3-NOx | Emergency Room Visits, Asthma | 0 - 17 | 2.42E+00 |
| IV | high_8x | O3-NOx | Hospital Admissions, All Respiratory | 65 - 99 | 5.55E-01 |

| Strategic area Src | Emissions | Species-Precursor | Health Endpoint | Age Range[1] | Incidences per year[2] (Mean) (Reduced Sacramento 4-km Domain) |
|---|---|---|---|---|---|
| IV | high_8x | O3-NOx | Mortality, Non-Accidental | 0 - 99 | 3.45E-01 |
| IV | high_8x | O3-NOx | Emergency Room Visits, Asthma | 18 - 99 | 2.94E+00 |
| IV | high_8x | O3-NOx | Emergency Room Visits, Asthma | 0 - 17 | 4.56E+00 |
| V | high_8x | O3-NOx | Hospital Admissions, All Respiratory | 65 - 99 | 3.79E-01 |
| V | high_8x | O3-NOx | Mortality, Non-Accidental | 0 - 99 | 2.33E-01 |
| V | high_8x | O3-NOx | Emergency Room Visits, Asthma | 18 - 99 | 3.04E+00 |
| V | high_8x | O3-NOx | Emergency Room Visits, Asthma | 0 - 17 | 1.94E+00 |
| VI | high_8x | O3-NOx | Hospital Admissions, All Respiratory | 65 - 99 | 4.71E-01 |
| VI | high_8x | O3-NOx | Mortality, Non-Accidental | 0 - 99 | 2.86E-01 |
| VI | high_8x | O3-NOx | Emergency Room Visits, Asthma | 18 - 99 | 4.04E+00 |
| VI | high_8x | O3-NOx | Emergency Room Visits, Asthma | 0 - 17 | 2.45E+00 |
| I | low_2x | O3-NOx | Hospital Admissions, All Respiratory | 65 - 99 | 1.93E-01 |
| I | low_2x | O3-NOx | Mortality, Non-Accidental | 0 - 99 | 1.24E-01 |
| I | low_2x | O3-NOx | Emergency Room Visits, Asthma | 18 - 99 | 1.21E+00 |
| I | low_2x | O3-NOx | Emergency Room Visits, Asthma | 0 - 17 | 7.18E-01 |
| II | low_2x | O3-NOx | Hospital Admissions, All Respiratory | 65 - 99 | 1.49E-01 |
| II | low_2x | O3-NOx | Mortality, Non-Accidental | 0 - 99 | 9.42E-02 |
| II | low_2x | O3-NOx | Emergency Room Visits, Asthma | 18 - 99 | 9.89E-01 |
| II | low_2x | O3-NOx | Emergency Room Visits, Asthma | 0 - 17 | 5.76E-01 |
| III | low_2x | O3-NOx | Hospital Admissions, All Respiratory | 65 - 99 | 1.30E-01 |
| III | low_2x | O3-NOx | Mortality, Non-Accidental | 0 - 99 | 8.05E-02 |
| III | low_2x | O3-NOx | Emergency Room Visits, Asthma | 18 - 99 | 1.04E+00 |
| III | low_2x | O3-NOx | Emergency Room Visits, Asthma | 0 - 17 | 6.44E-01 |
| IV | low_2x | O3-NOx | Hospital Admissions, All Respiratory | 65 - 99 | 1.50E-01 |
| IV | low_2x | O3-NOx | Mortality, Non-Accidental | 0 - 99 | 9.39E-02 |
| IV | low_2x | O3-NOx | Emergency Room Visits, Asthma | 18 - 99 | 1.25E+00 |
| IV | low_2x | O3-NOx | Emergency Room Visits, Asthma | 0 - 17 | 8.12E-01 |
| V | low_2x | O3-NOx | Hospital Admissions, All Respiratory | 65 - 99 | 9.97E-02 |
| V | low_2x | O3-NOx | Mortality, Non-Accidental | 0 - 99 | 6.18E-02 |
| V | low_2x | O3-NOx | Emergency Room Visits, Asthma | 18 - 99 | 8.00E-01 |
| V | low_2x | O3-NOx | Emergency Room Visits, Asthma | 0 - 17 | 5.11E-01 |
| VI | low_2x | O3-NOx | Hospital Admissions, All Respiratory | 65 - 99 | 1.23E-01 |

| Strategic area Src | Emissions | Species-Precursor | Health Endpoint | Age Range[1] | Incidences per year[2] (Mean) (Reduced Sacramento 4-km Domain) |
|---|---|---|---|---|---|
| VI | low_2x | O3-NOx | Mortality, Non-Accidental | 0 - 99 | 7.45E-02 |
| VI | low_2x | O3-NOx | Emergency Room Visits, Asthma | 18 - 99 | 1.06E+00 |
| VI | low_2x | O3-NOx | Emergency Room Visits, Asthma | 0 - 17 | 6.39E-01 |
| I | high_8x | O3-VOC | Hospital Admissions, All Respiratory | 65 - 99 | 4.25E-02 |
| I | high_8x | O3-VOC | Mortality, Non-Accidental | 0 - 99 | 2.61E-02 |
| I | high_8x | O3-VOC | Emergency Room Visits, Asthma | 18 - 99 | 3.01E-01 |
| I | high_8x | O3-VOC | Emergency Room Visits, Asthma | 0 - 17 | 1.84E-01 |
| II | high_8x | O3-VOC | Hospital Admissions, All Respiratory | 65 - 99 | 4.29E-02 |
| II | high_8x | O3-VOC | Mortality, Non-Accidental | 0 - 99 | 2.68E-02 |
| II | high_8x | O3-VOC | Emergency Room Visits, Asthma | 18 - 99 | 3.09E-01 |
