Form Appendix H

BAY AREA AIR QUALITY MANAGEMENT DISTRICT
939 Ellis Street . . . San Francisco, CA 94109. . . (415) 749-4990 . . . FAX (415) 749-5030
Website: www.baaqmd.gov

APPENDIX H

ENVIRONMENTAL INFORMATION FORM

(To Be Completed By Applicant)

Date Filed: 6/23/16

General Information

1. Name and address of developer or project sponsor:
   Phillips 66 Company
2. Address of project: 1380 San Pablo Avenue, Rodeo, CA 94572-1354

   Assessor's Block and Lot Number: (see attachment to Appendix H)
3. Name, address, and telephone number of person to be contacted concerning this project:
   Brent P. Eastep (510) 245-4672
4. Indicate number of the permit application for the project to which this form pertains:
   ____
5. List and describe any other related permits and other public approvals required for this project, including those required by city, regional, state, and federal agencies:
   none
6. Existing zoning district: __________
7. Proposed use of site (Project for which this form is filed):
   Project is to increase crude and gas oil off-loading at the marine terminal.

Project Description

8. Site size.
9. Square footage.
10. Number of floors of construction.
11. Amount of off-street parking provided.
12. Attach plans.
13. Proposed scheduling.
14. Associated project.
15. Anticipated incremental development.

16. If residential, include the number of units, schedule of unit sizes, range of sale prices or rents, and type of household size expected.

17. If commercial, indicate the type, whether neighborhood, city or regionally oriented, square footage of sales area, and loading facilities.

18. If industrial, indicate type, estimated employment per shift, and loading facilities

19. If institutional, indicate the major function, estimated employment per shift, estimated occupancy, loading facilities, and community benefits to be derived from the project.

20. If the project involves a variance, conditional use or rezoning application, state this and indicate clearly why the application is required.

Are the following items applicable to the project or its effects? Discuss below all items checked yes. Attach additional sheets as necessary.

	Yes	No
21. Change in existing features of any bays, tidelands, beaches, or hills, or substantial alteration of ground contours.	☐	☒
22. Change in scenic views or vistas from existing residential areas or public lands or roads.	☐	☒
23. Change in pattern, scale or character of general area of project.	☐	☒
24. Significant amounts of solid waste or litter.	☐	☒
25. Change in dust, ash, smoke, fumes or odors in vicinity.	☐	☒
26. Change in ocean, bay, lake, stream or groundwater quality or quantity, or alteration of existing drainage patterns.	☐	☒
27. Substantial change in existing noise or vibration levels in the vicinity.	☐	☒
28. Site on filled land or on slope of 10 percent or more.	☐	☒
29. Use of disposal of potentially hazardous materials, such as toxic substances, flammables or explosives.	☐	☒
30. Substantial change in demand for municipal services (police, fire, water, sewage, etc.).	☐	☒
31. Substantially increase fossil fuel consumption (electricity, oil, natural gas, etc.).	☐	☒
32. Relationship to a larger project or series of projects.	☐	☒

Environmental Setting

33. Describe the project site as is exists before the project, including information on topography, soil stability, plants and animals, and any cultural, historical or scenic aspects. Describe any existing structures on the site, and the use of the structures. Attach photographs of the site. Snapshots or Polaroid photos will be accepted.

34. Describe the surrounding properties, including information on plants and animals and any cultural, historical or scenic aspects. Indicate the type of land use (residential, commercial, etc.), intensity of land use (one-family, apartment houses, shops, department stores, etc.), and scale of development (height, frontage, set-back, rear yard, etc.). Attach photographs of the vicinity. Snapshots or Polaroid photos will be accepted.

Certification

I hereby certify that the statements furnished above and in the attached exhibits present the data and information required for this initial evaluation to the best of my ability, and that the facts, statements, and information presented are true and correct to the best of my knowledge and belief.

6/23/16
Date

Signature

For Brent P Eastep

(Note: This is only a suggested form. Public agencies are free to devise their own format for initial studies.)

Phillips 66 Company - San Francisco Refinery
Form Appendix H – Addendum

Project Description

2. Assessors Block and Lot Numbers: The Phillips 66 Rodeo Refinery is situated on property with the following assessor's parcel numbers:

Parcel Number
357-310-003-3
357-310-005-8
357-310-006-6
355-040-002-6
355-040-003-4
357-010-002-8
357-010-003-6
357-300-005-0
357-300-008-4
357-310-001-7
357-310-002-5
355-040-009-1
357-320-002-3

8. Site size. *The project will be at the existing refinery.*

9. Square footage. *There will be no additional building square footage developed in association with this project.*

10. Number of floors of construction.

    There will be no construction in association with this project.

11. Amount of off-street parking provided.

    Because construction activities are not required, no additional parking facilities would be necessary.

12. Attach plans.

    There are no plans required.

13. Proposed scheduling.

    The modification would potentially be implemented upon approval and continue indefinitely.

14. Associated project.

This is a stand-alone project.

15. Anticipated incremental development.

    No additional incremental development is anticipated.

16. If residential, include the number of units, schedule of unit sizes, range of sale prices or rents, and type of household size expected.

    Not Applicable.

17. If commercial, indicate the type, whether neighborhood, city or regionally oriented, square footage of sales area, and loading facilities.

    Not Applicable.

18. If industrial, indicate type, estimated employment per shift, and loading facilities.

    The proposed project will not require additional operator support or employment.

19. If institutional, indicate the major function, estimated employment per shift, estimated occupancy, loading facilities, and community benefits to be derived from the project.

    Not Applicable.

20. If the project involves a variance, conditional use or rezoning application, state this and indicate clearly why the application is required.

    None Required.

21. Change in existing features of any bays, tidelands, beaches, or hills, or substantial alteration of ground contours.

    No physical modifications are necessary for project implementation. The project would have no effect on bays, tidelands, beaches, or hills, or substantial alteration of ground contours.

22. Change in scenic views or vistas from existing residential areas or public lands or roads.

    No physical modifications are necessary for project implementation. The Project would have no effect on a scenic vista, and would not degrade the existing visual character or quality of the site and its surroundings.

23. Change in pattern, scale or character of general area of project.

The proposed project would not change the pattern, scale or character of the general area. The refinery is located at a site zoned and planned for heavy industrial use.

24. Significant amounts of solid waste or litter.

    The Project would not generate additional quantities of solid waste.

25. Change in dust, ash, smoke, fumes or odors in vicinity.

    During operation, the proposed project would not result in an increase in emissions above already permitted levels. Project operation emissions will be reviewed and permitted by BAAQMD and will comply with applicable requirements.

26. Change in ocean, bay, lake, stream or groundwater quality or quantity, or alteration of existing drainage patterns.

    The project would not result in a change to the quality or quantity of water in San Pablo Bay or groundwater in the vicinity.

    The project does not propose to alter existing site drainage patterns. No excavation, cutting, filling or changing of contours is required.

27. Substantial change in existing noise or vibration levels in the vicinity.

    There will be no new noise-generating equipment included as part of the project. There will be no perceptible increases in existing noise levels.

28. Site on filled land or on slope of 10 percent or more.

    The proposed project site is within the existing refinery. No site grading is required for this project.

29. Use of disposal of potentially hazardous materials, such as toxic substances, flammables or explosives.

    The project does not anticipate use or disposal of any hazardous materials, toxic substances or explosives. The use or disposal of any of these types of materials present at the refinery would not change as a result of this project.

30. Substantial change in demand for municipal services (police, fire, water, sewage, etc.).

    The Refinery has emergency response teams that are trained and equipped to respond to fires, rescues, hazardous material releases, and *other emergencies that could occur at the Refinery. This project would not increase the probability of fires, rescues, hazardous material releases, and other emergencies that would require by refinery personnel or outside municipal services.*

31. Substantially increase fossil fuel consumption (electricity, oil, natural gas, etc.).

    The proposed project would not increase fossil fuel consumption at the refinery.

32. Relationship to a larger project or series of projects.

    This is a stand-alone project.

Environmental Setting

33. Describe the project site as is exists before the project, including information on topography, soil stability, plants and animals, and any cultural, historical or scenic aspects. Describe any existing structures on the site, and the use of the structures. Attach photographs of the site. Snapshots or Polaroid photos will be accepted.

    The project would be undertaken at the existing refinery, a previously disturbed, leveled, industrialized area currently occupied with refinery equipment. Existing structures include distillation columns, heaters, compressors, pumps, pipe racks and process vessels. No physical changes to existing equipment or the site are proposed as part of this project.

34. Describe the surrounding properties, including information on plants and animals and any cultural, historical or scenic aspects. Indicate the type of land use (residential, commercial, etc.), intensity of land use (one family, apartment houses, shops, department stores, etc.), and scale of development (height, frontage, setback, rear yard, etc.). Attach photographs of the vicinity. Snapshots or Polaroid photos will be accepted.

    The proposed project would be located entirely within the Phillips 66 Refinery. The refinery encompasses a total of 1,100 acres of land consisting of the 495-acre active area of the Refinery, and another 600 acres of undeveloped areas. The property is zoned Heavy Industrial.

Land uses to the northeast of the Refinery are a combination of industrial (Shore Oil Terminal to the north) and undeveloped open space to the east. Land use to the south is light industry, the Bayo Vista residential area is to the southwest, beyond a 300-600 foot undeveloped area, and San Pablo Bay is to the west. Both undeveloped areas are Phillips 66 property and are maintained as greenbelt areas between the developed portion of the refinery property and adjacent lands.

The barren and urban areas of the developed refinery complex provide little to no habitat for plants and animals. Urban habitat (including eucalyptus tree groves, street strips, and other landscaped features around office and administration buildings) provides for occasional use by wildlife (e.g., doves and sparrows). Undeveloped areas to the north, east and south are primarily non-native grassland and coastal scrub. Wildlife commonly found in these habitats include mice, gophers, ground squirrels, red fox, gopher snakes, red-tailed hawk, American kestrel and black-tailed deer. Freshwater, saltwater and brackish marsh wetlands are found in the southwestern part of the Refinery Complex. Plants found here include wetland grasses, sedges, rushes, and cattails. Animals include salt marsh harvest mouse, waterfowl and shorebirds.

There are no known sites of cultural significance in the vicinity of the refinery, and the only historical resource, the Selby Smelter, is no longer present. The Refinery has been an active industrial facility for more than 100 years and is an established part of the visual landscape of the area. It is the dominant visual feature, particularly from Interstate 80, which separates the main Refinery process area and storage tank facilities from another portion of the tank farm. It contrasts with the rolling and grassy hills to the east and north, residential areas to the south, and views of San Pablo Bay at Rodeo's western waterfront, including a diverse mixture of salt marshes, railroad tracks, industrial activities, housing and parkland.

Prepared for:
Phillips 66
San Francisco Refinery

Estimated Emissions Increases and Human Health Risk Impacts Associated with the Marine Terminal III Project

Phillips 66 San Francisco Refinery
Rodeo, California

June 2016

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The world's leading sustainability consultancy

ERM

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LIST OF ACRONYMS

µg	micrograms
µg/m³	micrograms per cubic meter
ASF	age sensitivity factor
BAAQMD	Bay Area Air Quality Management District
bbl	barrels
CARB	California Air Resources Board
CO	carbon monoxide
DPM	diesel particulate matter
DWT	dry weight tonnage
ERM	ERM-West, Inc.
g/kW-hr	grams per kilowatt-hour
g/s	grams per second
HC	hydrocarbons
HI	hazard index
hp	horsepower
HRA	health risk assessment
IMO	International Maritime Organization
kW	kilowatt
L/kg BW-day	liters per kilogram of body weight per day
LF	load factor
MEIR	maximum exposed individual at a residence
MEIW	maximum exposed individual at a place of work
mg	milligram
mg/kg BW-day	milligrams per kilogram of body weight per day
nm	nautical miles
NOx	nitrogen oxides
OEHHA	Office of Environmental Health Hazard Assessment
OGV	Ocean-Going Vessel
Phillips 66	Phillips 66 – San Francisco Refinery
PM	particulate matter
PM_{10}	PM with aerodynamic diameters less than 10 micrometers

$PM_{2.5}$	PM with aerodynamic diameters less than 2.5 micrometers
POC	Precursor organic compounds
PSD	prevention of significant deterioration
PTO	Permit to Operate
MDO	Marine Distillate Oil
ROG	reactive organic gases
SO_2	sulfur dioxide
SOx	sulfur oxides
TAC	toxic air contaminant
USEPA	U.S. Environmental Protection Agency
UTM	Universal Transverse Mercator
VOC	volatile organic compounds

EXECUTIVE SUMMARY

The Phillips 66 San Francisco Refinery in Rodeo, California, is proposing to increase the allowable crude and gas oil delivered to its Marine Terminal to a total of 130,000 barrels per day (bbl/day) based on a 12-month rolling average. The current Permit to Operate (PTO) issued by the Bay Area Air Quality Management District (BAAQMD) currently limits the Marine Terminal to 51,182 bbl/day based on a 12-month rolling average, approved in 2012. This proposed increase would not change the overall amount of crude and gas oil that the refinery is currently permitted to process.

This document presents estimated emissions for the proposed action, as well as an assessment of potential health risks posed by the proposed allowable emissions increases. This information is provided for consideration by the BAAQMD in assessing this project compared to an historical baseline and for amendment of the current air permit.

Section 2.0 of this document presents estimated air emissions increases as a result of the proposed increase in allowable crude and gas oil deliveries to the Phillips 66 Marine Terminal. These would include marine vessel main and auxiliary engine emissions while transiting and maneuvering in California Coastal Waters and through San Pablo Bay to the Marine Terminal, and vessel emissions from auxiliary engines and boilers for pumping and/or space/ water heating during hoteling at the Marine Terminal. Two emissions scenarios are described:

- Historical Baseline Assessment. Emissions increases with an increased shipping volume of 99,318 bbl/day (on a 12-month rolling average basis), which is relative to the pre-2012 baseline of 30,682 bbl/day average.
- Air Permitting Assessment. Emissions increases with an increase in shipping volume of 78,818 bbl/day (on a 12-month rolling average basis), which is relative to the current permitted limit of 51,182 bbl/day average.

The Historical Baseline Assessment scenario is provided for purposes of project assessment compared to the previous marine terminal activity levels, given that this new request is only 4 years after the prior increase permitted at the Marine Terminal. For historical baseline purposes, Section 2.0 provides emission estimates from the pre-2012 baseline of 30,682 bbl/day to 130,000 bbl/day on a 12-month rolling average basis for marine vessel activity from the Sea Buoy (11 nautical miles (nm) out from the Golden Gate) to the Phillips 66 Marine Terminal berth, hoteling at the Marine Terminal, and back out to the Sea Buoy.

The Air Permitting Assessment scenario is provided for air permitting purposes for amending the current air permit limit of 51,182 bbl/day to 130,000 bbl/day on a 12-month rolling average basis. For air permitting purposes, emissions under BAAQMD jurisdiction include only vessel hoteling and pumping emissions while berthed at the Marine Terminal. However, required facility emissions to be offset also include vessel transiting and maneuvering emissions from the Sea Buoy to the Marine Terminal and back to the Sea Buoy, so for this purpose, these are also calculated under the assumptions of this scenario and presented in Section 2.0.

Emissions include diesel particulate matter (DPM) and other toxic air contaminants (TACs) that can pose human health risks, which were estimated for the proposed action by a health risk assessment (HRA). Air dispersion modeling was performed as described in Section 3.0, and an HRA prepared under both scenarios following recently revised guidelines issued by the California Office of Environmental Health Hazard Assessment (OEHHA) as described in Section 4.0. Results are reported for maximum cancer risks and for hazard indices (HIs) for chronic and acute non-cancer health effects. Thresholds for significant health impacts are cancer risks greater than 10 in one million and HIs exceeding 1.0.

One HRA run supports the historical baseline (Historical Baseline Assessment) and the other supports air permitting (Air Permitting Assessment). Impacts from marine vessel transiting, maneuvering, and while docked at the Marine Terminal were included in the Historical Baseline Assessment. For air permitting, only impacts while marine vessels were docked were included. Table ES-1 summarizes the maximum health risk findings.

