Appendix D: Air Quality Overview Supplemental Information

This appendix contains additional information on technical datasets and analyses that were described in Chapter 5: Air Quality Overview and covers the topics below:

- **Emissions Inventory Development**, including a description of the methods and datasets used to develop the emissions inventory
- **Dispersion Modeling**, including a description of the methods and datasets used to conduct dispersion modeling for key local sources
- **Emissions Forecasts**, including a summary of "business as usual" emissions inventories for 5- and 10-year milestones (2032 and 2037) after CERP adoption

Emissions Inventory Development

As part of the technical assessment process, the California Air Resources Board (CARB) prescribes the development of a planning emissions inventory for all Assembly Bill 617 (AB 617) communities. This inventory must include criteria pollutants1 and toxic air contaminants (TACs)2 for all sources within the community boundary for a selected base year (California Air Resources Board, 2019). The Bay Area Air District (Air District) worked with CARB to establish a base year (2022) and emissions inventory domain for the Bayview Hunters Point/Southeast San Francisco (BVHP/SESF) community. The inventory domain was defined as a rectangular area that aligns with a network of 1-km x 1-km grid cells from CARB's statewide modeling domain (California Air Resources Board, 2020). As previously shown in Figure 5-23 of the CERP, this rectangular emissions inventory boundary covers the BVHP/SESF area, as well as surrounding areas with emission sources that are likely to impact the community. It should be noted that aligning the emissions inventory boundary with the 1-km modeling domain was necessary because emissions estimates for some areawide and off-road mobile source categories were derived from gridded emissions data developed for regional modeling applications. In those cases, county-level emissions estimates from CARB or the Air District were allocated to grid cells in the modeling domain using spatial surrogates such as land use or population data. Emissions for grid cells in the community emissions boundary were then extracted.

The BVHP/SESF emissions inventory is organized into four broad source sectors: stationary sources, areawide sources, on-road mobile sources, and off-road mobile sources. Table D-1 provides a definition of these source sectors and summarizes the general methods used to estimate their emissions in the BVHP/SESF area. Note that the baseline inventory represents a combination of information from the Air District and CARB, and that detailed local data were used where available.

[1] Criteria pollutants include carbon monoxide (CO), nitrogen oxides (NOx), total organic gases (TOG), reactive organic gases (ROG), ammonia (NH_3), sulfur oxides (SOx), particulate matter 10 microns or smaller (PM_{10}), and particulate matter 2.5 microns or smaller ($PM_{2.5}$).

[2] TACs, or "air toxics," have been identified by CARB or the U.S. Environmental Protection Agency (EPA) as pollutants that may cause cancer or other serious health effects (e.g., birth defects).

Table D-1. Emissions inventory methods by source sector

Source Sector	Definition	Methodology
Stationary	Facility-related sources that have been issued a permit or registered by the Air District; also includes emissions estimates for some classes of non-permitted sources (e.g., fuel combustion at commercial operations)	Facility-level emissions based on data reported to the Air District annually by each permitted facility and reviewed by Air District engineers. For non-permitted stationary sources, aggregate emissions estimates are prepared using methods like those described below under "areawide" sources.
Areawide	Sources that are generally small, spread over large areas, and not identified with a single, identifiable location (e.g., fireplaces, water heaters, and consumer products)	Emissions estimated by CARB or the Air District at the county level were gridded using spatial surrogates such as land use or population data. For commercial cooking, the Air District developed restaurant-specific estimates that were based on generalized assumptions about the type and quantities of meat cooked at various types of restaurants.
On-road mobile	Vehicles that operate on roadways (e.g., cars, trucks and buses)	Roadway emissions based on detailed traffic data from Bentley's Streetlytics dataset and emission factors from CARB's EMFAC2021 model. Road dust emissions were estimated using a CARB methodology that is based on traffic volumes, vehicle weights, and silt loadings that are assigned by road type.[3]
Off-road mobile	Mobile sources such as ships, locomotives, and construction equipment that do not operate on roadways	Emissions for locomotives were prepared by the Air District based on local activity data. Emissions for remaining off-road sources were prepared by CARB using a variety of approaches and were spatially allocated to the community scale using the gridding approach described above.

