Appendix B3

Health Effects of Criteria Pollutants

MEMORANDUM

To:	Memorandum to File
From:	Nicholas Lorenzen, Dudek
Subject:	Health Effects from Criteria Air Pollutants Associated with the Inland Empire North Logistics Center Project, Apple Valley, California
Date:	September 6, 2024

1 Purpose and Introduction

In response to the California Supreme Court's *Sierra Club v. County of Fresno* (2018) 6 Cal. 5th 502 decision (referred to herein as the Friant Ranch decision), this memorandum addresses the potential for adverse health effects related to emissions of criteria air pollutants associated with construction and operation of the proposed 1M Warehouse Project (proposed project) located in Apple Valley, California, based on scientific information and technological methods available at the time of this memorandum's preparation. The published Friant Ranch decision (issued on December 24, 2018) addresses the need to correlate mass emission values for criteria air pollutants to specific health consequences, and contains the following direction from the California Supreme Court: "The Environmental Impact Report (EIR) must provide an adequate analysis to inform the public how its bare numbers translate to create potential adverse impacts or it must explain what the agency *does* know and why, given existing scientific constraints, it cannot translate potential health impacts further" (*Sierra Club v. County of Fresno* 2018; italics in original).

As discussed below, at the time of this memorandum's preparation, no expert agency, including the Mojave Desert Air Quality Management District (MDAQMD), the California Air Resources Board (CARB), or the U.S. Environmental Protection Agency (EPA), have approved a quantitative method to reliably, meaningfully, and consistently translate the mass emission estimates for the criteria air pollutants resulting from the proposed project to specific health effects. No California air district or other expert agency/entity has published *quantitative* guidance on how to address the Friant Ranch decision.[1] However, in April 2019, the Sacramento Metropolitan Air Quality Management District (SMAQMD) published an Interim Recommendation on implementing the Friant Ranch decision in the review and analysis of proposed projects under the California Environmental Quality Act (CEQA) in Sacramento County (SMAQMD 2019). In June 2020, the SMAQMD published instructions for using a health effects screening tool that is summarized in Section 4 below.

Nonetheless, following the Supreme Court's Friant Ranch decision, some EIRs where estimated criteria air pollutant emissions exceeded applicable air district thresholds have included a quantitative analysis of potential project-generated health effects using a combination of a regional photochemical grid model and the EPA Benefits Mapping and Analysis Program (BenMAP or BenMAP-Community Edition [CE]). The publicly available health impact assessments (HIA) typically present results in terms of an increase in health incidences and/or the increase in background health incidence for various health outcomes resulting from the project's estimated increase in concentrations of ozone (O_3) and particulate matter (PM) with an aerodynamic diameter less than or equal to 2.5

1 The following air districts, state agencies, and entities were contacted by Dudek in January 2019, but could not provide guidance on how to proceed in response to the Friant Ranch decision at that time: San Diego Air Pollution Control District (APCD), MDAQMD, San Joaquin Valley APCD, Santa Barbara County APCD, San Luis Obispo County APCD, Bay Area AQMD, California Air Resources Board, California Office of Planning and Research, California Air Pollution Control Officers Association, and Office of Environmental Health Hazard Assessment.

microns ($PM_{2.5}$). To date, all of the HIAs that are publicly available have concluded that the evaluated project's health effects associated with the estimated project-generated increase in concentrations of O_3 and $PM_{2.5}$ represent a small increase in incidences and a very small percent of the number of background incidences, indicating that these health impacts are negligible and potentially within the models' margin of error. A review of the publicly available HIAs in CEQA documents is provided in Section 4.

2 National and California Ambient Air Quality Standards

As discussed in Section 4.2, Air Quality, of the proposed project's EIR, ambient air quality standards (AAQS) define clean air and are established to protect even the most sensitive individuals (CARB 2023a). An AAQS defines the maximum amount of a pollutant averaged over a specified period of time that can be present in outdoor air without harm to the public's health. The EPA and California Air Resources Board are both authorized to set AAQS.

The Clean Air Act Amendments of 1970 instruct the EPA to set primary National AAQS (NAAQS) to protect public health, and secondary NAAQS to protect plants, forests, crops, and materials from damage due to exposure to the following criteria air pollutants: O_3, nitrogen dioxide (NO_2), carbon monoxide (CO), sulfur dioxide (SO_2), particulate matter with an aerodynamic diameter less than or equal to 10 microns (PM_{10}), $PM_{2.5}$, and lead.

The federal Clean Air Act requires that the EPA reassess, at least every 5 years, whether adopted standards are adequate to protect public health based on current scientific evidence. The EPA is required to rely on the advice of an independent scientific panel, the Clean Air Scientific Advisory Committee. Reviewing the NAAQS is a lengthy undertaking and includes the following major phases: planning, integrated science assessment, risk/exposure assessment, policy assessment, and rulemaking (EPA 2022a). During the integrated science assessment, a comprehensive review, synthesis, and evaluation of the most policy-relevant science is conducted, including key science judgments that are important to inform the development of the risk and exposure assessments (EPA 2018a). Then, the risk/exposure assessment draws upon information and conclusions presented in the integrated science assessment to develop quantitative characterizations of exposures and associated risks to human health or the environment associated with recent air quality conditions and with air quality estimated to just meet the current or alternative standard(s) under consideration (EPA 2022a). Scientific review during policy assessment development, and the NAAQS review process in general, is thorough and extensive.

In 1959, California enacted legislation requiring the state Department of Public Health to establish AAQS and necessary controls for motor vehicle emissions (CARB 2023b). California's AAQS (CAAQS) were adopted in 1971 (CARB 2023b). The CAAQS are established for O_3, NO_2, CO, SO_2, PM_{10}, and $PM_{2.5}$, as well as hydrogen sulfide, vinyl chloride, sulfates, and visibility-reducing particles.

Air quality standard setting in California commences with a critical review of all relevant peer-reviewed scientific literature. The EPA's Office of Environmental Health Hazard Assessment uses the review of health literature to develop a recommendation for the standard. The recommendation can be for no change, or it can recommend a new standard. The review, including the Office of Environmental Health Hazard Assessment recommendation, is summarized in a document called the draft Initial Statement of Reasons (ISOR), which is released for comment by the public, and also for public peer review by the Air Quality Advisory Committee. Committee members are appointed by the President of the University of California for their expertise in the range of subjects covered in the ISOR, including health, exposure, air quality monitoring, atmospheric chemistry and physics, and effects on plants, trees, materials, and ecosystems. The Committee provides written comments on the draft ISOR. CARB staff next revises the ISOR based on comments from the Air Quality Advisory Committee and the public. The revised ISOR is then released for a 45-day public comment period prior to consideration by the Board of CARB at a regularly scheduled Board hearing (CARB 2023c).

Federal law requires that all states attain the NAAQS. Failure of a state to reach attainment of the NAAQS by the target date can trigger penalties, including withholding of federal highway funds (CARB 2023b). California law similarly continues to mandate CAAQS, although attainment of the NAAQS has precedence over attainment of the CAAQS (CARB 2023b).

Of importance to this memorandum, California air districts have based their thresholds of significance for CEQA purposes on the levels that scientific and factual data demonstrate that the air basin can accommodate without affecting the attainment date for the NAAQS or CAAQS. Since an AAQS is based on maximum pollutant levels in outdoor air that would not harm the public's health, and air district thresholds pertain to attainment of the AAQS, this means that the thresholds established by air districts are also protective of human health. The particular thresholds of relevance to the proposed project are illustrated in Table 4.2-4, Mojave Desert Air Quality Management District Daily Air Quality Significance Thresholds, of the EIR. Because O_3 is not emitted directly, air districts have established emissions-based thresholds for O_3 precursors—volatile organic compounds (VOCs) and oxides of nitrogen (NO_x)—which are intended to serve as a surrogate for an "O_3 significance threshold" (i.e., the potential for adverse O_3 impacts to occur).

The NAAQS and CAAQS for O_3, NO_2, CO, SO_2, PM_{10}, and $PM_{2.5}$ are presented in Table 1. Hydrogen sulfide, vinyl chloride, sulfates, and visibility-reducing particles are not addressed further in this evaluation because they are not routinely associated with land use development projects subject to CEQA review, and are thus not presented in Table 1.

Table 1. Ambient Air Quality Standards

Pollutant	Averaging Time	California Standards[a]	National Standards[b]	
		Concentration[c]	Primary[c,d]	Secondary[c,e]
O_3	1 hour	0.09 ppm (180 μg/m³)	No Data	Same as Primary Standard[f]
	8 hours	0.070 ppm (137 μg/m³)	0.070 ppm (137 μg/m³)[f]	
NO_2[g]	1 hour	0.18 ppm (339 μg/m³)	0.100 ppm (188 μg/m³)	Same as Primary Standard
	Annual Arithmetic Mean	0.030 ppm (57 μg/m³)	0.053 ppm (100 μg/m³)	
CO	1 hour	20 ppm (23 mg/m³)	35 ppm (40 mg/m³)	None
	8 hours	9.0 ppm (10 mg/m³)	9 ppm (10 mg/m³)	
SO_2[h]	1 hour	0.25 ppm (655 μg/m³)	0.075 ppm (196 μg/m³)	No Data
	3 hours	No Data	No Data	0.5 ppm (1,300 μg/m³)
	24 hours	0.04 ppm (105 μg/m³)	0.14 ppm (for certain areas)[g]	No Data

Table 1. Ambient Air Quality Standards

Pollutant	Averaging Time	California Standards[a]	National Standards[b]	
		Concentration[c]	Primary[c,d]	Secondary[c,e]
	Annual	No Data	0.030 ppm (for certain areas)[g]	No Data
PM_{10}[i]	24 hours	50 μg/m³	150 μg/m³	Same as Primary Standard
	Annual Arithmetic Mean	20 μg/m³	No Data	
$PM_{2.5}$[i]	24 hours	No Data	35 μg/m³	Same as Primary Standard
	Annual Arithmetic Mean	12 μg/m³	12.0 μg/m³	15.0 μg/m³

Source: CARB 2016.

