Refinery Community Air Monitoring Plan

Ambient Air Quality Monitoring Plan for the Major Stationary Source Community Air Monitoring Program and Site Analysis for the Communities Surrounding the Bay Area Refineries

Bay Area Air Quality Management District

Updated May 2024

About the Bay Area Air Quality Management District

The California Legislature created the Air District in 1955 as the first regional air pollution control agency in the country. The Air District is tasked with regulating stationary sources of air pollution in the nine counties that surround San Francisco Bay: Alameda, Contra Costa, Marin, Napa, San Francisco, San Mateo, Santa Clara, southwestern Solano, and southern Sonoma counties. It is governed by a 24-member Board of Directors composed of locally elected officials from each of the nine Bay Area counties.

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Table of Contents

1.0 Introduction

Air pollution comes in many forms including gas, fumes, mist, vapor, smoke, soot, dust, and other particulates. It originates from natural sources like wildfires and dust storms, as well as human-made sources like power plants, factories, ships, cars, and even our own homes. Scientific studies have shown that certain air pollutants can have harmful short- and long-term effects on our health and on the environment.

To effectively decrease air pollution, we must understand the type and amount of pollutants that are present in the atmosphere. However, the lifecycle of air pollution in the environment is a complex process. At a given time or location, the concentration of air pollution depends on many factors such as the specific emission sources in an area, the location of those emission sources, meteorological conditions, and the presence of hills, mountains, tall buildings, and other features that affect the flow of air. By monitoring air quality directly, we gain valuable information about how these processes work and we obtain data that tells us how much pollution people may be exposed to.

While the Air District operates numerous ambient air monitoring stations across the Bay Area, the data from those stations do not reflect pollutant concentrations at every location. Furthermore, exposure to pollution varies from place to place and some communities near large industrial facilities may bear a disproportionate burden from air emissions or other forms of pollution. Additional steps are often needed to better understand and address cumulative environmental concerns in these “fenceline communities.”

To that end, the Air District launched its Major Stationary Source Community Air Monitoring Program in 2016 with a goal of establishing air monitoring stations in areas where large stationary sources of pollution may contribute to near-source impacts that are not captured by the Air District’s existing network. The Air District is initially prioritizing communities with petroleum refineries and large renewable fuels manufacturing facilities but monitoring stations may also be placed in communities with other types of facilities in the future. The additional data generated by these community air monitors will support analysis of air quality trends and other air quality assessments, and it will provide the public with additional information about air quality conditions near the refineries and other large facilities.

This document is split into two parts. The main body of the document provides an overview of the Major Stationary Source Community Air Monitoring Program, and it outlines the general process for considering information to identify areas that would meet the objectives for new community air monitoring locations. Following that overview is a series of technical appendices, which provide case-by-case analyses for the identification of preferred locations for the specific monitoring stations near the five Bay Area refineries.

Because the siting of new monitoring stations takes time, and because many steps in the process are beyond the Air District’s control, this plan is meant to be a living document and portions of it (particularly the technical appendices) may be modified as the program is further developed and implemented.

1.1 About the Major Stationary Source Community Air Monitoring Program

In 2014, the Air District’s Board of Directors adopted a resolution committing the agency to further reducing emissions from petroleum refineries. Among those commitments was preparation of Air District Regulation 12, Rule 15 (Petroleum Refining Emissions Tracking) for adoption by the Board (BAAQMD, 2014). As originally envisioned, Regulation 12, Rule 15 would have required the refinery operators to prepare and submit an annual emissions inventory, establish fenceline monitoring systems to measure air pollution concentrations at or near the property boundaries, and establish community air monitoring systems to measure ambient air pollution concentrations in the communities surrounding the facilities (BAAQMD, 2015). The Board adopted this landmark legislation in 2016 but in response to concerns about the refinery operators having responsibility for siting and operating community monitors, the Air District removed those requirements from the rule before it was adopted and assumed responsibility for implementing the Major Stationary Source Community Air Monitoring Program itself. The objectives of the program are to:

- collect localized data about typical ambient air pollutant concentrations near refineries and other major stationary sources of pollution by establishing a near real-time air monitoring station in fenceline communities,
- provide community members with access to near-real time air pollution data reflecting day-to-day cumulative air pollution levels near refineries and other major sources of pollution, and
- use the collected data to assess air quality trends and support other short- and long-term air quality assessments.

This type of air quality assessment is important in these communities since they have historically experienced disproportionate health impacts from racially and economically motivated land use decision-making, such as redlining, that allowed concentrations of polluting facilities in close proximity to where our most vulnerable populations live.

Given the suggested scope of the measurement program, the stations may also capture upset or incident emissions from a facility under certain conditions, but a single station is not a robust method of meeting that objective, nor are these stations expected to be a compliance tool.

Communities near the five refineries in the Bay Area will be the first to receive additional air monitoring stations, and communities near other large sources may follow at a later time.

Financial support for the program comes from fees paid by facilities that emit 35 tons per year or more of organic compounds, sulfur oxides, nitrogen oxides, carbon monoxide, or PM_{10} within the vicinity of a proposed monitoring location. The fee was established in 2016 through an amendment to Regulation 3 (Fees), which established fee Schedule X; currently the fee amounts to $60.61 per ton of emissions. Shortly after the launch of the Air District's Major Stationary Source Community Air Monitoring Program, the State of California enacted Assembly Bill 1647 in 2017, which requires:

1. owners and operators of petroleum refineries to develop, install, operate, and maintain fence line monitoring systems at the refineries; and
2. air districts to establish refinery-related community air monitoring systems.

