FINAL REPORT

COMMUNITY HEALTH EQUITY EVALUATION FOR SAN DIEGO FORWARD: THE 2021 REGIONAL PLAN

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1 INTRODUCTION AND BACKGROUND

The San Diego Association of Governments (SANDAG) prepared the Draft San Diego Forward: The 2021 Regional Plan (SANDAG 2021a) (Draft 2021 Regional Plan) that provides a 30-year plan for how the San Diego Region will grow and travel within the region. The Draft 2021 Regional Plan merges three documents: the Regional Transportation Plan, Sustainable Communities Strategy (SCS), and Regional Comprehensive Plan. On April 9, 2021, SANDAG Board of Directors passed Resolution No. 2021-17 in support of the Draft 2021 Regional Plan. This Community Health Equity Evaluation addresses the following component of the resolution:

- The health results caused by implementing the [Draft] 2021 Regional Plan, with an emphasis on disadvantaged communities that have historically borne a disproportionate share of pollution.

Using the *Technical Report on the Modeling Evaluation Study Supporting the Community Health Equity Evaluation for San Diego Forward: the 2021 Regional Plan* (ICF 2021) (Health Outcome Report), this evaluation identifies potential disproportionate share of pollution on disadvantaged communities (DACs) and the benefits associated with implementation of the Draft 2021 Regional Plan as it relates to DACs.

1.1 BACKGROUND

1.1.1 2021 REGIONAL PLAN

The Draft 2021 Regional Plan supports other regional transportation planning and programming efforts and aims to provide people with more travel choices, protect the environment, create healthy communities, and stimulate economic growth for the benefit of the San Diego residents. The Draft 2021 Regional Plan must comply with specific state and federal mandates, including an SCS, per Senate Bill 375. This would have the Draft 2021 Regional Plan achieve greenhouse gas (GHG) emission reduction targets set by the California Air Resources Board (CARB); comply with federal civil rights requirements (Title VI); and consider environmental justice, air quality conformity, and engage in a public participation process. The Draft 2021 Regional Plan was completed in 2021 with a public review and comment period between May 28, 2021 to August 6, 2021.

California Assembly Bill 805 (Chapter 658, Statutes of 2017) requires the Draft 2021 Regional Plan to identify DACs and include transportation strategies to reduce pollution exposure within these communities. As the Draft 2021 Regional Plan's projects, policies, and programs were developed, their benefits in relation to DACs were considered. Appendix H: Social Equity: Engagement and Analysis of the Draft 2021 Regional Plan (SANDAG 2021b) describes how DACs were defined in coordination with the Social Equity Working Group and how strategies in the Draft 2021 Regional Plan reduce pollution exposure in these areas. DACs as defined in Appendix H of the Draft 2021 Regional Plan are identified in Section 3 of this document.

1.1.2 2021 REGIONAL PLAN DRAFT PROGRAM EIR

For the Draft 2021 Regional Plan, SANDAG prepared a Draft Program Environmental Impact Report (EIR) (SANDAG 2021c) in accordance with the California Environmental Quality Act (CEQA) and CEQA Guidelines. The public review and comment period was between August 27, 2021 and October

11, 2021. The Draft Program EIR evaluated human health risk associated with inhalation of air toxic pollutants directly emitted from mobile sources associated with the Draft 2021 Regional Plan, and changes in land use that may change levels of exposure to existing toxic air pollutants. In compliance with CEQA, Chapter 4.3, Air Quality, of the Draft Program EIR includes a health risk assessment (HRA), which analyzed exposure of sensitive receptors to substantial concentrations of toxic air contaminants (TACs) and increases in cancer risk associated with such exposure. TACs are pollutants that have no ambient standard but pose the potential to increase the risk of developing cancer or acute or chronic health risks. Those risks are characterized in terms incremental cancer, non-cancer chronic, and non-cancer acute population risks for specific types of sensitive receptors, based on land use. The HRA identified and mapped sensitive receptors in 2016 and future years (2025, 2035, 2050) within the areas exposed to specified concentrations of TAC emissions to determine where cancer and non-cancer risk thresholds are exceeded. For the HRA, sensitive receptors are locations represented by residential, school, and recreational land uses. The HRA also disclosed TAC exposure of new land use added by the Draft 2021 Regional Plan's regional growth and land use changes. Sensitive receptors associated with new land uses include future residential and park uses near existing pollution sources, such as roads, rail, and stationary sources.

1.1.3 HEALTH OUTCOME REPORT

The *Technical Report on the Modeling Evaluation Study Supporting the Community Health Equity Evaluation for San Diego Forward: the 2021 Regional Plan* (Health Outcome Report) is not a CEQA required analysis and is complementary to the air quality analysis in the Draft Program EIR. The Health Outcome Report was prepared to address SANDAG Resolution No. 2021-17 and to analyze potential air quality pollution exposure in the SANDAG region with the implementation of the Draft 2021 Regional Plan.

Per SANDAG direction, health impacts modeled in the Health Outcome Report uses the CALPUFF model with the Environmental Protection Agency's (EPA) Benefits Mapping and Analysis Program – Community Edition (BenMAP-CE) model.[1] BenMAP-CE is EPA's model for estimating the health impacts and accompanying economic benefits associated with changes in air quality. To estimate health impacts, BenMAP-CE relies on input air pollutant concentrations in the form of gridded surface estimates, population, and baseline incidence rates of adverse health effects. The model applies health impact functions, which relate a change in the concentration of a pollutant with a population estimate of the change in the incidence of a health endpoint[2], to produce detailed estimates of the human health benefits resulting from the changes in air pollution.

The Health Outcome Report is based on fine particulate matter ($PM_{2.5}$) concentrations but differs from the Draft Program EIR's localized analysis by addressing the regional component of particulate pollution and considering impacts both near and far from sources of pollution and impacts of both "primary" pollution and "secondary" pollution (PM formed through chemical and physical reactions in the atmosphere). It uses the CALPUFF model for this where the EIR used AERMOD to simulate local PM impacts. As long-term exposure to particulate matter air pollution is related to a range of adverse health outcomes, the Health Outcome Report uses the predicted changes in total $PM_{2.5}$ due to the Draft 2021 Regional Plan to estimate the expected changes in these outcomes. This analysis considers the

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[1] Available at: Environmental Benefits Mapping and Analysis Program – Community Edition (BenMAP-CE), website: https://www.epa.gov/benmap.

[2] BenMAP health effects include premature mortality, heart attacks, chronic respiratory illnesses, asthma exacerbation and lost productivity endpoints such as work loss days and minor restricted activity days.

impact of human exposure to $PM_{2.5}$ and evaluates changes in the incidence of adverse health outcomes (referred to collectively as morbidity and mortality) in the population from exposure to regional $PM_{2.5}$. Other pollutants are considered in various parts of the analysis, but only to the extent to which they are precursors to $PM_{2.5}$ in atmospheric physical and chemical reactions.

The Health Outcome Report focuses on predicted changes in health outcomes in the San Diego County region as a whole and DACs within the Region. For the purpose of the Health Outcome Report, DACs are identified as any Census block group in the modeled portion of San Diego County region with a CalEnviroScreen 4.0 score in the 75th percentile or higher. Based on the BenMAP-CE modeling, the number of avoided $PM_{2.5}$-deathes or illness within DACs across the county region (considered in aggregate) is identified and compared with outcomes at the San Diego County regional level. The following summarizes the key findings of the Health Outcome Report as it relates to health affects in DACs:

- DACs generally have a higher overall $PM_{2.5}$ concentration in both 2016 and 2050 compared to the entire modeled area (San Diego County region). Both the minimum and average long-term average $PM_{2.5}$ concentrations in DACs are higher than in in the entire modeled area in both 2016 and 2050. However, the modeling shows average $PM_{2.5}$ air quality improving in DACs more than in the entire San Diego County region (1.6 vs. 1.3 $\mu g/m^3$ reduction on average).
- The total population for the entire San Diego County region is projected to increase by approximately 13% from 2016 to 2050. In areas that are currently considered DACs the relative population growth is more than double that of the entire modeled area (29%). While the share of the population that is older adults (aged 65 to 99 years) is higher in the entire modeled area than in DACs (14% vs. 10% in 2016; 21% vs. 18% by 2050), the rate of growth in the older adult population is much higher in DACs (74% in the general population; 140% in DACs). Based on the higher growth rate of older adult populations in the DACs, air-quality related health impacts may have a higher occurrence in the DACs as older adults are more susceptible to air quality-induced health effects.
- With the implementation of the Draft 2021 Regional Plan, the regionwide population would experience an average of 30 fewer premature deaths per 100,000 persons. In the DACs, improved air quality with the implementation of the Draft 2021 Regional Plan would result in 48 fewer premature deaths per 100,000 persons on average. Reduced cases of hospital admissions for asthma and chronic lung disease, ER visits for asthma, exacerbated asthma, minor restricted activity days, acute bronchitis, upper and lower respiratory symptoms, and lost workdays would occur for the San Diego County region and in the DACs. Therefore, the DACs would experience greater improved health benefits with the implementation of the Draft 2021 Regional Plan

See Appendix A for the *Technical Report on the Modeling Evaluation Study Supporting the Community Health Equity Evaluation for San Diego Forward: the 2021 Regional Plan.*

1.2 ORGANIZATION OF THIS EVALUATION

This report is organized into six sections:

1. **Introduction and Background.** An introduction to the purpose of this Community Health Equity Evaluation, discussion of related studies, and the context for the analysis.
2. **Methodology.** A detailed discussion of the data sources used to define DACs and approach to the Community Health Equity Evaluation as it relates to DACs and the Draft 2021 Regional Plan.
3. **Identification of Disadvantaged Communities.** A detailed summary of the DACs used for the purpose of this Community Health Equity Evaluation and as identified in Appendix H of the Draft 2021 Regional Plan.
4. **Community Health Equity Analysis.** Based on the data and conclusions of the Health Outcome Report, determination of whether implementation of the Draft 2021 Regional Plan would result in disproportionate health impacts in DACs in the San Diego County region.
5. **Conclusion.** A summary of the Community Health Equity Analysis.
6. **References**. A list of references used to develop the Community Health Equity Evaluation.

1.3 KEY FINDINGS

The following summarizes the conclusions of this Community Health Equity Evaluation:

- Similar to the reductions in health incidences for the San Diego County region, the DACs would result in fewer premature mortalities for infants and adults; reduction of instances of hospital admissions for chronic lung disease; fewer minor restricted activity days; fewer lost workdays due to illnesses; and a reduction of cases of childhood illnesses (exacerbated asthma, acute bronchitis, upper respiratory symptoms, and respiratory symptoms).
- The San Diego County region and the DACs would have a slight increase of cases of non-fatal heart attacks and hospital admissions for cardiovascular and respiratory illnesses in adults. This increase in incidence is attributed to the rapid growth of senior population 65 and older independent of air quality. Regardless, with the implementation of the Draft 2021 Regional Plan, the increase in health incidences in the DACs would not be significantly greater than the San Diego County region.
- Reductions and increases of $PM_{2.5}$-related health effects would occur in the San Diego County region and in the DACs. The DACs would benefit from the implementation of the Draft 2021 Regional Plan as would the San Diego County region and have slightly greater reductions in total avoided mortalities compared to the region.
- Based on the analysis presented, the DACs would not be disproportionately impacted or bear a disproportionate share of $PM_{2.5}$-related health effects and would benefit from the implementation of the Draft 2021 Regional Plan.

2 METHODOLOGY

2.1 DEFINING DISADVANTAGED COMMUNITIES

This analysis uses similar methodology (population-based and geographic-based methods) as Appendix H of the Draft 2021 Regional Plan in identifying population groups who are vulnerable or disadvantaged. Accordingly, the 12 DACs in this analysis are the same as identified in the Draft 2021 Regional Plan. DACs are identified pursuant to Title VI, Executive Order 12898 and the 1999 Department of Transportation Memorandum "Implementing Title VI Requirements in Metropolitan and State Planning". SANDAG's population-based method selected three population groups that represent the disadvantaged populations that are analyzed in the transportation model: (1) minorities, (2) low-income populations, and (3) seniors. The geographic-based method used the CalEnviroScreen index. The following details the socioeconomic factors and the CalEnviroScreen 4.0 index used to identify the DACs for the purpose of this analysis.

2.1.1 MINORITY POPULATIONS

The Federal Transit Administration (FTA) Circular FTA C4703.1 *Environmental Justice Policy Guidance for Federal Transit Administration Recipients* was used to define minority populations and low-income populations and identify disadvantaged communities in the SANDAG Region.

The United States Department of Transportation (USDOT) Order 5610.2C and subsequent agency guidance provides clear definitions of minority groups addressed by Executive Order 12898. A "minority population" means any readily identifiable group or groups of minority persons who live in geographic proximity, and if circumstances warrant, geographically dispersed or transient persons (such as migrant workers or Native Americans) who will be similarly affected by a proposed program, policy, or activity.

USDOT defines minority groups as:

- Black refers to people having origins in any of the black racial groups of Africa;
- Hispanic includes persons of Mexican, Puerto Rican, Cuban, Central or South American, or other Spanish culture or origin, regardless of race;
- Asian American refers to people having origins in any of the original peoples of the Far East, Southeast Asia, or the Indian subcontinent (including for example Cambodia, China, India, Japan, Korea, Malaysia, Pakistan, Philippine Islands, Thailand, and Vietnam);
- American Indian and Alaskan Native refers to people having origins in any of the original people of North and South America (including Central America), and who maintain cultural identification through tribal affiliation or community attachment; and
- Native Hawaiian or Other Pacific Islander refers to people having origins in any of the original peoples of Hawaii, Guam, Samoa, or other Pacific Islands.

2.1.2 LOW-INCOME POPULATIONS

A “low-income population” means any readily identifiable group or groups of low-income persons who live in geographic proximity, and if circumstances warrant, geographically dispersed or transient persons (such as migrant workers or Native Americans) who will be similarly affected by a proposed program, policy or activity. USDOT Order 5610.2C and subsequent agency guidance defines “low-income” as a person whose median household income is at or below the U.S. Department of Health and Human Services (HHS) poverty guidelines. However, FTA Circular 4703.1 also states that a locally developed threshold, such as that used for FTA’s grant program or a percentage of median income for the area, provided that the threshold is at least as inclusive as the HHS poverty guidelines. For this study, and to be consistent with the “low-income” threshold used in the Draft 2021 Regional Plan, the threshold selected was populations with household income at or below 200% of the 2016 federal poverty level. The rationale to use 200% of the federal poverty level was twofold: (1) 200% of the poverty level reflects the higher cost of living in the San Diego region as compared to other areas of the state and nation and (2) this indicator can be forecasted.[3]

2.1.3 SENIOR POPULATION

As discussed in Appendix H of the Draft 2021 Regional Plan, the San Diego region’s median age is expected to increase from 36.1 to 40.3 years of age between 2016 and 2050. The number of residents between 65 and 84 years old is expected to more than double, and the number of residents 85 years old and above is expected to increase almost threefold. As the region continues to grow and evolve, transportation plans must adapt to support the needs of the region’s changing population. The Draft 2021 Regional Plan utilizes a senior population of 75 years and older; a threshold based on dialogue with social equity stakeholders regarding mobility and age. However, for the purpose of this study, senior population of 65 years and older is used and is a more comprehensive approach to corelate with data presented in the Health Outcome Report.

2.1.4 CALENVIROSCREEN 4.0

As discussed in Appendix H of the Draft 2021 Regional Plan, CalEnviroScreen 3.0 was used to identify disadvantaged communities and include transportation strategies that reduce pollution exposure in these communities. The purpose of CalEnviroScreen is to identify the areas state that historically have faced multiple pollution burdens so programs and funding can be targeted appropriately toward improving the environmental health and economic vitality of the most impacted communities. CalEnviroScreen is intended to provide a snapshot of existing conditions based on historical data, not to predict future conditions for disadvantaged communities. For this region, CalEnviroScreen shows that communities of color disproportionately reside in highly impacted communities, while whites are overrepresented in the least-burdened communities. Communities with high total CalEnviroScreen scores have high cumulative pollution burdens and highly vulnerable population characteristics that cause pollutants to become more deadly. The score measures the relative pollution burdens and vulnerabilities in one census tract compared to others and is not a measure of health risk.

At the time of preparation of Appendix H, CalEnviroScreen 3.0 was the latest version and last updated in June 2018. Census block groups of the DACs with a CalEnviroScreen 3.0 score in the 50th percentile

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[3] 2018 SANDAG Board Report, Item 19. San Diego Forward: The 2019–2050 Regional Plan – Social Equity Analysis Framework and Approach. June 22, 2018.

or higher were identified. Since the completion of Appendix H, CalEnviroScreen 4.0 was released in February 2021. CalEnviroScreen 4.0 incorporates the most recent data available for all indicators; improved calculations from some indicators (drinking water contaminants, pesticide use, groundwater threats, hazardous waste, $PM_{2.5}$ and diesel PM air quality); and one new indicator to reflect children's risk of lead exposure (OEHHA 2021). For purposes of this study and to be consistent with the BenMAP-CE modeling data used in the Health Outcome Report prepared for this analysis, CalEnviroScreen 4.0 was used. Areas identified with a CalEnviroScreen 4.0 score in the 50th percentile or higher are identified as DACs for the purpose of this study.

2.2 DATA SOURCES

For purposes of this analysis, the demographic and socioeconomic data presented is from the U.S. Census Bureau's block group-level 2015-2019 American Community Survey (ACS) 5-Year Estimates released in 2020, consistent with the data source used for the Draft 2021 Regional Plan. Socioeconomic datasets are not directly available for non-Census Designated Places (CDPs) (such as for communities within the City of San Diego). As a result, these estimates were derived from aggregating data from census block groups that are within the communities. For City of San Diego communities, block groups were selected and summed if the center point of the block group fell within that community.

GIS was used to join block group census data and census tract CalEnviroScreen 4.0 data to block group geographies. As CalEnviroScreen 4.0 data is only available at the census tract geographies, block groups within a CalEnviroScreen 4.0 census tract were each given the value of the tract in which it belongs. Block groups with a CalEnviroScreen 4.0 score in the 50th percentile or higher were selected and then summed together.

2.3 APPROACH TO ANALYSIS

This Community Health Equity Evaluation and the Health Outcome Report (discussed in Section 1.1.3) was prepared to address SANDAG Resolution No. 2021-17. This evaluation uses the BenMAP-CE modeling data presented in the Health Outcome Report. Based on this data and the conclusions of the Health Outcome Report, the number of avoided PM2.5-deathes or illness for the DAC is compared with the San Diego County region. This comparison is to determine if DACs will be disproportionately impacted or bear a disproportionate share of PM2.5-related health effects with the implementation of the Draft 2021 Regional Plan (2050) compared to the past (2016).

3 IDENTIFICATION OF DISADVANTAGED COMMUNITIES

As discussed in Section 2.1 of this document, the identification of DACs utilizes similar methodology as Appendix H of the Draft 2021 Regional Plan. DACs identified in Appendix H are based on minority population, low-income population, senior population of 65 years and older. In addition, communities that contain block groups with a CalEnviroScreen 3.0 score above the 50th percentile are also identified. Based on these criteria, The Draft 2021 Regional Plan identified 12 DACs: the City of San Diego communities of Barrio Logan, City Heights, Encanto, Linda Vista, San Ysidro, Skyline-Paradise Hills, and Southeastern San Diego; City of Chula Vista; City of Escondido; City of El Cajon; City of National City; and City of Vista.

Using the same methodology and a CalEnviroScreen 4.0 score in the 50th percentile or higher for the purpose of this analysis, the same DACs were identified.

Table 1 summarizes the socioeconomic factors and DACs that contain block groups with a CalEnviroScreen 4.0 score above the 50th percentile. The San Diego County region and the City of San Diego are included as a comparative geographical reference. As shown in Table 1, each DAC has a minority population greater than San Diego County (54.4% minority population) with the exception of the City of El Cajon (41.5% minority population). The community of Skyline-Paradise Hills (14.1% population age 65 years and older) has a senior population age 65 years and older greater than the San Diego County region (13.7% population age 65 years and older). Each of the DACs has a low-income population greater than San Diego County (27.8% low-income population) with the exception of the City of Chula Vista (25.8% low-income population). Each of the 12 DACs contains Census block groups with CalEnviroScreen 4.0 scores above the 50th percentile.

Figures 1 and 2 illustrate the minority population and low-income population for San Diego County region. Figure 3 illustrates the senior population 65 years old and older for the San Diego County region. Figure 4 shows the CalEnviroScreen 4.0. scores for the San Diego County region. Figure 5 identifies the Census block groups within the 12 DACs with a CalEnviroScreen 4.0 score above the 50th percentile.

Table 1. Socioeconomic Data of the Disadvantaged Communities Identified in the San Diego County Region (2019)

Community [a,b]	Percent Minority Population	Hispanic or Latino of Any Race	Non-Hispanic or Latino							Age 65 years and Older	Percent Low-Income Population	Contains Census Block Groups with CalEnviroScreen Score above the 50th Percentile
			White	Black	Amer. Indian Alaska Native	Asian	Native Hawaiian Other Pacific Islander	Some Other Race	Two or More Race			
San Diego County	54.4%	33.7%	45.6%	4.7%	0.4%	11.6%	0.4%	0.2%	3.4%	13.7%	27.8%	—
City of San Diego	57.2%	30.3%	42.8%	6.0%	0.2%	16.4%	0.4%	0.2%	3.6%	12.6%	28.5%	—
Barrio Logan	91.2%	88.2%	8.8%	1.9%	0.0%	1.1%	0.0%	0.0%	0.0%	8.6%	63.4%	Yes
City Heights	86.7%	58.1%	13.3%	11.9%	0.0%	14.9%	0.1%	0.1%	1.6%	8.0%	60.1%	Yes
Encanto	92.9%	53.5%	7.1%	20.5%	0.6%	15.5%	0.5%	0.1%	2.4%	11.5%	46.7%	Yes
Linda Vista	62.1%	34.7%	37.9%	5.1%	0.4%	18.1%	0.1%	0.2%	3.6%	8.8%	38.7%	Yes
San Ysidro	97.2%	93.7%	2.8%	1.2%	0.0%	1.9%	0.0%	0.0%	0.4%	10.9%	51.1%	Yes
Skyline-Paradise Hills	88.5%	40.2%	11.5%	15.9%	0.1%	27.3%	0.9%	0.1%	4.0%	14.1%	29.2%	Yes
Southeastern San Diego	92.3%	81.6%	7.7%	7.0%	0.1%	2.2%	0.1%	0.0%	1.3%	7.8%	57.5%	Yes
City of Chula Vista	83.2%	59.8%	16.8%	4.1%	0.0%	15.8%	0.4%	0.3%	2.9%	12.1%	25.8%	Yes
City of Escondido	64.9%	51.7%	35.1%	2.0%	0.4%	6.9%	0.4%	0.2%	3.3%	12.3%	37.0%	Yes
City of El Cajon	41.5%	27.8%	58.5%	5.4%	0.1%	3.2%	0.4%	0.6%	4.0%	11.7%	41.7%	Yes
City of National City	88.4%	63.5%	11.6%	4.4%	0.2%	18.3%	0.5%	0.0%	1.6%	13.4%	44.9%	Yes
City of Vista	60.4%	50.9%	39.6%	2.9%	0.3%	3.9%	0.4%	0.1%	1.8%	10.0%	33.8%	Yes

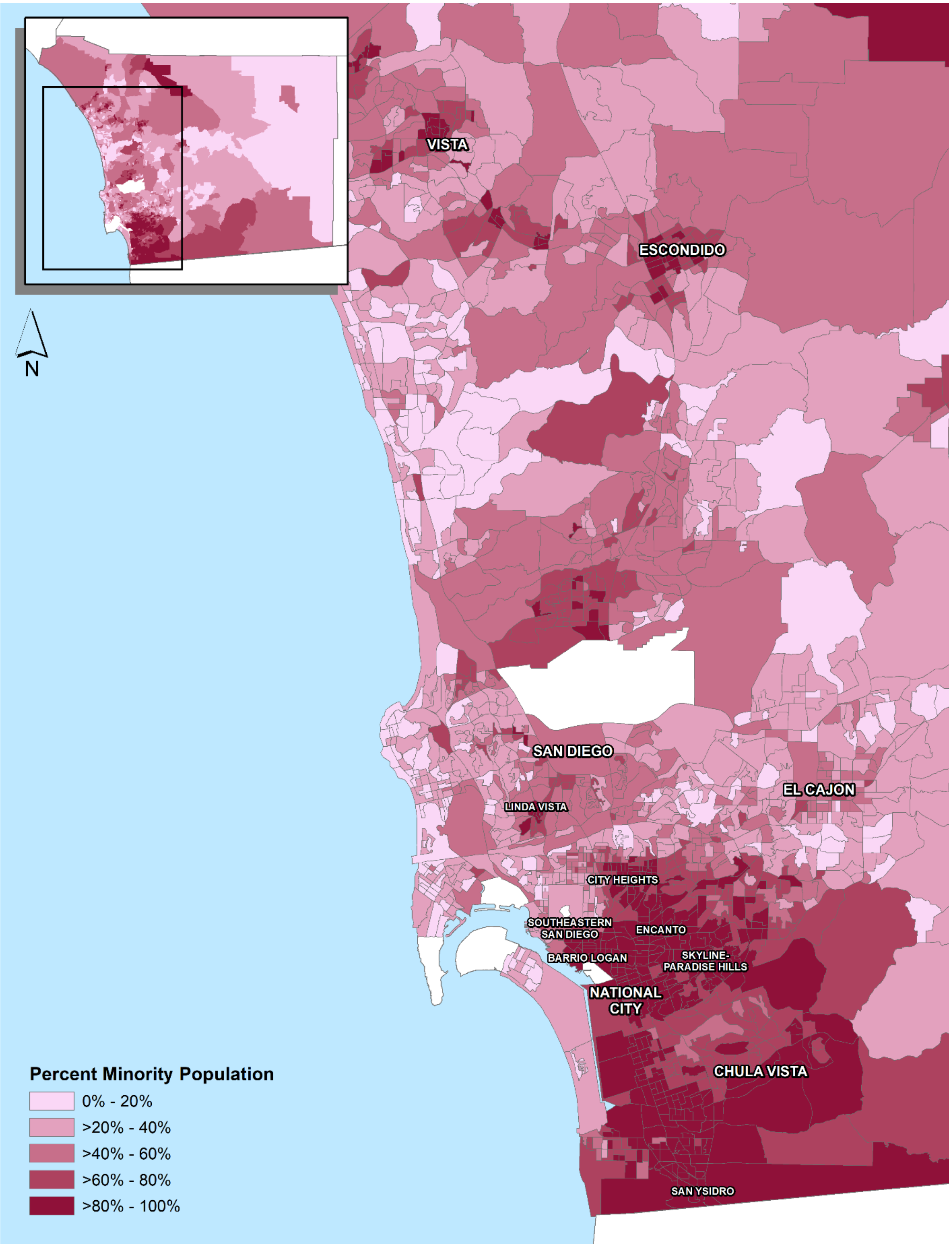
Source: TAHA, 2021. US Census Bureau, 2015-2019 American Community Survey. OEHHA, CalEnviroScreen 4.0.

Notes:

[a] County of San Diego and City of San Diego are included for comparative purposes.

[b] Disadvantaged community boundaries are based on center point Census block groups that are located within a community. The socioeconomic data presented is for the community as a whole.

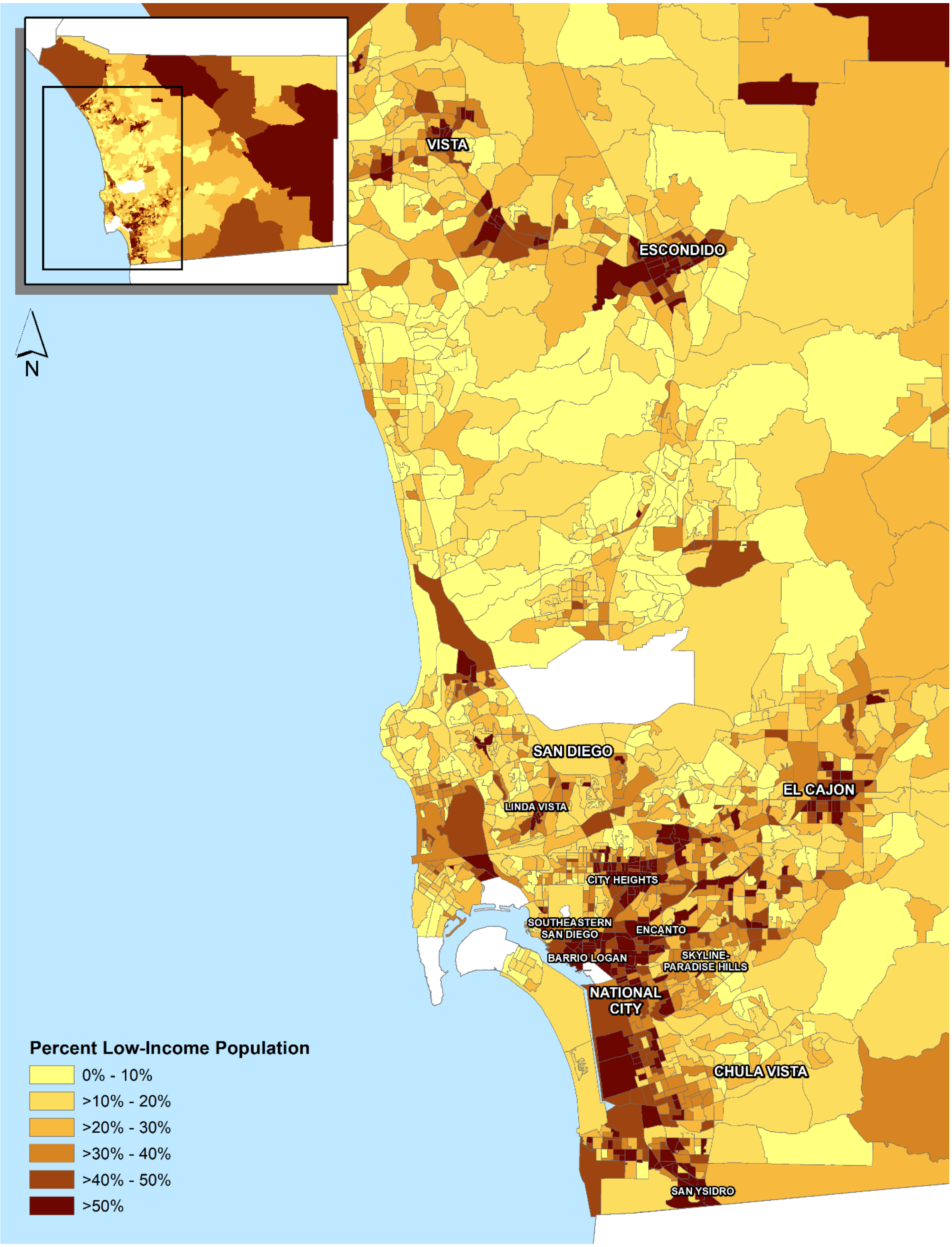
Figure 1. Minority Population in the San Diego County Region (2019)



Source: TAHA, 2021.