Notes: μg/m³ = micrograms per cubic meter; mg/m³= milligrams per cubic meter; ppm = parts per million by volume; O_3 = ozone; NO_2 = nitrogen dioxide; CO = carbon monoxide; SO_2 = sulfur dioxide; PM_{10} = particulate matter with an aerodynamic diameter less than or equal to 10 microns; $PM_{2.5}$ = particulate matter with an aerodynamic diameter less than or equal to 2.5 microns.

a California standards for O_3, CO, SO_2 (1-hour and 24-hour), NO_2, suspended particulate matter (PM_{10}, $PM_{2.5}$), and visibility-reducing particles are values that are not to be exceeded. All others are not to be equaled or exceeded. CAAQS are listed in the Table of Standards in Section 70200 of Title 17 of the California Code of Regulations.

b National standards (other than O_3, NO_2, SO_2, particulate matter, and those based on annual averages or annual arithmetic mean) are not to be exceeded more than once per year. The O_3 standard is attained when the fourth highest 8-hour concentration measured at each site in a year, averaged over 3 years, is equal to or less than the standard. For PM_{10}, the 24-hour standard is attained when the expected number of days per calendar year with a 24-hour average concentration above 150 μg/m³ is equal to or less than 1. For $PM_{2.5}$, the 24-hour standard is attained when 98% of the daily concentrations, averaged over 3 years, are equal to or less than the standard.

c Concentration expressed first in units in which it was promulgated. Equivalent units given in parentheses are based on a reference temperature of 25°C and a reference pressure of 760 torr. Most measurements of air quality are to be corrected to a reference temperature of 25°C and a reference pressure of 760 torr; ppm in this table refers to ppm by volume, or micromoles of pollutant per mole of gas.

d National Primary Standards: The levels of air quality necessary, with an adequate margin of safety, to protect the public health.

e National Secondary Standards: The levels of air quality necessary to protect the public welfare from any known or anticipated adverse effects of a pollutant.

f On October 1, 2015, the national 8-hour O_3 primary and secondary standards were lowered from 0.075 to 0.070 ppm.

g To attain the national 1-hour standard, the 3-year average of the annual 98th percentile of the 1-hour daily maximum concentrations at each site must not exceed 100 parts per billion (ppb). Note that the national 1-hour standard is in units of ppb. California standards are in units of ppm. To directly compare the national 1-hour standard to the California standards, the units can be converted from ppb to ppm. In this case, the national standard of 100 ppb is identical to 0.100 ppm.

h On June 2, 2010, a new 1-hour SO_2 standard was established, and the existing 24-hour and annual primary standards were revoked. To attain the national 1-hour standard, the 3-year average of the annual 99th percentile of the 1-hour daily maximum concentrations at each site must not exceed 75 ppb. The 1971 SO_2 national standards (24-hour and annual) remain in effect until 1 year after an area is designated for the 2010 standard, except that in areas designated nonattainment of the 1971 standards, the 1971 standards remain in effect until implementation plans to attain or maintain the 2010 standards are approved.

i CARB adopted new PM standards in June of 2002, responding to requirements of the Children's Environmental Health Protection Act (Senate Bill 25, Escutia 1999), specifically the evaluation of all health-based AAQS to determine if the standards adequately protect human health, particularly that of infants and children. The subsequent review of the PM standards resulted in the recommendation of more health-protective AAQS for PM_{10} and a new standard for $PM_{2.5}$. The new PM standards became effective in 2003. Upon further review, the national annual $PM_{2.5}$ primary standard was lowered from 15 μg/m³ to 12.0 μg/m³ on December 14, 2012. The existing national 24-hour $PM_{2.5}$ standards (primary and secondary) were retained at 35 μg/m³, as was the annual secondary standard of 15 μg/m³. The existing 24-hour PM_{10} standards (primary and secondary) of 150 μg/m³ were also retained. The form of the annual primary and secondary standards is the annual mean averaged over 3 years.

Pursuant to the 1990 federal Clean Air Act amendments, the EPA classifies air basins (or portions thereof) as “attainment” or “nonattainment” for each criteria air pollutant, based on whether the NAAQS have been achieved.

Generally, if the recorded concentrations of a pollutant are lower than the standard, the area is classified as "attainment" for that pollutant. If an area exceeds the standard, the area is classified as "nonattainment" for that pollutant. If there is not enough data available to determine whether the standard is exceeded in an area, the area is designated as "unclassified" or "unclassifiable." The designation of "unclassifiable/attainment" means that the area meets the standard or is expected to meet the standard despite a lack of monitoring data. Areas that achieve the standards after a nonattainment designation are redesignated as maintenance areas and must have approved maintenance plans to ensure continued attainment of the standards. The California Clean Air Act, like its federal counterpart, called for the designation of areas as "attainment" or "nonattainment," but based on CAAQS rather than the NAAQS. Table 2 depicts the current attainment status of the project area with respect to the NAAQS and CAAQS. Notably, the Mojave Desert Air Basin (MDAB) has experienced a substantial reduction in maximum 8-hour concentrations of O_3 over time, as well as reductions in PM_{10}, from strategies including implementation of Reasonable Available Control Technology, vehicle emission standards, and other measures, as described in the respective MDAQMD O_3 attainment plan (MDAQMD 2008) and PM_{10} attainment demonstration and maintenance plan (MDAQMD 1995).

Table 2. Mojave Desert Air Basin Attainment Classification

Pollutant	Designation/Classification[a]	
	Federal Standards	State Standards
O_3 – 1 hour	No federal standard	**Nonattainment**
O_3 – 8 hours	**Severe nonattainment**[b]	**Nonattainment**
NO_2	Unclassifiable/attainment	Attainment
CO	Unclassifiable/attainment	Attainment
SO_2	Unclassifiable/attainment	Attainment
PM_{10}	**Moderate nonattainment**[c]	**Nonattainment**
$PM_{2.5}$	Unclassifiable/attainment	Attainment[d]
Lead	Unclassifiable/attainment	Attainment
Hydrogen sulfide	No federal standard	Unclassified[e]
Sulfates	No federal standard	Attainment
Visibility-reducing particles	No federal standard	Unclassified
Vinyl chloride	No federal standard	No designation

Sources: EPA 2021 (federal); CARB 2021 (state).
Notes: O_3 = ozone; NO_2 = nitrogen dioxide; CO = carbon monoxide; SO_2 = sulfur dioxide; PM_{10} = coarse particulate matter; $PM_{2.5}$ = fine particulate matter.
a Designations/classifications in **bold** type indicate nonattainment.
b West Mojave Desert portion of the MDAB, where the project is located, is designated severe nonattainment. The Kern County portion of the MDAB is designated moderate nonattainment, and the remaining areas of the MDAB are designated unclassifiable/attainment.
c The project is located in an area designated moderate nonattainment in the MDAB.
d The project is located in an area designated attainment in the MDAB.
e The entire MDAB is designated unclassified, except for the Searles Valley portion of the basin, which is designated nonattainment.
Definitions: attainment = meets the standards; attainment/maintenance = achieve the standards after a nonattainment designation; nonattainment = does not meet the standards; unclassified or unclassifiable = insufficient data to classify; unclassifiable/attainment = meets the standard or is expected to be meet the standard despite a lack of monitoring data.

In summary, the project is located in an area of the MDAB that is designated as a nonattainment area for federal and state O_3 standards and federal and state PM_{10} standards, and unclassifiable/attainment for all other criteria air pollutants (EPA 2021; CARB 2021).

3 Health Effects of Criteria Air Pollutants and Their Precursors

Numerous scientific studies published over the past 50 years point to the harmful effects of air pollution (CARB 2023b). As explained above, the AAQS are designed to prevent these effects (CARB 2023b). According to the South Coast Air Quality Management District (SCAQMD) 2016 Air Quality Management Plan (SCAQMD 2017), the adverse health effects associated with air pollution are diverse and include:

- Premature mortality
- Cardiovascular effects
- Increased health care utilization (hospitalization, physician and emergency room visits)
- Increased respiratory illness and other morbidity (symptoms, infections, and asthma exacerbation)
- Decreased lung function (breathing capacity)
- Lung inflammation
- Potential immunological changes
- Increased airway reactivity to a known pharmacological agent exposure – a method used in laboratories to evaluate the tendency of airways to have an increased possibility of developing an asthmatic response
- A decreased tolerance for exercise
- Adverse birth outcomes such as low birth weights

The evidence linking these effects to air pollutants is derived from population-based observational and field studies (epidemiological) as well as controlled laboratory studies involving human subjects and animals. There have been an increasing number of studies focusing on the mechanisms (that is, on how specific organs, cell types, and biomarkers are involved in the human body's response to air pollution) and specific pollutants responsible for individual effects. Yet the underlying biological pathways for these effects are not always clearly understood (SCAQMD 2017).

