Appendix G - Air Toxics Modeling and Risk Assessment for the Portside Environmental Justice Community in San Diego, California

Executive Summary

In response to Assembly Bill (AB) 617's requirement (C. Garcia, Chapter 136, Statutes of 2017), the San Diego County Air Pollution Control District (District) has developed the Community Emissions Reduction Plan (CERP) which specifies strategies with an aim to reduce both air pollution emissions and community exposure to air pollution in the Portside communities. The Portside Community Steering Committee (CSC) has fully involved/engaged in the development and implementation of the CERP through a number of the public meetings, extensive public outreach and public workshops. In addition to regulatory efforts, the CSC has proposed a series of actions to reduce air pollution in the community. Each action is to be carried out based on a set of strategies, goals and timelines. Among those goals listed in the actions, Goals #5 and #6 are described as follows:

> *Goal #5: By December 2021, APCD to present the cumulative cancer risk for Portside Communities from Health Risk Assessments and modeling of cumulative risk (including freeways, rail, vessels, stationary sources, etc.) to inform Goal #6. APCD can achieve this modeling goal with CARB assistance and input from the Portside Community Steering Committee including methodology and input data.*
>
> *Goal #6: By February 2022, establish an estimated cancer risk reduction goal based on the modeling that is done in Goal #5. Estimated cancer risk at all census tracts in Portside Community from locally generated emissions, including both stationary and mobile sources, to meet goals of ___/ million by 2026 and ___ /million by 2031.*

It is apparent that there is a need to develop a health risk model to estimate the base years' cumulative cancer risk and predict risk reduction in the future years to inform air toxics reduction progress/trend over time. CARB's statewide regional[1] air toxics risk modeling was leveraged to help the CSC meet the above two goals. Specifically, the objectives of the CSC's health risk model are to: 1) assess cumulative population exposure and health risk from toxic pollutants; 2) quantify the relative contribution of different emission sources or categories, including those located outside of the Portside Community; 3) identify geographic areas with higher pollution burden; 4) inform strategies for reducing exposure and health risk from sources causing the greatest risk; 5) help prioritize health risks and

[1] The regional scale modeling refers to the study of a geographically-defined region, like county, air basin, and statewide.

resources; 7) complement data from monitoring network; and 7) further inform cancer risk reduction goals.

The risk estimates from this regional modeling analysis were developed based on population-weighted averages over all census blocks in the community to better identify the sources of highest impact to the community as a whole (a census block is defined as an area with an average of about 52 residents in California, ranging from 0 to 7,900, by the Census Bureau). Individual local risks within a census block may vary significantly from average risk within the census due to differences in proximity to sources and how pollutants are emitted from a source (e.g., near surface or aloft). For example, if a census block covers a city block, residents within that census block that live immediately next to a source having ground-level emissions may be exposed to significantly higher concentrations than the concentrations averaged over the entire census block.

The primary findings from the regional modeling analysis are summarized as follows:

- For the 2017 regional emissions analysis[2], Diesel Particulate Matter (DPM) was the main contributing pollutant to total average risk within the community and accounted for 85% of the total risk. The overall population-weighted cancer risk from all toxic air contaminants (TACs) was estimated to be about 987 chances per million. Among all DPM sources in 2017, on-road mobile sources were the top contributor (~40% of total DPM risk).
- For the 2017 local emissions analysis[3], DPM was still the main driver of overall risk in the community and accounted for about 76% of the overall risk. The overall population-weighted cancer risk from local emissions was estimated to be about 320 chances per million. Among DPM emission sources located within the Portside boundary, on-road mobile sources were also the top contributor (collectively ~56% of total DPM risk). Meanwhile, areawide (e.g., construction) and aggregated area-point sources (e.g., gasoline stations and dry cleaners) were the main contributors to VOC cancer risks, while stationary sources, such as industrial facilities or power plants, were the main contributors to risks from heavy metals.
- Overall, around 33% of total potential population-weighted cancer risk in the Portside community resulted from local sources (i.e., emissions within the community boundary).
- In the future, the risk associated with on-road DPM emissions would be significantly reduced from both local and regional sources. This reduction is attributed to DPM emission reductions primarily from the On-road Truck and Bus rule. Programs

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[1] For the regional analysis, the geographical modeling domain covers the whole County of San Diego and a portion of Mexico near the border of CA and Mexico, and the emissions included those sources from both inside and outside of the Portside community.

[2] Local or microscale modeling is referred to a geographically-defined small region, like a small city or a suburban. For the local analysis, the geographical domain of interest is the Portside community, and the emissions included those sources from within the community only.

designed to reduce emissions from ocean going vessels (OGV), commercial harbor craft (CHC), cargo handling equipment (CHE), transport refrigeration units (TRU) and other sources have also been and/or will be implemented, but the relative contributions from these sources (compared to on-road mobile) are still projected to increase with time, even though absolute risks would be decreasing.

Recommended use of the findings for CERP Goals 5 and 6:

- The modeling results are best used in a qualitative manner to inform which source categories and pollutants are contributing most to the overall risk within the community, which can then be used to inform and prioritize emission reduction strategies that target the sources most likely to lead to additional reductions in risk over time.
- Future-year risk estimates are best used to help focus on those sources that are not already projected to decrease significantly due to existing regulations, so as to achieve the greatest overall reduction in risk over time.
- Since this study is different from an HRA under the "hot spots" program, we don't expect this study's results to be used: 1) as a definitive means to pinpoint specific risk values at a specific location; 2) as part of a hot spot program or an HRA or as a permitting application; and 3) as a sole basis for policy decisions.

INTRODUCTION

The California Air Resources Board (CARB) staff has completed the regional air quality and toxics modeling for the County of San Diego with the emission of 2017. In this study, CALPUFF was used to model inert toxics, namely diesel particulate matter (DPM) and 5 toxic heavy metals (cadmium, hexavalent chromium, lead, arsenic, and nickel), while the Community Multiscale Air Quality Modeling System (CMAQ) was utilized to simulate 6 reactive toxic volatile organic compounds (VOCs: benzene, 1,3-butadiene, formaldehyde, acetaldehyde, perchloroethylene and p-dichlorobenzene). Annual average concentrations of individual toxic species have been simulated and the associated toxic health risks have been assessed. Based on the regional modeling, toxics exposure and associated health risk in the Portside Environmental Justice (EJ) Communities (Portside) have been analyzed with the following objectives: 1) assess cumulative population exposure and associated health risk in Portside; 2) quantify relative contribution of emission sources/categories (including those located outside of Portside) to the overall impact in Portside; 3) identify geographic areas with higher pollution burden in Portside; and 4) help identify strategies for reducing exposure and health risk. Nevertheless, community-level analysis using the results from the above-mentioned regional modeling cannot determine relative or absolute contribution of each emission source or category located within Portside to the overall impact.

In response to Assembly Bill (AB) 617's requirement (C. Garcia, Chapter 136, Statutes of 2017), the San Diego County Air Pollution Control District (District) has recently developed the Community Emissions Reduction Plan (CERP) which specifies strategies with an aim to reduce both air pollution emissions and community exposure to air pollution in the Portside communities. The CERP was adopted by the District Board July 2021 and approved by CARB October 2021.

To address one of the Action A3 goals/objectives laid out in the CERP, i.e., assessing toxic health impact from emission sources only located within Portside and identify each emission source (category)'s relative contribution to the overall impact, a micro-scale modeling with a domain encompassing Portside has been conducted. This study can serve as a model template/tool that will help quantify and prioritize health risks from air pollutants in other AB617 communities. In addition to the goals listed above, this study can be used to meet the following goals which are laid out in the CERP for Portside: 1) identify geographic areas with higher pollution burden and emission sources or toxic species responsible of the greatest health risks; 2) help identify strategies for reducing exposure and health risk from those sources identified as causing the greatest risk; 3) establish a baseline of health risk for further informing health risk reduction goals and tracking progress of the reduction over time in the Portside communities; and 4) complement data from monitoring network. The monitor measurements are usually limited due to resources and cost, while modeling data can complement the data gaps.

MODELING APPROACH

Conducting an air toxics risk assessment based on the statewide triennial modeling includes four main steps: 1) prepare detailed model inputs such as high-resolution meteorological fields and detailed emission inventory for each of the toxic air contaminants (TACs), i.e., the amount of emissions emitted by individual sources with temporal, spatial and chemically speciated allocations for the calendar year of 2017. This includes separation of local emissions located within the Portside community boundaries from the rest of regional emissions to better inform the District's CERP Goal #6; 2) estimate ambient concentrations of individual TACs using air quality modeling (i.e., use of mathematical formulations to characterize the atmospheric processes and calculate pollutant concentrations at selected receptor locations), 3) estimate population exposures (i.e., consideration of certain important exposure variables, such as human activity patterns/receptor type, exposure pathways, exposure duration, etc.), and 4) characterize potential health risks from inhalation at the census block level (i.e., assess the risk associated with TACs at each census block based on the concentration and type of the TACs).