Table ES-1 Summary of Health Risk Assessment

	Residential	**Offsite Worker**
Historical Baseline Assessment		
Cancer Risk	9.85 in one million	0.72 in one million
Chronic Hazard Index	0.008	0.009
Acute Hazard Index[1]	0.54	0.77
Air Permitting Assessment		
Cancer Risk	5.71 in one million	0.48 in one million
Chronic Hazard Index	0.006	0.007
Acute Hazard Index[1]	0.54	0.77

[1] Note: The maximum acute emissions case is one marine vessel docked in any given hour, thus the maximum acute HI case is the same for both runs.

1.0 INTRODUCTION

1.1 Purpose of Document

The Phillips 66 San Francisco Refinery (Phillips 66) requested ERM-West, Inc. (ERM) to prepare detailed marine vessel emissions estimates and a health risk assessment (HRA) of its proposed increase in crude and gas oil delivered to their Marine Terminal. The purpose of this document is to provide a description of the methodologies used to develop the marine vessel emissions estimates and HRA, as well as present the results. The marine vessel emissions estimates and HRA will be used during the permitting process under the jurisdiction of the Bay Area Air Quality Management District (BAAQMD) and also in evaluating the potential impacts to air quality required compared to an historical baseline.

1.2 Proposed Project Description

Phillips 66 is seeking to increase the allowable crude and gas oil delivered to its Marine Terminal to a total of 130,000 barrels per day (bbl/day) based on a rolling 12-month average, termed in this document as the "Marine Terminal III Project." Currently Permit Condition 4336, Part 7 (PC 4336-7) limits the amount of crude and gas oil delivered to 51,182 bbl/day based on a rolling 12-month average.

In 2012, Phillips 66 obtained a revision to the existing Permit to Operate (PTO) and a Minor Revision to the Major Facility Review (Title V) Permit issued by BAAQMD to the Phillips 66 San Francisco Refinery (BAAQMD Facility #A0016). Phillips 66 requested an increase of 20,500 bbl/day in the Marine Terminal (S425, S426) offloading limit contained in PTO Permit Condition 4336-7. Upon BAAQMD approval, this limit was increased from 30,682 to 51,182 bbl/day, on a 12-month rolling average basis. This previous project was described in the *Marine Terminal Offload Limit Revision Project Initial Study* (BAAQMD 2012).

Phillips 66 does not propose to make any physical changes to the Marine Terminal or any associated equipment at the refinery. This proposed increase would not change the overall amount of crude and gas oil that the refinery intends to process. It is simply a change in how the refinery may receive its crude oil supplies. There will be no increase in the total amount of crude and gas oil currently permitted to be processed by the Phillips 66 refinery.

Phillips 66 recognizes that the proposed marine vessel delivery limit increase is requested only 4 years after the prior increase permitted at the Marine Terminal. Thus, the analysis described in this document compares the proposed marine vessel emission increases and impacts to levels consistent with both the currently permitted operation, and operations prior to 2012. This would establish emission increases from current permit limit, as well as a total emissions increase from all recently requested marine vessel delivery increases combined.

The pre-2012 marine vessel delivery baseline was 30,682 bbl/day. Therefore the net increase in requested maximum marine vessel deliveries from this pre-2012 baseline is 99,318 bbl/day. This delivery volume increase was used to estimate the total change in associated criteria pollutant emissions as well as increase in health risks since the pre-2012 baseline.

As part of the *Marine Terminal Offload Limit Revision Project* (BAAQMD 2012), the mass emissions increase of nitrogen oxides (NO_x) was mitigated to net zero through the surrender of offsets. Phillips 66 intends to also offset the proposed NO_x emissions increase associated with the proposed additional marine vessel deliveries. The current permit limit for marine vessel deliveries is 51,182 bbl/day, which would establish a net increase for offsetting purposes of 78,818 bbl/day to reach the desired total maximum marine vessel delivery limit of 130,000 bbl/day.

1.3 Air Permitting Assessment

1.3.1 Air Permitting Emissions Increases

Emission increases from receiving an additional 78,818 bbl/day by marine vessel (the proposed increment from the current PTO limit of 51,182 bbl/day) would be associated with marine vessels while traveling within BAAQMD waters and while berthed at the Marine Terminal. For stationary source permitting purposes, including compliance with prevention of significant deterioration (PSD) applicability, only the emissions from ships at the wharf are considered.

For purposes of offsets required by BAAQMD Rules 2-2-302 and 2-2-303, ship transit emissions must also be included in addition to emissions at the wharf while the ship is docked. The transit distance extends from the Marine Terminal out to 11 nautical miles (nm) west of the Golden Gate Bridge, which is the location where licensed Bar Pilots are required to navigate into the San Francisco Bay. Emissions associated with marine vessel deliveries up to the current 51,182 bbl/day limit have already been offset, so emissions subject to offsets would be those associated with the additional proposed 78,818 bbl/day marine vessel deliveries, as previously mentioned.

1.3.2 Air Permitting Health Risk Assessment

An HRA was performed to evaluate the potential increase in cancer and non-cancer chronic health risks from ship emissions increases at the berth. BAAQMD

Rule 2-5 (New Source Review of Toxic Air Contaminants [TACs]) requires analysis of impacts from TAC emissions from new or modified sources, subject to BAAQMD Rule 2-1. This analysis was based upon the additional 78,818 bbl/day of marine vessel deliveries as just discussed.

1.4 Historical Baseline Assessment

1.4.1 Historical Baseline Emissions Increases

Emission increases from receiving an additional 99,318 bbl/day by marine vessel (the proposed increment from the pre-2012 baseline of 30,682 bbl/day) for the historical baseline impact analysis would be associated with marine vessels while traveling within BAAQMD waters and while berthed at the Marine Terminal. There would not be any construction emissions associated with the project, or any other operational emission increases.

1.4.2 Historical Baseline Health Risk Assessment

Health risk impacts for the historical baseline analysis evaluated cancer risk and chronic non-cancer health effects from vessel transit to the refinery and hoteling at the berth. In addition, acute health effects were evaluated for activities occurring while the vessels are hoteling at the Marine Terminal. This analysis was based upon the additional 99,318 bbl/day of marine vessel deliveries as just discussed.

2.0 MARINE VESSEL EMISSIONS

The Marine Terminal III Project emissions are from engines and boilers operating on ships and barges associated with off-loading crude and gas oils at the Phillips 66 Marine Terminal, and associated tugboat emissions. Criteria pollutant and TAC emission increases that occur while ships and barges are stationed at the Phillips 66 Marine Terminal would be used to determine PSD applicability as described in Regulation 2-2. Additional emissions of criteria pollutants are estimated for ships and barges transiting out 11 nm from the Golden Gate Bridge for purposes of offsetting criteria pollutant emissions. For purposes of the HRA, TAC emissions from transiting a few nautical miles to and from the Marine Terminal are also assessed so the health impact from these emissions are included for sensitive receptors located near the Phillips 66 Marine Terminal.

2.1 Methodology

This section describes the methodology used to develop the emission inventories to quantify both criteria pollutant and TACs associated with increased ship and barge calls to the Phillips 66 Marine Terminal. For the various types of marine vessels, emissions are estimated by the source's activity multiplied by an emission factor characteristic of that source for each pollutant. Section 2.1.1 describes the vessel types. Section 2.1.2 describes the ship and barge characteristics that are needed to define the ship and barge activities. Section 2.1.3 details criteria pollutant emission factors that are characteristic of the ship and barge sources. Finally, Section 2.1.4 describes the speciation profiles used to develop TAC emission estimates for the HRA.

2.1.1 Vessel Types

There are several types of vessels that may be used to deliver crude and gas oil to the Phillips 66 Marine Terminal. Barges are typically used to deliver small loads of crude or gas oil to the refinery. Tankers are the type of ship vessel used to deliver larger quantities of crude or gas oil to the refinery. Tankers come in a wide variety of sizes and carrying capacities. A typical classification for tankers is based on the total dry weight tonnage (DWT) of a tanker. A Panamax tanker has a DWT between 50,000 and 79,999 and can carry around 500,000 bbl of crude. An Aframax tanker has a DWT between 80,000 and 119,999 and can carry around 750,000 bbl of crude. A Suezmax tanker has a DWT between 120,000 and 199,999 and can carry around 1,000,000 bbl of crude.

Phillips 66's history of recent ship calls to its Marine Terminal was evaluated to determine the types of vessels that typically deliver crude and gas oils. While Phillips 66 had vessels of various sizes including tankers from the Panamax, Aframax, and Suezmax classes, the majority of tankers could be placed in either the Suezmax or Panamax class. To simplify vessel classification of the ship call history, tankers were classified as"Suezmax" or "Panamax" tankers. Information on tanker size was based on vessel name and International Maritime Organization (IMO) number for all tankers that could be found in publicly available sources. The ship call history also indicated the number of barge calls. Once the tanker and barge calls were classified, the average amount of crude and gas oil unloaded per call per vessel class was estimated. Based on Phillips 66's recent history, 60 percent of crude and gas oil volume was delivered by Suezmax vessels, 30 percent by volume was delivered by Panamax vessels and 10 percent by volume was delivered by barges. According to discussions with Phillips 66 staff from the Marine Terminal, about 40-60 percent of vessels use a boiler to offload crude and gas oil. Therefore, it was assumed that all Suezmax tankers used a boiler for product offloading, which is consistent with this estimate. Panamax tankers were assumed to use their auxiliary engines to offload crude and gas oil. Table 2-1 summarizes the vessel classification used to determine the types of vessels analyzed for these emission estimates. Engine sizes for the various tanker classes were found in the *Port of Long Beach Air Emissions Inventory – 2011* (Starcrest 2012).

Table 2-1 Vessel Characteristics

Characteristics	**Vessel Type**		
	Suezmax Tanker	Panamax Tanker	Barge
DWT	120,000-199,999	50,000-79,999	--
Average load bbl per call	415,991	283,070	61,444
% of total volume	60%	30%	10%
Total number of calls - historical baseline increment	54.92	40.35	61.97
Total number of calls - air permit increment	44.13	32.42	49.79
Total main engine Size	18,587 kW	11,060 kW	--
Auxiliary engine size	988 kW	867 kW	99 kW
Boiler size	3,000 kW	--	--

kW = Kilowatts

Tugboats are also used to guide vessels as they transit through the San Francisco Bay and maneuver into the berths. Suezmax and Panamax tankers require one to four tugs at various phases in their pathway from sea to berth. Barges typically are paired with a tug to provide propulsion and require additional tugs for some phases for steering and guidance. Table 2-2 shows the assumptions used for tug assistance. The engine size of the tugs is based on the Port of Richmond 2005 Emission Inventory, which lists values for Class A tugs (Moffatt & Nichol et al. 2010).

Table 2-2 Tugboat Characteristics

Characteristics	Vessel Type		
	Suezmax Tanker	Panamax Tanker	Barge
At berth	0	0	1
Maneuvering	3	2	2
Transiting	2	2	2 to Sea Buoy 25 1 other areas
Main engine size	4,344 hp	4,344 hp	4,344 hp
Auxiliary engine size	128 hp	128 hp	128 hp

hp = Horsepower

2.1.2 Ship and Barge Activity

Ships and barges may have up to three main types of emission sources: propulsion main engines, auxiliary engines, and auxiliary boilers. Typically barges do not have propulsion main engines, but rely on tugboats for propulsion. Tugboats are required to guide ships and barges through the San Francisco Bay. Tugboats typically have propulsion main engines and auxiliary engines. Tugboat emissions are included with transiting activities. For barges, one tug is assumed to be parked with a barge at all times.

Activities for vessels are typically discussed by referencing three modes of operation: transiting, maneuvering, and hoteling at berth. Transiting occurs when the vessel is moving from the outer sea into the San Francisco Bay and continuing through the Bay along the deep water ship channel until it is near the Marine Terminal. Maneuvering occurs as the engine is in its final approach to the berth. During maneuvering, the vessel will decrease main engine activity and start to increase auxiliary engines and boilers in preparation for mooring. Once the vessel is moored, it is considered to be hoteling at the Marine Terminal. While hoteling, the main engines are not in operation. Boilers and/or auxiliary engines will be operating to provide power to unload the crude or gas oil and to operate any necessary ship lighting and other miscellaneous auxiliary equipment.

To describe the vessel activities that may occur, the vessel types that may call on Phillips 66 were characterized. The following subsections describe the detailed activity occurring at the berth and during transiting and maneuvering.

2.1.2.1 Hoteling at Berth Activities

The vessel upon reaching the berth properly moors (secures with ropes to the berth) and conducts inspections. Once the vessel is properly moored and inspected, the vessel will begin to unload the crude and gas oils via pipeline. The pumping action is driven by either an auxiliary internal combustion engine or a boiler used to drive a hydraulic pump. It was assumed that the pumping rate is 20,000 bbl per hour. This was based on conversations with Phillips 66 Marine Terminal staff on rates of unloading, evaluation of historical time spent at berth and amount unloaded. After product is unloaded, the vessel starts the unmooring process. Occasionally a vessel may need to wait at the berth until the tides are at the proper level and they have been cleared to transit through the shipping channel. Based on discussions with Phillips 66 Marine Terminal staff and analyzing historical ship call information at Phillips 66 Marine Terminal, it was estimated that an additional 6 hours is required beyond the pumping time to account for mooring, inspecting, and unmooring activities.

2.1.2.2 Transiting and Maneuvering Activities

To estimate the vessel's transit time, the vessel routes from the Sea Buoy (Pilot boarding point) located 11 nm west of the Golden Gate Bridge to the Phillips 66 Marine Terminal were considered. The distance and speed that vessels travel are important in estimating emissions during transiting and maneuvering. Table 2-3 shows the distances, assumed transiting speeds, and travel time for several key travel segments. An additional 0.25 hour each way was added to maneuvering to account for positioning during mooring and unmooring. For the HRA, only segments between San Pablo Point and the Phillips 66 Marine Terminal were included. The full segment length out to the Sea Buoy was included for analysis of criteria pollutant emissions for purposes of assessing emissions offset requirements. Tugs were assumed to travel along vessels for the entire length considered in the HRA. Tugs were assumed to travel the same amount of total time as vessels for criteria pollutant estimates toward emissions offset requirements.

Table 2-3 Transiting Segment Characteristics

Segment	Distance (nm)	Speed (knots)	Time (hours)
Pilot Station Sea Buoy to Mile Rock 1 nm west of Golden Gate Bridge	10	12	0.83
Mile Rock (1 nm west of Golden Gate Bridge) - SPB Light #5	19	10	1.90
SPB Light #5 to Richmond-San Rafael Bridge	2.02	8	0.25
Richmond-San Rafael Bridge-Maneuvering	9.77	8	1.22
Maneuvering-Berth	0.2	5	0.29
Berth-Maneuvering	0.2	5	0.29
Maneuvering to Richmond-San Rafael	9.77	8	1.22

Bridge			
Richmond-San Rafael Bridge to SPB Light #5	2.02	8	0.25
SPB Light #5– Mile Rock 1 nm west of Golden Gate bridge	33	10	3.3
Mile Rock 1 nm west of GG bridge to Pilot Station Sea Buoy	10	12	0.83
Total Round Trip	95.96		10.39

nm = nautical miles

The load on the main and auxiliary engines as well as boilers varies depending on the travel phase. The engine loads or loaded power ratings are shown in Table 2-4. The maneuvering and transiting load factor (LF) is based on a power law corresponding to vessel speed as described in the *Port of Long Beach Air Emissions Inventory – 2013* (Starcrest 2014). This LF is combined with the total engine power to estimate the loaded power rating. Auxiliary engine loaded power ratings were taken from the *Port of Long Beach Air Emissions Inventory – 2013* (Starcrest 2014), which is based on observations of loaded power ratings for tanker auxiliary engines while in use. Since this is a loaded power rating, it is not combined with an LF. For auxiliary engines on barges, the loaded power rating value for an ocean tug auxiliary engine reported in the *Port of Long Beach Air Emissions Inventory – 2013* (Starcrest 2014) was used. Tug load factors were taken from the *Port of Richmond 2005 Emissions Inventory* (Moffatt & Nichol et al. 2010). Boiler loads during maneuvering were based on the *Port of Long Beach Air Emissions Inventory – 2011* (Starcrest 2012).

