Fuel Gas System – Overview

The existing Fuel Gas system includes gases produced in the No. 5 Gas Plant (S-1526) and No. 4 Gas Plant (S-955 through S-960), as well as recovered vapors from the Wet Gas system and recovered Flare Gas. Wet gas is comprised of off-gasses from various units that are usable as fuel gas. Wet Gas is typically routed to the No. 5 Gas Plant where it collects the wet gas streams in the refinery, compresses those gases, separates out heavier gasses like propane and butane, and treats the remainder to remove H_2S, and sent to the 100# Fuel Gas system. If the No. 5 Gas Plant is down, the wet gas streams are diverted to the No. 4 Gas Plant, where similar processing takes place at a lower capacity.

The existing Fuel Gas system also includes gases recovered from the Vapor Recovery system which includes tank vapors, vapors from the Marine Vapor Recovery system, and a vapors from a few other very low-pressure streams. In addition, No. 1 Hydrogen Plant off-gasses are sent to the 40# fuel gas system. Purchased natural gas is added to the Fuel Gas system to make up for any shortage between the fuel gas produced and consumed, maintaining pressure control in the system. Lastly, propane or butane can be added to the Fuel Gas system, if needed, to increase the BTU content of the fuel gas.

The fuel gas (100# and 40# Refinery Fuel Gas) is sent to fuel gas users such as furnaces and boilers throughout the refinery.

Proposed Changes:

Marathon is proposing to shut down various units that would normally generate wet gas to be processed at the No. 5 Gas Plant and shut down various fuel gas users at the facility. Typically, the refinery producers will generate 70-90 MMSCFD of wet gas. After being processed at the No. 5 Gas Plant, where butane and propane are recovered, about 40-60 MMSCFD of fuel gas is produced. After the implementation of this project, Marathon is estimating that the No. 5 Gas Plant will produce at most 40 MMSCFD of fuel gas. In addition, Marathon is proposing to introduce the vent gas from the No. 1 Gas Plant (normally 40# fuel gas) into the main fuel gas system at the No. 5 Gas Plant. Therefore, the facility will no longer produce and use 40# fuel gas.

The ratio of fuel gas production to consumption is typically 1:1. 100# Fuel Gas will be combusted at various process units, heaters, and boilers, or fed to the No. 1 Hydrogen Plant (S-1005) as feedstock.

Furthermore, Marathon is proposing to shut down No. 4 Gas Plant (S-955 through S-960). An alternate disposition of wet gas streams is no longer required as the refinery will be down if the No. 5 Gas Plant is down.

The anticipated composition of fuel gas is shown in the Table A-1 and compared to historical refinery fuel gas. Based on the anticipated composition, the properties of fuel gas will be comparable to refinery fuel gas primarily due to the hydrogen content. Note that the composition of 100# fuel gas is shown in comparison to refinery 100# fuel gas, and that the alternative fuels facility will not produce 40# fuel gas.

Table A-1: Composition of Refinery Fuel Gas and Fuel Gas

	100# RFG [1]	FG [2]
	(Normalized mol%)	
H2	17.672	12.0
N2	4.123	1.8
C1	57.116	80.0
CO	0.647	0.2
CO2	0.285	0.6
H2S	0.001	-
COS	0.000	-
Ar	0.034	-
O2	0.000	0.2
C2	10.545	1.3
C2=	3.787	-
C3	2.685	2.6
C3=	2.130	-
C4==	0.003	-
IC4	0.193	0.1
NC4	0.124	0.5
C4=1	0.033	-
iC4=	0.029	-
trC4=2	0.035	-
cisC4=2	0.026	-
3meC4=1	0.008	-
2meC4=1	0.016	-
2meC4=2	0.014	-
IC5	0.218	0.1
NC5	0.120	0.3
C5=1	0.010	-
trC5=2	0.011	-
cisC5=2	0.000	-
C6+s	0.135	0.1
H2O	-	0.2
Sum	100	100

[1] Based on 2019 fuel analysis.
[2] Based on process simulation.

Table A-2: Heat Content/Higher Heating Value (HHV) of Refinery Fuel Gas and Fuel Gas

	HHV (Btu/scf)
FG	976
100# RFG (2019)	989

The following process heaters will continue to operate within the permitted design parameters and there will be no physical changes to the heaters except for S-920. S-920 will require physical changes, but the firing duty will not change. The properties of the fuel gas will change from the production of alternative fuels, but the new fuel gas combusted in the heaters will have a similar or lower heat content on a volumetric basis (Btu/scf) and less sulfur due to changes in facility operations. See Appendix A for more details on the Marathon's existing fuel gas system and new fuel gas properties. Marathon will provide fuel gas analysis to demonstrate that firing fuel gas is similar to refinery fuel gas per Permit Condition #27583, Parts 8 and 16.

Table B-1 – Overview of Process Heaters at Marathon

Source No.	Source Description	Fuel Type	Change Description	Firm Limit
919	No. 2 HDS Depent Reboiler (F19)	NG/RFG	Change in the Method of Operation	65 MMBtu/hour 569,400 MMBtu/year
920	No. 2 HDS Charge Heater (F20)	NG/RFG	Physical Change	63 MMBtu/hour 551,880 MMBtu/year
928	HDN Reactor A Heater (F28)	NG/RFG	Change in the Method of Operation	20 MMBtu/hour 175,200 MMBtu/year
929	HDN Reactor B Heater (F29)	NG/RFG	Change in the Method of Operation	20 MMBtu/hour 175,200 MMBtu/year
930	HDN Reactor C Heater (F30)	NG/RFG	Change in the Method of Operation	20 MMBtu/hour 175,200 MMBtu/year
931	Hydrocracker Reactor 1 Heater (F31)	NG/RFG	Change in the Method of Operation	20 MMBtu/hour 175,200 MMBtu/year
932	Hydrocracker Reactor 2 Heater (F32)	NG/RFG	Change in the Method of Operation	20 MMBtu/hour 175,200 MMBtu/year
933	Hydrocracker Reactor 3 Heater (F33)	NG/RFG	Change in the Method of Operation	20 MMBtu/hour 175,200 MMBtu/year
934	Hydrocracker Stabilizer Reboiler (F34)	NG/RFG	Change in the Method of Operation	135 MMBtu/hour 1,182,600 MMBtu/year
937	Hydrogen Plant Heater (F37)	NG/RFG	Change in the Method of Operation	743 MMBtu/hour 6,508,680 MMBtu/year
973	No. 3 HDS Recycle Gas Heater (F55), Abated by A-31 SCR	NG/RFG	Change in the Method of Operation	110 MMBtu/hour 963,600 MMBtu/year
1511	Hot Oil Heater #1 (F78), Natural Gas, Fuel Gas, Abated by A-1511 SCR	NG/RFG	Change in the Method of Operation	230 MMBtu/hour 2,014,800 MMBtu/year
1512	Hot Oil Heater #2 (F79), Backup, Natural Gas, Fuel Gas, Abated by A-1512 SCR	NG/RFG	Change in the Method of Operation	230 MMBtu/hour 2,014,800 MMBtu/year

Table B-2 – Pre-Project Criteria PTE

Pollutant	919		920		928		929		930		931		932		933		934		937		973		1511		1512	
	lbs/ day	tons/ year	lbs/ day	tons/ year	lbs/ day	tons/ year	lbs/ day	tons/ year	lbs/ day	tons/ year	lbs/ day	tons/ year	lbs/ day	tons/ year	lbs/ day	tons/ year	lbs/ day	tons/ year	lbs/ day	tons/ year	lbs/ day	tons/ year	lbs/ day	tons/ year	lbs/ day	tons/ year
PM_{10}	11.6	2.121	11.3	2.056	3.6	0.653	3.6	0.653	3.6	0.653	3.6	0.653	3.6	0.653	3.6	0.653	24.1	4.406	132.9	24.248	19.8	3.623	41.1	7.506	41.1	7.506
$PM_{2.5}$	11.6	2.121	11.3	2.056	3.6	0.653	3.6	0.653	3.6	0.653	3.6	0.653	3.6	0.653	3.6	0.653	24.1	4.406	132.9	24.248	19.8	3.623	41.1	7.506	41.1	7.506
NO_x	113.6	20.732	110.4	20.144	76.8	14.016	76.8	14.016	76.8	14.016	76.8	14.016	76.8	14.016	76.8	14.016	236.5	43.165	1,301.7	237.567	130.5	23.823	46.9	8.563	46.9	8.563
CO	211.8	38.648	205.3	37.459	0.7	0.136	0.7	0.130	0.7	0.136	0.7	0.123	0.9	0.168	0.9	0.155	2.6	0.472	107.0	19.526	2.1	0.381	143.5	26.192	143.5	26.192
SO_2	41.8	7.636	40.6	7.401	12.9	2.350	12.9	2.350	12.9	2.350	12.9	2.350	12.9	2.350	12.9	2.350	86.9	15.860	478.3	87.290	71.5	13.041	32.0	5.838	32.0	5.838
POC	16.9	3.081	16.4	2.987	2.6	0.472	2.6	0.472	2.6	0.472	2.6	0.472	2.6	0.472	2.6	0.472	0.8	0.149	13.5	2.460	0.4	0.080	0.5	0.088	0.7	0.126

Table B-2 – Post-Project Criteria PTE

Pollutant	919		920		928		929		930		931		932		933		934		937		973		1511		1512	
	lbs/ day	tons/ year	lbs/ day	tons/ year	lbs/ day	tons/ year	lbs/ day	tons/ year	lbs/ day	tons/ year	lbs/ day	tons/ year	lbs/ day	tons/ year	lbs/ day	tons/ year	lbs/ day	tons/ year	lbs/ day	tons/ year	lbs/ day	tons/ year	lbs/ day	tons/ year	lbs/ day	tons/ year
PM_{10}	11.6	2.121	11.3	2.056	3.6	0.653	3.6	0.653	3.6	0.653	3.6	0.653	3.6	0.653	3.6	0.653	24.1	4.406	132.9	24.248	19.8	3.623	41.1	7.506	41.1	7.506
$PM_{2.5}$	11.6	2.121	11.3	2.056	3.6	0.653	3.6	0.653	3.6	0.653	3.6	0.653	3.6	0.653	3.6	0.653	24.1	4.406	132.9	24.248	19.8	3.623	41.1	7.506	41.1	7.506
NO_x	113.6	20.732	110.4	20.144	76.8	14.016	76.8	14.016	76.8	14.016	76.8	14.016	76.8	14.016	76.8	14.016	236.5	43.165	1,301.7	237.567	130.5	23.823	46.9	8.563	46.9	8.563
CO	211.8	38.648	205.3	37.459	0.7	0.136	0.7	0.130	0.7	0.136	0.7	0.123	0.9	0.168	0.9	0.155	2.6	0.472	107.0	19.526	2.1	0.381	143.5	26.192	143.5	26.192
SO_2	25.8	1.650	40.6	7.401	12.9	2.350	12.9	2.350	12.9	2.350	12.9	2.350	12.9	2.350	12.9	2.350	86.9	15.860	478.3	87.290	71.5	13.041	32.0	5.838	32.0	5.838
POC	16.9	3.081	16.4	2.987	2.6	0.472	2.6	0.472	2.6	0.472	2.6	0.472	2.6	0.472	2.6	0.472	0.8	0.149	13.5	2.460	0.4	0.080	0.5	0.088	0.7	0.126

Table B-3 – Criteria Emissions Increase

Pollutant	919		920		928		929		930		931		932		933		934		937		973		1511		1512	
	lbs/day	tons/ year	lbs/day	tons/ year	lbs/day	tons/ year	lbs/day	tons/ year	lbs/day	tons/ year	lbs/day	tons/ year	lbs/day	tons/ year	lbs/day	tons/ year	lbs/day	tons/ year	lbs/day	tons/ year	lbs/day	tons/ year	lbs/day	tons/ year	lbs/day	tons/ year
PM_{10}	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0
$PM_{2.5}$	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0
NO_x	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0
CO	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0
SO_2	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0
POC	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0

Table B-4 – Pre-Project TAC PTE

Pollutant	919		920		928		929		930		931		932		933		934		937		973		1511		1512	
	lbs/hour	lbs/year	lbs/hour	lbs/year	lbs/hour	lbs/year	lbs/hour	lbs/year	lbs/hour	lbs/year	lbs/hour	lbs/year	lbs/hour	lbs/year	lbs/hour	lbs/year	lbs/hour	lbs/year	lbs/hour	lbs/year	lbs/hour	lbs/year	lbs/hour	lbs/year	lbs/hour	lbs/year
Sulfuric Acid	1.8E-03	1.6E+01	1.8E-03	1.6E+01	5.7E-04	5.0E+00	5.7E-04	5.0E+00	5.7E-04	5.0E+00	5.7E-04	5.0E+00	5.7E-04	5.0E+00	5.7E-04	5.0E+00	3.8E-03	3.3E+01	2.1E-02	1.8E+02	3.1E-03	2.8E+01	1.4E-03	1.2E+01	1.4E-03	1.2E+01
PAH (as B(a)P-equivalent)	7.1E-05	6.2E-01	6.9E-05	6.1E-01	2.2E-05	1.9E-01	2.2E-05	1.9E-01	2.2E-05	1.9E-01	2.2E-05	1.9E-01	2.2E-05	1.9E-01	2.2E-05	1.9E-01	1.5E-04	1.3E+00	8.2E-04	7.1E+00	1.2E-04	1.1E+00	2.4E-04	2.1E+00	2.4E-04	2.1E+00
Ammonia	9.2E-03	8.1E+01	8.5E-03	7.5E+01	2.7E-03	2.4E+01	2.7E-03	2.4E+01	2.7E-03	2.4E+01	2.7E-03	2.4E+01	2.7E-03	2.4E+01	2.7E-03	2.4E+01	1.8E-02	1.6E+02	1.0E-01	8.8E+02	1.6E-02	1.4E+02	1.0E+00	9.1E+03	1.0E+00	9.1E+03
1,4-Dichlorobenzene(p)	7.6E-05	6.7E-01	7.4E-05	6.5E-01	2.4E-05	2.1E-01	2.4E-05	2.1E-01	2.4E-05	2.1E-01	2.4E-05	2.1E-01	2.4E-05	2.1E-01	2.4E-05	2.1E-01	1.6E-04	1.4E+00	8.7E-04	7.7E+00	1.3E-04	1.1E+00	2.7E-04	2.4E+00	2.7E-04	2.4E+00
Acetaldehyde	3.4E-03	2.9E+01	3.1E-03	2.7E+01	9.9E-04	8.6E+00	9.9E-04	8.6E+00	9.9E-04	8.6E+00	9.9E-04	8.6E+00	9.9E-04	8.6E+00	9.9E-04	8.6E+00	6.7E-03	5.8E+01	3.7E-02	3.2E+02	5.7E-03	5.0E+01	3.2E-03	2.8E+01	3.2E-03	2.8E+01
Arsenic	5.5E-05	4.8E-01	5.0E-05	4.4E-01	1.6E-05	1.4E-01	1.6E-05	1.4E-01	1.6E-05	1.4E-01	1.6E-05	1.4E-01	1.6E-05	1.4E-01	1.6E-05	1.4E-01	1.1E-04	9.4E-01	5.9E-04	5.2E+00	9.3E-05	8.2E-01	4.6E-05	4.0E-01	4.6E-05	4.0E-01
Benzene	3.1E-03	2.7E+01	2.9E-03	2.5E+01	9.1E-04	7.9E+00	9.1E-04	7.9E+00	9.1E-04	7.9E+00	9.1E-04	7.9E+00	9.1E-04	7.9E+00	9.1E-04	7.9E+00	6.1E-03	5.4E+01	3.4E-02	3.0E+02	5.3E-03	4.6E+01	2.6E-03	2.3E+01	2.6E-03	2.3E+01
Beryllium	9.5E-07	8.3E-03	8.8E-07	7.7E-03	2.8E-07	2.4E-03	2.8E-07	2.4E-03	2.8E-07	2.4E-03	2.8E-07	2.4E-03	2.8E-07	2.4E-03	2.8E-07	2.4E-03	1.9E-06	1.6E-02	1.0E-05	9.1E-02	1.6E-06	1.4E-02	3.0E-05	2.6E-01	3.0E-05	2.6E-01
Cadmium	3.9E-05	3.4E-01	3.6E-05	3.1E-01	1.1E-05	9.9E-02	1.1E-05	9.9E-02	1.1E-05	9.9E-02	1.1E-05	9.9E-02	1.1E-05	9.9E-02	1.1E-05	9.9E-02	7.7E-05	6.7E-01	4.2E-04	3.7E+00	6.6E-05	5.8E-01	2.5E-04	2.2E+00	2.5E-04	2.2E+00
Chromium (hexavalent)	8.3E-05	7.3E-01	7.7E-05	6.7E-01	2.4E-05	2.1E-01	2.4E-05	2.1E-01	2.4E-05	2.1E-01	2.4E-05	2.1E-01	2.4E-05	2.1E-01	2.4E-05	2.1E-01	1.6E-04	1.4E+00	9.1E-04	7.9E+00	1.4E-04	1.2E+00	0.0E+00	0.0E+00	0.0E+00	0.0E+00
Copper	3.7E-04	3.3E+00	3.4E-04	3.0E+00	1.1E-04	9.5E-01	1.1E-04	9.5E-01	1.1E-04	9.5E-01	1.1E-04	9.5E-01	1.1E-04	9.5E-01	1.1E-04	9.5E-01	7.3E-04	6.4E+00	4.0E-03	3.5E+01	6.3E-04	5.6E+00	1.9E-04	1.7E+00	1.9E-04	1.7E+00
Cyanide and compounds	1.7E-04	1.5E+00	1.6E-04	1.4E+00	5.1E-05	4.4E-01	5.1E-05	4.4E-01	5.1E-05	4.4E-01	5.1E-05	4.4E-01	5.1E-05	4.4E-01	5.1E-05	4.4E-01	3.4E-04	3.0E+00	1.9E-03	1.6E+01	3.0E-04	2.6E+00	0.0E+00	0.0E+00	0.0E+00	0.0E+00
Ethyl benzene	1.2E-03	1.0E+01	1.1E-03	9.3E+00	3.4E-04	3.0E+00	3.4E-04	3.0E+00	3.4E-04	3.0E+00	3.4E-04	3.0E+00	3.4E-04	3.0E+00	3.4E-04	3.0E+00	2.3E-03	2.0E+01	1.3E-02	1.1E+02	2.0E-03	1.7E+01	2.6E-04	2.3E+00	2.6E-04	2.3E+00
Formaldehyde	6.5E-03	5.7E+01	6.0E-03	5.2E+01	1.9E-03	1.7E+01	1.9E-03	1.7E+01	1.9E-03	1.7E+01	1.9E-03	1.7E+01	1.9E-03	1.7E+01	1.9E-03	1.7E+01	1.3E-02	1.1E+02	7.0E-02	6.2E+02	1.1E-02	9.7E+01	1.7E-02	1.5E+02	1.7E-02	1.5E+02
Hexane	1.2E-01	1.0E+03	1.1E-01	9.9E+02	3.6E-02	3.2E+02	3.6E-02	3.2E+02	3.6E-02	3.2E+02	3.6E-02	3.2E+02	3.6E-02	3.2E+02	3.6E-02	3.2E+02	2.4E-01	2.1E+03	1.3E+00	1.2E+04	2.0E-01	1.8E+03	4.1E-01	3.6E+03	4.1E-01	3.6E+03
Hydrochloric acid	5.3E-02	4.6E+02	4.9E-02	4.3E+02	1.5E-02	1.4E+02	1.5E-02	1.4E+02	1.5E-02	1.4E+02	1.5E-02	1.4E+02	1.5E-02	1.4E+02	1.5E-02	1.4E+02	1.0E-01	9.2E+02	5.8E-01	5.0E+03	9.0E-02	7.9E+02	0.0E+00	0.0E+00	0.0E+00	0.0E+00
Hydrogen sulfide	5.2E-03	4.6E+01	4.8E-03	4.2E+01	1.5E-03	1.3E+01	1.5E-03	1.3E+01	1.5E-03	1.3E+01	1.5E-03	1.3E+01	1.5E-03	1.3E+01	1.5E-03	1.3E+01	1.0E-02	9.1E+01	5.7E-02	5.0E+02	8.9E-03	7.8E+01	2.0E-02	1.7E+02	2.0E-02	1.7E+02
Lead	1.6E-04	1.4E+00	1.5E-04	1.3E+00	4.7E-05	4.1E-01	4.7E-05	4.1E-01	4.7E-05	4.1E-01	4.7E-05	4.1E-01	4.7E-05	4.1E-01	4.7E-05	4.1E-01	3.2E-04	2.8E+00	1.7E-03	1.5E+01	2.7E-04	2.4E+00	1.1E-04	9.9E-01	1.1E-04	9.9E-01
Manganese	3.0E-04	2.6E+00	2.8E-04	2.4E+00	8.8E-05	7.7E-01	8.8E-05	7.7E-01	8.8E-05	7.7E-01	8.8E-05	7.7E-01	8.8E-05	7.7E-01	8.8E-05	7.7E-01	6.0E-04	5.2E+00	3.3E-03	2.9E+01	5.1E-04	4.5E+00	8.5E-05	7.5E-01	8.5E-05	7.5E-01
Mercury	1.6E-05	1.4E-01	1.4E-05	1.3E-01	4.6E-06	4.0E-02	4.6E-06	4.0E-02	4.6E-06	4.0E-02	4.6E-06	4.0E-02	4.6E-06	4.0E-02	4.6E-06	4.0E-02	3.1E-05	2.7E-01	1.7E-04	1.5E+00	2.7E-05	2.3E-01	5.8E-05	5.0E-01	5.8E-05	5.0E-01
Naphthalene	3.1E-05	2.7E-01	1.4E-04	1.2E+00	4.4E-05	3.9E-01	4.4E-05	3.9E-01	4.4E-05	3.9E-01	4.4E-05	3.9E-01	4.4E-05	3.9E-01	4.4E-05	3.9E-01	3.0E-04	2.6E+00	1.6E-03	1.4E+01	5.3E-05	4.6E-01	2.6E-04	2.3E+00	2.6E-04	2.3E+00
Nickel	3.2E-04	2.8E+00	3.0E-04	2.6E+00	9.4E-05	8.3E-01	9.4E-05	8.3E-01	9.4E-05	8.3E-01	9.4E-05	8.3E-01	9.4E-05	8.3E-01	9.4E-05	8.3E-01	6.4E-04	5.6E+00	3.5E-03	3.1E+01	5.5E-04	4.8E+00	4.8E-04	4.2E+00	4.8E-04	4.2E+00
Phenol	3.0E-04	2.6E+00	2.8E-04	2.4E+00	8.8E-05	7.7E-01	8.8E-05	7.7E-01	8.8E-05	7.7E-01	8.8E-05	7.7E-01	8.8E-05	7.7E-01	8.8E-05	7.7E-01	6.0E-04	5.2E+00	3.3E-03	2.9E+01	5.1E-04	4.5E+00	9.2E-04	8.1E+00	9.2E-04	8.1E+00
Propylene	1.3E-04	1.2E+00	3.3E-04	2.9E+00	1.0E-04	9.2E-01	1.0E-04	9.2E-01	1.0E-04	9.2E-01	1.0E-04	9.2E-01	1.0E-04	9.2E-01	1.0E-04	9.2E-01	7.1E-04	6.2E+00	3.9E-03	3.4E+01	2.3E-04	2.0E+00	5.4E-02	4.7E+02	5.4E-02	4.7E+02
Selenium	3.2E-04	2.8E+00	3.0E-04	2.6E+00	9.4E-05	8.3E-01	9.4E-05	8.3E-01	9.4E-05	8.3E-01	9.4E-05	8.3E-01	9.4E-05	8.3E-01	9.4E-05	8.3E-01	6.4E-04	5.6E+00	3.5E-03	3.1E+01	5.5E-04	4.8E+00	2.0E-04	1.8E+00	2.0E-04	1.8E+00
Toluene	5.5E-03	4.8E+01	5.0E-03	4.4E+01	1.6E-03	1.4E+01	1.6E-03	1.4E+01	1.6E-03	1.4E+01	1.6E-03	1.4E+01	1.6E-03	1.4E+01	1.6E-03	1.4E+01	1.1E-02	9.4E+01	5.9E-02	5.2E+02	9.3E-03	8.2E+01	6.8E-03	5.9E+01	6.8E-03	5.9E+01
Vanadium	1.5E-04	1.3E+00	1.4E-04	1.3E+00	4.6E-05	4.0E-01	4.6E-05	4.0E-01	4.6E-05	4.0E-01	4.6E-05	4.0E-01	4.6E-05	4.0E-01	4.6E-05	4.0E-01	3.1E-04	2.7E+00	1.7E-03	1.5E+01	2.6E-04	2.2E+00	5.3E-04	4.6E+00	5.3E-04	4.6E+00
Xylenes	2.7E-03	2.4E+01	2.5E-03	2.2E+01	7.9E-04	6.9E+00	7.9E-04	6.9E+00	7.9E-04	6.9E+00	7.9E-04	6.9E+00	7.9E-04	6.9E+00	7.9E-04	6.9E+00	5.3E-03	4.7E+01	2.9E-02	2.6E+02	4.6E-03	4.0E+01	3.3E-03	2.9E+01	3.3E-03	2.9E+01

Table B-5 – Post-Project TAC PTE

Pollutant	919		920		928		929		930		931		932		933		934		937		973		1511		1512	
	lbs/hour	lbs/year	lbs/hour	lbs/year	lbs/hour	lbs/year	lbs/hour	lbs/year	lbs/hour	lbs/year	lbs/hour	lbs/year	lbs/hour	lbs/year	lbs/hour	lbs/year	lbs/hour	lbs/year	lbs/hour	lbs/year	lbs/hour	lbs/year	lbs/hour	lbs/year	lbs/hour	lbs/year
Sulfuric Acid	1.8E-03	1.6E+01	1.8E-03	1.6E+01	5.7E-04	5.0E+00	5.7E-04	5.0E+00	5.7E-04	5.0E+00	5.7E-04	5.0E+00	5.7E-04	5.0E+00	5.7E-04	5.0E+00	3.8E-03	3.3E+01	2.1E-02	1.8E+02	3.1E-03	2.8E+01	1.4E-03	1.2E+01	1.4E-03	1.2E+01
PAH (as B(a)P-equivalent)	7.1E-05	6.2E-01	6.9E-05	6.1E-01	2.2E-05	1.9E-01	2.2E-05	1.9E-01	2.2E-05	1.9E-01	2.2E-05	1.9E-01	2.2E-05	1.9E-01	2.2E-05	1.9E-01	1.5E-04	1.3E+00	8.2E-04	7.1E+00	1.2E-04	1.1E+00	2.4E-04	2.1E+00	2.4E-04	2.1E+00
Ammonia	9.2E-03	8.1E+01	8.5E-03	7.5E+01	2.7E-03	2.4E+01	2.7E-03	2.4E+01	2.7E-03	2.4E+01	2.7E-03	2.4E+01	2.7E-03	2.4E+01	2.7E-03	2.4E+01	1.8E-02	1.6E+02	1.0E-01	8.8E+02	1.6E-02	1.4E+02	1.0E+00	9.1E+03	1.0E+00	9.1E+03
1,4-Dichlorobenzene(p)	7.6E-05	6.7E-01	7.4E-05	6.5E-01	2.4E-05	2.1E-01	2.4E-05	2.1E-01	2.4E-05	2.1E-01	2.4E-05	2.1E-01	2.4E-05	2.1E-01	2.4E-05	2.1E-01	1.6E-04	1.4E+00	8.7E-04	7.7E+00	1.3E-04	1.1E+00	2.7E-04	2.4E+00	2.7E-04	2.4E+00
Acetaldehyde	3.4E-03	2.9E+01	3.1E-03	2.7E+01	9.9E-04	8.6E+00	9.9E-04	8.6E+00	9.9E-04	8.6E+00	9.9E-04	8.6E+00	9.9E-04	8.6E+00	9.9E-04	8.6E+00	6.7E-03	5.8E+01	3.7E-02	3.2E+02	5.7E-03	5.0E+01	3.2E-03	2.8E+01	3.2E-03	2.8E+01
Arsenic	5.5E-05	4.8E-01	5.0E-05	4.4E-01	1.6E-05	1.4E-01	1.6E-05	1.4E-01	1.6E-05	1.4E-01	1.6E-05	1.4E-01	1.6E-05	1.4E-01	1.6E-05	1.4E-01	1.1E-04	9.4E-01	5.9E-04	5.2E+00	9.3E-05	8.2E-01	4.6E-05	4.0E-01	4.6E-05	4.0E-01
Benzene	3.1E-03	2.7E+01	2.9E-03	2.5E+01	9.1E-04	7.9E+00	9.1E-04	7.9E+00	9.1E-04	7.9E+00	9.1E-04	7.9E+00	9.1E-04	7.9E+00	9.1E-04	7.9E+00	6.1E-03	5.4E+01	3.4E-02	3.0E+02	5.3E-03	4.6E+01	2.6E-03	2.3E+01	2.6E-03	2.3E+01
Beryllium	9.5E-07	8.3E-03	8.8E-07	7.7E-03	2.8E-07	2.4E-03	2.8E-07	2.4E-03	2.8E-07	2.4E-03	2.8E-07	2.4E-03	2.8E-07	2.4E-03	2.8E-07	2.4E-03	1.9E-06	1.6E-02	1.0E-05	9.1E-02	1.6E-06	1.4E-02	3.0E-05	2.6E-01	3.0E-05	2.6E-01
Cadmium	3.9E-05	3.4E-01	3.6E-05	3.1E-01	1.1E-05	9.9E-02	1.1E-05	9.9E-02	1.1E-05	9.9E-02	1.1E-05	9.9E-02	1.1E-05	9.9E-02	1.1E-05	9.9E-02	7.7E-05	6.7E-01	4.2E-04	3.7E+00	6.6E-05	5.8E-01	2.5E-04	2.2E+00	2.5E-04	2.2E+00
Chromium (hexavalent)	8.3E-05	7.3E-01	7.7E-05	6.7E-01	2.4E-05	2.1E-01	2.4E-05	2.1E-01	2.4E-05	2.1E-01	2.4E-05	2.1E-01	2.4E-05	2.1E-01	2.4E-05	2.1E-01	1.6E-04	1.4E+00	9.1E-04	7.9E+00	1.4E-04	1.2E+00	0.0E+00	0.0E+00	0.0E+00	0.0E+00
Copper	3.7E-04	3.3E+00	3.4E-04	3.0E+00	1.1E-04	9.5E-01	1.1E-04	9.5E-01	1.1E-04	9.5E-01	1.1E-04	9.5E-01	1.1E-04	9.5E-01	1.1E-04	9.5E-01	7.3E-04	6.4E+00	4.0E-03	3.5E+01	6.3E-04	5.6E+00	1.9E-04	1.7E+00	1.9E-04	1.7E+00
Cyanide and compounds	1.7E-04	1.5E+00	1.6E-04	1.4E+00	5.1E-05	4.4E-01	5.1E-05	4.4E-01	5.1E-05	4.4E-01	5.1E-05	4.4E-01	5.1E-05	4.4E-01	5.1E-05	4.4E-01	3.4E-04	3.0E+00	1.9E-03	1.6E+01	3.0E-04	2.6E+00	0.0E+00	0.0E+00	0.0E+00	0.0E+00
Ethyl benzene	1.2E-03	1.0E+01	1.1E-03	9.3E+00	3.4E-04	3.0E+00	3.4E-04	3.0E+00	3.4E-04	3.0E+00	3.4E-04	3.0E+00	3.4E-04	3.0E+00	3.4E-04	3.0E+00	2.3E-03	2.0E+01	1.3E-02	1.1E+02	2.0E-03	1.7E+01	2.6E-04	2.3E+00	2.6E-04	2.3E+00
Formaldehyde	6.5E-03	5.7E+01	6.0E-03	5.2E+01	1.9E-03	1.7E+01	1.9E-03	1.7E+01	1.9E-03	1.7E+01	1.9E-03	1.7E+01	1.9E-03	1.7E+01	1.9E-03	1.7E+01	1.3E-02	1.1E+02	7.0E-02	6.2E+02	1.1E-02	9.7E+01	1.7E-02	1.5E+02	1.7E-02	1.5E+02
Hexane	1.2E-01	1.0E+03	1.1E-01	9.9E+02	3.6E-02	3.2E+02	3.6E-02	3.2E+02	3.6E-02	3.2E+02	3.6E-02	3.2E+02	3.6E-02	3.2E+02	3.6E-02	3.2E+02	2.4E-01	2.1E+03	1.3E+00	1.2E+04	2.0E-01	1.8E+03	4.1E-01	3.6E+03	4.1E-01	3.6E+03
Hydrochloric acid	5.3E-02	4.6E+02	4.9E-02	4.3E+02	1.5E-02	1.4E+02	1.5E-02	1.4E+02	1.5E-02	1.4E+02	1.5E-02	1.4E+02	1.5E-02	1.4E+02	1.5E-02	1.4E+02	1.0E-01	9.2E+02	5.8E-01	5.0E+03	9.0E-02	7.9E+02	0.0E+00	0.0E+00	0.0E+00	0.0E+00
Hydrogen sulfide	5.2E-03	4.6E+01	4.8E-03	4.2E+01	1.5E-03	1.3E+01	1.5E-03	1.3E+01	1.5E-03	1.3E+01	1.5E-03	1.3E+01	1.5E-03	1.3E+01	1.5E-03	1.3E+01	1.0E-02	9.1E+01	5.7E-02	5.0E+02	8.9E-03	7.8E+01	2.0E-02	1.7E+02	2.0E-02	1.7E+02
Lead	1.6E-04	1.4E+00	1.5E-04	1.3E+00	4.7E-05	4.1E-01	4.7E-05	4.1E-01	4.7E-05	4.1E-01	4.7E-05	4.1E-01	4.7E-05	4.1E-01	4.7E-05	4.1E-01	3.2E-04	2.8E+00	1.7E-03	1.5E+01	2.7E-04	2.4E+00	1.1E-04	9.9E-01	1.1E-04	9.9E-01
Manganese	3.0E-04	2.6E+00	2.8E-04	2.4E+00	8.8E-05	7.7E-01	8.8E-05	7.7E-01	8.8E-05	7.7E-01	8.8E-05	7.7E-01	8.8E-05	7.7E-01	8.8E-05	7.7E-01	6.0E-04	5.2E+00	3.3E-03	2.9E+01	5.1E-04	4.5E+00	8.5E-05	7.5E-01	8.5E-05	7.5E-01
Mercury	1.6E-05	1.4E-01	1.4E-05	1.3E-01	4.6E-06	4.0E-02	4.6E-06	4.0E-02	4.6E-06	4.0E-02	4.6E-06	4.0E-02	4.6E-06	4.0E-02	4.6E-06	4.0E-02	3.1E-05	2.7E-01	1.7E-04	1.5E+00	2.7E-05	2.3E-01	5.8E-05	5.0E-01	5.8E-05	5.0E-01
Naphthalene	3.1E-05	2.7E-01	1.4E-04	1.2E+00	4.4E-05	3.9E-01	4.4E-05	3.9E-01	4.4E-05	3.9E-01	4.4E-05	3.9E-01	4.4E-05	3.9E-01	4.4E-05	3.9E-01	3.0E-04	2.6E+00	1.6E-03	1.4E+01	5.3E-05	4.6E-01	2.6E-04	2.3E+00	2.6E-04	2.3E+00
Nickel	3.2E-04	2.8E+00	3.0E-04	2.6E+00	9.4E-05	8.3E-01	9.4E-05	8.3E-01	9.4E-05	8.3E-01	9.4E-05	8.3E-01	9.4E-05	8.3E-01	9.4E-05	8.3E-01	6.4E-04	5.6E+00	3.5E-03	3.1E+01	5.5E-04	4.8E+00	4.8E-04	4.2E+00	4.8E-04	4.2E+00
Phenol	3.0E-04	2.6E+00	2.8E-04	2.4E+00	8.8E-05	7.7E-01	8.8E-05	7.7E-01	8.8E-05	7.7E-01	8.8E-05	7.7E-01	8.8E-05	7.7E-01	8.8E-05	7.7E-01	6.0E-04	5.2E+00	3.3E-03	2.9E+01	5.1E-04	4.5E+00	9.2E-04	8.1E+00	9.2E-04	8.1E+00
Propylene	1.3E-04	1.2E+00	3.3E-04	2.9E+00	1.0E-04	9.2E-01	1.0E-04	9.2E-01	1.0E-04	9.2E-01	1.0E-04	9.2E-01	1.0E-04	9.2E-01	1.0E-04	9.2E-01	7.1E-04	6.2E+00	3.9E-03	3.4E+01	2.3E-04	2.0E+00	5.4E-02	4.7E+02	5.4E-02	4.7E+02
Selenium	3.2E-04	2.8E+00	3.0E-04	2.6E+00	9.4E-05	8.3E-01	9.4E-05	8.3E-01	9.4E-05	8.3E-01	9.4E-05	8.3E-01	9.4E-05	8.3E-01	9.4E-05	8.3E-01	6.4E-04	5.6E+00	3.5E-03	3.1E+01	5.5E-04	4.8E+00	2.0E-04	1.8E+00	2.0E-04	1.8E+00
Toluene	5.5E-03	4.8E+01	5.0E-03	4.4E+01	1.6E-03	1.4E+01	1.6E-03	1.4E+01	1.6E-03	1.4E+01	1.6E-03	1.4E+01	1.6E-03	1.4E+01	1.6E-03	1.4E+01	1.1E-02	9.4E+01	5.9E-02	5.2E+02	9.3E-03	8.2E+01	6.8E-03	5.9E+01	6.8E-03	5.9E+01
Vanadium	1.5E-04	1.3E+00	1.4E-04	1.3E+00	4.6E-05	4.0E-01	4.6E-05	4.0E-01	4.6E-05	4.0E-01	4.6E-05	4.0E-01	4.6E-05	4.0E-01	4.6E-05	4.0E-01	3.1E-04	2.7E+00	1.7E-03	1.5E+01	2.6E-04	2.2E+00	5.3E-04	4.6E+00	5.3E-04	4.6E+00
Xylenes	2.7E-03	2.4E+01	2.5E-03	2.2E+01	7.9E-04	6.9E+00	7.9E-04	6.9E+00	7.9E-04	6.9E+00	7.9E-04	6.9E+00	7.9E-04	6.9E+00	7.9E-04	6.9E+00	5.3E-03	4.7E+01	2.9E-02	2.6E+02	4.6E-03	4.0E+01	3.3E-03	2.9E+01	3.3E-03	2.9E+01

