Fenceline Monitoring Plan for the Chevron Refinery in El Segundo, California

Monitoring Plan Prepared for the
South Coast Air Quality Management District
Diamond Bar, CA

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Fenceline Monitoring Plan for the Chevron Refinery in El Segundo, California

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Monitoring Plan

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Introduction

Rule 1180 Requirements for Fenceline Monitoring Plans

On December 1, 2017, the South Coast Air Quality Management District (SCAQMD) adopted Rule 1180, "Refinery Fenceline and Community Air Monitoring" (South Coast Air Quality Management District, 2017a). Rule 1180 requires petroleum refineries within the SCAQMD to establish air monitoring systems at facility perimeters (fencelines); these systems will measure pollutant concentrations and provide the public with real-time information about air quality near the refineries. Rule 1180 also requires a detailed fenceline air monitoring plan (this document) that follows SCAQMD guidelines (South Coast Air Quality Management District, 2017b).

According to the SCAQMD's guidelines, an air monitoring plan must include detailed information on several elements to justify the measurement and data dissemination approach being proposed to satisfy Rule 1180 requirements. Section numbers in the following list indicate where each element is discussed in this plan.

- An evaluation of routine emission sources at the refinery (e.g., utilizing remote sensing or other measurement techniques or modeling studies, such as those used for health risk assessments) (Section 1). *This plan relies on emissions used in Chevron's Voluntary Risk Reduction Plan.*
- An analysis of the distribution of operations and processes within the refinery to determine potential emissions sources (Section 1). *This plan describes refinery operations and processes and also assesses on-site emissions sources.*
- An assessment of air pollutant distribution in surrounding communities (e.g., mobile surveys, gradient measurements, and/or modeling studies used for health risk assessments) (Section 1). *This plan relies on pollutant concentrations modeled for the Voluntary Risk Reduction Plan.*
- A summary of fenceline air monitoring instruments and ancillary equipment that are proposed to continuously measure, monitor, record, and report air pollutant levels in real-time near the petroleum refinery facility perimeter (i.e., fenceline) (Section 2). *This plan relies on both open-path and point instruments to satisfy Rule 1180 requirements.*
- A summary of instrument specifications, detectable pollutants, minimum and maximum detection limits for all air monitoring instruments (Section 2). *This plan relies on information provided by reputable instrument manufacturers for instrument specifications.*
- Proposed monitoring equipment siting and selected pathways (when applicable) for fenceline instruments, including the justification for selecting specific locations based on the assessments mentioned above (Section 2). *This plan covers all important fencelines around the refinery and has accounted for the measurement of all chemical species listed in Rule 1180.*

- Operation and maintenance (O&M) requirements for the proposed monitoring systems; an implementation schedule consistent with the requirements of Rule 1180; Procedures for implementing quality assurance and quality control of data (Table 1 below, Sections 2 and 3). *Draft O&M requirements are provided in this plan. Final O&M requirements will be determined once instruments are procured.*
- A web-based system for disseminating information collected by the fenceline air monitoring system (Section 4). *This plan provides the key content of the web system; final design will be created during implementation, after this plan is approved.*
- Details of the proposed public notification system (Section 5). *This plan provides the key content of the public notification system; final design will be created during implementation, after this plan is approved.*
- Demonstration of independent oversight (Section 3). *This plan proposes annual independent instrument and system audits.*

An implementation schedule detailing the key milestones for implementation of the monitoring system is shown in Table 1.

Table 1. Approximate implementation schedule for Chevron El Segundo Rule 1180 monitoring project.

Project Element	Completion Date
Develop monitoring plan and receive approval from SCAQMD	At time of approval
Select instrument types based on measurement needs; order instruments, shelters, and supplies	One month following approval.
Determine final site locations	At time of approval
Develop specifications for infrastructure (shelters, pads, power, mounts, etc.)	1 month prior to approval
Perform preliminary infrastructure design	1 month prior to approval
Perform detailed infrastructure design	1 month following approval
Perform engineering and construction work	2 months following approval
Complete site infrastructure	9 months following approval
Acquire instruments	8 months following approval

Project Element	Completion Date
Complete and test data management system	9 months following approval
Complete internal and external websites and internal notification system	9 months following approval
Install and test instruments and associated equipment	10 months following approval
Finalize Quality Assurance Project Plan	8 months following approval
Start monitoring and reporting	12 months following approval
Operate and maintain equipment, data system, website, notification system; perform daily data checks	12 months following approval; continuous

Summary of Monitoring Plan for Chevron El Segundo

Chevron's El Segundo Refinery is surrounded by residential areas on three sides and is also bounded by commercial zones and several major industrial facilities. Chevron proposes to monitor concentrations across 11 open paths. These paths are shown in **Figure 1**. The Refinery selected these paths after considering dominant wind patterns, sources of potential air emissions on the refinery property, nearby local receptors, and logistical feasibility. These paths will provide coverage for downwind communities under typical and atypical wind patterns. The instruments used will be capable of measuring the pollutants listed in Rule 1180 in real time and include open-path FTIR and UVDOAS instruments, as well as point instruments for BC, H_2S, meteorological, and visibility. All required pollutants will be measured as shown in **Table 2** below.

The monitoring data will be quality-assured and displayed to the public via a website in real time. Links to educational materials will be provided so the data can be understood in context of health benchmarks and regional pollutant concentrations. Notifications will be issued when thresholds are exceeded, when other activities affect the monitoring system, and when quarterly reports are available.

The following sections provide details of the plan, including a discussion of all items in SCAQMD's fenceline air monitoring plan checklist (see **Appendix A**).

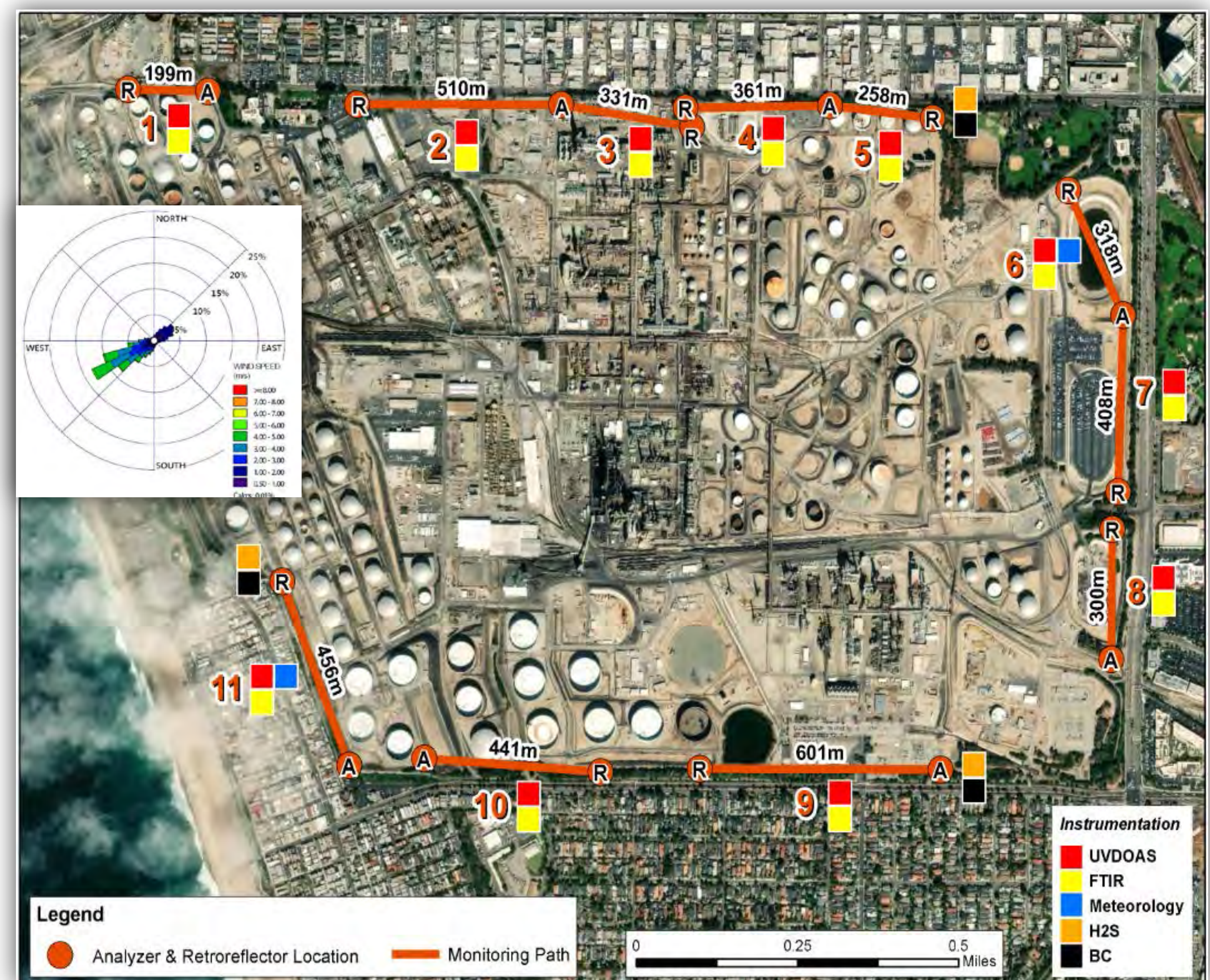

Figure 1. Proposed monitoring paths for the Chevron El Segundo refinery.

Table 2. List of pollutants to be measured and proposed instruments and paths.

Pollutant	Instrument	Path
Criteria Air Pollutants		
Sulfur Dioxide	OP UVDOAS and FTIR	1-11
Nitrogen Dioxide	OP FTIR	1-11
Volatile Organic Compounds		
Total alkanes	OP FTIR	1-11
Formaldehyde	OP FTIR	1-11
Acetaldehyde	OP FTIR	1-11
Acrolein	OP FTIR	1-11
1,3-Butadiene	OP FTIR	1-11
Styrene	OP FTIR	1-11
BTEX Compounds	OP UVDOAS and FTIR	1-11
Other Compounds		
Hydrogen Sulfide	Point Monitor, Type TBD	5, 9, and 11
Carbonyl Sulfide	OP FTIR	1-11
Ammonia	OP FTIR	1-11
Black Carbon	Point Aethalometer	5, 9, and 11
Hydrogen Cyanide	OP FTIR	1-11
Hydrogen Fluoride (if the facility uses it)	NA[1]	NA[1]

[1] The El Segundo refinery does not use hydrogen fluoride.

1. Spatial Coverage

To provide a monitoring network that best serves the community by monitoring the emissions at the refinery fenceline, the following factors were considered while designing the monitoring network: (1) the characteristics of the refinery location, including topology and meteorology, (2) emissions characteristics, (3) sensitive receptors, and (4) the spatial coverage of the monitors. The monitors selected will be described in more detail in Section 2.

1.1 Characteristics of Refinery Location

This section characterizes the refinery location, emphasizing important factors controlling potential exposure of the nearby community to pollutants. These factors include the refinery's geographical setting with respect to other non-refinery sources, topography and meteorology, location of sensitive receptors, refinery emissions, and modeling of the dispersion of those emissions to surrounding areas.

1.1.1 Geographical Setting

Chevron's El Segundo Refinery is located at 324 W. El Segundo Blvd. in the city of El Segundo, California (**Figure 2**). Chevron's 929-acre property is mostly developed and can provide the infrastructure necessary for a fenceline monitoring program. The refinery is surrounded by residential areas on three sides: El Segundo to the north and east, and Manhattan Beach to the south and west. Santa Monica Bay is also to the west. The refinery is additionally bounded by commercial zones and several major industrial facilities.

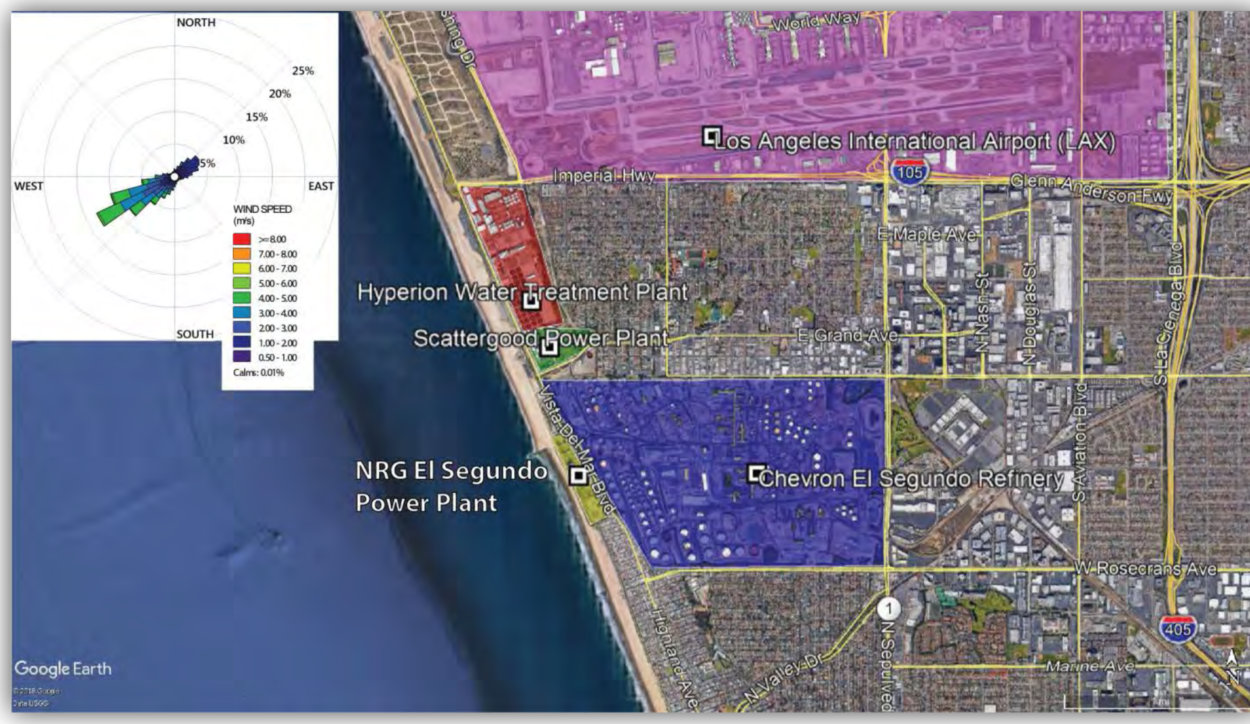

Figure 2. Chevron El Segundo refinery and the surrounding area. The wind pattern is dominated by west-southwesterly (sea-breeze) and northeasterly (land-breeze) winds.

1.1.2 Topography and Meteorology

The land within the refinery location is characterized by undulating hills approximately 100 to 160 feet above sea level. The refinery is positioned at a coastal site; thus, for the majority of the time, the winds are dominated by the sea breeze-land breeze pattern. To assess wind climatology, meteorological data from the LAX Hastings site (33.9550, -118.4303) from 1/1/2007 to 12/30/2011 were used to generate the wind roses shown in Figures 2 and 3; these are the same meteorological surface wind data that were used in Chevron's 2017 Voluntary Risk Reduction Plan (VRRP) for this facility (ERM, 2017).[1] The LAX Hastings site is located only three miles north of the refinery and is one mile from the coast; thus, the meteorological data from this site is very representative of the conditions at the El Segundo refinery. The petals of a wind rose show the direction the wind is coming from. The annual average wind rose from the 2007–2011 period shows that onshore southwesterly winds and offshore northeasterly winds dominate for the majority of time:

- **Onshore winds.** Winds blow from southwest to northeast most frequently (approximately 51% of the time, as seen in Figure 2). These winds move across the refinery into the residential and commercial areas to the northeast of the refinery. These winds are associated

[1] Although text in the VRRP report indicates that Long Beach surface meteorological data were used, that is incorrect, as STI discovered that LAX Hastings surface meteorological data were actually used in the VRRP modeling.

with the sea breeze phenomenon and are strongest during the daytime, during the early evening, and during the summer.

- **Offshore winds.** Winds blowing from the northeast to the southwest (approximately 25% of the time) move from the Los Angeles Basin through the refinery out towards the ocean. These winds are associated with the land breeze phenomenon and tend to be stronger during the nighttime, during early morning hours, and during the winter

To capture the seasonal variability of the winds, average monthly wind roses were plotted for the data from 1/1/2007 to 12/31/2011 (Figure 3). During the coldest months (November, December, and January), the offshore wind pattern is the most prevalent because of the cooler land temperatures. During the early spring and late fall months, both onshore and offshore winds occur with roughly equal frequency. From late spring to early fall, the onshore wind pattern is the most frequent. In general, there is little deviation from the southwesterly onshore or northeasterly offshore flow throughout the year.

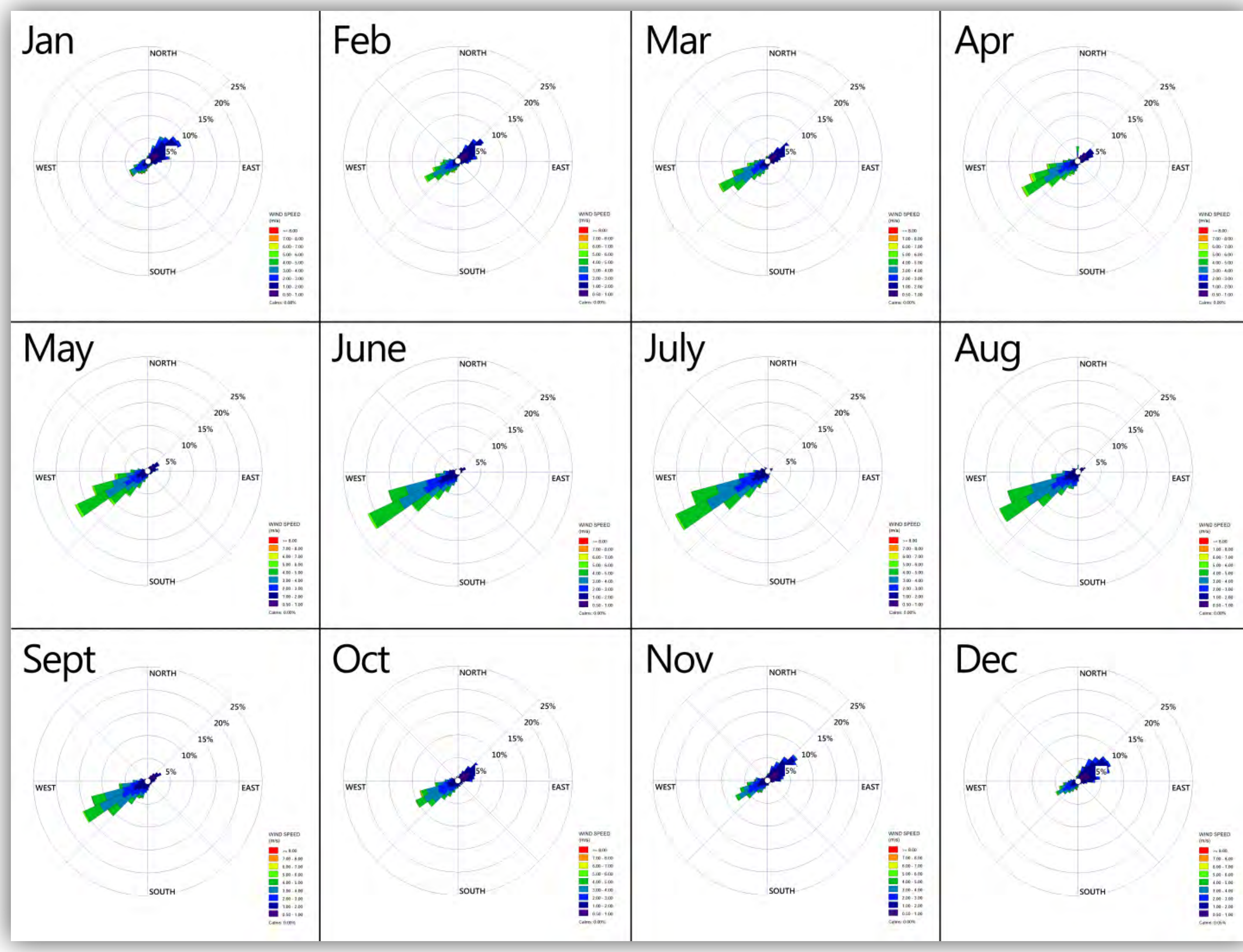

Figure 3. Average monthly wind roses for 1/1/2007-12/31/2011 at LAX-Hastings. Onshore flow (from the southwest) dominates most of the year except late fall and winter. Winds from the northwest and the southeast are infrequent.

1.1.3 Non-Refinery Pollution Sources

Major non-refinery pollutant sources include two power plants (Scattergood Generating Station and NRG El Segundo Power), Los Angeles International Airport (LAX), Hyperion water treatment plant, and Interstate 405 (Figure 2). Because the refinery is located in a densely populated area, typical urban emissions of pollutants are expected. The power plants generate electricity via combustion of natural gas and are thus expected to be significant sources of nitrogen oxides (NO_x). The Hyperion water treatment plant is one of the largest such plants in the area and is likely a significant source of hydrogen sulfide and sulfur oxides (SO_x) to the surrounding community. LAX contributes to NO_x pollution due to heavy traffic loads and air traffic emissions, and Interstate 405 is another major source of NO_x pollution due to heavy traffic. Interstate 405 is also a major source of diesel particulate matter due to the large volume of heavy-duty vehicle traffic. All of these sources, at times, may impact the proposed fenceline monitoring network as well as the community.

1.1.4 Sensitive Receptors

Figure 4 shows the location of several types of sensitive receptors with respect to the refinery, including schools and childcare facilities, adult health facilities, recreation areas, and residential areas. At least one of each type of receptor is located within a mile of the refinery fenceline. The combination of winds and proximity of sensitive receptors helps guide the placement of fenceline monitoring systems.

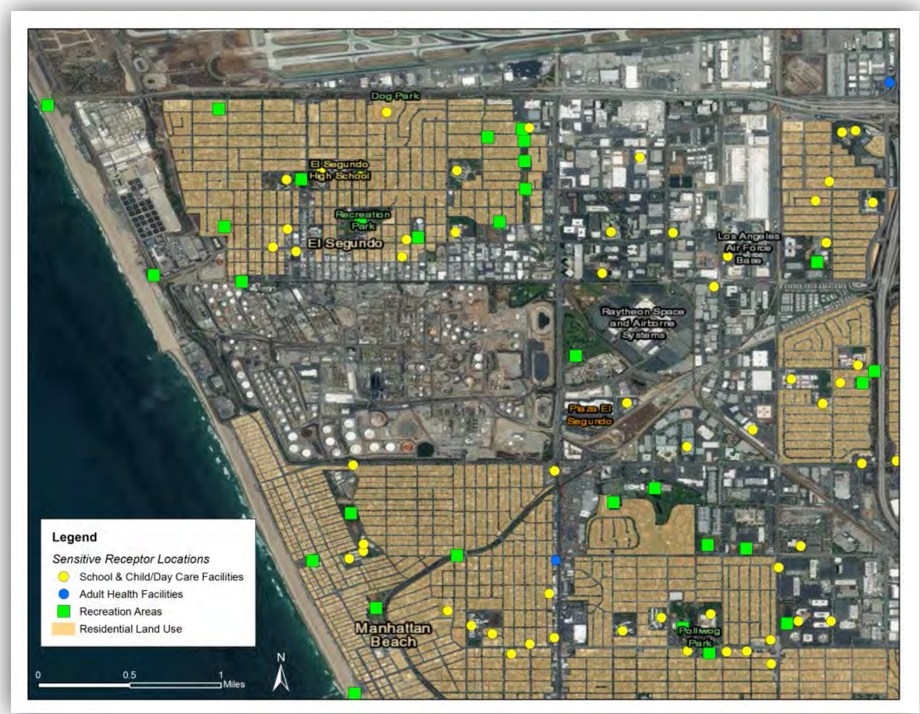

Figure 4. Map of sensitive receptors.