Table 2-4 Engine Loads or Loaded Power Rating

	Phase	Suezmax Tanker	Panamax Tanker	Barge	Tug
Main engine	At Berth	0	0	NA	0
	Maneuvering	0.037 (LF)		NA	0.31 (LF)
	Transiting	0.15 @8 knots (LF) 0.30 @ 10 knots (LF) 0.512 @12 knots (LF)		NA	
Auxiliary engine	At Berth	778 kW	683 kW	99 kW	0.43 (LF)
	Maneuvering	988 kW	867 kW	99 kW	
	Transiting	718 kW	630 kW	99 kW	
Boiler	At Berth	1 (LF)	NA	NA	NA
	Maneuvering	0.12 (LF)	NA	NA	NA
	Transiting	0	NA	NA	NA

LF = Load factor
kW = Kilowatts
NA = Not applicable

2.1.3 Criteria Pollutant Emission Factors

Criteria pollutant emission factors are based on the engine or boiler type, fuel type, and other factors. Emission factors are listed in Table 2-5.

2.1.3.1 Tanker Main Engines

The emission factors for main engines for both the Suezmax and Panamax tankers were derived from the base emission factors from the California Air Resources Board (CARB) Ocean-Going Vessel (OGV) emission inventory methodology, *Emissions Estimation Methodology for Ocean-Going Vessels*, Appendix D, Tables II-6 and II-7 (CARB 2011). The emission factor for a slow engine speed using 0.1 percent sulfur Marine Distillate Oil (MDO) was used. These emission factors are adjusted upward in Table 2-5 to account for increased emissions under low load, based on the low load adjustment multipliers listed in the Port of Long Beach's 2013 Emission Inventory (Starcrest 2014) for any loads less than 20 percent.

2.1.3.2 Tanker Auxiliary Engines

The emission factors for auxiliary engines for both the Suezmax and Panamax tankers are based on the emission factor for auxiliary engines using 0.1 percent sulfur from CARB *Emissions Estimation Methodology for Ocean-Going Vessels* (CARB 2011).

2.1.3.3 Tanker Boilers

The emission factors for boilers are based on emission factors from CARB *Emissions Estimation Methodology for Ocean-Going Vessels* (CARB 2011) adjusted to 0.1 percent sulfur fuel using fuel correction factors listed in the Port of Long Beach's 2011 Emission Inventory (Starcrest 2012).

2.1.3.4 Barge Auxiliary Engines

The emission factors for auxiliary engines for barges are based on the emission factors for auxiliary engines using 0.1 percent sulfur from CARB *Emissions Estimation Methodology for Ocean-Going Vessels* (CARB 2011).

2.1.3.5 Tug Main and Auxiliary Engines

The emission factors for main and auxiliary engines in tugs are based on emission factors used in the *Port of Richmond 2005 Emissions Inventory* (Moffatt & Nichol et al 2010), which incorporate typical fleet characteristics of Class A tugs used in the San Francisco Bay following CARB's harbor craft emission factor methodology using deterioration factors (CARB 2007).

Table 2-5 Vessel and Tug Emission Factors

Vessel Type	Engine Type	Segment	PM	ROG	NOx	SO_2	CO
			g/kW-hr				
Suezmax & Panamax Tanker	Main	Maneuvering	0.9959	7.008	2.34184	0.00282	9.044
		Transiting	0.2553 @8 knot 0.23 @10-12 knots	0.816 @ 8 knot 0.6 @ 10-12 knots	0.8501 @8 knot 0.802 @10-12 knots	0.3924 @ 8 knots 0.36 @ 10-12 knots	1.848 @ 8 knots 1.4 @ 10-12 knots
	Auxiliary	All modes	0.25	0.52	13.9	0.42	1.1
	Boiler (Suezmax tanker only)	All modes	0.136	0.11	1.97	0.61	0.2
Barge	Auxiliary	All modes	0.25	0.52	13.9	0.42	1.1
Tugs	Main	All modes	0.44	0.69	11.41	0.09	2.82
	Auxiliary	All modes	0.59	0.85	11.13	0.09	3.3

g/kW-hr = grams per kilowatt-hour

ROG = reactive organic gases -- used interchangeably with volatile organic compounds (VOC) in this document, as explained further in a footnote in Section 2.2.1.

SO_2 = sulfur dioxide

2.1.4 TAC Speciation Profiles

For the main and auxiliary engines, it was assumed that the TAC was diesel particulate matter (DPM) and that this was equivalent to the particulate matter (PM_{10}) emissions. For boilers, the volatile organic compound (VOC) emissions were speciated based on CARB speciation profile 504 for hydrocarbons (HC). The PM_{10} emissions for boilers were speciated based on combination of USEPA PM speciation profiles 127102.5 and 5676. In this combined speciation profile, the highest value was used if a chemical was listed in both profiles. Table 2-6 shows the speciation profile used for boilers, restricting it to those chemicals that have an acute, chronic, or cancer toxicity value according to the California Office of Environmental Health Hazard Assessment (OEHHA).

Table 2-6 Boiler Speciation Profile

Chemical	Weight Fraction	Weight Fraction Basis
Arsenic	0.00002	PM_{10}
Benzene	0.0216	HC
Cadmium	0.0000288	PM_{10}
Chlorobenzene	0.0005	HC
Copper	0.0000504	PM_{10}
Ethylbenzene	0.0007	HC
Formaldehyde	0.001	HC
Hexane	0.0159	HC
Lead	0.00032	PM_{10}
m-Xylene	0.0045	HC
Naphthalene	0.007	HC
Nickel	0.00718	PM_{10}
o-Xylene	0.0031	HC
Propylene	0.0456	HC
Selenium	0.00002	PM_{10}
Sulfate	0.441766	PM_{10}
Toluene	0.0215	HC
Vanadium	0.018309	PM_{10}
Xylenes	0.0034	HC

PM_{10} = Particulate matter with aerodynamic diameter less than 10 micrometers
HC = Hydrocarbon

2.2 Mass Emissions of Criteria Pollutants and TACs

The detailed characteristics of the vessels, barges, and tugs are combined with emission factors to calculate the total mass of emissions emitted. The generalized equation for emissions is the following:

*Emissions = Activity * Emission Factor*

For marine engines and boilers, activity is a combination of the in-use or loaded engine power (kW or hp) multiplied by the amount of time over which the activity occurs. Emission factors for marine engines and boilers are given as a mass of pollutant per loaded power per time (e.g., g/kW-hr). In the previous sections, the detailed activity and emission factors for the Phillips 66 Marine Terminal III Project were presented. This section combines this activity data with the emission factors to arrive at total emissions.

2.2.1 Criteria Pollutant Emissions

Criteria pollutants are those pollutants that have an ambient air quality standard or are precursors to such pollutants. This includes coarse particulate matter with aerodynamic diameters of 10 micrometers or less (PM_{10}) and fine particulate matter with aerodynamic diameters of 2.5 micrometers or less ($PM_{2.5}$). Other criteria pollutants include VOC[1], NO_x, sulfur dioxide (SO_2)[2], and carbon monoxide (CO).

2.2.1.1 Criteria Pollutant Emissions Including Tankers and Barges from Sea Buoy

Using the activity and emission factors described earlier, Table 2-7 shows total emissions for activity from the Sea Buoy (11 nm west of the Golden Gate) to the Phillips 66 Marine Terminal berth, hoteling at the Marine Terminal, and back out to the Sea Buoy. Table 2-7 shows emissions for the two emission scenarios over this distance assessed in this report.

The first scenario (Historical Baseline Assessment) shows the emissions for an increase in shipping volume of 99,318 bbl/day (on a 12-month rolling average basis), which is the total criteria pollutant emissions increase that would occur compared to the shipping levels prior to the *Marine Terminal Offload Limit Revision Project* in 2012. The pre-2012 baseline was 30,682 bbl/day average. These are the emissions values that would be used in a historical baseline analysis for comparison of mass emission increases for the project compared to the historical pre-Marine Terminal II project emission levels.

The second scenario (Air Permitting Assessment) shows the emissions for an increase in shipping volume of 78,818 bbl/day (on a 12-month rolling average basis), which represents the additional proposed criteria pollutant emissions above the current permitted limit of 51,182 bbl/day average. These are the values that would be used to determine what offsets would be applicable to the project under BAAQMD Regulation 2-2. Emissions up to the 51,182 bbl/day were offset under the previous Marine Terminal project (BAAQMD 2012).

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[1] Used here, VOC means precursors to ozone formation, or "precursor organic compounds" (POC) as defined by the BAAQMD. In Tables 2-7 and 2-8, these are tabulated as VOC, but come from literature sources that either tabulate these emissions as ROG or HC, depending on the emissions source. Treating these all as POC is conservative.

[2] In Tables 2-7 and 2-8 as SO_2, but come from literature sources that either tabulate these emissions as SO_2 or sulfur oxides (SOx), depending on the emissions source. Most SOx emissions from combustion source become SO_2, thus a slightly conservative interpretation.

Table 2-7 Annual Criteria Pollutant Emissions Increases Including Tankers and Barges from Sea Buoy

Scenario	Source	Engine Type	Tons per Year				
			PM	VOC	NOx	SO_2	CO
Historical Baseline Assessment: 99,318 bbl/day average	Suezmax Tanker	Main Engine	0.73	2.09	2.52	1.13	4.68
		Auxiliary Engine	0.41	0.86	22.93	0.69	1.81
		Boiler	0.64	0.52	9.28	2.87	0.94
		Tug Main Engine	0.73	0.84	12.09	0.03	3.38
		Tug Auxiliary Engine	0.04	0.06	0.75	0.01	0.22
	Panamax Tanker	Main Engine	0.32	0.91	1.10	0.49	4.68
		Auxiliary Engine	0.22	0.45	12.06	0.36	0.95
		Boiler	0.00	0.00	0.00	0.00	0.00
		Tug Main Engine	0.52	0.59	8.51	0.02	2.39
		Tug Auxiliary Engine	0.03	0.04	0.54	0.00	0.16
	Barge	Main Engine	0.00	0.00	0.00	0.00	0.00
		Auxiliary Engine	0.05	0.10	2.69	0.08	0.21
		Boiler	0.00	0.00	0.00	0.00	0.00
		Tug Main Engine	0.52	0.59	8.57	0.02	2.39
		Tug Auxiliary Engine	0.09	0.12	1.61	0.01	0.48
	Total		4.29	7.18	82.64	5.73	22.31
Air Permitting Assessment: 78,818 bbl/day average	Suezmax Tanker	Main Engine	0.58	1.66	2.00	0.90	3.72
		Auxiliary Engine	0.33	0.68	18.20	0.55	1.44
		Boiler	0.51	0.41	7.36	2.28	0.75
		Tug Main Engine	0.58	0.67	9.59	0.02	2.68
		Tug Auxiliary Engine	0.03	0.05	0.60	0.00	0.18
	Panamax Tanker	Main Engine	0.26	0.73	0.87	0.39	3.72
		Auxiliary Engine	0.17	0.36	9.57	0.29	0.76
		Boiler	0.00	0.00	0.00	0.00	0.00
		Tug Main Engine	0.41	0.47	6.75	0.01	1.90
		Tug Auxiliary Engine	0.02	0.03	0.43	0.00	0.13
	Barge	Main Engine	0.00	0.00	0.00	0.00	0.00
		Auxiliary Engine	0.04	0.08	2.13	0.06	0.17
		Boiler	0.00	0.00	0.00	0.00	0.00
		Tug Main Engine	0.41	0.47	6.80	0.02	1.90
		Tug Auxiliary Engine	0.07	0.10	1.28	0.01	0.38
	Total		3.41	5.70	65.58	4.54	17.71

2.2.1.2 Criteria Pollutants at Berth Only

For purposes of comparing criteria pollutants to air permitting thresholds such as PSD applicability, only sources that occur at the Phillips 66 Marine Terminal need to be considered. Table 2-8 shows the criteria air pollutant emissions that occur at berth. No transiting or maneuvering emissions are included. The Historical Baseline Assessment shows the at-berth emissions increases since the pre-2012 baseline, while the Air Permitting Assessment shows these emissions increases since the previous Marine Terminal project (BAAQMD 2012).

Table 2-8 Annual Incremental Increase in Criteria Pollutant Emissions at Berth

Scenario	Source	Engine Type	Tons Per Year				
			PM	VOC	NOx	SO_2	CO
Historical Baseline Assessment: 99,318 bbl/day average	Suezmax Tanker	Auxiliary Engine	0.30	0.63	16.83	0.51	1.33
		Boiler	0.63	0.51	9.20	2.85	0.93
	Panamax Tanker	Auxiliary Engine	0.20	0.41	10.86	0.33	0.86
	Barge	Auxiliary Engine	0.04	0.09	2.42	0.07	0.19
		Tug Auxiliary Engine	0.06	0.08	1.08	0.01	0.32
	Total		1.23	1.72	40.37	3.77	3.63
Air Permitting Assessment: 78,818 bbl/day average	Suezmax Tanker	Auxiliary Engine	0.24	0.50	13.36	0.40	1.06
		Boiler	0.50	0.41	7.30	2.26	0.74
	Panamax Tanker	Auxiliary Engine	0.15	0.32	8.61	0.26	0.68
	Barge	Auxiliary Engine	0.03	0.07	1.92	0.06	0.15
		Tug Auxiliary Engine	0.05	0.07	0.85	0.01	0.25
	Total		0.98	1.37	32.04	2.99	2.88

2.2.2 Toxic Air Contaminant Emissions

TACs are chemicals that have been classified as potentially causing adverse health effects if an individual is exposed to excess concentrations of these pollutants. OEHHA and BAAQMD have identified lists of chemical pollutants that are classified as TACs. Combustion of fuel in marine engines results in emissions of diesel particulate matter (DPM), which is classified as a TAC in California and has cancer and chronic non-cancer health effects. DPM is used to classify the complex mixture of chemicals contained in PM from diesel engine exhaust. Since the boilers are not engines, the complex mixture of chemicals in the exhaust is estimated based on speciation profiles. The chemicals include several metals: arsenic, cadmium, copper, lead, nickel, selenium and vanadium. The VOC fraction consists of several organic TACs: benzene, chlorobenzene, ethylbenzene, formaldehyde, hexane, naphthalene, propylene, toluene, and xylene. The TAC emissions used in the HRA analyses are described in more detail in Section 2.3.

2.3 Health Risk Assessment Emissions

Emissions used in an HRA are in the form of an emission rate, which is the amount of TAC released per time (e.g., grams per second). For an HRA, there are two distinct time periods that are important:

Annual average emission rate. Emissions due to vessel transit, maneuvering, and/or hoteling averaged over an annual period are used to estimate cancer and chronic non-cancer health effects.

Maximum hourly emission rate. Emissions due to operating at maximum capacity are used to assess acute non-cancer health effects. It is assumed that all applicable emissions sources are operating at maximum rates.

2.3.1 Air Permitting HRA

For assessing health risks under the Air Permitting Assessment, activities only occurring at berth are considered. This includes emissions from auxiliary engines and boilers that operate at berth. It does not include any emissions that occur during transiting and maneuvering. Table 2-9 shows the at-berth TAC emission rates used in the Air Permitting HRA. For cancer risk and chronic non-health effects, the average annual emission rates were used. For acute health effects, the HRA considered the maximum hourly emission rate for only one worst-case vessel type (Suezmax tanker) since there is only one berth at the Phillips 66 Marine Terminal.