Table B-6 – TAC Emissions Increase

Pollutant	919		920		928		929		930		931		932		933		934		937		973		1511		1512	
	lbs/hour	lbs/year	lbs/hour	lbs/year	lbs/hour	lbs/year	lbs/hour	lbs/year	lbs/hour	lbs/year	lbs/hour	lbs/year	lbs/hour	lbs/year	lbs/hour	lbs/year	lbs/hour	lbs/year	lbs/hour	lbs/year	lbs/hour	lbs/year	lbs/hour	lbs/year	lbs/hour	lbs/year
Sulfuric Acid	0.0E+00	0.0E+00	0.0E+00	0.0E+00	0.0E+00	0.0E+00	0.0E+00	0.0E+00	0.0E+00	0.0E+00	0.0E+00	0.0E+00	0.0E+00	0.0E+00	0.0E+00	0.0E+00	0.0E+00	0.0E+00	0.0E+00	0.0E+00	0.0E+00	0.0E+00	0.0E+00	0.0E+00	0.0E+00	0.0E+00
PAH (as B(a)P-equivalent)	0.0E+00	0.0E+00	0.0E+00	0.0E+00	0.0E+00	0.0E+00	0.0E+00	0.0E+00	0.0E+00	0.0E+00	0.0E+00	0.0E+00	0.0E+00	0.0E+00	0.0E+00	0.0E+00	0.0E+00	0.0E+00	0.0E+00	0.0E+00	0.0E+00	0.0E+00	0.0E+00	0.0E+00	0.0E+00	0.0E+00
Ammonia	0.0E+00	0.0E+00	0.0E+00	0.0E+00	0.0E+00	0.0E+00	0.0E+00	0.0E+00	0.0E+00	0.0E+00	0.0E+00	0.0E+00	0.0E+00	0.0E+00	0.0E+00	0.0E+00	0.0E+00	0.0E+00	0.0E+00	0.0E+00	0.0E+00	0.0E+00	0.0E+00	0.0E+00	0.0E+00	0.0E+00
1,4-Dichlorobenzene(p)	0.0E+00	0.0E+00	0.0E+00	0.0E+00	0.0E+00	0.0E+00	0.0E+00	0.0E+00	0.0E+00	0.0E+00	0.0E+00	0.0E+00	0.0E+00	0.0E+00	0.0E+00	0.0E+00	0.0E+00	0.0E+00	0.0E+00	0.0E+00	0.0E+00	0.0E+00	0.0E+00	0.0E+00	0.0E+00	0.0E+00
Acetaldehyde	0.0E+00	0.0E+00	0.0E+00	0.0E+00	0.0E+00	0.0E+00	0.0E+00	0.0E+00	0.0E+00	0.0E+00	0.0E+00	0.0E+00	0.0E+00	0.0E+00	0.0E+00	0.0E+00	0.0E+00	0.0E+00	0.0E+00	0.0E+00	0.0E+00	0.0E+00	0.0E+00	0.0E+00	0.0E+00	0.0E+00
Arsenic	0.0E+00	0.0E+00	0.0E+00	0.0E+00	0.0E+00	0.0E+00	0.0E+00	0.0E+00	0.0E+00	0.0E+00	0.0E+00	0.0E+00	0.0E+00	0.0E+00	0.0E+00	0.0E+00	0.0E+00	0.0E+00	0.0E+00	0.0E+00	0.0E+00	0.0E+00	0.0E+00	0.0E+00	0.0E+00	0.0E+00
Benzene	0.0E+00	0.0E+00	0.0E+00	0.0E+00	0.0E+00	0.0E+00	0.0E+00	0.0E+00	0.0E+00	0.0E+00	0.0E+00	0.0E+00	0.0E+00	0.0E+00	0.0E+00	0.0E+00	0.0E+00	0.0E+00	0.0E+00	0.0E+00	0.0E+00	0.0E+00	0.0E+00	0.0E+00	0.0E+00	0.0E+00
Beryllium	0.0E+00	0.0E+00	0.0E+00	0.0E+00	0.0E+00	0.0E+00	0.0E+00	0.0E+00	0.0E+00	0.0E+00	0.0E+00	0.0E+00	0.0E+00	0.0E+00	0.0E+00	0.0E+00	0.0E+00	0.0E+00	0.0E+00	0.0E+00	0.0E+00	0.0E+00	0.0E+00	0.0E+00	0.0E+00	0.0E+00
Cadmium	0.0E+00	0.0E+00	0.0E+00	0.0E+00	0.0E+00	0.0E+00	0.0E+00	0.0E+00	0.0E+00	0.0E+00	0.0E+00	0.0E+00	0.0E+00	0.0E+00	0.0E+00	0.0E+00	0.0E+00	0.0E+00	0.0E+00	0.0E+00	0.0E+00	0.0E+00	0.0E+00	0.0E+00	0.0E+00	0.0E+00
Chromium (hexavalent)	0.0E+00	0.0E+00	0.0E+00	0.0E+00	0.0E+00	0.0E+00	0.0E+00	0.0E+00	0.0E+00	0.0E+00	0.0E+00	0.0E+00	0.0E+00	0.0E+00	0.0E+00	0.0E+00	0.0E+00	0.0E+00	0.0E+00	0.0E+00	0.0E+00	0.0E+00	0.0E+00	0.0E+00	0.0E+00	0.0E+00
Copper	0.0E+00	0.0E+00	0.0E+00	0.0E+00	0.0E+00	0.0E+00	0.0E+00	0.0E+00	0.0E+00	0.0E+00	0.0E+00	0.0E+00	0.0E+00	0.0E+00	0.0E+00	0.0E+00	0.0E+00	0.0E+00	0.0E+00	0.0E+00	0.0E+00	0.0E+00	0.0E+00	0.0E+00	0.0E+00	0.0E+00
Cyanide and compounds	0.0E+00	0.0E+00	0.0E+00	0.0E+00	0.0E+00	0.0E+00	0.0E+00	0.0E+00	0.0E+00	0.0E+00	0.0E+00	0.0E+00	0.0E+00	0.0E+00	0.0E+00	0.0E+00	0.0E+00	0.0E+00	0.0E+00	0.0E+00	0.0E+00	0.0E+00	0.0E+00	0.0E+00	0.0E+00	0.0E+00
Ethyl benzene	0.0E+00	0.0E+00	0.0E+00	0.0E+00	0.0E+00	0.0E+00	0.0E+00	0.0E+00	0.0E+00	0.0E+00	0.0E+00	0.0E+00	0.0E+00	0.0E+00	0.0E+00	0.0E+00	0.0E+00	0.0E+00	0.0E+00	0.0E+00	0.0E+00	0.0E+00	0.0E+00	0.0E+00	0.0E+00	0.0E+00
Formaldehyde	0.0E+00	0.0E+00	0.0E+00	0.0E+00	0.0E+00	0.0E+00	0.0E+00	0.0E+00	0.0E+00	0.0E+00	0.0E+00	0.0E+00	0.0E+00	0.0E+00	0.0E+00	0.0E+00	0.0E+00	0.0E+00	0.0E+00	0.0E+00	0.0E+00	0.0E+00	0.0E+00	0.0E+00	0.0E+00	0.0E+00
Hexane	0.0E+00	0.0E+00	0.0E+00	0.0E+00	0.0E+00	0.0E+00	0.0E+00	0.0E+00	0.0E+00	0.0E+00	0.0E+00	0.0E+00	0.0E+00	0.0E+00	0.0E+00	0.0E+00	0.0E+00	0.0E+00	0.0E+00	0.0E+00	0.0E+00	0.0E+00	0.0E+00	0.0E+00	0.0E+00	0.0E+00
Hydrochloric acid	0.0E+00	0.0E+00	0.0E+00	0.0E+00	0.0E+00	0.0E+00	0.0E+00	0.0E+00	0.0E+00	0.0E+00	0.0E+00	0.0E+00	0.0E+00	0.0E+00	0.0E+00	0.0E+00	0.0E+00	0.0E+00	0.0E+00	0.0E+00	0.0E+00	0.0E+00	0.0E+00	0.0E+00	0.0E+00	0.0E+00
Hydrogen sulfide	0.0E+00	0.0E+00	0.0E+00	0.0E+00	0.0E+00	0.0E+00	0.0E+00	0.0E+00	0.0E+00	0.0E+00	0.0E+00	0.0E+00	0.0E+00	0.0E+00	0.0E+00	0.0E+00	0.0E+00	0.0E+00	0.0E+00	0.0E+00	0.0E+00	0.0E+00	0.0E+00	0.0E+00	0.0E+00	0.0E+00
Lead	0.0E+00	0.0E+00	0.0E+00	0.0E+00	0.0E+00	0.0E+00	0.0E+00	0.0E+00	0.0E+00	0.0E+00	0.0E+00	0.0E+00	0.0E+00	0.0E+00	0.0E+00	0.0E+00	0.0E+00	0.0E+00	0.0E+00	0.0E+00	0.0E+00	0.0E+00	0.0E+00	0.0E+00	0.0E+00	0.0E+00
Manganese	0.0E+00	0.0E+00	0.0E+00	0.0E+00	0.0E+00	0.0E+00	0.0E+00	0.0E+00	0.0E+00	0.0E+00	0.0E+00	0.0E+00	0.0E+00	0.0E+00	0.0E+00	0.0E+00	0.0E+00	0.0E+00	0.0E+00	0.0E+00	0.0E+00	0.0E+00	0.0E+00	0.0E+00	0.0E+00	0.0E+00
Mercury	0.0E+00	0.0E+00	0.0E+00	0.0E+00	0.0E+00	0.0E+00	0.0E+00	0.0E+00	0.0E+00	0.0E+00	0.0E+00	0.0E+00	0.0E+00	0.0E+00	0.0E+00	0.0E+00	0.0E+00	0.0E+00	0.0E+00	0.0E+00	0.0E+00	0.0E+00	0.0E+00	0.0E+00	0.0E+00	0.0E+00
Naphthalene	0.0E+00	0.0E+00	0.0E+00	0.0E+00	0.0E+00	0.0E+00	0.0E+00	0.0E+00	0.0E+00	0.0E+00	0.0E+00	0.0E+00	0.0E+00	0.0E+00	0.0E+00	0.0E+00	0.0E+00	0.0E+00	0.0E+00	0.0E+00	0.0E+00	0.0E+00	0.0E+00	0.0E+00	0.0E+00	0.0E+00
Nickel	0.0E+00	0.0E+00	0.0E+00	0.0E+00	0.0E+00	0.0E+00	0.0E+00	0.0E+00	0.0E+00	0.0E+00	0.0E+00	0.0E+00	0.0E+00	0.0E+00	0.0E+00	0.0E+00	0.0E+00	0.0E+00	0.0E+00	0.0E+00	0.0E+00	0.0E+00	0.0E+00	0.0E+00	0.0E+00	0.0E+00
Phenol	0.0E+00	0.0E+00	0.0E+00	0.0E+00	0.0E+00	0.0E+00	0.0E+00	0.0E+00	0.0E+00	0.0E+00	0.0E+00	0.0E+00	0.0E+00	0.0E+00	0.0E+00	0.0E+00	0.0E+00	0.0E+00	0.0E+00	0.0E+00	0.0E+00	0.0E+00	0.0E+00	0.0E+00	0.0E+00	0.0E+00
Propylene	0.0E+00	0.0E+00	0.0E+00	0.0E+00	0.0E+00	0.0E+00	0.0E+00	0.0E+00	0.0E+00	0.0E+00	0.0E+00	0.0E+00	0.0E+00	0.0E+00	0.0E+00	0.0E+00	0.0E+00	0.0E+00	0.0E+00	0.0E+00	0.0E+00	0.0E+00	0.0E+00	0.0E+00	0.0E+00	0.0E+00
Selenium	0.0E+00	0.0E+00	0.0E+00	0.0E+00	0.0E+00	0.0E+00	0.0E+00	0.0E+00	0.0E+00	0.0E+00	0.0E+00	0.0E+00	0.0E+00	0.0E+00	0.0E+00	0.0E+00	0.0E+00	0.0E+00	0.0E+00	0.0E+00	0.0E+00	0.0E+00	0.0E+00	0.0E+00	0.0E+00	0.0E+00
Toluene	0.0E+00	0.0E+00	0.0E+00	0.0E+00	0.0E+00	0.0E+00	0.0E+00	0.0E+00	0.0E+00	0.0E+00	0.0E+00	0.0E+00	0.0E+00	0.0E+00	0.0E+00	0.0E+00	0.0E+00	0.0E+00	0.0E+00	0.0E+00	0.0E+00	0.0E+00	0.0E+00	0.0E+00	0.0E+00	0.0E+00
Vanadium	0.0E+00	0.0E+00	0.0E+00	0.0E+00	0.0E+00	0.0E+00	0.0E+00	0.0E+00	0.0E+00	0.0E+00	0.0E+00	0.0E+00	0.0E+00	0.0E+00	0.0E+00	0.0E+00	0.0E+00	0.0E+00	0.0E+00	0.0E+00	0.0E+00	0.0E+00	0.0E+00	0.0E+00	0.0E+00	0.0E+00
Xylenes	0.0E+00	0.0E+00	0.0E+00	0.0E+00	0.0E+00	0.0E+00	0.0E+00	0.0E+00	0.0E+00	0.0E+00	0.0E+00	0.0E+00	0.0E+00	0.0E+00	0.0E+00	0.0E+00	0.0E+00	0.0E+00	0.0E+00	0.0E+00	0.0E+00	0.0E+00	0.0E+00	0.0E+00	0.0E+00	0.0E+00

Table B-7 – Review of Emissions Increase Above Regulation 2, Rule 5 Thresholds

Pollutant	919		920		928		929		930		931		932		933		934		937		973		1511		1512	
	lbs/hour	lbs/year	lbs/hour	lbs/year	lbs/hour	lbs/year	lbs/hour	lbs/year	lbs/hour	lbs/year	lbs/hour	lbs/year	lbs/hour	lbs/year	lbs/hour	lbs/year	lbs/hour	lbs/year	lbs/hour	lbs/year	lbs/hour	lbs/year	lbs/hour	lbs/year	lbs/hour	lbs/year
Sulfuric Acid	No	No	No	No	No	No	No	No	No	No	No	No	No	No	No	No	No	No	No	No	No	No	No	No	No	No
PAH (as B(a)P-equivalent)	No	No	No	No	No	No	No	No	No	No	No	No	No	No	No	No	No	No	No	No	No	No	No	No	No	No
Ammonia	No	No	No	No	No	No	No	No	No	No	No	No	No	No	No	No	No	No	No	No	No	No	No	No	No	No
1,4-Dichlorobenzene(p)	No	No	No	No	No	No	No	No	No	No	No	No	No	No	No	No	No	No	No	No	No	No	No	No	No	No
Acetaldehyde	No	No	No	No	No	No	No	No	No	No	No	No	No	No	No	No	No	No	No	No	No	No	No	No	No	No
Arsenic	No	No	No	No	No	No	No	No	No	No	No	No	No	No	No	No	No	No	No	No	No	No	No	No	No	No
Benzene	No	No	No	No	No	No	No	No	No	No	No	No	No	No	No	No	No	No	No	No	No	No	No	No	No	No
Beryllium	No	No	No	No	No	No	No	No	No	No	No	No	No	No	No	No	No	No	No	No	No	No	No	No	No	No
Cadmium	No	No	No	No	No	No	No	No	No	No	No	No	No	No	No	No	No	No	No	No	No	No	No	No	No	No
Chromium (hexavalent)	No	No	No	No	No	No	No	No	No	No	No	No	No	No	No	No	No	No	No	No	No	No	No	No	No	No
Copper	No	No	No	No	No	No	No	No	No	No	No	No	No	No	No	No	No	No	No	No	No	No	No	No	No	No
Cyanide and compounds	No	No	No	No	No	No	No	No	No	No	No	No	No	No	No	No	No	No	No	No	No	No	No	No	No	No
Ethyl benzene	No	No	No	No	No	No	No	No	No	No	No	No	No	No	No	No	No	No	No	No	No	No	No	No	No	No
Formaldehyde	No	No	No	No	No	No	No	No	No	No	No	No	No	No	No	No	No	No	No	No	No	No	No	No	No	No
Hexane	No	No	No	No	No	No	No	No	No	No	No	No	No	No	No	No	No	No	No	No	No	No	No	No	No	No
Hydrochloric acid	No	No	No	No	No	No	No	No	No	No	No	No	No	No	No	No	No	No	No	No	No	No	No	No	No	No
Hydrogen sulfide	No	No	No	No	No	No	No	No	No	No	No	No	No	No	No	No	No	No	No	No	No	No	No	No	No	No
Lead	No	No	No	No	No	No	No	No	No	No	No	No	No	No	No	No	No	No	No	No	No	No	No	No	No	No
Manganese	No	No	No	No	No	No	No	No	No	No	No	No	No	No	No	No	No	No	No	No	No	No	No	No	No	No
Mercury	No	No	No	No	No	No	No	No	No	No	No	No	No	No	No	No	No	No	No	No	No	No	No	No	No	No
Naphthalene	No	No	No	No	No	No	No	No	No	No	No	No	No	No	No	No	No	No	No	No	No	No	No	No	No	No
Nickel	No	No	No	No	No	No	No	No	No	No	No	No	No	No	No	No	No	No	No	No	No	No	No	No	No	No
Phenol	No	No	No	No	No	No	No	No	No	No	No	No	No	No	No	No	No	No	No	No	No	No	No	No	No	No
Propylene	No	No	No	No	No	No	No	No	No	No	No	No	No	No	No	No	No	No	No	No	No	No	No	No	No	No
Selenium	No	No	No	No	No	No	No	No	No	No	No	No	No	No	No	No	No	No	No	No	No	No	No	No	No	No
Toluene	No	No	No	No	No	No	No	No	No	No	No	No	No	No	No	No	No	No	No	No	No	No	No	No	No	No
Vanadium	No	No	No	No	No	No	No	No	No	No	No	No	No	No	No	No	No	No	No	No	No	No	No	No	No	No
Xylenes	No	No	No	No	No	No	No	No	No	No	No	No	No	No	No	No	No	No	No	No	No	No	No	No	No	No

Table C-1 – Pre-Project (Baseline) and Post-Project Criteria Pollutant Emissions for Storage Tanks

		Pre-Project			Post-Project			Emissions Increase	
S-#	New Source Description	Throughput	POC Emissions (lbs/day)	POC Emissions (tons/year)	Throughput	POC Emissions (lbs/day)	POC Emissions (tons/year)	POC Emissions (lbs/day)	POC Emissions (tons/year)
Existing Storage Tanks									
323	Tank A-323, FRT, Slop Oil, A-14 Vapor Recovery	22,000 bbl/day 2,000,000 bbl/year	30.4	0.961	22,000 bbl/day 60,833 bbl/year	30.4	0.100	0	0
598	Tank A-598, Pressurized, Renewable Naphtha	0	0	0	n/a	0	0	0	0
601	Tank A-601, IFRT, Black, Recovered Oil, Gas Oil	6,105 bbl/day 243,882 bbl/year	4.1	0.431	6,105 bbl/day 60,833 bbl/year	4.1	0.414	0	0
621	Tank A-621, EFRT, Intermediate HDO Product	0	0	0	58,000 bbl/day 12,045,000 bbl/year	8.1	1.019	8.1	1.019
652	Tank A-652, Pressurized, Renewable Naphtha	0	0	0	n/a	0	0	0	0
650	Tank A-650, EFRT, Sour Waste Water	81,751 bbl/day 743,831 bbl/year	5.9	0.031	81,751 bbl/day 351,000 bbl/year	5.9	0.017	0	0
651	Tank A-651, EFRT, Oil/Water Mixture, Sour Waste Water	26,731 bbl/day 1,298,071 bbl/year	2.0	0.059	26,731 bbl/day 5,631,429 bbl/year	2.0	0.207	0	0.148
656	Tank A-846, FRT, Foul Water Stripper Charge Tank, Sour Waste Water, A-12, A-14 Vapor Recovery	47,870 bbl/day 13,706,224 bbl/year	0.4	0.007	47,870 bbl/day 13,365,257 bbl/year	0.4	0.007	0	0
658	Tank A-847, FRT, Foul Water Stripper Charge Tank, Sour Waste Water, A-12, A-14 Vapor Recovery	47,870 bbl/day 13,706,224 bbl/year	0.4	0.007	47,870 bbl/day 13,365,257 bbl/year	0.4	0.007	0	0
692	Tank A-692, EFRT, Renewable Naphtha	54,882 bbl/day 2,650,447 bbl/year	33.9	1.613	54,882 bbl/day 365,000 bbl/year	25.1	1.517	0	0
695	Tank A-695, Pressurized, Renewable Naphtha	0	0	0	n/a	0	0	0	0
699	Tank A-699, White, API Separator Recovered Oil, A-14 Vapor Recovery	14,982 bbl/day 522,234 bbl/year	0.9	0.014	14,982 bbl/day 302,381 bbl/year	0.9	0.010	0	0
700	Tank 2-A-700, Light grey, API Separator Sludge	23,039 bbl/day 1,166,667 bbl/year	28.8	0.119	28 bbl/day 10,476 bbl/year	28.8	0.016	0	0
1464	Tank A-868, EFRT, R100 Renewable Diesel	36,000 bbl/day 10,000,000 bbl/year	9.8	0.461	72,000 bbl/day 10,000,000 bbl/year	5.1	0.353	0	0

		Pre-Project			Post-Project			Emissions Increase	
S-#	New Source Description	Throughput	POC Emissions (lbs/day)	POC Emissions (tons/year)	Throughput	POC Emissions (lbs/day)	POC Emissions (tons/year)	POC Emissions (lbs/day)	POC Emissions (tons/year)
Existing Storage Tanks (cont'd)									
1465	Tank A-869, EFRT, R100 Renewable Diesel	36,000 bbl/day 12,800,000 bbl/year	9.8	0.461	72,000 bbl/day 10,000,000 bbl/year	5.1	0.353	0	0
B19	B19 Tank, EFRT, R99 Renewable Diesel (Plant #21200)	192,000 bbl/day 14,016,000 bbl/year	43.7	6.281	192,000 bbl/day 14,016,000 bbl/year	16.0	0.643	0	0
B21	B21 Tank, EFRT, R99 Renewable Diesel (Plant #21200)	192,000 bbl/day 14,016,000 bbl/year	31.2	6.281	192,000 bbl/day 14,016,000 bbl/year	16.0	0.643	0	0
Existing Storage Tanks [Exempt]									
517	Tank A-517, FRT, Renewable Feedstock (Clean)	0	0	0	5,803,500 bbl/year	119.3	1.572	119.3	1.572
620	Tank A-620, FRT, Renewable Feedstock (Raw)	0	0	0	5,803,500 bbl/year	157.4	1.578	157.4	1.578
622	Tank A-622, FRT, R100 Renewable Diesel	0	0	0	17,410,500 bbl/year	203.3	2.362	203.3	2.362
648	Tank A-648, Pressurized, Renewable Propane Tank	0	0	0	n/a	0	0	0	0
649	Tank A-649, Pressurized, Renewable Propane Tank	0	0	0	n/a	0	0	0	0
666	Tank A-666, Pressurized, Renewable Propane Tank	0	0	0	n/a	0	0	0	0
667	Tank A-667, Pressurized, Renewable Propane Tank	0	0	0	n/a	0	0	0	0
668	Tank A-668, Pressurized, Renewable Propane Tank	0	0	0	n/a	0	0	0	0
669	Tank A-669, Pressurized, Renewable Propane Tank	0	0	0	n/a	0	0	0	0
670	Tank A-670, Pressurized, Renewable Propane Tank	0	0	0	n/a	0	0	0	0
873	Tank A-895, FRT, Renewable Feedstock (Raw)	0	0	0	5,803,500 bbl/year	143.3	1.797	143.3	1.797
1463	Tank A-867, EFRT, Renewable Feedstock (Raw)	84,000 bbl/day 50,000,000 bbl/year	22.6	8.268	288,000 bbl/day 17,520,000 bbl/year	17.9	1.554	0	0
1468	Tank A-877, FRT, Spent Sulfidic Caustic, A-14 Vapor Recovery	0	0	0	116,800 bbl/year	0.3	0.001	2.5E-01	1.2E-03

		Pre-Project			Post-Project			Emissions Increase	
S-#	New Source Description	Throughput	POC Emissions (lbs/day)	POC Emissions (tons/year)	Throughput	POC Emissions (lbs/day)	POC Emissions (tons/year)	POC Emissions (lbs/day)	POC Emissions (tons/year)
Existing Storage Tanks [Exempt] (cont'd)									
1554	Tank A-943, FRT, Renewable Feedstock (Clean)	10,000,000 bbl/year	3.8	0.193	10,000,000 bbl/year	3.7	0.087	0	0
2007	Tank A-905, FRT, R99 Renewable Diesel	0	0	0	8,705,250 bbl/year	181.7	2.331	181.7	2.331
2008	Tank A-933, FRT, R99 Renewable Diesel	0	0	0	8,705,250 bbl/year	283.0	2.622	283.0	2.622
2011	Tank A-981, FRT, Fossil Diesel	0	0	0	87,053 bbl/year	6.0	0.010	6.0	0.010
2012	Tank A-961, FRT, Fossil Diesel	0	0	0	87,053 bbl/year	6.0	0.010	6.0	0.010
2028	Tank A-932, FRT, R99 Renewable Diesel	0	0	0	8,705,250 bbl/year	181.7	1.739	181.7	1.739
New Storage Tanks									
2023	Tank TK-1044, Polymer Storage Tank	0	0	0	30.9 bbl/day 250 bbl/year	~~0.048~~2.6	0.019	0.048	0.019
New Storage Tanks [Exempt]									
2002	Tank TK-1048, Antifoam Tank	0	0	0	n/a	0	0	0	0
2004	Tank TK-845, Sodium Hypochlorite Storage Tank	0	0	0	n/a	0	0	0	0
2005	Tank TK-10162, Demulsifier Storage Tank	0	0	0	1,418 bbl/year	0.044	0.007	0.044	0.007
2006	Tank TK-958, Fresh Caustic Storage Tank	0	0	0	n/a	0	0	0	0
2014	Sodium Sulfide Tank No. 1	0	0	0	n/a	0	0	0	0
2015	Sodium Sulfide Tank No. 2	0	0	0	n/a	0	0	0	0
2018	Tank TK-1036, Sulfuric Acid Storage Tank	0	0	0	5,006 bbl/year	0.013	8.1E-06	0.013	8.1E-06
2019	Tank TK-10193, Coagulant Storage Tank	0	0	0	n/a	0	0	0	0
2022	Tank TK-10198, Urea Storage Tank	0	0	0	n/a	0	0	0	0
2024	Tank TK-1035, Phosphoric Acid Storage Tank	0	0	0	834 bbl/year	0.019	5.2E-06	0.019	5.2E-06
2026	Tank NV-406, Weak Acid Tank Storage Tank	0	0	0	n/a	0	0	0	0

Notes:

1. Calculated using AP-42 methodology. Please refer to attached tank calculations in Section 4.0 of this appendix.

2. The pre-project (baseline) emission is set to zero for existing storage tanks without an Air District source number, i.e., previously exempt, and will be treated as a new source.
3. Basis for zero or negligible emissions:

- S-2002 - Representative SDS for the antifoam does not contain POCs; therefore, the tank does not emit criteria pollutants
- S-2004 - Representative SDS for sodium hypochlorite does not contain POCs; therefore, the tank does not emit criteria pollutants
- S-2006 - Per the National Institute of Health's (NIH) PubChem online database, sodium hydroxide (caustic) has a negligible vapor pressure at ambient conditions (25 C) and will thus generate negligible emissions of the compound.
- S-2014/2015 - The liquid stored in this tank is an aqueous solution of sodium sulfide. The liquid generates a very low vapor pressure, as noted in the SDS provided previously, that is attributable only to the water content of this liquid. The sodium sulfide generates a negligible vapor pressure, and thus negligible emissions from the tank.
- S-2019 - Representative SDSs for the potential DAF coagulants do not contain POCs; therefore, the tank does not emit criteria pollutants
- S-2022 - Per the National Institute of Health's (NIH) PubChem online database, urea has a vapor pressure of 0.0000125 mmHg at ambient conditions (25 C). This is an extraordinarily low vapor pressure that will generate negligible emissions from this tank.
- S-2026 - Per the National Institute of Health's (NIH) PubChem online database, citric acid has a vapor pressure of 1.7E-8 mmHg at ambient conditions (25 C). This is an extraordinarily low vapor pressure that will generate negligible emissions from this tank.

Table C-2 – Pre-Project (Baseline) Toxic Air Contaminant Emissions for Storage Tanks

Pre-Project TAC PTE

Pollutant	323		601		621		622		650		651		656		658		692		699		700	
	lbs/hour	lbs/year	lbs/hour	lbs/year	lbs/hour	lbs/year	lbs/hour	lbs/year	lbs/hour	lbs/year	lbs/hour	lbs/year	lbs/hour	lbs/year	lbs/hour	lbs/year	lbs/hour	lbs/year	lbs/hour	lbs/year	lbs/hour	lbs/year
Benzene	1.0E-02	9.5E+00	3.8E-03	6.6E+00	-	-	4.5E-01	5.1E+01	4.0E-03	1.3E+01	3.7E-03	1.3E+01	1.6E-02	1.4E+01	1.6E-02	1.4E+01	5.5E-03	1.1E+01	3.3E-03	9.8E-01	4.9E-02	8.1E+00
Biphenyl	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-
Cresol (-m)	-	-	-	-	-	-	1.0E-04	8.6E-03	1.0E-03	2.9E-01	1.4E-03	6.1E-01	-	-	-	-	-	-	-	1.0E-04	-	1.0E-03
Cresol (-o)	-	-	-	-	-	-	-	-	-	-	-	-	5.0E-05	2.2E-02	5.0E-05	2.3E-02	-	-	-	-	-	-
Cresols (Mixed Isomers)	-	-	-	-	-	-	1.0E-04	8.6E-03	1.0E-03	2.9E-01	1.4E-03	6.1E-01	5.0E-05	2.2E-02	5.0E-05	2.3E-02	-	-	-	-	-	-
Cyclohexane	3.6E-03	3.3E+00	1.3E-03	2.3E+00	-	-	3.1E-01	3.5E+01	-	-	-	-	-	-	-	-	7.0E-03	1.4E+01	2.3E-03	6.9E-01	3.4E-02	5.8E+00
Ethylbenzene	1.2E-03	1.0E+00	3.4E-03	1.2E+00	-	-	1.0E-01	1.0E+01	-	-	-	-	-	-	-	-	5.7E-03	5.1E+00	5.0E-04	1.7E-01	1.0E-02	1.4E+00
Ethylene Glycol	8.5E-03	8.0E+00	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-
Hexane (n)	1.0E-02	9.1E+00	2.3E-03	5.4E+00	-	-	-	-	-	-	-	-	-	-	-	-	1.9E-02	4.5E+01	-	-	-	-
Isooctane	-	-	6.3E-03	6.8E+00	-	-	-	-	-	-	-	-	-	-	-	-	2.0E-02	3.1E+01	-	-	-	-
Isoprene	8.7E-04	7.2E-01	-	-	-	-	-	-	-	-	-	-	-	-	-	-	2.6E-04	8.4E-01	-	-	-	-
Isopropyl benzene	1.7E-04	2.8E-02	5.1E-03	1.3E+00	-	-	7.0E-02	7.0E+00	-	-	-	-	-	-	-	-	3.2E-04	2.5E-01	4.1E-04	1.1E-01	6.1E-03	9.2E-01
Methanol	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-
Naphthalene	-	-	-	-	-	-	3.9E-02	3.5E+00	-	-	-	-	-	-	-	-	7.3E-04	4.8E-01	2.0E-04	4.8E-02	3.0E-03	4.0E-01
Phenol	-	-	-	-	-	-	-	-	1.0E-03	3.0E-01	1.4E-03	6.3E-01	2.3E-05	3.8E-02	3.1E-05	3.8E-02	-	-	-	-	-	-
Toluene	4.0E-03	3.5E+00	4.1E-03	2.9E+00	-	-	5.4E-01	5.8E+01	-	-	-	-	-	-	-	-	2.8E-02	3.6E+01	3.5E-03	1.0E+00	5.0E-02	8.7E+00
Trimethylbenzene (1,2,4)	-	-	-	-	-	-	1.5E-01	1.5E+01	-	-	-	-	-	-	-	-	1.1E-02	7.9E+00	8.5E-04	2.2E-01	1.3E-02	1.8E+00
Xylene (m)	-	-	-	-	-	-	1.9E-01	2.0E+01	1.0E-03	1.3E+00	1.6E-03	1.6E+00	1.5E-03	1.1E+00	1.5E-03	1.1E+00	2.7E-02	2.4E+01	1.0E-03	3.3E-01	2.0E-02	2.7E+00
Xylene (o)	5.0E-04	4.2E-01	2.0E-03	6.2E-01	-	-	1.6E-01	1.6E+01	-	-	-	-	-	-	-	-	-	-	1.0E-03	2.6E-01	1.0E-02	2.2E+00
Xylene (p)	-	-	-	-	-	-	2.0E-01	2.1E+01	-	-	-	-	-	-	-	-	-	-	1.3E-03	3.5E-01	1.9E-02	2.9E+00
Total Xylenes	5.0E-04	4.2E-01	2.0E-03	6.2E-01	-	-	5.5E-01	5.6E+01	1.0E-03	1.3E+00	1.6E-03	1.6E+00	1.5E-03	1.1E+00	1.5E-03	1.1E+00	2.7E-02	2.4E+01	3.3E-03	9.4E-01	4.9E-02	7.7E+00
Ammonia	-	-	-	-	-	-	-	-	-	-	-	-	6.2E-02	1.2E+02	8.4E-02	1.2E+02	-	-	-	-	-	-
Hydrogen Sulfide	-	-	1.6E-07	1.4E-03	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-
Sodium Hydroxide	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-
Phosphoric Acid	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-
Sulfuric Acid	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-

Table C-2 (cont'd) – Pre-Project (Baseline) Toxic Air Contaminant Emissions for Storage Tanks

Pre-Project TAC PTE

Pollutant	1464		1465		2005		2006		2007		2008		2011		2012		2018		2024		2028	
	lbs/hour	lbs/year	lbs/hour	lbs/year	lbs/hour	lbs/year	lbs/hour	lbs/year	lbs/hour	lbs/year	lbs/hour	lbs/year	lbs/hour	lbs/year	lbs/hour	lbs/year	lbs/hour	lbs/year	lbs/hour	lbs/year	lbs/hour	lbs/year
Benzene	4.5E-07	4.0E-03	4.5E-07	4.0E-03	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-
Biphenyl	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-
Cresol (-m)	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-
Cresol (-o)	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-
Cresols (Mixed Isomers)	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-
Cyclohexane	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-
Ethylbenzene	6.2E-06	5.4E-02	6.2E-06	5.4E-02	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-
Ethylene Glycol	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-
Hexane (n)	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-
Isooctane	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-
Isoprene	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-
Isopropyl benzene	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-
Methanol	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-
Naphthalene	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-
Phenol	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-
Toluene	7.4E-06	6.5E-02	7.4E-06	6.5E-02	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-
Trimethylbenzene (1,2,4)	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-
Xylene (m)	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-
Xylene (o)	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-
Xylene (p)	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-
Total Xylenes	3.8E-05	3.3E-01	3.8E-05	3.3E-01	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-
Ammonia	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-
Hydrogen Sulfide	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-
Sodium Hydroxide	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-
Phosphoric Acid	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-
Sulfuric Acid	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-

Table C-3 – Post-Project Toxic Air Contaminant Emissions for Storage Tanks

Post-Project TAC PTE

	323		601		621		622		650		651		656		658		692		699		700	
Pollutant	**lbs/hour**	**lbs/year**	**lbs/hour**	**lbs/year**	**lbs/hour**	**lbs/year**	**lbs/hour**	**lbs/year**	**lbs/hour**	**lbs/year**	**lbs/hour**	**lbs/year**	**lbs/hour**	**lbs/year**	**lbs/hour**	**lbs/year**	**lbs/hour**	**lbs/year**	**lbs/hour**	**lbs/year**	**lbs/hour**	**lbs/year**
Benzene	1.0E-02	1.5E+00	3.8E-03	6.2E+00	-	-	-	-	4.0E-03	1.3E+01	3.7E-03	1.5E+01	1.6E-02	1.3E+01	1.6E-02	1.3E+01	6.1E-03	1.3E+01	3.3E-03	6.7E-01	4.9E-02	1.1E+00
Biphenyl	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-
Cresol (-m)	-	-	-	-	-	-	-	-	1.0E-03	1.4E-01	1.4E-03	2.0E+00	-	-	-	-	-	-	-	5.0E-05	-	-
Cresol (-o)	-	-	-	-	-	-	-	-	-	-	-	-	5.0E-05	2.2E-02	5.0E-05	2.2E-02	-	-	-	-	-	-
Cresols (Mixed Isomers)	-	-	-	-	-	-	-	-	1.0E-03	1.4E-01	1.4E-03	2.0E+00	5.0E-05	2.2E-02	5.0E-05	2.2E-02	-	-	-	-	-	-
Cyclohexane	3.6E-03	5.3E-01	1.3E-03	2.2E+00	-	-	-	-	-	-	-	-	-	-	-	-	3.1E-03	6.5E+00	2.3E-03	4.7E-01	3.4E-02	7.5E-01
Ethylbenzene	1.2E-03	1.6E-01	3.4E-03	8.0E-01	-	-	-	-	-	-	-	-	-	-	-	-	1.1E-03	7.2E-01	5.0E-04	1.2E-01	1.0E-02	1.9E-01
Ethylene Glycol	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-
Hexane (n)	8.5E-03	1.3E+00	2.3E-03	5.2E+00	-	-	-	-	-	-	-	-	-	-	-	-	1.3E-01	3.0E+02	-	-	-	-
Isooctane	1.0E-02	1.4E+00	6.3E-03	6.1E+00	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-
Isoprene	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-
Isopropyl benzene	8.7E-03	1.1E-01	5.1E-03	6.8E-01	2.0E-04	1.1E+00	1.1E-01	5.9E+01	-	-	-	-	-	-	-	-	1.0E-03	4.2E-01	4.1E-04	7.6E-02	6.1E-03	1.2E-01
Methanol	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-
Naphthalene	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	2.0E-04	3.3E-02	3.0E-03	5.2E-02
Phenol	-	-	-	-	-	-	-	-	1.0E-03	1.6E-01	1.4E-03	2.1E+00	2.3E-05	3.7E-02	3.1E-05	3.7E-02	-	-	-	-	-	-
Toluene	4.0E-03	5.6E-01	4.1E-03	2.4E+00	-	-	-	-	-	-	-	-	-	-	-	-	3.2E-03	3.9E+00	3.5E-03	7.2E-01	5.0E-02	1.1E+00
Trimethylbenzene (1,2,4)	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	8.5E-04	1.5E-01	1.3E-02	2.4E-01
Xylene (m)	-	-	-	-	-	-	-	-	1.0E-03	1.2E+00	1.6E-03	3.1E+00	1.5E-03	1.1E+00	1.5E-03	1.1E+00	-	-	1.0E-03	2.2E-01	2.0E-02	3.5E-01
Xylene (o)	5.0E-04	6.8E-02	2.0E-03	3.6E-01	-	-	-	-	-	-	-	-	-	-	-	-	-	-	1.0E-03	1.8E-01	1.0E-02	2.8E-01
Xylene (p)	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	1.7E-03	1.0E+00	1.3E-03	2.4E-01	1.9E-02	3.8E-01
Total Xylenes	5.0E-04	6.8E-02	2.0E-03	3.6E-01	-	-	-	-	1.0E-03	1.2E+00	1.6E-03	3.1E+00	1.5E-03	1.1E+00	1.5E-03	1.1E+00	1.7E-03	1.0E+00	3.3E-03	6.4E-01	4.9E-02	1.0E+00
Ammonia	-	-	-	-	-	-	-	-	-	-	-	-	6.2E-02	1.2E+02	8.4E-02	1.2E+02	-	-	-	-	-	-
Hydrogen Sulfide	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-
Sodium Hydroxide	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-
Phosphoric Acid	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-
Sulfuric Acid	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-

Table C-3 (cont'd) – Post-Project Toxic Air Contaminant Emissions

Post-Project TAC PTE

Pollutant	1464		1465		2005		2006		2007		2008		2011		2012		2018		2024		2028	
	lbs/hour	lbs/year	lbs/hour	lbs/year	lbs/hour	lbs/year	lbs/hour	lbs/year	lbs/hour	lbs/year	lbs/hour	lbs/year	lbs/hour	lbs/year	lbs/hour	lbs/year	lbs/hour	lbs/year	lbs/hour	lbs/year	lbs/hour	lbs/year
Benzene	-	-	-	-	-	-	-	-	-	-	-	-	7.6E-03	6.8E-01	7.6E-03	6.8E-01	-	-	-	-	-	-
Biphenyl	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-
Cresol (-m)	-	-	-	-	-	-	-	-	-	-	-	-	1.0E-06	7.3E-05	1.0E-06	7.3E-05	-	-	-	-	-	-
Cresol (-o)	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-
Cresols (Mixed Isomers)	-	-	-	-	-	-	-	-	-	-	-	-	1.0E-06	7.3E-05	1.0E-06	7.3E-05	-	-	-	-	-	-
Cyclohexane	-	-	-	-	-	-	-	-	-	-	-	-	5.3E-03	4.8E-01	5.3E-03	4.8E-01	-	-	-	-	-	-
Ethylbenzene	-	-	-	-	3.8E-05	2.9E-01	-	-	-	-	-	-	1.5E-03	1.2E-01	1.5E-03	1.2E-01	-	-	-	-	-	-
Ethylene Glycol	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-
Hexane (n)	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-
Isooctane	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-
Isoprene	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-
Isopropyl benzene	2.3E-04	8.2E-01	2.3E-04	7.2E-01	1.8E-05	1.4E-01	-	-	9.5E-02	5.9E+01	1.5E-01	6.6E+01	9.6E-04	7.8E-02	9.6E-04	7.8E-02	-	-	-	-	9.5E-02	4.4E+01
Methanol	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-
Naphthalene	-	-	-	-	-	-	-	-	-	-	-	-	4.5E-04	3.4E-02	4.5E-04	3.4E-02	-	-	-	-	-	-
Phenol	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-
Toluene	-	-	-	-	-	-	-	-	-	-	-	-	8.5E-03	7.3E-01	8.5E-03	7.3E-01	-	-	-	-	-	-
Trimethylbenzene (1,2,4)	-	-	-	-	4.1E-05	3.0E-01	-	-	-	-	-	-	2.0E-03	1.6E-01	2.0E-03	1.6E-01	-	-	-	-	-	-
Xylene (m)	-	-	-	-	1.7E-04	1.3E+00	-	-	-	-	-	-	2.8E-03	2.3E-01	2.8E-03	2.3E-01	-	-	-	-	-	-
Xylene (o)	-	-	-	-	-	-	-	-	-	-	-	-	2.2E-03	1.8E-01	2.2E-03	1.8E-01	-	-	-	-	-	-
Xylene (p)	-	-	-	-	-	-	-	-	-	-	-	-	2.9E-03	2.4E-01	2.9E-03	2.4E-01	-	-	-	-	-	-
Total Xylenes	-	-	-	-	1.7E-04	1.3E+00	-	-	-	-	-	-	7.9E-03	6.5E-01	7.9E-03	6.5E-01	-	-	-	-	-	-
Ammonia	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-
Hydrogen Sulfide	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-
Sodium Hydroxide	-	-	-	-	-	-	5.2E-03	1.3E-01	-	-	-	-	-	-	-	-	-	-	-	-	-	-
Phosphoric Acid	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	7.8E-04	1.0E-02	-	-
Sulfuric Acid	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	5.5E-04	1.6E-02	-	-	-	-

Table C-3 – Summary of Toxic Air Contaminant Emissions Increases

TAC Emissions Increase

Pollutant	323		601		621		622		650		651		656		658		692		699		700	
	lbs/hour	lbs/year	lbs/hour	lbs/year	lbs/hour	lbs/year	lbs/hour	lbs/year	lbs/hour	lbs/year	lbs/hour	lbs/year	lbs/hour	lbs/year	lbs/hour	lbs/year	lbs/hour	lbs/year	lbs/hour	lbs/year	lbs/hour	lbs/year
Benzene	-	-	-	-	-	-	-	-	-	-	-	1.4E+00	-	-	-	-	5.8E-04	1.6E+00	-	-	-	-
Biphenyl	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-
Cresol (-m)	-	-	-	-	-	-	-	-	-	-	-	1.4E+00	-	-	-	-	-	-	-	-	-	-
Cresol (-o)	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-
Cresols (Mixed Isomers)	-	-	-	-	-	-	-	-	-	-	-	1.4E+00	-	-	-	-	-	-	-	-	-	-
Cyclohexane	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-
Ethylbenzene	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-
Ethylene Glycol	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-
Hexane (n)	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	1.1E-01	2.6E+02	-	-	-	-
Isooctane	1.0E-02	1.4E+00	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-
Isoprene	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-
Isopropyl benzene	8.7E-04	1.1E-01	-	-	2.0E-04	1.1E+00	3.7E-02	5.2E+01	-	-	-	-	-	-	-	-	7.1E-04	1.7E-01	-	-	-	-
Methanol	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-
Naphthalene	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-
Phenol	-	-	-	-	-	-	-	-	-	-	-	1.4E+00	-	-	-	-	-	-	-	-	-	-
Toluene	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-
Trimethylbenzene (1,2,4)	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-
Xylene (m)	-	-	-	-	-	-	-	-	-	-	-	1.4E+00	-	-	-	-	-	-	-	-	-	-
Xylene (o)	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-
Xylene (p)	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	1.7E-03	1.0E+00	-	-	-	-
Total Xylenes	-	-	-	-	-	-	-	-	-	-	-	1.4E+00	-	-	-	-	-	-	-	-	-	-
Ammonia	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-
Hydrogen Sulfide	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-
Sodium Hydroxide	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-
Phosphoric Acid	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-
Sulfuric Acid	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-

Table C-3 (cont'd) – Summary of Toxic Air Contaminant Emissions Increases

TAC Emissions Increase

Pollutant	1464		1465		2005		2006		2007		2008		2011		2012		2018		2024		2028	
	lbs/hour	lbs/year	lbs/hour	lbs/year	lbs/hour	lbs/year	lbs/hour	lbs/year	lbs/hour	lbs/year	lbs/hour	lbs/year	lbs/hour	lbs/year	lbs/hour	lbs/year	lbs/hour	lbs/year	lbs/hour	lbs/year	lbs/hour	lbs/year
Benzene	-	-	-	-	-	-	-	-	-	-	-	-	7.6E-03	6.8E-01	7.6E-03	6.8E-01	-	-	-	-	-	-
Biphenyl	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-
Cresol (-m)	-	-	-	-	-	-	-	-	-	-	-	-	1.0E-06	7.3E-05	1.0E-06	7.3E-05	-	-	-	-	-	-
Cresol (-o)	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-
Cresols (Mixed Isomers)	-	-	-	-	-	-	-	-	-	-	-	-	1.0E-06	7.3E-05	1.0E-06	7.3E-05	-	-	-	-	-	-
Cyclohexane	-	-	-	-	-	-	-	-	-	-	-	-	5.3E-03	4.8E-01	5.3E-03	4.8E-01	-	-	-	-	-	-
Ethylbenzene	-	-	-	-	3.8E-05	2.9E-01	-	-	-	-	-	-	1.5E-03	1.2E-01	1.5E-03	1.2E-01	-	-	-	-	-	-
Ethylene Glycol	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-
Hexane (n)	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-
Isooctane	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-
Isoprene	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-
Isopropyl benzene	2.3E-04	8.2E-01	2.3E-04	8.2E-01	1.8E-05	1.4E-01	-	-	9.5E-02	5.9E+01	1.5E-01	6.6E+01	9.6E-04	7.8E-02	9.6E-04	7.8E-02	-	-	-	-	9.5E-02	4.4E+01
Methanol	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-
Naphthalene	-	-	-	-	-	-	-	-	-	-	-	-	4.5E-04	3.4E-02	4.5E-04	3.4E-02	-	-	-	-	-	-
Phenol	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-
Toluene	-	-	-	-	-	-	-	-	-	-	-	-	8.5E-03	7.3E-01	8.5E-03	7.3E-01	-	-	-	-	-	-
Trimethylbenzene (1,2,4)	-	-	-	-	4.1E-05	3.0E-01	-	-	-	-	-	-	2.0E-03	1.6E-01	2.0E-03	1.6E-01	-	-	-	-	-	-
Xylene (m)	-	-	-	-	1.7E-04	1.3E+00	-	-	-	-	-	-	2.8E-03	2.3E-01	2.8E-03	2.3E-01	-	-	-	-	-	-
Xylene (o)	-	-	-	-	-	-	-	-	-	-	-	-	2.2E-03	1.8E-01	2.2E-03	1.8E-01	-	-	-	-	-	-
Xylene (p)	-	-	-	-	-	-	-	-	-	-	-	-	2.9E-03	2.4E-01	2.9E-03	2.4E-01	-	-	-	-	-	-
Total Xylenes	-	-	-	-	1.7E-04	1.3E+00	-	-	-	-	-	-	7.9E-03	6.5E-01	7.9E-03	6.5E-01	-	-	-	-	-	-
Ammonia	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-
Hydrogen Sulfide	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-
Sodium Hydroxide	-	-	-	-	-	-	5.2E-03	1.3E-01	-	-	-	-	-	-	-	-	-	-	-	-	-	-
Phosphoric Acid	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	7.8E-04	1.0E-02	-	-
Sulfuric Acid	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	5.5E-04	1.6E-02	-	-	-	-

Table C-4 – Review of Emissions Increase Above Regulation 2, Rule 5 Thresholds

Emissions Increase Exceeds 2-5 Threshold?