Although individuals inhale pollutants as a mixture under ambient conditions, the regulatory framework and the control measures developed are pollutant-specific for six major outdoor pollutants covered under Sections 108 and 109 of the Clean Air Act. This is appropriate, in that different pollutants usually differ in their sources, their times and places of occurrence, the kinds of health effects they may cause, and their overall levels of health risk. Different pollutants, from the same or different sources, oftentimes occur together. Evidence for more than additive effects has not been strong and, as a practical matter, health scientists, as well as regulatory officials, usually must deal with one pollutant at a time in adopting AAQS (SCAQMD 2017).

Health effects associated with criteria air pollutants are discussed below; the same or similar information is provided in Section 4.2.1, Existing Conditions, of the proposed project's Draft EIR.

Ozone (O3). O_3 in the troposphere causes numerous adverse health effects; short-term exposures (lasting for a few hours) to O_3 at levels typically observed in Southern California can result in breathing pattern changes, reduction of breathing capacity, respiratory symptoms, worsening of lung disease leading to premature death, increased susceptibility to infections, inflammation of and damage to the lung tissue, and some immunological changes (EPA

2013; CARB 2023d). These health problems are particularly acute in sensitive receptors such as the sick, older adults, and young children.

Inhalation of O_3 causes inflammation and irritation of the tissues lining human airways, causing and worsening a variety of symptoms. Exposure to O_3 can reduce the volume of air that the lungs breathe in and cause shortness of breath. O_3 in sufficient doses increases the permeability of lung cells, rendering them more susceptible to toxins and microorganisms. The occurrence and severity of health effects from O_3 exposure vary widely among individuals, even when the dose and the duration of exposure are the same. Research shows adults and children who spend more time outdoors participating in vigorous physical activities are at greater risk from the harmful health effects of O_3 exposure. While there are relatively few studies of O_3's effects on children, the available studies show that children are no more or less likely to suffer harmful effects than adults. However, there are a number of reasons why children may be more susceptible to O_3 and other pollutants. Children and teens spend nearly twice as much time outdoors and engaged in vigorous activities as adults. Children breathe more rapidly than adults and inhale more pollution per pound of their body weight than adults. Also, children are less likely than adults to notice their own symptoms and avoid harmful exposures. Further research may be able to better distinguish between health effects in children and adults. Children, adolescents, and adults who exercise or work outdoors, where O_3 concentrations are the highest, are at the greatest risk of harm from this pollutant (CARB 2023d).

A number of population groups are potentially at increased risk for O_3 exposure effects. In the ongoing review of O_3, the EPA has identified populations as having adequate evidence for increased risk from O_3 exposures including individuals with asthma, younger and older age groups, individuals with reduced intake of certain nutrients such as Vitamins C and E, and outdoor workers. There is suggestive evidence for other potential factors, such as gender, socioeconomic status, obesity, and variations in genes related to oxidative metabolism or inflammation. However, further evidence is needed (SCAQMD 2017).

The adverse effects reported with short-term O_3 exposure are greater with increased activity because activity increases the breathing rate and the volume of air reaching the lungs, resulting in an increased amount of O_3 reaching the lungs. Children may be a particularly vulnerable population to air pollution effects because they spend more time outdoors, are generally more active, and have a higher specific ventilation relative to their body weight, compared to adults (SCAQMD 2017).

Volatile Organic Compounds (VOCs). The primary health effects of VOCs result from the formation of O_3 and its related health effects. High levels of VOCs in the atmosphere can interfere with oxygen intake by reducing the amount of available oxygen through displacement. Carcinogenic forms of hydrocarbons, such as benzene, are considered toxic air contaminant (TACs). There are no separate health standards for VOCs as a group. Within this evaluation, VOC and reactive organic gases are used interchangeably.

Nitrogen Dioxide (NO2). A large body of health science literature indicates that exposure to NO_2 can induce adverse health effects. The strongest health evidence, and the health basis for the AAQS for NO_2, is the results from controlled human exposure studies that show that NO_2 exposure can intensify responses to allergens in allergic asthmatics. In addition, a number of epidemiological studies have demonstrated associations between NO_2 exposure and premature death, cardiopulmonary effects, decreased lung function growth in children, respiratory symptoms, emergency room visits for asthma, and intensified allergic responses. Infants and children are particularly at risk because they have disproportionately higher exposure to NO_2 than adults due to their greater breathing rate relative to their body weight and their typically greater outdoor exposure duration. Several studies have shown that long-term NO_2 exposure during childhood, the period of rapid lung growth, can lead to smaller lungs at maturity in children with higher levels of exposure as compared to lower levels. In addition, children with asthma have a greater degree of airway responsiveness compared with adult asthmatics. In adults, the greatest risk is to people who have chronic respiratory diseases, such as asthma and chronic obstructive pulmonary disease (CARB 2023e).

Carbon Monoxide (CO). Carbon monoxide is harmful because it binds to hemoglobin in the blood, reducing the ability of blood to carry oxygen. This interferes with oxygen delivery to the body's organs. The most common effects of CO exposure are fatigue, headaches, confusion and reduced mental alertness, and light-headedness and dizziness due to inadequate oxygen delivery to the brain. For people with cardiovascular disease, short-term CO exposure can further reduce their body's already compromised ability to respond to the increased oxygen demands of exercise, exertion, or stress. Inadequate oxygen delivery to the heart muscle leads to chest pain and decreased exercise tolerance. Unborn babies whose mothers experience high levels of CO exposure during pregnancy are at risk of adverse developmental effects. Unborn babies, infants, elderly people, and people with anemia or with a history of heart or respiratory disease are most likely to experience health effects with exposure to elevated levels of CO (CARB 2023f).

Sulfur Dioxide (SO2). SO_2 is an irritant gas that attacks the throat and lungs and can cause acute respiratory symptoms and diminished ventilator function in children. When combined with particulate matter (PM), SO_2 can injure lung tissue and reduce visibility and the level of sunlight. SO_2 can worsen asthma resulting in increased symptoms, increased medication usage, and emergency room visits.

Controlled human exposure and epidemiological studies show that children and adults with asthma are more likely to experience adverse responses with SO_2 exposure, compared with the non-asthmatic population. Effects at levels near the 1-hour standard are those of asthma exacerbation, including bronchoconstriction accompanied by symptoms of respiratory irritation such as wheezing, shortness of breath, and chest tightness, especially during exercise or physical activity. Also, exposure at elevated levels of SO_2 (above 1 part per million [ppm]) results in increased incidence of pulmonary symptoms and disease, decreased pulmonary function, and increased risk of mortality. The elderly and people with cardiovascular disease or chronic lung disease (such as bronchitis or emphysema) are most likely to experience these adverse effects (CARB 2023g).

SO_2 is of concern both because it is a direct respiratory irritant and because it contributes to the formation of sulfate and sulfuric acid in PM (NRC 2005). People with asthma are of particular concern, both because they have increased baseline airflow resistance and because their SO_2-induced increase in resistance is greater than in healthy people, and increases with the severity of their asthma (NRC 2005). SO_2 is thought to induce airway constriction via neural reflexes involving irritant receptors in the airways (NRC 2005).

Particulate Matter (PM10 and PM2.5). A number of adverse health effects have been associated with exposure to both $PM_{2.5}$ and PM_{10}. For $PM_{2.5}$, short-term exposures (up to 24-hours duration) have been associated with premature mortality, increased hospital admissions for heart or lung causes, acute and chronic bronchitis, asthma attacks, emergency room visits, respiratory symptoms, and restricted activity days. These adverse health effects have been reported primarily in infants, children, and older adults with preexisting heart or lung diseases. In addition, of all of the common air pollutants, $PM_{2.5}$ is associated with the greatest proportion of adverse health effects related to air pollution, both in the United States and world-wide, based on the World Health Organization's Global Burden of Disease Project. Short-term exposures to PM_{10} have been associated primarily with worsening of respiratory diseases, including asthma and chronic obstructive pulmonary disease, leading to hospitalization and emergency department visits (CARB 2023h).

Long-term (months to years) exposure to $PM_{2.5}$ has been linked to premature death, particularly in people who have chronic heart or lung diseases, and reduced lung function growth in children. The effects of long-term exposure to PM_{10} are less clear, although several studies suggest a link between long-term PM_{10} exposure and respiratory mortality. The International Agency for Research on Cancer published a review in 2015 that concluded that PM in outdoor air pollution causes lung cancer (CARB 2023h).

People with influenza, people with chronic respiratory and cardiovascular diseases, and older adults may suffer worsening illness and premature death as a result of breathing PM. People with bronchitis can expect aggravated symptoms from breathing PM. Children may experience a decline in lung function due to breathing in PM_{10} and $PM_{2.5}$ (EPA 2009).