2.3.2 Historical Baseline HRA

For assessing health risks under the Historical Baseline Assessment, marine transiting and maneuvering emissions were considered, as well as emissions from auxiliary engines and boilers that operate at berth. For assessing the incremental health impacts from marine transiting and maneuvering to receptors located near the Marine Terminal, marine activity out to Point San Pablo was included. Table 2-10 shows the annual average TAC emission rates used to assess cancer risk and chronic non-cancer health effects in the Historical Baseline HRA. Table 2-11 presents the TAC emissions modeled for the Historical Baseline incremental emissions increase compared to the shipping levels prior to the *Marine Terminal Offload Limit Revision Project* in 2012.

For assessing acute non-cancer health effects under the historical baseline, it was assumed there would be no overlap in emissions from at berth and transiting/maneuvering, since the Phillips 66 Marine Terminal has capacity for only one vessel at a time. In addition, only maximum hourly TAC emissions from at-berth marine boiler activity (shown in Table 2-10) was used to assess acute health effects. DPM from marine engines are not used for acute health effects under the current OEHHA methodology.

Table 2-9 At-Berth TAC Emission Rates – Air Permitting Assessment

Source	Engine Type	Chemical	Annual Average Emission Rate (g/s)	Maximum Emission Rate (g/s)
Suezmax Tanker	Boiler	Arsenic	2.8989E-07	2.2667E-06
	Boiler	Benzene	2.5323E-04	1.9800E-03
	Boiler	Cadmium	4.1711E-07	3.2614E-06
	Boiler	Chlorobenzene	5.8617E-06	4.5833E-05
	Boiler	Copper	7.2994E-07	5.7074E-06
	Boiler	Ethylbenzene	8.2064E-06	6.4167E-05
	Boiler	Formaldehyde	1.1723E-05	9.1667E-05
	Boiler	Hexane	1.8640E-04	1.4575E-03
	Boiler	Lead	4.6382E-06	3.6267E-05
	Boiler	m-Xylene	5.2756E-05	4.1250E-04
	Boiler	Naphthalene	8.2064E-05	6.4167E-04
	Boiler	Nickel	1.0407E-04	8.1372E-04
	Boiler	o-Xylene	3.6343E-05	2.8417E-04
	Boiler	Propylene	5.3459E-04	4.1800E-03
	Boiler	Selenium	2.8989E-07	2.2667E-06
	Boiler	Sulfate	6.4032E-03	5.0067E-02
	Boiler	Toluene	2.5205E-04	1.9708E-03
	Boiler	Vanadium	2.6538E-04	2.0751E-03
	Boiler	Xylenes	3.9860E-05	3.1167E-04
Suezmax Tanker	Auxiliary Hoteling	DPM	6.9098E-03	--
Panamax Tanker	Auxiliary Hoteling	DPM	4.4572E-03	--
Barge	Auxiliary Hoteling	DPM	9.9214E-04	--
Barge	Tug Auxiliary Hoteling	DPM	1.3017E-03	--

g/s = grams per second

Note: In Table 2-9 and 2-10, no maximum emission rates are given for DPM sources, since there is no acute reference exposure level for DPM.

Table 2-10 TAC Emission Rates – Historical Baseline Assessment

Source	Engine Type	Chemical	Annual Average Emission Rate (g/s)	Maximum Emission Rate (g/s)
Suezmax Tanker	Boiler	Arsenic	3.65288E-07	2.2667E-06
	Boiler	Benzene	3.19090E-04	1.9800E-03
	Boiler	Cadmium	5.25595E-07	3.2614E-06
	Boiler	Chlorobenzene	7.38634E-06	4.5833E-05
	Boiler	Copper	9.19790E-07	5.7074E-06
	Boiler	Ethylbenzene	1.03409E-05	6.4167E-05
	Boiler	Formaldehyde	1.47727E-05	9.1667E-05
	Boiler	Hexane	2.34886E-04	1.4575E-03
	Boiler	Lead	5.84461E-06	3.6267E-05
	Boiler	m-Xylene	6.64771E-05	4.1250E-04
	Boiler	Naphthalene	1.03409E-04	6.4167E-04
	Boiler	Nickel	1.31136E-04	8.1372E-04
	Boiler	o-Xylene	4.57953E-05	2.8417E-04
	Boiler	Propylene	6.73634E-04	4.1800E-03
	Boiler	Selenium	3.65288E-07	2.2667E-06
	Boiler	Sulfate	8.06860E-03	5.0067E-02
	Boiler	Toluene	3.17613E-04	1.9708E-03
	Boiler	Vanadium	3.34409E-04	2.0751E-03
	Boiler	Xylenes	5.02271E-05	3.1167E-04
Suezmax Tanker	Auxiliary Hoteling	DPM	8.707E-03	--
	Auxiliary Maneuvering	DPM	2.95E-05	--
	Main Maneuvering	DPM	8.178E-05	--
	Main & Auxiliary Tug Maneuvering	DPM	2.237E-04	--
	Auxiliary Transiting	DPM	2.014E-06	--
	Main Transiting	DPM	8.078E-06	--
	Tug Main & Auxiliary Transiting	DPM	1.40268E-05	--
Panamax Tanker	Auxiliary Hoteling	DPM	5.6165E-03	--
	Auxiliary Maneuvering	DPM	1.89988E-05	--
	Main Maneuvering	DPM	3.57581E-05	--
	Main & Auxiliary Tug Maneuvering	DPM	1.09566E-04	--
	Auxiliary Transiting	DPM	1.29865E-06	--
	Main Transiting	DPM	3.53195E-06	--
	Tug Main & Auxiliary Transiting	DPM	1.03067E-05	--
Barge	Auxiliary Hoteling	DPM	1.25018E-03	--
Barge	Tug Auxiliary Hoteling	DPM	1.64032E-03	--
Barge	Auxiliary Maneuvering	DPM	3.33147E-06	--
Barge	Tug Maneuvering	DPM	1.67888E-04	--
Barge	Auxiliary Transiting	DPM	3.13387E-07	--
Barge	Tug Main & Auxiliary	DPM	1.57929E-05	--

	Transiting			

Table 2-11 Annual Incremental Increase in TAC Emissions - Historical Baseline Assessment

Chemical	**Pounds per Year**		
	Vessel Main and Aux Engines	**Tug Main and Aux Engines**	**Boilers**
Arsenic			0.03
Benzene			22.18
Cadmium			0.04
Chlorobenzene			0.51
Copper			0.06
DPM	1210	37.63	
Ethylbenzene			0.72
Formaldehyde			1.03
Hexane			16.33
Lead			0.41
m-Xylene			4.62
Naphthalene			7.19
Nickel			9.12
o-Xylene			3.18
Propylene			46.83
Selenium			0.03
Sulfate			560.97
Toluene			22.08
Vanadium			23.25
Xylenes			3.49

3.0 AIR DISPERSION MODELING

Air dispersion modeling is used to calculate the concentration of the TACs at nearby sensitive receptors. The air dispersion modeling uses information about how a TAC is released from the source combined with meteorological data to assess the location and quantity of TACs dispersed into the nearby ambient air.

3.1 AERMOD Dispersion Model

The USEPA AERMOD dispersion model was used to estimate exposure to pollutants from marine vessels traveling to the refinery and hoteling at berth. The emissions sources include internal combustion engines for main and auxiliary power and boilers for pumping and/or space/ water heating during hoteling. The modeling approach makes use of the concentrations predicted by dispersion modeling using a 1-gram-per-second emission rate in AERMOD. The resulting dispersion factor at each receptor is referred to as "χ/Q" (ground-level concentration per unit emission rate [$\mu g/m^3$ per g/s]). The dispersion factor is then combined with emission rates to obtain final concentrations of TACs at nearby sensitive receptors. The predicted concentrations are used with toxicity and exposure factors (discussed below) to calculate overall health risk from pollutant exposure. The model inputs and assumptions are summarized below.

3.2 Source Characterization

Ships were modeled as separated volume sources at slow cruise while traveling to the refinery, with a tug assist for each ship. These sources are assumed to slow to maneuvering mode when approaching the berth, which was modeled as a series of volume sources. Marine vessels hoteling at berth would run on auxiliary power from the auxiliary engines and/or on-board boilers during pumping and were modeled as point sources. Figure 3-1 shows the modeling setup for the ships.

3.2.1 Source Parameters

The source parameters are shown in Table 3-1.

Table 3-1 Source Parameters

Ships Transiting and Maneuvering - Line Source (as Separated Volume Source)		
Length Considered for Modeling = Length of the Line Source	18,380	m/trip
Source Type	Elevated source on or adjacent to a building	
Length of the Side of the Volume Source = W	25.0	m
Spacing of Separated Volume Source Along Line (c/c) = 2W	50.0	m
Release Height	30.48	m
Initial Lateral Dimension (SYINIT) = 2W/2.15	23.26	m
Initial Vertical Dimension (SZINIT) = Building Height/2.15	2.33	m
Number of Volume Sources	361 for transiting 8 for maneuvering	volume sources/line
Tugs Assisting and Cruising - Line Source (as Separated Volume Source)		
Length Considered for Modeling = Length of the Line Source, L_{RS}	18,380	m/trip
Source Type	Line source represented by separated volume sources, elevated source on or adjacent to a building	
Length of the Side of the Line/Volume Source = W	25.0	m
Spacing of Separated Volume Source Along Line (c/c)	50.0	m
Release Height	12.192	m
Initial Lateral Dimension (SYINIT) = 2W/2.15	23.26	m
Initial Vertical Dimension (SZINIT) = Building Height/2.15	2.33	m
Number of Volume Sources	362 for transiting 8 for maneuvering	volume sources/line
Ship Auxiliary Engine Hoteling - Point Source		
Exhaust Type	Vertical Exit	
Stack Tip Downwash	On	
Release Height	37.19	m
Release/Exhaust Temperature	573.15	K
Exit Velocity	3.99	m/s
Exhaust Diameter	0.39	m
Ship Auxiliary Boiler Hoteling - Point Source		
Exhaust Type	Vertical Exit	
Stack Tip Downwash	On	
Release Height	39.93	m
Release/Exhaust Temperature	559.26	K
Exit Velocity	5.06	m/s
Exhaust Diameter	0.49	m

c/c = center-to-center of sources
m = meter
K = degrees Kelvin
m/s = meters per second

3.3 Receptor Grids and Coordinate System

Receptors were modeled in a 100-meter grid placed only over primarily residential areas, out to a distance of 4.3 kilometers to the south, 3.4 kilometers to the north, and 3.8 kilometers to the east. Receptors on water and open space land were excluded. This is the same receptor grid used in the *Marine Terminal Offload Limit Revision Project* (BAAQMD 2012). The receptor grid is shown in Figure 3-1.

The Universal Transverse Mercator (UTM) coordinate system (NAD83) was used to identify source and receptor locations. Standard USEPA defaults were used in the modeling.

3.4 Meteorological Data

Five years of meteorological data (2005, 2007, 2008, 2009, and 2010) from the refinery monitoring station were used for modeling. These datasets were processed with AERMET, with land use data around the refinery analyzed to derive surface parameters, including surface roughness, Bowen ratio, and albedo, by 360-degree sector. The BAAQMD previously approved the use of these processed meteorological data for the Propane Recovery Project.

3.5 Terrain

Terrain information was obtained from the United States Geological Survey using "geotiff" data of the National Elevation Dataset. The terrain information was extracted using the AERMOD pre-processor for terrain, AERMAP. It was conservatively assumed that the area was rural.

3.6 Building Downwash

Building downwash parameters were not included in the modeling. The ship deck height was treated as "ground level," as it is the approximate height of the berth platform. In addition, there are no buildings present at the berth to affect the plume, so downwash was not considered.

4.0 HEALTH RISK ASSESSMENT

4.1 Methodology

The OEHHA, which is the state agency that establishes procedures for calculating health risk from TACs, released its revised risk assessment guidelines on 6 March 2015. These updates require explicit consideration of the effect of TAC concentrations on infants and children as well as adults. The updated OEHHA *Risk Assessment Guidelines* (OEHHA 2015) now have different values to account for varied breathing rates in different age groups, and results in an overall increase in breathing volume compared to the breathing rate assumptions used previously.

Cancer and non-cancer chronic and acute adverse health effects were calculated following the recently revised OEHHA *Risk Assessment Guidelines*. The approach makes use of the concentrations predicted by the AERMOD dispersion modeling. The resulting concentrations at each receptor are referred to as "χ/Q," or the ground-level concentrations per unit emission rate.

Cancer risk is the probability of contracting cancer over the assumed exposure period, expressed as chances in one million. BAAQMD's threshold for a potentially significant increased cancer risk is 10 in one million or greater.

Equation [1] is the approach used to calculate inhalation cancer risk per the updated OEHHA guidelines. The updated OEHHA guidelines require age sensitivity factors (ASFs) to reflect increased cancer risk susceptibility in younger age groups, which are applied to cancer risks calculated over the exposure duration of each age bin. The age-specific breathing rates and ASFs were used in this current analysis, and are shown in Table 4-1. The BAAQMD has indicated use of a 30-year duration for residential exposures and 25 years for offsite workers. The BAAQMD will also allow for use of a fraction of time spent at home (FAH) of 0.73 for the 16 to <30 year age bin in residential exposures. The FAH for younger age bins was set to 1.0 for this current analysis.

Equation [1]

$$\text{Cancer Risk} = {}_{i,j}\sum \left({}_{k}\sum \chi/Q \times ER_{i,k}\right) \times EF \times BR_j \times A \times [1/1000] \times CSF_i \times ASF_j \times FAH_j \times (ED_j/AT)$$

Where:

χ/Q = concentration modeled for unit emission rate [($\mu g/m^3$) / (g/s)]

ER = emission rate of TAC
CSF = cancer slope factor for TAC [(mg/kg BW-day) $^{-1}$]
ED = exposure duration in age bin [years]
AT =averaging period (70 years for lifetime cancer risk)
ASF = Age sensitivity factor in age bin
BR = Breathing rate in age bin [liters (L) of air per kg of body weight per day]
EF = exposure frequency (days per 365 days)
[1/1000] = conversion factor: mg/1000 μg
A = absorption factor (set to 1)
FAH = fraction of time at home by age bin
i = the i^{th} TAC
j = the j^{th} age bin
k = the k^{th} source

Table 4-1 Factors Applied to HRA Based on Updated OEHHA Guidelines

Age Bin	Exposure Duration (ED) (Years)[1]	Breathing Rate (BR) (L/kg BW-day)[2]	ASF
Third Trimester	0.25	361	10
0 - <2 Years	2	1,090	10
2 - <16 Years	14	572	3
16 - <30 Years (residential)	14	261	1
16 - <70 Years (offsite worker)	25[3]	230	1

L/kg BW-day = liters per kilogram of body weight per day

Notes:

1. The total exposure duration for residential sums to 30.25 years due to the in utero child exposure. OEHHA recommends leaving the 16<30 year age bin at 14 years rather than 13.75. This results in a slight over estimation of a 30-year exposure duration in cancer risk.

2. These represent the 95^{th} percentile can be used for the third trimester to age of 2, while 80^{th} percentile can be used for over the age of 2. The BAAQMD follows this approach.

3. The BAAQMD uses a 25-year exposure period for offsite workers.

Non-inhalation cancer risks were estimated by developing weighted risk factors for major non-inhalation pathways including soil ingestion, dermal absorption, consumption of homegrown produce, and consumption of mother's milk. These factors were developed using CARB's HARP2 model with an atmospheric deposition rate of 0.02 m/s, since vessel and tug emissions are primarily $PM_{2.5}$. The weighted risk factors were then multiplied by the modeled concentrations to assess the non-inhalation cancer risk.

Chronic and acute non-cancer health effects are assessed by hazard index (HI), the modeled pollutant concentration divided by the OEHHA Reference Exposure Level for that pollutant, then summed over all pollutants for individual target organs. An HI of 1.0 or greater represents a significant non-cancer health impact.

4.2 Results – Air Permitting

Results of the air permitting (stationary source) HRA for emissions from hoteling at berth for up to 78,818 bbl/day (average) of additional marine vessel activity are presented in Table 4-2 below and shown in Figure 4-1.

