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Torrance Refining Company LLC
Torrance, California

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VOLUME I - TORRANCE REFINERY RULE 1180 PLAN

TORRANCE, CALIFORNIA

REVISION HISTORY

Revision	Date	Prepared by	Approved by	Comment
Revision 0.1	July 27, 2018	Glenn England	Scott Weaver	For SCAQMD review
Revision 1.1	November 30, 2018	Glenn England	Scott Weaver	For SCAQMD review

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ACRONYMS AND ABBREVIATIONS

Acronym	Definition
AAM	annual arithmetic mean
AB	Assembly Bill
AC	alternating current
AEGL	acute exposure guideline levels
AER	annual emissions report
AERMOD	American Meteorological Society/Environmental Protection Agency regulatory model
AIHA	Industrial Hygiene Association
AQ	air quality
AQ-SPEC	Air Quality Sensor Performance Evaluation Center
BC	black carbon
BNSF	Burlington Northern Santa Fe
CAAQS	California Ambient Air Quality Standards
CAPCOA	California Air Pollution Control Officers Association
CARB	California Air Resources Board
CCD	charge-coupled device
CHD	catalytic desulfurization
CO	carbon monoxide
DIAL	differential absorption light detection and ranging
DOE	Department of Energy
DTLAGS	L-alanine doped triglycine sulfate
EIR	Environmental Impact Report
EPA	Environmental Protection Agency
ERPG	Emergency Response Planning Guidelines
FAQ	frequently-asked-questions
FCCU	fluid catalytic cracking unit
FEM	Federal equivalent method
FRM	Federal reference method
GB	gigabytes
GHz	gigahertz
GIS	geographic information system
H_2S	hydrogen sulfide
HARP2	Hotspots Analysis and Reporting Program
HF	hydrofluoric acid
ICR	Information Collection Request
IDLH	immediately dangerous to life and health
IH	industrial hygiene
LPG	liquid petroleum gas
LPM	liter per minute
m^2/g	square meters per gram
MAC	mass absorption cross-section
MCT	mercury-cadmium-telluride
mg/m^3	milligrams/cubic meter
NAAQS	National Ambient Air Quality Standards
NIOSH	National Institute for Occupational Safety and Health

Acronym	Definition
NMHC	non-methane hydrocarbons
NO	nitric oxide
NO_2	nitrogen dioxide
NO_X	oxides of nitrogen
O_3	ozone
OEEHA	Office of Environmental Hazard and Health Assessment
OP-FTIR	open path Fourier transform infrared spectroscopy
OP-TDLAS	tunable diode laser absorption spectroscopy
OP-UVDOAS	open path ultraviolet differential optical absorption spectroscopy
PAC	protective action criteria
PAH	polycyclic aromatic hydrocarbons
PAX	photoacoustic extinctiometer
PCB	polychlorinated biphenyl
PERP	portable equipment registration program
PM	particulate matter
PM_{10}	particulate matter with aerodynamic diameter of 10 microns and smaller
$PM_{2.5}$	particulate matter with aerodynamic diameter of 2.5 microns and smaller
ppb	parts per billion
ppm	parts per million
QA	quality assurance
QAPP	quality assurance project plan
QC	quality control
R1180	Rule 1180
REL	reference exposure level
RH	relative humidity
SCAQMD	South Coast Air Quality Management District
SiC	silicon carbide
SO_2	sulfur dioxide
SOP	standard operating procedure
SRA	Source/Receptor Area
TAC	toxic air contaminant
TBD	to be determined
TEEL	temporary emergency exposure limit
TORC	Torrance Refining Company
TRI	Toxic Release Inventory
TYP	typical
USB	universal serial bus
USEPA	United States Environmental Protection Agency
UTM	Universal Transverse Mercator coordinate system
UV	ultraviolet
VAC	voltage alternating current
VDC	voltage direct current
VOC	volatile organic compound
WSW	west-southwest
ZnSe	zinc selenide

Acronym	Definition
$\mu g/m^3$	micrograms per cubic meter

1. EXECUTIVE SUMMARY

This document presents the Torrance Refining Company's plan for a fenceline air monitoring system that will be installed at the Torrance Refinery to comply with South Coast Air Quality Management District Rule 1180 *Refinery Fenceline and Community Air Monitoring.*[1] This Plan is intended to satisfy the requirements of Rule 1180 and its associated *Refinery Fenceline Air Monitoring Guidelines*.[2] Rule 1180 was adopted on December 1, 2017 and states:

> *"The purpose of this rule is to require real-time fenceline air monitoring systems and to establish a fee schedule to fund refinery-related community air monitoring systems that provide air quality information to the public about levels of various criteria air pollutants, volatile organic compounds, metals, and other compounds, at or near the property boundaries of petroleum refineries and in nearby communities."*

Rule 1180 applies to petroleum refineries within the jurisdiction of the District, including the Torrance Refinery, and addresses requirements for both community monitoring stations that will be designed, installed and operated by the District in communities near Southern California refineries and the fenceline air monitoring systems to be designed, installed and operated by each refinery. The Rule requires refineries to prepare a fenceline air monitoring plan for review and approval by SCAQMD, and fully implement the fenceline air monitoring system within one year following SCAQMD approval. California state Assembly Bill 1647[3] ("AB1647"), effective October 17, 2017, also requires that the *"…refinery shall develop, install, operate, and maintain a fence-line monitoring system…on or before January 1, 2020."*

This Plan is intended to be fully responsive to the requirements of the Rule and Guidelines. The Torrance Refinery's goal is to provide the public with monitoring results in a manner that provides meaningful information to help understand the refinery's contribution to air quality in nearby communities.

1.1 The Torrance Refinery

The Torrance Refinery[4] was built in 1929, covers approximately 750 acres, and has more than 580 employees, with another 300-500 contractors working there on a daily basis. It processes an average of approximately 155,000 barrels of crude oil per day. The Torrance Refinery refines crude oil to produce gasoline, diesel fuel, aviation fuels, liquefied petroleum gases, coke, and sulfur. It has a perimeter fenceline that extends approximately 4.3 miles (6860 meters) along heavily-travelled thoroughfares within the City of Torrance.

1.2 Torrance Refinery Fenceline Air Monitoring System Description

The fenceline air monitoring system will incorporate a combination of "open path" analyzers the measure pollutant concentrations along a path of light and "point" analyzers that measure pollutant concentrations at a fixed location, in real time. The System as described

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[1] Rule 1180 *Refinery Fenceline and Community Air Monitoring; South Coast Air Quality Management District, 2017. See* http://www.aqmd.gov/docs/default-source/rule-book/reg-xi/r1180.pdf?sfvrsn=9 (accessed July 2018).

[2] Rule 1180 Refinery Fenceline Air Monitoring Plan Guidelines; South Coast Air Quality Management District: Diamond Bar, CA, 2017. See http://www.aqmd.gov/docs/default-source/rule-book/support-documents/1180/rule-1180-guidelines.pdf (accessed July 2018).

[3] *AB-1647 Petroleum refineries: air monitoring systems*; California Legislative Information. See https://leginfo.legislature.ca.gov/faces/billTextClient.xhtml?bill_id=201720180AB1647 (accessed July 2018).

[4] Torrance Refining Company Home Page. See https://torrancerefinery.com/about-us-2/ (accessed July 2018).

in this Plan will include paths that will actively monitor pollutant concentrations along approximately 85 percent of the refinery perimeter fenceline. These paths will border residential, commercial and industrial communities on all sides of the refinery and provide near-complete coverage on the predominantly downwind sides. This Plan presents the layout of the paths and monitors along or near the fenceline and an analysis of refinery air emissions, air quality impacts in the nearby communities and locations of sensitive receptors to support the System arrangement.

The System described in this Plan will be capable of continuously monitoring pollutant concentrations at levels sufficiently low to compare with health-based air quality thresholds and standards. This will provide useful information to nearby communities, especially the most sensitive community members, for understanding day-to-day air quality. The system will monitor concentrations of chemicals listed in the Rule that are or may be emitted by the refinery. These include "criteria" air pollutants for which federal air quality standards are established and volatile organic and other compounds. This Plan presents details of the technologies and instruments that will be employed. The System will be operated and maintained in accordance with a comprehensive quality assurance plan to ensure that the System produces reliable, high-quality data.

The monitoring data will be made available to the nearby communities and the public via an internet website. The website will display the data in "real time" as the data are collected and processed. The data management system will collect and process the monitoring data, automatically check data quality, and provide updated data every five to ten minutes for display. The data will be displayed in a transparent, clear, understandable and contextual manner to provide the most useful information. The data will be reviewed by the System manager on a quarterly basis, compiling summaries in quarterly reports that will be posted on the website, and as needed in response to monitoring events. The website also will provide a means for subscribers to provide comments and feedback and to receive email message notifications of monitoring events. TORC will conduct public outreach efforts during implementation to engage community stakeholders and provide information regarding the System.

1.3 Torrance Refinery Fenceline Air Monitoring System Implementation

The Torrance Refinery has overall responsibility for development, implementation and operation of the fenceline air monitoring system (Figure 1-1). Once this Plan is approved by the District, the refinery will proceed with implementation and operation. The key steps for implementing the system include planning, engineering, equipment procurement, construction, installation, start-up, commissioning, beta testing and, finally, continuous operation. These are discussed later in this Plan.

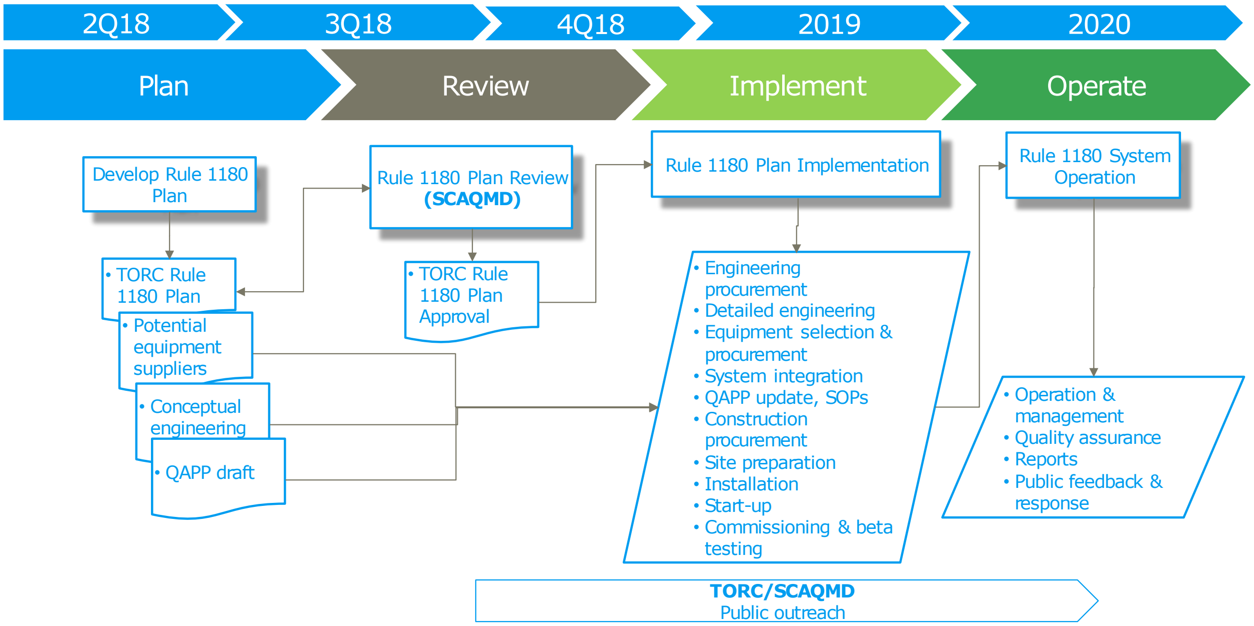

Figure 1-1: Project timeline

2. INTRODUCTION

This document presents the Torrance Refining Company ("TORC") plan for a fenceline air monitoring system that will be installed at the Torrance Refinery to comply with South Coast Air Quality Management District ("SCAQMD") Rule 1180 *Refinery Fenceline and Community Air Monitoring*[5] (the "Rule"). This Plan is intended to satisfy the requirements of Rule 1180 and its associated *Refinery Fenceline Air Monitoring Guidelines*.[6] (the "Guidelines")

2.1 Regulatory Setting

Rule 1180 was adopted on December 1, 2017. As stated in the Rule,

"The purpose of this rule is to require real-time fenceline air monitoring systems and to establish a fee schedule to fund refinery-related community air monitoring systems that provide air quality information to the public about levels of various criteria air pollutants, volatile organic compounds, metals, and other compounds, at or near the property boundaries of petroleum refineries and in nearby communities."

The Rule applies to refineries within the jurisdiction of the SCAQMD, including the Torrance Refinery. It addresses requirements for both community monitoring stations that will be designed, installed and operated by SCAQMD in communities near Southern California refineries and air monitoring systems to be designed, installed and operated on the fenceline of each refinery.

The Rule requires refineries to prepare a fenceline air monitoring plan ("Plan") for review and approval by SCAQMD, and fully implement the fenceline air monitoring system ("System") within one year following SCAQMD approval. California state Assembly Bill 1647[7] ("AB1647"), effective October 17, 2017, also requires that the *"…refinery shall develop, install, operate, and maintain a fence-line monitoring system…on or before January 1, 2020."*

2.2 Project Roles

TORC has overall responsibility for development, implementation and operation of the fenceline air monitoring system (Figure 2-1). Ramboll US Corporation ("Ramboll") prepared this Plan on behalf of TORC and will support TORC during SCAQMD review of the plan. Once the Plan is approved by SCAQMD, TORC will proceed with implementation and operation.

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[5] Rule 1180 *Refinery Fenceline and Community Air Monitoring; South Coast Air Quality Management District, 2017. See* http://www.aqmd.gov/docs/default-source/rule-book/reg-xi/r1180.pdf?sfvrsn=9 (accessed July 2018)

[6] Rule 1180 Refinery Fenceline Air Monitoring Plan Guidelines; South Coast Air Quality Management District: Diamond Bar, CA, 2017. See http://www.aqmd.gov/docs/default-source/rule-book/support-documents/1180/rule-1180-guidelines.pdf (accessed July 2018).

[7] *AB-1647 Petroleum refineries: air monitoring systems*; California Legislative Information. See https://leginfo.legislature.ca.gov/faces/billTextClient.xhtml?bill_id=201720180AB1647 (accessed July 2018).

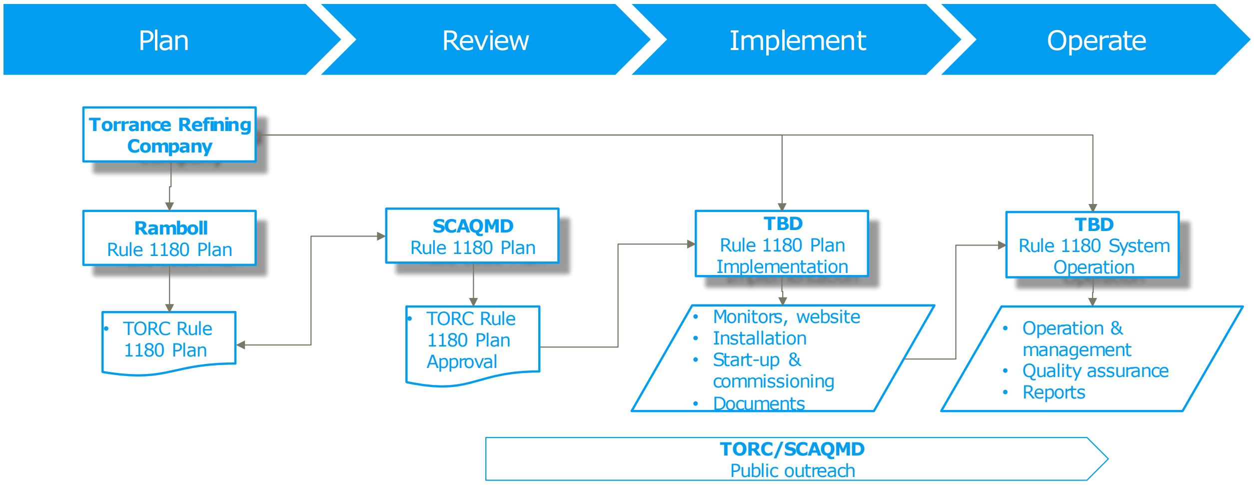

Figure 2-1: Project roles

2.3 Plan Organization and Crosswalk

This Plan (Volume I) is presented in the following sections:

- 1 – Executive Summary
- 2 – Introduction
- 3 – Refinery Description
- 4 - Target Pollutants
- 5 – Monitor Paths & Siting
- 6 – Monitoring Systems
- 7 – Data Display and Website
- 8 – Stakeholder Outreach & Communications
- 9 – Quality Assurance
- 10 – Implementation Plan

A draft quality assurance project plan (QAPP) was prepared in accordance with the Guidelines.[8] Table 2-1 provides a crosswalk indicating where Plan information specified in the Rule and Guidelines is addressed in the sections of this Plan and in the QAPP.

Table 2-1: Rule 1180 and Fenceline Air Monitoring Plan crosswalk

Section	Rule 1180 Plan Elements	Rule/Guidance Reference
Volume I – Torrance Refinery Rule 1180 Plan		
3.1, 5.1	*Distribution of operations and processes*	Rule 1180 Guidelines section 1.
3.3, 5.1	*Evaluation of emission sources at the refinery*	Rule 1180 Guidelines section 1.

[8] *Volume II - Quality Assurance Project Plan, Torrance Refinery Rule 1180 Fenceline Air Monitoring System*, Revision 0.1, prepared for Torrance Refining Company, Ramboll US Corporation, Irvine, California, July 27, 2018.

Table 2-1: Rule 1180 and Fenceline Air Monitoring Plan crosswalk

Section	Rule 1180 Plan Elements	Rule/Guidance Reference
3.3, 5.1	*Assessment of air pollutant distribution in surrounding communities*	Rule 1180 Guidelines section 1.
3.3, 5.1	*Identify the facility's proximity to sensitive receptors affected by the refinery operation:* *- 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*	Rule 1180 Guidelines Checklist
3.3, 5.1	*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*	Rule 1180 Guidelines Checklist
3.3, 5.1	*Explanation of background concentrations and/or contributions from other sources*	Rule 1180 Guidelines section 5.
3.3, 5.2	*Specify proximity of proposed monitoring equipment to residences and sensitive receptors*	Rule 1180 Guidelines section 2(e)
3.3	*Chemical compounds associated with health risk and those measured at other ambient air monitoring locations should be identified in the air monitoring plans.*	Rule 1180 Guidelines section 2(a)
3.3	*Identify potential compounds that pose the highest risk in nearby communities*	Rule 1180 Guidelines section 2(a)(i)
4	*Explanation for Pollutants to be monitored*	R1180(d)(3); R1180 guidelines section 1.
4.2	*[Identify] specified VOCs to represent refinery fugitive emissions and/or health risk drivers.*	Rule 1180 Guidelines section 2(a)(i)
5.1	*siting & selected pathways*	Rule 1180 Guidelines section 1.
5.1	*Identify pollutant "hot spots" along fenceline*	Rule 1180 Guidelines section 2(a)(i); 2(e)(iii)
5.1	*Specify areas along the perimeter that are likely to detect compounds associated with refinery operations*	Rule 1180 Guidelines section 2(e)
5.2	*Siting Specifications*	R1180(d)(2)(B); R1180 guidelines section 2e.

Table 2-1: Rule 1180 and Fenceline Air Monitoring Plan crosswalk

Section	Rule 1180 Plan Elements	Rule/Guidance Reference
5.2	*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*	Rule 1180 Guidelines Checklist
5.2	*GIS coordinates for equipment sites*	Rule 1180 Guidelines section 2(e)
5.2	*Elevations at which equipment will be placed*	Rule 1180 Guidelines section 2(e)
5.2	*Length of each monitored path*	Rule 1180 Guidelines section 2(e)
5.2	*Rationale for choosing equipment sites and paths*	Rule 1180 Guidelines section 2(e)
5.3	*Meteorological Equipment*	R1180(d)(2)(C); R1180 guidelines section 3.
5.3	*Meteorological monitor siting considerations and equipment*	Rule 1180 Guidelines section 3
6.3	*Detailed Information about Continuous Monitoring Equipment along with detection limits and detectable pollutants*	R1180(d)(2)(A); R1180 guidelines section 2c.
6.3	*Fenceline air monitoring instruments & ancillary equipment*	Rule 1180 Guidelines section 1.
6.3	*Instrument specifications, detectable pollutants, minimum and maximum detection limits, time resolution capabilities*	Rule 1180 Guidelines section 1; 2(c).
6.3	*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*	Rule 1180 Guidelines Checklist
7	*Web-based system for disseminating information*	Rule 1180 Guidelines section 1.

Table 2-1: Rule 1180 and Fenceline Air Monitoring Plan crosswalk

Section	Rule 1180 Plan Elements	Rule/Guidance Reference
7	*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*	Rule 1180 Guidelines Checklist
7	*If [5-minute average] is not feasible, provide rationale for any time resolutions greater than 5-minute average*	Rule 1180 Guidelines section 2(b)
7	*Describe how the system will effectively provide relevant information for all nearby downwind communities*	Rule 1180 Guidelines section 2(e)(iv)
7.1, 7.2	*Means for providing automated, reliable, useful, understandable information*	Rule 1180 Guidelines section 5.
7.1	*Data Handling*	R1180(d)(2)(G); R1180 guidelines section 5.
7.2	*Information and examples of how QC'd data will be displayed and steps taken to provide context to the public*	Rule 1180 Guidelines section 5.
7.3	*Details of public notification system*	Rule 1180 Guidelines section 6.
7.3	*Identify alternative methods of accessing periodic reports for non-internet users*	Rule 1180 Guidelines section 5.

Table 2-1: Rule 1180 and Fenceline Air Monitoring Plan crosswalk

Section	Rule 1180 Plan Elements	Rule/Guidance Reference
7.4	*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*	Rule 1180 Guidelines Checklist
8	*Public Outreach Program*	Rule 1180 Guidelines section 5.
10	*Implementation schedule*	R1180(d)(2)(F); R1180 guidelines section 1.
Volume II – Quality Assurance Project Plan		
Volume II	*Equipment maintenance and failure procedures*	R1180(d)(2)(D); R1180 guidelines section 1.
Volume II	*Quality Assurance Procedures*	R1180(d)(2)(E); R1180 guidelines section 4.
Volume II	*Demonstration of independent oversight*	Rule 1180 Guidelines section 1.
Volume II	*Operation & maintenance requirements*	Rule 1180 Guidelines section 1.
Volume II	*Procedures for implementing data QA/QC*	Rule 1180 Guidelines section 1.
Volume II	*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*	Rule 1180 Guidelines Checklist
Volume II	*Quality assurance - personnel training, documentation, SOPs, routine maintenance, calibration checks, technical audits, data verification and validation, data quality assessment, monitoring network and instrumentation goals, required data quality, data acceptance, data review and management, definitions, procedures.*	Rule 1180 Guidelines section 4

3. FACILITY DESCRIPTION

3.1 Rule 1180 Guideline Requirements

The Guidelines specify that the Plan must address the following elements related to the facility description:

- Evaluation of emission sources at the refinery;
- Distribution of operations and processes;
- Assessment of air pollutant distribution in surrounding communities;
- Identify the facility's proximity to sensitive receptors affected by the refinery operation:
  - Distance from facility to closest sensitive receptor(s);
  - Location of downwind and upwind communities; and
  - 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
- Identify potential compounds that pose the highest risk in nearby communities
- Explanation of background concentrations and/or contributions from other sources

These elements are addressed in this section of the Plan. Some aspects of these elements also are addressed in Section 5 of this Plan.

3.2 Refinery Operations and Emissions

The Torrance Refinery is located at 3700 W. 190th Street, in the City of Torrance, County of Los Angeles (Figure 3-1). The refinery was built in 1929, covers approximately 750 acres, and processes an average of approximately 155,000 barrels of crude oil per day.

The Torrance Refinery refines gasoline, diesel fuel, aviation fuels, liquefied petroleum gases, coke, and sulfur. Most of the production units are located near the center of the facility, including:

- Crude Unit
- Fluid Catalytic Cracking Unit (FCCU)
- Hydrocracker Unit
- Hydrogen Plants
- Alkylation Unit

- Catalytic Desulfurization (CHD) Unit
- Saturated and Unsaturated Gas Plants
- Liquid Petroleum Gas (LPG) Merox Unit
- Pretreater
- North and South Coker Units
- Hydrotreater Unit
- Fuel Gas Treating
- Sulfur Plant

The east side of the facility includes most of the product storage tanks, a coke handling facility and a wastewater treatment unit. The area near the southern boundary includes additional storage tanks and a flare area. The area near the western boundary includes loading and unloading operations that can be accessed via rail and truck. The northern boundary is the location of various administration buildings, offices, and a park with tennis courts and a baseball diamond (Pegasus Park).

The estimated emissions of Rule 1180 target pollutants from various source categories at the refinery (Table 3-1) are based on recent emissions estimates prepared to reflect in-progress changes in refinery equipment that will be completed in 2019. These are adapted from TORC's 2016 Annual Emissions Report (AER) submitted to the SCAQMD.[9] The majority of Rule 1180 target pollutant emissions are reported from external combustion sources (e.g., nitrogen oxides, acrolein, ammonia, and carbonyl sulfide), internal combustion sources (e.g., black carbon), storage tanks (e.g., benzene), and other process units (e.g., 1,3-butadiene, ethyl benzene, formaldehyde, toluene, and hydrogen cyanide).

3.3 Fenceline Description

The Torrance Refinery occupies a contiguous area of land between W. 190th Street to the north, Van Ness Avenue to the east, railroad tracks and Del Amo Boulevard to the south, and Prairie Avenue to the west. The entire refinery fenceline (Figure 3-2) spans a distance of approximately 6,860 meters (4.3 miles), with approximately 2,370 meters along the north boundary (parallel to W. 190th Street), 1,190 meters along the east boundary (parallel to Van Ness Avenue), 1,850 meters along the south boundary (parallel to Del Amo Boulevard), 800 meters along the southwest boundary (parallel to the train tracks, between Del Amo Boulevard and Prairie Avenue), and 650 meters along the west boundary (parallel to Prairie Avenue). The fenceline generally consists of an approximately six-foot tall concrete wall or chain link structure topped with barbed wire. Large portions of the fenceline are surrounded with vegetation, including mature trees and hedging (especially along the north fenceline).

9 Estimated emissions of sulfur dioxide are based on sulfur oxides emissions reported in the AER. Estimated emissions of black carbon are based on estimates of diesel exhaust particulate matter emissions. There are no estimated emissions of hydrogen fluoride because its process use is closed loop.

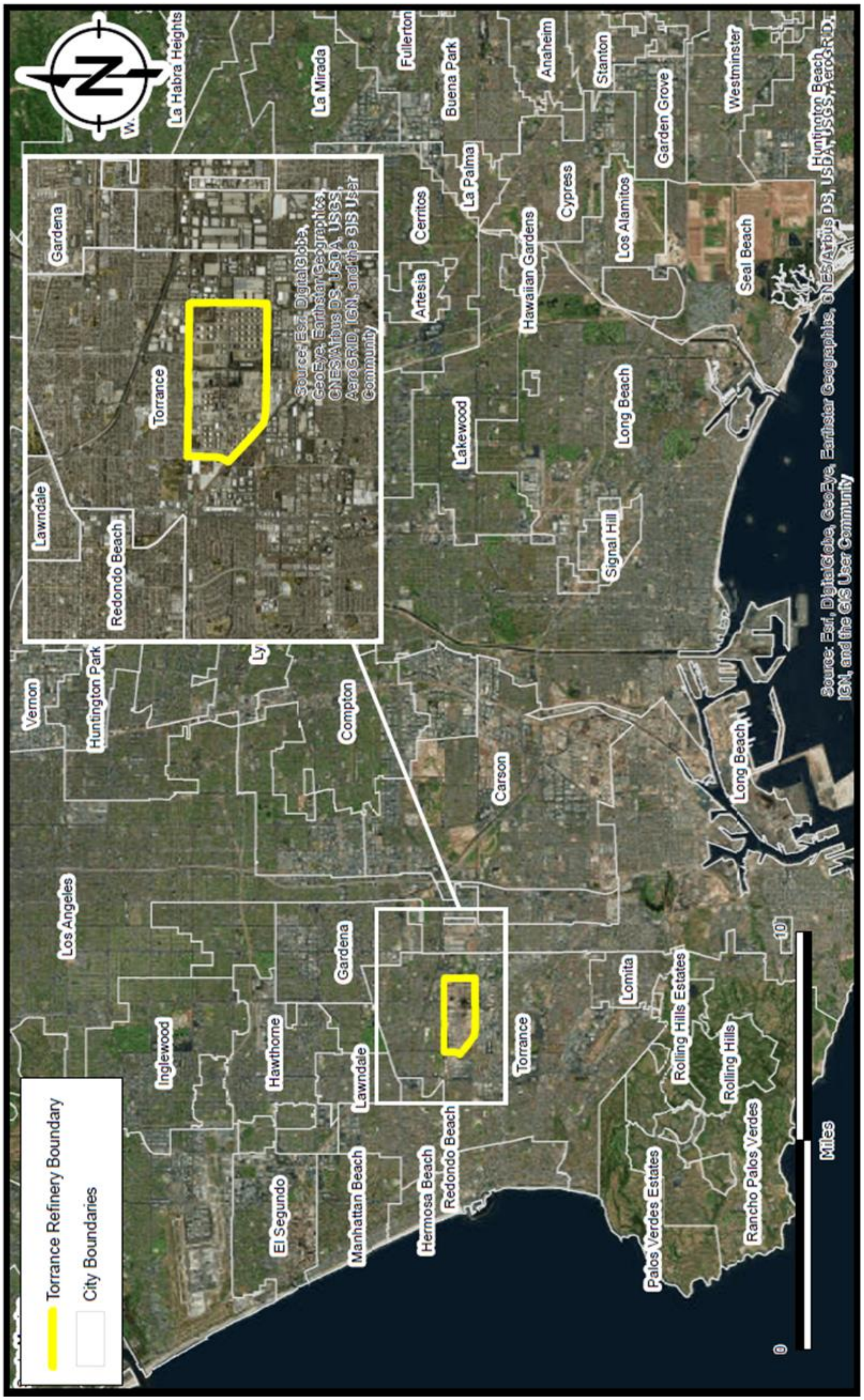

Figure 3-1: Refinery location and surrounding area

Table 3-1: Emissions of Rule 1180 pollutants from Torrance Refinery

Rule 1180 pollutants	Emissions (pounds/year)						
	External combustion	Fugitive components	Internal combustion	Other process emissions[10]	Spray coating s/booth s	Startup/ Shutdown/ Turnaround and Upsets	Storage tanks
Criteria air pollutants							
Sulfur dioxide	233,527	--	7,321	243,360	--	5	--
Nitrogen oxides	1,557,356	--	68,094	223,389	--	15	--
Volatile organic compounds							
Total VOCs[11]	141,234	678,513	32,312	378,204	139	18,973	72,086
Total VOC TACs	8,859	1,263	169	122,624	139	521	4,087
1,3-Butadiene	--	2.4	5.2	215	--	0.0052	19
Acetaldehyde	315	--	4.7	443	--	0.10	0.0086
Acrolein	372	--	1.1	5.9	--	0.15	--
Benzene	1,313	164	21	1,536	--	1.0	531
Ethyl benzene	358	4.7	9.3	1,073	--	7.4	86
Formaldehyde	1,504	--	19	8,021	--	0.45	--
Styrene	0.37	0.49	0.81	109	139	1.5	207 (0)[12]
Toluene	3,260	220	42	10,034	--	373	789
Xylenes	714	390	37	1,601	--	5.3	414
Hydrogen cyanide	--	2.3	--	67,518	--	--	--
Other Compounds							
Hydrogen sulfide	1,615	617	--	4,355	--	11	1,699

[10] Other process emissions include flares, FCCU startup heater and regenerator (common stack), fugitive coke emissions, coke drum vents, cooling tower vents, vacuum truck emissions, onsite laboratory, LPG bulk loading, tank degassing, hydrogen plant vents, and spray coating.

[11] Includes all VOC emissions reported in the AER. This includes VOCs not listed in Rule 1180 Table 1 including methanol, propylene, ethylene, etc.

[12] The 2016 AER estimated 209 pounds per hour of styrene emissions from residual oil storage tanks. This was based on a single residual oil laboratory analysis performed in the 2000s. TORC recently re-evaluated this estimate based on a new residual oil laboratory analysis which found no detectable styrene. Using the new test result, TORC's total annual emissions of styrene from storage tanks are now estimated to zero.

Table 3-1: Emissions of Rule 1180 pollutants from Torrance Refinery

Rule 1180 pollutants	Emissions (pounds/year)						
	External combustion	Fugitive components	Internal combustion	Other process emissions[10]	Spray coatings/booths	Startup/ Shutdown/ Turnaround and Upsets	Storage tanks
Carbonyl sulfide	293	--	--	61	--	--	--
Ammonia	88,525	421	--	875	--	5.4	0.51
Black carbon	--	--	473	--	--	--	--

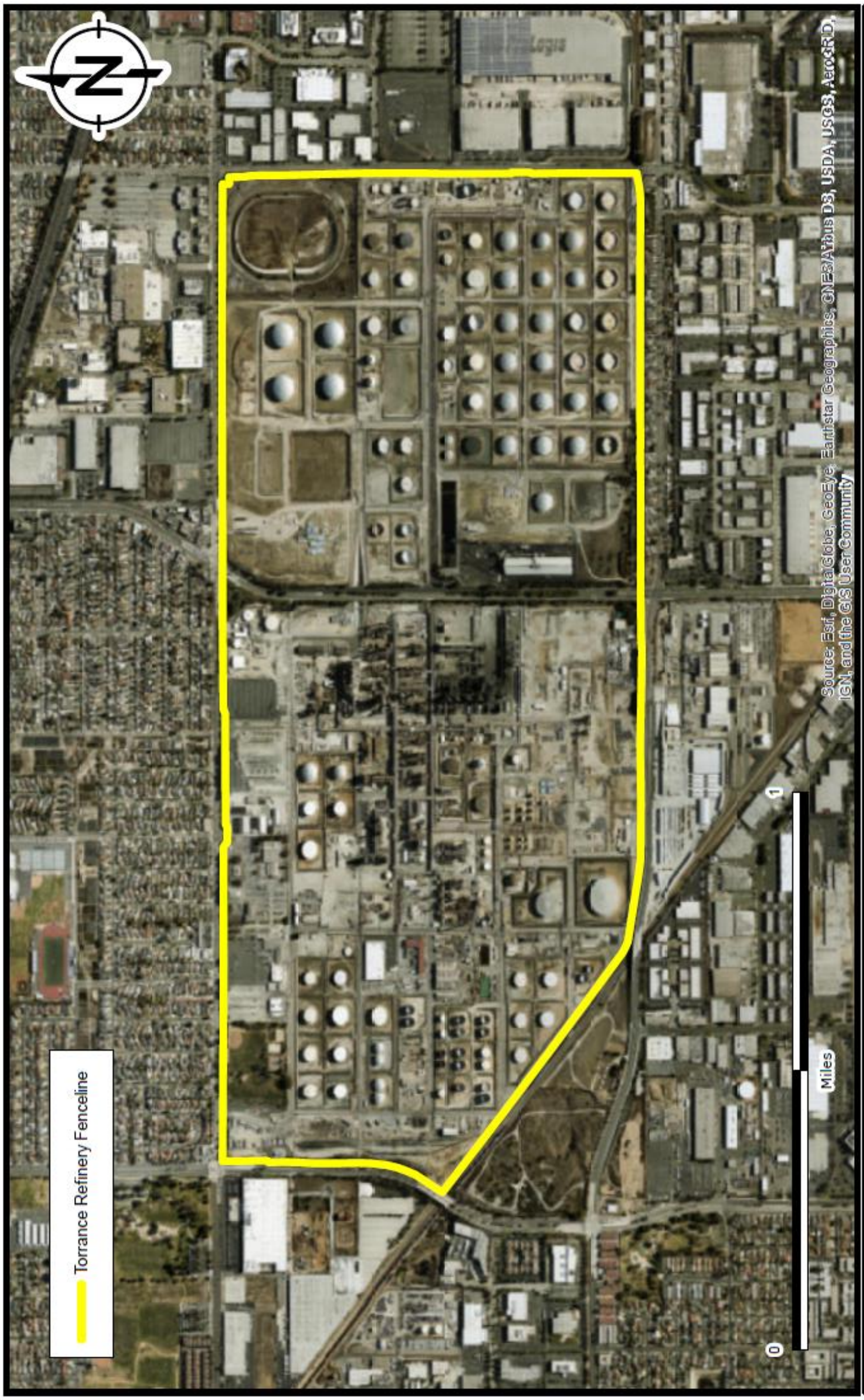

Figure 3-2: Torrance refinery fenceline

The refinery has several active access points along the perimeter fenceline allowing traffic entry/exit or transit, including the following:

- Gate 2 on W. 190th Street (west of Pegasus Park);
- Contractor Gate 3 on W. 190th Street (east of Pegasus Park);
- Main Gate on W. 190th Street;
- Contractor Gate 7 on W. 190th Street, approximately 500 meters east of the Main Gate;
- Gate along southwest boundary for railcars entering the loading/unloading area; and
- Crenshaw Boulevard, a six-lane two-way road on refinery property granted as an easement to the City of Torrance which transects the refinery in the north-south direction.

The topography of the facility is generally flat, with an average elevation along the fenceline of approximately 21 meters (range is 16 to 26 meters). Along the south fenceline, there is an approximately 350-meter portion of Del Amo Boulevard that is grade separated for a railcar underpass. The elevation difference between the elevated portion of Del Amo Boulevard and the fenceline is approximately 12 meters. In addition, along the west fenceline, there is an approximately 250-meter portion of Prairie Avenue that is elevated to create an underpass for railcars. The fenceline follows this overpass in the northbound direction (towards W. 190th Street) and reaches a maximum elevation of approximately 45 meters, which is approximately 21 meters higher than the adjacent loading/unloading area. These overpasses (and the associated underpasses for trains) have the potential to impact wind flow in these general areas of the facility.

3.4 Surrounding Land Uses

Land uses surrounding the facility (Figure 3-3)[13] are varied and include residential, commercial, industrial, business and public uses (Table 3-2):

Table 3-2: Land uses near Torrance Refinery fenceline

Fenceline Section	Primary Land Uses Adjacent to Fenceline				
	Residential	Commercial	Industrial	Business Park	Public/Open Space
North	√	√	√		√
East				√	
South	√	√	√		√
Southwest			√		
West			√		√

The closest residential areas are across W. 190th Street to the north and along Del Amo Boulevard near the south fenceline (east of Crenshaw Boulevard). Columbia Regional Park is located northwest of the refinery. Other land uses to the north, east, west, and south include

[13] *General Plan Land Use Policy Map*; City of Torrance, 2018.See https://www.torranceca.gov/home/showdocument?id=2778 (accessed July 2018).

industrial and commercial facilities, a BNSF rail line, and a business park. The areas surrounding the refinery can be characterized as a blend of heavy and light industrial, commercial, medium and high-density residential, and industrial/manufacturing. The refinery property is zoned by the City of Torrance as Heavy Manufacturing (M-2).

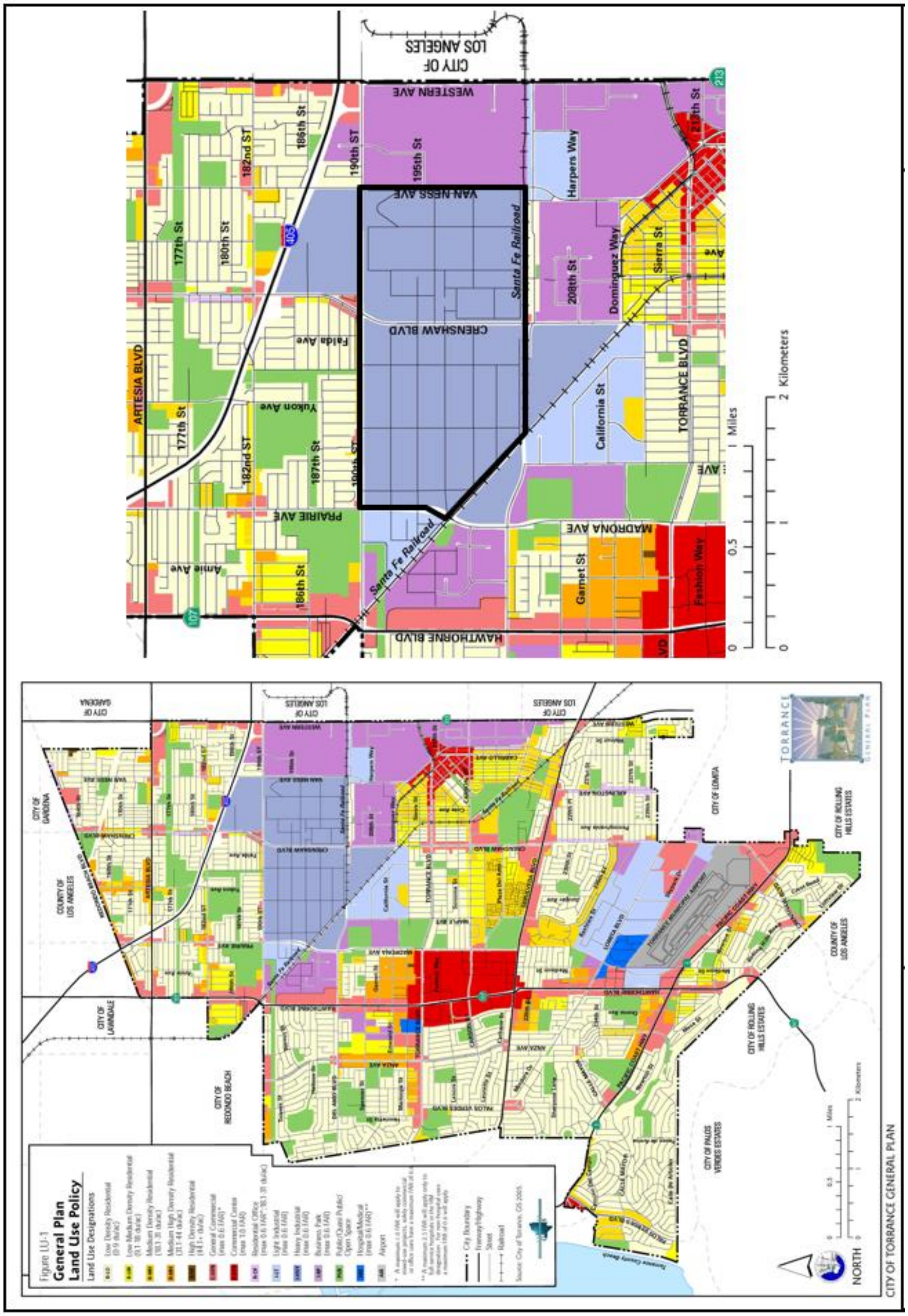

Figure 3-3: City of Torrance's general land use map showing land uses adjacent to the Torrance Refinery

3.5 Meteorological Conditions

The climate in the South Coast Air Basin (Basin) is characterized by sparse winter rainfall and hot summers tempered by cool ocean breezes. During the summer months, a warm air mass frequently descends over the cool, moist marine layer produced by the interaction between the ocean's surface and the lowest layer of the atmosphere. The warm upper layer forms a cap or "inversion" over the cool marine layer and inhibits the pollutants released into the marine layer from dispersing upward. In addition, light winds during the summer further limit dispersion. Finally, sunlight triggers the photochemical reactions which produce ozone, and this region experiences more days of sunlight than many other major urban areas in the nation.[14]

Wind flow patterns play an important role in the transport of air pollutants in the Basin. The winds flow from offshore and blow eastward during the daytime hours. In summer, the sea breeze starts in mid-morning, peaks around 10-15 miles per hour, and subsides after sundown. There is a calm period until about midnight. At that time, the land breeze begins from the northwest, typically becoming calm again about sunrise. In winter, the same general wind flow patterns exist except that summer wind speeds average slightly higher than winder wind speeds. This pattern of low wind speeds is a major factor that allows the pollutants to accumulate in the Basin. The normal wind patterns in the Basin are interrupted by the unstable air accompanying the passing storms during the winter and infrequent strong northeasterly Santa Ana wind flows from the mountains and deserts north of the Basin.[15]

The Hawthorne-Jack Northrop Field station, which is located approximately 4.5 miles north of the Torrance Refinery is the nearest Automated Surface Observing System (ASOS) station to the Torrance Refinery that is located in similar terrain. The predominant wind direction is from the west-southwest (WSW), and the average wind speed is approximately 2.5 meters per second (m/s) (Figure 3-4). Thus, the communities to the east and northeast of the Torrance refinery are typically downwind of refinery operations, while the communities to the west and southwest are typically upwind. However, as shown in the wind rose, winds have been recorded from all directions, so communities to the north and south that are typically crosswind may occasionally be downwind of refinery operations. Nearly 3% of the winds are calm (i.e., less than 0.5 m/s).[16]

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[14] *2017 Air Quality Management Plan*; South Coast Air Quality Management District, 2017. See https://www.aqmd.gov/home/air-quality/clean-air-plans/air-quality-mgt-plan/final-2016-aqmp (accessed July 2018).

[15] *BP Carson Refinery Safety, Compliance and Optimization Project Final EIR, SCH 2005111057*; British Petroleum (BP), 2006. See. http://www.aqmd.gov/docs/default-source/ceqa/documents/permit-projects/2006/bp-carson-safety/ (accessed July 2018).

[16] *SCAQMD Meteorological Data for AERMOD*; South Coast Air Quality Management District, 2018. See http://www.aqmd.gov/home/air-quality/air-quality-data-studies/meteorological-data/aermod-table-1 (accessed July 2018).

