BAAQMD Rule 12-15 Proposed Air Monitoring Plan

Phillips 66 Rodeo Refinery

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List of Acronyms

BAAQMD – Bay Area Air Quality Management District

BTEX – Benzene, Toluene, Ethylbenzene, Xylenes

FTIR – Fourier Transform Infrared Spectroscopy

H_2S – Hydrogen Sulfide

Organic Gas Detectors (OGDs)

PPB - Parts Per Billion

QA/QC – Quality Assurance / Quality Control

SO_2 – Sulfur Dioxide

TDL – Tunable Diode Laser

UV-DOAS – Ultraviolet Differential Optical Absorption Spectroscopy

Section 1 - Overview:

In April 2016, the Bay Area Air Quality Management District (BAAQMD) published guidelines for refineries to meet the requirements of BAAQMD Rule 12-15. [1] The Phillips 66 Rodeo Refinery (the Refinery) has followed these guidelines to generate this Air Monitoring Plan for submission to BAAQMD. As presented in "Air Monitoring Guidelines for Petroleum Refineries, Air District Regulation 12, Rule 15: Petroleum Refining Emissions Tracking," the key elements of the BAAQMD guidelines are as follows:

1.1 - Requirement #1 – Gases Requiring Open-path Measurements

Refinery operators must measure benzene, toluene, ethylbenzene, xylenes (BTEX), and hydrogen sulfide (H_2S) concentrations at refinery fence lines with open path technology capable of measuring in the parts per billion (ppb) range regardless of path length.

1.2 - Requirement #2 - Other Gases to be Considered for Measurements

Measurement of sulfur dioxide (SO_2), alkanes or other organic compound indicators, 1,3-butadiene, and ammonia concentrations are to be considered in the Air Monitoring Plan. Refinery operators must provide a rationale in the Air Monitoring Plan for not measuring all of the above compounds. The rationale must address the following: why these compounds are not contained in the compositional matrix of emissions, are not expected at concentrations measurable by available equipment, and/or address the technical or other considerations that make specific measurements inappropriate or unavailable.

1.3 - Requirement #3 – Fence Line Coverage

Measurements must cover populated areas within 1 mile of the refinery fence line likely to be affected when the annual mean wind direction lies in an arc within 22.5 degrees of a direct line from source to receptors 10% of the time, or greater, based on the most representative meteorological measurements for sources likely to emit the compounds listed above at the refinery. In addition, the monitoring plan should take into consideration seasonal and short term meteorological events.

1.4 - Requirement #4 – Sample Time Resolution and Data Completeness

Fence line measurements must be continuously measured with a time resolution of five minutes. If this is not the case, refinery operators must provide rationale in the Air Monitoring Plan for lesser time resolutions based on equipment or other operational limitations. Instrumentation must meet a minimum of 75% completeness on an hourly basis 90% of the time

[1] *Air Monitoring Guidelines for Petroleum Refineries, Air District Regulation 12, Rule 15: Petroleum Refining Emissions Tracking;* available at http://www.baaqmd.gov/~/media/files/planning-and-research/public-hearings/2016/9-14-and-12-15/042016-hearing/1215-amg-041416-pdf.pdf?la=en.

based on annual quarters. Atmospheric conditions beyond the control of the refinery that affect accurate measurements, such as dense fog, shall not be counted against data completeness calculations.

1.5 - Requirement #5– Data Presentation to the Public

Measurements must be provided to the public on a real-time basis, with appropriate Quality Assurance/Quality Control (QA/QC) measures taken to provide reasonable assurance of data accuracy.

1.6 - Requirement #6 - Develop a Quality Assurance Project Plan

A Quality Assurance Project Plan (QAPP) that follows EPA guidelines must be developed that outlines the QA/QC parameters.

This air monitoring plan for the Phillips 66 Rodeo Refinery was prepared in accordance with the applicable BAAQMD Rule 12-15 requirements and the guidelines as presented in the April 2016 BAAQMD Air Monitoring Guidelines for Petroleum Refineries. This includes meeting all downwind fence line siting requirements, uptime requirements, and quantifiable detection levels. Site locations for the fence line equipment were selected to strategically position the fence line monitors using the predominant and variable meteorological conditions and topographical features within the Refinery. Finally, the specific chemicals that require monitoring were evaluated from emissions estimates based on available TRI reporting information. The following sections provide a summary of the Refinery's methodology for meeting all requirements of Rule 12-15.

Section 2 - Evaluation of Fence Line Requirements

2.1 - Background

Phillips 66 (a successor to Unocal), Communities for a Better Environment, the Crockett/Rodeo Coalition, the Shoreline Environmental Alliance, and the local community have previously established a Good Neighbor Agreement (GNA) which includes the installation and operation of a Fence Line Air Monitoring System at the Refinery. The Fence Line Monitoring (FLM) system that the Refinery operates under the GNA consists of two Open Path Fourier Transform Infrared Spectrometers (FTIR), two Open Path Ultraviolet (UV) Monitoring Systems, two Open Path Tunable Diode Laser (TDL) systems, and six organic gas detectors (OGDs). It also includes one meteorological station to provide wind direction, wind speed, temperature, and relative humidity information. The portions of this FLM system that fall under siting, equipment selection, or gas analysis requirements of Rule 12-15 have been integrated into this monitoring plan. However, it should be noted that the requirements of the GNA do not supersede the requirements of Rule 12-15. Similarly, requirements associated with the implementation of Rule 12-15 do not supersede the existing requirements for the operation of the FLM system associated with the GNA. As such, Phillips 66 will still continue to operate the fence line equipment that is

associated with the GNA but that is not required under Rule 12-15 in addition to the equipment which is stipulated by Rule 12-15.

2.2 - Requirement #1 – Gases Requiring Open-path Measurements

Phillips 66 has installed open-path air monitoring systems for the detection and quantification of benzene, toluene, xylene, and H_2S. Pursuant to the requirements of Rule 12-15, Phillips 66 will add the capability to detect and quantify ethylbenzene. BTEX will be detected and quantified using Open-path UV Differential Optical Absorption Spectroscopy (UV-DOAS) air monitoring systems. H_2S will be detected and quantified using open-path Tunable Diode Laser (TDL) air monitoring systems.

2.3 - Requirement #2 - Other Gases to be Considered for Open-path Measurements

As required by Rule 12-15, Phillips 66 considered the measurement of sulfur dioxide (SO_2), alkanes or other organic compound indicators, 1,3-butadiene, and ammonia for inclusion in the Air Monitoring Plan. Alkanes and SO_2 will be included in the monitoring plan as they have the potential to be present in measurable quantities. 1,3-Butadiene will not be included in the fence line monitoring program because it is not produced as an intermediate or end product at the Refinery, and is not present in significant quantities at the Refinery. In addition, ammonia will not be included in the fence line monitoring program as anhydrous ammonia is not used in routine processes at the Refinery. Phillips 66 will use Open-path Fourier Transform Infrared Spectrometers (Op-FTIR) to measure alkanes. These gases are currently being measured at the Refinery and are represented as Total Hydrocarbons (THC) on the Phillips 66 real-time community website. In addition, SO_2 will be measured using UV-DOAS and is currently being reported on the Phillips 66 real-time community website. Other specific chemicals requiring monitoring were evaluated from emissions estimates based on available TRI reporting information. Based on this analysis, other gases are already being captured in this monitoring program or did not meet the criteria for monitoring.