PM encompasses a physically and chemically diverse class of ambient air pollutants of both anthropogenic and biological origin. The PM standard is the only NAAQS that does not target a specific chemical or family of chemical species (NRC 2005). The range of human health effects associated with ambient PM levels or demonstrated in laboratory studies has expanded from earlier concerns for total mortality and respiratory morbidity to include cardiac mortality and morbidity, blood vessel constriction, stroke, premature birth, low birth weight, retarded lung growth, enhancement of allergic responses, reduced resistance to infection, degenerative lesions in the brain, and lung cancer (EPA 2004).

4 Scientific and Technological Complexities

At issue in the Friant Ranch decision was the fact that the Friant Ranch Community Plan Update and Friant Ranch Specific Plan Program Environmental Impact Report (PEIR) did not connect its mass emission totals to specific adverse human health effects. Concerned with the sufficiency of the PEIR as an informational document, and specifically whether the magnitude of project impacts was adequately disclosed, the California Supreme Court stated the following: “The task for real party and the County is clear: The EIR must provide an adequate analysis to inform the public how its bare numbers translate to create potential adverse impacts or it must adequately explain what the agency *does* know and why, given existing scientific constraints, it cannot translate potential health impacts further” (*Sierra Club v. County of Fresno* 2018; italics in original).

As discussed further below, at the time of this writing, no available modeling tools have been proven to provide a reliable and meaningful analysis to correlate an increase in mass totals or concentrations of criteria air pollutants from an individual project to specific health effects, or estimate additional pollutant nonattainment days relative to the NAAQS and CAAQS due to a single project.

4.1 Formation of Secondary Pollutants

The California Supreme Court noted in the Friant Ranch decision: “The raw numbers estimating the tons per year of ROG and NO_x from the Project do not give any information to the reader about how much ozone is estimated to be produced as a result.”

In response, the formation of O_3 and PM in the atmosphere, as secondary pollutants,[2] involves complex chemical and physical interactions of multiple pollutants from natural and anthropogenic sources, as further explained below. The complexity in how secondary pollutants are formed and dispersed has resulted in ongoing difficulties in measuring and regulating those pollutants.

Tropospheric, or ground level O_3, is not emitted directly into the air, but is created by chemical reactions between NO_x and VOCs (EPA 2022b). This happens when pollutants emitted by cars, power plants, industrial boilers, refineries, chemical plants, and other sources chemically react in the presence of sunlight (EPA 2022b). O_3 is most likely to reach unhealthy levels on hot sunny days in urban environments, but can still reach high levels during colder months (EPA 2022b). O_3 can also be transported long distances by wind, so even rural areas can experience high O_3 levels (EPA 2022b).

The O_3 reaction is self-perpetuating (or catalytic) in the presence of sunlight because NO_2 is photochemically reformed from nitric oxide (NO). In this way, O_3 is controlled by both NO_x and VOC emissions (NRC 2005). The complexity of these interacting cycles of pollutants means that incremental decreases in one emission may not result in proportional decreases in O_3 (NRC 2005). Although these reactions and interactions are well understood, variability in emission source operations and meteorology creates uncertainty in the modeled O_3 concentrations to which downwind populations may be exposed (NRC 2005). This is especially true for individual projects, like the proposed project, where project-generated criteria air pollutant emissions are not derived from a single "point source," but from mobile sources (cars and trucks) driving to, from, and around the project area and area sources (consumer products, architectural coating, natural gas fireplaces, etc.).

In many urban areas, O_3 nonattainment is not caused by emissions from the local area alone (EPA 2008). Due to atmospheric transport, contributions of precursors from the surrounding region can also be important (EPA 2008, O_3 NAAQS). Thus, in designing control strategies to reduce O_3 concentrations in a local area, it is often necessary to account for regional transport within the U.S. (EPA 2008). In some areas, such as California, global transport of O_3 from beyond North America also can contribute to nonattainment areas (EPA 2008).

According to the 2015 amicus brief from San Joaquin Valley Air Pollution Control District (SJVAPCD), PM can be divided into two categories: directly emitted PM and secondary PM. Secondary PM, like O_3, is formed via complex chemical reactions in the atmosphere between precursor chemicals such as SO_x and NO_x (SJVAPCD 2015). In general, PM_{10} is composed largely of primary particles, and a much greater portion of $PM_{2.5}$ contains secondary particles (EPA 2022c). The secondary formation of $PM_{2.5}$ is dominated by a variety of chemical species or components of atmospheric particles, such as ammonium sulfate, ammonium nitrate, organic carbon mass, elemental carbon, and other soil compounds and oxidized metals. $PM_{2.5}$, sulfate, nitrate, and ammonium ions are predominantly the result of chemical reactions of the oxidized products of SO_2 and NO_x emissions with direct ammonia emission (82 FR 5182-5235. Because of the complexity of secondary PM formation, including the potential to be transported long distances by wind, the tonnage of PM-forming precursor emissions in an area does not necessarily result in an equivalent concentration of secondary PM in that area (SJVAPCD 2015).

Because of the long-range transport of some pollutants, important emission sources may be far from the locations where measured pollutant concentrations exceed the AAQS (NRC 2005). Thus, for areas experiencing higher

2 Air pollutants formed through chemical reactions in the atmosphere are referred to as secondary pollutants.

ambient concentrations of pollutants, such as O_3 and PM, controlling emissions of those pollutants and their precursors is typically a regional, often multistate, problem, not a local one (NRC 2005).

4.2 San Joaquin Valley Air Pollution Control District and South Coast Air Quality Management District Briefs

In connection with the judicial proceedings culminating in issuance of the Friant Ranch decision, SJVAPCD and SCAQMD filed amicus briefs attesting to the extreme difficulty of correlating an individual project's criteria air pollutant emissions to specific health impacts. Both the SJVAPCD and the SCAQMD have among the most sophisticated air quality modeling and health impact evaluation capabilities of the air districts in the State. While the information and arguments presented in those briefs was considered by the California Supreme Court, the Court noted that such information was not part of the administrative record associated with the County's decision to approve the Friant Ranch project. A summary of the key, relevant points of the SJVAPCD and SCAQMD briefs is provided below.

Difference between Toxic Air Contaminants and Criteria Air Pollutants

As explained in Section 4.2.1, Existing Conditions, a TAC is an air pollutant, identified in regulation by CARB, which may cause or contribute to an increase in deaths or in serious illness, or which may pose a present or potential hazard to human health. TACs are considered under a different regulatory process (California Health and Safety Code section 39650 et seq.) than pollutants subject to CAAQS and NAAQS. Health effects to TACs may occur at extremely low levels and it is typically difficult to identify levels of exposure that do not produce adverse health effects. A criteria air pollutant, on the other hand, is an air pollutant for which acceptable levels of exposure can be determined and for which an AAQS has been set (CARB 2023i).

As the SJVAPCD explained in their brief, "Although criteria air pollutants can also be harmful to human health, they are distinguishable from TACs and are regulated separately. The most relevant difference between criteria pollutants and TACs for purposes of this case is the manner in which human health impacts are accounted for. While it is common practice to analyze the correlation between an individual facility's TAC emissions and the expected localized human health impacts, such is not the case for criteria pollutants" (SJVAPCD 2015). Unlike with TACs (where assessment occurs in conjunction with environmental analysis for individual projects), the human health impacts associated with criteria air pollutants are analyzed and taken into consideration when EPA sets the NAAQS for each criteria pollutant. (42 U.S.C. § 7409(b)(1).) The health impact of a particular criteria pollutant is analyzed on a regional and not a facility or individual project level based on how close the area is to complying with (attaining) the NAAQS (SJVAPCD 2015). The SJVAPCD concluded that while it is possible to perform a health impact analysis for TACs, "it is not feasible to conduct a similar analysis for criteria air pollutants because currently available computer modeling tools are not equipped for this task" (SJVAPCD 2015).

Disconnect Between Mass and Concentration

Another important technical nuance is that health effects from air pollutants are related to the concentration of the air pollutant that an individual is exposed to, not necessarily the individual mass quantity of emissions associated with an individual project. For example, health effects from O_3 are correlated with increases in the ambient level of

O_3 in the air a person breathes (SCAQMD 2015). However, it takes a large amount of additional precursor emissions to cause a modeled increase in ambient O_3 levels over an entire region (SCAQMD 2015).

For CEQA analyses, project-generated emissions are typically estimated in pounds per day or tons per year and compared to mass daily or annual emission thresholds. While CEQA thresholds are established at levels that the air basin can accommodate without affecting the attainment date for the AAQS, even if a project exceeds established CEQA significance thresholds, this does not mean that one can easily determine the concentration of O_3 or PM that will be created at or near the project site on a particular day or month of the year, or what specific health impacts will occur (SJVAPCD 2015).