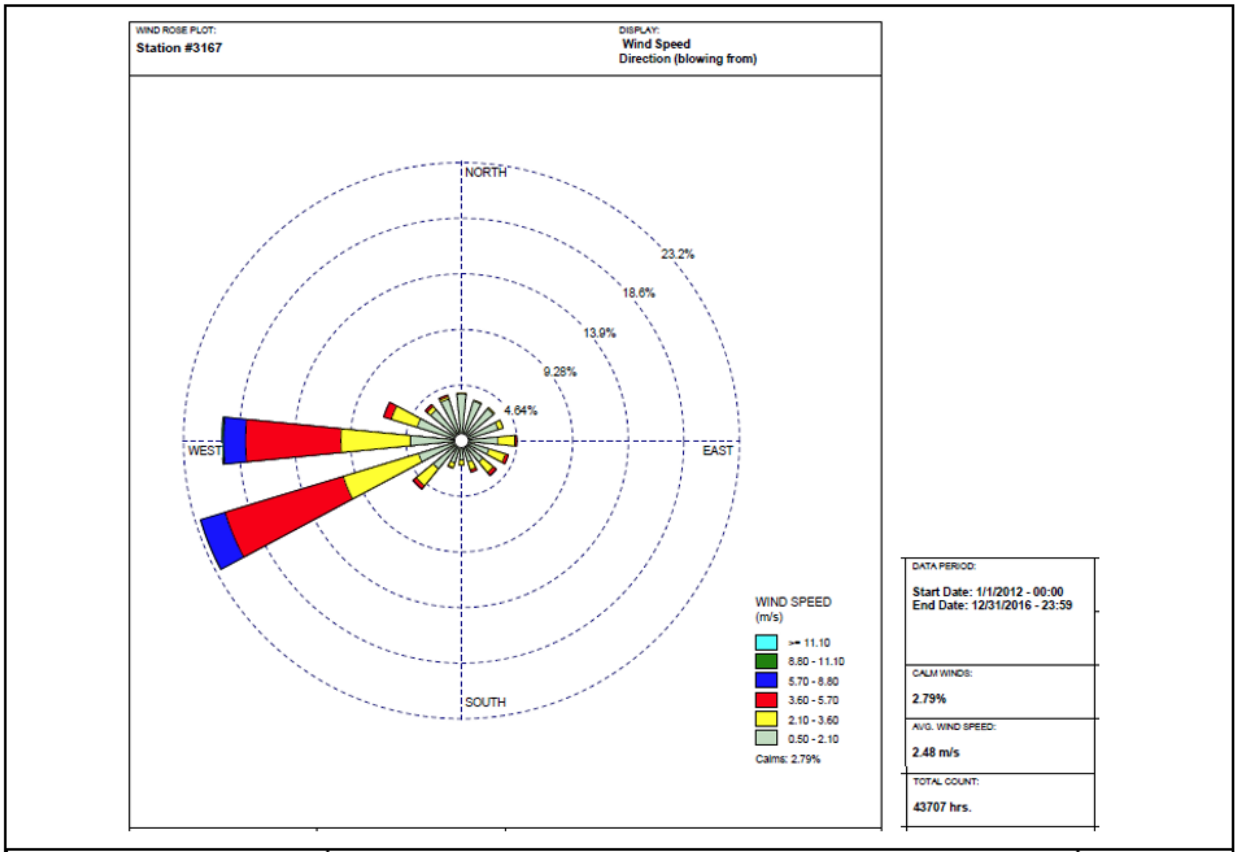

Figure 3-4: Wind rose for KHHR (Hawthorne-Jack Northrop Field), 2012-2016

3.6 Air Quality Assessment in Surrounding Communities

The SCAQMD is responsible for ensuring that state and federal ambient air quality standards are achieved and maintained in its geographical jurisdiction. Health-based air quality standards have been established by California and the federal government for the following criteria air pollutants: ozone, carbon monoxide (CO), nitrogen dioxide (NO_2), fine particulate matter (PM_{10} and $PM_{2.5}$), sulfur dioxide (SO_2), and lead. These standards were established to protect sensitive receptors within a margin of safety from adverse health impacts due to exposure to air pollution. In most cases, the California standards are more stringent than the federal standards. California has also established standards for sulfate, visibility, hydrogen sulfide, and vinyl chloride.

The SCAQMD monitors levels of the criteria pollutants at nearly 40 monitoring stations throughout the Basin. In addition, the SCAQMD and California Air Resources Board (CARB) conduct air monitoring for many toxic air contaminants (TACs) at various locations throughout California. Additional details on historical air quality for criteria air pollutants and TACs near the Torrance Refinery are presented below.

3.6.1 Local Air Quality for Criteria Air Pollutants

The Torrance Refinery is located within SCAQMD's Source/Receptor Area (SRA) No. 3. The closest SCAQMD monitoring station is Southwest Coastal Los Angeles County monitoring station (Station 820) near the Los Angeles International Airport, and data for the most recent two years (2015-2016)[17,18] are presented in Table 3-3. This area has shown a general improvement in air quality with decreasing or consistent concentrations of most pollutants. In 2016, air quality at this station complied with the state and federal ambient air quality standards for CO, NO_2, SO_2, PM_{10}, and lead, and the state sulfate standard and one-hour ozone standard. At this site measured concentrations were above the federal eight-hour average ozone standard on two days in 2016, and above the state eight-hour average ozone standard on three days in 2016. $PM_{2.5}$ was not monitored at this station in 2016. Instead, data from the next closest station (South Coastal Los Angeles County 1, Station 072) in Long Beach, California is presented. In 2016, all $PM_{2.5}$ concentrations measured at Station 072 were below the state and federal ambient air quality standards.

Table 3-3: Summary of air monitoring data for criteria air pollutants (SCAQMD Station 820)[19]

Carbon monoxide				No. days standard exceeded	
Year	No. days of data	Max. conc. (ppm, 1 hour)	Max. conc. (ppm, 8-hour)	Federal 9 ppm, 8-hour	State 9.0 ppm, 8-hour
2015	357	1.7	1.4	0	0
2016	362	1.6	1.3	0	0

Ozone					No. days standard exceeded				
Year	No. days of data	Max. conc. (ppm, 1-hr)	Max. conc. (ppm, 8-hr)	Fourth-highest conc. (ppm, 8-hr)	Health advisory 0.15 ppm, 1-hr	Federal[20]		State	
						0.12 ppm, 1-hr (old standard)	0.07 ppm, 8-hr	0.09 ppm, 1-hr	0.07 ppm, 8-hr
2015	365	0.096	0.077	0.069	0	0	3	1	3
2016	361	0.087	0.080	0.067	0	0	2	0	3

17 *2015 Air Quality Data Tables*; South Coast Air Quality Management District, D2018. See http://www.aqmd.gov/docs/default-source/air-quality/historical-data-by-year/2015datacard.pdf?sfvrsn=8 (accessed July 2018).

18 *2016 Air Quality Data Tables*; South Coast Air Quality Management District, 2018. See http://www.aqmd.gov/docs/default-source/air-quality/historical-data-by-year/2016-air-quality-data-tables.pdf?sfvrsn=14 (accessed July 2018).

19 ppm = parts per million parts of air, by volume. µg/m3 = micrograms per cubic meter (1 atm, 293 K). "(*)" indicates that there are insufficient or no data available to determine the value. For estimated risk, may indicate that the pollutant is not a risk driver.

20 The current (2015) O_3 federal standard was revised effective December 28, 2015.

Table 3-3: Summary of air monitoring data for criteria air pollutants (SCAQMD Station 820)[19]

Nitrogen dioxide				**No. days standard exceeded**	
				Federal	State
Year	No. days of data	Max. conc. (ppm, 1-hour)	Annual average AAM conc. (ppm)[21]	0.10 ppm, 1-hr	0.18 ppm, 1-hr
2015	358	0.087	0.0109	0	0
2016	348	0.082	0.0101	0	0

Sulfur dioxide				**No. days standard exceeded**	
Year	No. Days of Data	Maximum Concentration		Federal	State
		(ppm, 1-hour)	99th Percentile (ppm, 1-hour)	0.075 ppm, 1-hr	0.25 ppm, 1-hr
2015	358	0.015	0.0068	0	0
2016	363	0.0097	0.0057	0	0

Suspended particulate matter (PM_{10})[22]					
Year	No. days of data	Max. conc. µg/m^3 24-hour	No. (%) Samples Exceeding Standard		Annual average[23] AAM conc. µg/m^3
			Federal 150 µg/m^3, 24-hr	State 50 µg/m^3, 24-hr	
2015	57	42	0	0	21.2
2016	60	43	0	0	21.6

[21] The NO_2 federal annual standard is annual arithmetic mean (AAM) NO_2 > 0.0534 ppm (53.4 ppb). The state annual standard is AAM > 0.030 ppm.

[22] PM_{10} statistics listed above are based on combined Federal Reference Method (FRM) and Federal Equivalent Method (FEM) data.

[23] State annual arithmetic mean (AAM) PM_{10} standard is > 20 µg/m^3. Federal annual PM_{10} standard (AAM > 50 µg/m^3) was revoked in 2006.

Table 3-3: Summary of air monitoring data for criteria air pollutants (SCAQMD Station 820)[19]

Suspended particulate matter ($PM_{2.5}$)[24]				
Year	No. days of data	Max. conc. µg/m³, 24-hour	No. (%) samples exceeding standard Federal 35 µg/m³, 24-hour	Annual average[25] AAM conc. µg/m³
2015	338	54.6	3 (1%)	10.81
2016	356	29.4	0	10.36

Lead		
Year	Max. monthly avg. conc. (µg/m³)[26]	Max. 3-months rolling avg. (µg/m³)[(h)]
2015	0.008	0.01
2016	0.006	0.01

PM_{10} sulfate		
Year	No. days of data	Max. conc. µg/m³ 24-hour[27]
2015	57	6.5
2016	58	6.2

The data in Table 3-3 reflect the following information:

- For each pollutant, the most recent complete set of data is used (i.e. where all values in the table are available).
- Data for VOCs are for the year 2012, with the following exceptions: carbon disulfide (2004); o-dichlorobenzene and p-dichlorobenzene (2006); methyl tertiary butyl-ether (2003);
- Data for PAHs are for the year 2004;
- The most recent data for inorganic compounds varies by year. Data is selected for the most recent year with a complete set of data: aluminum, barium, bromine, calcium, mercury, phosphorous, potassium, rubidium, silicon, uranium, yttrium (2001); lead

[24] $PM_{2.5}$ data are not available for station 820. Instead, data from the closest station (South Coastal LA County 1, station no. 072) are used. $PM_{2.5}$ statistics listed above are for the FRM data only. FEM $PM_{2.5}$ continuous monitoring instruments were operated at some of the above locations for real-time alerts and forecasting only.

[25] Both Federal and State standards are annual arithmetic mean (AAM) > 12.0 µg/m³.

[26] The Federal lead standard is 3-months rolling average > 0.15 µg/m³, and the State standard is monthly average ≥ 1.5 µg/m³. Lead standards were not exceeded.

[27] The California state sulfate standard is 24-hour ≥ 25 µg/m³. There is no Federal standard for sulfate.

(2009); molybdenum, strontium, tin (2010); antimony, arsenic, cadmium, cobalt, manganese, sulfur (2011); hexavalent chromium, iron, nickel, selenium, titanium, vanadium, zirconium (2012); beryllium, copper, zinc (2013);

- Source for particulate matter: http://www.aqmd.gov/docs/default-source/air-quality/air-toxic-studies/mates-iv/f-appendix.pdf?sfvrsn=7, North Long Beach site; and
- The cited source does not report the maximum concentration, so the 90th percentile value is provided.

3.6.2 Toxic Air Contaminants

A toxic air contaminant (TAC) is defined as an air pollutant that may cause or contribute to an increase in deaths or in serious illness, or which may pose a present or potential hazard to human health.[28] TACs are usually present in trace quantities in the ambient air. However, their toxicity or health risk may pose a threat to public health even at low concentrations. In general, for those TACs that may cause cancer, there is no concentration that does not present some risk. This contrasts with the criteria air pollutants for which acceptable levels of exposure can be determined and for which the state and federal governments have set ambient air quality standards.[29]

Monitoring for TACs is limited as compared to monitoring for criteria air pollutants because toxic pollutant impacts are typically more localized than criteria air pollutant impacts. As noted above, CARB conducts air monitoring for selected TACs at various locations throughout California. The closest CARB TAC monitoring location with a complete set of data is the North Long Beach site. Table 3-4[30] presents a summary of the most recent annual air toxics monitoring data for this site, including the minimum, maximum, and median concentrations for VOCs, polycyclic aromatic hydrocarbons (PAHs), and inorganic compounds.

Table 3-4 also presents the “estimated risks” for each carcinogenic chemical, which are calculated by CARB using Office of Environmental Health Hazard Assessment's risk assessment guidance.[31] They represent the inhalation (breathing) pathway and follow CARB and California Air Pollution Control Officers Association’s (CAPCOA's) *Risk Management Policy for Inhalation Risk Assessments.*[32] The estimated risks are expressed as the chance per million population that people may have of developing cancer from exposure to the annual mean concentration of that chemical over 70 years. For example, an estimated risk of "10" means there are an estimated 10 chances in a million (or a 0.001% chance) that people represented by that annual mean may develop cancer from exposure to the monitored air

[28] *Final 2012 Air Quality Management Plan Glossary*; South Coast Air Quality Management District, 2012. See http://www.aqmd.gov/docs/default-source/clean-air-plans/air-quality-management-plans/2012-air-quality-management-plan/final-2012-aqmp-(february-2013)/glossary-final-2012.pdf (accessed July 2018).

[29] *The California Almanac of Emissions and Air Quality 2005 Edition*; California Air Resources Board, 2005. See https://www.arb.ca.gov/aqd/almanac/almanac05/almanac2005all.pdf (accessed July 2018).

[30] CARB Source for VOCs, PAHs, and inorganic compound website. See https://www.arb.ca.gov/adam/toxics/sitesubstance.html (accessed July 2018).

[31] *Air Toxics Hot Spots Program Guidance Manual for the Preparation of Health Risk Assessments 2015*; Office of Environmental Health Hazard Assessment. 2015. See https://oehha.ca.gov/air/crnr/notice-adoption-air-toxics-hot-spots-program-guidance-manual-preparation-health-risk-0 (accessed July 2018).

[32] *Risk Management Policy for Inhalation Risk Assessments*; California Air Pollution Control Officers Association, 2015. Seehttps://www.arb.ca.gov/toxics/rma/rmaguideline.htm (accessed July 2018).

toxic. As indicated in this table, some of the primary cancer risk drivers at the North Long Beach station include benzene, 1,3-butadiene, carbon tetrachloride, and formaldehyde.

According to SCAQMD's Multiple Air Toxics Exposure Study IV (MATES IV), which was a monitoring and evaluation study conducted for the Basin in 2010, the estimated cancer risk in the approximately 1-mile area surrounding the Torrance Refinery ranges from 809 in a million to 1,219 in a million (compared to the populated weighted risk of 367 in a million). As further discussed in chapter 5, the area near the Torrance Refinery has other facilities with reported TAC emissions. In addition, this area has a substantial amount of vehicular traffic, including Interstate 405 passing approximately 400 meters northeast of the Torrance Refinery. Compared to previous studies of air toxics, the MATES IV study found decreasing air toxics exposure, with the estimated Basin-wide population-weighted risk down by about 57% from the analysis done for the MATES III time period. The ambient air toxics data from the 10 fixed monitoring locations included in the MATES study also demonstrated a similar reduction in air toxic levels and risks.[33]

[33] *Multiple Air Toxics Exposure Study IV (MATES IV)*; South Coast Air Quality Management District: Diamond Bar, CA, 2015. See http://www.aqmd.gov/home/air-quality/air-quality-studies/health-studies/mates-iv (accessed July 2018).

Table 3-4: Summary of annual air toxics monitoring data for north Long Beach

Pollutant	Maximum Concentration	Mean Concentration	Median Concentration	Estimated Risk	Pollutant	Maximum Concentration	Mean Concentration	Median Concentration	Estimated Risk
VOCs (1)	(parts per billion by volume)			in a million		(parts per billion by volume)			in a million
Acetaldehyde	3.3	0.99	0.9	15	Ethyl Benzene	0.4	0.13	0.1	4
Acetone	14	5.82	5.6	*	Formaldehyde	5.3	2.32	2.3	49
Acetonitrile	1.4	0.2	0.15	*	Methyl Bromide	0.07	0.023	0.015	*
Acrolein	3.5	0.75	0.6	*	Methyl Chloroform	0.01	0.007	0.005	*
Benzene	1.0	0.402	0.32	105	Methyl Ethyl Ketone	0.3	0.07	0.05	*
1,3-Butadiene	0.31	0.074	0.05	80	Methyl Tertiary-Butyl Ether	2	0.45	0.15	2
Carbon Disulfide	2.3	0.84	0.8	*	Methylene Chloride	0.4	0.186	0.15	2
Carbon Tetrachloride	0.1	0.084	0.08	65	Perchloroethylene	0.09	0.024	0.02	3
Chloroform	0.07	0.037	0.04	3	Styrene	0.3	0.08	0.05	*
ortho-Dichlorobenzene	0.15	0.15	0.15	*	Toluene	2.2	0.82	0.7	*
para-Dichlorobenzene	0.15	0.15	0.15	29	Trichloroethylene	0.09	0.017	0.01	0.5
cis-1,3-Dichloropropene	0.05	0.05	0.05	10	meta/para-Xylene	1.3	0.44	0.3	*
trans-1,3-Dichloropropene	0.05	0.05	0.05	10	ortho-Xylene	0.5	0.17	0.1	*
PAHs (2) (nanograms per cubic meter)									
Benzo(a)pyrene	0.61	0.107	0.025	0.3	Benzo(k)fluoranthene	0.19	0.055	0.025	0.02
Benzo(b)fluoranthene	0.51	0.116	0.06	0.04	Dibenz(a,h)anthracene	0.18	0.032	0.025	0.1
Benzo(g,h,i)perylene	1.7	0.444	0.3	*	Ideno(1,2,3-cd)pyrene	0.64	0.136	0.06	0.04
Inorganic compounds (3) (nanograms per cubic meter)									
Aluminum	2,200	1,140	1,100	*	Nickel	4.5	4.5	4.5	3
Antimony	9	3.0	1.5	*	Phosphorous	94	40.8	35	*
Arsenic	0.75	0.75	0.75	7	Potassium	630	433	440	*
Barium	150	48	47	*	Rubidium	5	2.2	2	*
Beryllium	0.3	*	0.3	*	Selenium	7.4	1.2	0.75	*
Bromine	17	9.1	8	*	Silicon	5,700	2,950	2,900	*
Cadmium	1.6	0.77	0.75	9	Strontium	25	6.22	6.4	*
Calcium	1,900	912	910	*	Sulfur	2,000	819	630	*
Cobalt	0.75	0.75	0.75	*	Tin	3.5	1.58	1.5	*
Copper	46	*	19.5	*	Titanium	65	21.5	18	*
Hexavalent Chromium	0.03	0.03	*	12	Uranium	3	1.1	1	*
Iron	1,700	699	610	*	Vanadium	5.3	1.96	2	*
Lead	16	7.65	6.6	0.3	Yttrium	2	1.1	1	*
Manganese	31	12.2	12	*	Zinc	90	*	36	*
Mercury	4	1.7	1.5	*	Zirconium	3.2	1.04	0.75	*
Molybdenum	2.6	1.05	0.75	*					
Particulate matter (4) (nanograms per cubic meter)									
Black Carbon	2,300 (5)	950	550	*					

4. TARGET POLLUTANT SELECTION

4.1 Target Pollutant Selection Criteria

The Rule specifies the Plan requirements for target pollutant selection as follows:

"The fenceline air monitoring plan required by paragraph (d)(1) shall address real time air monitoring for the air pollutants specified in Table 1 on a continuous basis. The fenceline air monitoring system required by subdivision (e) shall monitor for all pollutants identified in Table 1. The owner or operator of a petroleum refinery must provide an explanation for not including real-time air monitoring for any of the pollutants specified in Table 1 in the fenceline air monitoring plan. Explanations for not including real-time air monitoring for any of the pollutants specified in Table 1 must be consistent with the criteria in the Rule 1180 Fenceline Air Monitoring Guidelines." (Rule 1180(d)(3).)

The Guidelines elaborate further on the Plan requirements for target pollutants:

Substantiate any exclusion of chemical compounds listed in Table 1 of Rule 1180 or measurement of a surrogate compound. (Guidelines Fenceline Air Monitoring Plan Checklist);

"Chemical compounds associated with health risk and those measured at other ambient air monitoring locations should be identified in the air monitoring plans. Identification of the health risk drivers can be informed by the health risk assessment studies performed at the refineries, as well as other information regarding potential health risk near refineries. Exclusion of any of these chemical compounds identified in Table 1 must be thoroughly explained and justified within the fenceline air monitoring plan. Additional chemicals may be of interest to monitor as a part of the fenceline air monitoring system, for example, if certain annual emissions exceed 10,000 lbs/year. Other chemicals may also be inherently monitored by the systems and may be included in the reporting for additional public information." (Guidelines 2(a).)

"The potential compounds emitted from refineries that pose the highest health risk in nearby communities should be identified along with the appropriate monitoring technologies selected to measure them. This assessment should be informed by the OEHHA report on Refinery Chemical Emissions and Health Effects Report." (Guidelines 2(a)(i).)

"The petroleum refinery air monitoring plan must explain exclusion or replacement of monitoring for any of the compounds identified in Table 1 below." (Guidelines 2(a)(i).)

The Guidelines elaborate further upon the nature of criteria air pollutants, volatile organic compounds, hydrogen sulfide and carbonyl sulfide, ammonia, black carbon, hydrogen cyanide and hydrogen fluoride.

This section of the Plan addresses the Rule and Guideline requirements for target pollutant selection.

4.2 TORC Target Air Pollutants for Fenceline Air Monitoring System

The continuous fenceline air monitoring system will be designed to monitor all the target pollutants listed in Rule 1180 Table 1 of Rule 1180 (Table 4-1) See discussion in Section 4.2.2 below.

Air dispersion modelling was conducted to assess potential air pollutant concentrations at the fenceline (see Section 5.1 of this Plan). Based on these results, emissions of the compounds listed in Table 4-1 were estimated to account for approximately 74% of the potential acute human inhalation health risk.[34] Thus, the target compounds listed in Table 4-1 are representative of the most important health risk drivers.

Table 4-1: Target air pollutants for TORC fenceline air monitoring system

Category	Target Pollutants
Criteria Air Pollutants	Sulfur dioxide Nitrogen oxides[35]
Volatile Organic Compounds	Total VOCs (non-methane hydrocarbons)[36] Formaldehyde Acetaldehyde Acrolein 1,3-Butadiene Benzene Styrene Toluene Ethylbenzene Xylenes[37] Hydrogen cyanide
Other Compounds	Hydrogen sulfide Carbonyl sulfide Ammonia Black carbon Hydrogen fluoride[38]

[34] Styrene does not contribute to acute inhalation risk.

[35] "Nitrogen oxides" will be determined as the sum of nitric oxide, if detected, and nitrogen dioxide.

[36] "Total VOCs (NMHC)" will be determined as the sum of VOCs listed in this table. VOCs in the atmosphere along the fenceline will be a combination of regional VOCs and VOCs from the refinery emissions. VOCs contributing to total NMHC will be reassessed during system commissioning.

[37] "Xylenes" will be determined as the sum of m-xylene, o-xylene and p-xylene isomers, if measured individually, or as total xylenes (spectral limitations may preclude speciation of all individual isomers with the open path monitors).

[38] Rule 1180 specifies that hydrogen fluoride must be measured only if the refinery utilizes it in refinery operations. Since the Torrance Refinery does use modified hydrogen fluoride as a catalyst in a closed-loop process of the alkylation plant, it is included among the target pollutants.

4.2.1 Criteria Air Pollutants

Criteria air pollutants are those for which U.S. National Ambient Air Quality Standards (NAAQS) are established. TORC will monitor concentrations of sulfur dioxide (SO_2) and nitrogen oxides (NO_X) along the refinery perimeter fenceline. NO_X will be determined as the sum of nitric oxide (NO) and nitrogen dioxide (NO_2), which are measured individually by the open path instruments. In the atmosphere, almost all NO_X is NO_2 and NO concentrations are typically below detectable levels using open path technologies. SO_2 and NO_X emissions that contribute to ambient air SO_2 and NO_2 concentrations arise primarily from combustion of fuels not only in mobile and industrial sources, but also from wildfires, volcanoes and other natural sources both near and far away. Thus, concentrations of SO_2 and NO_X along the TORC fenceline arise from many sources throughout the region including, but not limited to, the heavily-travelled thoroughfares and freeway infrastructure which surround the TORC facility.

4.2.2 Volatile Organic Compounds

Volatile organic compounds (VOCs) constitute a broad range of individual organic chemicals that evaporate under normal atmospheric conditions, typically defined by having vapor pressures at atmospheric temperatures above a certain pressure or boiling points below a certain temperature. VOCs also are defined in various rules and regulations. For example, the SCAQMD defines VOCs in SCAQMD Rule 102[39] as *"…any volatile compound of carbon, excluding methane, carbon monoxide, carbon dioxide, carbonic acid, metallic carbides or carbonates, ammonium carbonate, and exempt compounds."* VOCs arise from a wide range of anthropogenic and natural sources. Anthropogenic sources include products of incomplete combustion in motor vehicles and industrial facilities, consumer products, solvents and coatings and petroleum fuel production, storage and transfer at refineries. The amount and composition of VOCs emitted from sources at any refinery depends on process types and designs, fuels used for production, product slate and storage, air emissions controls, weather conditions and other factors. The term "VOCs" has various regulatory and measurement method definitions but loosely refers to organic (carbon-containing) chemicals that are present in the air as gases (owing to having significant vapor pressures at ambient air temperatures). A subset of VOCs are ambient air ozone precursors and/or are associated with human inhalation health risks. This subset of VOCs constitutes the compounds of general interest in Rule 1180. Individual target VOCs will consist of formaldehyde, acetaldehyde, acrolein, 1,3-butadiene, benzene, toluene, ethylbenzene, xylenes and hydrogen cyanide.[40]

4.2.2.1 Styrene

Styrene is included among the Rule 1180 Table 1 compounds. Styrene is a ubiquitous pollutant. The primary sources of styrene in the atmosphere are industrial facilities that

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[39] *Rule 102 Definition of Terms*; South Coast Air Quality Management District, 2014. See http://www.aqmd.gov/docs/default-source/rule-book/reg-i/rule-102-definition-of-terms.pdf (accessed July 2018).

[40] Hydrogen cyanide is often considered by chemists to be an inorganic compound, but it falls within the definition of VOCs under SCAQMD Rule 102. Hydrogen cyanide arises from certain industrial processes involving blast furnaces, gas works, coke ovens and refinery fluid catalytic cracking units and from natural sources such as almond and fruit trees.

manufacture, use or treat styrene.[41] Styrene in the atmosphere also comes from a wide variety of outdoor and indoor sources including cigarettes, vehicle engine emissions (there are busy thoroughfares and heavy truck/locomotive routes near the Refinery and throughout the City of Torrance), wood smoke, building materials, consumer products, incomplete combustion, boat manufacturing, laser printers, and photocopiers.[42],[43] Because it is very photochemically reactive, its lifetime in the atmosphere is typically very short.

Styrene is not carcinogenic, has low toxicity (higher acute and chronic reference exposure levels[44] compared with most other Rule 1180 Table 1 compounds), and it is not a significant health risk driver for this facility. Styrene is harmful to health only at relatively high concentrations (210 ppb 8-hr REL, 4,900 ppb 1-hr REL, 20,000 ppb 1-hr AEGL).[45] Estimated total styrene emissions from the refinery are very low. There are only trace concentrations of styrene in the products stored in tanks, used in most spray coatings, and in cooling tower water. According to TORC's 2016 Annual Emissions Report (AER), total estimated styrene emissions are approximately 460 pounds per year and the three largest sources of styrene emissions are tank fugitives (45%), spray coatings/booths (30%), and cooling towers (24%).

In the 2016 AER, residual oil storage tanks accounted for all styrene emissions from storage tanks (45% of total emissions from all sources). This estimate is based on a single residual oil analysis performed in the early 2000s. Styrene is not expected to be present at detectable levels in residual oil. TORC recently re-evaluated this estimate based on a new residual oil analysis which found no detectable styrene. Using the new test result, TORC's total annual emissions of styrene are now estimated to be only 251 pounds per year.

Thus, there are no high concentration sources inside the refinery that could result in significant unplanned releases of styrene. Furthermore, the facility does not concentrate styrene or use it as a feedstock in any of its processes. The highest predicted 1-hour average styrene concentration at the refinery fenceline (from dispersion modelling, see Section 5 of this Plan) is only 0.5 parts per billion, which is below the expected detection capabilities of the advanced monitoring technologies for this Plan and far below the 8-hour acute reference exposure level of 210 parts per billion. Actual concentrations further away from the refinery in the nearby communities would be even lower. The highest predicted annual average fenceline concentration is extremely low (0.02 parts per billion), far below the detection capabilities of the monitors and any health-based air quality threshold.

Furthermore, measured styrene concentrations along the refinery fenceline may give a misleading perception of refinery emissions due to the presence of a much larger nearby potential styrene source not associated with TORC, a styrene production plant, located to the south of the refinery. The Torrance Refinery's southern sectors are downwind of the styrene

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[41] *Locating and Estimating Air Emissions from Sources of Styrene*, Office of Air Quality Planning and Standards, U.S. Environmental Protection Agency, Research Triangle Park, North Carolina, April, 1993. EPA-454/R-93-011.

[42] Air Quality Guidelines for Europe, Second Edition, Regional Office for Europe, World Health Organization, Copenhagen, Denmark, 2000. WHO Regional Publications, European Series, No. 91. See http://apps.who.int/iris/bitstream/handle/10665/107335/E71922.pdf?sequence=1&isAllowed=y (accessed October 2018).

[43] *Answers to Common Questions About Styrene*, International Styrene Industry Forum, see http://www.styreneforum.org/faq_index.html (accessed October 2018).

[44] See Section 7.3 of this Plan for definitions and discussion of reference exposure levels.

[45] See Section 7.3.1 of this Plan for discussion of health-based thresholds for pollutants.

facility when winds blow from the southerly directions (prevailing winds are from the west and west south west, but blow from all southerly directions with lesser regularity). Thus, there is a distinct probability of measuring elevated styrene concentrations along the southern and southeastern fenceline paths that originate from this styrene production plant.

Because styrene concentrations detected along the Torrance Refinery fenceline paths that originate from the styrene production plant could cause unfounded concern regarding Torrance Refinery operations, an analysis of styrene concentrations will be reported to the community in the quarterly quality assurance reports. Real-time styrene results will be made available to SCAQMD for review. SCAQMD will periodically review styrene monitoring results to confirm that there are no significant sources of styrene emissions within the Torrance Refinery and otherwise determine if any amendments to this approach are advised.

4.2.2.2 Other VOCs

"Total VOCs (non-methane hydrocarbons)," as the name implies, refers to a sum of hydrocarbon VOCs excluding methane. In the context of ambient air quality, the term "VOCs" typically refers to reactive VOCs that are ground-level ozone precursors. Methane and ethane are defined as VOCs because of their physical properties, but neither is considered a significant ozone precursor nor are they classified as toxic air contaminants. Approximately 40% of total VOC toxic air contaminant (TAC) emissions[46] from all sources at the refinery and 50% of fugitive VOC TAC emissions are accounted for by the individual VOC target compounds listed in Table 1.[47] Thus, these compounds are robust indicators of total VOCs emitted from the various sources inside the refinery. The target VOCs listed in Table 1 will be summed and reported by the fenceline air monitoring system as Total VOCs (NMHC). VOCs in the atmosphere along the fenceline will be a combination of regional VOCs and VOCs from the refinery emissions. VOCs contributing to total NMHC will be reassessed during system commissioning. The approach for quantifying total VOCs discussed above may be revised depending on actual compounds present, measurement interferences from other gases, and background levels measured on upwind paths.

"Xylenes" refers to various isomers of xylene. Xylenes will be determined as the sum of m-xylene, o-xylene and p-xylene, depending on how they can be measured by the fenceline air monitoring system analyzers.

4.2.3 Other Compounds

Other compounds reported by the continuous fenceline air monitoring system will consist of hydrogen sulfide, carbonyl sulfide, ammonia, black carbon and hydrogen fluoride. Except for black carbon, which is a component of particulate matter, these compounds are gases. Hydrogen sulfide and carbonyl sulfide arise from certain industrial processes, bacterial decomposition of wastes and from natural sources such as geothermal activity and occur naturally in crude petroleum and natural gas. These are primarily produced in refineries as a by-product of refining crude oil. Hydrogen fluoride rarely occurs from natural sources but is manufactured for use in industrial processes such as pharmaceutical and polymer manufacturing. Hydrofluoric acid (aqueous solution of HF) is a strong acid and is widely used for industrial purposes like glass etching, metal cleaning, and rust removal, some of which are used at refineries. Modified hydrofluoric acid is used as an internal process catalyst in the

[46] Based on recent emissions estimates (see Section 3.2 of this Plan).

[47] These plus methanol and propylene account for 85% of all and 66% of fugitive non-methane hydrocarbon emission estimates.

alkylation process at some refineries (including TORC) and is carefully controlled and monitored to prevent any unplanned releases to the atmosphere. Ammonia arises from many industrial and natural sources including some processes at TORC. Ammonia is also released from emission control devices which use ammonia as reagent for particulate and NO_X emissions reduction.

5. FENCELINE AIR MONITOR SITING

The Rule 1180 Guidelines specify that the Plan must address the following elements regarding siting of the fenceline air monitors:

- Siting and selected pathways;
- Identify pollutant "hot spots" along fenceline;
- Specify areas along the perimeter that are likely to detect compounds associated with refinery operations;
- Siting Specifications;
- "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; and
  - A description of how the monitoring system will cover all nearby downwind communities.
- GIS coordinates for equipment sites;
- Elevations at which equipment will be placed;
- Length of each monitored path;
- Rationale for choosing equipment sites and paths;
- Meteorological Equipment;
- Meteorological monitor siting considerations and equipment;
- Distribution of operations and processes;
- Evaluation of emission sources at the refinery;
- Assessment of air pollutant distribution in surrounding communities;
- Identify the facility's proximity to sensitive receptors affected by the refinery operation:
  - 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); and
  - 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; and
- Dispersion modeling.

- Explanation of background concentrations and/or contributions from other sources; and
- Specify proximity of proposed monitoring equipment to residences and sensitive receptors.

This section of the Plan addresses these required elements. Additional aspects of some of these elements are addressed in Section 3 of this Plan.

5.1 Spatial Air Monitoring Coverage

The primary objective of the fenceline air monitoring system is to measure concentrations of air pollutants at or near the refinery fenceline and that have the potential to migrate to offsite locations, especially in the direction of nearby residences and other sensitive receptors (e.g., daycares, schools, etc.). This section summarizes land uses surrounding the Torrance Refinery, nearby offsite (non-refinery) emission sources, and estimated Rule 1180 chemical concentrations associated with emissions for the Torrance Refinery.

5.1.1 Nearby Receptors and Communities

The fenceline air monitoring system has been designed to measure Rule 1180 pollutants that have the potential to migrate offsite into communities surrounding the refinery. As discussed in Section 3, the areas surrounding the refinery can be characterized as a blend of heavy and light industrial, commercial, medium and high-density residential, and industrial/ manufacturing. The closest residential areas are to the north across W. 190th Street (approximately 35 meters from the fenceline) and to the south along Del Amo Boulevard and east of Crenshaw Boulevard (approximately 10 meters from the fenceline). The residences located along Del Amo Boulevard are the closest sensitive receptors to the fenceline. Columbia Regional Park is located northwest of the refinery. Other land uses to the north, east, west, and south include industrial and commercial facilities, a BNSF railroad line, and a business park. In addition to these offsite areas, Linde, LLC operates a plant near the refinery fenceline that receives carbon dioxide and hydrogen from the refinery, located along the southern boundary directly west of Crenshaw Boulevard.

Figure 3-4 contains a wind rose for the Hawthorne-Jack Northrop Field station, which is located approximately 4.5 miles north of the Torrance Refinery and is the nearest Automated Surface Observing System (ASOS) station to the facility that is located in similar terrain. As shown in this wind rose, the predominant wind direction in the vicinity of the Torrance Refinery is from the west-southwest (WSW), and the average wind speed is approximately 2.5 meters per second (m/s). Thus, the communities to the east and northeast of the refinery are typically downwind of refinery operations, while the communities to the west and southwest are typically upwind. However, as shown in the wind rose, winds have been recorded from all directions, so communities to the north and south that are typically crosswind may occasionally be downwind of refinery operations. Nearly 3% of the winds are calm (i.e., less than 0.5 m/s).

5.1.2 Nearby Non-Refinery Emission Sources

The Torrance Refinery is surrounded by several non-refinery industrial facilities. These non-refinery facilities include large Title V facilities and smaller facilities (e.g., cleaners, auto shops, gas stations, etc.). Figures 5-1 through 5-12 show the locations of nearby non-refinery major (i.e., Title V) sources and the associated Rule 1180 pollutant emissions from each source.[48] These figures also show major nearby roadways and major thoroughfares. However, emissions of target pollutants from the roadways and thoroughfares, which could be very significant especially for NO_X, black carbon and VOCs, are not included. As indicated in these figures, there are several offsite sources that have the potential to influence pollutant concentrations measured at the Torrance Refinery fenceline.

AmSty operates a polystyrene manufacturing plant located on Crenshaw Blvd. directly south of the refinery across Del Amo Boulevard, which is a potential source of styrene emissions. We were not able find any styrene emissions estimates for this facility from public records. The location of this plant relative to the refinery is shown in Figure 5-14.

[48] Emissions for the Torrance Refinery were obtained from recent emissions estimates prepared to reflect in-progress changes in refinery equipment that will be completed in 2019. Emissions for other facilities were obtained from the SCAQMD's Facility Information Detail (F.I.N.D.) database for the most recent year available. Diesel particulate matter is used as a surrogate for black carbon. If data were missing from the F.I.N.D. database, data were obtained from the USEPA's Toxic Reporting Inventory (TRI) for the most recent year available. Emissions for the following Rule 1180 pollutants were not reported in the F.I.N.D database for the Title V facilities near the Torrance Refinery: styrene, hydrogen sulfide, carbonyl sulfide, and hydrogen cyanide. Sources: Facility Information Detail (F.I.N.D.); South Coast Air Quality Management District, 2018. See https://www.aqmd.gov/nav/FIND (accessed July 2018);
Toxic Release Inventory (TRI); U.S. Environmental Protection Agency, 2018. See: https://iaspub.epa.gov/triexplorer/tri_release.chemical