2.4 - Requirement #3 – Fence Line Coverage

2.4.1 - Summary of Requirements for Fence Line Coverage

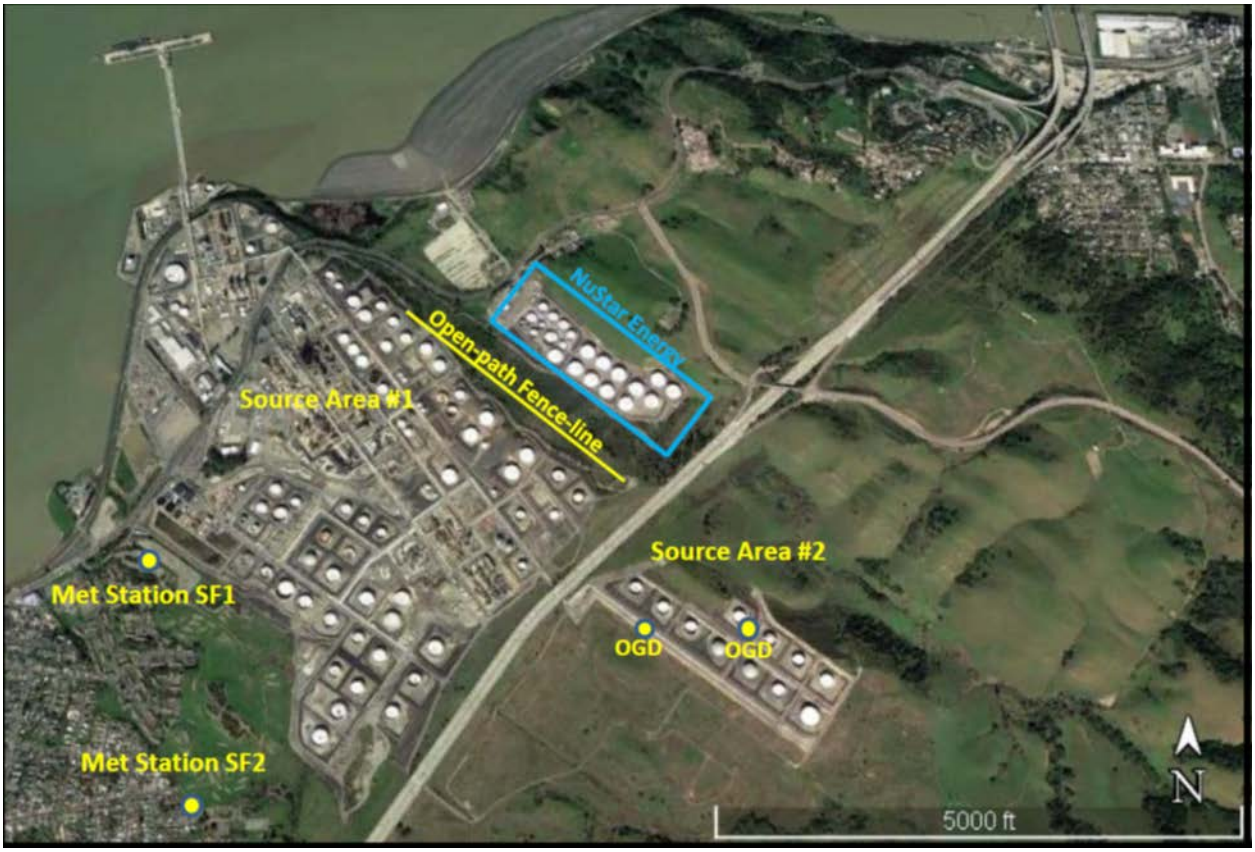
According to Rule 12-15, measurements must cover populated areas within one mile of the Refinery fence line likely to be affected when the annual mean wind direction lies in an arc within 22.5 degrees of a direct line from source to receptors 10% of the time, or greater, based on the most representative meteorological measurements for sources likely to emit the subject compounds at the Refinery. In addition, the monitoring plan should take into consideration seasonal and short term meteorological events. The subsequent sections describe the following:

- Process used to determine which portions of the fence line surrounding the Refinery require monitoring coverage based on meteorological data analysis and the types of sources present in each area of the refinery,

- Types of monitoring equipment that will be used, and
- Any notable variances to the coverage requirements.

For this analysis, refinery sources were divided into two areas as shown in Figure 1. Source Area #1 includes the refinery process units and storage tanks. Emissions from the sources in Area #1 include alkanes, BTEX, sulfur dioxide, and hydrogen sulfide. Open-path FTIR, UV-DOAS, and TDL air monitoring systems will be used to cover these sources. Source Area #2 includes seasonal storage tanks. Seasonal storage emissions only include volatile organic compounds (VOCs). Sensors that can detect VOCs will be used to monitor these sources. It should also be noted that tanks north of the Source Area #1 are owned by NuStar Energy and are not part of the Phillips 66 Refinery. Thus, the equipment in that area is not part of this Monitoring Plan as it is not subject to BAAQMD Rule 12-15. Figure 1 also includes the location of the fence line monitoring systems as well as the meteorological system used to form the meteorological data analysis.

Figure 1 - Source Areas and Refinery Overview



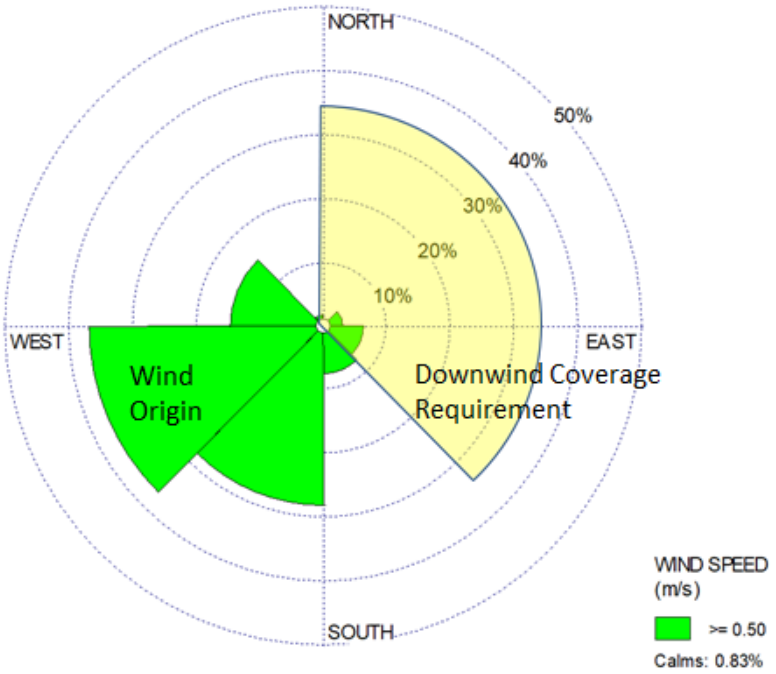
2.4.2 - Meteorological Data Analysis

In order to determine which portions of the fence line surrounding the Refinery are to be covered by monitoring under Rule 12-15 requirements, Phillips 66 followed the guidance presented by the BAAQMD. Specifically, according to the guidance, measurements must cover populated areas within

one mile of the refinery fence line likely to be affected when the annual mean wind direction lies in an arc within 22.5 degrees of a direct line from source to receptors 10 percent of the time, or greater, based on the most representative meteorological measurements for sources likely to emit the compounds listed above at the refinery. BAAQMD has provided guidance that this aspect of the analysis should result in an eight segment wind rose that is used for comparison against the 10 percent threshold mentioned above.

In order to perform this analysis, Phillips 66 generated eight segment wind roses composed of sectors that make up 45-degree arcs. The first sector spanned the 0 to 45 degree range (i.e., the arc is centered at 22.5 degrees and extends out 22.5 degrees in each direction). Each additional section was defined by moving 45 degrees from the previous arc's centerline, and extending out 22.5 degrees in each direction. Phillips 66 generated wind roses using data collected from January 1, 2012, to December 31, 2016, from an on-site meteorological (Met) station located at label SF1 as shown in Figure 1. Other Met stations located near the refinery were considered for this analysis, but SF1 was chosen as the most representative station based on its close proximity to the refinery. To be thorough, Phillips 66 analyzed data from the next closest Met station (SF2, shown in Figure 1), and found that the station provided comparable wind data to SF1. Wind direction and speed data collected from the SF1 Met station was used to generate various wind roses for the Refinery in accordance with guidelines discussed above. These wind roses were used to determine the percentage of time the wind blows in each sector. The annual wind rose showing this information is presented in Figure 2.

Figure 2 - Annual Wind Rose (SF1 Met Data Analysis January 1, 2012 - December 31, 2016)



Based on this analysis, one can see that three sectors have wind blowing at least 10% of the time on an annual basis. Note that the wind rose shows the direction that wind originates (i.e., the direction the wind is coming from). Thus, the areas which may require monitoring under Rule 12-15 are those with populations that lie in an arc between 0 degrees (due North) and 135 degrees (Southeast) of the Refinery. For clarity, Phillips 66 has overlaid this downwind coverage requirement on the wind rose in Figure 2. Areas requiring monitoring were then identified by generating an arc for the applicable wind rose sectors (i.e., the downwind coverage requirement arc shown in Figure 2) and overlaying that arc with the potential emission sources within the refinery. Using the source as the focus of the arc, a downwind flow map was generated by extending the arc a distance of 1 mile from the origin. Figures 3 and 4 show the downwind sectors from Source Areas #1 and #2 that meet the annual wind rose requirements for Rule 12-15 as they apply to the populations surrounding the Refinery. The populations that are less than one mile from the Refinery and lie within this arc are portions of Crockett. As seen in Figure 5, no population south of the Refinery is subject to fence line coverage under Rule 12-15 as there is no population in that direction that lies within the arc representing the annual wind rose coverage requirement.