Note: The white areas are military areas and are excluded from the analysis.

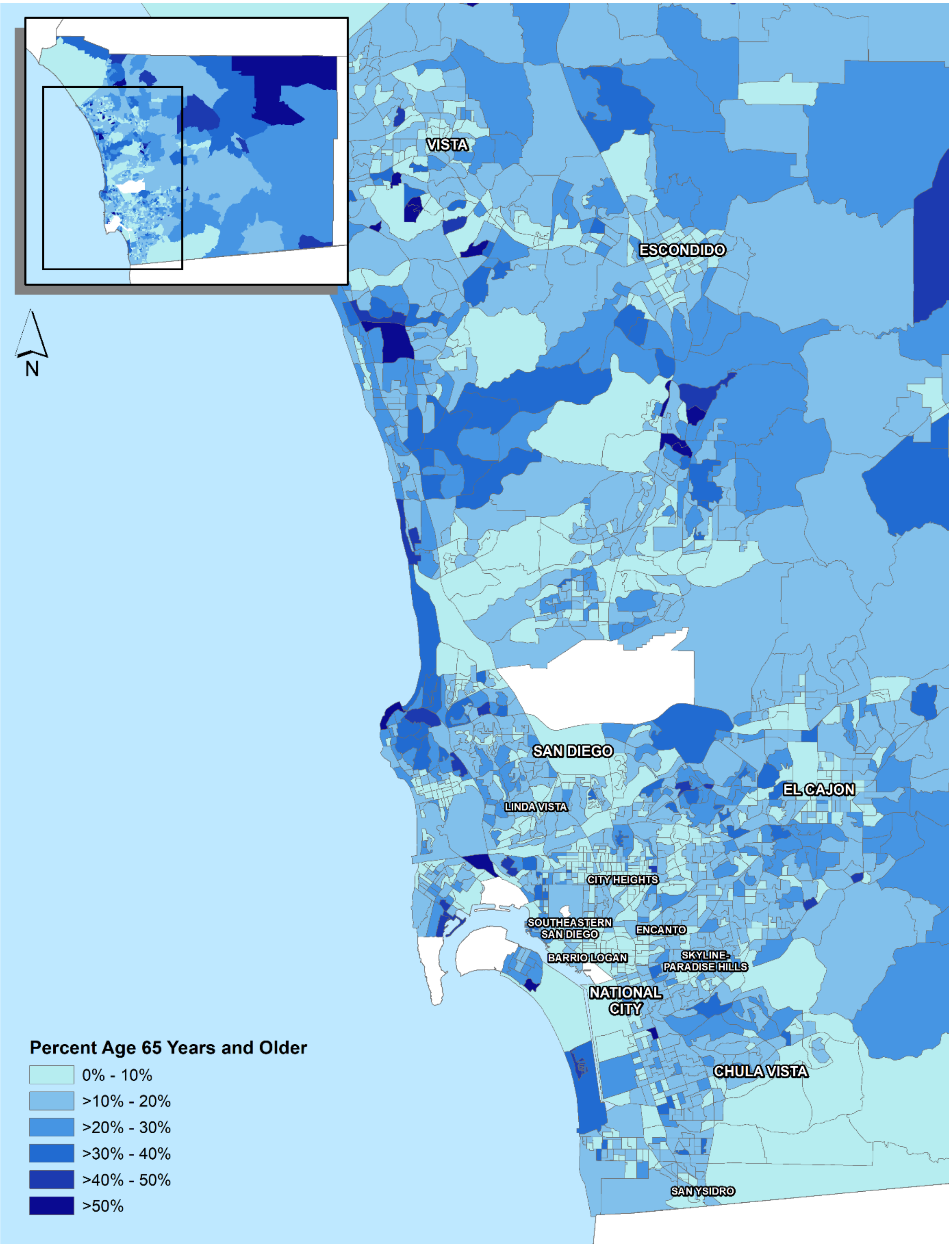
Figure 2. Low-Income Population in the San Diego County Region (2019)



Source: TAHA, 2021.

Note: The white areas are military areas and are excluded from the analysis.

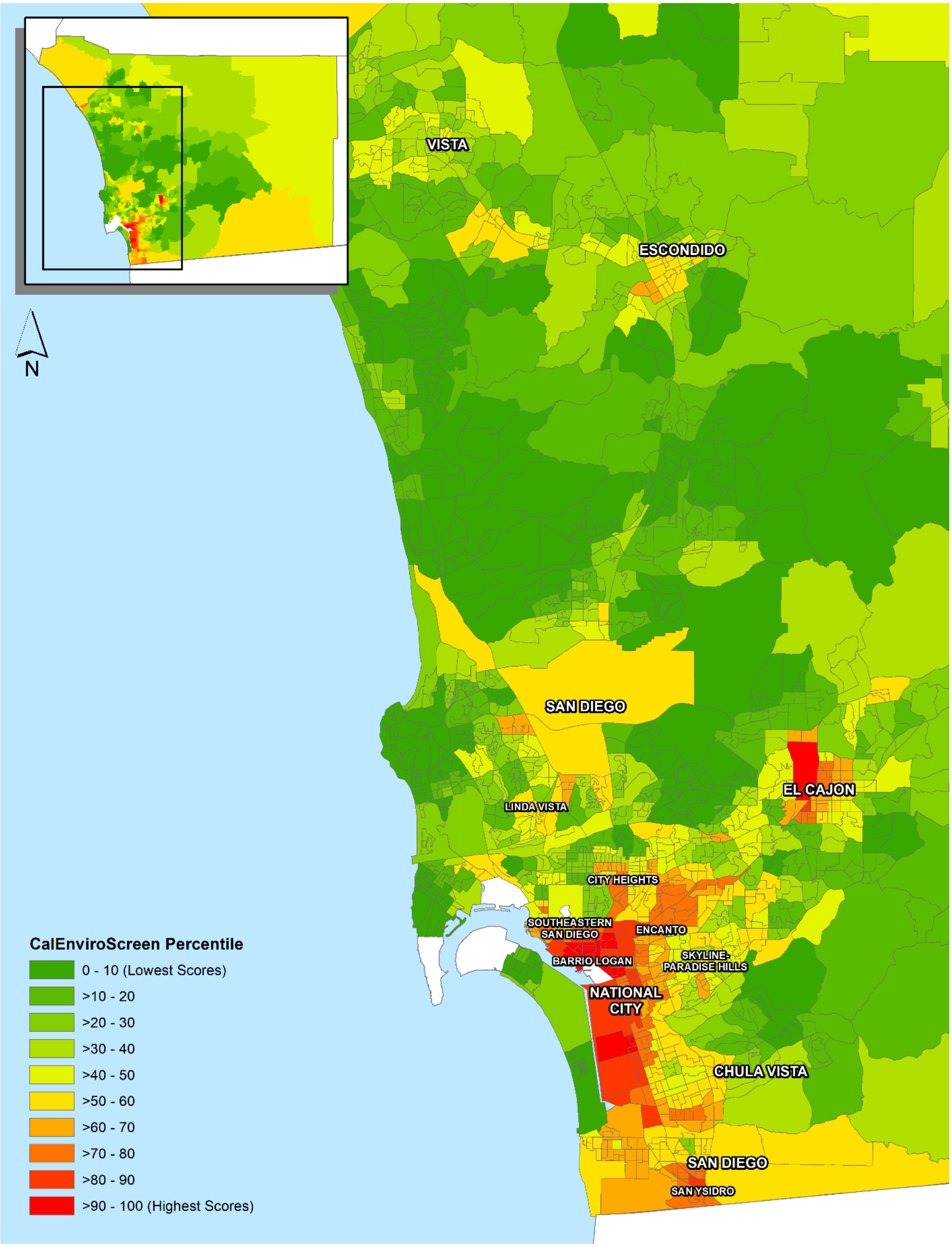
Figure 3. Senior Population Age 65 Years and Older in the San Diego County Region (2019)



Source: TAHA, 2021.

Note: The white areas are military areas and are excluded from the analysis.

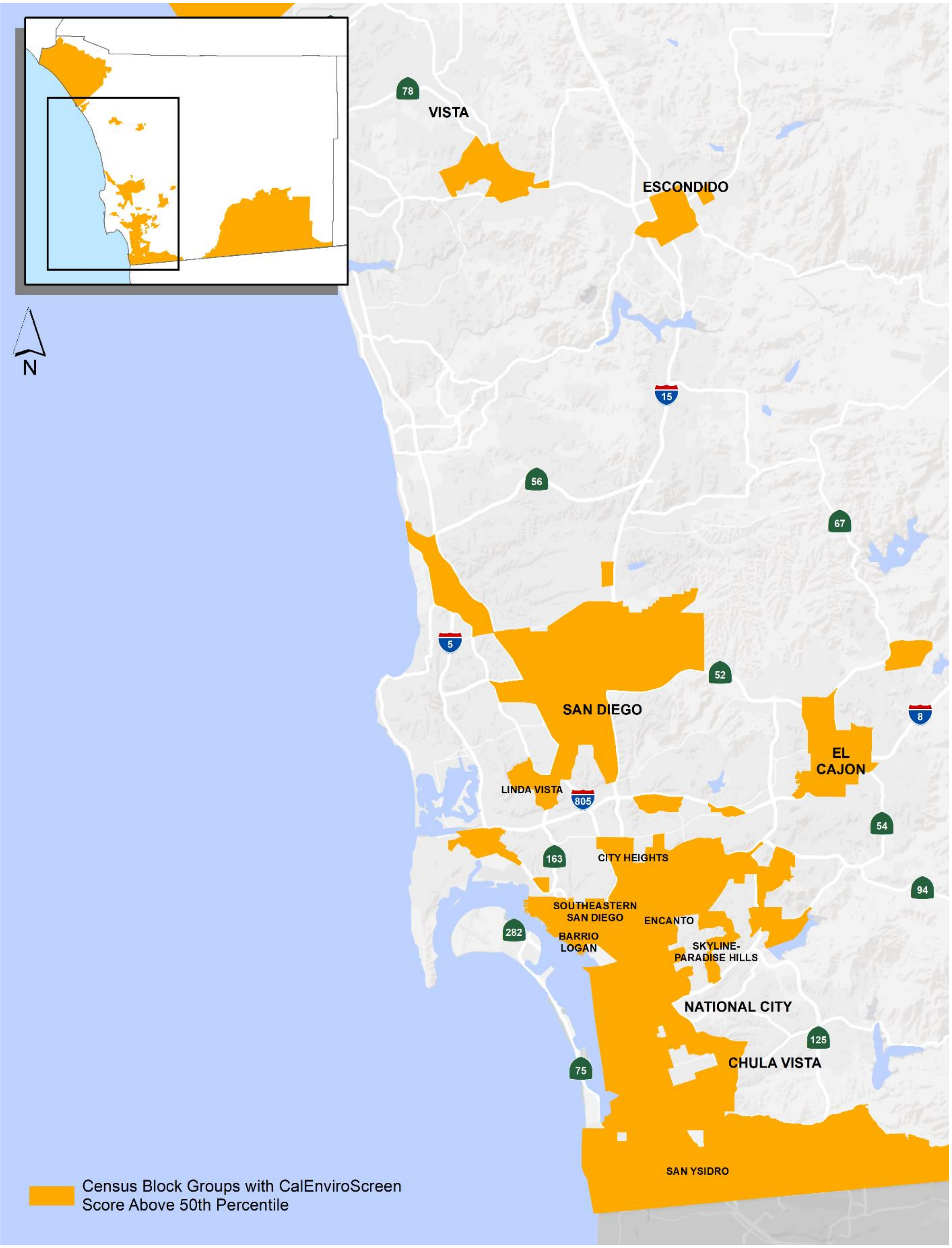
Figure 4. CalEnviroScreen 4.0 Score Percentiles in the San Diego County Region



Source: TAHA, 2021.

Note: The white areas are military areas and are excluded from the analysis.

Figure 5. Census Block Groups of the Disadvantaged Communities with a CalEnviroScreen 4.0 Score in the 50th Percentile



Source: TAHA, 2021.

4 COMMUNITY HEALTH EQUITY ANALYSIS

The following analysis uses the avoided $PM_{2.5}$-deaths or illness data for the DACs and San Diego County region from the Health Outcome Report to determine if DACs will be disproportionately burdened by pollution more than they have in the past with the implementation of the Draft 2021 Regional Plan. Based on the Health Outcome Report, the DACs have a higher overall minimum and average annual average $PM_{2.5}$ concentration compared to the San Diego County region for 2016 and 2050. However, with the implementation of the Draft 2021 Regional Plan, overall $PM_{2.5}$ concentrations would be reduced both at the regional level and in the DACs.

Summarized in Table 2, annual average $PM_{2.5}$ concentrations at the regional level would have an average reduction from 9.62 μg/m^3 to 8.30 μg/m^3 (13.7% reduction) by 2050 under the Draft 2021 Regional Plan. DACs would result in similar $PM_{2.5}$ reductions from 10.07 μg/m^3 to 8.80 μg/m^3 (12.6% reduction) by 2050 under the Draft 2021 Regional Plan. The maximum $PM_{2.5}$ concentrations in 2050 are similar for the San Diego County region compared to the DACs.

Table 2. Average $PM_{2.5}$ Air Quality Change in the San Diego County Region and within the Disadvantaged Communities

Area	Statistic	Annual Average $PM_{2.5}$ Concentration (μg/m^3)		
		2016	2050	
			Average	% Change [a]
San Diego County Region	Minimum	4.10	3.89	-5.1%
	Maximum	11.90	15.69	31.8%
	Average	9.62	8.30	-13.7%
Disadvantaged Communities [b]	Minimum	8.50	6.81	-19.9%
	Maximum	11.70	15.69	34.1%
	Average	10.07	8.80	-12.6%

Source: ICF, 2021. TAHA, 2021.

[a] Percent change is the change from 2016 to 2050.

[b] Disadvantaged communities include the City of San Diego communities of Barrio Logan, City Heights, Encanto, Linda Vista, San Ysidro, Skyline-Paradise Hills, and Southeastern San Diego; City of Chula Vista; City of Escondido; City of El Cajon; City of National City; and City of Vista. Estimates for disadvantaged communities are derived from Census block groups that fall within the disadvantaged communities and have a CalEnviroScreen 4.0 score in the 50th percentile or higher.

The Health Outcome Report also estimated the prevalence for $PM_{2.5}$-related deaths and illnesses. This includes premature deaths (infant mortality and adult mortality), non-fatal heart attacks, hospital admission (cardiovascular, respiratory, chronic lung disease), childhood illnesses (exacerbated asthma, acute bronchitis, upper respiratory systems, lower respiratory systems) and affected days as a result of illness (minor restricted-activity days as a result of poor air quality and lost work days due to illness).

Table 3 through Table 5 summarizes the predicted avoided $PM_{2.5}$-related premature deaths and illnesses for the entire San Diego County region and the DACs for 2050. Negative numbers indicate an increase in incidences of adverse health effects; positive numbers indicate a reduction in incidences of adverse health effects (avoidance of premature deaths and illnesses). See Appendix B: Avoided $PM_{2.5}$-Related Premature Deaths and Illnesses with the Implementation of the Draft 2021 Regional Plan for a full accounting of impacts including for individual DACs in the region.

Table 3. Avoided $PM_{2.5}$-Related Premature Deaths and Illnesses Per with the Implementation of the Draft 2021 Regional Plan (Per 100,000 Persons): Total Avoided Premature Mortality

Premature Mortalities	Age Range	San Diego County Region [a]	Disadvantaged Communities [a,b]
Total Avoided Premature Mortalities	0, 30 to 99	30	32
Infant Avoided Mortalities	0	5.2	5.1
Adult Avoided Mortalities [c]	30 to 64	25	27

Source: ICF, 2021. TAHA, 2021.

Values reflect the difference between premature deaths and illness cases (per 100,000 persons) estimated in 2016 (baseline) and 2050 (Regional Plan). Because populations differ among these estimates, negative morbidity effect estimates may be attributable to changes in population among the years evaluated. Baseline mortality incidences differ among these estimates, so negative values associated with changes in mortality cases may result from both population differences and baseline mortality incidence differences.

[a] Values rounded to two significant digits. Positive values indicate the number of avoided premature deaths and illnesses. Negative values indicate an increase in the number of incidences of health effects.

b Disadvantaged communities include the City of San Diego communities of Barrio Logan, City Heights, Encanto, Linda Vista, San Ysidro, Skyline-Paradise Hills, and Southeastern San Diego; City of Chula Vista; City of Escondido; City of El Cajon; City of National City; and City of Vista. Estimates for disadvantaged communities are derived from Census block groups that fall within the disadvantaged communities and have a CalEnviroScreen 4.0 score in the 50th percentile or higher.

[c] Adult avoided mortalities is the average of the low estimates (Adult mortality 30-64, Turner and Adult mortality 65+, Turner) and the high estimates (Adult mortality 30-64, Turner and Adult mortality 65+, Di) for adult avoided mortalities. Details are provided in Appendix A.

Total Mortality. Table 3 shows the average total of avoided premature mortality for infants and adults that would occur with the implementation of the Draft 2021 Regional Plan. Total avoided premature mortalities is the total of infant avoided mortalities and adult avoided mortalities. With the implementation of the Draft 2021 Regional Plan, the San Diego County region would have an average of 30 fewer premature deaths per 100,000 persons. In comparison, the DACs would have 32 fewer premature deaths per 100,000 persons. The DACs would see slightly greater reductions in premature mortalities compared to the San Diego County region. Therefore, the DACs would not be disproportionately impacted and would benefit slightly more than the San Diego County region from the implementation of the Draft 2021 Regional Plan.

Table 4. Avoided $PM_{2.5}$-Related Premature Deaths and Illnesses with the Implementation of the Draft 2021 Regional Plan (Per 100,000 Persons) for 2050: Adult Illnesses, Hospital Admissions, and Restricted Days

Health Effect Avoided	Age Range	San Diego County Region [a]	Disadvantaged Communities [a,b]
Non-Fatal Heart Attacks [c]	18 to 99	-3.3	-4.0
Hospital Admissions—Cardiovascular	18 to 99	-2.2	-2.8
Hospital Admissions—Respiratory	65 to 99	-1.2	-1.9
Hospital Admissions—Chronic Lung Disease	18 to 64	0.4	0.3
Minor Restricted-Activity Days Avoided	18 to 64	6,200	4,803
Number of Lost Workdays Avoided	18 to 64	960	707

Source: ICF, 2021. TAHA, 2021.

Values reflect the difference between premature deaths and illness cases (per 100,000 persons) estimated in 2016 (baseline) and 2050 (Regional Plan). Because populations differ among these estimates, negative morbidity effect estimates may be attributable to changes in population among the years evaluated. Baseline mortality incidences differ among these estimates, so negative values associated with changes in mortality cases may result from both population differences and baseline mortality incidence differences.

[a] Values rounded to two significant digits. Positive values indicate the number of avoided premature deaths and illnesses. Negative values indicate an increase in the number of incidences of health effects.

[b] Disadvantaged communities include the City of San Diego communities of Barrio Logan, City Heights, Encanto, Linda Vista, San Ysidro, Skyline-Paradise Hills, and Southeastern San Diego; City of Chula Vista; City of Escondido; City of El Cajon; City of National City; and City of Vista. Estimates for disadvantaged communities are derived from Census block groups that fall within the disadvantaged communities and have a CalEnviroScreen 4.0 score in the 50th percentile or higher.

[c] The pooled nonfatal heart attack estimate is based on four studies: Pope et al. (2006), Sullivan et al. (2005), Zanobetti and Schwartz (2006), and Zanobetti et al. (2009). Details are provided in Appendix A: *Technical Report on the Modeling Evaluation Study Supporting the Community Health Equity Evaluation for San Diego Forward: the 2021 Regional Plan*.

Adult Illnesses, Hospital Admissions, and Restricted Days. Table 4 shows the predicted number of avoided incidences of adult illnesses (non-fatal heart attacks), hospital admissions (cardiovascular, respiratory, chronic lung disease), and restricted days (restricted activity as a result of poor air quality or illnesses leading to lost workdays) with the implementation of the Draft 2021 Regional Plan by 2050 relative to 2016. A positive value means fewer incidences of the particular health effect would occur (i.e., fewer incidences for hospital admissions for chronic lung diseases, fewer restricted-activity days that would occur and fewer workdays missed as a result of illness). A negative value means that an increase of incidences of the particular category (i.e., increase in non-fatal heart attack incidences, and an increase in hospital admissions for cardiovascular and respiratory illnesses) would occur.

The San Diego County region would have a slight increase of cases of non-fatal heart attacks (-3.3 cases per 100,000 persons), hospital admissions for cardiovascular (-2.2 cases per 100,000 persons) and respiratory illnesses (-1.2 cases per 100,000 persons). In a similar trend as the San Diego County region, the DACs would also have a slight increase in average non-fatal heart attacks (-4.0 cases per 100,000 persons), hospital admissions for cardiovascular (-2.8 cases per 100,000 persons) and respiratory illnesses (-1.9 cases per 100,000 persons). However, the increase of health effect incidences would be similar to the San Diego County region and represent very small increases in health incidences.

Any increase in non-fatal heart attacks and hospital admissions are not attributable to the Draft 2021 Regional Plan, but rather can be attributed to a rapidly growing population, especially among the senior population 65 years and older, which may be more susceptible to poor health outcomes. Even with the implementation of the Draft 2021 Regional Plan and improved air quality, improved health outcomes may not always occur due to the aging of the population seen in 2050 relative to 2016. Regardless, with the implementation of the Draft 2021 Regional Plan, the increase in health cases in the DACs would not be significantly greater than the San Diego County region.

The San Diego County region is predicted to have a reduction of instances of hospital admissions for chronic lung disease (0.4 cases per 100,000 person), fewer minor restricted activity days (limited activities caused by poor air quality) (6,200 days) and fewer lost workdays due to illnesses (960 days). Similarly, the DACs are also predicted to have a reduction of instances of hospital admissions for chronic lung disease (0.3 cases per 100,000 person), fewer minor restricted activity days (limited activities caused by poor air quality) (4,803 days) and fewer lost workdays due to illnesses (707 days). The DACs would experience similar increases and reductions in adult illnesses, hospital admissions, and restricted days compared to the San Diego County region. Therefore, the DACs would not be disproportionately impacted and would benefit from the implementation of the Draft 2021 Regional Plan.

Table 5. Avoided $PM_{2.5}$-Related Premature Deaths and Illnesses with the Implementation of the Draft 2021 Regional Plan (Per 100,000 Persons) for 2050: Childhood Illnesses

Health Effect Avoided	Age Range	San Diego County Region [a]	Disadvantaged Communities [a,b]
Exacerbated Asthma	6 to 18	1,100	874
Acute Bronchitis	8 to 12	93	71
Upper Respiratory Symptoms	9 to 11	3,400	2,621
Lower Respiratory Symptoms	7 to 14	780	598

Source: ICF, 2021. TAHA, 2021.

Values reflect the difference between premature deaths and illness cases (per 100,000 persons) estimated in 2016 (baseline) and 2050 (Regional Plan). Because populations differ among these estimates, negative morbidity effect estimates may be attributable to changes in population among the years evaluated. Baseline mortality incidences differ among these estimates, so negative values associated with changes in mortality cases may result from both population differences and baseline mortality incidence differences.

[a] Values rounded to two significant digits. Positive values indicate the number of avoided premature deaths and illnesses. Negative values indicate an increase in the number of incidences of health effects.

[b] Disadvantaged communities include the City of San Diego communities of Barrio Logan, City Heights, Encanto, Linda Vista, San Ysidro, Skyline-Paradise Hills, and Southeastern San Diego; City of Chula Vista; City of Escondido; City of El Cajon; City of National City; and City of Vista. Estimates for disadvantaged communities are derived from Census block groups that fall within the disadvantaged communities and have a CalEnviroScreen 4.0 score in the 50th percentile or higher.

Childhood Illnesses. A positive value means fewer incidences of the particular health effect would occur for 2050. Table 5 shows the number of avoided incidences of childhood illnesses (exacerbated asthma acute bronchitis, upper respiratory symptoms, and lower respiratory symptoms) with the implementation of the Draft 2021 Regional Plan. The San Diego County region would have a reduction in cases of childhood exacerbated asthma (1,100 cases per 100,000 persons), acute bronchitis (93 cases per 100,000 persons), upper respiratory symptoms (3,400 cases per 100,000 persons), and lower respiratory symptoms (780 cases per 100,000 persons). The trend for fewer cases of childhood illnesses would also occur in the DACs. The DACs would have a reduction in cases of childhood exacerbated asthma (874 cases per 100,000 persons), acute bronchitis (71 cases per 100,000 persons), upper respiratory symptoms (2,621 cases per 100,000 persons), and lower respiratory symptoms (598 cases per 100,000 persons).

The DACs would have similar reductions in cases of childhood illnesses compared to the San Diego County region and would benefit from the implementation of the Draft 2021 Regional Plan. Therefore, the DACs would not be disproportionately impacted and would benefit from the implementation of the Draft 2021 Regional Plan.

5 CONCLUSION

Implementation of the Draft 2021 Regional Plan would address traffic congestion with alternative methods of transportation and create equal access to jobs, education, healthcare, and other community resources. Nonetheless, air quality-related health effects would still occur in the San Diego County region and DACs. With the implementation of the Draft 2021 Regional Plan, improvements to air quality would occur and in turn result in reductions in health incidences for the San Diego County region and the DACs.

Similar to the reductions in health incidences for the San Diego County region, the DACs are predicted to result in fewer premature mortalities for infants and adults; reduction of instances of hospital admissions for chronic lung disease; fewer minor restricted activity days; fewer lost workdays due to illnesses; and a reduction of cases of childhood illnesses (exacerbated asthma, acute bronchitis, upper respiratory symptoms, and respiratory symptoms).

However, the San Diego County region and the DACs are predicted by 2050 to have a slight increase of cases of non-fatal heart attacks and hospital admissions for cardiovascular and respiratory illnesses in adults. Any increases in non-fatal heart attacks and hospital admissions are not attributable to the Draft 2021 Regional Plan, but rather the increase can be attributed to a rapidly growing population among the senior population 65 years and older, which may be more susceptible to poor health outcomes. Regardless, with the implementation of the Draft 2021 Regional Plan, the increase in health incidences in the DACs would not be significantly greater than the San Diego County region.

Reductions and increases of $PM_{2.5}$-related health effects would occur in the San Diego County region and in the DACs. Reductions and increases of incidences of health effects would be similar at the region and DAC level. The DACs would benefit from the implementation of the Draft 2021 Regional Plan as the San Diego County region and would have slightly greater reductions in total avoided mortalities compared to the region. Therefore, based on the analysis presented, the DACs would not be disproportionately impacted or bear a disproportionate share of $PM_{2.5}$-related health effects, and would benefit from the implementation of the Draft 2021 Regional Plan.

6 REFERENCES

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Appendix A

Technical Report on the Modeling Evaluation Supporting the Community Health Equity Evaluation for San Diego Forward: The 2021 Regional Plan

FINAL TECHNICAL REPORT ON THE MODELING EVALUATION SUPPORTING THE COMMUNITY HEALTH EQUITY EVALUATION FOR SAN DIEGO FORWARD: THE 2021 REGIONAL PLAN

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Appendix A. Summary Tables of Air Quality and Health Changes

Appendix B. Detailed Output Spreadsheet of Results: Air Quality and Health Changes

1 INTRODUCTION

In response to SANDAG Board of Directors Resolution No. 2021-17, this report documents the analysis conducted to determine the potential changes in public health associated with changes in air pollution levels to which the public are exposed that may result from implementation of the proposed Plan. This health impact analysis (HIA) considers regional emissions and the changes predicted in mobile emissions under the Plan to predict the changes in total particulate matter air pollution concentrations and the resulting changes in health outcomes that may be expected. These changes are reported regionally across the western portion of the County. Detailed results by demographic category are provided in an appendix. This analysis also reports changes within disadvantaged communities (DAC).

1.1 BACKGROUND AND SUMMARY OF THE ANALYSIS

SANDAG Board of Directors' Resolution No. 2021-17 requested analysis of "the health results caused by implementing the 2021 Regional Plan, with an emphasis on DAC that have historically borne a disproportionate share of pollution." This analysis addresses this request.