The monitoring activities described in this plan represent the Air District's implementation of the requirements in AB 1647 pertaining to community air monitoring systems.

1.2 Implementation Schedule

The installation of a new air monitoring station involves three main phases of work: design and siting, construction, and operation. Table 1 identifies the activities that generally take place in each phase. It is difficult to establish a definitive timeline for these activities in each community because some of them are not entirely within the Air District's control (e.g., leasing and permitting a site). However, the Air District will proceed to establish the community monitoring sites as expeditiously as possible.

Table 1 – Activities Associated with the Siting, Construction & Operation of a Monitoring Station

Design and Siting	Construction	Operation
Gather public input	Site construction & station setup	Begin monitoring
Identify general areas where the monitoring station should be placed	Equipment procurement	Ongoing station maintenance
Identify specific candidate sites & available spaces	Equipment installation	Data quality assurance
Assess available spaces & select preferred site	Equipment testing	Data analysis & reporting
Negotiate lease agreement		
Design monitoring site		
Permit site		

1.3 Background on the Bay Area's Petroleum Refineries and Renewable Fuels Manufacturing Facilities

A better understanding of ambient air pollution associated with refineries begins with an understanding of the facilities and the emissions that come from them.

In general terms, a refinery is a facility that processes raw materials to create products of higher value. Where petroleum refining is concerned, crude oil is a mixture of hydrocarbon compounds with smaller amounts of impurities, including as sulfur, nitrogen, oxygen, organic acids, and metals (e.g., iron, copper, nickel, and vanadium). Using a number of complex industrial processes, petroleum refineries convert crude oil into a variety of products such as gasoline, diesel fuel, aviation fuels, lubricating oils, waxes, and asphalt. Generally, the steps in the refining process can be divided into five categories (OSHA, n.d.):

- **Distillation –** Distillation involves the separation of crude oil into different groups of hydrocarbons (or "fractions") based on the boiling point range of each group.
- **Conversion –** In order to produce final products with specific properties, the refinery uses a number of processes to alter the size or structure of the hydrocarbon molecules. Processes such as cracking, coking, and visbreaking break large molecules into smaller ones, while polymerization and alkylation processes combine small molecules into larger ones. Other processes, known as isomerization and reforming, rearrange the structure of molecules to produce higher-value compounds using the same atoms.
- **Treatment –** Treatment processes remove contaminants or other undesirable compounds to produce final products or prepare hydrocarbon streams for additional processing. Processes known as hydrodesulfurization, hydrotreating, chemical sweetening, and acid gas removal are used to remove elements such as sulfur, nitrogen, and oxygen.
- **Formulating and blending –** Mixing of hydrocarbon streams with additives to produce the desired finished products; and
- **Auxiliary operations –** Refineries include a wide assortment of processes and equipment that are not directly involved in the processing of crude oil but that are necessary for the safe and efficient operation of the facility. For example, the processes described above are carried out in facilities that typically require clean water, steam, or heat. Other examples of support operations include product

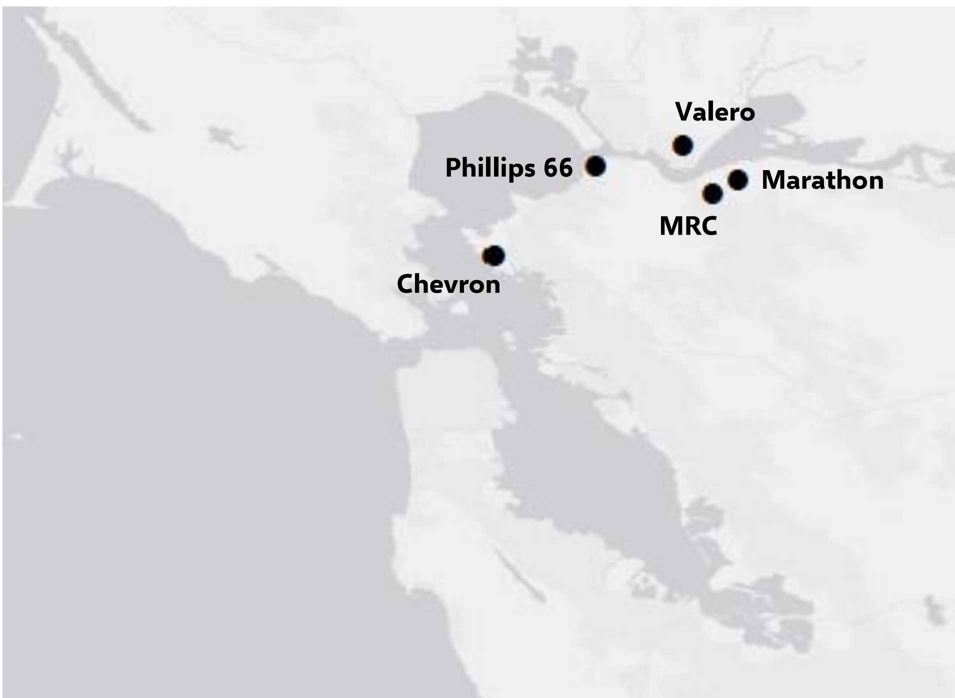
handling and storage, process cooling, sulfur recovery, waste treatment, power generation, and safety systems.

Figure A-1 in Appendix A presents a generalized and simplified diagram of the petroleum refining process for further reference. Note that specific process units and flow diagrams differ by refinery.