Figure 3 - Downwind Coverage Requirements – Source Area 1

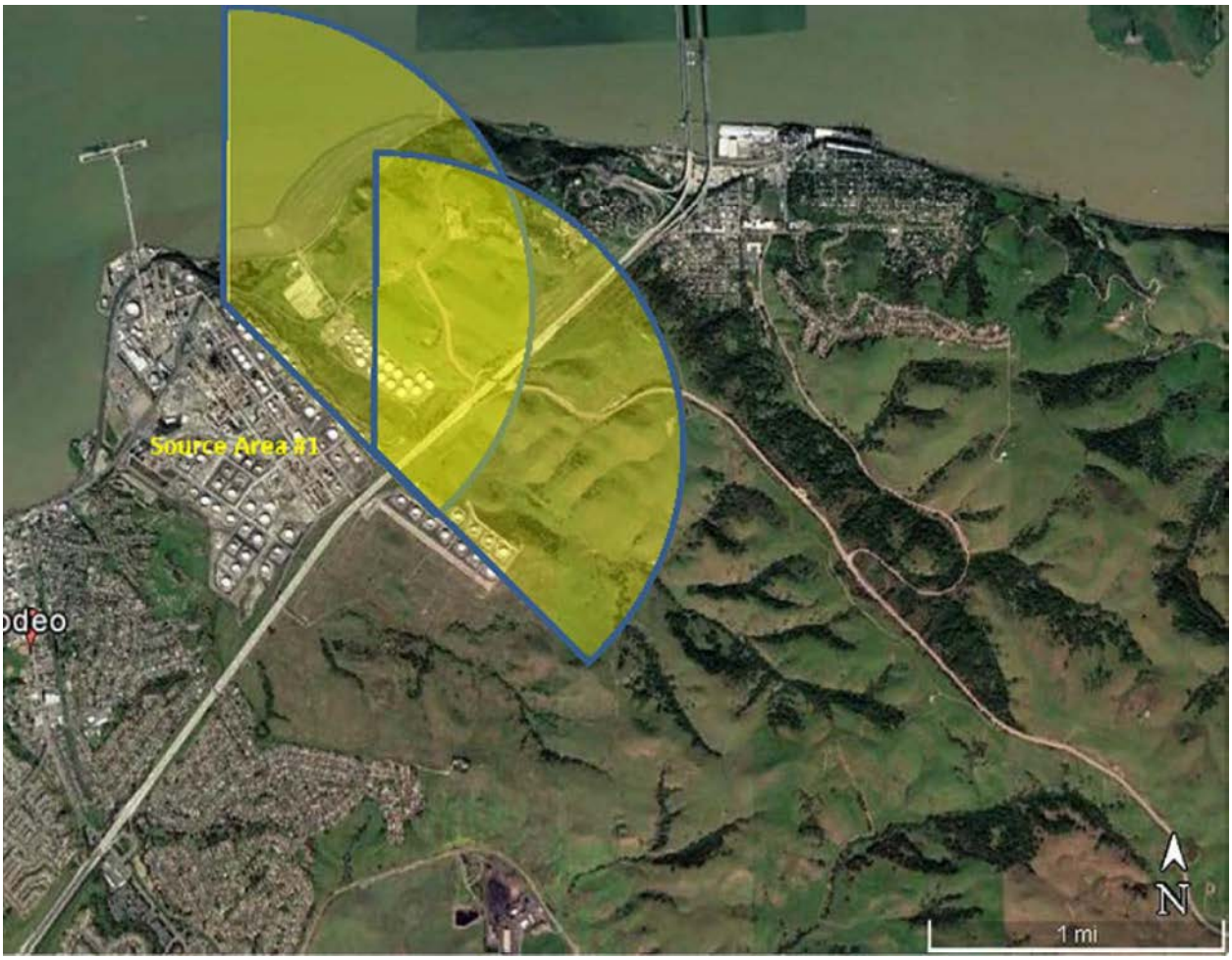


Figure 4 – Downwind Coverage Requirement – Source Area 2

Figure 5 - Downwind Coverage Requirement - Southernmost Potential Source

In addition to annual wind patterns, a review of seasonal meteorological events was conducted and results considered in the development of this Air Monitoring Plan. This review of seasonal patterns included analyzing data from January 1, 2012, to December 31, 2016. To determine whether the wind blows in a particular wind rose sector for a significant amount of time on a seasonal basis, a significance threshold of 20% was set for seasonal meteorological events. This threshold is equivalent to an annual significance threshold of 5% of the time for any given wind rose sector because the time basis for a seasonal wind rose is 3 months (as opposed to 12 months for the annual wind rose shown in Figure 2). As the BAAQMD Air Monitoring Guidelines specify a 10% significance threshold on annual basis, Phillips 66 considers it conservative to evaluate seasonal wind pattern significance using a threshold equivalent to 5% on an annual basis. The wind rose data for this seasonal analysis is presented in Figures 6 through 9.

Figure 6 - Wind Rose - Winter Months (December, January, February: 2012-2016)

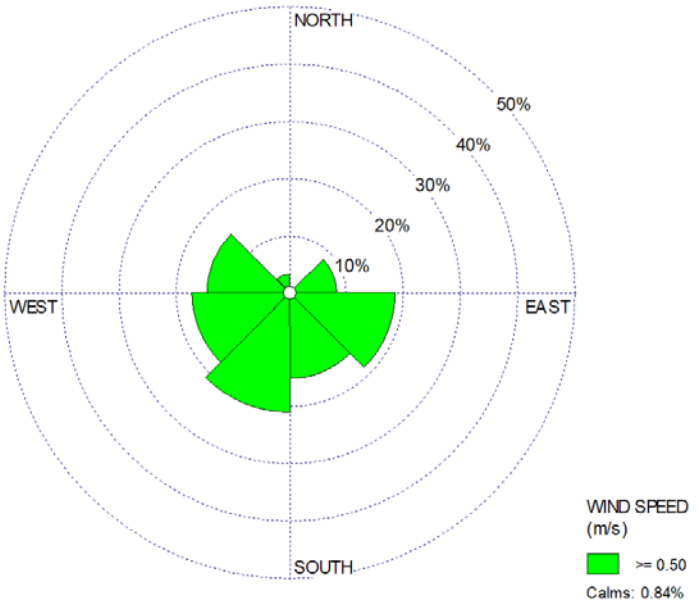


Figure 7 - Wind Rose – Spring Months (March, April, May: 2012 - 2016)

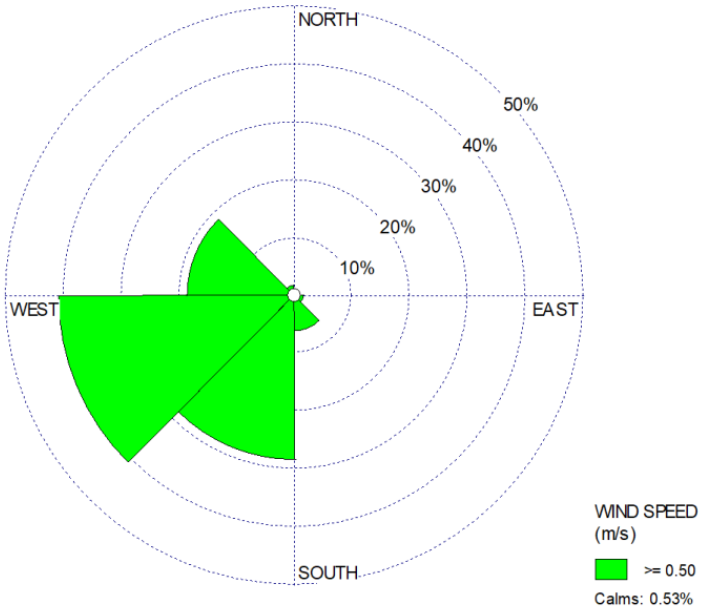


Figure 8 - Wind Rose - Summer Months (June, July, August: 2012 - 2016)