This document is complementary to the air quality analysis included in the proposed Plan EIR (Section 4.3) but has prepared to address the specific request in Resolution No. 2021-17. The EIR analysis included a project-level "hotspot" analysis of localized particulate matter (PM10 and PM2.5) pollution concentrations near existing and new sources of emissions. It also included a health risk assessment (HRA) examining the cancer and non-cancer risk burden from toxic air pollutants that may be related to the location of sources or receptors under the proposed Plan.

This analysis is also based on particulate matter concentrations but differs from the localized analysis by addressing the regional component of particulate pollution and considering impacts both near and far from sources of both "primary" pollution and "secondary" pollution (particulate matter formed through chemical and physical reactions in the atmosphere). Because long-term exposure to particulate matter air pollution is related to a range of adverse health outcomes, this analysis uses the predicted changes in total PM2.5 due to the Plan to estimate the expected changes in these outcomes. For example, this analysis estimates the change in premature mortalities due to air pollution between current levels of air pollution and those expected under the proposed Plan.

Furthermore, these changes are tracked spatially across the County. This analysis considers both the total changes in outcomes, as well as change in areas considered DACs. This analysis addresses Resolution No. 2021-17 by focusing on predicted changes in health outcomes in DACs caused by the Plan.

1.2 SCOPE OF THE ANALYSIS

This HIA considers only the potential morbidity and mortality impacts associated with the Plan, and is not a CEQA air quality impact analysis, For example, this HIA does not have any significance threshold This analysis explores Plan impacts by looking at the changes in health outcomes between a future year (2050) and current conditions (as of 2016). 2016 is taken as the baseline, consistent with the analysis in the EIR.

Changes in emissions under the Plan are associated with mobile sources such as roads and rail. These changes in emissions are taken from the EIR analysis. Other emissions sources such as aircraft, marine vessels, recreational boating, and electricity generation that affect regional air quality but are not directly affected by the Plan are included in the modeling to support characterizing secondary PM2.5 formation. These values are taken from available literature and assumed constant to focus on Plan impacts. Section 2.3.1 discusses emissions used in the analysis.

Existing air quality in the region is based on measured air pollution levels, including by high-resolution satellite observations. Future air quality under the Plan is based on the existing conditions and predicted changes based on modeling with the CALPUFF modeling system, v7. [Exponent, 2019] CALPUFF is used to simulate changes in PM2.5 concentration across time with the given emissions and is spatially resolved at the census block group (CBG) level to identify impacts with fine spatial resolution and support identifying impacts by "neighborhood". The analysis then uses the model's predicted changes in air pollution levels between 2050 and 2016 due to the Plan with the observed 2016 total PM2.5 air quality values to predict total PM2.5 concentrations in 2050. Using the model-predicted changes with the satellite data helps to minimize any bias, errors, or incomplete characterization that may be present in the modeling approach. Section 2.3.2 discusses the air quality analysis.

The expected impact on public health from the changes in PM pollution between 2016 and 2050 is modeled using the EPA's Environmental Benefits and Mapping Program-Community Edition (BenMAP-CE) software. BenMAP-CE predicts changes in incidences of health endpoints, such as premature mortality, heart attacks, asthma exacerbation, and other adverse health effects to help identify the human health burden from air pollution. The health impact is related to the changes in air quality, underlying health incidence and prevalence, and affected population. The predictions determined here include projected changes in these values. Consistent with the air quality modeling, the analysis models changes in incidences of adverse health effects at the CBG level. This approach represents changes between baseline (2016) and Plan (2050) conditions, with high spatial resolution. Section 2.3.3 discusses the health impact modeling. Section 2.3.2 notes that changing air quality was modeled using two different approaches. Both are valid. Both are used to determine health impacts. Accordingly, health impacts are presented under both approaches along with the average of the two.

Section 3 includes a discussion and summary of the air quality and health impacts of the Plan across the SANDAG region and within DACs. Detailed results by CBG and demographic categories included as an appendix to this report. This analysis supports community health equity evaluation by looking at how health outcomes in DACs may be affected by the Project and the potential for disparity in health outcomes in DACs. The community health equity evaluation based on the detailed modeling results is a separate document.[1]

1.3 ORGANIZATION OF THIS MEMORANDUM

This draft report summarizes the methodology and results of the HIA. It is organized into 6 Sections:

1. An **introduction** to the analysis, its scope, purpose, and elements.
2. Details of the HIA **methodology**.
3. Summary of **air quality and health impact findings from the HIA**, presenting the potential morbidity and mortality impacts to targeted populations in the Plan area due to changes in PM2.5 emissions associated with the Plan, including net changes in health endpoints.
4. A summary of sources of **uncertainty** in these results.

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[1] Draft Report: Community Health Equity Evaluation for San Diego Forward: The 2021 Regional Plan. Prepared for San Diego Association of Governments by TAHA. October 2021.

5. Key **references**.

6. **Appendix** providing a processed summary table of changes in health endpoint incidences in the Plan year by CBG and demographic categories for the modeled areas.

1.4 KEY FINDINGS

- DACs generally have a higher overall PM2.5 concentration compared to the entire modeled area. Both the minimum and average values of long-term average PM2.5 concentrations within DACs are higher than in the region overall (the study area for modeling includes the more populous areas of San Diego County) in both 2016 and 2050. However, the modeling shows average PM2.5 air quality improving in DACs more than in the entire modeled area (1.6 vs. 1.3 $\mu g/m^3$ reduction on average).

- The total population for the entire modeled area is projected to increase by approximately 13% from 2016 to 2050. In areas that are currently considered DACs the relative population growth is more than double that of the entire modeled area, 29%. While the share of the population that is older adults (aged 65 to 99 years) is higher in the entire modeled area than in DACs (14 vs. 10% in 2016; 21 vs. 18% by 2050), the rate of growth in the older adult population is much higher in DACs (74% in the general population; 140% in DACs). Older adults are more susceptible to air quality-induced health effects, such as heart attacks.

- Under the Plan regionwide, the population would experience an average of 30 fewer premature deaths per 100,000 persons and, on average, reduced cases of hospital admissions for asthma and chronic lung disease, ER visits for asthma, exacerbated asthma, minor restricted activity days, acute bronchitis, upper and lower respiratory symptoms, and lost workdays. In DACs, the benefits are greater. There, air quality changes under the Plan would result in 48 fewer premature deaths per 100,000 persons on average. Even with improving air quality, some health outcomes, such as non-fatal heart attacks, are worse in 2050 than 2016. This is related to the aging of the population.

2 ANALYSIS METHODOLOGY

This is a modeling assessment of the air pollution-related health impacts associated with the proposed Plan. The following discusses the pollutants modeled, the health impacts addressed, the models used to conduct the analysis, and how the results were quality assured. The methodology detailed here follows direction received from SANDAG March 2021.

2.1 POLLUTANTS AND HEALTH IMPACTS MODELED

This analysis considers the impact of human exposure to PM2.5. Other pollutants are considered in various parts of the analysis, but only to the extent to which they are precursors to PM2.5 in atmospheric physical and chemical reactions.

PM2.5 is the pollutant most associated with health risk from air pollution [WHO, 2014]. For example, Fann and Risley [2011] found that, nationally, for avoided mortalities from air pollution changes from 2000 to 2007, PM2.5 reductions were roughly 20 times more impactful than ozone. PM2.5 is more impactful than larger particulates because they are more respirable, impact deeper in the lungs, and may be transmitted to the blood or internal organs.[2] Consequentially, this analysis used BenMAP-CE to model health risks (see Section 2.2.2) in terms of exposure to PM2.5 only.

A range of fatal and non-fatal outcomes associated with air pollution are considered in this analysis; Section 2.3.3 provides the full list. These impacts are distinct from the health risk assessment performed in the EIR (Section 4.3 and Appendix D). The EIR evaluated the human health risk associated with inhalation of air toxic pollutants directly emitted from mobile sources associated with the Plan, and changes in land use that may change levels of exposure to existing toxic air pollutants. Those risks are characterized in terms incremental cancer, non-cancer chronic, and non-cancer acute population risks for specific types of sensitive receptors, based on land use. Here, in a non-CEQA analysis to address the specific request in Resolution No. 2021-17, changes in the incidence of adverse health outcomes (referred to collectively as morbidity and mortality) in the population from exposure to regional particulate matter air pollution are evaluated. This includes the pollutants directly emitted as a result of the Plan, which vary in time, and other pollutants from regional sources (which are assumed static in time) that influence regional air quality. The HIA also itemizes changes in specific health outcomes.

2.2 SELECTED MODELING TOOLS

2.2.1 AIR QUALITY MODEL

Per SANDAG direction, the CALPUFF[3,4,5] model [Exponent, 2019] was used to simulate spatial and temporal changes in PM2.5 concentration within the modeling domain. CALPUFF is a non-steady-state puff dispersion model that simulates the effects of time- and space-varying meteorological conditions on pollution transport, transformation, and removal. It is currently listed by EPA as an “alternative model” under Appendix W.[6] The

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[2] Particulate Matter (PM) Basics, US EPA. 2021. Available at https://www.epa.gov/pm-pollution/particulate-matter-pm-basics.

[3] http://www.src.com/

[4] http://www.src.com/calpuff/download/CALPUFF_v7_UserGuide_Addendum.pdf

[5] http://www.src.com/calpuff/download/calpuff_usersguide.pdf

[6] https://www.epa.gov/scram/air-quality-dispersion-modeling-alternative-models#calpuff. Note that CALPUFF’s status changed in the 2017 Appendix W updates. However, it is likely still suitable for this non-regulatory analysis.

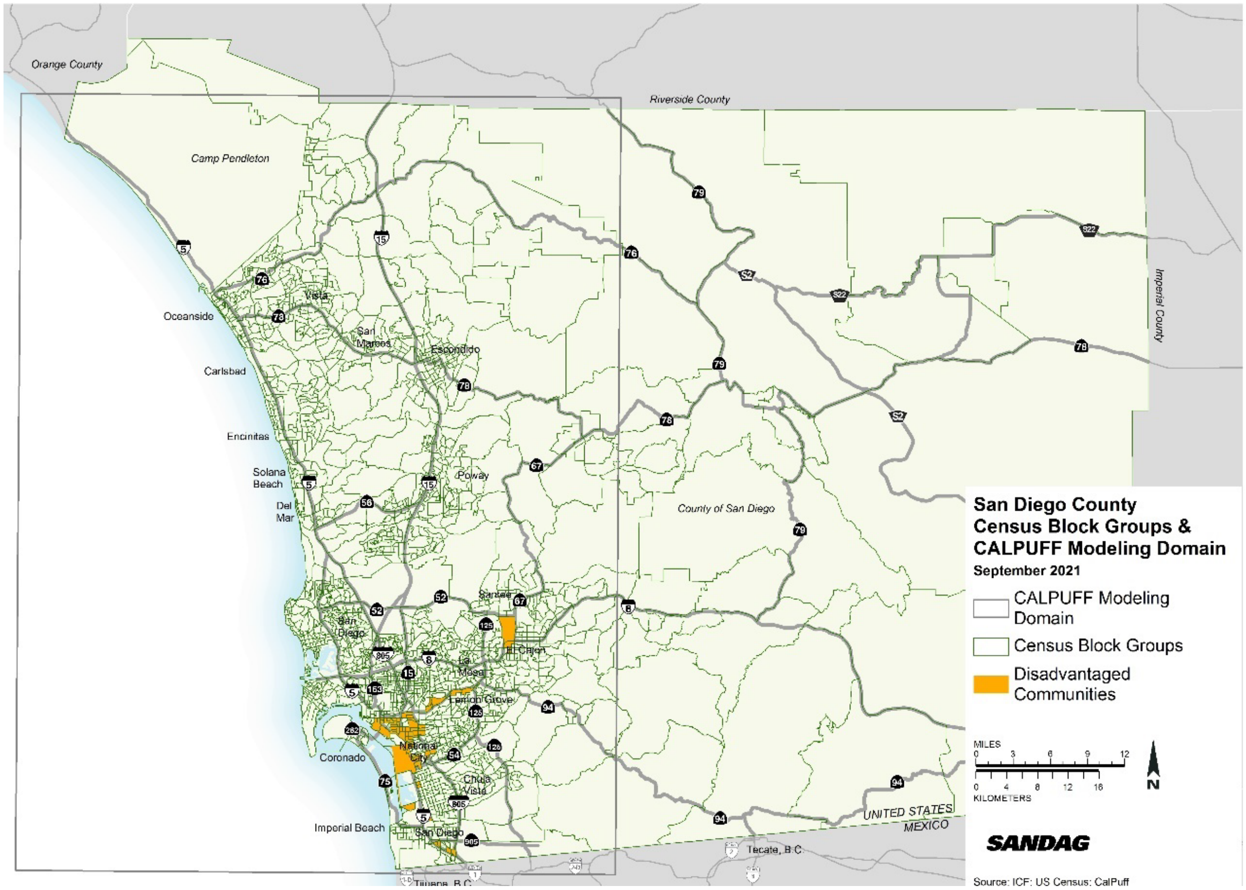
primary benefit of CALPUFF is that, unlike AERMOD, it can approximate secondary PM2.5 pollutant formation from sulfate and nitrate chemistry, but not organic species. CALPUFF is typically used to assess visibility in Federal Class 1 areas (such as national parks and wilderness areas). The model consists of three main components:

1. CALMET, a diagnostic three-dimensional meteorological model;
2. CALPUFF, an air quality dispersion model;
3. CALPOST, a post-processing package, along with numerous other processors to prepare geophysical data, other meteorological (surface, upper air, precipitation, and buoy) and air quality (ozone concentration for chemistry) data, and interfaces to other models.

Figure 1 shows the CALPUFF modeling domain and the CBGs included in the analysis. Receptors—locations at which air quality concentrations were determined—were placed at the geographic center of each CBG to represent average, modeled air pollutant concentration within the CBG. Unlike the AERMOD modeling for air quality hotspot analyses (see Appendix D to the EIR), here CALPUFF was used to consider much longer transport distances and capture regional influences on air quality. Accordingly, this analysis considers only a single modeling domain. The shape is rectangular to simplify analysis and positioned to capture the majority of Plan sources and potential for maritime influence on air quality.

CALPUFF was used to model total PM2.5, that is, the sum of primary and secondary particulates. CALPUFF does not track the size of secondary particulates. Accordingly, all secondary PM is assumed to be PM2.5. This is reasonable as most mass associated with larger particles are mechanically generated (e.g., dust) while exhaust pollution and fresh condensates – such as considered here – are in the smaller (i.e., <2.5 μm) size range.

Figure 1. San Diego County, with included Census Block Groups displayed and the CALPUFF modeling domain



Source: ICF; US Census; CalPuff

This domain is focused on the County's populated areas. It covers a population of about 3.23 million people (2016 values), compared to the total San Diego County population in 2016 of 3.30 million. Thus, the modeling domain captures impacts to about 98% of the County's population. The model included a total of 4,548 and 4,394 sources in 2016 and 2050, respectively, of various types (see Section 2.3.1) and 1,757 CBG centroids as receptors.

Figure 1 also shows DAC in the area, in yellow. Throughout this analysis, DAC is defined as a Census Block Group (CBG) with a CalEnviroScreen v4.0 [CalEPA, 2021] score of 75th percentile or higher.[7]

To accommodate the limitations of the CALPUFF model with this larger, aggregated modeling domain, certain modifications were made to the model and source configurations relative to those used in the EIR. These included identifying and recompiling the CALPUFF model with adjusted memory allocations to accommodate this large number of sources. CALPUFF had to be specifically compiled to be able to accommodate the much larger source and receptor arrays and update the model's memory allocation to accommodate this large number of sources and receptors. The CALPUFF source code was also modified for area sources. CALPUFF in its original configuration will only accept rectangular area sources. To match the sources in the EIR as much as possible, the Fortran source code was modified to accept irregularly shaped area sources to more accurately

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[7] Due to timing of this analysis, all results are based on the DRAFT CalEnviroScreen v4.0. The final version was released October 13, 2021.

represent the polygons used in rail and on road mobile emissions. This code was based on the implementation for "areapoly" sources in AERMOD.

The specifics of the modeling are discussed in Section 2.3.2, which includes a detailed summary of the various inputs and processing steps included.

2.2.2 HEALTH IMPACT MODEL

Per SANDAG direction, health impacts were modeled using the EPA's BenMAP-CE model.[8] Here BenMAP-CE is used to estimate population-level changes in health outcomes resulting from changes in exposure to air pollutants [e.g., Fann and Risley, 2011].

BenMAP-CE is EPA's model for estimating the health impacts and accompanying economic benefits associated with changes in air quality. To estimate health impacts, BenMAP-CE relies on input air pollutant concentrations in the form of gridded surface estimates, population, and baseline incidence rates of adverse health effects. The model applies health impact functions—which relate a change in the concentration of a pollutant with a change in the incidence of a health endpoint[9]—to produce detailed estimates of the human health benefits resulting from the changes in air pollution.

The model outputs changes in incidences of adverse health outcomes at locations of interest, with resolution as fine as the CBG level. These calculations require inputs of population and underlying health incidence and prevalence metrics, demographically resolved, in addition to the simulated air quality changes, at the modeled geographic scale. Because this information is not always available, analyses at the CBG level are not common. Section 2.3.3 describes the source of these values in this modeling exercise.

The BenMAP-CE software was used here without modifications. While default BenMAP-CE baseline health incidence and prevalence data were used, the model was customized with CBG-specific air quality data and population estimates by race, ethnicity, and age group. For estimating changes in the incidence of health effects, the health effects configuration and pooling framework used in the EPA Affordable Clean Energy (ACE) rule (U.S. EPA, 2019)[10] was used and was supplemented with more recent health impact functions for avoided premature mortality based on Turner et al. (2016) and Di et al. (2017).

Outputs from BenMAP-CE include the change in the number of cases of adverse health effects in a given population (in this analysis, per CBG). BenMAP-CE pooled outputs were postprocessed in R to evaluate average changes in cases between 2016 and 2050 considering two 2050 air quality estimation approaches, to evaluate per capita changes in cases under the Plan, and to summarize overall results by race/ethnicity and for the entire modeled population. These postprocessing steps are described in greater detail in Section 2.3.3.

2.3 MODELING APPROACH

The remainder of this section describes how the two models were used with available information to complete the HIA analysis.

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[8] Available at: https://www.epa.gov/benmap.

[9] BenMAP health effects include premature mortality, heart attacks, chronic respiratory illnesses, asthma exacerbation and lost productivity endpoints such as work loss days and minor restricted activity days.

[10] "ACE rule air quality and configuration files (zip)" from https://www.epa.gov/benmap/benmap-community-edition

2.3.1 EMISSIONS AND EMISSION SOURCES

The first step in modeling the HIA was to prepare emissions for use in the CALPUFF modeling. This section describes the emissions preparation for the dispersion modeling, including the source release parameters used in the modeling. All other CALPUFF inputs are described in Section 2.3.2.

Section 2.2.1 discussed the approach for using CALPUFF to simulate both primary and secondary components of PM2.5. The focus of this work is on the sources affected by the proposed Plan. However, other regional (non-Plan) sources were included to support the model's simulation of secondary PM formation. The Plan sources are modeled for both years 2016 and 2050 with their emissions tied to the actual locations and varying over time according to the Plan. The non-Plan sources generally are less specific in terms of location and are assumed to be unchanged between the years. The objective in this approach was to reach 90% of the regional emissions to adequately describe the aerosol physical and chemical processes in the region. Because modeled concentrations in the two years are combined to adjust the observed 2016 air quality values to 2050, this simplification for non-Plan sources, the bias in the modeling results from omission of sources, and other potential issues in the PM concentration modeling will "difference out" in the net results. (This is described further in Section 2.3.2.)

Table 1 summarizes the emissions used in the modeling for year 2016, the overall share of regional emissions captured, and the sources for the values used. These species are included to represent secondary PM formation in the CALPUFF model. In some locations, particularly in agricultural areas, ammonia can be a significant contributor to secondary PM. However, this is not expected to be true here. Thus, while the ammonia modeled with the sources included here is a small portion of the overall county total, modeled total PM2.5 concentrations are not expected to be significantly impacted. This list of sources was assembled to reach the 90 percent threshold of PM2.5 emissions with the fewest number of sources included to maximize efficiency in the CALPUFF model.

Table 2 summarizes the total emissions from Plan sources in 2050. As the non-Plan sources are identical in both years, Table 2 does not repeat these values. This is described further below.

Table 1. Summary of Baseline Emissions Used in CALPUFF, Tons Per Year, 2016

Source	Sector	PM2.5	SOx	NOx	NH_3
Plan Sources					
SANDAG Plan	Mobile	1288.0	130.7	11,748.1	1,006.3
SANDAG Plan	Freight Rail	2.6	0.1	156.4	0.1
SANDAG Plan	Passenger Rail	10.7	5.9	298.0	0.1
Non-Plan Sources, Countywide					
CEPAM -ARB	Aircraft - Civil	1.3	0.9	19.3	-
CEPAM -ARB	Aircraft - Military	610.6	66.4	715.1	-
CEPAM -ARB	Aircraft - Commercial	0	0	1,459.2	-
CEPAM -ARB	Ocean Going Vessels Maneuvering and at Berth (activity within SD Bay) and All Commercial Harbor Craft	35.9	29.2	1,125.3	0.1
CEPAM -ARB	Ocean Going Vessels Transit (outside the bay and within 3 nautical miles of shore)	1.9	4.6	624.8	0.2
CEPAM -ARB	Recreational Boating	157.1	0.9	690.6	1.2
CEPAM -ARB	Off Road (Recreational, Farm, and Other Equipment)	294.8	5.1	4,691.2	5.1
CEPAM -ARB	Construction & Demolition	1,222.3	-	-	-
CEPAM -ARB	Residential Fuel Combustion	668.1	49.4	914.7	31.2
CEPAM -ARB	Cooking	1,164.9	-	-	-
CEPAM -ARB	Fuel Combustion: Service and Commercial	150.3	15.4	405.0	-
ARB Mapping Tool	Electricity Generation	201.0	28.0	345.0	
CEPAM -ARB	Landfills	145.6	15.5	84.2	197.1
CEPAM -ARB	Unpaved Road Dust	368.7	-	-	-
Total					
		6,373.5	415.1	23,953.6	1,259.0
Regional Inventory, Omitting Natural Sources					
CEPAM -ARB		7,057.8	433.7	30,122.0	4,996.8
Percent of Regional Total Included					
		90%	96%	80%	25%

Table 2. Summary of Plan Emissions Used in CALPUFF, Tons per Year, 2050

Source	Sector	PM2.5	SOx	NOx	NH_3
Plan Sources					
SANDAG Plan	Mobile	1,163.1	82.3	2,497.9	1,724.9
SANDAG Plan	Freight Rail	0.6	0.2	45.7	0.2
SANDAG Plan	Passenger Rail	8.4	85.2	430.4	1.7

The following section first discusses the sources of emissions that are directly affected by the Plan. It then discusses the other, countywide sources included in the modeling.

PLAN SOURCES: ROAD

Road sources are taken directly from the AERMOD modeling discussed in Appendix D of the EIR. This includes major links modeled individually for light and heavy vehicles, and minor links modeled in aggregate across the area, as well as light and heavy vehicles used in the AERMOD modeling for the EIR. The source geometry used in CALPUFF matches that in AERMOD for the EIR. While the EIR accounted for sources that cross subdomain borders by duplicating them in both modeling subdomains; a single modeling domain was used here and unique source identification values were imported. The analysis relied on the original road emission database and source parameters developed for the EIR for emissions, which were processed and incorporated into the CALPUFF modeling. Here, the analysis assumed the tailpipe NO and NO_2 split to each be 50% of NOx emissions. When translating these for use here, there is a slight difference, up to 10% across pollutants, compared to what was used in the EIR. This is attributed to rounding errors due to the rebuilding of emissions from AERMOD sources for use here, and is not expected to impact results, particularly since the bias is small and roughly consistent in both years.

PLAN SOURCES: RAIL

Rail sources are also taken from the same underlying data used for the AERMOD modeling for the EIR. Minor modifications were made to this rail data, namely adjusting the NOx partition and updating the area data for the rail sources. For rail emissions, the tailpipe ratio of NOx emissions was assumed to be 90% NO and NOx and 9.2% NO_2. This was based on the Western Regional Air Partnership (WRAP) modeling platform parameters based on speciation profiles from EPA's SPECIATE database.[11] Release parameters remained the same as AERMOD, including the different profiles for day and night.

Rail sources are slightly different than in the EIR. As with roads, sources were taken from the AERMOD modeling including the same emissions densities. However, the larger domain used here along with CALPUFF's limits on the number of sources and the complexity of their shapes required additional processing for inclusion here. Thus, the rail sources were consolidated and redefined for use here. It was discovered after completion of the modeling that, because of a mismatch in the original and refined shapes, the CALPUFF emissions for rail sources were underestimated relative to those used in the EIR by approximately 25% in 2050 and 40% in 2016 compared those in AERMOD.

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[11] See Technical Memorandum No. 13: Parameters, 2013. Available at: https://www.wrapair2.org/pdf/Memo13_Parameters_Sep30_2013.pdf.

This implies the rail emissions in both years are smaller than they should be, and the error is larger in 2016, which biases the modeled improvement in air quality under the Plan to be smaller than expected. However, this error is expected to have a very small impact on the regional air quality and health impacts since rail emissions are two orders of magnitude smaller than road emissions regionwide. Furthermore, unlike in the EIR where receptors target individual sources, the focus on regional impacts here used the same receptors in both years, so rail cannot drive impacts at "new receptors" as were some impacts seen in the EIR.

ADDITIONAL (NON-PLAN) SOURCES

Table 1 summarizes the additional sources included in the CALPUFF modeling for regional PM2.5 impacts and their emissions magnitude. As the focus of the analysis is on isolating impacts due to the Plan, the same emissions for non-Plan sources were used in both 2016 and 2050 without modification. This list of sources is not exhaustive. The goal of this exercise was to obtain the most emissions from the fewest sources. These additional sources were included to reach 90 percent of the CARB County inventory for 2016 to support the model's estimation of atmospheric formation of secondary PM. The source of emission totals for all sources other than electricity generation is from ARB's CEPAM inventory.[12] The source of electricity generating emissions in the county is taken from the ARB's Pollution Mapping Tool for year 2016.[13] In all cases natural sources (non-anthropogenic) were excluded, which are all wildfire-related except from some NH_3 emissions.

Aircraft and Airport Emissions

Aircraft and airport data were taken from the CEPAM inventory and grouped into three broad categories: civil, military, and commercial. For this application, civil emissions were assumed to occur completely at Montgomery field, military emissions at Miramar, and commercial emissions at KSAN (Lindbergh Field). As above, these non-Plan sources are assumed constant in time and used to determine secondary air chemistry. Thus, the exact location for these sources is not critical because the direct impact of these sources will difference out when comparing across years. These sources were all modeled as area sources.

Area data was developed using GIS analysis of fence lines and facility perimeters unique to each location. An effective release height of 12 m and an initial vertical dispersion parameter (szi) of 4.1 m were used for each of the sources. These are the default values for all ground-based aircraft in the EDMS model, and is consistent with the EDMS assumption that most emissions affecting ground-level air quality are released below 1,000 ft.[14]

Marine Emissions

As shown in Table 1, three categories of marine emission sources were included here:

- Ocean going vessels (OGV) and commercial harbor craft (CHC) operating within San Diego Bay only.
- OGV activity outside of San Diego Bay but within 3 nautical miles (nm).

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

[13] https://www.arb.ca.gov/ei/tools/pollution_map/

[14] https://www.faa.gov/about/office_org/headquarters_offices/apl/research/models/edms_model/media/EDMS%205.0%20User%20Manual.pdf

- Recreational boating emissions based on all activity countywide.

Emissions for all three categories are taken from ARB's CEPAM inventory from 2016. OGV and CHC marine emissions were determined from CEPAM at the county resolution, which is understood to be limited to 3 NM from the coast. OGV activity within 3 NM is primarily emissions from large vessels transiting the area. For these vessels, an effective release height of 26.1 m and σ_{zi} of 13 m was used.[15] For OGV outside the Bay, the same source but OGV-only parameters of 49 m and 24.5 m, respectively, was used. Recreational boating includes sources such as pleasure craft and jet skis. The emissions from these vessels can occur anywhere in the county. For modeling purposes here, all activity is assumed to be offshore within 3 NM of the coast and inside of both the San Diego and Mission Bays. A release height of 0.8 m and σ_{zi} of 2.6 m were assumed. These values are consistent with light-duty vehicle use, and EPA's guidance for those vehicles from its PM Hotspot guidance, Appendix J.[16]

Electricity Generating Units

For electricity generating unit (EGU) emissions, the point sources listed in Table 3 were included. In each case, these were modeled as a single "stack" with the best available release parameters. Although it is important that these sources be modeled as point sources to reasonably estimate their overall impacts in the modeling domain, the fact that they are treated the same in both modeled years negates the need to add greater specificity to the individual sources. Thus, as with the other non-Plan sources, some parameters are rough estimates of the actual emission release profiles of the facilities. These estimates for modeling were based on available literature for each facility, or average values from all facilitates, as indicated in the table.

All EGU emissions are mapped to individual sources. All facility level EGU emissions and locations were taken from the from ARB's Pollution Mapping tool[17] for year 2016.