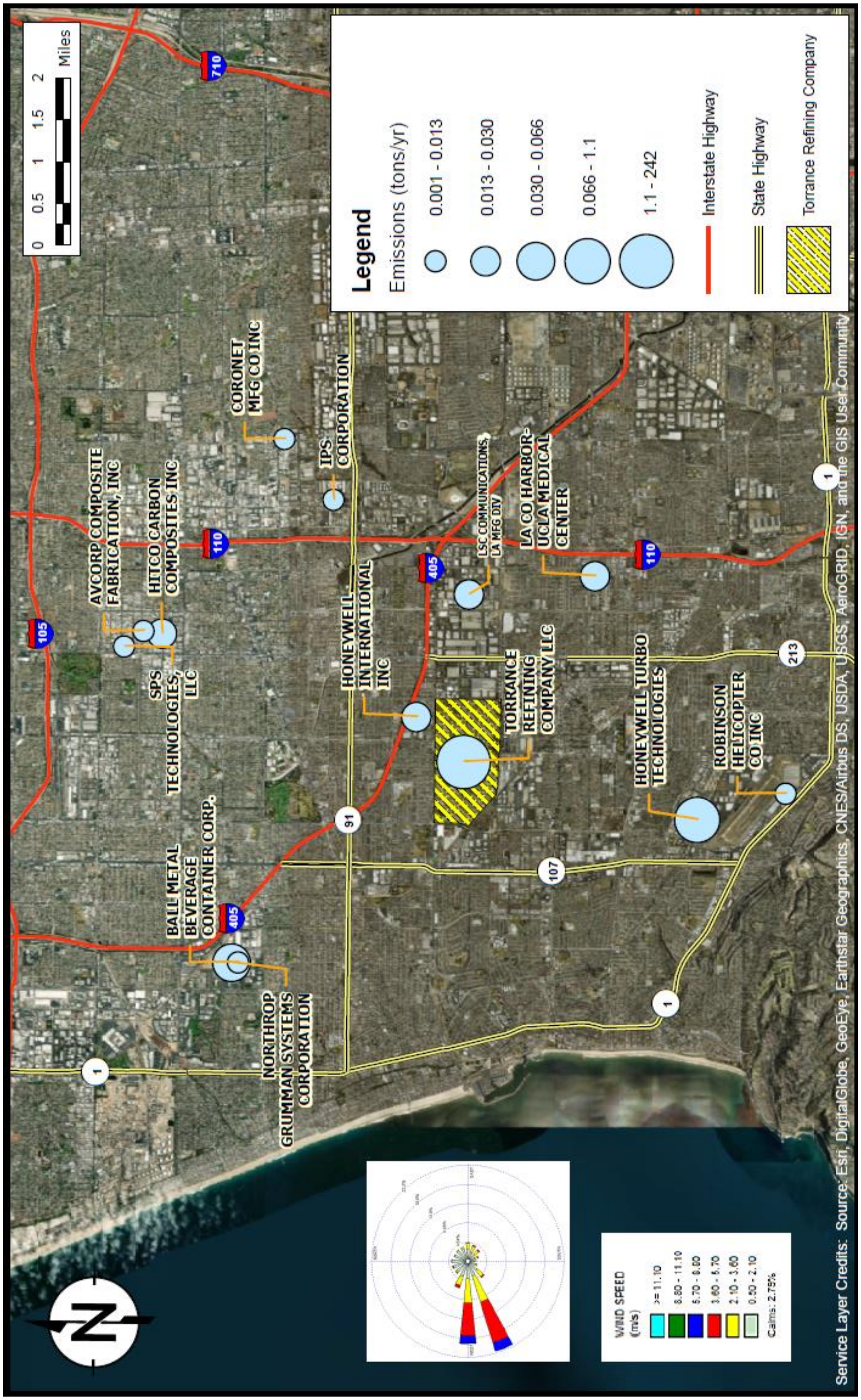

Figure 5-1: Locations of nearby major sources with sulfur oxides emissions

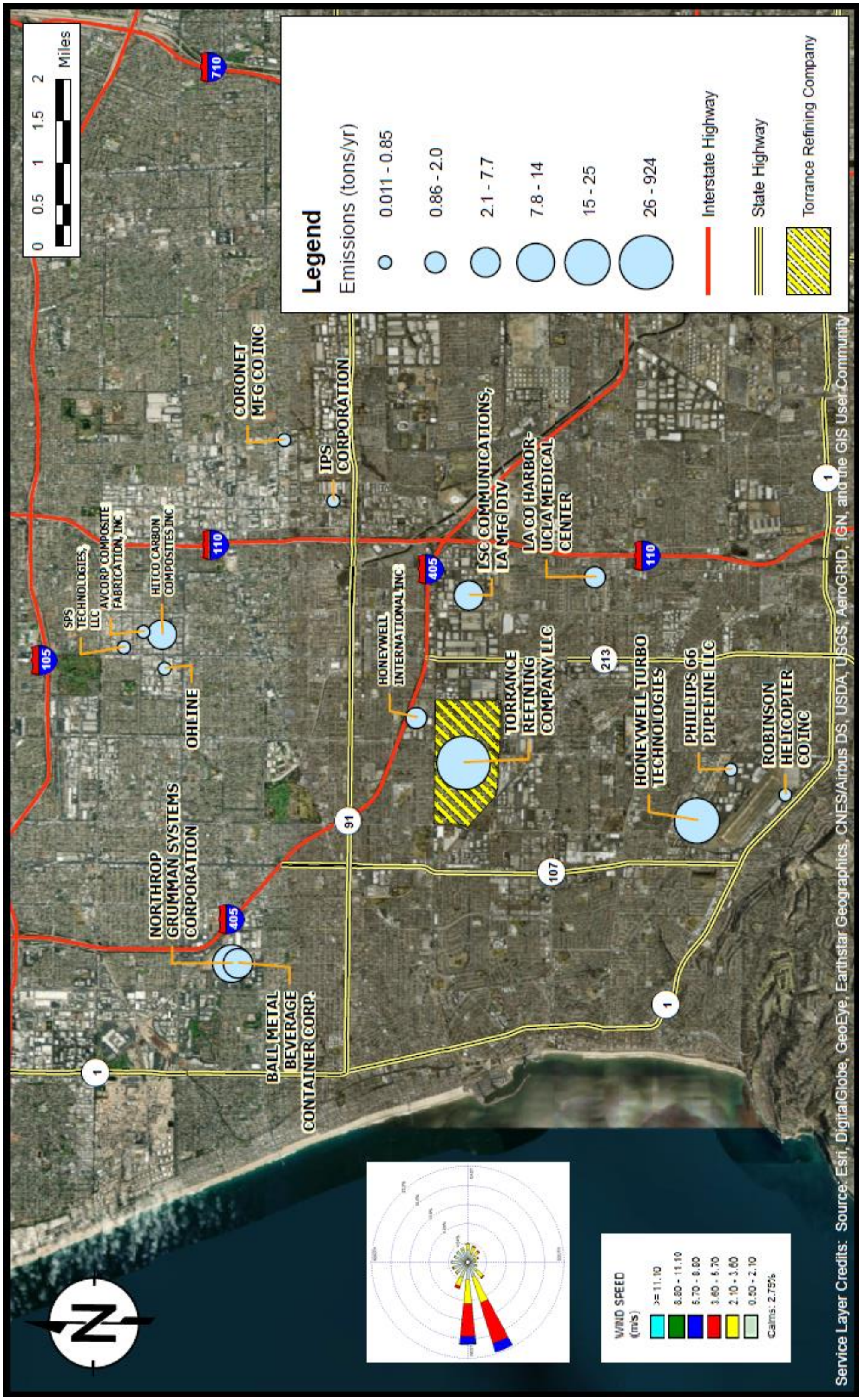

Figure 5-2: Locations of nearby major sources with nitrogen oxides emissions

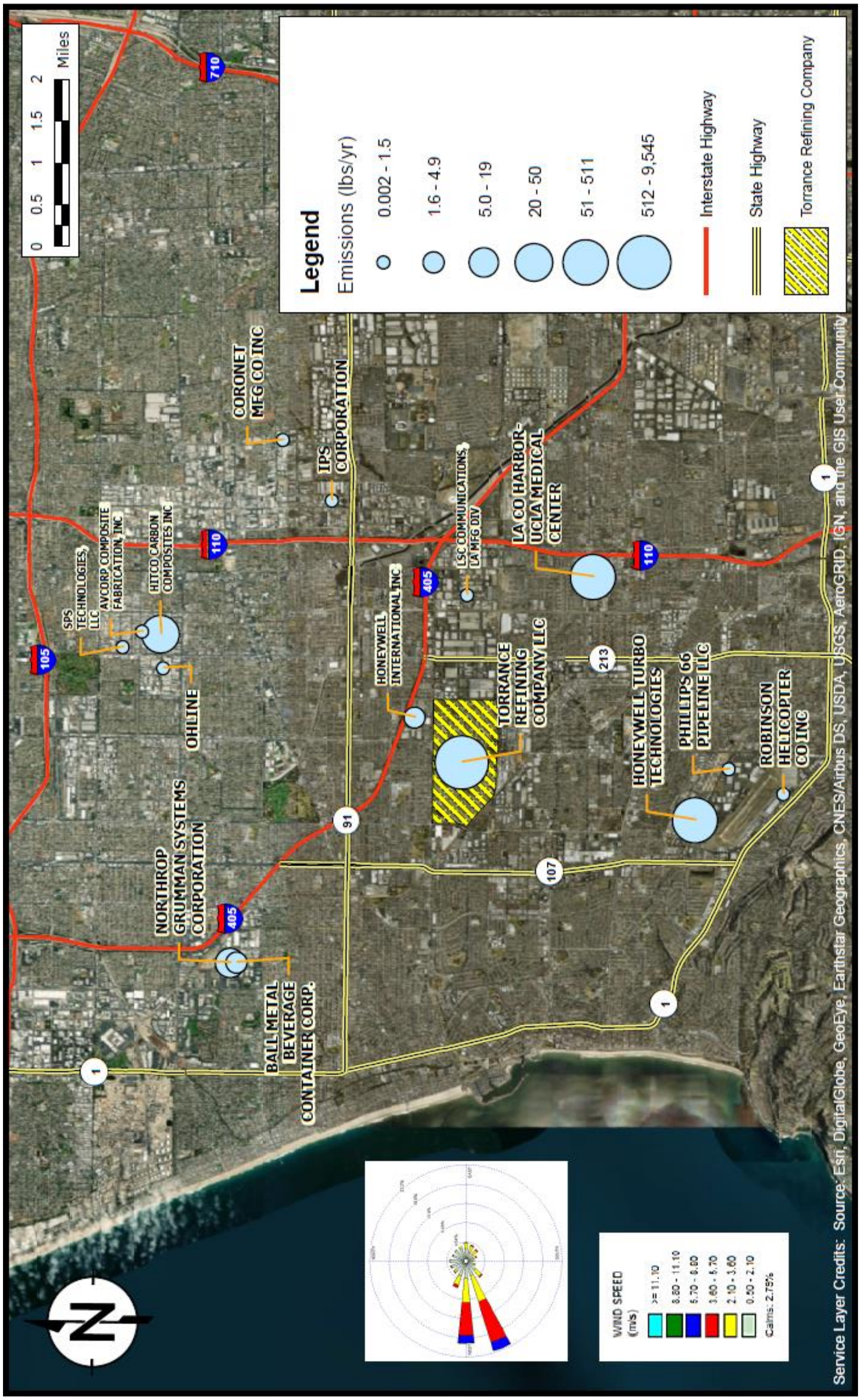

Figure 5-3: Locations of nearby major sources with formaldehyde emissions

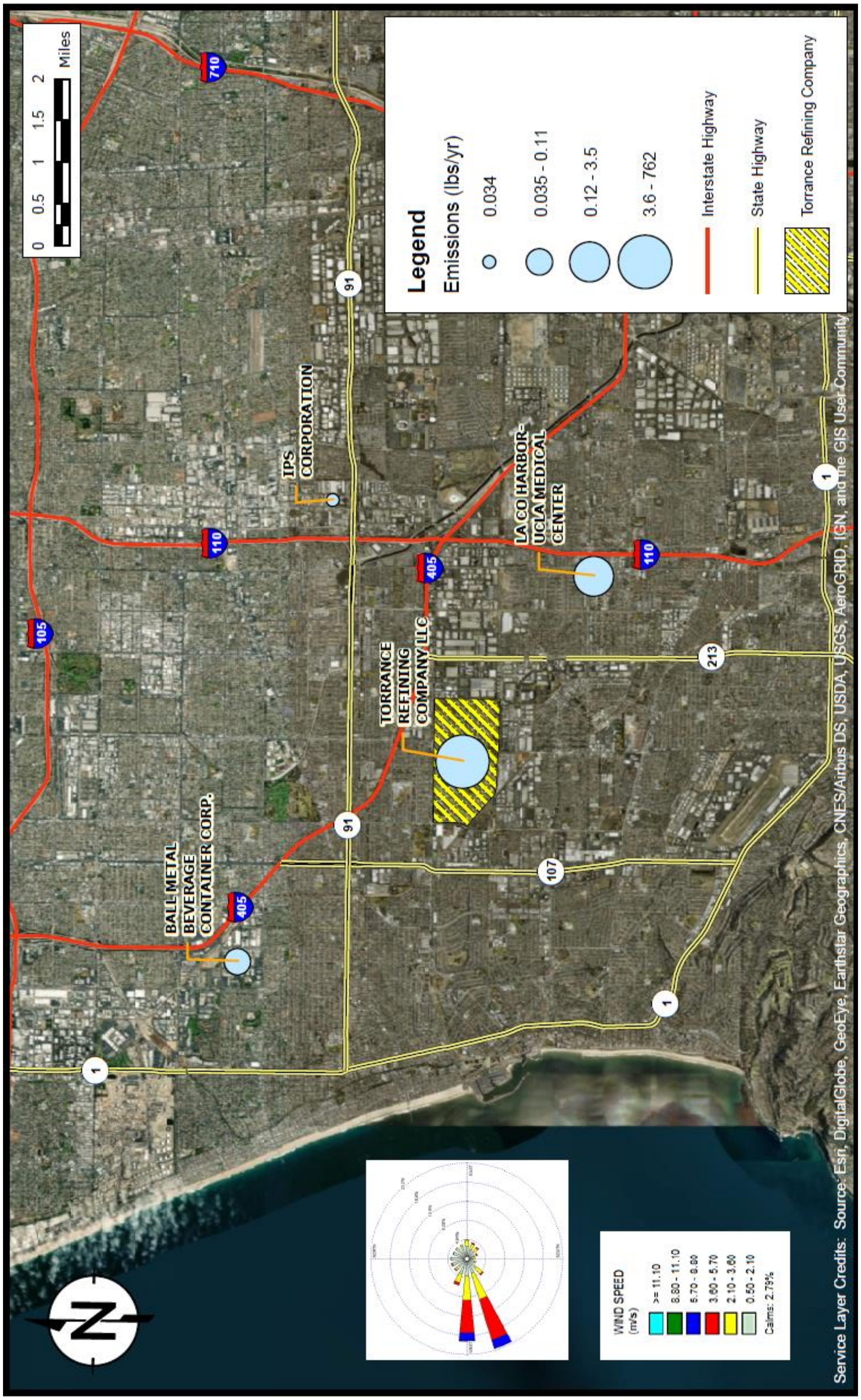

Figure 5-4: Locations of nearby major sources with acetaldehyde emissions

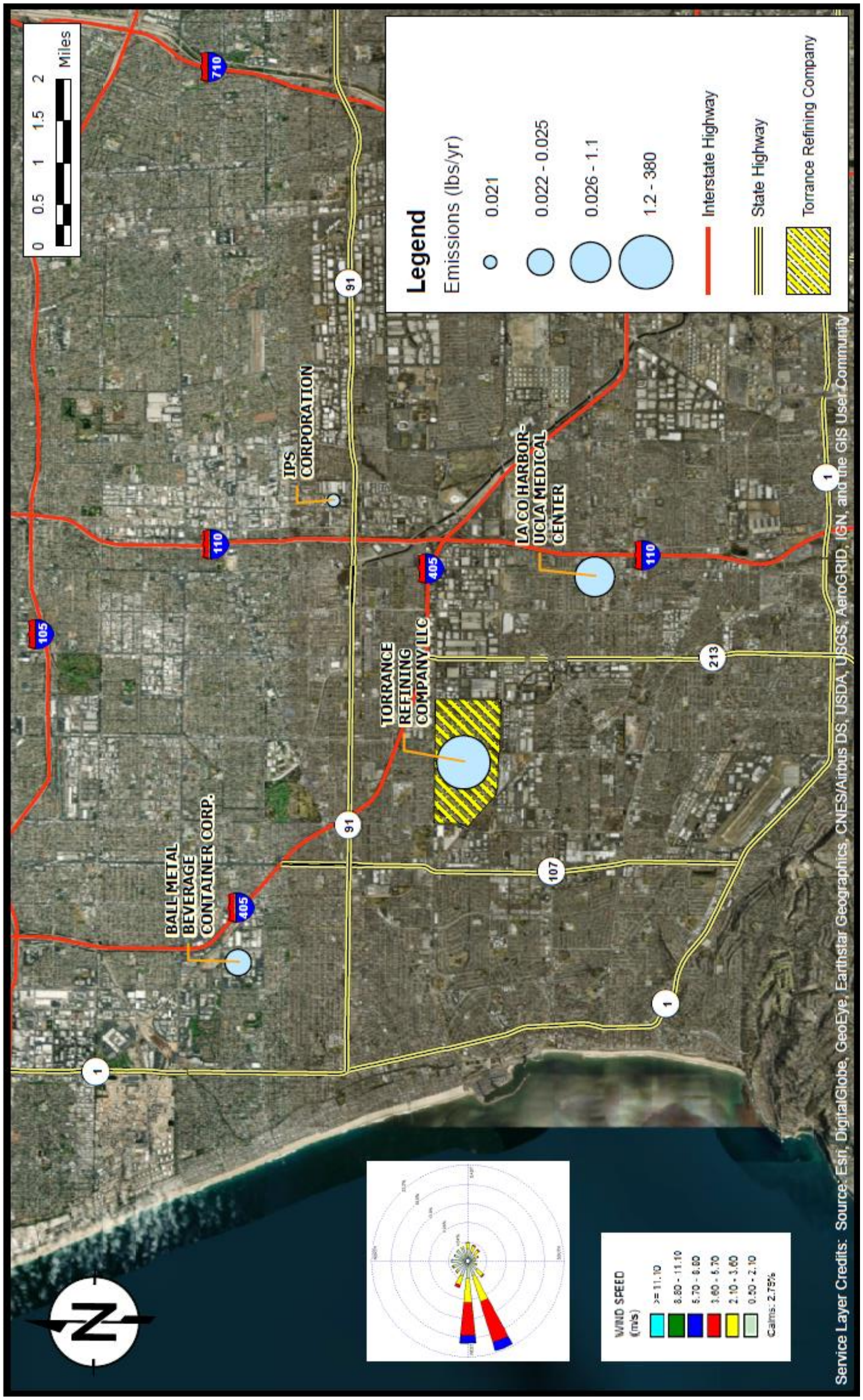

Figure 5-5: Locations of nearby major sources with acrolein emissions

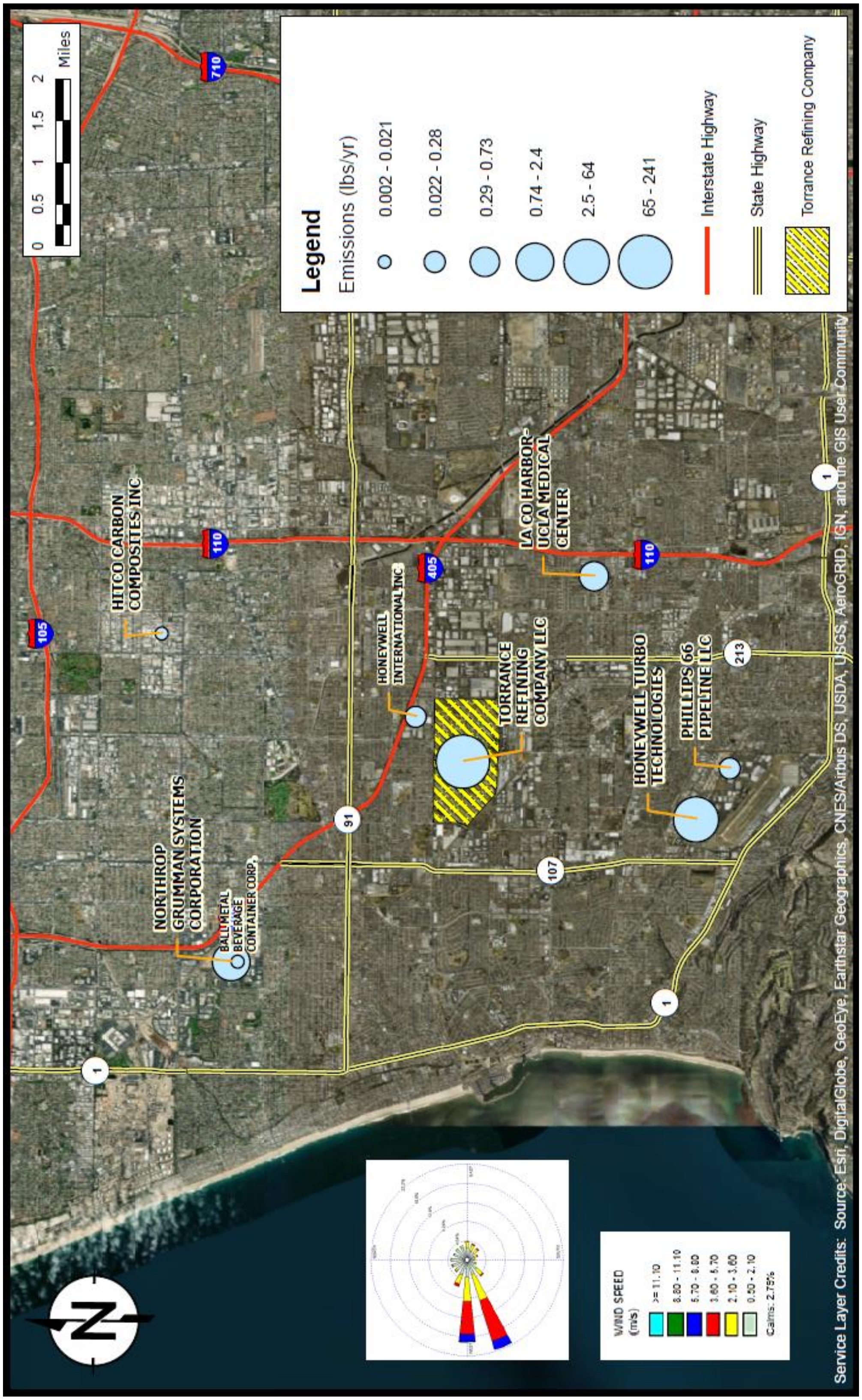

Figure 5-6: Locations of nearby major sources with 1,3-butadiene emissions

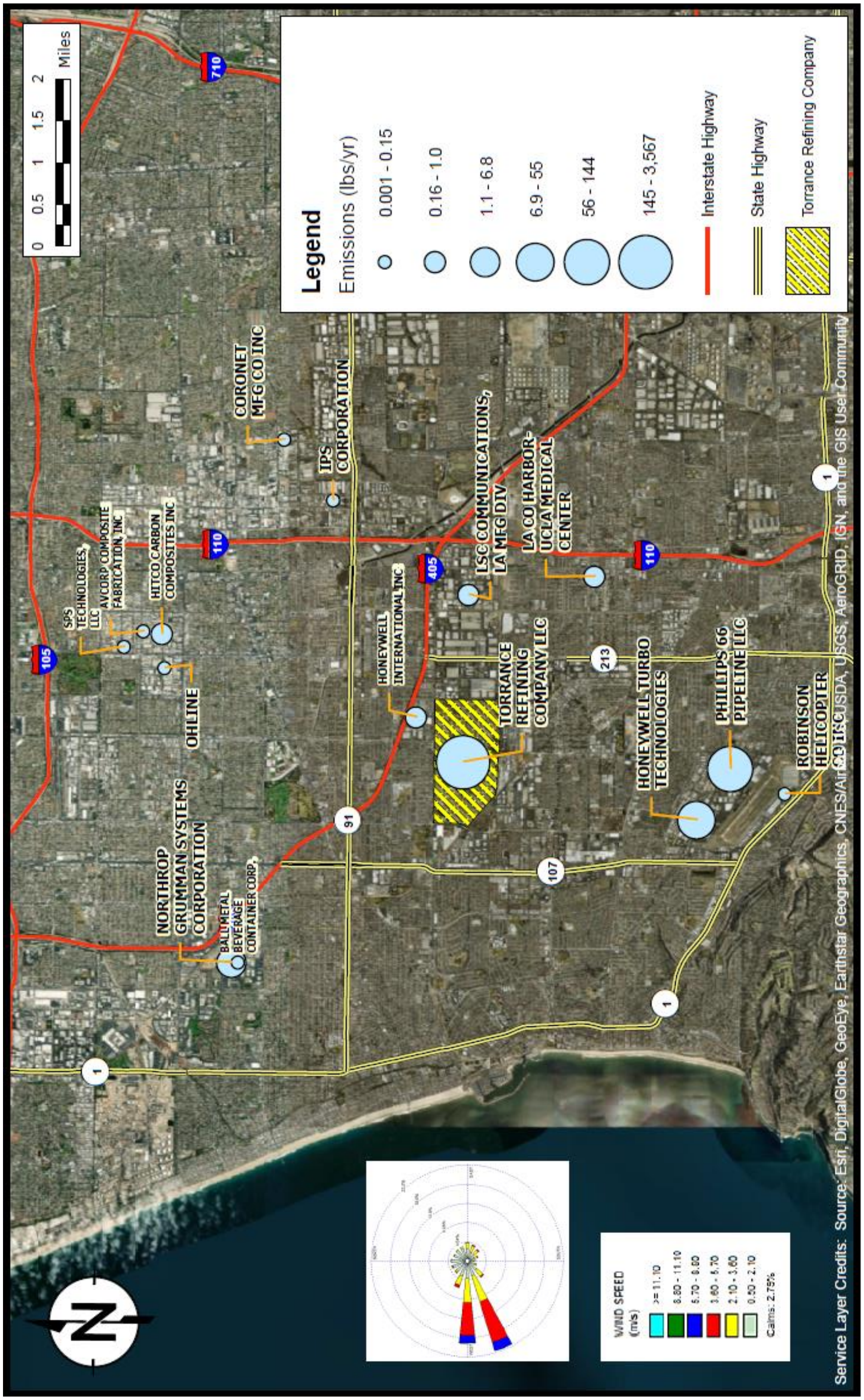

Figure 5-7: Locations of nearby major sources with benzene emissions

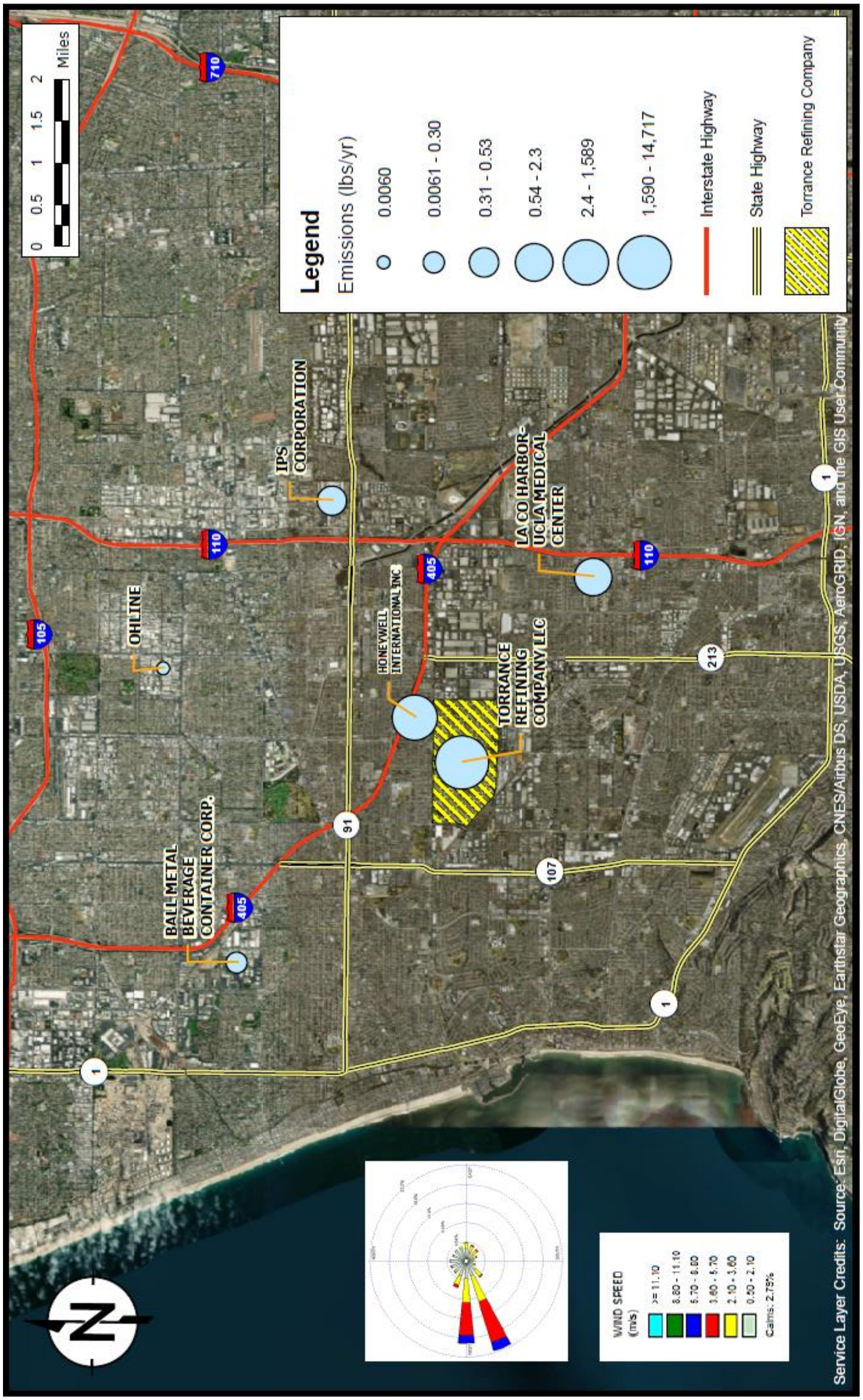

Figure 5-8: Locations of nearby major sources with toluene emissions

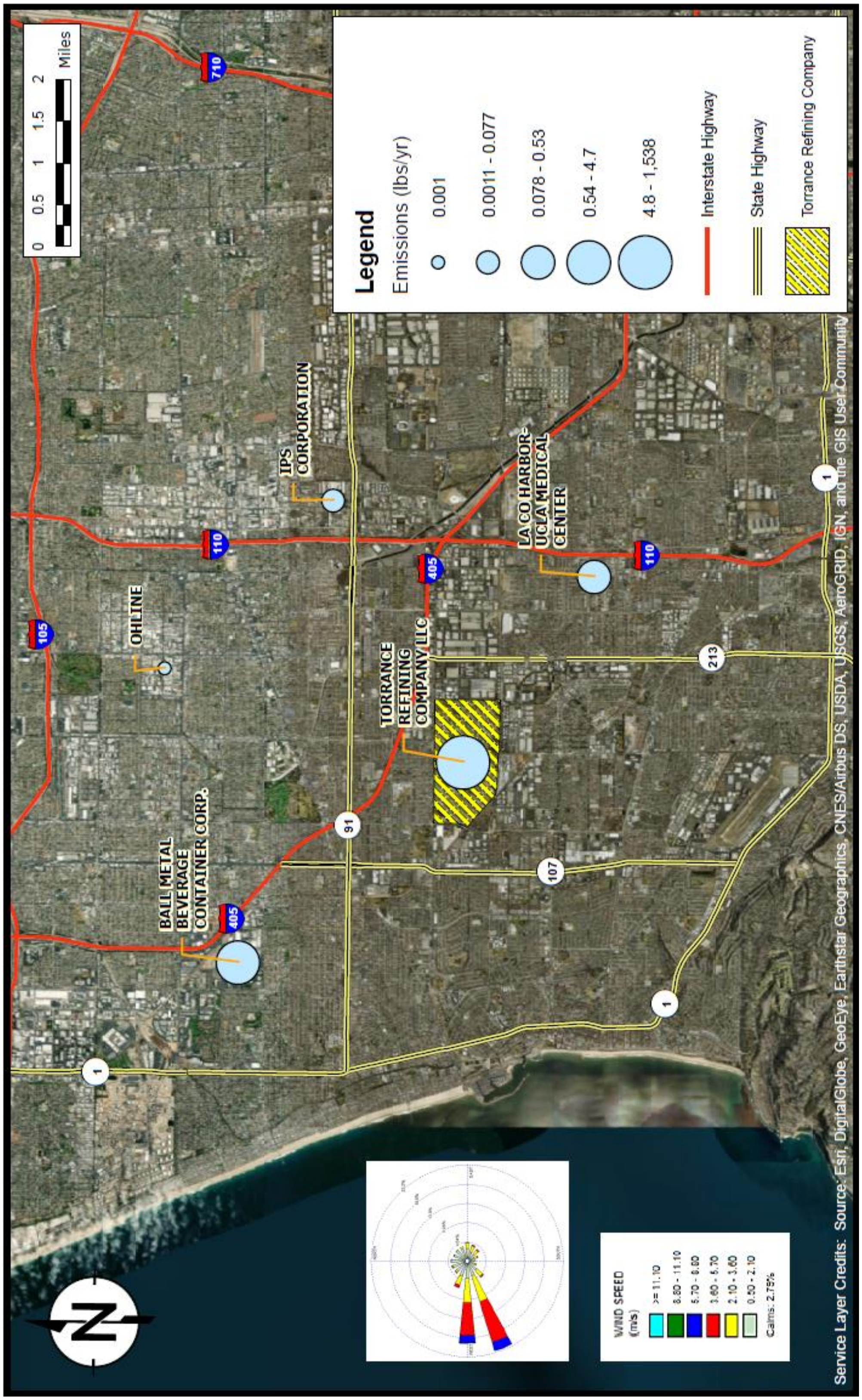

Figure 5-9: Locations of nearby major sources with ethyl benzene emissions

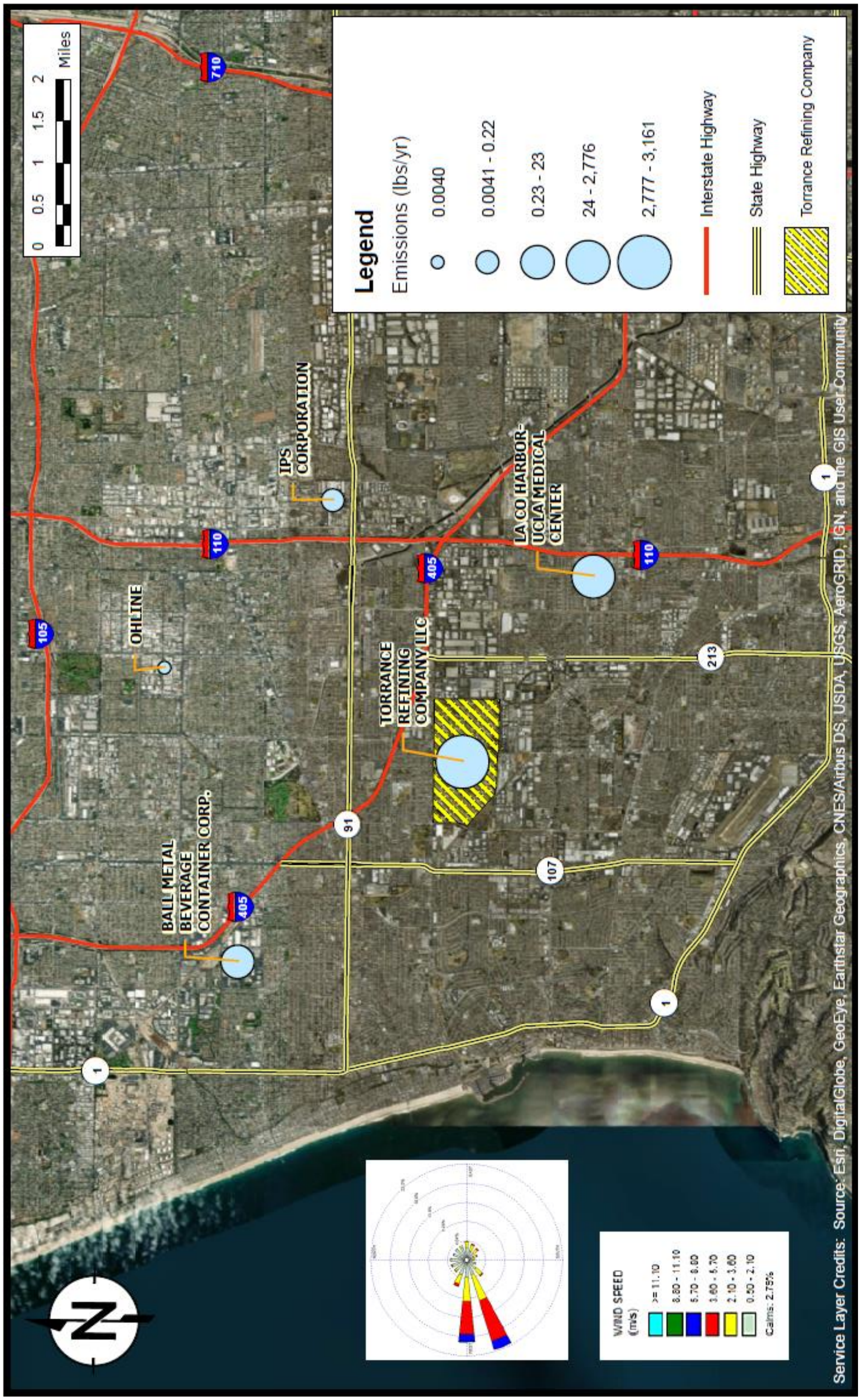

Figure 5-10: Locations of nearby major sources with xylenes emissions

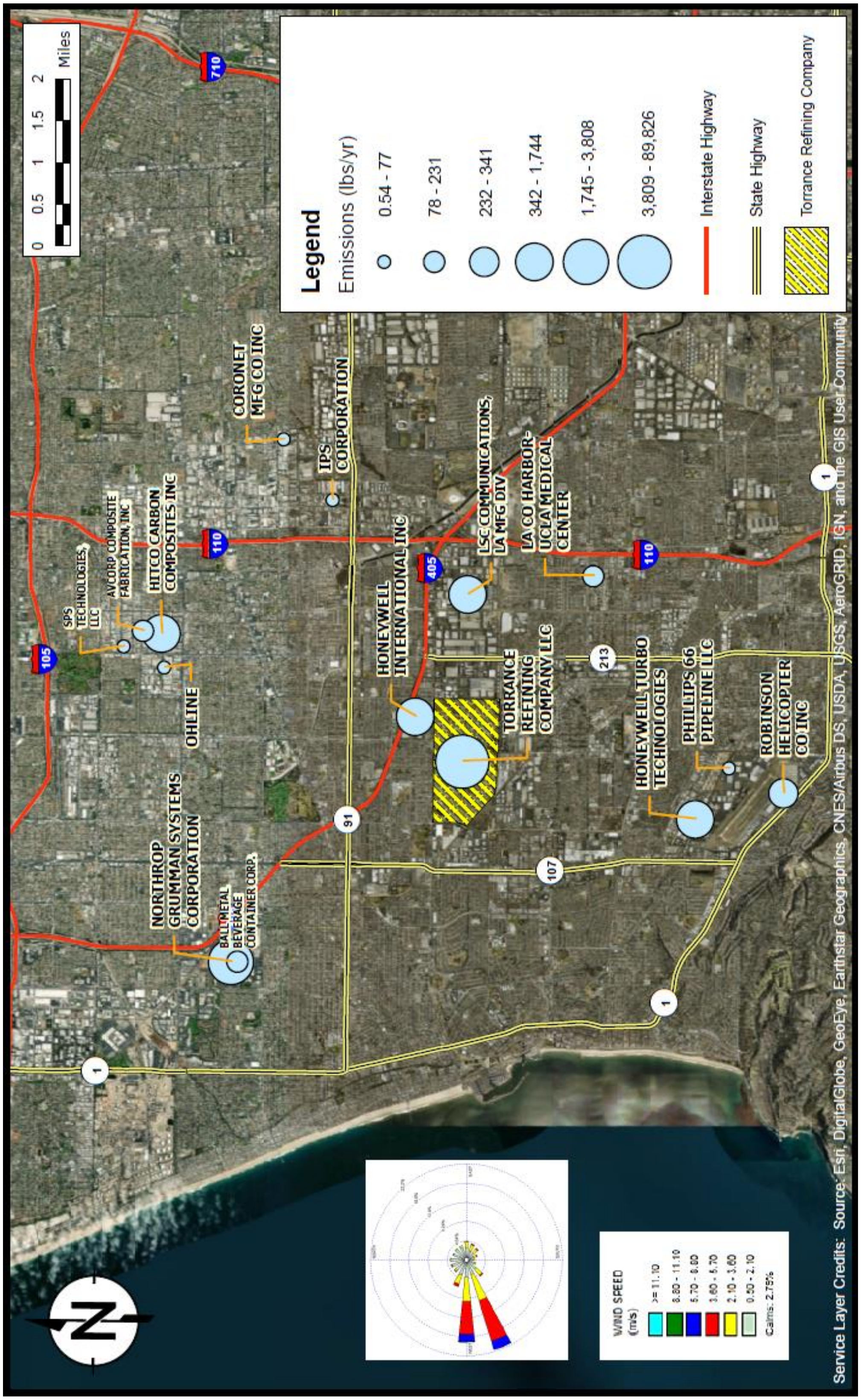

Figure 5-11: Locations of nearby major sources with ammonia emissions

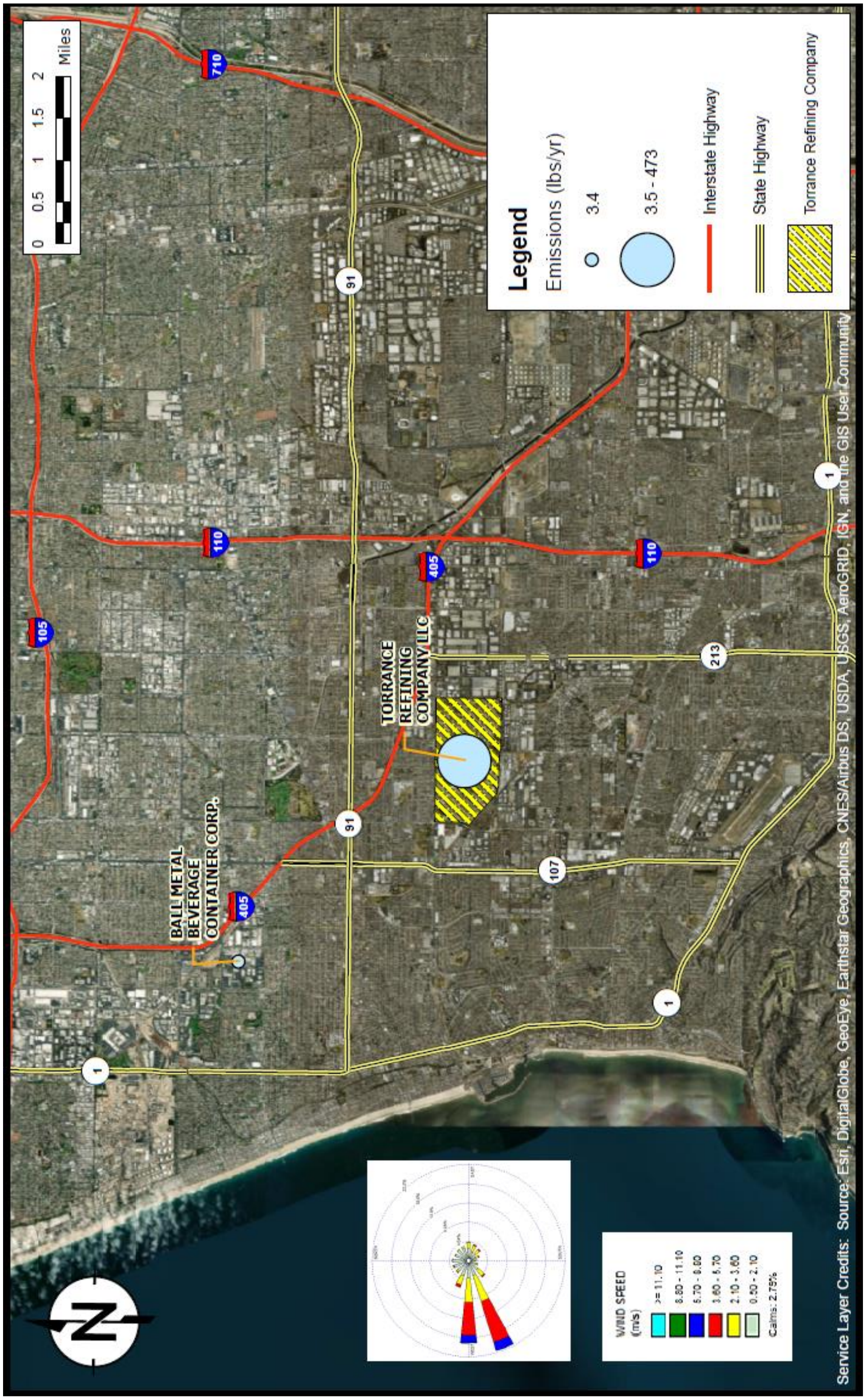

Figure 5-12: Locations of nearby major sources with diesel particulate matter emissions

Note: Only Title V major sources are shown. We believe there are other nearby facilities which may use hydrogen fluoride but are not major sources under Title V. We were not able to identify or obtain hydrogen fluoride emissions estimates for such facilities.

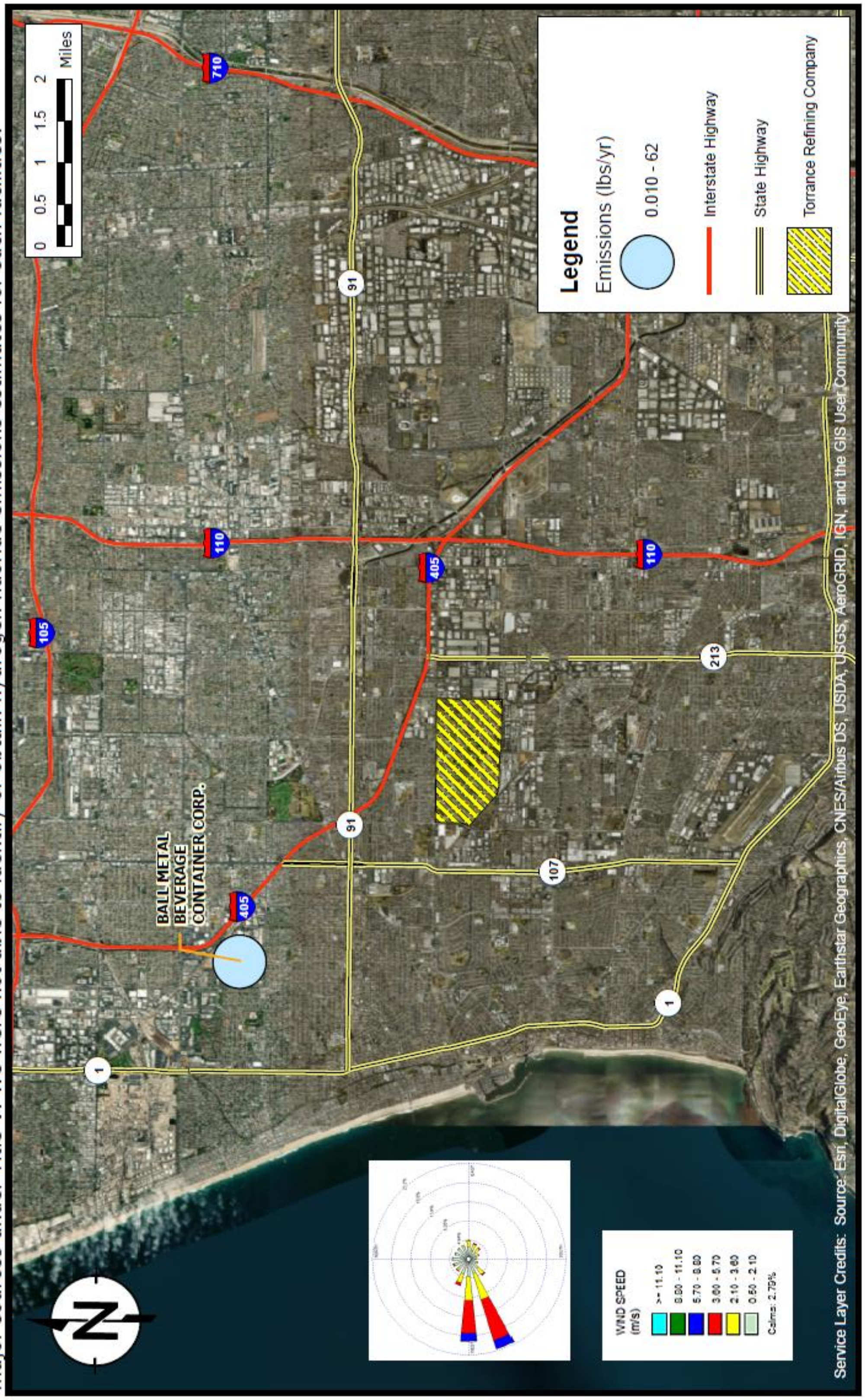

Figure 5-13: Locations of nearby major sources with hydrogen fluoride emissions

Figure 5-14: Location of nearby styrene production facility

5.1.3 Torrance Refinery Emissions and Dispersion into Surrounding Communities

To evaluate how emissions from the Torrance Refinery disperse into the surrounding communities, Ramboll conducted dispersion modeling. Dispersion modeling was conducted using the same inputs (i.e., emissions, source parameters, building dimensions) that were previously developed for recent air quality modelling efforts reflecting in-progress refinery equipment changes that will be completed in 2019.

The modeled emissions are consistent with the facility's 2016 Annual Emissions Reporting Program (AER) documentation, with the following exceptions:

- Inclusion of portable equipment registration program (PERP) engine emissions which are exempt from AER reporting;
- Inclusion of other AER-exempt emissions (e.g., contractor permitted activities);
- Exclusion of non-routine emissions (e.g., asbestos remediation);
- Updated coke drum vent emissions based on recent US EPA refinery emissions estimating procedures;[49;50]
- Updated cooling tower emissions based on more recent toxic speciation data;
- Replacement of CAS No. 1151 polycyclic aromatic hydrocarbon (PAH) emissions with individual PAH species data;
- Replacement of individual diesel engine toxic emissions with diesel particulate matter exhaust emissions; and
- Updated emissions to more accurately reflect operations (internal combustion engines, coke handling, painting)

The modeling was conducted using the latest version of the California Air Resources Board's (CARB's)[51] Hotspots Analysis and Reporting Program (HARP2 version 18159) and the United States Environmental Protection Agency's (USEPA's) recommended steady state dispersion model, AERMOD (version 18081). Modeling was conducted using the same receptors used in the recent modeling effort, including:

- Cartesian grid extending approximately 5 kilometers to the west and north, 6.5 kilometers to the south, and 11 kilometers to the east of the fenceline;
- Fenceline receptors;
- Offsite worker receptors; and
- Offsite sensitive receptors such as schools and daycares.

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[49] *Emission Estimation Protocol for Petroleum Refineries, Version 3;* RTI International: Research Triangle Park, NC, 2015.See https://www3.epa.gov/ttn/chief/efpac/protocol/Protocol%20Report%202015.pdf (accessed July 2018).

[50] Based on discussions with TORC, the source parameters for the coker vents were updated to better reflect the actual configuration. For this modeling effort, the coker vents were modeled as a series of horizontal stacks with a height of 10 feet, diameter of 10 inches, velocity of 2 feet per minute, and temperature of 220°F.

[51] *Hotspots Analysis and Reporting Program (HARP2)*; California Air Resources Board (CARB),2018. See https://www.arb.ca.gov/toxics/harp/harp.htm (accessed July 2018).

The fenceline receptors were updated to reflect the sale of the triangular parcel located near the west fenceline that is bounded by W. Del Amo Boulevard, Prairie Avenue, and the railroad tracks. In addition, to obtain a more accurate estimate of pollutant concentrations at the fenceline, the fenceline receptors were refined by increasing the density of the spacing from 100 meters to 30 meters and including three additional rows of receptors along both sides of the fenceline (total of 6 additional rows) that were spaced at intervals of 15 meters, 30 meters, and 45 meters from the fenceline. All receptors were modeled at the following heights to evaluate how concentrations vary with height:

- 1.8 meters (~6 feet), which corresponds to breathing height;
- 4.6 meters (~15 feet), which corresponds to the proposed monitoring height around the fenceline as it is slightly above the height of typical vehicles/trucks that might otherwise interfere with open path technologies; and
- 10 meters (~33 feet), which corresponds to the height of a standard meteorological station and is higher than most sources at the Torrance Refinery.