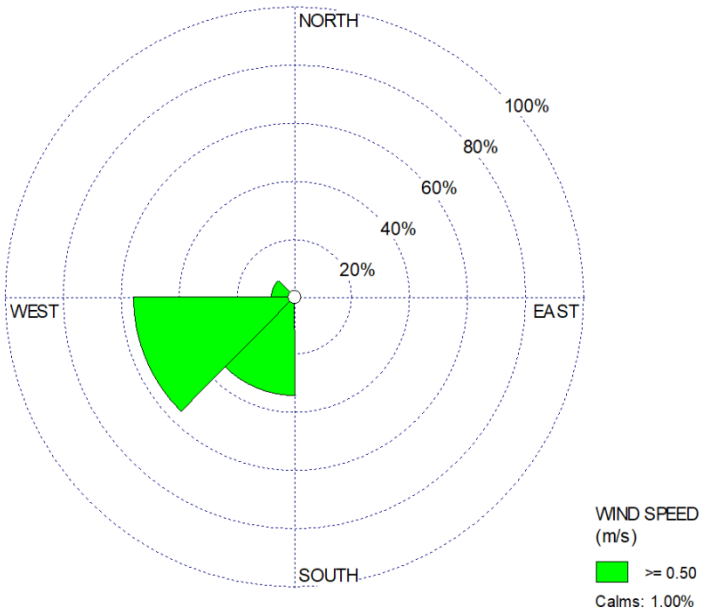
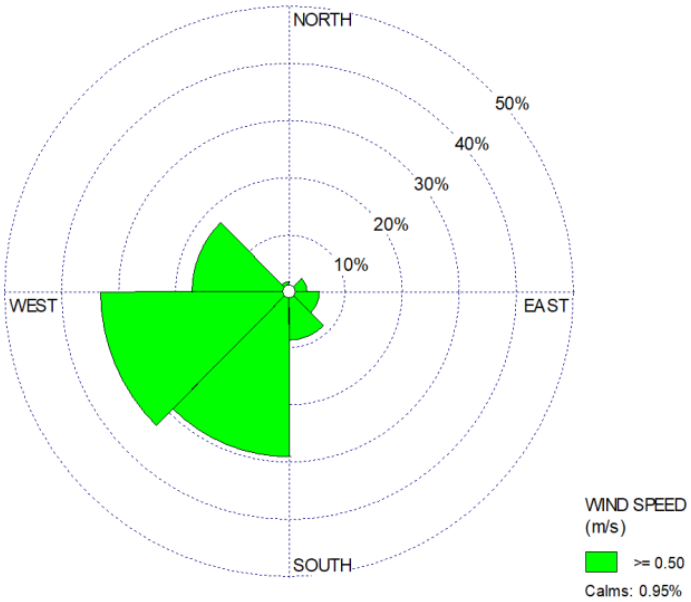


Figure 9 - Wind Rose - Fall Months (September, October, November: 2012 - 2016)



The results of this analysis reveal that wind patterns in the spring, summer, and fall show the same predominant wind directions as the annual average. While the winds during winter tend to broaden out, they show the same general trend as the annual average with respect to predominant wind direction. In each seasonal wind rose, there are sectors in which the wind blows for a period of time that is above the seasonal significance threshold discussed above. However, in each of those cases, the sector already requires FLM equipment coverage based on the annual wind patterns. Thus, the potential downwind exposure addressed in this plan does not change due to seasonal variation.

2.4.3 - Description of Monitoring Equipment

The fence line air monitoring equipment uses beams of light to detect and quantify gases in the air. Different compounds in the air will absorb different wavelengths of light. Thus, the general principal of operation of the open path systems is that a beam of light is sent out into the open-air, and if a gas is present that absorbs light, the system can identify the specific gas by determining which wavelengths of light were absorbed. Once the gas is identified, the amount of that gas present in the beam path can be determined by how much of each target wavelength was absorbed. A single instrument can send a beam of light out over half a mile, so open path instruments are very effective in covering large portions of facility fence lines. The different types of air monitoring instruments use different light sources to detect specific gases. For example, benzene gas absorbs specific wavelengths of ultraviolet light and hydrogen sulfide gas absorbs specific wavelengths of infrared light. Table 1 presents the technology used to cover the sources and populations associated with the Rule 12-15 monitoring requirements, along with common potential interferences for each instrument type.

Table 1 – Monitoring Equipment Overview

Equipment	Capabilities	Interferences[1]	Restrictions	Required LDL
Open-path FTIR	Detects alkanes, path length up to 1,000 meters	Water and CO_2 which can typically be compensated for with analytical software	Heavy Fog and Rain	10 ppb
Open-path UV	Detects Benzene, Toluene, Xylene, Ethylbenzene, and Sulfur Dioxide at path lengths up to 1,000 meters	Ozone and Oxygen which can typically be compensated for with analytical software.	Heavy Fog and Rain	Ethylbenzene: 100 ppb Others: 10 ppb
Open-path TDL	Detects Hydrogen Sulfide Gas	Water and CO_2	Heavy Fog and Rain	300 ppb
Organic Gas Detectors	Detects Total Hydrocarbons	Water	None	See Note 2.

1. It should be noted the interferences and restrictions listed above represent the most common type of interferences and restrictions encountered with these analytical methods. However, it is acknowledged that this list is not exhaustive and other possible interferences may occur or restrictions encountered.

2. OGDs have a detection range of 0-100% LFL with an accuracy of +/- 3% in the 0-50% LFL range and an accuracy of +/- 5% in the 51-100% LFL range.

When an open path instrument provides a measurement, it will provide the measurement of a specific compound in the form of a "path averaged concentration." While the equipment provides chemical analyses over a large area, it cannot distinguish between a low-level gas concentration that spans most of the path length and a higher gas concentration concentrated in a relatively small plume width. Thus, the meaning of a concentration measurement from an open path instrument represents the average concentration of a specific compound along the entirety of the beam path.

As the open path equipment is located at the fence line of the refinery (see Figure 1 for reference regarding where the open path beam is located), it is evident that measured gas concentrations are indicative of that space only. Thus, the measurements of the open path instruments may be representative of near field impact of refinery emissions but are not likely representative of far field impacts. Air dispersion can be complex based on specific terrain, meteorology, and other factors. However, in general, a plume moving through the open path will disperse to lower concentrations as it moves away from the fence line. The plume will experience mixing, turbulence, and other general dispersion effects as is the nature of air dispersion. Thus, a detection of a specific gas on the fence line monitoring equipment does not readily or easily translate to the presence of that gas in a community not immediately in the vicinity of the open path being monitored.

Additionally, it is notable that the air monitoring equipment is capable of detecting the type and quantity of gas molecules in the air but it cannot identify the specific source of those gases. Although the systems are set up at the fence line of the refinery, they may detect gases from other sources such as vehicle exhaust and other sources of pollution. Vehicle exhaust is an example of a non-refinery source that may contribute to gases detected by the Refinery fence line equipment because Interstate 80 is adjacent to the Refinery.

Another item that is important to understand about the measurements produced by the open path fence line equipment is the period of time that the measurement represents. This is referred to as an averaging time. Air quality standards have an averaging time associated with them. The shortest air quality standards averaging periods use one hour averages, and longer term standards include 24 hour and annual averages. As specified by BAAQMD's air monitoring guidelines, the air monitoring equipment used for meeting the requirements for Rule 12-15 present data that is measured on a 5-minute basis. The advantage of this shorter time period is that the monitoring system can provide a better real-time measurement of what gases are present in the monitored open path near the fence line. However, one disadvantage of this high time resolution is it does not provide a metric comparable to traditional air quality standards or other established exposure standards. The state of California has generated guidance for acceptable exposure levels for many compounds. This guidance is published by California's Office of Environmental Health Hazard Assessment (OEHHA). For further information regarding the potential health impacts of gases that will be monitored as part of the FLM program, please refer to the OEHHA guidelines on the topic (https://oehha.ca.gov/chemicals).

Detection limits for the data generated by the equipment are normally set to be at least two times the manufacturer's MDL. This is done to minimize the occurrence of false detections being reported to the real-time public website. For the majority of gases, the required lower detection limit (LDL) used for real-time fence line monitoring under Rule 12-15 is 10 parts per billion (ppb). The exceptions are ethylbenzene and hydrogen sulfide gases. Ethylbenzene has a detection limit of 100 ppb because the equipment manufacturer has determined its detection limit is approximately ten times the limit of the other BTEX gases. The manufacturer of the equipment that detects H_2S has recently determined the

detection limit of their equipment is approximately 300 ppb for the length of fence line monitoring path to the north of the Refinery. As with any instrument, the possibility of measurement error exists. However, the Quality Assurance Project Plan (QAPP) specifically identifies QA/QC processes intended to minimize errors for the fence line program.

With regard to evaluation of the fence line system performance, P66 currently has a process in place in which the local community is engaged in evaluating the performance of the fence line system. The process involves evaluating the data collected by the fence line equipment using the Measurement Quality Objectives (MQOs) specified by the QAPP. The process of data validation is used to generate the on-stream efficiency (OSE) for each analyzer, as well as the Internet connection used by the real-time website. When a component of the system fails to meet its target OSE threshold, corrective actions are initiated and used to fix the issue and improve the system performance. Over the years of Phillips 66 operating FLM equipment, this approach has identified system issues and driven numerous improvements to the fence line system. This approach continues to be effective as well. After the first year of data collection, P66 will perform a review of the fence line monitoring network performance using the same approach.

2.4.4 – Fence Line Coverage

The populations that are downwind of Source Area #1 are covered by the open-path air monitoring equipment on the north fence line of the Refinery, as shown in Figure 1. This air monitoring equipment includes open-path UV, tunable diode laser, and Op-FTIR air monitoring equipment that extends along a path length of approximately 920 meters. As noted above, the open path equipment provides chemical analyses over a large area, but does not distinguish between low-level gas concentrations along the entire path versus a higher gas concentration concentrated in a relatively small plume width. Therefore, results from measurements from these instruments represents the path average gas concentration.