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[15] https://kentico.portoflosangeles.org/getmedia/94def661-4e49-4991-955a-a67ce76cbad5/Appendix_D3_Health_Risk_Assessment

[16] https://nepis.epa.gov/Exe/ZyPdf.cgi?Dockey=P100NN22.pdf

[17] https://www.arb.ca.gov/ei/tools/pollution_map/

Table 3. Electricity Generating Unit Sites Modeled (Emissions in Short Tons)[a]

Facility	VOC	NOx	SOx	PM2.5	CEIDARS ID	Street Address	Modeled stack height (m)	Modeled stack diameter (m)	Modeled exit velocity (m/s)	Modeled exit temperature (K)
CalPeak Power - Border[b]	0.2	1.6	0.1	2.9	7835 (FACID)	2060 Sanyo Rd., San Diego, CA 92154	15	3.7	35	644
CalPeak Power - Enterprise[c]	0.2	2.4	0.1	3.2	7594 (FACID)	201 Enterprise St., Escondido, CA 92029	15	3.7	35	644
Escondido Energy Center, LLC[d]	0	0.2	0	0.1	7112 (FACID)	1968 Don Lee Place, Escondido, CA 92029	22	3.7	15	623
Orange Grove Energy Center[e]	0.2	2.4	0.1	0.8	6289 (FACID)	35435 Pala Del Norte Rd., Pala, CA 92059	27	13.5	19	730
Pio Pico Energy Center[f]	0	0	0	0	(FACID)	7363 Calzada De La Fuente, San Diego, CA 92154	30	4.4	31	692
San Marcos Energy LLC[g]	0.2	4.7	1.1	0.4	5924 (FACID)	1615 San Elijo Road, San Marcos, CA 92069	44	5.6	18	388
Calpine - Otay Mesa Energy Center[i]	13.4	70.5	0.7	85.7	10882 (FACID)	606 De La Fuente Court, San Diego, CA 92154	26	6	26	620
Chula Vista Energy Center[h]	0	0.2	0	0.1	7084 (FACID)	3497 Main Street, Chula Vista, CA 91911	29	12	26	620
El Cajon Energy, LLC[i]	0.1	1.9	0.1	0.7	6554 (FACID)	222 N. Johnson Ave., El Cajon, CA 92020	26	6	26	620
MM San Diego LLC - North City[i]	0.6	30	2.4	7.6	96224 (FACID)	4949 Eastgate Mall Road, San Diego, CA 92121	26	6	26	620

Facility	VOC	NOx	SOx	PM2.5	CEIDARS ID	Street Address	Modeled stack height (m)	Modeled stack diameter (m)	Modeled exit velocity (m/s)	Modeled exit temperature (K)
Miramar - MM and Miramar Energy[i]	12.4	49.1	7.3	14	96387 (FACID)	5244 Convoy Street, San Diego, CA 92111	26	6	26	620
NRG Energy - El Cajon[i]	0	0	0	0	544 (FACID)	800 W Main Street, El Cajon, CA 97219	26	6	26	620
NRG Energy - Encina[i]	16.7	45.9	2	39.1	73 (FACID)	4600 Carlsbad Boulevard, Carlsbad, CA 92008	26	6	26	620
NRG Energy - Kearny 2 and 3[i]	0.1	7.8	0	0.5	79 (FACID)	5459 Complex Street, San Diego, CA 92123	26	6	26	620
NRG Energy - Miramar[i]	0	2	0	0.1	540 (FACID)	6897 Consolidated Way, San Diego, CA 92121	26	6	26	620
Otay Landfill Gas LLC[i]	1	43.7	4.8	15	6068 (FACID)	1600 Maxwell Rd, Chula Vista, CA 91911	26	6	26	620
SDG&E - Cuyamaca Peak Energy Plant[i]	0.1	1.1	0.1	2.1	7592 (FACID)	200 North Johnson Ave, El Cajon, CA 92020	26	6	26	620
SDG&E - Miramar Energy Facility[i]	0.5	5.4	0.3	13.8	94325 (FACID)	6875 Consolidated Way, San Diego, CA 92121	26	6	26	620
SDG&E - Palomar Energy Center[i]	0.1	52	5.5	8.4	8013 (FACID)	2300 Harveson Place, Escondido, CA 92029	26	6	26	620
Sycamore Energy LLC[i]	0.8	17	3.6	1.3	6257 (FACID)	8514 Mast Blvd., Santee, CA 92072	26	6	26	620
Wildflower Energy, LP - Larkspur Energy Facility, LLC[i]	0.8	6.8	0.2	5.2	7630 (FACID)	9355 Otay Mesa Rd., San Diego, CA 92154	26	6	26	620

[a] Stack parameters are as modeled, not necessarily the actual facility's parameters.

[b] Stack parameters estimated from https://ww2.energy.ca.gov/sitingcases/peakers/border/documents/Border_STAFF_ASSESSMENT.PDF

[c] Stack parameters estimated from https://ww2.energy.ca.gov/sitingcases/peakers/calpeak/documents/01-EP-10_ASSESSMENT.PDF

[d] Stack parameters estimated from https://efiling.energy.ca.gov/GetDocument.aspx?tn=217681&DocumentContentId=23506

[e] Stack parameters estimated from https://www.transmissionhub.com/wp-content/uploads/2018/12/Carlsbad-MAY-13-2014-Amendments.pdf

[f] Stack parameters estimated from CEC docket info: https://efiling.energy.ca.gov/Lists/DocketLog.aspx?docketnumber=11-AFC-01

[g] Stack parameters estimated from: https://ww2.energy.ca.gov/sitingcases/palmdale/documents/applicant/afc/volume_02/Appendix%20G%20-%20Air%20Quality%20Supporting%20Documentation.pdf

[h] Parameters stack height and elevation estimated via https://ww2.energy.ca.gov/sitingcases/southbay/documents/applicants/afc/SBRP%20AFC%20Volume%201/Section%208.1%20-%20Air%20Quality.pdf. Other parameters are facility averages.

[i] No facility release parameter information available. Stack parameter values are averages of those documented in references a-h.

Landfills

Like EGUs, landfills are modeled as individual point sources. Table 4 summarizes the distinct facilitates included in the CALPUFF simulation. Source information is determined from U.S. EPA's Landfill Data,[18] representing sites in San Diego County with known locations, with electricity generation from combustion (excluding Camp Pendleton) and removing any known to have shut down by 2016. Note that while all these included facilities were open in 2016, some are scheduled to close before 2050. As noted above, all non-Plan sources are assumed constant in time to emphasize Plan impacts. Thus 2050 emissions for some of these facilities will be overestimated (but not necessarily for the sector in aggregate).

Countywide emissions are taken from the ARB's CEPAM database for 2016.[19] The EPA Landfill Data includes an estimate of landfill gas collected for combustion at the site. This amount was used to apportion the countywide emissions to these facilities. Furthermore, each site contains more than one "project" in the EPA dataset. For example, the Otay landfill consists of four different projects due to historical site expansion. For purposes here, each project is treated as a different source. Thus, the Otay landfill is represented in the CALPUFF modeling as four different point sources, with the emissions shown in Table 4. The apportionment of CEPAM county emissions data thus distributes these emissions to nine total point sources in the county at these three sites.

As with EGUs, actual release parameters are unknown, yet insignificant because these sources are held constant in the two compared years. Following BAAQMD,[20] all landfills were treated like generators with the following release parameters. All facilities were modeled as a single stack with the same release parameters: modeled stack diameter of 1.8 m, modeled exit velocity of 45 m/s, and modeled exit temperature of 740 K. For these sources a release height of 1 m was assumed.

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[18] Project and Landfill Data by State, Landfill Methane Outreach Program (LMOP), U.S. EPA: https://www.epa.gov/lmop/project-and-landfill-data-state.

[19] CEPAM: 2016 SIP - Standard Emission Tool (ca.gov): https://www.arb.ca.gov/app/emsinv/fcemssumcat/fcemssumcat2016.php.

[20] The San Francisco Community Risk Reduction Plan: Technical Support Documentation, December 2012, Table 13: http://ab900balboa.com/EIR_References/2012_1201_baaqmd_sfdph.pdf.

Table 4. Distinct Landfill Sites Modeled (Emissions in Short Tons Per Year)[a]

Landfill ID	Landfill Name	Physical Address	Landfill Owner Organiza-tion(s)	Number of Projects at the Site	Year Landfill Opened	Landfill Closure Year	Project Type Category	LFG Energy Project Type	PM2.5	SOx	NOx	NH3
236	Otay LF	1700 Maxwell Road, Chula Vista 91911	Republic Services, Inc.	4	1963	2028	Electricity	Reciprocating Engine	14	1.5	8.3	19.3
287	Sycamore SLF	8514 Mast Boulevard, Santee 92071	Republic Services, Inc.	2	1962	2091	Electricity	Gas Turbine	16	1.7	9.3	21.7
214	West Miramar SLF	5180 Convoy Street, San Diego 92111	United States Navy	3	1983	2025	Electricity	Reciprocating Engine	19	2.0	10.9	25.4

[a] Stack Parameters are as modeled in CALPUFF. These are not necessarily the actual facility's parameters.

Off-Road

Finally, additional off-road, regional sources were also included. Emissions for all categories are taken from ARB's CEPAM inventory from 2016 without modification.[21] These sources were spatially aggregated to either the entire county or the urbanized area of the county, as noted in Table 5 below. That is, the emissions density (emissions per unit area) was first determined for each source based on the total area or the urbanized area of the county. Then the physical shape of the source was determined using GIS, with the specified area limited to the portion of the county within the modeling domain. Finally, each source was parameterized in CALPUFF as a series of 5 km-by-5 km squares. A regular grid of these 5 km squares was assembled to cover the area of the source. Each square was assigned the emissions density for the source, as previously described. This way, the sources were "digitized" into smaller grid cells that could better capture the underlying terrain and avoid any issues of surface-based emissions being simulated as released either far below or far above ground. Table 5 summarizes these sources.

Table 5. Summary of Off-Road Sources, as Modeled

Source Category	Geographic Area as Modeled	Release Height (m)	Initial Vertical Dispersion (σ_{zi}, m)
Off road farm equipment, off-road equipment, and off-road recreational vehicles [a]	Countywide	5.0	1.4
Construction & demolition [b]	Countywide	5.0	1.4
Residential fuel combustion [c]	Urbanized area	7.6	2.8
Cooking [d]	Urbanized area	7.6	2.8
Fuel combustion: service and commercial [e]	Urbanized area	1.8	1.0
Unpaved road dust [f]	Countywide	0.0	2.6

[a] Release parameters from: https://www.santaclaraca.gov/home/showpublisheddocument?id=64659

[b] Release parameters from: https://www.santaclaraca.gov/home/showpublisheddocument?id=64659

[c] Release parameters assume a 2 ft. chimney on a 2-story building, following EPA recommendations on σ_{zi} from the AERMOD User's Guide.

[d] Release parameters assumed the same as for residential fuel combustion

[e] Release parameters from http://ab900balboa.com/EIR_References/2012_1201_baaqmd_sfdph.pdf, for other/unknown sources

[f] Release parameters assume ground-level release, with σ_{zi} from EPA's Hotspot Guidance for Light Duty Vehicles: https://nepis.epa.gov/Exe/ZyPdf.cgi?Dockey=P100NN22.pdf.

2.3.2 AIR QUALITY

The CALPUFF model was used to simulate total PM2.5 air quality. Total PM2.5 includes both primary emissions of particulates and secondary particulates formed in the atmosphere. CALPUFF was selected as it does not have the same spatial limitation inherent in AERMOD, allowing a single model domain to encompass the entire area of concern and chemistry to be tracked as plumes of pollution are advected across the modeling domain.

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[21] CEPAM: 2016 SIP - Standard Emission Tool (ca.gov): https://www.arb.ca.gov/app/emsinv/fcemssumcat/fcemssumcat2016.php.

Section 2.3.1 discussed the emission sources used in the air quality modeling, including parameters such as initial plume dimensions (σ_{zi}) and release heights that are critical to determining ambient concentrations with the model. Here all the other aspects of the air quality modeling methodology are discussed. Unlike in the EIR, air quality modeling here is only used to predict relative changes in PM2.5 concentration across time due to the Plan. These relative changes are coupled with observed air concentrations to predict total air quality values that are used in the HIA. The following first discusses the CALPUFF modeling approach, then the coupling with observed data.

CALPUFF MODELING

The HIA is a comparison of impacts between impacts under a build case and from the 2016 baseline. The build case is analyzed for year 2050. A no-build case is not currently available for future conditions without the Plan. Accordingly, the 2016 baseline air quality was used for comparison, consistent with the air quality and HRA approach in the EIR. Total PM2.5 pollutant concentrations were modeled across the modeling domain (Figure 1) for both 2016 and 2050 with the CALPUFF model.

Figure 1 in Section 2.2.1 introduced the CALPUFF modeling domain, the census block groups (CBG) used to represent populations, and the CBG centroids used as receptors to represent the average concentrations in each "neighborhood" in the modeling. Plan sources included in the modeling (see Section 2.3.1) were generally treated consistently with the parameterization in the air quality modeling analysis (using the AERMOD model) for PM hotspots and health risks in the EIR but were modified for use in the CALPUFF model. Non-Plan sources discussed in Section 2.3.1 were not included in the modeling for the EIR and are included here to support secondary PM formation.

CALPUFF is a non-steady state air quality model.[22] The model's formulation is different from AERMOD, and thus requires similar, but distinct input data and parameterizations. The following summarizes the input data and settings used in this analysis.

The analysis generally assumed default settings for puff formation, splitting, and other factors. Dry deposition was not modeled because data was not available for all species. The analysis did assume a background NH_3 value of 1 ppb according to IWAQM document[23] referencing Langford et al. [1992] for arid land. Monthly

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[22] That is, it tracks individual "puffs" of air pollutants around the modeling domain in time and space as meteorology and terrain vary and the puff evolves, including chemically. Per the US EPA (https://www.epa.gov/scram/air-quality-dispersion-modeling-alternative-models):

> CALPUFF is a multi-layer, multi-species non-steady-state puff dispersion model that simulates the effects of time- and space-varying meteorological conditions on pollution transport, transformation and removal. CALPUFF can be applied on scales of tens to hundreds of kilometers. It includes algorithms for subgrid scale effects (such as terrain impingement), as well as, longer range effects (such as pollutant removal due to wet scavenging and dry deposition, chemical transformation, and visibility effects of particulate matter concentrations).

Also see http://www.src.com/ for more information.

[23] Available at: https://nepis.epa.gov/Exe/ZyNET.exe/2000D5UH.txt?ZyActionD=ZyDocument&Client=EPA&Index=1995%20Thru%201999&Docs=&Query=%28ammonia%29%20OR%20FNAME%3D%222000D5UH.txt%22%20AND%20FNAME%3D%222000D5UH.txt%22&Time=&EndTime=&SearchMethod=1&TocRestrict=n&Toc=&TocEntry=&QField=&QFieldYear=&QFieldMonth=&QFieldDay=&UseQField=&IntQFieldOp=0&ExtQFieldOp=0&XmlQuery=&File=D%3A%5CZYFILES%5CINDEX%20DATA%5C95THRU99%5CTXT%5C00000012%5C2000D5UH.txt&User=ANONYMOUS&Password=anonymous&SortMethod=h%7C-&MaximumDocuments=1&FuzzyDegree=0&ImageQuality=r75g8/r75g8/x150y150g16/i425&Display=hpfr&DefSe

background fine particulate (PM2.5) and organic fraction was calculated using 2016 speciation data FROM SD-APCD FSD and LES URG3000 speciation data. This data is used in the secondary organic aerosol (SOA) chemistry module specific to the chemistry parameter chosen (MCHEM = 7 with CalTech SOA).

Meteorological data was largely consistent with that used in the AERMOD EIR analysis. However, CALPUFF allows multiple metrological stations across the domain. A single, comprehensive meteorological surface was assembled that included all parameters necessary for this modeling, starting with the same raw data as AERMOD, but adding stations, including a buoy station to facilitate overwater and near-shore evaluation. The analysis also used a precipitation station's data to support evolution of wet deposition. Table 6 summarizes the stations included in the analysis.

CALMET preprocessors were used as follows: READ62 to process sounding data, SMERGE to process surface meteorological data, PMERGE to process precipitation data, and BUOY to process buoy meteorological station data. Then the MAKEGEO preprocessor was used to assemble this data run in CALMET to create the data used for each analyzed year. As with the EIR, the same meteorological dataset was used for both calendar years (2016 and 2050), with the emissions varying between the years. In both cases, the single CALMET file covers the period January 1, 2010, to December 31, 2012, consistent with that in the EIR.[24] Both calendar years used a three-year meteorological period to avoid bias in any single year.

To integrate this data, the following general approaches were used. Precipitation interpolation used a 1/r approach with a radius of influence of 200 km. A radius of influence that was intentionally larger than modelling domain was used as only one precipitation station could adequately model conditions in the domain. Other precipitation stations in San Diego County are too far east of the modeling domain, in mountainous areas, or would otherwise erroneously skew the modeled precipitation and thus increase wet deposition. Temperature interpolation also used a 1/r approach with a radius of influence of 80 km. A smaller radius than the default (500 km) was used here because nine stations were available within modeling domain. For wind, CALMET does not allow the interpolation approach to be specified, only the radius of influence. A radius of 100 km was used for land and 200 km over water as only one buoy station was available.

Background hourly ozone (O_3) data is also needed to support atmospheric chemistry calculations. Hourly O_3 data were used from the following San Diego APCD sites. The assembled record covered the period January 1 to December 31, 2012:

- 06-073-0001
- 06-073-0003
- 06-073-0006
- 06-073-1001
- 06-073-1002
- 06-073-1006
- 06-073-1008
- 06-073-1010
- 06-073-1011
- 06-073-1016
- 06-073-1201
- 06-073-2007

The ISORROPIA v2.1 chemistry model in CALPUFF was used to simulate secondary particulate formation. Specifically, the MCHEM = 7 chemistry mechanism was used in CALPUFF, with the updated RIVAD scheme and

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ekPage=x&SearchBack=ZyActionL&Back=ZyActionS&BackDesc=Results%20page&MaximumPages=1&ZyEntry=20&SeekPage=f.

[24] As discussed in Appendix D of the EIR, five of the six modeling subdomains used meteorological data from the 2010-2012 period, while one used 2014-2016.

CalTech secondary organic aerosol (SOA) parameterization using ISORROPIA chemistry to capture organic, sulfate, and nitrate secondary particulates.

Table 6. Summary of Metrological Stations Included

Station	Station ID	Station Type	Location: UTM Easting (km)	Location: UTM Northing (km)
MCAS Miramar (NKX; 3190)	3190	Atmospheric Sounding	485.966	3636.552
Buoy 27NM SE OF SAN CLEMENTE IS CA	46086	Buoy met station	438.963	3600.036
Lindbergh Field	047710	Precipitation	480.324	3621.929
Lindbergh Field	KSAN; 722900	Met	480.324	3621.929
McLellan-Palomar Airport	CRQ; 722927	Met	474.814	3665.509
MCAS Miramar	NKX; 722931	Met	485.966	3636.552
Chula Vista	CVA; 231881	Met	494.455	3610.402
Camp Pendleton	CMP; 731008	Met	463.082	3675.421
Del Mar	DMR; 731001	Met	475.317	3646.008
El Cajon	ECA; 730003	Met	505.421	3628.141
Escondido	ESC; 731002	Met	492.970	3665.449
Perkins E.S.	PES; 731010	Met	485.972	3618.205

The analysis included terrain and land use parameterizations to describe atmospheric flow across the domain. The TERREL preprocessor was used to process terrain to the 1 km square CALPUFF gridded domain. Terrain was used from SRTM, void-filled, with 1 arc second resolution. The following datasets were used:[25]

- n32_w117_1arc_v2
- n32_w118_1arc_v2
- n33_w117_1arc_v2
- n33_w118_1arc_v2

For land use, the same descriptions as included in the AERMOD EIR analysis were used. However, the land use categories were consolidated into seven specific types for the CTGPROC CALPUFF pre-processor. The land use types used in modelling were water, urban, agriculture, forest, rangeland, wetland, and barren land. Land use was specific to 2016 and 2050 plan years. The MAKEGEO preprocessor was then used to combine land use and terrain data into a single file, which was then used as input for CALMET.

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[25] https://earthexplorer.usgs.gov/

The following pollutants were included in the model simulation:

- SO_2
- SO_4
- NO
- NO_2
- HNO_3
- NO_3
- Primary Organic Carbon (POC)
- Toluene
- Condensable products of gaseous Toluene
- Condensable products from particulate Toluene
- Condensable products of gaseous Xylene
- Condensable product from particulate Xylene
- Long-chain alkanes
- Condensable product of gaseous alkane
- Condensable product of particulate alkane
- PAH
- Condensable product of gaseous PAH
- Condensable product from particulate PAH
- PM25
- NH_3

This list includes both gas and particulate species in the simulation. As noted, CALPUFF was selected primarily to include secondary PM fraction in the total particulate concentrations. That is, Total PM2.5 = Primary PM2.5 + secondary particulate. Secondary particulate is not size segregated in CALPUFF but is expected to be essentially all PM2.5. Table 7 lists the species included in formation of secondary particulate.

Table 7. Species Included in Secondary Particulate

Species Name	Description
SO_4	Sulfate
NO_3	Nitrate
POC	Primary Organic Carbon
ATOLA1	Condensable product from Toluene
ATOLA2	Condensable product from Toluene
AXYLA1	Condensable product from Xylene
AXYLA2	Condensable product from Xylene
APAHA1	Condensable product from PAH
APAHA2	Condensable product from PAH

BenMAP air quality inputs should represent long-term average of 24-hour average concentrations of species. A combination of custom postprocessing and CALPUFF routines were used to generate these outputs. First, CALAVE was used to determine 24-hour averages from modeled hourly concentrations. Then the APPEND routine was used to “stitch” each month of model data together for each meteorological year (2010, 2011, 2012). Then the CALPOST routine was used to calculate the average 24-hour PM value for each individual meteorological year. Finally, custom Python scripts were used to sum all primary and secondary PM together and determine the three-year average total PM2.5 concentration.

TOTAL 2016 AND 2050 AIR QUALITY SURFACES

In this analysis, the term "air quality surfaces" describes the profile of air pollutant concentrations across the modeling domain at ground level. That is, how the concentrations vary across space at a given time. Since this analysis explores annual average PM concentrations, the reported air quality surface is the set of annual average PM2.5 concentrations across the modeled region in each year.

The 2016 high-resolution, historical PM2.5 concentration data were used as the baseline (existing condition) air quality surface in the BenMAP analysis (van Donkelaar et al., 2019). This "satellite" dataset is from the Atmospheric Composition Analysis Group's North American regional satellite estimates (V4.NA.03).[26] It provides estimates of ground-level fine PM concentrations over North America by combining the GEOS-Chem chemical transport model with aerosol optical depth retrievals from NASA MODIS, MISR, and SeaWIFS satellite observation instruments. Estimates were then further calibrated to regional ground-based observations of total and compositional mass. For this analysis, only the total PM2.5 mass from this North American dataset is used, clipped to the modeling domain. The satellite data are provided as a grid. the data grid was downloaded and the CBG centroid locations identified (which are used as modeling receptors; see Section 2.3.2) with this grid to determine the existing PM2.5 concentrations for each CBG for this analysis.

Two options were evaluated for estimating 2050 air quality (hereafter referred to as AQ_{2050}) based on a combination of the CALPUFF modeling results and the satellite data. The first of these options (a) relies on the proportion of 2050 and 2016 modeled sources. The second option (b) relies on the increment between 2050 and 2016 modeled sources:

a) **Proportional:**

$$AQ_{2050,Proportional} = AQ_{Background} + \left(AQ_{Satellite} - AQ_{Background}\right) * \left(\frac{Model_{2050}}{Model_{2016}}\right)$$

$AQ_{Background}$ is assumed to be 2.5 ug/m^3 based on the U.S. EPA Office of Air Quality Planning and Standards (OAQPS) 2005 Particulate Matter Health Risk Assessment background levels in the western U.S.[27] This estimate incorporates the EPA estimate of background PM2.5 levels along with the ratio of the modeled anthropogenic sources in 2050 under the Plan and modeled anthropogenic sources in 2016. That is, it attempts to combine the observed, total PM from the satellite and the modeled anthropogenic PM2.5 from CALPUFF using a ratio of modeled values across time to remove model bias.

b) **Incremental:**

$$AQ_{2050,Incremental} = AQ_{Satellite} + (Model_{2050} - Model_{2016})$$

This approach begins with the satellite PM2.5 2016 levels. It then subtracts the modeled anthropogenic sources from 2016 from the total satellite surface, then adds back in the modeled anthropogenic 2050 sources. This approach does not assume any particular background value and assumes a linear contribution to remove any model bias.

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[26] See http://fizz.phys.dal.ca/~atmos/martin/?page_id=140.

[27] The U.S. EPA determined that background PM2.5 levels in Los Angeles, Phoenix, and San Jose were 2.5 ug/m^3.

Both approaches have advantages and disadvantages, and both are suitable in this application. To avoid bias in predictions of 2050 air quality, both were used. Section 2.3.3 discusses how these two options are used to predict changes in health impacts.

2.3.3 HEALTH IMPACT

Only changes in health effect incidence were analyzed. Modeled health impacts were based on modeled changes in PM2.5 concentrations. BenMAP relies on several inputs to estimate health impacts from changes in exposures to air pollution. The inputs include 2016 (baseline) and 2050 (build) air quality data, baseline health statistics for each health outcome of interest, health impact functions derived from epidemiological studies, and data on the population exposed to air quality changes. In developing BenMAP inputs for this analysis, modeled PM2.5 concentrations for the years 2016 and 2050 from CALPUFF, baseline satellite data PM2.5 concentrations for 2016 from the Atmospheric Composition Analysis Group, CBG-specific population data provided by SANDAG, and default health incidence data included within the BenMAP software were used. The health endpoints selected for evaluation in BenMAP are consistent with the endpoints selected to quantify impacts for the ACE rule and are listed below:

- Mortality
- Infant Mortality
- Nonfatal Heart Attacks
- Hospital Admits, All Respiratory
- Hospital Admits, Cardiovascular (except heart attacks)
- Hospital Admits, Asthma
- Hospital Admits, Chronic Lung Disease
- Acute Bronchitis
- Upper Respiratory Symptoms
- Lower Respiratory Symptoms
- Emergency Room Visits, Asthma
- Minor Restricted Activity Days[28]
- Work Loss Days
- Asthma Exacerbation

The health impact functions included in BenMAP rely on recent assessments of the published scientific literature to ascertain the relationship between particulate matter and adverse health effects. EPA selected studies based on location and design, the characteristics of the study population, and whether the study was peer reviewed. EPA has evaluated this collection of health endpoints in numerous BenMAP analyses to inform regulatory decisions, including the National Ambient Air Quality Standards (NAAQS),[29] Final Transportation

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[28] These occur when individuals reduce most usual daily activities and replace them with less strenuous activities or rest but do not miss work or school. See Hubbell et al., https://www.ncbi.nlm.nih.gov/pmc/articles/PMC1253713/.

[29] U.S. EPA (2006). Final Regulatory Impact Analysis: 2006 National Ambient Air Quality Standards for Particulate Matter. Office of Air Quality Planning and Standards. See: Chapter 5. Available at: http://www.epa.gov/ttn/ecas/regdata/RIAs/Chapter%205--Benefits.pdf; U.S. EPA (2008). Final Ozone NAAQS Regulatory Impact Analysis. Office of Air Quality Planning and Standards. March. See: Chapter 6. Available at: http://www.epa.gov/ttn/ecas/regdata/RIAs/6-ozoneriachapter6.pdf; U.S. EPA (2010). Final Regulatory Impact Analysis (RIA) for the SO2 National Ambient Air Quality Standards (NAAQS). Office of Air Quality Planning and Standards. June. See: Chapter 5. Available at: http://www.epa.gov/ttn/ecas/regdata/RIAs/fso2ria100602ch5.pdf; U.S. EPA (2012). Regulatory Impact Analysis for the Final Revisions to the National Ambient Air Quality Standards for Particulate Matter. See: Chapter 5. Available at: http://www.epa.gov/ttnecas1/regdata/RIAs/finalria.pdf.

Rule,[30] and the Locomotive Marine Engine Rule.[31] The health impact analysis was further customized to replace health impact functions that relate adult mortality to changes in PM2.5 concentrations based on studies from Krewski et al. (2009) and Lepeule et al. (2012) with updated functions from Turner et al. (2016) and Di et al. (2017).

the health impact function pooling framework implemented in the ACE rule was followed, which, for certain endpoints, estimates a single effect based on pooled results from multiple studies. The ACE rule configuration and pooling framework includes a selection of studies from one or multiple authors for use in the BenMAP-CE analysis based on study quality, the sources of the epidemiological evidence, and the specific C-R parameters applied (U.S. EPA, 2019). For analysis of health endpoints based on multiple studies, the pooling framework outputs a single health effect estimate by selecting random or fixed effects pooling of multiple studies or specifying user-defined weights to pool estimates from multiple studies. For instance, the ACE rule pooling framework assigns equal weight to studies of hospital admissions for all respiratory illnesses from Kloog et al. (2012) and Zanobetti et al. (2009), while the framework selects "random or fixed effects" pooling of age-specific nonfatal heart attack studies from Pope et al. (2006), Sullivan et al. (2005), Zanobetti and Schwartz (2006), and Zanobetti et al. (2009).

The health impact is related to the changes in air quality, underlying health incidence, and population as described above. SANDAG expressed concerns over addressing both changes in population and air quality, which are affected simultaneously by the Plan. The Plan will induce both temporal and spatial changes air pollutant concentration, land use, population growth, and location of that growth.

BenMAP is not configured to analyze these concurrent changes in its default application. For similar reasons, BenMAP is not able to analyze differences across years, rather it is designed for policy differences such as through a business-as-usual vs. control scenarios. To accommodate this limitation, and per SANDAG direction[32], the BenMAP analysis was executed as described below. Conceptually, the standard BenMAP health impact estimation framework is as follows:

$$Cases = Population * Incidence * f(AQ_{Baseline} - AQ_{Control})$$

The following general calculations were performed to account for changes in both population and air quality under baseline and Plan conditions:[33]

(1) $Cases_{2050} = Population_{2050} * Incidence_{2050} * f(AQ_{2050} - 0)$
This estimate corresponds to cases of adverse health effects attributable to the total burden of air pollution in 2050, assuming 2050 population and baseline incidence conditions.