Pollutant	323		601		621		622		650		651		656		658		692		699		700	
	lbs/hour	lbs/year	lbs/hour	lbs/year	lbs/hour	lbs/year	lbs/hour	lbs/year	lbs/hour	lbs/year	lbs/hour	lbs/year	lbs/hour	lbs/year	lbs/hour	lbs/year	lbs/hour	lbs/year	lbs/hour	lbs/year	lbs/hour	lbs/year
Benzene	No	No	No	No	No	No	No	No	No	No	No	No	No	No	No	No	No	No	No	No	No	No
Biphenyl	No	No	No	No	No	No	No	No	No	No	No	No	No	No	No	No	No	No	No	No	No	No
Cresol (-m)	No	No	No	No	No	No	No	No	No	No	No	No	No	No	No	No	No	No	No	No	No	No
Cresol (-o)	No	No	No	No	No	No	No	No	No	No	No	No	No	No	No	No	No	No	No	No	No	No
Cresols (Mixed Isomers)	No	No	No	No	No	No	No	No	No	No	No	No	No	No	No	No	No	No	No	No	No	No
Cyclohexane	No	No	No	No	No	No	No	No	No	No	No	No	No	No	No	No	No	No	No	No	No	No
Ethylbenzene	No	No	No	No	No	No	No	No	No	No	No	No	No	No	No	No	No	No	No	No	No	No
Ethylene Glycol	No	No	No	No	No	No	No	No	No	No	No	No	No	No	No	No	No	No	No	No	No	No
n-Hexane	No	No	No	No	No	No	No	No	No	No	No	No	No	No	No	No	No	No	No	No	No	No
2,2,4-Trimethylpentane	No	No	No	No	No	No	No	No	No	No	No	No	No	No	No	No	No	No	No	No	No	No
Isoprene	No	No	No	No	No	No	No	No	No	No	No	No	No	No	No	No	No	No	No	No	No	No
Cumene	No	No	No	No	No	No	No	No	No	No	No	No	No	No	No	No	No	No	No	No	No	No
Methanol	No	No	No	No	No	No	No	No	No	No	No	No	No	No	No	No	No	No	No	No	No	No
Naphthalene	No	No	No	No	No	No	No	No	No	No	No	No	No	No	No	No	No	No	No	No	No	No
Phenol	No	No	No	No	No	No	No	No	No	No	No	No	No	No	No	No	No	No	No	No	No	No
Toluene	No	No	No	No	No	No	No	No	No	No	No	No	No	No	No	No	No	No	No	No	No	No
1,2,4-Trimethylbenzene	No	No	No	No	No	No	No	No	No	No	No	No	No	No	No	No	No	No	No	No	No	No
Xylene (-m)	No	No	No	No	No	No	No	No	No	No	No	No	No	No	No	No	No	No	No	No	No	No
Xylene (-o)	No	No	No	No	No	No	No	No	No	No	No	No	No	No	No	No	No	No	No	No	No	No
Xylene (-p)	No	No	No	No	No	No	No	No	No	No	No	No	No	No	No	No	No	No	No	No	No	No
Total Xylenes	No	No	No	No	No	No	No	No	No	No	No	No	No	No	No	No	No	No	No	No	No	No
Ammonia	No	No	No	No	No	No	No	No	No	No	No	No	No	No	No	No	No	No	No	No	No	No
Hydrogen Sulfide	No	No	No	No	No	No	No	No	No	No	No	No	No	No	No	No	No	No	No	No	No	No
Sodium Hydroxide	No	No	No	No	No	No	No	No	No	No	No	No	No	No	No	No	No	No	No	No	No	No
Phosphoric Acid	No	No	No	No	No	No	No	No	No	No	No	No	No	No	No	No	No	No	No	No	No	No
Sulfuric Acid	No	No	No	No	No	No	No	No	No	No	No	No	No	No	No	No	No	No	No	No	No	No

Table C-4 (cont'd) – Review of Emissions Increase Above Regulation 2, Rule 5 Thresholds

Emissions Increase Exceeds 2-5 Threshold?

Pollutant	1464		1465		2005		2006		2007		2008		2011		2012		2018		2024		2028	
	lbs/hour	lbs/year	lbs/hour	lbs/year	lbs/hour	lbs/year	lbs/hour	lbs/year	lbs/hour	lbs/year	lbs/hour	lbs/year	lbs/hour	lbs/year	lbs/hour	lbs/year	lbs/hour	lbs/year	lbs/hour	lbs/year	lbs/hour	lbs/year
Benzene	No	No	No	No	No	No	No	No	No	No	No	No	No	No	No	No	No	No	No	No	No	No
Biphenyl	No	No	No	No	No	No	No	No	No	No	No	No	No	No	No	No	No	No	No	No	No	No
Cresol (-m)	No	No	No	No	No	No	No	No	No	No	No	No	No	No	No	No	No	No	No	No	No	No
Cresol (-o)	No	No	No	No	No	No	No	No	No	No	No	No	No	No	No	No	No	No	No	No	No	No
Cresols (Mixed Isomers)	No	No	No	No	No	No	No	No	No	No	No	No	No	No	No	No	No	No	No	No	No	No
Cyclohexane	No	No	No	No	No	No	No	No	No	No	No	No	No	No	No	No	No	No	No	No	No	No
Ethylbenzene	No	No	No	No	No	No	No	No	No	No	No	No	No	No	No	No	No	No	No	No	No	No
Ethylene Glycol	No	No	No	No	No	No	No	No	No	No	No	No	No	No	No	No	No	No	No	No	No	No
n-Hexane	No	No	No	No	No	No	No	No	No	No	No	No	No	No	No	No	No	No	No	No	No	No
2,2,4-Trimethylpentane	No	No	No	No	No	No	No	No	No	No	No	No	No	No	No	No	No	No	No	No	No	No
Isoprene	No	No	No	No	No	No	No	No	No	No	No	No	No	No	No	No	No	No	No	No	No	No
Cumene	No	No	No	No	No	No	No	No	No	No	No	No	No	No	No	No	No	No	No	No	No	No
Methanol	No	No	No	No	No	No	No	No	No	No	No	No	No	No	No	No	No	No	No	No	No	No
Naphthalene	No	No	No	No	No	No	No	No	No	No	No	No	No	No	No	No	No	No	No	No	No	No
Phenol	No	No	No	No	No	No	No	No	No	No	No	No	No	No	No	No	No	No	No	No	No	No
Toluene	No	No	No	No	No	No	No	No	No	No	No	No	No	No	No	No	No	No	No	No	No	No
1,2,4-Trimethylbenzene	No	No	No	No	No	No	No	No	No	No	No	No	No	No	No	No	No	No	No	No	No	No
Xylene (-m)	No	No	No	No	No	No	No	No	No	No	No	No	No	No	No	No	No	No	No	No	No	No
Xylene (-o)	No	No	No	No	No	No	No	No	No	No	No	No	No	No	No	No	No	No	No	No	No	No
Xylene (-p)	No	No	No	No	No	No	No	No	No	No	No	No	No	No	No	No	No	No	No	No	No	No
Total Xylenes	No	No	No	No	No	No	No	No	No	No	No	No	No	No	No	No	No	No	No	No	No	No
Ammonia	No	No	No	No	No	No	No	No	No	No	No	No	No	No	No	No	No	No	No	No	No	No
Hydrogen Sulfide	No	No	No	No	No	No	No	No	No	No	No	No	No	No	No	No	No	No	No	No	No	No
Sodium Hydroxide	No	No	No	No	No	No	No	No	No	No	No	No	No	No	No	No	No	No	No	No	No	No
Phosphoric Acid	No	No	No	No	No	No	No	No	No	No	No	No	No	No	No	No	No	No	No	No	No	No
Sulfuric Acid	No	No	No	No	No	No	No	No	No	No	No	No	No	No	No	No	No	No	No	No	No	No

Appendix C Notes:

[1] Calculated using AP-42 methodology. Please refer to attached tank calculations for details.

[2] S-648/649/666/667/668/669/670 - Based on the material safety data sheets of propane, there are no TACs. As such, there is no increase in emissions of TAC above Regulation 2, Rule 5, trigger levels.

[3] S-517/620/873/1463/1554 - Based on the material safety data sheets of alternative feedstocks, there are no TACs. As such, there is no increase in emissions of TAC above Regulation 2, Rule 5, trigger levels.

[4] S-2014/2015/2019/2022/2023 - Based on the material safety data sheets of chemical additives for wastewater treatment, there are no TACs. As such, there is no increase in emissions of TAC above Regulation 2, Rule 5, trigger levels.

[5] S-2026 - Based on the material safety data sheets of weak acids for the pretreatment unit, there are no TACs. As such, there is no increase in emissions of TAC above Regulation 2, Rule 5, trigger levels.

NaOH Emissions from Caustic Storage Tanks

	Post-Project PTE (lbs/year)	
Source ID	S-1468	S-2006
Tank ID	A-877	A-958
Material	Spent Caustic	Fresh Caustic
Annual Throughput (gal/year)	4,905,600	4,905,600
Working Water Losses (lbs/year)	627	615
Standing Water Losses (lbs/year)	942	338
Estimated Additional "Throughput" from Standing Losses[1] (gal)	7,369,374	2,695,069
Total Effective Throughput (gal)	12,274,974	7,600,669
Total Effective Throughput (m^3)	46,465.8	28,771.6
NaOH Emissions[2] (mg NaOH/year)	92,931.6	57,543.3
NaOH Emissions (lbs NaOH/year)	0.205	0.127
Control Efficiency (%)	98%	0%
Controlled NaOH Emissions (lbs NaOH/year)	4.1E-03	1.3E-01

	Post-Project PTE (lbs/hr)	
Source ID	S-1468	S-2006
Tank ID	A-877	A-958
Material	Spent Caustic	Fresh Caustic
Maximum Hourly Throughput (gal/hr)	42,000	311,338
Maximum Effective Throughput (m^3)	159.0	1178.5
NaOH Emissions[2] (mg NaOH/hr)	318.0	2357.1
NaOH Emissions (lbs NaOH/hr)	0.001	0.005
Control Efficiency (%)	98%	0%
Controlled NaOH Emissions (lbs NaOH/hr)	1.4E-05	5.2E-03

Notes:

(1) Conservatively assumed additional "throughput" based on the total water or VOC losses shown above, divided by just the working losses shown above.
(2) Solid caustic (sodium hydroxide, NaOH) has an extremely low vapor pressure and needs to be heated to 513 °C just to have an equilibrium vapor pressure of 1 Pa ≈ 0.0075 mm Hg [CRC Handbook of Chemistry and Physics, 78th edition (1997-1998), p. 6-66.]. Because it is less volatile than water, studies of the vapor pressure above caustic solutions show that the total vapor pressure above the solution decreases as the NaOH concentration increases [See, for example, D.S. Davis (1942), "Vapor Pressure Nomographs for Aqueous Sodium Hydroxide Solutions", Industrial and Engineering Chemistry 34(9), 1131-1132.], and essentially all of the vapor pressure above the solutions is still just water vapor.

That being said, it is well known that the vapors above concentrated NaOH can be a respiratory irritant and that NaOH can be present in aerosols which are not accounted for by vapor-liquid equilibrium calculations. We are not aware of any model that would provide a quantitative estimate of aerosol generation. However, measurements of exposures in the aluminum production and textile industries have been made, and for processes most similar to ours (i.e., no heating/sparging/splashing) – i.e., measurements made on top of a tank being filled with caustic wash, and near NaOH storage – the exposures were measured as being approximately 1-2 mg/m3 [European Chemicals Bureau, European Union Risk Assessment Report: sodium hydroxide (Volume: 73), EUR 23040 EN, Final Report, 2007, pp. 50-53.]. These calculations conservatively assume a concentration of 2 mg NaOH/m3 of displaced vapor space.

H_2S Emissions from Spent Caustic

H_2S is a gas which can be dissolved in liquids; actual data are preferable to methods based on Raoult's Law (which would also require that concentrations in the liquid be known).

Tesoro identified that in January 2016, David Beter used an MX6 handheld analyzer to measure H_2S vapors from the side sample taps of Tanks 134 and 137 (fixed-roof slop oil tanks) and obtained readings of 13.5 ppm H_2S and 15.2 ppm H_2S respectively. Calculations below are based on the assumption that these values are roughly representative for concentrations emitted from both slop oil and crude tanks.

Appendix C – Summary of Storage Tanks Emissions Calculation

For fixed-roof tanks, emissions are approximately proportional to the product of (1) the volume of air and vapor emitted from the tank, (2) the true vapor pressure (TVP), and (3) the vapor molecular weight. Therefore the volume emitted can be approximated by dividing the VOC emissions by the product of the TVP (psi) and vapor molecular weight, and then H2S emissions can be calculated by multiplying by 0.00022 psi (equivalent to 15 ppmv) and the vapor molecular weight of H_2S (34).

For floating-roof tanks, calculations can be thrown off by assumptions regarding withdrawal losses (which in the current methods are a function of liquid density only, regardless of volatility); therefore, the same procedure identified above is applied only to the standing losses, rather than the total emissions.

Vapor H2S Concentration (eng. est.)

15	ppmv H_2S
0.00022	psi
21	mg/m^3

	Post-Project PTE (lb/year)		Post-Project PTE (lb/hr)
Source ID	S-1468	Source ID	S-1468
Tank ID	A-877	Tank ID	A-877
Material	Spent Caustic	Material	Spent Caustic
Concentration (mg/m^3)	21	Concentration (mg/m^3)	21
Total Effective Throughput (m^3)	46,468.7	Total Effective Throughput (m^3)	159.0
Uncontrolled H_2S (lbs/year)	2.2E+00	Uncontrolled H_2S (lbs/hr)	7.4E-03
Control Efficiency of Control Device (%)	98%	Control Efficiency	98%
Controlled H_2S (lbs/year)	4.3E-02	Controlled H_2S (lbs/hr)	1.5E-04

Notes:
(1) There is projected to be negligible sulfur content within the renewable feedstocks used post-project.
(2) Historic analyses at the refinery identified an estimated concentration of H2S in the vapor space 15 ppmv in the vapor space of crude oil and slop oil tanks. H2S emissions are assumed to be directly proportional to the standing losses from the tank based on the partial pressure of 0.00022 psi for H2S at (estimated based on the 15 ppmv concentration) relative to the total vapor pressure of VOCs in the tanks.
(3)The same analysis was completed for the maximum lb/hr emission rate, except that this analysis conservatively assumes that the H2S emissions are directly proportional to the total VOC lb/hr emission rate as opposed to just the standing losses.

Table C-5 – Summary of NaOH and H_2S Emissions for S-1468 and S-2006

	S-1468		**S-2006**		**Acute Trigger Level**	**Chronic Trigger Level**	**Trigger?**
TAC	Emissions (lbs/hr)	Emissions (lbs/year)	Emissions (lbs/hr)	Emissions (lbs/year)	(lbs/hr)	(lbs/year)	
NaOH	1.4E-05	4.1E-03	5.2E-03	1.3E-01	1.8E-02	None	N
H_2S	1.5E-04	4.3E-02	0	0	9.3E-02	3.9E+02	N

Emissions from equipment leaks of components monitored within a Leak Detection and Repair (LDAR) program such as the one required by Regulation 8, Rule 18, may be estimated using correlation equations[1] developed by both the United States Environmental Protection Agency (EPA) and the California Air Pollution Control Officers Association (CAPCOA). The equations correlate equipment leak concentrations to mas emissions dependent upon the component type (e.g., compressor seal, valves, connectors). The potential to emit for the project components may be estimated using these defined correlation equations and the maximum allowable leak standards of Regulation 8, Rule 18. Emission factors for various component types and service types are shown in Table D-1.

Table D-1: Emission Factors for Fugitive Components

Component Type	Service Type	Screening Value[1] (ppm)	Component Type by Table IV-3a Definition	Correlation Equation[2] (kg/hr/source)	Leak Rate (kg/hr/source)
Compressor	Gas / Vapor	100	Other	8.69E-06(SV)^0.642	1.67E-04
Connector	Gas / Vapor	100	Connector	1.53E-06(SV)^0.736	4.54E-05
Connector	Light Liquid	100	Connector	1.53E-06(SV)^0.736	4.54E-05
Connector	Heavy Liquid	100	Connector	1.53E-06(SV)^0.736	4.54E-05
Flange	Gas / Vapor	100	Flange	4.53E-06(SV)^0.706	1.17E-04
Flange	Light Liquid	100	Flange	4.53E-06(SV)^0.706	1.17E-04
Flange	Heavy Liquid	100	Flange	4.53E-06(SV)^0.706	1.17E-04
Pressure Relief Valve	Gas / Vapor	500	Other	8.69E-06(SV)^0.642	4.70E-04
Pressure Relief Valve	Light Liquid	500	Other	8.69E-06(SV)^0.642	4.70E-04
Pressure Relief Valve	Heavy Liquid	500	Other	8.69E-06(SV)^0.642	4.70E-04
Pump	Light Liquid	100	Pump Seal	5.07E-05(SV)^0.622	8.89E-04
Pump	Heavy Liquid	100	Pump Seal	5.07E-05(SV)^0.622	8.89E-04
Valve	Gas / Vapor	100	Valve	2.27E-06(SV)^0.747	7.08E-05
Valve	Light Liquid	100	Valve	2.27E-06(SV)^0.747	7.08E-05
Valve	Heavy Liquid	100	Valve	2.27E-06(SV)^0.747	7.08E-05
Drain	All	100	Other	8.69E-06(SV)^0.642	1.67E-04
Other	All	100	Other	8.69E-06(SV)^0.642	1.67E-04

[1]Screening values reflect leak thresholds defined in BAAQMD Regulation 8-18: Equipment Leaks, or BACT requirements, whichever is lower.

[2]*California Implementation Guidelines for Estimating Mass Emissions of Fugitive Hydrocarbon Leaks* Table IV-3a CAPCOA - Revised 1995 EPA Correlation Equations and Factors for Refineries and Marketing Terminals.

Fugitive emission calculations are based on the project count of fugitive components, subdivided into process service, and applying the unit component emission factor that represents each component's potential to emit. Marathon has provided pre-project and post-project component counts. Fugitive emissions for new equipment and units resulting in an increase in net component counts are calculated. Fugitive emissions for units resulting in a decrease in net component counts are expected to decrease.

Fugitive emissions are summarized in Table D-2 by source. Component count changes and emission calculations are shown in Table D-3. Toxic Air Contaminant Emissions are shown in Table D-4. Total new and replaced components and emission calculations for the Renewable Fuels Project are shown in Table D-5.

Table D-2: Fugitive Emissions by Source

		Emissions Increase/Decrease (lbs)		
Source No.	**Unit Name**	**Hourly**	**Daily**	**Annual**
S-1526	No. 5 Gas Plant (A003)	(1.3E+00)	(31.4)	(11,470)
S-1003	Diesel HDO Unit No. 2 (formerly No. 2 HDS Unit) (A004)	3.9E-02	0.9	339
S-1002	Propane Dryers (formerly No. 1 HDS Unit) (A005)	(1.5E+00)	(36.0)	(13,140)
S-1560	Avon Wharf (A015)	-	-	-
S-1600	Foul Water Strippers (A018)	(1.5E-01)	(3.5)	(1,296)
S-55 (Plant #14629)	Amorco Wharf (A026)	-	-	-
S-952, S-953, S-954	No. 1 Gas Plant (A034)	-	-	-
S-1008	Diesel HDO Unit No. 1 (formerly Hydrocracker Unit [Hydrocracker 1st Stage]) (A067)	8.8E-02	2.1	768
S-1007	Diesel Isomerization Unit (formerly Hydrocracker Unit [Hydrocracker 2nd Stage]) (A068)	(3.6E-01)	(8.6)	(3,143)
S-1025	TRACT No. 6 Gasoline Blending (A071)	-	-	-
S-850	Diesel HDO Unit No. 3 (formerly No. 3 HDS Unit) (A076)	(4.2E-01)	(10.0)	(3,642)
S-1510	Delayed Coker Unit (A102)	(1.7E+00)	(40.3)	(14,697)
S-2025	Pretreatment Unit	4.4E-01	10.6	3,881
S-2001	Stage 1 Wastewater Treatment Unit	4.4E-01	10.5	3,847
	Total	(4.4E+00)	(105.6)	(38,552)

Table D-3.1 – Component Counts and Estimated Maximum Equipment Leak Emissions for S-1526

Component Type	**Project Component Counts**			**Emissions (lbs)**		
	Pre-Project	**Post-Project**	**Net**	**Hourly**	**Daily**	**Annual**
Valves:						
Gas / Vapor	1,707	784	(923)	(1.4E-01)	(3.5)	(1,262)
Light Liquid	3,204	1,470	(1,734)	(2.7E-01)	(6.5)	(2,371)
Heavy Liquid	-	-	-	-	-	-
Equipment:						
Connectors	5,344	2,452	(2,892)	(2.9E-01)	(6.9)	(2,534)
Flanges	3,451	1,584	(1,867)	(4.8E-01)	(11.6)	(4,218)
PSV's	50	23	(27)	(2.8E-02)	(0.7)	(245)
Compressors	4	2	(2)	(7.4E-04)	(0.0)	(6)
Pumps (Light Liquids)	61	28	(33)	(6.5E-02)	(1.6)	(567)
Pumps (Heavy Liquids)	-	-	-	-	-	-
Process Drains	154	71	(83)	(3.1E-02)	(0.7)	(268)
Total	13,975	6,414	(7,561)	(1.3E+00)	(31.4)	(11,470)

Table D-3.2 – Component Counts and Estimated Maximum Equipment Leak Emissions for S-1003

Component Type	Project Component Counts			Emissions (lbs)		
	Pre-Project	Post-Project	Net	Hourly	Daily	Annual
Valves:						
Gas / Vapor	868	890	22	3.4E-03	0.1	30
Light Liquid	711	729	18	2.8E-03	0.1	25
Heavy Liquid	562	577	15	2.3E-03	0.1	21
Equipment:						
Connectors	4,623	4,741	118	1.2E-02	0.3	103
Flanges	1,793	1,839	46	1.2E-02	0.3	104
PSV's	25	26	1	1.0E-03	0.0	9
Compressors	8	9	1	3.7E-04	0.0	3
Pumps (Light Liquids)	19	20	1	2.0E-03	0.0	17
Pumps (Heavy Liquids)	18	19	1	2.0E-03	0.0	17
Process Drains	83	86	3	1.1E-03	0.0	10
Total	8,710	8,936	226	3.9E-02	0.9	339

Table D-3.3 – Component Counts and Estimated Maximum Equipment Leak Emissions for S-1002

Component Type	Project Component Counts			Emissions (lbs)		
	Pre-Project	Post-Project	Net	Hourly	Daily	Annual
Valves:						
Gas / Vapor	1,253	290	(963)	(1.5E-01)	(3.6)	(1,317)
Light Liquid	1,408	326	(1,082)	(1.7E-01)	(4.1)	(1,479)
Heavy Liquid	503	117	(386)	(6.0E-02)	(1.4)	(528)
Equipment:						
Connectors	5,953	1,378	(4,575)	(4.6E-01)	(11.0)	(4,008)
Flanges	2,947	682	(2,265)	(5.8E-01)	(14.0)	(5,117)
PSV's	36	9	(27)	(2.8E-02)	(0.7)	(245)
Compressors	11	3	(8)	(2.9E-03)	(0.1)	(26)
Pumps (Light Liquids)	19	5	(14)	(2.7E-02)	(0.7)	(240)
Pumps (Heavy Liquids)	-	-	-	-	-	-
Process Drains	74	18	(56)	(2.1E-02)	(0.5)	(181)
Total	12,204	2,828	(9,376)	(1.5E+00)	(36.0)	(13,140)

Table D-3.4 – Component Counts and Estimated Maximum Equipment Leak Emissions for S-1560

Component Type	Project Component Counts			Emissions (lbs)		
	Pre-Project	Post-Project	Net	Hourly	Daily	Annual
Valves:						
Gas / Vapor	54	54	-	-	-	-
Light Liquid	459	459	-	-	-	-
Heavy Liquid	202	202	-	-	-	-
Equipment:						
Connectors	1,633	1,633	-	-	-	-
Flanges	505	505	-	-	-	-
PSV's	35	35	-	-	-	-
Compressors	-	-	-	-	-	-
Pumps (Light Liquids)	8	8	-	-	-	-
Pumps (Heavy Liquids)	10	10	-	-	-	-
Process Drains	-	-	-	-	-	-
Total	2,906	2,906	-	-	-	-

Table D-3.5 – Component Counts and Estimated Maximum Equipment Leak Emissions for S-656, S-658

Component Type	Project Component Counts			Emissions (lbs)		
	Pre-Project	Post-Project	Net	Hourly	Daily	Annual
Valves:						
Gas / Vapor	407	284	(123)	(1.9E-02)	(0.5)	(168)
Light Liquid	503	351	(152)	(2.4E-02)	(0.6)	(208)
Heavy Liquid	-	-	-	-	-	-
Equipment:						
Connectors	1,389	968	(421)	(4.2E-02)	(1.0)	(369)
Flanges	622	434	(188)	(4.8E-02)	(1.2)	(425)
PSV's	10	7	(3)	(3.1E-03)	(0.1)	(27)
Compressors	4	3	(1)	(3.7E-04)	(0.0)	(3)
Pumps (Light Liquids)	7	5	(2)	(3.9E-03)	(0.1)	(34)
Pumps (Heavy Liquids)	-	-	-	-	-	-
Process Drains	63	44	(19)	(7.0E-03)	(0.2)	(61)
Total	3,005	2,096	(909)	(1.5E-01)	(3.5)	(1,296)

Table D-3.6 – Component Counts and Estimated Maximum Equipment Leak Emissions for S-55 (Plant #14629)

Component Type	Project Component Counts			Emissions (lbs)		
	Pre-Project	Post-Project	Net	Hourly	Daily	Annual
Valves:						
Gas / Vapor	-	-	-	-	-	-
Light Liquid	77	77	-	-	-	-
Heavy Liquid	34	34	-	-	-	-
Equipment:						
Connectors	132	132	-	-	-	-
Flanges	108	108	-	-	-	-
PSV's	10	10	-	-	-	-
Compressors	-	-	-	-	-	-
Pumps (Light Liquids)	-	-	-	-	-	-
Pumps (Heavy Liquids)	-	-	-	-	-	-
Process Drains	70	70	-	-	-	-
Total	431	431	-	-	-	-

Table D-3.7 – Component Counts and Estimated Maximum Equipment Leak Emissions for No. 1 Gas Plant (S-952, S-953, S-954)

Component Type	Project Component Counts			Emissions (lbs)		
	Pre-Project	Post-Project	Net	Hourly	Daily	Annual
Valves:						
Gas / Vapor	578	578	-	-	-	-
Light Liquid	112	112	-	-	-	-
Heavy Liquid	-	-	-	-	-	-
Equipment:						
Connectors	1,308	1,308	-	-	-	-
Flanges	800	800	-	-	-	-
PSV's	16	16	-	-	-	-
Compressors	12	12	-	-	-	-
Pumps (Light Liquids)	8	8	-	-	-	-
Pumps (Heavy Liquids)	-	-	-	-	-	-
Process Drains	48	48	-	-	-	-
Total	2,882	2,882	-	-	-	-

Table D-3.8 – Component Counts and Estimated Maximum Equipment Leak Emissions for S-1008

Component Type	Project Component Counts			Emissions (lbs)		
	Pre-Project	Post-Project	Net	Hourly	Daily	Annual
Valves:						
Gas / Vapor	1,566	1,693	127	2.0E-02	0.5	174
Light Liquid	99	108	9	1.4E-03	0.0	12
Heavy Liquid	47	51	4	6.2E-04	0.0	5
Equipment:						
Connectors	3,235	3,498	263	2.6E-02	0.6	230
Flanges	1,334	1,443	109	2.8E-02	0.7	246
PSV's	28	31	3	3.1E-03	0.1	27
Compressors	13	15	2	7.4E-04	0.0	6
Pumps (Light Liquids)	4	5	1	2.0E-03	0.0	17
Pumps (Heavy Liquids)	3	4	1	2.0E-03	0.0	17
Process Drains	115	125	10	3.7E-03	0.1	32
Total	6,444	6,973	529	8.8E-02	2.1	768

Table D-3.9 – Component Counts and Estimated Maximum Equipment Leak Emissions for S-1007

Component Type	Project Component Counts			Emissions (lbs)		
	Pre-Project	Post-Project	Net	Hourly	Daily	Annual
Valves:						
Gas / Vapor	1,824	1,481	(343)	(5.4E-02)	(1.3)	(469)
Light Liquid	1,031	837	(194)	(3.0E-02)	(0.7)	(265)
Heavy Liquid	485	394	(91)	(1.4E-02)	(0.3)	(124)
Equipment:						
Connectors	7,132	5,789	(1,343)	(1.3E-01)	(3.2)	(1,177)
Flanges	2,179	1,769	(410)	(1.1E-01)	(2.5)	(926)
PSV's	16	13	(3)	(3.1E-03)	(0.1)	(27)
Compressors	3	3	-	-	-	-
Pumps (Light Liquids)	27	22	(5)	(9.8E-03)	(0.2)	(86)
Pumps (Heavy Liquids)	22	18	(4)	(7.8E-03)	(0.2)	(69)
Process Drains	-	-	-	-	-	-
Total	12,719	10,326	(2,393)	(3.6E-01)	(8.6)	(3,143)

Table D-3.10 – Component Counts and Estimated Maximum Equipment Leak Emissions for S-1025

Component Type	Project Component Counts			Emissions (lbs)		
	Pre-Project	Post-Project	Net	Hourly	Daily	Annual
Valves:						
Gas / Vapor	2	2	-	-	-	-
Light Liquid	935	935	-	-	-	-
Heavy Liquid	-	-	-	-	-	-
Equipment:						
Connectors	2,510	2,510	-	-	-	-
Flanges	856	856	-	-	-	-
PSV's	19	19	-	-	-	-
Compressors	-	-	-	-	-	-
Pumps (Light Liquids)	34	34	-	-	-	-
Pumps (Heavy Liquids)	-	-	-	-	-	-
Process Drains	-	-	-	-	-	-
Total	4,356	4,356	-	-	-	-

Table D-3.11 – Component Counts and Estimated Maximum Equipment Leak Emissions for S-850

Component Type	Project Component Counts			Emissions (lbs)		
	Pre-Project	Post-Project	Net	Hourly	Daily	Annual
Valves:						
Gas / Vapor	1,633	1,338	(295)	(4.6E-02)	(1.1)	(403)
Light Liquid	735	603	(132)	(2.1E-02)	(0.5)	(180)
Heavy Liquid	581	476	(105)	(1.6E-02)	(0.4)	(144)
Equipment:						
Connectors	11,377	9,319	(2,058)	(2.1E-01)	(4.9)	(1,803)
Flanges	2,251	1,844	(407)	(1.0E-01)	(2.5)	(919)
PSV's	34	28	(6)	(6.2E-03)	(0.1)	(54)
Compressors	6	5	(1)	(3.7E-04)	(0.0)	(3)
Pumps (Light Liquids)	8	7	(1)	(2.0E-03)	(0.0)	(17)
Pumps (Heavy Liquids)	11	10	(1)	(2.0E-03)	(0.0)	(17)
Process Drains	173	142	(31)	(1.1E-02)	(0.3)	(100)
Total	16,809	13,772	(3,037)	(4.2E-01)	(10.0)	(3,642)

Table D-3.12 – Component Counts and Estimated Maximum Equipment Leak Emissions for S-1510

Component Type	Project Component Counts			Emissions (lbs)		
	Pre-Project	Post-Project	Net	Hourly	Daily	Annual
Valves:						
Gas / Vapor	2,200	1,100	(1,100)	(1.7E-01)	(4.1)	(1,504)
Light Liquid	618	309	(309)	(4.8E-02)	(1.2)	(422)
Heavy Liquid	501	251	(250)	(3.9E-02)	(0.9)	(342)
Equipment:						
Connectors	18,343	9,172	(9,171)	(9.2E-01)	(22.0)	(8,034)
Flanges	3,020	1,510	(1,510)	(3.9E-01)	(9.3)	(3,411)
PSV's	11	6	(5)	(5.2E-03)	(0.1)	(45)
Compressors	-	-	-	-	-	-
Pumps (Light Liquids)	11	6	(5)	(9.8E-03)	(0.2)	(86)
Pumps (Heavy Liquids)	18	9	(9)	(1.8E-02)	(0.4)	(155)
Process Drains	433	217	(216)	(8.0E-02)	(1.9)	(697)
Total	25,155	12,580	(12,575)	(1.7E+00)	(40.3)	(14,697)

Table D-3.13 – Component Counts and Estimated Maximum Equipment Leak Emissions for S-2025

Component Type	Project Component Counts			Emissions (lbs)		
	Pre-Project	Post-Project	Net	Hourly	Daily	Annual
Valves:						
Gas / Vapor	-	-	-	-	-	-
Light Liquid	-	-	-	-	-	-
Heavy Liquid	-	400	400	6.2E-02	1.5	547
Equipment:						
Connectors*	-	-	-	-	-	-
Flanges*	-	1,400	1,400	3.6E-01	8.7	3,163
PSV's	-	-	-	-	-	-
Compressors	-	-	-	-	-	-
Pumps (Light Liquids)	-	-	-	-	-	-
Pumps (Heavy Liquids)	-	10	10	2.0E-02	0.5	172
Process Drains	-	-	-	-	-	-
Total	-	1,810	1,810	4.4E-01	10.6	3,881

*For conservatism, component counts for connectors are included in flanges.

Table D-3.14 – Component Counts and Estimated Maximum Equipment Leak Emissions for S-2001

Component Type	Project Component Counts			Emissions (lbs)		
	Pre-Project	Post-Project	Net	Hourly	Daily	Annual
Valves:						
Gas / Vapor	-	-	-	-	-	-
Light Liquid	-	100	100	1.6E-02	0.4	137
Heavy Liquid	-	300	300	4.7E-02	1.1	410
Equipment:						
Connectors*	-	-	-	-	-	-
Flanges*	-	1,400	1,400	3.6E-01	8.7	3,163
PSV's	-	-	-	-	-	-
Compressors	-	-	-	-	-	-
Pumps (Light Liquids)	-	2	2	3.9E-03	0.1	34
Pumps (Heavy Liquids)	-	6	6	1.2E-02	0.3	103
Process Drains	-	-	-	-	-	-
Total	-	1,808	1,808	4.4E-01	10.5	3,847

*For conservatism, component counts for connectors are included in flanges.