I. Emission Inventory

TACs of Concern. A total of 12 TACs were simulated in this study: DPM, 6 toxic gaseous VOCs (acetaldehyde, benzene, 1,3-butadiene, formaldehyde, p-dichlorobenzene, and perchloroethylene), and 5 heavy metals (cadmium, hexavalent chromium, lead, arsenic, and nickel). Our regional modeling analyses for the County of San Diego have indicated that the 12 TACs cumulatively account for more than 98% of TACs emissions in the County of San Diego.

Emission Sources/Categories. There are many sources that emit emissions in Portside but not all sources contribute to air pollution equally. Contributing sources were grouped into four categories: on-road mobile sources, off-road mobile sources, area sources, and stationary point sources. On-road mobile sources include all motor vehicles on major and minor roadways, such as passenger cars, trucks, and motorcycles, and were modeled as line sources following the road network. More specifically for the Portside community, the on-road mobile sources included more than 10 miles of freeways that support regional and local transportation needs, such as Interstate Highways I-5 and I-15, and local business and residential traffic roads. The off-road mobile sources included such as locomotives, railyards, airports, ocean going vessels (OGVs), commercial harbor crafts (CHC), cargo handling equipment (CHE), and port trucks from the Port. Note that very small portions of CHC, CHE, OGV at berth were located within the Portside community boundaries, and therefore were mostly accounted for in the regional modeling. The area sources included construction, charbroils, livestock, various fires (wildfires, agricultural fires, prescribed fires, structure fires, residential wood combustion), paved and nonpaved road dust, aggregated commercial and industrial equipment such as forklift, air compressors, generators, etc., and small point sources (e.g., gasoline stations, dry cleaners and autobody shops). The stationary sources (businesses regulated by District) included, but are not limited to, electric utilities, metal fabrication and coating operations, petroleum bulk terminals, medicinal and botanical manufacturing and many others.

Emission Inventory Development. CARB staff has developed a state-of-the-science methodology and various tools to generate very detailed TAC emission inventories with highly resolved spatial and temporal allocations, as well as chemical speciation for all on-road mobile, off-road mobile, area and point sources statewide. These emission inventories include 25-30 emission source subcategories, which are explicitly tracked for individual TACs (see Table G-1). Initially the emission Inventory was developed for the County of San Diego, which was based on the version 1.01 of the California Emission Projection Analysis Model (CEPAMv1.01), also tracked as rf3043-snap20190508 with toxic stationary sources based on the California Toxics Inventory (CTI) CEIDARS 2017 stationary inventory with stamp date 10-24-2019. The on-road portion of emission inventories were generated from the EMissionFACtor (EMFAC) model 2017.

For this community study, the emission sources within Portside were separated from the regional emission inventory in the whole County using GIS techniques. Note that sources within the community were defined using the official Portside AB 617 boundary, so that "locally generated emissions" were defined as emissions that fall strictly within the community boundary. If any emission sources such as freeways and local traffic roads cross the Portside boundary lines, only the fraction of the emissions within Portside was considered.

Table G-1. Emission source types, categories and sectors used in the modeling study.

Source Type	Source Categories	Source Sectors
Point sources	Off-road mobile Stationary	• OGV at berth • Stationary Toxics – Hotspots program
Line sources	On-road mobile Off-road mobile	• On-road major traffic • OGV (maneuvering / transit) • Aircraft 3D • Locomotives (in progress)
Area sources (1km x 1km)	Off-road mobile Area sources Mexico sources	• Commercial harbor craft, cargo handling equipment, aircraft (military), locomotive (current), OGV (military), TRU • Ag burn, agriculture activities, construction, managed burns, residential wood combustion, structural burns, wildfires / prescribed burn, charbroil • Others: off-road equipment such as forklifts, generator sets, pumps, air compressors, food and agricultural processing, manufacturing and industrial equipment, etc. • Mexico (on-road, off-road, point and areas)

Emission Summary. The 2017 annual DPM emissions total within the community was estimated as 11.7 TPY, in which on-road, off-road, area and point sources accounted for 32%, 37%, 28% and 3%, respectively. Metals and VOCs emissions were weighted to DPM potency equivalent emissions based on their inhalation cancer potency values. The total TACs emissions amount to an estimated 16.3 TPY (DPM potency equivalent) within Portside. Figure G-1 shows the distribution of annual total emissions by each TAC. DPM accounted for about 72% of the total TACs emissions. The other significant TAC species (i.e., contribution >1%) were hexavalent chromium (8.8%), benzene (6.2%), arsenic (4.6%), 1,3-butadiene (2.9%), cadmium (2.5%), and formaldehyde (1.3%).

Figure G-2 shows that the distribution of DPM emissions by source categories in Portside differs from the SD County as a whole. In Portside, on-road and off-road mobile sources account for 69% of total DPM emissions, while the same categories account for 52% of total DPM emissions countywide. Figure G-3 shows the spatial distribution of DPM emissions for on-road mobile sources, including freeways and local traffic roadways within Portside. The freeways (I-5, I-15, SR54 and SR75) and the local roadways account for about 80% and 20% of the total on-road mobile DPM emissions, respectively.

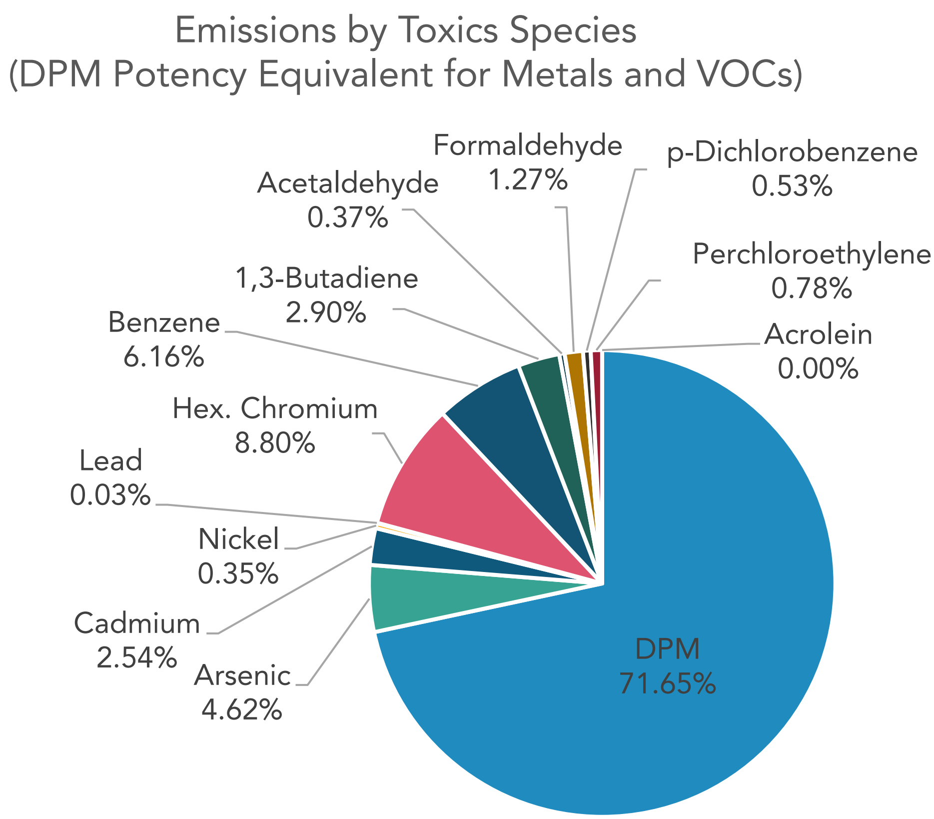

Figure G-1. Distribution of Annual Total Emissions by TAC Species (the emissions of VOCs and metals were expressed in DPM potency equivalent).