For TACs, CARB has established a methodology for developing community-scale emissions inventories and for comparing the relative toxicity of different compounds through the calculation of toxicity weighted emissions (TWE). In this methodology, point source emissions are based on toxics inventories reported to air districts by individual permitted facilities. For stationary non-permitted sources and all mobile sources, TAC emissions are calculated by applying chemical speciation profiles to particulate matter (PM) and total organic gases (TOG) emissions. These speciation profiles, which are maintained by CARB, break down PM and TOG emissions for a given source category into individual chemical species. Then all the species that are listed in Appendix A-I of AB 2588 Air Toxics "Hot Spots" Emission Inventory Criteria and Guidelines Regulation are filtered out as toxics (California Air Resources Board, 2021). TWE are then calculated by multiplying the mass emissions for each TAC by corresponding health values from the Office of Environmental Health Hazard Assessment (OEHHA). These health values include

[3] Road dust emissions are an area of active research, and the Air District is currently evaluating results from recent studies in West Oakland and Southern California (University of California Riverside, 2025) to see if findings are applicable to BVHP/SESF and other AB 617 communities.

cancer potency factors and non-cancer chronic and acute reference exposure levels (RELs), and the TWE calculations also include molecular weight adjustment factors to account for the molecular weight fraction of a compound associated with the specific health effects (California Air Resources Board, 2021). As noted above, the resulting TWE provide a useful means of comparing the relative toxicity of TACs in an inventory; however, TWE do not quantify specific health risks, which are based on exposures to concentrations of specific TACs rather than emission levels only.

Once the emissions inventory was complete, emissions estimates for fine particulate matter (PM2.5) and TACs were configured for use in dispersion modeling efforts. Modeling inventories were developed for all sources for which sufficient information (e.g., emissions rate, physical characteristics, spatiotemporal resolution) was available at the time of analysis.

Dispersion Modeling

Once emitted to the atmosphere, pollutants are subject to processes such as dispersion and deposition. Air quality models use emissions inventories, meteorological data, and other inputs to simulate these processes and provide estimates of pollutant concentrations in specified locations of interest. To quantify concentrations of $PM_{2.5}$ and other pollutants in the BVHP/SESF community, the Air District used the American Meteorological Society/Environmental Protection Agency Regulatory Model (AERMOD). AERMOD is the U.S. Environmental Protection Agency (U.S. EPA)'s preferred model for near-field dispersion modeling and is required for all health risk assessment (HRA) modeling performed by or for the Air District (Bay Area Air Quality Management District, 2020). In addition, AERMOD is the only model currently approved by U.S. EPA for mobile source applications such as PM hot-spot analyses (U.S. Environmental Protection Agency, 2021). Because of its ability to handle multiple source types, AERMOD was used to model dispersion from all local sources assessed in the BVHP/SESF emissions domain.

In general, AERMOD was applied using approaches consistent with those previously developed during the technical assessment for the West Oakland AB 617 community (Bay Area Air Quality Management District, 2019). One key difference from the West Oakland approach involves the meteorological data used for dispersion modeling. In West Oakland, the District operates a meteorological monitoring station at the Oakland Sewage Treatment Plant (OST) that measures wind speed, wind direction and temperature, parameters required by the AERMOD model. Because this station is centrally located within the relatively small and flat West Oakland study area, meteorological data from the OST station was used for all AERMOD runs. However, the BVHP/SESF area lacks a central monitoring station that would be representative of the entire study area. Therefore, the Air District relied on modeled meteorological data from the Weather Research and Forecasting (WRF) model to run AERMOD. WRF provided gridded meteorological data at a 1-km resolution, and a U.S. EPA utility program called the Mesoscale Model Interface Program (MMIF) was used to convert WRF outputs into AERMOD-ready meteorological inputs. All sources in BVHP/SESF were modeled using WRF outputs from the 1-km grid cell in which the source was located.