The populations that are downwind of Source Area #2 are covered by organic gas detectors (OGDs) that are currently operated at the site. Source Area #2 has four regulated storage tanks that are within one mile of approximately 12 houses downwind of the source. The OGDs have the capability of measuring total Volatile Organic Compounds (VOCs) on a continuous, real-time basis and satisfy the rule requirement for sample collection time. An additional benefit of the OGD air monitoring technology is the systems can generally remain in operation during periods of time when the open-path systems may be inoperable due to signal loss from weather conditions. Further detail regarding the use of the OGDs in this area is discussed in the next section.

2.4.5 - Variances and Area Specific Coverage Notes

Every effort has been made to ensure all populations and sources identified as being part of Rule 12-15 are addressed in the Monitoring Plan. However, there are certain areas where locating fence line equipment is not possible or is not required under Rule 12-15. Note that the siting of existing fence line equipment was a collaborative effort between the community and the Refinery as part of the GNA for operating the existing fence line monitoring program.

The sources located at the north end of the Refinery are covered by the open-path air monitoring equipment that is currently in operation along the north fence line. However, there is a small portion of this fence line that cannot be covered primarily due to siting issues. This area includes a small number

of storage tanks west of the fence line air monitoring equipment that is currently in operation at the Refinery. Extending the path to accommodate the additional storage tanks is not possible due to the terrain and would also degrade the data quality of the FLM system by extending the range beyond maximum manufacturer recommended path lengths. The same siting issues are present for point sample technologies as the terrain is unsuitable for the infrastructure necessary to site a point sampling system. Thus, Phillips 66 is operating the maximum possible path length within these siting and technological constraints. Additionally, three of the five tanks in this area are exempt from regulation, indicating that few emissions are expected from those tanks.

In the area at the east of Interstate 80, the seasonal storage tanks are monitored using technologies other than open-path monitoring equipment. This source presents a very low potential risk to population downwind of the source primarily because of 1) the nature of storage tank emissions and operations, 2) the distance between the source and receptors, and 3) the relatively low amount of populated area within one mile of the source.

The emissions plume from liquid storage tanks is typically a broad plume (i.e., as opposed to a narrow plume) that does not carry much buoyancy in the air. This is because storage tank emissions are not released with significant upward velocity, are not high temperature, and many of the organic compounds which may be found in these emissions are heavier than air as well. Considering this nature of the emissions, a release from the tanks in the seasonal storage area would need to be an abnormally large release in order to immediately affect the downwind population. Additionally, the nearest residence to these storage tanks is nearly one mile away (>0.95 miles) with approximately 12 homes being within 1 mile. This provides a reasonable distance for air emissions dispersion to occur.

Nonetheless, Phillips 66 has proposed to include monitoring in this area as part of the monitoring plan under Rule 12-15. This monitoring will consist of two organic gas detectors as described previously in this plan. In the event of an abnormal release from one of the tanks located in this area, it is highly likely emissions from such a release will be detected by an organic gas detector near the tank due to the nature of storage tank emissions. In addition, two organic gas detectors are included in the Monitoring Plan to provide enhanced coverage as this configuration helps to cover the tanks for a variety of met conditions.

It is also noteworthy that only four storage tanks in this area are regulated and fall within a mile of the nearest downwind residence, and that the OGDs are located immediately adjacent to these tanks. These tanks are the three tanks that are nearest to the westernmost OGD as shown in Figure 1, and the tank located immediately to the southeast of the easternmost OGD. Also, when applying the annual wind rose measurements to this community within a mile of the nearest tank, the winds blow towards this population less than 8% of the time. Finally, note that all regulated storage tanks are included in the refinery tank seal inspection program to monitor the condition of tank seals.

The area that is west of the San Pablo Avenue contains no active refinery product processing areas. For this reason, there is no need for air monitoring equipment in this area. Finally, it should be noted that Phillips 66 operates fence line air monitoring equipment similar to the north fence line monitoring stations along the south side of the Refinery. Figure 5 shows the annual wind sectors requiring coverage and the associated coverage arc extending one mile out from the southernmost source. While the FLM equipment along the south side of the Refinery is not required as part of Rule 12-15, Phillips 66 will still continue to operate this equipment under the GNA.

2.5 - Requirement #4 – Sample Time Resolution and Data Completeness

All air monitoring equipment specified for the Phillips 66 FLM system are set to collect data on five-minute averages. All air monitoring equipment specified for the Phillips 66 system will meet a minimum of 75% completeness on an hourly basis 90% of the time based on calendar quarters. Atmospheric conditions beyond the control of the Refinery that affect accurate measurements, such as dense fog, shall not be counted against data completeness requirements as long as appropriate measurements are made that will allow for time periods to be documented when these conditions exist.

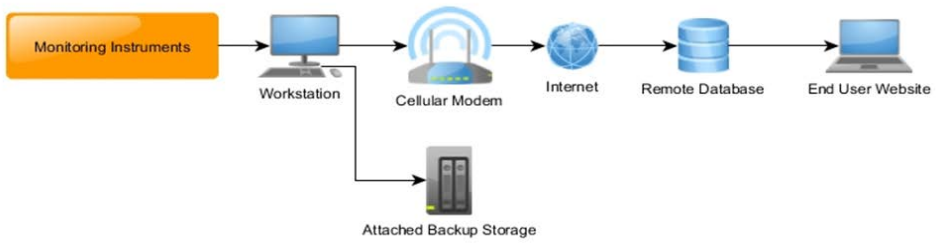
Atmospheric conditions beyond the control of the Refinery that affect accurate measurements are typically rain and fog. When these occur, the open-path measurement of light signal will drop below a level where data can be reliably quantified. The reason for this is the light beams produced by the open-path air monitoring systems are scattered as they interact with the water vapor in the air. Once scattered, the light can no longer be received and used by the instruments. When an instrument's signal drops below a predetermined level, the signal strength of the other open path instruments is evaluated during the same time period. If another instrument shows a pattern of signal drop, the data will be identified and flagged as meeting the criteria of atmospheric conditions beyond the control of the Refinery. This method should provide information that is more accurate than a separate visibility monitor as the signal reading is directly tied to the instrument's quantification abilities, and information is gathered directly from at least two instruments used in the fence line program, as opposed to a single measurement from a separate analyzer.

In addition to rain and fog, other types of atmospheric conditions beyond the control of the refinery can occur. These include environmental factors such as strong winds, dust, and earthquakes, all of which can affect the ability of an open-path instrument to provide accurate measurements. In the event an instrument indicates a low signal, the data may be flagged as being caused by other environmental factors.

2.6 - Requirement #5– Data Presentation to the Public

Phillips 66 has collaborated with the community on the methods used to most effectively present the data collected from the fence line air monitoring system to the public. Data from the monitoring stations will be combined together and transmitted to an Internet website where the real-time results can be viewed by the public. Under normal circumstances, a 5-minute average measurement will appear on the website within 10 minutes of the end of the measurement period. Figure 10 provides an example of how the monitoring data will be handled. In addition to the data from the analyzers, additional resources will be provided to assist in interpreting the data. This will include a display of meteorological data including wind speed and wind direction. The website will also make available a rolling 24 hour trend of the 5 minute data for each gas reported. Data on the community website will be filtered in real-time whenever real-time data quality indicators point to the potential of poor data quality. For example, in cases where the manufacturer has made real-time signal information available directly from the instrument, data will be filtered when the light signal from an analyzer drops below a level where monitoring data can be reliably quantified. During this condition, the website will display a notification such as "Low Signal" to inform the public of the condition.

Figure 10 - Data Communication System



Phillips 66 will provide other resources on the website to assist the public in viewing the monitoring data. Information regarding the instruments and the principles of operation will be provided on the public website to the interested viewer. Also, context and background information on the specific pollutants will be provided using sources of published information on the topic, such as resources developed and published by OEHHA. Finally, following QA/QC of recorded monitoring data, Phillips 66 will provide one-hour average concentration data in a tabular format to the BAAQMD. The BAAQMD may make the one-hour average data available to the public through a BAAQMD website or through a public records request. As needed, the refinery will make data available to BAAQMD upon request prior to the report submittal. Further information regarding this reporting process is available in the QAPP.

Data from monitoring equipment will be presented on the community website that is operated under existing FLM agreements. This website was developed with extensive input from the various stakeholders within the community and may evolve in the future as stakeholder needs change. The community website includes a message board to inform the public of relevant information as needed. For example, the message board may be updated when an analyzer goes off line due to system failure, an analyzer is undergoing calibration checks, maintenance, or other conditions where an analyzer is not in an operational state for an extended period of time. In addition, the public is able to sign up for email notification when the message board is updated and will be able to send emails suggesting enhancements to the public access website or any other issue of interest to the community.