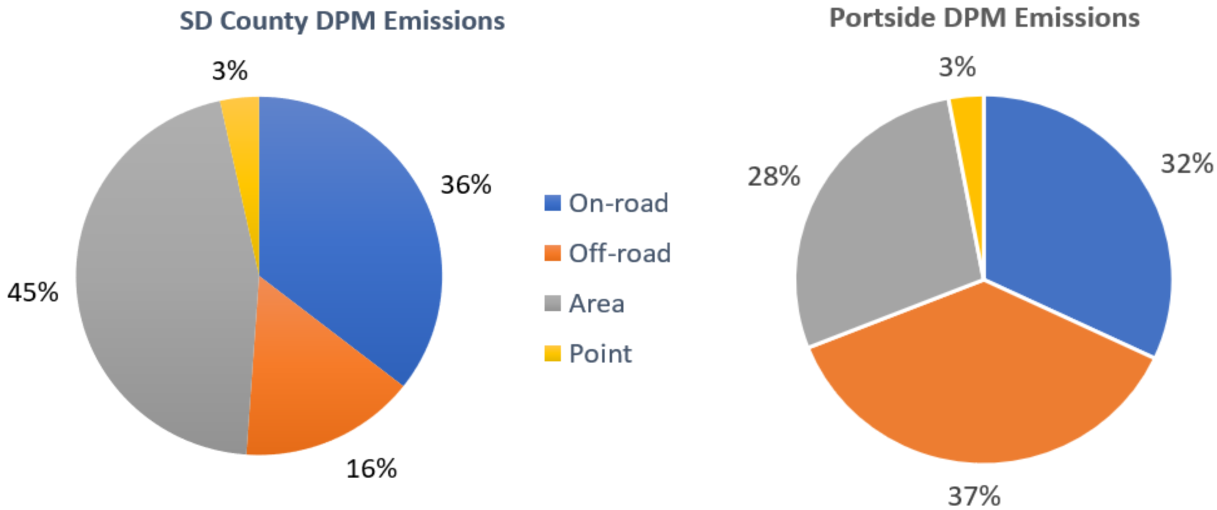

Figure G-2. DPM emissions by source category for SD County (left) and Portside (right) for 2017.

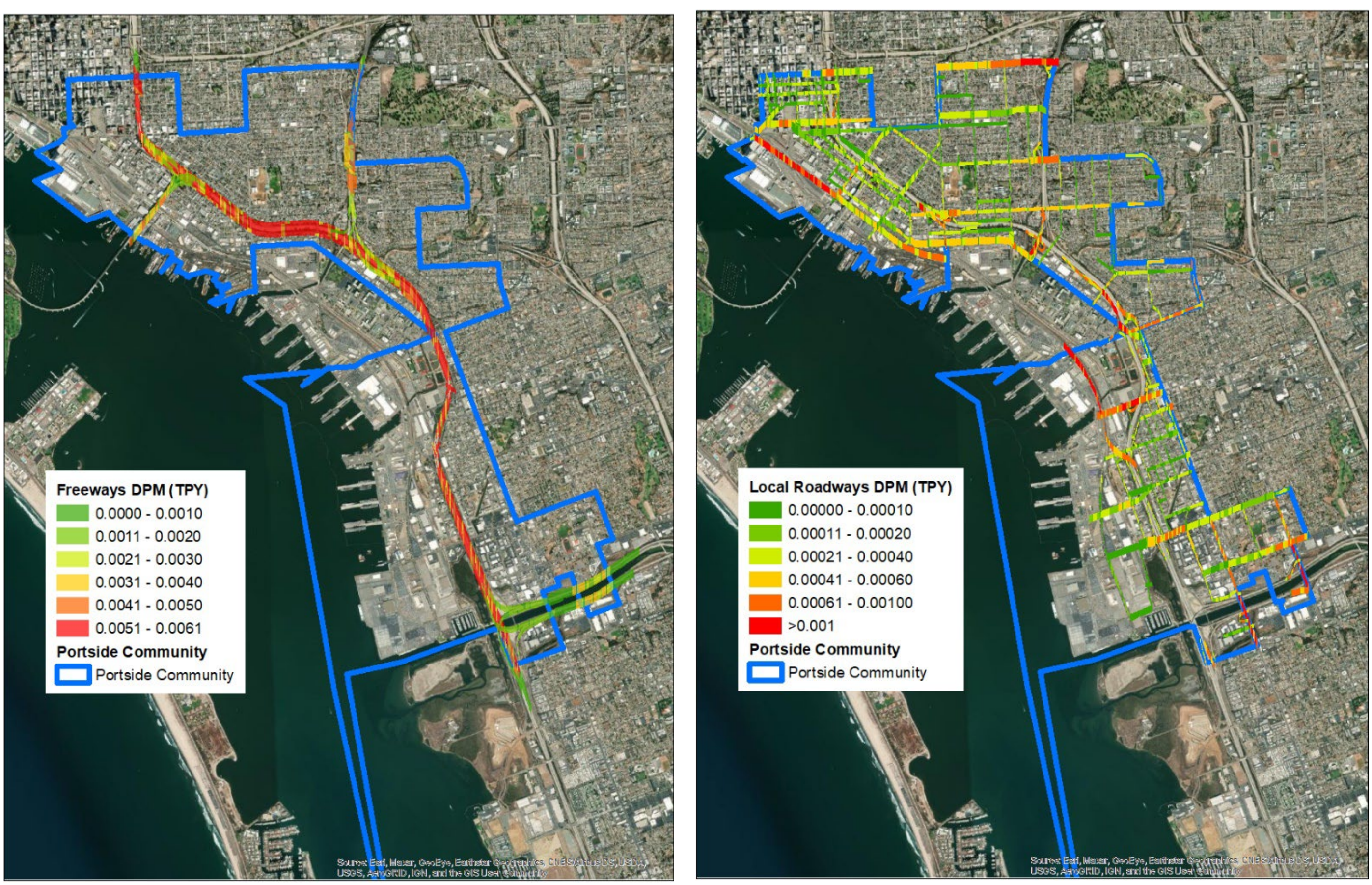

Figure G-3. Spatial distribution of annual DPM emissions for on-road mobile sources within Portside for 2017.

II. Air Quality Modeling

Model Domain. The modeling domain encompasses the entire community of interest and extends in all directions by about 5 kilometers so that the impact by the emission sources within the community can be fully assessed (Figure G-4). The extended buffer zones will allow air parcels reentering the community after they leave the area for a brief time. This is important in those areas influenced by mountain-valley breeze or land-sea breeze, such as the Portside community.

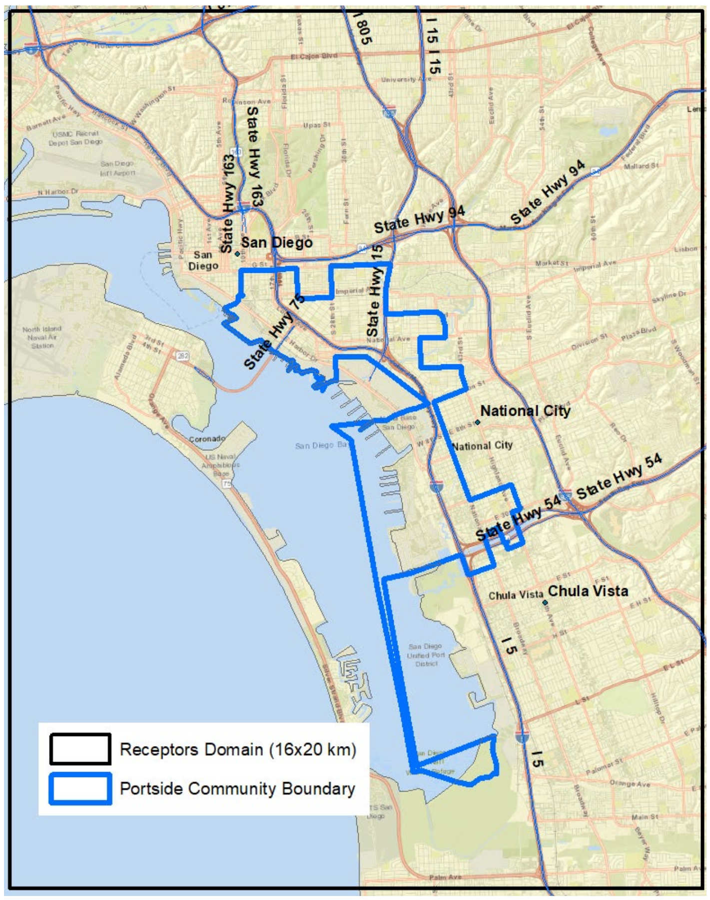

Figure G-4. Modeling domain for the Portside community.

Model Selection. Generally speaking, grid-based photochemical models such as CMAQ are not suited for modeling on a small domain like Portside since the K-theory imbedded in grid-based air quality models would be invalid. This suggests that plume- or puff-based dispersion models would be the only viable tools. Both the U.S. EPA preferred dispersion model - AERMOD and the recommended puff model - CALPUFF can be used in the community level modeling. With the considerations of 1) the consistency with our regional modeling for the County of San Diego, and 2) AERMOD may not adequately capture the horizontal variations of the meteorological field surrounding Portside, we utilized CALPUFF to simulate individual emission sources and species' emissions within Portside. 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 has the capability to characterize emissions sources more explicitly (i.e., no averaging to the grid cell such as CMAQ modeling) and to place receptors at any desired locations (i.e., not restricted to a uniform grid, so non-uniform census block/tract receptors can be used) to calculate pollutant concentrations. It is also scientifically robust in terms of handling transport and dispersion of pollutants in the atmosphere, and so can be used to simulate near-source impacts as well as more regional effects. CALPUFF can be applied on scales of tens to hundreds of kilometers. The modeling system consists of three main components and a set of pre-processing and post-processing programs. The main components of the modeling system are CALMET (a diagnostic three-dimensional meteorological model), CALPUFF (an air quality dispersion model), and CALPOST (a post-processing package).