A total of five refineries are located in the San Francisco Bay Area:

- Chevron Products Company – located in Richmond, CA
- Marathon Petroleum Corporation – located in Martinez, CA
- Martinez Refining Company (MRC) – located in Martinez, CA
- Phillips 66 – located in Rodeo, CA
- Valero Refining Co – located in Benicia, CA

Figure 1 – Location of the Bay Area Petroleum Refineries



In part because of their complexity, their energy needs, and the materials involved in the refining process, these facilities are among the largest stationary sources of air pollution in the Bay Area. Significant amounts of particulate matter, nitrogen oxide, sulfur oxide, hydrogen sulfide, volatile organic compound (VOC), and toxic air contaminant (TAC) emissions are emitted directly from process units such catalytic cracking units, sulfur recovery units, coking units, and wastewater treatment plants. In addition, refineries may also have significant amounts of "fugitive emissions," which typically originate from leaky valves, seals, and other faulty equipment. Since they do not pass through an opening like a smokestack or a vent, fugitive emissions usually cannot be captured and treated.

Table 2 below provides the annual emissions from each of the five Bay Area refineries as reported by the California Emissions Inventory Data Analysis and Reporting System (CEIDARS) maintained by the California

Air Resources Board. The criteria pollutant emissions are for the 2019 reporting year while the TAC data are compiled and reported over multiple years.

Table 2 – Annual Emissions from the Bay Area Refineries(1, 2)

Facility (CEIDARS ID)	Annual Emissions (tons/year)						
	CO	**NOx**	**PM_{10}**	**$PM_{2.5}$**	**ROG**	**SOx**	**TACs**
Chevron (10)	306	797	554	538	510	388	168
Marathon (14628)	966	422	322	322	249	383	126
Martinez Refining (11)	815	771	528	464	229	1,018	208
Phillips 66 (21359)	113	214	72	72	88	360	85
Valero (12626)	423	955	174	174	413	47	52

Notes: (1) Criteria pollutant emissions are for the 2019 reporting year; (2) TAC data are compiled over multiple years and the most recently available data are shown above

Communities near these facilities are concerned about these emissions, and about the cumulative impacts they experience. While the Air District has made substantial progress in reducing emissions from the Bay Area's largest sources, additional air monitoring data can help sustain that progress.

Figure 2 shows the locations of the monitors that currently comprise the Air District's long-term ambient air monitoring network. Although it is extensive and it generates valuable information about typical air urban air pollution levels, not every monitoring station measures every pollutant. Moreover, the long-term network may not detect localized differences in concentrations at locations in between the monitors. This is especially true in areas with large sources of pollution like refineries. Given this, the Air District's Major Stationary Source Community Air Monitoring Program seeks to place additional air monitoring stations near the refineries and other areas with unique mixes of mobile and stationary sources whose collective impacts may not be fully represented by our existing monitoring network. The resulting data will fill a crucial gap in assessing the impacts of the refineries and other large sources on their surrounding communities and in keeping the public informed about air quality in localized areas.

In 2020 and 2021, two of the five refineries submitted permit applications to the Air District for modifications to the facilities associated with a change in operation from petroleum refining to the production of fuel using alternative non-petroleum feedstocks. In a separate process, the Air District amended several of its regulations to ensure the rules applicable to petroleum refineries continue to apply to the same facilities after the change in operations. For the purposes of this air monitoring plan, the Air District will also continue to treat the facilities similarly.

Figure 2 – Location of Monitors in the Air District's Long-term Ambient Air Monitoring Network

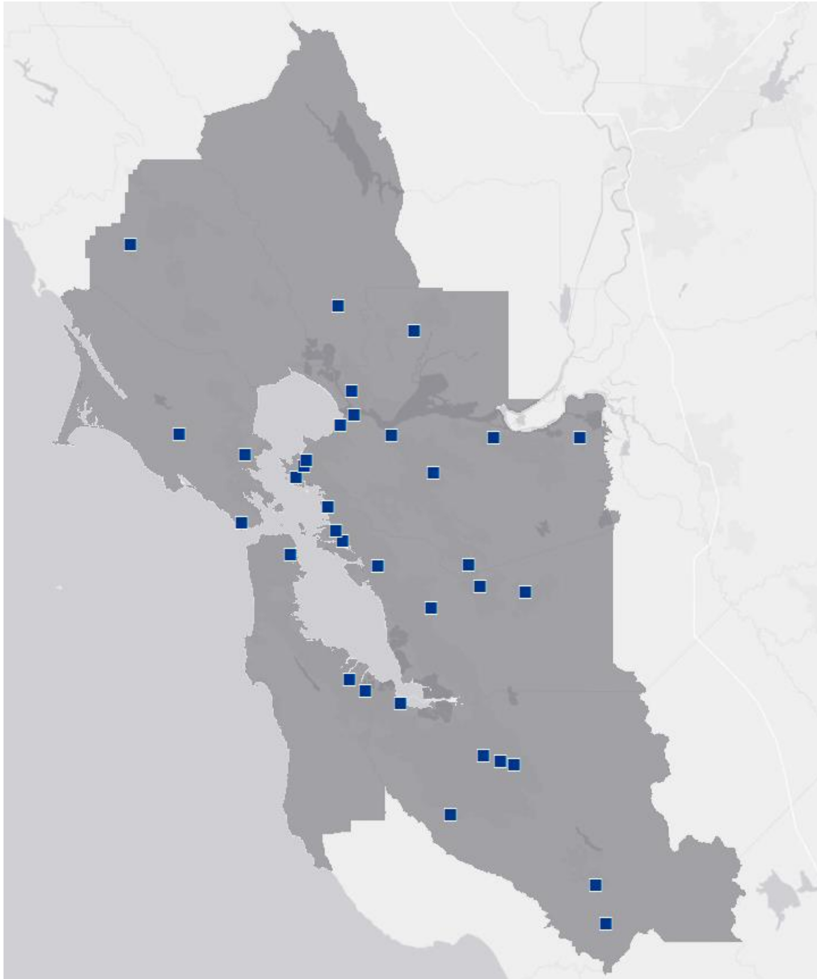
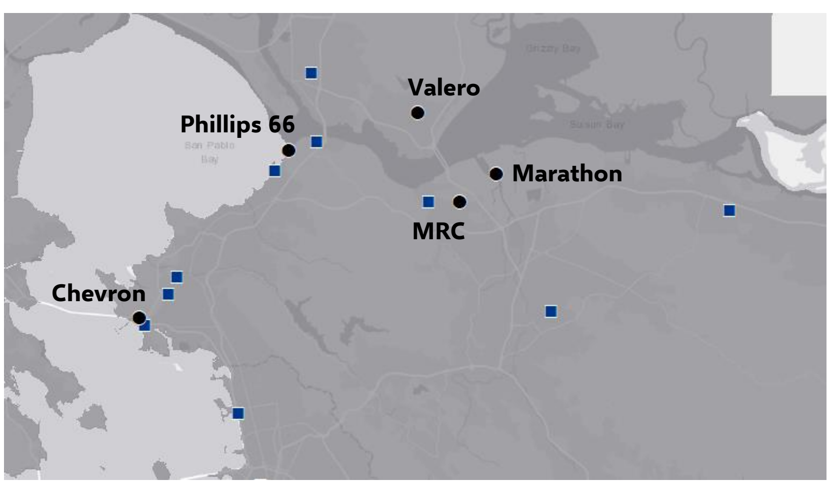