Table D-3.15 – Component Counts and Estimated Maximum Equipment Leak Emissions for S-2009

Component Type	Project Component Counts			Emissions (lbs)		
	Pre-Project	Post-Project	Net	Hourly	Daily	Annual
Valves:						
Gas / Vapor	-	-	-	-	-	-
Light Liquid	-	-	-	-	-	-
Heavy Liquid	-	60	60	1.1E-08	0.0	0
Equipment:		-	-			
Connectors	-	230	230	2.3E-02	0.6	201
Flanges	-	-	-	-	-	-
PSV's	-	2	2	2.1E-03	0.0	18
Compressors	-	-	-	-	-	-
Pumps (Light Liquids)	-	-	-	-	-	-
Pumps (Heavy Liquids)	-	2	2	3.9E-03	0.1	34
Process Drains	-	22	22	8.1E-03	0.2	71
Total	-	316	316	3.7E-02	0.9	325

Table D-4.1 – Toxic Air Contaminant Hourly Emissions Increase/Decrease (lbs/hour)

Pollutant	S-1526 (A003)	S-1003 (A004)	S-1002 (A005)	S-1560 (A015)	S-1600 (A018)	S-55 (A026)	S-952, S-953, S-954 (A034)	S-1008 (A067)	S-1007 (A068)	S-1025 (A071)	S-850 (A076)	S-1510 (A102)	S-2025 (PRE)	S-2001 (STG1)
Ammonia	-1.2E-03	-1.2E-05	-1.9E-04	-1.4E-05	-3.8E-04	0.0E+00	-8.7E-04	5.8E-05	-2.6E-05	0.0E+00	6.9E-06	-6.3E-04	0.0E+00	0.0E+00
Benzene	-4.5E-03	4.0E-05	-7.8E-03	-2.4E-03	-8.5E-04	-1.4E-04	-9.6E-04	-5.3E-04	-1.8E-02	-1.0E-02	-1.3E-02	-1.8E-02	0.0E+00	0.0E+00
Biphenyl	0.0E+00	0.0E+00	0.0E+00	0.0E+00	0.0E+00	0.0E+00	0.0E+00	0.0E+00	0.0E+00	0.0E+00	0.0E+00	0.0E+00	0.0E+00	0.0E+00
1,2,4-Trimethylbenzene	-9.5E-03	-8.6E-03	-7.5E-03	-2.3E-03	-5.4E-07	-1.5E-05	-4.3E-05	-5.9E-04	-4.8E-04	-2.6E-02	-2.2E-03	-2.0E-03	0.0E+00	0.0E+00
1,3-Butadiene	0.0E+00	0.0E+00	0.0E+00	-2.9E-05	0.0E+00	-1.1E-05	0.0E+00	0.0E+00	-7.5E-06	0.0E+00	0.0E+00	0.0E+00	0.0E+00	0.0E+00
2,2,4-Trimethylpentane	-1.0E-02	-3.9E-03	-3.6E-03	-4.5E-03	-7.0E-04	0.0E+00	-8.0E-03	-5.9E-04	-5.8E-04	-2.9E-02	-4.3E-04	-1.5E-03	0.0E+00	0.0E+00
Cresols (Mixed Isomers)	-1.6E-03	-1.1E-03	-1.1E-03	-1.4E-05	-3.9E-04	0.0E+00	-8.9E-04	3.8E-05	-3.2E-05	0.0E+00	-3.9E-04	-1.0E-03	0.0E+00	0.0E+00
Cumene	1.2E-03	5.7E-04	-8.0E-04	-2.1E-03	-6.5E-04	-5.1E-05	-3.8E-05	1.1E-03	1.6E-03	-1.3E-03	1.5E-03	-1.7E-03	0.0E+00	0.0E+00
Cyclohexane	1.6E-02	1.0E-02	8.2E-03	-2.0E-03	-3.0E-04	-4.5E-04	-9.1E-05	7.9E-03	-6.3E-03	-4.7E-03	8.0E-03	-2.9E-03	0.0E+00	0.0E+00
DEA	-6.9E-02	0.0E+00	0.0E+00	0.0E+00	0.0E+00	0.0E+00	0.0E+00	0.0E+00	0.0E+00	0.0E+00	0.0E+00	0.0E+00	0.0E+00	0.0E+00
Ethylbenzene	-3.8E-03	-1.0E-03	-2.1E-03	-2.8E-03	-4.4E-04	-1.4E-04	-2.8E-05	6.4E-04	-1.0E-03	-1.3E-02	1.1E-03	-1.2E-03	0.0E+00	0.0E+00
Ethylene	1.5E-05	1.0E-05	0.0E+00	0.0E+00	5.8E-05	0.0E+00	0.0E+00	7.4E-06	1.1E-05	0.0E+00	1.3E-05	1.1E-03	0.0E+00	0.0E+00
Ethylene Glycol	-1.4E-04	-1.9E-04	-3.4E-04	-1.5E-05	-7.2E-05	0.0E+00	-1.5E-04	-5.5E-04	-4.8E-04	0.0E+00	-8.1E-04	-1.9E-04	2.5E-05	2.4E-05
Hydrogen Sulfide	-3.0E-03	1.9E-05	-3.8E-04	-5.7E-04	-5.8E-04	0.0E+00	-1.0E-03	2.2E-05	-8.5E-05	-1.2E-04	3.9E-05	-1.0E-03	0.0E+00	0.0E+00
Methanol	0.0E+00	0.0E+00	0.0E+00	0.0E+00	0.0E+00	0.0E+00	0.0E+00	0.0E+00	0.0E+00	0.0E+00	0.0E+00	0.0E+00	4.8E-05	4.7E-05
Methyl Tert-Butyl Ether (MTBE)	0.0E+00	0.0E+00	0.0E+00	0.0E+00	0.0E+00	0.0E+00	0.0E+00	0.0E+00	0.0E+00	-4.9E-02	0.0E+00	0.0E+00	0.0E+00	0.0E+00
Naphthalene	-2.9E-03	-1.9E-03	-1.7E-03	-3.2E-04	-3.0E-06	-1.7E-05	-8.5E-06	-1.7E-04	-1.5E-04	-3.1E-03	-5.8E-04	-4.7E-04	0.0E+00	0.0E+00
n-Hexane	9.2E-02	4.5E-02	-2.8E-03	-4.0E-03	-5.4E-04	-8.1E-04	-4.2E-04	2.9E-02	-4.2E-02	-1.4E-02	1.7E-02	-4.1E-02	0.0E+00	0.0E+00
Phenol	-1.2E-03	-1.2E-05	-1.9E-04	-1.4E-05	-3.8E-04	0.0E+00	-8.7E-04	5.8E-05	-2.6E-05	0.0E+00	6.9E-06	-6.3E-04	0.0E+00	0.0E+00
Propylene	-1.2E-01	-4.3E-03	-5.8E-02	-2.2E-02	0.0E+00	-8.9E-06	0.0E+00	-7.8E-04	-3.3E-02	0.0E+00	0.0E+00	0.0E+00	0.0E+00	0.0E+00
Sodium Hydroxide	-4.1E-02	0.0E+00	-6.1E-03	0.0E+00	0.0E+00	0.0E+00	-3.3E-03	-1.5E-03	-1.5E-03	-2.9E-03	0.0E+00	0.0E+00	0.0E+00	0.0E+00
Sulfuric Acid	0.0E+00	0.0E+00	0.0E+00	0.0E+00	0.0E+00	0.0E+00	0.0E+00	0.0E+00	0.0E+00	0.0E+00	0.0E+00	0.0E+00	0.0E+00	0.0E+00
Toluene	-2.8E-02	-1.1E-02	-1.6E-02	-8.8E-03	-5.5E-04	-3.6E-04	-7.5E-05	-1.4E-04	-4.7E-02	-7.2E-02	-1.1E-03	-2.8E-03	2.9E-09	2.8E-09
Total Xylenes	-2.7E-02	-1.3E-02	-1.3E-02	-8.0E-03	-6.5E-04	-4.3E-04	-9.3E-04	-2.0E-04	-3.2E-03	-6.9E-02	-6.8E-04	-3.9E-03	0.0E+00	0.0E+00
Xylene (-m)	-1.2E-02	-6.4E-03	-5.9E-03	-3.4E-03	-1.4E-06	-1.3E-04	-1.8E-05	-7.9E-04	-1.5E-03	-3.5E-02	-1.1E-03	-9.0E-04	0.0E+00	0.0E+00
Xylene (-o)	-8.5E-03	-4.3E-03	-3.9E-03	-3.0E-03	-2.6E-04	-1.9E-04	-3.1E-05	-4.7E-04	-8.3E-04	-1.9E-02	-9.4E-04	-1.5E-03	0.0E+00	0.0E+00
Xylene (-p)	-9.2E-03	-1.8E-03	-3.3E-03	-1.6E-03	-9.1E-07	-1.0E-04	-1.8E-05	-3.8E-04	-9.0E-04	-1.5E-02	-1.0E-03	-8.9E-04	0.0E+00	0.0E+00

Table D-4.2 – Toxic Air Contaminant Annual Emissions Increase/Decrease (lbs/year)

Pollutant	S-1526 (A003)	S-1003 (A004)	S-1002 (A005)	S-1560 (A015)	S-1600 (A018)	S-55 (A026)	S-952, S-953, S-954 (A034)	S-1008 (A067)	S-1007 (A068)	S-1025 (A071)	S-850 (A076)	S-1510 (A102)	S-2025 (PRE)	S-2001 (STG1)
Ammonia	-1.1E+01	-1.0E-01	-1.7E+00	-1.2E-01	-3.4E+00	0.0E+00	-7.6E+00	5.0E-01	-2.2E-01	0.0E+00	6.1E-02	-5.5E+00	0.0E+00	0.0E+00
Benzene	-3.9E+01	3.5E-01	-6.8E+01	-2.1E+01	-7.5E+00	-1.2E+00	-8.4E+00	-4.7E+00	-1.6E+02	-9.1E+01	-1.2E+02	-1.6E+02	0.0E+00	0.0E+00
Biphenyl	0.0E+00	0.0E+00	0.0E+00	0.0E+00	0.0E+00	0.0E+00	0.0E+00	0.0E+00	0.0E+00	0.0E+00	0.0E+00	0.0E+00	0.0E+00	0.0E+00
1,2,4-Trimethylbenzene	-8.3E+01	-7.6E+01	-6.6E+01	-2.0E+01	-4.7E-03	-1.3E-01	-3.8E-01	-5.2E+00	-4.2E+00	-2.2E+02	-1.9E+01	-1.7E+01	0.0E+00	0.0E+00
1,3-Butadiene	0.0E+00	0.0E+00	0.0E+00	-2.6E-01	0.0E+00	-9.4E-02	0.0E+00	0.0E+00	-6.5E-02	0.0E+00	0.0E+00	0.0E+00	0.0E+00	0.0E+00
2,2,4-Trimethylpentane	-8.9E+01	-3.4E+01	-3.1E+01	-4.0E+01	-6.1E+00	0.0E+00	-7.0E+01	-5.2E+00	-5.1E+00	-2.5E+02	-3.7E+00	-1.3E+01	0.0E+00	0.0E+00
Cresols (Mixed Isomers)	-1.4E+01	-9.7E+00	-9.5E+00	-1.2E-01	-3.4E+00	0.0E+00	-7.8E+00	3.4E-01	-2.8E-01	0.0E+00	-3.4E+00	-8.8E+00	0.0E+00	0.0E+00
Cumene	1.1E+01	5.0E+00	-7.0E+00	-1.9E+01	-5.7E+00	-4.5E-01	-3.3E-01	9.4E+00	1.4E+01	-1.1E+01	1.3E+01	-1.5E+01	0.0E+00	0.0E+00
Cyclohexane	1.4E+02	8.8E+01	7.2E+01	-1.8E+01	-2.6E+00	-4.0E+00	-8.0E-01	6.9E+01	-5.5E+01	-4.1E+01	7.0E+01	-2.5E+01	0.0E+00	0.0E+00
DEA	-6.0E+02	0.0E+00	0.0E+00	0.0E+00	0.0E+00	0.0E+00	0.0E+00	0.0E+00	0.0E+00	0.0E+00	0.0E+00	0.0E+00	0.0E+00	0.0E+00
Ethylbenzene	-3.3E+01	-8.9E+00	-1.9E+01	-2.4E+01	-3.8E+00	-1.2E+00	-2.4E-01	5.6E+00	-9.0E+00	-1.1E+02	9.4E+00	-1.1E+01	0.0E+00	0.0E+00
Ethylene	1.4E-01	8.8E-02	0.0E+00	0.0E+00	5.1E-01	0.0E+00	0.0E+00	6.5E-02	9.5E-02	0.0E+00	1.1E-01	9.7E+00	0.0E+00	0.0E+00
Ethylene Glycol	-1.2E+00	-1.7E+00	-3.0E+00	-1.3E-01	-6.3E-01	0.0E+00	-1.3E+00	-4.8E+00	-4.2E+00	0.0E+00	-7.1E+00	-1.7E+00	2.2E-01	2.1E-01
Hydrogen Sulfide	-2.6E+01	1.7E-01	-3.3E+00	-5.0E+00	-5.1E+00	0.0E+00	-8.9E+00	1.9E-01	-7.4E-01	-1.0E+00	3.4E-01	-9.1E+00	0.0E+00	0.0E+00
Methanol	0.0E+00	0.0E+00	0.0E+00	0.0E+00	0.0E+00	0.0E+00	0.0E+00	0.0E+00	0.0E+00	0.0E+00	0.0E+00	0.0E+00	4.2E-01	4.1E-01
Methyl Tert-Butyl Ether (MTBE)	0.0E+00	0.0E+00	0.0E+00	0.0E+00	0.0E+00	0.0E+00	0.0E+00	0.0E+00	0.0E+00	-4.3E+02	0.0E+00	0.0E+00	0.0E+00	0.0E+00
Naphthalene	-2.5E+01	-1.7E+01	-1.5E+01	-2.8E+00	-2.6E-02	-1.5E-01	-7.5E-02	-1.5E+00	-1.3E+00	-2.7E+01	-5.1E+00	-4.1E+00	0.0E+00	0.0E+00
n-Hexane	8.1E+02	3.9E+02	-2.5E+01	-3.5E+01	-4.7E+00	-7.1E+00	-3.6E+00	2.5E+02	-3.7E+02	-1.2E+02	1.5E+02	-3.6E+02	0.0E+00	0.0E+00
Phenol	-1.1E+01	-1.0E-01	-1.7E+00	-1.2E-01	-3.4E+00	0.0E+00	-7.6E+00	5.0E-01	-2.2E-01	0.0E+00	6.1E-02	-5.5E+00	0.0E+00	0.0E+00
Propylene	-1.0E+03	-3.7E+01	-5.1E+02	-2.0E+02	0.0E+00	-7.8E-02	0.0E+00	-6.8E+00	-2.9E+02	0.0E+00	0.0E+00	0.0E+00	0.0E+00	0.0E+00
Sodium Hydroxide	-3.6E+02	0.0E+00	-5.4E+01	0.0E+00	0.0E+00	0.0E+00	-2.9E+01	-1.3E+01	-1.3E+01	-2.5E+01	0.0E+00	0.0E+00	0.0E+00	0.0E+00
Sulfuric Acid	0.0E+00	0.0E+00	0.0E+00	0.0E+00	0.0E+00	0.0E+00	0.0E+00	0.0E+00	0.0E+00	0.0E+00	0.0E+00	0.0E+00	0.0E+00	0.0E+00
Toluene	-2.4E+02	-9.2E+01	-1.4E+02	-7.7E+01	-4.9E+00	-3.1E+00	-6.6E-01	-1.3E+00	-4.1E+02	-6.3E+02	-9.5E+00	-2.5E+01	2.5E-05	2.5E-05
Total Xylenes	-2.4E+02	-1.1E+02	-1.2E+02	-7.0E+01	-5.7E+00	-3.8E+00	-8.2E+00	-1.8E+00	-2.8E+01	-6.0E+02	-5.9E+00	-3.4E+01	0.0E+00	0.0E+00
Xylene (-m)	-1.1E+02	-5.6E+01	-5.2E+01	-3.0E+01	-1.3E-02	-1.2E+00	-1.6E-01	-6.9E+00	-1.3E+01	-3.0E+02	-9.3E+00	-7.9E+00	0.0E+00	0.0E+00
Xylene (-o)	-7.5E+01	-3.8E+01	-3.4E+01	-2.6E+01	-2.3E+00	-1.7E+00	-2.7E-01	-4.2E+00	-7.3E+00	-1.7E+02	-8.2E+00	-1.3E+01	0.0E+00	0.0E+00
Xylene (-p)	-8.0E+01	-1.6E+01	-2.9E+01	-1.4E+01	-8.0E-03	-9.1E-01	-1.5E-01	-3.3E+00	-7.9E+00	-1.3E+02	-9.1E+00	-7.8E+00	0.0E+00	0.0E+00

Table D-4.3 – Review of Emissions Increase Above Regulation 2, Rule 5 Thresholds

Pollutant	S-1526 (A003)	S-1003 (A004)	S-1002 (A005)	S-1560 (A015)	S-1600 (A018)	S-55 (A026)	S-952, S-953, S-954 (A034)	S-1008 (A067)	S-1007 (A068)	S-1025 (A071)	S-850 (A076)	S-1510 (A102)	S-2025 (PRE)	S-2001 (STG1)
Ammonia	No	No	No	No	No	No	No	No	No	No	No	No	No	No
Benzene	No	No	No	No	No	No	No	No	No	No	No	No	No	No
Biphenyl	No	No	No	No	No	No	No	No	No	No	No	No	No	No
1,2,4-Trimethylbenzene	No	No	No	No	No	No	No	No	No	No	No	No	No	No
1,3-Butadiene	No	No	No	No	No	No	No	No	No	No	No	No	No	No
2,2,4-Trimethylpentane	No	No	No	No	No	No	No	No	No	No	No	No	No	No
Cresols (Mixed Isomers)	No	No	No	No	No	No	No	No	No	No	No	No	No	No
Cumene	No	No	No	No	No	No	No	No	No	No	No	No	No	No
Cyclohexane	No	No	No	No	No	No	No	No	No	No	No	No	No	No
DEA	No	No	No	No	No	No	No	No	No	No	No	No	No	No
Ethylbenzene	No	No	No	No	No	No	No	No	No	No	No	No	No	No
Ethylene	No	No	No	No	No	No	No	No	No	No	No	No	No	No
Ethylene Glycol	No	No	No	No	No	No	No	No	No	No	No	No	No	No
Hydrogen Sulfide	No	No	No	No	No	No	No	No	No	No	No	No	No	No
Methanol	No	No	No	No	No	No	No	No	No	No	No	No	No	No
Methyl Tert-Butyl Ether (MTBE)	No	No	No	No	No	No	No	No	No	No	No	No	No	No
Naphthalene	No	No	No	No	No	No	No	No	No	No	No	No	No	No
n-Hexane	No	No	No	No	No	No	No	No	No	No	No	No	No	No
Phenol	No	No	No	No	No	No	No	No	No	No	No	No	No	No
Propylene	No	No	No	No	No	No	No	No	No	No	No	No	No	No
Sodium Hydroxide	No	No	No	No	No	No	No	No	No	No	No	No	No	No
Sulfuric Acid	No	No	No	No	No	No	No	No	No	No	No	No	No	No
Toluene	No	No	No	No	No	No	No	No	No	No	No	No	No	No
Total Xylenes	No	No	No	No	No	No	No	No	No	No	No	No	No	No
Xylene (-m)	No	No	No	No	No	No	No	No	No	No	No	No	No	No
Xylene (-o)	No	No	No	No	No	No	No	No	No	No	No	No	No	No
Xylene (-p)	No	No	No	No	No	No	No	No	No	No	No	No	No	No

Table D-4.4 – Review of Emissions Increase Above Regulation 2, Rule 5 Thresholds

Pollutant	S-1526 (A003)	S-1003 (A004)	S-1002 (A005)	S-1560 (A015)	S-1600 (A018)	S-55 (A026)	S-952, S-953, S-954 (A034)	S-1008 (A067)	S-1007 (A068)	S-1025 (A071)	S-850 (A076)	S-1510 (A102)	S-2025 (PRE)	S-2001 (STG1)
Ammonia	No	No	No	No	No	No	No	No	No	No	No	No	No	No
Benzene	No	No	No	No	No	No	No	No	No	No	No	No	No	No
Biphenyl	No	No	No	No	No	No	No	No	No	No	No	No	No	No
1,2,4-Trimethylbenzene	No	No	No	No	No	No	No	No	No	No	No	No	No	No
1,3-Butadiene	No	No	No	No	No	No	No	No	No	No	No	No	No	No
2,2,4-Trimethylpentane	No	No	No	No	No	No	No	No	No	No	No	No	No	No
Cresols (Mixed Isomers)	No	No	No	No	No	No	No	No	No	No	No	No	No	No
Cumene	No	No	No	No	No	No	No	No	No	No	No	No	No	No
Cyclohexane	No	No	No	No	No	No	No	No	No	No	No	No	No	No
DEA	No	No	No	No	No	No	No	No	No	No	No	No	No	No
Ethylbenzene	No	No	No	No	No	No	No	No	No	No	No	No	No	No
Ethylene	No	No	No	No	No	No	No	No	No	No	No	No	No	No
Ethylene Glycol	No	No	No	No	No	No	No	No	No	No	No	No	No	No
Hydrogen Sulfide	No	No	No	No	No	No	No	No	No	No	No	No	No	No
Methanol	No	No	No	No	No	No	No	No	No	No	No	No	No	No
Methyl Tert-Butyl Ether (MTBE)	No	No	No	No	No	No	No	No	No	No	No	No	No	No
Naphthalene	No	No	No	No	No	No	No	No	No	No	No	No	No	No
n-Hexane	No	No	No	No	No	No	No	No	No	No	No	No	No	No
Phenol	No	No	No	No	No	No	No	No	No	No	No	No	No	No
Propylene	No	No	No	No	No	No	No	No	No	No	No	No	No	No
Sodium Hydroxide	No	No	No	No	No	No	No	No	No	No	No	No	No	No
Sulfuric Acid	No	No	No	No	No	No	No	No	No	No	No	No	No	No
Toluene	No	No	No	No	No	No	No	No	No	No	No	No	No	No
Total Xylenes	No	No	No	No	No	No	No	No	No	No	No	No	No	No
Xylene (-m)	No	No	No	No	No	No	No	No	No	No	No	No	No	No
Xylene (-o)	No	No	No	No	No	No	No	No	No	No	No	No	No	No
Xylene (-p)	No	No	No	No	No	No	No	No	No	No	No	No	No	No

Table D-5 – New and Replaced Component Counts and Estimated Maximum Equipment Leak Emissions from Renewable Fuels Project

Component Type	New/Replaced Component Counts	Emissions (lbs)		
		Hourly	Daily	Annual
Valves:				
Gas / Vapor	1,283	2.0E-01	4.8	1,754
Light Liquid	879	1.4E-01	3.3	1,202
Heavy Liquid	1,026	1.6E-01	3.8	1,403
Equipment:				
Connectors	5,078	5.1E-01	12.2	4,449
Flanges	4,569	1.2E+00	28.3	10,322
PSV's	28	2.9E-02	0.7	254
Compressors	10	3.7E-03	0.1	32
Pumps (Light Liquids)	21	4.1E-02	1.0	361
Pumps (Heavy Liquids)	29	5.7E-02	1.4	498
Process Drains	86	3.2E-02	0.8	278
Total	13,009	2.3E+00	56.3	20,552

Emissions from loading operations are estimated using the methodology and equation presenting in EPA AP-42, Chapter 5.2:

$$L_L = 12.46 \frac{SPM}{T}\left(1 - \frac{eff}{100}\right)$$

where,

L_L = loading loss (lbs/10^3 gal) of liquid loaded

S = saturation factor

P = true vapor pressure of liquid loaded (psia)

M = molecular weight of vapors (lb/lb-mole)

T = temperature of bulk liquid loaded (°R, °F + 460)

Eff = Overall Efficiency = Control Efficiency x Collection Efficiency)

Table E-1 – Emissions Calculation for Loading Operations

Source No.	Material	Potential Loading (bbl/day)	Potential Loading (bbl/year)	S	P (psia)	MW (lb/lb-mol)	T (°F)	L_L (lbs/10^3 gal)	Control Eff.	Collection Eff.	Controlled EF (lbs/10^3 gal)	Daily Emissions (lbs/day)	Annual Emissions (lbs/year)	Annual Emissions (tons/year)
55 (Plant #14629)	Renewable Diesel	124,800	9,855,000	0.5	0.012	130	80	0.018	0.0%	0.0%	0.018	94.3	7,449	3.725
1025	Gasoline	12,500	4,562,500	1	9.9	66	80	15.1	99.5%	99.2%	0.04[a]	21.0	7,665	3.833
1025	Petroleum Diesel	3,000	1,095,000	1	0.012	130	80	0.04	99.5%	98.7%	0.00065	0.1	30	0.015
1025	Renewable Diesel	3,000	1,095,000	1	0.012	130	80	0.04	99.5%	98.7%	0.00065	0.1	30	0.015
1560	Renewable Naphtha	55,200	365,000	0.5	4.900	81.3	80	4.596	98.5%[b]		0.069	159.8	1,057	0.528
1560	Renewable Diesel	192,000	29,635,000	0.5	0.012	130	80	0.018	0.0%[c]		0.018	145.1	22,401	11.201

[a] Emission factor for gasoline calculated from AP-42 is greater than the emission factor allowed in Permit Condition 21849, Parts 9 and 11 and emission limit of 0.04 lbs/10^3 gal per Regulation 8, Rule 33; therefore, the more stringent emission factor of 0.04 lbs/10^3 gal is used.

[b] Overall Efficiency of 98.5% is used to be consistent with Application 27990, which determined that the BACT requirement of 98.5% capture and control efficiency provides a conservative emissions estimate for not only the furnace destruction efficiency (expected to exceed 99.5% per Permit Condition #13605, Part 3), but also the capture system emissions at the berth, the pipeline to the No. 1 Gas Plant, and any losses at the gas compression, the fuel gas treating, and the fuel gas distribution system to the furnaces.

[c] Renewable diesel is not a regulated organic liquid per Regulation 8, Rule 44; therefore, controls are not required.

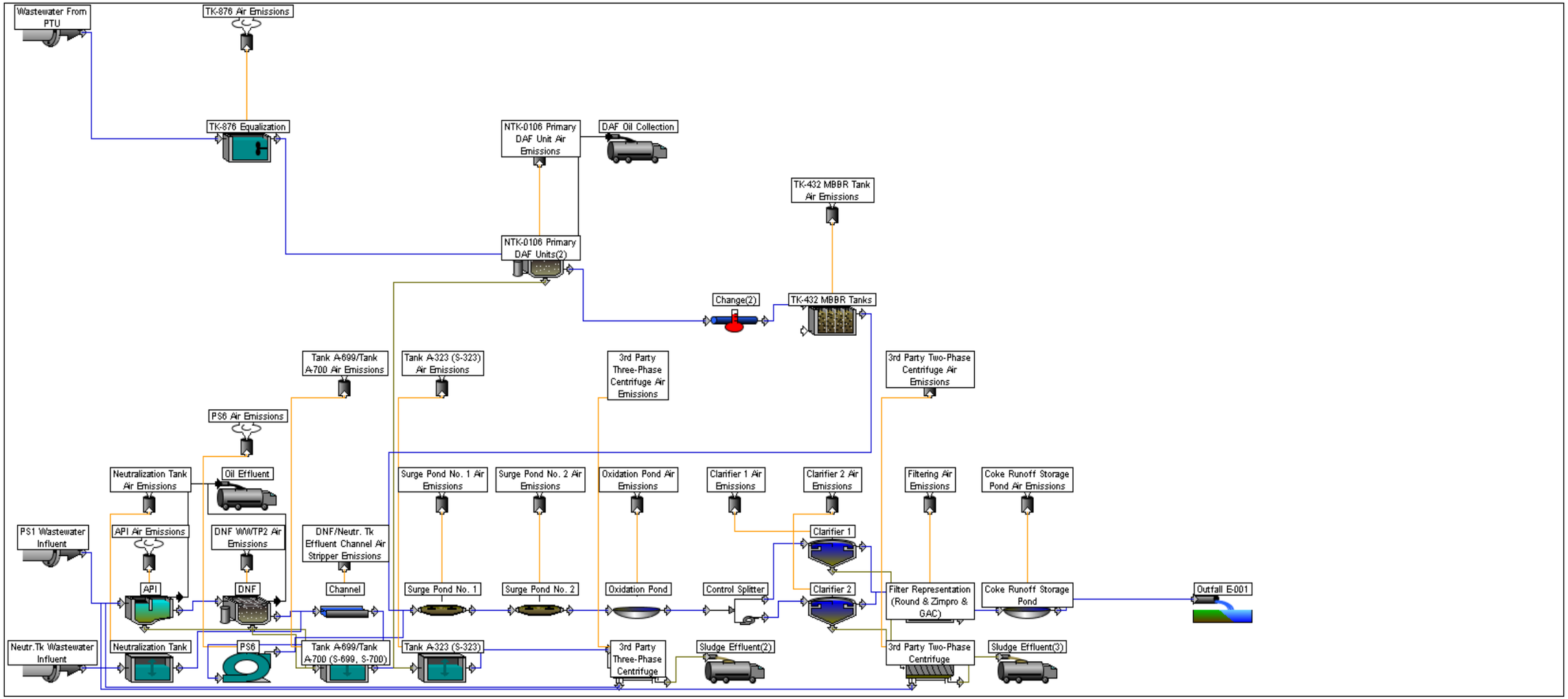

Figure F.1 – Overview and Layout of TOXCHEM Model

Table F-1 – Summary of Criteria Pollutants

		Pre-Project		Post-Project		Emissions Increase	
Source No.	**Description**	**POC Emissions (lbs/day)**	**POC Emissions (lbs/year)**	**POC Emissions (lbs/day)**	**POC Emissions (lbs/year)**	**POC Emissions (lbs/day)**	**POC Emissions (lbs/year)**
Existing Sources							
819	API Oil-Water, Separator/Dissolved Nitrogen Flotation System, Abated by A-39 Thermal Oxidizer or A-14 Vapor Recovery	1.9E-02	6	1.9E-02	6	0.0	0
830	Wastewater Surge Ponds	46.1	5,428	43.4	4,769	0.0	0
831	Bio-Oxidation Pond Open Pond	4.2	144	3.3	122	0.0	0
842	Wastewater Treatment Plant Clarifiers, filters, and granular activated carbon	0.6	13	3.9E-01	10	0.0	0
1026	DNF Effluent Air Stripper, Abated by A-39 Thermal Oxidizer	10.7	1,660	4.8	1,257	0.0	0
2010	Tank A-876, FRT, Stage 1 WWTP, Equalization Tank (formerly S-1496)	0	0	7.3	2,675	7.3	2,675
2013	Tank A-432, Open-Top, Moving Bed Biofilm Reactor (formerly S-432)	0	0	85.5	26,105	85.5	26,105
Plant #21432 (S-1)	3rd Party Three-Phase Centrifuge	4.0E-02	15	1.7E-03	5E-01	0.0	0
Plant #21432 (S-19)	3rd Party Two-Phase Centrifuge	0.1	40	3.6E-09	1E-06	0.0	0
New Sources							
2003	DAF Unit	0.0	0	0.3	122	0.3	122
New Sources [Exempt]							
2016	Neutralization Tank T-796	0.0	0	5.8	2,115	5.8	2,115
2017	Neutralization Tank T-797	0.0	0	5.8	2,115	5.8	2,115

Notes:
1. Maximum daily POC emissions are calculated based on maximum pump rate (bbl/hr) and operating 24 hours/day, unless stated otherwise.
2. S-819 and S-1026 - Pre-Project emissions are calculated based on Toxchem analysis using highest throughput (11/29/2018).
3. S-830, S-831, S-842 – Pre-Project emissions are calculated based on Toxchem analysis using highest throughput (1/10/2017).
4. S-2010 and S-2013 – Sources are switching service from storage tanks to wastewater processing units; therefore, these are considered new sources.
5. Plant #21432, S-1 - Pre-project daily and annual emissions are from Application No. 10647.
6. Plant #21432, S-19 - Pre-project daily and annual emissions are from Application No. 18569.

Table F-2 – Baseline Toxic Air Contaminant Emissions (lbs/hour)

Source No.	S-2013	S-819	S-830	S-831	S-842	S-1026	S-2010	S-2003	S-2016	S-2017	P#21432 (S-1)	P#21432(S-19)
Caprylic Acid	-	-	-	-	-	-	-	-	-	-	-	-
Capric Acid	-	-	-	-	-	-	-	-	-	-	-	-
Lauric Acid	-	-	-	-	-	-	-	-	-	-	-	-
Myristic Acid	-	-	-	-	-	-	-	-	-	-	-	-
Palmitic Acid	-	-	-	-	-	-	-	-	-	-	-	-
Stearic Acid	-	-	-	-	-	-	-	-	-	-	-	-
Arachidic Acid	-	-	-	-	-	-	-	-	-	-	-	-
Behenic Acid	-	-	-	-	-	-	-	-	-	-	-	-
Lignoceric Acid	-	-	-	-	-	-	-	-	-	-	-	-
Oleic Acid	-	-	-	-	-	-	-	-	-	-	-	-
Linoleic Acid	-	-	-	-	-	-	-	-	-	-	-	-
alpha-Linoleic Acid	-	-	-	-	-	-	-	-	-	-	-	-
Toluene	-	2.1E-04	1.0E-01	8.2E-05	1.2E-05	3.9E-02	-	-	-	-	-	-
Ethanol	-	-	-	-	-	-	-	-	-	-	-	-
Methanol	-	-	-	-	-	-	-	-	-	-	-	-
Propylene Glycol	-	-	-	-	-	-	-	-	-	-	-	-
Ethylene Glycol Monopropyl Ether	-	-	-	-	-	-	-	-	-	-	-	-
Triethylene Glycol	-	-	-	-	-	-	-	-	-	-	-	-
Ethylene Glycol	-	-	-	-	-	-	-	-	-	-	-	-
Ammonia	-	6.3E-08	1.2E-03	5.8E-06	7.7E-07	3.6E-05	-	-	-	-	-	-
Aluminum	-	-	-	-	-	-	-	-	-	-	-	-
Cadium	-	-	-	-	-	-	-	-	-	-	-	-
Chromium	-	-	-	-	-	-	-	-	-	-	-	-
Copper	-	-	-	-	-	-	-	-	-	-	-	-
Lead	-	-	-	-	-	-	-	-	-	-	-	-
Nickel	-	-	-	-	-	-	-	-	-	-	-	-
Zinc	-	-	-	-	-	-	-	-	-	-	-	-
Benzene	-	8.2E-05	2.8E-02	5.7E-06	8.7E-07	6.8E-02	-	-	-	-	-	-
Ethylbenzene	-	4.0E-05	6.2E-03	5.0E-06	7.7E-07	1.0E-02	-	-	-	-	-	-
Xylene	-	1.5E-04	1.8E-01	5.4E-04	8.4E-05	2.3E-02	-	-	-	-	-	-
Naphthalene	-	7.9E-06	4.6E-02	1.5E-04	2.2E-05	8.8E-08	-	-	-	-	-	-
Phenanthrene	-	2.1E-07	5.0E-03	2.2E-03	3.1E-04	2.4E-04	-	-	-	-	-	-
Diethyl Phthalate	-	-	-	-	-	-	-	-	-	-	-	-
Cumene (Isopropylbenzene)	-	3.0E-05	1.4E-03	2.2E-06	3.4E-07	4.8E-05	-	-	-	-	-	-
Cyclohexane	-	4.9E-06	4.4E-06	7.0E-09	1.1E-09	2.3E-02	-	-	-	-	-	-
Diethanolamine	-	-	5.7E-08	2.4E-08	2.9E-09	-	-	-	-	-	-	-
Hexane(-N)	-	9.9E-05	8.4E-06	1.5E-08	2.3E-09	-	-	-	-	-	-	-
Trimethylbenzene,1,2,4-	-	4.9E-07	5.6E-04	1.9E-06	3.0E-07	2.3E-04	-	-	-	-	-	-
Hydrogen Sulfide	-	2.8E-04	8.2E-01	1.5E-03	3.0E-04	-	-	-	-	-	-	-
Acenaphthene	-	4.3E-07	5.3E-03	1.5E-04	2.1E-05	-	-	-	-	-	-	-
Chloroform (Trichloromethane)	-	8.0E-06	4.1E-02	1.6E-04	2.4E-05	3.7E-04	-	-	-	-	-	-
Cresol	-	3.1E-08	1.2E-04	2.5E-07	3.0E-08	4.2E-04	-	-	-	-	-	-
Dimethylphenol,2,4-	-	1.2E-04	1.0E-01	4.7E-05	7.0E-06	2.8E-01	-	-	-	-	-	-
Ethanolamine(Mono-)	-	1.3E-10	1.3E-04	6.1E-05	7.4E-06	-	-	-	-	-	-	-
Fluorene	-	2.7E-07	3.4E-03	2.2E-04	3.2E-05	-	-	-	-	-	-	-
Methyl Tert-Butyl Ether	-	3.5E-07	8.9E-03	2.3E-05	3.2E-06	5.4E-05	-	-	-	-	-	-
Methyl Chloride (Chloromethane)	-	4.6E-06	5.2E-03	4.1E-06	6.6E-07	1.0E-03	-	-	-	-	-	-
Methylnaphthalene,2-	-	2.5E-05	1.4E+00	1.7E-01	2.6E-02	-	-	-	-	-	-	-
Phenol	-	7.4E-08	3.9E-04	1.6E-06	1.9E-07	1.9E-04	-	-	-	-	-	-
Dichloropropene(1,3)	-	1.8E-06	6.6E-03	1.0E-05	1.5E-06	2.3E-04	-	-	-	-	-	-

Baseline emissions are from TOXCHEM, unless stated otherwise. Baseline for Plant #21432, S-1 and S-19 is conservatively assumed to be zero.

Table F-3 – Baseline Toxic Air Contaminant Emissions (lbs/year)

Source No.	S-2013	S-819	S-830	S-831	S-842	S-1026	S-2010	S-2003	S-2016	S-2017	P#21432 (S-1)	P#21432(S-19)
Caprylic Acid	-	-	-	-	-	-	-	-	-	-	-	-
Capric Acid	-	-	-	-	-	-	-	-	-	-	-	-
Lauric Acid	-	-	-	-	-	-	-	-	-	-	-	-
Myristic Acid	-	-	-	-	-	-	-	-	-	-	-	-
Palmitic Acid	-	-	-	-	-	-	-	-	-	-	-	-
Stearic Acid	-	-	-	-	-	-	-	-	-	-	-	-
Arachidic Acid	-	-	-	-	-	-	-	-	-	-	-	-
Behenic Acid	-	-	-	-	-	-	-	-	-	-	-	-
Lignoceric Acid	-	-	-	-	-	-	-	-	-	-	-	-
Oleic Acid	-	-	-	-	-	-	-	-	-	-	-	-
Linoleic Acid	-	-	-	-	-	-	-	-	-	-	-	-
alpha-Linoleic Acid	-	-	-	-	-	-	-	-	-	-	-	-
Toluene	-	1.7E+00	1.2E+02	1.7E-02	1.4E-03	2.9E+02	-	-	-	-	-	-
Ethanol	-	-	-	-	-	-	-	-	-	-	-	-
Methanol	-	-	-	-	-	3.8E-01	-	-	-	-	-	-
Propylene Glycol	-	-	-	-	-	-	-	-	-	-	-	-
Ethylene Glycol Monopropyl Ether	-	-	-	-	-	-	-	-	-	-	-	-
Triethylene Glycol	-	-	-	-	-	-	-	-	-	-	-	-
Ethylene Glycol	-	-	-	-	-	-	-	-	-	-	-	-
Ammonia	-	5.5E-04	3.8E+00	6.6E-03	7.8E-04	2.1E-01	-	-	-	-	-	-
Aluminum	-	-	-	-	-	-	-	-	-	-	-	-
Cadium	-	-	-	-	-	-	-	-	-	-	-	-
Chromium	-	-	-	-	-	-	-	-	-	-	-	-
Copper	-	-	-	-	-	-	-	-	-	-	-	-
Lead	-	-	-	-	-	-	-	-	-	-	-	-
Nickel	-	-	-	-	-	-	-	-	-	-	-	-
Zinc	-	-	-	-	-	-	-	-	-	-	-	-
Benzene	-	6.7E-01	3.8E+01	1.3E-03	1.1E-04	2.2E+02	-	-	-	-	-	-
Ethylbenzene	-	3.2E-01	5.8E+00	8.2E-04	7.0E-05	5.5E+01	-	-	-	-	-	-
Xylene	-	1.2E+00	2.5E+02	1.3E-01	1.1E-02	2.2E+02	-	-	-	-	-	-
Naphthalene	-	6.9E-02	1.4E+02	7.9E-02	6.7E-03	1.6E+01	-	-	-	-	-	-
Phenanthrene	-	1.8E-03	1.6E+01	1.5E+00	1.6E-01	1.0E+00	-	-	-	-	-	-
Diethyl Phthalate	-	-	-	-	-	-	-	-	-	-	-	-
Cumene (Isopropylbenzene)	-	2.3E-01	8.9E-01	2.3E-04	2.1E-05	1.9E+01	-	-	-	-	-	-
Cyclohexane	-	2.0E-02	2.1E-04	5.7E-08	4.7E-09	4.8E+01	-	-	-	-	-	-
Diethanolamine	-	-	2.0E-04	3.7E-05	4.3E-06	1.7E-07	-	-	-	-	-	-
Hexane(-N)	-	3.2E-01	3.1E-04	9.8E-08	8.2E-09	4.7E+00	-	-	-	-	-	-
Trimethylbenzene,1,2,4-	-	4.2E-03	1.2E+00	7.0E-04	6.3E-05	1.2E+00	-	-	-	-	-	-
Hydrogen Sulfide	-	2.3E+00	1.1E+03	4.0E-01	3.9E-02	3.2E+02	-	-	-	-	-	-
Acenaphthene	-	3.7E-03	1.6E+01	8.4E-02	7.8E-03	9.0E-01	-	-	-	-	-	-
Chloroform (Trichloromethane)	-	6.7E-02	6.4E+01	4.4E-02	3.6E-03	1.1E+01	-	-	-	-	-	-
Cresol	-	2.7E-04	3.7E-01	2.2E-04	2.5E-05	8.1E-01	-	-	-	-	-	-
Dimethylphenol,2,4-	-	1.0E+00	1.9E+02	1.4E-02	1.2E-03	7.0E+02	-	-	-	-	-	-
Ethanolamine(Mono-)	-	1.2E-06	4.6E-01	9.5E-02	1.1E-02	3.1E-04	-	-	-	-	-	-
Fluorene	-	2.4E-03	1.1E+01	1.3E-01	1.3E-02	5.8E-01	-	-	-	-	-	-
Methyl Tert-Butyl Ether	-	3.1E-03	2.6E+01	1.1E-02	9.2E-04	8.4E-01	-	-	-	-	-	-
Methyl Chloride (Chloromethane)	-	3.7E-02	4.6E+00	6.2E-04	4.9E-05	5.9E+00	-	-	-	-	-	-
Methylnaphthalene,2-	-	2.2E-01	4.5E+03	1.4E+02	1.3E+01	5.1E+01	-	-	-	-	-	-
Phenol	-	6.4E-04	1.2E+00	1.4E-03	1.6E-04	5.0E-01	-	-	-	-	-	-
Dichloropropene(1,3)	-	1.5E-02	1.2E+01	3.1E-03	2.5E-04	2.9E+00	-	-	-	-	-	-

Baseline emissions are from TOXCHEM, unless stated otherwise. Baseline for Plant #21432, S-1 and S-19 is conservatively assumed to be zero.