As stated above, regional scale photochemical models (such as CMAQ) were not used to simulate chemistry of toxic VOC species due to the fact that Portside covers a relatively small area (only a few kilometers across), thus application of photochemical models is invalid in this exercise. Nevertheless, we conducted a sensitivity study using a Single Column (1-D) modeling approach to assess impact of chemistry on toxic VOCs concentrations within Portside. The adjusted factors for each VOC species derived from the sensitivity study were used to adjust the CALPUFF's modeling results for VOCs.

Emission Sources Characterization. The emission sources within Portside were treated the same ways as in the regional modeling. Specifically:

- On-road mobile: as individual line sources.
- Off-road mobile:
    - OGV's transit and maneuvering: as line sources;
    - airplanes' landing and taking-off in airports: as 3-D line sources;
    - locomotives, CHE, CHC, port-trucks: as polygons-based area sources.
- Area sources: 1km x 1km or smaller grid size or polygon-based area sources.
- Point sources: industrial facilities and OGV's at-berth (idling) treated with consideration of stacks.

Note that a lot of the Port of San Diego's (Port) activities are located outside of the Portside boundary. Therefore, those Port-related emission sources such as OGV emissions over water and CHC were not included in the local sources but are included as part of the emissions outside of the community with the rest of the regional emissions.

QA/QC for Emission Sources. Since emission information is of critical importance in determining concentrations of toxic air contaminants, every effort has been made to ensure the accuracy and reliability of all emissions data, especially for those of emission sources that have the potentials to impose significant impact and those in proximity to high-density residents and sensitive receptors.

Receptors. Since the objective of this modeling exercise was to identify the emission sources or source categories that impact the residents, in particular the most vulnerable people, it suffices to place receptors at all centroids of census blocks and at sensitive receptors such as hospitals, senior homes, kindergartens, and preschools. Concentrations at these receptors would provide adequate information needed to calculate health risks associated with the emission sources included in the modeling, and to assess the severity of air pollution at the sensitive receptors.

Meteorological Data. In this study, CALPUFF was driven by the meteorological data generated by the Weather Research and Forecasting (WRF) model, with 2 km x 2 km horizontal resolution and 31 vertical layers up to 100 mb for the year of 2017. The WRF meteorological outputs were processed through the Mesoscale Model Interface (MMIF) program to create the CALPUFF-ready meteorological inputs.

The major meteorological parameters required by CALPUFF include hourly wind speed and direction, temperature, humidity, cloud cover, rain and solar radiation levels, etc. Wind speed determines how rapidly pollutants are transported away from the source, while wind direction determines where pollutants are transported to. The difference in ambient temperature and the exhaust temperature determines the initial buoyancy of emissions from point sources. CALPUFF also requires some boundary layer parameters to estimate air dispersion of pollutants in the atmosphere, including, but not limited to, atmospheric stability (a measure of atmospheric turbulence that determines the rate at which pollutants are mixed laterally and vertically), the vertical temperature gradient, and the convective and mechanical boundary layer heights (the vertical depth through which pollutants may be dispersed), etc.

Note that the WRF modeling outputs were statistically evaluated by comparing with observations for accuracy. Observations used to evaluate WRF were taken from the EPA's Air Quality System, the CARB meteorological network, the remote automatic weather stations, and the National Climate Data Center. In addition, WRF was also qualitatively evaluated by analyzing some phenomenological features, such as slope flows, channeled flows, sea/land breeze and low-level jet, etc. The vertical profile of observed and simulated meteorological fields was compared at several upper air meteorological stations, including San Diego, Vanderburg, Oakland, Medford, Reno, and Las Vegas. The WRF model performed reasonably well in every evaluation category. The evaluation results are not included in this report.

III. Population Exposures and Risk Characterization

Exposure represents the extent of public exposure to a TAC[4]. An exposure assessment can involve quantification of emissions from emission sources, modeling of environmental transport and fate, and estimation of exposure levels over a certain period of time. CALPUFF can't directly measure exposure because it does not address certain important exposure variables, such as human activity patterns. Instead, the modeled annual average concentrations for TACs are used to represent exposure. Exposure to TACs can occur through multiple pathways, including inhalation and non- inhalation pathways (e.g., soil ingestion, ingestion of mother's milk, etc.). The South Coast Air Quality Management District' MATES-V study[5] showed that including risk from multiple pathways increased overall risk by approximately 7.3% compared to the inhalation-only risk. CARB staff has conducted sensitivity analyses on risk associated with various exposure pathways and found that the inhalation pathway can account for over 95% of the total exposure, which is consistent with MATES-V findings. Thus, only inhalation exposure was considered in this study.

The annual average concentration of each TAC was modeled for the receptors of census blocks and sensitive population groups within Portside. Only those in the census blocks are reported in this report. This is because the major objective of this study is to investigate current pollution level and relative contribution of each emission category to overall impact within the Portside communities.

Cancer risk represents the probability of a person developing cancer if exposed continuously to a TAC over their lifetime (70 years, in units of chances per million people)[6], but it does not necessarily mean that individuals will certainly develop cancer due to TACs. In other words, the risk number is not actual cancer case. Cancer risk calculation in this study is for TACs only and it does not include other risk factors for developing cancer, such as aging, genetics, etc. The California Environmental Protection Agency's Office of Environmental Health Hazard Assessment's (OEHHA) most recent risk assessment guidelines - Guidance Manual for Preparation of Health Risk (2015) were used to characterize cancer risk resulting from exposure to the modeled TACs in this study. Cancer risk is calculated by multiplying the daily inhalation or oral dose by a cancer potency factor, the age sensitivity factor, the frequency of time spent at home (for residents only), and the exposure duration divided by averaging time, to yield the excess cancer risk. For residential inhalation exposure, the excess potential cancer risk is calculated separately by age groups and then summed to yield an overall

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[4] According to section 39655 of the California Health and Safety Code, a toxic air contaminant (TAC) is "an air pollutant which may cause or contribute to an increase in mortality or an increase in serious illness, or which may pose a present or potential hazard to human health".

[5] *http://www.aqmd.gov/docs/default-source/planning/mates-v/appendixix_final.pdf?sfvrsn=4*, Table IX-7-11.

[6] Often, scientific notation is used and you may see it expressed as 1×10^{-5} or 10^{-5}. Therefore, if you see a potential cancer risk of 10 chances per million, that means if one million people were exposed to a certain level of a TAC there is a chance that 10 of them may develop cancer over their 70-year lifetime. This would be 10 new/excess chances of cancer above the expected rate (background) of cancer in the population.

cancer risk at the receptor locations. Cancer risk due to all TACs is the sum of potential cancer risks for all individual TACs. Note that an exposure duration of 30 years with the Risk Management Policy (RMP) method (95th/80th percentile DBR) was used for assessing potential cancer risk (inhalation only).

MODELING RESULTS

I. Exposure

Annual average concentrations of all modeled TACs were calculated and their isopleths are plotted using GIS mapping techniques. Figure G-5 shows the annual average concentrations of diesel PM from all emission sources that are within the Portside community. The highest concentrations are located in the intersecting area of Freeway I-5 and State Highway 75, peaking at about 1.0 to 1.2 $\mu g/m^3$. The concentrations along I-5 within Portside range mostly from 0.6 to 1.2 $\mu g/m^3$. A small portion of the north edge of the Community also show concentrations of 0.6 to 0.8 $\mu g/m^3$, where the I-5 and the commercial and industrial off-road equipment had the largest contributions.