There are also several recreation areas along the fencelines that include small community parks, El Segundo and Manhattan beaches, and a golf course (to the east). There are schools located close to the northern fenceline in the city of El Segundo; these include preschools, elementary, middle, high, and nursery schools. There are slightly fewer schools to the south in the town of Manhattan Beach. Daycare facilities are present in both the residential and commercial neighborhoods. Based on the dominant wind directions and the location of sensitive receptors in residential areas, the residential areas along the northeast and southwest fencelines are the most important areas to monitor.

1.2 Historical Emission Patterns and Hotspots

This section describes refinery operations, processes, emissions sources, and dispersion modeling used to characterize the potential transport of specific pollutants beyond the refinery property. Emissions information, together with the information provided about the topology and geographic setting (Section 1.1), is used as additional basis for the placement of the fenceline monitoring systems.

1.2.1 Operations and Processes Within the Facility's Perimeter

Chevron's El Segundo Refinery is a petroleum refinery producing fuel products, such as liquefied petroleum gas (LPG), gasoline, jet fuels, diesel fuels, residual fuel oils, and coke through distillation of crude oil, coking, cracking, alkylation, and reforming. Crude oil, used to produce gasoline and other refinery products, is delivered by ship to the marine terminal or received via pipeline directly to the Refinery. The crude oil is then processed in the crude units, where it is heated and distilled into multiple feedstock components that are later processed elsewhere in the Refinery. The heavy residual oil leaving the crude units is further distilled in the vacuum units to yield additional, lighter hydrocarbon products and vacuum residuum. The vacuum residuum is processed in the Coker Unit, and the lighter hydrocarbon components from the crude units and vacuum units are fed to other Refinery units for further processing. Some of the major downstream processes are cracking in the Fluid Catalytic Cracking Unit (FCCU) and ISOMAX Unit, processing to recover sulfur in the hydrotreating units such as the Vacuum Residuum Desulfurization (VRDS) Unit, synthesizing in the Alkylation Unit, and reforming in the Continuous Catalytic Reforming (CCR) Unit. Auxiliary systems are also needed to support Refinery operations; these include hydrogen plants (to produce hydrogen needed for certain refinery reactions), boilers to produce steam, cogeneration plants to produce electricity and steam, and wastewater treatment systems.

1.2.2 On-Site Emissions Sources and Emissions Levels

In 2017, Chevron submitted a Voluntary Risk Reduction Plan (VRRP) to the South Coast Air Quality Management District (SCAQMD). As part of this plan, an extensive emissions inventory was generated under SCAQMD Rule 1402 for the 2015 reporting year (ERM, 2017). The emissions information presented here is a result of that effort. Table 3 lists the annual emissions of the chemical species listed under SCAQMD Rule 1180. The remainder of this section summarizes the main source areas of the major Rule 1180 species. Figures 5 through 9 represent emissions of key Rule 1180 species gridded on a map of the facility. Reported facility toxics emissions in 2015, along with coordinate and dimension information, were obtained from the 2015 VRRP modeling data. Emissions were gridded in a geographic information system (GIS) by location and source type in order to locate sources within the facility fenceline that had the highest emissions, on a per-pollutant basis.

Table 3. Emissions of species listed in Rule 1180 at the Chevron El Segundo Refinery. NO_x and SO_x were not part of the VRRP and are thus not included in this table.

Pollutant Name	Emissions (kg/yr)
Ammonia	69796.5
Hydrogen Sulfide	13073.0
Xylenes	2343.3
Hexane	1805.7
Formaldehyde	1727.1
Toluene	1539.1
Ethyl Benzene	655.7
Carbonyl Sulfide	593.0
Benzene	408.0
Acrolein	276.3
DieselExhPM	266.4
Acetaldehyde	202.1
Naphthalene	122.1
1,3-Butadiene	10.1
Styrene	2.3

For the purposes of dispersion modeling (see Section 1.2.3), 326 sources were developed, including 80 point sources, 155 volume sources, 79 area sources, and 12 poly-area sources. For both the current and proposed facility risk configurations, all of these sources were included in the risk impacts. All stationary sources where the emissions passed through a stack or a vent were modeled as point sources. This includes all stationary combustion sources.

All above-ground tanks were modeled as volume sources (155 in total), taking into consideration the tank height and diameter in determining the initial vertical and horizontal dimensions, following U.S.

EPA guidelines. Since emissions from tanks are generally released at the top of the tank, the release height was assumed to be at the roof height for each volume source.

Many of the fugitive emissions associated with specific common regions were modeled as area sources. For the El Segundo Refinery, a total of 79 specific areas sources were identified for a wide variety of rectangular regions, and the release heights were based upon each source's release geometry as identified in the VRRP submitted to the SCAQMD.

Other fugitive emissions that could not be identified with a specific location were assumed to occur within a plant region and were modeled as poly-area sources, and specific fugitive emissions releases were identified with the plant region. A poly-area source configuration was used for these releases because of the unusual footprint of each of the nine plant regions. Welding emissions occurred across eight of the nine plant areas, and the emissions were equally spread over the eight plant area sources, excluding the maintenance plant area. The release height for each plant area was assumed to be at the ground surface. Because of operations occurring at these areas, it was assumed that emissions would initially be dispersed evenly through a 10-meter height.

Portable diesel and gasoline internal combustion engine (ICEs) emissions could occur anywhere within the facility.

Ammonia is emitted at several locations throughout the refinery (**Figure 5**), including the fluidic catalytic cracker (FCC), process heaters and furnaces, and a number of other areas. Ammonia emissions are primarily related to uses in pollution control devices.

Hydrogen sulfide emissions are primarily due to processes involved with sulfur removal (H_2S plant, vacuum residual desulfurization, etc.). The spatial distribution of hydrogen sulfide emissions is shown in **Figure 6**; the spatial distribution of carbonyl sulfide matches closely the distribution for hydrogen sulfide, albeit at lower levels.

The emission locations of benzene, toluene, ethylbenzene, and xylenes (BTEX) are shown in **Figure 7**. Emissions of these hydrocarbons are widely distributed around the refinery property. Emissions maps of the individual BTEX compounds are similar to each other because they are typically emitted in the same process streams. The gridded emissions of 1,3-butadiene are shown in **Figure 8.**

Acrolein and acetaldehyde gridded emissions show high spatial correlation to each other and are shown in **Figure 9**. Both are simple aldehydes that are expected to be emitted from similar processes.

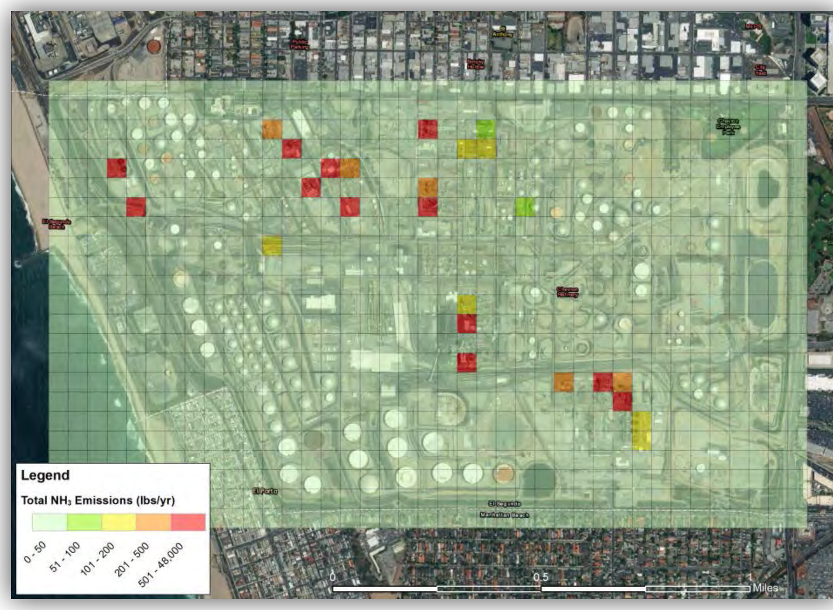

Figure 5. Gridded emissions of ammonia.

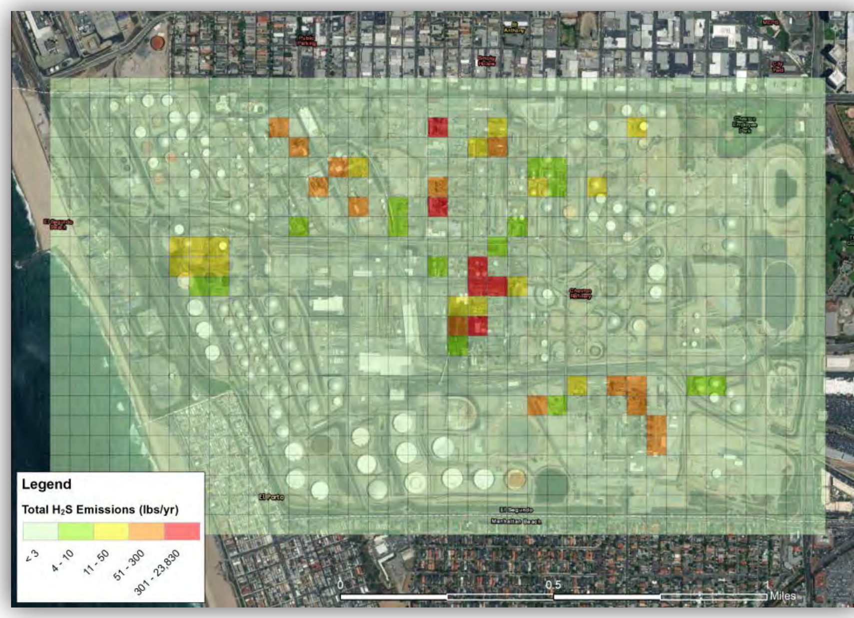

Figure 6. Gridded emissions of hydrogen sulfide.

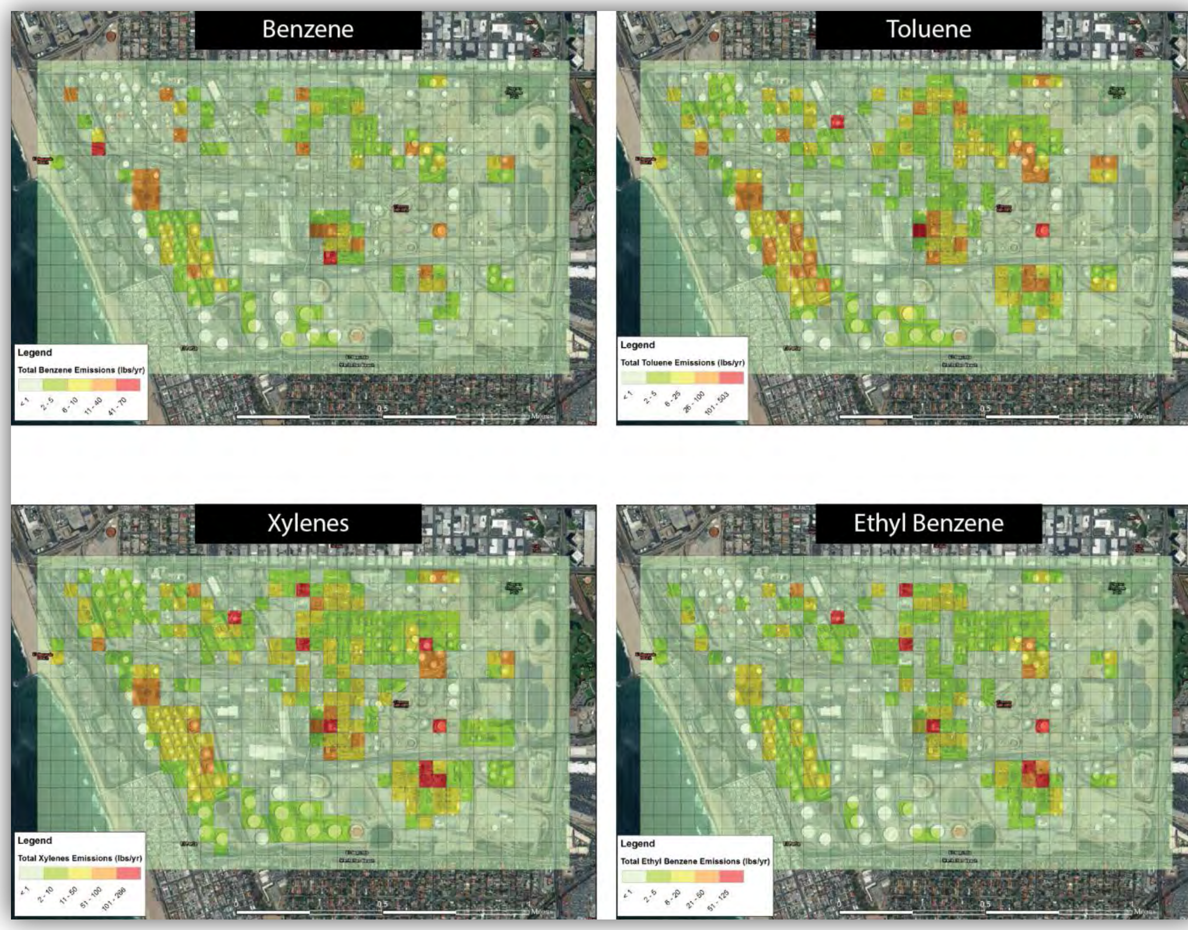

Figure 7. Gridded emissions of BTEX compounds.

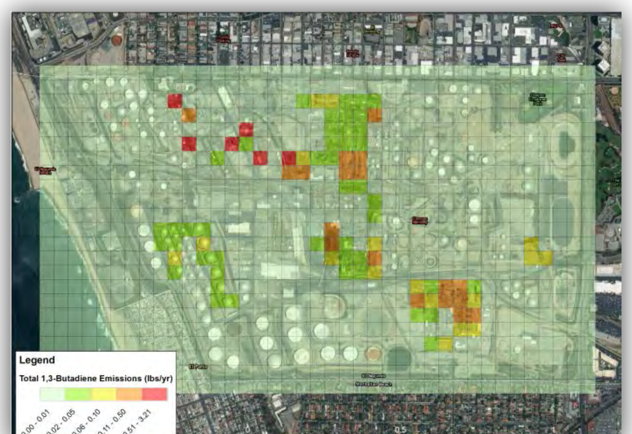

Figure 8. Gridded emissions of 1,3-butadiene.

Figure 9. Gridded emissions of acrolein and acetaldehyde.

1.2.3 Dispersion Modeling

Based on the emission source areas, receptors, and wind patterns, the most important areas for fenceline monitoring include the majority of the northern fenceline, the northern portion of the eastern fenceline, and the southwest fencelines. Additional evidence is provided by dispersion modeling.

Emissions data, topographic features, and meteorological measurements were used to model the spatial distribution of species that impact the community. To facilitate the combination of emissions and wind patterns, a modeling study was done as part of the 2015 VRRP (ERM, 2017). The current facility could not be fully evaluated with the emissions inventory module (EIM), as the EIM only provides emission source strengths and locations at the facility. Therefore, modeled facility concentrations using Air Dispersion Modeling and Risk Tool (ADMRT) results from the Hotspots Analysis and Reporting Program (HARP) model were plotted. Annual average unit concentrations were calculated using the SCAQMD 5-year hourly AERMOD-ready meteorological data set for LAX Hastings. Concentrations were calculated at each of 3,298 receptors that represented fenceline, commercial, and residential/sensitive receptors out to a distance of 2,800 m from the north and south boundaries, 1,700 m from the eastern boundary, and to the ocean on the west. The EPA's regulatory default parameters were used in the modeling, along with a single urban area, defined as Los Angeles with a population of 9,862,049.

The model results showing the five-year average concentration for each species are shown in Figures 10 through 14. Key points are as follows:

- Modeled benzene concentrations (Figure 10) show significant concentrations along the northern fenceline and the southwest corner of the refinery.

- Modeled 1,3-butadiene concentrations (**Figure 11**) show a similar trend compared to benzene.

- Modeled naphthalene concentrations (**Figure 12**) show fairly uniform concentrations over the refinery property with little spillover into the nearby community. The highest modeled naphthalene concentrations occur at the marine terminal processing facility along the beach.

- Hydrogen sulfide and ammonia concentration maps are shown in **Figures 13 and 14**. The dispersion modeling results for these species reinforce the importance of covering the north/northwest and southwest fencelines.

- There are virtually no pollution impacts for the southeast corner of the refinery, because the winds rarely blow in this direction and there are no emission sources in the southeast corner of the refinery.

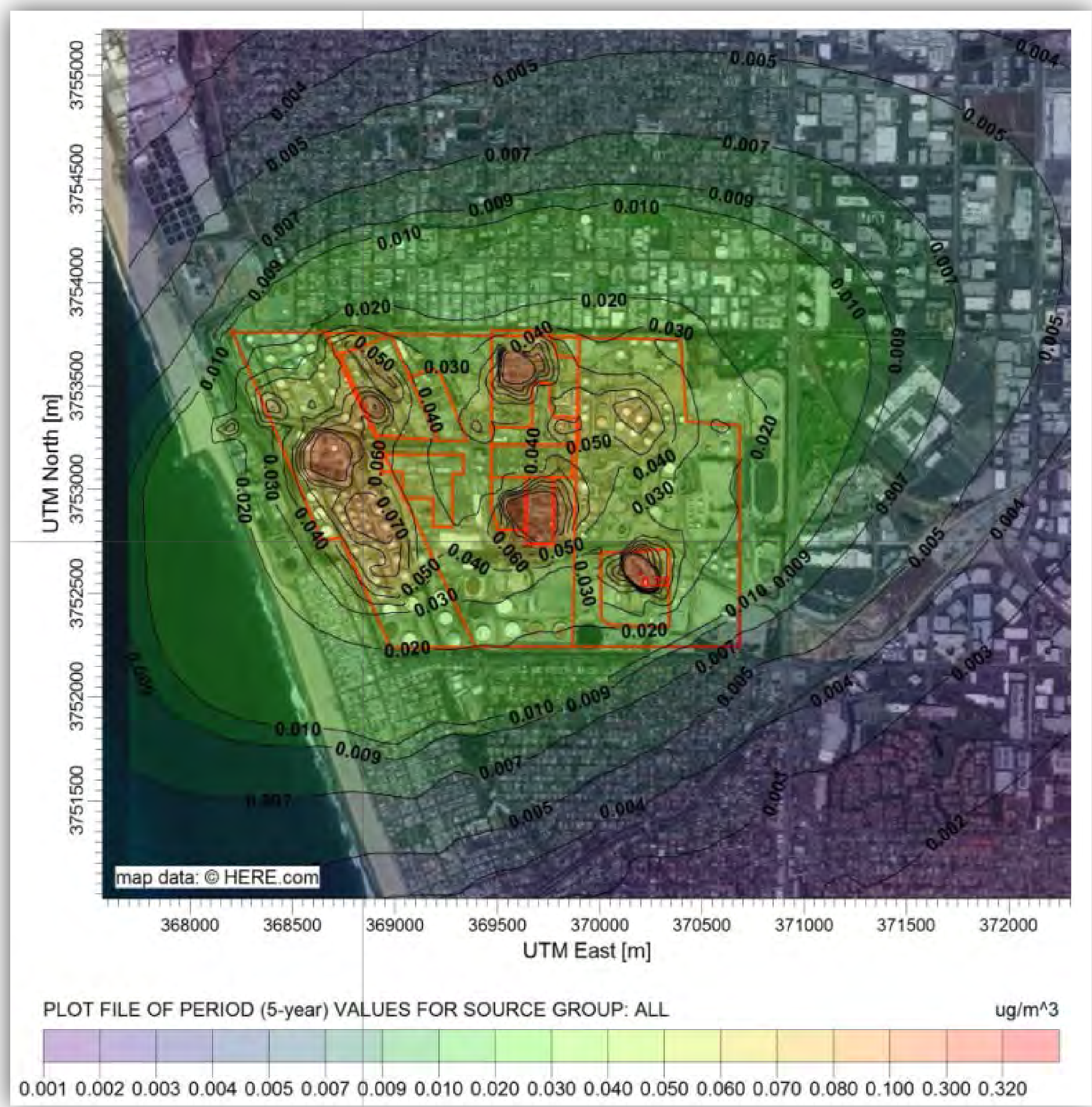

Figure 10. Benzene 5-year average concentrations during 2007-2011, using LAX Hastings surface meteorological data. Axes show the Universal Transverse Mercator (UTM) coordinates.

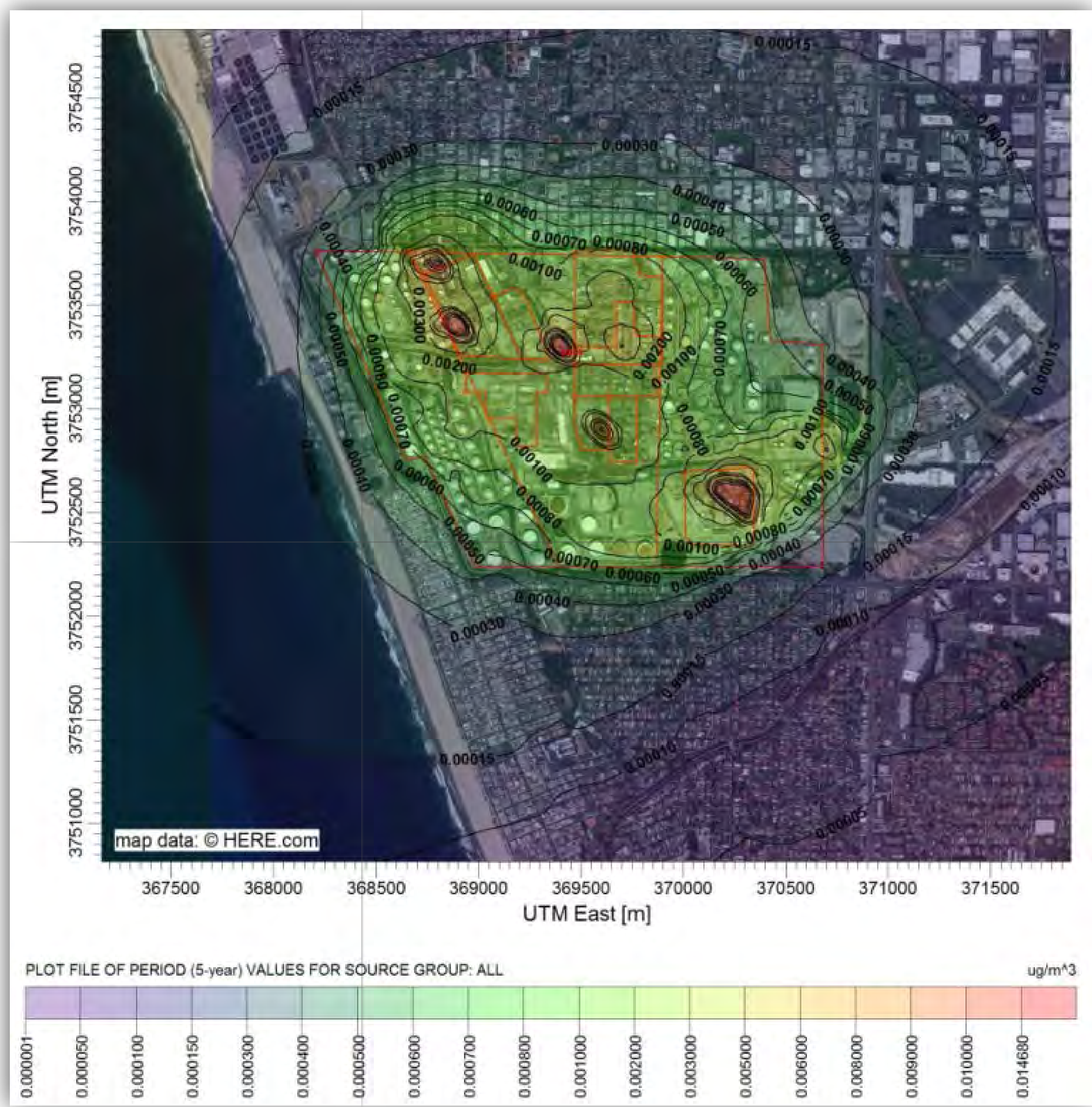

Figure 11. 1,3-butadiene 5-year average concentrations during 2007-2011, using LAX Hastings surface meteorological data.