Emission inputs prepared for AERMOD included source-specific information such as emissions rates (e.g., grams of $PM_{2.5}$ per second), location coordinates, dispersion-related parameters (e.g., stack height, stack exit temperature), and temporal patterns (e.g., operating hours). As previously noted, many emissions sources could not be modeled due to a lack of information on source locations or characteristics. This is especially true of areawide and off-road mobile source emissions estimates that were based on gridded data. An exception is Transport Refrigeration Unit (TRU) emissions, which could be modeled based on facility locations provided by CARB.

AERMOD also requires a receptor file defining locations for which the model will estimate pollutant concentrations. A master receptor grid was generated with receptors spaced every 50 m in the x and y directions within the receptor domain, resulting in 23,200 discrete receptor locations. For BVHP/SESF, AERMOD was used to estimate $PM_{2.5}$ concentrations, diesel particulate matter (DPM) concentrations, cancer risk, and chronic hazard index (HI) at each of these receptors. Because separate AERMOD runs were performed for individual sources (e.g., road segments, industrial processes), this modeling approach provided hyper-local, source-specific information.

After completing the AERMOD runs, annual average pollutant concentrations were integrated with 2020 Census tract–level population data to estimate community exposure and associated health risks. Residential population counts were obtained from the 2020 decennial U.S. Census at the Census block level. This modeled population reflects a residential ("nighttime") population, similar to that used in most large-scale epidemiological studies of outdoor air pollution. Total population exposure has units of persons multiplied by concentration (e.g., person-$\mu g/m^3$). We computed average exposures by first computing total exposures at Census-block resolution. We then computed an average exposure for all residents in the BVHP/SESF area by summing population exposure across all Census blocks and dividing by the sum of population. Consistent with epidemiological studies, we use "average exposures" interchangeably with "population-weighted concentrations," or, equivalently, exposures "per capita." These all have the same units as modeled concentrations. For $PM_{2.5}$, for example, the units are micrograms per cubic meter ($\mu g/m^3$).

Contributions from individual emission sources and source categories to average residential exposure metrics were estimated using results from the AERMOD runs. This approach, commonly referred to as source attribution or source apportionment, relied on the fact that each emissions source (or source group) was modeled separately in AERMOD. As a result, modeled concentrations and risk metrics (e.g., $PM_{2.5}$, cancer risk, and chronic hazard index) were inherently source-resolved at each receptor location. Outputs from the individual source models were spatially aligned to a common set of receptor locations and combined into a unified dataset. For each receptor, contributions from individual sources or source groups were retained as distinct components, allowing direct comparison across sources. Total concentrations or risks at a receptor were calculated as the sum of contributions from all modeled sources, consistent with the additive nature of dispersion modeling outputs. This framework enabled systematic evaluation of how different source categories (such as on-road mobile, industrial, marine sources, and rail lines) contribute to pollutant concentrations, population exposure, and cancer risk across the community.

Emissions Forecasts

In addition to the 2022 baseline emissions inventory, the Air District worked with CARB to develop preliminary forecast emissions estimates for the years 2032 and 2037. The years represent 5- and 10-year milestones from 2027, the year of Community Emissions Reduction Plan (CERP) adoption. Forecasted emissions were estimated by combining the baseline 2022 data with ancillary datasets that provide growth factors and control factors based on the current regulatory environment. Here, "growth" refers to anticipated changes in activity (e.g., increases in vehicle miles traveled for the on-road fleet), while "control" refers to changes in emissions characteristics (e.g., lower motor vehicle emission rates due to new technology introduced into the fleet). These forecasts only consider controls resulting from existing ("on the books") regulations and can be viewed as conditions that are projected to occur in the BVHP/SESF area without the implementation of the CERP.

Note that the emission forecasts presented in this section account for the impact of the 2025 revocation of U.S. EPA waivers that allowed CARB to set stricter vehicle emissions standards. This action affected adopted CARB regulations like the Advanced Clean Trucks and Advanced Clean Cars II rules, and CARB supported the Air District in estimating the projected emissions reductions that will be lost in future years.