| II | high_8x | O3-VOC | Emergency Room Visits, Asthma | 0 - 17 | 1.86E-01 |
| III | high_8x | O3-VOC | Hospital Admissions, All Respiratory | 65 - 99 | 7.49E-02 |
| III | high_8x | O3-VOC | Mortality, Non-Accidental | 0 - 99 | 4.72E-02 |
| III | high_8x | O3-VOC | Emergency Room Visits, Asthma | 18 - 99 | 6.57E-01 |
| III | high_8x | O3-VOC | Emergency Room Visits, Asthma | 0 - 17 | 4.05E-01 |
| IV | high_8x | O3-VOC | Hospital Admissions, All Respiratory | 65 - 99 | 7.10E-02 |
| IV | high_8x | O3-VOC | Mortality, Non-Accidental | 0 - 99 | 4.39E-02 |
| IV | high_8x | O3-VOC | Emergency Room Visits, Asthma | 18 - 99 | 4.09E-01 |
| IV | high_8x | O3-VOC | Emergency Room Visits, Asthma | 0 - 17 | 6.28E-01 |
| V | high_8x | O3-VOC | Hospital Admissions, All Respiratory | 65 - 99 | 3.66E-02 |
| V | high_8x | O3-VOC | Mortality, Non-Accidental | 0 - 99 | 2.28E-02 |
| V | high_8x | O3-VOC | Emergency Room Visits, Asthma | 18 - 99 | 3.10E-01 |
| V | high_8x | O3-VOC | Emergency Room Visits, Asthma | 0 - 17 | 1.97E-01 |
| VI | high_8x | O3-VOC | Hospital Admissions, All Respiratory | 65 - 99 | 3.60E-02 |
| VI | high_8x | O3-VOC | Mortality, Non-Accidental | 0 - 99 | 2.13E-02 |
| VI | high_8x | O3-VOC | Emergency Room Visits, Asthma | 18 - 99 | 3.14E-01 |
| VI | high_8x | O3-VOC | Emergency Room Visits, Asthma | 0 - 17 | 1.86E-01 |
| I | low_2x | O3-VOC | Hospital Admissions, All Respiratory | 65 - 99 | 1.01E-02 |
| I | low_2x | O3-VOC | Mortality, Non-Accidental | 0 - 99 | 6.18E-03 |
| I | low_2x | O3-VOC | Emergency Room Visits, Asthma | 18 - 99 | 7.17E-02 |
| I | low_2x | O3-VOC | Emergency Room Visits, Asthma | 0 - 17 | 4.40E-02 |
| II | low_2x | O3-VOC | Hospital Admissions, All Respiratory | 65 - 99 | 1.02E-02 |

| Strategic area Src | Emissions | Species-Precursor | Health Endpoint | Age Range[1] | Incidences per year[2] (Mean) (Reduced Sacramento 4-km Domain) |
|---|---|---|---|---|---|
| II | low_2x | O3-VOC | Mortality, Non-Accidental | 0 - 99 | 6.35E-03 |
| II | low_2x | O3-VOC | Emergency Room Visits, Asthma | 18 - 99 | 7.35E-02 |
| II | low_2x | O3-VOC | Emergency Room Visits, Asthma | 0 - 17 | 4.43E-02 |
| III | low_2x | O3-VOC | Hospital Admissions, All Respiratory | 65 - 99 | 1.82E-02 |
| III | low_2x | O3-VOC | Mortality, Non-Accidental | 0 - 99 | 1.15E-02 |
| III | low_2x | O3-VOC | Emergency Room Visits, Asthma | 18 - 99 | 1.60E-01 |
| III | low_2x | O3-VOC | Emergency Room Visits, Asthma | 0 - 17 | 9.84E-02 |
| IV | low_2x | O3-VOC | Hospital Admissions, All Respiratory | 65 - 99 | 1.72E-02 |
| IV | low_2x | O3-VOC | Mortality, Non-Accidental | 0 - 99 | 1.06E-02 |
| IV | low_2x | O3-VOC | Emergency Room Visits, Asthma | 18 - 99 | 1.52E-01 |
| IV | low_2x | O3-VOC | Emergency Room Visits, Asthma | 0 - 17 | 9.90E-02 |
| V | low_2x | O3-VOC | Hospital Admissions, All Respiratory | 65 - 99 | 8.81E-03 |
| V | low_2x | O3-VOC | Mortality, Non-Accidental | 0 - 99 | 5.46E-03 |
| V | low_2x | O3-VOC | Emergency Room Visits, Asthma | 18 - 99 | 7.47E-02 |
| V | low_2x | O3-VOC | Emergency Room Visits, Asthma | 0 - 17 | 4.74E-02 |
| VI | low_2x | O3-VOC | Hospital Admissions, All Respiratory | 65 - 99 | 8.81E-03 |
| VI | low_2x | O3-VOC | Mortality, Non-Accidental | 0 - 99 | 5.19E-03 |
| VI | low_2x | O3-VOC | Emergency Room Visits, Asthma | 18 - 99 | 7.66E-02 |
| VI | low_2x | O3-VOC | Emergency Room Visits, Asthma | 0 - 17 | 4.53E-02 |
| I | high_8x | PM25-NOx | Emergency Room Visits, Asthma | 0 - 99 | 4.15E-01 |
| I | high_8x | PM25-NOx | Mortality, All Cause | 30 - 99 | 9.73E-01 |
| I | high_8x | PM25-NOx | Hospital Admissions, Asthma | 0 - 64 | 2.62E-02 |
| I | high_8x | PM25-NOx | Hospital Admissions, All Cardiovascular (less Myocardial Infarctions) | 65 - 99 | 7.58E-02 |