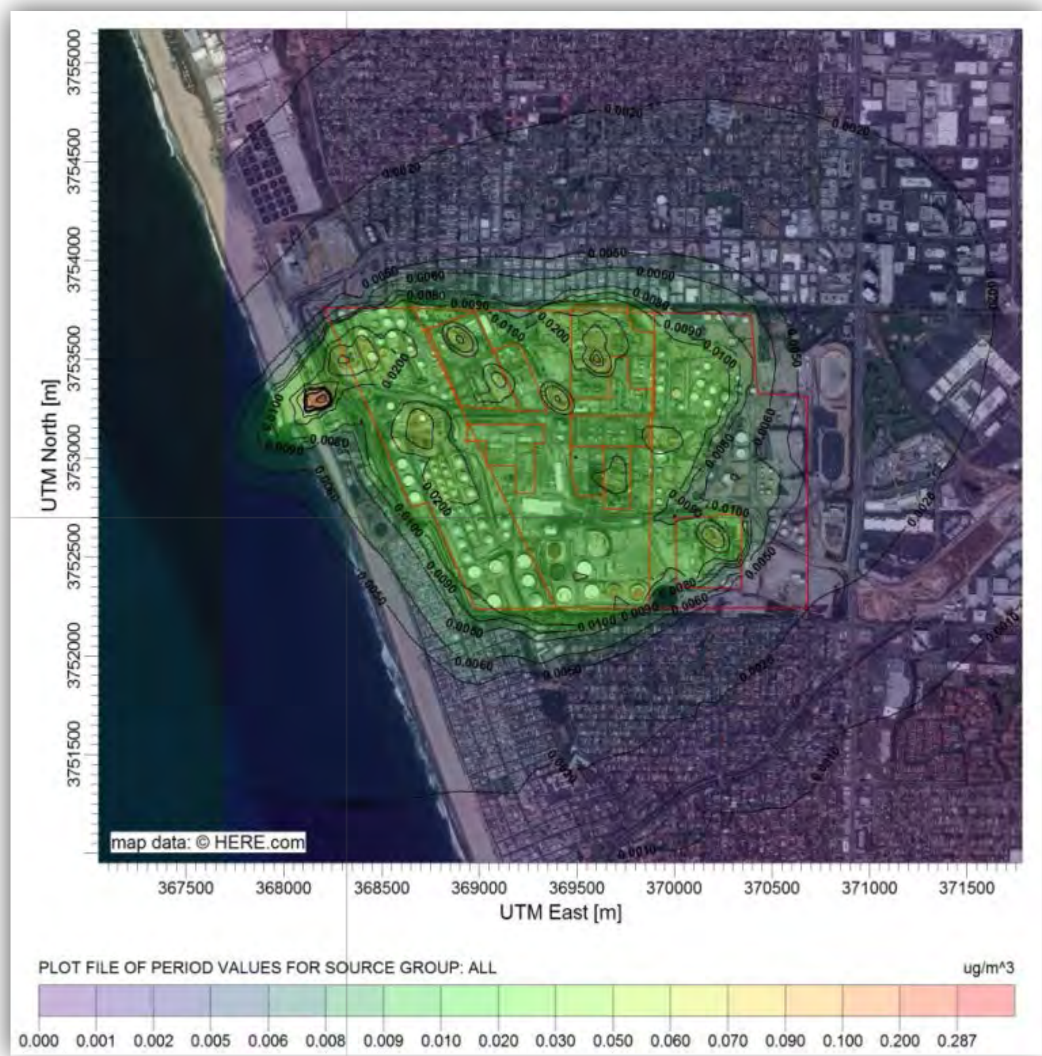

Figure 12. Naphthalene 5-year average concentrations during 2007-2011, using LAX Hastings surface meteorological data.

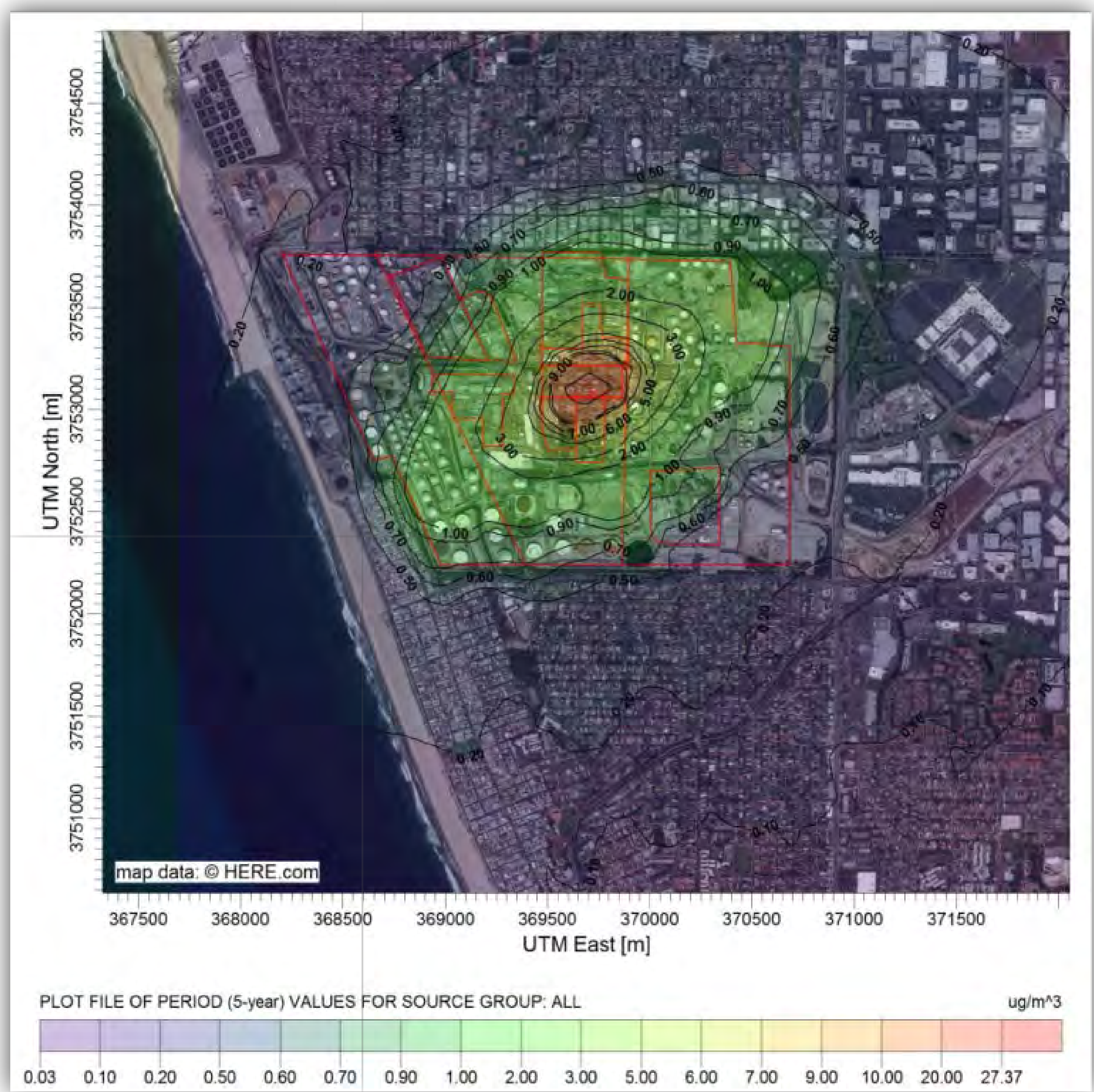

Figure 13. Hydrogen sulfide 5-year average concentrations for 2007-2011, using LAX Hastings surface meteorological data.

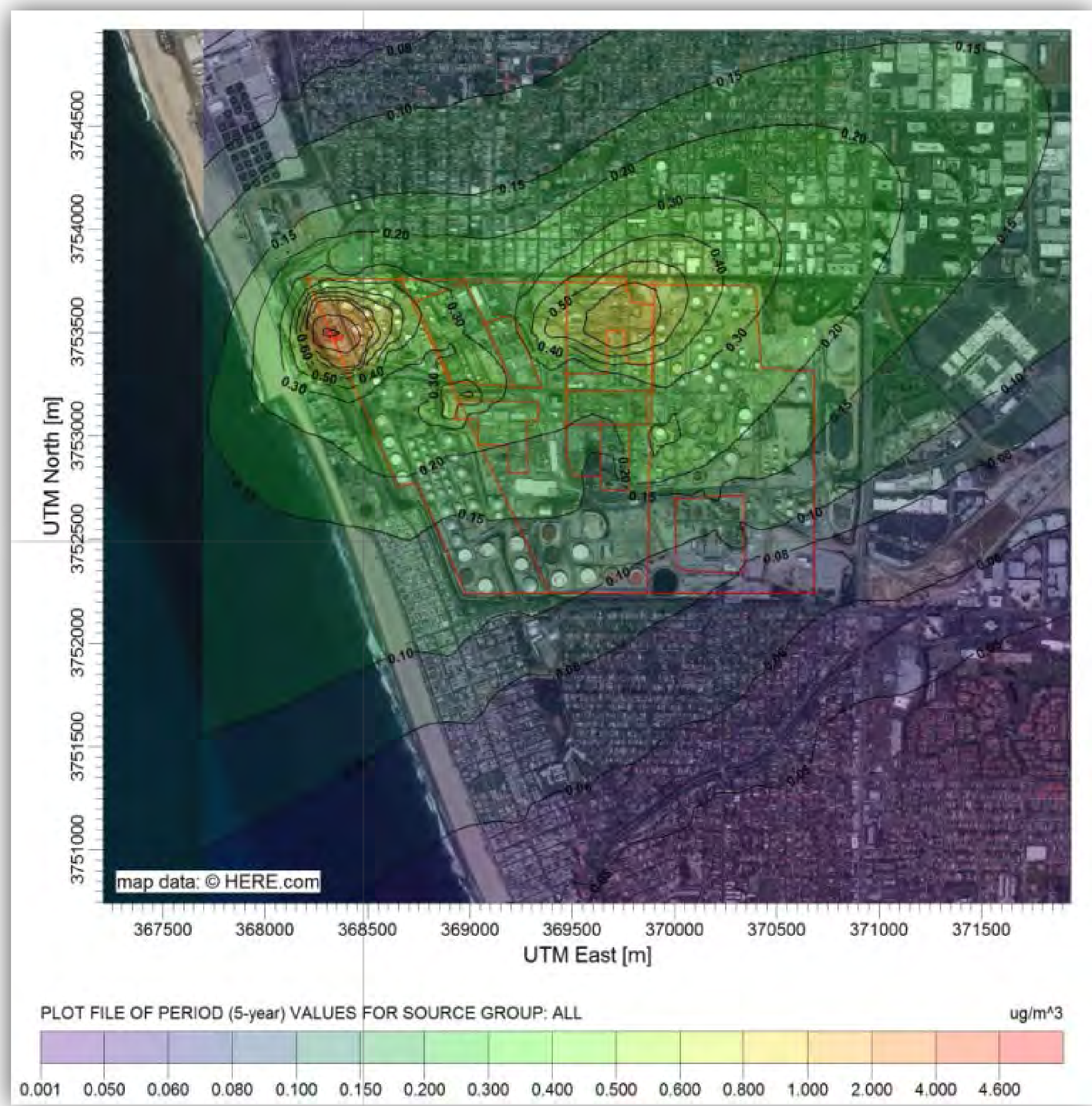

Figure 14. Ammonia 5-year average concentrations for 2007-2011, using LAX Hastings surface meteorological data.

2. Monitoring Locations and Equipment

This section describes the sampling locations, paths, and monitor types selected for the fenceline monitoring, as well as the specifications and maintenance requirements for each monitor. The compounds that will be monitored along each path/location are also provided. Since the Rule 1180 guidance stresses the use of open-path measurements wherever possible, point measurements are proposed only for diesel particulate matter (DPM), meteorology measurements, and H_2S. Open-path technology for H_2S has not been proven to have a MDL at or below the California Office of Environmental Health Hazard Assessment's (OEHHA) acute exposure threshold of 30 ppb; therefore, this technology will not be used. Moreover, DPM (using Black Carbon [BC] as a surrogate) cannot be measured using open-path technology. The selection of monitoring locations and instrument types was based on the emissions characteristics and dispersion modeling results presented in Section 1.

2.1 Selected Sampling Locations

Chevron proposes to monitor concentrations across 11 paths (shown in **Figure 15**). The locations of these paths are also documented in **Table 4**. The type of measurement at each path is indicated by the legend in Figure 15. The specific point instrument technology has not yet been chosen for H_2S monitoring. Each meteorological station will include a visibility sensor in addition to measuring wind, temperature, and relative humidity. Chevron selected these locations after considering dominant wind patterns, sources of potential air emissions on the refinery property, and nearby local receptors. Transmitter-detectors/analyzers will be located at sites labeled "A" (identified in Figure 15), and retroreflectors will be placed at the sites labeled "R". The exact paths may need to be adjusted based on final site logistics and exact instrument capabilities, particularly in regard to the maximum path lengths for which the instruments can reliably measure the compounds of interest. Analyzers and reflectors will be mounted from about 2 m to 15 m above ground level depending on logistical constraints. Note that the height of the measurement along the light beam path will vary depending on topography.

The following is Chevron's rationale for selecting the open-path monitoring locations identified in Figure 15.

- Overall, these paths cover the areas of concern based on the analysis and modeling presented in Section 1 and also include areas where impact potential is very low.

- Path 1 is positioned between one of the refinery's tank farms and the community of El Segundo. Hydrogen sulfide and DPM are not a concern for this path, because this area is not downwind of any major sources of these species.
- Paths 2-7 provide coverage for the most frequent onshore southwesterly winds. Paths 2-7 are between the refinery's process block and tank farms, and commercial and residential neighborhoods and other sensitive receptors. Open-path FTIR and UVDOAS will provide measurements of all species required in Rule 1180. Additionally, site 5R will have a meteorological station (that includes a visibility monitor), an Aethalometer for BC, and an appropriate point instrument for measuring H_2S. 5R was chosen as the site for BC and H_2S monitoring based on emissions modeling discussed in Section 1.2.3 and because this site is downwind from the refinery for the majority of the time. Also, being free of major obstructions, 6R provides the best siting opportunity for measuring winds. Therefore, meteorological measurements of winds, temperature, visibility, and relative humidity will be sited at 6R.
- Path 8 is located between the refinery and areas to the southeast. While the analysis shows that this path is very unlikely to be impacted by refinery emissions, it has been included to ensure a very robust monitoring network.
- Paths 9, 10, and 11 are positioned between the refinery's main processing block and storage tanks, and the occupied areas of Manhattan Beach toward the southwest. As discussed in Section 1.1.2, frequent winds blowing from the refinery areas towards Paths 10 and 11 are associated with the land breeze phenomenon and tend to be stronger during the nighttime, during early morning hours, and during the winter. Open-path UVDOAS and FTIR instruments will provide measurements of all species required in Rule 1180 along these paths. Additionally, sites 9A and 11R will have Aethalometers for measuring BC and point instruments for measuring H_2S. A meteorological station will also be positioned at 11A to provide meteorological information closer to the coast.
- No monitors are needed on the western fenceline between Path 1 and Path 11 because there are no downwind sensitive receptors in this area. In addition, any aloft emissions generated by upwind offsite sources to the west would pass over any monitors located at the ground level.

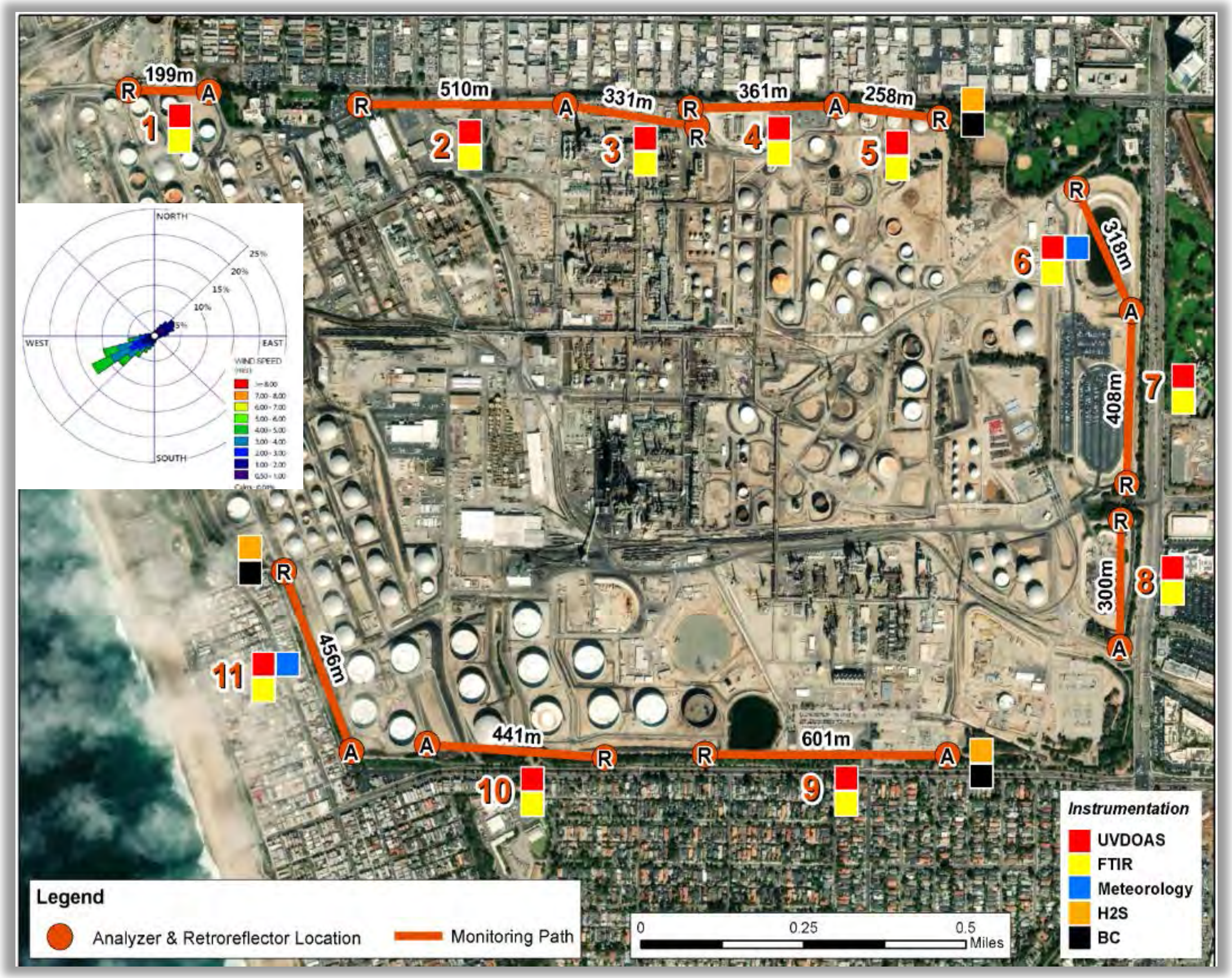

Figure 15. Location of sensors and measurement paths. Each path consists of a transmitter-detector (A) and a retroreflector (R). The wind rose shows annual average winds for 2007-2011.

Table 4. Locations of equipment to be used in fenceline monitoring program at the El Segundo refinery. All instruments and reflectors will be located between 2 m and 15 m above ground level depending on site logistics. Note that the height above ground level of the light beam will vary based on topography.

Path #	Analyzer Location	Retroreflector Location	Path Length (m)	Instrument(s)
1	33.916283, -118.421439	33.916303, -118.423593	199	FTIR, UVDOAS
2	33.916115, -118.411899	33.916066, -118.417415	510	FTIR, UVDOAS
3	33.916115, -118.411899	33.915688, -118.408355	331	FTIR, UVDOAS
4	33.916183, -118.404639	33.916088, -118.408540	361	FTIR, UVDOAS
5	33.916183, -118.404639	33.915951, -118.401860	258	FTIR, UVDOAS H_2S, BC
6	33.911914, -118.396659	33.914490, -118.398170	318	UVDOAS, FTIR, Meteorology
7	33.911914, -118.396659	33.908235, -118.396726	408	FTIR, UVDOAS
8	33.904759, -118.396856	33.907462, -118.396868	300	FTIR, UVDOAS
9	33.902415, -118.401430	33.902358, -118.407929	601	FTIR, UVDOAS H_2S, BC
10	33.902484, -118.415367	33.902256, -118.410606	441	FTIR, UVDOAS
11	33.902317, -118.417389	33.906121, -118.419267	456	UVDOAS, FTIR, Meteorology, H_2S, BC

2.2 Instrument Specifications and Pollutants to Be Measured

Chevron's El Segundo Refinery is a petroleum refinery producing fuel products—primarily gasoline, diesel, liquefied petroleum gas (LPG), residual fuel oils, and petroleum coke—through distillation of crude oil, coking, cracking, hydroprocessing, alkylation, and reforming processes. In consideration of the refinery's products, processes, and potential emissions sources, the rationales summarized in **Table 5** were applied to determine which species would be proposed for inclusion in this Monitoring Plan. Literature reviews, site surveys, and interviews with instrument manufacturers were performed to determine the instruments needed to meet Rule 1180 requirements. Both fixed-site (point monitors) and open-path instruments were investigated. Based on the distances that need to be covered by measurements (hundreds of meters), data time-resolution requirements (5 minutes), and current measurement technology, various open-path instruments were selected to best measure the target species.

Table 5. Summary of monitoring for species listed in Rule 1180.

Species	Required by the SCAQMD	To Be Measured (Paths)	Instrument(s)	Rationale for Exclusion (If Not Required)
Benzene	Yes	Yes (1-11)	OP UVDOAS with Xenon and FTIR	Required
Toluene	Yes	Yes (1-11)	OP UVDOAS with Xenon and FTIR	Required
Ethylbenzene	Yes	Yes (1-11)	OP UVDOAS with Xenon and FTIR	Required
Xylenes	Yes	Yes (1-11)	OP UVDOAS with Xenon and FTIR	Required
H_2S	Yes	Yes (5, 9, and 11)	Point, TBD	Required
NO_x	Yes	Yes (1-11)	OP FTIR	Measures NO_2 only; however, most NO_x in the refinery is emitted from elevated sources and thus would not be measured by fenceline monitors regardless.
SO_2	Yes	Yes (1-11)	OP UVDOAS with Xenon	Required
NH_3	Yes	Yes (1-11)	OP FTIR	Required
Acrolein	Yes	Yes (1-11)	OP FTIR	Required
Acetaldehyde	Yes	Yes (1-11)	OP FTIR	Required
1,3-butadiene	Yes	Yes (1-11)	OP FTIR	Required
Carbonyl Sulfide	Yes	Yes (1-11)	OP FTIR	Required
Formaldehyde	Yes	Yes (1-11)	OP FTIR	Required

Species	Required by the SCAQMD	To Be Measured (Paths)	Instrument(s)	Rationale for Exclusion (If Not Required)
Hydrogen Cyanide	Yes	Yes (1-11)	OP FTIR	Required
Hydrogen Fluoride	Yes, if used	No	NA	The refinery does not use hydrogen fluoride in any major processes.
Styrene	Yes	Yes (1-11)	OP FTIR	Required
Total VOCs (non-methane hydrocarbons)	Yes	Yes (1-11)	OP FTIR	Will report "total alkanes."
Black Carbon	Yes	Yes (5, 9, and 11)	Point Aethalometer	Required. Black carbon (BC) is a surrogate for diesel particulate matter.