Figure 3 – Close-up View of the Air District's Long-term Ambient Air Monitoring Network Near the Bay Area Refineries



2.0 Overview of the Site Identification and Selection Process

Decisions about where to place ambient air monitors are crucial to the success of the overall monitoring effort. In general, four steps are involved in identifying and selecting suitable sites (EPA, 2017):

1. understanding the monitoring objectives;
2. identifying the spatial scale most appropriate for the monitoring objectives;
3. performing a preliminary assessment of preferred locations to identify general areas where monitors could be placed to collect representative pollutant measurements; and
4. identifying and evaluating candidate sites, and making final selections.

These steps are discussed generally below for reference, and case-by-case analyses for specific community monitoring sites are provided in the appendices.

2.1 Understanding Monitoring Objectives

Ambient air monitoring data are valuable only to the extent they can be used for a specific purpose or objective. Because the location of a monitor and its surroundings can greatly affect the quality and validity of the data, care must be taken to define specific monitoring objectives and place monitors at suitable locations so they yield representative data.

Federal regulations passed by the EPA provide criteria that should be applied when establishing monitoring stations for certain regulatory purposes. However, the monitoring stations associated with the Major Stationary Source Community Monitoring Program are not typically installed to meet minimum federal ambient air monitoring requirements. As a result, the monitors at these stations are classified as "special purpose monitors" (SPM). Compared monitors that are installed to meet minimum federal monitoring requirements, this classification affords the Air District some latitude when siting the monitors in order to achieve the specific objectives associated with them. As described above, the objectives for installing community air monitors in this case are to collect localized data about typical ambient air pollutant concentrations near the refineries and other large facilities, identify air quality trends and support other air quality assessments, improve the public's understanding of air pollution, and provide the public with additional data about air quality conditions near large facilities.

2.2 Identifying the Spatial Scale Most Appropriate for the Objectives

The "spatial scale" (or "measurement scale") of a monitor is a technical concept that reflects how representative data are with respect to different monitoring objectives. The spatial scale is determined by the physical location of the monitoring site in relation to pollution sources, and it estimates the size of the area surrounding the monitor that is likely to experience uniform pollutant concentrations (CARB, 2009). The categories of spatial scale that typically have the greatest relevance are:

- **Microscale -** An area of uniform pollutant concentrations ranging from several meters up to 100 meters
- **Middle Scale -** Uniform pollutant concentrations in an area of about 100 meters to 0.5 kilometer
- **Neighborhood Scale -** An area with dimensions in the 0.5 to 4.0 kilometer range
- **Urban Scale -** Citywide pollutant conditions with dimensions ranging from 4 to 50 kilometers
- **Regional Scale –** A large area, usually rural, of the same general geography and without large sources that extends from tens to hundreds of kilometers

As a simple example of how this concept is applied in practice, assume for a moment that the goal of a monitoring study is to measure background pollution concentrations. In that case it would be unwise to place the monitor near major roadways, industrial facilities, or other large sources of pollution since the emissions from those sources could heavily influence the measured concentrations. In this example, the urban or regional scale is likely the most appropriate – the monitor should be placed far enough away so the emissions from all sources in the area have sufficient time and space to mix, and the measured concentrations are more representative of actual background levels.