| I | high_8x | PM25-NOx | Acute Myocardial Infarction, Nonfatal | 18 - 24 | 3.65E-05 |
| I | high_8x | PM25-NOx | Acute Myocardial Infarction, Nonfatal | 25 - 44 | 2.91E-03 |
| I | high_8x | PM25-NOx | Acute Myocardial Infarction, Nonfatal | 45 - 54 | 7.09E-03 |
| I | high_8x | PM25-NOx | Acute Myocardial Infarction, Nonfatal | 55 - 64 | 1.15E-02 |
| I | high_8x | PM25-NOx | Acute Myocardial Infarction, Nonfatal | 65 - 99 | 4.63E-02 |
| I | high_8x | PM25-NOx | Hospital Admissions, All Respiratory | 65 - 99 | 1.53E-01 |
| II | high_8x | PM25-NOx | Emergency Room Visits, Asthma | 0 - 99 | 3.94E-01 |
| II | high_8x | PM25-NOx | Mortality, All Cause | 30 - 99 | 9.27E-01 |

| Strategic area Src | Emissions | Species-Precursor | Health Endpoint | Age Range[1] | Incidences per year[2] (Mean) (Reduced Sacramento 4-km Domain) |
|---|---|---|---|---|---|
| II | high_8x | PM25-NOx | Hospital Admissions, Asthma | 0 - 64 | 2.50E-02 |
| II | high_8x | PM25-NOx | Hospital Admissions, All Cardiovascular (less Myocardial Infarctions) | 65 - 99 | 7.45E-02 |
| II | high_8x | PM25-NOx | Acute Myocardial Infarction, Nonfatal | 18 - 24 | 3.38E-05 |
| II | high_8x | PM25-NOx | Acute Myocardial Infarction, Nonfatal | 25 - 44 | 2.77E-03 |
| II | high_8x | PM25-NOx | Acute Myocardial Infarction, Nonfatal | 45 - 54 | 6.87E-03 |
| II | high_8x | PM25-NOx | Acute Myocardial Infarction, Nonfatal | 55 - 64 | 1.12E-02 |
| II | high_8x | PM25-NOx | Acute Myocardial Infarction, Nonfatal | 65 - 99 | 4.59E-02 |
| II | high_8x | PM25-NOx | Hospital Admissions, All Respiratory | 65 - 99 | 1.46E-01 |
| III | high_8x | PM25-NOx | Emergency Room Visits, Asthma | 0 - 99 | 4.69E-01 |
| III | high_8x | PM25-NOx | Mortality, All Cause | 30 - 99 | 9.99E-01 |
| III | high_8x | PM25-NOx | Hospital Admissions, Asthma | 0 - 64 | 2.95E-02 |
| III | high_8x | PM25-NOx | Hospital Admissions, All Cardiovascular (less Myocardial Infarctions) | 65 - 99 | 7.88E-02 |
| III | high_8x | PM25-NOx | Acute Myocardial Infarction, Nonfatal | 18 - 24 | 4.12E-05 |
| III | high_8x | PM25-NOx | Acute Myocardial Infarction, Nonfatal | 25 - 44 | 3.24E-03 |
| III | high_8x | PM25-NOx | Acute Myocardial Infarction, Nonfatal | 45 - 54 | 7.70E-03 |
| III | high_8x | PM25-NOx | Acute Myocardial Infarction, Nonfatal | 55 - 64 | 1.27E-02 |
| III | high_8x | PM25-NOx | Acute Myocardial Infarction, Nonfatal | 65 - 99 | 4.85E-02 |
| III | high_8x | PM25-NOx | Hospital Admissions, All Respiratory | 65 - 99 | 1.61E-01 |
| IV | high_8x | PM25-NOx | Emergency Room Visits, Asthma | 0 - 99 | 1.35E+01 |
| IV | high_8x | PM25-NOx | Mortality, All Cause | 30 - 99 | 2.70E+01 |
| IV | high_8x | PM25-NOx | Hospital Admissions, Asthma | 0 - 64 | 8.94E-01 |
| IV | high_8x | PM25-NOx | Hospital Admissions, All Cardiovascular (less Myocardial Infarctions) | 65 - 99 | 2.36E+00 |
| IV | high_8x | PM25-NOx | Acute Myocardial Infarction, Nonfatal | 18 - 24 | 1.22E-03 |
| IV | high_8x | PM25-NOx | Acute Myocardial Infarction, Nonfatal | 25 - 44 | 9.72E-02 |
| IV | high_8x | PM25-NOx | Acute Myocardial Infarction, Nonfatal | 45 - 54 | 2.43E-01 |
| IV | high_8x | PM25-NOx | Acute Myocardial Infarction, Nonfatal | 55 - 64 | 4.02E-01 |
| IV | high_8x | PM25-NOx | Acute Myocardial Infarction, Nonfatal | 65 - 99 | 1.52E+00 |
| IV | high_8x | PM25-NOx | Hospital Admissions, All Respiratory | 65 - 99 | 4.10E+00 |
| V | high_8x | PM25-NOx | Emergency Room Visits, Asthma | 0 - 99 | 2.70E-01 |
| V | high_8x | PM25-NOx | Mortality, All Cause | 30 - 99 | 5.87E-01 |
| V | high_8x | PM25-NOx | Hospital Admissions, Asthma | 0 - 64 | 1.62E-02 |

| Strategic area Src | Emissions | Species-Precursor | Health Endpoint | Age Range[1] | Incidences per year[2] (Mean) (Reduced Sacramento 4-km Domain) |
|---|---|---|---|---|---|