Table F-4 – Post-Project Toxic Air Contaminant Emissions from TOXCHEM (Maximum Daily at 600 gpm – lbs/day)

Source No.	S-2013	S-819	S-830	S-831	S-842	S-1026	S-2010	S-2003	S-2016	S-2017	P#21432 (S-1)	P#21432(S-19)
Control Efficiency (%)	0	95	0	0	0	95	0	0	0	0	0	0
Caprylic Acid	-	-	-	-	-	-	-	-	-	-	-	-
Capric Acid	2.1E-02	7.5E-09	3.3E-03	3.5E-05	5.3E-06	5.1E-06	2.2E-04	2.8E-05	-	-	7.2E-08	-
Lauric Acid	5.3E-02	1.9E-08	7.9E-03	8.4E-05	1.3E-05	1.3E-05	5.3E-04	7.0E-05	-	-	1.8E-07	-
Myristic Acid	7.0E-01	2.5E-07	1.0E-01	1.1E-03	1.6E-04	1.7E-04	6.9E-03	9.3E-04	-	-	2.4E-06	-
Palmitic Acid	3.8E+00	1.3E-06	5.3E-01	5.8E-03	8.6E-04	9.1E-04	3.6E-02	5.0E-03	-	-	1.3E-05	-
Stearic Acid	2.9E+00	1.0E-06	3.9E-01	4.4E-03	6.4E-04	7.0E-04	2.7E-02	3.8E-03	-	-	9.8E-06	-
Arachidic Acid	-	-	-	-	-	-	-	-	-	-	-	-
Behenic Acid	-	-	-	-	-	-	-	-	-	-	-	-
Lignoceric Acid	-	-	-	-	-	-	-	-	-	-	-	-
Oleic Acid	1.4E+01	4.8E-06	1.9E+00	2.1E-02	3.0E-03	3.3E-03	1.3E-01	1.8E-02	-	-	4.6E-05	2.6E-10
Linoleic Acid	4.3E-01	1.5E-07	5.9E-02	6.5E-04	9.5E-05	1.0E-04	4.0E-03	5.6E-04	-	-	1.4E-06	-
alpha-Linoleic Acid	1.3E-01	4.6E-08	1.8E-02	2.0E-04	2.9E-05	3.1E-05	1.2E-03	1.7E-04	-	-	4.4E-07	-
Toluene	3.8E-02	4.9E-03	1.6E+00	1.0E-03	1.4E-04	1.1E+00	1.4E-03	3.4E-04	2.6E-01	2.6E-01	2.1E-04	-
Ethanol	4.7E+01	4.2E-06	1.8E+00	2.9E-02	3.3E-03	2.2E-03	5.0E+00	2.1E-01	-	-	2.7E-04	-
Methanol	7.0E+00	1.4E-06	4.6E-02	1.4E-04	1.6E-05	7.5E-04	1.8E+00	7.2E-02	-	-	9.3E-05	-
Propylene Glycol	8.4E+00	2.3E-07	4.0E+00	9.8E-01	6.1E-02	1.2E-04	3.0E-01	1.2E-02	-	-	1.5E-05	1.6E-10
Ethylene Glycol Monopropyl Ether	1.6E-01	9.0E-09	2.3E-02	2.3E-03	2.8E-04	4.7E-06	1.0E-02	3.9E-04	-	-	5.4E-07	-
Triethylene Glycol	1.5E-01	1.2E-08	2.3E-02	2.2E-03	2.7E-04	6.7E-06	8.9E-03	3.3E-04	-	-	5.5E-07	-
Ethylene Glycol	1.2E-02	2.8E-10	9.2E-03	4.0E-03	4.8E-04	1.5E-07	3.8E-04	1.4E-05	-	-	1.8E-08	-
Ammonia	4.7E-03	1.5E-06	2.3E-02	9.1E-05	1.2E-05	5.7E-04	1.5E-03	6.3E-05	1.0E-04	1.0E-04	2.3E-07	-
Aluminum	-	-	-	-	-	-	-	-	-	-	-	-
Cadmium	-	-	-	-	-	-	-	-	-	-	-	-
Chromium	-	-	-	-	-	-	-	-	-	-	-	-
Copper	-	-	-	-	-	-	-	-	-	-	-	-
Lead	-	-	-	-	-	-	-	-	-	-	-	-
Nickel	-	-	-	-	-	-	-	-	-	-	-	-
Zinc	-	-	-	-	-	-	-	-	-	-	-	-
Benzene	1.6E-01	2.0E-03	5.8E-01	8.8E-05	1.2E-05	6.1E-01	1.3E-02	2.7E-03	4.2E-01	4.2E-01	1.0E-04	-
Ethylbenzene	1.9E-01	9.6E-04	1.0E-01	6.9E-05	9.7E-06	2.1E-01	3.9E-03	3.3E-03	7.9E-02	7.9E-02	7.0E-05	-
Xylene	8.2E-01	3.6E-03	2.9E+00	7.3E-03	1.0E-03	8.8E-01	1.8E-02	1.0E-02	1.3E-01	1.3E-01	2.4E-04	-
Naphthalene	3.9E-02	1.9E-04	8.0E-01	2.3E-03	3.1E-04	6.0E-02	9.8E-04	9.4E-05	2.7E-07	2.7E-07	1.1E-05	-
Phenanthrene	4.7E-04	5.0E-06	1.3E-01	2.5E-02	3.2E-03	2.2E-03	1.1E-05	5.7E-07	6.8E-04	6.8E-04	2.0E-07	-
Diethyl Phthalate	1.3E-04	1.4E-11	1.4E-05	5.7E-07	6.9E-08	8.5E-09	5.4E-06	2.1E-07	-	-	4.1E-10	-
Cumene (Isopropylbenzene)	-	7.3E-04	2.0E-02	2.4E-05	3.6E-06	1.1E-01	-	-	5.0E-04	5.0E-04	3.9E-05	-
Cyclohexane	-	1.2E-04	1.1E-03	1.4E-06	1.9E-07	9.0E-02	-	-	3.6E+00	3.6E+00	1.6E-06	-
Diethanolamine	-	-	1.0E-06	3.6E-07	4.4E-08	5.9E-10	-	-	-	-	-	-
Hexane(-N)	-	2.4E-03	5.9E-05	8.7E-08	1.1E-08	3.1E-02	-	-	-	-	9.8E-06	-
Trimethylbenzene,1,2,4-	-	1.2E-05	1.1E-02	2.9E-05	4.3E-06	3.8E-03	-	-	9.2E-04	9.2E-04	6.5E-07	-
Hydrogen Sulfide	-	6.7E-03	1.2E+01	1.7E-02	2.7E-03	1.5E+00	-	-	-	-	4.4E-04	-
Acenaphthene	-	1.0E-05	9.5E-02	1.9E-03	2.7E-04	3.3E-03	-	-	-	-	5.1E-07	-
Chloroform (Trichloromethane)	-	1.9E-04	6.4E-01	1.8E-03	2.4E-04	4.7E-02	-	-	2.1E-03	2.1E-03	1.5E-05	-
Cresol	-	7.4E-07	8.0E-03	1.3E-05	1.6E-06	9.8E-04	-	-	1.2E-03	1.2E-03	7.1E-08	-
Dimethylphenol,2,4-	-	3.0E-03	3.0E+00	1.1E-03	1.4E-04	1.4E+00	-	-	1.3E+00	1.3E+00	2.4E-05	-
Ethanolamine(Mono-)	-	3.2E-09	2.4E-03	9.2E-04	1.1E-04	1.1E-06	-	-	-	-	3.2E-10	-
Fluorene	-	6.6E-06	6.3E-02	2.5E-03	3.4E-04	2.1E-03	-	-	-	-	2.9E-07	-
Methyl Tert-Butyl Ether	-	8.5E-06	1.6E-01	3.0E-04	3.7E-05	2.8E-03	-	-	1.7E-04	1.7E-04	6.9E-07	-
Methyl Chloride (Chloromethane)	-	1.1E-04	8.0E-02	4.5E-05	6.2E-06	2.3E-02	-	-	9.0E-03	9.0E-03	5.5E-06	-
Methylnaphthalene,2-	-	6.0E-04	2.4E+01	2.2E+00	3.1E-01	1.9E-01	-	-	-	-	3.1E-05	3.2E-09
Phenol	-	1.8E-06	1.0E-02	3.3E-05	4.0E-06	9.2E-04	-	-	5.2E-04	5.2E-04	1.6E-07	-
Dichloropropene(1,3)	-	4.3E-05	1.1E-01	1.2E-04	1.6E-05	1.1E-02	-	-	1.1E-03	1.1E-03	3.1E-06	-
Total POC (lbs/day)	8.5E+01	1.9E-02	4.3E+01	3.3E+00	3.9E-01	4.8E+00	7.3E+00	3.4E-01	5.8E+00	5.8E+00	1.2E-03	3.6E-09

Table F-5 – Post-Project Toxic Air Contaminant Emissions from TOXCHEM (Maximum Annual at 450 gpm – lbs/day)

Source No.	S-2013	S-819	S-830	S-831	S-842	S-1026	S-2010	S-2003	S-2016	S-2017	P#21432 (S-1)	P#21432(S-19)
Control Efficiency (%)	0	95	0	0	0	95	0	0	0	0	0	0
Caprylic Acid	-	-	-	-	-	-	-	-	-	-	-	-
Capric Acid	2.1E-02	6.7E-08	2.5E-03	7.5E-06	9.1E-07	2.6E-05	2.2E-04	2.8E-05	-	-	4.8E-08	-
Lauric Acid	5.2E-02	1.7E-07	5.9E-03	1.8E-05	2.2E-06	6.4E-05	5.3E-04	7.0E-05	-	-	1.2E-07	-
Myristic Acid	6.9E-01	2.2E-06	7.6E-02	2.4E-04	2.9E-05	8.5E-04	6.9E-03	9.3E-04	-	-	1.6E-06	-
Palmitic Acid	3.8E+00	1.2E-05	4.0E-01	1.3E-03	1.5E-04	4.6E-03	3.6E-02	5.0E-03	-	-	8.5E-06	-
Stearic Acid	2.9E+00	9.1E-06	3.0E-01	9.4E-04	1.1E-04	3.5E-03	2.7E-02	3.8E-03	-	-	6.5E-06	-
Arachidic Acid	-	-	-	-	-	-	-	-	-	-	-	-
Behenic Acid	-	-	-	-	-	-	-	-	-	-	-	-
Lignoceric Acid	-	-	-	-	-	-	-	-	-	-	-	-
Oleic Acid	1.3E+01	4.3E-05	1.4E+00	4.5E-03	5.4E-04	1.7E-02	1.3E-01	1.8E-02	-	-	3.1E-05	1.6E-10
Linoleic Acid	4.2E-01	1.3E-06	4.4E-02	1.4E-04	1.7E-05	5.2E-04	4.0E-03	5.6E-04	-	-	9.6E-07	-
alpha-Linoleic Acid	1.3E-01	4.1E-07	1.4E-02	4.3E-05	5.2E-06	1.6E-04	1.2E-03	1.7E-04	-	-	2.9E-07	-
Toluene	2.8E-02	4.5E-03	8.3E-02	8.2E-06	6.6E-07	5.3E-01	1.4E-03	3.4E-04	2.6E-01	2.6E-01	2.0E-04	-
Ethanol	3.6E+01	1.5E-05	9.7E-01	2.4E-03	2.1E-04	5.1E-03	5.0E+00	2.1E-01	-	-	1.7E-04	-
Methanol	5.3E+00	5.3E-06	2.8E-02	1.2E-05	1.1E-06	1.7E-03	1.8E+00	7.2E-02	-	-	5.8E-05	-
Propylene Glycol	7.4E+00	8.6E-07	2.8E+00	1.6E-01	8.9E-03	2.8E-04	3.0E-01	1.2E-02	-	-	9.4E-06	-
Ethylene Glycol Monopropyl Ether	1.4E-01	3.4E-08	1.4E-02	3.5E-04	4.0E-05	1.1E-05	1.0E-02	3.9E-04	-	-	3.4E-07	-
Triethylene Glycol	1.3E-01	5.6E-08	1.5E-02	4.4E-04	5.2E-05	2.0E-05	8.9E-03	3.3E-04	-	-	3.5E-07	-
Ethylene Glycol	1.1E-02	1.0E-09	6.8E-03	1.1E-03	1.3E-04	3.4E-07	3.8E-04	1.4E-05	-	-	1.1E-08	-
Ammonia	3.5E-03	1.5E-06	7.3E-03	8.2E-06	9.6E-07	5.7E-04	1.5E-03	6.3E-05	1.0E-04	1.0E-04	1.7E-07	-
Aluminum	-	-	-	-	-	-	-	-	-	-	-	-
Cadmium	-	-	-	-	-	-	-	-	-	-	-	-
Chromium	-	-	-	-	-	-	-	-	-	-	-	-
Copper	-	-	-	-	-	-	-	-	-	-	-	-
Lead	-	-	-	-	-	-	-	-	-	-	-	-
Nickel	-	-	-	-	-	-	-	-	-	-	-	-
Zinc	-	-	-	-	-	-	-	-	-	-	-	-
Benzene	1.1E-01	1.8E-03	5.3E-02	1.1E-06	7.7E-08	4.5E-01	1.3E-02	2.7E-03	4.2E-01	4.2E-01	9.2E-05	-
Ethylbenzene	1.4E-01	8.4E-04	4.3E-03	5.0E-07	4.6E-08	9.8E-02	3.9E-03	3.3E-03	7.9E-02	7.9E-02	6.1E-05	-
Xylene	6.2E-01	3.3E-03	1.9E-01	8.6E-05	7.8E-06	4.1E-01	1.8E-02	1.0E-02	1.3E-01	1.3E-01	2.1E-04	-
Naphthalene	3.4E-02	1.9E-04	1.6E-01	8.6E-05	8.3E-06	3.9E-02	9.8E-04	9.3E-05	2.7E-07	2.7E-07	1.0E-05	-
Phenanthrene	4.6E-04	4.8E-06	6.1E-02	3.4E-03	4.0E-04	2.5E-03	1.1E-05	5.7E-07	6.8E-04	6.8E-04	1.9E-07	-
Diethyl Phthalate	1.1E-04	8.1E-11	9.2E-06	1.2E-07	1.4E-08	3.1E-08	5.4E-06	2.1E-07	-	-	2.7E-10	-
Cumene (Isopropylbenzene)	-	6.0E-04	3.6E-04	8.8E-08	9.3E-09	3.2E-02	-	-	5.0E-04	5.0E-04	3.6E-05	-
Cyclohexane	-	4.8E-05	1.6E-06	3.0E-10	-	8.8E-02	-	-	3.6E+00	3.6E+00	1.5E-06	-
Diethanolamine	-	-	2.5E-07	3.2E-08	3.6E-09	4.3E-10	-	-	-	-	-	-
Hexane(-N)	-	7.5E-04	1.4E-08	-	-	6.6E-03	-	-	-	-	1.0E-05	-
Trimethylbenzene,1,2,4-	-	1.1E-05	1.9E-03	1.0E-06	1.1E-07	2.7E-03	-	-	9.2E-04	9.2E-04	5.9E-07	-
Hydrogen Sulfide	-	6.3E-03	5.7E-01	1.0E-04	8.3E-06	5.5E-01	-	-	-	-	3.8E-04	-
Acenaphthene	-	1.0E-05	2.2E-02	1.0E-04	1.1E-05	2.2E-03	-	-	-	-	4.7E-07	-
Chloroform (Trichloromethane)	-	1.8E-04	3.9E-02	1.5E-05	1.1E-06	2.0E-02	-	-	2.1E-03	2.1E-03	1.3E-05	-
Cresol	-	7.4E-07	6.5E-03	2.3E-06	2.4E-07	2.6E-03	-	-	1.2E-03	1.2E-03	5.9E-08	-
Dimethylphenol,2,4-	-	2.8E-03	6.2E-01	3.1E-05	2.4E-06	1.6E+00	-	-	1.3E+00	1.3E+00	2.9E-05	-
Ethanolamine(Mono-)	-	3.3E-09	5.8E-04	8.3E-05	9.7E-06	7.9E-07	-	-	-	-	2.6E-10	-
Fluorene	-	6.4E-06	1.6E-02	1.6E-04	1.8E-05	1.4E-03	-	-	-	-	2.8E-07	-
Methyl Tert-Butyl Ether	-	8.5E-06	3.3E-02	8.1E-06	5.7E-07	2.0E-03	-	-	1.7E-04	1.7E-04	5.9E-07	-
Methyl Chloride (Chloromethane)	-	1.0E-04	2.5E-03	1.7E-07	1.1E-08	1.0E-02	-	-	9.0E-03	9.0E-03	5.0E-06	-
Methylnaphthalene,2-	-	5.8E-04	5.7E+00	1.6E-01	1.7E-02	1.2E-01	-	-	-	-	2.8E-05	2.5E-09
Phenol	-	1.8E-06	5.3E-03	3.8E-06	4.1E-07	1.5E-03	-	-	5.2E-04	5.2E-04	1.3E-07	-
Dichloropropene(1,3)	-	4.0E-05	9.3E-03	1.4E-06	9.8E-08	5.6E-03	-	-	1.1E-03	1.1E-03	2.7E-06	-
Total POC (lbs/day)	7.2E+01	1.6E-02	1.3E+01	3.3E-01	2.8E-02	3.4E+00	7.3E+00	3.4E-01	5.8E+00	5.8E+00	9.9E-04	2.6E-09
Total POC (lbs/year)	2.6E+04	5.8E+00	4.8E+03	1.2E+02	1.0E+01	1.3E+03	2.7E+03	1.2E+02	2.1E+03	2.1E+03	3.6E-01	9.6E-07

Table F-6 – Summary of Toxic Air Contaminant Emissions Increase (lbs/hour)

Source No.	S-2013	S-819	S-830	S-831	S-842	S-1026	S-2010	S-2003	S-2016	S-2017	P#21432 (S-1)	P#21432(S-19)
Caprylic Acid	-	-	-	-	-	-	-	-	-	-	-	-
Capric Acid	8.8E-04	3.1E-10	1.4E-04	1.5E-06	2.2E-07	2.1E-07	9.3E-06	1.2E-06	-	-	3.0E-09	-
Lauric Acid	2.2E-03	7.7E-10	3.3E-04	3.5E-06	5.2E-07	5.3E-07	2.2E-05	2.9E-06	-	-	7.4E-09	-
Myristic Acid	2.9E-02	1.0E-08	4.2E-03	4.6E-05	6.8E-06	7.0E-06	2.9E-04	3.9E-05	-	-	9.9E-08	-
Palmitic Acid	1.6E-01	5.6E-08	2.2E-02	2.4E-04	3.6E-05	3.8E-05	1.5E-03	2.1E-04	-	-	5.3E-07	-
Stearic Acid	1.2E-01	4.2E-08	1.6E-02	1.8E-04	2.7E-05	2.9E-05	1.1E-03	1.6E-04	-	-	4.1E-07	-
Arachidic Acid	-	-	-	-	-	-	-	-	-	-	-	-
Behenic Acid	-	-	-	-	-	-	-	-	-	-	-	-
Lignoceric Acid	-	-	-	-	-	-	-	-	-	-	-	-
Oleic Acid	5.7E-01	2.0E-07	7.8E-02	8.6E-04	1.3E-04	1.4E-04	5.4E-03	7.5E-04	-	-	1.9E-06	1.1E-11
Linoleic Acid	1.8E-02	6.3E-09	2.4E-03	2.7E-05	4.0E-06	4.3E-06	1.7E-04	2.4E-05	-	-	6.0E-08	-
alpha-Linoleic Acid	5.5E-03	1.9E-09	7.5E-04	8.3E-06	1.2E-06	1.3E-06	5.1E-05	7.2E-06	-	-	1.8E-08	-
Toluene	1.6E-03	4.2E-08	(3.3E-02)	(3.8E-05)	(6.5E-06)	8.3E-03	6.0E-05	1.4E-05	1.1E-02	1.1E-02	8.9E-06	-
Ethanol	1.9E+00	1.7E-07	7.3E-02	1.2E-03	1.4E-04	9.0E-05	2.1E-01	8.6E-03	-	-	1.1E-05	-
Methanol	2.9E-01	6.0E-08	1.9E-03	5.8E-06	6.5E-07	3.1E-05	7.4E-02	3.0E-03	-	-	3.9E-06	-
Propylene Glycol	3.5E-01	9.7E-09	1.7E-01	4.1E-02	2.5E-03	5.0E-06	1.2E-02	4.8E-04	-	-	6.3E-07	6.5E-12
Ethylene Glycol Monopropyl Ether	6.9E-03	3.7E-10	9.8E-04	9.8E-05	1.2E-05	2.0E-07	4.2E-04	1.6E-05	-	-	2.3E-08	-
Triethylene Glycol	6.5E-03	5.1E-10	9.6E-04	9.1E-05	1.1E-05	2.8E-07	3.7E-04	1.4E-05	-	-	2.3E-08	-
Ethylene Glycol	5.1E-04	1.1E-11	3.8E-04	1.6E-04	2.0E-05	6.1E-09	1.6E-05	5.8E-07	-	-	7.5E-10	-
Ammonia	2.0E-04	1.7E-10	(2.3E-04)	(2.0E-06)	(2.9E-07)	(1.2E-05)	6.4E-05	2.6E-06	4.2E-06	4.2E-06	9.6E-09	-
Aluminum	-	-	-	-	-	-	-	-	-	-	-	-
Cadium	-	-	-	-	-	-	-	-	-	-	-	-
Chromium	-	-	-	-	-	-	-	-	-	-	-	-
Copper	-	-	-	-	-	-	-	-	-	-	-	-
Lead	-	-	-	-	-	-	-	-	-	-	-	-
Nickel	-	-	-	-	-	-	-	-	-	-	-	-
Zinc	-	-	-	-	-	-	-	-	-	-	-	-
Benzene	6.5E-03	6.1E-08	(4.0E-03)	(2.0E-06)	(3.8E-07)	(4.2E-02)	5.4E-04	1.1E-04	1.7E-02	1.7E-02	4.2E-06	-
Ethylbenzene	7.8E-03	5.3E-08	(1.9E-03)	(2.2E-06)	(3.7E-07)	(1.4E-03)	1.6E-04	1.4E-04	3.3E-03	3.3E-03	2.9E-06	-
Xylene	3.4E-02	1.4E-07	(5.6E-02)	(2.4E-04)	(4.0E-05)	1.4E-02	7.5E-04	4.2E-04	5.4E-03	5.4E-03	1.0E-05	-
Naphthalene	1.6E-03	6.2E-09	(1.3E-02)	(6.1E-05)	(9.4E-06)	2.5E-03	4.1E-05	3.9E-06	1.1E-08	1.1E-08	4.7E-07	-
Phenanthrene	2.0E-05	(6.9E-10)	3.8E-04	(1.1E-03)	(1.8E-04)	(1.5E-04)	4.7E-07	2.4E-08	2.8E-05	2.8E-05	8.1E-09	-
Diethyl Phthalate	5.3E-06	5.9E-13	5.8E-07	2.4E-08	2.9E-09	3.5E-10	2.3E-07	8.6E-09	-	-	1.7E-11	-
Cumene (Isopropylbenzene)	-	(2.6E-08)	(6.1E-04)	(1.2E-06)	(1.9E-07)	4.5E-03	-	-	2.1E-05	2.1E-05	1.6E-06	-
Cyclohexane	-	(9.9E-09)	4.3E-05	5.2E-08	7.0E-09	(2.0E-02)	-	-	1.5E-01	1.5E-01	6.5E-08	-
Diethanolamine	-	-	(1.5E-08)	(8.9E-09)	(1.1E-09)	2.5E-11	-	-	-	-	-	-
Hexane(-N)	-	(3.7E-07)	(6.0E-06)	(1.2E-08)	(1.8E-09)	1.3E-03	-	-	-	-	4.1E-07	-
Trimethylbenzene,1,2,4-	-	2.6E-11	(1.1E-04)	(6.9E-07)	(1.2E-07)	(7.1E-05)	-	-	3.8E-05	3.8E-05	2.7E-08	-
Hydrogen Sulfide	-	4.4E-07	(3.1E-01)	(8.3E-04)	(1.8E-04)	6.2E-02	-	-	-	-	1.8E-05	-
Acenaphthene	-	(2.7E-10)	(1.3E-03)	(7.0E-05)	(1.0E-05)	1.4E-04	-	-	-	-	2.1E-08	-
Chloroform (Trichloromethane)	-	1.7E-08	(1.5E-02)	(8.0E-05)	(1.4E-05)	1.6E-03	-	-	8.6E-05	8.6E-05	6.2E-07	-
Cresol	-	5.8E-11	2.2E-04	3.0E-07	3.5E-08	(3.8E-04)	-	-	4.8E-05	4.8E-05	3.0E-09	-
Dimethylphenol,2,4-	-	(5.6E-07)	2.1E-02	(2.6E-06)	(1.1E-06)	(2.2E-01)	-	-	5.6E-02	5.6E-02	1.0E-06	-
Ethanolamine(Mono-)	-	2.6E-13	(3.5E-05)	(2.2E-05)	(2.8E-06)	4.6E-08	-	-	-	-	1.3E-11	-
Fluorene	-	(4.7E-10)	(7.7E-04)	(1.2E-04)	(1.8E-05)	8.9E-05	-	-	-	-	1.2E-08	-
Methyl Tert-Butyl Ether	-	6.1E-10	(2.4E-03)	(1.0E-05)	(1.7E-06)	6.2E-05	-	-	7.0E-06	7.0E-06	2.9E-08	-
Methyl Chloride (Chloromethane)	-	6.6E-09	(1.8E-03)	(2.2E-06)	(4.0E-07)	(7.1E-05)	-	-	3.8E-04	3.8E-04	2.3E-07	-
Methylnaphthalene,2-	-	(1.1E-08)	(3.7E-01)	(8.2E-02)	(1.3E-02)	7.8E-03	-	-	-	-	1.3E-06	1.3E-10
Phenol	-	1.3E-10	4.5E-05	(1.8E-07)	(2.4E-08)	(1.5E-04)	-	-	2.1E-05	2.1E-05	6.5E-09	-
Dichloropropene(1,3)	-	2.8E-09	(2.1E-03)	(5.0E-06)	(8.5E-07)	2.4E-04	-	-	4.6E-05	4.6E-05	1.3E-07	-

Table F-7 – Summary of Toxic Air Contaminant Emissions Increase (lbs/year)

Source No.	S-2013	S-819	S-830	S-831	S-842	S-1026	S-2010	S-2003	S-2016	S-2017	P#21432 (S-1)	P#21432(S-19)
Caprylic Acid	-	-	-	-	-	-	-	-	-	-	-	-
Capric Acid	7.5E+00	2.4E-05	9.1E-01	2.7E-03	3.3E-04	9.4E-03	8.1E-02	1.0E-02	-	-	1.7E-05	-
Lauric Acid	1.9E+01	6.1E-05	2.2E+00	6.5E-03	8.0E-04	2.3E-02	1.9E-01	2.5E-02	-	-	4.3E-05	-
Myristic Acid	2.5E+02	8.1E-04	2.8E+01	8.6E-02	1.0E-02	3.1E-01	2.5E+00	3.4E-01	-	-	5.7E-04	-
Palmitic Acid	1.4E+03	4.4E-03	1.5E+02	4.6E-01	5.6E-02	1.7E+00	1.3E+01	1.8E+00	-	-	3.1E-03	-
Stearic Acid	1.0E+03	3.3E-03	1.1E+02	3.4E-01	4.2E-02	1.3E+00	9.8E+00	1.4E+00	-	-	2.4E-03	-
Arachidic Acid	-	-	-	-	-	-	-	-	-	-	-	-
Behenic Acid	-	-	-	-	-	-	-	-	-	-	-	-
Lignoceric Acid	-	-	-	-	-	-	-	-	-	-	-	-
Oleic Acid	4.9E+03	1.6E-02	5.2E+02	1.6E+00	2.0E-01	6.0E+00	4.7E+01	6.6E+00	-	-	1.1E-02	5.7E-08
Linoleic Acid	1.5E+02	4.9E-04	1.6E+01	5.1E-02	6.2E-03	1.9E-01	1.5E+00	2.1E-01	-	-	3.5E-04	-
alpha-Linoleic Acid	4.7E+01	1.5E-04	5.0E+00	1.6E-02	1.9E-03	5.8E-02	4.5E-01	6.3E-02	-	-	1.1E-04	-
Toluene	1.0E+01	(3.3E-02)	(9.0E+01)	(1.4E-02)	(1.2E-03)	(9.9E+01)	5.2E-01	1.2E-01	9.6E+01	9.6E+01	7.3E-02	-
Ethanol	1.3E+04	5.6E-03	3.5E+02	8.7E-01	7.8E-02	1.8E+00	1.8E+03	7.5E+01	-	-	6.1E-02	-
Methanol	1.9E+03	1.9E-03	1.0E+01	4.5E-03	4.0E-04	2.6E-01	6.5E+02	2.6E+01	-	-	2.1E-02	-
Propylene Glycol	2.7E+03	3.1E-04	1.0E+03	5.9E+01	3.3E+00	1.0E-01	1.1E+02	4.2E+00	-	-	3.4E-03	-
Ethylene Glycol Monopropyl Ether	5.0E+01	1.2E-05	5.1E+00	1.3E-01	1.4E-02	4.1E-03	3.7E+00	1.4E-01	-	-	1.2E-04	-
Triethylene Glycol	4.9E+01	2.0E-05	5.3E+00	1.6E-01	1.9E-02	7.2E-03	3.2E+00	1.2E-01	-	-	1.3E-04	-
Ethylene Glycol	4.1E+00	3.7E-07	2.5E+00	4.0E-01	4.6E-02	1.2E-04	1.4E-01	5.1E-03	-	-	4.1E-06	-
Ammonia	1.3E+00	5.8E-06	(1.2E+00)	(3.6E-03)	(4.3E-04)	(2.5E-04)	5.6E-01	2.3E-02	3.7E-02	3.7E-02	6.4E-05	-
Aluminum	-	-	-	-	-	-	-	-	-	-	-	-
Cadium	-	-	-	-	-	-	-	-	-	-	-	-
Chromium	-	-	-	-	-	-	-	-	-	-	-	-
Copper	-	-	-	-	-	-	-	-	-	-	-	-
Lead	-	-	-	-	-	-	-	-	-	-	-	-
Nickel	-	-	-	-	-	-	-	-	-	-	-	-
Zinc	-	-	-	-	-	-	-	-	-	-	-	-
Benzene	4.2E+01	(9.9E-03)	(1.9E+01)	(9.0E-04)	(7.7E-05)	(6.0E+01)	4.6E+00	9.7E-01	1.5E+02	1.5E+02	3.3E-02	-
Ethylbenzene	5.1E+01	(7.4E-03)	(4.3E+00)	(6.4E-04)	(5.3E-05)	(1.9E+01)	1.4E+00	1.2E+00	2.9E+01	2.9E+01	2.2E-02	-
Xylene	2.3E+02	(2.1E-02)	(1.8E+02)	(1.0E-01)	(8.4E-03)	(7.0E+01)	6.5E+00	3.6E+00	4.8E+01	4.8E+01	7.7E-02	-
Naphthalene	1.2E+01	(3.8E-04)	(7.7E+01)	(4.7E-02)	(3.7E-03)	(2.1E+00)	3.6E-01	3.4E-02	9.8E-05	9.8E-05	3.7E-03	-
Phenanthrene	1.7E-01	(8.6E-05)	5.7E+00	(2.2E-01)	(2.0E-02)	(1.1E-01)	4.1E-03	2.1E-04	2.5E-01	2.5E-01	6.9E-05	-
Diethyl Phthalate	4.2E-02	3.0E-08	3.4E-03	4.4E-05	5.1E-06	1.1E-05	2.0E-03	7.5E-05	-	-	1.0E-07	-
Cumene (Isopropylbenzene)	-	(1.1E-02)	(7.6E-01)	(2.0E-04)	(1.8E-05)	(7.8E+00)	-	-	1.8E-01	1.8E-01	1.3E-02	-
Cyclohexane	-	(2.6E-03)	3.9E-04	5.2E-08	(4.7E-09)	(1.5E+01)	-	-	1.3E+03	1.3E+03	5.6E-04	-
Diethanolamine	-	-	(1.1E-04)	(2.5E-05)	(3.0E-06)	(1.4E-08)	-	-	-	-	-	-
Hexane(-N)	-	(4.6E-02)	(3.0E-04)	(9.8E-08)	(8.2E-09)	(2.3E+00)	-	-	-	-	3.8E-03	-
Trimethylbenzene,1,2,4-	-	(7.8E-05)	(5.0E-01)	(3.3E-04)	(2.4E-05)	(2.3E-01)	-	-	3.4E-01	3.4E-01	2.2E-04	-
Hydrogen Sulfide	-	(4.5E-02)	(9.3E+02)	(3.6E-01)	(3.6E-02)	(1.2E+02)	-	-	-	-	1.4E-01	-
Acenaphthene	-	(7.4E-05)	(8.4E+00)	(4.7E-02)	(3.7E-03)	(9.5E-02)	-	-	-	-	1.7E-04	-
Chloroform (Trichloromethane)	-	(5.0E-04)	(5.0E+01)	(3.8E-02)	(3.2E-03)	(3.6E+00)	-	-	7.5E-01	7.5E-01	4.7E-03	-
Cresol	-	2.0E-06	2.0E+00	6.0E-04	6.4E-05	1.2E-01	-	-	4.2E-01	4.2E-01	2.2E-05	-
Dimethylphenol,2,4-	-	(2.8E-02)	4.0E+01	(3.0E-03)	(3.3E-04)	(1.2E+02)	-	-	4.9E+02	4.9E+02	1.1E-02	-
Ethanolamine(Mono-)	-	8.6E-09	(2.5E-01)	(6.5E-02)	(7.7E-03)	(2.6E-05)	-	-	-	-	9.6E-08	-
Fluorene	-	(7.4E-05)	(5.0E+00)	(7.4E-02)	(6.5E-03)	(5.5E-02)	-	-	-	-	1.0E-04	-
Methyl Tert-Butyl Ether	-	1.3E-05	(1.4E+01)	(8.5E-03)	(7.2E-04)	(9.2E-02)	-	-	6.2E-02	6.2E-02	2.2E-04	-
Methyl Chloride (Chloromethane)	-	(8.0E-04)	(3.7E+00)	(5.5E-04)	(4.5E-05)	(2.2E+00)	-	-	3.3E+00	3.3E+00	1.8E-03	-
Methylnaphthalene,2-	-	(4.0E-03)	(2.5E+03)	(8.5E+01)	(6.8E+00)	(6.3E+00)	-	-	-	-	1.0E-02	9.0E-07
Phenol	-	4.4E-06	6.9E-01	(7.2E-05)	(1.2E-05)	4.4E-02	-	-	1.9E-01	1.9E-01	4.8E-05	-
Dichloropropene(1,3)	-	(9.5E-05)	(8.4E+00)	(2.6E-03)	(2.2E-04)	(8.4E-01)	-	-	4.1E-01	4.1E-01	9.7E-04	-

Table F-8 – Review of Emissions Increase Above Regulation 2, Rule 5 Thresholds

Source No.	S-2013	S-819	S-830	S-831	S-842	S-1026	S-2010	S-2003	S-2016	S-2017	P#21432 (S-1)	P#21432(S-19)
Caprylic Acid	-	-	-	-	-	-	-	-	-	-	-	-
Capric Acid	-	-	-	-	-	-	-	-	-	-	-	-
Lauric Acid	-	-	-	-	-	-	-	-	-	-	-	-
Myristic Acid	-	-	-	-	-	-	-	-	-	-	-	-
Palmitic Acid	-	-	-	-	-	-	-	-	-	-	-	-
Stearic Acid	-	-	-	-	-	-	-	-	-	-	-	-
Arachidic Acid	-	-	-	-	-	-	-	-	-	-	-	-
Behenic Acid	-	-	-	-	-	-	-	-	-	-	-	-
Lignoceric Acid	-	-	-	-	-	-	-	-	-	-	-	-
Oleic Acid	-	-	-	-	-	-	-	-	-	-	-	-
Linoleic Acid	-	-	-	-	-	-	-	-	-	-	-	-
alpha-Linoleic Acid	-	-	-	-	-	-	-	-	-	-	-	-
Toluene	No	No	No	No	No	No	No	No	No	No	No	No
Ethanol	-	-	-	-	-	-	-	-	-	-	-	-
Methanol	No	No	No	No	No	No	No	No	No	No	No	No
Propylene Glycol	-	-	-	-	-	-	-	-	-	-	-	-
Ethylene Glycol Monopropyl Ether	-	-	-	-	-	-	-	-	-	-	-	-
Triethylene Glycol	-	-	-	-	-	-	-	-	-	-	-	-
Ethylene Glycol	No	No	No	No	No	No	No	No	No	No	No	No
Ammonia	No	No	No	No	No	No	No	No	No	No	No	No
Aluminum	-	-	-	-	-	-	-	-	-	-	-	-
Cadium	No	No	No	No	No	No	No	No	No	No	No	No
Chromium	No	No	No	No	No	No	No	No	No	No	No	No
Copper	No	No	No	No	No	No	No	No	No	No	No	No
Lead	No	No	No	No	No	No	No	No	No	No	No	No
Nickel	No	No	No	No	No	No	No	No	No	No	No	No
Zinc	-	-	-	-	-	-	-	-	-	-	-	-
Benzene	Yes	No	No	No	No	No	Yes	No	Yes	Yes	No	No
Ethylbenzene	Yes	No	No	No	No	No	No	No	No	No	No	No
Xylene	No	No	No	No	No	No	No	No	No	No	No	No
Naphthalene	Yes	No	No	No	No	No	No	No	No	No	No	No
Phenanthrene	-	-	-	-	-	-	-	-	-	-	-	-
Diethyl Phthalate	-	-	-	-	-	-	-	-	-	-	-	-
Cumene (Isopropylbenzene)	-	-	-	-	-	-	-	-	-	-	-	-
Cyclohexane	-	-	-	-	-	-	-	-	-	-	-	-
Diethanolamine	No	No	No	No	No	No	No	No	No	No	No	No
Hexane(-N)	No	No	No	No	No	No	No	No	No	No	No	No
Trimethylbenzene,1,2,4-	-	-	-	-	-	-	-	-	-	-	-	-
Hydrogen Sulfide	No	No	No	No	No	No	No	No	No	No	No	No
Acenaphthene	-	-	-	-	-	-	-	-	-	-	-	-
Chloroform (Trichloromethane)	No	No	No	No	No	No	No	No	No	No	No	No
Cresol	No	No	No	No	No	No	No	No	No	No	No	No
Dimethylphenol,2,4-	-	-	-	-	-	-	-	-	-	-	-	-
Ethanolamine(Mono-)	-	-	-	-	-	-	-	-	-	-	-	-
Fluorene	-	-	-	-	-	-	-	-	-	-	-	-
Methyl Tert-Butyl Ether	No	No	No	No	No	No	No	No	No	No	No	No
Methyl Chloride (Chloromethane)	-	-	-	-	-	-	-	-	-	-	-	-
Methylnaphthalene,2-	-	-	-	-	-	-	-	-	-	-	-	-
Phenol	No	No	No	No	No	No	No	No	No	No	No	No
Dichloropropene(1,3)	-	-	-	-	-	-	-	-	-	-	-	-

Appendix G - Transportation Emissions (Marine Vessels, Trucks, Rails)

Post-Project Throughputs

		Receipts						Deliveries			
Commodity	**Units**	Truck to MTZ	Rail to Truck to MTZ	Rail to Pipeline to MTZ	Rail to MTZ	Rail to Barge to Avon	Ship to Avon	MTZ to Truck	Rail from MTZ	Ship from Amorco	Ship from Avon
RD Fd Stock	MBPD				6.5	26.5	15.0				
Gasoline	MBPD						28.0	8.0			
Renewable Naphtha	MBPD										1.0
Renewable Diesel	MBPD							8.2		27.8	11.7
Bio Diesel	MBPD		0.1								
Diesel	MBPD	0.2									
Ethanol	MBPD		0.8								
Propane	MBPD				0.1				3.7		
Butane/Mixed Butanes	MBPD										
Citric Acid	MBPD	0.4									
WWT Solids	yd^3/day							61.9			
DMDS	gal/day	604.8									
Miscellaneous	MBPD	6.0									

Total product transferred at Avor 30.00 MMbbl/year
Current Avon throughput limit: 30.00 MMbbl/year
Current prohibition against transferring crude oil at Avon.