2.2.1 Pollutant Detection Limits

Table 6 summarizes the approximate minimum detectable levels (MDLs) and upper detection limits (UDLs) by open-path instrument for Chevron's monitoring program. Detection limits are approximate and are based on the theoretical capabilities of the instruments; however, they are supported by manufacturers' lab tests and real-world applications. Again, actual detection limits will depend on atmospheric conditions and on the specific instrument brand used. The detection limits are for the average species concentration along a path; narrow plumes that only cover a portion of the path would need to have a higher concentration than the MDL to be detected.

Open-path instruments transmit light or infrared energy across a long open path. Absorption of light relates to the average concentration of gases of interest along the path according to the Beer-Lambert absorption law. Individual gases absorb most effectively at characteristic wavelengths; therefore, measurements of absorption at specific wavelengths can be used to infer path-average concentrations for species of interest. The transmitted light is typically either detected remotely by a targeted detector or reflected for detection elsewhere. Often a combined transmitter-detector unit is positioned at one end of a path, and a retroreflector—a type of mirror with a geometric shape that gathers and re-focuses the transmitted light—is positioned at the other end of the path. The retroreflector returns the transmitted light to the transmitter-detector unit for detection. Figure 16 illustrates the basic concepts of open-path measurements.

Note that open-path instruments are not able to distinguish between a widely dispersed, low-concentration plume and a narrow, high-concentration plume. Rather, the instruments detect average concentrations across the entire distance from the transmitter to the detector (or the distance from the transmitter-detector to a retroreflector, and back again). Periods of poor visibility due to weather-related conditions (e.g., fog) are known to interfere with open-path measurements. Rule 1180 anticipates some data loss due to poor visibility and allows for such data loss if supported by visibility measurements. The Refinery will monitor visibility using a standard extinction measurement to identify periods of poor visibility that may cause data loss. The visibility sensors will be located in the southwest and northeast corners of the refinery as part of the meteorological stations (Figure 15, Paths 6 and 11).

Point monitor detection limits for H_2S will be less than 2 ppb. Point monitor detection limits for black carbon will be less 0.5 µg/m^3.

Table 6. Range of approximate open-path instrument minimum detection limits (MDL) and upper detection limits (UDL) in parts per billion (ppb) by technology, species, and path length. UDLs for some species are to be determined (TBD). Actual detection limits depend on atmospheric conditions.

	1180 Compound	Shortest Path (199 m)		Longest Path (601 m)	
		MDL	UDL	MDL	UDL
FTIR	1,3-Butadiene	5	24000	2	7900
	Acetaldehyde	3	500000	1	170000
	Acrolein	4	230000	1	75000
	Ammonia	1	140000	0	45000
	Benzene	30	75000	15	25000
	Carbonyl Sulfide	2	TBD	1	TBD
	Ethylbenzene	17	94000	6	31000
	Formaldehyde	2	63000	1	21000
	Hydrocarbons	10	15000	3	5000
	Hydrogen Cyanide	34	50000	11	17000
	Nitrogen Dioxide	15	TBD	5	TBD
	Styrene	6	29000	2	9500
	Total Xylenes	14	190000	5	62000
UVDOAS	Acrolein	21	480000	7	160000
	Benzene	1	80000	0.2	26000
	Ethylbenzene	1	55000	0.3	18000
	Naphthalene	1	430	0.2	140
	Styrene	3	TBD	2	TBD
	Sulfur Dioxide	2	100000	0.6	34000
	Toluene	2	110000	0.7	37000
	Total Xylenes	2	19000	0.8	6200

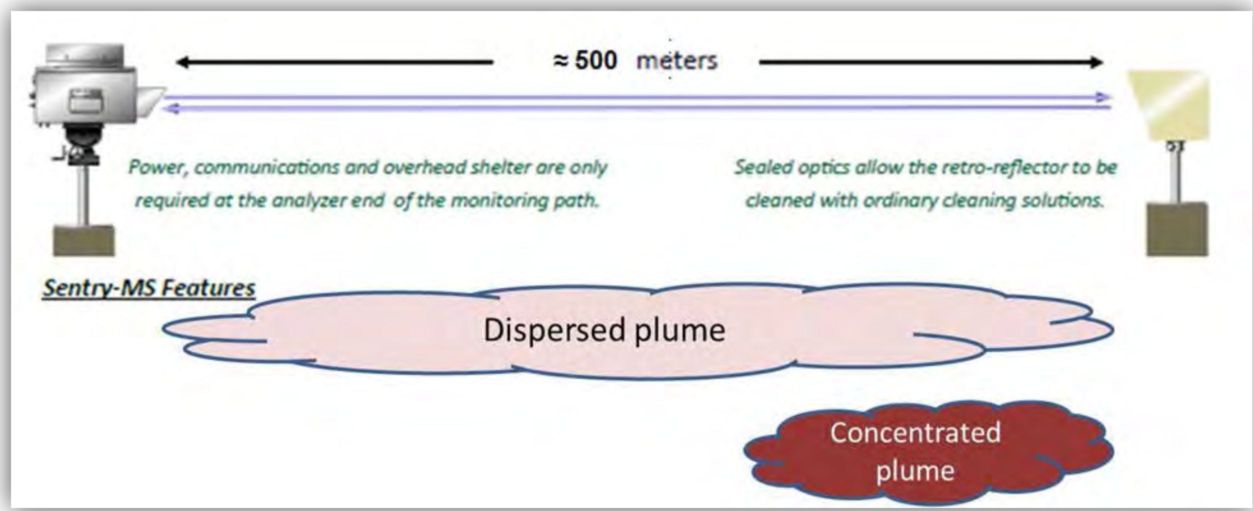

Figure 16. Basic premise for open-path instrument operation. Image from Cerex Sentry-MS monitoring brochure, used with permission (Cerex Monitoring Solutions, LLC).

Monostatic (as opposed to bistatic) open path instruments have been selected to reduce the need for substantial power at the retroreflector sites and improve minimum detection limits by increasing effective path lengths. Thus, only the light-source/ detector end of the monitoring path requires substantial power, communications, and shelter. Limited power is needed for heaters at the retroreflectors. The retroreflector needs to be aligned at the other end of the path for maximum performance and should be cleaned regularly. An example of a UVDOAS analyzer and receiver in a shelter is shown in Figure 17, and a retroreflector is shown in Figure 18.

Figure 17. An example of a UVDOAS analyzer (may not be configuration of actual installation).

Figure 18. An example of a UVDOAS retroreflector (may not be configuration of actual installation).

2.2.2 Hydrogen Sulfide

While it is possible to measure high concentrations of H_2S using open-path FTIR or open-path tunable diode laser spectroscopy (TDLAS), the detection limits of these measurements may be too high to measure common threshold values (30 ppb). Therefore, H_2S will be measured with a point monitor that operates on the principle of UV fluorescence spectroscopy, extractive tunable diode laser spectroscopy, or light extinction resulting from a reaction between H_2S and lead acetate.

The basic measurement principle for UV fluorescence is as follows: the H_2S in the sample gas is converted into SO_2, which is then exposed to ultraviolet light, causing the SO_2 molecules to change to an excited state (SO_2*). As these SO_2* molecules decay back into SO_2, they fluoresce. The instrument measures the amount of fluorescence to determine the amount of SO_2 present in the sample chamber and, by inference, the amount of H_2S present in the sample gas. This instrument can reliably detect ambient levels of H_2S near industrial sites.

Extractive tunable diode laser spectroscopy operates by scanning the wavelength of a laser either through a closed optical cell to measure the absorption spectrum of H_2S. The strength of the absorption line can be related to concentrations of the H_2S using Beer's law.

The Galvanic Applied Sciences ProTech H_2S analyzer is designed to measure the concentration of hydrogen sulfide (H_2S) gas. The instrument works by exposing a lead acetate [$Pb(CH_3COOH)_2$]– laden tape to the gas to be measured. If the sample gas contains H_2S, the following reaction occurs:

$$Pb(CH_3COOH)_2 + H_2S \longrightarrow \boldsymbol{PbS} + 2CH_3COOH$$

The lead sulfide (**PbS**) formed leaves a brown stain on the tape that can be measured optically. The rate of color change on the tape is directly proportional to the concentration of H_2S in the sample gas. Thus, if calibrated with known gas concentrations, the ProTech analyzer can determine the H_2S concentration in the sample gas stream.

2.2.3 Black Carbon

To measure black carbon, an Aethalometer will be used. An Aethalometer works by pulling the air through a filter tape where particulate matter is deposited. The transmission of the filter is monitored as several wavelengths. The black carbon concentration is calculated from the attenuation of light passing through the filter.

2.2.4 Operations and Maintenance

Instrument operations, maintenance, and bump tests include daily checks to ensure that data are flowing consistently, as well as monthly, quarterly, and annual maintenance activities. Further details are provided in the following sections, which describe routine instrument and data management operations. Additional details and documentation, including standard operating procedures (SOPs), for example, will be included in the finalized Quality Assurance Project Plan (QAPP, Appendix B).

UVDOAS

The UVDOAS system is designed to require only modest service and maintenance. Table 7 summarizes typical UVDOAS maintenance activities as recommended by a manufacturer. Preventive maintenance frequency depends on the operating environment and may need to be adjusted beyond manufacturers' recommendations once the instruments are deployed in the field. On an as-needed basis, system status alarms will alert operators to specific issues needing to be addressed.

Table 7. Typical schedule of maintenance activities for the UVDOAS.

Activity	Monthly	Quarterly	Annually
Visually inspect the system.	✓	✓	✓
Inspect optics on detector and retroreflector; clean if necessary.	✓	✓	✓
Inspect system filters.	✓	✓	✓
Confirm the alignment to verify there has not been significant physical movement. Note: this is automatically monitored as well.	✓	✓	✓
Download data from detector hard drive and delete old files to free space, if needed.	✓	✓	✓
Ensure there are no obstructions between the detector and the retroreflector (such as equipment, vegetation, vehicles).	✓	✓	✓
Change out the UV source.		✓	
Replace ventilation exit and intake filters.		✓	
Clean optics on detector and retroreflector.		✓	
Realign system after service.		✓	✓
Check system performance indicators.		✓	✓
Perform bump test (simulates system-observed gas content at the required path average concentration) to verify the system can detect at or below a lower alarm limit.		✓	
Review and test light and signal levels. Check average light intensity to establish baseline for bulb change frequency.		✓	✓
Verify system settings.			✓

FTIR

The FTIR has maintenance activities similar to those for the UVDOAS. The FTIR system is also designed to require only modest service and maintenance. Table 8 summarizes FTIR maintenance activities, as recommended by a typical manufacturer. Preventative maintenance frequency depends on the operating environment and may need to be adjusted. On an as-needed basis, system status alarms may alert operators to specific issues that need to be addressed. Bump tests are performed on site.

Table 8. Typical schedule of maintenance activities for the FTIR.

Activity	Monthly	Quarterly	Semi-Annually	Annually	18 Months	Five Years
Visually inspect the system.	✓	✓		✓		
Inspect and clean AC system exterior heat sink.			✓			
Inspect and clean AC system interior heat sink.				✓		
Confirm the alignment to verify there has not been significant physical movement. *Note: this is automatically monitored as well.*	✓	✓		✓		
Download data from detector hard drive and delete old files to free space, if needed.	✓	✓		✓		
Ensure there are no obstructions between the detector and the retro-reflector (such as equipment, vegetation, vehicles).	✓	✓		✓		
Change out the IR source.						✓
Realign system after service.		✓		✓		

Activity	Monthly	Quarterly	Semi-Annually	Annually	18 Months	Five Years
Check system performance indicators.		✓		✓		
Perform bump test.		✓				
Review and test light and signal levels. Check average light intensity to establish baseline for IR Source change frequency and retroreflector wear.				✓		
Verify system settings.		✓				
Replace cryocooler or swap detector module assembly.					✓	

Hydrogen Sulfide

Although the specific monitor for H_2S has not been selected, the typical maintenance schedule for a UV fluorescence-based monitor is shown as an example in **Table 9**, which summarizes typical UV fluorescence maintenance activities as recommended by a manufacturer. Preventive maintenance frequency depends on the operating environment and may need to be adjusted beyond manufacturers' recommendations once the instruments are deployed in the field. On an as-needed basis, system status alarms will alert operators to specific issues needing to be addressed.

Table 9. Typical schedule of maintenance activities for point monitors using UV fluorescence.

Activity	Weekly	Monthly	Quarterly	Annually	Every 2 Years
Visually inspect the system.		✓	✓	✓	✓
Replace catalyst			✓		
Replace SO_2 scrubber			✓		
Replace particulate filter	✓				
Verify test functions	✓				
Zero/span check	✓				
Zero span calibration			✓		
Flow check			✓		
Replace critical orifice and sintered filters				✓	
Replace internal span permeation tube				✓	
Pneumatic leak check				✓	
Replace pump diaphragm					✓

Aethalometer

The Aethalometer system is designed to require only modest service and maintenance. Table 10 summarizes typical Aethalometer maintenance activities as recommended by a manufacturer. Preventive maintenance frequency depends on the operating environment and may need to be adjusted beyond manufacturers' recommendations once the instruments are deployed in the field. On an as-needed basis, system status alarms will alert operators to specific issues needing to be addressed.

Table 10. Typical schedule of maintenance activities for Aethalometers.

Activity	Monthly	Semiannual	Annual
Visually inspect the system.	✓	✓	✓
Inlet flow check	✓		
Clean size selective inlet	✓		
Clean cyclone	✓		
Verify date and time	✓		
Inspect optical chamber and clean as necessary		✓	
Calibrate flow		✓	
Change bypass cartridge filter			✓
Check tape roll, install new tape roll if necessary	✓		
Calibrate tape sensor		✓	

Additional Maintenance and Failure Activities

Normal routine scheduled maintenance for open-path instruments occurs once per month (at least). During those maintenance visits, the operator will carry normal repair parts to the site. It is expected that routine maintenance periods when the equipment might not be reporting data will be about 2 hours.

If, between routine visits, monitors fail to report data or appear to be reporting erroneous data, both remote diagnosis and, if necessary, a site visit will be conducted. If the problem cannot be resolved with the equipment or parts on hand, then Chevron will obtain replacement parts from the vendor. After being selected as a vendor, Chevron's vendor will have spare parts, including major components, available for emergency repairs. It is expected that with these measures, the problem can be resolved within 24 hours. If downtime exceeds 24 hours, Chevron will respond with the required written notification. Because UVDOAS and FTIR will be installed along all paths, each FTIR instrument will serve as a backup to the UVDOAS and vice versa. In addition, if both instruments fail on a given path, monitors on the adjacent paths will provide backup data. In the event of a prolonged power outage or other issue affecting multiple monitors, passive sampling conducted to comply with the EPA benzene rule will provide backup data.

Chevron will call 1-800-CUT-SMOG to notify the SCAQMD Executive Officer within two hours of discovering that the equipment failed to accurately provide real-time air monitoring information. Chevron will also provide the name of the petroleum refinery, the name of the air monitor, the date and time of the occurrence, and the reason for the lapse in collecting and/or reporting the real-time air monitoring information.

Chevron will submit the required written notification to the SCAQMD Executive Officer of any equipment failure that results in a failure to accurately provide continuous, real-time air monitoring information for 24 hours or longer. The written notification will be submitted to the Executive Officer within 24 hours of discovering the equipment failure and will include the following:

- An explanation of activities currently being pursued or taken to remedy the equipment failure;
- Estimated time needed to restore the fenceline air monitoring equipment to normal operating conditions that comply with the approved fenceline and community air monitoring plan; and
- Temporary air monitoring measures to be implemented until the fenceline air monitoring system is restored to normal operating conditions (see above)

2.2.5 Excluded Pollutants

Hydrogen fluoride is not used in any major processes at the El Segundo refinery; therefore, it will not be measured. Any emissions of hydrogen fluoride are expected to be negligible.

3. Quality Assurance

This section outlines quality assurance (QA) procedures related to this monitoring program. A draft quality assurance project plan (QAPP) that covers these items as well as additional detail is available in Appendix B. Some elements of the QAPP will be finalized upon plan approval and selection of the instrument brands. The QAPP will be reviewed annually and updated as needed.

3.1 Data QA Procedures

Raw data management occurs on a daily, monthly, quarterly, and annual basis. On a daily basis, data are transferred from infield instruments through a data acquisition system (DAS) to a Data Management System (DMS) in real-time. Data are also stored onsite on instrument computers in case of data network failure.

The DMS can handle the large volumes of data that will be generated in this project. The DMS will be used to automatically quality control data, detect outliers and problems, and create alerts. The auto-screening and graphical capabilities will be used for continuous examination of data quality. The DMS will feed auto-screened data to the field operations website and notification system to inform project and facility staff. The operations website will show maps and time-series plots of the pollutants, winds, and visibility data. The auto-QC'd air quality data will be fed to the public website (see Section 4) in near-real time. The DMS data will be backed up on a daily basis.

All data produced by the instrument are initially considered **Level 0**. All Level 0 data values that are not associated with bump tests or other instrument maintenance will undergo basic automatic quality control and will be displayed to the public in near-real time (i.e., about 10 minutes or less); these data are considered **Level 0.5**. Automated screening checks of data feeds are helpful to focus the analyst's efforts on the data that need the most attention and are used to screen out invalid data. All data above notification threshold levels (Section 5) will be flagged as suspect for review and verification. Screening criteria (flags and rates of change) are preliminary and will be refined during the project based on actual observations and instrument performance. In summary, the DMS auto-screening checks that will be used include:

- **Range –** These checks will ensure the instrument is not reporting values outside of reasonable minimum and maximum concentrations.
- **Sticking –** If values are repeated for a number of sampling intervals, data will be reviewed for validity. Typically, four or more intervals of sticking values are a reasonable time span to indicate that investigation is needed. Sticking checks will not be applied to data below the instrument detection limit.

- **Rate of Change –** Values that change rapidly without reasonable cause will be flagged as suspect and reviewed.
- **Missing –** If data are missing, data during those time periods will be marked as missing.
- **Sensor OP codes and alarms –** If the instrument assigns operation (OP) codes to data automatically (e.g., for bump tests, internal flow rate checks), the data will be reviewed, op codes confirmed, and data flags checked.

Additional QC checks for the instruments are summarized in Table 11. Data that fail checks will be flagged in the DMS and brought to the attention of the reviewer. Data are invalidated only if a known reason can be found for the anomaly or automated screening check failure. If the data are anomalous or fail screening, but no reason can be found to invalidate the data, the data are flagged as suspect. Additional analysis may be needed to deem data valid or invalid. Common reasons for invalidation include instrument malfunction, power failure, and bump test data that were not identified as such. As the measurements progress over time, Chevron will update and refine the screening checks including those needed to be added for the H_2S instrument. Screening checks are typically specific to the site, instrument, time of day, and season, and adjusted over time as more data are collected.

Hydrogen sulfide QA/QC procedures will be determined once the instrument type is selected. All up-to-date procedures will be included in the finalized QAPP.

Table 11. Typical instrument QA/QC checks.

QA/QC Checks	Frequency	Acceptance Criteria
UVDOAS		
Bump test (accuracy)	Quarterly and after major service	±20%
Baseline stability	Continuous	±5%
Single point bump test in field	Quarterly	±20%
Measurement quality (R^2)	Continuous	0.7 to 1.0
Integration time	Continuous	80-200 mS *400 mS integration time results in a warning notification*
Signal intensity	Continuous	>30% *Signal intensity below 30 results in a warning notification*
Aethalometer		
Flow rate		±10%

QA/QC Checks	Frequency	Acceptance Criteria
Span check		±10%
Zero check		<550 ng/m^3 for Ch. 6
TDLAS (if used)		
Bump Test	Quarterly	±20%
FTIR		
Bump test	Quarterly and after major service	±20%
Baseline stability	Continuous	±5%
IR single beam ratio test (background vs. sample intensity)	Real time	*To be determined*
Measurement quality (R^2)	Continuous	0.7 to 1.0
Signal intensity	Continuous	>5% *Signal intensity below 5 results in a warning notification*

If data are subsequently proven to be invalid by subjective data review and/or post processing, they will be removed from the public display, and the rationale for data removal will be provided.

A non-public field operations website will be used for daily graphical review of the data (an example is provided in Figure 19). Common data problems include flat signal/constant values, no signal/missing data, extremely noisy signal, rapid changes (spikes or dips), and negative concentrations (see annotated Figure 20 for examples).

An initial review, typically of a three-to-five-day running time-series plot of selected parameters for each instrument, allows the analyst to see common problems and verify instruments are operational. If it appears that an instrument is not operating, or the data are missing, the field operator will be notified and further investigation and corrective action, if needed, will be taken.

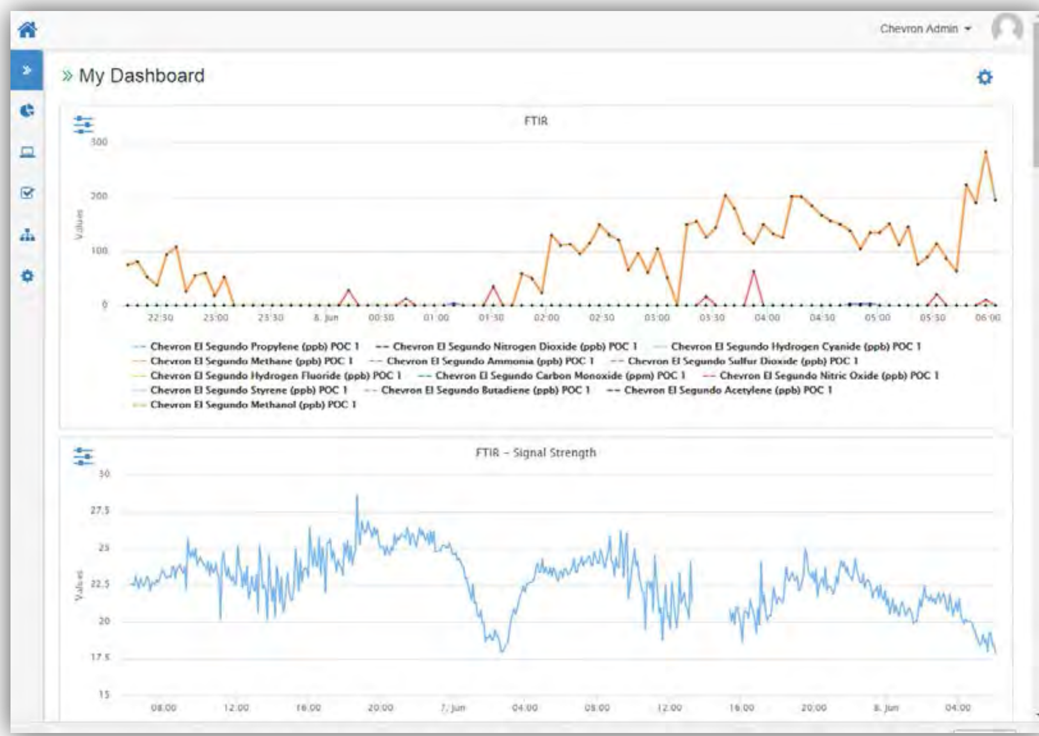

Figure 19. Example of a non-public field operations website used for daily review of instrument operations.