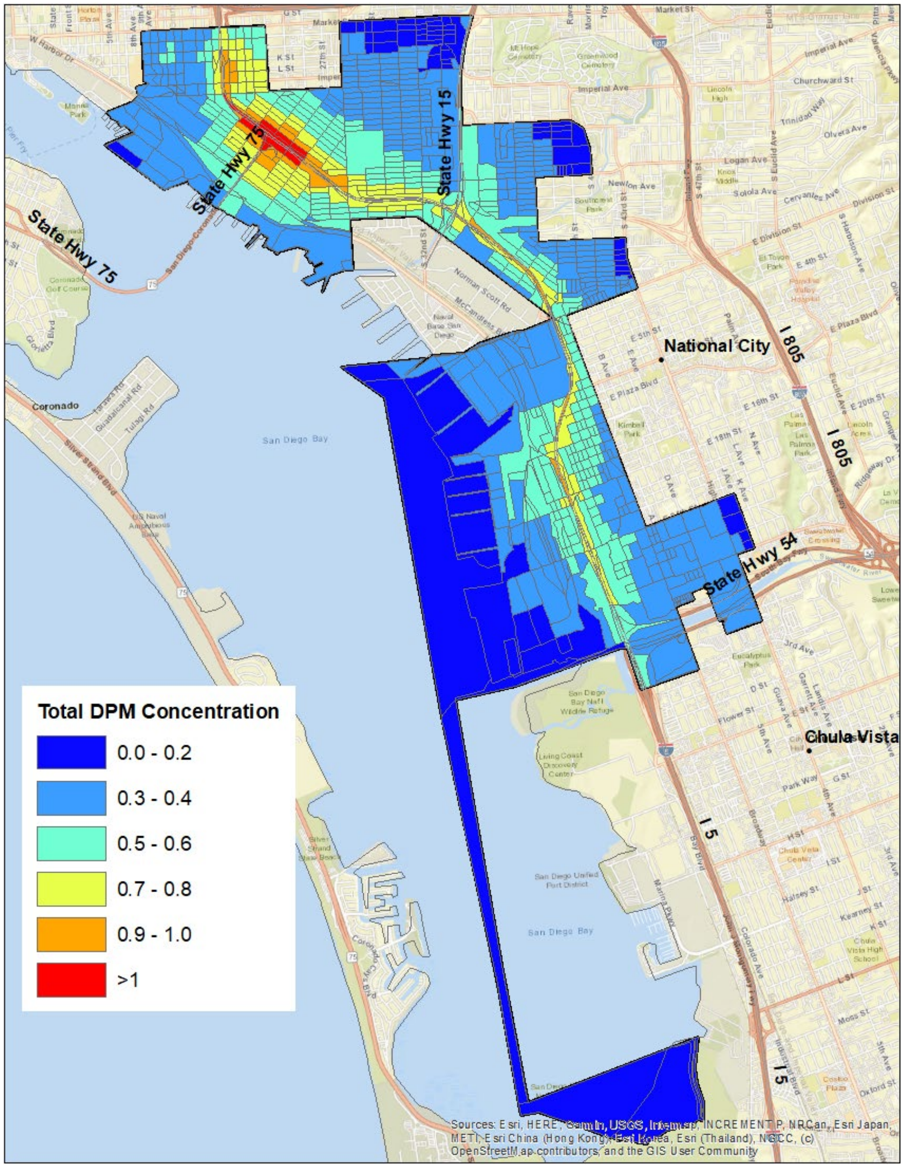

Figure G-5. Simulated annual average DPM concentrations from all emissions sources within Portside for 2017.

Figures G-6 and G-7 show annual average concentrations of a typical gaseous TAC - benzene and a typical heavy metal – hexavalent chromium, respectively. Simulated annual average concentrations of benzene range up to 1.1 µg/m^3 and are distributed along freeways (I-5). This is not surprised because most of benzene are from on-road mobile emissions, whereas hot spots of hexavalent chromium are located near the industrial emission sources.

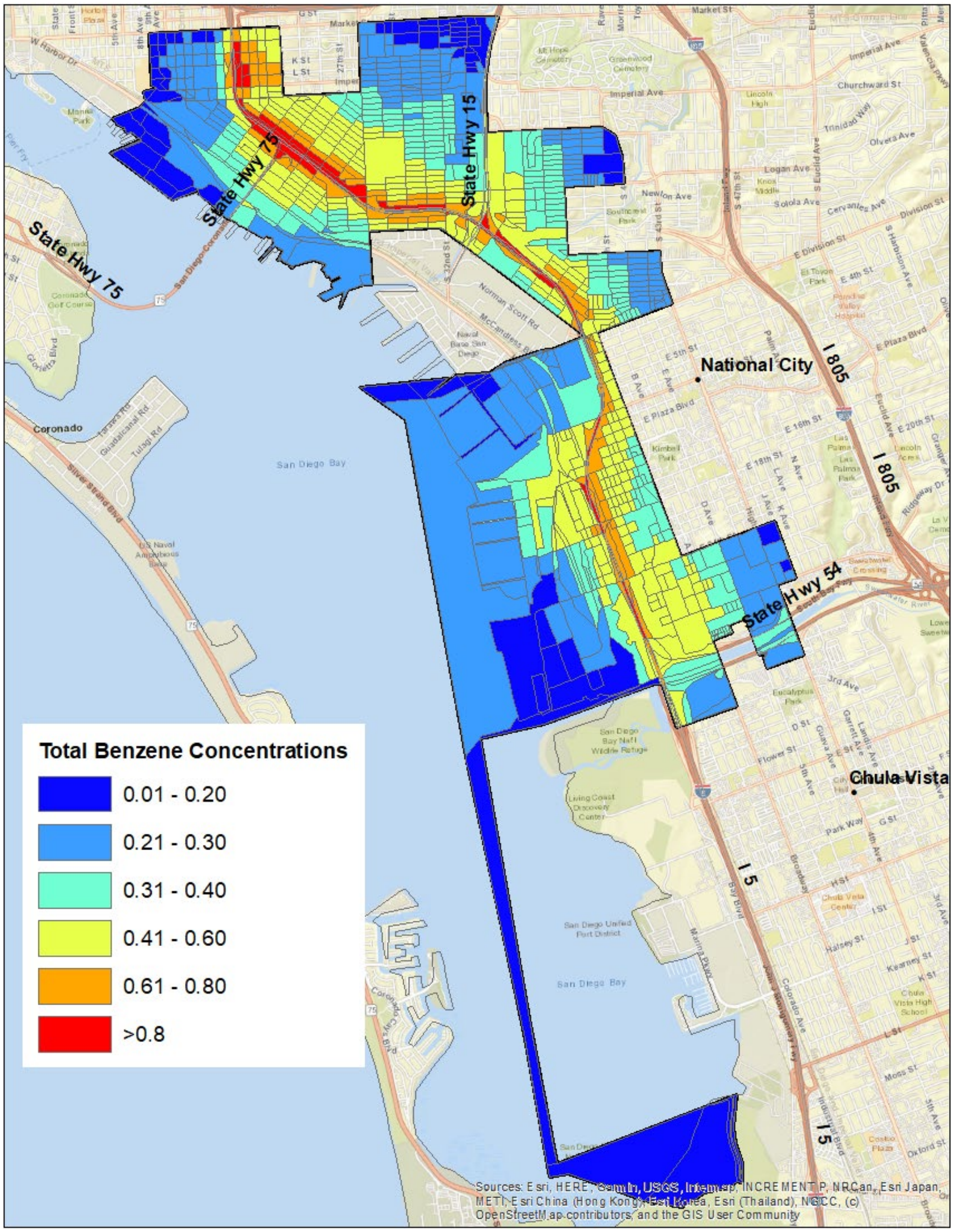

Figure G-6. Simulated annual average concentrations of benzene for 2017.