The modeling included all pollutants that were included in the recent modeling effort, which includes all the Rule 1180 pollutants except sulfur dioxide, nitrogen oxides, and total VOCs.[52] Modeling of sulfur dioxide and nitrogen oxides was not conducted because these pollutants are regional pollutants that are well characterized by SCAQMD's ambient air monitoring network (see Section 3 of this Plan). Total VOCs were not modeled because the model already considered the individual VOC species.

The fenceline results of the air modeling of the Rule 1180 pollutants are summarized in Figure 5-15 through 5-23 (maximum 1-hour average, maximum 8-hour average and annual average)[53]. Chemical concentrations estimated for each averaging period and for the entire modeling domain are presented in Appendix A of this Plan. The modeling indicates the following:

- While the annual average concentrations are generally highest along the downwind (east) fenceline, each pollutant tends to have a somewhat unique dispersion pattern. In addition, the shorter-term averaging periods (1-hour, 8-hour) yield more variable dispersion patterns, with the highest concentrations at different locations along the fenceline. As a result, broad monitoring coverage along the fenceline would be needed to monitor the peak fenceline concentrations for all pollutants.
- The dispersion patterns are generally similar for the different receptor heights included in the model (1.8 meters, 4.6 meters, and 10 meters). Based on these results, we recommend locating the open path monitor paths at a height of approximately 4.6 meters. This height is recommended because it is high enough to avoid potential interferences from fenceline walls and ground level traffic/railcars that might otherwise block the path of the open path monitors, yet low enough to safely and feasibly provide instrument access for regular service and maintenance.

[52] Hydrogen cyanide was conservatively modeled as cyanide compounds. Black carbon was modeled using diesel exhaust particulate matter as a surrogate.

[53] Although there are no hydrogen fluoride emissions from the refinery and the refinery has never had an off-site modified hydrogen fluoride release, a hypothetical emission was included in the modeling to inform placement of the fenceline air monitors for purposes of this Plan.

- The predicted fenceline concentrations will likely be below the minimum measurable range, with some exceptions, of the advanced technology instruments proposed for the fenceline air monitoring system (see Section 6 for additional details on monitors).

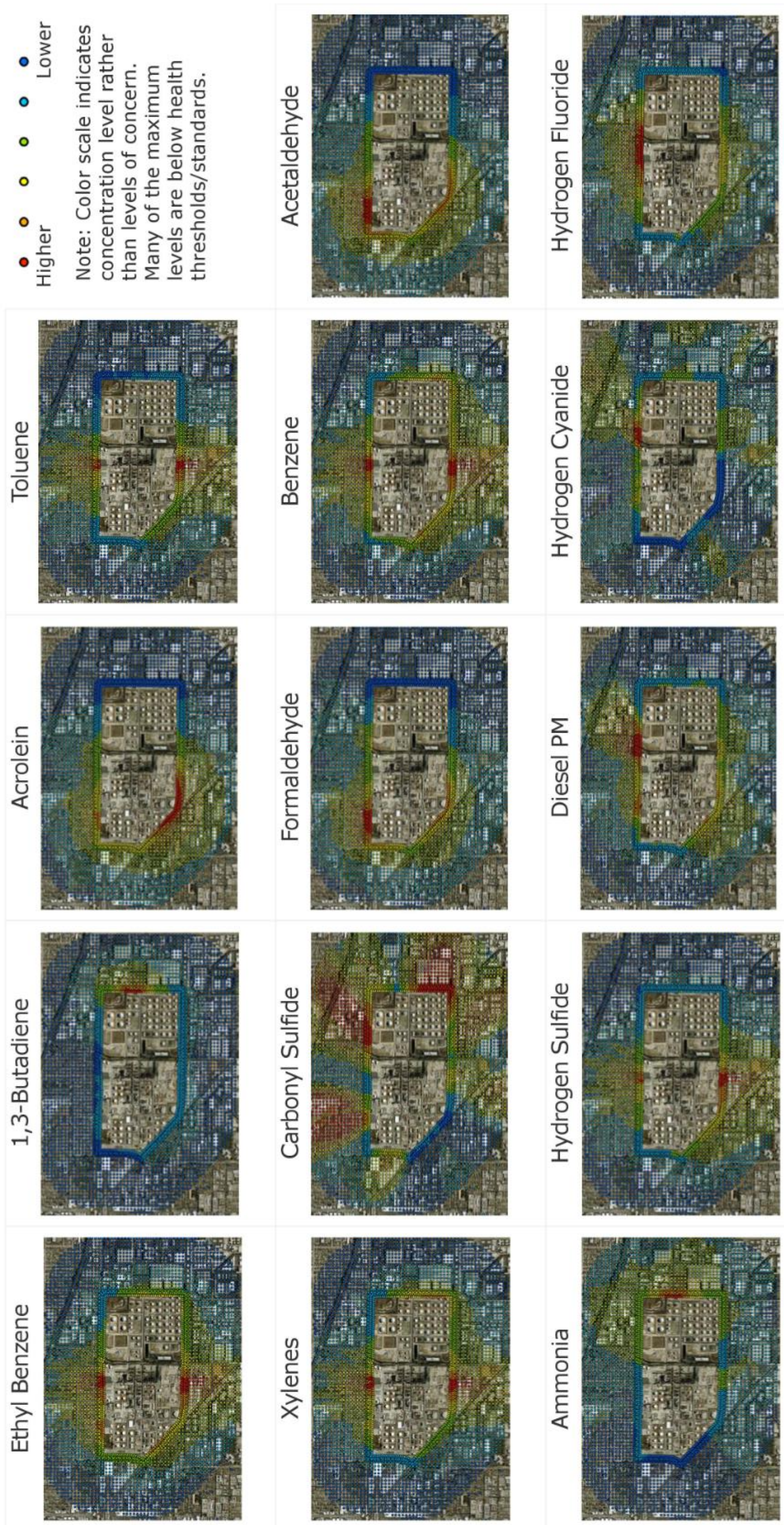

Figure 5-15: Modeled maximum 1-hour average concentrations (receptor height = 1.8 meters)

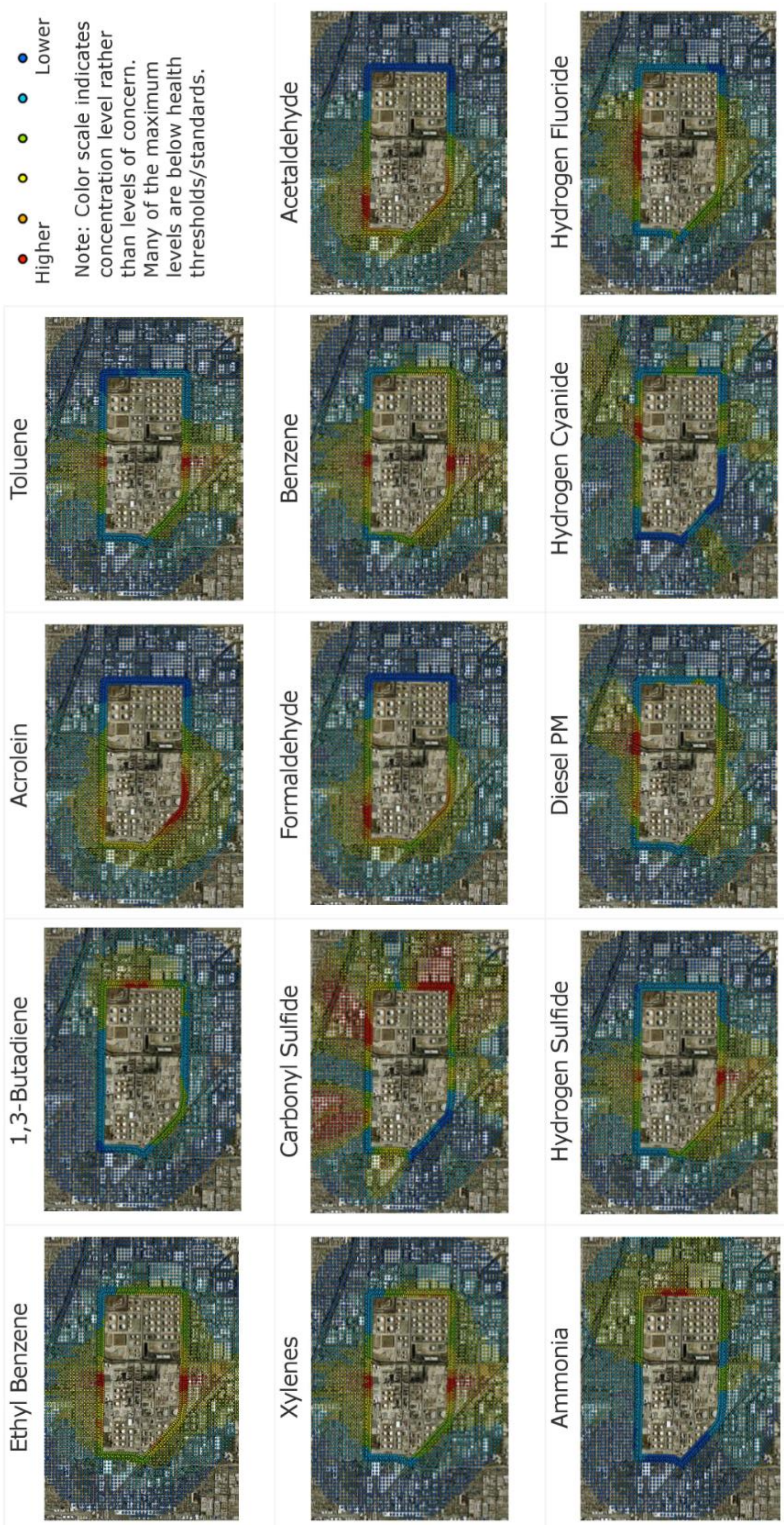

Figure 5-16: modeled maximum 1-hour average concentrations (receptor height = 4.6 meters)

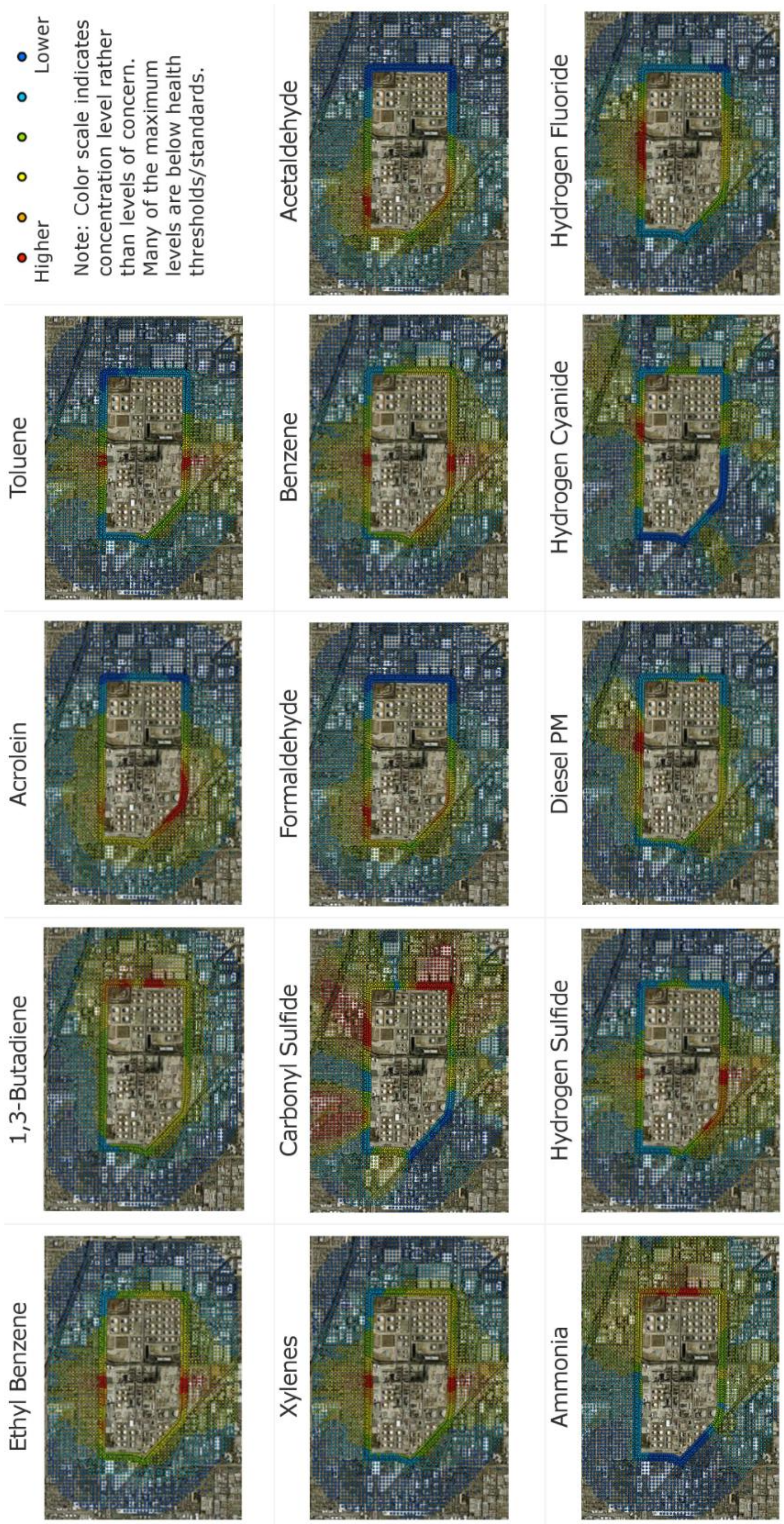

Figure 5-17: Modeled maximum 1-hour average concentrations (receptor height = 10 meters)

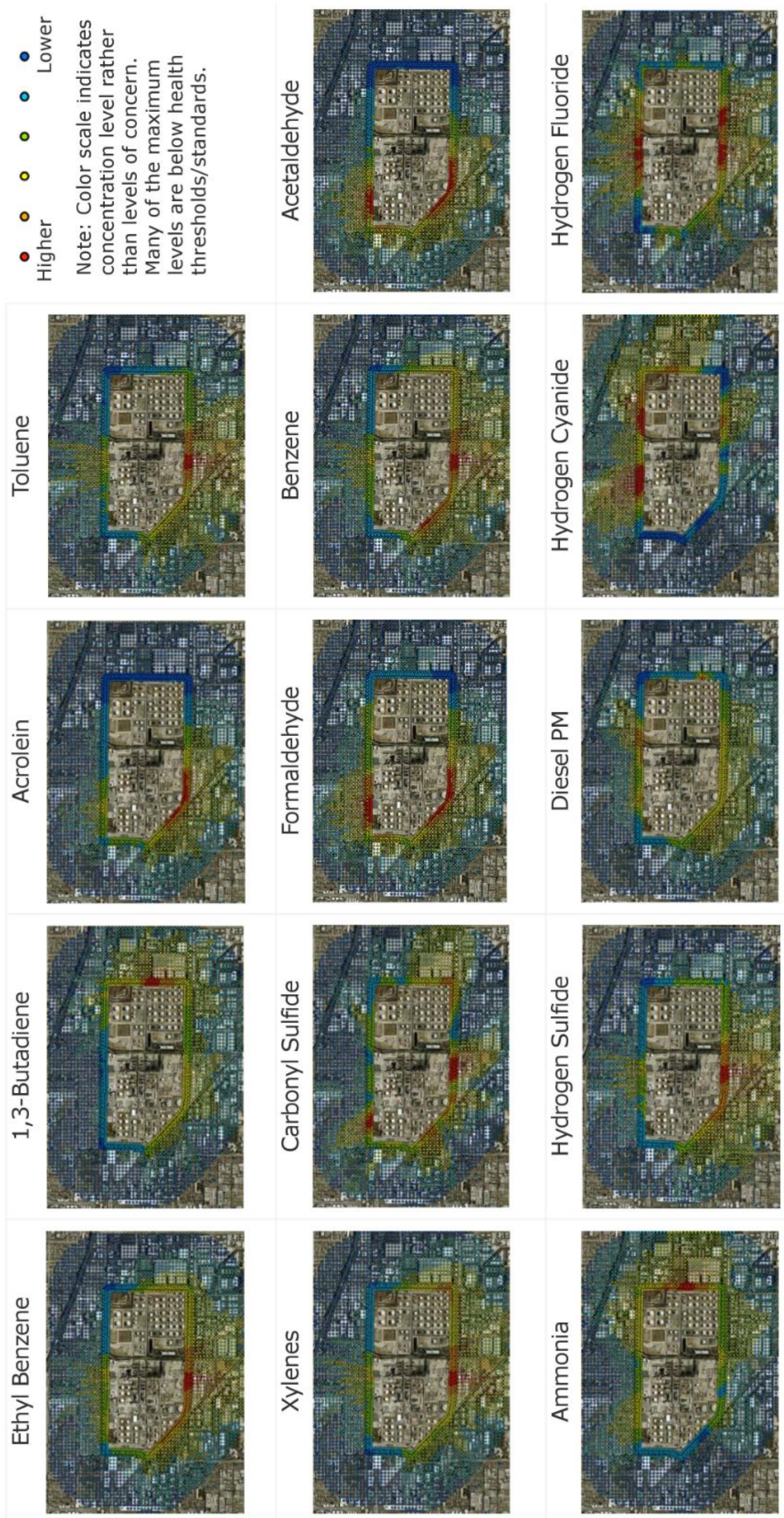

Figure 5-18: Modeled maximum 8-hour average concentrations (receptor height = 1.8 meters)

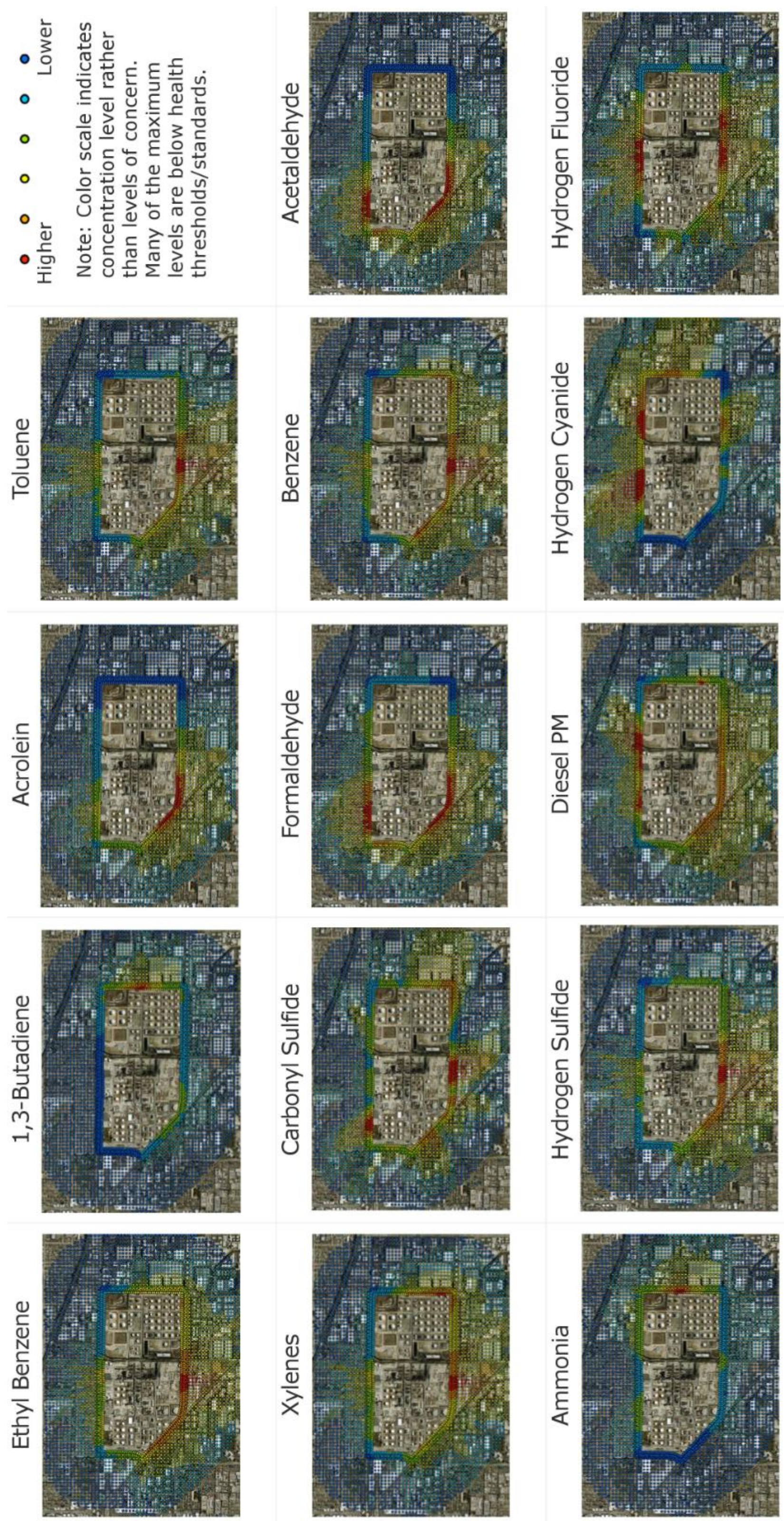

Figure 5-19: Modeled maximum 8-hour average concentrations (receptor height = 4.6 meters)

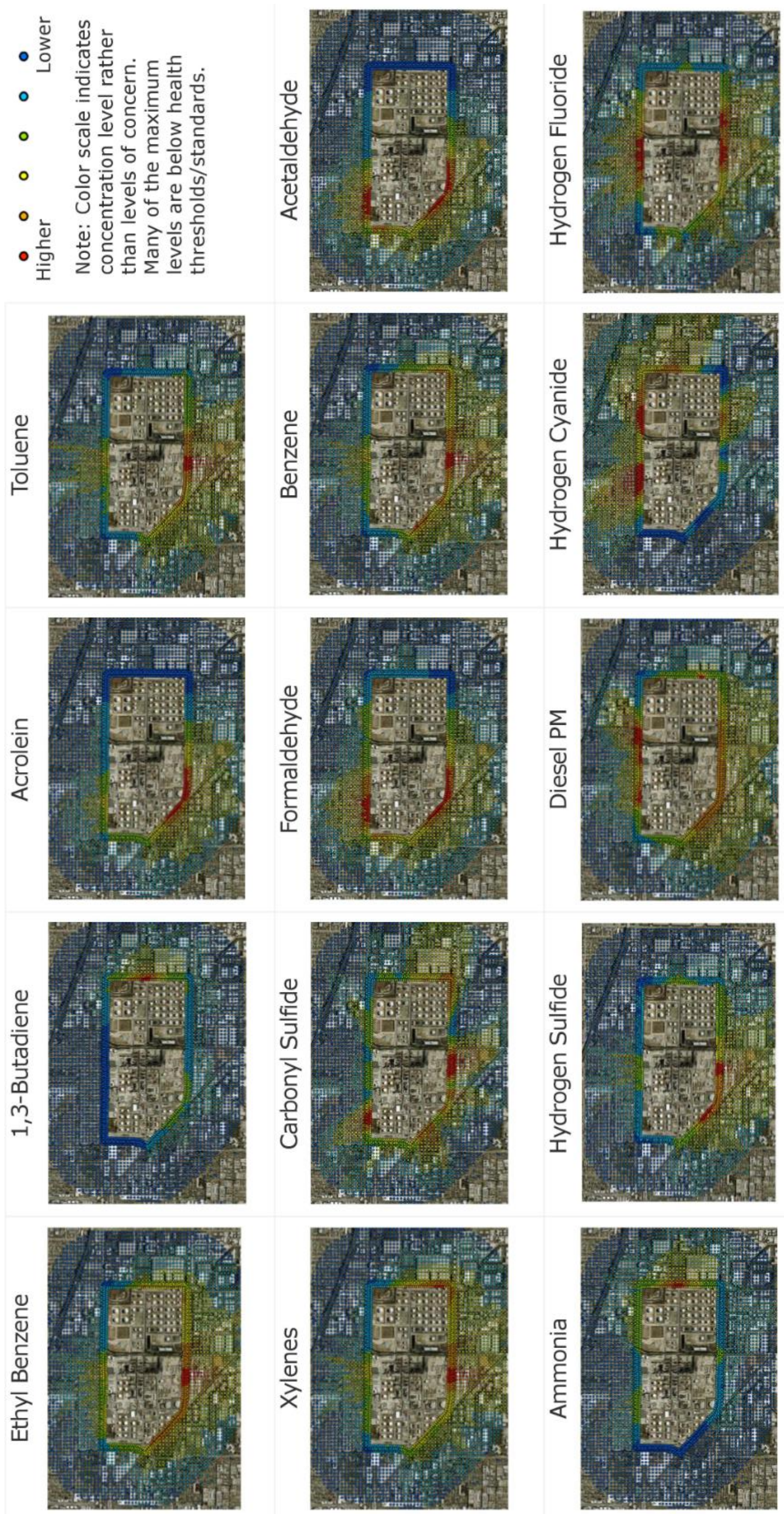

Figure 5-20: Modeled maximum 8-hour average concentrations (receptor height = 10 meters)

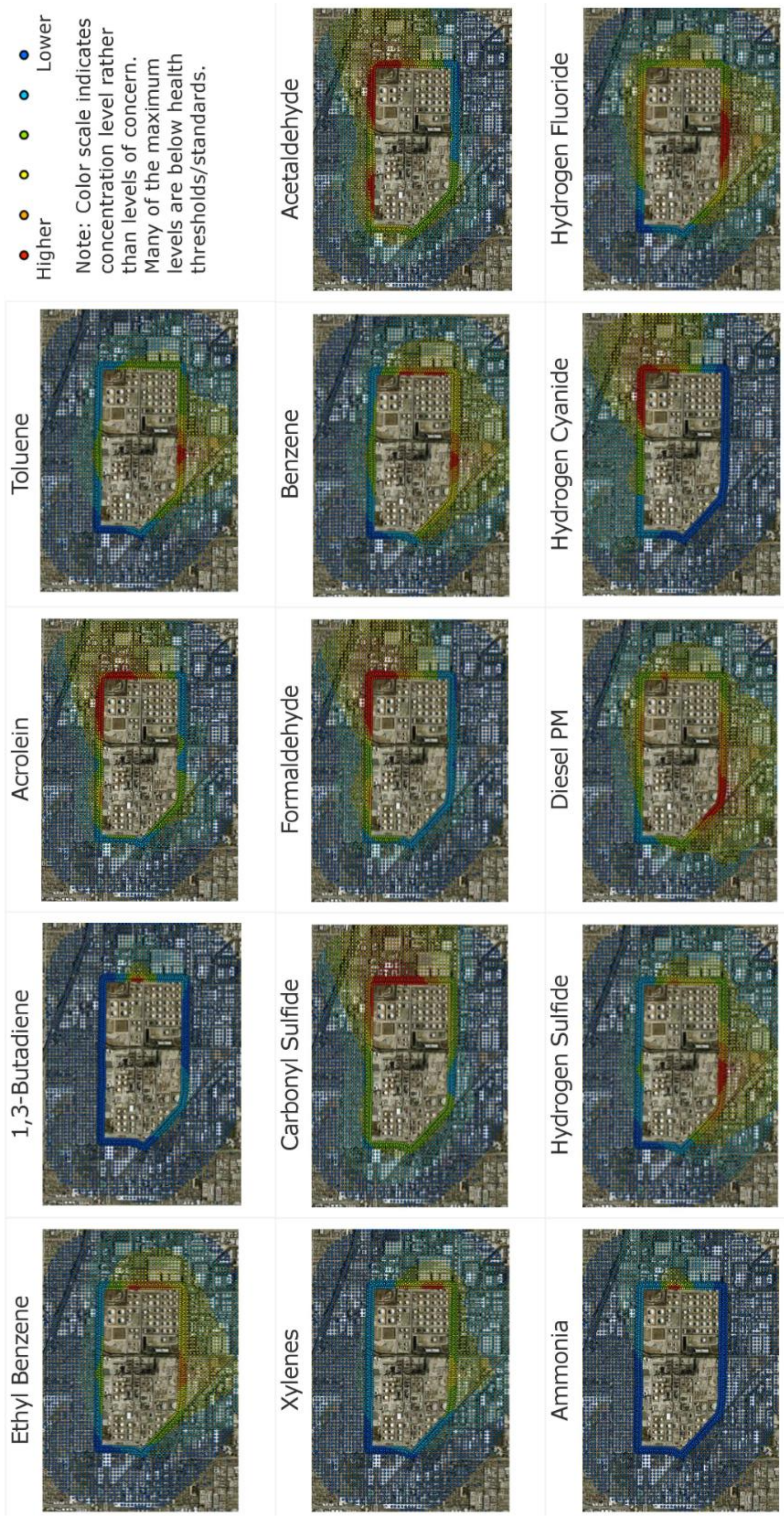

Figure 5-21: Modeled annual average concentrations (receptor height = 1.8 meters)

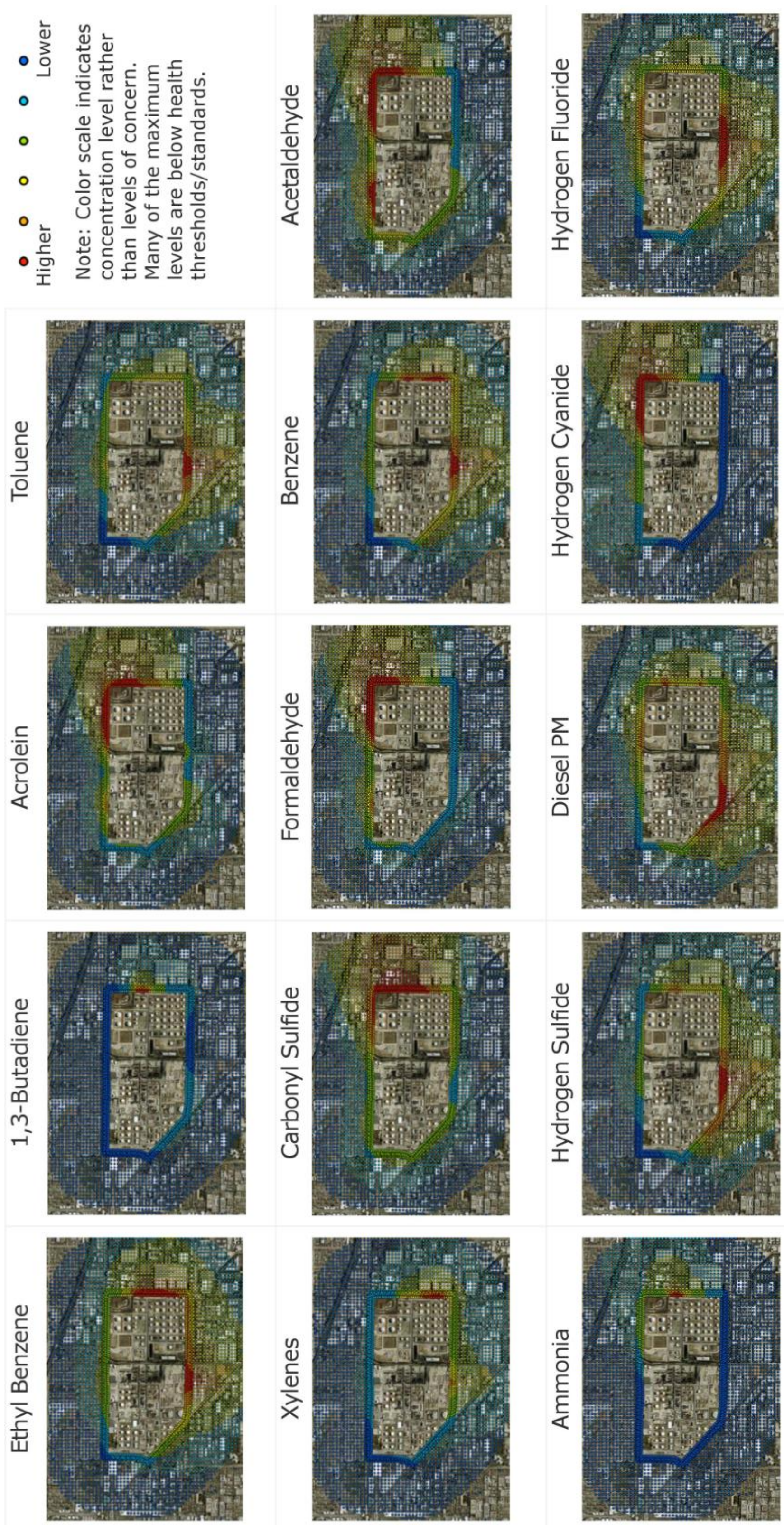

Figure 5-22: Modeled annual average concentrations (receptor height = 4.6 meters)

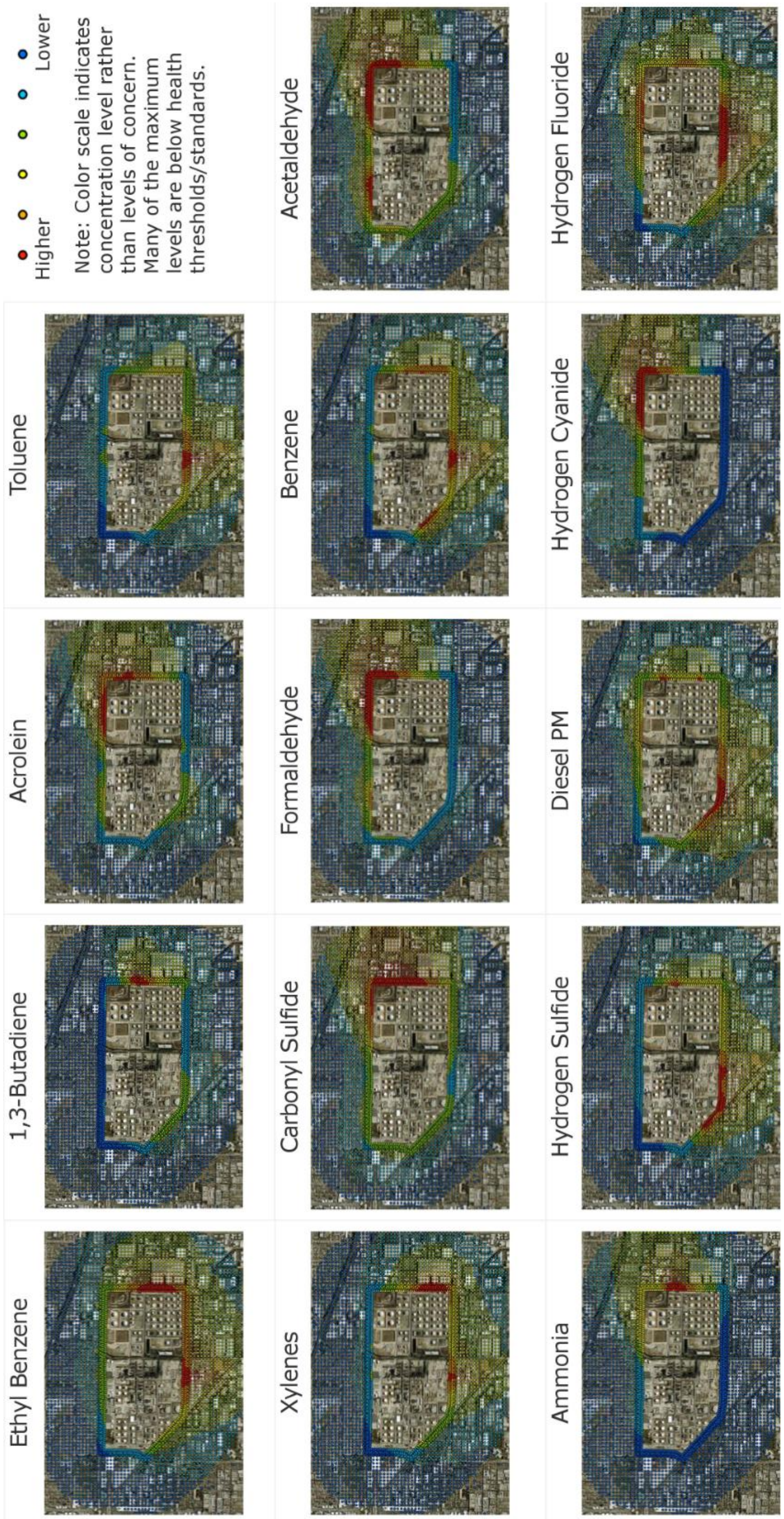

Figure 5-23: Modeled annual average concentrations (receptor height = 10 meters)

5.2 Fenceline Air Monitor Locations

The primary objective of the fenceline air monitoring system is to measure ambient concentrations of air pollutants that may have the potential to migrate offsite, especially in the direction of residences and other sensitive receptors (e.g., daycares, schools, etc.).

Selection of the fenceline air monitoring locations was based on several key criteria, including:

- Monitoring Technologies: As further discussed in Chapter 6, TORC evaluated a variety of monitoring technologies, including open path systems and fixed monitoring systems. While the open path systems have the advantage of being able to measure concentrations over a larger (2-dimensional) area, the beam attenuates with distance. In terms of detection limits, longer path lengths help achieve better detection limits until beam attenuation becomes a factor. Two open-path technologies will be employed: Fourier transform infrared (OP-FTIR) and ultraviolet differential optical absorption spectroscopy (OP-UVDOAS). Based on feedback from open path system manufacturers, the optimal path lengths for OP-FTIR systems is between approximately 500 to 600 meters. For open path OP-UVDOAS system, the optimal path length is between approximately 500 and 1000 meters;
- Location of Highest Modeled Concentrations/Risks: Based on the air dispersion modeling described above, we identified the locations along the fenceline and in the surrounding communities that may have the highest estimated concentrations and health risks (based on the computer modeling) due to emissions from Torrance Refinery sources. The fenceline monitor locations have been selected to capture these peak concentrations for evaluating potential "hot spots;"
- Location of Nearby Communities: The fenceline air monitoring system has been designed to detect emissions of refinery sources that have the potential to migrate offsite into surrounding communities. As noted earlier, the facility is surrounded by a variety of land uses. There are sensitive receptors within one mile of the fenceline on the north, west and south sides. The closest sensitive receptors are residential areas to the north across W. 190th Street (approximately 35 meters from the fenceline) and to the south along Del Amo Boulevard and east of Crenshaw Boulevard (approximately 10 meters from the fenceline). While winds are predominantly from the west-southwest (WSW), winds have been recorded from all directions, so the fenceline air monitoring program has been designed to measure concentrations around most of the facility;
- Logistics: The design of the fenceline air monitoring system accounts for numerous logistical considerations, including access to electrical power, ease of access for installation/maintenance, protection against vandalism/security, avoidance of physical interferences (e.g., traffic, railcars, trees, power lines), and local topography. The locations of the open path systems have been selected to achieve clear lines of site without obstructions; and
- Recommendations from the SCAQMD during preliminary plan reviews.

Based on these considerations, TORC proposes to install a combination of fixed-point monitors and open path systems at the locations identified in Figure 5-24 (both OP-FTIR and

OP-UVDOAS monostatic[54] systems). Fixed-point monitors will measure black carbon and hydrogen sulfide, and the open path systems will measure the remaining Rule 1180 pollutants. Figure 5-24 shows the layout of the system for monostatic OP-FTIR and monostatic UV-DOAS monitors with approximately 500-meter path intervals used throughout.

Each analyzer will be mounted on computer-controlled auto-positioning pan and tilt pedestals so that they can rotate alternately between two retroreflectors at five minute time intervals per retroreflector (10-minute cycle time). This will enable each monostatic analyzer to alternately monitor two different 500-meter path distance intervals (total of 1000 meters per analyzer).

The coordinates of each monitor analyzer/source and retroreflector are given in Table 5-1.

[54] Monostatic refers to systems with co-located light source and receiver at one end of the path and a retroreflector at the other end. Bistatic refers to systems with light source and receiver at opposite ends of the path.

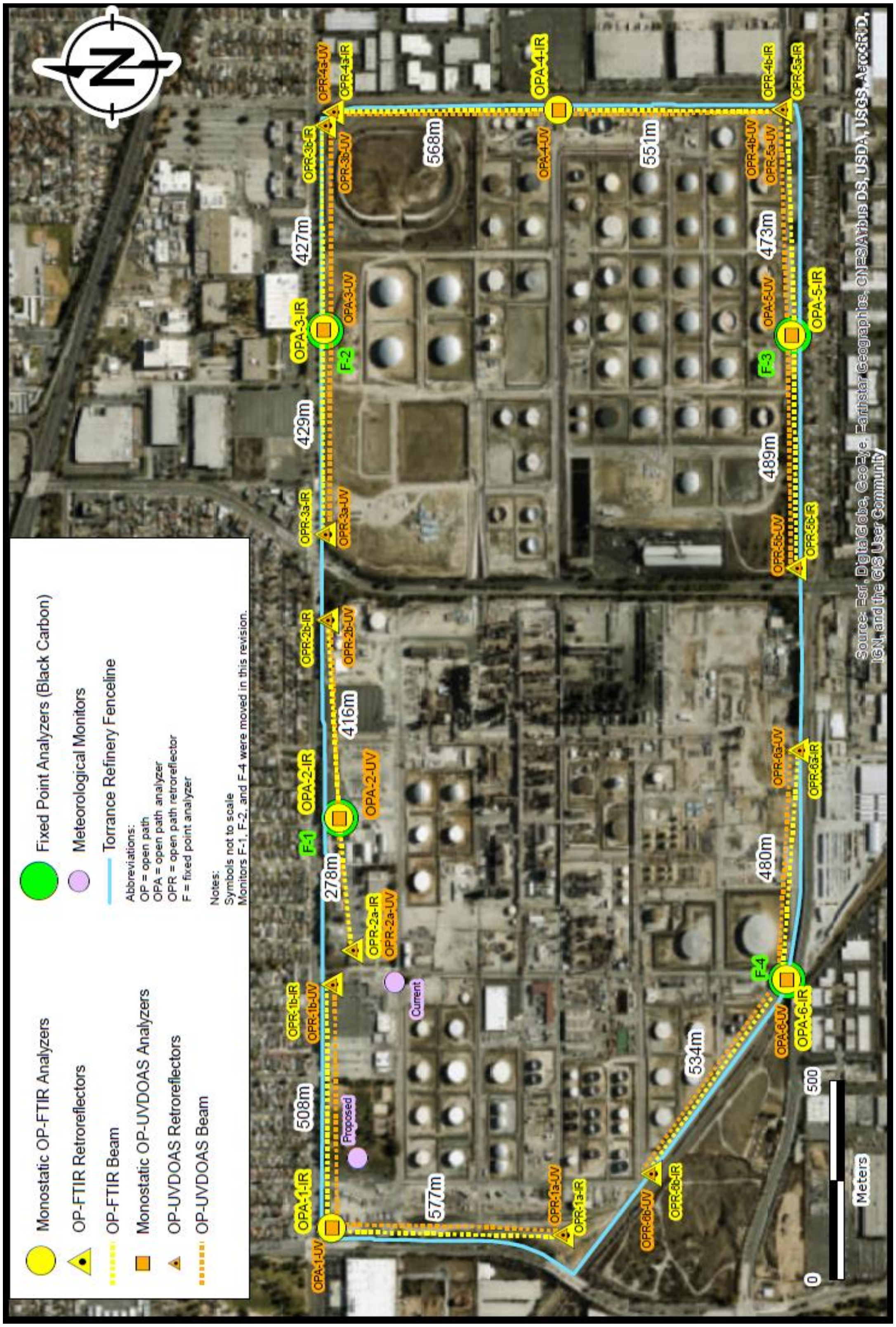

Figure 5-24: Layout of monostatic OP-FTIR, monostatic open path OP-UVDOAS and fixed-point monitors.

Table 5-1: Proposed locations of Torrance Refinery fenceline air monitoring stations.

	Enclosure ID (Enclosure tag no.)	OPA-6 & F-4 (A55002)	OPA-5 & F-3 (A50003)	OPA-4 (A72001)	OPA-3 & F-2 (A55001)	OPA-2 & F-1 (A50002)	OPA-1 (A50001)
Analyzer	**Location**	Southwest	Southeast	East	Northeast	North	Northwest
	UTMx (m)	376,242	377,591	378,070	377,617	376,548	375,737
	UTMy (m)	3,746,065	3,746,035	3,746,615	3,747,209	3,747,169	3,747,215
	Height Above Grade (m)	4.6	4.6	4.6	4.6	4.6	4.6
Retroreflector 1	**Reflector ID**	OPR-6a	OPR-5a	OPR-4a	OPR-3a	OPR-2a	OPR-1a
	UTMx (m)	376,721	378,064	378,073	377,188	376,317	375,714
	UTMy (m)	3,746,033	3,746,058	3,747,184	3,747,215	3,747,158	3,746,638
	Height Above Grade (m)	4.6	4.6	4.6	4.6	4.6	4.6
	Distance to Analyzer (m)	480	473	568	429	233	577
Retroreflector 2	**Reflector ID**	OPR-6b	OPR-5b	OPR-4b	OPR-3b	OPR-2b	OPR-1b
	UTMx (m)	375,839	377,102	378,064	378,044	377,009	376,245
	UTMy (m)	3,746,415	3,746,034	3,746,058	3,747,204	3,747,211	3,747,210
	Height Above Grade (m)	4.6	4.6	4.6	4.6	4.6	4.6
	Distance to Analyzer (m)	534	489	551	427	461	508

The proposed open path monitors generally surround the entire fenceline, with a few minor exceptions that are not covered due to obstructions or path interferences:

- Approximately 230-meter gap between OP-FTIR retroreflector OPR-1b and OP-FTIR Analyzer OPA-2, located along the north fenceline near the main entrance along W. 190th Street.
- Approximately 180-meter gap between OP-FTIR retroreflector OPR-2b and OP-FTIR Reflector OPR-3a, located along the north fenceline near the Crenshaw Boulevard intersection.
- Approximately 34-meter gap between OP-FTIR retroreflector OPR-3b and OP-FTIR retroreflector OPR-4a, located in the northeast corner of the facility.
- Approximately 350-meter gap between OP-FTIR retroreflector OPR-5b and OP-FTIR retroreflector OPR-6a, located along the south fenceline near the Crenshaw Boulevard intersection.
- Approximately 260-meter gap between OP-FTIR retroreflector OPR-6b and OP-FTIR retroreflector OPR-1a, located along the southwest fenceline adjacent to the rail line.