(2) $Cases_{2016} = Population_{2016} * Incidence_{2016} * f(AQ_{2016} - 0)$
This estimate corresponds to cases of adverse health effects attributable to the total burden of air pollution in 2016, assuming 2016 population and baseline incidence conditions.

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[30] U.S. EPA (2011). Regulatory Impact Analysis (RIA) for the Final Transport Rule. Office of Air and Radiation. June. See: Chapter 5. Available at: http://www.epa.gov/airtransport/pdfs/FinalRIA.pdf.

[31] U.S. EPA (2008). Regulatory Impact Analysis: Control of Emissions of Air Pollution from Locomotive Engines and Marine Compression Ignition Engines Less than 30 Liters Per Cylinder. Office of Transportation and Air Quality. EPA420-R-08-001a. May. See: Chapter 6. Available at: http://www.epa.gov/otaq/regs/nonroad/420r08001a.pdf.

[32] SANDAG,, ICF meeting, 3/18/21.

[33] Here and below we refer to years 2016 for baseline and 2050 for Plan.

(3) $Cases = Cases_{2016} - Cases_{2050}$
The change in the overall number of cases attributable to air pollution between 2016 and 2050. Under this approach, it was expected that improvements in air quality would reduce the burden of air pollution, whereas population growth and aging would increase the burden of air pollution.

In these equations, AQ_{2016} represents the satellite data PM2.5 concentrations (including both anthropogenic and background sources) from the Atmospheric Composition Analysis Group and AQ_{2050} represents estimated 2050 PM2.5 concentrations under the Plan. As introduced in Section 2.3.2, BenMAP was run considering both proportional and incremental estimation approaches for AQ_{2050} when calculating $Cases_{2050}$. Outputs for both options and the average of the two forms were reported. The change in cases between 2050 and 2016 were evaluated using the average of the two options:

$$Cases = Cases_{2016} - mean(Cases_{2050,Proportional}, Cases_{2050,Incremental})$$

As above, all air quality surfaces were specified at the CBG level. BenMAP outputs were summarized by location (CBG), health endpoint, and the demographic groups available for reporting in the model: age, race, and ethnicity.[34]

<u>*Demographic inputs*</u>

SANDAG provided the race- and ethnicity-specific data required for input into the health impact analysis.[35] The data included CBG-specific populations stratified by race/ethnicity (Hispanic and non-Hispanic White, Black, Asian, American Indian), age (<1, 1-4, 5-9,…[5 year age groups through 84], 85+), and sex. The data were provided for both years, 2016 and 2050. This data reflects the number of people affected by changes in PM2.5 levels under the Plan.

<u>*Incidence data*</u>

The baseline incidence rates are estimates of the average number of people who would experience an adverse health effect in a given population over a specified period of time (e.g., count of persons with acute bronchitis per total population *per year).* County-specific incidence data was requested for use in this analysis from the County of San Diego Health & Human Services Agency. However, due to commitments related to supporting Covid issues, they were not able to provide the detailed information requested. Thus, default baseline health incidence data included in BenMAP was used.

BenMAP includes pre-loaded age-, cause-, and county-specific mortality rates for the United States in five-year increments, from years 2000 to 2060. Pre-loaded all-cause mortality incidence rates associated with the year closest to the two model years are used (2015 mortality rates for the 2016 model year and 2050 mortality rates for the 2050 model year). For non-mortality health endpoints, BenMAP includes pre-loaded incidence rates that reflect incidence data from the year 2014 or earlier. Certain non-mortality health endpoint baseline incidence data is provided at the county-level, while other baseline incidence data reflect state-level averages of health incidence. BenMAP does not include baseline health incidence data at the CBG level nor does the default incidence data vary by race or ethnicity. The product of the baseline incidence rates and the CBG-level

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[34] Outputs are reported for each health impact and include the age groups pertinent to each health impact function and the associated CBG-level population per race and ethnicity.

[35] See https://datasurfer.sandag.org/download/sandag_forecast_13_region_san-diego.pdf.

population provides the total baseline incidence per year in the analysis region – a necessary input for the health impact functions.

Postprocessing

Separate BenMAP models were run for each race/ethnicity-specific population in batch mode via BenMAP's command line feature (U.S. EPA, 2021).[36] Outputs of the BenMAP command line analyses included 3 files for each race/ethnicity, year, and AQ_{2050} estimation approach (proportional or incremental):

1. Configuration Output: Individual study-specific health impact results
2. Incidence Output: Pooled estimates of health impacts
3. Audit Trail Reports: Meta-data describing inputs and selections for each analysis

The BenMAP configuration and incidence outputs were postprocessed using the R software package to produce summary results that calculated average estimates based on 2050 analysis proportional and incremental air quality approaches, evaluated the changes in cases from 2016 to 2050, and evaluated the per capita changes in cases from 2016 to 2050. While the incidence output provided the health effect-specific point estimates of changes in the number of cases for each year considered, the configuration output provided the associated populations associated with each estimate for calculating per capita changes in cases from 2016 to 2050. Audit trail reports were reviewed for quality assurance to evaluate consistency between input datasets and model selections for each model run. This R code also produced health effect-specific summaries for the entire modeling domain by total population and race/ethnicity subpopulation. For instance, to calculate the per capita change in the number of cases of acute bronchitis for all Hispanic Asians within the modeling domain, the sum of change in cases estimates for all CBGs was divided by the total population of Hispanic Asians within the age range evaluated in the acute bronchitis health impact function (ages 8 to 12).

2.3.4 QUALITY ASSURANCE

The following summarizes the quality assurance (QA) steps performed on each step of this detailed modeling chain.

Emissions Modeling

Raw emissions for Plan sources underwent thorough QA as part of the EIR process. For this HIA, the modifications made were confirmed by comparing them to those from the EIR once they were consolidated across the entire CALPUFF domain.

Emissions for non-Plan sources were taken entirely from published values. QA consisted of ensuring that these values were included correctly in the model.

Air Quality Modeling

QA of the air quality modeling consisted of carefully reviewing model settings and outputs and the consolidated combination of model outputs combined with the observed satellite data. For the model outputs, the CALPOST

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[36] BenMAP's command line feature performs all the functions of the graphical user interface version of BenMAP and is useful for performing analyses that require generation of a substantial number of files.

output was used to provide coordinates for each receptor, and confirm that the range and distribution of results were reasonable, ensuring that results were not incorrectly scaled and that there were no other postprocessing mistakes. The results were then reviewed across the receptor domain and were found to be within expected bounds. The runs were set up so each single simulation produced output text files that log the status of each simulation at each modelling timestep. These logs were then reviewed to ensure all runs completed as expected and without error.

Health Impact Modeling

BenMAP was run using the command line feature to automate modeling of year-, race-, and ethnicity-specific analyses. The command line modeling scripts were configured to include audit trail reports specifying model grid and health incidence pooling selections as well as the file names of pollutant concentration and population inputs. QA steps for the BenMAP analysis included:

1 Review of audit trail reports to ensure inclusion of proper model inputs and selections;

2 Comparison of populations associated with health incidence estimates to original population data provided by SANDAG; and

3 Comparison of pooled incidence results and associated health impact function authors to EPA-recommended pooling configurations used in the ACE Rule.

BenMAP outputs were further postprocessed to combine results from the proportional and incremental air quality estimation approaches and to produce summary tables in R. QA of these scripts was performed by performing calculations in Excel to validate the R program outputs.

3 OUTPUT AND RESULTS

3.1 AIR QUALITY

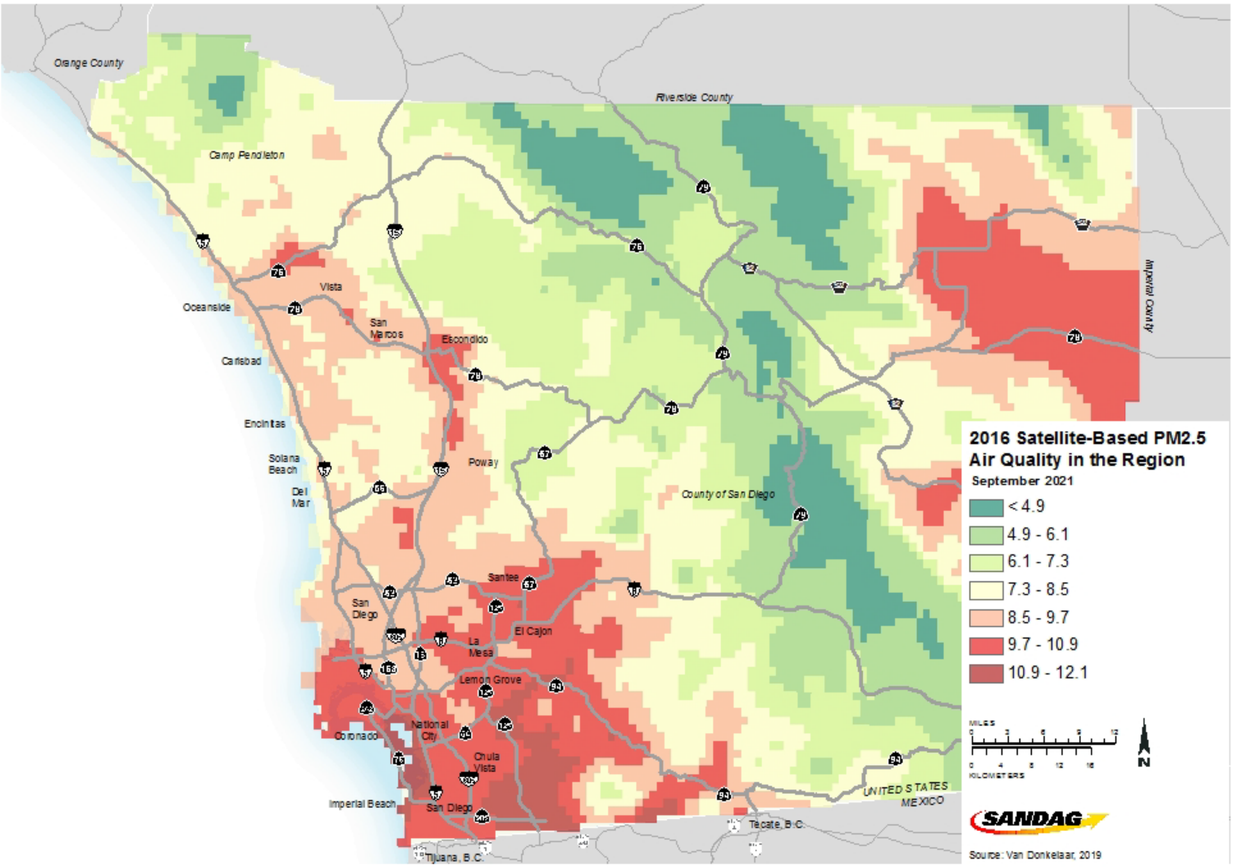
Section 2.3.2 discussed the approach used to obtain total PM2.5 air quality surfaces for years 2016 (from satellite data) and 2050 (from a combination of satellite data and CALPUFF modeling). The results from this analysis are summarized here.

Figure 2 shows the baseline PM2.5 air quality surface. This is the “satellite” data, in units of μg/m^3, discussed in Section 2.3.2.

Figure 3 shows the predicted changes in PM2.5 concentration between 2016 and 2050 using the two approaches discussed in Section 2.3.2. In these figures, positive values indicate reductions, that is, improved air quality. Although the spatial trends are similar between the two approaches, the nonlinear, proportional approach shown on the left leads to a more complex air quality surface when combined with the 2016 data than does the incremental approach. Both tend to show the greatest improvements in air quality near the center of the modeling domain and the greatest predicted degradation of air quality in the southeastern portion of the modeling domain. However, this degradation is barely negative with the incremental approach but is strongly so in the proportional approach. That is, the linear, incremental case produces a “flatter” air quality surface than the nonlinear, proportional approach. For example, regarding the southeastern corner of the domain (southeast of Chula Vista), the modeled concentrations are small, but show degradation between 2016 and 2050. When this is coupled with the satellite data, which shows the worst air quality in this area. So even though there are few modeled sources in this area, the combination of the modeled change with the observed PM2.5 field leads to a notable increase in this area. None of the areas showing increases are considered DACs.

As discussed in Section 2.3.2, the 2050 air quality surfaces are not directly modeled, but based on a combination of modeled and observed data. The values shown in Figure 3 are distinct from the EIR results and should not be directly compared with those in the EIR. They use different scopes and a different model. The focus here is on the best prediction of changes in the regional air quality due to the Plan, while the EIR focused on near-source “hotspots” that are directly impacted by Plan sources. The surfaces derived here are intended for use in predicting regional health impacts of the Plan with the BenMAP model.

Figure 2. 2016 Satellite-Based PM2.5 Concentrations (µg/m3) in San Diego County



Source: Van Donkelaar, 2019

Figure 3. Predicted Changes in PM2.5 Concentrations (2016-2050, μg/m3) in the Region under Two Approaches (Left Is Proportional, Right Is Incremental)

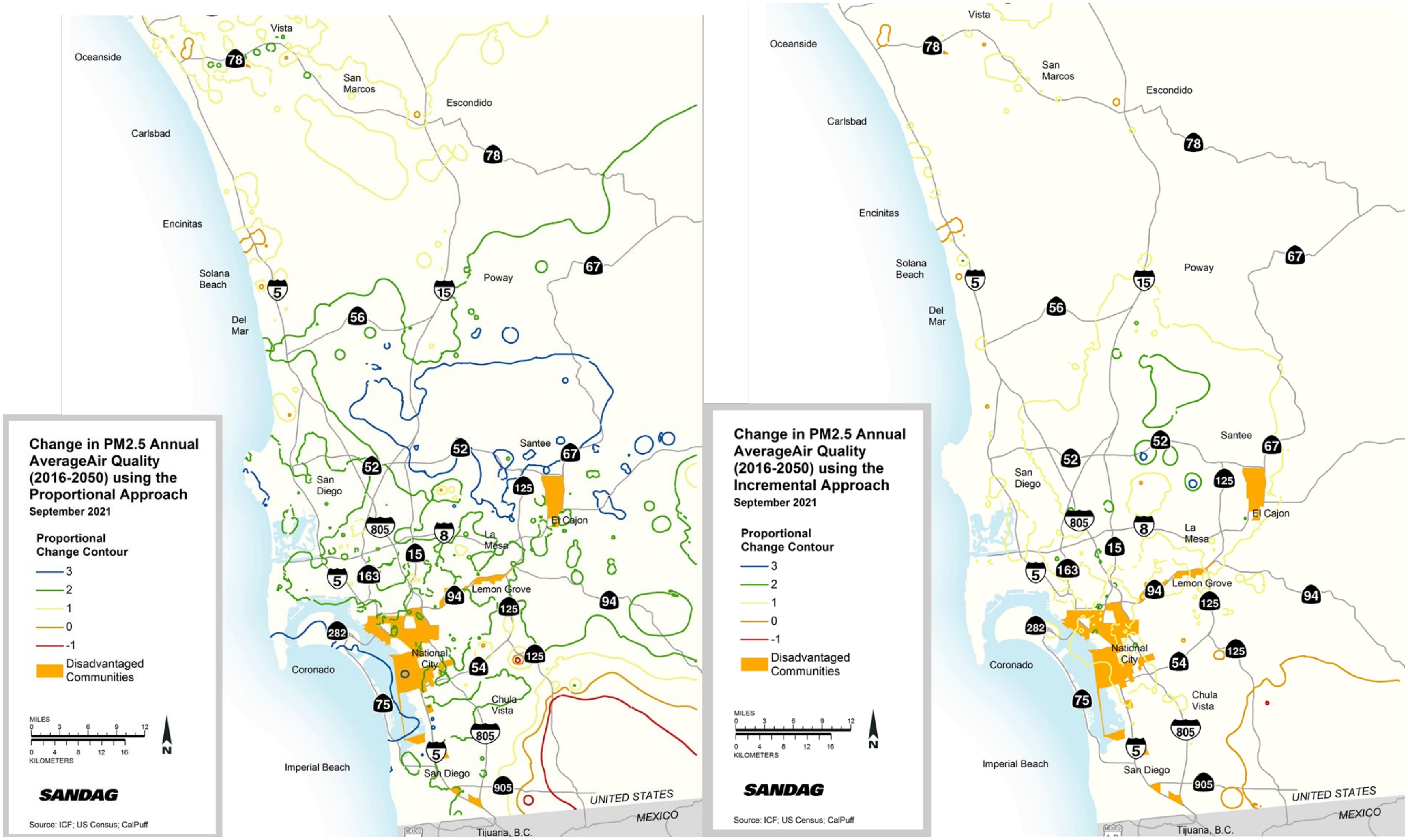


Table 8 presents the minimum, maximum, and average PM2.5 concentrations in 2016 (based on satellite data) and in 2050. These are long-term average concentrations, 3-year average of 24-hour average concentrations, and comparable to an annual average value. The 2050 values represent three potential options of the combining the satellite data and modeled CALPUFF results: the proportional and incremental approaches, and the average of these two. These statistics are shown for two different portions of the County: the entire modeling domain and the portion of the modeling domain considered DAC. DAC is considered to be a CBG with a CalEnviroScreen 4.0 score of more than 75 percent or higher. As described in Sections 2.3.2 and 2.3.3, the two approaches represent the two different forms of 2050 PM2.5 concentration surfaces used in the separate BenMAP analyses: one based on a proportional change in the 2016 satellite data and another based on an incremental change in the 2016 satellite data.

DAC have a higher overall minimum and average PM2.5 concentration compared to the entire modeling domain. For example, the entire modeling domain has an average PM2.5 concentration in 2016 of 9.62 μg/m^3, with the "average approach" predicting that value will decrease to 8.3 μg/m^3 by 2050 under the Plan. DACs see a slightly steeper reduction, from an average concentration of 10.35 to 8.78 μg/m^3 (using the "average approach"). Notably, maximum PM2.5 concentrations in 2050 are higher in the entire modeling domain compared to DAC. This is due to the combination of high satellite concentrations and marginal increases in PM concentrations in the modeling with the proportional approach, discussed above.

Table 8. Average PM2.5 Air Quality

Area	Statistic	PM2.5 Concentration (μg/m^3)			
		2016	2050		
			Average	Proportional	Incremental
Entire Modeling Domain	Minimum	4.10	3.89	3.70	4.08
	Maximum	11.90	15.69	18.82	12.56
	Average	9.62	8.30	7.75	8.85
Disadvantaged Communities[a]	Minimum	9.40	7.66	7.11	7.73
	Maximum	11.70	9.77	9.52	11.06
	Average	10.35	8.78	8.18	9.38

[a] Disadvantaged communities are defined in this work as any CBG with a CalEnviroScreen percent score of 75% or higher.

This modeling is not a comprehensive evaluation of secondary PM but is discussed here to illustrate trends. The predicted secondary fraction of PM2.5 was extracted across the modeling domain to review model predictions in this configuration. Primary PM2.5 concentrations comparing long-term average concentrations spatially averaged across the domain decrease from 2016 to 2050 by approximately 26%. This is somewhat higher but comparable to the AERMOD outputs from the EIR, which showed domain-average annual average concentrations dropping from 2016 to 2050 by about 20%. Differences were expected due to the different modeling approaches and tools, including the larger number and range of sources and spatial coverage compared to the AERMOD approach. (The EIR only examined direct impacts within 500 ft. of major sources.) Given the differences, these trends are reasonable. This modeling predicts that the secondary fraction of PM in the modeling domain is very small, only about 5 percent. This is likely an underestimate due to CALPUFF's limited chemistry. Secondary concentrations as well as secondary fractions decrease in the projected year. This is to be expected because precursor pollutants are reduced along with primary PM. So, according to this modeling, the secondary fraction is small and becomes less important. In both 2016 and 2050, the secondary fraction tends to be higher inland than on the coast, although the 2050 distribution is more nuanced, showing peaks near La Jolla, while 2016 is generally largest north of Escondido. As a fraction, this is a product of both secondary chemistry and the primary mass.

Table 9. Predicted Primary and Secondary PM2.5 (μg/m³, or fraction) Across the Modeling Domain

	2016			2050			Growth		
	Primary PM2.5	Secon-dary PM	Secon-dary Fraction	Primary PM2.5	Secon-dary PM	Secon-dary Fraction	Primary	Secon-dary	Total
Mean	2.95	0.14	5%	2.24	0.08	4%	-26%	-37%	-26%
Standard Deviation	1.75	0.09	1%	1.51	0.04	2%	13%	26%	11%

3.2 HEALTH IMPACT

Table 10 presents a comparison of the populations for the entire modeling domain and among DACin 2016 and 2050. While the entire population aged 0 to 99 years increases by approximately 13% from 2016 to 2050 in the modeling domain, the percentage population increase among DAC in this period is more than double that of the modeling domain (29%). The sharpest increases in population in both the modeling domain and the subset of CBGs defined as DAC are among adults aged 65 to 99 years, which has implications for potential air quality-induced changes in health effects that tend to afflict older populations, such as heart attacks. While the population of adults aged 65 to 99 years nearly doubles (74% increase, 450k to 780k) in 2050 among the entire area, this population grows much faster among DACs, more than doubling (140% increase, 18k to 43k). In 2016 roughly 4% of this age group lives in DACs, but 5.5% by 2050.

Table 10. Overall Population Age Distribution

Age Range	2016[a]		2050[a]	
	Entire Modeling Domain	Disadvantaged Communities[b]	Entire Modeling Domain	Disadvantaged Communities[b]
0 to 64	2,784,030	163,102	2,877,333	189,899
65 to 99	448,718	17,841	781,719	42,665
0 to 99	3,233,835	181,047	3,668,688	232,997

[a] This table reports total populations per applicable age range only associated with census block groups for which there are nonzero 2016 and 2050 populations. Thus, the sum of the population values for ages 0 to 64 and 65 to 99 are not equivalent to the 0 to 99 population.
[b] Disadvantaged communities are defined in this work as any Census Block Group with a CalEnviroScreen score greater than or equal to 75%.

Figure 4 and Figure 5 provide race/ethnicity-specific breakdowns of population changes between 2016 and 2050 in the entire modeling domain and among the subset of CBGs defined as DACs, respectively. Figure 4 indicates that the population aged 65 to 99 years is increasing among most of the race/ethnicity subpopulations evaluated in this analysis, while the population aged 0 to 64 years is increasing at a less rapid rate or is decreasing (e.g., among the non-Hispanic Black and non-Hispanic White subpopulations). Within the subset of CBGs defined as DACs, a similar pattern is shown, where the population aged 65 to 99 years is increasing among most of the race/ethnicity subpopulations (Figure 5). However, among the DAC CBGs the age 0 to 64 population is decreasing among the Hispanic Other and Hispanic White subpopulations and increasing among the non-Hispanic White subpopulation. Figure 6 presents the percentage of the total population that are aged 0 to 64 and aged 65 to 99 in the entire modeling domain and among DAC in 2016 and 2050. Among both sets of populations, the percentage of the population aged 65 to 99 years is increasing in 2050, while the percentage of the population aged 0 to 64 years is decreasing in 2050.

Figure 4. Comparison of the 2016 and 2050 Populations Living within the Modeling Domain in 2016 and 2050 by Race and Ethnicity

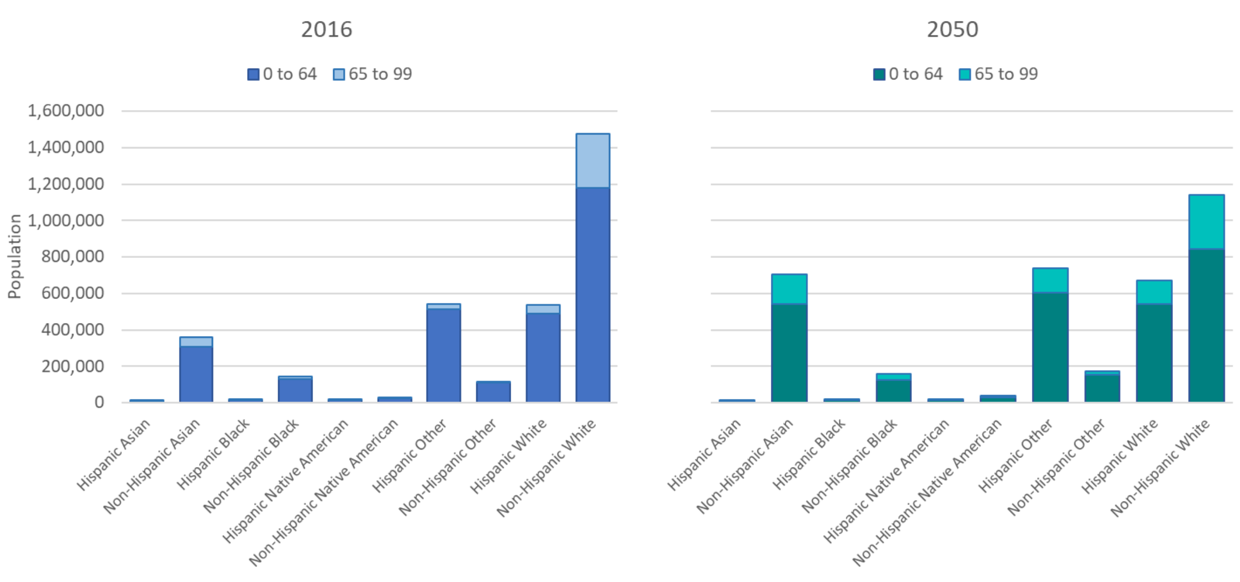


Figure 5. Comparison of the 2016 and 2050 Populations Living in Disadvantaged Communities by Race and Ethnicity

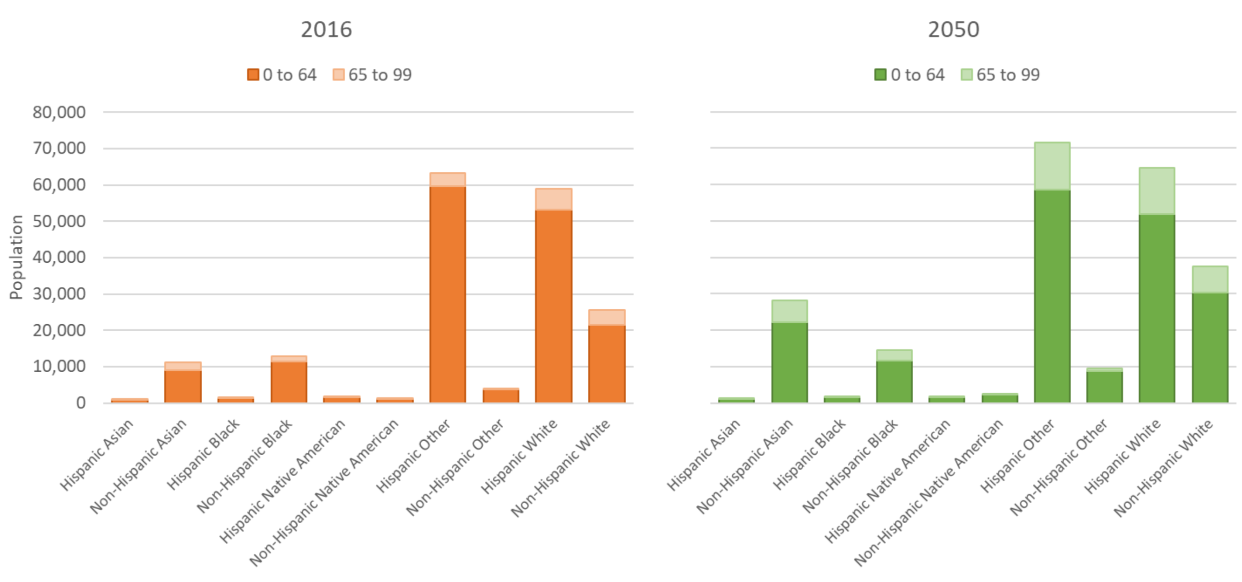


Figure 6. Comparison of Population Percentages Among the Modeling Domain and Disadvantaged Communities in 2016 and 2050

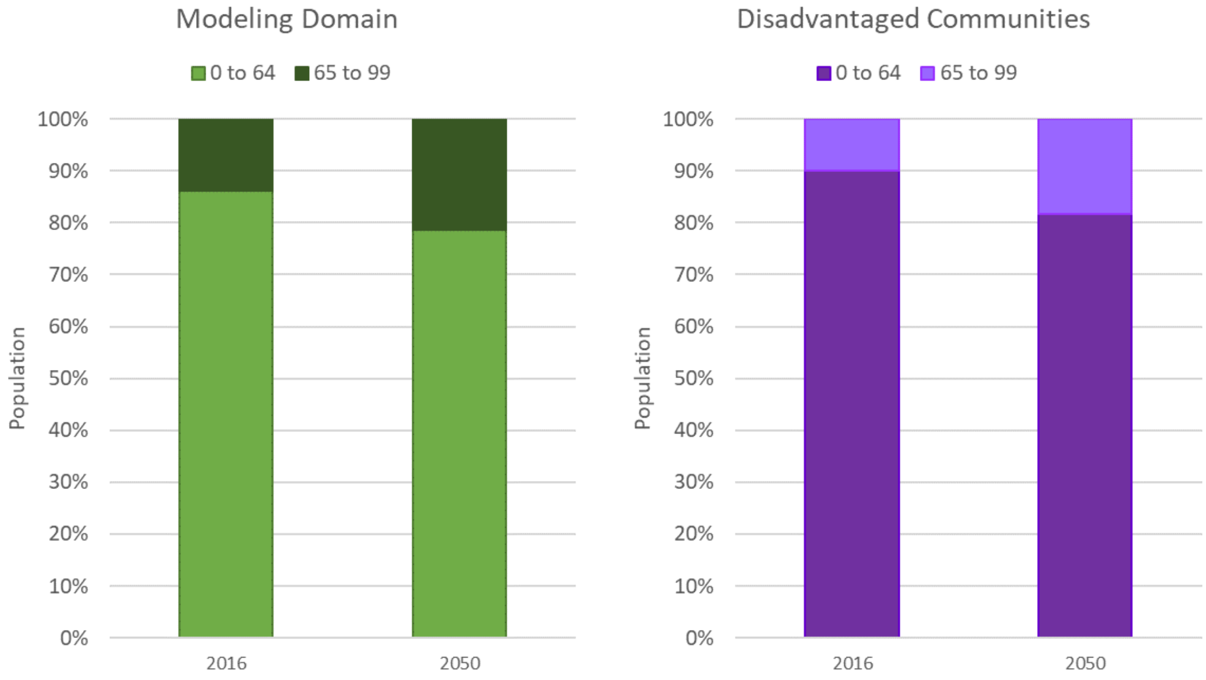


Table 11 provides a summary of changes in PM2.5-related deaths and illnesses within all the evaluated CBGs under the Plan and within CBGs identified as DAC based on their CalEnviroScreen (4.0) percentile score. Note that these modeled, population estimates are based on best-available information including predictions of future air quality, demographics, population, and current understanding of health impacts of air pollution. They should be understood as central values of statistical estimates of impacts rather than specific counts of mortalities or other adverse health outcomes. Appendix B includes 90% confidence interval estimates for the individual predictions. Results are presented in nearly the same format as PM2.5-related results provided in the US EPA's ACE rule, including separate estimates for separate mortality and non-fatal heart attack functions and age groups as well as pooled estimates among endpoints based on multiple studies. Positive values indicate avoided premature deaths and illnesses, while negative values indicate potential increases in deaths and illnesses under the Plan.