As the SJVAPCD points out, the tonnage of PM “emitted does not always equate to the local PM concentration because it can be transported long distances by wind,” and “[s]econdary PM, like O_3, is formed via complex chemical reactions in the atmosphere between precursor chemicals such as sulfur dioxides (SO_x) and NO_x,” meaning that “the tonnage of PM-forming precursor emissions in an area does not necessarily result in an equivalent concentration of secondary PM in that area” (SJVAPCD 2015). The disconnect between the tonnage of precursor pollutants (NO_x, SO_x and VOCs) and the concentration of O_3 or PM formed is important because it is not necessarily the tonnage of precursor pollutants that causes human health effects, but the concentration of resulting O_3 or PM (SJVAPCD 2015). As discussed previously, the AAQS are established as concentrations of O_3 or PM and not as tonnages of their precursor pollutants (SJVAPCD 2015). The disconnect between the amount of precursor pollutants and the concentration of O_3 or PM formed makes it difficult to determine potential health impacts, which are related to the concentration of O_3 and PM experienced by the receptor rather than levels of NO_x, SO_x, and VOCs produced by a source (SJVAPCD 2015).

As discussed above, attainment of a particular AAQS occurs when the concentration of the relevant pollutant remains below a set threshold on a consistent basis throughout a particular region (SJVAPCD 2015). Because the AAQS are focused on achieving a particular concentration of pollution region-wide, an air district's tools and plans for attaining the AAQS are regional in nature (SJVAPCD 2015). For instance, the computer models used to simulate and predict an attainment date for the O_3 or PM NAAQS in the San Joaquin Valley are based on regional inputs, such as regional inventories of precursor pollutants (NO_x, SO_x and VOCs) and the atmospheric chemistry and meteorology of the San Joaquin Valley (SJVAPCD 2015). At a very basic level, the models simulate future O_3 or PM levels based on predicted changes in precursor emissions San Joaquin Valley Air Basin-wide (SJVAPCD 2015). Because the AAQS are set levels necessary to protect human health, the closer a region is to attaining a particular AAQS, the lower the human health impact is from that pollutant (SJVAPCD 2015).

The goal of these modeling exercises is not to determine whether the emissions generated by a particular factory or development project will affect the date that the San Joaquin Valley Air Basin attains the AAQS (SJVAPCD 2015). Rather, the SJVAPCD’s modeling and planning strategy is regional in nature and based on the extent to which all of the emission-generating sources in the San Joaquin Valley Air Basin (current and future) must be controlled in order to reach attainment (SJVAPCD 2015).

Correlation to Health Effects

The SJVAPCD ties the difficulty of correlating the emission of criteria pollutants to health impacts to how O_3 and PM are formed, as explained above. According to SJVAPCD, “even once a model is developed to accurately ascertain local increases in concentrations of photochemical pollutants like O_3 and some particulates, it remains impossible, using today's models, to correlate that increase in concentration to a specific health impact [because] such models are designed to determine regional, population-wide health impacts, and simply are not accurate when applied at the local level" (SJVAPCD 2015).

To demonstrate the relative scale between emissions within the MDAQMD jurisdiction used in photochemical and other regional modeling and proposed project-level emissions, emissions for the MDAQMD jurisdiction from the CARB California Emissions Projection Analysis Model (CEPAM) emissions inventory and estimated emissions from the proposed project are summarized below. CEPAM produces projected emissions that can then be gridded to serve as the emission input for photochemical modeling. Including all sources except natural sources,[3] total emissions for the MDAQMD for the CEPAM baseline year of 2017 is as follows: 26 tons per day for VOC, 76 tons per day of NO_x, 100 tons per day of CO, 2 tons per day for SO_x, 71 tons per day of PM_{10}, and 16 tons per day of $PM_{2.5}$ (CARB 2023j). For the year 2050 (the latest year available), total projected emissions for the MDAQMD for all sources except natural, as forecasted by CEPAM, is as follows: 26 tons per day for VOC, 68 tons per day of NO_x, 100 tons per day of CO, 2 tons per day for SO_x, 89 tons per day of PM_{10}, and 20 tons per day of $PM_{2.5}$ (CARB 2023j). Construction of the proposed project is estimated to result in maximum daily emissions of 0.05 ton per day for VOC, 0.02 ton per day of NO_x, 0.03 ton per day of CO, less than 0.01 ton per day for SO_x, less than 0.01 ton per day of PM_{10}, and less than 0.01 ton per day of $PM_{2.5}$ (see Table 4.2-9, Estimated Maximum Daily Construction Criteria Air Pollutant Emissions - Unmitigated). The maximum daily emissions associated with the proposed project operation in 2025 is anticipated to result in maximum daily emissions of 0.03 ton per day for VOC, 0.22 ton per day of NO_x, 1.46 ton per day of CO, less than 0.01 ton per day for SO_x, 0.01 ton per day of PM_{10}, and 0.01 ton per day of $PM_{2.5}$ (see Table 4.2-10, Estimated Maximum Daily Operational Criteria Air Pollutant Emissions - Unmitigated). As presented above, proposed project emissions represent a small fraction of the total emissions in the MDAQMD jurisdiction.

SCAQMD used O_3, which is formed from the chemical reaction of NO_x and VOCs in the presence of sunlight, as an example of why it is impracticable to determine specific health outcomes from criteria pollutants for all but very large, regional-scale projects. First, forming O_3 "takes time and the influence of meteorological conditions for these reactions to occur, so ozone may be formed at a distance downwind from the sources" (SCAQMD 2015). Second, "it takes a large amount of additional precursor emissions (NO_x and VOCs) to cause a modeled increase in ambient ozone levels over an entire region," with a 2012 study showing that "reducing NO_x by 432 tons per day (157,680 tons/year) and reducing VOC by 187 tons per day (68,255 tons/year) would reduce ozone levels at the SCAQMD's monitor site with the highest levels by only 9 parts per billion" (SCAQMD 2015). SCAQMD thus concludes that it "does not currently know of a way to accurately quantify O_3-related health impacts caused by NO_x or VOC emissions from relatively small projects" (SCAQMD 2015).

Essentially, SCAQMD takes the position that a project emitting only 10 tons per year of NO_x or VOC is small enough that its regional impact on ambient O_3 levels may not be detected in the regional air quality models that are currently used to determine O_3 levels; thus, in this case it would not be feasible to directly correlate project emissions of VOC or NO_x with specific health impacts from O_3 (SCAQMD 2015). Therefore, lead agencies that use SCAQMD's thresholds of significance may determine that many projects have "significant" air quality impacts and must apply all feasible mitigation measures, yet will not be able to precisely correlate the project to quantifiable health impacts.

3 Natural sources are non-humanmade emission sources, which include biological and geological sources, wildfires, windblown dust, and biogenic emissions from plants and trees.

Effects on Number of Nonattainment Days

In regard to regional concentrations and air basin attainment, the SJVAPCD emphasized that attempting to identify a change in background pollutant concentrations that can be attributed to a single project, even one as large as the entire Friant Ranch Specific Plan, is a theoretical exercise. The SJVAPCD brief noted that it "would be extremely difficult to model the impact on NAAQS attainment that the emissions from the Friant Ranch project may have" (SJVAPCD 2015). The situation is further complicated by the fact that background concentrations of regional pollutants are not uniform either temporally or geographically throughout an air basin, but are constantly fluctuating based upon meteorology and other environmental factors. As discussed above, the currently available modeling tools are equipped to model the impact of all emission sources in the San Joaquin Valley Air Basin on attainment (SJVAPCD 2015). The SJVAPCD brief then indicated that, "Running the photochemical grid model used for predicting O_3 attainment with the emissions solely from the Friant Ranch project (which equate to less than one-tenth of one percent of the total NO_x and VOC in the Valley) is not likely to yield valid information given the relative scale involved" (SJVAPCD 2015).

4.3 Sacramento Metropolitan Air Quality Management District

As previously discussed, the SMAQMD is to date the only California air district to formally release guidance (SMAQMD 2019) for lead agencies and practitioners preparing CEQA documents for projects within Sacramento County to comply with the Friant Ranch decision. In June 2020, the SMAQMD released Instructions for Sac Metro Air District Minor Project and Strategic Area Project Health Effects Screening Tools (SMAQMD 2020a), which was developed to estimate health effects for proposed projects within the Five-Air-District Region (Sacramento, El Dorado, Sutter, Yuba, and Yolo Counties and the portions of Solano County within the Sacramento Valley). The user inputs the location of the proposed project in latitude and longitude coordinates using decimal degrees. The SMAQMD also released the Guidance to Address the Friant Ranch Ruling for CEQA Projects in the Sac Metro Air District, which fully details how projects should address the Friant Ranch ruling within their jurisdiction (SMAQMD 2020b). This guidance provides insight on the health effects that may result from a project emitting at the maximum thresholds of significance levels in the Five-Air-District Region for NO_x, VOCs, and PM, in addition to levels of CO and SO_x calculated proportional to NO_x; provides look-up tables for estimating health effects for strategic areas where growth exceeding thresholds of significance is anticipated; provides modeling guidance for CEQA projects that have emissions in excess of the significance thresholds and are located outside the strategic areas modeled; and provides information on disclosing health effects in an overall health context in a CEQA document.