| V | high_8x | PM25-NOx | Hospital Admissions, All Cardiovascular (less Myocardial Infarctions) | 65 - 99 | 4.19E-02 |
| V | high_8x | PM25-NOx | Acute Myocardial Infarction, Nonfatal | 18 - 24 | 2.69E-05 |
| V | high_8x | PM25-NOx | Acute Myocardial Infarction, Nonfatal | 25 - 44 | 1.66E-03 |
| V | high_8x | PM25-NOx | Acute Myocardial Infarction, Nonfatal | 45 - 54 | 3.83E-03 |
| V | high_8x | PM25-NOx | Acute Myocardial Infarction, Nonfatal | 55 - 64 | 6.25E-03 |
| V | high_8x | PM25-NOx | Acute Myocardial Infarction, Nonfatal | 65 - 99 | 2.49E-02 |
| V | high_8x | PM25-NOx | Hospital Admissions, All Respiratory | 65 - 99 | 9.56E-02 |
| VI | high_8x | PM25-NOx | Emergency Room Visits, Asthma | 0 - 99 | 2.22E-01 |
| VI | high_8x | PM25-NOx | Mortality, All Cause | 30 - 99 | 4.75E-01 |
| VI | high_8x | PM25-NOx | Hospital Admissions, Asthma | 0 - 64 | 1.22E-02 |
| VI | high_8x | PM25-NOx | Hospital Admissions, All Cardiovascular (less Myocardial Infarctions) | 65 - 99 | 3.52E-02 |
| VI | high_8x | PM25-NOx | Acute Myocardial Infarction, Nonfatal | 18 - 24 | 1.93E-05 |
| VI | high_8x | PM25-NOx | Acute Myocardial Infarction, Nonfatal | 25 - 44 | 1.19E-03 |
| VI | high_8x | PM25-NOx | Acute Myocardial Infarction, Nonfatal | 45 - 54 | 2.97E-03 |
| VI | high_8x | PM25-NOx | Acute Myocardial Infarction, Nonfatal | 55 - 64 | 4.76E-03 |
| VI | high_8x | PM25-NOx | Acute Myocardial Infarction, Nonfatal | 65 - 99 | 2.01E-02 |
| VI | high_8x | PM25-NOx | Hospital Admissions, All Respiratory | 65 - 99 | 7.88E-02 |
| I | low_2x | PM25-NOx | Emergency Room Visits, Asthma | 0 - 99 | 1.02E-01 |
| I | low_2x | PM25-NOx | Mortality, All Cause | 30 - 99 | 2.39E-01 |
| I | low_2x | PM25-NOx | Hospital Admissions, Asthma | 0 - 64 | 6.41E-03 |
| I | low_2x | PM25-NOx | Hospital Admissions, All Cardiovascular (less Myocardial Infarctions) | 65 - 99 | 1.86E-02 |
| I | low_2x | PM25-NOx | Acute Myocardial Infarction, Nonfatal | 18 - 24 | 8.93E-06 |
| I | low_2x | PM25-NOx | Acute Myocardial Infarction, Nonfatal | 25 - 44 | 7.14E-04 |
| I | low_2x | PM25-NOx | Acute Myocardial Infarction, Nonfatal | 45 - 54 | 1.74E-03 |
| I | low_2x | PM25-NOx | Acute Myocardial Infarction, Nonfatal | 55 - 64 | 2.82E-03 |
| I | low_2x | PM25-NOx | Acute Myocardial Infarction, Nonfatal | 65 - 99 | 1.14E-02 |
| I | low_2x | PM25-NOx | Hospital Admissions, All Respiratory | 65 - 99 | 3.75E-02 |
| II | low_2x | PM25-NOx | Emergency Room Visits, Asthma | 0 - 99 | 9.82E-02 |
| II | low_2x | PM25-NOx | Mortality, All Cause | 30 - 99 | 2.31E-01 |
| II | low_2x | PM25-NOx | Hospital Admissions, Asthma | 0 - 64 | 6.22E-03 |
| II | low_2x | PM25-NOx | Hospital Admissions, All Cardiovascular (less Myocardial Infarctions) | 65 - 99 | 1.86E-02 |

| Strategic area Src | Emissions | Species-Precursor | Health Endpoint | Age Range[1] | Incidences per year[2] (Mean) (Reduced Sacramento 4-km Domain) |
|---|---|---|---|---|---|
| II | low_2x | PM25-NOx | Acute Myocardial Infarction, Nonfatal | 18 - 24 | 8.41E-06 |
| II | low_2x | PM25-NOx | Acute Myocardial Infarction, Nonfatal | 25 - 44 | 6.90E-04 |
| II | low_2x | PM25-NOx | Acute Myocardial Infarction, Nonfatal | 45 - 54 | 1.71E-03 |
| II | low_2x | PM25-NOx | Acute Myocardial Infarction, Nonfatal | 55 - 64 | 2.80E-03 |
| II | low_2x | PM25-NOx | Acute Myocardial Infarction, Nonfatal | 65 - 99 | 1.15E-02 |
| II | low_2x | PM25-NOx | Hospital Admissions, All Respiratory | 65 - 99 | 3.64E-02 |
| III | low_2x | PM25-NOx | Emergency Room Visits, Asthma | 0 - 99 | 1.18E-01 |
| III | low_2x | PM25-NOx | Mortality, All Cause | 30 - 99 | 2.51E-01 |
| III | low_2x | PM25-NOx | Hospital Admissions, Asthma | 0 - 64 | 7.40E-03 |
| III | low_2x | PM25-NOx | Hospital Admissions, All Cardiovascular (less Myocardial Infarctions) | 65 - 99 | 1.98E-02 |