As mentioned above, federal regulations passed by the US Environmental Protection Agency (EPA) provide criteria that should be applied when establishing monitoring stations for certain regulatory purposes. Among others, those criteria include the relationship between the different spatial scales and various monitoring objectives as summarized below:

Table 3 – Relationships between Monitoring Objectives and Spatial Scales

Objective	Appropriate Spatial Scales
Determine the highest concentrations expected to occur in an area	Micro, middle, neighborhood (urban or regional may also be appropriate in specific cases)
Characterize the typical air pollution levels in populated areas	Neighborhood, urban
Determine the impact of significant sources on air quality	Micro, middle, neighborhood
Determine general background levels	Urban, regional
Determine the extent of regional pollutant transport among areas	Urban, regional
Determine air pollution impacts on visibility, vegetation, or other welfare-based	Urban, regional

As previously explained, the Air District has some latitude when establishing the refinery community monitoring sites in order to achieve specific objectives. However, the above criteria are nevertheless relevant when siting a new monitoring station and will be considered. Furthermore, with regard to the refineries in particular, Section 42705.6 of the California Health and Safety Code requires the installation of community air monitoring stations near refineries to be consistent with the requirements and guidance applicable to the siting of air quality monitors as established by the EPA.

In this case, we have multiple objectives but they all relate to the impacts the refineries and other large sources may have on their surrounding communities. This suggests the middle or neighborhood scales are most appropriate to consider and that we should seek to place the monitors within a few kilometers of each facility.

2.3 Preliminary Assessment of Preferred Locations

After establishing the monitoring objectives and determining the appropriate spatial scale of the monitor, the next step in siting a monitoring station is to conduct a preliminary assessment of preferred monitoring locations. The purpose of this analysis is to identify general areas that will yield representative pollutant measurements. In doing so, this step eliminates unsuitable areas from consideration and narrows the areas that need to be searched for the actual parcel of land on which the station will sit.

General locations for a monitoring station are typically identified through a case-by-case analysis of the following factors:

- Proximity of the monitor to various sources of pollution
- Population centers

- Historic meteorological conditions such as wind speed, direction, and variability
- Topography and other factors that affect air flow between the refinery and the community
- Location of sensitive populations and other environmental justice considerations
- Historic air monitoring or air modeling data that are relevant to understanding ambient concentrations and/or the potential contributions from the refinery
- Community input

Case-by-case preliminary site analyses for the refineries are provided in Appendices B through F of this document, and a map of the recommended siting areas is provided in Appendix G.

2.4 Identifying and Evaluating Candidate Sites

After identifying general locations that will yield representative pollution measurements, the search begins for specific parcels of land within those areas on which to place the monitoring stations. Because monitoring stations contain specialized equipment that must be operated and maintained continuously, potential sites must meet a number of specific requirements. Typically, the following factors are considered when identifying candidate sites and selecting final locations from the available options:

- Site infrastructure and logistics
    - **Sufficient space –** Adequate space is required to operate a monitoring station. This includes space inside the station for instrumentation, computers, and ancillary equipment as well as walking areas around the station so exterior facilities and equipment are accessible.
    - **Availability of sufficient power –** Based on the station equipment needs, a dedicated electrical drop is required for operation of continuous equipment.
    - **Availability of telecommunications –** Telecommunication access is based on station location. Internet service providers vary across the Bay Area region.
    - **Availability of the site for a long-term lease –** The District requests long term occupancy and will negotiate terms with the land owner.
    - **Presence of buildings, trees, and other potential obstructions –** Buildings, trees, and other obstructions are avoided to prevent interference of air flow and scrubbing action of vegetation in proximity to the station inlets.
    - **Location of existing air monitors –** Depending on the circumstances, the Air District may seek to place a new monitoring station at a location that is not represented by existing stations. Alternatively, there may be opportunities to expand or consolidate existing stations.
    - **Site safety –** Safety is of paramount concern when establishing a new site and maintaining existing sites. Considerations include ensuring safe access to entryways and exits, slip and fall hazards, equipment and cylinder storage, as well as safety ladders.
    - **Ease of access –** Provisions made for controlled access points with security systems, fencing, and locks for safety at all access points.
- Community input
    - **Air pollution and exposure concerns –** Information from community members about sources of air pollution or locations where air pollution impacts are experienced
    - **Community assets –** Information from the community about locations where people live or congregate, particularly where parts of the population more vulnerable to the impacts of exposure to air pollution are located, also referred to as sensitive receptors.

3.0 Monitoring Approach

3.1 Monitored Pollutants

As described above, petroleum refineries emit a broad range of air pollutants. Multi-pollutant monitoring is a means for better understanding the complex mixture of substances that may exist in the ambient air near these facilities. Although Regulation 3 establishes fees for funding the Major Stationary Source Community Air Monitoring Program, it does not specify guidelines for program implementation such as which pollutants should be measured. It is thus incumbent upon Air District staff to make this determination.

In 2019, the California Office of Environmental Health Hazard Assessment (OEHHA) partnered with the California Air Resources Board to produce a publication titled *Analysis of Refinery Chemical Emissions and Health Effects*. Among other potential uses, this report was produced for the express purpose of assisting CARB, local air districts, and communities in developing plans for air monitoring near refineries in California. Based on data reported to CARB and the US EPA, the report identifies 188 chemicals that are emitted from California refineries. Of those chemicals, the report identifies eighteen top candidates for air monitoring based on their toxicity, average levels of emissions, and involvement in routine refinery processes and incidents. Those candidates are:

- Acetaldehyde
- Ammonia
- Benzene
- 1,3-butadiene
- Cadmium
- Diethanolamine
- Formaldehyde
- Hydrogen fluoride
- Hydrogen sulfide
- Manganese
- Naphthalene
- Nickel
- Nitrogen oxides
- Polycyclic aromatic hydrocarbons
- Particulate matter
- Sulfur dioxide
- Sulfuric acid
- Toluene

As the 2019 OEHHA report notes, not all of the candidate chemicals are emitted in the same amounts from every refinery, and some chemicals are emitted only in small amounts from individual sources. As a result, when developing a monitoring plan for an individual facility, it is worthwhile to consider source-specific emissions. Table 4 below provides the 2019 criteria pollutant emissions data in tons/year for each facility and Table 6 (p. 17) provides the most recently available toxic air contaminant emissions data in lbs/year as reported by CARB's CEIDARS database. The individual toxic air contaminants listed in Table 6 are those emitted in quantities greater than 100 lbs per year.[1]

[1] OEHHA (2019) generally refers to minimal emissions as those less than 100 lbs/year.