4.4 Methods Available

At the time of writing, no specific tools have been developed for use in CEQA documents to connect criteria air pollutant emissions from an individual project to specific health effects in response to Friant Ranch outside of the SMAQMD jurisdiction. However, it has been demonstrated to be technically feasible to use existing regional models and an existing health effect modeling program to evaluate individual projects, which has been conducted for a few projects in 2019. The following CEQA documents included a quantitative HIA to address Friant Ranch:

- California State University Dominguez Hills 2018 Campus Master Plan EIR (CSUDH MP) (CSUDH 2019)
- March Joint Powers Association K4 Warehouse and Cactus Channel Improvements EIR (March JPA K4) (March JPA 2019)

- Mineta San Jose Airport Amendment to the Airport Master Plan EIR (San Jose Airport) (City of San Jose 2019)
- City of Inglewood Basketball and Entertainment Center Project EIR (IBEC) (City of Inglewood 2019)
- San Diego State University Mission Valley Campus Master Plan EIR (SDSU) (San Diego State University 2019)

The first step in all of the five above-listed examples includes running a regional photochemical grid model, such as the Community Multiscale Air Quality (CMAQ)[4] model or the Comprehensive Air Quality Model with extensions (CAMx),[5] to estimate the increase in concentrations of O_3 and $PM_{2.5}$ as a result of project-generated emissions of criteria and precursor pollutants. Air districts, such as the SCAQMD, use photochemical air quality models for regional air quality planning. These photochemical models are large-scale air quality models that simulate the changes of pollutant concentrations in the atmosphere using a set of mathematical equations characterizing the chemical and physical processes in the atmosphere (EPA 2022d).

After estimating the increase in concentrations of O_3 and $PM_{2.5}$, the second step in the five examples includes use of BenMAP or BenMAP-CE to estimate the resulting associated health effects. BenMAP estimates the number of health incidences resulting from changes in air pollution concentrations (EPA 2022e). The health impact function in BenMAP-CE incorporates four key sources of data: (1) modeled or monitored air quality changes, (2) population, (3) baseline incidence rates, and (4) an effect estimate. While BenMAP can estimate the health effects of emissions of VOC, NO_x, CO, SO_2, and $PM_{2.5}$, O_3 and $PM_{2.5}$ were determined to have the most critical health impacts and thus, were the pollutants evaluated to determine the project's health effects in three of the five examples (CSUDH MP, March JPA K4, and San Jose Airport). The current version of BenMAP-CE only has health impact functions associated with O_3 and $PM_{2.5}$, which is why the example HIA using BenMAP-CE only quantitatively addressed O_3 and $PM_{2.5}$-related health outcomes. As such, all example HIAs focused on O_3 and $PM_{2.5}$.

BenMAP outputs include O_3- and PM-related health endpoints such as premature mortality, hospital admissions, and emergency room visits (City of San Jose 2019). BenMAP uses the following simplified formula to relate changes in ambient air pollution to certain health endpoints:

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

Population characteristics are a key variable in the BenMAP estimate of health incidences. As such, small increases in emissions in an area with a high population may have a much greater affect than large increases in emissions over an area with a small population. While location and associated population is a key factor, making the five examples specific not only to the project-generated emissions, but also to the geographic location and underlying population estimates, the findings of the five examples are provided herein for context, particularly for the conclusions. For the CSUDH MP, the proposed project retains the existing campus enrollment cap of 20,000 full-time-equivalent students, while providing a framework for development of CSUDH's campus in a forward-looking manner that accommodates growth from the current enrollment of approximately 11,000 full-time-equivalent students to the maximum enrollment

4 The CMAQ modeling system includes state-of-the-science capabilities for conducting urban-to-regional-to-hemispheric scale simulations of multiple air quality issues, including tropospheric O_3, fine particles, TACs, acid deposition, and visibility degradation. CMAQ brings together three kinds of models: (1) meteorological models to represent atmospheric and weather activities, (2) emission models to represent man-made and naturally occurring contributions to the atmosphere, and (3) an air chemistry-transport model to predict the atmospheric fate of air pollutants under varying conditions (EPA 2022f).

5 CAMx is a three-dimensional grid-based Eulerian air quality model designed to estimate the formation and fate of oxidant precursors, primary and secondary particulate matter concentrations, and deposition over regional and urban spatial scales (e.g., over the contiguous United States) (EPA 2015).

of 20,000 full-time-equivalent students over a planning horizon extending to 2035. The project is located within the MDAQMD jurisdictional boundaries (within the Mojave Desert Air Basin). For context, the maximum daily emissions of relevant pollutants generated by the CSUDH MP were estimated to be 482.6 pounds per day of VOC, 240.1 pounds per day of NO_x, 2.7 pounds per day of SO_2, and 79.5 pounds per day of $PM_{2.5}$.

The CSUDH MP presented HIA results in terms of an increase in health incidences and the increase in background health incidence for various health outcomes referred to as endpoints. The background health incidence is the actual incidence of health effects as measured in the local population in the absence of additional emissions from the project (CSUDH 2019).

The two highest $PM_{2.5}$-related health outcomes attributed to the CSUDH MP project-related increases in ambient air concentrations included mortality (10.31 incidences per year, 0.0032% in background health incidence) and asthma-related emergency room visits (4.38 incidences per year, 0.0033% in background health incidence). The remaining health endpoints, including asthma-related hospital admissions, all cardiovascular-related hospital admissions (not including myocardial infarctions), all respiratory-related hospital admissions, and nonfatal acute myocardial infarction, ranged from 0.00044 to 2.44 incidences per year (0.00047% to 0.0014% in background health incidence) (CSUDH 2019).

O_3-related health outcomes attributed to the CSUDH project-related increases in ambient air concentrations included respiratory-related hospital admissions (0.67 incidences per year, 0.00034% in background health incidence), mortality (0.28 incidences per year, 0.00013% in background health incidence), and asthma-related emergency room visits for any age range (lower than 3.38 incidences per year for all age groups, lower than 0.0058% percent in background health incidence for all age groups) (CSUDH 2019).

The CSUDH MP HIA then concluded that "for all these health endpoints, the number of estimated incidences is less than 0.0058% of the background health incidence. … When taken into context, the small increase in incidences and the very small percent of the number of background incidences indicate that these health impacts are negligible in a developed, urban environment" (CSUDH 2019).

The March JPA K4 project is located within the SCAQMD jurisdictional boundaries (within the South Coast Air Basin), in Riverside County. The project involves the development of the five parcels on the 35.4-acre K4 Parcel with a 718,000-square-foot building conservatively assumed to be occupied by High-Cube ecommerce/fulfillment center use. The mitigated maximum daily operational emissions of relevant pollutants generated by the March JPA K4 were estimated to be 41.0 pounds per day of VOC, 253.0 pounds per day of NO_x, 1.4 pounds per day of SO_x, and 30.3 pounds per day of $PM_{2.5}$. The March JPA K4 HIA determined that, "for all these health endpoints, the number of estimated incidences is less than 0.0042% of the baseline number of incidences," and that "these health impacts are conservatively estimated, and the actual impacts may be zero" (March JPA 2019).

The SDSU project is located within the City of San Diego. The SDSU project proposes construction and operation of the SDSU Mission Valley campus, stadium, parks, recreation, and innovation area to accommodate up to 15,000 full-time-equivalent students over time, resulting in a total student headcount of approximately 20,000 students. The maximum daily emissions of relevant pollutants generated by SDSU were estimated to be 314.1 pounds per day of VOC, 1,120.7 pounds per day of NO_x, 6.5 pounds per day of SO_2, and 205.9 pounds per day of $PM_{2.5}$ (SDSU 2019).

The $PM_{2.5}$-related health outcomes attributed to the SDSU project-related increases in ambient air concentrations included mortality (8.97 incidences per year, 0.0026% in background health incidence) and asthma-related emergency room visits (5.29 incidences per year, 0.0040% in background health incidence). The remaining health endpoints, including asthma-related hospital admissions, all cardiovascular-related hospital admissions (not including myocardial infarctions), all respiratory-related hospital admissions, and nonfatal acute myocardial infarction, ranged from 0.00083 to 3.33 incidences per year (0.00223% to 0.00164% in background health incidence) (SDSU 2019).

O_3-related health outcomes attributed to the SDSU project-related increases in ambient air concentrations included respiratory-related hospital admissions (0.45 incidences per year, 0.0002% in background health incidence), mortality (0.21 incidences per year, 0.00010% in background health incidence), asthma-related emergency room visits for age groups 0–17 (1.73 incidences per year, 0.003% percent in background health incidence), and asthma-related emergency room visits for age groups 18–99 (2.02 incidences per year, 0.002% percent in background health incidence) (SDSU 2019).

The SDSU HIA found that "health effects estimation using the log-linear method presumes that effects seen at large concentration differences can be linearly scaled down to small increases in concentration, with no consideration of potential thresholds below which health effects may occur; thus, this potentially overstates the potential effects. In summary, health effects are conservatively estimated, and the actual effects may be zero" (SDSU 2019).

San Jose Airport is located in Santa Clara County within the Bay Area AQMD jurisdictional boundaries (within the San Francisco Bay Area Air Basin). The San Jose Airport project includes amending the approved 2018 Airport Master Plan to (1) shift the planning horizon year from 2027 to 2037, (2) modify future facility requirements at the airport to reflect updated demand forecasts, and (3) modify certain components of the airfield to reduce the potential for runway incursions (City of San Jose 2019). The estimated maximum daily incremental operational emissions of relevant pollutants generated by the San Jose Airport project were estimated to be -49.4 pounds per day of VOC, 5,325 pounds per day of NO_x, and 52 pounds per day of $PM_{2.5}$. However, the following emissions inventory was assumed for the HIA: 57.3 pounds per day of VOC, 5,643.0 pounds per day of NO_x, and 51.6 pounds per day of $PM_{2.5}$.