| III | low_2x | PM25-NOx | Acute Myocardial Infarction, Nonfatal | 18 - 24 | 1.03E-05 |
| III | low_2x | PM25-NOx | Acute Myocardial Infarction, Nonfatal | 25 - 44 | 8.14E-04 |
| III | low_2x | PM25-NOx | Acute Myocardial Infarction, Nonfatal | 45 - 54 | 1.93E-03 |
| III | low_2x | PM25-NOx | Acute Myocardial Infarction, Nonfatal | 55 - 64 | 3.20E-03 |
| III | low_2x | PM25-NOx | Acute Myocardial Infarction, Nonfatal | 65 - 99 | 1.22E-02 |
| III | low_2x | PM25-NOx | Hospital Admissions, All Respiratory | 65 - 99 | 4.02E-02 |
| IV | low_2x | PM25-NOx | Emergency Room Visits, Asthma | 0 - 99 | 1.34E-01 |
| IV | low_2x | PM25-NOx | Mortality, All Cause | 30 - 99 | 2.76E-01 |
| IV | low_2x | PM25-NOx | Hospital Admissions, Asthma | 0 - 64 | 8.52E-03 |
| IV | low_2x | PM25-NOx | Hospital Admissions, All Cardiovascular (less Myocardial Infarctions) | 65 - 99 | 2.25E-02 |
| IV | low_2x | PM25-NOx | Acute Myocardial Infarction, Nonfatal | 18 - 24 | 1.17E-05 |
| IV | low_2x | PM25-NOx | Acute Myocardial Infarction, Nonfatal | 25 - 44 | 9.29E-04 |
| IV | low_2x | PM25-NOx | Acute Myocardial Infarction, Nonfatal | 45 - 54 | 2.26E-03 |
| IV | low_2x | PM25-NOx | Acute Myocardial Infarction, Nonfatal | 55 - 64 | 3.71E-03 |
| IV | low_2x | PM25-NOx | Acute Myocardial Infarction, Nonfatal | 65 - 99 | 1.39E-02 |
| IV | low_2x | PM25-NOx | Hospital Admissions, All Respiratory | 65 - 99 | 4.44E-02 |
| V | low_2x | PM25-NOx | Emergency Room Visits, Asthma | 0 - 99 | 6.70E-02 |
| V | low_2x | PM25-NOx | Mortality, All Cause | 30 - 99 | 1.46E-01 |
| V | low_2x | PM25-NOx | Hospital Admissions, Asthma | 0 - 64 | 4.03E-03 |
| V | low_2x | PM25-NOx | Hospital Admissions, All Cardiovascular (less Myocardial Infarctions) | 65 - 99 | 1.04E-02 |
| V | low_2x | PM25-NOx | Acute Myocardial Infarction, Nonfatal | 18 - 24 | 6.71E-06 |

| Strategic area Src | Emissions | Species-Precursor | Health Endpoint | Age Range[1] | Incidences per year[2] (Mean) (Reduced Sacramento 4-km Domain) |
|---|---|---|---|---|---|
| V | low_2x | PM25-NOx | Acute Myocardial Infarction, Nonfatal | 25 - 44 | 4.12E-04 |
| V | low_2x | PM25-NOx | Acute Myocardial Infarction, Nonfatal | 45 - 54 | 9.52E-04 |
| V | low_2x | PM25-NOx | Acute Myocardial Infarction, Nonfatal | 55 - 64 | 1.55E-03 |
| V | low_2x | PM25-NOx | Acute Myocardial Infarction, Nonfatal | 65 - 99 | 6.18E-03 |
| V | low_2x | PM25-NOx | Hospital Admissions, All Respiratory | 65 - 99 | 2.38E-02 |
| VI | low_2x | PM25-NOx | Emergency Room Visits, Asthma | 0 - 99 | 5.58E-02 |
| VI | low_2x | PM25-NOx | Mortality, All Cause | 30 - 99 | 1.19E-01 |
| VI | low_2x | PM25-NOx | Hospital Admissions, Asthma | 0 - 64 | 3.04E-03 |
| VI | low_2x | PM25-NOx | Hospital Admissions, All Cardiovascular (less Myocardial Infarctions) | 65 - 99 | 8.80E-03 |
| VI | low_2x | PM25-NOx | Acute Myocardial Infarction, Nonfatal | 18 - 24 | 4.83E-06 |
| VI | low_2x | PM25-NOx | Acute Myocardial Infarction, Nonfatal | 25 - 44 | 2.98E-04 |
| VI | low_2x | PM25-NOx | Acute Myocardial Infarction, Nonfatal | 45 - 54 | 7.43E-04 |
| VI | low_2x | PM25-NOx | Acute Myocardial Infarction, Nonfatal | 55 - 64 | 1.19E-03 |
| VI | low_2x | PM25-NOx | Acute Myocardial Infarction, Nonfatal | 65 - 99 | 5.01E-03 |
| VI | low_2x | PM25-NOx | Hospital Admissions, All Respiratory | 65 - 99 | 1.97E-02 |
| I | high_8x | PM25-PM | Emergency Room Visits, Asthma | 0 - 99 | 5.87E+00 |
| I | high_8x | PM25-PM | Mortality, All Cause | 30 - 99 | 1.66E+01 |
| I | high_8x | PM25-PM | Hospital Admissions, Asthma | 0 - 64 | 3.60E-01 |
| I | high_8x | PM25-PM | Hospital Admissions, All Cardiovascular (less Myocardial Infarctions) | 65 - 99 | 1.16E+00 |
| I | high_8x | PM25-PM | Acute Myocardial Infarction, Nonfatal | 18 - 24 | 5.29E-04 |