Table 4 – 2019 Criteria Pollutant Emissions from the Bay Area Refineries (tons/year)

Facility	Pollutant					
	CO	NOx	PM_{10}	$PM_{2.5}$	ROG	SOx
Chevron (10)	306	797	554	538	510	388
Marathon (14628)	966	422	322	322	249	383
PBF Energy (11)	815	771	528	464	229	1018
Phillips 66 (21359)	113	214	72	72	88	360
Valero (12626)	423	955	174	174	413	47

As shown in Table 6, OEHHA's candidate pollutants are emitted in varying amounts from the five Bay Area refineries. For example, MRC reported more than 81,000 lbs of sulfuric acid emissions per year while Chevron reported less than 22,000 lbs per year. Other pollutants from the list are reported in very small quantities or not at all. In such cases, emissions from the refineries alone may not result in ambient concentrations above minimum detection levels. As a result, ambient air monitoring at fixed sites like those being established under the Major Stationary Source Community Air Monitoring Program may not yield actionable data unless additional emissions sources are nearby.

Other guidelines may also be pertinent when determining which pollutants should be monitored at the community monitoring stations near refineries. In particular, air monitoring guidelines issued by the Air District (2016) for purposes of Regulation 12, Rule 15 (Petroleum Refining Emissions Tracking) require the refineries to measure benzene, toluene, ethyl benzene, and xylenes (BTEX) and hydrogen sulfide. The guidelines further require the refineries to consider whether sulfur dioxide; alkanes; 1,3-butadiene; and ammonia should also be monitored when preparing their facility-specific air monitoring plans.

Beyond these guidelines, additional analysis suggests that a relatively small number of toxic air contaminants contribute to much of the ambient risk levels in the Bay Area. For example, a 2017 staff report prepared for Air District Regulation 11, Rule 18 (Reduction of Risk from Air Toxic Emissions at Existing Facilities) identified six TACs, which are collectively responsible for 98% of the contribution to ambient risk in the region: diesel particulate matter (64%), carbon tetrachloride (11%), benzene (8%), 1,3-butadiene (6%), hexavalent chromium (5%), and formaldehyde (4%). Of these, the staff report states that health risks associated with petroleum refining are due primarily to the emissions of benzene, 1-3, butadiene, formaldehyde, and diesel particulate matter (DPM).

Also referred to as "soot," "black carbon," or "BC," DPM is the solid material found in diesel exhaust. It is generally composed of carbon particles along with numerous organic compounds. At a refinery, DPM typically comes from trucks with heavy-duty diesel engines, ships, small diesel-powered generators, and other combustion sources. Outside of the refineries, major sources of DPM include trucks, trains, ships, planes, school buses and other combustion sources (including biofuel combustion). While ambient DPM itself cannot be measured directly, black carbon can be measured and may be used to estimate DPM levels.

More than 90% of DPM is less than 1 μm in diameter and because it is a subset of $PM_{2.5}$, DPM also contributes to the same non-cancer health effects as $PM_{2.5}$ exposure. For all of these reasons, the Air District will additionally measure ambient black carbon concentrations at all of the refinery community air monitoring stations and take size-fractionated PM measurements at sizes of 10, 2.5, and 0.1 micrometers. In consideration of the 2019 guidance from OEHAA, the Air District's own community air monitoring guidelines, reported emissions from the facilities, Air District analysis performed to support other air toxics risk reduction measures, the mix of other sources near the refineries, and the goal of the program to provide data about typical ambient air pollutant concentrations in communities near large sources of emissions, the Air District intends to monitor the following pollutants at each refinery community air monitoring station:

Table 5 – Air Pollutants Monitored at Refinery Community Air Monitoring Stations

- Benzene
- Black carbon
- Ethylbenzene
- Hydrogen sulfide
- Nitrogen dioxide
- Ozone
- PM_{10}
- $PM_{2.5}$
- Size-fractionated PM(1)
- Sulfur dioxide
- Toluene
- Xylene

Notes: (1) Measurements could include size fractions of 10, 2.5, 0.1 micrometers

The pollutants listed above are expected to be primary health drivers and are often co-emitted with the other pollutants listed earlier. As Air District resources and station logistics allow, other parameters of interest may be monitored at these stations in the future based on nearby source emissions or health impacts.

Collectively, the pollutants listed in Table 5 reflect potential emissions from a broad range of refinery processes described in Section 1.3 and depicted in Figure A-1 including crude units, boilers and heaters, cogeneration units, catalytic cracking units, alkylation units, cokers, sulfur recovery units, vents, cooling towers, thermal oxidizers, flares, storage tanks, and wastewater treatment. For a more detailed list of pollutants that are generally associated with each process, refer to Appendix B of the 2019 OEHHA guidance document.