Based on the air modeling described above, the predicted concentrations of Rule 1180 chemicals in these locations with gaps are similar to the concentrations in surrounding areas that are proposed for monitoring, so the lack of coverage in these areas is not expected to compromise the quality or reliability of the proposed air monitoring system.

As shown in Figure 5-24, fixed monitors for measuring black carbon and hydrogen sulfide will be located along north and the south portion of the fenceline, collocated with OPA-2, OPA-3, OPA-5 and OPA-6 enclosures. These locations were selected based on the general areas of maximum model-predicted annual average concentrations for diesel particulate matter (a surrogate for black carbon), and SCAQMD's recommended placement of the fixed point monitors.

5.3 Meteorological Monitoring

5.3.1 Proposed Meteorological Monitor

An understanding and assessment of the meteorological conditions at the Torrance Refinery is critical to the design and interpretation of the fenceline air monitoring program. Sub-paragraph (d)(2)(C) of Rule 1180 requires fenceline air monitoring locations to continuously record wind speed and wind direction data. TORC currently operates a meteorological monitor, installed in 2016, located near the visitor center at the front gate, shown in Figure 5-25. The monitor is a RainWise MKIII-RTI-LR integrated unit that measures wind speed/direction, temperature, humidity, precipitation, and barometric pressure at the top of a 10-meter pole.

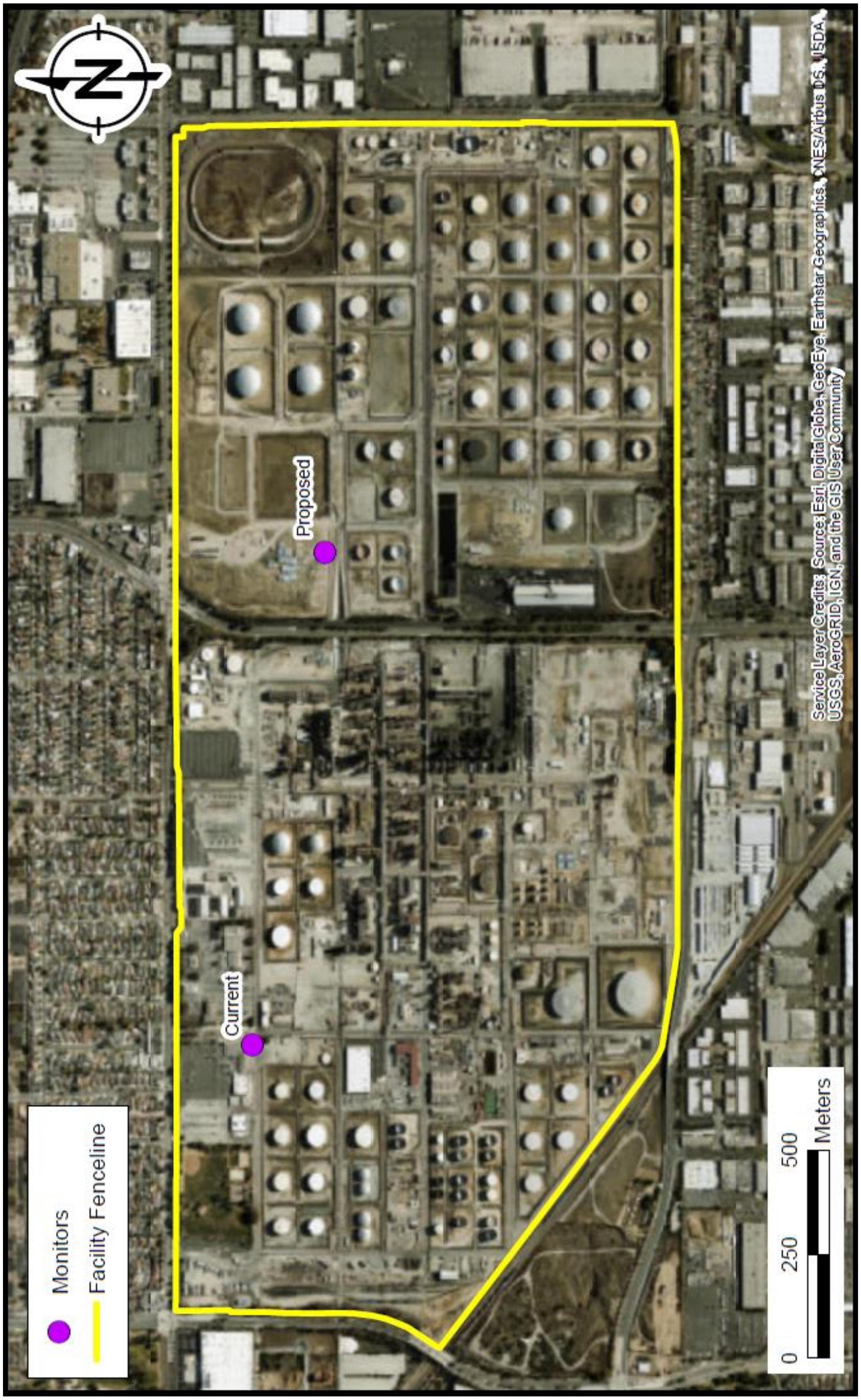

Figure 5-25: Location of existing and proposed weather stations

The RainWise station does not satisfy the criteria established in USEPA's guidelines for meteorological measurements regarding both system performance and location/siting.[55] As a result, TORC is proposing to install a new weather station that is specifically designed to comply with USEPA guidelines for air quality and regulatory meteorological monitoring. The weather station that TORC proposes to install will have similar or the same specifications as a Met One Instruments, Inc. (Met One) model (see Appendix B of this Plan).

5.3.2 Measured Variables

Meteorological conditions can significantly affect both the concentrations of air pollutants in the nearby communities and the performance of the open path monitoring systems. Below are the meteorological variables that TORC proposes to continuously measure with a new weather station:

- Wind speed and wind direction: Wind is the most critical element for transport of refinery emissions to surrounding areas. Measurements of both wind speed and wind direction are important in interpreting the fenceline air monitoring results; for example, to determine the amount of initial dilution experienced by a plume and whether the measured pollutant concentrations are downwind or upwind from the refinery emission sources.
- Ambient temperature: Temperature can affect the amount of buoyancy a plume experiences from a source. In addition, temperature can affect fugitive emissions (e.g., pressure relief from storage tanks with warmer temperatures).
- Precipitation and relative humidity: Occurrence of rain and/or fog can impact measurements from fenceline monitors, so it is important to measure rainfall and moisture content of the air.
- Barometric pressure: While not as significant as the above variables in interpreting pollutant concentrations, long-term trends in atmospheric pressure can influence the meteorological patterns that persist in the region.
- Visibility: Low visibility could be an indication of heavy fog or other aerosol or particulate matter in the air, which has the potential to impact the open-path FTIR and UVDOAS fenceline air monitors.

5.3.3 System Performance and Monitor Siting

As shown in Table 5-5, the performance of the Met One weather station for the above variables complies with or exceeds guidance for all operating range, system accuracy, and measurement resolution outline by the USEPA for meteorological measurements (USEPA 2008). Instrumentation in the weather station are all in compliance with USEPA guidance. To best comply with the siting and obstruction requirements of meteorological monitors, a location for the meteorological station has been preliminarily identified, shown in Figure 5-26, subject to change. The site is being considered because it meets most of USEPA's siting criteria. Other sites inside the refinery also currently are being evaluated for feasibility. The final location will be selected during the detailed design phase. The anemometer and airfoil

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[55] *Quality Assurance Handbook for Air Pollution Measurement Systems, Volume IV: Meteorological Measurements Version 2.0*; U.S. Environmental Protection Agency; Office of Air Quality Planning and Standards: Research Triangle Park, NC, 2008; EPA-454/B-08-002. See https://www3.epa.gov/ttn/amtic/files/ambient/met/Volume_IV_Meteorological_Measurements.pdf (accessed July 2018).

vane monitors will be located atop the 10-meter tower, while sensors for temperature, humidity, and pressure will be fixed on a boom two meters above the ground on the tower. Precipitation will be measured by a sensor (enclosed in a wind shield) that is closer to the ground near the tower. Visibility will be measured at approximately 4.6 meters above grade, which is the proposed height for the fenceline monitors.

Table 5-5: Performance evaluation for proposed weather station (Met One AQ or similar)

Sensor Type	Instrument		Operating Range		System Accuracy		Measurement Resolution	
	USEPA Guidance	Met One AQ Weather Station	USEPA Guidance	Met One AQ Weather Station	USEPA Guidance	Met One AQ Weather Station	USEPA Guidance	Met One AQ Weather Station
Wind Speed	Cup or sonic anemometer	3-cup anemometer	0.5 - 50.0 m/s	0.4 - 55.9 m/s	± 0.2 m/s	± 0.07 m/s	0.1 m/s	< 0.1 m/s
Wind Direction	Vane or sonic anemometer	Airfoil vane	0 - 360 °	0 - 360 °	± 5 °	± 3 °	1.0 °	< 0.1 °
Ambient Temperature	Thermal resistor	Platinum thermal resistor	-30 - 50 °C	-50 - 70°C	± 0.5 °C	± 0.1 °C	0.1 °C	0.1 °C
Relative Humidity	Psychrometer/ Hygrometer	Electronic thin film hygrometer	0 - 100 %	0 - 100 %	± 7 %	± 0.8 %	0.5%	0.1%
Precipitation	Tipping bucket	Dual-chambered tipping bucket	0 - 50 mm/hr	0 - 76 mm/hr	± 10 % observed	± 1 % observed	0.3 mm/hr	0.2 mm/hr
Pressure	Aneroid barometer	Piezo-resistive aneroid barometer	600 - 1,100 hPa	500 - 1,100 hPa	± 3 hPa	± 0.3 hPa	0.5 hPa	0.01 hPa

Abbreviations:
mm/hr - millimeter per hour
hPa - hectopascal
m/s - meter per second
cm - centimeter
USEPA - United States Environmental Protection Agency
°C - degrees Celsius

Table 5-6 shows the probe placement and obstruction proximity for the proposed meteorological station compared to USEPA guidance for simple terrain.[56] At the proposed location, the temperature, humidity, precipitation, and pressure instruments all comply with USEPA guidance for height, terrain, and obstruction proximity. In accordance with the guidance, the wind speed and direction sensors will be placed 10 meters above ground over open terrain; however, there is a storage tank to the south of the proposed location that is closer than the distance recommended by the guidance (i.e., ten times the height of nearby obstructions). With all the structures, buildings, and paved surfaces in the Torrance Refinery, it would not be possible to find an area where the wind speed/direction instruments would be at a distance greater than ten times the height of the nearest obstruction in open terrain. However, USEPA guidance does acknowledge that many industrial sites face similar constraints and allows for some leniency in the siting of anemometers, stating in cases where it is difficult to satisfy the criteria of the guidance that the sensor should be located such that "it is reasonably unaffected by local obstructions." [57]

[56] USEPA defines simple terrain as any site where the terrain effects on meteorological measurements, such as changes in elevation, are non-significant (USEPA, 2000).

[57] *Meteorological Monitoring Guidance for Regulatory Modeling Applications*; U.S. Environmental Protection Agency; Office of Air Quality Planning and Standards: Research Triangle Park, NC, 2000; EPA-454/R-99-005. See https://www3.epa.gov/scram001/guidance/met/mmgrma.pdf (accessed July 2018).

Table 5-6: Siting and exposure evaluation for proposed weather station

Sensor Type	Probe Placement		Obstruction Proximity	
	USEPA Guidance	Met One AQ Weather Station	USEPA Guidance	Met One AQ Weather Station
Wind Speed & Direction	10m above ground over level open terrain, over grass or gravel	10m above ground, near gravel	Nearby buildings/major structures should be avoided, placed over open terrain at distance of 10x height of any nearby obstruction; site-specific leniency allowed	In open terrain away from buildings, to be located as far away from nearby obstructions, but less than 10x
Temperature and Humidity	2m above ground. In case of snow should not be higher than 10m	2m above ground	Distance of 1.5x the tower diameter	To be located on a boom at 1.5x the diameter of the tower
	Open level area at least 9m in diameter, surface should be covered by short grass (or natural earth)	To be located in open terrain greater than 9m in diameter, surface is natural earth	30m from large paved areas	To be located at a distance greater than 30m from nearest paved road
	Temperature sensor should be shielded and aspirated	Sensor has radiation shield and naturally aspirated	Avoid large industrial heat sources, rooftops, shaded areas, away from exhaust and industrial heat sources	To be located in open area, away from heavy industrial activity on site
Precipitation	Placed level to the ground with mouth horizontal and open to sky	Sensor is level to the ground and open to the sky	Best placement in sheltered area, where the height of objects and distance to sensor is the same	Station includes a wind screen for shelter
	Underlying surface should be covered with short grass or gravel	To be located over natural earth	In open area, should be 2-4x distance from height of obstruction	To be located in open area, at a distance of at least 2x the height of nearby obstructions
	Height of opening should be as low as possible (minimum 30cm from ground) but high enough to avoid splashing	46cm above ground		
	Above level of snow accumulation	N/A		
Pressure	Minimum 30cm above ground, above natural vegetation or gravel	Located at same height as temperature sensor	1m from tower	To be located on a boom at least 1m from the tower

Abbreviations:
cm - centimeter
m - meter
USEPA - United States Environmental Protection Agency

Figure 5-26 shows a comparison of wind speed/direction measurements from the current RainWise system to the nearest Automated Surface Observing System (ASOS) station with data processed by SCAQMD (Hawthorne-Jack Northrop Field, or KHHR), which located approximately 4.5 miles north of the Torrance Refinery. Even though the current location of the RainWise system does not meet USEPA guidance for siting, Figure 5-26 shows that the measured wind patterns are similar, with predominant winds blowing from the west-southwest. The new proposed location is further away from obstructions.

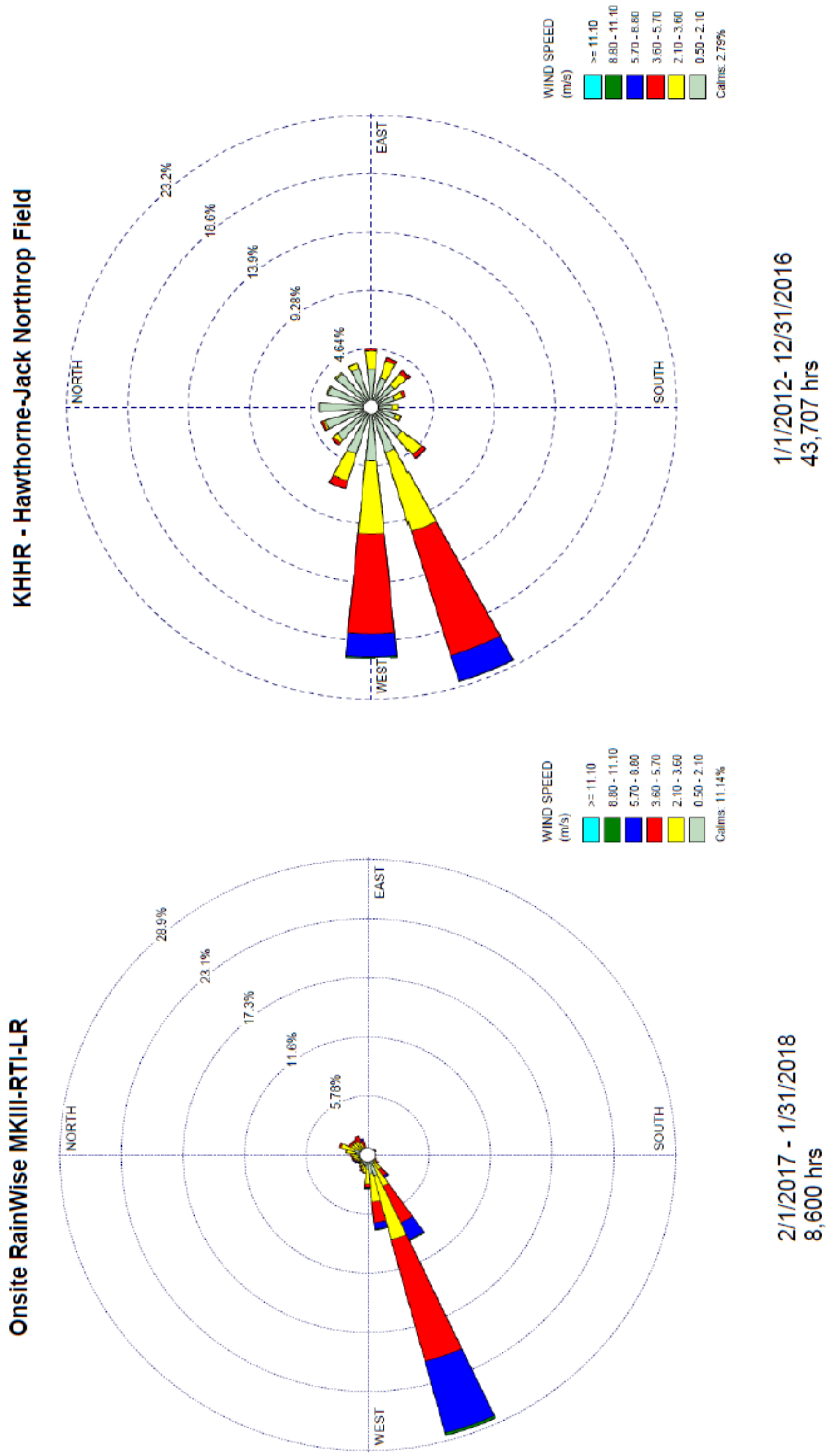

Figure 5-26: Comparison of existing onsite vs. nearby offsite (KHHR) wind roses

5.3.4 Data Storage and Communications

The meteorological data will be recorded with an automatic data logger in accordance with USEPA guidance that is relayed, for example, to a cloud-based service via cellular[58], satellite or ethernet connection, that enables TORC to have immediate access to the data and easily visualize measured variables. All data will be backed up and archived at a secure data center. See Section 7 of this Plan for additional details regarding data handling and storage.

[58] Met One's cloud service: http://metone.com/communication-data-handling/comet-cloud-service/

6. FENCELINE AIR MONITORING SYSTEM

The Rule specifies requirements for the fenceline air monitoring system Plan:

- *"…provide detailed information regarding the equipment to be used to continuously monitor, record, and report air pollutant levels for the pollutants specified in Table 1 – Air Pollutants to be Addressed by Fenceline Air Monitoring Plans in real-time, at or near the property boundary of the petroleum refinery."* (Rule 1180(d)(2)(A).)
- *"Provide detailed information regarding equipment...to continuously monitor, record and report air pollutant levels…."*
- *"Temporary air monitoring measures that will be implemented in the event of an equipment failure or during routine maintenance activities and used until the fenceline air monitoring system is restored to normal operating conditions."* (Rule 1180(d)(2)(D).)

The Guidelines elaborate further on the Plan requirements:

- *"… provide detailed information about the installation, operation and maintenance of a fenceline air monitoring system… as a combination of equipment that measures and records air pollutant concentrations at or near the property…capable of measuring routine emissions…and detecting leaks, as well as unplanned releases."* (Guidelines Section 1.)
- *"The air monitoring plan shall include:*
  - *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); and*
  - *A summary of instrument specifications, detectable pollutants, minimum and maximum detection limits for all air monitoring instruments."* (Guidelines Section 1.)
- *"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; and*
  - *Substantiate any request to use alternative technologies"* (Guidelines Section 2, Fenceline Air Monitoring Plan Checklist).
- *"The fenceline monitoring shall be operated continuously with a required time resolution of five-minute averaging when feasible. …If achieving the desired time resolution is not feasible…provide rationale in the air monitoring plan for any proposed time resolutions greater than five-minute averaging (e.g., based on the equipment employed, the number of paths covered by each open-path system, or other operational limitations)."* (Guidelines Section 2.b.)
- *"… provide specifications for the fenceline instruments selected for a fenceline air monitoring system, such as detection limits of the equipment for each chemical and time-resolution capabilities. Also, the air monitoring plan must demonstrate that the*

instruments can measure the pollutants identified in Table 1. The selected open-path instruments should be able to record and store the measured spectral absorption and associated average concentrations of measured pollutants for retrospective investigations. Where open-path monitors are being operated, all factors that could affect air pollutant measurements, such as the maximum path length the instruments are capable of measuring and potential interferences must be discussed in the air monitoring plan. In certain instances, a refinery owner or operator may demonstrate that other air monitoring techniques and/or technologies (e.g., emerging technologies) could be used in place of open-path technology depending on the pollutant(s) that are monitored." (Guidelines Section 2.c.)

This Section 6 of the Plan addresses these requirements. Some aspects of the above elements regarding maintenance are addressed in the Quality Assurance Project Plan (see Section 9 of this Plan).

6.1 Technologies Considered for Fenceline Air Monitoring System

Two types of monitoring technologies were considered: conventional point sampling monitors; and advanced open-path optical spectroscopy.

Light is a form of electromagnetic radiation. Light consists of many colors characterized by their wavelengths – visible colors and colors in the infrared and ultraviolet wavelengths that are mostly invisible to a human eye. A prism, for example, splits visible light into its individual colors or wavelengths. As light passes through the air, each gas absorbs different parts of the light spectrum in a unique way – a "fingerprint" for each gas. The analysis of the way gases absorb and emit light is called spectroscopy.

Light is a form of electromagnetic energy. When a molecule absorbs light, the energy of the molecule is increased and the molecule is promoted from its lowest energy state (ground state) to an excited state. Light energy stimulates molecular vibrations. Molecular species display their own characteristic vibrational structure when stimulated by electromagnetic radiation in various parts of the light spectrum. The units of vibrational frequency are wave number. Wave number and vibrational structure are used to identify a molecule.

Four open-path optical spectroscopy technologies were considered:

- Fourier transform infrared (OP-FTIR);
- Ultraviolet differential optical absorption spectroscopy (OP-UVDOAS);
- Tunable diode laser absorption spectroscopy (OP-TDLAS); and
- Differential absorption light detection and ranging (DIAL).

DIAL technology is not yet available for permanently-installed monitoring systems on a commercial basis; therefore, it was not considered feasible for this Plan. OP-FTIR, OP-UVDOAS and OP-TDLAS are discussed further below.

6.1.1 OP-FTIR

FTIR is a special type of optical spectroscopy called interferometry and is useful for determining the concentrations of individual gases that absorb infrared light in a gas mixture such as air. The vibrational frequencies of all the light absorbing molecules in the infrared beam path are captured in the infrared spectrum. OP-FTIR instrumentation has five main components: an infrared light source, a special device called a Michelson interferometer, transmitter and receiver optics (telescopes), an infrared light detector and a data system controller/computer (Figure 6-1).[59],[60] The infrared light source is typically a heated element with known infrared radiation properties (e.g., made of silicon carbide). The interferometer has a beam splitter, a fixed mirror and a moving mirror, and a laser. The infrared energy goes from the light source to the beam-splitter, which splits the beam into two parts. One part is reflected to a moving mirror and one part is transmitted to a fixed mirror. The moving mirror oscillates back and forth at a constant velocity, which modulates the light as a function of wavelength. This velocity is timed according to the very precise laser wavelength, which also acts as an internal wavelength calibration. The beam reflected from the moving mirror and the beam reflected from the fixed mirror are recombined at the same or a secondary beam-splitter. When the beams are recombined, some of the wavelengths recombine constructively and some destructively, which creates an interference pattern.

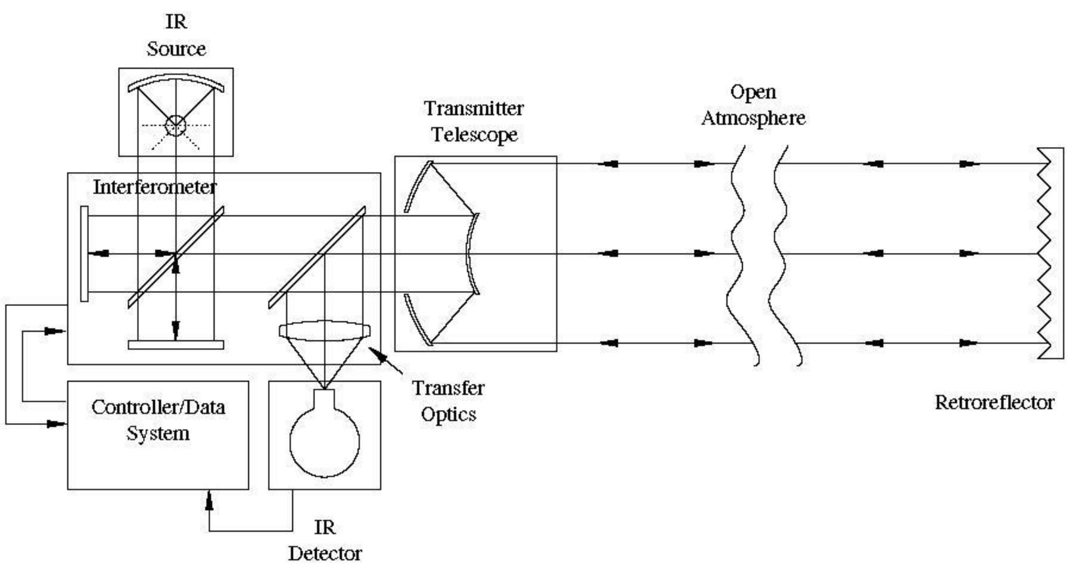

Figure 6-1: OP-FTIR system (single-telescope monostatic configuration)[61]

The recombined infrared beam is transmitted via transfer optics (a telescope) through the open path to a receiver. The receiver may be located at the opposite end of the path (bistatic configuration) or the beam may be reflected by a special mirror and returned to a receiving telescope co-located with the transmitter (monostatic configuration). A benefit of monostatic configuration is that the reflector does not need electrical power which simplifies the installation. The receiving telescope transmits the modulated light beam to the infrared detector where the interference pattern is detected. A mercury-cadmium-telluride (MCT) detector is most commonly used for its sensitivity. The detector must be cooled to very low temperatures using liquid nitrogen (requiring manual re-filling every few days) or a Stirling cycle heat pump (less manual labor, but higher equipment cost and relatively short lifespan).

[59] *EPA Handbook: Optical Remote Sensing for Measurement and Monitoring of Emissions Flux*; U.S. Environmental Protection Agency; Office of Air Quality Planning and Standards: Research Triangle Park, NC, 2011; GD-052, See https://www3.epa.gov/ttnemc01/guidlnd/gd-052.pdf (accessed July 2018).

[60] Liptak, B.G. *Chapter 8.40 Open Path Spectroscopy*. (UV, IR, FT-IR), Volume I, Process Measurement and Analysis; CRC Press: Boca Raton, Florida, 2003.

[61] Liptak, B.G. *Chapter 8.40 Open Path Spectroscopy*. (UV, IR, FT-IR), Volume I, Process Measurement and Analysis; CRC Press: Boca Raton, Florida, 2003.

The detector digitizes the interference pattern for processing by the data system. The data system mathematically transforms the interferogram into an infrared frequency spectrum using an algorithm known as a Fourier transform. The data system typically averages several hundred individual interferometer scans (each cycle of the interferometer moving mirror is called a scan) over a several minutes to develop a single measurement (increasing the averaging time typically results in lower detection limits).

For the monostatic configurations, corner-cube retroreflectors are typically used. These are constructed of many individual reflectors, each with three perpendicular reflective surfaces in the shape of the corner of a cube. The corner cube retroreflector reflects light coming from any direction through 180 degrees back to exactly the point of origin. An advantage of monostatic configurations over bistatic ones is that the alignment between devices at opposite ends of the beam is far less critical to system performance. Corner-cube retroreflectors also reduce the divergence of the beam on its return path back to the receiver compared to divergence that would result from a flat retroreflector.

For monostatic configurations, a single telescope may serve as transmitter and receiver or separate transmitter and receiver telescopes may be used. For single-telescope configurations, the modulated infrared beam is split twice, once at the source and again at the receiver. The second beam splitter removes 50 percent of the light from the outgoing beam and 50 percent of the light from the return beam for an overall loss of 75 percent of the total light intensity. Dual telescope configurations do not require the secondary beam splitter and thus have greater range and sensitivity (due to greater optical efficiency), but are costlier, than single-telescope configurations.

For monostatic configurations the maximum distance between analyzer and reflector is typically limited to 500 to 800 meters because water vapor and carbon dioxide (present at percent concentration levels, compared with ppm to ppb concentrations of interest for target pollutants) effectively absorb infrared light, which both interferes with the spectra of the target gases and reduces the strength of the infrared beam with increasing distance.

OP-FTIR is a well-developed technology which has been demonstrated extensively in research applications, but instrumentation for permanent monitoring systems is still evolving and relatively unproven. While there are a small number of installations that have been operating for several years, they require a high level of on-going maintenance by highly-skilled personnel with advanced college degrees.

6.1.2 OP-UVDOAS

UVDOAS is form of optical spectroscopy that quantifies concentrations of gaseous compounds by measuring the absorption of ultraviolet light by chemical compounds in the air and applying the Beer-Lambert law.

An OP-UVDOAS uses unique absorptions of specific wave lengths by chemicals in the ultraviolet, visible, and near infrared spectrum to detect and quantify compounds. Typical applications of OP-UVDOAS restrict the ultraviolet light to a wavelength range of 245 to 380 nanometers. OP-UVDOAS technology measures the absorption spectra throughout the range of wavelengths, instead of just intensity at a single wavelength. This makes it possible to separate out and identify the absorption structures of a multitude of compounds.

OP-UVDOAS instrumentation consists of a light source, transmitting and receiving optics (telescopes), a spectrometer, a detector, and a data system computer (Figure 6-2). A light source or a lamp, often a tungsten halogen bulb or Xenon arc lamp (some use deuterium as well), provides light, which is focused in a collimated beam before it is sent through a transmitting telescope and into the measurement path. A receiving telescope collects the light and directs it to the spectrometer, which diffracts the light onto the detector array. The detector is typically a solid-state array such as a charge-coupled device (CCD). This allows the detector to collect light of different wavelengths without moving parts. The spectra bands can be extracted from the spectrum and compared to reference spectra to determine which compounds were present along the path and at what concentrations.

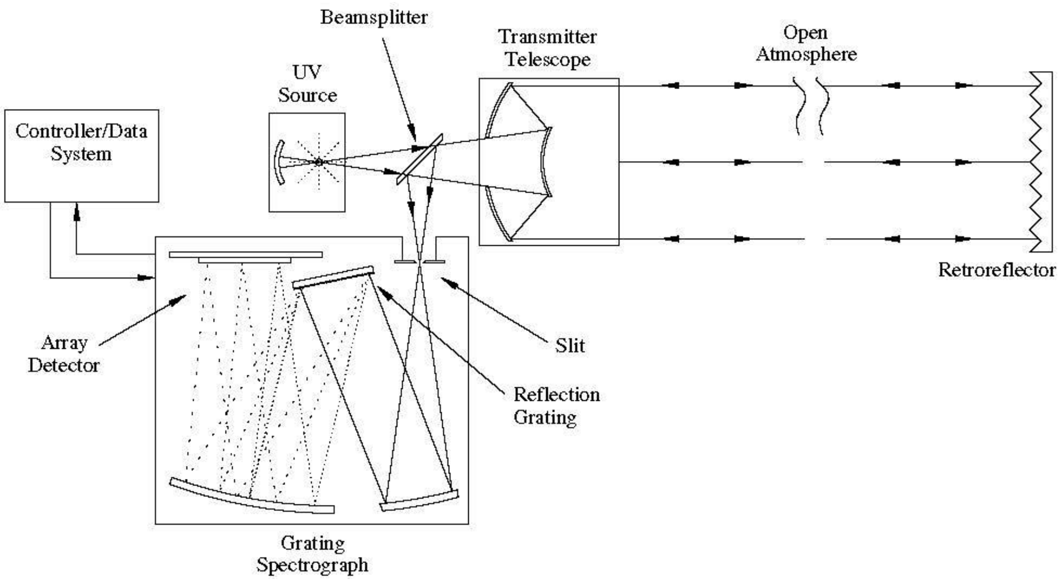

Figure 6-2: OP-UVDOAS system (monostatic single-telescope configuration)[62]

Interferences in the atmosphere cause absorption to occur at all points in the measurement spectrum. In the atmosphere, the light beam undergoes attenuation by air molecules and aerosols, turbulence, and absorption by many trace gases. DOAS overcomes the effects of the beam extinction by mathematically separating and removing the nonspecific beam extinction from the target gas absorption by measuring the difference between the absorption peak caused by the compound of interest and absorption peaks at wavelengths on either side of that targeted peak. The concentration is determined by the light intensity in the absence of a structured absorption band, rather than the light intensity in the absence of all absorption.

As with OP-FTIR, OP-UVDOAS may be configured bistatic or monostatic arrangements with similar benefits and limitations. Maximum path length for OP-UVDOAS instruments is greater than OP-FTIR because water vapor and carbon dioxide do not absorb ultraviolet light in the range of interest. Path lengths of approximately 1000 meters have been used successfully in air pollutant monitoring applications. But aerosols such as fog, rain, snow, smoke and haze can greatly degrade beam strength and oxygen and ozone interference is significant at shorter wavelengths. These factors typically limit instrument performance in adverse atmospheric conditions.

[62] Liptak, B.G. *Chapter 8.40 Open Path Spectroscopy*. (UV, IR, FT-IR), Volume I, Process Measurement and Analysis; CRC Press: Boca Raton, Florida, 2003.

Like the OP-FTIR, the OP-UVDOAS is a well-developed technology which has been demonstrated extensively in research applications, but instrumentation for permanent long-term monitoring systems is still evolving and relatively unproven.

6.1.3 OP-TDLAS

OP-TDLAS instruments rely on the same light absorption characteristics of gases as do OP-FTIR, OP-UVDOAS and conventional light absorption spectroscopy, but the operate at a very narrow range of light source wavelengths selected for a spectral absorption feature of a single gas. The light source is a diode laser. The light is directed via a transmitting telescope to the open measurement path. A receiving telescope collects the light and directs it to a photodetector, typically a solid-state device. The detector signal is processed by a data system controller to determine the concentration of the gas in the measurement path.

Tunable diode lasers can generate light over a narrow range of wavelengths by adjusting the diode temperature and electrical current. This enables not only detection of a gas's light absorption feature at a central wavelength, but also the "shape" of that feature at nearby wavelengths enabling improved discrimination from gases that absorb at the same wavelengths. OP-TDLAS instruments typically modulate the laser to continuously scan a narrow range of wavelengths around the central feature. Because the emitted wavelength is narrow, and can be chosen as compound specific, OP-TDLAS eliminates most interferences from other gases. Tunable diode lasers are available in a wide range of wavelengths from near-infrared to ultraviolet enabling detection of a wide variety of gases. Some commercial OP-TDLAS instruments can be fitted with multiple lasers to measure more than one gas. Some instruments incorporate a beam splitter that directs part of the light through a cell containing the target gas to facilitate tuning the laser to the precise frequency for that gas (Figure 6-3).

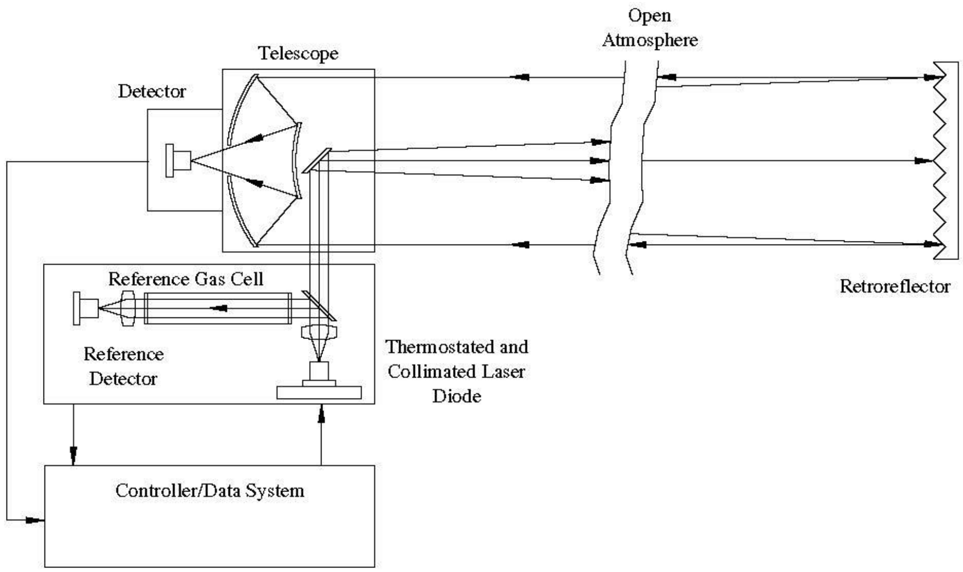

Figure 6-3: Open path TDLAS instrument (monostatic configuration with reference gas cell)[63]

[63] Liptak, B.G. *Chapter 8.40 Open Path Spectroscopy*. (UV, IR, FT-IR), Volume I, Process Measurement and Analysis; CRC Press: Boca Raton, Florida, 2003.

The measured absorption signature is recorded and used to determine a quantitative measurement of concentration by combining the spectra with measured gas temperature and pressure, path length, and known line strength. As with OP-FTIR and OP-UVDOAS, OP-TDLAS instruments can be configured in bistatic or monostatic arrangements.

6.1.4 Black Carbon Monitors

Black carbon is a form of particulate matter aerosol. The composition of aerosols cannot be measured using OP-FTIR, OP-UVDOAS or OP-TDLAS technologies. Therefore, black carbon measurement relies on collection of an aerosol sample from the ambient air into an analyzer which determines the amount of black carbon in the sample. Black carbon is associated with soot, a product of incomplete combustion.

6.1.4.1 Aethalometer

Aethalometers measure light absorbing aerosols at several different wavelengths. Black carbon is measured at a wavelength of approximately 880 nm. Aethalometers measure the attenuation of a light signal through a filter media which has aerosol particles deposited on it. Ambient air is collected through an air inlet and onto a filter tape where aerosols in the gas stream are deposited. Light at different wavelengths (880 nanometers for black carbon) is then directed through the filter tape, to measure the attenuation of the light through the trapped aerosols; as more black carbon builds up on the filter, more light is attenuated. A flow rate meter monitors the rate at which air is drawn onto the filter tape. Combined, these measurements provide enough information so that black carbon concentrations are calculated.

Aethalometers can sample and provide concentration data in seconds, so data can be nearly assessed in real-time. A major potential interference is that filter loading can cause falsely high measurements due to shadowing of particles on top of one another. Aethalometers typically compensate for filter loading issues by drawing in samples at two different flow rates simultaneously to identify loading effects. Additionally, the presence of other organic material may change the absorption property of black carbon.

6.1.4.2 Photoacoustic Extinctiometer

In addition to aethalometers, another technology for black carbon measurement is the photoacoustic extinctiometer (PAX). The PAX technology draws in ambient air through an air inlet where that gas is drawn into a light chamber. While Aethalometers deposit aerosol particles onto a filter tape, the PAX technology allows aerosol particles to stay suspended in the sample gas while a laser (870 nm) excites the particles and transfers heat to the surrounding air. The heat given off from the excitation of the molecules creates a pressure and sound wave which is measured by a highly sensitive microphone. The amplitude of the sound wave is directly correlated with the absorption coefficient of black carbon. In conjunction with an assumed black carbon mass absorption cross-section, the concentration of black carbon is identified.

The PAX technology can also provide concentration data in seconds, so data can be nearly assessed in real-time. A potential drawback of this technology is the assumption of a singular black carbon mass absorption cross-section (MAC). The more coated a black carbon particle is, the larger the value of the MAC. Theoretical MAC values at 870 nm wavelength range from approximately 4.7 – 7.1 m2/g and can impact the calculation of black carbon concentration.

6.1.5 Hydrogen Sulfide UV Fluorescence Monitors

Hydrogen sulfide is measured on the principle that hydrogen sulfide can be converted into sulfur dioxide. Sulfur dioxide is measured through excitation by ultraviolet (UV) light, where Sulfur dioxide molecules absorb UV light and become excited at one wavelength, then decay to a lower energy state emitting UV light at a different wavelength. Excitation light is reflected off selective mirrors that reflect only the wavelengths that excite sulfur dioxide molecules, and the emitted light is captured on a photomultiplier tube or photodiode array through a bandpass filter tuned to wavelengths emitted by excited sulfur dioxide molecules. The hydrogen sulfide converter is designed to minimize conversion of reduced sulfur species other than hydrogen sulfide (e.g., molybdenum converter operating at 315 °C). Two sulfur dioxide readings are taken: one from gas that has passed through the hydrogen sulfide converter, and another from gas that has bypassed the converter. The difference between the two values is the hydrogen sulfide concentration.

6.2 Open Path Technologies vs. Point Sampling Monitors and Methods

"Point" sampling monitors and methods collect samples of air drawn into the apparatus from one or more locations. There are a variety types of point sampling techniques. Some of these use real-time instruments that display concentration data for pollutants of interest (e.g., - aethalometers, photoionization detectors, flame ionization detectors, extractive FTIR or UVDOAS instruments, gas chromatographs, etc.) while others collect air samples that must be analyzed in laboratories (e.g., – canisters, sorbent tubes, etc.). Emerging technologies such as low-cost point sensors also might be applied. While a small number of low-cost point sensors can provide accurate measurements for particulate matter, ozone, NO_X and SO_2, none have been proven for all the target pollutants listed in Section 4 of this Plan. Many point monitors would be necessary to monitor the refinery fenceline in its entirety.

Open path systems can operate with telescopes transmitting and receiving the light beam so monitoring of long outdoor paths is possible. Open path systems measure the average concentrations of different gases along an open path of air (Figure 6-4). They do this by emitting a concentrated beam of light into the air and measuring its interactions with various gaseous components of air, including the target pollutants listed in Section 4.

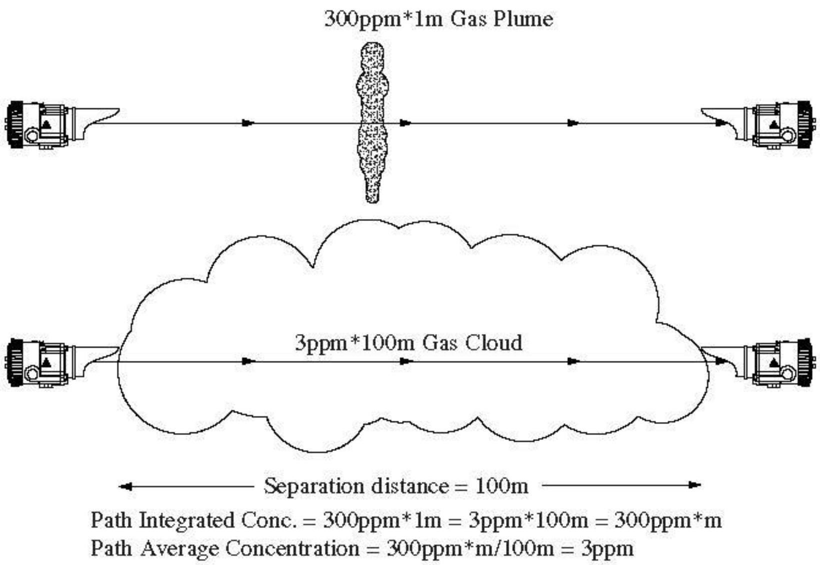

Figure 6-4: Conceptual illustration of an open path optical absorption spectroscopy system[64]

Open path technologies provide an average gas concentration over a line of sight (the instrument optical path length). They do not distinguish whether the measured concentration is due to a broadly dispersed cloud of gas or a narrow cloud of higher concentration.

6.2.1 Known Drawbacks of Open Path Technologies

While open-path analyzers clearly have certain advantages over conventional monitors, there are certain drawbacks:

- These measurements depend on the intensity of the light beam and thus, poor visibility conditions caused by rain, fog, smoke, etc. affect the ability of these instruments to measure the target pollutants;
- Water vapor, oxygen and carbon dioxide gases are present in air at concentrations much greater than most of the pollutants of interest and absorb light at the wavelengths of interest. This affects the capability of the OP-FTIR analyzer to measure any of the target pollutants and the level at which they can be measured. Oxygen and ozone affect the UV analyzer in a similar manner;
- Many organic and inorganic gases absorb light in the wavelengths of interest. These can interfere with measurement of the target pollutants depending on their relative concentrations and to the extent their absorption spectra overlap;
- Because of sensitivity to interfering gases and visibility, the detection limits for target gases will vary with weather and the presence of other gases in the atmosphere;
- Because open path analyzers measure average concentrations along an entire path, they do not differentiate between a widely dispersed low concentration plume and a high concentration narrow plume; and

[64] Liptak, B.G. *Chapter 8.40 Open Path Spectroscopy*. (UV, IR, FT-IR), Volume I, Process Measurement and Analysis; CRC Press: Boca Raton, Florida, 2003.

- These types of analyzers have been applied for advanced short-term research purposes for many years. However, their introduction for use in permanently installed monitoring systems for regulatory compliance purposes is only very recent. The technology is highly sophisticated requiring very highly trained and experienced individuals (e.g., Ph.D. level physicists or chemists) to setup and operate the systems and to properly interpret the monitoring data. Few big companies work in the field of open path and many of these analyzers have been developed by smaller specialized companies with less than 25 employees, some of which are only recently formed, that rely on the expertise of less than a handful of individuals. While few systems have been developed, installed and maintained for over 20 years world-wide, there are still unknowns about the long-term ruggedness and reliability of these types of systems, their ability to satisfy regulatory data quality requirements, and the sustainability of the companies that supply and service them.