Quality Assurance Project Plan for the Phillips 66 Rodeo Refinery Fence Line Monitoring Program

Revision 1.0

Phillips 66 Rodeo Refinery

Document Control			
Revision #	Revision Date	Description	Signature
1.0		Original	

Table of Contents

1- Background

1.1 - Introduction

The purpose of this Quality Assurance Project Plan (QAPP) is to prescribe requirements, procedures, and guidelines for the Phillips 66 Rodeo Refinery (the Refinery) Fence Line Air Monitoring Program. It is intended to serve as a reference document for implementing the Quality Assurance/Quality Control program and describes operational procedures for the measurement processes used by Phillips 66 and contractors in the operation and maintenance of the monitoring equipment. The QAPP is a compilation of QA requirements, procedures, and guidelines that are applicable to air pollution and meteorological measurement systems. These systems are designed to achieve a high percentage of valid data readings while maintaining integrity and accuracy within prescribed limits. This QAPP clearly and thoroughly establishes QA protocols and QC criteria required to successfully implement and maintain the Fence Line Monitoring (FLM) Program in accordance with the Air Monitoring Plan submitted to BAAQMD under Rule 12-15.

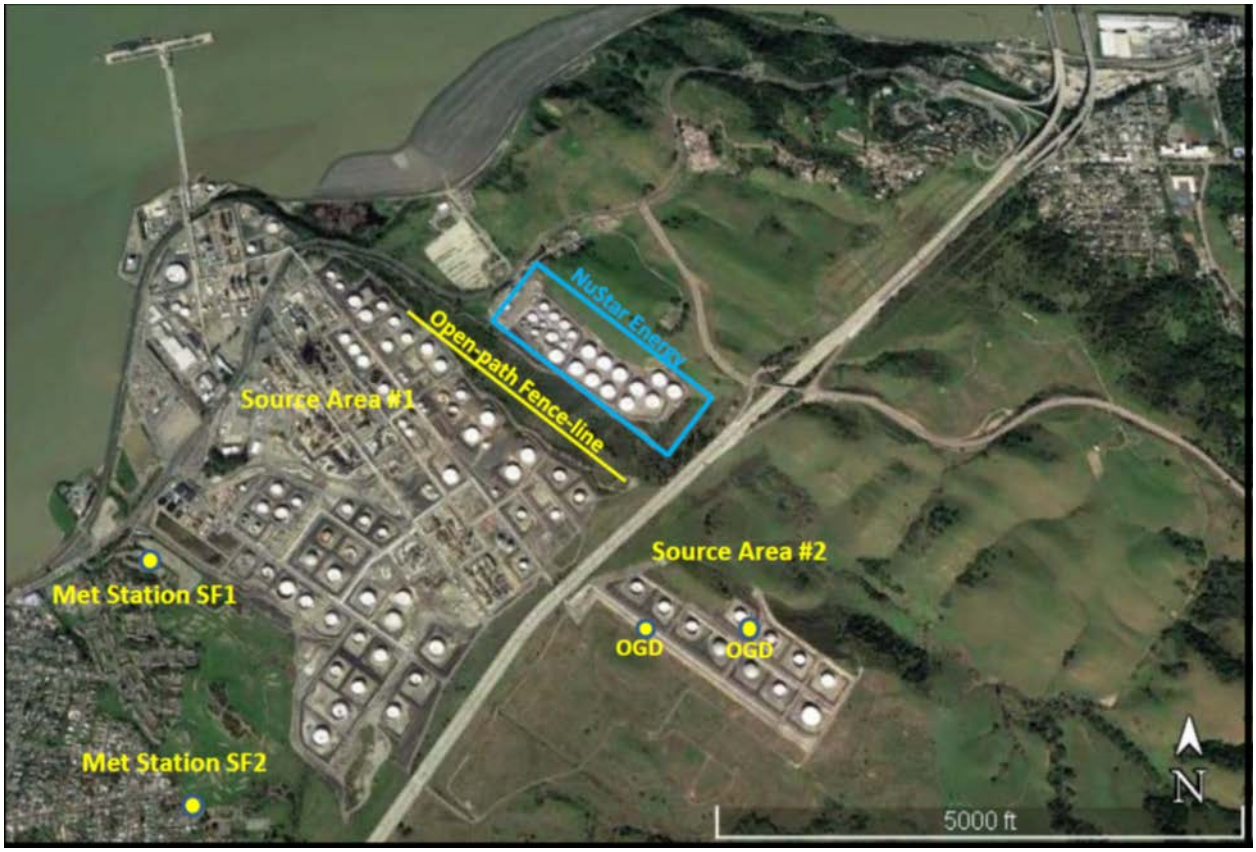
1.2 - Project Description

The Refinery Fence Line Monitoring Program is composed of a number of ambient air monitoring systems meeting the siting requirements specified in BAAQMD Rule 12-15. Data gathered from the monitoring instrumentation is averaged over a 5-minute period and polled by a data logging system that stores each data point in a local database. The data is also copied to a remote server, which is used for the real-time public access web page. Data validation checks will be performed to meet the data quality objectives outlined in this document. A description of the FLM system is presented in the Air Monitoring Plan submitted to the BAAQMD. Table 1 lists the locations of the monitoring equipment sites and Figure 1 shows these locations on an aerial image.

Table 1 – Monitoring Site Locations

Site Name	Equipment	GPS (Latitude)	GPS (Longitude)	Elevation (feet AGL)	Path-length (m)
North Fence Line Source Tower	FTIR Source, TDL Reflector, and OP-UV Source	38° 2'51.3”N	122°15'7.4"W	Approx. 15	920
North Fence line Receivers	FTIR, TDL and UV workstations.	38° 2'32.4"N	122°14'37.6"W	<10	920
Organic Gas Detector #1	Organic Gas Detector	38° 2'17.5"N	122°14'24.0"W	<10	NA
Organic Gas Detector #2	Organic Gas Detector	38° 2'18.5"N	122°14'37.0"W	<10	NA

Figure 1 - Map of Monitoring Equipment



2 - Program Organization

The facility may opt to utilize a contractor to maintain and operate the FLM system equipment. While this arrangement may be changed in the future as appropriate, the FLM program is currently organized between Phillips 66 and a contractor tasked with operating and maintaining the systems.

A project manager at Phillips 66 will be responsible for managing the work performed by the contractor operating and maintaining the fence line system. In addition, the project manager will act as the primary interface between all stakeholders including the refinery management, the BAAQMD, and the public. Field technicians and the operations manager will be responsible for the day-to-day operation of the fence line monitoring system.

Key Personnel

In general, the following organizational roles associated with the fence line monitoring program are outlined below. These roles may change in the future as needed.

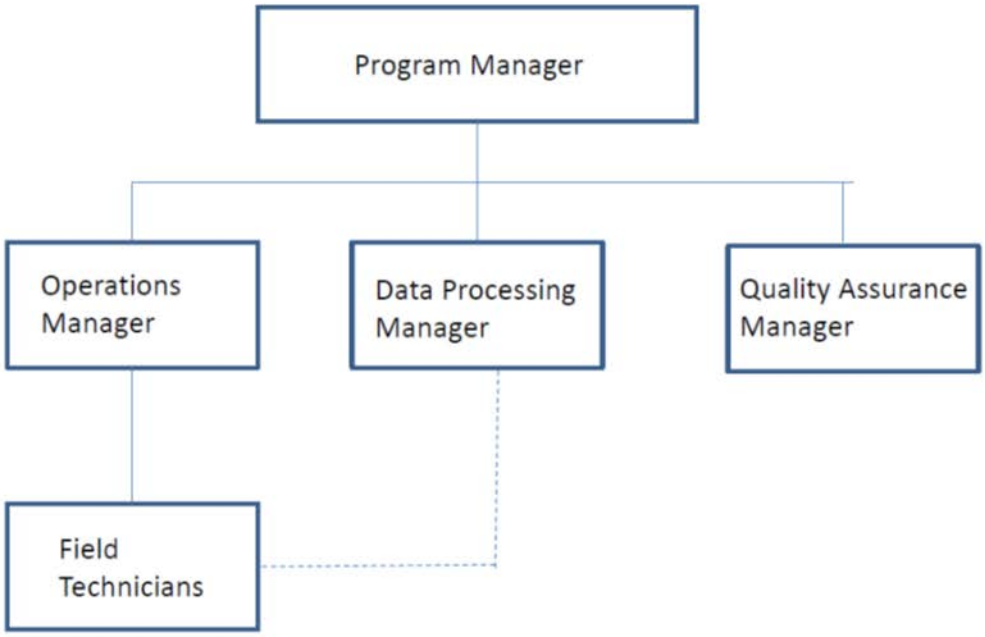
Program Manager - The Program Manager is responsible overall management of the fence line system.