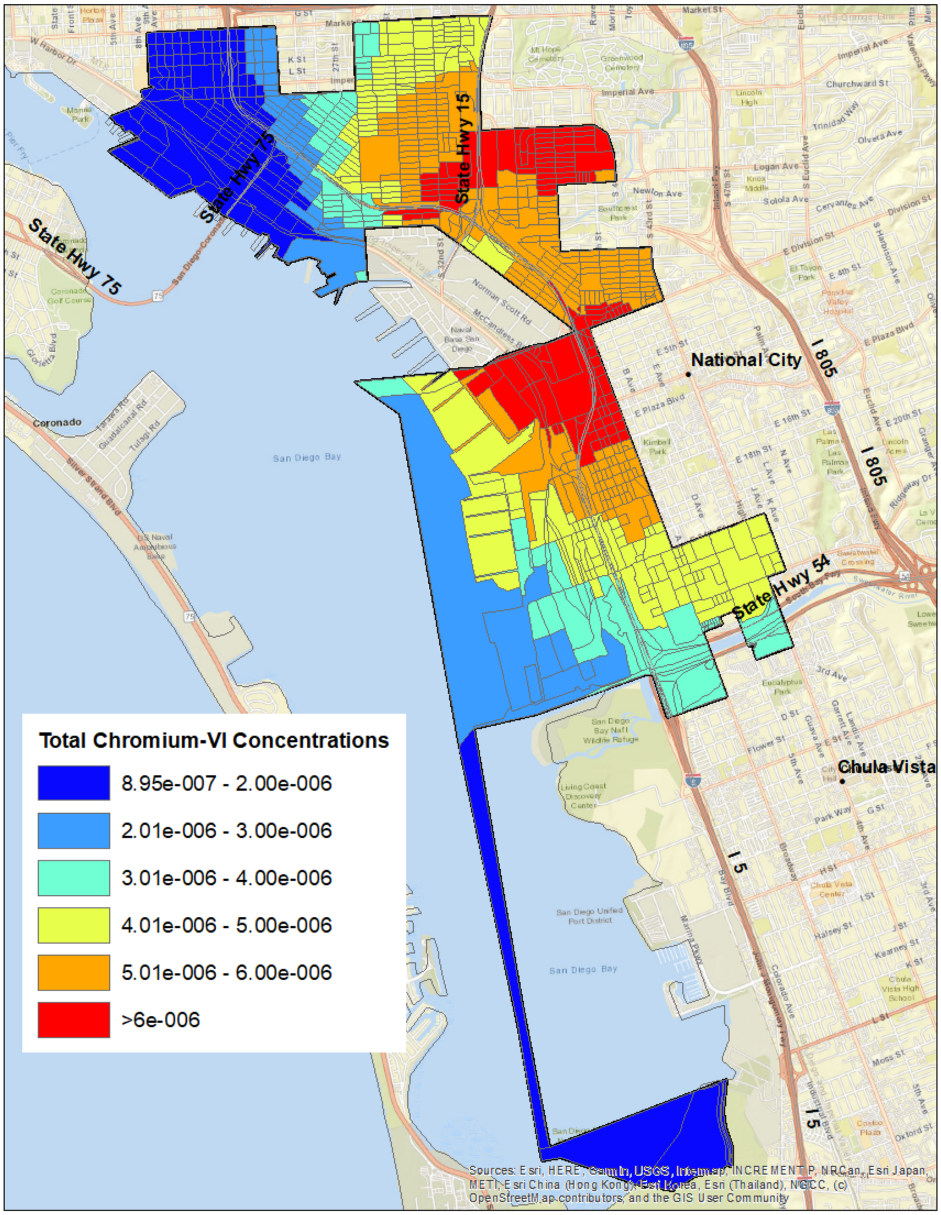

Figure G-7. Simulated annual average concentrations of hexavalent chromium for 2017.

II. Model Performance Evaluation

The total simulated concentrations from all TACs and all sources (regional including local) are compared against available observations for the purpose of validating the CALPUFF and CMAQ models. First, we used observational data at three monitoring stations in the County of San Diego from the USEPA AIR database (Figure G-8) for an overall evaluation of our regional modeling results. The observed annual average concentrations at the monitor stations were compared against our modeled annual average concentrations for individual TACs (2km x 2km grid average for VOCs, at the center of census blocks for heavy metals and elemental carbon (EC)). Note that EC was used as a surrogate for evaluating DPM since DPM cannot be directly distinguished in the measurements.

Table G-2 summarizes the observed and modeled annual average concentrations for EC, four typical toxic VOCs (benzene,1,3-butadiene, acetaldehyde, and formaldehyde) and four heavy metals (lead, arsenic, nickel, and cadmium) at the three air monitoring stations, including Lexington Elementary School in El Cajon, Chula Vista, and Donovan in Otay Mesa. The results show that the simulated EC in El Cajon by CALPUFF and four VOCs in El Cajon and Chula Vista by CMAQ have a reasonable agreement with the observations, while the simulated heavy metals at the three monitoring sites by CALPUFF are greatly underestimated compared to the observations. It indicates substantial uncertainty in emissions estimates for metals. This finding indicates that modeled cancer risks associated with toxic metals may also be underestimated.

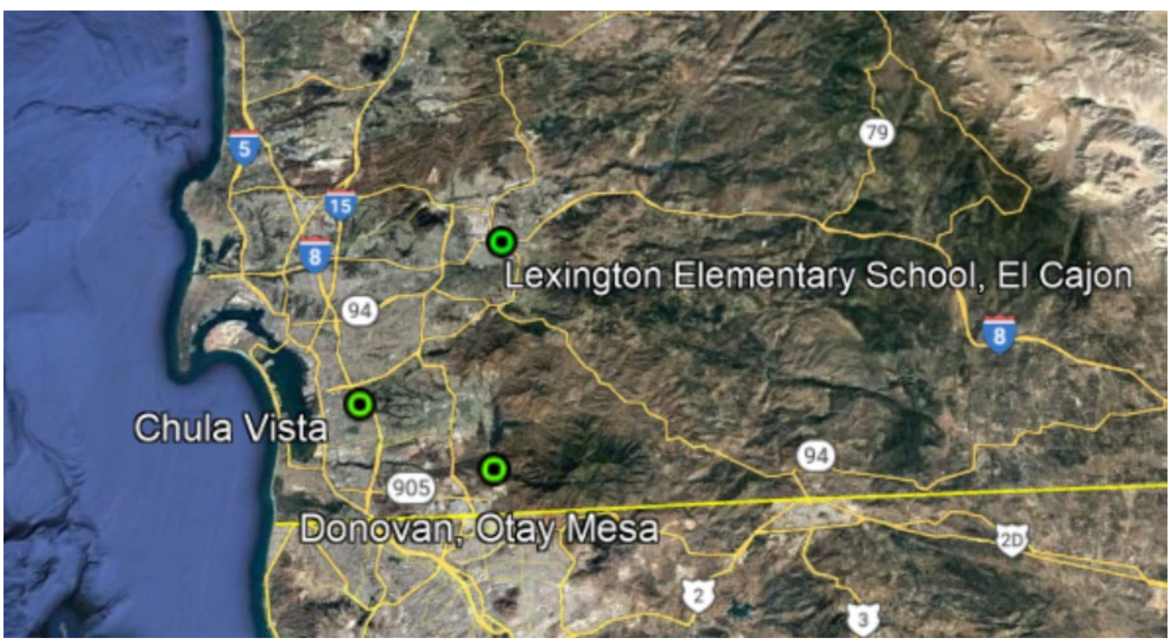

Figure G-8. The locations of three point measurement sites, including Lexington Elementary School in El Cajon, Chula Vista, and Donovan in Otay Mesa.

Table G-2. Annual average concentrations (µg/m3) from measurements and model simulations for VOCs, heavy metals, and EC. The locations of measurement sites are referred to Figure G-8.

	Chula Vista			Lexington Elementary School			Donovan		
	obs	mod	NMB	obs	mod	NMB	obs	mod	NMB
VOCs									
1,3-Butadiene	0.093	0.10	7%	0.098	0.08	-18%			
Acetaldehyde	1.146	1.087	-5%	1.651	1.193	-28%			
Benzene	0.621	0.616	-1%	0.831	0.523	-37%			
Formaldehyde	2.731	1.667	-39%	4.006	1.787	-55%			
Heavy Metals									
Arsenic	0.0011	0.0004	-64%	0.0008	0.0003	-63%	0.0007	0.0007	0%
Cadmium	0.001	0.0002	-80%	0.0006	0.0002	-67%	0.0005	0.0004	-20%
Lead	0.0108	0.0026	-76%	0.0039	0.0068	74%	0.0339	0.004	-88%
Nickel	0.0023	0.0025	9%	0.0017	0.0019	12%	0.0078	0.0034	-56%
Element Carbon (EC)				0.5877	0.7529	28%			

Since October 2019, measurements of hourly black carbon (BC) within the Portside community have been available[7]. Based on those measurements, the corresponding potential cancer risks of DPM can be compared [8] against our 2017 modeling results at another three monitoring sites and are presented in Table G-3. Note that the risks should be higher in 2017 (our modeling year) than in 2021-2022 (the measurement years) due to emission reductions over time. To estimate 2021-2022 risk from the 2017 modeling, the 2017

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[7] https://aqview.arb.ca.gov

[8] Assuming: 1) about 85% of ambient BC come from fossil fuel-related sources based on measurement data from the South Coast Air Quality Management District, and 2) 1 gram BC ≈ 1.3 gram DPM (https://www.sdapcd.org/content/dam/sdapcd/documents/capp/meetings/portside-csc/011921/011921-VII-Presentation-OEHHA.pdf).

results were scaled based on the rate of change in risk from 2012 to 2017, where 2012 was the first year modeled as part of CATA's first statewide risk assessment. As can be seen, our projected modeling results are comparable with DPM estimates derived from monitoring measurements. This comparison increases our confidence for the risk estimates in this study.

Table G-3. Comparison between modeled and observed DPM potential cancer risks at three monitoring sites in Portside.