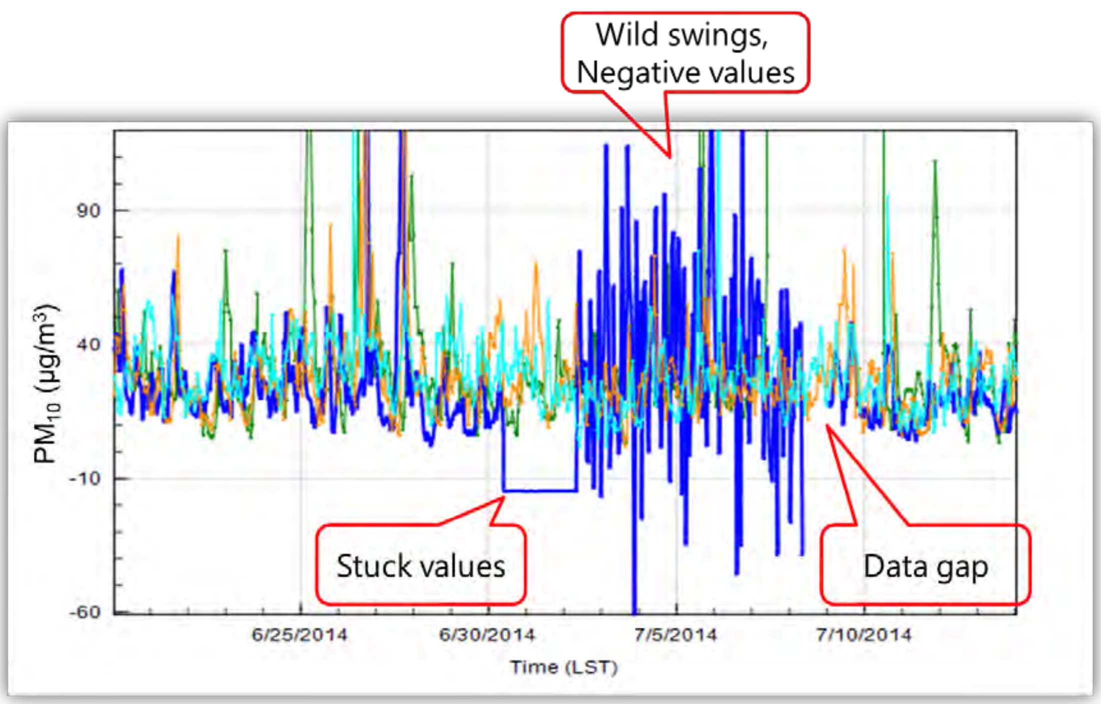

Figure 20. Example of species concentration time series showing stuck values, wild swings, large negative values, and a data gap. Such features in the data indicate instrument issues.

Once it is clear that instruments are operational, the next step will be to review whether the species concentration patterns are reasonable with respect to the time of day, season, meteorology, facility operations, and concentrations are expected and observed at other sites. If anomalies are observed, additional analysis will be conducted to determine whether there is an instrument malfunction or the data are truly anomalous, but explainable and valid. These subjectively reviewed data are considered **Level 1.0**.

In addition to auto-screening and daily visual checks, data will be subjected to more in-depth review on a quarterly basis and when data fail screening. These data are considered **Level 2.0.** Final data sets will be compiled quarterly, 60 days after each quarter's end and will be provided to the SCAQMD. Chevron will maintain a data record for five years consistent with Rule 1180.

Any corrections or updates will be copied to the website. Validation checks will include:

- Looking for statistical anomalies and outliers in the data.
- Inspecting several sampling intervals before and after data issues, bump tests, or repairs.
- Evaluating monthly summaries of minimum, maximum, and average values.
- Ensuring data reasonableness by comparing to remote background concentrations and average urban concentrations.
- Referring to site and operator logbooks to see whether some values may be unusual or questionable based on observations by site operator.
- Ensuring that data are realistically achievable, i.e., not outside the limits of what can be measured by the instrument.
- Confirming that bump tests were conducted and were within specifications.

These in-depth analyses typically require data that are not available in real time and ensure that the data on the website are updated.

On a quarterly basis, to ensure daily QC tasks are complete, analysts will:

- Review any instrument bump test results.
- Verify that daily instrument checks were acceptable.
- Review manual changes to operations/data, and verify that the changes were logged and appropriately flagged.
- Ensure that daily bump tests or instrument checks have the appropriate QC codes applied.

On a quarterly basis, analysts will subject the data to final QC including filling in missing records with null values, and adding Null Codes.

- If a record is not created for a particular site/date/time/parameter combination, a null record will be created for data completeness purposes.
- Invalid data will have a Null Code, or in other words, a reason for being invalid.
- Inspect data consistency over three months.
- Review ranges of values for consistency—ranges should remain consistent over months of monitoring.

- Check bump test values for consistency.
- Review data completeness.

Actions will be documented to retain the raw data and support traceability of actions taken to produce the data on the website. Additional details on the final QC process are provided in the QAPP (Appendix B).

On an annual basis, Chevron or its designated contractor will review the performance of the network by reviewing the data completeness by monitoring path, instrument, and species; by reviewing results of bump tests; by analyzing the reported values in the context of refinery operations; and by analyzing the data in the context of the meteorology. The results will be summarized in a technical memorandum and provided to the SCAQMD upon request.

Data flagged through auto-screening checks (discussed in Section 3.1) will be graphically reviewed. QC flags will be updated as needed with daily, monthly, and quarterly actions (see Figure 21), and the QC flags will be updated on the public website as needed. DMS keeps track of data QC changes.

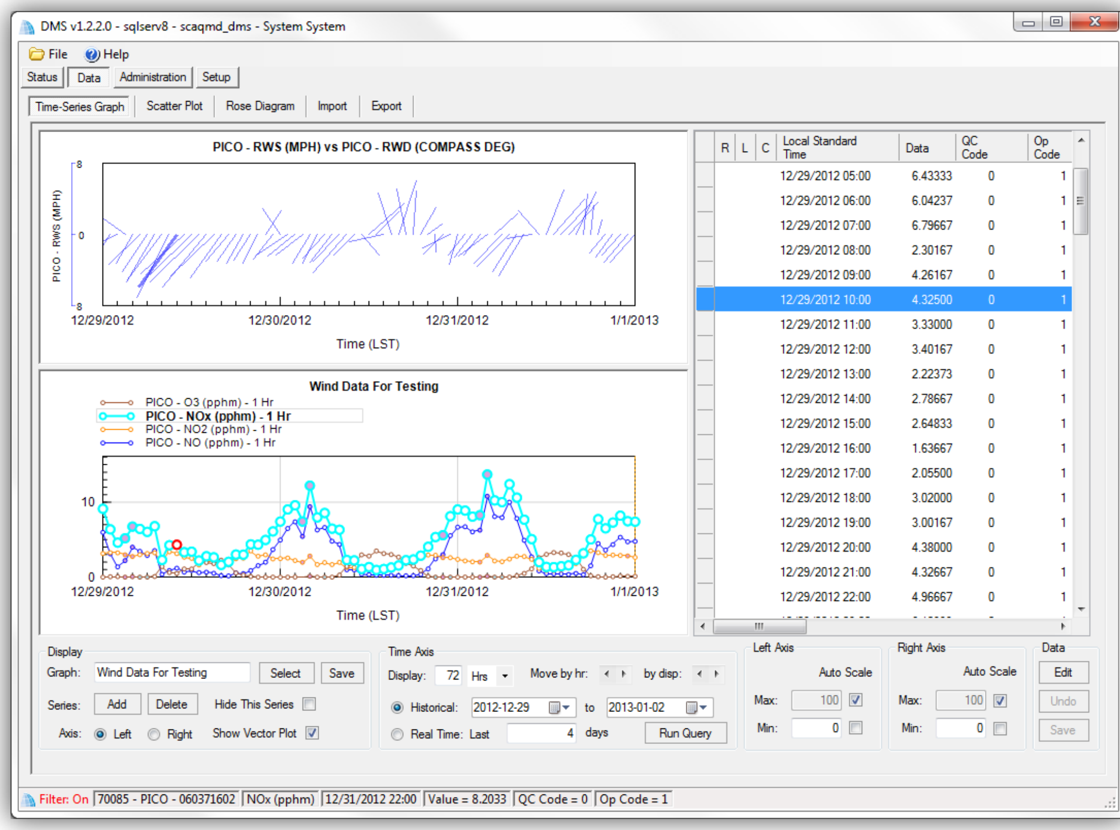

Figure 21. Screenshot of a typical DMS showing winds and species concentrations. Actual screen(s) may vary.

3.2 SOPs for Equipment

SOPs for the selected instruments will be finalized and provided after the monitoring plan is approved and instrumentation is selected.

3.3 Routine Equipment and Data Audits

Rule 1180 specifically calls for “procedures for implementing quality assurance by a qualified independent party, including quality control and audits of the fenceline air monitoring systems” (South Coast Air Quality Management District, 2017a). The audit procedures outlined here were informed by published EPA methods and recommendations. These methods will be used in the finalization of the QAPP. Quality assurance takes two forms. Internal quality assessment is conducted or arranged within Chevron as directed by the QA Manager. External QA will be provided by a third party to be determined at a later date. Chevron will notify SCAQMD in advance of audits.

The following is a list of internal and external assessment tools utilized by the Chevron refinery:

Internal Audits

- Data quality assessments – as requested by QA Manager
- Performance Evaluations – initial, semiannual
- Flow rate audits – initial, quarterly
- Internal technical system audits – initial, 3 to 5 years

External Audits (by Third Party)

- Third-party performance audit – initial, annual
- Third-party technical systems audit – every 3 years

The audit function has two components: the system audit (in essence, a challenge to the QAPP) and the performance audit (a challenge to the individual measurement systems).

The system audit provides an overall assessment of the commitment to data validity; as such, all commitments made in the QAPP should be subject to challenge. Typical questions asked in the systems audit include, "Are standard operating procedures being followed?" and "Are there any errors in the data flow from the instrument to the website?" During this audit, the QA Manager reviews the calibration sources and methods used, compares actual test procedures to those specified in this protocol, and reviews data acquisition and handling procedures. The QA Manager also reviews instrument calibration records and gas certificates of analysis. All deficiencies should be recorded in the audit report along with an assessment of the likely effect on data quality. Corrective actions related to a systems audit should be obvious if the appropriate questions are asked.

The performance audit is similar to a calibration in terms of the types of activities performed—all the performance audit adds is an independent assurance that the calibrations are done correctly and that the documentation is complete and accurate. In the ideal case, when both the auditor and site operator are equally knowledgeable, the auditor functions as an observer while the site operator performs the calibration; in this instance, the auditor functions in a "hands-off" mode. In initial audits, since newly hired site operators may have little or no experience with instruments, the hands-off approach may not be practical or desirable. In these instances, the audit may also function as a training exercise for the site operator (U.S. Environmental Protection Agency, 2000). Table 12 describes acceptance testing parameters for the sensors described in this monitoring plan.

Table 12. Description of performance audits for the systems described herein.

Sensor	Test	Acceptance Criteria
UVDOAS	5 ppm Benzene; 0.5 m QA cell for 500 m path	±20%
FTIR	5 ppm NH_3; 0.5 m QA cell for 500 m path	±20%
H_2S Monitor	100 ppb	±10%
Aethalometer	Bubble flow meter, internal leak check	±10%
Temperature	Two point test	±0.5ºC
Relative Humidity	Hygrometer	±7%
Wind Speed	Starting threshold test; transfer function test	±0.25 m/s below 5 m/s and ± 5% above 5 m/s
Wind Direction	Angle verification	±5 degrees
Visibility	Extinction	±10%

Where possible, NIST-traceable gas standards should be used for the UVDOAS, FTIR, and H_2S instruments. All open path instruments will be challenged with the appropriate gas. The exact method will depend on the instrumentation selected.

The Aethalometer should be subjected to both a leak check and flow rate check.

The simplest acceptance test for temperature is a two-point test using room temperature and a stirred ice slurry. A mercury-in-glass thermometer with an up-to-date calibration can be used to verify agreement to within 1°C. For anemometers, the instrument is challenged with various rotation rates to test the performance from the transducer in the sensor to the output. The starting torque of the bearing assembly is measured and compared to the range of values provided by the manufacturer (U.S. Environmental Protection Agency, 2000). The visibility measurement will be challenged using a special optic having a known extinction value.

The QA Manager, during the course of any assessment or audit, shall identify to the technical staff performing experimental activities any immediate corrective action that should be taken. If serious quality problems exist, the QA Manager is authorized to stop work. Once the assessment report has been prepared, the Field Staff Manager ensures that a response is provided for each adverse finding or potential problem and implements any necessary follow-up corrective action. The QA Manager shall ensure that follow-up corrective action has been taken.

4. Data Display to the Public

A key part of this monitoring program is disseminating the measured data to the public. This will be accomplished using a public-facing website that is linked to the DMS described in Section 3. This section describes how the information will be displayed to the public. For the public website, key components will include:

- Visual display of data in near-real time
- Context for the public to better understand the concentrations displayed
- A mechanism for public feedback on the website
- A mechanism for requesting data for further exploration
- A description of monitoring techniques
- A description of monitored pollutants
- A description of QA/QC procedures, including data management
- Documentation of QC flags
- Hyperlinks to related information
- Links to quarterly reports, information that relates measured concentrations to health thresholds, and other details related to QA/QC
- Information to assist non-English speakers

4.1 Educational Material

Along with the actual monitoring data, educational material will be provided to provide context to the measurements. The objectives of the monitoring system, a description of the techniques, and some relevant information regarding the background concentrations of the monitored species will be provided.

Quarterly data reports will be made available for public viewing at Chevron.

4.2 Objectives and Capabilities of Monitoring System

The home page of the public-facing website will be dedicated to providing background on reasons the monitoring is taking place and the type of technology being used in the monitoring system. Figure 22 shows a mockup of a home page of a public-facing website. A brief paragraph written in plain English will explain the objectives of monitoring and give a short overview of the monitoring program. From the home page, a “Resources” page will include web links to Rule 1180 and the 1180 guidance. Links to other publicly available 1180 monitoring websites will be provided on the "Resources" page. As part of the "Resources" page, a frequently asked questions (FAQ) topic will describe the nature of real-time data vs. non-real-time data so that the public appreciates the rapid nature of the reporting system. FAQs will not necessarily evolve based on public comment and Chevron may decide to modify FAQs at any time.

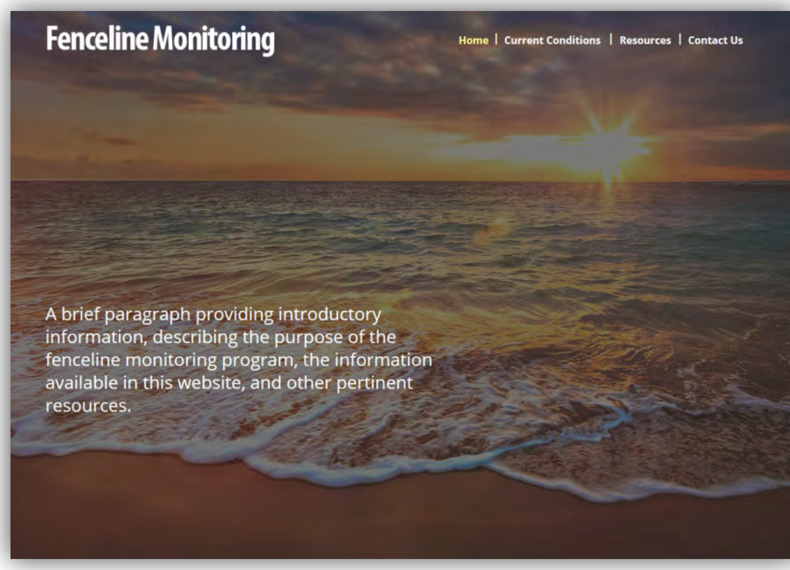

Figure 22. Screenshot showing an example of a home page of a public-facing fenceline monitoring site. The final website may have a different look and feel.

4.3 Description of Pollutants, Measurement Techniques, and Data Archive

Data for all pollutants measured will be displayed under a "current conditions" section of the website (Figure 23) that is readily available from the home page. In this view, a member of the public has the option of choosing either a graphical/spatial view of the data or a tabular view of the data. Under the "spatial view," the user can select any one of a number of parameters (Benzene is shown in Figure 23) to display on the map. Once this action is complete, the concentrations for the selected species are displayed for each monitoring site with the meteorological information.

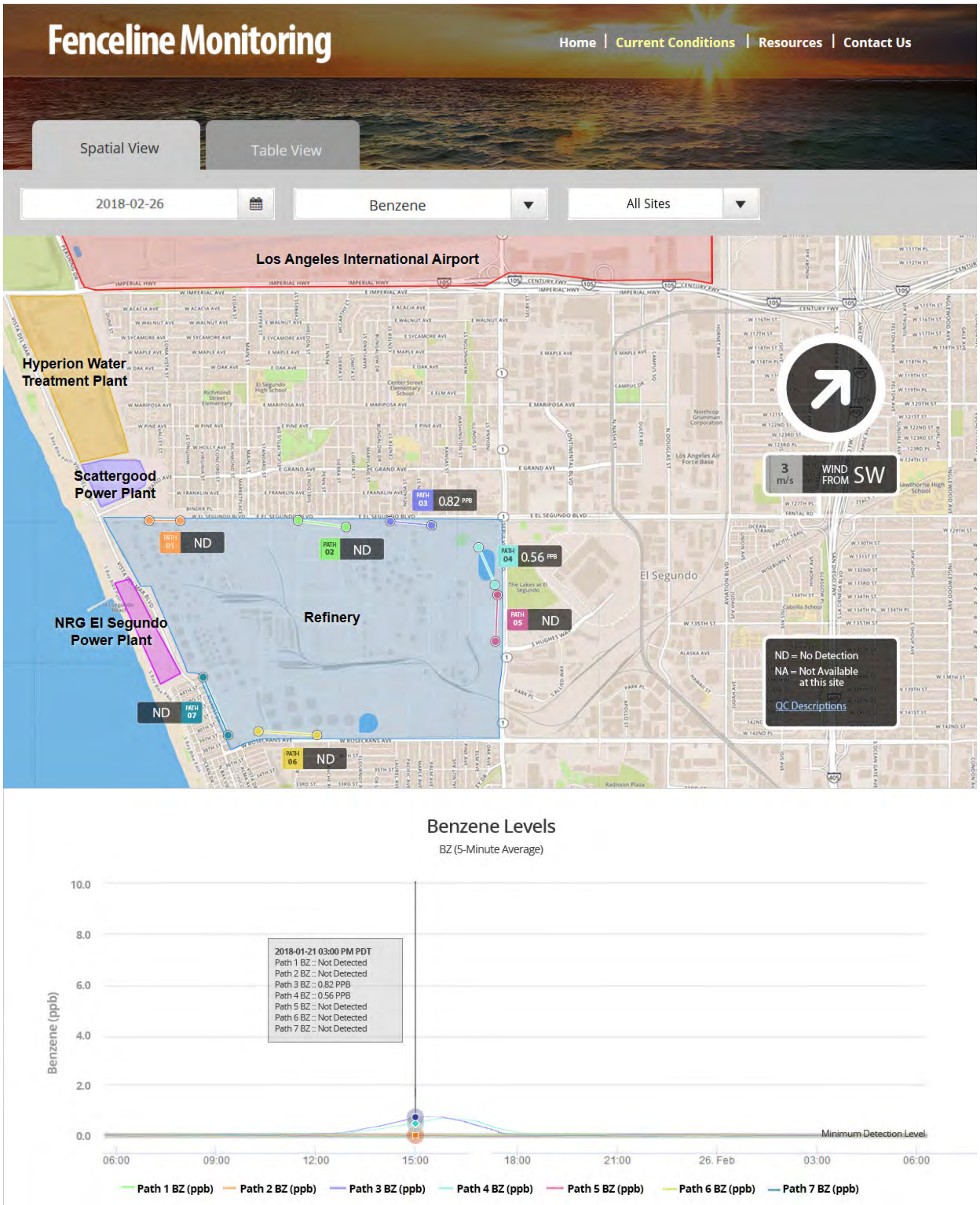

Figure 23. An example of the data display for any subset of the variables measured as part of this monitoring program. This example shows benzene concentrations by site, wind direction, and with a 1-day time series; a dialog box appears when the user hovers over a data point. The final website may have a different look and feel, but the type of content will be the same.

The "table view" provides a side-by-side display of all species measured at each site, along with on-site meteorological conditions (Figure 24).

Figure 24. An example of the data display for any subset of the variables measured as part of this monitoring program. This example shows the most recent measurements from multiple species by site, as well as meteorological conditions.

From both the spatial view and the tabular view, historical archived data will be available. As shown in Figure 23, when the user hovers over a data point, a dialog box will appear. This dialog box shows the value (concentration, etc.), time, and any pertinent QC flags.

4.4 Pollutant Background Levels and Context for Fenceline Measurements

Rule 1180 requires that concentration data be set in the context of pollutant concentrations measured elsewhere in the Los Angeles Basin. The public website will display the fenceline monitoring concentrations of the species listed in Rule 1180, along with links to other sources of data such as the SCAQMD Multiple Air Toxics Study (MATES IV or MATES V).

4.5 Data Upload Procedures and Quality Control for the Public Website

The pathway followed by the data from the sensor to the public website is shown in Figure 25. Depending on the sensor used, data will be collected into a data processing server via a "pulling" or "pushing" method, depending on the source monitor. The data will then be archived and ingested into the DMS. Data will be screened in real time upon upload into the DMS, as described in previous sections. Automated procedures will be used to ensure that data are properly uploaded, stored, processed, and quality-assured, and that products are delivered to a public-facing website in near-real time (defined here as 10 minutes or less after data collection).

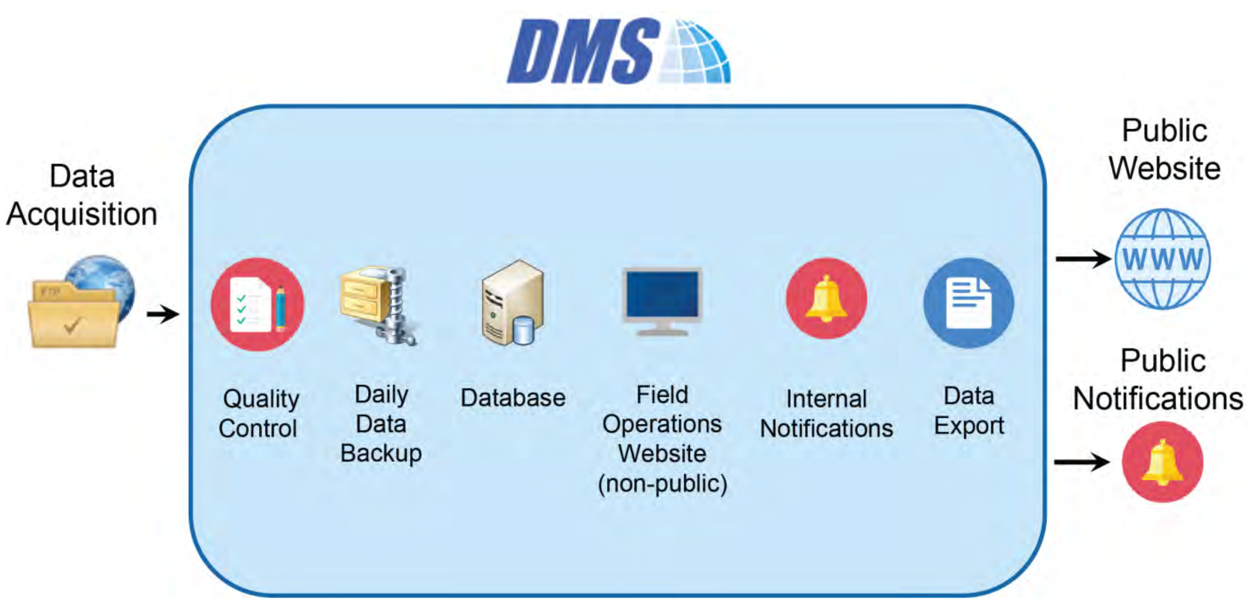

Figure 25. Schematic representation of the flow of data from acquisition at the sensor to display on the public website.

The preliminary quality-controlled data will be presented as time series of species concentrations, visibility, and wind speed and direction. Data will be provided as 5-minute averages. Data will be annotated for quality (valid, invalid, suspect, or missing). In the event that high concentration levels occur, Chevron will follow its existing procedures to determine whether any additional information needs to be provided to the public.

An example of a public-facing website that allows users to explore 5-minute data was shown in Figure 23. Displaying the data in a map format showing wind direction further helps to explain observed concentrations.