Barge Scenarios for "Rail to Barge to Avon" throughput:

ATB	0%
Brownwater (1 barge tow)	0%
Brownwater (1-2 barge tow)	100%
Total	100%

S-1560 (Avon) Baseline Emissions

Avon Wharf Pre-Project Cargo Carrier Emissions (Permitted)

	BAAQMD					
	POC	SO2	NOx	CO	PM10	PM2.5
	tpy	tpy	tpy	tpy	tpy	tpy
Avon Wharf:	**10.74**	**9.37**	**188.83**	**34.43**	**4.16**	**4.16**

Notes:

- Avon pre-project cargo carrier emissions here are permit limits established January 2017, and represent fully offset and mitigated emissions.
- See Title V permit, Condition 26406 parts 1 and 2, restricting annual throughput and cargo carrier emissions at Berth 1A.

Avon Wharf Post-Project Cargo Carrier Emissions

S-1560 (Avon) Post-Project

Annual Total		BAAQMD					
		POC	SO_2	NOx	CO	PM_{10}	$PM_{2.5}$
Operating Scenario	# Trips	tpy	tpy	tpy	tpy	tpy	tpy
Ship to/From Avon - Gasoline / Renewable Naphtha	36	2.18	1.17	28.55	7.45	0.99	0.92
Ship to/From Avon - Renewable Diesel	3	0.20	0.30	2.98	0.61	0.13	0.12
Ship to Avon - RD Fd Stock	22	1.12	0.69	16.64	3.42	0.53	0.49
Rail to Barge to Avon (Brownwater (1-2 barge tow)) - RD Fd Stock	306	3.39	0.164	35.74	22.88	1.20	1.20
Avon Total		**6.89**	**2.31**	**83.91**	**34.36**	**2.85**	**2.73**

Notes:

- See the attached tables detailing the emission calculations associated with each vessel operating scenario for Avon.

Post-Project Annual Delta:

	POC	SO_2	NOx	CO	PM_{10}	$PM_{2.5}$
	tpy	tpy	tpy	tpy	tpy	tpy
Avon Wharf:	**-3.85**	**-7.06**	**-104.92**	**-0.07**	**-1.31**	**-1.43**

Appendix G - Transportation Emissions (Marine Vessels, Trucks, Rails)

Mobile Source - Marine Vessel Post-Project Emissions

Operational Marine Vessel Emissions

Ship to/From Avon - Gasoline / Renewable Naphtha

Vessel Type	HandyMax Tanker
Berth Location	Avon
Cargo Per Vessel (Mbbl)	285
Round Trips/Year	36
Max speed (kn)	15.1

Transfer Activities Per Round-Trip

Material	Direction	Mbbl/yr	Mbbl/trip	Transfer Rate bbl/hr	Time hrs	Escort Tug Needed?
Gasoline	Inbound	10,220	283.89	10,000	28.39	TRUE
Renewable Naphtha	Outbound	365	10.14	6,000	1.69	TRUE

Additional Hoteling Time

Activity	Hrs
Hook-up (start)	3
Hook-up (end)	2
Bunkering (2-6 hrs on ~50% of ships)	1.5

Emissions Summary

	Emissions (Pounds)						Emissions (MT)			
	POC	CO	NOx	SO_2	PM10	PM2.5	CO2	CH4	N2O	CO2e
Emissions/Round-Trip	121.18	413.67	1,586.36	64.75	54.77	51.18	58	0.00	0.004	60
Annual Total	4,362	14,892	57,109	2,331	1,972	1,842	2,103	0.03	0.132	2,145
Daily Total	12	41	156	6	5	5	6	0.00	0.000	6
Annual Onsite	412	993	9,646	1,375	496	442	950	0.00	0.07	972

Notes:
- Onsite emissions include hotelling only.

OGV Main Engine Usage per Round-Trip

Activity	Mode	# Escort Tugs Req'd	Propulsion Max kW [1]	Speed (kn)	Load Factor [1]	Distance (nm/trip)	Duration (hr/trip)	kW-hr/ Round-Trip
Pilot Boarding (Sea Buoy) to COLREGS Line	Transit	0	9000	12	0.50	8.8	0.73	3,313
COLREGS Line to Golden Gate Bridge	Transit	1	9000	10	0.29	2.3	0.23	601
Golden Gate Bridge to Echo Buoy	Transit	1	9000	10	0.29	16.45	1.65	4,300
Echo Buoy to SPB Light #15	Transit	1	9000	10	0.29	7.7	0.77	2,013
SPB Light #15 to Near Plains Terminal	Transit	1	9000	8	0.15	7.9	0.99	1,322
Near Plains Terminal to Avon Wharf	Transit	1	9000	5	0.04	0.5	0.10	33
At Avon Wharf (Docking)	Maneuvering	0	9000	n/a	0.02	n/a	1.50	270
At Avon Wharf (Hoteling and Prod. Transfer)	Hotelling	0	9000	n/a	0.00	n/a	36.58	-
At Avon Wharf (Undocking)	Maneuvering	0	9000	n/a	0.02	n/a	1.50	270
Avon Wharf to Near Plains Terminal	Transit	1	9000	8	0.15	0.5	0.06	84
Near Plains Terminal to SPB Light #15	Transit	1	9000	10	0.29	7.9	0.79	2,065
SPB Light #15 to COLREGS Line	Transit	1	9000	10	0.29	26.45	2.65	6,914
COLREGS Line to Pilot Boarding (Sea Buoy)	Transit	0	9000	12	0.50	8.8	0.73	3,313

Notes: (1) Load factor = (speed/max speed)^3. Load factor of 0.02 represents minimum load factor for propulsion engines.
(2) Assume 1.5 hrs for docking and 1.5 hrs for undocking.
(3) Escort tug required to or from Golden Gate Bridge when carrying hydrocarbon.
(4) Maximum vessel speed based on Port of Los Angeles Air Emissions Inventory - 2019, Table 2.9

OGV Main Engine Emissions per Round-Trip

EF Lookup	Lb/Trip						MT/Trip			
	POC	CO	NOx	SO_2	PM10	PM2.5	CO2	CH4	N2O	CO2e
OGV Main Engines	4.38	10.22	105.16	2.92	2.34	2.12	2.0	0.00	0.000	2.0
OGV Main Engines	0.80	1.86	19.09	0.53	0.42	0.38	0.4	0.00	0.000	0.4
OGV Main Engines	5.69	13.27	136.51	3.79	3.03	2.75	2.5	0.00	0.000	2.6
OGV Main Engines	2.66	6.21	63.90	1.77	1.42	1.29	1.2	0.00	0.000	1.2
OGV Main Engines	2.39	5.44	44.74	1.17	1.04	0.94	0.8	0.00	0.000	0.8
OGV Main Engines	0.38	0.54	2.50	0.03	0.08	0.07	0.0	0.00	0.000	0.0
OGV Main Engines	7.56	8.08	39.64	0.24	1.39	1.26	0.2	0.00	0.000	0.2
OGV Main Engines	0.00	0.00	0.00	0.00	0.00	0.00	0.0	0.00	0.000	0.0
OGV Main Engines	7.56	8.08	39.64	0.24	1.39	1.26	0.2	0.00	0.000	0.2
OGV Main Engines	0.15	0.34	2.83	0.07	0.07	0.06	0.0	0.00	0.000	0.1
OGV Main Engines	2.73	6.37	65.56	1.82	1.46	1.32	1.2	0.00	0.000	1.2
OGV Main Engines	9.15	21.34	219.50	6.10	4.88	4.42	4.1	0.00	0.000	4.1
OGV Main Engines	4.38	10.22	105.16	2.92	2.34	2.12	2.0	0.00	0.000	2.0

E = [EF g/kW-hr] x [Energy kW-hr] x [Low Load Factor] x [Conversion from g to lb or MT]

OGV Auxiliary Generator Usage per Round-Trip

Activity	Mode	Aux Eng. Max kW	Load Factor [1]	Hours/ Trip	kW-hr/ Round-Trip
I	Transit	750	24%	0.73	132
COLREGS Line to Golden Gate Bridge	Transit	750	24%	0.23	41
Golden Gate Bridge to Echo Buoy	Transit	750	24%	1.65	296
Echo Buoy to SPB Light #15	Transit	750	24%	0.77	139
SPB Light #15 to Near Plains Terminal	Transit	750	24%	0.99	178
Near Plains Terminal to Avon Wharf	Transit	750	24%	0.10	18
At Avon Wharf (Docking)	Maneuvering	750	33%	1.50	371
At Avon Wharf (Hoteling and Prod. Transfer)	Hotelling	750	26%	36.58	7,133
At Avon Wharf (Undocking)	Maneuvering	750	33%	1.50	371
Avon Wharf to Near Plains Terminal	Transit	750	24%	0.06	11
Near Plains Terminal to SPB Light #15	Transit	750	24%	0.79	142
SPB Light #15 to COLREGS Line	Transit	750	24%	2.65	476
COLREGS Line to Pilot Boarding (Sea Buoy)	Transit	750	24%	0.73	132

Notes: (1) California ARB, May 2011, Appendix D, Emissions Estimation Methodology for Ocean-Going Vessels, Table II-5

OGV Auxiliary Generator Emissions per Round-Trip

EF Lookup	Lb/Trip						MT/Trip			
	POC	CO	NOx	SO_2	PM10	PM2.5	CO2	CH4	N2O	CO2e
OGV Auxiliary Engines	0.12	0.32	3.06	0.14	0.09	0.08	0.1	0.00	0.00	0.1
OGV Auxiliary Engines	0.04	0.10	0.96	0.04	0.03	0.03	0.0	0.00	0.00	0.0
OGV Auxiliary Engines	0.26	0.72	6.85	0.30	0.21	0.19	0.2	0.00	0.00	0.2
OGV Auxiliary Engines	0.12	0.34	3.21	0.14	0.10	0.09	0.1	0.00	0.00	0.1
OGV Auxiliary Engines	0.16	0.43	4.11	0.18	0.13	0.11	0.1	0.00	0.00	0.1
OGV Auxiliary Engines	0.02	0.04	0.42	0.02	0.01	0.01	0.0	0.00	0.00	0.0
OGV Auxiliary Engines	0.33	0.90	8.59	0.38	0.26	0.24	0.3	0.00	0.00	0.3
OGV Auxiliary Engines	6.29	17.30	165.12	7.34	5.03	4.56	4.9	0.00	0.00	5.0
OGV Auxiliary Engines	0.33	0.90	8.59	0.38	0.26	0.24	0.3	0.00	0.00	0.3
OGV Auxiliary Engines	0.01	0.03	0.26	0.01	0.01	0.01	0.0	0.00	0.00	0.0
OGV Auxiliary Engines	0.13	0.34	3.29	0.15	0.10	0.09	0.1	0.00	0.00	0.1
OGV Auxiliary Engines	0.42	1.15	11.02	0.49	0.34	0.30	0.3	0.00	0.00	0.3
OGV Auxiliary Engines	0.12	0.32	3.06	0.14	0.09	0.08	0.1	0.00	0.00	0.1

E = [EF g/kW-hr] x [Energy kW-hr] x [Conversion from g to lb or MT]

Appendix G - Transportation Emissions (Marine Vessels, Trucks, Rails)

Mobile Source - Marine Vessel Post-Project Emissions

Operational Marine Vessel Emissions

Ship to/From Avon - Gasoline / Renewable Naphtha

OGV Auxiliary Boiler Usage per Round-Trip

Activity	Mode	Boiler kW per Vessel [1,2]	Hours/ Transit	kW-hr/ Round-Trip
Pilot Boarding (Sea Buoy) to COLREGS Line	Transit	144	0.73	106
COLREGS Line to Golden Gate Bridge	Transit	144	0.23	33
Golden Gate Bridge to Echo Buoy	Transit	144	1.65	237
Echo Buoy to SPB Light #15	Transit	144	0.77	111
SPB Light #15 to Near Plains Terminal	Transit	144	0.99	142
Near Plains Terminal to Avon Wharf	Transit	144	0.10	14
At Avon Wharf (Docking)	Maneuvering	144	1.50	216
At Avon Wharf (Hoteling and Prod. Transfer)	Hotelling	638	36.58	23,319
At Avon Wharf (Undocking)	Maneuvering	144	1.50	216
Avon Wharf to Near Plains Terminal	Transit	144	0.06	9
Near Plains Terminal to SPB Light #15	Transit	144	0.79	114
SPB Light #15 to COLREGS Line	Transit	144	2.65	381
COLREGS Line to Pilot Boarding (Sea Buoy)	Transit	144	0.73	106

Notes: (1) Port of Los Angeles Air Emissions Inventory - 2019 - Table 3.5 (Starcrest, 2020); Assume Tanker - Handysize

(2) Boiler load during hotelling based on engineering estimate of fuel consumption

OGV Auxiliary Boiler Emissions per Round-Trip

	Lb/Trip						MT/Trip			
EF Lookup	POC	CO	NOx	SO_2	PM10	PM2.5	CO2	CH4	N2O	CO2e
OGV Auxiliary Boilers	0.02	0.05	0.47	0.14	0.04	0.03	0.1	0.00	0.00	0.1
OGV Auxiliary Boilers	0.01	0.01	0.15	0.04	0.01	0.01	0.0	0.00	0.00	0.0
OGV Auxiliary Boilers	0.05	0.10	1.04	0.31	0.09	0.08	0.2	0.00	0.00	0.2
OGV Auxiliary Boilers	0.02	0.05	0.49	0.15	0.04	0.04	0.1	0.00	0.00	0.1
OGV Auxiliary Boilers	0.03	0.06	0.63	0.19	0.05	0.05	0.1	0.00	0.00	0.1
OGV Auxiliary Boilers	0.00	0.01	0.06	0.02	0.01	0.00	0.0	0.00	0.00	0.0
OGV Auxiliary Boilers	0.05	0.10	0.95	0.29	0.08	0.07	0.2	0.00	0.00	0.2
OGV Auxiliary Boilers	5.14	10.28	102.82	30.85	8.74	7.71	21.5	0.00	0.00	22.0
OGV Auxiliary Boilers	0.05	0.10	0.95	0.29	0.08	0.07	0.2	0.00	0.00	0.2
OGV Auxiliary Boilers	0.00	0.00	0.04	0.01	0.00	0.00	0.0	0.00	0.00	0.0
OGV Auxiliary Boilers	0.03	0.05	0.50	0.15	0.04	0.04	0.1	0.00	0.00	0.1
OGV Auxiliary Boilers	0.08	0.17	1.68	0.50	0.14	0.13	0.4	0.00	0.00	0.4
OGV Auxiliary Boilers	0.02	0.05	0.47	0.14	0.04	0.03	0.1	0.00	0.00	0.1

Tugboat Usage during Escort & Assist

Engine Type	Max Hp Per Tug	Load Factor [1]	# Tugboats	Tug-Hrs/ Round-Trip [2]	hp-hr/ Round-Trip
Escort - Main Engine	5,351	0.31	See above	7.23	11,992
Escort - Auxiliary Generator	402	0.43	See above	7.23	1,251
Assist - Main Engine	5,351	0.31	2	9.00	14,928
Assist - Auxiliary Generator	402	0.43	2	9.00	1,557

Notes: (1) Port of Long Beach Air Emissions Inventory - 2013 - Table 3.4 (Starcrest 2014); Assume Assist tug category

(2) Time spent operating per vessel trip. Estimated assist time to account for tug movement, docking, and undocking, plus 4x30 minute trips to/from temporary tug base.

(3) If escort tug is present, it will serve as one of the two assist tugs for docking/undocking, eliminating the need for one 30 minute trip to/from temporary tug base.

Tugboat Emissions during Escort & Assist

	Lb/Trip						MT/Trip			
EF Lookup	POC	CO	NOx	SO_2	PM10	PM2.5	CO2	CH4	N2O	CO2e
Tug ME (1900-3300 hp, 2009)	23.63	116.23	168.14	0.15	7.82	7.82	5.8	0.000	0.000	5.9
Tug AE (250-500 hp, 2009)	2.87	11.96	15.99	0.02	0.59	0.59	0.6	0.000	0.000	0.6
Tug ME (1900-3300 hp, 2009)	29.41	144.68	209.30	0.18	9.73	9.73	7.2	0.000	0.000	7.3
Tug AE (250-500 hp, 2009)	3.58	14.89	19.90	0.02	0.74	0.74	0.8	0.000	0.000	0.8

Emission Calculation Notes:

For OGV main & aux engines:

[Emissions (g)] = [Energy (kW-hr)] x [EF (g/kW-hr)] x LLA

For OGV aux engines:

[Emissions (g)] = [Energy (kW-hr)] x [EF (g/kW-hr)]

For OGV aux boilers:

[Emissions (g)] = [Energy (kW-hr)] x [EF (g/kW-hr)]

For tug main & aux engines:

[Emissions (g) = [Energy hp-hr] x [EFo g/bhp-hr] x (1+[Deterioration Factor] x [Engine Age]/[Useful Life])

Appendix G - Transportation Emissions (Marine Vessels, Trucks, Rails)

Mobile Source - Marine Vessel Post-Project Emissions

Operational Marine Vessel Emissions

Ship to Avon - RD Fd Stock

Vessel Type	HandyMax Tanker
Berth Location	Avon
Cargo Per Vessel (Mbbl)	260
Round Trips/Year	22
Max speed (kn)	15.1

Transfer Activities Per Round-Trip

Material	Direction	Mbbl/yr	Mbbl/trip	Transfer Rate bbl/hr	Time hrs	Escort Tug Needed?
RD Fd Stock	Inbound	5,475	248.86	10,000	24.89	FALSE
	Outbound	0	0.00	6,000	0.00	FALSE

Additional Hoteling Time

Activity	Hrs
Hook-up (start)	3
Hook-up (end)	2
Bunkering (2-6 hrs on ~50% of ships)	1.5

Emissions Summary

	Emissions (Pounds)						Emissions (MT)			
	POC	CO	NOx	SO_2	PM10	PM2.5	CO2	CH4	N2O	CO2e
Emissions/Round-Trip	101.83	311.20	1,512.34	62.46	48.24	44.62	51	0.00	0.003	52
Annual Total	2,240	6,846	33,272	1,374	1,061	982	1,129	0.02	0.070	1,151
Daily Total	6	19	91	4	3	3	3	0.00	0.000	3
Annual Onsite	216	521	5,058	721	260	232	498	0.00	0.04	510

Notes:
- Onsite emissions include hotelling only.

OGV Main Engine Usage per Round-Trip

Activity	Mode	# Escort Tugs Req'd	Propulsion Max kW [1]	Speed (kn)	Load Factor [1]	Distance (nm/trip)	Duration (hr/trip)	kW-hr/ Round-Trip
Pilot Boarding (Sea Buoy) to COLREGS Line	Transit	0	9000	12	0.50	8.8	0.73	3,313
COLREGS Line to Golden Gate Bridge	Transit	0	9000	10	0.29	2.3	0.23	601
Golden Gate Bridge to Echo Buoy	Transit	0	9000	10	0.29	16.45	1.65	4,300
Echo Buoy to SPB Light #15	Transit	0	9000	10	0.29	7.7	0.77	2,013
SPB Light #15 to Near Plains Terminal	Transit	0	9000	8	0.15	7.9	0.99	1,322
Near Plains Terminal to Avon Wharf	Transit	0	9000	5	0.04	0.5	0.10	33
At Avon Wharf (Docking)	Maneuvering	0	9000	n/a	0.02	n/a	1.50	270
At Avon Wharf (Hoteling and Prod. Transfer)	Hotelling	0	9000	n/a	0.00	n/a	31.39	-
At Avon Wharf (Undocking)	Maneuvering	0	9000	n/a	0.02	n/a	1.50	270
Avon Wharf to Near Plains Terminal	Transit	0	9000	8	0.15	0.5	0.06	84
Near Plains Terminal to SPB Light #15	Transit	0	9000	12	0.50	7.9	0.66	2,974
SPB Light #15 to COLREGS Line	Transit	0	9000	12	0.50	26.45	2.20	9,956
COLREGS Line to Pilot Boarding (Sea Buoy)	Transit	0	9000	12	0.50	8.8	0.73	3,313

Notes: (1) Load factor = (speed/max speed)^3. Load factor of 0.02 represents minimum load factor for propulsion engines.
(2) Assume 1.5 hrs for docking and 1.5 hrs for undocking.
(3) Escort tug required to or from Golden Gate Bridge when carrying hydrocarbon.
(4) Maximum vessel speed based on Port of Los Angeles Air Emissions Inventory - 2019, Table 2.9

OGV Main Engine Emissions per Round-Trip

EF Lookup	Lb/Trip						MT/Trip			
	POC	CO	NOx	SO_2	PM10	PM2.5	CO2	CH4	N2O	CO2e
OGV Main Engines	4.38	10.22	105.16	2.92	2.34	2.12	2.0	0.00	0.000	2.0
OGV Main Engines	0.80	1.86	19.09	0.53	0.42	0.38	0.4	0.00	0.000	0.4
OGV Main Engines	5.69	13.27	136.51	3.79	3.03	2.75	2.5	0.00	0.000	2.6
OGV Main Engines	2.66	6.21	63.90	1.77	1.42	1.29	1.2	0.00	0.000	1.2
OGV Main Engines	2.39	5.44	44.74	1.17	1.04	0.94	0.8	0.00	0.000	0.8
OGV Main Engines	0.38	0.54	2.50	0.03	0.08	0.07	0.0	0.00	0.000	0.0
OGV Main Engines	7.56	8.08	39.64	0.24	1.39	1.26	0.2	0.00	0.000	0.2
OGV Main Engines	0.00	0.00	0.00	0.00	0.00	0.00	0.0	0.00	0.000	0.0
OGV Main Engines	7.56	8.08	39.64	0.24	1.39	1.26	0.2	0.00	0.000	0.2
OGV Main Engines	0.15	0.34	2.83	0.07	0.07	0.06	0.0	0.00	0.000	0.1
OGV Main Engines	3.93	9.18	94.41	2.62	2.10	1.90	1.8	0.00	0.000	1.8
OGV Main Engines	13.17	30.73	316.08	8.78	7.02	6.37	5.9	0.00	0.000	6.0
OGV Main Engines	4.38	10.22	105.16	2.92	2.34	2.12	2.0	0.00	0.000	2.0

E = [EF g/kW-hr] x [Energy kW-hr] x [Low Load Factor] x [Conversion from g to lb or MT]

OGV Auxiliary Generator Usage per Round-Trip

Activity	Mode	Aux Eng. Max kW	Load Factor [1]	Hours/ Trip	kW-hr/ Round-Trip
I	Transit	750	24%	0.73	132
COLREGS Line to Golden Gate Bridge	Transit	750	24%	0.23	41
Golden Gate Bridge to Echo Buoy	Transit	750	24%	1.65	296
Echo Buoy to SPB Light #15	Transit	750	24%	0.77	139
SPB Light #15 to Near Plains Terminal	Transit	750	24%	0.99	178
Near Plains Terminal to Avon Wharf	Transit	750	24%	0.10	18
At Avon Wharf (Docking)	Maneuvering	750	33%	1.50	371
At Avon Wharf (Hoteling and Prod. Transfer)	Hotelling	750	26%	31.39	6,120
At Avon Wharf (Undocking)	Maneuvering	750	33%	1.50	371
Avon Wharf to Near Plains Terminal	Transit	750	24%	0.06	11
Near Plains Terminal to SPB Light #15	Transit	750	24%	0.66	119
SPB Light #15 to COLREGS Line	Transit	750	24%	2.20	397
COLREGS Line to Pilot Boarding (Sea Buoy)	Transit	750	24%	0.73	132

Notes: (1) California ARB, May 2011, Appendix D, Emissions Estimation Methodology for Ocean-Going Vessels, Table II-5

OGV Auxiliary Generator Emissions per Round-Trip

EF Lookup	Lb/Trip						MT/Trip			
	POC	CO	NOx	SO_2	PM10	PM2.5	CO2	CH4	N2O	CO2e
OGV Auxiliary Engines	0.12	0.32	3.06	0.14	0.09	0.08	0.1	0.00	0.00	0.1
OGV Auxiliary Engines	0.04	0.10	0.96	0.04	0.03	0.03	0.0	0.00	0.00	0.0
OGV Auxiliary Engines	0.26	0.72	6.85	0.30	0.21	0.19	0.2	0.00	0.00	0.2
OGV Auxiliary Engines	0.12	0.34	3.21	0.14	0.10	0.09	0.1	0.00	0.00	0.1
OGV Auxiliary Engines	0.16	0.43	4.11	0.18	0.13	0.11	0.1	0.00	0.00	0.1
OGV Auxiliary Engines	0.02	0.04	0.42	0.02	0.01	0.01	0.0	0.00	0.00	0.0
OGV Auxiliary Engines	0.33	0.90	8.59	0.38	0.26	0.24	0.3	0.00	0.00	0.3
OGV Auxiliary Engines	5.40	14.84	141.68	6.30	4.32	3.91	4.2	0.00	0.00	4.3
OGV Auxiliary Engines	0.33	0.90	8.59	0.38	0.26	0.24	0.3	0.00	0.00	0.3
OGV Auxiliary Engines	0.01	0.03	0.26	0.01	0.01	0.01	0.0	0.00	0.00	0.0
OGV Auxiliary Engines	0.10	0.29	2.74	0.12	0.08	0.08	0.1	0.00	0.00	0.1
OGV Auxiliary Engines	0.35	0.96	9.18	0.41	0.28	0.25	0.3	0.00	0.00	0.3
OGV Auxiliary Engines	0.12	0.32	3.06	0.14	0.09	0.08	0.1	0.00	0.00	0.1

E = [EF g/kW-hr] x [Energy kW-hr] x [Conversion from g to lb or MT]

Mobile Source - Marine Vessel Post-Project Emissions

Operational Marine Vessel Emissions

Ship to Avon - RD Fd Stock

OGV Auxiliary Boiler Usage per Round-Trip

Activity	Mode	Boiler kW per Vessel [1,2]	Hours/ Transit	kW-hr/ Round-Trip
Pilot Boarding (Sea Buoy) to COLREGS Line	Transit	144	0.73	106
COLREGS Line to Golden Gate Bridge	Transit	144	0.23	33
Golden Gate Bridge to Echo Buoy	Transit	144	1.65	237
Echo Buoy to SPB Light #15	Transit	144	0.77	111
SPB Light #15 to Near Plains Terminal	Transit	144	0.99	142
Near Plains Terminal to Avon Wharf	Transit	144	0.10	14
At Avon Wharf (Docking)	Maneuvering	144	1.50	216
At Avon Wharf (Hoteling and Prod. Transfer)	Hotelling	638	31.39	20,009
At Avon Wharf (Undocking)	Maneuvering	144	1.50	216
Avon Wharf to Near Plains Terminal	Transit	144	0.06	9
Near Plains Terminal to SPB Light #15	Transit	144	0.66	95
SPB Light #15 to COLREGS Line	Transit	144	2.20	317
COLREGS Line to Pilot Boarding (Sea Buoy)	Transit	144	0.73	106

Notes: (1) Port of Los Angeles Air Emissions Inventory - 2019 - Table 3.5 (Starcrest, 2020); Assume Tanker - Handysize

(2) Boiler load during hotelling based on engineering estimate of fuel consumption

OGV Auxiliary Boiler Emissions per Round-Trip

	Lb/Trip						MT/Trip			
EF Lookup	POC	CO	NOx	SO_2	PM10	PM2.5	CO2	CH4	N2O	CO2e
OGV Auxiliary Boilers	0.02	0.05	0.47	0.14	0.04	0.03	0.1	0.00	0.00	0.1
OGV Auxiliary Boilers	0.01	0.01	0.15	0.04	0.01	0.01	0.0	0.00	0.00	0.0
OGV Auxiliary Boilers	0.05	0.10	1.04	0.31	0.09	0.08	0.2	0.00	0.00	0.2
OGV Auxiliary Boilers	0.02	0.05	0.49	0.15	0.04	0.04	0.1	0.00	0.00	0.1
OGV Auxiliary Boilers	0.03	0.06	0.63	0.19	0.05	0.05	0.1	0.00	0.00	0.1
OGV Auxiliary Boilers	0.00	0.01	0.06	0.02	0.01	0.00	0.0	0.00	0.00	0.0
OGV Auxiliary Boilers	0.05	0.10	0.95	0.29	0.08	0.07	0.2	0.00	0.00	0.2
OGV Auxiliary Boilers	4.41	8.82	88.22	26.47	7.50	6.62	18.4	0.00	0.00	18.9
OGV Auxiliary Boilers	0.05	0.10	0.95	0.29	0.08	0.07	0.2	0.00	0.00	0.2
OGV Auxiliary Boilers	0.00	0.00	0.04	0.01	0.00	0.00	0.0	0.00	0.00	0.0
OGV Auxiliary Boilers	0.02	0.04	0.42	0.13	0.04	0.03	0.1	0.00	0.00	0.1
OGV Auxiliary Boilers	0.07	0.14	1.40	0.42	0.12	0.10	0.3	0.00	0.00	0.3
OGV Auxiliary Boilers	0.02	0.05	0.47	0.14	0.04	0.03	0.1	0.00	0.00	0.1

Tugboat Usage during Escort & Assist

Engine Type	Max Hp Per Tug	Load Factor [1]	# Tugboats	Tug-Hrs/ Round-Trip [2]	hp-hr/ Round-Trip
Escort - Main Engine	5,351	0.31	See above	0.00	-
Escort - Auxiliary Generator	402	0.43	See above	0.00	-
Assist - Main Engine	5,351	0.31	2	10.00	16,587
Assist - Auxiliary Generator	402	0.43	2	10.00	1,730

Notes: (1) Port of Long Beach Air Emissions Inventory - 2013 - Table 3.4 (Starcrest 2014); Assume Assist tug category

(2) Time spent operating per vessel trip. Estimated assist time to account for tug movement, docking, and undocking, plus 4x30 minute trips to/from temporary tug base.

(3) If escort tug is present, it will serve as one of the two assist tugs for docking/undocking, eliminating the need for one 30 minute trip to/from temporary tug base.

Tugboat Emissions during Escort & Assist

	Lb/Trip						MT/Trip			
EF Lookup	POC	CO	NOx	SO_2	PM10	PM2.5	CO2	CH4	N2O	CO2e
Tug ME (1900-3300 hp, 2009)	0.00	0.00	0.00	0.00	0.00	0.00	0.0	0.000	0.000	0.0
Tug AE (250-500 hp, 2009)	0.00	0.00	0.00	0.00	0.00	0.00	0.0	0.000	0.000	0.0
Tug ME (1900-3300 hp, 2009)	32.68	160.76	232.56	0.20	10.81	10.81	8.0	0.000	0.000	8.2
Tug AE (250-500 hp, 2009)	3.98	16.54	22.11	0.02	0.82	0.82	0.9	0.000	0.000	0.9

Emission Calculation Notes:

For OGV main & aux engines:

[Emissions (g)] = [Energy (kW-hr)] x [EF (g/kW-hr)] x LLA

For OGV aux engines:

[Emissions (g)] = [Energy (kW-hr)] x [EF (g/kW-hr)]

For OGV aux boilers:

[Emissions (g)] = [Energy (kW-hr)] x [EF (g/kW-hr)]

For tug main & aux engines:

[Emissions (g) = [Energy hp-hr] x [EFo g/bhp-hr] x (1+[Deterioration Factor] x [Engine Age]/[Useful Life])

Appendix G - Transportation Emissions (Marine Vessels, Trucks, Rails)

Operational Marine Vessel Emissions
Ship from Avon - Renewable Diesel

Vessel Type	HandyMax Tanker
Berth Location	Avon
Cargo Per Vessel (Mbbl)	260
Round Trips/Year	3
Max speed (kn)	15.1

Transfer Activities Per Round-Trip

Material	Direction	Mbbl/yr	Mbbl/trip	Transfer Rate bbl/hr	Time hrs	Escort Tug Needed?
	Inbound	0	0.00	10,000	0.00	FALSE
Renewable Diesel	Outbound	730	243.33	6,000	40.56	TRUE

Additional Hoteling Time

Activity	Hrs
Hook-up (start)	3
Hook-up (end)	2
Bunkering (2-6 hrs on ~50% of ships)	1.5

OGV Main Engine Usage per Round-Trip

Activity	Mode	# Escort Tugs Req'd	Propulsion Max kW [1]	Speed (kn)	Load Factor [1]	Distance (nm/trip)	Duration (hr/trip)	kW-hr/ Round-Trip
Pilot Boarding (Sea Buoy) to COLREGS Line	Transit	0	9000	12	0.50	8.8	0.73	3,313
COLREGS Line to Golden Gate Bridge	Transit	0	9000	10	0.29	2.3	0.23	601
Golden Gate Bridge to Echo Buoy	Transit	0	9000	10	0.29	16.45	1.65	4,300
Echo Buoy to SPB Light #15	Transit	0	9000	10	0.29	7.7	0.77	2,013
SPB Light #15 to Near Plains Terminal	Transit	0	9000	8	0.15	7.9	0.99	1,322
Near Plains Terminal to Avon Wharf	Transit	0	9000	5	0.04	0.5	0.10	33
At Avon Wharf (Docking)	Maneuvering	0	9000	n/a	0.02	n/a	1.50	270
At Avon Wharf (Hoteling and Prod. Transfer)	Hotelling	0	9000	n/a	0.00	n/a	47.06	-
At Avon Wharf (Undocking)	Maneuvering	0	9000	n/a	0.02	n/a	1.50	270
Avon Wharf to Near Plains Terminal	Transit	1	9000	8	0.15	0.5	0.06	84
Near Plains Terminal to SPB Light #15	Transit	1	9000	10	0.29	7.9	0.79	2,065
SPB Light #15 to COLREGS Line	Transit	1	9000	10	0.29	26.45	2.65	6,914
COLREGS Line to Pilot Boarding (Sea Buoy)	Transit	0	9000	12	0.50	8.8	0.73	3,313

Notes: (1) Load factor = (speed/max speed)^3. Load factor of 0.02 represents minimum load factor for propulsion engines.
(2) Assume 1.5 hrs for docking and 1.5 hrs for undocking.
(3) Escort tug required to or from Golden Gate Bridge when carrying hydrocarbon.
(4) Maximum vessel speed based on Port of Los Angeles Air Emissions Inventory - 2019, Table 2.9

OGV Auxiliary Generator Usage per Round-Trip

Activity	Mode	Aux Eng. Max kW	Load Factor [1]	Hours/ Trip	kW-hr/ Round-Trip
Pilot Boarding (Sea Buoy) to COLREGS Line	Transit	750	24%	0.73	132
COLREGS Line to Golden Gate Bridge	Transit	750	24%	0.23	41
Golden Gate Bridge to Echo Buoy	Transit	750	24%	1.65	296
Echo Buoy to SPB Light #15	Transit	750	24%	0.77	139
SPB Light #15 to Near Plains Terminal	Transit	750	24%	0.99	178
Near Plains Terminal to Avon Wharf	Transit	750	24%	0.10	18
At Avon Wharf (Docking)	Maneuvering	750	33%	1.50	371
At Avon Wharf (Hoteling and Prod. Transfer)	Hotelling	750	26%	47.06	9,176
At Avon Wharf (Undocking)	Maneuvering	750	33%	1.50	371
Avon Wharf to Near Plains Terminal	Transit	750	24%	0.06	11
Near Plains Terminal to SPB Light #15	Transit	750	24%	0.79	142
SPB Light #15 to COLREGS Line	Transit	750	24%	2.65	476
COLREGS Line to Pilot Boarding (Sea Buoy)	Transit	750	24%	0.73	132

Notes: (1) California ARB, May 2011, Appendix D, Emissions Estimation Methodology for Ocean-Going Vessels, Table II-5

Emissions Summary

	Emissions (Pounds)						Emissions (MT)			
	POC	CO	NOx	SO_2	PM10	PM2.5	CO2	CH4	N2O	CO2e
Emissions/Round-Trip	132.81	404.68	1,985.05	196.90	89.31	81.25	148	0.00	0.011	151
Annual Total	398	1,214	5,955	591	268	244	443	0.00	0.033	453
Daily Total	1	3	16	2	1	1	1	0.00	0.000	1
Annual Onsite	105	228	2,247	511	156	138	355	0.00	0.03	364

Notes:
- Onsite emissions include hotelling only.

OGV Main Engine Emissions per Round-Trip

EF Lookup	Lb/Trip						MT/Trip			
	POC	CO	NOx	SO_2	PM10	PM2.5	CO2	CH4	N2O	CO2e
OGV Main Engines	4.38	10.22	105.16	2.92	2.34	2.12	2.0	0.00	0.000	2.0
OGV Main Engines	0.80	1.86	19.09	0.53	0.42	0.38	0.4	0.00	0.000	0.4
OGV Main Engines	5.69	13.27	136.51	3.79	3.03	2.75	2.5	0.00	0.000	2.6
OGV Main Engines	2.66	6.21	63.90	1.77	1.42	1.29	1.2	0.00	0.000	1.2
OGV Main Engines	2.39	5.44	44.74	1.17	1.04	0.94	0.8	0.00	0.000	0.8
OGV Main Engines	0.38	0.54	2.50	0.03	0.08	0.07	0.0	0.00	0.000	0.0
OGV Main Engines	7.56	8.08	39.64	0.24	1.39	1.26	0.2	0.00	0.000	0.2
OGV Main Engines	0.00	0.00	0.00	0.00	0.00	0.00	0.0	0.00	0.000	0.0
OGV Main Engines	7.56	8.08	39.64	0.24	1.39	1.26	0.2	0.00	0.000	0.2
OGV Main Engines	0.15	0.34	2.83	0.07	0.07	0.06	0.0	0.00	0.000	0.1
OGV Main Engines	2.73	6.37	65.56	1.82	1.46	1.32	1.2	0.00	0.000	1.2
OGV Main Engines	9.15	21.34	219.50	6.10	4.88	4.42	4.1	0.00	0.000	4.1
OGV Main Engines	4.38	10.22	105.16	2.92	2.34	2.12	2.0	0.00	0.000	2.0

E = [EF g/kW-hr] x [Energy kW-hr] x [Low Load Factor] x [Conversion from g to lb or MT]

OGV Auxiliary Generator Emissions per Round-Trip

EF Lookup	Lb/Trip						MT/Trip			
	POC	CO	NOx	SO_2	PM10	PM2.5	CO2	CH4	N2O	CO2e
OGV Auxiliary Engines	0.12	0.32	3.06	0.14	0.09	0.08	0.1	0.00	0.00	0.1
OGV Auxiliary Engines	0.04	0.10	0.96	0.04	0.03	0.03	0.0	0.00	0.00	0.0
OGV Auxiliary Engines	0.26	0.72	6.85	0.30	0.21	0.19	0.2	0.00	0.00	0.2
OGV Auxiliary Engines	0.12	0.34	3.21	0.14	0.10	0.09	0.1	0.00	0.00	0.1
OGV Auxiliary Engines	0.16	0.43	4.11	0.18	0.13	0.11	0.1	0.00	0.00	0.1
OGV Auxiliary Engines	0.02	0.04	0.42	0.02	0.01	0.01	0.0	0.00	0.00	0.0
OGV Auxiliary Engines	0.33	0.90	8.59	0.38	0.26	0.24	0.3	0.00	0.00	0.3
OGV Auxiliary Engines	8.09	22.25	212.41	9.44	6.47	5.87	6.3	0.00	0.00	6.4
OGV Auxiliary Engines	0.33	0.90	8.59	0.38	0.26	0.24	0.3	0.00	0.00	0.3
OGV Auxiliary Engines	0.01	0.03	0.26	0.01	0.01	0.01	0.0	0.00	0.00	0.0
OGV Auxiliary Engines	0.13	0.34	3.29	0.15	0.10	0.09	0.1	0.00	0.00	0.1
OGV Auxiliary Engines	0.42	1.15	11.02	0.49	0.34	0.30	0.3	0.00	0.00	0.3
OGV Auxiliary Engines	0.12	0.32	3.06	0.14	0.09	0.08	0.1	0.00	0.00	0.1

E = [EF g/kW-hr] x [Energy kW-hr] x [Conversion from g to lb or MT]

Appendix G - Transportation Emissions (Marine Vessels, Trucks, Rails)

OGV Auxiliary Boiler Usage per Round-Trip

Activity	Mode	Boiler kW per Vessel [1]	Hours/ Transit	kW-hr/ Round-Trip
Pilot Boarding (Sea Buoy) to COLREGS Line	Transit	144	0.73	106
COLREGS Line to Golden Gate Bridge	Transit	144	0.23	33
Golden Gate Bridge to Echo Buoy	Transit	144	1.65	237
Echo Buoy to SPB Light #15	Transit	144	0.77	111
SPB Light #15 to Near Plains Terminal	Transit	144	0.99	142
Near Plains Terminal to Avon Wharf	Transit	144	0.10	14
At Avon Wharf (Docking)	Maneuvering	144	1.50	216
At Avon Wharf (Hoteling and Prod. Transfer)	Hotelling	2586	47.06	121,686
At Avon Wharf (Undocking)	Maneuvering	144	1.50	216
Avon Wharf to Near Plains Terminal	Transit	144	0.06	9
Near Plains Terminal to SPB Light #15	Transit	144	0.79	114
SPB Light #15 to COLREGS Line	Transit	144	2.65	381
COLREGS Line to Pilot Boarding (Sea Buoy)	Transit	144	0.73	106

Notes: (1) Port of Los Angeles Air Emissions Inventory - 2019 - Table 3.5 (Starcrest, 2020); Assume Tanker - Handysize

OGV Auxiliary Boiler Emissions per Round-Trip

	Lb/Trip						MT/Trip			
EF Lookup	POC	CO	NOx	SO_2	PM10	PM2.5	CO2	CH4	N2O	CO2e
OGV Auxiliary Boilers	0.02	0.05	0.47	0.14	0.04	0.03	0.1	0.00	0.00	0.1
OGV Auxiliary Boilers	0.01	0.01	0.15	0.04	0.01	0.01	0.0	0.00	0.00	0.0
OGV Auxiliary Boilers	0.05	0.10	1.04	0.31	0.09	0.08	0.2	0.00	0.00	0.2
OGV Auxiliary Boilers	0.02	0.05	0.49	0.15	0.04	0.04	0.1	0.00	0.00	0.1
OGV Auxiliary Boilers	0.03	0.06	0.63	0.19	0.05	0.05	0.1	0.00	0.00	0.1
OGV Auxiliary Boilers	0.00	0.01	0.06	0.02	0.01	0.00	0.0	0.00	0.00	0.0
OGV Auxiliary Boilers	0.05	0.10	0.95	0.29	0.08	0.07	0.2	0.00	0.00	0.2
OGV Auxiliary Boilers	26.83	53.65	536.54	160.96	45.61	40.24	112.2	0.00	0.01	115.0
OGV Auxiliary Boilers	0.05	0.10	0.95	0.29	0.08	0.07	0.2	0.00	0.00	0.2
OGV Auxiliary Boilers	0.00	0.00	0.04	0.01	0.00	0.00	0.0	0.00	0.00	0.0
OGV Auxiliary Boilers	0.03	0.05	0.50	0.15	0.04	0.04	0.1	0.00	0.00	0.1
OGV Auxiliary Boilers	0.08	0.17	1.68	0.50	0.14	0.13	0.4	0.00	0.00	0.4
OGV Auxiliary Boilers	0.02	0.05	0.47	0.14	0.04	0.03	0.1	0.00	0.00	0.1

Tugboat Usage during Escort & Assist

Engine Type	Max Hp Per Tug	Load Factor [1]	# Tugboats	Tug-Hrs/ Round-Trip [2]	hp-hr/ Round-Trip
Escort - Main Engine	5,351	0.31	See above	3.50	5,801
Escort - Auxiliary Generator	402	0.43	See above	3.50	605
Assist - Main Engine	5,351	0.31	2	9.50	15,758
Assist - Auxiliary Generator	402	0.43	2	9.50	1,643

Notes: (1) Port of Long Beach Air Emissions Inventory - 2013 - Table 3.4 (Starcrest 2014); Assume Assist tug category

(2) Time spent operating per vessel trip. Estimated assist time to account for tug movement, docking, and undocking, plus 4x30 minute trips to/from temporary tug base.