	Monitoring measurements		Model values	Model projected values	
Site / Year	2021	2022	2017	2021	2022
Chicano Park	664.8	615.9	1260.9	849.8	747.1
Downtown Sherman Elementary	599.6	513.3	1103.0	581.7	468.2
Oceanview Blvd	654.2	540.0	809.8	507.9	447.3

III. Risk Characterization

The potential cancer risk in the community from ***regional*** emission sources presented in the main report (section VI.C) is the total cumulative cancer risk from ALL emission sources, inside and outside of the community boundaries, including OGV emissions over the ocean and emissions from Mexico near the US-Mexico border. The charts showing relative contributions from each TAC and emission source categories (Figures VI-28 and VI-29 in the main report) were made based on population-weighted averages over all census blocks in the community, with the goal of helping the community identify the sources of highest impact to the community as a whole. It is worth mentioning here that local risks and source apportionment may vary significantly across specific locations depending on their nearby emission sources.

The potential cancer risk in the community from ***local*** emissions is the cumulative cancer risk that results from emission sources located within the community boundaries only. The main findings of the locally sourced health impact analysis are presented below. The overall risk distribution in census blocks within the Portside community is presented in Figure G-9. The highest cancer risks are estimated to occur in Barrio Logan, especially in the intersection area of Interstate-5 (I-5) and State Hwy 75, with the highest risk ranging from 600 to 800 per million. In this area, DPM from various trucks (including the port trucks moving between the Port and I-5) is the main driver, with minor contributions from 1,3-Butadiene from commercial and industrial off-road equipment. It is important to note that although overall risk numbers are shown in Figure G-9, risk calculations are highly dependent on the scale and proximity of receptors to emission sources, so it is recommended to focus more on the sources and species contributing to the overall risk as opposed to focusing on the absolute risk values.

When only local emission sources are considered, DPM accounted for 76% of the cancer risk within the community, while VOCs accounted for about 23% and heavy metals for the remaining 1% (Figure G-10). The highest three contributors of VOCs are1,3-butadiene (~11%), benzene (~7%) and formaldehyde (~2%). Together, the top-four TACs contribute to about 96% of total toxic risk. The overall population-weighted cancer risk associated with local sources is estimated to be about 322 per million within Portside.

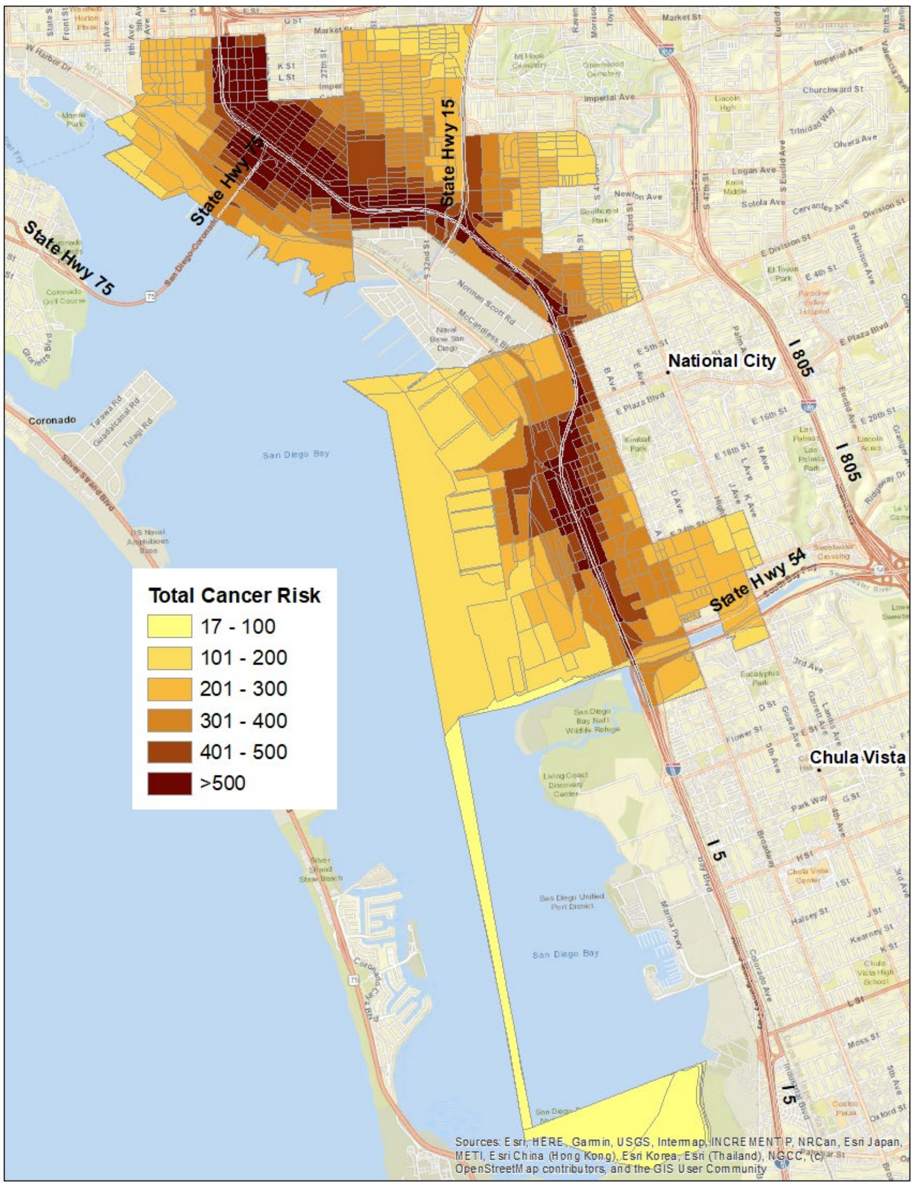

Figure G-9. Overall risk distribution in the Portside community (2017 local community emissions only).

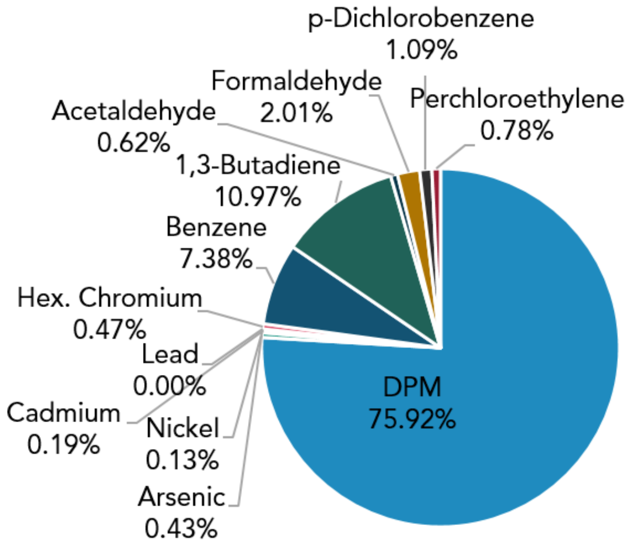

Figure G-10. Relative contributions of individual TACs to overall excess cancer risk in Portside from 2017 local emissions only.

As stated in section I of this appendix on Emission Inventory, the four big emission source categories are: on-road mobile, off-road mobile, area and point sources. Figure G-11 shows the relative contributions of each emission categories to total DPM, total heavy metals, total VOCs and overall risk in Portside, respectively. The results show that for each toxic species (i.e., DPM, VOCs and heavy metals), the relative importance of each emission categories is different. For example, on-road mobile, off-road mobile, area and point sources contribute about 56%, 17%, 27% and <1 % to the overall DPM risk within Portside, respectively. In other words, on-road emission sources dominate total DPM risk, whereas point sources dominate total metals risk, and area sources dominate total VOCs risk. Combining all TACs together, on-road, off-road, area and point sources account for 51%, 13%, 35% and 1% of the overall risk within Portside, respectively.