6.3 Fenceline Air Monitoring Technology Selection

The primary goal driving technology selection is the capability to detect and quantify the target pollutants, reliably and without false positives or false negatives, at minimum concentration levels that are meaningful with respect to the thresholds of interest discussed later in Section 7 of this Plan. Table 6-1 below compares the range of minimum detection levels reported by various suppliers[65] for a 500-meter interval between analyzer and reflector for monostatic configurations or a range of 500-meter to 1000-meter interval between light source and analyzer for bistatic configurations,[66] unless otherwise stated. Values in Table 6-1 that are in ***bold italic font*** indicate the anticipated primary measurement technology that will be used to detect each target pollutant. Some pollutants can be measured by multiple technologies at different ranges. In these cases, another technology also may serve as a backup and/or extend the upper range of measurable concentrations. The determinations made here are based on detection limit data provided by manufacturers during development of this Plan. However, the primary technology used for each pollutant may be updated once the systems are in operations and real data are available.

The fenceline air monitoring system will employ a combination of state-of-the-art open path technologies for gaseous pollutants. Between the OP-FTIRs and OP-UVDOAS, the fenceline air monitoring system will be able to monitor all gaseous pollutants discussed in Section 4 of this Plan at levels which are lower than health-based air quality standards and inhalation exposure thresholds discussed in Section 7, except for acrolein, 1,3 butadiene and hydrogen sulfide. This is discussed in more detail below. Because black carbon is not a gas but rather a form of particle, it cannot be measured with optical absorption spectroscopy. Therefore, point monitors will be used for black carbon. Both the aethalometer and the PAX technologies can determine black carbon levels at meaningfully low levels.

[65] Detection limits for open path technologies depend on various factors. While suppliers have provided their best guess estimate for these, actual detection limits achievable at TORC will depend on the final System design and atmospheric conditions that are unique to TORC.

[66] Most commercial OP-UVDOAS systems identified during Plan development are bistatic. Only one supplier offered monostatic configuration. A monostatic UV-DOAS system will installed.

Table 6-1: Lower detection limit ranges achievable by different technologies (for OP-FTIR and OP-UVDOAS, based on 500 meter monostatic path intervals for 1000 meter optical path length)

Pollutants	OP-FTIR (ppb)	OP-UVDOAS (ppb)	OP-TDLAS (ppb)[67]	Black Carbon Analyzers (µg/m³)	UV Fluorescence Analyzer (ppb)
Criteria air pollutants					
Sulfur dioxide	7 – 20	***0.3 - 4***	--	--	--
Nitrogen oxides	3 - 12	~2	--	--	--
Volatile organic compounds					
Total VOCs (NMHC)	***0.9 - 9***	--	--	--	--
Formaldehyde	***0.1 – 3***	~12	--	--	--
Acetaldehyde	***1 – 15***	~3	--	--	--
Acrolein	***2 – 6***	8 - 10	--	--	--
1,3 Butadiene	***1 – 15***	--	--	--	--
Benzene	5 – 10	***0.2 - 0.7***	--	--	--
Toluene	3 – 9	***0.8 - 2***	--	--	--
Ethylbenzene	2 – 12	***0.3 - 9***	--	--	--
Xylenes	4 – 9	***~0.5 - 5***	--	--	--
Hydrogen cyanide	***2 – 6***	~5	2-5	--	--
Other target compounds					
Hydrogen sulfide	230 – 1,000	--	200-600	--	***~ 0.4 – 1.5***
Carbonyl sulfide	***0.4 – 1.9***	20 - 50	--	--	--
Ammonia	***0.2 – 2***	~3	10-25	--	--
Black carbon	**--**	--	--	**~ 0.01 – 0.2** (5-minute)	--
Hydrogen fluoride	***0.3 – 4***	--	2-3	--	--

Detection of acrolein is more likely to occur via the OP-FTIR. Based on the health thresholds discussed in Section 7, there is a possibility that the selected technology will not be able to

[67] Detection Limits for the TDLAS systems are based on a 100-meter path length. Commercial TDLAS systems suppliers identified in this study did not recommend path lengths longer than 200-300 meters.

measure acrolein below some of these thresholds.[68] There are no other viable open-path technology options that can be implemented on a permanent basis to successfully measure acrolein below these thresholds.

The detection of 1,3 butadiene is also likely to occur via OP-FTIR as the UV system is incapable of measuring 1,3 butadiene. Based on the health thresholds discussed in Section 7, there is a possibility that the selected technology will not be able to measure 1,3 butadiene below some of these thresholds.[69] There are no other viable open-path technology options that can be implemented on a permanent basis to successfully measure 1,3 butadiene below these thresholds.

Detection limits for OP-FTIR and OP-TDLAS are similar for pollutants that can be measured with both technologies. For all pollutants except for hydrogen sulfide, the detection limits are well below the health thresholds discussed in Section 7. The OP-TDLAS is only slightly better in terms of the achievable detection limits for hydrogen sulfide and generally performs better at shorter path lengths. Although the detection limits achievable by both OP-FTIR and OP-TDLAS can determine hydrogen sulfide at levels below thresholds that would warrant immediate health concerns (also discussed in Section 7 of this Plan), effective hydrogen sulfide measurement using open path technologies is an industry-wide issue and these levels (~200-500 ppb)[70] are higher than the OEHHA 1-hour acute REL and the California ambient air quality standard (30 ppb) for hydrogen sulfide. For these reasons, UV fluorescence hydrogen sulfide point monitors are planned. UV fluorescence analyzers can determine hydrogen sulfide concentrations down to a few ppb, levels which are well below the health thresholds for hydrogen sulfide.

6.3.1 Monitoring System Layout

6.3.1.1 OP-FTIR

Each OP-FTIR analyzer will be mounted on rotating pedestal to serve two separate paths[71] (i.e., – one light source alternating between two reflectors) for five minutes at a time. The distance between the analyzer and each reflector will be approximately 500 meters (1640 feet or approximately one third of a mile) but may be somewhat longer or shorter depending on the specific location (see Section 5 of this Plan). For an OP-FTIR, the following equipment will be installed on each path:

- FTIR analyzer;
- Auto positioner;
- Retroreflector;
- Computer; and

[68] Note, the expected field detection limits are higher than the 1-hr Acute REL, 8-hr acute REL and annual chronic REL, but lower than the AEGLs (See section 7).

[69] Note, the expected field detection limits are only higher than 8-hr acute REL and annual chronic REL, but lower than the 1-hr acute REL and AEGLs (See section 7).

[70] While most OP-TDLAS suppliers agree it is not feasible to detect hydrogen sulfide below 200 ppb, some have indicated the possibility of lowering detection limits under ideal conditions. There is however, no certainty or examples of prior installations that suggest this will be achieved in the field.

[71] Note, one of the FTIRs located at the north fence of the facility will serve only a single path. See Section 5 of this Plan for more details.

- Remote power controller (optional).

6.3.1.2 OP-UVDOAS

TORC will install monostatic OP-UVDOAS systems. For the monostatic setup, each ultraviolet light source[72] will be mounted on a rotating pedestal to serve two separate paths for 5 minutes at a time. The distance between the analyzer and each reflector will be approximately 500 meters (1640 feet or approximately one third of a mile) but may be somewhat longer or shorter depending on the specific location (see Section 5 of this Plan). For a OP-UVDOAS system, the following equipment will be installed on each path:

- Light transmitters/receivers;
- Retroreflectors;
- Analyzer/detector; and
- Portable computer.

For these systems, interval length is the distance between the light source and the reflector (monostatic configurations). For open-path instruments, higher path lengths generally mean better detection limits with light intensity being a limiting factor. In theory a 1000-meter path length could give better detection limits compared to 500-meters, however in the field as the light beam must travel twice the distance, there is loss of signal and thus the actual detection limits end up being higher. The 500-meter path length for monostatic systems is based on manufacturer recommendations and good engineering judgement as well as cost considerations.

6.3.1.3 Black Carbon Monitors

Four black carbon monitors will be located all along the north and south fencelines (see Section 5 for more details). No determination is made at this point on which of the two technologies (aethalometer or PAX) will be used to give TORC the flexibility to choose between suppliers and receive competitive bids from multiple suppliers during the implementation phase.

6.3.1.4 Hydrogen sulfide Analyzers

Four UV fluorescence hydrogen sulfide analyzers will be installed all along the north and south fenceline, collocated with four of the monitoring station enclosures (see section 5 for more details). The hydrogen sulfide analyzers will require sample transport systems and provisions for periodic reference gas zero and span calibrations. No determination is made on the supplier as TORC will have the flexibility to choose between suppliers and receive competitive bids from potential suppliers during the implementation phase.

6.4 Fenceline Air Monitoring Equipment Specifications

Table 6-2 summarizes the overall configuration fenceline air monitoring system and lists target pollutants that will be monitored by each instrument. Tables 6-4 lists the major components for the system layout.

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[72] Note, one of the monostatic UV systems located at the north fence of the facility will serve only a single path. See Section 5 of this Plan for more details.

Table 6-2: Fenceline air monitoring system summary

Technology	Primary Pollutants Monitored	Setup
OP-FTIR	Nitrogen oxides, total VOCs (NMHC), formaldehyde, acetaldehyde, acrolein, 1,3 butadiene, hydrogen sulfide, carbonyl sulfide, ammonia, hydrogen cyanide and hydrogen fluoride.	Six monostatic systems total, with each supporting two nominally 500-meter path lengths (approximately 280 to 580 meters actual). See Section 5 for location details.
OP-UVDOAS	Sulfur dioxide, benzene, toluene, ethylbenzene, xylenes (m, o, p)	Six monostatic systems, with each supporting two 500-meter path lengths. See Section 5 for location details.
Aethalometer or photoacoustic extinctiometer (PAX)	Black carbon	Four aethalometers or photoacoustic extinctiometer analyzers.
UV fluorescence	Hydrogen sulfide	Four UV fluorescence hydrogen sulfide analyzers

Table 6-3: Major system components for monostatic OP-FTIR and monostatic UV DOAS[73]

Component	Count
Monostatic OP-FTIR systems	6
Auto positioner pedestals - OP-FTIR	6
OP-FTIR retroreflectors	12
Monostatic OP-UVDOAS systems	6
Auto positioner pedestals - UV	6
OP-UVDOAS retroreflectors	12
Black carbon monitors	4
Hydrogen sulfide UV fluorescence monitors	4
Shelter constructions (for all analyzers)	6
Power source locations (wired)	6

Tables 6-4 to 6-17 provide preliminary specifications for the fenceline air monitoring equipment. These specifications are subject to change based on the final system layout and detailed designs that will be developed during System implementation. They are shown here to provide details typical of these systems and illustrating the overall concept for the System.

[73] See Figure 5-24.

Minimum detection limit specifications are presented as targets that the instrument selected should ideally be able to meet. The actual detection limits achieved will depend on many factors including instrument specifications and atmospheric conditions. Preliminary targets are based on the two factors: the information provided by various suppliers regarding realistically achievable detection limits in the field under typical or favorable atmospheric conditions; and health thresholds of concern as discussed in Section 7 of this Plan. Detection limits for open path instruments are dynamic, i.e., they change with various atmospheric conditions and are dependent on the noise of the instrument.[74] The actual detection limits achievable may be different based on the typical atmospheric conditions[75] found at Torrance that could affect open path monitor performance (temperature, relative humidity, PM2.5 concentration, etc.). During the implementation/installation and commissioning phase of the plan, TORC will optimize these instruments to achieve the lowest possible detection limits at these typical atmospheric conditions.

The upper detection target indicates the desired upper limit of the measurable range (Table 6-4). The specifications reflect a factor 1.5 above the AEGL-1 thresholds where these are available or ten times the one-hour acute reference exposure levels (see Section 7 of this Plan for further discussion of air quality thresholds and standards). Suppliers of open path instruments indicated that the actual upper end of the measurable range may be higher than given in Table 6-5 and will be dependent on saturation, i.e., when the pollutant concentration is high enough to absorb all the light energy.

Table 6-4: OP-FTIR Detection limit specifications (500-meter path interval)

Pollutants	Minimum instrument detection limit (ppb)	Upper detection target (ppb)
NO_X[76]	≤ 10	≥ 750
Total VOCs (NMHC)[77]	--	--
Formaldehyde	≤ 2	≥ 1,1400
Acetaldehyde	≤ 10	≥ 68,000
Acrolein	≤ 4	≥ 45

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[74] US EPA Method TO-16 defines minimum detection limit as the minimum concentration of a compound that can be detected by an instrument with a given statistical probability. Usually the detection limit is given as three times the standard deviation of the noise in the system. In this case, the minimum concentration can be detected with a probability of 99.7%.
Compendium Method TO-16 Long-Path Open-Path Fourier Transform Infrared Monitoring Of Atmospheric Gases, in *Compendium of Methods for the Determination of Toxic Organic Compounds in Ambient Air*, Second Edition, U.S. Environmental Protection Agency, Cincinnati, Ohio, January 1999. See https://www3.epa.gov/ttn/amtic/files/ambient/airtox/to-16r.pdf (accessed July 2018).

[75] Based on recent meteorological data, average highs are around 71.4 ^{O}F and average lows are around 53.8 ^{O}F. Average high RH is 85% and average low RH is 46%. Annual average PM_{10} concentration for the southwest Coastal LA county station was 21.6 μg/m^3 for 2016.

[76] Upper detection limit for NO_X is based on AEGL-1 for NO_2 only as NO has no recommended AEGL value. NO_X will be reported as sum of NO, if detected and NO_2

[77] Total VOCs (NMHC) will be calculated by adding all the other Rule 1180 VOC pollutants that are detected.

Table 6-4: OP-FTIR Detection limit specifications (500-meter path interval)

Pollutants	Minimum instrument detection limit (ppb)	Upper detection target (ppb)
1,3 Butadiene	≤ 8	≥ 1,000,000
Carbonyl sulfide[78]	≤ 1.5	≥ 2,600
Ammonia	≤ 2	≥ 45,000
Hydrogen cyanide	≤ 3	≥ 3,000
Hydrogen fluoride	≤ 4	≥ 1,500

Table 6-5: OP-UVDOAS instrument detection limit specifications

Pollutants	Minimum instrument detection limit (ppb)	Upper detection target (ppb)
SO_2	≤ 4	≥ 900
Benzene	≤ 0.5	≥ 78,000
Toluene	≤ 2	≥ 100,000
Ethyl benzene	≤ 5	≥ 50,000
Xylenes[79]	≤ 5	≥ 190,000

Table 6-6: Black carbon analyzer detection limit specifications

Pollutants	Minimum Instrument Detection limit - Target ($\mu g/m^3$)	Upper detection Target ($\mu g/m^3$)
Black carbon	≤ 0.2	≥ 100

Table 6-7: Hydrogen sulfide analyzer detection limit specifications

Pollutants	Minimum Instrument Detection limit - Target (ppb)	Upper detection Target (ppb)
Hydrogen sulfide	≤ 1.5	≥ 765

[78] The upper detection target is calculated as 10 times greater than the Acute 1-hr REL threshold.

[79] Specs shown here are for total xylenes, as they will be reported as total xylenes. The UV-system will detect the o, m and p isomers separately or as total xylenes (spectral limitations may preclude speciation of all individual isomers with the open path monitors).

Table 6-8: FTIR analyzer specifications

Parameter	Units	Specification	Comment
Analyzer type	None	FTIR	
Wave resolution	cm^{-1}	0.125 - 32	
Spectral range	cm^{-1}	600 – 6,660	Range is dependent on supplier
Scan frequency	scans/second	Varies – 0.5 to 2 at 0.5 cm^{-1}	Scan frequency increases as wave number increases.
Receiver configuration	None	monostatic	
Source type	None	SiC (1226 °C) or Ceramic (1200 °C), or Air Cooled MIR radiation source	
Detector type	None	Mercury Cadmium Telluride (MCT) or deuterated, L-alanine doped triglycine sulfate DTLAGS	
Detector cooling type	None	Stirling cyrocooler or liquid nitrogen dewar	Optimize for life and operating cost
Detector temperature	K	77	
Beam splitter	None	ZnSe or Kbr	
Interferometer type	None	Continuous scan Michelson interferometer	Manufacturer of interferometer depends on supplier
Signal to noise ratio	None	1,000:1 to 50,000:1	Signal to noise dependent on supplier
Bench stabilization	None	Thermally-stabilized	Reduces noise
QA gas cell type	None	Internal linear dual pass or multi-pass cell	Cell is permanently mounted in beam path.
Cell Window	None	Kbr or ZnSe	
Operating Temperature	°C	-40 to 60	
Time resolution (averaging time)	Minutes per reading	5 per path	
Power requirement	VAC	110 - 240	
Signal sampling	ADC	18-bit or 24-bit	Used for data acquisition
Output	None	RS-232, RS 485, or LAN link	
Material of construction	None	Stainless steel or similar	Robust and ruggedness required

Table 6-9: FTIR – Ancillary Equipment Specifications

Parameter	Units	Specification	Comment
Alignment Mechanism/Rotating Pedestal/Auto-positioner			
Type	None	Moog MPT-90, QPT 90 or similar	
Mechanism	None	Pan and Tilt Unit	Required to remotely position analyzer
Load Capacity	Lb	Varies	Should be able to hold the analyzer
Pan Movement Range	°	360°	
Tilt Movement Range	°	150 ~ 180°	Varies with supplier
Operating temperature	F	5 to 131	Without heaters (heaters not required in southern california weather conditions)
Motor Type	None	Stepper	
Communications to Pan & Tilt		RS232 to PC	
Communications to Sensors		RS232 Analog via internal PCB	
Material	None	Housing: 6061-T6 Aluminum, SS hardware permanently sealed radial ball bearings	
Retroreflectors			
Configuration	None	Open hollow cubes	Hollow cube retro reflectors have three flat sides that are attached in an orientation so that the reflected beam exits at nearly the same angle of incidence as the incoming beam.
Mounting	None	Rear mount to plate or Installation specific cradle	
Material (Substrate)	None	Fabricated glass, replicated aluminum, or similar	
Coating	None	Gold coating	

Table 6-9: FTIR – Ancillary Equipment Specifications

Parameter	Units	Specification	Comment
Surface quality	None	80-50 scratch dig at 30 arc-sec	
Adhesion	None	Mil F-48616; Humidity MIL F-48616 or equivalent	
Operating temperature range	°C	-40 to 60	
Reflectivity	cm-1	700 to 4500	Min requirement for FTIR spectrum
Array configuration	None	60 to 67 cubes	Varies by path length
Enclosure	None	Customer supplied	Recommend 24 x 24 x 8 box or similar
Heater	None	Optional, but recommended	To reduce condensation
Heater power consumption	W	480 maximum	Required 120 VAC, 5A, 60 Hz.

Table 6-10: FTIR – Computer and Software Specifications

Parameter	Specification	Comment
Computer	Windows 7 or above, 32-bit; Memory: 3GB minimum; Dual Core 2.1 GHz processor; Min. 2 USB ports; Ethernet port; 802.11 b/g/n wireless LAN.	Recommended configuration. Note – many options available.
Software		
Type	Real-time monitoring of pollutants	Proprietary for each supplier
Data display	Real-time display of results as well as instrument diagnostics.	
Alarms	User programmable to set alarms when thresholds or action levels are exceeded	
Notifications	Ability to send notificaitons in case of exceedences	
Beam intensity	Ability to display beam intensity being measured	

Table 6-10: FTIR – Computer and Software Specifications

Parameter	Specification	Comment
Communication	Compatible with all computer systems and software for data processing	The equipment should be able to communicate alarms, operational parameters and results with a computer.
Remote control	Calibrations and adjuments done remotely	
Smart Features	Analytical method customization; Background and interference compensation; Retroactive spectra analysis.	

Table 6-11: OP-UVDOAS Analyzer Specifications

Parameter	Units	Specification	Comment
Analyzer type	None	OP-UVDOAS	
Receiver configuration	None	monostatic	
Spectrometer resolution	nm	0.05 - 0.20	Varies with supplier
UV Source		> 100 W Xenon lamp or deuterium lamp	
UV Source replacement	hours	Every 2000 – 3000 hours	
Operational wavelength	nm	~ 210 – 415	
Beam Operating temperature	°C	-20 to 50	
Indoor shelter temperature limits	°C	-15 to 35	
Bench stability	None	Thermally-stabilized	Temperature controlled housing assembly with feedback control or similar
Operating humidity	%	0 to 100%	
Detector type	None	2048 Pixel spectrometer or similar TE Cooled	
QA gas cell	None	Required	Dimension and type dependent on supplier
Electrical requirements	VAC	110 or 240, single phase, 50-60 Hz, 5 Amp maximum	

Table 6-11: OP-UVDOAS Analyzer Specifications

Parameter	Units	Specification	Comment
Time resolution (averaging time)	minutes	5 minutes per reading	
Data acquisition rate	Milliseconds/scan	10-400	
Data output rate		10 sec – 5 min TYP	User configurable
Output	None	RS-232, RS 485, or LAN link	
Material of construction	None	Stainless steel or similar	Robust and ruggedness required

Table 6-12: OP-UVDOAS – Ancillary Equipment Specifications

Parameter	Units	Specification	Comment
Alignment Mechanism / Rotating Pedestal / Auto-positioner			
Type	None	Moog MPT-90, QPT 90 or similar	
Mechanism	None	Pan and Tilt Unit	Required to remotely position analyzer
Load Capacity	Lb	Varies	Should be able to hold the analyzer
Pan Movement Range	°	360°	
Tilt Movement Range	°	150 ~ 180°	Varies with supplier
Operating temperature	F	5 to 131	Without heaters (heaters not required in southern california weather conditions)
Motor Type	None	Stepper	
Communications to Pan & Tilt		RS232 to PC	
Communications to Sensors		RS232 Analog via internal PCB	
Material	None	Housing: 6061-T6 Aluminum, SS hardware permanently sealed radial ball bearings	
Retroreflectors			

Table 6-12: OP-UVDOAS – Ancillary Equipment Specifications

Parameter	Units	Specification	Comment
Configuration	None	Open hollow cubes	Hollow cube retro reflectors have three flat sides that are attached in an orientation so that the reflected beam exits at nearly the same angle of incidence as the incoming beam.
Mounting	None	Rear mount to plate or Installation specific cradle	
Material (Substrate)	None	Fabricated glass, replicated aluminum, or similar	
Coating	None	Gold coating	
Surface quality	None	80-50 scratch dig at 30 arc-sec	
Adhesion	None	Mil F-48616; Humidity MIL F-48616 or equivalent	
Operating temperature range	°C	-40 to 60	
Reflectivity	cm-1	700 to 4500	Min requirement for FTIR spectrum
Array configuration	None	60 to 67 cubes	Varies by path length
Enclosure	None	Customer supplied	Recommend 24 x 24 x 8 box or similar
Heater	None	Optional, but recommended	To reduce condensation
Heater power consumption	W	480 maximum	Required 120 VAC, 5A, 60 Hz.

Table 6-13: OP-UVDOAS – Computer and Software Specifications

Parameter	Specification	Comment
Computer	Windows 7 or above, 32-bit; Memory: 3GB minimum; Dual Core 2.1 GHz processor; Min. 2 USB ports; Ethernet port; 802.11 b/g/n wireless LAN.	Recommended configuration. Note – many options available.

Table 6-13: OP-UVDOAS – Computer and Software Specifications

Parameter	Specification	Comment
Software		
Type	Real-time monitoring of pollutants	Proprietary for each supplier
Data display	Real-time display of results as well as instrument diagnostics.	
Alarms	User programmable to set alarms when thresholds or action levels are exceeded	
Notifications	Ability to send notificaitons in case of exceedences	
Beam intensity	Ability to display beam intensity being measured	
Communication	Compatible with all computer systems and software for data processing	The equipment should be able to communicate alarms, operational parameters and results with a computer.
Remote control	Calibrations and adjuments done remotely	
Smart Features	Analytical method customization; Background and interference compensation; Retroactive spectra analysis.	

Table 6-14: Aethalometer specifications

Parameter	Units	Specification	Comment
Cartridge filter bypass	None	Required	Filter used for clean air tests, should be replaced once a year.
Electronic data output	None	RS-232, Ethernet, or USB port capabilities; Capability to transmit analyzer information to software	See “Software Specifications” below.
Calibration kit	None	Neutral density optical filter calibration kit or equivalent	Ability to calibrate the absorptive properties of the instrument
Filter tape material	None	Teflon-coated glass fiber or similar	Reduce effects of relative humidity.

Table 6-14: Aethalometer specifications

Parameter	Units	Specification	Comment
Flow rate options	Liter per minute (LPM)	0.05 - 5	Varies
Internal vacuum pump	None	Internal diaphragm type	
Light source	(nm)	LED light sources at different wavelengths	Different wavelengths measure the absorption of different types of carbon.
Power supply	Watts (W)	100-230VAC, 50/60Hz (auto-switching) - 25 W average	Minimize power usage. Standard US connection.
Pulse damper	None	Recommended	Decrease pump pulsations to minimize interferences with sensitive measurements.
Resolution	Microgram (µg)	0.001	
Sample inlet tubing	None	Static Dissipative tubing	Minimize amount of tubing required.
Time base of measurements	Seconds (s)	5-minute time base preference; possibility of both shorter and longer averaging times	

Table 6-15: Photoacoustic extinctiometer specifications

Parameter	Units	Specification	Comment
Calibration particles - absorption	None	Strongly absorbing particles such as black smoke from a fuel-rich gas lamp, or glassy black carbon.	Calibration of absorption of black carbon particles
Flow/pressure measurement	None	Critical orifice	Modulates flow rate
Flow rate	Liter per minute (LPM)	1	Flow rate is set by the ctitical orifice
Internal Vacuum Pump	None	Internal diaphragm type	
Laser Source	None	870 nm, 2 W 1500 Hz nominal, square wave	Laser required to excite black carbon molecules

Table 6-15: Photoacoustic extinctiometer specifications

Parameter	Units	Specification	Comment
Power Supply	Voltage (V)	90 - 264 V, 47 - 63 Hz (AC power) or 12 VDC	
Microphone	None	Knowles Electronics Model: EK-230-28-P22 or similar	Microphone picks up heat produced soundwaves from excited black carbon particles.
Resolution	Microgram (µg)	0.001	Resolution above the detection limit is expected to be
Sample inlet tubing	None	Static dissipative tubing	Minimize amount of tubing required.
Sampling inlet head	None	Protective cover to minimize debris/insect/moisture in the sample line; may be specific inlet head for PM2.5	
Size selective cyclone	None	Sharp-cut cyclone cut at 2.5 µm at desired flowrate	Cut at 2.5µm depends on flowrate identified
Air stream dryer (Optional)	None	Membrane dryer with or without external pump	May reduce noise caused by fluctuations in RH
Time base of measurements	Seconds (s)	5-minute time base preference; possibility of both shorter and longer averaging times	

Table 6-16: Black carbon analyzers - Computer and software specifications

Parameter	Specification	Comment
Computer	Minimum 1 GB. Must be operable on Windows XP, Vista or Windows 7 or better	
Software		
Alarms	Operational parameters and analyzer operation issues logged	
Communication	Compatible with all computer systems and software for data processing	

Table 6-16: Black carbon analyzers - Computer and software specifications

Parameter	Specification	Comment
Remote control	Alarm identification and troubleshooting, calibration and flow checks, ability to view real time concentrations remotely	May not be possible for all equipment software.
Data display	Physical display on equipment and remote display of consolidated data	
Data processing	5-minute, 1-hour, 8-hour averaging capabilities, processing of alarms and QA check information	

Table 6-17: Hydrogen sulfide UV Fluorescence Analyzer specifications

Parameter	Units	Specification	Comment
Electronic data output	None	RS-232, Ethernet, or USB port capabilities; Capability to transmit analyzer information to software	
Flow rate options	Liter per Minute (LPM)	0.65 - 1	
Light source	(nm)	LED light sources in the range of SO2 absorption wavelengths	UV light in the range of wavelengths absorbed by SO2 (190 nm - 230 nm).
Power supply	Watts (W)	100-230VAC, 50/60Hz (auto-switching) – 200-300 W average	Minimize power usage. Standard US Connection.
Resolution	ppb	1	
Time base of measurements	Seconds (s)	5-minute time base preference; possibility of both shorter and longer averaging times	
Operating Temperature	°C	20-30	Wider operating temperature range preferred.
Lag time	s	25	

6.5 Fenceline Air Monitoring System Supplier Selection

There are many considerations for selection of specific analyzers beyond pollutant capability and detection limits, some of which are listed below.

- Measurement reliability:
  - Interferences from atmospheric gases, weather, haze;
  - Minimize false positives and negatives;
  - Accuracy and detection limits commensurate with thresholds;
  - High system availability.
- Performance:
  - 20+ year life;
  - High ruggedness and reliability;
  - Operability during weather extremes and site conditions
  - Electronic component ratings
  - Materials of construction and finishes
  - High maintainability
  - Consumables and replacement parts
  - Analyzer construction & layout
  - Parts and service availability
  - Warranty
- Supplier qualifications
  - Experience

The final determination on instrument suppliers will be made under competitive procurement during the implementation phase of this project. Based on a comprehensive review of information collected during development of this Plan, the suppliers listed below are currently being considered (listed alphabetically).

- OP-FTIR:
  - Bruker Optics (sold and integrated through Atmosfir Optics Ltd.);
  - Cerex Monitoring Solutions;
  - Kassay Field Services, Inc.; and
  - Spectrum Environmental Solutions.
- OP-UVDOAS:
  - Argos Scientific;
  - Cerex Monitoring Solutions; and
  - Opsis.

- Black carbon monitors:
  - Met One Instruments (Model 1060 aethalometer); and
  - Magee Scientific (Model AE-33 aethalometer).
  - Droplet Measurement Technologies (Model PAX photoacoustic extinction).
- Hydrogen sulfide monitors:
  - Thermo-Fisher (Model EPM-450i UV fluorescence); and
  - Teledyne API (Model T-101 UV fluorescence).

6.6 Fenceline Air Monitoring System Integration

As noted in Section 6.4, TORC fenceline air monitoring system will include OP-FTIRs, OP-UVDOAS and black carbon point monitors. A system integrator will install and shop-test the monitor systems (analyzers, auto-positioners, electronics enclosures, heating/cooling systems, electrical and instrument wiring, etc.) in pre-assembled shelters for each location. This will ensure that the entire system operates as designed and that operation of each location is verified before field installation.

TORC expects to make the final selection of a system integrator under competitive procurement during the implementation phase of this project. Note, some of the instrument suppliers listed above also offer system integrator services.

6.7 Alternative/Back-Up Monitoring Systems

Alternate or temporary monitoring systems are required per Rule 1180 when the continuous monitoring systems are offline for extended periods for maintenance or repair.

It should be noted, that interferences from fog, rain, and particulate matter (smoke, dust, haze) can affect the open path instruments' ability to detect target compounds at appropriate detection levels. These periods of interference due to atmospheric conditions are expected to be short and are inherent shortcomings of open path technology, which is recommended technology under Rule 1180 guidelines. The alternative monitoring systems will not be used to determine individual gaseous target compounds and/or surrogates when the open path systems are down due to atmospheric interferences,[80] but only in case of extended periods for maintenance or repair or outages.

The following temporary backup monitoring is currently being evaluated and will be finalized during the implementation stage. The sections below include options the facility could pursue in case of an extended outage.

6.7.1 VOCs

A tiered approach is presented below as a VOC temporary back-up monitoring system in case of extended instrument outage. In addition to the tiered options identified below, continued development of low-cost sensor technologies may expand the range of Rule 1180 target pollutants that could be measured cost-effectively at multiple points along the fenceline. However, low cost sensors with verified performance are currently available only

[80] In the unlikely event of extended atmospheric interferences, e.g. two weeks of rain, TORC may consider using back-up systems.

for particulate matter (PM_{10} and/or $PM_{2.5}$), ozone, NO_X and SO_2. TORC may update this section of the Plan if effective low-cost sensors are available in the future.

Tier I: For pollutants that can be measured with both OP-UVDOAS and OP-FTIR, these systems can work as backups for each other. For this option, ideally the overlapping or the closest OP-UVDOAS or OP-FTIR path will be used as a backup. This back-up option will only be triggered if one of the systems is down for a reasonable amount of time (greater than 1 day). These systems can save detailed emissions data, enabling manual examination of historical data, if required.

While the detection limits of the back-up instruments will be slightly higher than the preferred primary instrument of choice, these should be able to back-up data for the following pollutants:

OP-FTIR: SO_2, benzene, toluene, ethylbenzene and xylenes.

OP-UVDOAS: NO_X, formaldehyde, acetaldehyde, acrolein, carbonyl sulfide and ammonia.

Tier II: If both the OP-UVDOAS and OP-FTIR systems are continuously offline for more than one-week, passive sampling devices will be used to collect VOC data. The passive samplers will be isolated prior to initiation of sampling. Samples will be collected every six days until the continuous monitoring system is back online or Tier III sampling is required. Samples will be collected using EPA Method 325A, *Volatile Organic Compounds From Fugitive And Area Sources,* and the sorbent tube samples will be analyzed using EPA Method 325B, *Volatile Organic Compounds From Fugitive And Area Sources*. Compounds monitored by these sampling tubes include 1,3 butadiene, benzene, toluene, ethylbenzene, xylene.[81] The existing passive sampling network for benzene monitoring which is based on EPA Method 325A/B tentatively will be used to collect these samples, pending confirmation of lab preparation and analysis details. However separate sorbent tubes may be used to avoid any conflicts with the existing benzene monitoring program. Samples will be collected from at least two locations nearest each open path affected by the outage.

Tier III: If both the OP-UVDOAS and OP-FTIR systems are continuously offline for more than one-month, passivated evacuated canisters (SUMMA® or similar) will be manually deployed to collect samples along the path(s) affected by the outage and sent to a laboratory for analysis. One canister will be located near each path of the system that is down, including at the analyzer location, the retroreflector location, and the beam midpoints and placed either on the ground or on existing shelters. The canisters will be configured with the critical orifice set for 24-hour sample collection. Canister samples will be collected every six days until the primary monitoring system is back online. Most of the gaseous target compounds will be determined generally following analytical techniques given in EPA Method TO-15, *Determination of Volatile Organic Compounds in Air Collected in Specially-Prepared Cannisters and Analyzed by Gas Chromatography/Mass Spectrometry.* Some gaseous target compounds may be inferred from others. EPA Method TO-15 generally provides a method detection limit in the range of <0.005 ppb for most compounds. EPA Method TO-15 has been validated for the following Rule 1180 target VOC compounds:

- 1,3 Butadiene,

[81] Note, BTEX compounds and 1,3 butadiene have uptake rates listed, and thus can be analyzed using the same sorbent tube (Carbopack™ or similar).

- Acrolein,
- Acetaldehyde,
- Benzene,
- Toluene,
- Ethyl benzene,
- Xylene, and
- Styrene.

6.7.2 Black Carbon

If three or more of the black carbon monitors are simultaneously and continuously offline for more than one week, a tiered approach using one of two options will be employed for back-up monitoring. One uses elemental carbon as a surrogate for black carbon, while other uses $PM_{2.5}$ as a surrogate for black carbon.

Tier I: If three or more of the black carbon analyzers are not functioning continuously for over one week, TORC will implement 24-hour collection on pre-fired quartz filters in a NIOSH filter sampler. These filters will be analyzed by thermal-optical absorbance/reflectance for elemental carbon, as a surrogate for black carbon. The samples will be analyzed within ten working days after collection. Samples will be collected once every six days while the system is offline at the same locations where black carbon monitors are located.

Tier II: Tier II is only presented here as an option for obtaining data with higher time resolution. If Tier I back-up is not deemed appropriate after the first few initial Tier I back-up system deployments, TORC will implement Tier II, in lieu of Tier I. Tier II includes low cost $PM_{2.5}$ sensors, where $PM_{2.5}$ could be used as surrogates for black carbon. SCAQMD's Air Quality Sensor Performance Evaluation Center (AQ-SPEC) has evaluated multiple low cost PM2.5 sensors. Moji Cina Airnut, Shinyei PM Evaluation Kit, and Purple Air PA-II are all highly rated sensors listed by AQ-SPEC.[82] Sensors would be installed at the same locations as the black carbon analyzers. If in the future, a low-cost sensor for black carbon becomes available, these will be considered as a back-up monitoring technology.

6.7.3 Hydrogen Sulfide

TORC has an existing hydrogen sulfide monitoring system in certain process areas inside the fenceline for facility alarms and emergency first responder notifications, and all refinery staff and contractors carry personal hydrogen sulfide monitors to detect unplanned releases of hydrogen sulfide. Given this additional on-site coverage, no alternative or back-up monitoring is proposed for hydrogen sulfide.

6.7.4 Hydrogen Fluoride

TORC has a very robust existing hydrogen fluoride monitoring system around the alkylation unit, which is only unit that uses modified hydrogen fluoride (MHF) inside the refinery, to detect any potential unplanned releases. This will serve as the alternative hydrogen fluoride monitoring system for purposes of this Rule 1180 Plan. The system consists of:

[82] *Air Quality Sensor Performance Evaluation Center*; South Coast Air Quality Management District. See http://www.aqmd.gov/aq-spec (accessed July 2018).

- Twenty-seven electrochemical point sensors located throughout unit and on perimeter. The system:
  - Detects hydrogen fluoride down to 0.1 parts per million (ppm);
  - Alarms internally at 2 ppm; and
  - Notifies SCAQMD and the City of Torrance Fire Department at 6 ppm;
- Open-path TDL hydrogen fluoride analyzers completely encircling the unit perimeter, that:
  - Detect hydrogen fluoride down to 0.1 ppm per meter (ppm-m); and
  - Alarm internally at 50 ppm-m and 75 ppm-m;
- New open path TDL systems are currently in engineering and design to encircle the fresh MHF and acid evacuation system (AES) vessel area in accordance with an agreement with the California Division of Occupational Safety and Health;
- Alkylation unit operator console alerts:
  - All detection systems display alarms on a plot plan schematic at the alkylation unit operator console to allow targeted response and rapid understanding of potential release movement;
- External Alerts:
  - Ability to close Crenshaw Boulevard and Del Amo Boulevard if potential public impact exists;
- Community alert sirens.

6.7.5 NO_x and SO_2

The approach listed above for alternate temporary monitoring addresses most of Rule 1180 pollutants. In addition to these, there is sufficient back up for SO_2 and NO_X as there are regional monitoring stations as well as proposed community air monitoring networks as a part of Rule 1180 that provide coverage for these pollutants.

6.7.6 Other Pollutants

6.7.6.1 Ammonia

If both the OP-UVDOAS and OP-FTIR systems are continuously offline for more than 1-week, passive sampling devices will be used to collect ammonia data. The samplers will be isolated prior to initiation of sampling. Ammonia samples will be collected using either sorbent tubes and sampling pumps or passive samplers and analyzed via NIOSH Method 6016 or OSHA method ID-188. Samples will be collected once every six days until the continuous monitoring system is back online. Samples will be co-located at locations along the existing passive sampling network for benzene monitoring. Samples will be collected from two to three locations nearest the path(s) affected by a fenceline air monitoring system outage.

6.7.6.2 Hydrogen Cyanide

If both the OP-UVDOAS and OP-FTIR systems are continuously offline on the same path for more than 1-week, passive sampling devices will be manually deployed to monitor hydrogen cyanide on the affected path during the monitor outage. Hydrogen cyanide samples will be collected using either sorbent tubes and sampling pumps or passive samplers and analyzed via NIOSH method 6010 or OSHA method 1015. Hydrogen cyanide samplers will be collected once every six days until the continuous monitoring system is back online. Samples will be co-located with the existing passive sampling benzene monitoring network at two to three locations nearest the path(s) affected by a fenceline air monitoring system outage.

6.7.6.3 Carbonyl Sulfide

Carbonyl sulfide emissions typically are closely tied to releases of hydrogen sulfide because both compounds are released from similar processes and sources. Therefore, the existing hydrogen sulfide monitoring systems and personal hydrogen sulfide monitors on refinery staff is considered sufficient to identify any significant releases of both hydrogen sulfide and carbonyl sulfide in the event of a monitor outage. Therefore, no additional or alternative monitoring is proposed for carbonyl sulfide.

7. DATA PRESENTATION TO THE PUBLIC

This section of the Plan describes the data management, public website content, quarterly reports and notification system for fenceline air quality monitoring system at the TORC. The Rule 1180 Regulation and/or Guidelines specify requirements for the Plan (Table 7-1) that are addressed in this Section.

Table 7-1: Crosswalk between Rule 1180 requirements and report sections where they are discussed

Rule 1180 Requirements for Plan	Addressed in Plan Section...
PUBLIC WEBSITE	
Web based system for disseminating information from fenceline monitors	7.2.2, 7.2.3, 7.2.4
Educational material	7.2.7
Description of pollutants	7.2.7
Description of background levels and context	7.2.7, 7.3
Hyperlinks to relevant sources of information	7.2.7
Means for the public to provide comments and feedback	7.2.6
Procedures to respond to comments and feedback from public	7.2.6
Provide relevant information for all downwind communities	7.3, 7.4.2
Quarterly data summary reports	7.5
Communication method for public notifications	7.4
Notifications about activities that could affect the fenceline air monitoring system	7.4.2
Notifications about the availability of periodic reports	7.4.3
Notifications about air quality threshold exceedances	7.4.1
DATA MANAGEMENT	
Procedures to upload data from the instruments to the website	7.1.1
Quality control methods	7.1.2
Quality control flags definition	7.1.2
Archived data with chain of custody information and QA/QC flags	7.1.2
5-minute average data resolution	7.1.1
Means for disseminating information to local response agencies and SCAQMD	7.1, 7.4.1

7.1 Data Management

This section describes the conceptual design for flow of data from the onsite instruments to various end points and interested parties, and the major steps of the data management process.

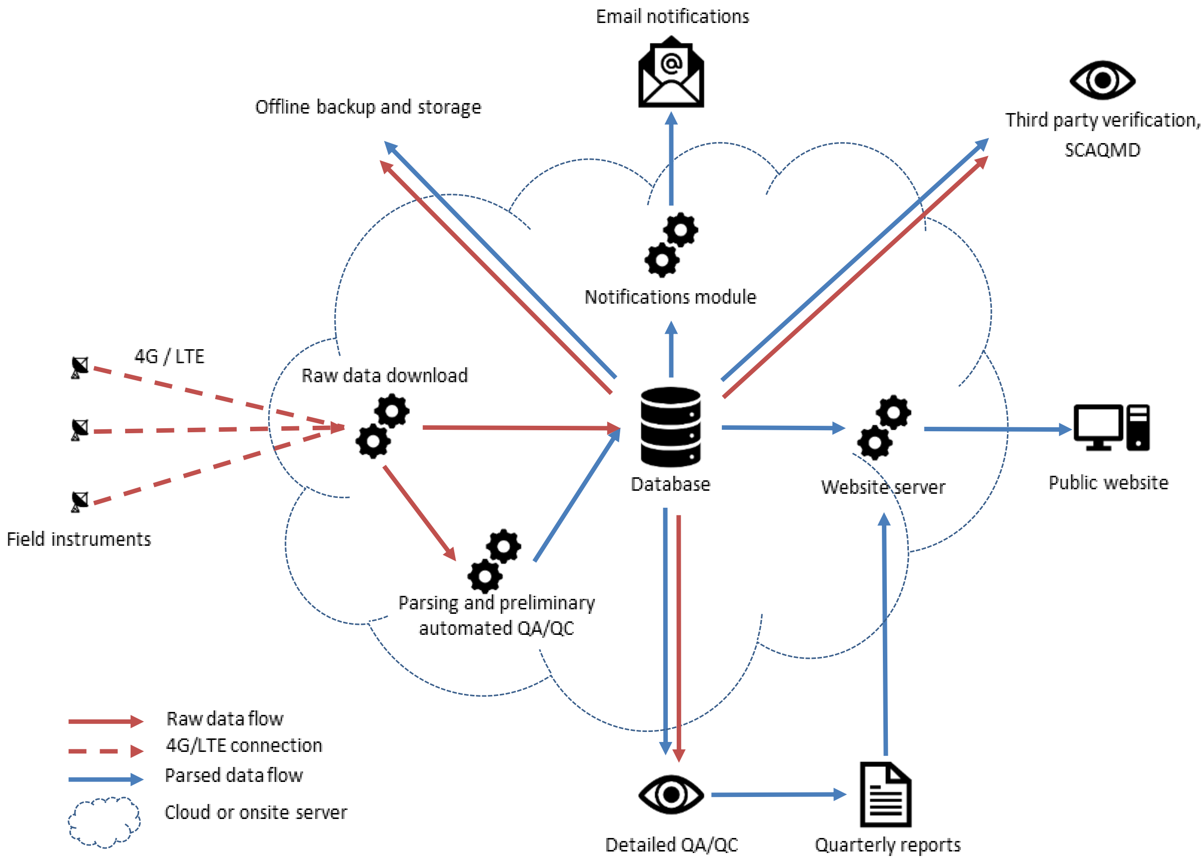

Figure 7-1: Network architecture and data flow schematic (conceptual design)

7.1.1 Data Download

The field instruments will be connected to the server via cellular 4G/LTE modems (Figure 7-1). At five- or ten-minute intervals, depending on the light path, a module on the server will query all field instruments and download the raw data as recorded by each instrument. These data, in their unaltered form, will be recorded in the database along with metadata for the date, time of day, location and specific pollutant.

7.1.2 Parsing and Preliminary Quality Assurance Checks

A copy of the raw data will be parsed and a preliminary automated quality assurance (QA) check will be performed on the results. These refined data will be recorded in a section of the database that is separate from the raw data. Therefore, with the use of metadata, logs and the raw instrument data one can verify how the raw data has been parsed, corrected and then finally posted on the website. The flow of raw data is indicated by red arrows in Figure 7-1, whereas the flow of refined data is indicated by blue arrows. Any data that fail the QA criteria described in this section will be marked as invalid and will not be shown in the website unless the QA flag is changed upon manual review. Data flagged for review will be displayed on the website but may be changed to invalid upon manual review and therefore would be removed from the website.