For cancer risk and chronic non-cancer health effects, TAC emissions were developed from the "Air Permitting Assessment" annual emissions increases for PM and VOC in Table 2-8. For PM emissions from engines, DPM was modeled. For boilers, the Table 2-6 PM_{10}/HC speciation profile was applied to the PM and VOC boiler emissions. The resulting at-berth annual average emission rates are shown in Table 2-9. For acute non-cancer health effects, the maximum emission rates in Table 2-9 were used.

Both residential and worker maximum impacts are below the significant risk threshold of 10 in one million. The acute and chronic non-cancer health effects are each less than significance threshold of 1.0.

Table 4-2 Health Risk Assessment Results – Air Permitting

	Residential (MEIR)	Worker (MEIW)
Cancer Risk	5.71 in one million	0.48 in one million
UTM Coordinates (meters)	566776.51, 4214524.03	566276.51, 4211524.03.0
Chronic Hazard Index	0.006	0.007
UTM Coordinates (meters)	567376.51, 4212224.03	566576.51, 4211924.03
Acute Hazard Index	0.54	0.77
UTM Coordinates (meters)	567576.51, 4211824.03	566576.51, 4211924.03

MEIR = maximum exposed individual at a residence
MEIW = maximum exposed individual at a place of work

4.3 Results – Historical Baseline Assessment

The HRA for the Historical Baseline Assessment includes evaluation of the combined marine vessel increases from the pre-2012 baseline, encompassing the previous project and the currently proposed project. This equates to 99,318 bbl/day of additional at-berth marine vessel activity. It also includes transiting and maneuvering activity out to San Pablo Point. HRA results for emissions from ships and tugs transiting to the berth and hoteling at berth for this case are presented in Table 4-3 below and shown in Figure 4-2.

For cancer risk and chronic non-cancer health effects, TAC emissions were developed from the "Historical Baseline Assessment" annual emissions increases for PM and VOC in Table 2-7. The only difference for HRA purposes is marine activity in Table 2-7 is covered all the way to the Sea Buoy, 11 nm west of the Golden Gate Bridge, while for HRA, marine emissions were modeled from the Marine Terminal to San Pablo Point. For PM emissions from engines, DPM was modeled. For boilers, the Table 2-6 PM_{10}/HC speciation profile was applied to the PM and VOC boiler emissions. The resulting annual average emission rates are shown in Table 2-10 for all sources, including hoteling, transiting, and maneuvering. Table 2-11 shows the total annual emissions used for the Historical Baseline HRA. For acute non-cancer health effects, the boiler maximum emission rates in Table 2-10 were used.

Both residential and worker maximum impacts are below the significant risk threshold of 10 in one million. The acute and chronic non-cancer health effects are each less than significance threshold of 1.0.

Table 4-3 Health Risk Assessment Results – Historical Baseline Assessment

	Residential (MEIR)	**Worker (MEIW)**
Cancer Risk	9.85 in one million	0.72 in one million
UTM Coordinates (meters)	566776.51, 4214324.03	566276.51, 4211524.03
Chronic Hazard Index	0.008	0.009
UTM Coordinates (meters)	566776.51, 4214524.03	566576.51, 4211924.03
Acute Hazard Index	0.54	0.77
UTM Coordinates (meters)	567576.51, 4211824.03	566576.51, 4211924.03

MEIR = maximum exposed individual at a residence
MEIW = maximum exposed individual at a place of work

5.0 REFERENCES

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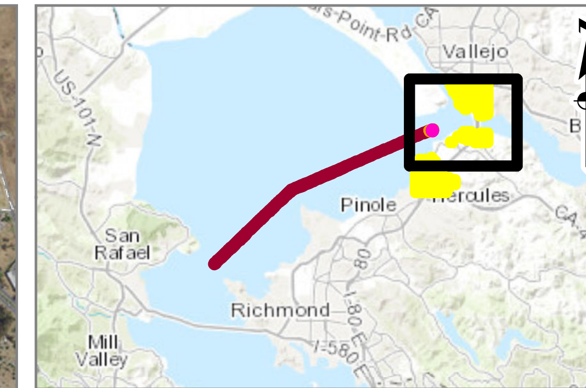
Figures



0 1,000 2,000 4,000 Feet

Legend

- Residential Cancer Risk in a million
- Residential Acute HI
- Residential Chronic HI
- Worker Cancer Risk in a million
- Worker Acute HI
- Worker Chronic HI
- At Berth Sources
- Manuevering Sources
- Transiting Sources

Project: 0274904 Date: 6/10/2016 Created By:

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Source: Basemap provided by ESRI web mapping services

ERM

Figure 4-2
HRA Results: Historical Baseline

Created By: Date: 4/13/2016 Project: 0274904

Source: Basemap provided by ESRI web mapping services

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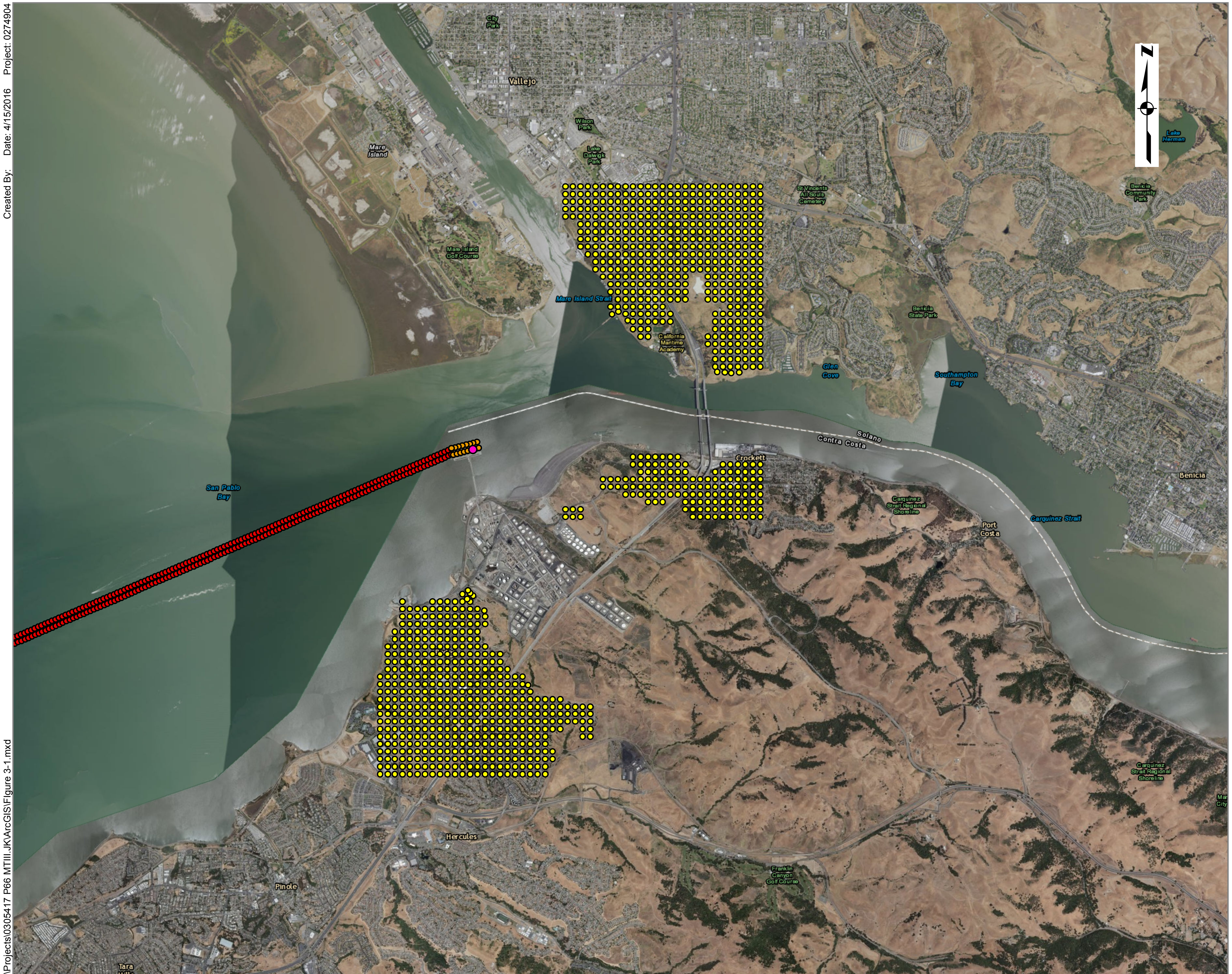
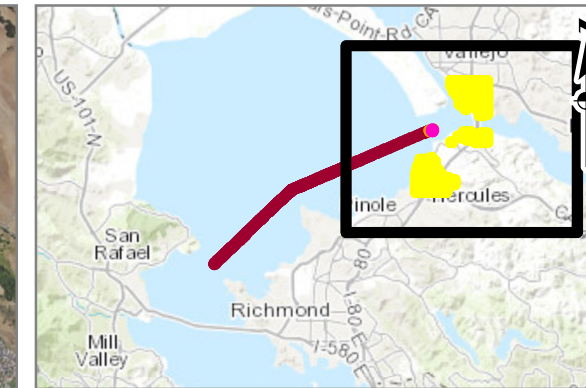
ERM

Figure 4-1
HRA Results: Permit

Created By: Date: 4/15/2016 Project: 0274904





0 2,150 4,300 8,600
Feet

Legend

- At Berth Sources
- Manuevering Sources
- Transiting Sources
- Receptors

Figure 3-1
Air Dispersion Modeling: Sources and Receptors

ERM

Source: Basemap provided by ESRI web mapping services

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Appendix A
Detailed Emissions Calculations

130,000 bbl/day Historical Baseline

						For Criteria only		
Emission Segment	Hoteling at Berth	Manuevering	Transiting link 1	Transiting link 2	Transiting link 3	Transiting link 4	Transiting link 5	
Model Source ID								
Segment Length (nmile)	NA	0.188984881	5.642548596	4.130669546	4.04	52	20	?
Vessel Speed (knots)	NA	5	8	8	8	10	12	10
Number Vessels per Year	52.28632831	52.28632831	52.28632831	52.28632831	52.28632831	52.28632831	52.28632831	52.28632831
Transiting Time	27	0.575593952	1.410637149	1.032667387	0.505	5.2	1.666666667	#VALUE!
Vessel Size (DWT)								
Vessel Type	SUEZMax	SUEZMax	SUEZMax	SUEZMax	SUEZMax	SUEZMax	SUEZMax	SUEZMax
Barrels	415,991	415,991	415,991	415,991	415,991	415,991	415,991	415,991
Unload/Load Rate	20,000	NA	NA	NA	NA	NA	NA	NA
# Main Engines	none operating							
Number		1	1	1	1	1	1	1
Size (kW)		18587	18587	18587	18587	18587	18587	18587
Load Factor		0.037037037	0.151703704	0.151703704	0.151703704	0.296296296	0.512	
PM EmissionFactor (g/kw-h)		0.9959	0.2553	0.2553	0.2553	0.23	0.23	
PM Emissions		0.022744178	0.058528094	0.042845925	0.020952721	0.379629073	0.210256102	
VOC EmissionFactor (g/kw-h)		7.008	0.816	0.816	0.816	0.6	0.6	
VOC Emissions		0.160047397	0.187069817	0.136945847	0.06696992	0.990336713	0.54849418	
NOx EmissionFactor (g/kw-h)		2.34184	0.85012	0.85012	0.85012	0.802	0.802	
NOx Emissions		0.053482505	0.194891903	0.142672063	0.069770182	1.323750074	0.733153887	
Sox EmissionFactor (g/kw-h)		0.8964	0.3924	0.3924	0.3924	0.36	0.36	
Sox Emissions		0.020471816	0.089958574	0.065854841	0.032204653	0.594202028	0.329096508	
CO EmissionFactor (g/kw-h)		9.044	1.848	1.848	1.848	1.4	1.4	
CO Emissions		0.206545185	0.423658115	0.310142065	0.151667173	2.310785665	1.279819753	
# Auxiliary	1	1	1	1	1	1	1	1
Size (kW)	778	988	718	718	718	718	718	718
Load Factor	1	1	1	1	1	1	1	
PM EmissionFactor (g/kw-h)	0.25	0.25	0.25	0.25	0.25	0.25	0.25	0.25
PM Emissions	0.302674709	0.008194188	0.014593939	0.010683601	0.005224546	0.05379731	0.017242728	
VOC EmissionFactor (g/kw-h)	0.52	0.52	0.52	0.52	0.52	0.52	0.52	
VOC Emissions	0.629563395	0.017043912	0.030355394	0.022221891	0.010867057	0.111898405	0.035864873	
NOx EmissionFactor (g/kw-h)	13.9	13.9	13.9	13.9	13.9	13.9	13.9	
NOx Emissions	16.82871381	0.455596869	0.811423021	0.59400824	0.290484783	2.991130434	0.958695652	
Sox EmissionFactor (g/kw-h)	0.42	0.42	0.42	0.42	0.42	0.42	0.42	
Sox Emissions	0.508493511	0.013766236	0.024517818	0.01794845	0.008777238	0.090379481	0.028967782	
CO EmissionFactor (g/kw-h)	1.1	1.1	1.1	1.1	1.1	1.1	1.1	
CO Emissions	1.331768719	0.036054428	0.064213333	0.047007846	0.022988004	0.236708164	0.075868001	
# Boiler								
Size (kW)	3000	3000	3000					
Load Factor	1	0.12	0.12	0	0	0	0	0
PM EmissionFactor (g/kw-h)	0.136	0.136	0.136					
PM Emissions	0.634916613	0.001624241	0.003980609					
VOC EmissionFactor (g/kw-h)	0.11	0.11	0.11					
VOC Emissions	0.513535496	0.001313724	0.00321961					
NOx EmissionFactor (g/kw-h)	1.97	1.97	1.97					
NOx Emissions	9.19695388	0.023527605	0.057660288					

130,000 bbl/day Historical Baseline

Sox EmissionFactor (g/kw-h)	0.61	0.61	0.61						
Sox Emissions	2.84778775	0.007285197	0.017854201						
CO EmissionFactor (g/kw-h)	0.2	0.2	0.2						
CO Emissions	0.933700901	0.002388589	0.005853836						
Number of Tugs		3	2	2	2	2	2	1	1
# Tug Main Engine		1	1	1	1	1	1	1	1
Size (hp)		4344	4344	4344	4344	4344	4344	4344	4344
Load Factor		0.31	0.31	0.31	0.31	0.31	0.31	0.31	0.5
PM EmissionFactor (g/kw-h)		0.44	0.44	0.44	0.44	0.44	0.44	0.44	0.44
PM Emissions		0.058970448	0.096347902	0.070532196	0.034491996	0.355165105	0.11383497		0
VOC EmissionFactor (g/kw-h)		0.69	0.49	0.49	0.49	0.49	0.49		
VOC Emissions		0.092476384	0.107296527	0.078547219	0.038411541	0.395524776	0.126770762		
NOx EmissionFactor (g/kw-h)		11.41	6.93	6.93	6.93	6.93	6.93		
NOx Emissions		1.529210937	1.517479459	1.110882092	0.543248933	5.593850404	1.792900771		
Sox EmissionFactor (g/kw-h)		0.09	0.01	0.01	0.01	0.01	0.01		
Sox Emissions		0.012062137	0.002189725	0.001603004	0.000783909	0.008071934	0.002587158		
CO EmissionFactor (g/kw-h)		2.82	1.97	1.97	1.97	1.97	1.97		
CO Emissions		0.377946963	0.431375835	0.315791879	0.154430072	1.590171038	0.509670205		
# Tug Auxiliary		1	1	1	1	1	1	1	
Size (hp)		128	128	128	128	128	128	128	
Load Factor		0.43	0.43	0.43	0.43	0.43	0.43	0.43	0.43
PM EmissionFactor (g/kw-h)		0.59	0.59	0.59	0.59	0.59	0.59	0.59	
PM Emissions		0.003231921	0.005280421	0.003865571	0.00189036	0.019465096	0.006238813		
VOC EmissionFactor (g/kw-h)		0.85	0.85	0.85	0.85	0.85	0.85		
VOC Emissions		0.004656157	0.007607386	0.005569043	0.0027234	0.028042934	0.00898812		
NOx EmissionFactor (g/kw-h)		11.13	11.13	11.13	11.13	11.13	11.13		
NOx Emissions		0.060968264	0.099612001	0.072921704	0.035660525	0.36719748	0.1176915		
Sox EmissionFactor (g/kw-h)		0.09	0.09	0.09	0.09	0.09	0.09		
Sox Emissions		0.000493005	0.000805488	0.000589663	0.00028836	0.002969252	0.000951683		
CO EmissionFactor (g/kw-h)		3.3	3.3	3.3	3.3	3.3	3.3		
CO Emissions		0.018076844	0.029534556	0.02162099	0.010573201	0.108872568	0.034895054		
Offloading									
ballasting									
amount unloaded									
maximum load									
Ratio of loading									