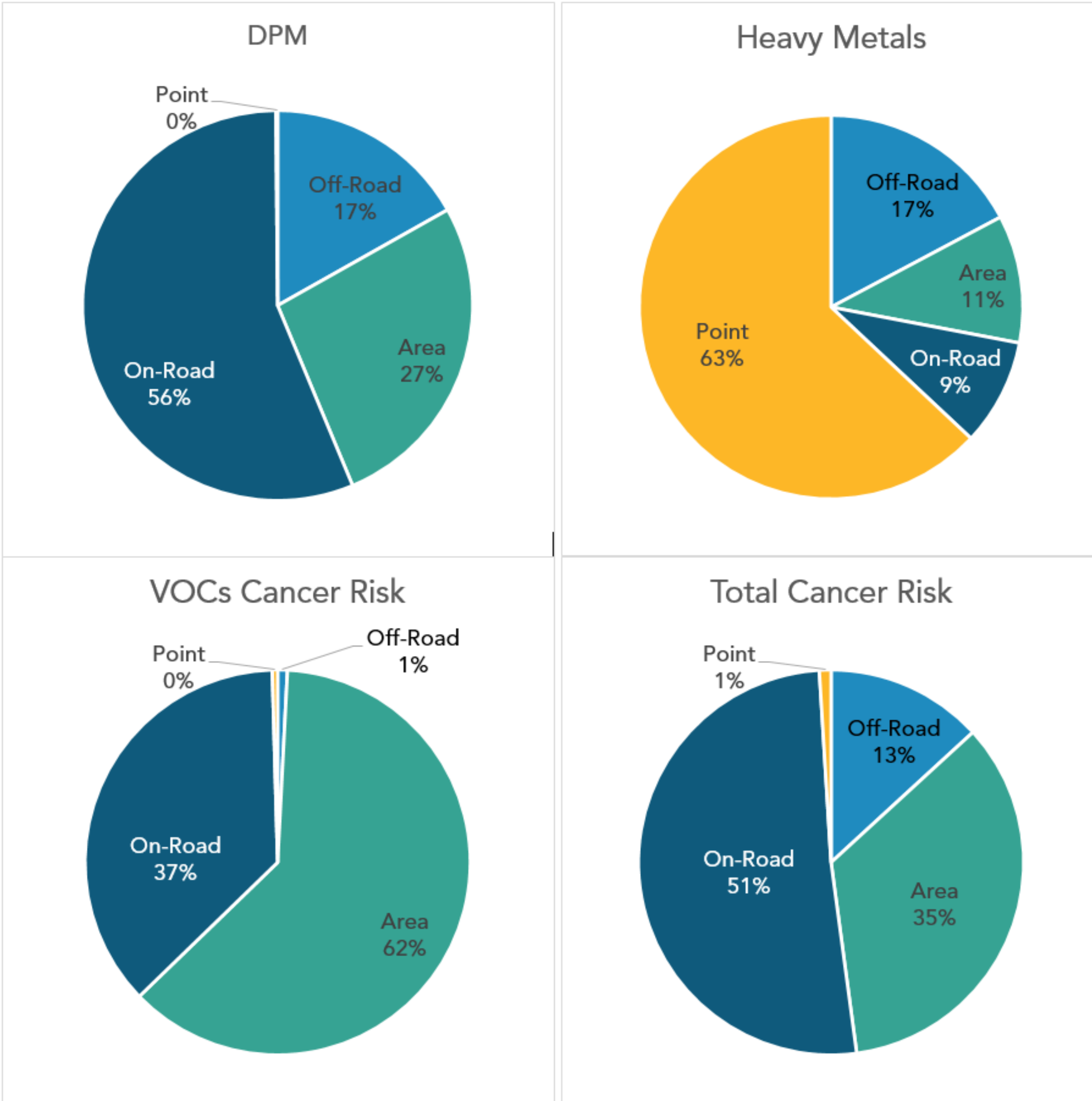

Figure G-11. Population-Weighted Average Cancer Risks of DPM, Total Heavy Metals, VOCs, and Total Cancer Risk by Emission Categories.

Figure G-12 breaks down further the sources of DPM risks by showing the contribution of all individual emission sources. Top contributors were on-road mobile sources (56%), in particular the I-5 that runs through the community and accounted for 32% of total DPM risks from local sources, aggregated area sources ("Others", 26%), TRU (7%), locomotives (5%), and OGV (5%).

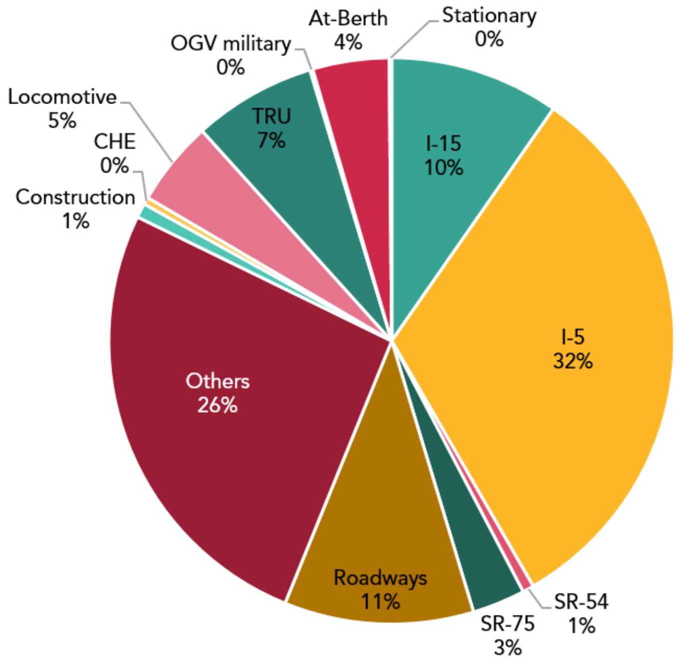

Figure G-12. Relative contributions to total DPM risk by emission sources (2017 local emissions only).

Overall, around 33% of total potential population-weighted cancer risk in the Portside community resulted from local sources, i.e., emissions within the community boundary (Figure G-13).

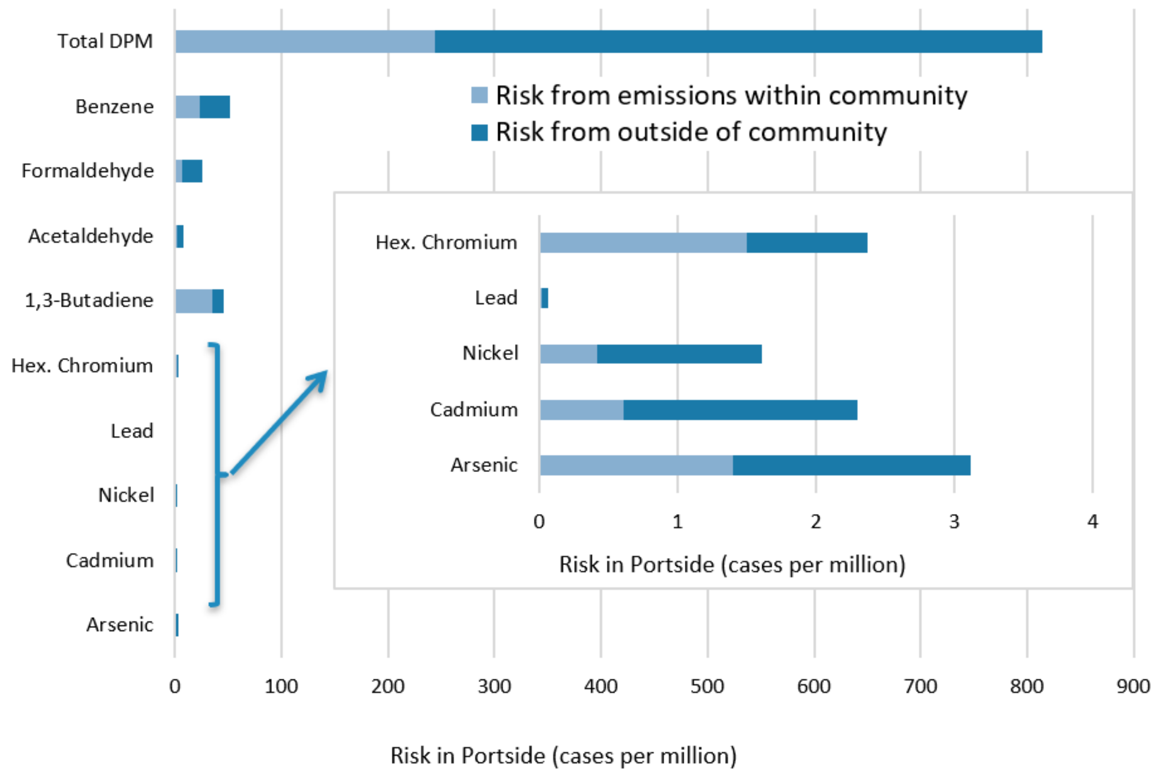

Figure G-13. Relative contributions to overall risk of each pollutant by regional versus local emissions in the Portside community (2017 base year).

It is important to keep in mind that individual risks at specific locations are highly dependent on their proximity to emission sources. Even though the impact from DPM sources dominates on average within the community, volatile organic compounds (VOCs) and heavy metals can generate high local risks at certain locations. Furthermore, when identifying priorities and developing strategies to reduce risk, it is important to take into consideration recent and future changes in emissions resulting from the implementation of regulations such as the state's Truck and Bus rule, and regulatory programs designed to reduce DPM emissions from off-road mobile sources such as ocean-going vessels (OGV), commercial harbor craft (CHC), cargo handling equipment (CHE) and transport refrigeration units (TRU). For future years, for example 2037, emission sectors such as OGV, TRU, area and stationary sources of VOCs and heavy metals could become as important as on-road mobile sources or exceed them in terms of risk impact on the community.