Web design will be finalized at a later date.

4.6 Further Information to Guide Public Understanding

The data to be collected have high time resolution, are spatially variable, and are chemically complex. To provide context to this complex data set for the public, the following information will be included through a combination of links, graphics, or captions:

- Information about the species measured and the measurement techniques.
- Context of what fenceline measurements represent as compared to other regional air quality measurements. This will include a discussion of: (1) species that are measured at the fenceline vs. regional monitors; (2) near-source vs. regional ambient air measurements; (3) the difference between open-path and point measurements; (4) 5-minute fenceline data versus longer time-averaged data that are collected by regional monitors; and (5) discussion of typical background concentrations.
- Discussion of levels of concern, via links to third-party sources such as the Office of Environmental Health Hazard Assessment website on the health effects of each species.
- Discussion of non-refinery sources that could affect the measured concentrations.
- Definitions of abbreviations.
- Discussion of data below MDL.
- Definition of data QC flags and their meaning.
- Quality procedures.

Information will be written at a public-friendly level with hyperlinks to additional resources for members of the public who want to delve deeper into the science. Clarity and thoroughness will help reduce the number of questions that arise.

4.7 Procedures for Public Comment, Feedback, and Response

Public feedback will be available through Chevron's corporate website and the community hotline. A log of comments will be made available upon request. The feedback will be delivered to a Chevron contact responsible for deciding whether and how to respond to the public comments. Chevron will determine whether some comments warrant a direct response and what that response procedure should be. Although not all comments have to be addressed, they will be made available to SCAQMD upon request. Some of the comments will aid in the creation of FAQs.

4.8 Links to Quarterly Reports

As part of this monitoring program, quarterly reports will be generated in .pdf format. These reports will contain a statistical summary of the data from all sensors, chain of custody information, as well as graphical views of the historical data. Access to these reports will be available to the public in the form of web links.

5. Notification System

Chevron will develop a notification in accordance with Rule 1180 Guidelines. The public will be notified via the publicly accessible website when values exceed thresholds. Notifications will also be coordinated with the Certified Union Program Agency (CUPA).

As part of this fenceline monitoring project, a notification system will be used to issue notifications for:

- Activities that could affect the monitoring system
- The availability of periodic reports
- Exceedances in thresholds

Notifications will be triggered automatically when concentrations exceed threshold levels listed in Table 13. The concentrations will be calculated to be a 1-hour rolling average that is updated every five minutes. These notifications will be accompanied by a message on the home page of the public website. Concentration thresholds correspond to the OEHHA acute relative exposure limits (RELs) (California Office of Environmental Health Hazard Assessment, 2017). Additional operational alarms will be in place for low visibility or drop in open path signal intensity. A drop in open path signal intensity causing data loss typically occurs when an object (car, vegetation) blocks the beam path, rendering the instrument incapable of producing concentration values.

Table 13. Thresholds for triggering automated notifications. Values for gaseous species in this table are acute 1-hour Reference Exposure Levels from OEHHA (OEHHA 2017, Table 3). Values in this table should be considered preliminary and may be refined either during the project implementation or after the instruments have been deployed.

Measurement	Level
1,3 –Butadiene	300 ppb
Acetaldehyde	260 ppb
Acrolein	1.1 ppb
Ammonia	460 ppb
Benzene	8.5 ppb
Black Carbon	10 $\mu g/m^3$ [a]
Carbonyl Sulfide	270 ppb
Ethylbenzene	460 ppb
Formaldehyde	45 ppb
Hydrogen Cyanide	310 ppb
Hydrogen Sulfide	30 ppb
Naphthalene	1.7 ppb
Nitrogen Dioxide	250 ppb
Sulfur Dioxide	250 ppb
Styrene	4900 ppb
Toluene	9800 ppb
Total Hydrocarbon	TBD
Total Xylene	5000 ppb

[a] OEHHA does not have an acute level for DPM; this is two times the chronic level.

6. References

California Office of Environmental Health Hazard Assessment (2017) Analysis of refinery chemical emissions and health effects. Draft report, September. Available at https://oehha.ca.gov/media/downloads/faqs/refinerychemicalsreport092717.pdf.

ERM (2017) 2015 voluntary risk reduction plan for the Chevron El Segundo refinery. Prepared for Chevron USA, Inc., March.

South Coast Air Quality Management District (2017a) Rule 1180: Refinery fenceline and community air monitoring. Final rule adopted December 1, 2017. Available at http://www.aqmd.gov/docs/default-source/rule-book/reg-xi/r1180.pdf?sfvrsn=9.

South Coast Air Quality Management District (2017b) Rule 1180 refinery fenceline air monitoring plan guidelines. December. Available at http://www.aqmd.gov/docs/default-source/rule-book/support-documents/1180/rule-1180-guidelines.pdf?sfvrsn=8.

U.S. Environmental Protection Agency (2000) Meteorological monitoring guidance for regulatory modeling applications. Office of Air Quality Planning and Standards, Research Triangle Park, NC, Document EPA-454/R-99-005, February. Available at http://www.epa.gov/scram001/guidance/met/mmgrma.pdf.

Appendix A. Fenceline Air Monitoring Plan Checklist

Fenceline Air Monitoring Plan Checklist	
Fenceline Air Monitoring Coverage (or Spatial Coverage) (Section 1)	
☒	**Identify the facility's proximity to sensitive receptors affected by the refinery operation and provide the information below.**
	• Distance from facility to closest sensitive receptor(s) • Location of downwind and upwind communities • Eminent sources of non-refinery emissions surrounding the facility (e.g. non-refinery industrial facilities) • Dispersion modeling†
☒	**Describe historical facility emission patterns and pollutant hotspots based on the following:**
	• On-site location of operations and processes within the facility's perimeter • On-site location of emissions sources and level of emissions • Facility plot plans and topography • Dispersion modeling†
Fenceline Air Monitoring Equipment Description (Section 2)	
☒	**Select sampling locations along the perimeter of the facility based on the information above. Also, provide the following:**
	• Locations where equipment will be sited (e.g., GIS coordinates) and measurement pathways • Elevations of equipment and pathways • A description of how the monitoring system will cover all nearby downwind communities
☒	**Select fenceline air monitoring equipment that is capable of continuously measuring air pollutants in real-time and provide the following:**
	• Specifications for the fenceline instruments (e.g., detection limits, time resolution, etc.) • Explanation of the operation and maintenance requirements for selected equipment • Substantiate any request to use alternative technologies

☒	**Monitor for the pollutants listed in Table 1 of Rule 1180 and include the following:**

- Specify pollutant detection limits for all instruments and paths measured
- Substantiate any exclusion of chemical compounds listed in Table 1 of Rule 1180 or measurement of a surrogate compound

Quality Assurance (Section 3)

☒	**Develop a Quality Assurance Project Plan (QAPP) that describes the following:**

- Quality assurance procedures for data generated by the fenceline air monitoring system (e.g. procedures for assessment, verification and validation data)
- Standard operating procedures (SOP) for all measurement equipment
- Routine equipment and data audits

Data Presentation to the Public (Section 4)

☒	**Design a data display website that includes the following:**

- Educational material that describes the objectives and capabilities of the fenceline air monitoring system
- A description of all pollutants measured and measurement techniques
- A description of background levels for all pollutants measured and provide context to levels measured at the fenceline
- Procedures to upload the data and ensure quality control
- Definition of QC flags
- Hyperlinks to relevant sources of information
- A means for the public to provide comments and feedback; Procedures to respond
- Archived data that with data quality flags, explains changes due to QA/QC and provides chain of custody information
- Quarterly data summary reports, including relationship to health thresholds, data completeness, instrument issues, and quality control efforts

Notification System (Section 5)

☒	**Design a notification system for the public to voluntarily participate in that includes the following:**

- Notifications for activities that could affect the fenceline air monitoring system (e.g., planned maintenance activities or equipment failures)
- Notifications for the availability of periodic reports that inform the community about air quality
- Triggers for exceedances in thresholds (e.g. Acute Reference Exposure Levels [RELs])
- Communication methods for notifications, such as, website, mobile applications, automated emails/text messages and social media

Appendix B. Quality Assurance Project Plan

Draft Quality Assurance Project Plan

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November 28, 2018

STI-918071-6956

Approvals

Quality Assurance Project Plan
Fenceline Monitoring for the Chevron Refinery in El Segundo, California

Signature	Date
Name	
Title	
Chevron Products Company	

Signature	Date
Name	
Title	
Sonoma Technology, Inc.	

Signature	Date
Name	
Title	
South Coast Air Quality Management District	

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1. Project Background and Management

1.1 Background

1.1.1 Purpose

Chevron Corporation proposes to conduct air quality monitoring at its El Segundo, California, refinery in response to the South Coast Air Quality Management District's (SCAQMD) Rule 1180.[1] The monitoring will follow a facility-specific air monitoring plan consistent with the SCAQMD's Refinery Fenceline Air Monitoring Plan Guidelines.[2] Rule 1180 requires routine monitoring near the fencelines of all South Coast refineries for specific air compounds, with data reported to the public.[3]

1.1.2 Rationale

Rule 1180 requires fenceline monitoring of multiple compounds to "provide air quality information to the public about levels of various criteria air pollutants, volatile organic compounds, and other compounds, at or near the property boundaries of petroleum refineries and in nearby communities."[1] In its monitoring plan, Chevron has proposed to conduct open-path and point pollutant monitoring and meteorological measurements to meet the regulations.

This quality assurance project plan (QAPP) documents the measures that the project team will take to ensure that the data collected are of the highest quality. This document will be finalized once final instrument brands are selected. In addition, this document will be reviewed annually and updated as needed.

1.2 Roles and Responsibilities

This project involves refinery staff; contractors; and quality-assurance, field, and website personnel. Figure 1 shows an organization chart for the project.

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[1] Refinery Fenceline and Community Air Monitoring (Rule 1180; approved by the SCAQMD on December 1, 2017). Available at http://www.aqmd.gov/docs/default-source/rule-book/reg-xi/r1180.pdf?sfvrsn=9.
[2] South Coast Air Quality Management District SCAQMD (2017) Refinery Fenceline Air Monitoring Plan Guidelines. December. Available at http://www.aqmd.gov/docs/default-source/rule-book/support-documents/1180/rule-1180-guidelines.pdf.
[3] The exact timing for the start of fenceline monitoring depends on when the monitoring plan is approved by the SCAQMD.

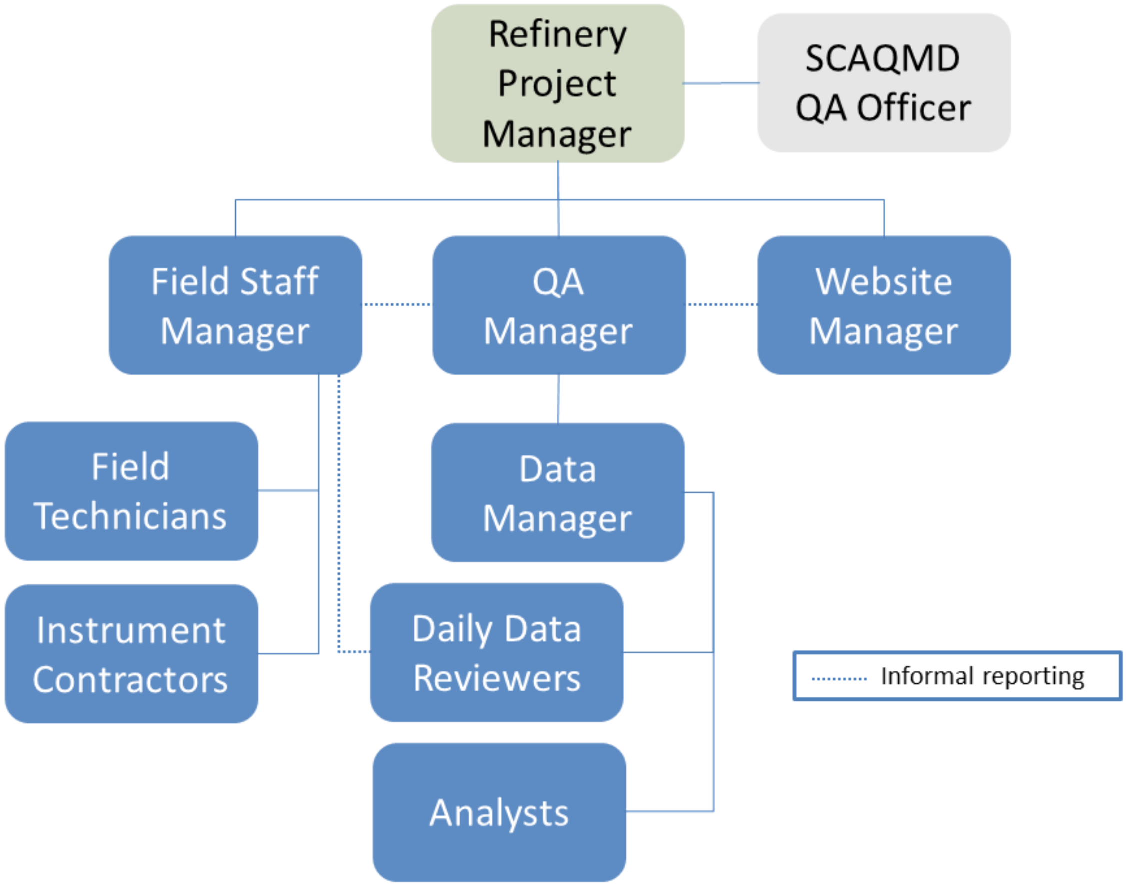

Figure 1. Organizational chart for the Chevron El Segundo refinery monitoring project.

The overall project will be run by a **Project Manager** appointed by the refinery. This PM acts as the central point of contact for the SCAQMD and the QA Manager, Field Staff Manager, and Website Manager. The PM is responsible for overseeing the project and reporting directly to the SCAQMD.

The **QA Manager** is responsible for ensuring the quality of data collected in this project. The QA Manager oversees data collection and review, provides QA oversight during the study, and oversees and reports on QA activities to the Refinery PM and SCAQMD QA Officer. The QA Manager oversees daily data review and data management; works with the Field Staff Manager to ensure that any data issues are addressed promptly by the field technicians; and works with the Website Manager to ensure that data provided to the public are of high quality.

The **Field Staff Manager** ensures that field technicians (site operators) are meeting the requirements of the project. The Field Staff Manager coordinates staff coverage and serves as a technical resource for site measurements.

Field Technicians/Site Operators perform instrument maintenance. The technicians ensure that all measurements are collected in accordance with SOPs, standard methods, and regulations, where applicable. Technicians perform the required quality checks on instruments and document all work in site logs.

The **Instrument Contractors** provide technical support for the instruments deployed in the field.

The **Data Manager** is responsible for ensuring that daily data review is conducted, that data that fail auto-screening are inspected, and that data validation follows the proper schedule and procedures. The Data Manager is also responsible for delivering the validated data to the PM.

Daily data review and data validation are conducted by experienced air quality analysts. The **Data Reviewers** communicate with the Data Manager when there are issues and may also interact with the Field Technicians when they notice an issue that needs to be addressed.

The **Website Manager** is responsible for properly displaying data on the website, managing inquiries from the public, and ensuring that validated data are available for download on a quarterly basis. Automated alerts will notify the Website Manager when the real-time data are not available on the website. This manager will be responsible for assessing and fixing data communication and other information technology–related issues concerning the website and data system.

2. Measurements

2.1 Instrument Selection and Descriptions

The required list of compounds to be measured is presented in **Table 1**. These compounds will be measured at a 5-minute resolution. Because of the distances that need to be covered by measurements (hundreds of meters), the data time-resolution requirements (5 minutes), and current state of measurement technology, open-path instruments (UVDOAS and FTIR) were selected for measuring all compounds except for black carbon and H_2S, which will be measured by point instruments.

Table 1. Pollutants listed in Table 1 of Rule 1180.

Air Pollutants
Criteria Air Pollutants
Sulfur Dioxide
Nitrogen Oxides
Volatile Organic Compounds (VOCs)
Total VOCs (Non-Methane Hydrocarbons)
Formaldehyde
Acetaldehyde
Acrolein
1,3-Butadiene
Styrene
BTEX Compounds (Benzene, Toluene, Ethylbenzene, Xylenes)
Other Compounds
Hydrogen Sulfide
Carbonyl Sulfide
Ammonia
Black Carbon
Hydrogen Cyanide
Hydrogen Fluoride (if the facility uses it)

Along all measurement paths (see Section 2.2), SO_2 and benzene, toluene, ethylbenzene, and xylenes (BTEX) will be measured by monostatic *Ultra Violet-Differential Optical Absorption Spectroscopy* (*UVDOAS*) with a xenon light source. The xenon light is required to achieve measurements over paths that are about 300 to 600 meters long and to achieve the minimum detection limits (MDL) for BTEX. The analyzer records the intensity of light at discrete wavelengths. Any UV-absorbing gas that is present in the beam absorbs at a specific wavelength of light. Each species of gas has a unique absorbance fingerprint (i.e., the ratios between the absorbance at several different wavelengths are unique to that gas). The analyzer compares regions within the sample absorbance spectra to the same regions within the reference absorbance spectra. The analyzer uses a classical least squares regression analysis to compare the measured absorption spectrum to calibrated reference absorption spectra files. Beer's Law is used to report gas concentrations. Though not written specifically for UVDOAS, this approach is the same as that specified in the U.S. Environmental Protection Agency's (EPA) TO-16 Methodology.[4] Closeness of fit is indicated by the correlation coefficient (R^2) of agreement between the measured spectra and the reference spectra. The R^2 is provided with each concentration so that interference can be detected if it is present. Selection of regions of analysis that are free of absorbance due to other gases within the sample is the primary means of avoiding cross-interference. Spectral subtraction is used in cases with overlapping absorbance features; the subtraction technique is proprietary to the instrument manufacturer.

Total VOCs (non-methane hydrocarbons), formaldehyde, acetaldehyde, acrolein, styrene, carbonyl sulfide, hydrogen cyanide, NH_3, 1,3-butadiene, and BTEX will be measured with a *Fourier Transform Infrared spectroscopy (FTIR)* instrument. The FTIR operates by sending a beam of infrared light through the open air. The IR beam is reflected back to the analyzer by a retro-reflector array (monostatic), where the absorption due to target gases is measured and recorded. The analyzer uses a classical least squares regression analysis to compare the measured absorption spectrum to calibrated reference absorption spectra files according to the EPA's TO-16 Methodology. Beer's Law is used to report accurate gas concentrations. The FTIR operates on a similar premise as the UVDOAS by using reference spectra. There are a variety of industry standard methods to mitigate interference from both water vapor and interference gases, including spectral subtraction, path length adjustments, and selecting isolated absorbance peaks for the gases of interest. Proprietary methods include multi-peak analytics.

Heavy fog may entirely block the signal from an open-path instrument and prevent data collection; however, even light fog can absorb the signal partially and interfere with measurements. Given the coastal location of the refinery, marine fog events are expected during the nighttime and early morning hours. Visibility measurements will be made at two representative locations in order to provide operational verification of fog events.

[4] Compendium of Methods for the Determination of Toxic Organic Compounds in Ambient Air. Compendium Method TO-16. Long-Path Open-Path Fourier Transform Infrared Monitoring Of Atmospheric Gases (1999) EPA/625/R-96/010b.

Hydrogen sulfide will be measured by extractive Tunable Diode Laser Absorption Spectroscopy (TDLAS), UV fluorescence, or a Galvanic Applied Sciences ProTech H_2S analyzer instrument. Black carbon will be measured by Aethalometers.

Table 2 summarizes the estimated range of MDL and upper detection limits (UDL) for each species by open-path instrument. The MDL is the lowest path-average concentration that can be measured at the path length, and the UDL is the highest path-average concentration that can be measured at the path length. Detection limits are approximate and are based on the theoretical capabilities of the instruments; however, they are supported by manufacturers' lab tests and real-world applications. Actual detection limits depend on atmospheric conditions and on the specific instrument used. The detection limits are for the average species concentration along a path; narrow plumes that cover only a portion of the path would only be detected at a higher concentration than the MDL.

Point monitor detection limits for H_2S will be less than 2 ppb. Point monitor detection limits for black carbon will be less than 0.5 µg/m^3.

Table 2. Range of approximate open-path instrument minimum detection limits (MDL) and upper detection limits (UDL) in parts per billion (ppb) by technology, species, and path length. UDLs for some species are to be determined (TBD). Actual detection limits depend on atmospheric conditions.

	1180 Compound	Shortest Path (199 m)		Longest Path (601 m)	
		MDL	UDL	MDL	UDL
FTIR	1,3-Butadiene	5	24000	2	7900
	Acetaldehyde	3	500000	1	170000
	Acrolein	4	230000	1	75000
	Ammonia	1	140000	0	45000
	Benzene	30	75000	15	25000
	Carbonyl Sulfide	2	TBD	1	TBD
	Ethylbenzene	17	94000	6	31000
	Formaldehyde	2	63000	1	21000
	Hydrocarbons	10	15000	3	5000
	Hydrogen Cyanide	34	50000	11	17000
	Nitrogen Dioxide	15	TBD	5	TBD
	Styrene	6	29000	2	9500
	Total Xylenes	14	190000	5	62000
UVDOAS	Acrolein	21	480000	7	160000
	Benzene	1	80000	0.2	26000
	Ethylbenzene	1	55000	0.3	18000
	Naphthalene	1	430	0.2	140
	Styrene	3	TBD	2	TBD
	Sulfur Dioxide	2	100000	0.6	34000
	Toluene	2	110000	0.7	37000
	Total Xylenes	2	19000	0.8	6200

2.2 Monitor Siting Overview

Chevron proposes to monitor concentrations across 11 paths (shown in **Figure 2**). The type of measurement at each path is indicated by the colored legend in Figure 2. The specific technology has not yet been chosen for H_2S point monitoring. The meteorological stations will include visibility sensors in addition to wind, temperature, and relative humidity measurements. Chevron selected these locations after considering dominant wind patterns, sources of potential air emissions on the refinery property, and nearby local receptors. Transmitter-detectors/analyzers will be located at sites labeled "A" (identified in Figure 2), and retroreflectors will be placed at the sites labeled "R". The exact paths may be adjusted, depending on final site logistics and exact instrument capabilities, particularly in regard to the maximum path lengths for which the instruments can reliably measure the compounds of interest.

2.3 Instrument Operations and Maintenance

Five instrument systems are included in this project: UVDOAS, FTIR, point instruments for H_2S, Aethalometers, and meteorological instruments, including visibility. Quality assurance is built into operations and maintenance. For all instruments, scheduled maintenance will occur monthly, quarterly, and/or annually. Emergency maintenance will occur as needed when problems are identified during daily data review and auto-screening of real-time data.

2.3.1 UVDOAS

The UVDOAS system is designed to require only modest service and maintenance. **Table 3** summarizes typical UVDOAS maintenance activities as recommended by the manufacturer. These actions help ensure data integrity and maximize up-time.