The forecasts described above were prepared using a variety of datasets:

- Growth profiles and control factors developed by the Air District as part of a recent trends analysis for criteria air pollutants.
- Forecasting scalars provided by CARB that combine growth and control factors for future years out to 2037. These scalars were based on data from CARB's California Emissions Projection Analysis Model (CEPAM) and reflect forecasts from the 2022 ozone state implementation plan (SIP) emissions inventory.
- Emissions reduction factors from CARB that reflect impacts of recently adopted statewide regulations that were not considered in the CEPAM data referenced above. These statewide regulations largely address nitrogen oxide (NOX) and PM emissions from mobile sources, and descriptions of these regulations are provided in Table D-2.

Table D-2: *Descriptions of recently adopted statewide regulations.*

Regulation	Description	Adoption Date
Heavy-Duty Inspection and Maintenance (HDIM)	Expands existing I&M programs to ensure all vehicle control systems (e.g., diesel particulate filters) are adequately maintained	December 2021
Small Off-Road Engine (SORE) Amendment	Accelerates the transition of SORE equipment (e.g., leaf blowers, portable generators) to zero-emission equipment starting in 2024	December 2021
Transport Refrigeration Unit (TRU) Regulation	Requires diesel-powered TRU to transition to zero-emission technology in two phases	February 2022
Commercial Harbor Craft (CHC) Regulation	Requires zero-emission options where feasible and Tier 3 and 4 engines on all other vessels	March 2022
In-Use Locomotive Regulation	Reduces harmful emissions from locomotives, in part to address long-standing environmental justice concerns for communities near railyards	April 2023

Note that for permitted sources in BVHP/SESF, emissions were generally held constant for the 5- and 10-year forecasts. The sub-sections that follow contain summary information about the forecasted inventories for 2032 and 2037 and how they compare to the 2022 baseline emissions.

Criteria Air Pollutants (CAPs)

This section provides a comparison between CAP emission levels for the 2022 baseline (Chapter 5 - Table 5-7) and forecasted years 2032 (Table D-3) and 2037 (Table D-4).

Table D-3: *BVHP/SESF 2032 CAP emissions by source sector in tons per year (tpy).*

Source Sector	$PM_{2.5}$	PM_{10}	NO_X	SO_X	CO	TOG	ROG
Stationary	18.7	46.5	127.9	18.3	102.6	3,556.1	875.7
Areawide	98.2	495.8	120.1	2.6	220.7	1,367.4	1,076.4
On-road	32.5	166.6	221.4	5.1	1,827.3	232.9	199.5
Off-road	21.1	25.6	614.3	17.3	4,228.1	335.6	299.2
TOTAL	170.5	734.5	1,083.7	43.4	6,378.6	5,492.1	2,450.7
Percent change from 2022	**-7%**	**6%**	**-23%**	**0%**	**-34%**	**-10%**	**-11%**

Table D-4: *BVHP/SESF 2037 CAP emissions by source sector in tons per year (tpy).*

Source Sector	$PM_{2.5}$	PM_{10}	NO_X	SO_X	CO	TOG	ROG
Stationary	17.7	45.4	126.6	18.2	98.2	3,217.0	863.2
Areawide	90.1	487.9	80.8	2.0	176.0	1,426.1	1,130.0
On-road	33.2	171.4	225.6	5.2	1,788.7	215.7	184.2
Off-road	21.0	25.6	523.8	18.2	3,724.0	295.2	261.3
TOTAL	162.0	730.3	956.8	43.5	5,786.8	5,154.1	2,438.7
Percent change from 2022	**-12%**	**6%**	**-32%**	**1%**	**-41%**	**-15%**	**-11%**

As shown in the last rows of Tables D-3 and D-4, future emissions are generally projected to decline for most pollutants. For 2032, reductions relative to 2022 range from 7% for $PM_{2.5}$ to 34% for carbon monoxide (CO). A similar pattern is observed for 2037, with forecasted reductions ranging from 11% for reactive organic gases (ROG) to 41% for CO. Following CO, NO_X show the next greatest overall reduction, reflecting emission decreases across all sectors. $PM_{2.5}$, which is of particular concern due to its health impacts, is projected to decrease by 7% by 2032 and 12% by 2037 compared to 2022 levels. In contrast, PM_{10} emissions are projected to increase slightly in future years, with anticipated increases in construction dust emissions offsetting reductions in emissions from other source categories.