130,000 bbl/day Historical Baseline

Emission Segment	Hoteling at Berth	Manuevering	Transiting link 1	Transiting link 2	Transiting link 3	Transiting link 4	Transiting link 5	Transiting link 6	Tug transit
Model Source ID									
Segment Length (nmile)	NA	0.188984881	5.642548596	4.130669546	4.04	52	20	?	
Vessel Speed (knots)	NA	5	8	8	8	10	12	10	
Number Vessels per Year	38.41919313	38.41919313	38.41919313	38.41919313	38.41919313	38.41919313	38.41919313	38.41919313	
Transiting Time	27	0.575593952	1.410637149	1.032667387	0.505	5.2	1.666666667	#VALUE!	
Vessel Size (DWT)									
Vessel Type	Panamax	Panamax	Panamax	Panamax	Panamax	Panamax	Panamax	Panamax	
Barrels	283,070	283,070	283,070	283,070	283,070	283,070	283,070	283,070	
Unload/Load Rate	20,000	NA	NA	NA	NA	NA	NA	NA	
# Main Engines									
Number		1	1	1	1	1	1	1	
Size (kW)		11060	11060	11060	11060	11060	11060	11060	
Load Factor		0.037037037	0.151703704	0.151703704	0.151703704	0.296296296	0.512	0.24	
PM EmissionFactor (g/kw-h)		0.9959	0.2553	0.2553	0.2553	0.23	0.23	0.9959	
PM Emissions		0.009944345	0.025590001	0.01873335	0.009161073	0.165983679	0.091929422		
VOC EmissionFactor (g/kw-h)		7.008	0.816	0.816	0.816	0.6	0.6		
VOC Emissions		0.069976874	0.081791777	0.059876277	0.029280987	0.433000903	0.239815884		
NOx EmissionFactor (g/kw-h)		2.34184	0.85012	0.85012	0.85012	0.802	0.802		
NOx Emissions		0.023383939	0.085211796	0.062379927	0.030505334	0.578777873	0.320553899		
Sox EmissionFactor (g/kw-h)		0.8964	0.3924	0.3924	0.3924	0.36	0.36		
Sox Emissions		0.008950809	0.039332222	0.028793445	0.01408071	0.259800542	0.143889531		
CO EmissionFactor (g/kw-h)		9.044	1.848	1.848	1.848	1.4	1.4		
CO Emissions		0.090306913	0.185234319	0.135602157	0.066312823	1.010335439	0.559570397		
# Auxiliary	1	1	1	1	1	1	1	1	
Size (kW)	683	867	630	630	630	630	630	630	
Load Factor	1	1	1	1				0.24	
PM EmissionFactor (g/kw-h)	0.25	0.25	0.25	0.25	0.25	0.25	0.25	0.25	
PM Emissions	0.195243837	0.005283579	0.009409114	0.006888012	0	0	0	#VALUE!	
VOC EmissionFactor (g/kw-h)	0.52	0.52	0.52	0.52	0.52	0.52	0.52		
VOC Emissions	0.406107181	0.010989844	0.019570957	0.014327064	0	0	0		
NOx EmissionFactor (g/kw-h)	13.9	13.9	13.9	13.9	13.9	13.9	13.9		
NOx Emissions	10.85555734	0.293766979	0.523146741	0.382973452	0	0	0		
Sox EmissionFactor (g/kw-h)	0.42	0.42	0.42	0.42	0.42	0.42	0.42		
Sox Emissions	0.328009646	0.008876412	0.015807312	0.01157186	0	0	0		
CO EmissionFactor (g/kw-h)	1.1	1.1	1.1	1.1	1.1	1.1	1.1		
CO Emissions	0.859072883	0.023247747	0.041400102	0.030307252	0	0	0		
# Boiler									
Size (kW)									
Load Factor	1	0.12	0.12	0	0	0	0	0	
PM EmissionFactor (g/kw-h)	0.136	0.136	0.136						
PM Emissions	0	0	0						
VOC EmissionFactor (g/kw-h)	0.11	0.11	0.11						
VOC Emissions	0	0	0						
NOx EmissionFactor (g/kw-h)	1.97	1.97	1.97						
NOx Emissions	0	0	0						
Sox EmissionFactor (g/kw-h)	0.61	0.61	0.61						
Sox Emissions	0	0	0						
CO EmissionFactor (g/kw-h)	0.2	0.2	0.2						

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CO Emissions	0	0	0						
Number of Tugs		2	2	2	2	2	2	0	1
# Tug Main Engine		1	1	1	1	1	1	1	1
Size (hp)		4344	4344	4344	4344	4344	4344	4344	4344
Load Factor		0.31	0.31	0.31	0.31	0.31	0.31	0.31	0.5
PM EmissionFactor (g/kw-h)		0.44	0.44	0.44	0.44	0.44	0.44	0.44	0.44
PM Emissions		0.028887055	0.070794963	0.051825977	0.02534419	0.260969879	0.083644192		0
VOC EmissionFactor (g/kw-h)		0.69	0.49	0.49	0.49	0.49	0.49		
VOC Emissions		0.045300154	0.078839845	0.057715293	0.028224212	0.290625547	0.093149214		
NOx EmissionFactor (g/kw-h)		11.41	6.93	6.93	6.93	6.93	6.93		
NOx Emissions		0.749093848	1.115020662	0.816259145	0.399170995	4.110275592	1.317396023		
Sox EmissionFactor (g/kw-h)		0.09	0.01	0.01	0.01	0.01	0.01		
Sox Emissions		0.005908716	0.001608976	0.001177863	0.000576004	0.005931134	0.001901004		
CO EmissionFactor (g/kw-h)		2.82	1.97	1.97	1.97	1.97	1.97		
CO Emissions		0.185139759	0.316968356	0.232039035	0.113472851	1.168433321	0.374497859		
# Tug Auxiliary		1	1	1	1	1	1	1	
Size (hp)		128	128	128	128	128	128	128	
Load Factor		0.43	0.43	0.43	0.43	0.43	0.43	0.43	0.43
PM EmissionFactor (g/kw-h)		0.59	0.59	0.59	0.59	0.59	0.59	0.59	
PM Emissions		0.001583177	0.003879972	0.002840362	0.001389008	0.014302654	0.004584184	#VALUE!	
VOC EmissionFactor (g/kw-h)		0.85	0.85	0.85	0.85	0.85	0.85		
VOC Emissions		0.002280848	0.00558979	0.004092047	0.002001113	0.020605519	0.006604333		
NOx EmissionFactor (g/kw-h)		11.13	11.13	11.13	11.13	11.13	11.13		
NOx Emissions		0.029865698	0.073193373	0.053581751	0.026202807	0.269811084	0.086477912		
Sox EmissionFactor (g/kw-h)		0.09	0.09	0.09	0.09	0.09	0.09		
Sox Emissions		0.000241502	0.00059186	0.000433276	0.000211883	0.002181761	0.000699282		
CO EmissionFactor (g/kw-h)		3.3	3.3	3.3	3.3	3.3	3.3		
CO Emissions		0.008855059	0.021701539	0.015886773	0.007769026	0.079997895	0.025640351		
Offloading									
ballasting									
amount unloaded									
maximum load									
Ratio of loading									

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Emission Segment	Hoteling at Berth	Manuevering	Transiting link 1	Transiting link 2	Transiting link 3	Transiting link 4	Transiting link 5	Transiting link 6	Tug transit
Model Source ID									
Segment Length (nmile)	NA	0.188984881	5.642548596	4.130669546	4.04	52	20	?	
Vessel Speed (knots)	NA	5	8	8	8	10	12	10	
Number Vessels per Year	58.99855153	58.99855153	58.99855153	58.99855153	58.99855153	58.99855153	58.99855153	58.99855153	
Transiting Time	27	0.575593952	1.410637149	1.032667387	0.505	5.2	1.666666667	#VALUE!	
Vessel Size (DWT)									
Vessel Type	Barge	Barge	Barge	Barge	Barge	Barge	Barge	Barge	
Barrels	61,444	61,444	61,444	61,444	61,444	61,444	61,444	61,444	
Unload/Load Rate	20,000	NA	NA	NA	NA	NA	NA	NA	
# Main Engines									
Number		0	0	0	0	0	0	0	
Size (kW)		11060	11060	11060	11060	11060	11060	11060	
Load Factor		0.33	0.28	0.28				0.24	
PM EmissionFactor (g/kw-h)		0.23	0.23	0.23	0.23	0.23	0.23	0.23	
PM Emissions		0	0	0	0	0	0		
VOC EmissionFactor (g/kw-h)		7.008	0.816	0.816	0.816	0.6	0.6		
VOC Emissions		0	0	0	0	0	0		
NOx EmissionFactor (g/kw-h)		2.34184	0.85012	0.85012	0.85012	0.802	0.802		
NOx Emissions		0	0	0	0	0	0		
Sox EmissionFactor (g/kw-h)		0.8964	0.3924	0.3924	0.3924	0.36	0.36		
Sox Emissions		0	0	0	0	0	0		
CO EmissionFactor (g/kw-h)		9.044	1.848	1.848	1.848	1.4	1.4		
CO Emissions		0	0	0	0	0	0		
# Auxiliary	1	1	1	1	1	1	1	1	
Size (kW)	99	99	99	99	99	99	99	99	
Load Factor	1	1	1	1				0.24	
PM EmissionFactor (g/kw-h)	0.25	0.25	0.25	0.25	0.25	0.25	0.25	0.25	
PM Emissions	0.043459521	0.000926483	0.002270578	0.001662194	0	0	0	#VALUE!	
VOC EmissionFactor (g/kw-h)	0.52	0.52	0.52	0.52	0.52	0.52	0.52		
VOC Emissions	0.090395804	0.001927084	0.004722803	0.003457363	0	0	0		
NOx EmissionFactor (g/kw-h)	13.9	13.9	13.9	13.9	13.9	13.9	13.9		
NOx Emissions	2.416349365	0.051512447	0.126244155	0.09241797	0	0	0		
Sox EmissionFactor (g/kw-h)	0.42	0.42	0.42	0.42	0.42	0.42	0.42		
Sox Emissions	0.073011995	0.001556491	0.003814572	0.002792485	0	0	0		
CO EmissionFactor (g/kw-h)	1.1	1.1	1.1	1.1	1.1	1.1	1.1		
CO Emissions	0.191221892	0.004076525	0.009990545	0.007313652	0	0	0		
# Boiler									
Size (kW)									
Load Factor	1	0.12	0.12	0	0	0	0	0	
PM EmissionFactor (g/kw-h)	0.136	0.136	0.136						
PM Emissions	0	0	0						
VOC EmissionFactor (g/kw-h)	0.11	0.11	0.11						
VOC Emissions	0	0	0						
NOx EmissionFactor (g/kw-h)	1.97	1.97	1.97						
NOx Emissions	0	0	0						
Sox EmissionFactor (g/kw-h)	0.61	0.61	0.61						
Sox Emissions	0	0	0						
CO EmissionFactor (g/kw-h)	0.2	0.2	0.2						

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CO Emissions	0	0	0						
Number of Tugs	1	2	2	2	1	1	1	0	1
# Tug Main Engine		1	1	1	1	1	1	1	1
Size (hp)		4334	4334	4334	4334	4334	4334	4334	4334
Load Factor		0.31	0.31	0.31	0.31	0.31	0.31	0.31	0.5
PM EmissionFactor (g/kw-h)		0.44	0.44	0.44	0.44	0.44	0.44	0.44	0.44
PM Emissions		0.044258375	0.108466233	0.07940351	0.019415144	0.199918318	0.064076384		0
VOC EmissionFactor (g/kw-h)		0.69	0.49	0.49	0.49	0.49	0.49		
VOC Emissions		0.069405179	0.120791941	0.088426636	0.021621411	0.222636308	0.071357791		
NOx EmissionFactor (g/kw-h)		11.41	6.93	6.93	6.93	6.93	6.93		
NOx Emissions		1.14770013	1.708343169	1.250605286	0.305788523	3.148713502	1.009203046		
Sox EmissionFactor (g/kw-h)		0.09	0.01	0.01	0.01	0.01	0.01		
Sox Emissions		0.009052849	0.002465142	0.001804625	0.000441253	0.004543598	0.001456281		
CO EmissionFactor (g/kw-h)		2.82	1.97	1.97	1.97	1.97	1.97		
CO Emissions		0.283655948	0.485632906	0.355511171	0.086926896	0.895088831	0.286887446		
# Tug Auxiliary	1	1	1	1	1	1	1	1	
Size (hp)	128	128	128	128	128	128	128	128	
Load Factor	0.43	0.43	0.43	0.43	0.43	0.43	0.43	0.43	0.43
PM EmissionFactor (g/kw-h)	0.59	0.59	0.59	0.59	0.59	0.59	0.59	0.59	
PM Emissions	0.057021701	0.002431211	0.005958291	0.004361811	0.001066517	0.010981957	0.003519858	#VALUE!	
VOC EmissionFactor (g/kw-h)	0.85	0.85	0.85	0.85	0.85	0.85	0.85		
VOC Emissions	0.082149908	0.003502592	0.008583979	0.006283965	0.001536508	0.015821464	0.005070982		
NOx EmissionFactor (g/kw-h)	11.13	11.13	11.13	11.13	11.13	11.13	11.13		
NOx Emissions	1.075680563	0.04586335	0.112399627	0.08228298	0.020119211	0.207168108	0.066400035		
Sox EmissionFactor (g/kw-h)	0.09	0.09	0.09	0.09	0.09	0.09	0.09		
Sox Emissions	0.008698226	0.000370863	0.000908892	0.000665361	0.000162689	0.001675214	0.000536928		
CO EmissionFactor (g/kw-h)	3.3	3.3	3.3	3.3	3.3	3.3	3.3		
CO Emissions	0.318934938	0.013598298	0.033326035	0.024396571	0.005965265	0.061424507	0.019687342		
Offloading									
ballasting									
amount unloaded									
maximum load									
Ratio of loading									