(3) If escort tug is present, it will serve as one of the two assist tugs for docking/undocking, eliminating the need for one 30 minute trip to/from temporary tug base.

Tugboat Emissions during Escort & Assist

	Lb/Trip						MT/Trip			
EF Lookup	POC	CO	NOx	SO_2	PM10	PM2.5	CO2	CH4	N2O	CO2e
Tug ME (1900-3300 hp, 2009)	11.43	56.22	81.34	0.07	3.78	3.78	2.8	0.000	0.000	2.9
Tug AE (250-500 hp, 2009)	1.39	5.79	7.73	0.01	0.29	0.29	0.3	0.000	0.000	0.3
Tug ME (1900-3300 hp, 2009)	31.05	152.72	220.93	0.19	10.27	10.27	7.6	0.000	0.000	7.8
Tug AE (250-500 hp, 2009)	3.78	15.72	21.01	0.02	0.78	0.78	0.8	0.000	0.000	0.9

Emission Calculation Notes:

For OGV main & aux engines:

[Emissions (g)] = [Energy (kW-hr)] x [EF (g/kW-hr)] x LLA

For OGV aux engines:

[Emissions (g)] = [Energy (kW-hr)] x [EF (g/kW-hr)]

For OGV aux boilers:

[Emissions (g)] = [Energy (kW-hr)] x [EF (g/kW-hr)]

For tug main & aux engines:

[Emissions (g) = [Energy hp-hr] x [EFo g/bhp-hr] x (1+[Deterioration Factor] x [Engine Age]/[Useful Life])

Appendix G - Transportation Emissions (Marine Vessels, Trucks, Rails)

Mobile Source - Marine Vessel Post-Project Emissions

Operational Marine Vessel Emissions

Rail to Barge to Avon (Brownwater (1-2 barge tow)) - RD Fd Stock

Vessel Type	Barge
Berth Location	Avon
Average Cargo Per Trip (Mbb	32.4
Round Trips/Year	306
Max speed (kn)	n/a

Transfer Activities Per Round-Trip

Material	Location	Mbbl/yr	Mbbl/trip	Transfer Rate bbl/hr	Time hrs	Escort Tug Needed?
RD Fd Stock	Stockton				9.79	FALSE
RD Fd Stock	Avon				15.49	FALSE

Additional Hoteling Time

Location	Hrs
Stockton	4.2
Avon	2.6

Transit Time	Hrs
Transit One-way	7.2

Emissions Summary

		Emissions (Pounds)						Emissions (MT)			
		POC	CO	NOx	SO_2	PM10	PM2.5	CO2	CH4	N2O	CO2e
Emissions/Round-Trip		40.17	263.03	405.33	1.32	14.03	14.01	29	0.00	0.001	29
Annual Total (BAAQMD)	BAAQMD	6,774	45,761	71,485	329	2,399	2,392	5,475	0.09	0.245	5,553
Annual Total (SJVAPCD)	SJVAPCD	5,516	34,726	52,546	75	1,896	1,896	3,351	0.06	0.150	3,399
Annual Total		12,291	80,487	124,031	404	4,294	4,287	8,827	0.15	0.395	8,953
Daily Total (BAAQMD)	BAAQMD	19	125	196	1	7	7	15	0.00	0.001	15
Daily Total (SJVAPCD)	SJVAPCD	15	95	144	0	5	5	9	0.00	0.000	9
Daily Total		34	221	340	1	12	12	24	0.00	0.001	25
Annual Onsite	BAAQMD	422	6,407	6,943	21	49	49	990	0.01	0.04	1,003

Notes: - Onsite emissions include hotelling only.

Propulsion Tug Main Engine Usage per Round-Trip

Propulsion tug main engine, hp 1500

Propulsion tug # main engines used 2

Activity	Mode	Air District	# Escort Tugs Req'd	Duration (hr/trip)	Load Factor [1]	hp-hr/ Transit
At Stockton (Hoteling and Prod. Transfer)	Hotelling	SJVAPCD	0	14.01	0.00	-
At Stockton (Undocking)	Maneuvering	SJVAPCD	0	1.00	0.45	1,350
Wait After (fleeting)	Fleeting	SJVAPCD	0	3.22	0.00	-
Cruise - SJVAPCD	Transit	SJVAPCD	0	2.55	0.45	3,444
Cruise - BAAQMD	Transit	BAAQMD	0	4.65	0.45	6,276
Wait Before (fleeting)	Fleeting	BAAQMD	0	18.52	0.00	-
At Avon Wharf (Docking)	Maneuvering	BAAQMD	0	1.00	0.45	1,350
At Avon Wharf (Hoteling and Prod. Transfer)	Hotelling	BAAQMD	0	18.06	0.00	-
At Avon Wharf (Undocking)	Maneuvering	BAAQMD	0	1.00	0.45	1,350
Wait After (fleeting)	Fleeting	BAAQMD	0	2.60	0.00	-
Cruise - BAAQMD	Transit	BAAQMD	0	4.65	0.45	6,276
Cruise - SJVAPCD	Transit	SJVAPCD	0	2.55	0.45	3,444
Wait Before (fleeting)	Fleeting	SJVAPCD	0	11.67	0.00	-
At Stockton (Docking)	Maneuvering	SJVAPCD	0	1.00	0.45	1,350

Notes: Load Factors from CARB, Appendix C Updates on the Emissions Inventory for Commercial Harbor Craft Operating in California, Table 3

Propulsion Tug Main Engine Emissions per Round-Trip

EF Lookup	Lb/Trip						MT/Trip			
	POC	CO	NOx	SO_2	PM10	PM2.5	CO2	CH4	N2O	CO2e
Propulsion Tug Main Engine	0.00	0.00	0.00	0.00	0.00	0.00	0.0	0.00	0.00	0.0
Propulsion Tug Main Engine	0.44	3.10	7.80	0.02	0.24	0.24	0.8	0.00	0.00	0.8
Propulsion Tug Main Engine	0.00	0.00	0.00	0.00	0.00	0.00	0.0	0.00	0.00	0.0
Propulsion Tug Main Engine	1.13	7.91	19.91	0.04	0.62	0.62	2.0	0.00	0.00	2.0
Propulsion Tug Main Engine	2.06	14.41	36.28	0.08	1.12	1.12	3.6	0.00	0.00	3.6
Propulsion Tug Main Engine	0.00	0.00	0.00	0.00	0.00	0.00	0.0	0.00	0.00	0.0
Propulsion Tug Main Engine	0.44	3.10	7.80	0.02	0.24	0.24	0.8	0.00	0.00	0.8
Propulsion Tug Main Engine	0.00	0.00	0.00	0.00	0.00	0.00	0.0	0.00	0.00	0.0
Propulsion Tug Main Engine	0.44	3.10	7.80	0.02	0.24	0.24	0.8	0.00	0.00	0.8
Propulsion Tug Main Engine	0.00	0.00	0.00	0.00	0.00	0.00	0.0	0.00	0.00	0.0
Propulsion Tug Main Engine	2.06	14.41	36.28	0.08	1.12	1.12	3.6	0.00	0.00	3.6
Propulsion Tug Main Engine	1.13	7.91	19.91	0.04	0.62	0.62	2.0	0.00	0.00	2.0
Propulsion Tug Main Engine	0.00	0.00	0.00	0.00	0.00	0.00	0.0	0.00	0.00	0.0
Propulsion Tug Main Engine	0.44	3.10	7.80	0.02	0.24	0.24	0.8	0.00	0.00	0.8

Barge Auxiliary Generator Usage per Round-Trip

Propulsion tug aux gen engine, hp 140

Activity	Mode	Air District	# Engines Operating	Duration (hr/trip)	Load Factor	hp-hr/ Transit
At Stockton (Hoteling and Prod. Transfer)	Hotelling	SJVAPCD	1	14.01	0.75	1,471
At Stockton (Undocking)	Maneuvering	SJVAPCD	1	1.00	0.75	105
Wait After (fleeting)	Fleeting	SJVAPCD	1	3.22	0.75	339
Cruise - SJVAPCD	Transit	SJVAPCD	1	2.55	0.75	268
Cruise - BAAQMD	Transit	BAAQMD	1	4.65	0.75	488
Wait Before (fleeting)	Fleeting	BAAQMD	1	18.52	0.75	1,944
At Avon Wharf (Docking)	Maneuvering	BAAQMD	1	1.00	0.75	105
At Avon Wharf (Hoteling and Prod. Transfer)	Hotelling	BAAQMD	1	18.06	0.75	1,896
At Avon Wharf (Undocking)	Maneuvering	BAAQMD	1	1.00	0.75	105
Wait After (fleeting)	Fleeting	BAAQMD	1	2.60	0.75	272
Cruise - BAAQMD	Transit	BAAQMD	1	4.65	0.75	488
Cruise - SJVAPCD	Transit	SJVAPCD	1	2.55	0.75	268
Wait Before (fleeting)	Fleeting	SJVAPCD	1	11.67	0.75	1,226
At Stockton (Docking)	Maneuvering	SJVAPCD	1	1.00	0.75	105

Notes: (1) Port of Los Angeles Air Emissions Inventory - 2019 - Table 3.2 (Starcrest, 2020); Assume Tanker - Handysize

Barge Auxiliary Generator Emissions per Round-Trip

EF Lookup	Lb/Trip						MT/Trip			
	POC	CO	NOx	SO_2	PM10	PM2.5	CO2	CH4	N2O	CO2e
Propulsion Tug Aux Gen Engine	0.42	9.63	7.98	0.02	0.04	0.04	0.8	0.00	0.00	0.8
Propulsion Tug Aux Gen Engine	0.03	0.69	0.57	0.00	0.00	0.00	0.1	0.00	0.00	0.1
Propulsion Tug Aux Gen Engine	0.10	2.22	1.84	0.00	0.01	0.01	0.2	0.00	0.00	0.2
Propulsion Tug Aux Gen Engine	0.08	1.75	1.45	0.00	0.01	0.01	0.2	0.00	0.00	0.2
Propulsion Tug Aux Gen Engine	0.14	3.20	2.65	0.01	0.01	0.01	0.3	0.00	0.00	0.3
Propulsion Tug Aux Gen Engine	0.55	12.73	10.55	0.02	0.05	0.05	1.1	0.00	0.00	1.1
Propulsion Tug Aux Gen Engine	0.03	0.69	0.57	0.00	0.00	0.00	0.1	0.00	0.00	0.1
Propulsion Tug Aux Gen Engine	0.54	12.42	10.29	0.02	0.05	0.05	1.1	0.00	0.00	1.1
Propulsion Tug Aux Gen Engine	0.03	0.69	0.57	0.00	0.00	0.00	0.1	0.00	0.00	0.1
Propulsion Tug Aux Gen Engine	0.08	1.78	1.48	0.00	0.01	0.01	0.2	0.00	0.00	0.2
Propulsion Tug Aux Gen Engine	0.14	3.20	2.65	0.01	0.01	0.01	0.3	0.00	0.00	0.3
Propulsion Tug Aux Gen Engine	0.08	1.75	1.45	0.00	0.01	0.01	0.2	0.00	0.00	0.2
Propulsion Tug Aux Gen Engine	0.35	8.02	6.65	0.01	0.03	0.03	0.7	0.00	0.00	0.7
Propulsion Tug Aux Gen Engine	0.03	0.69	0.57	0.00	0.00	0.00	0.1	0.00	0.00	0.1

E = [EF g/kW-hr] x [Energy kW-hr] x [Conversion from g to lb or MT]

Appendix G - Transportation Emissions (Marine Vessels, Trucks, Rails)

Mobile Source - Marine Vessel Post-Project Emissions

Operational Marine Vessel Emissions

Rail to Barge to Avon (Brownwater (1-2 barge tow)) - RD Fd Stock

Barge Offload Pump Usage per Round-Trip

Barge aux pump engine, hp 345

Activity	Mode	Air District	# Engines Operaing	Duration (hr/trip)	Load Factor	hp-hr/ Transit
At Avon Wharf (Hoteling and Prod. Transfer	Hotelling	BAAQMD	1	15.49	0.71	3,795

Notes: (1) Port of Los Angeles Air Emissions Inventory - 2019 - Table 3.5 (Starcrest, 2020); Assume Tanker - Handysize

Barge Offload Pump Emissions per Round-Trip

	Lb/Trip						MT/Trip			
EF Lookup	POC	CO	NOx	SO_2	PM10	PM2.5	CO2	CH4	N2O	CO2e
Barge Aux Pump Engine	0.84	8.52	12.40	0.05	0.11	0.11	2.2	0.00	0.00	2.2

Barge Circulation Pump Usage per Round-Trip

Barge circ pump engine, hp 140

Activity	Mode	Air District	# Engines Operaing	Duration (hr/trip)	Load Factor	hp-hr/ Transit
Near Avon Wharf	Fleeting	BAAQMD	1	0.22	0.71	22

Notes: Load Factor from CARB, Appendix C Updates on the Emissions Inventory for Commercial Harbor Craft Operating in California, Table 3

Barge Circulation Pump Emissions per Round-Trip

	Lb/Trip						MT/Trip			
EF Lookup	POC	CO	NOx	SO_2	PM10	PM2.5	CO2	CH4	N2O	CO2e
Barge Circ Pump Engine	0.01	0.15	0.12	0.00	0.00	0.00	0.0	0.00	0.00	0.0

Barge Circulation Heater Usage per Round-Trip

Barge circ heater, MMBtu/hr 8

Activity	Mode	Air District	# Heaters Operaing	Duration (hr/trip)	Load Factor	kW-hr/ Transit
Near Avon Wharf	Fleeting	BAAQMD	1	0.22	1	521

Notes: Load factor not known

Barge Circulation Heater Emissions per Round-Trip

	Lb/Trip						MT/Trip			
EF Lookup	POC	CO	NOx	SO_2	PM10	PM2.5	CO2	CH4	N2O	CO2e
OGV Auxiliary Boilers	0.11	0.23	2.30	0.69	0.20	0.17	0.5	0.00	0.00	0.5

Tugboat Usage during Escort & Assist

Engine Type	# Tugboats	Air District	Max HP per Tug	Load Factor [1]	Tug-Hours/ Round-Trip [2]	hp-hr/ Round-Trip
Escort - Main Engine (BAAQMD)	See above	BAAQMD	5,351	0.31	0.00	-
Escort - Auxiliary Generator (BAAQMD)	See above	BAAQMD	402	0.43	0.00	-
Escort - Main Engine (SJVAPCD)	See above	SJVAPCD	5,000	0.31	0.00	-
Escort - Auxiliary Generator (SJVAPCD)	See above	SJVAPCD	402	0.43	0.00	-
Assist - Main Engine (BAAQMD)	1	BAAQMD	5,351	0.31	4.00	6,635
Assist - Auxiliary Generator (BAAQMD)	1	BAAQMD	402	0.43	4.00	692
Assist - Main Engine (SJVAPCD)	1	SJVAPCD	5,000	0.31	4.00	6,200
Assist - Auxiliary Generator (SJVAPCD)	1	SJVAPCD	402	0.43	4.00	692

Notes: (1) Port of Long Beach Air Emissions Inventory - 2013 - Table 3.4 (Starcrest 2014), Assist Tug category

(2) Time spent operating per vessel trip. Estimated assist time to account for tug movement, docking, and undocking, plus 4x30 minute trips to/from temporary tug base.

(3) If escort tug is present, it will serve as an assist tug for docking/undocking.

Tugboat Emissions during Escort & Assist

	Lb/Trip						MT/Trip			
EF Lookup	POC	CO	NOx	SO_2	PM10	PM2.5	CO2	CH4	N2O	CO2e
Tug ME (1900-3300 hp, 2009)	0.00	0.00	0.00	0.00	0.00	0.00	0.0	0.000	0.000	0.0
Tug AE (250-500 hp, 2009)	0.00	0.00	0.00	0.00	0.00	0.00	0.0	0.000	0.000	0.0
Tug ME (1900-3300 hp, 2009)	0.00	0.00	0.00	0.00	0.00	0.00	0.0	0.000	0.000	0.0
Tug AE (250-500 hp, 2009)	0.00	0.00	0.00	0.00	0.00	0.00	0.0	0.000	0.000	0.0
Tug ME (1900-3300 hp, 2009)	13.07	64.30	93.02	0.08	4.33	4.33	3.2	0.000	0.000	3.3
Tug AE (250-500 hp, 2009)	1.59	6.62	8.85	0.01	0.33	0.33	0.4	0.000	0.000	0.4
Tug ME (1900-3300 hp, 2009)	12.22	60.09	86.93	0.08	4.04	4.04	3.0	0.000	0.000	3.0
Tug AE (250-500 hp, 2009)	1.59	6.62	8.85	0.01	0.33	0.33	0.4	0.000	0.000	0.4

Emission Calculation Notes:

For propulsion tug main & aux engines:

[Emissions (g) = [Energy hp-hr] x [EFo g/bhp-hr] x (1+[Deterioration Factor] x [Engine Age]/[Useful Life])

For tug main & aux engines:

[Emissions (g) = [Energy hp-hr] x [EFo g/bhp-hr] x (1+[Deterioration Factor] x [Engine Age]/[Useful Life])

Appendix G - Transportation Emissions (Marine Vessels, Trucks, Rails)

Summary of Marine Vessel Emissions
Amorco Terminal
2017 - 2019 Operations

S-55 (Amorco) Baseline Emissions

Annual Emissions - Amorco

Year	Round Trips/Year	BAAQMD Criteria Pollutant Emissions (TPY)					
		POC	SO2	NOx	CO	PM10	PM2.5
2017	80	6.45	4.46	108.20	19.25	3.37	3.10
2018	91	7.18	4.86	118.87	21.45	3.70	3.41
2019	94	7.57	5.31	126.57	22.54	3.96	3.64
Average		**7.07**	**4.88**	**117.88**	**21.08**	**3.68**	**3.38**

2017 Operations

Annual Total			BAAQMD					
			POC	SOx	NOx	CO	PM10	PM2.5
Sheet	Wharf	Round Trips/Year	tpy	tpy	tpy	tpy	tpy	tpy
2017 - 1	Amorco	28	2.32	1.54	38.74	6.82	1.18	1.09
2017 - 2	Amorco	39	3.14	2.23	53.58	9.47	1.68	1.55
2017 - 3	Amorco	9	0.74	0.52	12.20	2.17	0.38	0.35
2017 - 4	Amorco	4	0.24	0.17	3.68	0.78	0.12	0.12
Total:		**80**	**6.45**	**4.46**	**108.20**	**19.25**	**3.37**	**3.10**

2018 Operations

Annual Total			BAAQMD					
			POC	SOx	NOx	CO	PM10	PM2.5
Sheet	Wharf	Round Trips/Year	tpy	tpy	tpy	tpy	tpy	tpy
2018 - 1	Amorco	34	2.83	1.89	47.31	8.30	1.44	1.33
2018 - 2	Amorco	26	2.09	1.48	35.59	6.30	1.12	1.03
2018 - 3	Amorco	19	1.52	1.02	24.75	4.48	0.77	0.71
2018 - 4	Amorco	12	0.74	0.47	11.21	2.36	0.37	0.34
Total:		**91**	**7.18**	**4.86**	**118.87**	**21.45**	**3.70**	**3.41**

2019 Operations

Annual Total			BAAQMD					
			POC	SOx	NOx	CO	PM10	PM2.5
Sheet	Wharf	Round Trips/Year	tpy	tpy	tpy	tpy	tpy	tpy
2019 - 1	Amorco	43	3.65	2.53	61.44	10.67	1.89	1.74
2019 - 2	Amorco	22	1.80	1.31	30.96	5.42	0.98	0.90
2019 - 3	Amorco	16	1.32	0.94	21.81	3.88	0.69	0.63
2019 - 4	Amorco	13	0.81	0.53	12.36	2.58	0.41	0.38
Total:		**94**	**7.57**	**5.31**	**126.57**	**22.54**	**3.96**	**3.64**

Appendix G - Transportation Emissions (Marine Vessels, Trucks, Rails)

Table 1a - Marine Vessel 2017 Emissions
Operational Marine Vessel Emissions
AfraMax Ship to Amorco - Crude

Vessel Type	AfraMax
Berth Location	Amorco
Cargo Per Vessel (Mbbl)	800
Round Trips/Year	28
Max speed (kn)	14.4

Transfer Activities Per Round-Trip

Material	Direction	Mbbl/yr	Mbbl/trip	Transfer Rate bbl/hr	Transfer Time hrs	Escort Tug Needed?
Crude	Inbound	10,669	381.05	10,000	33.57	TRUE
	Outbound	0	0.00	6,000		FALSE

Additional Hoteling Time

Activity	Hrs
Hook-up (start)	3
Hook-up (end)	2
Bunkering (2-6 hrs on ~50% of ships)	1.5

OGV Main Engine Usage per Round-Trip

Activity	Mode	# Escort Tugs Req'd (3)	Propulsion Max kW (1)	Speed (kn)	Load Factor (1)	Distance (nm/trip)	Duration (hr/trip)	kW-hr/ Round-Trip
Pilot Boarding (Sea Buoy) to COLREGS Line	Transit	0	13500	12	0.58	8.8	0.73	5,729
COLREGS Line to Golden Gate Bridge	Transit	1	13500	10	0.33	2.3	0.23	1,040
Golden Gate Bridge to Echo Buoy	Transit	1	13500	10	0.33	16.45	1.65	7,437
Echo Buoy to SPB Light #15	Transit	1	13500	10	0.33	7.7	0.77	3,481
SPB Light #15 to Near Shell Terminal	Transit	1	13500	8	0.17	6	0.75	1,736
Near Shell Terminal to Amorco Wharf	Transit	1	13500	5	0.04	0.5	0.10	57
At Amorco Wharf (Docking)	Maneuvering	0	13500	n/a	0.02	n/a	1.50	405
At Amorco Wharf (Hoteling and Prod. Transfer)	Hotelling	0	13500	n/a	0.00	n/a	40.07	-
At Amorco Wharf (Undocking)	Maneuvering	0	13500	n/a	0.02	n/a	1.50	405
Amorco Wharf to Near Shell Terminal	Transit	0	13500	8	0.17	0.5	0.06	145
Near Shell Terminal to SPB Light #15	Transit	0	13500	12	0.58	6	0.50	3,906
SPB Light #15 to COLREGS Line	Transit	0	13500	12	0.58	26.45	2.20	17,220
COLREGS Line to Pilot Boarding (Sea Buoy)	Transit	0	13500	12	0.58	8.8	0.73	5,729

Notes: (1) Load factor = (speed/max speed)3. Load factor of 0.02 represents minimum load factor for propulsion engines.
(2) Assume 1.5 hrs for docking and 1.5 hrs for undocking.
(3) Escort tug required to or from Golden Gate Bridge when carrying hydrocarbon.
(4) Maximum vessel speed based on Port of Los Angeles Air Emissions Inventory - 2019, Table 2.9

OGV Auxiliary Generator Usage per Round-Trip

Activity	Mode	Aux Eng. Max kW	Load Factor (1)	Hours/ Trip	kW-hr/ Round-Trip
Pilot Boarding (Sea Buoy) to COLREGS Line	Transit	2339	24%	0.73	412
COLREGS Line to Golden Gate Bridge	Transit	2339	24%	0.23	129
Golden Gate Bridge to Echo Buoy	Transit	2339	24%	1.65	923
Echo Buoy to SPB Light #15	Transit	2339	24%	0.77	432
SPB Light #15 to Near Shell Terminal	Transit	2339	24%	0.75	421
Near Shell Terminal to Amorco Wharf	Transit	2339	24%	0.10	56
At Amorco Wharf (Docking)	Maneuvering	2339	33%	1.50	1,158
At Amorco Wharf (Hoteling and Prod. Transfer)	Hotelling	2339	26%	40.07	24,370
At Amorco Wharf (Undocking)	Maneuvering	2339	33%	1.50	1,158
Amorco Wharf to Near Shell Terminal	Transit	2339	24%	0.06	35
Near Shell Terminal to SPB Light #15	Transit	2339	24%	0.50	281
SPB Light #15 to COLREGS Line	Transit	2339	24%	2.20	1,237
COLREGS Line to Pilot Boarding (Sea Buoy)	Transit	2339	24%	0.73	412

Notes: (1) California ARB, May 2011, Appendix D, Emissions Estimation Methodology for Ocean-Going Vessels, Table II-5

Emissions Summary

	Emissions (Pounds)						Emissions (MT)			
	POC	CO	NOx	SOx	PM10	PM2.5	CO2	CH4	N2O	CO2e
Emissions/Round-Trip	166.03	486.86	2,766.93	109.75	84.27	77.54	86	0.00	0.005	87
Annual Total	4,649	13,632	77,474	3,073	2,359	2,171	2,400	0.04	0.140	2,444
Daily Total	13	37	212	8	6	6	7	0.00	0.000	7
Annual Onsite	759	1,970	18,950	1,648	749	673	1,128	0.01	0.07	1,151

Notes:
- Onsite emissions include hotelling only.

OGV Main Engine Emissions per Round-Trip

EF Lookup	Lb/Trip						MT/Trip			
	POC	CO	NOx	SOx	PM10	PM2.5	CO2	CH4	N2O	CO2e
OGV Main Engines	7.58	17.68	181.88	5.05	4.04	3.66	3.4	0.00	0.000	3.4
OGV Main Engines	1.38	3.21	33.01	0.92	0.73	0.66	0.6	0.00	0.000	0.6
OGV Main Engines	9.84	22.95	236.11	6.56	5.25	4.75	4.4	0.00	0.000	4.4
OGV Main Engines	4.60	10.74	110.52	3.07	2.46	2.23	2.1	0.00	0.000	2.1
OGV Main Engines	2.69	6.22	56.81	1.53	1.29	1.17	1.0	0.00	0.000	1.0
OGV Main Engines	0.54	0.81	3.80	0.05	0.12	0.11	0.0	0.00	0.000	0.0
OGV Main Engines	11.35	12.12	59.47	0.36	2.08	1.89	0.2	0.00	0.000	0.3
OGV Main Engines	0.00	0.00	0.00	0.00	0.00	0.00	0.0	0.00	0.000	0.0
OGV Main Engines	11.35	12.12	59.47	0.36	2.08	1.89	0.2	0.00	0.000	0.3
OGV Main Engines	0.22	0.52	4.73	0.13	0.11	0.10	0.1	0.00	0.000	0.1
OGV Main Engines	5.17	12.06	124.01	3.44	2.76	2.50	2.3	0.00	0.000	2.3
OGV Main Engines	22.78	53.15	546.68	15.19	12.15	11.01	10.1	0.00	0.000	10.3
OGV Main Engines	7.58	17.68	181.88	5.05	4.04	3.66	3.4	0.00	0.000	3.4

E = [EF g/kW-hr] x [Energy kW-hr] x [Low Load Factor] x [Conversion from g to lb or MT]

OGV Auxiliary Generator Emissions per Round-Trip

EF Lookup	Lb/Trip						MT/Trip			
	POC	CO	NOx	SOx	PM10	PM2.5	CO2	CH4	N2O	CO2e
OGV Auxiliary Engines	0.36	1.00	9.53	0.42	0.29	0.26	0.3	0.00	0.00	0.3
OGV Auxiliary Engines	0.11	0.31	2.99	0.13	0.09	0.08	0.1	0.00	0.00	0.1
OGV Auxiliary Engines	0.81	2.24	21.38	0.95	0.65	0.59	0.6	0.00	0.00	0.6
OGV Auxiliary Engines	0.38	1.05	10.01	0.44	0.30	0.28	0.3	0.00	0.00	0.3
OGV Auxiliary Engines	0.37	1.02	9.75	0.43	0.30	0.27	0.3	0.00	0.00	0.3
OGV Auxiliary Engines	0.05	0.14	1.30	0.06	0.04	0.04	0.0	0.00	0.00	0.0
OGV Auxiliary Engines	1.02	2.81	26.80	1.19	0.82	0.74	0.8	0.00	0.00	0.8
OGV Auxiliary Engines	21.49	59.10	564.13	25.07	17.19	15.58	16.7	0.00	0.00	16.9
OGV Auxiliary Engines	1.02	2.81	26.80	1.19	0.82	0.74	0.8	0.00	0.00	0.8
OGV Auxiliary Engines	0.03	0.09	0.81	0.04	0.02	0.02	0.0	0.00	0.00	0.0
OGV Auxiliary Engines	0.25	0.68	6.50	0.29	0.20	0.18	0.2	0.00	0.00	0.2
OGV Auxiliary Engines	1.09	3.00	28.64	1.27	0.87	0.79	0.8	0.00	0.00	0.9
OGV Auxiliary Engines	0.36	1.00	9.53	0.42	0.29	0.26	0.3	0.00	0.00	0.3

E = [EF g/kW-hr] x [Energy kW-hr] x [Conversion from g to lb or MT]

Appendix G - Transportation Emissions (Marine Vessels, Trucks, Rails)

Table 1a - Marine Vessel 2017 Emissions
Operational Marine Vessel Emissions
AfraMax Ship to Amorco - Crude

OGV Auxiliary Boiler Usage per Round-Trip

Activity	Mode	Boiler kW per Vessel (1,2)	Hours/ Transit	kW-hr/ Round-Trip
Pilot Boarding (Sea Buoy) to COLREGS Line	Transit	144	0.73	106
COLREGS Line to Golden Gate Bridge	Transit	144	0.23	33
Golden Gate Bridge to Echo Buoy	Transit	144	1.65	237
Echo Buoy to SPB Light #15	Transit	144	0.77	111
SPB Light #15 to Near Shell Terminal	Transit	144	0.75	108
Near Shell Terminal to Amorco Wharf	Transit	144	0.10	14
At Amorco Wharf (Docking)	Maneuvering	144	1.50	216
At Amorco Wharf (Hoteling and Prod. Transfer)	Hotelling	638	40.07	25,547
At Amorco Wharf (Undocking)	Maneuvering	144	1.50	216
Amorco Wharf to Near Shell Terminal	Transit	144	0.06	9
Near Shell Terminal to SPB Light #15	Transit	144	0.50	72
SPB Light #15 to COLREGS Line	Transit	144	2.20	317
COLREGS Line to Pilot Boarding (Sea Buoy)	Transit	144	0.73	106

Notes: (1) Port of Los Angeles Air Emissions Inventory - 2019 - Table 3.5 (Starcrest, 2020); Assume Tanker - Handysize
(2) Boiler load during hotelling based on engineering estimate of fuel consumption

Tugboat Usage during Escort & Assist

Engine Type	Max Hp Per Tug	Load Factor (1)	# Tugboats	Tug-Hrs/ Round-Trip (2)	hp-hr/ Round-Trip
Escort - Main Engine	5,351	0.31	See above	3.50	5,797
Escort - Auxiliary Generator	402	0.43	See above	3.50	605
Assist - Main Engine	5,351	0.31	2	9.50	15,758
Assist - Auxiliary Generator	402	0.43	2	9.50	1,643

Notes: (1) Port of Long Beach Air Emissions Inventory - 2013 - Table 3.4 (Starcrest 2014); Assume Assist tug category
(2) Time spent operating per vessel trip. Estimated assist time to account for tug movement, docking, and undocking, plus 4x30 minute trips to/from temporary tug base.
(3) If escort tug is present, it will serve as one of the two assist tugs for docking/undocking, eliminating the need for one 30 minute trip to/from temporary tug base.

OGV Auxiliary Boiler Emissions per Round-Trip

	Lb/Trip						MT/Trip			
EF Lookup	POC	CO	NOx	SOx	PM10	PM2.5	CO2	CH4	N2O	CO2e
OGV Auxiliary Boilers	0.02	0.05	0.47	0.14	0.04	0.03	0.1	0.00	0.00	0.1
OGV Auxiliary Boilers	0.01	0.01	0.15	0.04	0.01	0.01	0.0	0.00	0.00	0.0
OGV Auxiliary Boilers	0.05	0.10	1.04	0.31	0.09	0.08	0.2	0.00	0.00	0.2
OGV Auxiliary Boilers	0.02	0.05	0.49	0.15	0.04	0.04	0.1	0.00	0.00	0.1
OGV Auxiliary Boilers	0.02	0.05	0.48	0.14	0.04	0.04	0.1	0.00	0.00	0.1
OGV Auxiliary Boilers	0.00	0.01	0.06	0.02	0.01	0.00	0.0	0.00	0.00	0.0
OGV Auxiliary Boilers	0.05	0.10	0.95	0.29	0.08	0.07	0.2	0.00	0.00	0.2
OGV Auxiliary Boilers	5.63	11.26	112.64	33.79	9.57	8.45	23.6	0.00	0.00	24.1
OGV Auxiliary Boilers	0.05	0.10	0.95	0.29	0.08	0.07	0.2	0.00	0.00	0.2
OGV Auxiliary Boilers	0.00	0.00	0.04	0.01	0.00	0.00	0.0	0.00	0.00	0.0
OGV Auxiliary Boilers	0.02	0.03	0.32	0.10	0.03	0.02	0.1	0.00	0.00	0.1
OGV Auxiliary Boilers	0.07	0.14	1.40	0.42	0.12	0.10	0.3	0.00	0.00	0.3
OGV Auxiliary Boilers	0.02	0.05	0.47	0.14	0.04	0.03	0.1	0.00	0.00	0.1

Tugboat Emissions during Escort & Assist

	Lb/Trip						MT/Trip			
EF Lookup	POC	CO	NOx	SOx	PM10	PM2.5	CO2	CH4	N2O	CO2e
Tug ME (1900-3300 hp, 2009)	11.42	56.18	81.28	0.07	3.78	3.78	2.8	0.000	0.000	2.9
Tug AE (250-500 hp, 2009)	1.39	5.78	7.73	0.01	0.29	0.29	0.3	0.000	0.000	0.3
Tug ME (1900-3300 hp, 2009)	31.05	152.72	220.93	0.19	10.27	10.27	7.6	0.000	0.000	7.8
Tug AE (250-500 hp, 2009)	3.78	15.72	21.01	0.02	0.78	0.78	0.8	0.000	0.000	0.9

Emission Calculation Notes:
For OGV main & aux engines:
[Emissions (g)] = [Energy (kW-hr)] x [EF (g/kW-hr)] x LLA
For OGV aux engines:
[Emissions (g)] = [Energy (kW-hr)] x [EF (g/kW-hr)]
For OGV aux boilers:
[Emissions (g)] = [Energy (kW-hr)] x [EF (g/kW-hr)]
For tug main & aux engines:
[Emissions (g) = [Energy hp-hr] x [EFo g/bhp-hr] x (1+[Deterioration Factor] x [Engine Age]/[Useful Life])

Appendix G - Transportation Emissions (Marine Vessels, Trucks, Rails)

Table 1b - Marine Vessel 2017 Emissions
Operational Marine Vessel Emissions
PanaMax Ship to Amorco - Crude

Vessel Type	PanaMax
Berth Location	Amorco
Cargo Per Vessel (Mbbl)	500
Round Trips/Year	39
Max speed (kn)	14.9

Transfer Activities Per Round-Trip

Material	Direction	Mbbl/yr	Mbbl/trip	Transfer Rate bbl/hr	Transfer Time hrs	Escort Tug Needed?
Crude	Inbound	16,256	416.83	10,000	31.99	TRUE
	Outbound	0	0.00	6,000		FALSE

Additional Hoteling Time

Activity	Hrs
Hook-up (start)	3
Hook-up (end)	2
Bunkering (2-6 hrs on ~50% of ships)	1.5

OGV Main Engine Usage per Round-Trip

Activity	Mode	# Escort Tugs Req'd (3)	Propulsion Max kW (1)	Speed (kn)	Load Factor (1)	Distance (nm/trip)	Duration (hr/trip)	kW-hr/ Round-Trip
Pilot Boarding (Sea Buoy) to COLREGS Line	Transit	0	11396	12	0.52	8.8	0.73	4,366
COLREGS Line to Golden Gate Bridge	Transit	1	11396	10	0.30	2.3	0.23	792
Golden Gate Bridge to Echo Buoy	Transit	1	11396	10	0.30	16.45	1.65	5,667
Echo Buoy to SPB Light #15	Transit	1	11396	10	0.30	7.7	0.77	2,653
SPB Light #15 to Near Shell Terminal	Transit	1	11396	8	0.15	6	0.75	1,323
Near Shell Terminal to Amorco Wharf	Transit	1	11396	5	0.04	0.5	0.10	43
At Amorco Wharf (Docking)	Maneuvering	0	11396	n/a	0.02	n/a	1.50	342
At Amorco Wharf (Hoteling and Prod. Transfer)	Hotelling	0	11396	n/a	0.00	n/a	38.49	-
At Amorco Wharf (Undocking)	Maneuvering	0	11396	n/a	0.02	n/a	1.50	342
Amorco Wharf to Near Shell Terminal	Transit	0	11396	8	0.15	0.5	0.06	110
Near Shell Terminal to SPB Light #15	Transit	0	11396	12	0.52	6	0.50	2,977
SPB Light #15 to COLREGS Line	Transit	0	11396	12	0.52	26.45	2.20	13,121
COLREGS Line to Pilot Boarding (Sea Buoy)	Transit	0	11396	12	0.52	8.8	0.73	4,366

Notes: (1) Load factor = (speed/max speed)3. Load factor of 0.02 represents minimum load factor for propulsion engines.
(2) Assume 1.5 hrs for docking and 1.5 hrs for undocking.
(3) Escort tug required to or from Golden Gate Bridge when carrying hydrocarbon.
(4) Maximum vessel speed based on Port of Los Angeles Air Emissions Inventory - 2019, Table 2.9

OGV Auxiliary Generator Usage per Round-Trip

Activity	Mode	Aux Eng. Max kW	Load Factor (1)	Hours/ Trip	kW-hr/ Round-Trip
Pilot Boarding (Sea Buoy) to COLREGS Line	Transit	3605	24%	0.73	634
COLREGS Line to Golden Gate Bridge	Transit	3605	24%	0.23	199
Golden Gate Bridge to Echo Buoy	Transit	3605	24%	1.65	1,423
Echo Buoy to SPB Light #15	Transit	3605	24%	0.77	666
SPB Light #15 to Near Shell Terminal	Transit	3605	24%	0.75	649
Near Shell Terminal to Amorco Wharf	Transit	3605	24%	0.10	87
At Amorco Wharf (Docking)	Maneuvering	3605	33%	1.50	1,784
At Amorco Wharf (Hoteling and Prod. Transfer)	Hotelling	3605	26%	38.49	36,078
At Amorco Wharf (Undocking)	Maneuvering	3605	33%	1.50	1,784
Amorco Wharf to Near Shell Terminal	Transit	3605	24%	0.06	54
Near Shell Terminal to SPB Light #15	Transit	3605	24%	0.50	433
SPB Light #15 to COLREGS Line	Transit	3605	24%	2.20	1,907
COLREGS Line to Pilot Boarding (Sea Buoy)	Transit	3605	24%	0.73	634

Notes: (1) California ARB, May 2011, Appendix D, Emissions Estimation Methodology for Ocean-Going Vessels, Table II-5

Emissions Summary

	Emissions (Pounds)						Emissions (MT)			
	POC	CO	NOx	SOx	PM10	PM2.5	CO2	CH4	N2O	CO2e
Emissions/Round-Trip	161.26	485.85	2,747.61	114.30	86.25	79.35	89	0.00	0.005	90
Annual Total	6,289	18,948	107,157	4,458	3,364	3,095	3,458	0.05	0.196	3,520
Daily Total	17	52	294	12	9	8	9	0.00	0.001	10
Annual Onsite	1,452	3,834	36,790	2,713	1,351	1,216	1,848	0.01	0.11	1,883

Notes:
- Onsite emissions include hotelling only.