Because the equations for the changes in cases in 2016 and 2050 rely on different inputs, the changes in the number of cases reported in this table are not due solely to changes in air quality. In other words, because BenMAP calculates the change in incidence or prevalence of various health effects based on a function that includes baseline health incidence or prevalence and population, the changes in the number of cases may be strongly correlated with the change in population from 2016 to 2050. Note, however, that except for mortality incidence, baseline incidence and prevalence data do not vary from year to year.

Results show that the "avoided cases" between 2016 to 2050 is often negative, indicating an increase in the incidence of a particular health effect under the Plan. In several circumstances, the average estimated increase in avoided deaths and illnesses shown in this table can be attributed to a rapidly growing population from 2016 to 2050, especially among adults aged 65 to 99 years. That is, more people leads to more incidences of poor health independent of other drivers including air quality. While air quality changes under the Plan might lead to lower incidence of a particular health effect in 2050, the population exposed is often much larger, so the number of cases of certain health effects estimated by BenMAP in 2050 are larger than in 2016.

Table 11 presents results based on certain studies and age ranges. It also shows the results separately for the proportional, incremental, and average approaches for air quality. Where it makes sense, these have been grouped into sums and averages. For example, with average air quality and average estimate of impacts, the results indicate that approximately 40 more premature deaths should be expected in DACs and 490 in the entire area in 2050 relative to 2016.

Table 11. Estimated Avoided PM2.5-Related Premature Deaths and Illnesses

Category	**Basis**	**Applicable Age Range**	**Entire Modeling Domain**[a,b]			**Disadvantaged Communities**[a,b,c]		
			Average	**Proportional**	**Incremental**	**Average**	**Proportional**	**Incremental**
Avoided premature death								
Adult Mortality, 30-64	Turner et al. (2016)	30 to 64	130	140	130	5.5	6.1	5.0
Adult Mortality, 65+	Turner et al. (2016)	65 to 99	-560	-480	-650	-41	-35	-48
	Di et al. (2017)	65 to 99	-680	-580	-780	-50	-42	-57
Infant Mortality	Woodruff et al. (2006)	0	2.6	2.8	2.5	0.19	0.21	0.18
Total avoided premature mortalities	Lower estimate (from Turner & Woodruff)	0, 30 to 99	-430	-340	-520	-36	-29	-43
	Higher estimate (from Turner, Di, & Woodruff)	0, 30 to 99	-540	-440	-650	-44	-36	-52
	Average of estimates	***0, 30 to 99***	***-490***	***-390***	***-590***	***-40***	***-32***	***-47***
Avoided non-fatal heart attacks among adults								
Peters et al. (2001)		18 to 99	-390	-320	-460	-34	-28	-39
Pooled estimate[d]		18 to 99	-44	-36	-53	-3.9	-3.2	-4.7
Average non-fatal heart attacks estimate		***18 to 99***	***-220***	***-180***	***-250***	***-19***	***-16***	***-22***
All other avoided morbidity effects								
Hospital admissions—cardiovascular		18 to 99	-130	-110	-160	-12	-9.4	-14
Hospital admissions—respiratory		65 to 99	-140	-120	-160	-10	-8.7	-12

Category	Basis	Applicable Age Range	Entire Modeling Domain[a,b]			Disadvantaged Communities[a,b,c]		
			Average	Proportional	Incremental	Average	Proportional	Incremental
Hospital admissions—asthma		0 to 64	8.0	11.0	5.2	0.21	0.48	-0.064
Hospital admissions—chronic lung disease		18 to 64	3.9	6.3	1.4	-0.35	-0.12	-0.58
ER visits for asthma		0 to 99	27	54	0.012	-0.10	2.5	-2.7
Exacerbated asthma		6 to 18	12,000	14,000	9,400	920	1,100	690
Minor restricted-activity days		18 to 64	25,000	82,000	-32,000	-6,900	-1,300	-13,000
Acute bronchitis		8 to 12	440	510	370	34	41	27
Upper resp. symptoms		9 to 11	9,200	11,000	7,600	720	880	560
Lower resp. symptoms		7 to 14	5,800	6,800	4,900	450	540	350
Lost work days		18 to 64	2,300	12,000	-7,600	-1,300	-270	-2,200

[a] Values rounded to two significant digits. Negative values indicate increases in incidence of health effect.
[b] Values reflect the difference between cases estimated in 2016 and cases estimated in 2050. Because populations differ among these estimates, negative morbidity effect estimates may be attributable to changes in population among the years evaluated. In addition, baseline mortality incidences differ among these estimates, so negative values associated with changes in mortality cases may result from both population differences and baseline mortality incidence differences.
[c] Disadvantaged communities are defined in this work as any Census Block Group with a California EnviroScreen percent score greater than or equal to 75%.
[d] The pooled nonfatal heart attack estimate is based on four studies: Pope et al. (2006), Sullivan et al. (2005), Zanobetti and Schwartz (2006), and Zanobetti et al. (2009).

To help avoid confusion related to the changing population exposed to air quality changes in 2016 and 2050, Table 12 presents normalized estimates of the changes in cases. That is, while Table 11 shows total cases, Table 12 divides these impacts by the population in each year and reports the change in cases per 100,000 persons.[37] The layout is identical to Table 11 and, as there, positive values indicate avoided premature deaths and illnesses, while negative values indicate potential increases in deaths and illnesses under the Plan. Although baseline mortality incidence varies among 2016 and 2050, the normalized estimates provide a more direct assessment of air quality impacts.

Results indicate that, under the Plan, the populations in the modeling domain would experience an average of 30 fewer deaths per 100,000 persons. This is the average of the estimates of total avoided premature mortalities from the incremental and proportional approaches, and average of lower and higher health impact estimates, considering all ages. This value is shown in bold. Similarly, reduced cases of hospital admissions for asthma and chronic lung disease, ER visits for asthma, exacerbated asthma cases, minor restricted activity days, acute bronchitis, upper and lower respiratory symptoms, and lost work days are positive across the region, indicating avoided cases, or improved health outcomes under the Plan. On average, the number of reduced cases per 100,000 persons among DACs are even higher than in the entire modeling domain for mortality cases, exacerbated asthma, minor restricted activity days, acute bronchitis, upper and lower respiratory symptoms, and lost work days. Here, the Plan is expected to avoid 48 premature deaths per 100,000.

While results indicate that incidence of nonfatal heart attacks will increase under the Plan, these results reflect sum-dependent pooling of individual estimates of nonfatal heart attacks for adults aged 18 to 24, 25 to 44, 45 to 54, 55 to 64, and 65 to 99 years as is standard in EPA's recommended pooling framework implemented in the ACE rule. In other words, BenMAP calculates the changes in cases of nonfatal heart attacks for each age group separately, based on populations and health impact function coefficients specific to each age group. The pooling method sums the resulting changes in cases to develop a single estimate for adults aged 18 to 99. However, population changes from 2016 to 2050 vary significantly depending on the age group: the population aged 18 to 24 years is increasing by 7%, the population aged 25 to 44 years is increasing by 20%, the population aged 45 to 54 years is increasing by 1%, the population aged 55 to 64 years is decreasing by 2%, and the population aged 65 to 99 years is increasing by 74%. For instance, the Peters et al. (2001) health impact function would yield positive changes in cases per 100,000 persons if each age bin were analyzed individually. However, due to the complicated nature of pooling methods defined in the EPA ACE rule configuration, pooled results are represented as per 100,000 persons regardless of age. When determining the change in cases from 2016 to 2050 based on overall population changes in the age 18 to 99 years cohort, age groups with population changes that are more drastic, such as the age 65 to 99 cohort, may have overdue influence on the overall change in cases per 100,000 persons estimate. A similar phenomenon occurs for cardiovascular hospital admissions, which reflect weighted pooling of estimates for adults aged 18 to 64 years and multiple studies for adults aged 65 to 99 years.

In other words, the differences in the population age distribution in 2016 and 2050 leads to the negative values in the reported avoided cases per 100,000 persons estimates (i.e., an increase in cases per capita). This is a mathematical consequence of the aging population, and the normalization of results by total population. For a given population, if that population is relatively older, they are more susceptible to poor health outcomes.

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[37] Technically, the per capita estimates are achieved by dividing the Point Estimate values for 2016 and 2050 by the 2016 and 2050 population values specific to the age group considered for each health impact function used to determine the outcomes. This population may be smaller than the total population, but the impact is consistent with the constraints of the underlying research.

Because of this, even improving air quality under the Plan may not always lead to improving health outcomes due to the aging population by 2050.

Results for respiratory hospital admissions, applicable to adults aged 65 to 99 years, vary based on the approach for quantifying air quality in 2050. Using the proportional approach, cases of respiratory hospital admissions for the entire modeling domain decrease, while using the incremental approach, cases increase.

Table 12. Estimated Avoided PM2.5-Related Premature Deaths and Illnesses Per 100,000 Persons

Category	Basis	Applicable Age Range	Entire Modeling Domain[a,b]			Disadvantaged Communities[a,b,c]		
			Average	Proportional	Incremental	Average	Proportional	Incremental
Avoided premature death								
Adult Mortality, 30-64	Turner et al. (2016)	30 to 64	9.9	10	9.5	10	10	9.4
Adult Mortality, 65+	Turner et al. (2016)	65 to 99	14	25	3	30	44	15
	Di et al. (2017)	65 to 99	16	29	3.5	35	53	18
Infant Mortality	Woodruff et al. (2006)	0	5.2	5.7	4.8	6	6.7	5.3
Total avoided premature mortalities	Lower estimate (from Turner & Woodruff)	0, 30 to 99	29	41	17	45	61	30
	Higher estimate (from Turner, Di, & Woodruff)	0, 30 to 99	32	45	18	51	70	32
	Average of estimates	0, 30 to 99	***30***	***43***	***18***	***48***	***66***	***31***
Avoided non-fatal heart attacks among adults								
Peters et al. (2001)		18 to 99	-5.9	-3.6	-8.3	-7.5	-4.5	-10
Pooled estimate[d]		18 to 99	-0.65	-0.35	-0.95	-0.82	-0.44	-1.2
Average non-fatal heart attacks estimate		18 to 99	-3.3	-2	-4.6	-4.2	-2.5	-5.8
All other avoided morbidity effects								
Hospital admissions—cardiovascular		18 to 99	-2.2	-1.4	-3.1	-2.6	-1.5	-3.7
Hospital admissions—respiratory		65 to 99	-1.2	1.2	-3.6	1.3	4.6	-2
Hospital admissions—asthma		0 to 64	0.35	0.44	0.25	0.43	0.58	0.29

Category	Basis	Applicable Age Range	Entire Modeling Domain[a,b]			Disadvantaged Communities[a,b,c]		
			Average	Proportional	Incremental	Average	Proportional	Incremental
Hospital admissions—chronic lung disease		18 to 64	0.4	0.51	0.29	0.29	0.45	0.13
ER visits for asthma		0 to 99	2.7	3.4	1.9	4	5.1	2.9
Exacerbated asthma		6 to 18	1100	1600	670	1600	2200	870
Minor restricted-activity days		18 to 64	6200	8700	3600	8600	12000	4700
Acute bronchitis		8 to 12	93	130	54	130	190	70
Upper resp. symptoms		9 to 11	3400	4900	2000	4800	7000	2700
Lower resp. symptoms		7 to 14	780	1100	450	1100	1600	590
Lost work days		18 to 64	960	1400	510	1400	2100	760

Notes:

(a) Values rounded to two significant digits. Negative values indicate increases in incidence of health effect.

(b) Values reflect the normalized (per 100,000 persons) difference between cases estimated in 2016 and cases estimated in 2050. Because populations differ among these estimates, negative morbidity effect estimates may be attributable to changes in population among the years evaluated. In addition, baseline mortality incidences differ among these estimates, so negative values associated with changes in mortality cases may result from both population differences and baseline mortality incidence differences.

(c) Disadvantaged communities are defined in this work as any Census Block Group with a CalEnviroScreen percent score greater than or equal to 75%.

(d) The pooled nonfatal heart attack estimate is based on four studies: Pope et al. (2006), Sullivan et al. (2005), Zanobetti and Schwartz (2006), and Zanobetti et al. (2009).

In addition to the summary tables shown above, a processed summary table of changes in health endpoint incidences by CBG and demographic categories for the modeled areas is provided. This output includes:

- CBG identifier,
- flag for disadvantaged community,
- CalEnviroScreen percentage score,
- endpoint,
- applicable ages of health impact function (e.g., the Mortality Turner et al. function applies only to ages 30-64),
- race,
- ethnicity,
- population associated with the age range and race/ethnicity,
- point estimate of incidence change (change in cases),
- air quality as total PM2.5 concentrations,
- normalized point estimate of incidence change (change in cases per 100,000 persons),
- 95 percent confidence intervals from the individual BenMAP simulations.

This file is attached as Appendix B.

4 UNCERTAINTY IN THE ANALYSIS

This section discusses some uncertainties present in this analysis.

4.1 AIR QUALITY

In the CALPUFF air quality modeling, only Plan sources are projected. Those are modeled with the best available information and generally consistent with the information in the EIR. For non-Plan sources, no consistent projection is available. In fact, both the amount and location of emissions in the county will change over the modeled time period. This leads to uncertainty in the total PM2.5 concentrations derived here. The focus here was to isolate the direct impact of the Plan. Observations are also integrated into the projection as much as possible to reduce modeled uncertainty.

CALPUFF is more sophisticated than AERMOD but is not a full atmospheric photochemical model. There is parametric and model formulation uncertainty in any modeling assessment due to the model itself and the inputs it uses. Particulate chemistry is also integrated to capture secondary formation of PM2.5, which adds uncertainty due to the parameterizations of chemical reactions in the model and the uncertainty in the chemistry formulations. Since direct PM cannot be speciated, the effect of particulate chemistry on secondary formation is not included, only an estimation of gas-to-particle transitions. the low secondary PM fraction modeled here may be due to this limitation, particularly for secondary organic species. CALPUFF was also modified for use here, as described in Section 2.2.1. Any related uncertainty was mitigated by reviewing coded logic, compiling parameters, and reviewing output from isolated, controlled test cases before applying to the scenario.

Non-Plan sources were also approximated to reach an arbitrary 90% threshold of regional emissions. It is possible that sources or species that are important for overall PM concentrations were not adequately included. For example, Mexican sources were omitted. The goal of using a combination of modeled and monitored air quality data is to reduce bias in the results, such as that which could result from omitting sources, including those from Mexico. Figure 2 clearly shows that these cross-border sources are important the baseline PM2.5 air quality. Section 2.3.2 discussed how the “proportional” approach exaggerated air quality impacts in the southeast portion of the domain. This uncertainty was mitigated by using observed data and including two different approaches of forecasting 2050 air quality.

4.2 HEALTH IMPACT

The key uncertainties associated with the health impact modeling (other than air quality; see Section 4.1) are related to population estimates, health impact functions, and related factors. Table 13 summarizes the principal limitations and sources of uncertainty related to using BENMAP in this application and other aspects of this health impact analysis.

Table 13. Limitations and Uncertainties in the Analysis of Human Health Effects from Changes in PM2.5 Concentration Levels under the Plan

Uncertainty/Assumption	Notes
The analysis assumes that the exposed population is the population living in each CBG and does not examine commuter impacts.	The modeling approach assumes that the CBG population is exposed to $PM_{2.5}$ levels associated with a particular CBG and does not consider different exposure levels for those who commute or travel regularly to other locations within or outside of San Diego County. This may result in an underestimate or overestimate of changes in health effects.
The analysis relies on population projections in a high-resolution grid.	Future population estimates in highly localized locations, such as CBGs, are uncertain due to the many unknown factors that could influence population changes, including migration, fertility, and future life expectancy. Population projections were provided by SANDAG and are the best available information. Furthermore, CBGs considered DACs may not remain so in future years, or vice-versa, due to population shifts.
The analysis is limited to populations associated with the age groups for which health impact functions were developed.	Certain health impact functions available in BenMAP are applicable only to specific age groups, based on the current state of science regarding the nature of air quality health effects (e.g., BenMAP evaluates Acute Bronchitis cases for those aged 8-12 only). Future advancements in the understanding of air quality health effects may result in health impact functions that are applicable to broader age groups.
BenMAP default health incidence data is projected to 2050 for mortality incidence only. Baseline incidences for all other health endpoints remain constant.	Local baseline incidence data was unavailable so The default BenMAP-CE baseline health incidence and prevalence data were used. Predictions of baseline health incidence for future years are not widely available for non-mortality health effects. This means that default morbidity health incidence data from 2014 or earlier are used in the analysis of both 2016 and 2050 health effects.
The analysis assumes that health impact functions based on national or regional studies are representative of exposure and population characteristics in San Diego County.	BenMAP does not include health impact functions specific to the San Diego region. Instead, default BenMAP health impact functions from peer reviewed studies that may focus on national data or regional U.S. locations are relied upon.
The analysis relies on the same health impact functions and baseline health incidence rates for all race/ethnicity subpopulations	BenMAP does not include health impact functions and baseline health incidence data that are specific to any race/ethnicity subpopulation included in the analysis.

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APPENDIX A. SUMMARY TABLES OF AIR QUALITY AND HEALTH CHANGES

Table A1 and Table A2 present the estimated avoided PM2.5-related premature deaths and illnesses for the entire modeling domain and for DAC, respectively, by race and ethnicity. These results represent the average change in cases considering both proportional and incremental 2050 air quality approaches. In these results, the highest-magnitude increase in cases (in other words, most negative values reported in the table) among health impacts that consider a wide range of ages tend to occur among subpopulations that will experience the largest increases in total population from 2016 to 2050 (non-Hispanic Asian, Hispanic Other, and Hispanic White subpopulations within the entire modeling domain and non-Hispanic Asian and Hispanic Other subpopulations within DAC).

Table A3 and Table A4 present the estimated avoided PM2.5-related premature deaths and illnesses, normalized to populations of 100,000 persons, for the entire modeling domain and for DAC, respectively, by race and ethnicity. These results represent the average change in cases considering both proportional and incremental 2050 air quality approaches. In terms of avoided premature mortality cases, the Asian, Hispanic Black, and Hispanic white subpopulations are likely to experience the greatest benefits of reduced PM2.5 exposure under the Plan. Within DAC, non-Hispanic Asian, Hispanic Black, and Hispanic white subpopulations are likely to experience the greatest avoided premature mortality benefits. In terms of avoided morbidity cases that afflict persons younger than 18 (exacerbated asthma, acute bronchitis, and upper and lower respiratory symptoms), Hispanic Black, Hispanic Other, and Hispanic White subpopulations are expected to experience the greatest benefits. Among DAC, the childhood morbidity patterns are less clear: Benefits of avoided exacerbated asthma cases are highest among Hispanic Black, non-Hispanic Other, and White subpopulations; avoided acute bronchitis cases are highest among the non-Hispanic Asian subpopulation; avoided cases of upper respiratory symptoms are highest among non-Hispanic Asian and Hispanic Native American subpopulations; and avoided cases of lower respiratory cases are similar throughout the DAC subpopulation groups. As discussed in Section3.2, differences in the population age distribution in 2016 and 2050 lead to the negative values in reported estimates for health effects that rely on pooled estimates of several different studies and among different age groups, such as non-fatal heart attacks and cardiovascular hospital admissions.

Table A 1. Estimated Avoided PM2.5-Related Premature Deaths and Illnesses in the Entire Modeling Domain by Race and Ethnicity

Category	Basis	Applicable Age Range	Asian		Black		Native American		Other		White	
			Hispanic	Non-Hispanic	Hispanic	Non-Hispanic	Hispanic	Non-Hispanic	Hispanic	Non-Hispanic	Hispanic	Non-Hispanic
Avoided premature death												
Adult Mortality, 30-64	Turner et al. (2016)	30 to 64	0.14	7.2	0.072	6.6	0.42	0.88	8.4	0.028	15	95
Adult Mortality, 65+	Turner et al. (2016)	65 to 99	-0.6	-170	-0.6	-41	-2.1	-5.2	-170	-21	-130	-17
	Di et al. (2017)	65 to 99	-0.68	-210	-0.74	-50	-2.5	-6.3	-200	-25	-160	-21
Infant Mortality	Woodruff et al. (2006)	0	0.00080	0.00074	0.0018	0.069	0.0016	0.0029	0.68	0.10	0.60	1.2
Total avoided premature mortalities	Lower estimate (from Turner & Woodruff)	0, 30 to 99	-0.4	-170	-0.5	-35	-1.7	-4.3	-160	-20	-120	79
	Higher estimate (from Turner, Di, & Woodruff)	0, 30 to 99	-0.5	-200	-0.7	-43	-2.1	-5.4	-190	-25	-150	75
	Average of estimates	***0, 30 to 99***	***-0.5***	***-180***	***-0.6***	***-39***	***-1.9***	***-4.8***	***-180***	***-22***	***-130***	***77***
Avoided non-fatal heart attacks among adults												
Peters et al. (2001)		18 to 99	-2.0	-150	-3.2	-23	-3.6	-5.1	-150	-26	-110	90
Pooled estimate[c]		18 to 99	-0.24	-18	-0.38	-2.7	-0.42	-0.59	-18	-3.0	-13	11
Average non-fatal heart attacks estimate		***18 to 99***	***-1.1***	***-85***	***-1.8***	***-13***	***-2.0***	***-2.8***	***-85***	***-14***	***-62***	***51***
All other avoided morbidity effects												
Hospital admissions—cardiovascular		18 to 99	-0.29	-52	-0.5	-7.9	-0.6	-1.4	-52	-7.9	-38	26

Category	Basis	Applicable Age Range	Asian		Black		Native American		Other		White	
			Hispanic	Non-Hispanic	Hispanic	Non-Hispanic	Hispanic	Non-Hispanic	Hispanic	Non-Hispanic	Hispanic	Non-Hispanic
Hospital admissions—respiratory		65 to 99	-0.16	-42	-0.2	-8.5	-0.5	-1.2	-41	-5.0	-33	-8.8
Hospital admissions—asthma		0 to 64	-0.0005	-3.3	-0.018	0.6	0.020	-0.06	0.22	-0.35	0.93	10
Hospital admissions—chronic lung disease		18 to 64	-0.05	-3.1	-0.11	0.3	-0.037	-0.08	-2.9	-1.0	-1.3	12
ER visits for asthma		0 to 99	-0.06	-37	-0.13	2.4	-0.04	-0.77	-3.9	-2.9	2.0	68
Exacerbated asthma		6 to 18	42	-2,000	99	680	71	33	4,000	750	3,800	4,100
Minor restricted-activity days		18 to 64	-840	-77,000	-1,700	5,800	-740	-2,600	-46,000	-21,000	-26,000	190,000
Acute bronchitis		8 to 12	1.2	-70	3.2	26	2.0	1.3	150	32	140	160
Upper resp. symptoms		9 to 11	23	-1,400	67	530	41	28	3,100	640	2,900	3,200
Lower resp. symptoms		7 to 14	15	-910	42	340	26	17	2,000	410	1,800	2,100
Lost work days		18 to 64	-140	-13,000	-290	910	-130	-490	-8,000	-3,600	-4,800	32,000

Notes:

(a) Values rounded to two significant digits. Negative values indicate increases in incidence of health effect.

(b) Values reflect the normalized (per 100,000 persons) difference between cases estimated in 2016 and cases estimated in 2050. Because populations differ among these estimates, negative morbidity effect estimates may be attributable to changes in population among the years evaluated. In addition, baseline mortality incidences differ among these estimates, so negative values associated with changes in mortality cases may result from both population differences and baseline mortality incidence differences.

(c) The pooled nonfatal heart attack estimate is based on four studies: Pope et al. (2006), Sullivan et al. (2005), Zanobetti and Schwartz (2006), and Zanobetti et al. (2009).

Table A 2. Estimated Avoided PM2.5-Related Premature Deaths and Illnesses in Disadvantaged Communities by Race and Ethnicity

Category	**Basis**	**Applicable Age Range**	**Asian**		**Black**		**Native American**		**Other**		**White**	
			Hispanic	**Non-Hispanic**	**Hispanic**	**Non-Hispanic**	**Hispanic**	**Non-Hispanic**	**Hispanic**	**Non-Hispanic**	**Hispanic**	**Non-Hispanic**
Avoided premature death												
Adult Mortality, 30-64	Turner et al. (2016)	30 to 64	0.013	0.080	0.0035	0.66	0.048	0.025	1.6	-0.061	1.9	1.2
Adult Mortality, 65+	Turner et al. (2016)	65 to 99	-0.080	-6.1	-0.11	-2.8	-0.23	-0.17	-15	-0.74	-10	-6.2
	Di et al. (2017)	65 to 99	-0.096	-7.3	-0.13	-3.3	-0.28	-0.21	-18	-0.89	-13	-7.4
Infant Mortality	Woodruff et al. (2006)	0	0.000023	-0.0046	0.00014	0.0036	0.00042	-0.000071	0.11	0.00072	0.080	0.0088
Total avoided premature mortalities	Lower estimate (from Turner & Woodruff)	0, 30 to 99	-0.067	-6.0	-0.11	-2.1	-0.19	-0.15	-13	-0.80	-8.4	-4.9
	Higher estimate (from Turner, Di, & Woodruff)	0, 30 to 99	-0.084	-7.2	-0.13	-2.6	-0.23	-0.18	-16	-0.95	-11	-6.2
	Average of estimates	***0, 30 to 99***	***-0.075***	***-6.6***	***-0.12***	***-2.4***	***-0.21***	***-0.17***	***-14***	***-0.87***	***-9.4***	***-5.6***
Avoided non-fatal heart attacks among adults												
Peters et al. (2001)		18 to 99	-0.23	-5.7	-0.31	-1.4	-0.34	-0.11	-13	-1.1	-8.5	-3.5
Pooled estimate[d]		18 to 99	-0.027	-0.67	-0.036	-0.16	-0.040	-0.012	-1.5	-0.13	-1.0	-0.39
Average non-fatal heart attacks estimate		***18 to 99***	***-0.13***	***-3.2***	***-0.17***	***-0.76***	***-0.19***	***-0.062***	***-7.1***	***-0.6***	***-4.8***	***-1.9***

Category	Basis	Applicable Age Range	Asian		Black		Native American		Other		White	
			Hispanic	Non-Hispanic	Hispanic	Non-Hispanic	Hispanic	Non-Hispanic	Hispanic	Non-Hispanic	Hispanic	Non-Hispanic
All other avoided morbidity effects												
Hospital admissions—cardiovascular		18 to 99	-0.032	-1.9	-0.065	-0.50	-0.063	-0.050	-4.3	-0.34	-3.0	-1.2
Hospital admissions—respiratory		65 to 99	-0.018	-1.5	-0.032	-0.60	-0.056	-0.031	-3.7	-0.18	-2.7	-1.3
Hospital admissions—asthma		0 to 64	-0.0010	-0.20	0.0030	0.044	0.0061	-0.017	0.28	-0.08	0.27	-0.10
Hospital admissions—chronic lung disease		18 to 64	-0.006	-0.17	-0.01	0.039	-0.0020	-0.0093	-0.14	-0.1	-0.03	0.040
ER visits for asthma		0 to 99	-0.016	-2.0	0.04	0.18	0.031	-0.15	2.0	-0.7	1.9	-1.4
Exacerbated asthma		6 to 18	4.4	-140	20	40	9.4	-11	730	-76	630	-280
Minor restricted-activity days		18 to 64	-110	-4,500	-150	470	-18	-380	-310	-1,700	250	-510
Acute bronchitis		8 to 12	0.12	-5.4	0.76	1.6	0.20	-0.32	26	-2.5	23	-9.4
Upper resp. symptoms		9 to 11	2.8	-110	16	30	4.3	-6.0	540	-52	470	-190
Lower resp. symptoms		7 to 14	1.6	-70	10	20	2.7	-4.1	340	-33	300	-120
Lost work days		18 to 64	-18	-790	-23	73	-3.2	-72	-51	-300	15	-89

Notes:

(a) Values rounded to two significant digits. Negative values indicate increases in incidence of health effect.