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Vessel Clas	SRCGRP		Total Emissions	Conversion tons-grams	Conversion yr to sec	Number of volume sources	Emission Rate (g/s)			
Large	H_AUX	HOTELICE	0.302674709	907184	3.17098E-08	1	0.008706927	PM10	0.008707	
Large	H_BOILER	HOTELBLR	0.634916613	907184	3.17098E-08	1	0.018264402	PM10	0.018264	
Large	H_BOILER	HOTELBLR	0.513535496	907184	3.17098E-08	1	0.014772678	HC	0.014773	
Large	M_Main	MAN_SHIP	0.022744178	907184	3.17098E-08	8	8.17841E-05	PM10	0	
Large	M_AUX	MAN_SHIP	0.008194188	907184	3.17098E-08	8	2.94649E-05	PM10	0	
Large	T_AUX	TRANS_SH	0.025277541	907184	3.17098E-08	361	2.01426E-06	PM10	0	
Large	T_MAIN	TRANS_SH	0.101374018	907184	3.17098E-08	361	8.07808E-06	PM10	0	
Large	M_TUG	MAN_TUG	0.062202369	907184	3.17098E-08	8	2.237E-04	PM10	0	
Large	T_TUG	TRANS_TU	0.17602609	907184	3.17098E-08	361	1.40268E-05	PM10	0	
Small	H_AUX	HOTELICE	0.195243837	907184	3.17098E-08	1	0.005616504	PM10	0.005617	
Small	H_BOILER	HOTELBLR	0	907184	3.17098E-08	1	0	PM10	0	
Small	H_BOILER	HOTELBLR	0	907184	3.17098E-08	1	0	HC	0	
Small	M_Main	MAN_SHIP	0.009944345	907184	3.17098E-08	8	3.57581E-05	PM10	0	
Small	M_AUX	MAN_SHIP	0.005283579	907184	3.17098E-08	8	1.89988E-05	PM10	0	
Small	T_AUX	TRANS_SH	0.016297126	907184	3.17098E-08	361	1.29865E-06	PM10	0	
Small	T_MAIN	TRANS_SH	0.044323351	907184	3.17098E-08	361	3.53195E-06	PM10	0	
Small	M_TUG	MAN_TUG	0.030470232	907184	3.17098E-08	8	1.09566E-04	PM10	0	
Small	T_TUG	TRANS_TU	0.129341275	907184	3.17098E-08	361	1.03067E-05	PM10	0	
Barge	H_AUX	HOTELICE	0.043459521	907184	3.17098E-08	1	1.25018E-03	PM10	0.00125	
Barge	H_BOILER	HOTELBLR	0	907184	3.17098E-08	1	0	PM10	0	
Barge	H_BOILER	HOTELBLR	0	907184	3.17098E-08	1	0	HC	0	
Barge	M_Main	MAN_SHIP	0	907184	3.17098E-08	8	0	PM10	0	
Barge	M_AUX	MAN_SHIP	0.000926483	907184	3.17098E-08	8	3.33147E-06	PM10	0	
Barge	T_AUX	TRANS_SH	0.003932772	907184	3.17098E-08	361	3.13387E-07	PM10	0	
Barge	T_MAIN	TRANS_SH	0	907184	3.17098E-08	361	0	PM10	0	
Barge	M_TUG	MAN_TUG	0.046689586	907184	3.17098E-08	8	1.67888E-04	PM10	0	
Barge	T_TUG	TRANS_TU	0.198189845	907184	3.17098E-08	361	1.57929E-05	PM10	0	
Barge	H_AUX	HOTELICE	0.057021701	907184	3.17098E-08	1	1.64032E-03	PM10	0.00164	
Large	H_BOILER	HOTELBLR	0.000449743	907184	0.000277778	1	0.113333333	PM10	0.113333	acute
Large	H_BOILER	HOTELBLR	0.000363763	907184	0.000277778	1	0.091666667	HC	0.091667	acute

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		Tons Per Year				
Source	Engine Type	PM	HC	NOx	SO2	CO
Large Tanker	Main Engine	0.73	2.09	2.52	1.13	4.68
	Auxiliary Engine	0.41	0.86	22.93	0.69	1.81
	Boiler	0.64	0.52	9.28	2.87	0.94
	Tug Main Engine	0.73	0.84	12.09	0.03	3.38
	Tug Auxiliary Engine	0.04	0.06	0.75	0.01	0.22
Small Tanker	Main Engine	0.32	0.91	1.10	0.49	4.68
	Auxiliary Engine	0.22	0.45	12.06	0.36	0.95
	Boiler	0.00	0.00	0.00	0.00	0.00
	Tug Main Engine	0.52	0.59	8.51	0.02	2.39
	Tug Auxiliary Engine	0.03	0.04	0.54	0.00	0.16
Barge	Main Engine	0.00	0.00	0.00	0.00	0.00
	Auxiliary Engine	0.05	0.10	2.69	0.08	0.21
	Boiler	0.00	0.00	0.00	0.00	0.00
	Tug Main Engine	0.52	0.59	8.57	0.02	2.39
	Tug Auxiliary Engine	0.09	0.12	1.61	0.01	0.48
Total		4.29	7.18	82.64	5.73	22.31

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		Tons Per Year				
Source	Engine Type	PM	BC	NOx	SO2	CO
Large Tanker	Auxiliary Engine	0.30	0.63	16.83	0.51	1.33
	Boiler	0.63	0.51	9.20	2.85	0.93
Small Tanker	Auxiliary Engine	0.20	0.41	10.86	0.33	0.86
Barge	Auxiliary Engine	0.04	0.09	2.42	0.07	0.19
	Tug Auxiliary Engine	0.06	0.08	1.08	0.01	0.32
Total		1.23	1.72	40.37	3.77	3.63

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						For Criteria only		
Emission Segment	Hoteling at Berth	Manuevering	Transiting link 1	Transiting link 2	Transiting link 3	Transiting link 4	Transiting link 5	
Model Source ID								
Segment Length (nmile)	NA	0.188984881	5.642548596	4.130669546	4.04	52	20 ?	
Vessel Speed (knots)	NA	5	8	8	8	10	12	10
Number Vessels per Year	41.49402752	41.49402752	41.49402752	41.49402752	41.49402752	41.49402752	41.49402752	41.49402752
Transiting Time	27	0.575593952	1.410637149	1.032667387	0.505	5.2	1.666666667	#VALUE!
Vessel Size (DWT)								
Vessel Type	SUEZMax	SUEZMax	SUEZMax	SUEZMax	SUEZMax	SUEZMax	SUEZMax	SUEZMax
Barrels	415,991	415,991	415,991	415,991	415,991	415,991	415,991	415,991
Unload/Load Rate	20,000	NA	NA	NA	NA	NA	NA	NA
# Main Engines	none operating							
Number		1	1	1	1	1	1	1
Size (kW)		18587	18587	18587	18587	18587	18587	18587
Load Factor		0.037037037	0.151703704	0.151703704	0.151703704	0.296296296	0.512	
PM EmissionFactor (g/kw-h)		0.9959	0.2553	0.2553	0.2553	0.23	0.23	
PM Emissions		0.018049605	0.046447444	0.034002196	0.016627918	0.301270709	0.166857624	
VOC EmissionFactor (g/kw-h)		7.008	0.816	0.816	0.816	0.6	0.6	
VOC Emissions		0.127012381	0.148457166	0.10867917	0.053146813	0.78592359	0.435280757	
NOx EmissionFactor (g/kw-h)		2.34184	0.85012	0.85012	0.85012	0.802	0.802	
NOx Emissions		0.042443304	0.154664714	0.113223451	0.055369079	1.050517865	0.581825279	
Sox EmissionFactor (g/kw-h)		0.8964	0.3924	0.3924	0.3924	0.36	0.36	
Sox Emissions		0.016246276	0.071390431	0.052261895	0.025557365	0.471554154	0.261168454	
CO EmissionFactor (g/kw-h)		9.044	1.848	1.848	1.848	1.4	1.4	
CO Emissions		0.163912668	0.336211818	0.246126355	0.1203619	1.833821709	1.015655101	
# Auxiliary	1	1	1	1	1	1	1	1
Size (kW)	778	988	718	718	718	718	718	718
Load Factor	1	1	1	1	1	1	1	
PM EmissionFactor (g/kw-h)	0.25	0.25	0.25	0.25	0.25	0.25	0.25	0.25
PM Emissions	0.240200318	0.006502845	0.011581638	0.008478424	0.00414616	0.042693131	0.013683696	
VOC EmissionFactor (g/kw-h)	0.52	0.52	0.52	0.52	0.52	0.52	0.52	
VOC Emissions	0.499616662	0.013525917	0.024089807	0.017635122	0.008624012	0.088801712	0.028462087	
NOx EmissionFactor (g/kw-h)	13.9	13.9	13.9	13.9	13.9	13.9	13.9	
NOx Emissions	13.35513769	0.361558167	0.643939061	0.471400365	0.230526487	2.373738079	0.760813487	
Sox EmissionFactor (g/kw-h)	0.42	0.42	0.42	0.42	0.42	0.42	0.42	
Sox Emissions	0.403536535	0.010924779	0.019457151	0.014243752	0.006965549	0.07172446	0.022988609	
CO EmissionFactor (g/kw-h)	1.1	1.1	1.1	1.1	1.1	1.1	1.1	
CO Emissions	1.0568814	0.028612517	0.050959206	0.037305065	0.018243103	0.187849776	0.060208262	
# Boiler								
Size (kW)	3000	3000	3000					
Load Factor	1	0.12	0.12	0	0	0	0	0
PM EmissionFactor (g/kw-h)	0.136	0.136	0.136					
PM Emissions	0.503864935	0.001288985	0.00315898					
VOC EmissionFactor (g/kw-h)	0.11	0.11	0.11					
VOC Emissions	0.407537815	0.001042561	0.002555058					

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NOx EmissionFactor (g/kw-h)	1.97	1.97	1.97						
NOx Emissions	7.298631778	0.018671326	0.045758761						
Sox EmissionFactor (g/kw-h)	0.61	0.61	0.61						
Sox Emissions	2.259982429	0.005781477	0.014168956						
CO EmissionFactor (g/kw-h)	0.2	0.2	0.2						
CO Emissions	0.740977845	0.001895566	0.004645559						
Number of Tugs		3	2	2	2	2	2	1	1
# Tug Main Engine		1	1	1	1	1	1	1	1
Size (hp)		4344	4344	4344	4344	4344	4344	4344	4344
Load Factor		0.31	0.31	0.31	0.31	0.31	0.31	0.31	0.5
PM EmissionFactor (g/kw-h)		0.44	0.44	0.44	0.44	0.44	0.44	0.44	0.44
PM Emissions		0.046798493	0.076460953	0.055973808	0.027372582	0.281856292	0.090338555		0
VOC EmissionFactor (g/kw-h)		0.69	0.49	0.49	0.49	0.49	0.49		
VOC Emissions		0.073388547	0.085149698	0.062334468	0.030483103	0.313885417	0.1006043		
NOx EmissionFactor (g/kw-h)		11.41	6.93	6.93	6.93	6.93	6.93		
NOx Emissions		1.213570024	1.204260013	0.881587474	0.43111817	4.439236605	1.422832245		
Sox EmissionFactor (g/kw-h)		0.09	0.01	0.01	0.01	0.01	0.01		
Sox Emissions		0.009572419	0.001737749	0.001272132	0.000622104	0.006405825	0.002053149		
CO EmissionFactor (g/kw-h)		2.82	1.97	1.97	1.97	1.97	1.97		
CO Emissions		0.299935799	0.342336541	0.250610003	0.122554516	1.261947491	0.40447035		
# Tug Auxiliary		1	1	1	1	1	1	1	
Size (hp)		128	128	128	128	128	128	128	
Load Factor		0.43	0.43	0.43	0.43	0.43	0.43	0.43	0.43
PM EmissionFactor (g/kw-h)		0.59	0.59	0.59	0.59	0.59	0.59	0.59	
PM Emissions		0.002564827	0.004190501	0.003067687	0.001500175	0.01544735	0.004951074		
VOC EmissionFactor (g/kw-h)		0.85	0.85	0.85	0.85	0.85	0.85		
VOC Emissions		0.00369509	0.006037163	0.00441955	0.00216127	0.022254657	0.007132903		
NOx EmissionFactor (g/kw-h)		11.13	11.13	11.13	11.13	11.13	11.13		
NOx Emissions		0.048383945	0.079051317	0.057870103	0.028299918	0.291405093	0.093399068		
Sox EmissionFactor (g/kw-h)		0.09	0.09	0.09	0.09	0.09	0.09		
Sox Emissions		0.000391245	0.000639229	0.000467952	0.00022884	0.002356375	0.000755249		
CO EmissionFactor (g/kw-h)		3.3	3.3	3.3	3.3	3.3	3.3		
CO Emissions		0.014345644	0.023438396	0.017158252	0.008390811	0.086400432	0.027692446		

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Emission Segment	Hoteling at Berth	Manuevering	Transiting link 1	Transiting link 2	Transiting link 3	Transiting link 4	Transiting link 5	Transiting link 6	Tug transit
Model Source ID									
Segment Length (nmile)	NA	0.188984881	5.642548596	4.130669546	4.04	52	20	?	
Vessel Speed (knots)	NA	5	8	8	8	10	12	10	
Number Vessels per Year	30.48917582	30.48917582	30.48917582	30.48917582	30.48917582	30.48917582	30.48917582	30.48917582	
Transiting Time	27	0.575593952	1.410637149	1.032667387	0.505	5.2	1.666666667	#VALUE!	
Vessel Size (DWT)									
Vessel Type	Panamax	Panamax	Panamax	Panamax	Panamax	Panamax	Panamax	Panamax	
Barrels	283,070	283,070	283,070	283,070	283,070	283,070	283,070	283,070	
Unload/Load Rate	20,000	NA	NA	NA	NA	NA	NA	NA	
# Main Engines									
Number		1	1	1	1	1	1	1	
Size (kW)		11060	11060	11060	11060	11060	11060	11060	
Load Factor		0.037037037	0.151703704	0.151703704	0.151703704	0.296296296	0.512	0.24	
PM EmissionFactor (g/kw-h)		0.9959	0.2553	0.2553	0.2553	0.23	0.23	0.9959	
PM Emissions		0.007891755	0.020308028	0.014866642	0.007270157	0.13172337	0.072954482		
VOC EmissionFactor (g/kw-h)		7.008	0.816	0.816	0.816	0.6	0.6		
VOC Emissions		0.055533108	0.064909324	0.047517352	0.023237165	0.343626182	0.190316039		
NOx EmissionFactor (g/kw-h)		2.34184	0.85012	0.85012	0.85012	0.802	0.802		
NOx Emissions		0.018557314	0.067623425	0.04950423	0.024208798	0.459313663	0.254389106		
Sox EmissionFactor (g/kw-h)		0.8964	0.3924	0.3924	0.3924	0.36	0.36		
Sox Emissions		0.007103293	0.031213749	0.022850256	0.011174343	0.206175709	0.114189624		
CO EmissionFactor (g/kw-h)		9.044	1.848	1.848	1.848	1.4	1.4		
CO Emissions		0.071666871	0.147000529	0.107612827	0.052625345	0.801794424	0.444070758		
# Auxiliary	1	1	1	1	1	1	1	1	
Size (kW)	683	867	630	630	630	630	630	630	
Load Factor	1	1	1	1				0.24	
PM EmissionFactor (g/kw-h)	0.25	0.25	0.25	0.25	0.25	0.25	0.25	0.25	
PM Emissions	0.154944006	0.004193007	0.007467	0.005466273	0	0	0	#VALUE!	
VOC EmissionFactor (g/kw-h)	0.52	0.52	0.52	0.52	0.52	0.52	0.52		
VOC Emissions	0.322283532	0.008721455	0.015531361	0.011369848	0	0	0		
NOx EmissionFactor (g/kw-h)	13.9	13.9	13.9	13.9	13.9	13.9	13.9		
NOx Emissions	8.614886715	0.233131213	0.415165225	0.303924782	0	0	0		
Sox EmissionFactor (g/kw-h)	0.42	0.42	0.42	0.42	0.42	0.42	0.42		
Sox Emissions	0.26030593	0.007044252	0.012544561	0.009183339	0	0	0		
CO EmissionFactor (g/kw-h)	1.1	1.1	1.1	1.1	1.1	1.1	1.1		
CO Emissions	0.681753625	0.018449233	0.032854802	0.024051601	0	0	0		
# Boiler									
Size (kW)									
Load Factor	1	0.12	0.12	0	0	0	0	0	
PM EmissionFactor (g/kw-h)	0.136	0.136	0.136						
PM Emissions	0	0	0						
VOC EmissionFactor (g/kw-h)	0.11	0.11	0.11						
VOC Emissions	0	0	0						
NOx EmissionFactor (g/kw-h)	1.97	1.97	1.97						
NOx Emissions	0	0	0						
Sox EmissionFactor (g/kw-h)	0.61	0.61	0.61						
Sox Emissions	0	0	0						
CO EmissionFactor (g/kw-h)	0.2	0.2	0.2						