The specific rules for the automated QA will depend on the pollutant and type of instrument. However, the following general types of checks (Table 7-2) will be performed on all measurements:

- Range checks will confirm the measurement is within pre-defined minimum and maximum values such as lower and upper detection limits.
- Sticking value checks will be used to flag data for further review if observations for four or more consecutive measurement intervals are exactly the same.
- Rate of change checks will test for spurious readings by confirming that adjacent observations change by a reasonable rate. If the rate exceeds the criterion the data will flagged for further review. The rate of change threshold will be applied only to the 5-minute average data.
- Instrument operational sensors, codes and alarms will be used to validate proper instrument operation. Data collected during improper instrument operation will be qualified as invalid.
- Beam intensity, for open path instruments, will be used to validate signal strength. Data collected below a minimum threshold will be marked as invalid.

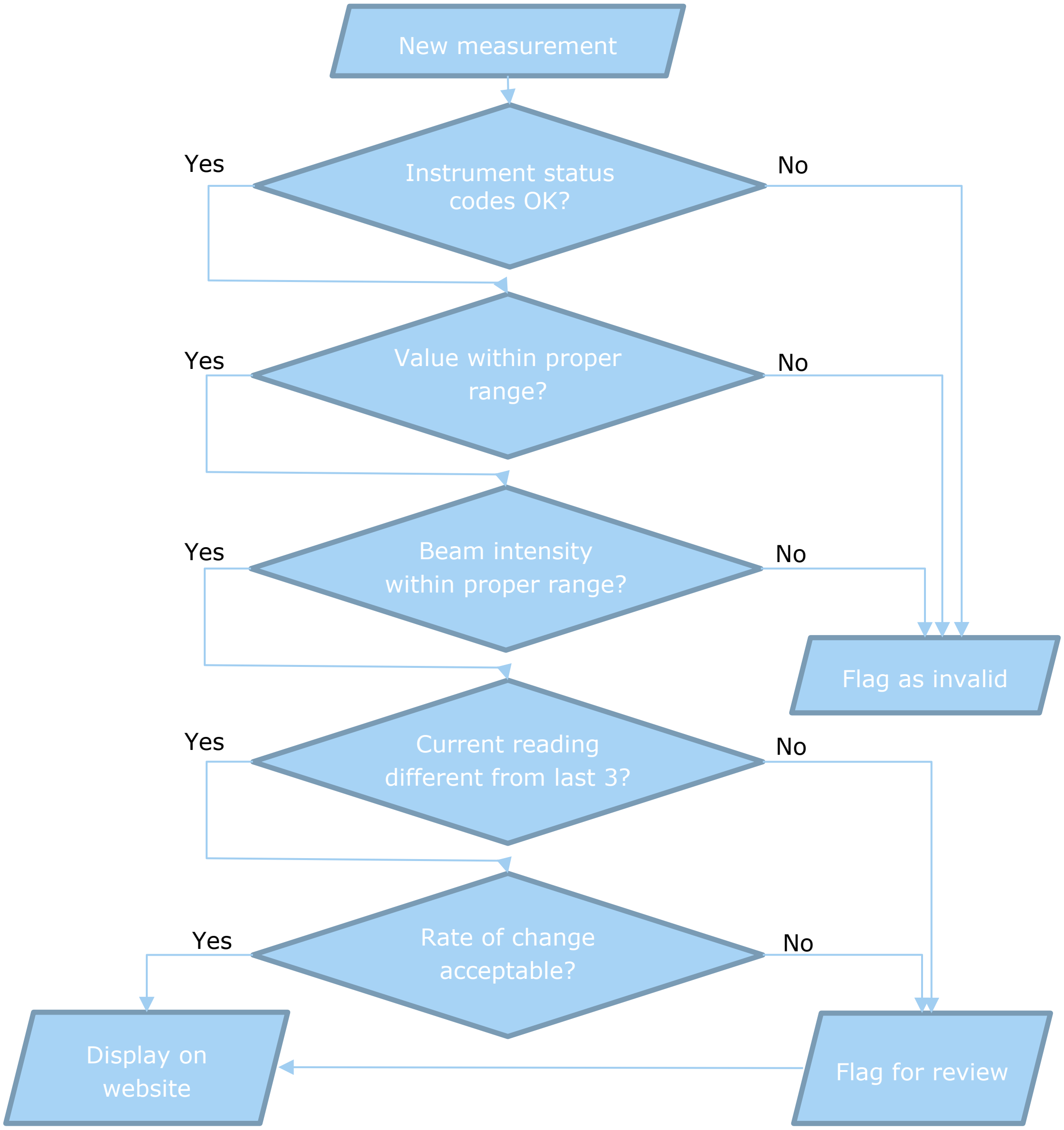

Figure 7-2: A flowchart diagram of the logic behind the automated QA checks

Table 7-2: Automated QA checks and criteria for invalid data

<table>
<tr><th>Pollutant</th><th>Measurement Technology</th><th>Range: LDL/ Minimum</th><th>Range: UDL/ Maximum</th><th>Sticking Check Threshold</th><th>Rate of Change Threshold</th><th>Beam Intensity</th></tr>
<tr><td colspan="7">[Values will be developed during system commissioning.]</td></tr>
<tr><td>SO_2</td><td>OP-UVDOAS</td><td rowspan="17"></td><td rowspan="17"></td><td rowspan="17">Value is within the proper range and observations are identical for >= 4 measurement intervals</td><td rowspan="17"></td><td rowspan="17"></td></tr>
<tr><td>NO_x</td><td>OP-UVDOAS</td></tr>
<tr><td>VOCs</td><td>OP-FTIR</td></tr>
<tr><td>Formaldehyde</td><td>OP-FTIR</td></tr>
<tr><td>Acetaldehyde</td><td>OP-FTIR</td></tr>
<tr><td>Acrolein</td><td>OP-FTIR</td></tr>
<tr><td>1,3-Butadiene</td><td>OP-FTIR</td></tr>
<tr><td>Benzene</td><td>OP-UVDOAS</td></tr>
<tr><td>Toluene</td><td>OP-UVDOAS</td></tr>
<tr><td>Ethylbenzene</td><td>OP-UVDOAS</td></tr>
<tr><td>Xylene</td><td>OP-UVDOAS</td></tr>
<tr><td>Hydrogen sulfide</td><td>UV fluorescence</td></tr>
<tr><td>Carbonyl sulfide</td><td>OP-FTIR</td></tr>
<tr><td>Ammonia</td><td>OP-FTIR</td></tr>
<tr><td>Black carbon</td><td>Aethalometer</td></tr>
<tr><td>Hydrogen Cyanide</td><td>OP-FTIR</td></tr>
<tr><td>Hydrogen fluoride</td><td>OP-FTIR</td></tr>
</table>

7.2 Website – Example Screenshots

Figures 7-3 to 7-12 contain screenshots of the public website mockup. The mockups are intended to show the conceptual layout of the website and the basic functionality. Any air quality data presented below has been randomly generated just for illustrative purposes. Furthermore, the precise wording, functionality, layout, visual appearance, color schemes and/or instrument positions are for illustrative purposes and may change as the website is developed and tested. The website content will be developed in English and translated to Spanish.

7.2.1 Home Page

The home page (Figure 7-3) will contain a refinery graphic or logo and a brief explanation of the website and data presented. Links to real-time data, message board, learning center, reports, etc. will be provided. Links also will be provided for contact and messaging.

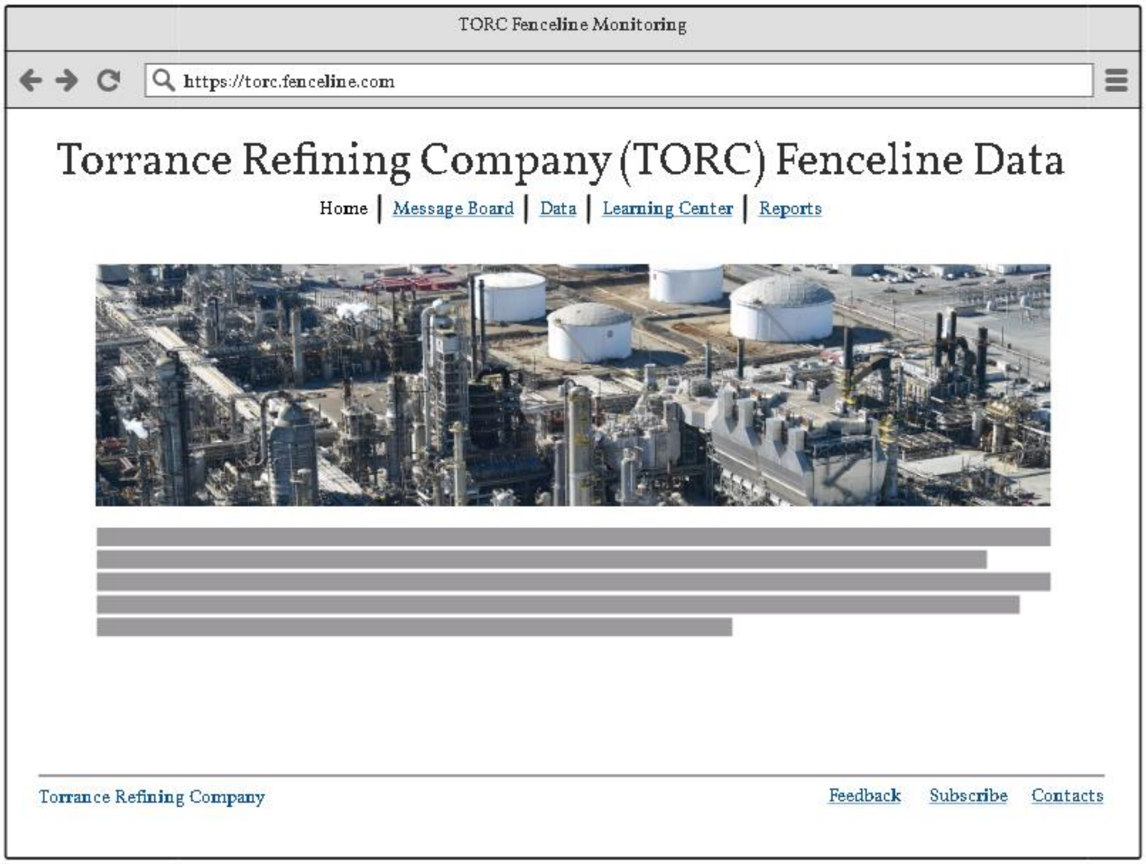

Figure 7-3: Screenshot #1: home page

7.2.2 Message Board

The message board (Figure 7-4) is meant to be an aggregation of all the messages that are sent to users who are subscribed to the notification service. Therefore, the message board will show messages in chronological order regarding:

- Threshold exceedances;
- Instrument outages (planned or unplanned); and
- Availability of reports.

7.2.3 Data Presentation

The data presentation map view (Figure 7-5) is the first page that is shown when a user clicks on the 'Data' link in the top navigation bar. The page contains several interactive elements:

- Symbols on the map can be clicked and they lead to a different page with a detailed view of the most current data of the selected analyzer or light path.

- Hovering over the symbols on the map will show a popup with information about the general status of the instrument.
- The dropdown menu at the top of the map can be used to select a specific analyzer or light path and will lead to a different page that shows details about the selected analyzer, similarly to clicking a path or analyzer symbol on the map.

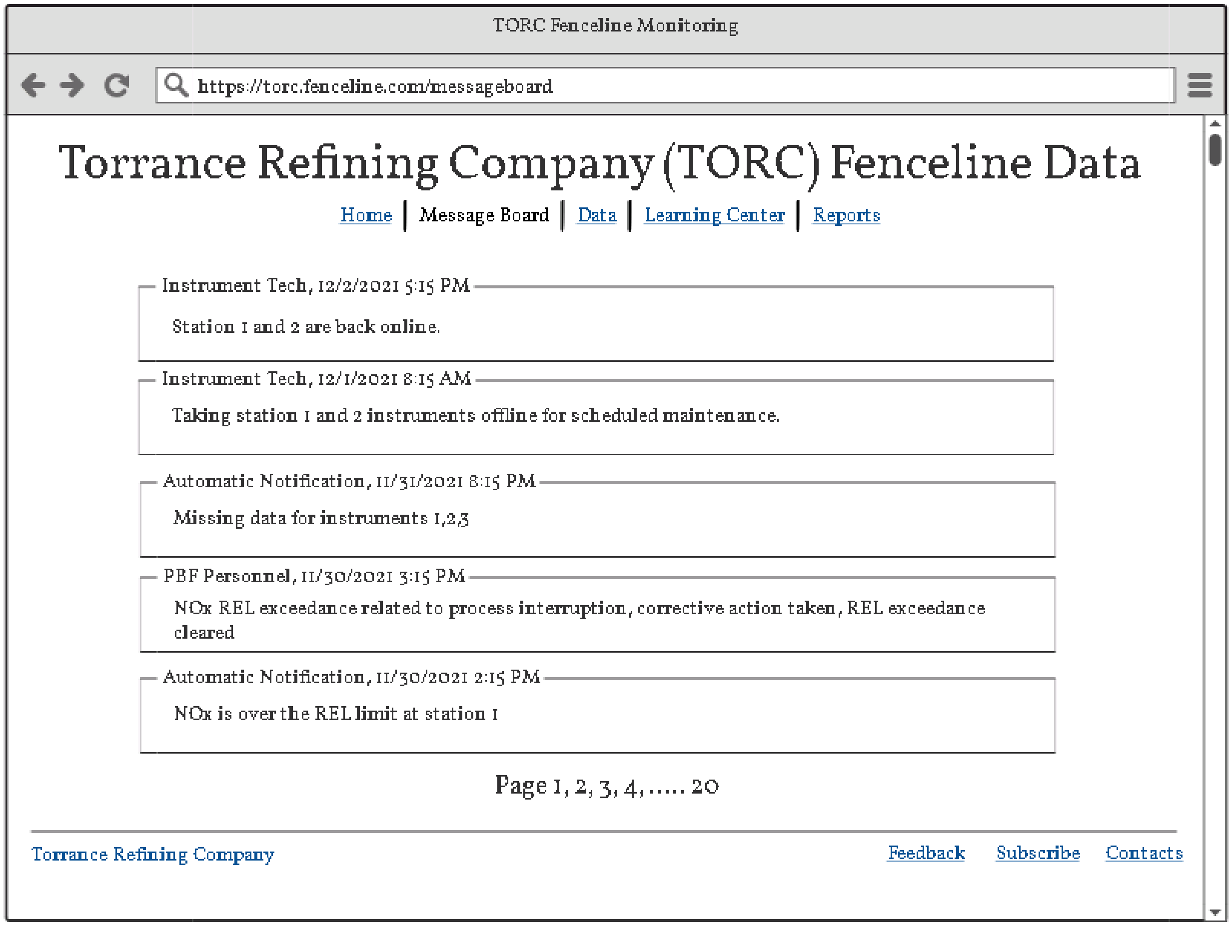

Figure 7-4: Screenshot #2: message board

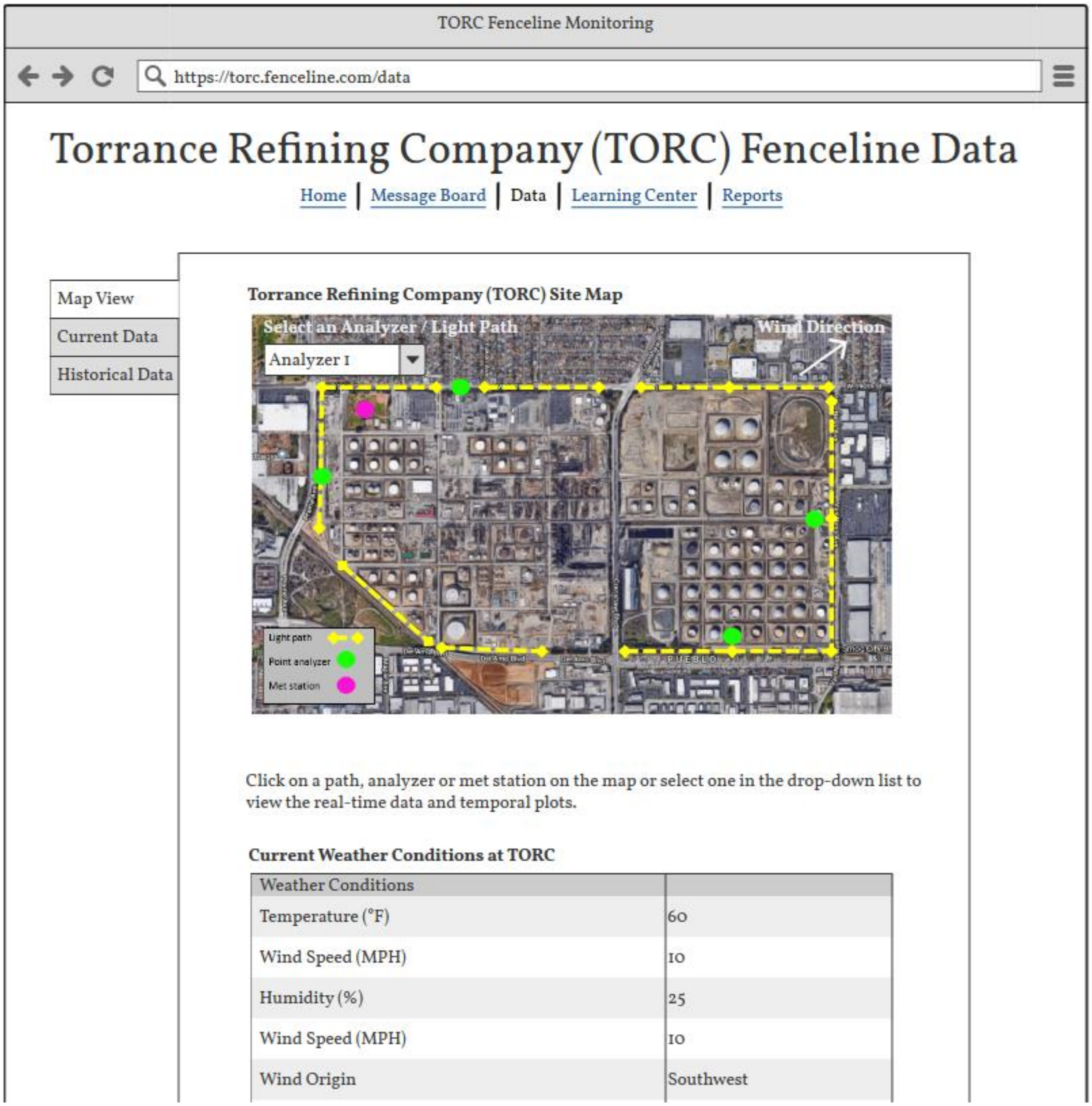

Figure 7-5: Screenshot #3: data presentation – map view

The current data page (Figure 7-6) shows the most current data from a specific analyzer. The analyzer as well as the required metric that will be shown in the time series plot can be selected in the dropdown menus at the top. In addition to the time series plot, the page contains a summary of the most recent observations for all combinations of pollutants and metrics, along with the applicable thresholds measured at the analyzer.

The historical trends page (Figure 7-7) will present historical data in a chart and tabular format for a specific analyzer, pollutant and metric. The selections of the two dropdown menus at the top will cause the data in the chart and table to update accordingly.

Furthermore, the date selection dialog in the top right section of the webpage enables users to select any past date and will update the displayed data.

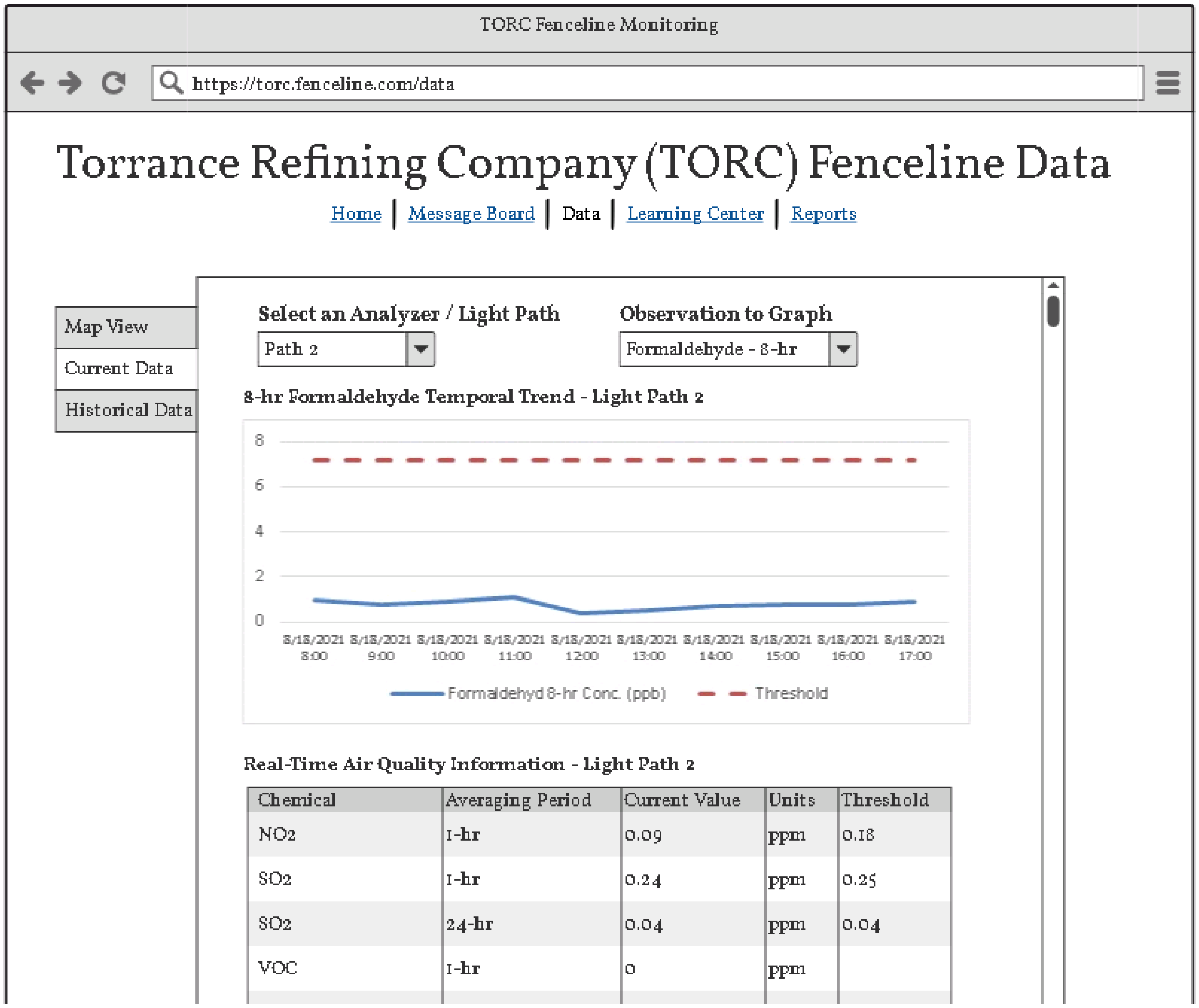

Figure 7-6: Screenshot #4: data presentation – current data

7.2.4 Reports

The reports page (Figure 7-8) will contain download links for all quarterly reports posted on the website. The name of the file and the date it was posted will be displayed.

7.2.5 Subscribe

The subscriber page (Figure 7-9) will be enable anyone to subscribe to the automated email notification service. The page has only a single field that requests the email of the user. An unsubscribe link also will be provided with email notifications.

7.2.6 Feedback

The feedback page (Figure 7-10) can be used by any visitor of the website to provide feedback about the website itself, the data presented or potential issues with air quality around the refinery. The page will generate an email that will be delivered to the designated system operator, who will respond to the email.

7.2.7 Learning Center

The Learning Center page (Figure 7-11) will provide links to various educational material and resources regarding the system. When a user clicks the 'Learning Center' link in the top navigation bar, the FAQ section of the learning center will be displayed by default. This section will contain a select list of questions that are deemed to be most popular among users. The list can also be periodically updated with questions received through user feedback.

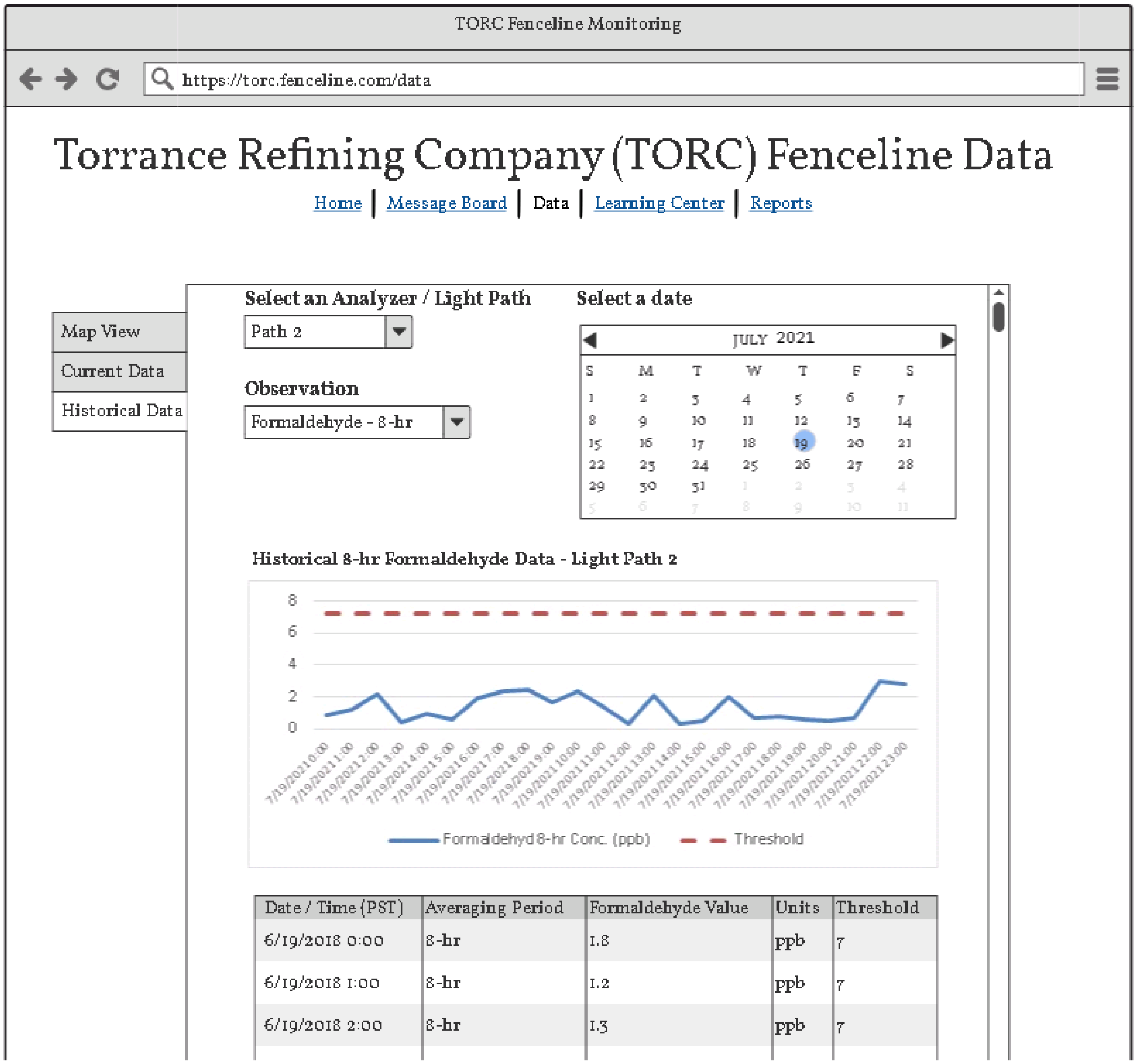

Figure 7-7: Screenshot #5: data presentation – historical trends

In addition to the FAQ section, the learning center will have sections addressing:

- Sensor Technology section that describes the different technologies used to measure different pollutant concentrations

  - For example, a description of the open-path and point analyzers and meterological sensors will be provided with illustrations and/or photos to explain their principles, function and limitations, with links to external websites for further information;
- Pollutants section, which describes the common sources of all measured pollutants as well as their effects on human health and the environment;
  - For example, a tabular summary of each of the Rule 1180 chemicals will be provided explaining what they are, where they come from, what they are used for by industry, and odor and color characteristics, etc.;
- Thresholds section which describes the metrics and thresholds used for each pollutant, their significance and how they are calculated;
  - For example, definitions of OEHHA RELs and EPA AEGLs will be provided with links to external websites for further information.
- Fenceline monitoring system description section that will describe how fenceline monitoring is conducted and how data is reported on the website;
- Monitor Locations section that describes the location of all monitors and how the measurement sites were selected.
  - For example, describing logistical and infrastructure requirements, path length limitations, coverage of fenceline perimeter, wind direction, proximity to structures and adjacent communities, etc. with links to CARB and EPA guidance documents.

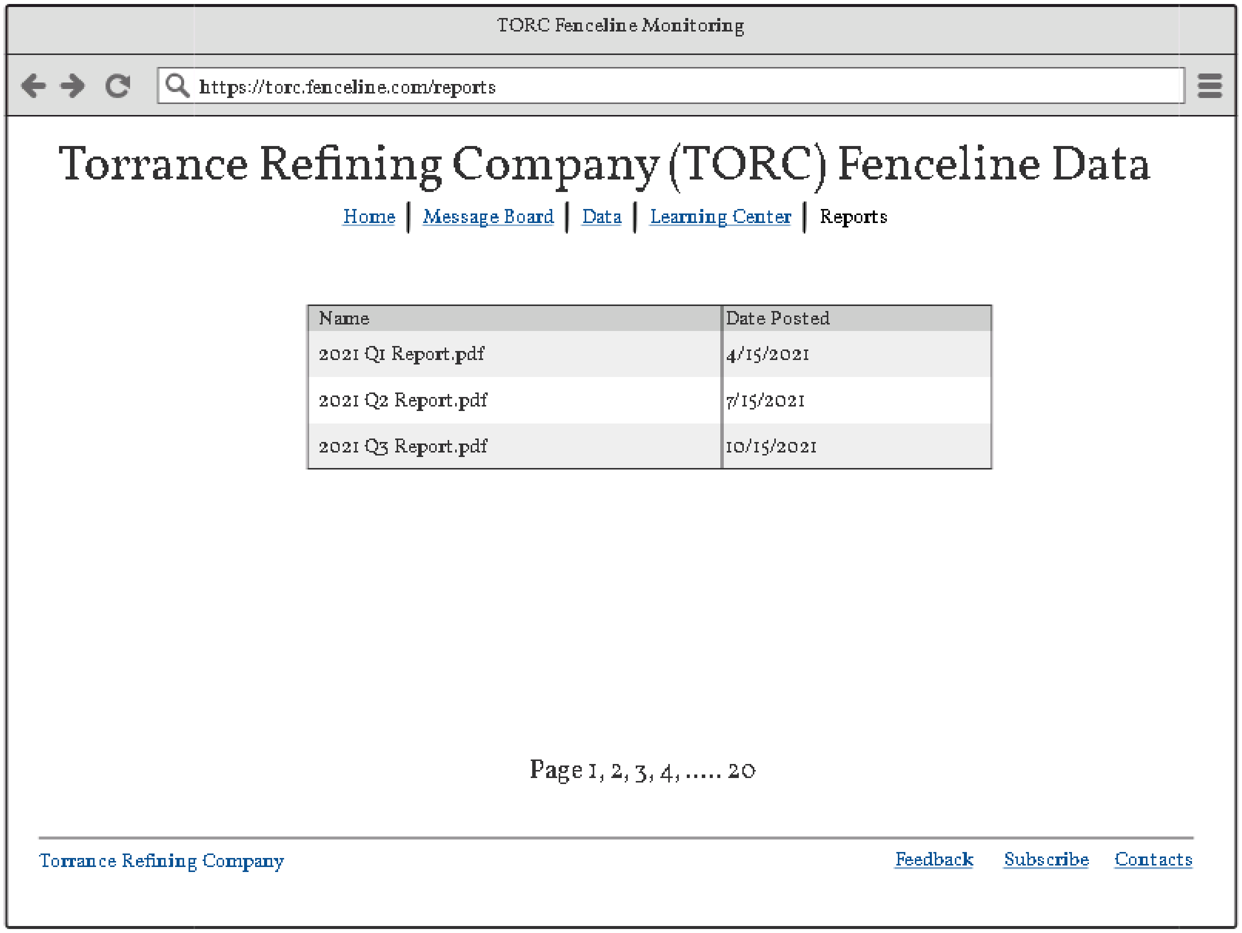

Figure 7-8: Screenshot #6: reports

- Air Quality Data section that describes how air quality data is managed in the website and how it is presented.
  - For example, this will describe the processes by which the data are recorded and stored, reviewed and checked for quality and processed for upload to the website;
- Website Instructions and Content Organization
  - Instructions and a site index for the website will be provided.
- Background Air Quality section that describes historical air quality trends and nearby sources of emissions beside the refinery.
  - For example, links to SCAQMD and CARB external websites providing current and historical air quality data and links to SCAQMD Rule 1180 resources and the Torrance community monitoring website will be provided.
- Terms and Definitions section which provides a glossary of terms and acronyms that some users may not be familiar with.
  - For example, definitions will be provided for technical terms such as units of measure, health-based air quality benchmarks, acute and chronic health effects, etc.

  - A list of acronyms used on the website will be provided.
- Additional Resources section with links to other websites where users can get even more information about air quality.

The 'Additional Resources' page (Figure 7-12) will contain links to websites with more information about air quality. At a minimum, the links shown in the screenshot above be included in this page.

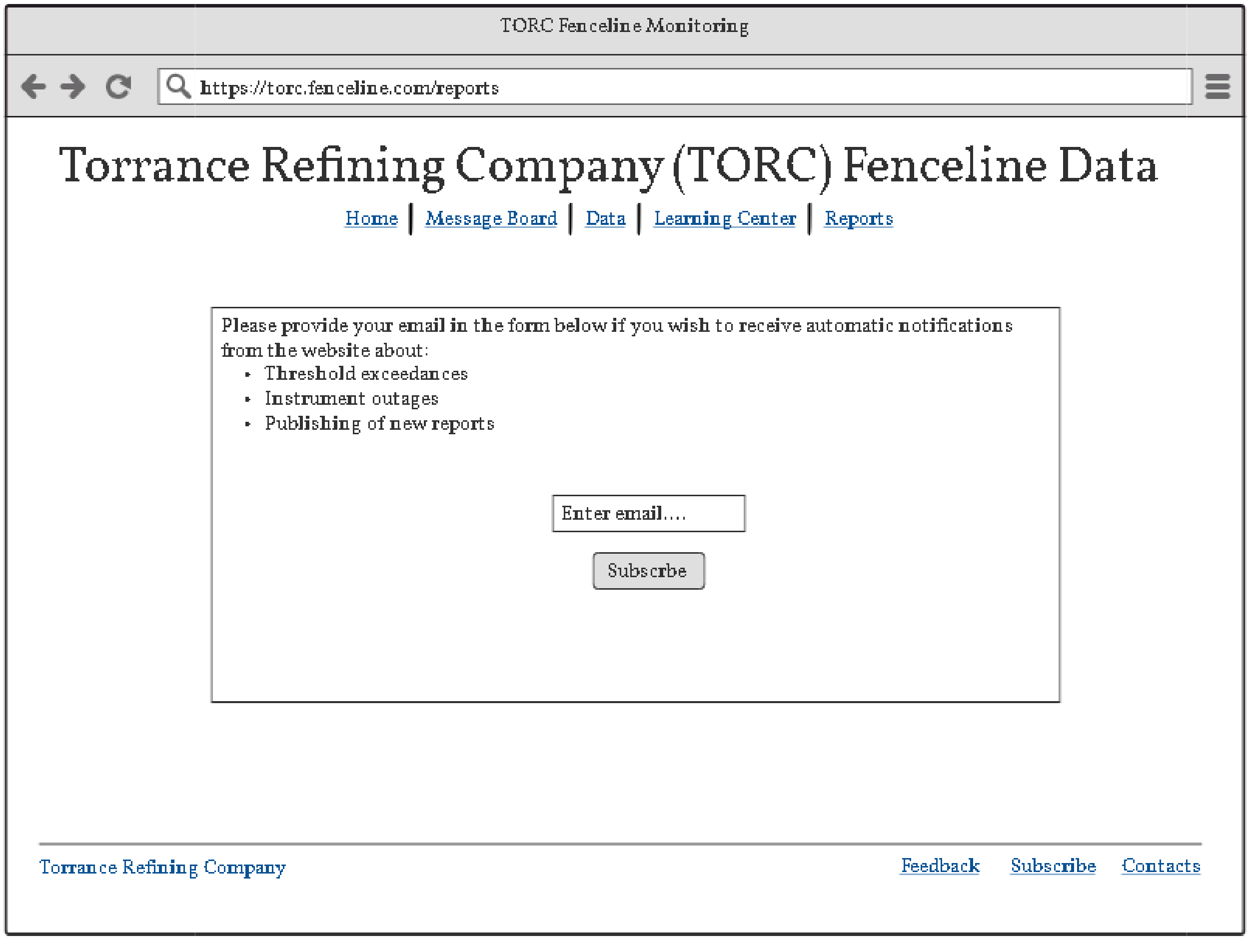

Figure 7-9: Screenshot #7: subscribe

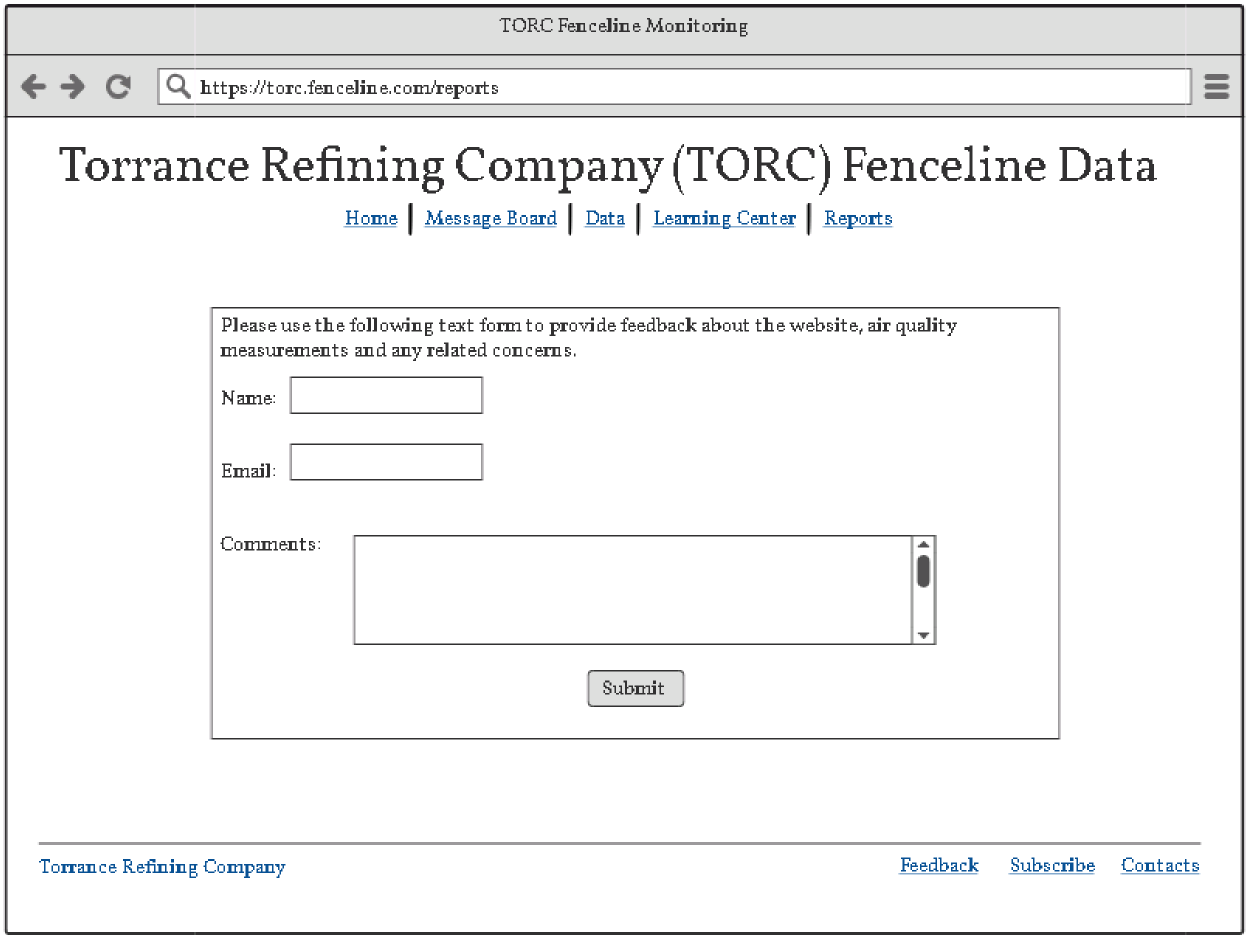

Figure 7-10: Screenshot #8: feedback

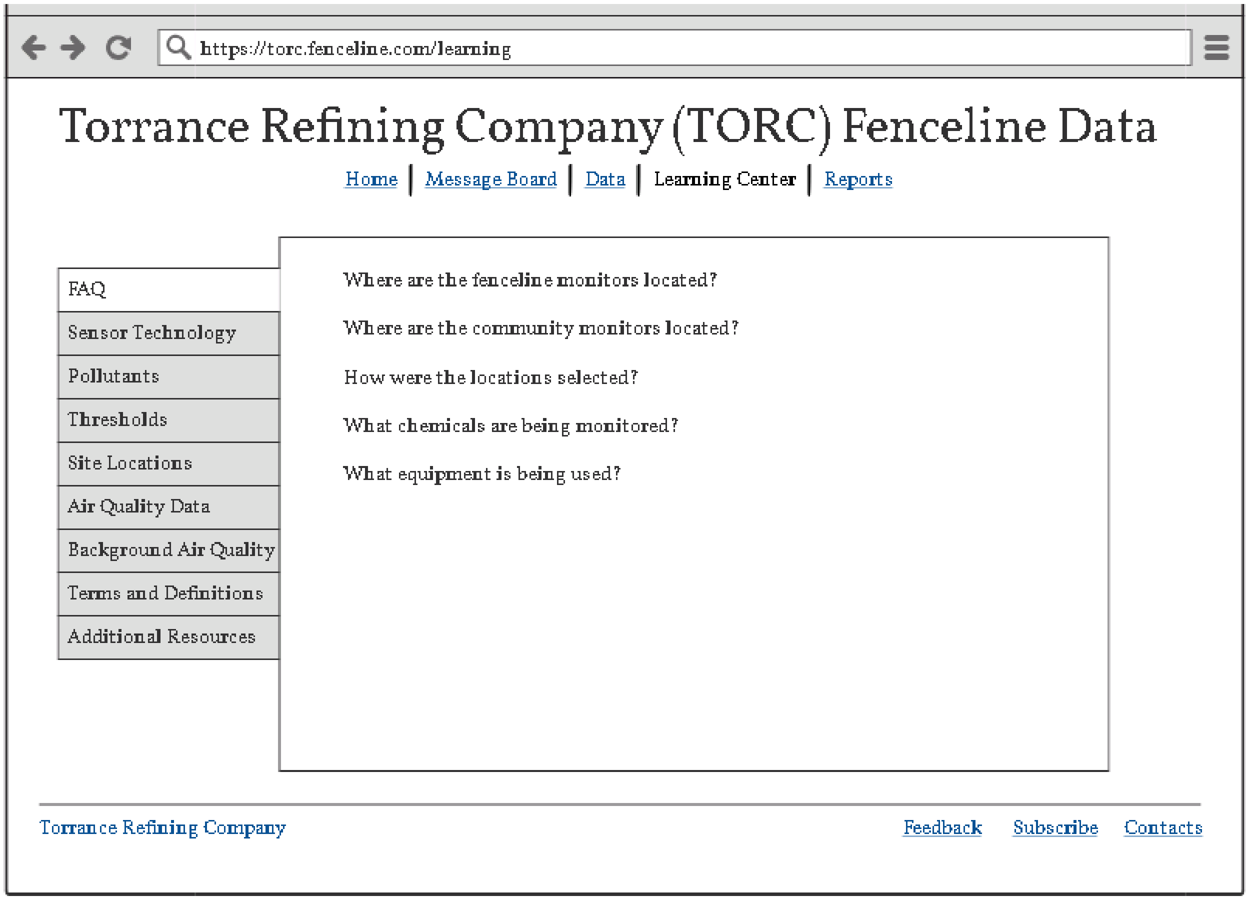

Figure 7-11: Screenshot #9: learning center – FAQ

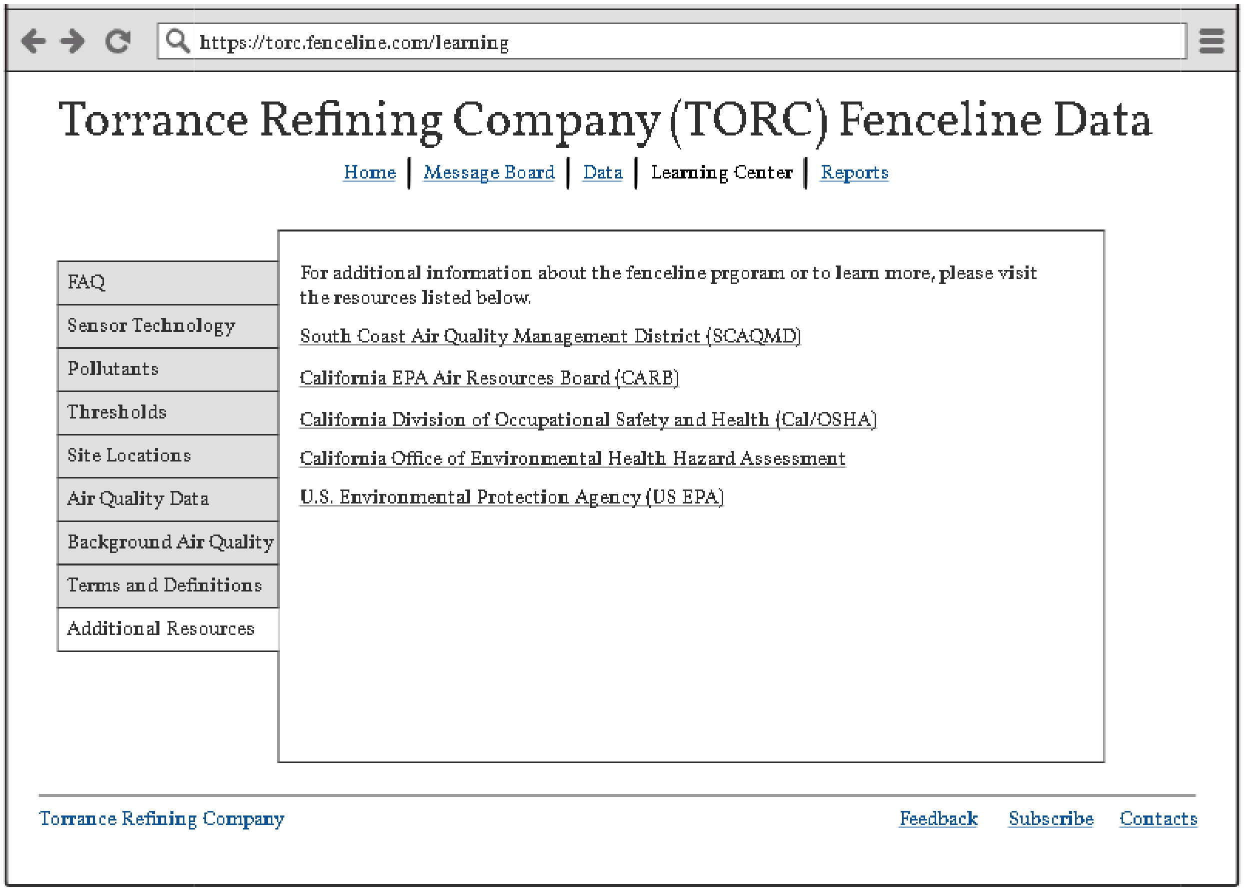

Figure 7-12: Screenshot #10: learning center – external resources

7.3 Data Presentation and Averaging

The purpose of the fenceline air monitoring system is to *"…provide air quality information to the public and local response agencies about levels of various criteria air pollutants, volatile organic compounds and other compounds at or near the property boundaries of petroleum refineries."* (at Rule 1180(a)) The Rule 1180 Guidelines also specify that the monitoring data *"…must be made available to the public in a relevant, useful and understandable manner…"* and *"…provided in a manner that the public can readily access and understand."*

To be relevant and useful, the monitoring data will be presented on the website in context with health-based air quality thresholds. This section describes the rationale for selecting the air quality thresholds, the significance of the selected thresholds as well as how the data presented on the website will be displayed and compared with these thresholds.