| I | high_8x | PM25-PM | Acute Myocardial Infarction, Nonfatal | 25 - 44 | 4.18E-02 |
| I | high_8x | PM25-PM | Acute Myocardial Infarction, Nonfatal | 45 - 54 | 9.84E-02 |
| I | high_8x | PM25-PM | Acute Myocardial Infarction, Nonfatal | 55 - 64 | 1.55E-01 |
| I | high_8x | PM25-PM | Acute Myocardial Infarction, Nonfatal | 65 - 99 | 6.85E-01 |
| I | high_8x | PM25-PM | Hospital Admissions, All Respiratory | 65 - 99 | 2.46E+00 |
| II | high_8x | PM25-PM | Emergency Room Visits, Asthma | 0 - 99 | 7.02E+00 |
| II | high_8x | PM25-PM | Mortality, All Cause | 30 - 99 | 1.79E+01 |
| II | high_8x | PM25-PM | Hospital Admissions, Asthma | 0 - 64 | 4.49E-01 |
| II | high_8x | PM25-PM | Hospital Admissions, All Cardiovascular (less Myocardial Infarctions) | 65 - 99 | 1.52E+00 |
| II | high_8x | PM25-PM | Acute Myocardial Infarction, Nonfatal | 18 - 24 | 5.76E-04 |
| II | high_8x | PM25-PM | Acute Myocardial Infarction, Nonfatal | 25 - 44 | 5.08E-02 |

| Strategic area Src | Emissions | Species-Precursor | Health Endpoint | Age Range[1] | Incidences per year[2] (Mean) (Reduced Sacramento 4-km Domain) |
|---|---|---|---|---|---|
| II | high_8x | PM25-PM | Acute Myocardial Infarction, Nonfatal | 45 - 54 | 1.31E-01 |
| II | high_8x | PM25-PM | Acute Myocardial Infarction, Nonfatal | 55 - 64 | 2.12E-01 |
| II | high_8x | PM25-PM | Acute Myocardial Infarction, Nonfatal | 65 - 99 | 9.61E-01 |
| II | high_8x | PM25-PM | Hospital Admissions, All Respiratory | 65 - 99 | 2.74E+00 |
| III | high_8x | PM25-PM | Emergency Room Visits, Asthma | 0 - 99 | 8.31E+00 |
| III | high_8x | PM25-PM | Mortality, All Cause | 30 - 99 | 2.10E+01 |
| III | high_8x | PM25-PM | Hospital Admissions, Asthma | 0 - 64 | 5.33E-01 |
| III | high_8x | PM25-PM | Hospital Admissions, All Cardiovascular (less Myocardial Infarctions) | 65 - 99 | 1.48E+00 |
| III | high_8x | PM25-PM | Acute Myocardial Infarction, Nonfatal | 18 - 24 | 7.59E-04 |
| III | high_8x | PM25-PM | Acute Myocardial Infarction, Nonfatal | 25 - 44 | 6.41E-02 |
| III | high_8x | PM25-PM | Acute Myocardial Infarction, Nonfatal | 45 - 54 | 1.44E-01 |
| III | high_8x | PM25-PM | Acute Myocardial Infarction, Nonfatal | 55 - 64 | 2.44E-01 |
| III | high_8x | PM25-PM | Acute Myocardial Infarction, Nonfatal | 65 - 99 | 9.53E-01 |
| III | high_8x | PM25-PM | Hospital Admissions, All Respiratory | 65 - 99 | 2.93E+00 |
| IV | high_8x | PM25-PM | Emergency Room Visits, Asthma | 0 - 99 | 1.35E+01 |
| IV | high_8x | PM25-PM | Mortality, All Cause | 30 - 99 | 2.70E+01 |
| IV | high_8x | PM25-PM | Hospital Admissions, Asthma | 0 - 64 | 2.36E+00 |
| IV | high_8x | PM25-PM | Hospital Admissions, All Cardiovascular (less Myocardial Infarctions) | 65 - 99 | 1.52E+00 |
| IV | high_8x | PM25-PM | Acute Myocardial Infarction, Nonfatal | 18 - 24 | 1.22E-03 |
| IV | high_8x | PM25-PM | Acute Myocardial Infarction, Nonfatal | 25 - 44 | 9.72E-02 |
| IV | high_8x | PM25-PM | Acute Myocardial Infarction, Nonfatal | 45 - 54 | 2.43E-01 |
| IV | high_8x | PM25-PM | Acute Myocardial Infarction, Nonfatal | 55 - 64 | 4.02E-01 |
| IV | high_8x | PM25-PM | Acute Myocardial Infarction, Nonfatal | 65 - 99 | 1.52E+00 |
| IV | high_8x | PM25-PM | Hospital Admissions, All Respiratory | 65 - 99 | 4.10E+00 |
| V | high_8x | PM25-PM | Emergency Room Visits, Asthma | 0 - 99 | 3.27E+00 |
| V | high_8x | PM25-PM | Emergency Room Visits, Asthma | 0 - 99 | 3.27E+00 |
| V | high_8x | PM25-PM | Mortality, All Cause | 30 - 99 | 9.58E+00 |
| V | high_8x | PM25-PM | Hospital Admissions, Asthma | 0 - 64 | 1.94E-01 |
| V | high_8x | PM25-PM | Hospital Admissions, All Cardiovascular (less Myocardial Infarctions) | 65 - 99 | 3.97E-01 |
| V | high_8x | PM25-PM | Acute Myocardial Infarction, Nonfatal | 18 - 24 | 4.70E-04 |