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CO Emissions	0	0	0						
Number of Tugs		2	2	2	2	2	2	0	1
# Tug Main Engine		1	1	1	1	1	1	1	1
Size (hp)		4344	4344	4344	4344	4344	4344	4344	4344
Load Factor		0.31	0.31	0.31	0.31	0.31	0.31	0.31	0.5
PM EmissionFactor (g/kw-h)		0.44	0.44	0.44	0.44	0.44	0.44	0.44	0.44
PM Emissions		0.022924544	0.056182337	0.041128697	0.020112954	0.207103686	0.066379387		0
VOC EmissionFactor (g/kw-h)		0.69	0.49	0.49	0.49	0.49	0.49		
VOC Emissions		0.035949853	0.062566694	0.045802412	0.022398517	0.230638196	0.073922499		
NOx EmissionFactor (g/kw-h)		11.41	6.93	6.93	6.93	6.93	6.93		
NOx Emissions		0.59447511	0.884871811	0.647776972	0.316779028	3.261883058	1.045475339		
Sox EmissionFactor (g/kw-h)		0.09	0.01	0.01	0.01	0.01	0.01		
Sox Emissions		0.004689111	0.001276871	0.000934743	0.000457113	0.004706902	0.001508622		
CO EmissionFactor (g/kw-h)		2.82	1.97	1.97	1.97	1.97	1.97		
CO Emissions		0.146925487	0.251543646	0.184144392	0.090051181	0.927259686	0.297198617		
# Tug Auxiliary		1	1	1	1	1	1	1	
Size (hp)		128	128	128	128	128	128	128	
Load Factor		0.43	0.43	0.43	0.43	0.43	0.43	0.43	0.43
PM EmissionFactor (g/kw-h)		0.59	0.59	0.59	0.59	0.59	0.59	0.59	
PM Emissions		0.001256397	0.003079116	0.00225409	0.001102306	0.011350476	0.003637973	#VALUE!	
VOC EmissionFactor (g/kw-h)		0.85	0.85	0.85	0.85	0.85	0.85		
VOC Emissions		0.001810064	0.004436015	0.003247417	0.001588068	0.016352381	0.005241148		
NOx EmissionFactor (g/kw-h)		11.13	11.13	11.13	11.13	11.13	11.13		
NOx Emissions		0.023701188	0.058085697	0.042522065	0.020794346	0.214119998	0.068628205		
Sox EmissionFactor (g/kw-h)		0.09	0.09	0.09	0.09	0.09	0.09		
Sox Emissions		0.000191654	0.000469696	0.000343844	0.000168148	0.001731429	0.000554945		
CO EmissionFactor (g/kw-h)		3.3	3.3	3.3	3.3	3.3	3.3		
CO Emissions		0.007027306	0.017222174	0.01260762	0.00616544	0.063485714	0.020347985		

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Emission Segment	Hoteling at Berth	Manuevering	Transiting link 1	Transiting link 2	Transiting link 3	Transiting link 4	Transiting link 5	Transiting link 6	Tug transit
Model Source ID									
Segment Length (nmile)	NA	0.188984881	5.642548596	4.130669546	4.04	52	20	?	
Vessel Speed (knots)	NA	5	8	8	8	10	12	10	
Number Vessels per Year	46.82079617	46.82079617	46.82079617	46.82079617	46.82079617	46.82079617	46.82079617	46.82079617	
Transiting Time	27	0.575593952	1.410637149	1.032667387	0.505	5.2	1.666666667	#VALUE!	
Vessel Size (DWT)									
Vessel Type	Barge	Barge	Barge	Barge	Barge	Barge	Barge	Barge	
Barrels	61,444	61,444	61,444	61,444	61,444	61,444	61,444	61,444	
Unload/Load Rate	20,000	NA	NA	NA	NA	NA	NA	NA	
# Main Engines									
Number		0	0	0	0	0	0	0	
Size (kW)		11060	11060	11060	11060	11060	11060	11060	
Load Factor		0.33	0.28	0.28				0.24	
PM EmissionFactor (g/kw-h)		0.23	0.23	0.23	0.23	0.23	0.23	0.23	
PM Emissions		0	0	0	0	0	0		
VOC EmissionFactor (g/kw-h)		7.008	0.816	0.816	0.816	0.6	0.6		
VOC Emissions		0	0	0	0	0	0		
NOx EmissionFactor (g/kw-h)		2.34184	0.85012	0.85012	0.85012	0.802	0.802		
NOx Emissions		0	0	0	0	0	0		
Sox EmissionFactor (g/kw-h)		0.8964	0.3924	0.3924	0.3924	0.36	0.36		
Sox Emissions		0	0	0	0	0	0		
CO EmissionFactor (g/kw-h)		9.044	1.848	1.848	1.848	1.4	1.4		
CO Emissions		0	0	0	0	0	0		
# Auxiliary	1	1	1	1	1	1	1	1	
Size (kW)	99	99	99	99	99	99	99	99	
Load Factor	1	1	1	1				0.24	
PM EmissionFactor (g/kw-h)	0.25	0.25	0.25	0.25	0.25	0.25	0.25	0.25	
PM Emissions	0.034489141	0.00073525	0.001801913	0.001319104	0	0	0	#VALUE!	
VOC EmissionFactor (g/kw-h)	0.52	0.52	0.52	0.52	0.52	0.52	0.52		
VOC Emissions	0.071737414	0.001529319	0.00374798	0.002743737	0	0	0		
NOx EmissionFactor (g/kw-h)	13.9	13.9	13.9	13.9	13.9	13.9	13.9		
NOx Emissions	1.917596249	0.040879882	0.100186389	0.073342189	0	0	0		
Sox EmissionFactor (g/kw-h)	0.42	0.42	0.42	0.42	0.42	0.42	0.42		
Sox Emissions	0.057941757	0.001235219	0.003027215	0.002216095	0	0	0		
CO EmissionFactor (g/kw-h)	1.1	1.1	1.1	1.1	1.1	1.1	1.1		
CO Emissions	0.151752221	0.003235099	0.007928419	0.005804058	0	0	0		
# Boiler									
Size (kW)									
Load Factor	1	0.12	0.12	0	0	0	0	0	
PM EmissionFactor (g/kw-h)	0.136	0.136	0.136						
PM Emissions	0	0	0						
VOC EmissionFactor (g/kw-h)	0.11	0.11	0.11						
VOC Emissions	0	0	0						

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NOx EmissionFactor (g/kw-h)	1.97	1.97	1.97						
NOx Emissions	0	0	0						
Sox EmissionFactor (g/kw-h)	0.61	0.61	0.61						
Sox Emissions	0	0	0						
CO EmissionFactor (g/kw-h)	0.2	0.2	0.2						
CO Emissions	0	0	0						
Number of Tugs	1	2	2	2	1	1	1	0	1
# Tug Main Engine		1	1	1	1	1	1	1	1
Size (hp)		4334	4334	4334	4334	4334	4334	4334	4334
Load Factor		0.31	0.31	0.31	0.31	0.31	0.31	0.31	0.5
PM EmissionFactor (g/kw-h)		0.44	0.44	0.44	0.44	0.44	0.44	0.44	0.44
PM Emissions		0.035123105	0.086077967	0.063014014	0.015407709	0.158653637	0.050850525		0
VOC EmissionFactor (g/kw-h)		0.69	0.49	0.49	0.49	0.49	0.49		
VOC Emissions		0.055079415	0.095859554	0.070174698	0.017158585	0.17668246	0.056628994		
NOx EmissionFactor (g/kw-h)		11.41	6.93	6.93	6.93	6.93	6.93		
NOx Emissions		0.910805985	1.355727983	0.992470725	0.242671417	2.498794789	0.800895766		
Sox EmissionFactor (g/kw-h)		0.09	0.01	0.01	0.01	0.01	0.01		
Sox Emissions		0.007184272	0.001956317	0.001432137	0.000350175	0.003605764	0.001155694		
CO EmissionFactor (g/kw-h)		2.82	1.97	1.97	1.97	1.97	1.97		
CO Emissions		0.225107176	0.385394535	0.282130928	0.068984515	0.710335604	0.227671668		
# Tug Auxiliary	1	1	1	1	1	1	1	1	
Size (hp)	128	128	128	128	128	128	128	128	
Load Factor	0.43	0.43	0.43	0.43	0.43	0.43	0.43	0.43	0.43
PM EmissionFactor (g/kw-h)	0.59	0.59	0.59	0.59	0.59	0.59	0.59	0.59	
PM Emissions	0.045251983	0.00192939	0.004728454	0.0034615	0.00084638	0.008715197	0.002793332	#VALUE!	
VOC EmissionFactor (g/kw-h)	0.85	0.85	0.85	0.85	0.85	0.85	0.85		
VOC Emissions	0.065193535	0.00277963	0.006812179	0.004986906	0.001219361	0.012555792	0.004024292		
NOx EmissionFactor (g/kw-h)	11.13	11.13	11.13	11.13	11.13	11.13	11.13		
NOx Emissions	0.853651811	0.036396801	0.089199478	0.06529914	0.015966451	0.164407016	0.052694556		
Sox EmissionFactor (g/kw-h)	0.09	0.09	0.09	0.09	0.09	0.09	0.09		
Sox Emissions	0.006902845	0.000294314	0.00072129	0.000528025	0.000129109	0.001329437	0.000426102		
CO EmissionFactor (g/kw-h)	3.3	3.3	3.3	3.3	3.3	3.3	3.3		
CO Emissions	0.253104311	0.010791504	0.026447285	0.019360931	0.004733988	0.048746015	0.015623723		

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Vessel Clas	SRCGRP		Total Emissions	Conversion tons-grams	Conversion yr to sec	Number of volume sources	Emission Rate (g/s)	
Large	H_AUX	HOTELICE	0.240200318	907184	3.17098E-08	1	6.9098E-03	PM10
Large	H_BOILER	HOTELBLR	0.503864935	907184	3.17098E-08	1	1.4494E-02	PM10
Large	H_BOILER	HOTELBLR	0.407537815	907184	3.17098E-08	1	1.1723E-02	HC
Large	M_Main	MAN_SHIP	0.018049605	907184	3.17098E-08	8	6.4903E-05	PM10
Large	M_AUX	MAN_SHIP	0.006502845	907184	3.17098E-08	8	2.3383E-05	PM10
Large	T_AUX	TRANS_SH	0.020060062	907184	3.17098E-08	361	1.5985E-06	PM10
Large	T_MAIN	TRANS_SH	0.08044964	907184	3.17098E-08	361	6.4107E-06	PM10
Large	M_TUG	MAN_TUG	0.049363321	907184	3.17098E-08	8	1.7750E-04	PM10
Large	T_TUG	TRANS_TU	0.13969295	907184	3.17098E-08	361	1.1132E-05	PM10
Small	H_AUX	HOTELICE	0.154944006	907184	3.17098E-08	1	4.4572E-03	PM10
Small	H_BOILER	HOTELBLR	0	907184	3.17098E-08	1	0.0000E+00	PM10
Small	H_BOILER	HOTELBLR	0	907184	3.17098E-08	1	0.0000E+00	HC
Small	M_Main	MAN_SHIP	0.007891755	907184	3.17098E-08	8	2.8377E-05	PM10
Small	M_AUX	MAN_SHIP	0.004193007	907184	3.17098E-08	8	1.5077E-05	PM10
Small	T_AUX	TRANS_SH	0.012933274	907184	3.17098E-08	361	1.0306E-06	PM10
Small	T_MAIN	TRANS_SH	0.03517467	907184	3.17098E-08	361	2.8029E-06	PM10
Small	M_TUG	MAN_TUG	0.024180941	907184	3.17098E-08	8	8.6950E-05	PM10
Small	T_TUG	TRANS_TU	0.10264424	907184	3.17098E-08	361	8.1793E-06	PM10
Barge	H_AUX	HOTELICE	0.034489141	907184	3.17098E-08	1	9.9214E-04	PM10
Barge	H_BOILER	HOTELBLR	0	907184	3.17098E-08	1	0.0000E+00	PM10
Barge	H_BOILER	HOTELBLR	0	907184	3.17098E-08	1	0.0000E+00	HC
Barge	M_Main	MAN_SHIP	0	907184	3.17098E-08	8	0.0000E+00	PM10
Barge	M_AUX	MAN_SHIP	0.00073525	907184	3.17098E-08	8	2.6438E-06	PM10
Barge	T_AUX	TRANS_SH	0.003121018	907184	3.17098E-08	361	2.4870E-07	PM10
Barge	T_MAIN	TRANS_SH	0	907184	3.17098E-08	361	0.0000E+00	PM10
Barge	M_TUG	MAN_TUG	0.037052496	907184	3.17098E-08	8	1.3323E-04	PM10
Barge	T_TUG	TRANS_TU	0.157281935	907184	3.17098E-08	361	1.2533E-05	PM10
Barge	H_AUX	HOTELICE	0.045251983	907184	3.17098E-08	1	1.3017E-03	PM10
Large	H_BOILER	HOTELBLR	0.000449743	907184	0.000277778	1	1.1333E-01	PM10
Large	H_BOILER	HOTELBLR	0.000363763	907184	0.000277778	1	9.1667E-02	HC

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		Tons Per Year				
Source	Engine Type	PM	HC	NOx	SO2	CO
Large Tanker	Main Engine	0.58	1.66	2.00	0.90	3.72
	Auxiliary Engine	0.33	0.68	18.20	0.55	1.44
	Boiler	0.51	0.41	7.36	2.28	0.75
	Tug Main Engine	0.58	0.67	9.59	0.02	2.68
	Tug Auxiliary Engine	0.03	0.05	0.60	0.00	0.18
Small Tanker	Main Engine	0.26	0.73	0.87	0.39	3.72
	Auxiliary Engine	0.17	0.36	9.57	0.29	0.76
	Boiler	0.00	0.00	0.00	0.00	0.00
	Tug Main Engine	0.41	0.47	6.75	0.01	1.90
	Tug Auxiliary Engine	0.02	0.03	0.43	0.00	0.13
Barge	Main Engine	0.00	0.00	0.00	0.00	0.00
	Auxiliary Engine	0.04	0.08	2.13	0.06	0.17
	Boiler	0.00	0.00	0.00	0.00	0.00
	Tug Main Engine	0.41	0.47	6.80	0.02	1.90
	Tug Auxiliary Engine	0.07	0.10	1.28	0.01	0.38
Total		3.41	5.70	65.58	4.54	17.71

130,000 bbl/day Permit Baseline

Source	Engine Type	Tons Per Year				
		PM	BC	NOx	SO2	CO
Large Tanker	Auxiliary Engine	0.24	0.50	13.36	0.40	1.06
	Boiler	0.50	0.41	7.30	2.26	0.74
Small Tanker	Auxiliary Engine	0.15	0.32	8.61	0.26	0.68
Barge	Auxiliary Engine	0.03	0.07	1.92	0.06	0.15
	Tug Auxiliary Engine	0.05	0.07	0.85	0.01	0.25
Total		0.98	1.37	32.04	2.99	2.88

Appendix B
AERMOD Input Files

```
**BEE-Line Software: BEEST Sui (Version 11.00) data input file
**  Model: AERMOD.EXE     Input File Creation Date: 8/7/2015  Time:
3:51:30 PM
NO ECHO


CO STARTING
CO TITLEONE P66MTIII CHI/Q
CO TITLETWO UTM NAD83 Z10
CO MODELOPT DFAULT CONC NODRYDPLT NOWETDPLT
CO AVERTIME 1 PERIOD
CO POLLUTID CHI-Q
CO RUNORNOT RUN
CO ERRORFIL "T:\Projects\P66 MTIII\ERM New Modeling July 2015\SRCGRP.err"
CO FINISHED

SO STARTING
SO ELEVUNIT METERS
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SO LOCATION SP1_0003 VOLUME 549622.12 4203077.66 0.
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SO LOCATION SP1_0004 VOLUME 549658.24 4203112.24 0.
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** Hoteling Boiler
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TG2_0100
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TG2_0106
SO SRCGROUP TRANS_TU  TG2_0107 TG2_0108 TG2_0109 TG2_0110 TG2_0111
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SO SRCGROUP TRANS_TU  TG2_0113 TG2_0114 TG2_0115 TG2_0116 TG2_0117
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