7.3.1 Health-Based Air Quality Thresholds

Various government agencies and scientific bodies developed health-based air quality standards and inhalation exposure thresholds to represent acceptable levels of air pollution that minimize the probability of harmful effects to human health. Examples of various thresholds include:

- National Ambient Air Quality Standards[83] (NAAQS) are federal standards established by the U.S. Environmental Protection Agency for six "criteria" air pollutants – carbon monoxide (CO), lead, nitrogen dioxide (NO_2), ozone (O_3), particulate matter (PM_{10} and $PM_{2.5}$) and sulfur dioxide (SO_2) - set at concentrations for which public health is adequately protected especially for "sensitive" populations such as asthmatics, children and the elderly;
- California Ambient Air Quality Standards[84] (CAAQS) are established by the California Air Resources Board for the six federal criteria pollutants plus visibility-reducing particles, sulfate, hydrogen sulfide and vinyl chloride;
- California Office of Environmental Hazard and Health Assessment (OEHHA) established inhalation reference exposure levels[85] (RELs) for a range of toxic air contaminants (TACs). OEHHA RELs are air concentrations or doses at or below which adverse non-cancer health effects are not expected even in the most sensitive of sensitive members of the general population. RELS are established for: acute (infrequent one-hour) exposures; repeated 8-hour exposures over a significant fraction of a lifetime such as may be experienced by workers; or chronic (continuous over a significant fraction of a lifetime) exposure;
- Acute Exposure Guideline Levels[86] (AEGLs) are published by the U.S. Environmental Protection Agency. AEGLs represent threshold exposure concentrations for use by emergency response planners applicable to the public for emergency exposures ranging from 10 minutes to 8 hours. AEGLs are associated with health effects that are: noticeable discomfort, irritation, or certain asymptomatic non-sensory effects that but that are not disabling and are transient and reversible (AEGL-1); irreversible or other serious, long-lasting adverse health effects or an impaired ability to escape (AEGL-2); or potentially life-threatening (AEGL-3);
- Emergency Response Planning Guidelines[87] (ERPGs) are published by the American Industrial Hygiene Association (AIHA). ERPGs represent concentrations for once in a lifetime exposure of the general population (but not particularly sensitive persons) for up to 1 hour associated with effects expected to be mild or transient (ERPG-1), irreversible or serious (ERPG-2), and potentially life-threatening (ERPG-3).

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[83] NAAQS Table, U.S. Environmental Protection Agency. See https://www.epa.gov/criteria-air-pollutants/naaqs-table (accessed July 2018).

[84] California Ambient Air Quality Standards (CAAQS). See https://www.arb.ca.gov/research/aaqs/caaqs/caaqs.htm (accessed July 2018).

[85] OEHHA Acute, 8-hour and Chronic Reference Exposure Level (REL) Summary. See https://oehha.ca.gov/air/general-info/oehha-acute-8-hour-and-chronic-reference-exposure-level-rel-summary (accessed July 2018).

[86] Compiled AEGL Values, U.S. Environmental Protection Agency. See https://www.epa.gov/sites/production/files/2016-03/documents/compiled_aegl_update_.pdf (accessed July 2018).

[87] Current ERPG® Values (2016). See https://www.aiha.org/get-involved/AIHAGuidelineFoundation/EmergencyResponsePlanningGuidelines/Documents/2016%20ERPG%20Table.pdf (accessed July 2018).

- Immediately Dangerous to Life and Health[88] (IDLH) levels are published by the U.S. National Institute for Occupational Safety and Health (NIOSH). IDLHs represent concentrations that are "likely to cause death or immediate or delayed permanent adverse health effects or prevent escape from such an environment."
- Protective Action Criteria[89] (PAC), formerly called Temporary Emergency Exposure Limits (TEELs) are published be the U.S. Department of Energy. PAC present AEGL and ERPG concentrations when available, and otherwise presents TEEL concentrations. TEELs are only intended for use until AEGLs or ERPGs are developed and adopted for general use.

In selecting appropriate thresholds for data presentation, we considered levels that would best inform the public regarding concentrations of concern, but not conflict with existing first responder and emergency action planning for the refinery. In general, we deferred to thresholds published by federal or state agencies. We also sought to avoid multiple notifications for the same event which could create confusion, cause users to disregard the high volume of emails or even cause panic. Some of the above threshold levels have concentrations of similar magnitude for several pollutants (e.g., 1-hour AEGL-1 and ERPG-1 concentrations) so it does not provide meaningfully different information to present both. AEGL-2, AEGL-3, ERPG-2, ERPG-3 and IDLH represent very high levels that would be associated with a public emergency, so these are not considered appropriate to present with the monitoring data because they could potentially interfere with first responder messaging and actions. These thresholds could be relevant for notifying first responder agencies.

OEEHA 1-hour 8-hour RELs represent very conservative (low) thresholds, concentrations at which only the most sensitive of sensitive persons might experience some symptoms. The 1-hour AEGL-1 threshold concentrations are similar to or lower than the 30-minute EPA AEGL thresholds. To ensure the data presentation is easily understandable, the 1-hour exposure AEGL-1 thresholds will be presented as indicators of more extreme fenceline concentration episodes.

The air quality thresholds that will be used for the fenceline air monitoring system data presentation and notifications are shown in Table 7-3. Monitoring events that reach the 1-hour REL and NAAQS thresholds represent some optimally low concentrations where certain population groups may experience some effects. The 1-hour AEGLs have concentration values that generally are an order of magnitude (or more) than the RELs and indicate events that may result in noticeable health effects by a larger population group. 1-hour and 8-hour OEEHA RELs and 1-hour AEGL-1 thresholds will be presented with the monitoring data and addressed in the subscriber notification system (see discussion of notification system later in this Section). Since the AEGLs are intended for emergency planning use, AEGL-1 thresholds also will serve as a basis for notifications to first responders.

The open-path analyzers will measure pollutant concentrations for five minutes (integrated average) on each of two paths, once every ten minutes. Therefore, each of these measurements will be presented in context with their respective 10-minute AEGLs.

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[88] Immediately Dangerous to Life or Health (IDLH) Values, Centers for Disease Control and Prevention. See https://www.cdc.gov/niosh/idlh/intridl4.html (accessed July 2018).

[89] Protective Action Criteria Database. See https://sp.eota.energy.gov/pac/Search (accessed July 2018).

Table 7-3: Health-based air quality standards and inhalation exposure thresholds for data presentation

Pollutants	**Health-based standards and inhalation exposure thresholds (converted to ppb or ppm, volume, for comparison purposes)**			
Rule 1180 CAP	**NAAQS 1-hr (ppb)**		**1-hr Acute REL (ppm)**	**1-hr AEGL-1 (ppm)**
Sulfur dioxide	75		0.25	0.20
Nitrogen oxides (NO+NO2 as NO2)	100		0.25	--
Rule 1180 VOCs	**Annual Chronic REL (ppb)**	**8-hr Worker REL (ppb)**	**1-hr Acute REL (ppm)**	**1-hr AEGL-1 (ppm)**
Total VOCs (NMHC)	--	--	--	--
Formaldehyde	7.2	7.2	0.044	0.90
Acetaldehyde	76	163	0.26	45
Acrolein	0.15	0.30	0.0011	0.030
1,3 Butadiene	0.89	4.0	0.29	670
Benzene	0.92	0.92	0.0083	52
Toluene	78	--	9.6	67
Ethylbenzene	450	--	--	33
Xylenes	160	--	5	130
Hydrogen cyanide	8.0	--	0.30	2.5
Rule 1180 Other	**Annual Chronic REL (ppb)**	**8-hr Worker REL (ppb)**	**1-hr Acute REL (ppm)**	**1-hr AEGL-1 (ppm)**
Hydrogen sulfide	7.0	--	0.030	0.51
Carbonyl sulfide	4.0	4.0	0.260	--
Ammonia	280	--	4.5	30
Black carbon	--	--	--	9 mg/m3 [90]
Hydrogen fluoride	17	--	0.29	1.0

[90] U.S. DOE Temporary Emergency Exposure Limits (TEELs) are only intended for use until AEGLs or ERPGs are developed.

7.3.2 Data Handling

Each OP-FTIR and OP-UVDOAS analyzer will serve two paths, alternately monitored for five minutes each. As a result, data for each path will be updated every ten minutes. The analyzer averages spectral data over several minutes for each single measurement. The measured concentrations for each path will be recorded in the database and used to generate the appropriate averages for comparison with the appropriate air quality thresholds.

Rolling averages will be used for comparison with all air quality thresholds except 10-minute AEGLs, which will be compared with individual (five-minute average) measurements. This means that updated one-hour and eight-hour average concentrations will be generated every five or ten minutes and the latest average will always include the latest five-minute reading as well as past five-minute concentrations up to the required period of time that corresponds to the threshold. For example, if new records are generated every ten minutes, one can generate 144 one-hour and 144 eight-hour averages for a single day (24 hours).

7.4 Notification System

A section of the server will be used to track all data and based on specified rules send automated notifications to subscribers of the website. Automated notifications will be sent when the following conditions are met:

- Thresholds for a specific pollutant are exceeded.
- Internet outages, signal or visibility problems.
- Planned or unplanned maintenance activities that require the instruments to be offline.

7.4.1 Threshold Exceedance Notifications

The fenceline air monitoring notification system will be developed following SCAQMD approval of this plan during monitoring system implementation. The discussion below presents a preliminary conceptual approach for the notification system. Certain aspects of the notification system may change as the design evolves during implementation and after the system is operational based on subscriber feedback.

Email notifications will be sent to subscribers when a pollutant fenceline concentration exceeds the 1-hour NAAQS, 1-hour or 8-hour RELs or 1-hour AEGLs. The logic and wording of the notifications will be carefully developed to provide clear and understandable information. The exceedance notification thresholds will be sent based on real-time data that has passed only automated data QA/QC. All data exceeding a threshold will be qualified as preliminary subject to manual QA/QC review for quarterly reports.

A tiered notification system based on increasing pollutant concentrations will be developed (Table 6). Tiers 1, 2 and 3 notifications will be sent to all subscribers. Chronic REL exposure thresholds with averaging periods of one year will be addressed only in the quarterly reports.

Table 7-4: The different tiers of notifications and their respective averaging periods

Threshold Averaging Period	Type of Notification
1-hour average AEGL-1[91]	Tier 3 message, subscriber notification
8-hour average REL (worker)	Tier 2 message, subscriber notification
1-hour average REL	Tier 1 message, subscriber notification
Chronic (annual average) REL	Discussed in quarterly reports only

The notification messages for each tier will be sent to all subscribers. The message will contain a tailored explanation of the pollutant(s) and thresholds are involved, which paths are involved, the affected areas downwind of the affected path(s), background (upwind fenceline) concentrations, and the threshold definition. The message algorithm will be based on the fenceline air monitor data, meteorological station data, downwind land use and other information to combine with pre-defined message scripts (Figure 7-3). If a relevant data feed from SCAQMD's community monitors is available, the message also will direct subscribers to the nearest community monitor(s) and provide local concentrations at that time.

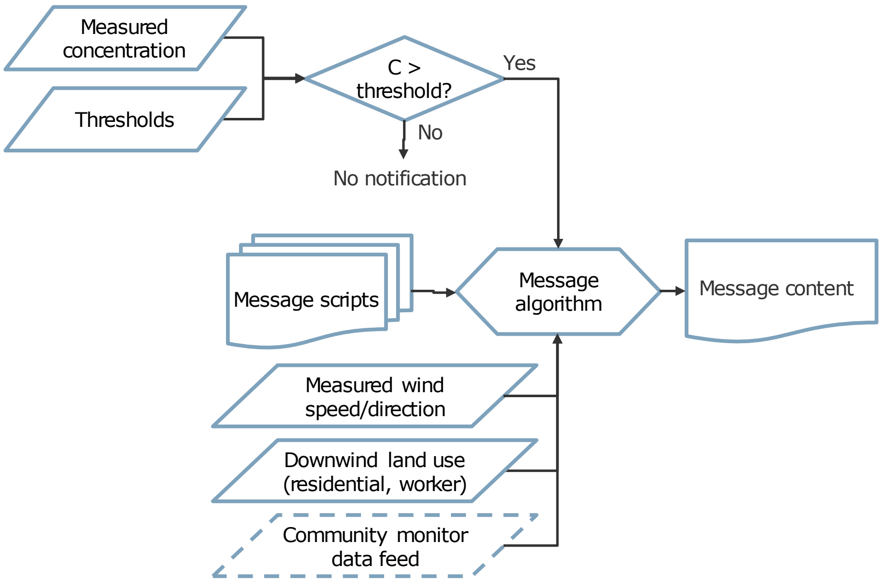


Figure 7-13: Conceptual approach for threshold exceedance message generation

To summarize, along with the definition of the air quality threshold, the exceedance notifications will contain the following information:

- Pollutant name and threshold
- Message content customized for threshold, wind direction, land use
- Refer to community monitors for local conditions
- If community monitor feed available, report conditions at nearest monitor

[91] May be above analyzer range depending on instrument performance during an event.

- Context
- Threshold definition
- Wind direction
- Background and/or upwind concentrations

7.4.2 Maintenance and Instrument Outage Notifications

Whenever any of the air quality measurement instruments or met station is taken offline for maintenance or any other reason, a message will be sent to website subscribers with the following content:

- Instrument name, location and identifications
- Pollutants and/or parameters measured
- Date and time when the instrument was deactivated
- Date and time when the instrument is expected to be reactivated

In addition to the notification generated by the website designated TORC personnel will directly notify SCAQMD if the scenarios outlined in the table below occur.

Table 7-5: Instrument outage scenarios and corresponding actions required by Rule 1180 Guidelines

Scenario	Action
48 hours prior to planned instrument outages	Phone call to 1-800-CUT-SMOG
Within 2 hours of discovering that an instrument failed to accurately provide real-time air monitoring information	Phone call to 1-800-CUT-SMOG
Within 24 hours of discovering that an instrument failed to accurately provide real-time air monitoring information for 24 hours or longer	Written notification to the Executive Officer and undertake temporary air monitoring measures
Failure to accurately provide real-time air monitoring information for more than 30 days	Revise and re-submit fenceline air monitoring plan

7.4.3 Periodic Report Availability Notifications

A notification will be sent to website subscribers whenever periodic reports are posted to the website. The notification message will have the following contents:

- Name of the report
- Range of dates that the report examines
- Hyperlink to the report

7.5 Reports

On a quarterly basis TORC personnel will review data from the website and generate detailed reports on the air quality, threshold exceedances, data quality and completeness. Furthermore, more detailed QA/QC will be performed on the refined data and appropriate corrective actions will be taken where applicable. These reports will be compiled in a pdf format and posted on the public website.

The following will be considered in preparing these reports:

- Instrument maintenance records
- Calibration and test records
- Air quality measurements near the refinery performed by third parties or government agencies
- Automatically generated QA flags and necessary corrections
- Prolonged instrument outages and data completeness
- Long term chronic exposure threshold exceedances
- Comparisons with recent historical data and community air quality data (if available)
- Summary of meteorological conditions

Table 7-6: Sample Table of Contents for the periodic fenceline air monitoring reports

Report Section	Explanation
Summary	Short summary of the period under consideration
Air Quality Threshold Exceedances Short term thresholds Long term thresholds Comparison with previous reporting period	A list of all exceedances along with potential causes and explanations
Instrument outages Planned Unplanned	Summary of instrument outages and the times when they occurred
Calibration Records	A list of all calibrations performed
Data Quality Automatic QA and corrections Manual QA and corrections	List of all data corrections whether automatic or manual.
Community air quality monitoring data (if available)	Comparison of community air quality data with fenceline data
Summary of fenceline air quality data	Summary charts of all air quality metrics for all pollutants
Summary of meteorological data	Summary charts of wind speed and direction

8. PUBLIC OUTREACH PROGRAM

The Guidelines state the Plan should address the following elements related to public outreach:

- *Designing an effective public outreach program (e.g., informational meetings, workshops, etc.) that informs the public about the health impacts associated with emissions levels detected by the fenceline air monitoring system and informs decision related to reducing community exposure*;
- *Identifying designated personnel to address SCAQMD's and public questions about fenceline monitoring equipment and readings*;
- *Promoting access to and awareness of the measurements and use of the real-time air pollution data through an active outreach and education program*; and
- *Make the data provided in this outreach as accessible as possible*.

The public outreach efforts discussed in this section of the Plan will help the public to understand the fenceline air monitoring system and monitoring results, and provide the public with a means of providing feedback regarding the system and monitoring results.

8.1 Public Outreach Overview

The outreach program will consist of the following key elements:

- Identify stakeholders;
- Develop written communications;
- Develop website;
- Host public meetings;
- Identify communications avenues; and
- Designate personnel.

8.1.1 Identify Stakeholders

The key stakeholders in the TORC fenceline air monitoring systems include residential and business neighbors, educators, emergency responders, educators, health care professionals, neighborhood association representatives, public officials, and others with an interest in refinery operations, as well as Company representatives. TORC currently conducts a robust community outreach program that engages stakeholders regarding refinery developments, emergency planning and response to public concerns. The fenceline air monitoring system outreach program will build on the existing stakeholder network.

8.2 Develop Written Communications

The guidelines state the following requirements for the data and information generated by the fenceline air monitoring system (addressed primarily by the website discussed in Section 7 of this Plan):

- *Developing multiple communication venues to ensure widespread access to environmental information and to appeal to the various communication preferences (e.g., text messages, email, website, etc.) among the end users*;

- *Developing contextual material to assist interpretation and understanding of the real-time data and its limitations*;
- *[Data]…provided in a manner that the public can readily access and understand. Websites for all refineries should be designed in a user-friendly format*.
- *…use data visualization tools to graphically depict information using maps and time series plots of measured pollutants and wind data*.
- *Provide context to this complex data set for the public by including information regarding the species measured and the measurement techniques, discussion of levels of concern for each measured species, typical background levels, potential non-refinery sources that could contribute to measured concentrations, and definition of data QC flags*.
- *Write data presentations at a public-friendly level with clarity and thoroughness and with links provided to additional sources of information*.
- *Include details via the website of how the public can report experiences and provide comments and feedback for improvement of the website and other data dissemination tools, and the fenceline monitoring activities in general*.

TORC will develop a variety of fixed and on-going written communications for publication via the website and other communications avenues. This will include the Learning Center elements discussed in Section 7 of this Plan, informational text for the website, and a frequently-asked-questions (FAQ) list of common questions and answers. Written communications will be developed to be understandable, clear and relevant to both technical and non-technical users.

8.3 Develop Website Resources

TORC will develop a list of informational and educational resources available via links provided on the public website. This will include:

- Links to U.S. Environmental Protection Agency, California Air Resources Board and other websites regarding ambient air quality standards, health effects of human exposure to Rule 1180 pollutants.
- Links to emergency response planning resources (e.g., link to City of Torrance and TORC websites) also will be provided.
- Links to City of Torrance emergency preparedness and first responder sites.

8.4 Public Meetings

TORC will participate in public meetings to establish communications with public stakeholders and provide information regarding the fenceline air monitoring system. Three meetings are envisioned for the initial roll-out of the system:

- TORC will participate in an initial public meeting organized in coordination with SCAQMD's planned Rule 1180 community monitoring system outreach program, expected during the third or fourth quarter of 2018. TORC will provide information regarding key elements of the planned fenceline air monitoring system such as the air pollutants that will be monitored, health impacts of the monitored pollutants and health-based thresholds, the monitoring technologies, the locations of the monitors, and plans for the public website and notification system.

- Approximately two to three months before TORC's fenceline air monitoring system goes live, TORC will organize a public meeting to provide a project update to highlight the resources and information that will be made available to the public. TORC will provide a summary of feedback received during the meeting to SCAQMD;
- Approximately three to six months after the fenceline air monitoring system goes live, TORC will organize a public meeting to provide an update on the fenceline air monitoring system and to solicit feedback from the public on the system. TORC will provide a summary of feedback received during the meeting to SCAQMD.

The information provided at the public meeting will be designed to be clear, concise and relevant. Materials provided by TORC for the public meetings may include information specific to the fenceline air monitoring systems such as an overview of the monitoring technology, data quality assurance, website instructions, project timeline, TORC and SCAQMD contact information and other pertinent information.

Notifications for public meetings will be provided via the TORC website, notices in local newspapers, stakeholder websites, and other avenues to inform Torrance community members of upcoming meetings. Notifications for public meetings organized by TORC will be provided in advance of each meeting.

8.5 Communications Avenues

Multiple communications avenues will be developed for engaging the Torrance community stakeholders. Communications avenues will include:

- For those with internet access, written communications will be made available via the website (including availability of materials announced via the message board and subscriber notification systems) described in Section 7 of this Plan.
- For those without internet access, hard copies of written communications may be made available at the City of Torrance public library. Written communications may also be made available upon request in writing or by calling the Torrance Refinery Community Relations Department.

8.6 Designated Personnel

A TORC representative will be designated as the point of contact to receive questions and comments from the public about the fenceline air monitoring system. Contact information will be provided on the website. Subject matter experts also will be identified for the fenceline air monitoring equipment, meteorological equipment, website administration and data quality assurance. The designated representative will direct questions to the appropriate subject matter expert. Questions and comments received via telephone will be entered into the website messaging system to track questions and responses and assure timely follow-up.

9. QUALITY ASSURANCE PROJECT PLAN

The quality assurance project plan addresses the following requirements specified in Rule 1180 and the Guidelines:

- *"The air monitoring plan shall address quality assurance, including training of personnel, development and maintenance of proper documentation [i.e., instrument manuals, Standard Operating Procedures (SOP), and a Quality Assurance Project Plan (QAPP)], routine maintenance and calibration checks, technical audits, data verification and validation, and data quality assessment."* (R1180 Guidelines Section 4.)
- *"A QAPP for each refinery fenceline monitoring project must be developed that outlines the QA/QC plan, following U.S.EPA guidelines[92]."* (R1180 Guidelines Section 4.)
- *"The QAPP should provide clear definitions and procedures for QA/QC that are necessary to indicate why some data may be missing, suspect, or invalid."* (R1180 Guidelines Section 4.)
- *"The critical functions to be addressed in the QAPP are summarized below:*
  - *Project background and management: The QAPP should provide background information and define the problem(s) to be addressed and the general goals of the fenceline and community monitoring, and describe project organization, quality objectives and acceptance criteria for measurement data, and plans for documentation, record keeping, and data dissemination.*
  - *Technical Approach: The QAPP should demonstrate that the appropriate approaches and methodologies are employed for performing measurements, data handling, and quality control are selected and address the design and implementation of the measurement systems.*
  - *Assessment/Oversight: The QAPP should offer appropriate QA/QC steps for ensuring the effectiveness of the monitoring plan covering experimental design, representativeness of the data, instrument operation and data acquisition, calibration check procedures, data quality indicators, independent systems and performance audits, and peer-review.*
  - *Data Validation and Usability: The QAPP should describe what steps will be taken to ensure that the individual data elements conform to the criteria specified in the monitoring plans."* (R1180 Guidelines Section 4.)
- *"Demonstration of independent oversight"* (Rule 1180 Guidelines Section 1.)
- *"…operation & maintenance of a fenceline air monitoring system."* (Rule 1180 Guidelines Section 1.)
- *"Procedures for implementing quality assurance and quality control of data;"* (Rule 1180 Guidelines Section 1.)
- *"Develop a Quality Assurance Project Plan (QAPP) that describes the following*:

[92] *Guidance for Quality Assurance Project Plans*, U.S. Environmental Protection Agency, Washington, D.C., December 2002, EPA/240/R-02/009. See https://www.epa.gov/sites/production/files/2015-06/documents/g5-final.pdf (accessed July 2018)

- *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."* (Guidelines Section 2, Fenceline Air Monitoring Plan Checklist.)

In addition, Section 7 of this Plan addresses automated data handling procedures to assure data quality control.

9.1 Quality Assurance Project Plan Elements

A draft QAPP (provided in Volume II) was prepared in accordance with the Guidelines.[93] The draft QAPP provides procedures and criteria for screening data, performing maintenance, and define accountability for ensuring that all instrumentation is maintained in good, working order.

The QAPP addresses the following elements:

- Background, location, and monitoring operations
- Identify key personnel responsible for operation
- Discuss goals and challenges of the program
- Monitor layout, and equipment to be used
- List data quality objectives, and criteria for screening data
- Define checks for continuous, automated screening
- Data validation checks
- List routine maintenance activities and instrument checks
- Appropriate actions if a quality check is failed
- Record keeping requirements
- The technical approach to collecting data
- An overview of how data is distributed to all parties, and the public

The draft QAPP is designed to ensure quality data collection, and to instruct all parties on proper quality control procedures. The draft QAPP has certain elements that have not yet been determined, such as specific names of persons and organizations, manufacturer-specific operating procedures and preventative maintenance activities, etc. These elements will be determined after the specific instruments and system manager contractors have been selected during implementation following the Rule 1180 Fenceline Air Monitoring Plan approval by SCAQMD. The QAPP is a living document that will be updated during implementation and thereafter as needed to meet quality objectives. During implementation, the QAPP will be updated to provide instrument-specific information, organizational information, standard operating procedures, instrument manuals and other details.

[93] *Volume II - Quality Assurance Project Plan, Torrance Refinery Rule 1180 Fenceline Air Monitoring System*, Revision 0.1, prepared for Torrance Refining Company, Ramboll US Corporation, Irvine, California, July 27, 2018.

10. IMPLEMENTATION PLAN

Rule 1180 and associated Guidelines identify the following Plan requirements concerning implementation of the fenceline air monitoring system:

- *"Procedures for implementing the fenceline air monitoring plan, including, information pertaining to the installation, operation, maintenance, and quality assurance, for the fenceline air monitoring system;"*
- *"Beginning no later than one year after a fenceline air monitoring plan is approved by the Executive Officer, the owner or operator of a petroleum refinery shall complete installation and begin operation of a real-time fenceline air monitoring system in accordance with the approved fenceline air monitoring plan;"*
- *"The air monitoring plan shall include detailed information for…an implementation schedule consistent with the requirements of Rule 1180;"*
- *"…a fenceline air monitoring plan must provide detailed information about the installation, operation and maintenance of a fenceline air monitoring system."*

This section of the Plan provides a plan and preliminary procurement/installation schedule for implementing the fenceline air monitoring system at TORC, addressing the requirements of the Rule and Guidelines as shown above. See also Section 9 of this Plan for information regarding operation, maintenance and quality assurance.

10.1 Implementation Approach

The overall approach for implementing the Rule 1180 fenceline air monitoring system at TORC consists of the following phases (Figure 10-1):

- Plan: develop Rule 1180 Plan and conceptual engineering (locations, shelter layouts, weight, utilities, equipment specifications & supplier alternatives); and
- Review: Review of the Rule 1180 Plan by SCAQMD and any revisions needed before approval;
- Implement: detailed engineering, equipment procurement, system installation and start-up/commissioning; and
- Operate: operation of the fenceline air monitoring system in accordance with the approved Rule 1180 Plan.

The discussion in this section of the Plan will focus on the Implement phase, here meaning design, procurement and installation of the fenceline air monitoring system. See also Section 8 for information regarding public outreach activities during implementation.

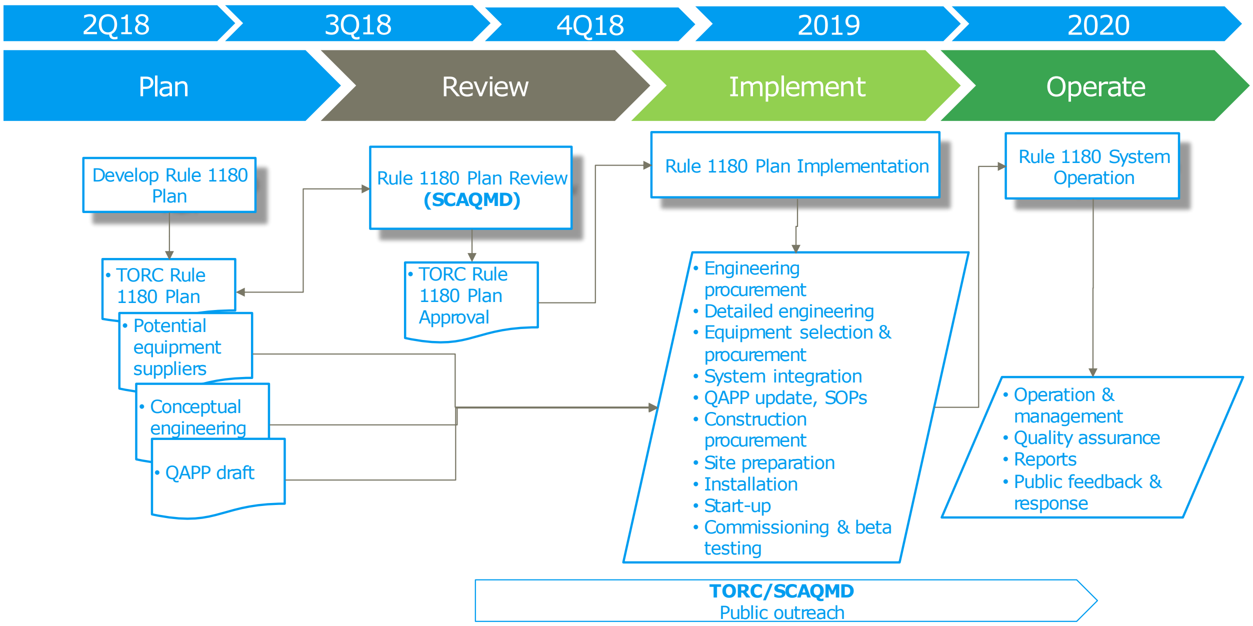


Figure 10-1: Overview of fenceline air monitoring system implementation

10.2 Implementation

A preliminary overall schedule for implementation will require approximately 12 months after SCAQMD Plan approval to produce an operational system (Figure 10-2). The sequence of activities and dates shown in Figure 10-2 are intended for illustrative purposes and may change as the detailed engineering design for the system develops. To assure completion on schedule, some activities may be initiated before the Rule 1180 Plan is approved such as project management and detailed engineering contractor support. Once SCAQMD approves the Plan, procurement of long-lead equipment items (OP-FTIR and OP-UVDOAS instruments, ancillary equipment, etc.), system integration design and detailed engineering will be initiated. If SCAQMD Plan approval is received by early December 2018, orders for long-lead items will be placed in 1Q2019, with delivery to the system integration contractor expected within 12 weeks after placing orders.

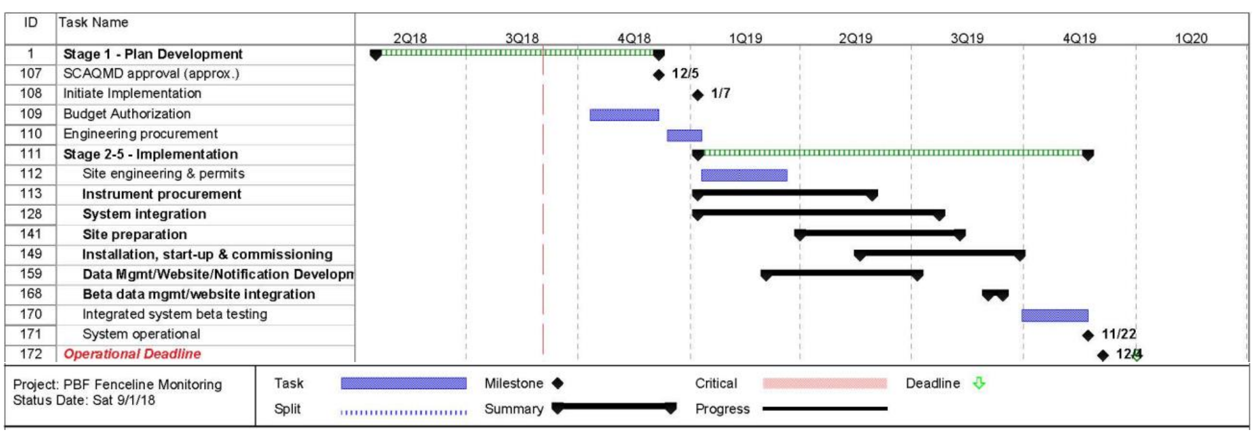


Figure 10-2: Preliminary implementation schedule for fenceline air monitoring system

The monitoring equipment will be installed into shop-assembled modules and completely checked out prior to delivery to the refinery site. The integration contractor will procure pre-fabricated shelters, install the monitoring equipment and ancillary equipment in the shelters at the integration contractor's shop, complete all electrical and instrument wiring and perform operational checks to assure all systems function properly. A factory acceptance test will be performed once the systems are operating properly. Following resolution of any test issues and successful completion of a factory acceptance test, the shop-assembled equipment modules will be shipped and delivered to TORC in early 3Q2019.

Detailed engineering of site preparations (foundations, structures, electrical utilities, etc.) and other items will be conducted in 1Q2019 in parallel with lead item procurement. Physical site preparations (excavations, steel and concrete for foundations, fabrication and installation of structures for equipment modules and the meteorological station tower, electrical conduit and wiring, etc.) will require approximately three to four months after the design is completed, commencing in 2Q2019 with completion in 3Q2019. Installation of the equipment modules including physical installation on foundations and structures, completion of electrical work, start-up and commissioning would be initiated in 3Q2019 with completion after delivery of the equipment modules in 3Q2019.

Development of the data management, website and notification system will commence soon after Plan approval by SCAQMD. The design and beta system will be developed with completion planned in 2Q2019. The integration with live instrument signals will proceed in parallel with start-up and commissioning activities. Up to eight weeks of beta testing will proceed following system commissioning starting in 3Q2019 with completion planned in early 4Q2019 within 12 months after SCAQMD approval.

Once the system enters the operational phase, the system will be operated in accordance with the QAPP (see Section 9 of this Plan). The QAPP will be updated during implementation to include information and SOPs specific to the instruments selected. The operation and performance of the system will be closely monitored in the initial year of operation to detect and correct any performance anomalies, respond to public feedback regarding the public-facing aspects of the system and ensure that the system continues to provide reliable, high quality data.

APPENDIX A
MODELLED RULE 1180 CHEMICAL CONCENTRATIONS

APPENDIX B
EQUIPMENT SPECIFICATIONS FOR EXAMPLE MET ONE WEATHER STATION

Met One Instruments, Inc.

AIR QUALITY WEATHER STATION

Overview

Met One Instruments, Inc.'s Air Quality Weather Stations are specifically designed to comply with Evironmental Protection Agency (EPA) and Nuclear Regulatory Commission (NRC) guidelines for air quality and regulatory meteorological monitoring. Stations are available in pre-packaged configurations for fastest delivery, and easily customized with additional sensors and accessories to suit the requirements of any specific application.

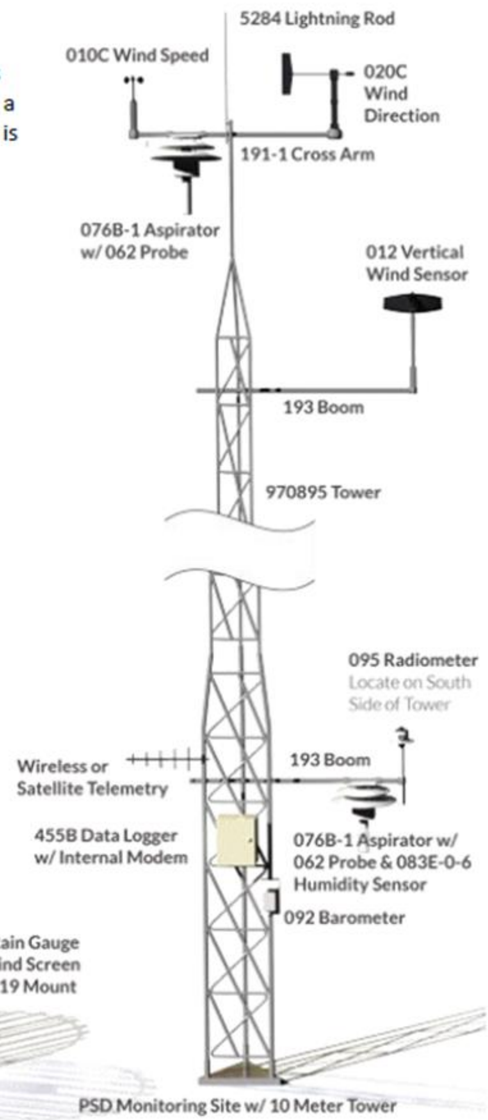
The Air Quality Weather Station includes the highest quality meteorological sensors, all required signal cables and mounting hardware, a 10 meter tilt over tower, and a data acquisition system or signal translator. The system is can be powered by AC or DC power, or an optional solar panel power system.

Measurements

- Wind speed
- Wind direction
- Ambient temperature
- Relative humidity
- Barometric pressure
- Rain (option)
- Solar radiation (option)
- 2 level delta temperature (option)

Benefits and features

- Pre-configured systems for quick shipment
- Fully customizable upon request
- EPA/NRC compliant sensors and system design
- Low power draw from AC, DC or solar supply
- 10 meter tilt over tower.
- Ethernet, serial RS-232/RS-485/MODBUS and analog 0-1V/0-5V/4-20mA output options.



1600 NW Washington Blvd., Grants Pass, OR 97526
www.metone.com

+1.541.471.7111
sales@metone.com

Met One Instruments, Inc.

PERFORMANCE SPECIFICATIONS:

010C/020C wind speed and direction sensors:

- Wind speed range: 0 to 125 mph
- Wind speed accuracy: ±1% of reading, or ±0.15 mph whichever is greater.
- Wind direction range: 0° to 360°
- Wind direction accuracy: ±3°
- Starting threshold: 0.4 m/s (0.9 mph)

597 temperature/humidity/pressure sensor

Temperature
- Element: platinum RTD class 1/3B
- Range: -50°C to +70°C (-58°F to 158°F)
- Accuracy: ±0.10°C (0.18°F) @25°C
- Resolution: 0.01°C

Relative humidity
- Element: thin film polymer capacitor
- Range: 0 to 100% RH
- Accuracy: ±0.8% from 0 to 100% RH
- Resolution: 0.1%

Barometric pressure

- Element: solid state transducer
- Range: 500 to 1100 hPa
- Accuracy: ±0.30 hPa (+25°C)

370 rain gauge (option)

- Element: magnetic reed switch
- Orifice: 8.0-in (20.3 cm) diameter
- Accuracy: ±1% @ 3.0-in per hr
- Resolution: 0.01-in standard (0.2 mm or 0.25 mm optional)

096 solar radiation sensor (option)

- Response: 400-1100 nanometers
- Sensitivity: 8mV/KWatt/m2 with 100ohm load, approx.
- Linearity: 1% from 0-3000 W/m2

970895 10M Tower

- 10M EPA compliant measurement height.
- Tilt over design for easy sensor access.
- Rated for 110mph winds
- Includes in ground base. Roof mount base available.

131WP MultiMet Translator:

- Provides 0-1V or 0-5V outputs for easy connection to industry standard air quality monitors or data loggers.

580 AutoMet Data Logger (Option):

- Simple user interface
- 16 recorded channels of measured and calculated values.
- Flexible I/O built in:
  - USB serial
  - RS-232 serial
  - MODBUS RS-485
  - Ethernet
  - 12 CH analog outputs
- Real time cloud data viewing and retrieval when paired with optional cell modem.
- AIR PLUS data logger support software provides simple remote data retrieval, viewing, and exporting.

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Met One Instruments, Inc.

MODEL 6400 ALL ENVIRONMENT VISIBILITY SENSOR

Features:

- HIGH ACCURACY
- PROVEN OPTICAL TECHNOLOGY
- DIGITAL AND RELAY OUTPUTS
- SELECTABLE RELAY THRESHOLDS
- COMPACT, LIGHTWEIGHT DESIGN
- CORROSION RESISTANCE
- METEOROLOGICAL OPTICAL RANGE (MOR)

The Met One Instruments Model 6400 Visibility Sensor is designed to monitor visibility conditions over a range of 20ft-50miles (6m-80km). The Model 6400 includes both digital and relay outputs. Digital RS232 output at 300-38,400 Baud can be used to indicate the present visibility, provide diagnostic information, and provide access to the configuration and calibration options. The SPDT relay with configurable pull in and drop out set points can provide signals to a VMS or other optional user system.

Met One takes advantage of Belfort's proven experience with visibility technology in re-designing this new sensor for applications which require high accuracy over an extended range of visibility. These sensors are designed to provide both accuracy and reliability in a cost-effective package. The Model 6400 now features ease of field serviceability. Applications include synoptic stations, lighthouses, highways, resort areas, as well as shipboard and other marine platforms.

Visibility is detected using widely accepted principles of forward scattering. A high output infrared LED transmitter projects light into a sample volume and light scattered in a forward direction is collected by the receiver. The light source is modulated to provide excellent rejection of background noise and natural variations in background light intensity. The sensors can asynchronously stream RS232 visibility data at user configured intervals, or can be operated in the polled mode, outputting information only when asked. Visibility is also compared to the preset relay thresholds, so that when an alarm condition is reached, the relay output is switched. Visibility thresholds can be set to any value within the instrument range.

These sensors are assembled around a compact, light-weight housing, which can be installed on a

Met One Instruments, Inc.

simple pipe mast. They are constructed entirely of corrosion resistant materials for durability. The standard unit includes small heaters to prevent condensation on the optics. Optional hood heaters are available for areas where the sensor will operate in freezing weather. Transmitter and receiver hoods are designed to divert precipitation away from the optical paths. A calibration kit is available for field calibration. Calibration is possible under most weather conditions. Belfort Visibility Sensors have earned a leading reputation with the world's foremost meteorological and transportation organizations. The Model 6400 Sensor continues this quality tradition at a more favorable cost.

SPECIFICATIONS

Range	20 ft. to 50 miles (6m to 80km)
Accuracy	±10%
Scatter Angle	42° nominal
Light Source	Infrared LED
Outputs	RS-232C, 300 to 38,400 baud
	SPDT Relay
Environmental	-40° to 130° F (-40° to +55° C)
	0 to 100% Humidity
Power Requirement	+12 VDC 500 ma 6 watts
with Hood Heater	30 watts
Dimensions	38" w x 13" h x 16" d
Weight	17.5 lbs. (7.9 kg)
Ingress Protection	IP66 (pending)

STANDARD FEATURES

- Meteorological Optical Range (MOR)
- Uses proven optical geometry
- U-bolt mounting for ease of installation (1½" to 3½")
- 12 VDC
- Low power consumption
- User configurable relay output

OPTIONS

- Calibration Kit (P/N 93001)
- Hood Heaters (Configurable)
- Analog Output (Configurable)

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