(b) Values reflect the difference between cases estimated in 2016 and cases estimated in 2050. Because populations differ among these estimates, negative morbidity effect estimates may be attributable to changes in population among the years evaluated. In addition, baseline mortality incidences differ among these estimates, so negative values associated with changes in mortality cases may result from both population differences and baseline mortality incidence differences.

(c) Disadvantaged communities are defined in this work as any Census Block Group with a California EnviroScreen percent score greater than or equal to 75%.

(d) The pooled nonfatal heart attack estimate is based on four studies: Pope et al. (2006), Sullivan et al. (2005), Zanobetti and Schwartz (2006), and Zanobetti et al. (2009).

Table A 3. Estimated Avoided PM2.5-Related Premature Deaths and Illnesses Per 100,000 Persons in the Entire Modeling Domain by Race and Ethnicity

Category	Basis	Applicable Age Range	Asian		Black		Native American		Other		White	
			Hispanic	Non-Hispanic	Hispanic	Non-Hispanic	Hispanic	Non-Hispanic	Hispanic	Non-Hispanic	Hispanic	Non-Hispanic
Avoided premature death												
Adult Mortality, 30-64	Turner et al. (2016)	30 to 64	8.1	9.3	7.2	10	9	9.9	7.7	7.5	9.3	11
Adult Mortality, 65+	Turner et al. (2016)	65 to 99	22	22	36	-31	-0.28	-6.5	20	8.5	28	-5
	Di et al. (2017)	65 to 99	26	26	43	-37	-0.44	-8	23	10	33	-6.2
Infant Mortality	Woodruff et al. (2006)	0	5.3	5.1	4.8	5.3	5	4.3	5.3	5	5.4	5.2
Total avoided premature mortalities	Lower estimate (from Turner & Woodruff)	0, 30 to 99	35	36	48	-15	14	7.7	33	21	43	11
	Higher estimate (from Turner, Di, & Woodruff)	0, 30 to 99	40	41	55	-22	14	6.2	36	23	48	9.9
	Average of estimates	*0, 30 to 99*	*38*	*38*	*52*	*-19*	*14*	*7*	*35*	*22*	*45*	*11*
Avoided Non-fatal heart attacks among adults												
Peters et al. (2001)		18 to 99	-11	-6.4	-13	-13	-14	-3.6	-16	-8.6	-9.9	-4.6
Pooled estimate[c]		18 to 99	-1.2	-0.71	-1.6	-1.5	-1.6	-0.38	-1.9	-0.98	-1.1	-0.47
Average non-fatal heart attacks estimate		*18 to 99*	*-5.9*	*-3.6*	*-7.4*	*-7.1*	*-7.6*	*-2*	*-8.9*	*-4.8*	*-5.5*	*-2.5*

Category	**Basis**	**Applicable Age Range**	**Asian**		**Black**		**Native American**		**Other**		**White**	
			Hispanic	**Non-Hispanic**	**Hispanic**	**Non-Hispanic**	**Hispanic**	**Non-Hispanic**	**Hispanic**	**Non-Hispanic**	**Hispanic**	**Non-Hispanic**
All other avoided morbidity effects												
Hospital admissions—cardiovascular		18 to 99	-0.77	-2.4	-1.2	-4.5	-2	-0.79	-5.6	-2.5	-3.6	-2
Hospital admissions—respiratory		65 to 99	-1.2	0.36	0.5	-5.8	-3.5	-2.4	-0.71	-0.49	0.17	-2.9
Hospital admissions—asthma		0 to 64	0.4	0.29	0.36	0.34	0.36	0.31	0.37	0.4	0.39	0.35
Hospital admissions—chronic lung disease		18 to 64	0.02	0.36	-0.23	0.38	0.17	0.37	-0.033	-0.11	0.2	0.72
ER visits for asthma		0 to 99	4.4	2.2	4.9	2.8	3.7	2.5	4.4	4.8	3.9	1.6
Exacerbated asthma		6 to 18	1100	990	1200	1100	1100	780	1200	950	1200	1100
Minor restricted-activity days		18 to 64	6100	6200	6300	6600	5900	5600	6300	6300	6400	6700
Acute bronchitis		8 to 12	88	90	98	87	90	68	96	81	97	90
Upper resp. symptoms		9 to 11	3200	3300	3700	3200	3300	2500	3600	3000	3600	3300
Lower resp. symptoms		7 to 14	730	750	820	730	750	570	800	680	810	750
Lost work days		18 to 64	1100	990	1200	1000	960	780	1100	1100	1000	1000

Notes:

(a) Values rounded to two significant digits. Negative values indicate increases in incidence of health effect.

(b) Values reflect the normalized (per 100,000 persons) difference between cases estimated in 2016 and cases estimated in 2050. Because populations differ among these estimates, negative morbidity effect estimates may be attributable to changes in population among the years evaluated. In addition, baseline mortality incidences differ among these estimates, so negative values associated with changes in mortality cases may result from both population differences and baseline mortality incidence differences.

(c) The pooled nonfatal heart attack estimate is based on four studies: Pope et al. (2006), Sullivan et al. (2005), Zanobetti and Schwartz (2006), and Zanobetti et al. (2009).

Table A 4. Estimated Avoided PM2.5-Related Premature Deaths and Illnesses Per 100,000 Persons in Disadvantaged Communities by Race and Ethnicity

Category	**Basis**	**Applicable Age Range**	**Asian**		**Black**		**Native American**		**Other**		**White**	
			Hispanic	**Non-Hispanic**	**Hispanic**	**Non-Hispanic**	**Hispanic**	**Non-Hispanic**	**Hispanic**	**Non-Hispanic**	**Hispanic**	**Non-Hispanic**
Avoided premature death												
Adult Mortality, 30-64	Turner et al. (2016)	30 to 64	9.4	11	7	11	8.9	13	8.7	8.3	10	11
Adult Mortality, 65+	Turner et al. (2016)	65 to 99	2.4	48	45	-13	5.2	-23	28	13	38	8.9
	Di et al. (2017)	65 to 99	2.7	58	54	-16	6.1	-28	34	16	45	10
Infant Mortality	Woodruff et al. (2006)	0	5.9	6.2	5.8	5.8	6.1	5.6	6	6.1	6	6
Total avoided premature mortalities	Lower estimate (from Turner & Woodruff)	0, 30 to 99	18	66	58	4	20	-4.4	43	28	54	26
	Higher estimate (from Turner, Di, & Woodruff)	0, 30 to 99	18	75	67	1.2	21	-9.3	49	30	61	27
	Average of estimates	***0, 30 to 99***	***18***	***70***	***63***	***2.6***	***21***	***-6.8***	***46***	***29***	***57***	***27***
Avoided non-fatal heart attacks among adults												
Peters et al. (2001)		18 to 99	-10	4.3	-11	-6	-14	14	-14	-0.52	-8.2	-1.6
Pooled estimate[d]		18 to 99	-1.1	0.6	-1.3	-0.65	-1.6	1.7	-1.7	-0.014	-0.91	-0.1
Average non-fatal heart attacks estimate		***18 to 99***	***-5.6***	***2.4***	***-6.4***	***-3.3***	***-7.9***	***7.6***	***-8.1***	***-0.26***	***-4.6***	***-0.84***

Category	Basis	Applicable Age Range	Asian		Black		Native American		Other		White	
			Hispanic	Non-Hispanic	Hispanic	Non-Hispanic	Hispanic	Non-Hispanic	Hispanic	Non-Hispanic	Hispanic	Non-Hispanic
All other avoided morbidity effects												
Hospital admissions—cardiovascular		18 to 99	-0.3	1.5	-2	-2.4	-2.4	3.3	-5	0.033	-2.9	-0.69
Hospital admissions—respiratory		65 to 99	0.11	4	3.3	-3.3	-1.7	-2.4	0.97	1.2	1.8	-0.5
Hospital admissions—asthma		0 to 64	0.51	0.4	0.45	0.43	0.47	0.29	0.43	0.37	0.47	0.28
Hospital admissions—chronic lung disease		18 to 64	0.13	0.58	-0.34	0.57	0.21	0.58	0.03	0.007	0.24	0.66
ER visits for asthma		0 to 99	5.2	2.7	6.1	3	4.6	2.1	5	4	4.6	1.3
Exacerbated asthma		6 to 18	1500	1500	1700	1500	1500	1500	1500	1600	1500	1600
Minor restricted-activity days		18 to 64	8400	9200	8600	8600	8300	8500	8200	8800	8400	9100
Acute bronchitis		8 to 12	120	140	130	120	130	130	120	120	130	130
Upper resp. symptoms		9 to 11	4700	5100	4900	4700	5100	4800	4700	4700	4800	4900
Lower resp. symptoms		7 to 14	1000	1100	1100	1000	1100	1100	1000	1000	1100	1100
Lost work days		18 to 64	1500	1500	1700	1400	1400	1100	1400	1600	1400	1600

Notes:

(a) Values rounded to two significant digits. Negative values indicate increases in incidence of health effect.

(b) Values reflect the difference between cases estimated in 2016 and cases estimated in 2050. Because populations differ among these estimates, negative morbidity effect estimates may be attributable to changes in population among the years evaluated. In addition, baseline mortality incidences differ among these estimates, so negative values associated with changes in mortality cases may result from both population differences and baseline mortality incidence differences.

(c) Disadvantaged communities are defined in this work as any Census Block Group with a CalEnviroScreen percent score greater than or equal to 75%.

(d) The pooled nonfatal heart attack estimate is based on four studies: Pope et al. (2006), Sullivan et al. (2005), Zanobetti and Schwartz (2006), and Zanobetti et al. (2009).

APPENDIX B. DETAILED OUTPUT SPREADSHEET OF RESULTS: AIR QUALITY AND HEALTH CHANGES

This file is attached as: “ApdxB-BenMAP_DetailedOutput.xlsx”

This file consists of one informational and two data tabs:

- “Readme” tab – This details the data in each of the other tabs.
- “Primary Results” tab – This has the (point estimate) modeling results of change in cases and change in cases per capita for each CBG in the modeling domain. It also has the CalEnviroScreen score, the population values for each year and change, and air quality values and changes. It lists results for each health endpoint and by race/ethnicity. Most analyses are expected to use this data.
- “BenMAP_Output_and_Statistics” tab. – This has more detailed outputs from BenMAP, including confidence intervals for the modeled results. 1his is provided mostly for reference.

Created by:	ICF
Date Created:	9/15/2021
Purpose:	To present BenMAP model results associated with Proposed Plan emissions changes in western San Diego county

Calculation Methodology Note:	Plan emissions and concentrations are modeled for 2016 (baseline) and 2050 (build). Due to differences in the analysis years modeled, we evaluate changes in cases of health impacts based on the number of cases in the year 2016 compared to the number of cases in the year 2050. Cases for each year i calculated as shown below: *Cases_2016 = Population_2016 * Incidence_rate_2016 * f(AQ_2016)* *Cases_2050 = Population_2050 * Incidence_rate_2050 * f(AQ_2050)* Cases = Cases_2016 – Cases_2050 The AQ impact on health is based on total PM burden (natural and anthropogenic). Both the total change in the number of cases and cases per capita are determined. Both air quality and population (total and by age) (Incidence remains constant for all health impacts other than mortality.) Baseline air quality (AQ_2016) is taken from satellite observations. We considered two different forms of AQ_2050: *Option 1* (proportion): AQ_2050 = AQ_background + (Satellite - AQ_background)*(Model_2050/Model_2016) *Option 2* (increment): AQ_2050 = Satellite + (Model_2050-Model_2016) AQ_background = 2.5 ug/m3 is the assumed natural background concentration Model_20xx = Calpuff modeled concentrations in year 20xx We report outputs for both Options ("Prop_" for the proportional Option 1 and "Incr_" for the incremental Option 2) and the average ("Avg_") of the two options. The BenMAP_Output_and_Statistics provides the raw with 95th percent confidence interval statistics for the "Prop_" and "Incr_" options.

Primary_Results	
Header Name	**Description**
CBG_ID	Census block group (CBG) MGRA13 codes (Master Geographic Reference Area used for SANDAG Series 13 Regional Growth Forecast), which are more detailed than federal information processing standards (FIPS) code ID is the block group number. The remaining numbers are census tract IDs. Census tract IDs can be as many as 6 digits.
Race_Ethn	Race and ethnicity of the exposed population. Ethnicities included in BenMAP are Hispanic and Non-Hispanic. Races included in BenMAP are Asian, Black, White, Native American, and other.
Endpoint_Rev	Endpoint group for which a given endpoint falls under.
Endpoint	Health effect endpoint.
Start_Age	Starting age for which the BenMAP health impact function applies.
End_Age	End age for which the BenMAP health impact function applies.
EJ_Flag	Flag indicating whether the CBG is an environmental justice (EJ) hotspot location. (Defined as ≥ 75th percentile CES v4.0 score)
CES_Score_Percentile	California EnviroScreen v4.0 score percentile.
Population_2016	Sum of the population in 2016 for each health impact function-specific age increment.
Population_2050	Sum of the population in 2050 for each health impact function-specific age increment.
Delta_Population_2016_2050	Change in population from 2016 to 2050 (Population_2016 - Population_2050).
PM_2016	Particulate matter concentration in 2016 (does not vary among Options 1 and 2).
Avg_PM_2050	Average particulate matter concentration in 2050.
Avg_DeltaPM_2016_2050	Average change in particulate matter concentration in 2050 (PM_2016 - Avg_PM_2050).
Avg_Ch_Cases_PtEst	Average of Option 1 and Option 2 change in cases from 2016 to 2050 based on population-specific point estimates.
Avg_Ch_PerCap_Cases_PtEst	Average of Option 1 and Option 2 change in per capita cases from 2016 to 2050.
Prop_PM_2050	Particulate matter concentration in 2050 under Option 1.
Prop_Ch_Cases_PtEst	Option 1 change in cases from 2016 to 2050 based on population-specific point estimate.
Prop_Ch_PerCap_Cases_PtEst	Option 1 change in per capita cases from 2016 to 2050.
Incr_PM_2050	Particulate matter concentration in 2050 under Option 2
Incr_Ch_Cases_PtEst	Option 2 change in cases from 2016 to 2050 based on population-specific point estimate.
Incr_Ch_PerCap_Cases_PtEst	Option 2 change in per capita cases from 2016 to 2050.

BenMAP_Output_and_Statistics	
Header Name	**Description**
CBG_ID	Census block group (CBG) MGRA13 codes (Master Geographic Reference Area used for SANDAG Series 13 Regional Growth Forecast), which are more detailed than federal information processing standards (FIPS) code ID is the block group number. The remaining numbers are census tract IDs. Census tract IDs can be as many as 6 digits.
Race_Ethn	Race and ethnicity of the exposed population. Ethnicities included in BenMAP are Hispanic and Non-Hispanic. Races included in BenMAP are Asian, Black, White, Native American, and other.
Endpoint_Rev	Endpoint group for which a given endpoint falls under.
Endpoint	Health effect endpoint.

CBG_ID	Race_Ethn	Endpoint_Rev	Endpoint	Start_Age	End_Age	EJ_Flag	CES_Score_Percentile	Population_2016	Population_2050	Delta_Population_2016_2050	PM_2016	Avg_PM_2050
1001	ASIAN_HISPANIC	Acute_Bronchitis	Acute Bronchitis	8	12	NA	8.10844893	0	0.4	-0.4	0	8.560947
1001	ASIAN_HISPANIC	Asthma_Exacerbation	Asthma Exacerbation Wheeze Asthma Ex	6	18	NA	8.10844893	0	0.8	-0.8	0	8.560947
1001	ASIAN_HISPANIC	ER_Asthma	Emergency Room Visits Asthma	0	99	NA	8.10844893	0	4	-4	0	8.560947
1001	ASIAN_HISPANIC	HA_AllRespiratory	HA All Respiratory	65	99	NA	8.10844893	0	1	-1	0	8.560947
1001	ASIAN_HISPANIC	HA_Asthma	HA Asthma	0	64	NA	8.10844893	0	3	-3	0	8.560947
1001	ASIAN_HISPANIC	HA_Cardiovascular	HA All Cardiovascular (less Myocardial In	18	64	NA	8.10844893	0	2	-2	0	8.560947
1001	ASIAN_HISPANIC	HA_Cardiovascular	HA All Cardiovascular (less Myocardial In	65	99	NA	8.10844893	0	1	-1	0	8.560947
1001	ASIAN_HISPANIC	HA_CLD	HA Chronic Lung Disease	18	64	NA	8.10844893	0	2	-2	0	8.560947
1001	ASIAN_HISPANIC	Lost_Work_Days	Work Loss Days	18	64	NA	8.10844893	0	2	-2	0	8.560947
1001	ASIAN_HISPANIC	Lower_Respiratory_Symptoms	Lower Respiratory Symptoms	7	14	NA	8.10844893	0	0.6	-0.6	0	8.560947
1001	ASIAN_HISPANIC	Minor_Restricted-Activity_Days	Minor Restricted Activity Days	18	64	NA	8.10844893	0	2	-2	0	8.560947
1001	ASIAN_HISPANIC	Mortality_Di_65+	Mortality All Cause	65	99	NA	8.10844893	0	1	-1	0	8.560947
1001	ASIAN_HISPANIC	Mortality_Turner_30-64	Mortality All Cause	30	64	NA	8.10844893	0	2	-2	0	8.560947
1001	ASIAN_HISPANIC	Mortality_Turner_65+	Mortality All Cause	65	99	NA	8.10844893	0	1	-1	0	8.560947
1001	ASIAN_HISPANIC	Non-FatalHeartAttacks_Peters	Acute Myocardial Infarction Nonfatal	18	99	NA	8.10844893	0	3	-3	0	8.560947
1001	ASIAN_HISPANIC	Non-FatalHeartAttacks_Pooled	Acute Myocardial Infarction Nonfatal	18	99	NA	8.10844893	0	3	-3	0	8.560947
1001	ASIAN_HISPANIC	Upper_Respiratory_Symptoms	Upper Respiratory Symptoms	9	11	NA	8.10844893	0	0.2	-0.2	0	8.560947
1001	ASIAN_NON-HISPANIC	Acute_Bronchitis	Acute Bronchitis	8	12	NA	8.10844893	1.8	4.4	-2.6	9.6	8.560947
1001	ASIAN_NON-HISPANIC	Asthma_Exacerbation	Asthma Exacerbation Wheeze Asthma Ex	6	18	NA	8.10844893	3.8	8	-4.2	9.6	8.560947
1001	ASIAN_NON-HISPANIC	ER_Asthma	Emergency Room Visits Asthma	0	99	NA	8.10844893	38	90	-52	9.6	8.560947
1001	ASIAN_NON-HISPANIC	HA_AllRespiratory	HA All Respiratory	65	99	NA	8.10844893	8	37	-29	9.6	8.560947
1001	ASIAN_NON-HISPANIC	HA_Asthma	HA Asthma	0	64	NA	8.10844893	30	53	-23	9.6	8.560947
1001	ASIAN_NON-HISPANIC	HA_Cardiovascular	HA All Cardiovascular (less Myocardial In	18	64	NA	8.10844893	26.4	44	-17.6	9.6	8.560947
1001	ASIAN_NON-HISPANIC	HA_Cardiovascular	HA All Cardiovascular (less Myocardial In	65	99	NA	8.10844893	8	37	-29	9.6	8.560947
1001	ASIAN_NON-HISPANIC	HA_CLD	HA Chronic Lung Disease	18	64	NA	8.10844893	26.4	44	-17.6	9.6	8.560947
1001	ASIAN_NON-HISPANIC	Lost_Work_Days	Work Loss Days	18	64	NA	8.10844893	26.4	44	-17.6	9.6	8.560947
1001	ASIAN_NON-HISPANIC	Lower_Respiratory_Symptoms	Lower Respiratory Symptoms	7	14	NA	8.10844893	3	7	-4	9.6	8.560947
1001	ASIAN_NON-HISPANIC	Minor_Restricted-Activity_Days	Minor Restricted Activity Days	18	64	NA	8.10844893	26.4	44	-17.6	9.6	8.560947
1001	ASIAN_NON-HISPANIC	Mortality_Di_65+	Mortality All Cause	65	99	NA	8.10844893	8	37	-29	9.6	8.560947
1001	ASIAN_NON-HISPANIC	Mortality_Turner_30-64	Mortality All Cause	30	64	NA	8.10844893	26	38	-12	9.6	8.560947
1001	ASIAN_NON-HISPANIC	Mortality_Turner_65+	Mortality All Cause	65	99	NA	8.10844893	8	37	-29	9.6	8.560947
1001	ASIAN_NON-HISPANIC	Non-FatalHeartAttacks_Peters	Acute Myocardial Infarction Nonfatal	18	99	NA	8.10844893	34.4	81	-46.6	9.6	8.560947

CBG_ID	Race_Ethn	Endpoint_Rev	Endpoint	Avg_DeltaPM_2016_2050	Avg_Ch_Cases_PtEst	Avg_Ch_PerCap_Cases_PtEst	Prop_PM_2050	Prop_Ch_Cases_PtEst	Prop_Ch_PerCap_Cases_PtEst	Incr_PM_2050
1001	ASIAN_HISPANIC	Acute_Bronchitis	Acute Bronchitis	-8.560947	-0.003218718	NA	8.390947	NA	NA	8.730947
1001	ASIAN_HISPANIC	Asthma_Exacerbation	Asthma Exacerbation Wheeze Asthma Ex	-8.560947	-0.071103535	NA	8.390947	NA	NA	8.730947
1001	ASIAN_HISPANIC	ER_Asthma	Emergency Room Visits Asthma	-8.560947	-0.000585217	NA	8.390947	NA	NA	8.730947
1001	ASIAN_HISPANIC	HA_AllRespiratory	HA All Respiratory	-8.560947	-0.000212953	NA	8.390947	NA	NA	8.730947
1001	ASIAN_HISPANIC	HA_Asthma	HA Asthma	-8.560947	-7.61824E-05	NA	8.390947	NA	NA	8.730947
1001	ASIAN_HISPANIC	HA_Cardiovascular	HA All Cardiovascular (less Myocardial In	-8.560947	-0.00022334	NA	8.390947	NA	NA	8.730947
1001	ASIAN_HISPANIC	HA_Cardiovascular	HA All Cardiovascular (less Myocardial In	-8.560947	-0.000261291	NA	8.390947	NA	NA	8.730947
1001	ASIAN_HISPANIC	HA_CLD	HA Chronic Lung Disease	-8.560947	-8.68286E-05	NA	8.390947	NA	NA	8.730947
1001	ASIAN_HISPANIC	Lost_Work_Days	Work Loss Days	-8.560947	-0.1386887	NA	8.390947	NA	NA	8.730947
1001	ASIAN_HISPANIC	Lower_Respiratory_Symptoms	Lower Respiratory Symptoms	-8.560947	-0.03943245	NA	8.390947	NA	NA	8.730947
1001	ASIAN_HISPANIC	Minor_Restricted-Activity_Days	Minor Restricted Activity Days	-8.560947	-0.9588703	NA	8.390947	NA	NA	8.730947
1001	ASIAN_HISPANIC	Mortality_Di_65+	Mortality All Cause	-8.560947	-0.000535814	NA	8.390947	NA	NA	8.730947
1001	ASIAN_HISPANIC	Mortality_Turner_30-64	Mortality All Cause	-8.560947	-0.00023762	NA	8.390947	NA	NA	8.730947
1001	ASIAN_HISPANIC	Mortality_Turner_65+	Mortality All Cause	-8.560947	-0.000445414	NA	8.390947	NA	NA	8.730947
1001	ASIAN_HISPANIC	Non-FatalHeartAttacks_Peters	Acute Myocardial Infarction Nonfatal	-8.560947	-0.001609985	NA	8.390947	NA	NA	8.730947
1001	ASIAN_HISPANIC	Non-FatalHeartAttacks_Pooled	Acute Myocardial Infarction Nonfatal	-8.560947	-0.000190536	NA	8.390947	NA	NA	8.730947
1001	ASIAN_HISPANIC	Upper_Respiratory_Symptoms	Upper Respiratory Symptoms	-8.560947	-0.053898405	NA	8.390947	NA	NA	8.730947
1001	ASIAN_NON-HISPANIC	Acute_Bronchitis	Acute Bronchitis	1.039053	-0.019367485	0.00086343	8.390947	-0.01873787	0.001006528	8.730947
1001	ASIAN_NON-HISPANIC	Asthma_Exacerbation	Asthma Exacerbation Wheeze Asthma Ex	1.039053	-0.3423147	0.00815232	8.390947	-0.3283164	0.009902112	8.730947
1001	ASIAN_NON-HISPANIC	ER_Asthma	Emergency Room Visits Asthma	1.039053	-0.005846612	1.7198E-05	8.390947	-0.005626162	1.96472E-05	8.730947
1001	ASIAN_NON-HISPANIC	HA_AllRespiratory	HA All Respiratory	1.039053	-0.009026423	0.00019651	8.390947	-0.008759878	0.000203714	8.730947
1001	ASIAN_NON-HISPANIC	HA_Asthma	HA Asthma	1.039053	-0.000303552	3.0524E-06	8.390947	-0.000285727	3.3887E-06	8.730947
1001	ASIAN_NON-HISPANIC	HA_Cardiovascular	HA All Cardiovascular (less Myocardial In	1.039053	-0.000611153	1.0789E-05	8.390947	-0.000566938	1.17941E-05	8.730947
1001	ASIAN_NON-HISPANIC	HA_Cardiovascular	HA All Cardiovascular (less Myocardial In	1.039053	-0.010204741	0.00018093	8.390947	-0.009911276	0.000188863	8.730947
1001	ASIAN_NON-HISPANIC	HA_CLD	HA Chronic Lung Disease	1.039053	-0.000252795	4.3335E-06	8.390947	-0.000234737	4.74393E-06	8.730947
1001	ASIAN_NON-HISPANIC	Lost_Work_Days	Work Loss Days	1.039053	-1.2327435	0.01016959	8.390947	-1.159674	0.011830258	8.730947
1001	ASIAN_NON-HISPANIC	Lower_Respiratory_Symptoms	Lower Respiratory Symptoms	1.039053	-0.2410531	0.00727662	8.390947	-0.2326392	0.00847861	8.730947
1001	ASIAN_NON-HISPANIC	Minor_Restricted-Activity_Days	Minor Restricted Activity Days	1.039053	-6.955605	0.05615352	8.390947	-6.54985	0.065375227	8.730947
1001	ASIAN_NON-HISPANIC	Mortality_Di_65+	Mortality All Cause	1.039053	-0.027469135	0.00262505	8.390947	-0.02627778	0.002657253	8.730947
1001	ASIAN_NON-HISPANIC	Mortality_Turner_30-64	Mortality All Cause	1.039053	0.001147024	7.2798E-05	8.390947	0.001192757	7.40014E-05	8.730947
1001	ASIAN_NON-HISPANIC	Mortality_Turner_65+	Mortality All Cause	1.039053	-0.02281698	0.00218438	8.390947	-0.0218214	0.002211287	8.730947
1001	ASIAN_NON-HISPANIC	Non-FatalHeartAttacks_Peters	Acute Myocardial Infarction Nonfatal	1.039053	-0.031364935	-8.4635E-05	8.390947	-0.0304807	-7.37183E-05	8.730947

CBG_ID	Race_Ethn	Endpoint_Rev	Endpoint	Incr_Ch_Cases_PtEst	Incr_Ch_PerCap_Cases_PtEst
1001	ASIAN_HISPANIC	Acute_Bronchitis	Acute Bronchitis	NA	NA
1001	ASIAN_HISPANIC	Asthma_Exacerbation	Asthma Exacerbation Wheeze Asthma E	NA	NA
1001	ASIAN_HISPANIC	ER_Asthma	Emergency Room Visits Asthma	NA	NA
1001	ASIAN_HISPANIC	HA_AllRespiratory	HA All Respiratory	NA	NA
1001	ASIAN_HISPANIC	HA_Asthma	HA Asthma	NA	NA
1001	ASIAN_HISPANIC	HA_Cardiovascular	HA All Cardiovascular (less Myocardial In	NA	NA
1001	ASIAN_HISPANIC	HA_Cardiovascular	HA All Cardiovascular (less Myocardial In	NA	NA
1001	ASIAN_HISPANIC	HA_CLD	HA Chronic Lung Disease	NA	NA
1001	ASIAN_HISPANIC	Lost_Work_Days	Work Loss Days	NA	NA
1001	ASIAN_HISPANIC	Lower_Respiratory_Symptoms	Lower Respiratory Symptoms	NA	NA
1001	ASIAN_HISPANIC	Minor_Restricted-Activity_Days	Minor Restricted Activity Days	NA	NA
1001	ASIAN_HISPANIC	Mortality_Di_65+	Mortality All Cause	NA	NA
1001	ASIAN_HISPANIC	Mortality_Turner_30-64	Mortality All Cause	NA	NA
1001	ASIAN_HISPANIC	Mortality_Turner_65+	Mortality All Cause	NA	NA
1001	ASIAN_HISPANIC	Non-FatalHeartAttacks_Peters	Acute Myocardial Infarction Nonfatal	NA	NA
1001	ASIAN_HISPANIC	Non-FatalHeartAttacks_Pooled	Acute Myocardial Infarction Nonfatal	NA	NA
1001	ASIAN_HISPANIC	Upper_Respiratory_Symptoms	Upper Respiratory Symptoms	NA	NA
1001	ASIAN_NON-HISPANIC	Acute_Bronchitis	Acute Bronchitis	-0.0199971	0.000720339
1001	ASIAN_NON-HISPANIC	Asthma_Exacerbation	Asthma Exacerbation Wheeze Asthma E	-0.356313	0.006402537
1001	ASIAN_NON-HISPANIC	ER_Asthma	Emergency Room Visits Asthma	-0.006067062	1.47483E-05
1001	ASIAN_NON-HISPANIC	HA_AllRespiratory	HA All Respiratory	-0.009292968	0.000189306
1001	ASIAN_NON-HISPANIC	HA_Asthma	HA Asthma	-0.000321376	2.71608E-06
1001	ASIAN_NON-HISPANIC	HA_Cardiovascular	HA All Cardiovascular (less Myocardial In	-0.000655367	9.78431E-06
1001	ASIAN_NON-HISPANIC	HA_Cardiovascular	HA All Cardiovascular (less Myocardial In	-0.010498206	0.000173
1001	ASIAN_NON-HISPANIC	HA_CLD	HA Chronic Lung Disease	-0.000270853	3.9231E-06
1001	ASIAN_NON-HISPANIC	Lost_Work_Days	Work Loss Days	-1.305813	0.008508917
1001	ASIAN_NON-HISPANIC	Lower_Respiratory_Symptoms	Lower Respiratory Symptoms	-0.249467	0.006074638
1001	ASIAN_NON-HISPANIC	Minor_Restricted-Activity_Days	Minor Restricted Activity Days	-7.36136	0.046931818
1001	ASIAN_NON-HISPANIC	Mortality_Di_65+	Mortality All Cause	-0.02866049	0.002592856
1001	ASIAN_NON-HISPANIC	Mortality_Turner_30-64	Mortality All Cause	0.00110129	7.15944E-05
1001	ASIAN_NON-HISPANIC	Mortality_Turner_65+	Mortality All Cause	-0.02381256	0.002157471
1001	ASIAN_NON-HISPANIC	Non-FatalHeartAttacks_Peters	Acute Myocardial Infarction Nonfatal	-0.03224917	-9.55513E-05