| V | high_8x | PM25-PM | Acute Myocardial Infarction, Nonfatal | 25 - 44 | 2.10E-02 |

| Strategic area Src | Emissions | Species-Precursor | Health Endpoint | Age Range[1] | Incidences per year[2] (Mean) (Reduced Sacramento 4-km Domain) |
|---|---|---|---|---|---|
| V | high_8x | PM25-PM | Acute Myocardial Infarction, Nonfatal | 45 - 54 | 3.77E-02 |
| V | high_8x | PM25-PM | Acute Myocardial Infarction, Nonfatal | 55 - 64 | 5.59E-02 |
| V | high_8x | PM25-PM | Acute Myocardial Infarction, Nonfatal | 65 - 99 | 2.50E-01 |
| V | high_8x | PM25-PM | Hospital Admissions, All Respiratory | 65 - 99 | 1.18E+00 |
| VI | high_8x | PM25-PM | Emergency Room Visits, Asthma | 0 - 99 | 6.86E+00 |
| VI | high_8x | PM25-PM | Mortality, All Cause | 30 - 99 | 1.29E+01 |
| VI | high_8x | PM25-PM | Hospital Admissions, Asthma | 0 - 64 | 2.43E-01 |
| VI | high_8x | PM25-PM | Hospital Admissions, All Cardiovascular (less Myocardial Infarctions) | 65 - 99 | 8.10E-01 |
| VI | high_8x | PM25-PM | Acute Myocardial Infarction, Nonfatal | 18 - 24 | 5.37E-04 |
| VI | high_8x | PM25-PM | Acute Myocardial Infarction, Nonfatal | 25 - 44 | 2.53E-02 |
| VI | high_8x | PM25-PM | Acute Myocardial Infarction, Nonfatal | 45 - 54 | 6.61E-02 |
| VI | high_8x | PM25-PM | Acute Myocardial Infarction, Nonfatal | 55 - 64 | 9.00E-02 |
| VI | high_8x | PM25-PM | Acute Myocardial Infarction, Nonfatal | 65 - 99 | 4.37E-01 |
| VI | high_8x | PM25-PM | Hospital Admissions, All Respiratory | 65 - 99 | 1.95E+00 |
| I | low_2x | PM25-PM | Emergency Room Visits, Asthma | 0 - 99 | 1.45E+00 |
| I | low_2x | PM25-PM | Mortality, All Cause | 30 - 99 | 4.13E+00 |
| I | low_2x | PM25-PM | Hospital Admissions, Asthma | 0 - 64 | 8.88E-02 |
| I | low_2x | PM25-PM | Hospital Admissions, All Cardiovascular (less Myocardial Infarctions) | 65 - 99 | 2.87E-01 |
| I | low_2x | PM25-PM | Acute Myocardial Infarction, Nonfatal | 18 - 24 | 1.31E-04 |
| I | low_2x | PM25-PM | Acute Myocardial Infarction, Nonfatal | 25 - 44 | 1.03E-02 |
| I | low_2x | PM25-PM | Acute Myocardial Infarction, Nonfatal | 45 - 54 | 2.43E-02 |
| I | low_2x | PM25-PM | Acute Myocardial Infarction, Nonfatal | 55 - 64 | 3.83E-02 |
| I | low_2x | PM25-PM | Acute Myocardial Infarction, Nonfatal | 65 - 99 | 1.70E-01 |
| I | low_2x | PM25-PM | Hospital Admissions, All Respiratory | 65 - 99 | 6.11E-01 |
| II | low_2x | PM25-PM | Emergency Room Visits, Asthma | 0 - 99 | 1.76E+00 |
| II | low_2x | PM25-PM | Mortality, All Cause | 30 - 99 | 4.48E+00 |
| II | low_2x | PM25-PM | Hospital Admissions, Asthma | 0 - 64 | 1.12E-01 |
| II | low_2x | PM25-PM | Hospital Admissions, All Cardiovascular (less Myocardial Infarctions) | 65 - 99 | 3.79E-01 |
| II | low_2x | PM25-PM | Acute Myocardial Infarction, Nonfatal | 18 - 24 | 1.44E-04 |
| II | low_2x | PM25-PM | Acute Myocardial Infarction, Nonfatal | 25 - 44 | 1.27E-02 |
| II | low_2x | PM25-PM | Acute Myocardial Infarction, Nonfatal | 45 - 54 | 3.28E-02 |

| Strategic area Src | Emissions | Species-Precursor | Health Endpoint | Age Range[1] | Incidences per year[2] (Mean) (Reduced Sacramento 4-km Domain) |
|---|---|---|---|---|---|
| II | low_2x | PM25-PM | Acute Myocardial Infarction, Nonfatal | 55 - 64 | 5.30E-02 |
| II | low_2x | PM25-PM | Acute Myocardial Infarction, Nonfatal | 65 - 99 | 2.40E-01 |
| II | low_2x | PM25-PM | Hospital Admissions, All Respiratory | 65 - 99 | 6.84E-01 |
| III | low_2x | PM25-PM | Emergency Room Visits, Asthma | 0 - 99 | 2.08E+00 |
| III | low_2x | PM25-PM | Mortality, All Cause | 30 - 99 | 5.25E+00 |
| III | low_2x | PM25-PM | Hospital Admissions, Asthma | 0 - 64 | 1.33E-01 |
| III | low_2x | PM25-PM | Hospital Admissions, All Cardiovascular (less Myocardial Infarctions) | 65 - 99 | 3.71E-01 |
| III | low_2x | PM25-PM | Acute Myocardial Infarction, Nonfatal | 18 - 24 | 1.90E-04 |