Figure 5-24 in Chapter 5: Air Quality Overview provided a detailed breakdown of $PM_{2.5}$ emissions by the four source sectors for 2022. A similar chart prepared for 2032 shows that the relative order of sector contributions remains generally unchanged, with areawide and on-road sources continuing to represent the largest contributors to local $PM_{2.5}$ emissions in BVHP/SESF (Figure D-1). Key areawide sources in BVHP/SESF include residential fuel combustion, construction-related activities, and commercial cooking.

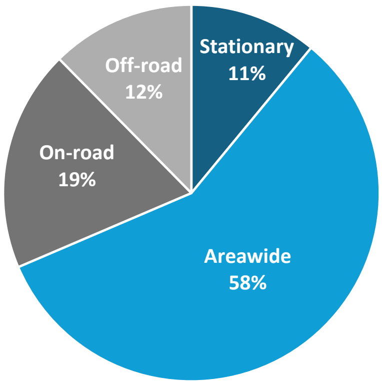

Figure D-1: *Projected $PM_{2.5}$ Emissions by Source Sector for 2032.*

Comparison of the absolute emission values in Chapter 5: Air Quality Overview (Table 5-7) with Tables D-2 and D-3 indicates that the projected 7% decrease in PM2.5 by 2032 are primarily driven by emission decreases in the off-road and areawide sectors (each approximately 6 tpy).

Toxic Air Contaminants (TACs)

This section provides a comparison between TAC emission levels for the 2022 baseline (Chapter 5, Table 5-8) and forecasted years 2032 (Table D-5) and 2037 (Table D-6). Comparisons are provided for all TACs combined and for TWE. As explained in the CERP Chapter 5: Air Quality Overview, toxicity weighting provides a way of accounting for the relative toxicities of carcinogens (cancer TWE) and TACs that cause other kinds of chronic health effects (chronic TWE). As shown in the last row of Table D-5, total TAC emissions are forecast to decrease by 9% between 2022 and 2032. The largest changes are associated with reductions in mobile source emissions (both off-road and on-road), primarily due to regulatory measures and fleet turnover. Total TAC emissions projected for 2037 do not show further reductions beyond 2032 levels and remain approximately the same as in 2032.

Notable reductions are projected for chronic TWE and cancer TWE by 2032, with decreases of 18% and 34%, respectively. These reductions are largely attributable to regulations targeting diesel-fueled vehicles and equipment. Similarly, projections for 2037 show a comparable pattern, with reductions of 21% for chronic TWE and 37% for cancer TWE relative to 2022 levels.

Table D-5: *BVHP/SESF 2032 TAC emissions by source sector.*

Source Sector	Unweighted	Toxicity Weighted	
	Total mass (lbs)	Cancer	Chronic
Stationary	980,539	7,818	143
Areawide	1,153,617	9,994	485
On-Road	297,941	8,693	192
Off-road	224,534	47,451	261
TOTAL	**2,656,630**	**73,957**	**1,082**
Percent change from 2022	**-9%**	**-34%**	**-18%**

Table D-6: *BVHP/SESF 2037 TAC emissions by source sector.*

Source Sector	Unweighted	Toxicity Weighted	
	Total mass (lbs)	Cancer	Chronic
Stationary	974,943	7,758	141
Areawide	1,180,151	9,730	469
On-Road	297,561	8,880	192
Off-road	205,326	44,460	243
TOTAL	**2,657,982**	**70,828**	**1,045**
Percent change from 2022	**-9%**	**-37%**	**-21%**

Emissions Tracking

Though it is difficult to do an up-front estimate of the impact of CERP actions, it is anticipated that implementation of the CERP will bring about additional emissions reductions, resulting in even lower future year emissions than the ones presented in this appendix. When implementation has been underway for five years, a new 2032 emissions inventory will be developed to track progress in achieving emissions reductions. That updated 2032 inventory will then be compared to the forecasts presented here.