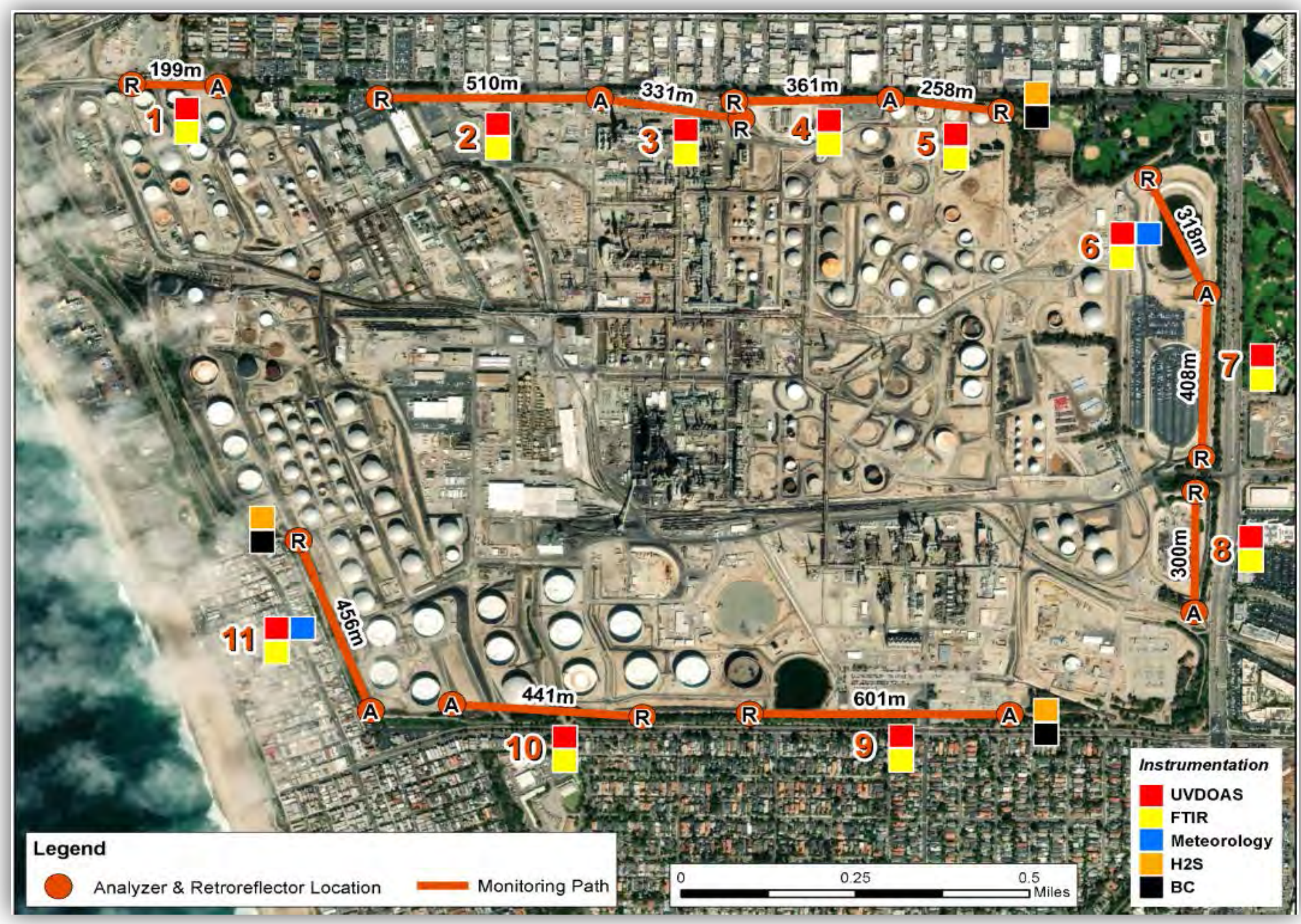

Figure 2. Location of sensors and measurement paths. Each path consists of a transmitter-detector (A) and a retroreflector (R).

Table 3. Typical schedule of maintenance activities for the UVDOAS.

Activity	Monthly	Quarterly	Annually
Visually inspect the system.	✓	✓	✓
Inspect optics on detector and retro-reflector; clean if necessary.	✓	✓	✓
Inspect system filters.	✓	✓	✓
Confirm the alignment to verify there has not been significant physical movement. Note: this is automatically monitored as well.	✓	✓	✓
Download data from detector hard drive and delete old files to free space, if needed.	✓	✓	✓
Ensure there are no obstructions between the detector and the retro-reflector (such as equipment, vegetation, vehicles).	✓	✓	✓
Change out the UV source.		✓	
Replace ventilation exit and intake filters.		✓	
Clean optics on detector and retro-reflector.		✓	
Realign system after service.		✓	✓
Check system performance indicators.		✓	✓
Perform bump test (simulates system-observed gas content at the required path average concentration) to verify the system can detect at or below a lower alarm limit.		✓	
Review and test light and signal levels. Check average light intensity to establish baseline for bulb change frequency.		✓	✓
Verify system settings.			✓

2.3.2 Hydrogen Sulfide (Point Instruments)

Although the specific type of point monitor for H_2S has not yet been selected, a typical maintenance schedule for UV fluorescence-based point monitors, as recommended by the manufacturer, is shown in Table 4. The frequency of preventive maintenance depends on the operating environment and may be adjusted beyond manufacturers' recommendations once the instruments are deployed in the field. On an as-needed basis, system status alarms will alert operators to specific issues needing to be addressed.

Table 4. Typical schedule of maintenance activities for point monitors using UV fluorescence.

Activity	Weekly	Monthly	Quarterly	Annually	Every 2 Years
Visually inspect the system		✓	✓	✓	✓
Replace catalyst			✓		
Replace SO_2 scrubber			✓		
Replace particulate filter	✓				
Verify test functions	✓				
Zero/span check	✓				
Zero span calibration			✓		
Flow check			✓		
Replace critical orifice and sintered filters				✓	
Replace internal span permeation tube				✓	
Pneumatic leak check				✓	
Replace pump diaphragm					✓

2.3.3 FTIR

Maintenance activities for the FTIR and the UVDOAS are similar. The FTIR system is also designed to require only modest service and maintenance. Table 5 summarizes FTIR maintenance activities, as recommended by a typical manufacturer. Preventative maintenance frequency depends on the operating environment and may need to be adjusted. On an as-needed basis, system status alarms may alert operators to specific issues that need to be addressed. Bump tests are performed on site.

Table 5. Typical schedule of maintenance activities for the FTIR.

Activity	Monthly	Quarterly	Semi-Annually	Annually	~18 months	Five Years
Visually inspect the system.	✓	✓		✓		
Inspect and clean AC system exterior heat sink.			✓			
Inspect and clean AC system interior heat sink.				✓		
Confirm the alignment to verify there has been no significant physical movement. [a]	✓	✓		✓		
Download data from detector hard drive and delete old files to free space, if needed.	✓	✓		✓		
Ensure there are no obstructions between the detector and the retro-reflector (such as equipment, vegetation, vehicles).	✓	✓		✓		
Change out the IR source.						✓
Realign system after service.		✓		✓		
Check system performance indicators.		✓		✓		
Perform bump test.		✓				
Review and test light and signal levels. Check average light intensity to establish baseline for IR Source change frequency and retro-reflector wear.				✓		
Verify system settings.		✓				
Replace cryocooler or swap detector module assembly.					✓	

[a] This is monitored both manually and automatically.

Aethalometer

The Aethalometer system is designed to require only modest service and maintenance. Table 6 summarizes typical Aethalometer maintenance activities as recommended by a manufacturer. Preventive maintenance frequency depends on the operating environment and may need to be adjusted beyond manufacturers' recommendations once the instruments are deployed in the field. On an as-needed basis, system status alarms will alert operators to specific issues needing to be addressed.

Table 6. Typical schedule of maintenance activities for Aethalometers.

Activity	Monthly	Semiannual	Annual
Visually inspect the system	✓	✓	✓
Inlet flow check	✓		
Clean size selective inlet	✓		
Clean cyclone	✓		
Verify date and time	✓		
Inspect optical chamber and clean as necessary		✓	
Calibrate flow		✓	
Change bypass cartridge filter			✓
Check tape roll, install new tape roll if necessary	✓		
Calibrate tape sensor		✓	

2.3.4 Visibility and Other Meteorological Sensors

Table 7 depicts the maintenance activities that will be performed during each site visit to ensure all instruments are performing correctly.

Table 7. Routine maintenance checklist.

Item	Action
Tower	Check that the tower is securely anchored to the shelter.
	Check the tower for signs of damage or excessive wear.
	Inspect all bolts at the tower base for any signs of corrosion (rust).
	Check the tower's vertical alignment.
Anemometer	Note whether any component (tail, propeller) is missing or has suffered obvious damage.
	Check that the whole sensor moves freely with a changing wind direction and the propeller rotates freely when windy.
Temperature/ RH Sensor and Shield	Inspect the hardware holding the temperature/RH sensor shield assembly to the tower and tighten the bolts if necessary.
	Check that the cable connections are secure.
Visibility Sensors	Inspect the sensor for dirt, spider webs, birds' nests, or other obstructions. Clean the glass windows.
	Check that the cable connections are secure.
	Inspect the hardware holding the sensors to the tower, and tighten the bolts if necessary.
Data Logger Enclosure Cables	Verify that the enclosure is secured inside the shelter and is operational.
	Check that the cabling to the enclosure is secure and undamaged.
	Check the integrity of the cables connecting the data logger box from the data logger to the sensors.
Data Logger Enclosure Guy Wires	Check that the sensor cables are attached to the tower.
	Where guy wires are used, check that they are taut and that the attachment points are tight. If the attachment points are loose, call STI for instructions.

2.3.5 Overview of Data Flow, Spectrum Generation, and Quality Control Parameters for Open-Path Instruments

This section provides context for some of the parameters used in QA/QC procedures for open-path systems. Most open-path monitors generate an absorption spectrum; from this spectrum, concentrations are derived. Generation of spectra using UVDOAS and FTIR is a distinctly different process that is dependent on the hardware used. However, in all cases the result is the similar: an absorbance spectrum file containing absorbance as a function of wavelength. To generate absorbance using FTIR and DOAS, the logarithm of the ratio of two "single beam" transmission spectra is calculated (one being the sample and the other being the "background"). For ambient open-path measurements, one single beam must be measured or estimated using a spectrum that does not contain the analyte of interest—this is the so-called "background." Different manufacturers have different methods for determining the appropriate background. In practice, the single gas MDL for one analyte in otherwise clean air will be lower than that for air that contains interfering species (species that absorb in the same spectral region as the analyte). Also affecting the MDLs is the total averaging time. The greater the number of scans averaged, the lower the MDL due to the reduction of noise. Several other parameters obtained during the collection of spectra may be used to quality-control the data.

For DOAS measurements, light is collected for a period of time (the so-called "integration time"). The instrument software determines the integration time, based on a minimum amount of light needed. Long integration times can indicate low light levels and can be used to flag data as questionable (due to the presence of fog or an object blocking the beam). For example, each manufacturer specifies a range of acceptable integration times for their system. A related metric that is applicable to all open-path measurements is the overall intensity of the light received at the analyzer; this is termed "signal strength." For certain DOAS measurements, signal strengths greater than 92% are generally acceptable; below these values, the data will be flagged as questionable. For typical FTIR measurements, the values are generally lower because of absorption by atmospheric gases (CO_2, H_2O, etc.). For example, acceptable values for a manufacturer's FTIR system may be between 10% and 100%.

In order to derive concentrations, spectra must be fit using a least squares procedure. A "library" spectra of known compounds is used to best fit the experimental spectra collected at the monitoring site. The goodness of fit is quantified using the well-known R^2 value which is equal to 1 for a perfect fit and zero for a measurement that is not correlated to the library spectra. Some instrument manufacturers use the term "percent match," which is $100*R^2$. Therefore, a positive detection of an analyte must satisfy an R^2 threshold value. For example, the fit to methane might have an R^2 of 0.70 or greater to be considered a valid detection.

2.4 System Corrective Actions

Corrective action will be taken to ensure that data quality objectives are met. Table 8 lists the types of issues that require corrective actions. (This table is not all-inclusive; additional checks may be added as the project progresses.) The daily data reviewers will review data to identify issues and will work with the field technicians and instrument contractors to resolve issues that need to be addressed on site.

Table 8. Potential sampling and data reporting problems and corrective actions.

Item	Problem	Action	Notification	Person Responsible
Erratic data	Possible instrument malfunction	Contact Field Manager and Instrument Contractor	Document in logbook, notify Field Manager	Field technician
Power	Power interruptions	Check line voltage, reset or restart instruments	Document in logbook, notify Field Manager	Field technician
Data downloading	Data will not transfer to the DMS	Contact Field Manager and Instrument Contractor	Document in logbook, notify Field Manager and Website/Data System Manager	Field technician
Supplies and consumables	Essential supplies run low	Contact Field Manager	Document in logbook, notify Field Manager	Field technician
Access to sites	Technician cannot access the sites	Contact Project Manager	Document in logbook, notify Project Manager	Field technician
Instrument Light level	A low light level alert is observed	Contact Instrument Manufacturer, replace bulb	Document in logbook, notify Field Manager	Field Technician
Website	Website is down	Contact Website Manager	Notify Project Manager	Website Manager

3. Quality Objectives and Criteria

3.1 Data and Measurement Quality Objectives

3.1.1 Discussion

To ensure success of field measurements, measurement performance criteria are established as part of the monitoring design. These criteria specify the data quality needed to minimize decision errors based on the data. Data quality is defined in terms of the degree of precision, accuracy, representativeness, comparability, and completeness needed for the monitoring. Of these five data quality indicators, precision and accuracy are quantitative measures, representativeness and comparability are qualitative measures, and completeness is a combination of quantitative and qualitative measures.

The quantitative performance criteria for the data collected by the fenceline measurement systems are provided in the following tables. The principal quantitative indicators of data quality for this study are data completeness, precision, and accuracy. Table 9 shows the data completeness objectives for all collected data for several time intervals. For communication purposes, the Percent Data Valid—the percentage of data values that are valid divided by the number of captured data values, corrected for low-visibility conditions—will also be computed.

Table 9. Data completeness objectives.

Completeness Requirement	Relevant to
75% of scans (open-path) or of data (point monitors)	5-minute average data
75% of 5-minute data	1-hr average data
75% of hourly data	8-hour average data
75% of hourly data	24-hour daily average data
75% of daily data	Monthly or quarterly average data

Other factors that affect data availability include instrument bump tests (approximately every quarter for a few hours), annual maintenance, and other maintenance (e.g., replacement of UV bulbs for the UVDOAS after every 2,000 hours of use, roughly quarterly, and replacement of the FTIR cryocoolers every 18 months). Regular maintenance and careful, responsive operation will minimize instrument downtime. Table 10 shows the performance criteria for the fenceline monitoring systems.

Table 10. Performance criteria for the fenceline monitoring systems.

Sensor	Test	Acceptance Criteria for Precision and Accuracy
UVDOAS	5 ppm benzene; 0.5 m QA cell for 500 m path	±20%
FTIR	5 ppm NH_3; 0.5 m QA cell for 500 m path	±20%
H_2S Point Monitor	100 ppb	±20%
Aethalometer	Bubble flow meter, internal leak check	±10%
Temperature	Two point test	±0.5°C
Relative Humidity	Hygrometer	±7%
Wind Speed	Starting threshold test; transfer function test	±0.25 m/s below 5 m/s and ± 5% above 5 m/s
Wind Direction	Angle verification	±5 degrees
Visibility	Extinction	±10%

3.2 Precision Checks, Bump Tests, and Verification

3.2.1 Open-Path Instruments

For the UVDOAS system, a bump test will be performed quarterly the first year or so and semi-annually in later years as high-quality, reliable system performance is confirmed. In the field, a bump test (simulates system-observed gas content at the required path average concentration) is used to verify that the system can detect concentrations at or below a set level of concern.

For the FTIR, bump tests will be performed onsite quarterly the first year or so and semi-annually in later years as high-quality, reliable system performance is confirmed.

For the open-path systems, precision will be measured by evaluating the variance of pollutant concentrations during a period of low variability, when atmospheric influence on variability is assumed to be minimal. Five-minute data will be selected during periods of low variability, but when concentrations are well above the MDL. The precision can then be evaluated by calculating the coefficient of variation (CV) during the period of low variability, as shown in Equation 1. If there are no periods of low variability with concentrations above the MDL, bump test data will be used to calculate precision.

$$\Pr ecision \approx CV = \frac{\sigma_{measured}}{\overline{[conc]}_{measured}} \times 100\% \quad \textbf{(1)}$$

where:

$$\sigma_{measured} = \sqrt{\frac{\sum\left([conc]_{measured} - \overline{[conc]}_{measured}\right)^2}{N-1}}$$

3.2.2 Point Instrument for H_2S

A permeation device will likely be used for the calibration of H_2S depending on the instrument type and brand selected. Permeation devices are preferred over compressed gas cylinders because of their higher dynamic range and portability. A VICI Dynacal 120 portable calibration gas generator will be used with the permeation devices to generate the zero and span checks. Permeation devices contain the pure calibration chemical in a two-phase equilibrium between the gas and liquid phases. The permeation device emits the calibration compound through a semi-permeable membrane at a known constant rate, provided the temperature is constant. One of the main functions of the Dynacal 120 is to keep the permeation device at a fixed temperature with a known carrier gas flow so that a constant, known gas concentration is generated. When the permeation devices are not being used, they will be stored under dry nitrogen at a temperature between 20° and 25°C. Prior to calibration, the permeation device will be allowed to equilibrate for 24 hours, as specified by the MOP. The permeation devices will be certified every six months either gravimetrically or against an acceptable reference method.

3.2.3 Black Carbon

The Aethalometers will subjected to both a leak check and flow rate check once per month.

3.2.4 Meteorological Equipment

Semi-annual audits will be conducted for the meteorological stations. The meteorological instrumentation calibrations will be conducted with reference to the recommendations in the EPA's *Quality Assurance Handbook for Air Pollution Measurement Systems (QA Handbook), Volumes I, II, and IV.*[5,6,7]

[5] U.S. Environmental Protection Agency (1994) Quality assurance handbook for air pollution measurement systems, Volume I: a field guide to environmental quality assurance. Report prepared by the U.S. Environmental Protection Agency, Research Triangle Park, NC, EPA/600/R-94/038a. Available at https://www3.epa.gov/ttn/amtic/qalist.html.

[6] U.S. Environmental Protection Agency (2008) Quality assurance handbook for air pollution measurement systems, Volume IV: meteorological measurements version 2.0 (final). Prepared by the U.S. Environmental Protection Agency, Office of Air Quality Planning and Standards, Air Quality Assessment Division, Research Triangle Park, NC, EPA-454/B-08-002, March. Available at https://www3.epa.gov/ttn/amtic/qalist.html.

[7] U.S. Environmental Protection Agency (2017) Quality assurance handbook for air pollution measurement systems, Volume II: ambient air quality monitoring program. Prepared by the U.S. Environmental Protection Agency, Office of Air Quality Planning and Standards, Air Quality Assessment Division, Research Triangle Park, NC, EPA-454/B-17-001, January. Available at https://www3.epa.gov/ttnamti1/qalist.html.

As part of the calibration process, each instrument will be first tested to determine whether it is operating within the prescribed operational limits and whether non-routine maintenance or adjustments are required. Based on an instrument's response to the initial performance test with respect to the minimum acceptable performance criteria, the instrument would then be repaired, calibrated, or in rare cases, replaced. A standard form will be used to document the performance of each sensor before and after any adjustments.

Wind Speed

An anemometer drive will be used to simulate known wind speeds. The propeller torque disc will be used to determine the anemometer starting threshold. Sensor starting threshold is a shaft-bearing efficiency measurement only.

The wind speed propeller and tail assembly will be visually inspected to ensure that they are not cracked or damaged. The propeller will be removed and the sensor shaft immobilized to simulate zero wind speed. The anemometer drive will be connected to the sensor shaft to simulate wind speeds between 0 and 44.1 m/s. The wind speed will be determined from wind speed coefficients provided by the manufacturer. The remote processing unit (RPU) responses will then be compared to the calculated values.

Wind Direction

A vane angle fixture will be used to set the vane to known directions at 45-degree intervals, moving clockwise and then counter-clockwise, through the full 360-degree range of the monitor. A pocket transit mounted on a tripod will be used in conjunction with a vane alignment rod to determine the orientation of the wind monitor on the tower mast. A vane torque gauge will be used to determine the vane starting threshold.

Ambient Temperature

A NIST-traceable thermometer will be used as the calibration transfer standard. The ambient temperature sensor will be tested by comparing the current ambient temperature, as measured by the digital thermometer, to the temperature reading from the RPU. The transfer standard will be placed near the temperature probe in a shaded location. Both sensors will be allowed to reach equilibration before the responses of the respective sensors are recorded.

Relative Humidity

A NIST-traceable psychrometer will be used as the calibration transfer standard. The relative humidity sensor will be tested by comparing the current relative humidity as measured by the psychrometer to the relative humidity reading from the RPU. The psychrometer will be placed near the temperature probe in a shaded location. Both sensors will be allowed to reach equilibration before their responses are recorded.

Visibility Sensors

An appropriate manufacturer-specific calibration kit will be used to test the visibility sensors. The calibration fixtures are instrument-specific. Generally, a calibration kit consists of a blocking plate or block for checking the sensor zero, and a scatter plate for checking the sensor span. The calibration fixture is assigned a factory-traceable extinction coefficient (ECO) used to calculate the expected values during calibrations.

3.2.5 Instrument or Standards Certifications

For factory calibrations, upon initial instrument purchase a certification of the standard gases used will be requested from the manufacturer. Also, the spectra background file version number used for signal processing will be documented.

4. Data Management

Data quality criteria are evaluated through (1) automatic data checks conducted through the data management system and (2) data review by trained analysts (daily data review and periodic, more thorough validation).

4.1 Data Acquisition and Communications

In near-real time, data are transferred from in-field instruments through a data acquisition system (DAS) to a Data Management System (DMS) using cell modem. Data are also stored onsite on instrument computers in case of cell modem failure. The DMS uses a Microsoft SQL relational database with stored procedures. These raw data are not yet intended for the public website.

The DMS automatically quality controls data, detects outliers and problems, generates reports, and creates alerts. The auto-screening and graphical capabilities will be used for continuous examination of data quality. The DMS will feed auto-screened data to the field operations website and notification system to inform/alert project and facility staff. The operations website will show maps and time series plots of all pollutants listed in Table 1.

The automatically quality-controlled air quality data will be fed to the public website 10 minutes after collection.

4.2 Automated Data Screening

Automated data screening is conducted within the DMS upon data ingest. Automated screening checks of data feeds are used to screen out invalid data for public display and are helpful to focus the data reviewer's efforts on the data that need the most attention. Initial screening checks, along with actions to be taken, are summarized in Table 11. The screening check concentration criteria are based on an analysis of expected instrument performance, concentration levels of concern by compound, and typical ambient concentrations by compound. All screening criteria (flags and rates of change) are preliminary and will be refined during the project based on actual observations. The DMS auto-screening checks that will be used include:

- **Range.** These checks will verify that the instrument is not reporting values outside of reasonable minimum and maximum concentrations.
- **Sticking.** If values are repeated for a number of sampling intervals, data will be reviewed for validity. Four or more repeated values may indicate that investigation is needed. Sticking checks will not be applied to data below the instrument detection limit.

- **Rate of Change.** Values that change rapidly without reasonable cause will be flagged and reviewed.
- **Missing.** If data are missing, data during those time periods will be coded as missing.
- **Sensor OP codes and alarms**. If the instrument assigns operation (OP) codes to data automatically (e.g., for bump tests or internal flow rate checks), the data will be reviewed, codes confirmed, and data flags checked.
- **Visibility impairment.** While the exact relationship between visibility and open-path measurements is not established, the expectation is that there would be no measurements when visibility is less than the twice the path length (two times the path length is used because the open-path sensor light travels to the mirror and back to the analyzer).

Additional parameters that may be monitored as indicators of data quality include data quality value for each concentration as reported by the instrument (i.e., correlation between measured and reference spectra), signal strength, wavelength versus intensity, and visual review of peaks. There are no previously set data quality objectives for these parameters; we will need to develop objectives for these parameters if we find that they are useful indicators for automated data quality screening or for data validation.

Data flags identified through auto-screening will be graphically reviewed during data validation (i.e., not in real time), and QC flags will be updated with daily and quarterly actions. DMS keeps track of data changes in its chain-of-custody feature—i.e., raw data are preserved as well as all changes.

Table 11. Initial screening checks for 5-minute data. All valid and flagged data values will be displayed to the public in real-time. If data are invalid, they will not be included in the public display. All screening values below (flags and rates of change) are preliminary and will be refined during the project. During data validation, flagged data will be further investigated.