| III | low_2x | PM25-PM | Acute Myocardial Infarction, Nonfatal | 25 - 44 | 1.60E-02 |
| III | low_2x | PM25-PM | Acute Myocardial Infarction, Nonfatal | 45 - 54 | 3.59E-02 |
| III | low_2x | PM25-PM | Acute Myocardial Infarction, Nonfatal | 55 - 64 | 6.11E-02 |
| III | low_2x | PM25-PM | Acute Myocardial Infarction, Nonfatal | 65 - 99 | 2.39E-01 |
| III | low_2x | PM25-PM | Hospital Admissions, All Respiratory | 65 - 99 | 7.31E-01 |
| IV | low_2x | PM25-PM | Emergency Room Visits, Asthma | 0 - 99 | 3.36E+00 |
| IV | low_2x | PM25-PM | Mortality, All Cause | 30 - 99 | 6.73E+00 |
| IV | low_2x | PM25-PM | Hospital Admissions, Asthma | 0 - 64 | 2.23E-01 |
| IV | low_2x | PM25-PM | Hospital Admissions, All Cardiovascular (less Myocardial Infarctions) | 65 - 99 | 5.86E-01 |
| IV | low_2x | PM25-PM | Acute Myocardial Infarction, Nonfatal | 18 - 24 | 3.04E-04 |
| IV | low_2x | PM25-PM | Acute Myocardial Infarction, Nonfatal | 25 - 44 | 2.42E-02 |
| IV | low_2x | PM25-PM | Acute Myocardial Infarction, Nonfatal | 45 - 54 | 6.04E-02 |
| IV | low_2x | PM25-PM | Acute Myocardial Infarction, Nonfatal | 55 - 64 | 1.00E-01 |
| IV | low_2x | PM25-PM | Acute Myocardial Infarction, Nonfatal | 65 - 99 | 3.78E-01 |
| IV | low_2x | PM25-PM | Hospital Admissions, All Respiratory | 65 - 99 | 1.02E+00 |
| V | low_2x | PM25-PM | Emergency Room Visits, Asthma | 0 - 99 | 8.16E-01 |
| V | low_2x | PM25-PM | Mortality, All Cause | 30 - 99 | 2.39E+00 |
| V | low_2x | PM25-PM | Hospital Admissions, Asthma | 0 - 64 | 4.86E-02 |
| V | low_2x | PM25-PM | Hospital Admissions, All Cardiovascular (less Myocardial Infarctions) | 65 - 99 | 9.92E-02 |
| V | low_2x | PM25-PM | Acute Myocardial Infarction, Nonfatal | 18 - 24 | 1.18E-04 |
| V | low_2x | PM25-PM | Acute Myocardial Infarction, Nonfatal | 25 - 44 | 5.25E-03 |
| V | low_2x | PM25-PM | Acute Myocardial Infarction, Nonfatal | 45 - 54 | 9.43E-03 |
| V | low_2x | PM25-PM | Acute Myocardial Infarction, Nonfatal | 55 - 64 | 1.40E-02 |

| Strategic area Src | Emissions | Species-Precursor | Health Endpoint | Age Range[1] | Incidences per year[2] (Mean) (Reduced Sacramento 4-km Domain) |
|---|---|---|---|---|---|
| V | low_2x | PM25-PM | Acute Myocardial Infarction, Nonfatal | 65 - 99 | 6.24E-02 |
| V | low_2x | PM25-PM | Hospital Admissions, All Respiratory | 65 - 99 | 2.94E-01 |
| VI | low_2x | PM25-PM | Emergency Room Visits, Asthma | 0 - 99 | 1.70E+00 |
| VI | low_2x | PM25-PM | Mortality, All Cause | 30 - 99 | 3.20E+00 |
| VI | low_2x | PM25-PM | Hospital Admissions, Asthma | 0 - 64 | 6.05E-02 |
| VI | low_2x | PM25-PM | Hospital Admissions, All Cardiovascular (less Myocardial Infarctions) | 65 - 99 | 2.01E-01 |
| VI | low_2x | PM25-PM | Acute Myocardial Infarction, Nonfatal | 18 - 24 | 1.33E-04 |
| VI | low_2x | PM25-PM | Acute Myocardial Infarction, Nonfatal | 25 - 44 | 6.30E-03 |
| VI | low_2x | PM25-PM | Acute Myocardial Infarction, Nonfatal | 45 - 54 | 1.65E-02 |
| VI | low_2x | PM25-PM | Acute Myocardial Infarction, Nonfatal | 55 - 64 | 2.25E-02 |
| VI | low_2x | PM25-PM | Acute Myocardial Infarction, Nonfatal | 65 - 99 | 1.09E-01 |
| VI | low_2x | PM25-PM | Hospital Admissions, All Respiratory | 65 - 99 | 4.83E-01 |

1. Affected age ranges are shown. Other age ranges are available, but the endpoints and age ranges shown here are the ones used by the USEPA in its health assessments. The age ranges are consistent with the epidemiological study that is the basis of the health function.
2. Health effects are shown in terms of incidences of each health endpoint and how these compare to the base (2035 base year health effect incidences, or “background health incidence”) values. Health effects and background health incidences are across the Sacramento reduced 4-km model domain.