Operations Manager - The Operations Manager is responsible for day-to-day activities associated with the fence line system.

Quality Assurance Manager – The Quality Assurance Manager is responsible for ensuring all Standard Operating Procedures are updated and maintained. Additional responsibilities include maintaining all real-time monitoring databases as well as summarizing and storing all data quality records associated with the fence line monitoring program.

Data Processing Manager – The Data Processing Manager is responsible for report generation and ensuring all measurement quality objectives are met for the fence line monitoring program.

Field Technician - The Field Technician is responsible for the day-to-day operation of the fence line monitoring system including following an equipment operation verification and maintenance schedule to assure data quality.



3 - Data Quality Objectives

3.1 - Instrument Types

Table 2 lists the specific equipment used in the fence line monitoring system to measure the target gases, as well as the detection limits for each system.

Table 2 – Equipment List

Gas	Detection Technology	Measurement Type	Required Lower Detection Limit (ppb)
Alkanes	Op-FTIR	Open-path	10
Benzene	UV-DOAS	Open-path	10
Ethylbenzene	UV-DOAS	Open-path	100
Hydrogen Sulfide	Tunable Diode Laser	Open-path	300
Sulfur Dioxide	UV-DOAS	Open-path	10
Toluene	UV-DOAS	Open-path	10
Xylene	UV-DOAS	Open-path	10
Volatile Organics	Organic Gas Detectors	Point Monitoring	*See Note 1*

1. OGDs have a detection range of 0-100% LFL with an accuracy of +/- 3% in the 0-50% LFL range and an accuracy of +/- 5% in the 51-100% LFL range.

3.2 - Operating Schedules - Sampling Frequency and Data Completeness Requirements

All air monitoring equipment specified for the Refinery fence line system are set to collect data on five-minute averages and will meet a minimum of 75% completeness on an hourly basis 90% of the time based on annual quarters. Atmospheric conditions beyond the control of the refinery that affect accurate measurements, such as dense fog, shall not be counted against data completeness requirements as long as appropriate measurements document times when these conditions exist. After accounting for these instances, the resultant data completeness metric is referred to as on-stream efficiency in this document.

3.3 - Weather Related Exclusions/Downtime

Atmospheric conditions beyond the control of the Refinery that affect accurate measurements are typically rain and fog. When these occur, the open-path measurement of light signal will drop below a level where data can be reliably quantified. The reason for this is the light beams produced by the open-path air monitoring systems are scattered as they interact with the water vapor in the air. Once scattered, the light can no longer be received and used by the

instruments. If one open-path instrument's light signal drops below a predetermined level and another instrument is also observed to experience a drop in signal during the same measurement period, the data will be identified and flagged as meeting the criteria of atmospheric conditions beyond the control of the Refinery.

In addition to rain and fog, other types of atmospheric conditions beyond the control of the refinery can occur. These include environmental factors such as strong winds, dust, and earthquakes, all of which can affect the ability of an open-path instrument to provide accurate measurements. In the event an instrument indicates a low signal, the data may be flagged as being caused by other environmental factors.

3.4 - Instrument Operation Verification

Throughout the measurement process, each analyzer will be checked for data quality. Each quality check is based on a core Data Quality Objective (DQO) that presents a description of the overall level of data quality to be met by the program. The DQO for the Rule 12-15 fence line monitoring program is to ensure the data obtained from the fence line system meets the quality standards needed for presenting data to the public. Measurement Quality Objectives (MQOs) are evaluations of certain parameters needed to assure the validity of data generated by the monitors. MQOs are designed to evaluate the measurement process to ensure the total measurement confidence needed to meet the DQO. Each MQO includes a data quality indicator which identifies specific criteria used to evaluate whether the instrument performance is satisfactory for that objective. This is referred to as the acceptance criteria below. If an analyzer fails an MQO, corrective action will be initiated to address the issue. The FLM system MQOs and associated acceptance criteria are discussed in the following sections.

3.4.1 – FLM System MQO #1 - Open Path FTIR - Detection Limit for Alkanes

Frequency: Monthly

Description: MQO #1 is to determine the detection limit using the method outlined in the Environmental Protection Agency's Environmental Technology Verification (ETV) Test Protocol for open-path air monitoring systems and to compare this result to the required lower detection limit for alkane gas specified in Table 2 of the QAPP.

Measurement Quality Objective: The minimum detection limit (MDL) is calculated by collecting a series of 26 single-beam spectra taken using the appropriate averaging time (5 min). The single-beam spectra are used to create absorption spectra, using each single beam spectrum as the background for the next spectrum. The absorption spectra are created by using the first and second single-beam spectra, the second and third, the third and fourth, etc. The resulting 25 absorption spectra are analyzed for the target gas. For this MQO, the MDL is defined as two times the standard deviation of the calculated concentrations.

Acceptance Criteria: MQO #1 will be considered to have been met if the calculated minimum detection limit is less than or equal to the required lower detection limit specified in Table 2 of the QAPP.

Corrective Action: If the system does not meet the acceptance criteria, the electronic records saved during the test will be sent to the equipment manufacturer or their representative to troubleshoot the issue.

3.4.2 – FLM System MQO #2 – Open Path FTIR - Concentration Limits for Methane

Frequency: Continuous

Description: MQO #2 is to check that as the FTIR air monitoring system records data, it is capable of detecting methane in the ambient air above concentrations of 1.7 ppm. This is the approximate natural concentration of methane in the ambient air. The FTIR includes internal status flags that record whether the quantified methane concentration is above this level. If the system fails this QA/QC check, a data flag is generated.

Measurement Quality Objective: Instrument quantified detection of methane is reviewed for each 5-minute period.

Acceptance Criteria: MQO #2 will be considered to have been met if the real-time measured value of methane gas is greater than or equal to 1.7 ppm.

Corrective Action: If the system does not meet the acceptance criteria, appropriate personnel will be notified via email that the system may not be operating correctly and troubleshooting will occur, as needed.

3.4.3 - FLM System MQO #3 - Open Path FTIR - Signal Strength Validation

Frequency: Monthly

Description: MQO #3 is to check the light signal from the FTIR system and compare it to a known signal strength needed to meet the detection limits listed in Table 2 for the FTIR system.

Measurement Quality Objective: At the end of each month's maintenance activities, the signal strength of the IR Beam will be measured at three different spectral areas as specified in Table 3. The measured value of the light signal must be greater than or equal to the percent of full scale or each wave number.

Table 3 – Infrared Light Wavelength Checks

Wavenumber (cm^{-1})	Percent of Full Scale
950	18.75
2750	2.5
4100	0.625

Acceptance Criteria: MQO #3 will be considered to have been met if the measured light signal is greater than or equal to the percentage of full scale of the light signal as noted in Table 3.

Corrective Action: If the system does not meet the acceptance criteria, the following tasks will be performed to improve the signal strength.

- A realignment of the source and receiver unit will be performed.
- If necessary, all optical components of the system will be cleaned.
- If necessary, the IR source will be replaced.

3.4.4 - FLM System MQO #4 - Open Path FTIR - Challenge of System with Gas

Frequency: Monthly

Description: MQO #4 is to perform a Quality Control check to ensure the FTIR is correctly quantifying alkane gases. Alkane gas will be introduced into the beam path of the FTIR air monitoring system. The values generated by the analyzer will be compared to an independent quantification of the gas concentration in the data spectrum.

Measurement Quality Objective: The real-time concentration results of the FTIR software will be compared to a validation check using an independent method of quantifying the gas.

Acceptance Criteria: MQO #4 will be considered to have been met if the real-time quantified result is within 25% of the expected value (i.e., the independently quantified value).

Corrective Action: If the system does not meet the acceptance criteria, the electronic records saved during the test will be sent to the equipment manufacturer or their representative to troubleshoot the issue.

3.4.5 - FLM System MQO #5 - Open Path UV – Challenge of System with Gas

Frequency: Monthly

Description: MQO #5 is a Quality Control check to ensure the UV air monitoring system is correctly quantifying target gases. A gas cell with a known concentration of Benzene and SO_2 gas will be introduced into the beam path of the UV air monitoring system. The values generated by the analyzer will be compared to the known value of the gas cell. Benzene and

SO_2 are used for this check as they have spectral absorption features that spans the spectral range of the spectrometer.

Measurement Quality Objective: Gas calibration cells that contain a mixture of benzene and SO_2 gas will be inserted into the beam path. The system will collect data with the calibration cells in the beam path and quantify concentrations of each gas.

Acceptance Criteria: MQO #5 will be considered to have been met if the quantified result is within 25% of the expected value (i.e., the gas concentration in the cell).

Corrective Action: If the system does not meet the acceptance criteria, the electronic records saved during the test will be sent to the equipment manufacturer or their representative to troubleshoot the issue.