3.2 Meteorological Monitoring

Meteorological conditions have a significant impact on ambient pollutant concentrations, and meteorological data may therefore be helpful when analyzing and interpreting air quality data. As a result, all community air monitoring stations will include meteorological instruments for measuring temperature, pressure, relative humidity, wind speed, and wind direction.

Table 6 – Toxic Air Contaminant Emissions from the Bay Area Petroleum Refineries(1)

Chevron	
Pollutant	**lbs/yr**
Ammonia	176,696
HCl	30,731
Propylene	24,529
Sulfuric Acid	21,694
Methanol	19,366
Formaldehyde	15,325
Toluene	14,315
Xylenes	10,217
Hexane	5,113
Benzene	3,332
Acetaldehyde	2,957
Diethanolamine	2,873
CS2	2,493
Phenol	1,256
Ethyl Benzene	1,242
MEK	645
Manganese	500
Naphthalene	492
Chloroform	420
1,3-Butadiene	390
Nickel	285
Copper	265
Propylene Oxide	198
Methylene Chlor	185
Lead	155
Diesel Exh PM	108

Marathon	
Pollutant	**lbs/yr**
Ammonia	93,754
Sulfuric Acid	46,164
Hexane	40,580
HCl	21,483
Toluene	11,681
Xylenes	7,656
Methanol	7,295
Benzene	5,498
Propylene	5,302
Formaldehyde	4,126
CS2	1,919
Ethylbenzene	1,657
Diethanolamine	1,149
Acetaldehyde	1,147
Naphthalene	389
Nickel	330
1,3-Butadiene	186
Phenol	182
Methylene Chlor	153
Copper	116
Selenium	102

MRC	
Pollutant	**lbs/yr**
Ammonia	214,954
Sulfuric Acid	81,560
Methanol	38,461
HCl	30,692
Formaldehyde	11,048
Xylenes	8,527
Hexane	7,355
Propylene	6,358
Toluene	4,954
CS2	4,080
Acetaldehyde	2,545
Ethylbenzene	2,347
Benzene	2,291
Acrolein	532
Phenol	394
Naphthalene	185
Manganese	179
Methylene Chlor	133

Phillips 66	
Pollutant	**lbs/yr**
Sulfuric Acid	56,347
Ammonia	54,728
Hexane	37,268
HCl	7,247
Propylene	3,487
Xylenes	2,976
Toluene	2,769
Formaldehyde	1,657
Benzene	1,226
Acetaldehyde	934
Ethylbenzene	520
Manganese	287
Naphthalene	214
Phenol	107

Valero	
Pollutant	**lbs/yr**
Ammonia	37,994
Sulfuric Acid	24,911
Acetaldehyde	13,307
Xylenes	6,428
Toluene	6,355
Hexane	4,399
Benzene	2,443
Formaldehyde	2,294
Propylene	1,529
Ethylbenzene	1,337
Manganese	451
CS2	441
Methanol	311
HCl	310
Phenol	291
Naphthalene	244

Notes: (1) OEHHA priority candidate pollutants

3.3 Monitoring Methods and Equipment

In most cases, the accurate measurement of ambient pollutant concentrations involves two fundamental processes: 1) sampling, and 2) sample analysis. For gaseous pollutants, the task of sampling is to deliver a quantity of air to an analyzer (whether in the field or in a laboratory) in a condition that the analyzer can accept and without altering the sample in a way that causes the measured concentration to deviate from the true ambient concentration. Similarly for particles, the challenge is to get a representative sample of particles from the air to the measuring device without changing the concentration or characteristics of the particles along the way (Tiwary, Williams & Colls, 2019). Once collected, the sample must then be analyzed with a method that can be trusted to produce accurate and precise measurements. All of this requires complex equipment that must be carefully designed, operated, and maintained, and procedures that must be strictly followed, in order to achieve the desired monitoring objectives. As a result, a number of factors must be considered when deciding what monitoring methods and equipment will be used (EPA, 2017; South Coast AQMD, 2020; Tiwary, Williams & Colls, 2019):

- The specificity of the method and its susceptibility to interference or cross-sensitivity from other compounds
- The sensitivity and operating range of the method
- Precision, accuracy, and stability
- Compatibility with local weather and geographic conditions
- Response time
- Equipment reliability
- Maintenance requirements
- Requirements for supporting materials and equipment
- Manual vs. automated methods
- Vendor performance and reliability
- Safety
- Initial and operating costs
- Compatibility with the Air District's existing network and supporting infrastructure

To a large extent, these factors must be considered in tandem with decisions about what pollutants will be monitored and with resource and logistical constraints related to the overall site design. They will accordingly be considered further by Air District staff during the site design process. However, as stated above in Section 1, one of the primary objectives of the Air District's Major Stationary Source Community Air Monitoring Program is to establish a near real-time air monitoring network in the vicinity of large facilities to collect data about ambient air pollutant concentrations experienced in those areas. As a result, the ability to produce continuous real-time or near real-time data is a driving consideration, and the Air District will attempt to utilize technology that can produce such data where it is feasible and commercially available. As a general matter, the Air District will also seek to use monitoring systems with response times that are capable of detecting changes in pollution levels on short time scales and that have a sensitivity and range adequate to characterize typical variation in the ambient air.

4.0 Community Engagement

Community engagement is essential for successful implementation of the Major Stationary Source Community Air Monitoring Program. With a unique knowledge of their communities and first-hand experience about the impacts of large emissions sources, members of the Bay Area's fenceline communities have insight that is valuable to the Air District throughout the site identification and selection process. Furthermore, one objective of the program is to provide community members with information about day-to-day air quality conditions near large facilities. Since they will be consumers of this information, the data and associated products should be designed with their needs and interests in mind.