Measurement Species (units)	Checks						
	Minimum detection limit (MDL): If concentration is below MDL, flag as below MDL	Range: If concentration is above value listed, flag as suspect and conduct investigation	Sticking: If same value observed for four or more intervals, flag as suspect and conduct investigation	Rate of Change Between Intervals: If concentration changes by more than value listed, flag as suspect and conduct investigation	Missing: If data are missing, flag as missing and investigate cause	Sensor OP Code/Alarm: If sensor indicates malfunction or bump test data, flag as appropriate	Visibility: If visibility is less than 1,000 m and data are missing, flag as appropriate
SO_2 (ppb)	SAME FOR ALL POLLUTANTS	750	SAME FOR ALL POLLUTANTS	250	SAME FOR ALL POLLUTANTS	SAME FOR ALL POLLUTANTS	SAME FOR ALL POLLUTANTS
Nitrogen Dioxide (ppb)		750		250			
Total VOCs (non-methane hydrocarbons) (ppb)		TBD		TBD			
Formaldehyde (ppb)		135		45			
Acetaldehyde (ppb)		780		260			
Acrolein (ppb)		3.3		1.1			
1,3-Butadiene (ppb)		900		300			
Styrene (ppb)		14,700		4,900			
Benzene (ppb)		27		9			
Toluene (ppb)		29,400		9,800			
Ethylbenzene (ppb)		1,380		460			
Total Xylenes (ppb)		15,000		5,000			
H_2S (ppb)		90		30			
Carbonyl Sulfide (ppb)				270			
NH_3 (ppb)		1,380		460			
Black Carbon (μg/m^3)		30		10			
Visibility (meters)	If value is <0, flag as suspect	1,000	Not applicable	Not applicable			Not applicable

4.3 Data Verification

4.3.1 Confirm Daily Operation

Operationally, data are reviewed daily by a data reviewer to assess instrument operation. This initial review, typically of a three- to five-day time-series plot of selected parameters for each instrument, allows the analyst to see common problems and verify instruments are operational. If it appears that an instrument is not operating, or the data are missing, the field operator will be notified and further investigation and corrective action, if needed, will be taken.

In addition to daily checks of the field website, an automated alerting system will let technicians and managers know when data have been missing for a specified period of time. Missing data may indicate a power issue, an instrument problem, or a data communication problem. The time period allowed for missing data will likely be adjusted as the project proceeds to reduce false or excessive alerting. The alerting will likely be set initially for 6 to 12 missing 5-minute values (i.e., 30 to 60 minutes).

4.3.2 Assess Data Reasonableness

Also operationally, the data reviewer quickly assesses whether the pollutant concentrations are reasonable with respect to the time of day, season, meteorology, and concentrations expected and observed along other paths. If anomalies are observed, additional analysis will be conducted to determine whether there is an instrument malfunction or the data are truly anomalous but explainable. Data reasonableness is also assessed more thoroughly during the data validation process.

4.4 Data QA Procedures

Raw data management occurs on a daily, monthly, quarterly, and annual basis. The DMS will be used to automatically quality control data, detect outliers and problems, and create alerts. The auto-screening and graphical capabilities will be used for continuous examination of data quality. The DMS will feed auto-screened data to the field operations website and notification system to inform project and facility staff. The operations website will show maps and time-series plots of the pollutants, winds, and visibility data. The auto-QC'd air quality data will be fed to the public website in near-real time. The DMS data will be backed up on a daily basis.

All data produced by the instrument are initially considered **Level 0**. All Level 0 data values that are not associated with bump tests or other instrument maintenance will undergo basic automatic quality control and will be displayed to the public in near-real time (i.e., about 10 minutes or less). At this point, these data are considered **Level 0.5**. Automated screening checks of data feeds are helpful to focus the analyst's efforts on the data that need the most attention and are used to screen out invalid data. All data above notification threshold levels will be flagged as suspect for review and verification. Screening criteria (flags and rates of change) are preliminary and will be refined during the project based on actual observations and instrument performance.

Additional QC checks for the instruments are summarized in **Table 12**. Data that fail checks will be flagged in the DMS and brought to the attention of the reviewer. Data are invalidated only if a known reason can be found for the anomaly or automated screening check failure. If the data are anomalous or fail screening, but no reason can be found to invalidate the data, the data are flagged as suspect. Additional analysis may be needed to deem data valid or invalid. Common reasons for invalidation include instrument malfunction, power failure, and bump test data that were not identified as such. As the measurements progress over time, Chevron will update and refine the screening checks including those needed to be added for the H_2S instrument. Screening checks are typically specific to the site, instrument, time of day, and season, and adjusted over time as more data are collected.

Hydrogen sulfide QA/QC procedures will be determined once the instrument type is selected. All up-to-date procedures will be included in the finalized QAPP once final instrument brands are selected.

If data are proven to be invalid by subjective data review and/or post processing, they will be removed from the public display, and the rationale for data removal will be provided.

A non-public field operations website will be used for daily graphical review of the data (an example is provided in **Figure 3**). Common data problems include flat signal/constant values, no signal/missing data, extremely noisy signal, rapid changes (spikes or dips), and negative concentrations (see annotated **Figure 4** for examples).

An initial review, typically of a three-to-five-day running time-series plot of selected parameters for each instrument, allows the analyst to see common problems and verify instruments are operational. If it appears that an instrument is not operating, or the data are missing, the field operator will be notified and further investigation and corrective action, if needed, will be taken.

Table 12. Typical instrument QA/QC checks.

QA/QC Checks	Frequency	Acceptance Criteria
UVDOAS		
Bump test (accuracy)	Quarterly and after major service	±20%
Baseline stability	Continuous	±5%
Single point bump test in field	Quarterly	±20%
Measurement quality (R^2)	Continuous	0.7 to 1.0
Integration time	Continuous	80-200 mS *400 mS integration time results in a warning notification*
Signal intensity	Continuous	>30% *Signal intensity below 30 results in a warning notification*
Aethalometer		
Flow rate		±10%
Span check		±10%
Zero check		<550 ng/m^3 for Ch. 6
FTIR		
Bump test	Quarterly and after major service	±20%
Baseline stability	Continuous	±5%
IR single beam ratio test (background vs. sample intensity)	Real time	*To be determined*
Measurement quality (R^2)	Continuous	0.7 to 1.0
Signal intensity	Continuous	>5% *Signal intensity below 5 results in a warning notification*

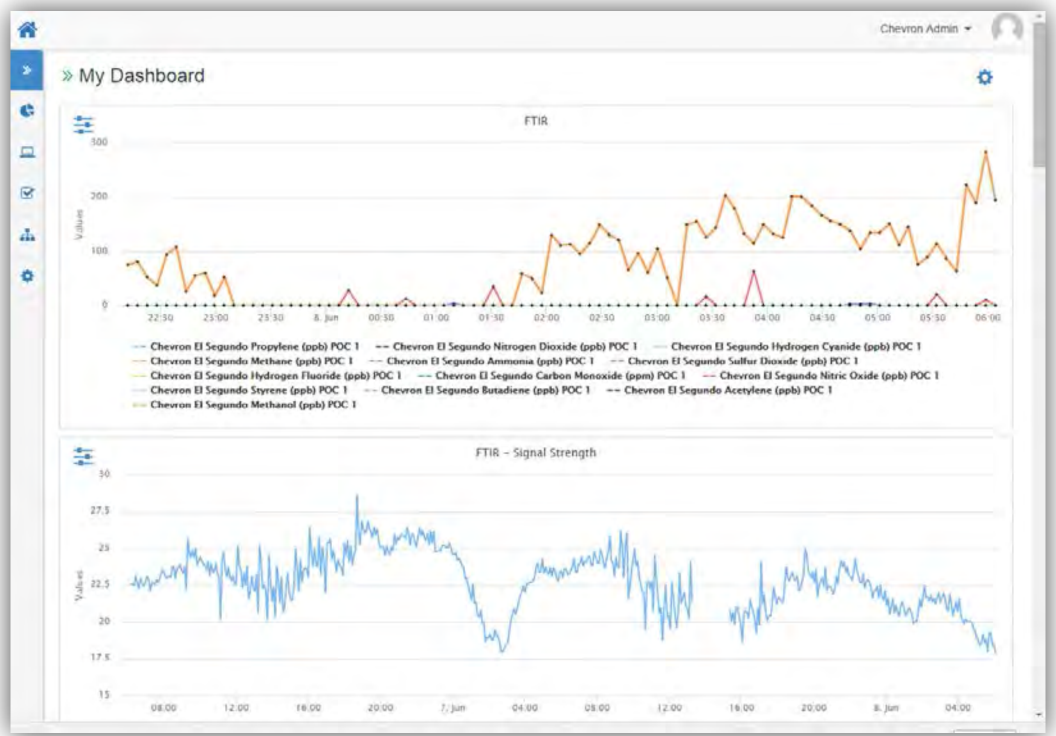

Figure 3. Example of a non-public field operations website used for daily review of instrument operations.

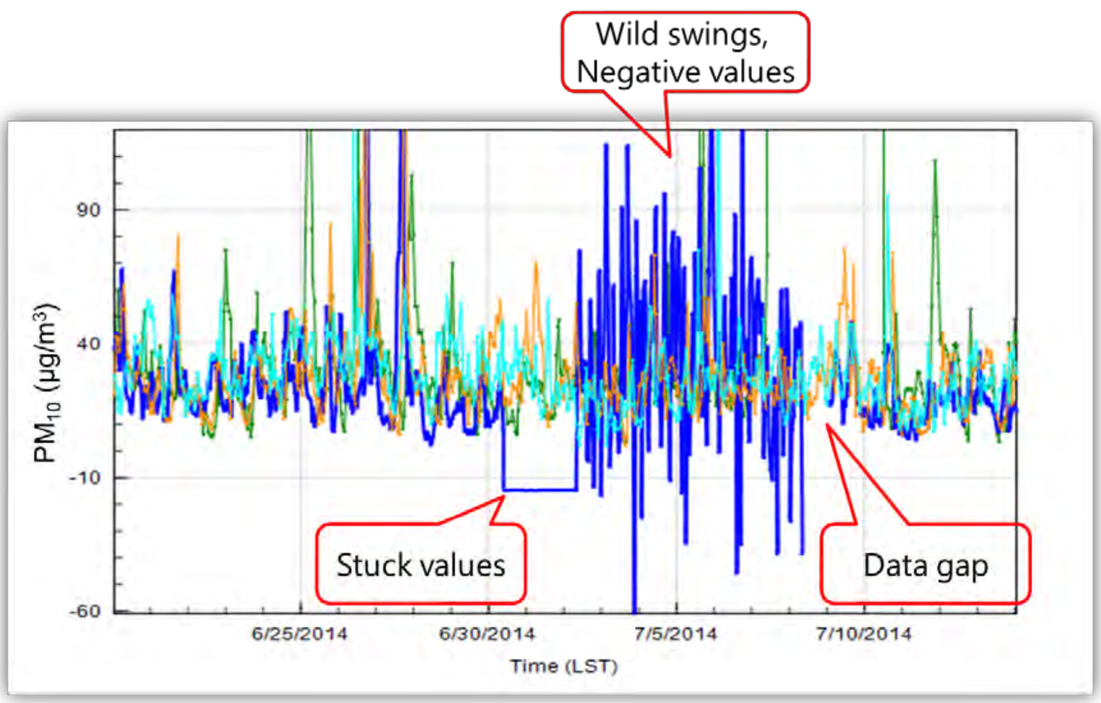

Figure 4. Example of species concentration time series showing stuck values, wild swings, large negative values, and a data gap. Such features in the data indicate instrument issues.

Once it is clear that instruments are operational, the next step will be to review whether the species concentration patterns are reasonable with respect to the time of day, season, meteorology, facility operations, and concentrations are expected and observed at other sites. If anomalies are observed, additional analysis will be conducted to determine whether there is an instrument malfunction or the data are truly anomalous, but explainable and valid. These subjectively reviewed data are considered **Level 1.0**.

In addition to auto-screening and daily visual checks, data will be subjected to more in-depth review on a quarterly basis and when data fail screening. These data are considered **Level 2.0.** Final data sets will be compiled quarterly, 60 days after each quarter's end and will be provided to the SCAQMD. Chevron will maintain a data record for five years consistent with Rule 1180.

Any corrections or updates will be copied to the public website. Validation checks will include:

- Looking for statistical anomalies and outliers in the data.
- Inspecting several sampling intervals before and after data issues, bump tests, or repairs.
- Evaluating monthly summaries of minimum, maximum, and average values.
- Ensuring data reasonableness by comparing to remote background concentrations and average urban concentrations.
- Referring to site and operator logbooks to see whether some values may be unusual or questionable based on observations by site operator.
- Ensuring that data are realistically achievable, i.e., not outside the limits of what can be measured by the instrument.
- Confirming that bump tests were conducted and were within specifications.

These in-depth analyses typically require data that are not available in real time and ensure that the data on the website are updated.

On a quarterly basis, to ensure daily QC tasks are complete, analysts will:

- Review any instrument bump test results.
- Verify that daily instrument checks were acceptable.
- Review manual changes to operations/data, and verify that the changes were logged and appropriately flagged.
- Ensure that daily bump tests or instrument checks have the appropriate QC codes applied.

On a quarterly basis, analysts will subject the data to final QC including filling in missing records with null values, and adding Null Codes.

- If a record is not created for a particular site/date/time/parameter combination, a null record will be created for data completeness purposes.
- Assign a Null Code (a reason for being invalidated) to invalid data.
- Inspect data consistency over three months.

- Review ranges of values for consistency—ranges should remain consistent over months of monitoring.
- Check bump test values for consistency.
- Review data completeness.

Actions will be documented to retain the raw data and support traceability of actions taken to produce the data on the website.

On an annual basis, Chevron or its designated contractor will review the performance of the network by reviewing the data completeness by monitoring path, instrument, and species; by reviewing results of bump tests; by analyzing the reported values in the context of refinery operations; and by analyzing the data in the context of the meteorology. The results will be summarized in a technical memorandum and provided to the SCAQMD upon request.

Data flagged through auto-screening checks will be graphically reviewed. QC flags will be updated as needed with daily, monthly, and quarterly actions (see Figure 5), and the QC flags will be updated on the public website as needed. DMS keeps track of data QC changes.

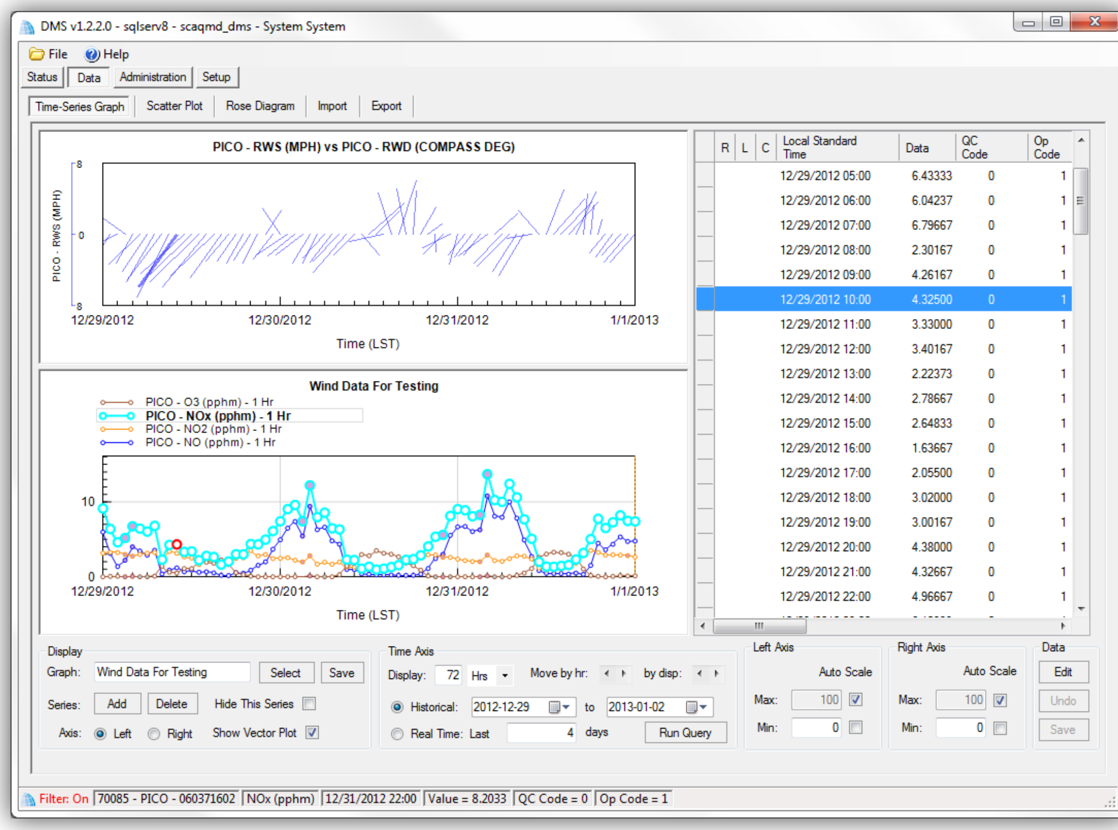

Figure 5. Screenshot of a typical DMS showing winds and species concentrations. Actual screen(s) may vary.

4.5 Data Storage and Processing

The DMS data will be backed up on a daily basis. Backup media will be moved weekly to a secure offsite facility. The data will be stored for a period of five years after sampling.

4.6 Data Delivery

Each quarter, annual summary information will be provided to the website, such as average concentration of each species by month, season, and year; maximum and minimum hourly values; and, as appropriate, explanations for any values that are well above background concentrations.

Final data sets will be compiled quarterly, 90 days after each quarter, and made available to the public on the website in graph format. Validated data will be provided to the SCAQMD annually. Data graphs will be stored and available on the website for a period of one year. Chevron will maintain data records for five years.

4.7 Data Flow to Website

4.7.1 Auto-Screening and Alert Review

All data values that are not associated with bump tests, other instrument maintenance, or instrument problems will be displayed to the public in near-real time. If data are subsequently proven to be invalid, they will be removed from the public display.

A non-public field operations website will be used for daily graphical review of the data. Common problems include flat signal/constant values, no signal/missing data, extremely noisy signal, rapid changes (spikes or dips), and negative values. An initial review, typically of a three- to five-day time-series plot of selected parameters for each instrument, allows the analyst to see common problems and verify instruments are operational. If it appears that an instrument is not operating, or the data are missing, the field operator will be notified and further investigation and corrective action, if needed, will be taken.

Data are screened in real time upon ingest into the DMS, as described in previous sections. Automated procedures will be used to ensure that data are properly ingested, stored, processed, and quality-assured, and that products are delivered to a public-facing website in real time, defined here as 10 minutes or less after the data are collected.

The preliminary QC'd data will be presented in a time series of concentrations of pollutants listed in Table 1; visibility; wind speed; and wind direction. Data will be provided as 1-hr running averages, updated every 5 minutes. It is easier to provide comparisons to levels of concern and to other areas using 1-hr averages because there are little or no 5-minute data available to the public for these compounds. Data will be color-coded and annotated for quality (valid, invalid, flagged, missing).

4.7.2 Data Backfill Process and Schedule

Prescreened, raw data in DMS will be augmented with validated data within 90 days after the end of the calendar quarter. Raw data graphs on the public website will be replaced with validated data graphs. All data, raw and validated, are retained in the DMS.

5. Routine Equipment and Data Audits

Rule 1180 specifically calls for "procedures for implementing quality assurance by a qualified independent party, including quality control and audits of the fenceline air monitoring systems."[9] The audit procedures outlined here were informed by published EPA methods and recommendations. These methods will be used in the finalization of the QAPP. Quality assurance takes two forms. Internal quality assessment is conducted or arranged within Chevron as directed by the QA Manager. External QA will be provided by a third party to be determined at a later date.

The following is a list of internal and external assessment tools used by the Chevron refinery:

Internal Audits

- Data quality assessments – as requested by QA Manager
- Performance evaluations – initial, semiannual
- Flow rate audits – initial, quarterly
- Internal technical system audits – initial, 3 to 5 years

External Audits (by Third Party)

- Third-party performance audit – initial, annual
- Third-party technical systems audit – every 3 years

The audit function has two components: the system audit (in essence, a challenge to the QAPP) and the performance audit (a challenge to the individual measurement systems).

The system audit provides an overall assessment of the commitment to data validity; as such, all commitments made in the QAPP should be subject to challenge. Typical questions asked in the systems audit include, "Are standard operating procedures being followed?" and "Are there any errors in the data flow from the instrument to the website?" During this audit, the QA Manager reviews the calibration sources and methods used, compares actual test procedures to those specified in this protocol, and reviews data acquisition and handling procedures. The QA Manager also reviews instrument calibration records and gas certificates of analysis. All deficiencies should be recorded in the audit report along with an assessment of the likely effect on data quality. Corrective actions related to a systems audit should be obvious if the appropriate questions are asked.

The performance audit is similar to a calibration in terms of the types of activities performed—all the performance audit adds is an independent assurance that the calibrations are done correctly and that the documentation is complete and accurate. In the ideal case, when both the auditor and site operator are equally knowledgeable, the auditor functions as an observer while the site operator performs the calibration; in this instance, the auditor functions in a "hands-off" mode. In initial audits,

[9] Refinery Fenceline and Community Air Monitoring (Rule 1180; approved by the SCAQMD on December 1, 2017). Available at http://www.aqmd.gov/docs/default-source/rule-book/reg-xi/r1180.pdf?sfvrsn=9.

since newly hired site operators may have little or no experience with instruments, the hands-off approach may not be practical or desirable. In these instances, the audit may also function as a training exercise for the site operator.[10] **Table 13** describes acceptance testing parameters for the sensors described in this monitoring plan.

Where possible, NIST-traceable gas standards should be used for the UVDOAS, FTIR, and H_2S instruments. All open-path instruments will be challenged with the appropriate gas with a short path ancillary cell. The exact method will depend on the instrumentation selected and whether a built-in cell is available.

The Aethalometer should be subjected to both a leak check and flow rate check. The simplest acceptance test for temperature is a two-point test using room temperature and a stirred ice slurry. A mercury-in-glass thermometer with an up-to-date calibration can be used to verify agreement to within 1°C. For anemometers, the instrument is challenged with various rotation rates to test the performance from the transducer in the sensor to the output. For the wind sensor, the starting torque of the bearing assembly is measured and compared to the range of values provided by the manufacturer.[10] The visibility measurement will be challenged using a special optic having a known extinction value. Additional details about calibration procedures will be provided in the final version of this QAPP once the instrument brands have been selected.

The QA Manager, during the course of any assessment or audit, shall identify to the technical staff performing experimental activities any immediate corrective action that should be taken. If serious quality problems exist, the QA Manager is authorized to stop work. Once the assessment report has been prepared, the Field Staff Manager ensures that a response is provided for each adverse finding or potential problem and implements any necessary follow-up corrective action. The QA Manager shall ensure that follow-up corrective action has been taken.

[10] U.S. Environmental Protection Agency (2000) Meteorological monitoring guidance for regulatory modeling applications. Office of Air Quality Planning and Standards, Research Triangle Park, NC, Document EPA-454/R-99-005, February. Available at http://www.epa.gov/scram001/guidance/met/mmgrma.pdf.

Table 13. Description of performance audits for the systems described herein.

Sensor	Test	Acceptance Criteria
UVDOAS	5 ppm Benzene; 0.5 m QA cell for 500 m path	±20%
FTIR	5 ppm NH_3; 0.5 m QA cell for 500 m path	±20%
H_2S Monitor	100 ppb	±10%
Aethalometer	Bubble flow meter, internal leak check	±10%
Temperature	Two point test	±0.5ºC
Relative Humidity	Hygrometer	±7%
Wind Speed	Starting threshold test; transfer function test	±0.25 m/s below 5 m/s and ±5% above 5 m/s
Wind Direction	Angle verification	±5 degrees
Visibility	Extinction	±10%

6. Standard Operating Procedures

Instrument-specific SOPs will be provided after instrument brand selection.