The San Jose Airport HIA estimated that the highest health endpoint from $PM_{2.5}$ was mortality at 4.46 incidences (0.0017% percent in background health incidence). All other $PM_{2\text{-}5}$-related health incidences ranged from 0.00022 to 1.89 (0.00027% to 0.0016% percent in background health incidence). For O_3-related health endpoints, the highest was emergency room visits for asthma, which was estimated to be 11.05 incidences (0.028% percent in background health incidence) for ages 0–17 and 14.59 incidences (0.019% percent in background health incidence) for ages 18–99 (City of San Jose 2019). Of the five examples discussed herein, the San Jose Airport resulted in the greatest O_3 incidences, which correlates with the estimated high emissions of ozone-precursors, specifically NO_x at 5,643 pounds per day. Nonetheless, the conclusion was that "when taken into context, the small increase in incidences and the very small percent of the number of background incidences indicate that these health impacts are negligible in a developed, urban environment" (City of San Jose 2019).

The IBEC project HIA provides another important data point for consideration. The IBEC project consists of an arena designed to host the LA Clippers basketball team with up to 18,000 fixed seats for National Basketball Association games and up to 500 additional temporary seats for events such as family shows, concerts, conventions, corporate events, and non-LA Clippers sporting events. The IBEC project is located within Los Angeles County within the jurisdictional boundaries of the SCAQMD (within the South Coast Air Basin). The IBEC EIR evaluated nine operational scenarios; across these multiple scenarios, the estimated maximum daily net increase in operational emissions of relevant pollutants was 94 pounds per day of VOC, 99 pounds per day of NO_x, 3 pounds per day of SO_x, and 89 pounds per day of $PM_{2.5}$.

The IBEC EIR analysis provided helpful context on using regional models for individual projects, as follows:

> Generally, models that correlate criteria air pollutant concentrations with specific health effects focus on regulatory decision-making that will apply throughout an entire air basin or region. These models focus on the region-wide health effects of pollutants so that regulators can assess the costs and benefits of adopting a proposed regulation that applies to an entire category of air pollutant sources, rather than the health effects related to emissions from a specific proposed project or source. Because of the scale of these analyses, any one project is likely to have only very small incremental effects which may be difficult to differentiate from the effects of air pollutant concentrations in an entire air basin. … For regional pollutants, it is difficult to trace a particular project's criteria air pollutant emissions to a specific health effect. Moreover, the modeled results may be misleading because the margin of error in such modeling is large enough that, even if the modeled results report a given health effect, the model is sufficiently imprecise that the actual effect may differ from the reported results; that is, the modeled results suggest precision, when in fact available models cannot be that precise on a project level (City of Inglewood 2019).

For O_3-related health endpoints, emergency room visits for asthma were estimated to be 0.087 incidence per year for all studied age groups combined, 0.016 incidence per year of respiratory-related hospital admissions, and less than 0.02 incidence per year of mortality; the amount of estimated incremental health effects incidence is less than 0.0001% of the baseline number of health effects incidences in the study area.

A key finding from the IBEC HIA was that for $PM_{2.5}$-related health endpoints, due to the very small changes in ambient $PM_{2.5}$ concentrations as modeled by CMAQ, all of the estimated incremental health incidences were negative values. The IBEC HIA stated that this further confirms that the modeled $PM_{2.5}$ concentrations are within the model's margin of error, no meaningful conclusions can be reached on the specific health effects that may be caused by the proposed project O_3 precursor and $PM_{2.5}$ emissions, and health impacts may in fact be zero, and they would still be well within the models' margin of error (City of Inglewood 2019).

It is also important to note that while these results conclude that the project emissions do not result in a substantial increase in health incidences, the estimated emissions and assumed toxicity is also conservatively inputted into the HIA and thus, overestimate health incidences, particularly for $PM_{2.5}$. For example, as discussed in the San Jose Airport HIA, "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 impacts of PM. Further, USEPA 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 and others. This is particularly important to note here, as the majority of PM emissions generated from the Project are from entrained roadway dust, and not from combustion. Therefore, by not considering the relative toxicity of PM components, the results presented here are conservative" (City of San Jose 2019).

As explained in the SJVAPCD brief and noted previously, running the photochemical grid model used for predicting O_3 attainment with the emissions solely from an individual project like the Friant Ranch project or the proposed project is not likely to yield valid information given the relative scale involved. The five examples discussed herein support the SJVAPCD's brief contention that consistent, reliable, and meaningful results may not be provided by methods applied at this time. Accordingly, additional work in the industry and more importantly, air district participation, is needed to develop a more meaningful analysis to correlate project-level mass criteria air pollutant emissions and health effects for decision-makers and the public. Furthermore, at the time of writing, no HIA has concluded that health effects estimated using the photochemical grid model and BenMAP approach are substantial provided that the estimated project-generated incidences represent a very small percent of the number of background incidences, potentially within the models' margin of error.

5 Evaluation of the Proposed Project's Health Effects

Based on the evaluation of methods provided in Section 4, this evaluation does not attempt to quantify health effects, but builds upon the discussion provided in Sections 2 and 3 to disclose potential health effects associated with the proposed project. As explained in Section 2, the EPA and CARB have established AAQS at levels above which concentrations could be harmful to human health and welfare, with an adequate margin of safety. Further, California air districts (like MDAQMD) have established emission-based thresholds that provide project-level estimates of criteria air pollutant quantities that air basins can accommodate without affecting the attainment dates for the AAQS. Accordingly, elevated levels of criteria air pollutants as a result of a proposed project's emissions could cause adverse health effects associated with these pollutants.

In this case, construction of the proposed project would not exceed the MDAQMD thresholds. The operation of the proposed project is estimated to exceed MDAQMD thresholds for NO_x and PM_{10} before mitigation is incorporated. As shown in Table 2 (Section 2), the MDAB is designated as a nonattainment area for O_3 and PM_{10} under the NAAQS and CAAQS.

As discussed in Section 3, health effects associated with O_3 include respiratory symptoms, worsening of lung disease leading to premature death, and damage to lung tissue (CARB 2023k). VOCs and NO_x are precursors to O_3, for which the MDAB is designated as nonattainment with respect to the NAAQS and CAAQS. The contribution of VOCs and NO_x to regional ambient O_3 concentrations is the result of complex photochemistry. The increases in O_3 concentrations in the MDAB due to O_3 precursor emissions tend to be found downwind from the source location to allow time for the photochemical reactions to occur. However, the potential for exacerbating excessive O_3 concentrations would also depend on the time of year that the VOC emissions would occur because exceedances of the O_3 AAQS tend to occur between April and October when solar radiation is highest. The holistic effect of a single project's emissions of O_3 precursors is speculative because of the lack of quantitative methods to assess this impact. As the project would exceed the MDAQMD threshold for NO_x after implementation of mitigation (MM-AQ-2), the project is expected anticipated to contribute to health effects associated with O_3.

Health effects associated with NO_x include lung irritation and enhanced allergic responses (see Section 3; CARB 2023k). Health impacts that result from NO_2 and NO_x include respiratory irritation. Although Project operations would generate NO_x emissions that would exceed the SCAQMD mass daily thresholds, it is unlikely that construction of the Project would contribute to exceedances of the NAAQS and CAAQS for NO_2 because the SCAB is designated as in attainment of the NAAQS and CAAQS for NO_2 and the existing NO_2 concentrations in the area are well below the NAAQS and CAAQS standards. Nonetheless, because there are nearby existing and proposed receptors that could be affected, the Project could result in potential health effects associated with NO_2 and NO_x.

Health effects associated with CO include chest pain in patients with heart disease, headache, light-headedness, and reduced mental alertness (See Section 3; CARB 2023k). CO tends to be a localized impact associated with congested intersections. The associated potential for CO hotspots was discussed in Section 4.2.4, Impacts Analysis, of the Draft EIR and are determined to be a less-than-significant impact.

Health effects associated with PM_{10} and $PM_{2.5}$ include premature death and hospitalization, primarily for worsening of respiratory disease (See Section 3; CARB 2022f). Operation of the Project would exceed the SCAQMD thresholds for PM_{10} and $PM_{2.5}$. As such, the Project would potentially contribute to exceedances of the NAAQS and CAAQS for particulate matter and obstruct the SCAB from coming into attainment for these pollutants. Because the Project has the potential to contribute substantial particulate matter during operation, the Project could result in associated health effects.

In summary, although the Project has the potential to result in health effects associated with emissions of criteria air pollutants as described above, there are numerous scientific and technological complexities associated with correlating criteria air pollutant emissions from an individual project to specific health effects or potential additional nonattainment days, and methods available to quantitatively evaluate health effects may not be appropriate to apply to emissions associated with the Project, which cannot be estimated with a high-level of accuracy.

6 References

82 FR 5182-5235. Final rule: “Revisions to the Guideline on Air Quality Models: Enhancements to the AERMOD Dispersion Modeling System and Incorporation of Approaches to Address Ozone and Fine Particulate Matter.” January 17, 2017.CAPCOA (California Air Pollution Control Officers Association). 2017. California Emissions Estimator Model (CalEEMod). http://www.caleemod.com/.