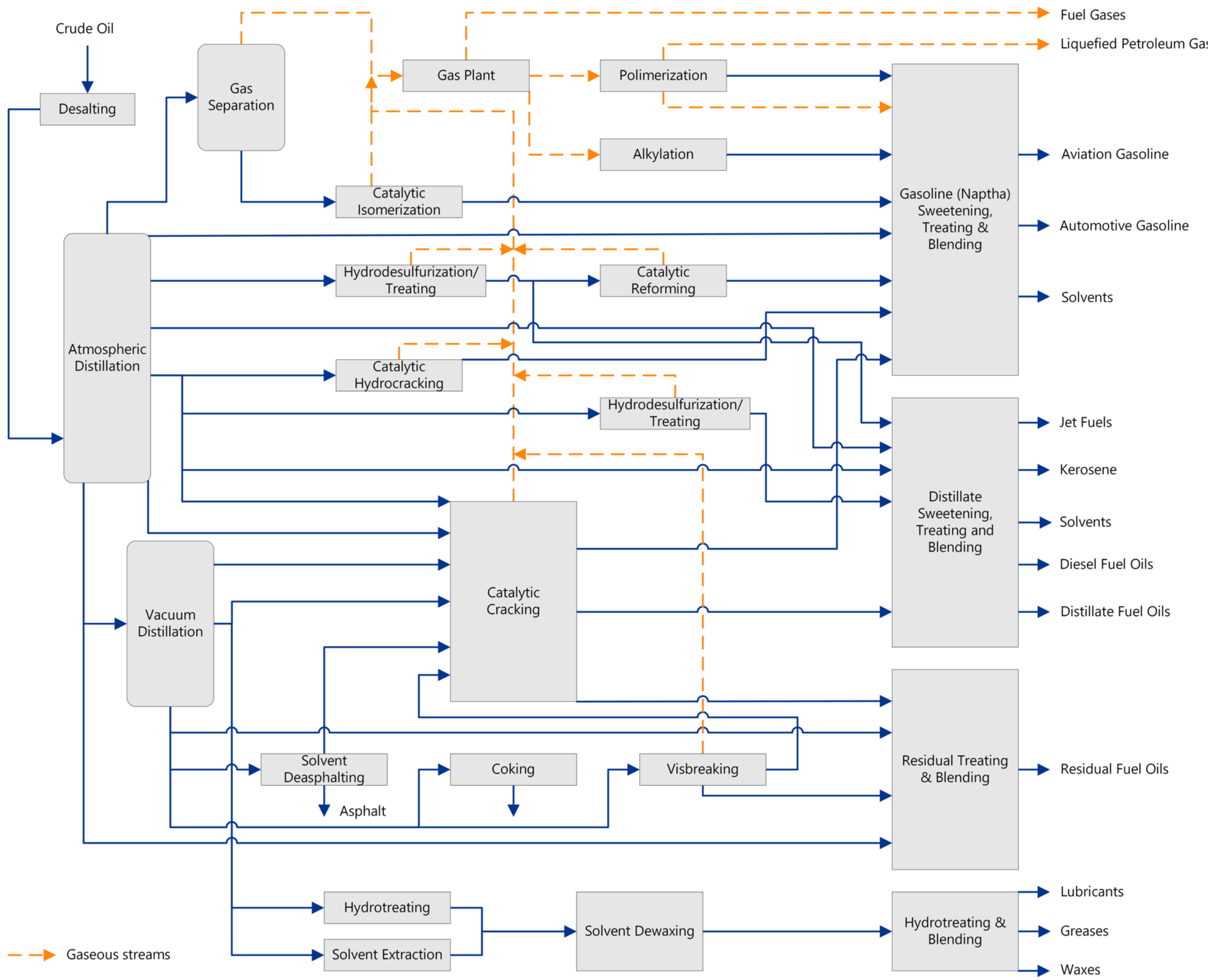
The Air District launched its Major Stationary Source Community Air Monitoring Program in 2018 with a series of community workshops to gather information about air quality concerns and suggested monitoring locations. Workshops were held in Benicia, Martinez, Richmond, and Rodeo. Participants were provided with background information on a variety of topics related to air quality and ambient air monitoring methods, followed by an open question and answer session and an opportunity for community members to suggest monitoring locations. All members of the public (whether they attended a workshop or not) were also invited to suggest monitoring locations and provide other feedback in an online Open Air Forum on the Air District's website. All of this input has been considered in the development of this plan. As implementation of the program proceeds, the Air District will continue to keep community members apprised of its progress at key milestones shown below in blue. To receive information directly from the Air District, community members are encouraged to sign up for our Refinery Stakeholders email distribution list on our website at https://www.baaqmd.gov/contact-us/sign-up-for-information. The Air District will also continue to seek out additional opportunities for community engagement, particularly as monitoring data become available.

Table 7 – Activities Associated with the Siting, Construction & Operation of a Monitoring Station

Siting	Construction	Operation
Gather public input	Site construction & station setup	Begin monitoring
Identify general areas where the monitoring station should be placed	Equipment procurement	Ongoing station maintenance
Identify specific candidate sites & available spaces	Equipment installation	Data quality assurance
Assess available spaces & select preferred site	Equipment testing	Data analysis & reporting
Negotiate lease agreement		
Design monitoring site		
Permit site		

Appendix A – Supplemental Figures

Figure A-1 – Simplified and Generalized Process Flow for Petroleum Refining Operations



Source: Adapted from OSHA (n.d. -b)