CBG_ID	Race_Ethn	Endpoint_Rev	Endpoint	Start_Age	End_Age	EJ_Flag	CES_Score_Percentile	Avg_PtEst_2016	Avg_PtEst_2050	Avg_PerCap_PtEst_2016	Avg_PerCap_PtEst_2050	Prop_PtEst_2016	Prop_PtEst_2050	Prop_PerCap_PtEst_2016
1001	ASIAN_HISPANIC	Acute_Bronchitis	Acute Bronchitis	8	12	NA	8.10844893	0	0.003218718	NA	0.008046795	0	0.00316148	NA
1001	ASIAN_HISPANIC	Asthma_Exacerbation	Asthma Exacerbation Wheeze Asth	6	18	NA	8.10844893	0	0.071103535	NA	0.088879419	0	0.06970371	NA
1001	ASIAN_HISPANIC	ER_Asthma	Emergency Room Visits Asthma	0	99	NA	8.10844893	0	0.000585217	NA	0.000146304	0	0.000573718	NA
1001	ASIAN_HISPANIC	HA_AllRespiratory	HA All Respiratory	65	99	NA	8.10844893	0	0.000212953	NA	0.000212953	0	0.000208755	NA
1001	ASIAN_HISPANIC	HA_Asthma	HA Asthma	0	64	NA	8.10844893	0	7.61824E-05	NA	2.53941E-05	0	7.4691E-05	NA
1001	ASIAN_HISPANIC	HA_Cardiovascular	HA All Cardiovascular (less Myocar	18	64	NA	8.10844893	0	0.00022334	NA	0.00011167	0	0.000218932	NA
1001	ASIAN_HISPANIC	HA_Cardiovascular	HA All Cardiovascular (less Myocar	65	99	NA	8.10844893	0	0.000261291	NA	0.000261291	0	0.000256133	NA
1001	ASIAN_HISPANIC	HA_CLD	HA Chronic Lung Disease	18	64	NA	8.10844893	0	8.68286E-05	NA	4.34143E-05	0	8.51205E-05	NA
1001	ASIAN_HISPANIC	Lost_Work_Days	Work Loss Days	18	64	NA	8.10844893	0	0.1386887	NA	0.06934435	0	0.1359885	NA
1001	ASIAN_HISPANIC	Lower_Respiratory_Symptoms	Lower Respiratory Symptoms	7	14	NA	8.10844893	0	0.03943245	NA	0.06572075	0	0.03871126	NA
1001	ASIAN_HISPANIC	Minor_Restricted-Activity_Days	Minor Restricted Activity Days	18	64	NA	8.10844893	0	0.9588703	NA	0.47943515	0	0.9404268	NA
1001	ASIAN_HISPANIC	Mortality_Di_65+	Mortality All Cause	65	99	NA	8.10844893	0	0.000535814	NA	0.000535814	0	0.000525491	NA
1001	ASIAN_HISPANIC	Mortality_Turner_30-64	Mortality All Cause	30	64	NA	8.10844893	0	0.00023762	NA	0.00011881	0	0.000233018	NA
1001	ASIAN_HISPANIC	Mortality_Turner_65+	Mortality All Cause	65	99	NA	8.10844893	0	0.000445414	NA	0.000445414	0	0.000436788	NA
1001	ASIAN_HISPANIC	Non-FatalHeartAttacks_Peters	Acute Myocardial Infarction Nonfa	18	99	NA	8.10844893	0	0.001609985	NA	0.000536662	0	0.001581201	NA
1001	ASIAN_HISPANIC	Non-FatalHeartAttacks_Pooled	Acute Myocardial Infarction Nonfa	18	99	NA	8.10844893	0	0.000190536	NA	6.35122E-05	0	0.000186757	NA
1001	ASIAN_HISPANIC	Upper_Respiratory_Symptoms	Upper Respiratory Symptoms	9	11	NA	8.10844893	0	0.053898405	NA	0.269492025	0	0.05283347	NA
1001	ASIAN_NON-HISPANIC	Acute_Bronchitis	Acute Bronchitis	8	12	NA	8.10844893	0.01603841	0.035405895	0.008910228	0.008046794	0.01603841	0.03477628	0.008910228
1001	ASIAN_NON-HISPANIC	Asthma_Exacerbation	Asthma Exacerbation Wheeze Asth	6	18	NA	8.10844893	0.3687206	0.7110353	0.097031737	0.088879413	0.3687206	0.697037	0.097031737
1001	ASIAN_NON-HISPANIC	ER_Asthma	Emergency Room Visits Asthma	0	99	NA	8.10844893	0.005403608	0.01125022	0.0001422	0.000125002	0.005403608	0.01102977	0.0001422
1001	ASIAN_NON-HISPANIC	HA_AllRespiratory	HA All Respiratory	65	99	NA	8.10844893	0.004495802	0.013522225	0.000561975	0.000365466	0.004495802	0.01325568	0.000561975
1001	ASIAN_NON-HISPANIC	HA_Asthma	HA Asthma	0	64	NA	8.10844893	0.00060695	0.000910502	2.02317E-05	1.71793E-05	0.00060695	0.000892678	2.02317E-05
1001	ASIAN_NON-HISPANIC	HA_Cardiovascular	HA All Cardiovascular (less Myocar	18	64	NA	8.10844893	0.001628815	0.002239968	6.16975E-05	5.09084E-05	0.001628815	0.002195753	6.16975E-05
1001	ASIAN_NON-HISPANIC	HA_Cardiovascular	HA All Cardiovascular (less Myocar	65	99	NA	8.10844893	0.004661854	0.014866595	0.000582732	0.0004018	0.004661854	0.01457313	0.000582732
1001	ASIAN_NON-HISPANIC	HA_CLD	HA Chronic Lung Disease	18	64	NA	8.10844893	0.000665204	0.000917999	2.51971E-05	2.08636E-05	0.000665204	0.000899941	2.51971E-05
1001	ASIAN_NON-HISPANIC	Lost_Work_Days	Work Loss Days	18	64	NA	8.10844893	2.520308	3.7530515	0.095466212	0.085296625	2.520308	3.679982	0.095466212
1001	ASIAN_NON-HISPANIC	Lower_Respiratory_Symptoms	Lower Respiratory Symptoms	7	14	NA	8.10844893	0.2189921	0.4600452	0.072997367	0.065720743	0.2189921	0.4516313	0.072997367
1001	ASIAN_NON-HISPANIC	Minor_Restricted-Activity_Days	Minor Restricted Activity Days	18	64	NA	8.10844893	14.13954	21.095145	0.535588636	0.479435114	14.13954	20.68939	0.535588636
1001	ASIAN_NON-HISPANIC	Mortality_Di_65+	Mortality All Cause	65	99	NA	8.10844893	0.03437135	0.061840485	0.004296419	0.001671364	0.03437135	0.06064913	0.004296419
1001	ASIAN_NON-HISPANIC	Mortality_Turner_30-64	Mortality All Cause	30	64	NA	8.10844893	0.003508479	0.002361456	0.000134942	6.21436E-05	0.003508479	0.002315722	0.000134942
1001	ASIAN_NON-HISPANIC	Mortality_Turner_65+	Mortality All Cause	65	99	NA	8.10844893	0.02859007	0.05140705	0.003573759	0.00138938	0.02859007	0.05041147	0.003573759
1001	ASIAN_NON-HISPANIC	Non-FatalHeartAttacks_Peters	Acute Myocardial Infarction Nonfa	18	99	NA	8.10844893	0.01809286	0.049457795	0.000525955	0.00061059	0.01809286	0.04857356	0.000525955
1001	ASIAN_NON-HISPANIC	Non-FatalHeartAttacks_Pooled	Acute Myocardial Infarction Nonfa	18	99	NA	8.10844893	0.002164945	0.005851771	6.29344E-05	7.22441E-05	0.002164945	0.005735801	6.29344E-05

CBG_ID	Race_Ethn	Endpoint_Rev	Endpoint	Prop_PerCap_PtEst_2050	Prop_Est2.5_2016	Prop_Est97.5_2016	Prop_Est2.5_2050	Prop_Est97.5_2050	Incr_PtEst_2016	Incr_PtEst_2050	Incr_PerCap_PtEst_2016	Incr_PerCap_PtEst_2050
1001	ASIAN_HISPANIC	Acute_Bronchitis	Acute Bronchitis	0.0079037	0	0	-0.000841761	0.006226346	0	0.003275956	NA	0.00818989
1001	ASIAN_HISPANIC	Asthma_Exacerbation	Asthma Exacerbation Wheeze Asth	0.087129638	0	0	-0.004040853	0.153006807	0	0.07250336	NA	0.0906292
1001	ASIAN_HISPANIC	ER_Asthma	Emergency Room Visits Asthma	0.000143429	0	0	-0.000219832	0.001196933	0	0.000596717	NA	0.000149179
1001	ASIAN_HISPANIC	HA_AllRespiratory	HA All Respiratory	0.000208755	0	0	-0.00014289	0.000424099	0	0.000217151	NA	0.000217151
1001	ASIAN_HISPANIC	HA_Asthma	HA Asthma	2.4897E-05	0	0	2.88235E-05	0.000119591	0	7.76738E-05	NA	2.58913E-05
1001	ASIAN_HISPANIC	HA_Cardiovascular	HA All Cardiovascular (less Myocar	0.000109466	0	0	0.000114353	0.000322496	0	0.000227749	NA	0.000113874
1001	ASIAN_HISPANIC	HA_Cardiovascular	HA All Cardiovascular (less Myocar	0.000256133	0	0	0.000101058	0.000519228	0	0.000266449	NA	0.000266449
1001	ASIAN_HISPANIC	HA_CLD	HA Chronic Lung Disease	4.25603E-05	0	0	2.95588E-05	0.00013979	0	8.85366E-05	NA	4.42683E-05
1001	ASIAN_HISPANIC	Lost_Work_Days	Work Loss Days	0.06799425	0	0	0.115421198	0.156350195	0	0.1413889	NA	0.07069445
1001	ASIAN_HISPANIC	Lower_Respiratory_Symptoms	Lower Respiratory Symptoms	0.064518767	0	0	0.015422981	0.059726506	0	0.04015364	NA	0.066922733
1001	ASIAN_HISPANIC	Minor_Restricted-Activity_Days	Minor Restricted Activity Days	0.4702134	0	0	0.770292699	1.107920289	0	0.9773138	NA	0.4886569
1001	ASIAN_HISPANIC	Mortality_Di_65+	Mortality All Cause	0.000525491	0	0	0.000511955	0.000538951	0	0.000546136	NA	0.000546136
1001	ASIAN_HISPANIC	Mortality_Turner_30-64	Mortality All Cause	0.000116509	0	0	0.000158628	0.000305937	0	0.000242222	NA	0.000121111
1001	ASIAN_HISPANIC	Mortality_Turner_65+	Mortality All Cause	0.000436788	0	0	0.000297346	0.000573473	0	0.00045404	NA	0.00045404
1001	ASIAN_HISPANIC	Non-FatalHeartAttacks_Peters	Acute Myocardial Infarction Nonfa	0.000527067	0	0	0.000415523	0.002577642	0	0.001638769	NA	0.000546256
1001	ASIAN_HISPANIC	Non-FatalHeartAttacks_Pooled	Acute Myocardial Infarction Nonfa	6.22525E-05	0	0	6.92633E-05	0.000489926	0	0.000194316	NA	6.47718E-05
1001	ASIAN_HISPANIC	Upper_Respiratory_Symptoms	Upper Respiratory Symptoms	0.26416735	0	0	0.009625426	0.095514908	0	0.05496334	NA	0.2748167
1001	ASIAN_NON-HISPANIC	Acute_Bronchitis	Acute Bronchitis	0.0079037	-0.004349198	0.031057948	-0.009259373	0.068489812	0.01603841	0.03603551	0.008910228	0.008189889
1001	ASIAN_NON-HISPANIC	Asthma_Exacerbation	Asthma Exacerbation Wheeze Asth	0.087129625	-0.021402188	0.809365511	-0.040408526	1.530068159	0.3687206	0.7250336	0.097031737	0.0906292
1001	ASIAN_NON-HISPANIC	ER_Asthma	Emergency Room Visits Asthma	0.000122553	-0.0020773	0.011235311	-0.004226618	0.023012873	0.005403608	0.01147067	0.0001422	0.000127452
1001	ASIAN_NON-HISPANIC	HA_AllRespiratory	HA All Respiratory	0.000358262	-0.003082385	0.009127421	-0.009073331	0.026929749	0.004495802	0.01378877	0.000561975	0.000372669
1001	ASIAN_NON-HISPANIC	HA_Asthma	HA Asthma	1.6843E-05	0.000234513	0.000970633	0.000344487	0.00142931	0.00060695	0.000928327	2.02317E-05	1.75156E-05
1001	ASIAN_NON-HISPANIC	HA_Cardiovascular	HA All Cardiovascular (less Myocar	4.99035E-05	0.000851109	0.002398356	0.001146889	0.003234446	0.001628815	0.002284182	6.16975E-05	5.19132E-05
1001	ASIAN_NON-HISPANIC	HA_Cardiovascular	HA All Cardiovascular (less Myocar	0.000393868	0.0018404	0.009445256	0.005749893	0.02954239	0.004661854	0.01516006	0.000582732	0.000409731
1001	ASIAN_NON-HISPANIC	HA_CLD	HA Chronic Lung Disease	2.04532E-05	0.000231198	0.001091499	0.000312512	0.001477936	0.000665204	0.000936057	2.51971E-05	2.1274E-05
1001	ASIAN_NON-HISPANIC	Lost_Work_Days	Work Loss Days	0.083635955	2.140031338	2.896459818	3.123410225	4.230988503	2.520308	3.826121	0.095466212	0.086957295
1001	ASIAN_NON-HISPANIC	Lower_Respiratory_Symptoms	Lower Respiratory Symptoms	0.064518757	0.087847374	0.335666806	0.17993477	0.696809232	0.2189921	0.4684591	0.072997367	0.066922729
1001	ASIAN_NON-HISPANIC	Minor_Restricted-Activity_Days	Minor Restricted Activity Days	0.470213409	11.5909729	16.64439964	16.94643974	24.3742485	14.13954	21.5009	0.535588636	0.488656818
1001	ASIAN_NON-HISPANIC	Mortality_Di_65+	Mortality All Cause	0.001639166	0.033489667	0.035247833	0.059086837	0.06220255	0.03437135	0.06303184	0.004296419	0.001703563
1001	ASIAN_NON-HISPANIC	Mortality_Turner_30-64	Mortality All Cause	6.09401E-05	0.00239111	0.004601265	0.001576441	0.003040389	0.003508479	0.002407189	0.000134942	6.33471E-05
1001	ASIAN_NON-HISPANIC	Mortality_Turner_65+	Mortality All Cause	0.001362472	0.019484797	0.037495017	0.034317903	0.066186927	0.02859007	0.05240263	0.003573759	0.001416287
1001	ASIAN_NON-HISPANIC	Non-FatalHeartAttacks_Peters	Acute Myocardial Infarction Nonfa	0.000599674	0.00480494	0.029204343	0.01276461	0.079183705	0.01809286	0.05034203	0.000525955	0.000621507
1001	ASIAN_NON-HISPANIC	Non-FatalHeartAttacks_Pooled	Acute Myocardial Infarction Nonfa	7.08124E-05	0.000803294	0.005661664	0.002127726	0.015050218	0.002164945	0.005967741	6.29344E-05	7.36758E-05

CBG_ID	Race_Ethn	Endpoint_Rev	Endpoint	Incr_Est2.5_2016	Incr_Est97.5_2016	Incr_Est2.5_2050	Incr_Est97.5_2050
1001	ASIAN_HISPANIC	Acute_Bronchitis	Acute Bronchitis	0	0	-0.000876747	0.006421075
1001	ASIAN_HISPANIC	Asthma_Exacerbation	Asthma Exacerbation Wheeze Asth	0	0	-0.004204635	0.159151599
1001	ASIAN_HISPANIC	ER_Asthma	Emergency Room Visits Asthma	0	0	-0.000228805	0.001243453
1001	ASIAN_HISPANIC	HA_AllRespiratory	HA All Respiratory	0	0	-0.000148705	0.000441072
1001	ASIAN_HISPANIC	HA_Asthma	HA Asthma	0	0	2.99849E-05	0.000124325
1001	ASIAN_HISPANIC	HA_Cardiovascular	HA All Cardiovascular (less Myocar	0	0	0.000118972	0.000335446
1001	ASIAN_HISPANIC	HA_Cardiovascular	HA All Cardiovascular (less Myocar	0	0	0.000105145	0.000540057
1001	ASIAN_HISPANIC	HA_CLD	HA Chronic Lung Disease	0	0	3.07525E-05	0.000145365
1001	ASIAN_HISPANIC	Lost_Work_Days	Work Loss Days	0	0	0.120019034	0.162539944
1001	ASIAN_HISPANIC	Lower_Respiratory_Symptoms	Lower Respiratory Symptoms	0	0	0.016028488	0.06183726
1001	ASIAN_HISPANIC	Minor_Restricted-Activity_Days	Minor Restricted Activity Days	0	0	0.800689995	1.151115298
1001	ASIAN_HISPANIC	Mortality_Di_65+	Mortality All Cause	0	0	0.000532084	0.000560107
1001	ASIAN_HISPANIC	Mortality_Turner_30-64	Mortality All Cause	0	0	0.000164946	0.000317921
1001	ASIAN_HISPANIC	Mortality_Turner_65+	Mortality All Cause	0	0	0.000309188	0.000595937
1001	ASIAN_HISPANIC	Non-FatalHeartAttacks_Peters	Acute Myocardial Infarction Nonfa	0	0	0.000431931	0.002664029
1001	ASIAN_HISPANIC	Non-FatalHeartAttacks_Pooled	Acute Myocardial Infarction Nonfa	0	0	7.20581E-05	0.00050918
1001	ASIAN_HISPANIC	Upper_Respiratory_Symptoms	Upper Respiratory Symptoms	0	0	0.010015093	0.09934853
1001	ASIAN_NON-HISPANIC	Acute_Bronchitis	Acute Bronchitis	-0.004349198	0.031057948	-0.009644217	0.070631824
1001	ASIAN_NON-HISPANIC	Asthma_Exacerbation	Asthma Exacerbation Wheeze Asth	-0.021402188	0.809365511	-0.042046346	1.591516018
1001	ASIAN_NON-HISPANIC	ER_Asthma	Emergency Room Visits Asthma	-0.0020773	0.011235311	-0.004399125	0.0239073
1001	ASIAN_NON-HISPANIC	HA_AllRespiratory	HA All Respiratory	-0.003082385	0.009127421	-0.009442594	0.028007507
1001	ASIAN_NON-HISPANIC	HA_Asthma	HA Asthma	0.000234513	0.000970633	0.000358369	0.001485879
1001	ASIAN_NON-HISPANIC	HA_Cardiovascular	HA All Cardiovascular (less Myocar	0.000851109	0.002398356	0.001193213	0.003364326
1001	ASIAN_NON-HISPANIC	HA_Cardiovascular	HA All Cardiovascular (less Myocar	0.0018404	0.009445256	0.005982426	0.030727483
1001	ASIAN_NON-HISPANIC	HA_CLD	HA Chronic Lung Disease	0.000231198	0.001091499	0.000325133	0.001536877
1001	ASIAN_NON-HISPANIC	Lost_Work_Days	Work Loss Days	2.140031338	2.896459818	3.247831821	4.398488998
1001	ASIAN_NON-HISPANIC	Lower_Respiratory_Symptoms	Lower Respiratory Symptoms	0.087847374	0.335666806	0.186999023	0.721434653
1001	ASIAN_NON-HISPANIC	Minor_Restricted-Activity_Days	Minor Restricted Activity Days	11.5909729	16.64439964	17.61518097	25.32453537
1001	ASIAN_NON-HISPANIC	Mortality_Di_65+	Mortality All Cause	0.033489667	0.035247833	0.061410081	0.064644277
1001	ASIAN_NON-HISPANIC	Mortality_Turner_30-64	Mortality All Cause	0.00239111	0.004601265	0.001639227	0.003159487
1001	ASIAN_NON-HISPANIC	Mortality_Turner_65+	Mortality All Cause	0.019484797	0.037495017	0.035684705	0.068779573
1001	ASIAN_NON-HISPANIC	Non-FatalHeartAttacks_Peters	Acute Myocardial Infarction Nonfa	0.00480494	0.029204343	0.013268668	0.081837483
1001	ASIAN_NON-HISPANIC	Non-FatalHeartAttacks_Pooled	Acute Myocardial Infarction Nonfa	0.000803294	0.005661664	0.00221358	0.0156417

DETAILED BENMAP OUTPUT SHEETS ARE IN THE 1,000s.

DETAILED SHEETS AVAILABLE UPON REQUEST.

Appendix B

Avoided $PM_{2.5}$-Related Premature Deaths and Illnesses with the Implementation of the Draft 2021 Regional Plan

Appendix B. Avoided $PM_{2.5}$-Related Premature Deaths and Illnesses with the Implementation of the Draft 2021 Regional Plan

Values presented in the table reflect the difference between premature deaths and illness cases (per 100,000 persons) estimated in 2016 (baseline) and 2050 (Regional Plan). Because populations differ among these estimates, negative morbidity effect estimates may be attributable to changes in population among the years evaluated. Baseline mortality incidences differ among these estimates, so negative values associated with changes in mortality cases may result from both population differences and baseline mortality incidence differences.

Positive values indicate the number of avoided premature deaths and illnesses. Negative values indicate an increased number of incidences of health effects. As a result of demographic changes, increases in illness or health effects can still occur with improved air quality with the implementation of the Draft 2021 Regional Plan.

		Avoided Adult Illnesses & Hospital Admissions, Restricted Days						**Avoided Childhood Illnesses**			
Disadvantaged Communities [a, b]	**Avoided Premature Mortalities [c]**	**Non-Fatal Heart Attacks [d]**	**Hospital Admin. - Cardiovascular**	**Hospital Admin. - Respiratory**	**Hospital Admin. - Chronic Lung Disease**	**Minor Restricted-Activity Days**	**Lost Work Days**	**Exacerbated Asthma**	**Acute Bronchitis**	**Respiratory Symptoms**	
										Upper	**Lower**
Age Range	***0, 30 to 99***	***18 to 99***	***18 to 99***	***65 to 99***	***18 to 24***	***18 to 64***	***18 to 64***	***6 to 18***	***8 to 12***	***9 to 11***	***7 to 14***
San Diego County Region	30	-3.3	-2.2	-1.2	0.40	6,200	960	1,100	93	3,400	780
Year 2016	253	21.3	12.7	39.5	2.38	53,500	9,150	9,600	893	30,300	7,320
Year 2050	223	24.6	15.0	40.7	1.98	47,400	8,190	8,500	800	26,900	6,540
Disadvantaged Community Total [e]	32	-4.0	-2.8	-1.9	0.30	4,803	707	874	71	2,621	598
City of San Diego	37	-3.7	-2.4	0.2	0.38	7,601	1,283	1,384	119	4,407	997
Barrio Logan	92	-3.6	-2.2	6.4	0.28	10,572	1,771	1,929	163	6,188	1,375
City Heights	39	-4.7	-3.0	0.8	0.29	8,297	1,392	1,543	128	4,792	1,080
Encanto	39	-3.3	-2.2	0.7	0.38	8,589	1,371	1,604	133	4,989	1,120
Linda Vista	34	-4.2	-2.8	-0.8	0.25	5,911	1,071	1,210	88	3,294	743
San Ysidro	41	-5.8	-3.7	-0.8	0.13	5,503	866	1,049	84	3,221	712
Skyline-Paradise Hills	19	-3.7	-2.5	-2.5	0.35	6,183	951	1,140	95	3,586	803
Southeastern San Diego	55	-5.3	-3.3	2.3	0.25	9,325	1,580	1,757	145	5,470	1,221
City of Chula Vista	15	-5.2	-3.6	-5.7	0.17	489	-101[f]	106	12	245	90
City of Escondido	31	-3.7	-2.5	-2.1	0.31	4,678	700	928	75	2,857	637

Appendix B. Avoided $PM_{2.5}$-Related Premature Deaths and Illnesses with the Implementation of the Draft 2021 Regional Plan

		Avoided Adult Illnesses & Hospital Admissions, Restricted Days						Avoided Childhood Illnesses			
Disadvantaged Communities [a, b]	**Avoided Premature Mortalities [c]**	**Non-Fatal Heart Attacks [d]**	**Hospital Admin. - Cardiovascular**	**Hospital Admin. - Respiratory**	**Hospital Admin. - Chronic Lung Disease**	**Minor Restricted-Activity Days**	**Lost Work Days**	**Exacerbated Asthma**	**Acute Bronchitis**	**Respiratory Symptoms**	
										Upper	**Lower**
City of El Cajon	43	-2.5	-1.8	0.5	0.61	8,951	1,397	1,678	137	5,229	1,161
City of National City	60	-1.1	-0.7	2.3	0.39	8,733	1,416	1,571	127	4,834	1,074
City of Vista	41	-3.2	-2.2	-0.4	0.38	5,694	858	1,056	86	3,220	724

Source: ICF, 2021. TAHA, 2021.

Notes:

Values rounded to two significant digits. Positive values indicate the number of avoided premature deaths and illnesses. Negative values indicate an increased number of incidences of health effects.

Values reflect the difference between premature deaths and illness cases (per 100,000 persons) estimated in 2016 (baseline) and 2050 (Regional Plan). Because populations differ among these estimates, negative morbidity effect estimates may be attributable to changes in population among the years evaluated. Baseline mortality incidences differ among these estimates, so negative values associated with changes in mortality cases may result from both population differences and baseline mortality incidence differences.

[a] Disadvantaged Communities identified based on socioeconomic data and CalEnviroScreen 4.0 scores in the 50th percentile or higher include the City of San Diego communities of Barrio Logan, City Heights, Encanto, Linda Vista, San Ysidro, Skyline-Paradise Hills, and Southeastern San Diego; City of Chula Vista; City of Escondido; City of El Cajon; City of National City; and City of Vista. The boundaries are based on center point Census block groups that are located within a community. Data presented is for the community as a whole.

[b] County of San Diego and City of San Diego are included for comparative purposes.

[c] Total mortalities is the average of the sum of infant mortalities, low estimates of adult avoided mortalities (Adult mortality 30-64, Turner and Adult mortality 65+, Turner) and the high estimates of adult avoided mortalities (Adult mortality 30-64, Turner and Adult mortality 65+, Di). Details are provided in Appendix A: *Technical Report on the Modeling Evaluation Study Supporting the Community Health Equity Evaluation for San Diego Forward: the 2021 Regional Plan*.

[d] The pooled nonfatal heart attack estimate is based on four studies: Pope et al. (2006), Sullivan et al. (2005), Zanobetti and Schwartz (2006), and Zanobetti et al. (2009). Details are provided in Appendix A: *Technical Report on the Modeling Evaluation Study Supporting the Community Health Equity Evaluation for San Diego Forward: the 2021 Regional Plan*.

[e] Disadvantaged Community Totals is the data presented in Tables 3 through 5 of the Community Health Equity Evaluation. The Disadvantaged Community Totals account for Census block groups within a community with a CalEnviroScreen 4.0 score in the 50th percentile or higher. The Disadvantaged Community Totals does not equal the sum of each whole community and reflect the normalized (per 100,000 persons) difference between cases estimated in 2016 (baseline) and 2050 (Regional Plan).

[f] The City of Chula Vista would have an increase in lost workdays as a result of illness or health effects despite the reduction of $PM_{2.5}$ with the implementation of the Draft 2021 Regional Plan. Due to demographic changes, increases in illness or health effects can still occur with improved air quality due to the Draft 2021 Regional Plan.