California Air Resources Board (CARB). 2016. “Ambient Air Quality Standards.” May 4, 2016. http://www.arb.ca.gov/research/aaqs/aaqs2.pdf.

CARB. 2021. “Area Designation Maps/State and National.” Accessed February 9, 2023. Available http://www.arb.ca.gov/desig/adm/adm.htm.

CARB. 2023a. “Air Quality Standards.” Accessed February 9, 2023. https://ww2.arb.ca.gov/resources /background-air-quality-standards.

CARB. 2023b. “National Ambient Air Quality Standards.” Accessed February 9, 2023. https://ww2.arb.ca.gov/resources/national-ambient-air-quality-standards.

CARB. 2023c. “California Ambient Air Quality Standards (CAAQS).” Accessed February 9, 2023. https://www.arb.ca.gov/research/aaqs/caaqs/caaqs.htm.

CARB. 2023d. “Ozone & Health.” Accessed February 6, 2023. https://ww2.arb.ca.gov/resources/ozone-and-health.

CARB. 2023e. "Nitrogen Dioxide & Health." Accessed February 6, 2023. https://ww2.arb.ca.gov/resources/nitrogen-dioxide-and-health.

CARB. 2023f. "Carbon Monoxide & Health." Accessed February 6, 2023. https://ww2.arb.ca.gov/resources/carbon-monoxide-and-health.

CARB. 2023g. "Sulfur Dioxide & Health." Accessed February 6, 2023. https://ww2.arb.ca.gov/resources/sulfur-dioxide-and-health.

CARB. 2023h. "Inhalable Particulate Matter and Health ($PM_{2.5}$ and PM_{10})." Accessed February 9, 2023. https://www.arb.ca.gov/research/aaqs/common-pollutants/pm/pm.htm.

CARB. 2023i. "Glossary of Air Pollutant Terms." Accessed February 9, 2023. http://www.arb.ca.gov/html/gloss.htm.

CARB. 2023j. California Emissions Projection Analysis Model (CEPAM): 2019 SIP – Standard Emission Tool Emission Projections by Summary Category. Accessed February 9, 2023. https://ww2.arb.ca.gov/applications/cepam2019v103-standard-emission-tool.

CARB. 2023k. "Common Air Pollutants." Accessed February 9, 2023. https://ww2.arb.ca.gov/resources/common-air-pollutants.

City of Inglewood. 2019. *Inglewood Basketball and Entertainment Center Project EIR*. http://ibecproject.com/D_AirQuality.pdf.

City of San Jose. 2019. *Mineta San Jose Airport Amendment to the Airport Master Plan EIR*. https://www.sanjoseca.gov/Home/ShowDocument?id=44596.

CSUDH. 2019. *California State University Dominguez Hills Campus Master Plan EIR*. https://www.csudh.edu/Assets/csudh-sites/fpcm/docs/campus-master-plan/2019-09-11-FEIR-appendices.pdf.

EPA (U.S. Environmental Protection Agency). 2004. *Air Quality Criteria for Particulate Matter, Vol. 1 and 2*. EPA/600/P-99/002aF. EPA, National Center for Environmental Assessment, Office of Research and Development. October 2004.

EPA. 2008. *Final Ozone NAAQS Regulatory Impact Analysis*. EPA-452/R-08-003. EPA, Office of Air Quality Planning and Standards, Health and Environmental Impacts Division. March 2008. Accessed February 6, 2023. https://www3.epa.gov/ttnecas1/regdata/RIAs/452_R_08_003.pdf.

EPA. 2009. *Integrated Science Assessment for Particulate Matter*. EPA/600/R-08/139F. EPA, National Center for Environmental Assessment, Office of Research and Development. December 2009. Accessed February 6, 2023. https://cfpub.epa.gov/ncea/risk/recordisplay.cfm?deid=216546.

EPA. 2013. "Integrated Science Assessment of Ozone and Related Photochemical Oxidants." EPA/600R-10/076F. https://cfpub.epa.gov/ncea/isa/recordisplay.cfm?deid=247492.

EPA. 2015. Office of Air and Radiation. Office of Air Quality Planning and Standards. *Regulatory Impact Analysis of the Final Revisions to the National Ambient Air Quality Standards for Ground-Level Ozone*. Research Triangle Park, NC. https://www3.epa.gov/ttn/ecas/docs/ria/naaqs-o3_ria_final_2015-09.pdf.

EPA. 2021. "Region 9: Air Quality Analysis, EPA Region 9 Air Quality Maps and Geographic Information." Last updated June 10, 2021. Accessed November 17, 2021. https://www3.epa.gov/region9/air /maps/index.html.

EPA. 2022a. "Process of Reviewing the National Ambient Air Quality Standards." Last updated October 26, 2022. https://www.epa.gov/criteria-air-pollutants/process-reviewing-national-ambient-air-quality-standards.

EPA. 2022b. "Ground-level Ozone Basics." Last updated June 14, 2022. https://www.epa.gov/ground-level-ozone-pollution/ground-level-ozone-basics.

EPA. 2022c. Report on the Environment – Particulate Matter Emissions. Last updated August 23, 2022. https://cfpub.epa.gov/roe/indicator.cfm?i=19.

EPA. 2022d. Support Center for Regulatory Atmospheric Modeling (SCRAM) - Photochemical Air Quality Modeling. Last updated March 16, 2022. https://www.epa.gov/scram/photochemical-air-quality-modeling.

EPA. 2022e. *Environmental Benefits Mapping and Analysis Program – Community Edition User's Manual*. January 2022. https://www.epa.gov/sites/production/files/2015-04/documents/benmap-ce_user_manual_march_2015.pdf.

EPA. 2022f. Community Multiscale Air Quality (CMAQ) Models. Updated September 30, 2022. https://www.epa.gov/cmaq/cmaq-models-0.

March JPA (Joint Powers Association). 2019. *K4 Warehouse and Cactus Channel Improvements EIR*. Ehqb2eUJImRQOIgiGAAWSHmDkaoZPmyRK24Uy0s3tId8G3IOWxuuhU_a7PpSB6ecz1qP5JgNptOuCa120.

MDAQMD. 1995. Final Mojave Desert Planning Area Federal PM10 Attainment Plan. July 31, 1995. Accessed November 17, 2021. Available https://www.mdaqmd.ca.gov/home/showpublisheddocument /176/636305689057870000.

MDAQMD. 2008. Federal 8-Hour Ozone Attainment Plan (Western Mojave Desert Non-Attainment Area). Adopted June 9, 2008. Accessed November 2021.NRC (National Research Council). 2005. *Interim Report of the Committee on Changes in New Source Review Programs for Stationary Sources of Air Pollutants*. Washington, DC: The National Academies Press. https://doi.org/10.17226/11208.

SCAQMD. 2015. Brief of Amicus Curiae in Support of Neither Party, *Sierra Club v. County of Fresno*, Case No. S219783 (filed Apr. 13, 2015). https://www.courts.ca.gov/documents/9-s219783-ac-south-coast-air-quality-mgt-dist-041315.pdf.

SCAQMD. 2017. "Health Effects." Appendix I in *2016 Air Quality Management Plan*. March 2017. Accessed February 6, 2023. https://www.aqmd.gov/docs/default-source/clean-air-plans/air-quality-management-plans/2016-air-quality-management-plan/final-2016-aqmp/appendix-i.pdf?sfvrsn=14.

SDSU (San Diego State University). 2019. *San Diego State University Mission Valley Campus Master Plan EIR Additional Information Regarding Potential Health Effects of Air Quality Impacts.* Prepared by Ramboll US Corporation. December 2019. https://missionvalley.sdsu.edu/pdfs/feir/appendices/4-2-3-sdsu-mv-health-effects-memo.pdf .

Sierra Club v. County of Fresno. 2018. 6 Cal. 5th 502. December 24, 2018. http://www.courts.ca.gov/opinions/documents/S219783A.PDF.

SJVAPCD. 2015. Brief of Amicus Curiae in Support of Defendant And Respondent, County Of Fresno, And Real Party In Interest And Respondent, Friant Ranch, L.P., *Sierra Club v. County of Fresno*, Case No. S219783 (filed Apr. 13, 2015). https://www.courts.ca.gov/documents/7-s219783-ac-san-joaquin-valley-unified-air-pollution-control-dist-041315.pdf.

SMAQMD (Sacramento Metropolitan Air Quality Management District). 2019. Friant Ranch Interim Recommendation. April 25, 2019. http://www.airquality.org/LandUseTransportation/Documents/FriantInterimRecommendation.pdf.

SMAQMD. 2020a. Instructions for Sac Metro Air District Minor Project and Strategic Area Project Health Effects Screening tools. June 15, 2020. Accessed July 2020. http://www.airquality.org/LandUseTransportation/Documents/SacMetroScreeningToolInstructions2020-06-15.pdf.

SMAQMD. 2020b. *Guidance to Address the Friant Ranch Ruling for CEQA Projects in the Sac Metro Air District*. Prepared by Ramboll Corporation. San Francisco, California. June 2020. Accessed July 2020. http://www.airquality.org/LandUseTransportation/Documents/SacMetroFriantDraftFinalPublic2020-06-15.pdf.