3.4.6 - FLM System MQO #6 – Open Path UV- Signal Strength Validation

Frequency: Monthly

Description: MQO #6 is to check the light signal from the UV system and compare it to a known signal strength needed to meet the detection limits listed in Table 2 for the UV system.

Measurement Quality Objective: At the end of each month's maintenance activities, the signal strength of the UV beam will be measured and recorded.

Acceptance Criteria: MQO #6 will be considered to have been met if the system achieves a signal strength of 75% of full scale at a sample integration time of 750 milliseconds or less.

Corrective Action: If the system does not meet the acceptance criteria, the following tasks will be performed:

- A realignment of the source and receiver unit will be performed.
- If necessary, all optical components of the system will be cleaned.
- If necessary, the UV light source will be replaced.

3.4.7 - FLM System MQO #7 – Open Path UV - Signal-to-Noise Check

Frequency: Monthly

Description: MQO #7 is to determine the signal-to-noise ratio of the UV air monitoring system.

Measurement Quality Objective: The MQO is defined by using the following process to measure the system noise:

- Two back-to-back spectra will be subtracted from each other to create an absorbance spectrum.
- The peak-to-peak noise absorbance spectrum will be examined in the region of 252.00 to 255.00 nanometers.

Acceptance Criteria: MQO #7 will be considered to have been met if the peak-to-peak noise is less than 0.003 absorbance units in the measurement region.

Corrective Action: If the system does not meet the acceptance criteria, system troubleshooting will occur. Additional actions such as aligning the source optics, cleaning system optical equipment, and replacing the light sources may be conducted as necessary. If the system fails this MQO upon system recheck, the manufacturer will be contacted for further assistance.

3.4.8 - FLM System MQO #8 - Organic Gas Detector – Calibration and Gas Challenge

Frequency: Quarterly

Description: MQO #8 is to check the response of the OGDs by introducing a calibration gas and noting the instrument response.

Measurement Quality Objective: The operation of the OGDs will be validated by challenging them with a known quantity of methane gas and checking the system response.

Acceptance Criteria: MQO #8 will be considered to have been met if the quantified result is within 25% of the expected value.

Corrective Action: If the system does not meet the acceptance criteria, the manufacturer or their representative will be contacted to troubleshoot the issue.

3.4.9 - FLM System MQO #9 - TDL Hydrogen Sulfide - Challenge of System with Gas

Frequency: Monthly

Description: MQO #9 is to perform a manufacturer-recommended test to validate the operation of the TDL unit by exposing it to a quantity of H_2S gas and checking the system response.

Measurement Quality Objective: The operation of the TDL will be validated by challenging it with H_2S gas and checking the system response.

Acceptance Criteria: MQO #9 will be considered to have been met if the quantified result is above the analyzer detection limits.

Corrective Action: If the system does not meet the acceptance criteria, the electronic records saved during the test will be sent to the equipment manufacturer or their representative to troubleshoot the issue.

4 - Data Management

4.1 - Real-time Data Management

Data generated by the fence line monitoring equipment undergoes review throughout the measurement and reporting process. Included in this process are automated QA/QC checks that occur before data is reported on the real-time website. An automated system conducts the Quality Assurance checks before the data is reported to the website.

Data review will be overseen by the Data Processing Manager. No data will be altered in this process, but rather it will be considered valid or invalid and flagged accordingly. Automated real-time data checks are listed in Table 4.

Table 4 – Summary of Real-time Data Checks

Real-Time Check	System Check	Follow-up Activities
Low Signal	Signal Threshold Test for UV or TDL	If the signal is below the threshold value: 1) The real-time website reports "Low Signal" to analyzer, and 2) an automated email is sent to the Program Manager, Operations Manager, and Field Technician.
Instrument Error Code	Instrument Error Code	The real-time website will report an "off-line" message. An email will be sent to the Program Manager, Operations Manager, and Field Technician notifying them of the situation. If necessary, the website message board will be updated to inform public that analyzer troubleshooting underway. If necessary, the website message board will be updated when system is back on line.
Analyzer Off-line	Analyzer Communication Check	The real-time website will report an "off-line" message. An email will be sent to the Program Manager, Operations Manager, and Field Technician. If appropriate, the website message board will be updated to inform the public that an analyzer is off-line and troubleshooting is underway. If appropriate the website message board will be updated when system is back on line.
Internet Connection Lost	Backup Connection Enabled	An email is sent to the Field Technician, Program Manager, and Operations Manager. A backup connection is enabled.
High Detection	Data Detection Above Threshold	The real-time website indicates a detection above certain thresholds by a background color change for the gas. A notification is sent to the Operations Manager, Program Manager, Shift Supervisor, and Field Technician. The message board on the website will be updated with notification that Phillips 66 personnel are aware of the situation and are performing an investigation. Raw data will be examined to validate or invalidate the detection. The refinery will perform site survey to identify possible sources of the detection. The message board on the website will be updated once further information is available.

4.2 - Post-Processed Data Management

Data from the fence line system will be reviewed and validated on a monthly basis with the results stored in a separate portion of the monitoring database from the raw data. Data review and validation includes screening the entire data set for the following invalid data:

- Non-field data such as calibration data,
- Spurious data associated with power or mechanical issues, and
- Data with a light signal below predetermined thresholds.

This data review will be overseen by the Data Processing Manager. No data will be altered in this process, but rather it will be considered valid or invalid and flagged accordingly. Table 5 summarizes the process by which monitoring data is reviewed and post processed.

Table 5. Summary of Data Validation Process

Post Process Data Check	System/Data Check	Follow up Activities
Gas Detection	Target Gas Detections	The Data Processing Manager will validate or invalidate all gas detections from the monitoring equipment.
Non-field Data Check	Maintenance logs and QA/QC logs will be checked to see when systems were not in a normal operating mode.	The Data Processing Manager will flag any non-field data such as data obtained during periods of maintenance activities. Such data will be excluded from future reporting.
Spurious Data	Instrument error codes will be reviewed and flagged if instrument error codes are recorded. Data associated with these codes will also be reviewed. As necessary, other spurious data may warrant review on a case by case basis (e.g., event based data, etc.).	The Data Processing Manager will flag any data when instrument error codes are recorded. Such data will be excluded from future reporting. If necessary, the Data Processing Manager will evaluate data of interest on a case by case basis and make a determination regarding the confidence of the data to reach a conclusion regarding data validity.
Low Signal	Data will be reviewed for low signal. If low signal is recorded, data will be flagged and the reason for low signal will be recorded.	The Data Processing Manager will flag any data when low signal flags are recorded. Such data will be excluded from future reporting.

4.3 - Corrective Actions

Phillips 66 will investigate any portion of the fence line system that fails to meet the above measurement quality objectives, or on-stream efficiency requirements under Rule 12-15. The investigation team will include members of the fence line management team and appropriate equipment vendors to assess the problem and to initiate corrective action. In addition,

improvement opportunities identified will be considered as possible further action to minimize the chance for similar problems in the future.

Phillips 66 is allowed to upgrade the system, without prior consultation of other parties, with substantially equivalent equipment or software (i.e., equipment that does not diminish the sensitivity of the equipment or the fence line system) as necessary to maintain system operability. Changes to equipment described in this QAPP may trigger a change in the Quality Assurance/Quality Control requirements associated with the updated equipment.

4.4 - Data Reporting and Availability

4.4.1 Public and BAAQMD Access

Data from the fence line monitors will be transmitted to an internet website where the near-real-time results can be viewed by the public. Automated QA/QC checks that will occur prior to the data being displayed on the public website are discussed in Section 4.1 of this document. Under normal circumstances, a 5-minute average measurement will appear on the website within 10 minutes of the end of the measurement period. However, the data uploaded may be impacted by internet traffic. The website will also make available a rolling 24-hour trend of the 5-minute data for each gas reported.

Once QA/QC of the final data is completed within 60 days after the end of each calendar quarter, the refinery will provide one-hour average concentration data in tabular format through a comma separated value data file to the BAAQMD. The BAAQMD may make the one-hour average data available to the public through a BAAQMD website or through a public records request. As needed, the refinery will make data available to BAAQMD upon request prior to the report submittal.

4.4.2 Annual BAAQMD Reporting

Phillips 66 will submit an annual report to the BAAQMD that summarizes overall performance of the fence line monitoring system. The report will include the following performance indicators:

- On-stream efficiency
- Annual averages of gas concentrations
- Any instances of failed MQOs

5 - Maintenance

Specific tasks for periodic testing, inspection, and maintenance are required for the air monitoring equipment to provide sufficient quality control to remain within the manufacturer's operating specifications and ensure that the quality goals are met. Initial testing of each piece of equipment is conducted to ensure equipment operation is within the manufacturer's specifications. Operational checks are repeated during installation before initial calibration and use in measuring field conditions. Each monitor has manufacturer-recommended maintenance schedules that are found in the operating manuals.