OGV Main Engine Emissions per Round-Trip

EF Lookup	Lb/Trip						MT/Trip			
	POC	CO	NOx	SOx	PM10	PM2.5	CO2	CH4	N2O	CO2e
OGV Main Engines	5.77	13.47	138.59	3.85	3.08	2.79	2.6	0.00	0.000	2.6
OGV Main Engines	1.05	2.45	25.15	0.70	0.56	0.51	0.5	0.00	0.000	0.5
OGV Main Engines	7.50	17.49	179.91	5.00	4.00	3.62	3.3	0.00	0.000	3.4
OGV Main Engines	3.51	8.19	84.21	2.34	1.87	1.70	1.6	0.00	0.000	1.6
OGV Main Engines	2.29	5.24	44.33	1.17	1.02	0.93	0.8	0.00	0.000	0.8
OGV Main Engines	0.48	0.68	3.18	0.04	0.10	0.09	0.0	0.00	0.000	0.0
OGV Main Engines	9.58	10.23	50.20	0.30	1.76	1.59	0.2	0.00	0.000	0.2
OGV Main Engines	0.00	0.00	0.00	0.00	0.00	0.00	0.0	0.00	0.000	0.0
OGV Main Engines	9.58	10.23	50.20	0.30	1.76	1.59	0.2	0.00	0.000	0.2
OGV Main Engines	0.19	0.44	3.69	0.10	0.09	0.08	0.1	0.00	0.000	0.1
OGV Main Engines	3.94	9.19	94.49	2.62	2.10	1.90	1.8	0.00	0.000	1.8
OGV Main Engines	17.36	40.50	416.56	11.57	9.26	8.39	7.7	0.00	0.000	7.8
OGV Main Engines	5.77	13.47	138.59	3.85	3.08	2.79	2.6	0.00	0.000	2.6

E = [EF g/kW-hr] x [Energy kW-hr] x [Low Load Factor] x [Conversion from g to lb or MT]

OGV Auxiliary Generator Emissions per Round-Trip

EF Lookup	Lb/Trip						MT/Trip			
	POC	CO	NOx	SOx	PM10	PM2.5	CO2	CH4	N2O	CO2e
OGV Auxiliary Engines	0.56	1.54	14.69	0.65	0.45	0.41	0.4	0.00	0.00	0.4
OGV Auxiliary Engines	0.18	0.48	4.61	0.20	0.14	0.13	0.1	0.00	0.00	0.1
OGV Auxiliary Engines	1.26	3.45	32.95	1.46	1.00	0.91	1.0	0.00	0.00	1.0
OGV Auxiliary Engines	0.59	1.62	15.42	0.69	0.47	0.43	0.5	0.00	0.00	0.5
OGV Auxiliary Engines	0.57	1.57	15.02	0.67	0.46	0.41	0.4	0.00	0.00	0.5
OGV Auxiliary Engines	0.08	0.21	2.00	0.09	0.06	0.06	0.1	0.00	0.00	0.1
OGV Auxiliary Engines	1.57	4.33	41.31	1.84	1.26	1.14	1.2	0.00	0.00	1.2
OGV Auxiliary Engines	31.82	87.49	835.15	37.12	25.45	23.07	24.7	0.00	0.00	25.1
OGV Auxiliary Engines	1.57	4.33	41.31	1.84	1.26	1.14	1.2	0.00	0.00	1.2
OGV Auxiliary Engines	0.05	0.13	1.25	0.06	0.04	0.03	0.0	0.00	0.00	0.0
OGV Auxiliary Engines	0.38	1.05	10.01	0.45	0.31	0.28	0.3	0.00	0.00	0.3
OGV Auxiliary Engines	1.68	4.62	44.15	1.96	1.35	1.22	1.3	0.00	0.00	1.3
OGV Auxiliary Engines	0.56	1.54	14.69	0.65	0.45	0.41	0.4	0.00	0.00	0.4

E = [EF g/kW-hr] x [Energy kW-hr] x [Conversion from g to lb or MT]

Appendix G - Transportation Emissions (Marine Vessels, Trucks, Rails)

Table 1b - Marine Vessel 2017 Emissions
Operational Marine Vessel Emissions
PanaMax Ship to Amorco - Crude

OGV Auxiliary Boiler Usage per Round-Trip

Activity	Mode	Boiler kW per Vessel (1,2)	Hours/ Transit	kW-hr/ Round-Trip
Pilot Boarding (Sea Buoy) to COLREGS Line	Transit	144	0.73	106
COLREGS Line to Golden Gate Bridge	Transit	144	0.23	33
Golden Gate Bridge to Echo Buoy	Transit	144	1.65	237
Echo Buoy to SPB Light #15	Transit	144	0.77	111
SPB Light #15 to Near Shell Terminal	Transit	144	0.75	108
Near Shell Terminal to Amorco Wharf	Transit	144	0.10	14
At Amorco Wharf (Docking)	Maneuvering	144	1.50	216
At Amorco Wharf (Hoteling and Prod. Transfer)	Hotelling	638	38.49	24,538
At Amorco Wharf (Undocking)	Maneuvering	144	1.50	216
Amorco Wharf to Near Shell Terminal	Transit	144	0.06	9
Near Shell Terminal to SPB Light #15	Transit	144	0.50	72
SPB Light #15 to COLREGS Line	Transit	144	2.20	317
COLREGS Line to Pilot Boarding (Sea Buoy)	Transit	144	0.73	106

Notes: (1) Port of Los Angeles Air Emissions Inventory - 2019 - Table 3.5 (Starcrest, 2020); Assume Tanker - Handysize
(2) Boiler load during hotelling based on engineering estimate of fuel consumption

Tugboat Usage during Escort & Assist

Engine Type	Max Hp Per Tug	Load Factor (1)	# Tugboats	Tug-Hrs/ Round-Trip (2)	hp-hr/ Round-Trip
Escort - Main Engine	5,351	0.31	See above	3.50	5,797
Escort - Auxiliary Generator	402	0.43	See above	3.50	605
Assist - Main Engine	5,351	0.31	2	9.50	15,758
Assist - Auxiliary Generator	402	0.43	2	9.50	1,643

Notes: (1) Port of Long Beach Air Emissions Inventory - 2013 - Table 3.4 (Starcrest 2014); Assume Assist tug category
(2) Time spent operating per vessel trip. Estimated assist time to account for tug movement, docking, and undocking, plus 4x30 minute trips to/from temporary tug base.
(3) If escort tug is present, it will serve as one of the two assist tugs for docking/undocking, eliminating the need for one 30 minute trip to/from temporary tug base.

OGV Auxiliary Boiler Emissions per Round-Trip

	Lb/Trip						MT/Trip			
EF Lookup	POC	CO	NOx	SOx	PM10	PM2.5	CO2	CH4	N2O	CO2e
OGV Auxiliary Boilers	0.02	0.05	0.47	0.14	0.04	0.03	0.1	0.00	0.00	0.1
OGV Auxiliary Boilers	0.01	0.01	0.15	0.04	0.01	0.01	0.0	0.00	0.00	0.0
OGV Auxiliary Boilers	0.05	0.10	1.04	0.31	0.09	0.08	0.2	0.00	0.00	0.2
OGV Auxiliary Boilers	0.02	0.05	0.49	0.15	0.04	0.04	0.1	0.00	0.00	0.1
OGV Auxiliary Boilers	0.02	0.05	0.48	0.14	0.04	0.04	0.1	0.00	0.00	0.1
OGV Auxiliary Boilers	0.00	0.01	0.06	0.02	0.01	0.00	0.0	0.00	0.00	0.0
OGV Auxiliary Boilers	0.05	0.10	0.95	0.29	0.08	0.07	0.2	0.00	0.00	0.2
OGV Auxiliary Boilers	5.41	10.82	108.19	32.46	9.20	8.11	22.6	0.00	0.00	23.2
OGV Auxiliary Boilers	0.05	0.10	0.95	0.29	0.08	0.07	0.2	0.00	0.00	0.2
OGV Auxiliary Boilers	0.00	0.00	0.04	0.01	0.00	0.00	0.0	0.00	0.00	0.0
OGV Auxiliary Boilers	0.02	0.03	0.32	0.10	0.03	0.02	0.1	0.00	0.00	0.1
OGV Auxiliary Boilers	0.07	0.14	1.40	0.42	0.12	0.10	0.3	0.00	0.00	0.3
OGV Auxiliary Boilers	0.02	0.05	0.47	0.14	0.04	0.03	0.1	0.00	0.00	0.1

Tugboat Emissions during Escort & Assist

	Lb/Trip						MT/Trip			
EF Lookup	POC	CO	NOx	SOx	PM10	PM2.5	CO2	CH4	N2O	CO2e
Tug ME (1900-3300 hp, 2009)	11.42	56.18	81.28	0.07	3.78	3.78	2.8	0.000	0.000	2.9
Tug AE (250-500 hp, 2009)	1.39	5.78	7.73	0.01	0.29	0.29	0.3	0.000	0.000	0.3
Tug ME (1900-3300 hp, 2009)	31.05	152.72	220.93	0.19	10.27	10.27	7.6	0.000	0.000	7.8
Tug AE (250-500 hp, 2009)	3.78	15.72	21.01	0.02	0.78	0.78	0.8	0.000	0.000	0.9

Emission Calculation Notes:
For OGV main & aux engines:
[Emissions (g)] = [Energy (kW-hr)] x [EF (g/kW-hr)] x LLA
For OGV aux engines:
[Emissions (g)] = [Energy (kW-hr)] x [EF (g/kW-hr)]
For OGV aux boilers:
[Emissions (g)] = [Energy (kW-hr)] x [EF (g/kW-hr)]
For tug main & aux engines:
[Emissions (g) = [Energy hp-hr] x [EFo g/bhp-hr] x (1+[Deterioration Factor] x [Engine Age]/[Useful Life])

Appendix G - Transportation Emissions (Marine Vessels, Trucks, Rails)

Table 1c - Marine Vessel 2017 Emissions
Operational Marine Vessel Emissions
SuezMax Ship to Amorco - Crude

Vessel Type	SuezMax
Berth Location	Amorco
Cargo Per Vessel (Mbbl)	1000
Round Trips/Year	9
Max speed (kn)	15.1

Transfer Activities Per Round-Trip

Material	Direction	Mbbl/yr	Mbbl/trip	Transfer Rate bbl/hr	Transfer Time hrs	Escort Tug Needed?
Crude	Inbound	5,028	558.65	10,000	41.79	TRUE
	Outbound	0	0.00	6,000		FALSE

Additional Hoteling Time

Activity	Hrs
Hook-up (start)	3
Hook-up (end)	2
Bunkering (2-6 hrs on ~50% of ships)	1.5

Emissions Summary

	Emissions (Pounds)						Emissions (MT)			
	POC	CO	NOx	SOx	PM10	PM2.5	CO2	CH4	N2O	CO2e
Emissions/Round-Trip	163.85	483.01	2,711.65	116.38	85.47	78.59	90	0.00	0.005	92
Annual Total	1,475	4,347	24,405	1,047	769	707	813	0.01	0.048	828
Daily Total	4	12	67	3	2	2	2	0.00	0.000	2
Annual Onsite	294	763	7,340	638	290	261	437	0.00	0.03	446

Notes:
- Onsite emissions include hotelling only.

OGV Main Engine Usage per Round-Trip

Activity	Mode	# Escort Tugs Req'd (3)	Propulsion Max kW (1)	Speed (kn)	Load Factor (1)	Distance (nm/trip)	Duration (hr/trip)	kW-hr/ Round-Trip
Pilot Boarding (Sea Buoy) to COLREGS Line	Transit	0	13500	12	0.50	8.8	0.73	4,969
COLREGS Line to Golden Gate Bridge	Transit	1	13500	10	0.29	2.3	0.23	902
Golden Gate Bridge to Echo Buoy	Transit	1	13500	10	0.29	16.45	1.65	6,450
Echo Buoy to SPB Light #15	Transit	1	13500	10	0.29	7.7	0.77	3,019
SPB Light #15 to Near Shell Terminal	Transit	1	13500	8	0.15	6	0.75	1,506
Near Shell Terminal to Amorco Wharf	Transit	1	13500	5	0.04	0.5	0.10	49
At Amorco Wharf (Docking)	Maneuvering	0	13500	n/a	0.02	n/a	1.50	405
At Amorco Wharf (Hoteling and Prod. Transfer)	Hotelling	0	13500	n/a	0.00	n/a	48.29	-
At Amorco Wharf (Undocking)	Maneuvering	0	13500	n/a	0.02	n/a	1.50	405
Amorco Wharf to Near Shell Terminal	Transit	0	13500	8	0.15	0.5	0.06	125
Near Shell Terminal to SPB Light #15	Transit	0	13500	12	0.50	6	0.50	3,388
SPB Light #15 to COLREGS Line	Transit	0	13500	12	0.50	26.45	2.20	14,935
COLREGS Line to Pilot Boarding (Sea Buoy)	Transit	0	13500	12	0.50	8.8	0.73	4,969

Notes: (1) Load factor = (speed/max speed)3. Load factor of 0.02 represents minimum load factor for propulsion engines.
(2) Assume 1.5 hrs for docking and 1.5 hrs for undocking.
(3) Escort tug required to or from Golden Gate Bridge when carrying hydrocarbon.
(4) Maximum vessel speed based on Port of Los Angeles Air Emissions Inventory - 2019, Table 2.9

OGV Main Engine Emissions per Round-Trip

EF Lookup	Lb/Trip						MT/Trip			
	POC	CO	NOx	SOx	PM10	PM2.5	CO2	CH4	N2O	CO2e
OGV Main Engines	6.57	15.34	157.74	4.38	3.51	3.18	2.9	0.00	0.000	3.0
OGV Main Engines	1.19	2.78	28.63	0.80	0.64	0.58	0.5	0.00	0.000	0.5
OGV Main Engines	8.53	19.91	204.77	5.69	4.55	4.12	3.8	0.00	0.000	3.9
OGV Main Engines	3.99	9.32	95.85	2.66	2.13	1.93	1.8	0.00	0.000	1.8
OGV Main Engines	2.73	6.20	50.97	1.33	1.18	1.07	0.9	0.00	0.000	0.9
OGV Main Engines	0.57	0.81	3.75	0.04	0.12	0.11	0.0	0.00	0.000	0.0
OGV Main Engines	11.35	12.12	59.47	0.36	2.08	1.89	0.2	0.00	0.000	0.3
OGV Main Engines	0.00	0.00	0.00	0.00	0.00	0.00	0.0	0.00	0.000	0.0
OGV Main Engines	11.35	12.12	59.47	0.36	2.08	1.89	0.2	0.00	0.000	0.3
OGV Main Engines	0.23	0.52	4.25	0.11	0.10	0.09	0.1	0.00	0.000	0.1
OGV Main Engines	4.48	10.46	107.55	2.99	2.39	2.17	2.0	0.00	0.000	2.0
OGV Main Engines	19.75	46.09	474.12	13.17	10.54	9.55	8.8	0.00	0.000	8.9
OGV Main Engines	6.57	15.34	157.74	4.38	3.51	3.18	2.9	0.00	0.000	3.0

E = [EF g/kW-hr] x [Energy kW-hr] x [Low Load Factor] x [Conversion from g to lb or MT]

OGV Auxiliary Generator Usage per Round-Trip

Activity	Mode	Aux Eng. Max kW	Load Factor (1)	Hours/ Trip	kW-hr/ Round-Trip
Pilot Boarding (Sea Buoy) to COLREGS Line	Transit	2339	24%	0.73	412
COLREGS Line to Golden Gate Bridge	Transit	2339	24%	0.23	129
Golden Gate Bridge to Echo Buoy	Transit	2339	24%	1.65	923
Echo Buoy to SPB Light #15	Transit	2339	24%	0.77	432
SPB Light #15 to Near Shell Terminal	Transit	2339	24%	0.75	421
Near Shell Terminal to Amorco Wharf	Transit	2339	24%	0.10	56
At Amorco Wharf (Docking)	Maneuvering	2339	33%	1.50	1,158
At Amorco Wharf (Hoteling and Prod. Transfer)	Hotelling	2339	26%	48.29	29,368
At Amorco Wharf (Undocking)	Maneuvering	2339	33%	1.50	1,158
Amorco Wharf to Near Shell Terminal	Transit	2339	24%	0.06	35
Near Shell Terminal to SPB Light #15	Transit	2339	24%	0.50	281
SPB Light #15 to COLREGS Line	Transit	2339	24%	2.20	1,237
COLREGS Line to Pilot Boarding (Sea Buoy)	Transit	2339	24%	0.73	412

Notes: (1) California ARB, May 2011, Appendix D, Emissions Estimation Methodology for Ocean-Going Vessels, Table II-5

OGV Auxiliary Generator Emissions per Round-Trip

EF Lookup	Lb/Trip						MT/Trip			
	POC	CO	NOx	SOx	PM10	PM2.5	CO2	CH4	N2O	CO2e
OGV Auxiliary Engines	0.36	1.00	9.53	0.42	0.29	0.26	0.3	0.00	0.00	0.3
OGV Auxiliary Engines	0.11	0.31	2.99	0.13	0.09	0.08	0.1	0.00	0.00	0.1
OGV Auxiliary Engines	0.81	2.24	21.38	0.95	0.65	0.59	0.6	0.00	0.00	0.6
OGV Auxiliary Engines	0.38	1.05	10.01	0.44	0.30	0.28	0.3	0.00	0.00	0.3
OGV Auxiliary Engines	0.37	1.02	9.75	0.43	0.30	0.27	0.3	0.00	0.00	0.3
OGV Auxiliary Engines	0.05	0.14	1.30	0.06	0.04	0.04	0.0	0.00	0.00	0.0
OGV Auxiliary Engines	1.02	2.81	26.80	1.19	0.82	0.74	0.8	0.00	0.00	0.8
OGV Auxiliary Engines	25.90	71.22	679.82	30.21	20.72	18.78	20.1	0.00	0.00	20.4
OGV Auxiliary Engines	1.02	2.81	26.80	1.19	0.82	0.74	0.8	0.00	0.00	0.8
OGV Auxiliary Engines	0.03	0.09	0.81	0.04	0.02	0.02	0.0	0.00	0.00	0.0
OGV Auxiliary Engines	0.25	0.68	6.50	0.29	0.20	0.18	0.2	0.00	0.00	0.2
OGV Auxiliary Engines	1.09	3.00	28.64	1.27	0.87	0.79	0.8	0.00	0.00	0.9
OGV Auxiliary Engines	0.36	1.00	9.53	0.42	0.29	0.26	0.3	0.00	0.00	0.3

E = [EF g/kW-hr] x [Energy kW-hr] x [Conversion from g to lb or MT]

Appendix G - Transportation Emissions (Marine Vessels, Trucks, Rails)

Table 1c - Marine Vessel 2017 Emissions
Operational Marine Vessel Emissions
SuezMax Ship to Amorco - Crude

OGV Auxiliary Boiler Usage per Round-Trip

Activity	Mode	Boiler kW per Vessel (1,2)	Hours/ Transit	kW-hr/ Round-Trip
Pilot Boarding (Sea Buoy) to COLREGS Line	Transit	144	0.73	106
COLREGS Line to Golden Gate Bridge	Transit	144	0.23	33
Golden Gate Bridge to Echo Buoy	Transit	144	1.65	237
Echo Buoy to SPB Light #15	Transit	144	0.77	111
SPB Light #15 to Near Shell Terminal	Transit	144	0.75	108
Near Shell Terminal to Amorco Wharf	Transit	144	0.10	14
At Amorco Wharf (Docking)	Maneuvering	144	1.50	216
At Amorco Wharf (Hoteling and Prod. Transfer)	Hotelling	638	48.29	30,786
At Amorco Wharf (Undocking)	Maneuvering	144	1.50	216
Amorco Wharf to Near Shell Terminal	Transit	144	0.06	9
Near Shell Terminal to SPB Light #15	Transit	144	0.50	72
SPB Light #15 to COLREGS Line	Transit	144	2.20	317
COLREGS Line to Pilot Boarding (Sea Buoy)	Transit	144	0.73	106

Notes: (1) Port of Los Angeles Air Emissions Inventory - 2019 - Table 3.5 (Starcrest, 2020); Assume Tanker - Handysize
(2) Boiler load during hotelling based on engineering estimate of fuel consumption

Tugboat Usage during Escort & Assist

Engine Type	Max Hp Per Tug	Load Factor (1)	# Tugboats	Tug-Hrs/ Round-Trip (2)	hp-hr/ Round-Trip
Escort - Main Engine	5,351	0.31	See above	3.50	5,797
Escort - Auxiliary Generator	402	0.43	See above	3.50	605
Assist - Main Engine	5,351	0.31	2	9.50	15,758
Assist - Auxiliary Generator	402	0.43	2	9.50	1,643

Notes: (1) Port of Long Beach Air Emissions Inventory - 2013 - Table 3.4 (Starcrest 2014); Assume Assist tug category
(2) Time spent operating per vessel trip. Estimated assist time to account for tug movement, docking, and undocking, plus 4x30 minute trips to/from temporary tug base.
(3) If escort tug is present, it will serve as one of the two assist tugs for docking/undocking, eliminating the need for one 30 minute trip to/from temporary tug base.

OGV Auxiliary Boiler Emissions per Round-Trip

	Lb/Trip						MT/Trip			
EF Lookup	POC	CO	NOx	SOx	PM10	PM2.5	CO2	CH4	N2O	CO2e
OGV Auxiliary Boilers	0.02	0.05	0.47	0.14	0.04	0.03	0.1	0.00	0.00	0.1
OGV Auxiliary Boilers	0.01	0.01	0.15	0.04	0.01	0.01	0.0	0.00	0.00	0.0
OGV Auxiliary Boilers	0.05	0.10	1.04	0.31	0.09	0.08	0.2	0.00	0.00	0.2
OGV Auxiliary Boilers	0.02	0.05	0.49	0.15	0.04	0.04	0.1	0.00	0.00	0.1
OGV Auxiliary Boilers	0.02	0.05	0.48	0.14	0.04	0.04	0.1	0.00	0.00	0.1
OGV Auxiliary Boilers	0.00	0.01	0.06	0.02	0.01	0.00	0.0	0.00	0.00	0.0
OGV Auxiliary Boilers	0.05	0.10	0.95	0.29	0.08	0.07	0.2	0.00	0.00	0.2
OGV Auxiliary Boilers	6.79	13.57	135.74	40.72	11.54	10.18	28.4	0.00	0.00	29.1
OGV Auxiliary Boilers	0.05	0.10	0.95	0.29	0.08	0.07	0.2	0.00	0.00	0.2
OGV Auxiliary Boilers	0.00	0.00	0.04	0.01	0.00	0.00	0.0	0.00	0.00	0.0
OGV Auxiliary Boilers	0.02	0.03	0.32	0.10	0.03	0.02	0.1	0.00	0.00	0.1
OGV Auxiliary Boilers	0.07	0.14	1.40	0.42	0.12	0.10	0.3	0.00	0.00	0.3
OGV Auxiliary Boilers	0.02	0.05	0.47	0.14	0.04	0.03	0.1	0.00	0.00	0.1

Tugboat Emissions during Escort & Assist

	Lb/Trip						MT/Trip			
EF Lookup	POC	CO	NOx	SOx	PM10	PM2.5	CO2	CH4	N2O	CO2e
Tug ME (1900-3300 hp, 2009)	11.42	56.18	81.28	0.07	3.78	3.78	2.8	0.000	0.000	2.9
Tug AE (250-500 hp, 2009)	1.39	5.78	7.73	0.01	0.29	0.29	0.3	0.000	0.000	0.3
Tug ME (1900-3300 hp, 2009)	31.05	152.72	220.93	0.19	10.27	10.27	7.6	0.000	0.000	7.8
Tug AE (250-500 hp, 2009)	3.78	15.72	21.01	0.02	0.78	0.78	0.8	0.000	0.000	0.9

Emission Calculation Notes:
For OGV main & aux engines:
[Emissions (g)] = [Energy (kW-hr)] x [EF (g/kW-hr)] x LLA
For OGV aux engines:
[Emissions (g)] = [Energy (kW-hr)] x [EF (g/kW-hr)]
For OGV aux boilers:
[Emissions (g)] = [Energy (kW-hr)] x [EF (g/kW-hr)]
For tug main & aux engines:
[Emissions (g) = [Energy hp-hr] x [EFo g/bhp-hr] x (1+[Deterioration Factor] x [Engine Age]/[Useful Life])

Appendix G - Transportation Emissions (Marine Vessels, Trucks, Rails)

Table 1d - Marine Vessel 2017 Emissions
Operational Marine Vessel Emissions
Medium Range Ship to Amorco - Crude

Vessel Type	MR
Berth Location	Amorco
Cargo Per Vessel (Mbbl)	300
Round Trips/Year	4
Max speed (kn)	14.9

Transfer Activities Per Round-Trip

Material	Direction	Mbbl/yr	Mbbl/trip	Transfer Rate bbl/hr	Transfer Time hrs	Escort Tug Needed?
Crude	Inbound	624	156.07	10,000	35.19	TRUE
	Outbound	992	248.01	6,000		FALSE

Additional Hoteling Time

Activity	Hrs
Hook-up (start)	3
Hook-up (end)	2
Bunkering (2-6 hrs on ~50% of ships)	1.5

Emissions Summary

	Emissions (Pounds)						Emissions (MT)			
	POC	CO	NOx	SOx	PM10	PM2.5	CO2	CH4	N2O	CO2e
Emissions/Round-Trip	121.46	391.01	1,840.89	83.92	62.25	57.58	68	0.00	0.004	70
Annual Total	486	1,564	7,364	336	249	230	274	0.00	0.017	279
Daily Total	1	4	20	1	1	1	1	0.00	0.000	1
Annual Onsite	92	236	2,274	221	95	85	152	0.00	0.01	155

Notes:
- Onsite emissions include hotelling only.

OGV Main Engine Usage per Round-Trip

Activity	Mode	# Escort Tugs Req'd (3)	Propulsion Max kW (1)	Speed (kn)	Load Factor (1)	Distance (nm/trip)	Duration (hr/trip)	kW-hr/ Round-Trip
Pilot Boarding (Sea Buoy) to COLREGS Line	Transit	0	8607	12	0.52	8.8	0.73	3,297
COLREGS Line to Golden Gate Bridge	Transit	1	8607	10	0.30	2.3	0.23	598
Golden Gate Bridge to Echo Buoy	Transit	1	8607	10	0.30	16.45	1.65	4,280
Echo Buoy to SPB Light #15	Transit	1	8607	10	0.30	7.7	0.77	2,003
SPB Light #15 to Near Shell Terminal	Transit	1	8607	8	0.15	6	0.75	999
Near Shell Terminal to Amorco Wharf	Transit	1	8607	5	0.04	0.5	0.10	33
At Amorco Wharf (Docking)	Maneuvering	0	8607	n/a	0.02	n/a	1.50	258
At Amorco Wharf (Hoteling and Prod. Transfer)	Hotelling	0	8607	n/a	0.00	n/a	41.69	-
At Amorco Wharf (Undocking)	Maneuvering	0	8607	n/a	0.02	n/a	1.50	258
Amorco Wharf to Near Shell Terminal	Transit	0	8607	8	0.15	0.5	0.06	83
Near Shell Terminal to SPB Light #15	Transit	0	8607	10	0.30	6	0.60	1,561
SPB Light #15 to COLREGS Line	Transit	0	8607	10	0.30	26.45	2.65	6,882
COLREGS Line to Pilot Boarding (Sea Buoy)	Transit	0	8607	12	0.52	8.8	0.73	3,297

Notes: (1) Load factor = (speed/max speed)3. Load factor of 0.02 represents minimum load factor for propulsion engines.
(2) Assume 1.5 hrs for docking and 1.5 hrs for undocking.
(3) Escort tug required to or from Golden Gate Bridge when carrying hydrocarbon.
(4) Maximum vessel speed based on Port of Los Angeles Air Emissions Inventory - 2019, Table 2.9

OGV Main Engine Emissions per Round-Trip

EF Lookup	Lb/Trip						MT/Trip			
	POC	CO	NOx	SOx	PM10	PM2.5	CO2	CH4	N2O	CO2e
OGV Main Engines	4.36	10.18	104.67	2.91	2.33	2.11	1.9	0.00	0.000	2.0
OGV Main Engines	0.79	1.85	19.00	0.53	0.42	0.38	0.4	0.00	0.000	0.4
OGV Main Engines	5.66	13.21	135.88	3.77	3.02	2.74	2.5	0.00	0.000	2.6
OGV Main Engines	2.65	6.18	63.60	1.77	1.41	1.28	1.2	0.00	0.000	1.2
OGV Main Engines	1.73	3.95	33.48	0.88	0.77	0.70	0.6	0.00	0.000	0.6
OGV Main Engines	0.36	0.52	2.40	0.03	0.08	0.07	0.0	0.00	0.000	0.0
OGV Main Engines	7.23	7.73	37.91	0.23	1.33	1.20	0.2	0.00	0.000	0.2
OGV Main Engines	0.00	0.00	0.00	0.00	0.00	0.00	0.0	0.00	0.000	0.0
OGV Main Engines	7.23	7.73	37.91	0.23	1.33	1.20	0.2	0.00	0.000	0.2
OGV Main Engines	0.14	0.33	2.79	0.07	0.06	0.06	0.0	0.00	0.000	0.0
OGV Main Engines	2.07	4.82	49.56	1.38	1.10	1.00	0.9	0.00	0.000	0.9
OGV Main Engines	9.10	21.24	218.48	6.07	4.86	4.40	4.1	0.00	0.000	4.1
OGV Main Engines	4.36	10.18	104.67	2.91	2.33	2.11	1.9	0.00	0.000	2.0

E = [EF g/kW-hr] x [Energy kW-hr] x [Low Load Factor] x [Conversion from g to lb or MT]

OGV Auxiliary Generator Usage per Round-Trip

Activity	Mode	Aux Eng. Max kW	Load Factor (1)	Hours/ Trip	kW-hr/ Round-Trip
Pilot Boarding (Sea Buoy) to COLREGS Line	Transit	1799	24%	0.73	317
COLREGS Line to Golden Gate Bridge	Transit	1799	24%	0.23	99
Golden Gate Bridge to Echo Buoy	Transit	1799	24%	1.65	710
Echo Buoy to SPB Light #15	Transit	1799	24%	0.77	332
SPB Light #15 to Near Shell Terminal	Transit	1799	24%	0.75	324
Near Shell Terminal to Amorco Wharf	Transit	1799	24%	0.10	43
At Amorco Wharf (Docking)	Maneuvering	1799	33%	1.50	891
At Amorco Wharf (Hoteling and Prod. Transfer)	Hotelling	1799	26%	41.69	19,499
At Amorco Wharf (Undocking)	Maneuvering	1799	33%	1.50	891
Amorco Wharf to Near Shell Terminal	Transit	1799	24%	0.06	27
Near Shell Terminal to SPB Light #15	Transit	1799	24%	0.60	259
SPB Light #15 to COLREGS Line	Transit	1799	24%	2.65	1,142
COLREGS Line to Pilot Boarding (Sea Buoy)	Transit	1799	24%	0.73	317

Notes: (1) California ARB, May 2011, Appendix D, Emissions Estimation Methodology for Ocean-Going Vessels, Table II-5

OGV Auxiliary Generator Emissions per Round-Trip

EF Lookup	Lb/Trip						MT/Trip			
	POC	CO	NOx	SOx	PM10	PM2.5	CO2	CH4	N2O	CO2e
OGV Auxiliary Engines	0.28	0.77	7.33	0.33	0.22	0.20	0.2	0.00	0.00	0.2
OGV Auxiliary Engines	0.09	0.24	2.30	0.10	0.07	0.06	0.1	0.00	0.00	0.1
OGV Auxiliary Engines	0.63	1.72	16.44	0.73	0.50	0.45	0.5	0.00	0.00	0.5
OGV Auxiliary Engines	0.29	0.81	7.70	0.34	0.23	0.21	0.2	0.00	0.00	0.2
OGV Auxiliary Engines	0.29	0.79	7.50	0.33	0.23	0.21	0.2	0.00	0.00	0.2
OGV Auxiliary Engines	0.04	0.10	1.00	0.04	0.03	0.03	0.0	0.00	0.00	0.0
OGV Auxiliary Engines	0.79	2.16	20.61	0.92	0.63	0.57	0.6	0.00	0.00	0.6
OGV Auxiliary Engines	17.20	47.29	451.37	20.06	13.76	12.47	13.4	0.00	0.00	13.6
OGV Auxiliary Engines	0.79	2.16	20.61	0.92	0.63	0.57	0.6	0.00	0.00	0.6
OGV Auxiliary Engines	0.02	0.07	0.62	0.03	0.02	0.02	0.0	0.00	0.00	0.0
OGV Auxiliary Engines	0.23	0.63	6.00	0.27	0.18	0.17	0.2	0.00	0.00	0.2
OGV Auxiliary Engines	1.01	2.77	26.44	1.17	0.81	0.73	0.8	0.00	0.00	0.8
OGV Auxiliary Engines	0.28	0.77	7.33	0.33	0.22	0.20	0.2	0.00	0.00	0.2

E = [EF g/kW-hr] x [Energy kW-hr] x [Conversion from g to lb or MT]

Appendix G - Transportation Emissions (Marine Vessels, Trucks, Rails)

Table 1d - Marine Vessel 2017 Emissions
Operational Marine Vessel Emissions
Medium Range Ship to Amorco - Crude

OGV Auxiliary Boiler Usage per Round-Trip

Activity	Mode	Boiler kW per Vessel (1,2)	Hours/ Transit	kW-hr/ Round-Trip
Pilot Boarding (Sea Buoy) to COLREGS Line	Transit	144	0.73	106
COLREGS Line to Golden Gate Bridge	Transit	144	0.23	33
Golden Gate Bridge to Echo Buoy	Transit	144	1.65	237
Echo Buoy to SPB Light #15	Transit	144	0.77	111
SPB Light #15 to Near Shell Terminal	Transit	144	0.75	108
Near Shell Terminal to Amorco Wharf	Transit	144	0.10	14
At Amorco Wharf (Docking)	Maneuvering	144	1.50	216
At Amorco Wharf (Hoteling and Prod. Transfer)	Hotelling	638	41.69	26,576
At Amorco Wharf (Undocking)	Maneuvering	144	1.50	216
Amorco Wharf to Near Shell Terminal	Transit	144	0.06	9
Near Shell Terminal to SPB Light #15	Transit	144	0.60	86
SPB Light #15 to COLREGS Line	Transit	144	2.65	381
COLREGS Line to Pilot Boarding (Sea Buoy)	Transit	144	0.73	106

Notes: (1) Port of Los Angeles Air Emissions Inventory - 2019 - Table 3.5 (Starcrest, 2020); Assume Tanker - Handysize
(2) Boiler load during hotelling based on engineering estimate of fuel consumption

Tugboat Usage during Escort & Assist

Engine Type	Max Hp Per Tug	Load Factor (1)	# Tugboats	Tug-Hrs/ Round-Trip (2)	hp-hr/ Round-Trip
Escort - Main Engine	5,351	0.31	See above	3.50	5,797
Escort - Auxiliary Generator	402	0.43	See above	3.50	605
Assist - Main Engine	5,351	0.31	2	9.50	15,758
Assist - Auxiliary Generator	402	0.43	2	9.50	1,643

Notes: (1) Port of Long Beach Air Emissions Inventory - 2013 - Table 3.4 (Starcrest 2014); Assume Assist tug category
(2) Time spent operating per vessel trip. Estimated assist time to account for tug movement, docking, and undocking, plus 4x30 minute trips to/from temporary tug base.
(3) If escort tug is present, it will serve as one of the two assist tugs for docking/undocking, eliminating the need for one 30 minute trip to/from temporary tug base.

OGV Auxiliary Boiler Emissions per Round-Trip

	Lb/Trip						MT/Trip			
EF Lookup	POC	CO	NOx	SOx	PM10	PM2.5	CO2	CH4	N2O	CO2e
OGV Auxiliary Boilers	0.02	0.05	0.47	0.14	0.04	0.03	0.1	0.00	0.00	0.1
OGV Auxiliary Boilers	0.01	0.01	0.15	0.04	0.01	0.01	0.0	0.00	0.00	0.0
OGV Auxiliary Boilers	0.05	0.10	1.04	0.31	0.09	0.08	0.2	0.00	0.00	0.2
OGV Auxiliary Boilers	0.02	0.05	0.49	0.15	0.04	0.04	0.1	0.00	0.00	0.1
OGV Auxiliary Boilers	0.02	0.05	0.48	0.14	0.04	0.04	0.1	0.00	0.00	0.1
OGV Auxiliary Boilers	0.00	0.01	0.06	0.02	0.01	0.00	0.0	0.00	0.00	0.0
OGV Auxiliary Boilers	0.05	0.10	0.95	0.29	0.08	0.07	0.2	0.00	0.00	0.2
OGV Auxiliary Boilers	5.86	11.72	117.18	35.15	9.96	8.79	24.5	0.00	0.00	25.1
OGV Auxiliary Boilers	0.05	0.10	0.95	0.29	0.08	0.07	0.2	0.00	0.00	0.2
OGV Auxiliary Boilers	0.00	0.00	0.04	0.01	0.00	0.00	0.0	0.00	0.00	0.0
OGV Auxiliary Boilers	0.02	0.04	0.38	0.11	0.03	0.03	0.1	0.00	0.00	0.1
OGV Auxiliary Boilers	0.08	0.17	1.68	0.50	0.14	0.13	0.4	0.00	0.00	0.4
OGV Auxiliary Boilers	0.02	0.05	0.47	0.14	0.04	0.03	0.1	0.00	0.00	0.1

Tugboat Emissions during Escort & Assist

	Lb/Trip						MT/Trip			
EF Lookup	POC	CO	NOx	SOx	PM10	PM2.5	CO2	CH4	N2O	CO2e
Tug ME (1900-3300 hp, 2009)	11.42	56.18	81.28	0.07	3.78	3.78	2.8	0.000	0.000	2.9
Tug AE (250-500 hp, 2009)	1.39	5.78	7.73	0.01	0.29	0.29	0.3	0.000	0.000	0.3
Tug ME (1900-3300 hp, 2009)	31.05	152.72	220.93	0.19	10.27	10.27	7.6	0.000	0.000	7.8
Tug AE (250-500 hp, 2009)	3.78	15.72	21.01	0.02	0.78	0.78	0.8	0.000	0.000	0.9

Emission Calculation Notes:
For OGV main & aux engines:
[Emissions (g)] = [Energy (kW-hr)] x [EF (g/kW-hr)] x LLA
For OGV aux engines:
[Emissions (g)] = [Energy (kW-hr)] x [EF (g/kW-hr)]
For OGV aux boilers:
[Emissions (g)] = [Energy (kW-hr)] x [EF (g/kW-hr)]
For tug main & aux engines:
[Emissions (g) = [Energy hp-hr] x [EFo g/bhp-hr] x (1+[Deterioration Factor] x [Engine Age]/[Useful Life])

Appendix G - Transportation Emissions (Marine Vessels, Trucks, Rails)

Table 2a - Marine Vessel 2018 Emissions
Operational Marine Vessel Emissions
AfraMax Ship to Amorco - Crude

Vessel Type	AfraMax
Berth Location	Amorco
Cargo Per Vessel (Mbbl)	800
Round Trips/Year	34
Max speed (kn)	14.4

Transfer Activities Per Round-Trip

Material	Direction	Mbbl/yr	Mbbl/trip	Transfer Rate bbl/hr	Transfer Time hrs	Escort Tug Needed?
Crude	Inbound	15,357	451.69	10,000	34.52	TRUE
	Outbound	0	0.00	6,000		FALSE

Additional Hoteling Time

Activity	Hrs
Hook-up (start)	3
Hook-up (end)	2
Bunkering (2-6 hrs on ~50% of ships)	1.5

Emissions Summary

	Emissions (Pounds)						Emissions (MT)			
	POC	CO	NOx	SOx	PM10	PM2.5	CO2	CH4	N2O	CO2e
Emissions/Round-Trip	166.68	488.53	2,782.96	111.14	84.90	78.11	87	0.00	0.005	88
Annual Total	5,667	16,610	94,621	3,779	2,887	2,656	2,946	0.04	0.172	3,000
Daily Total	16	46	259	10	8	7	8	0.00	0.000	8
Annual Onsite	944	2,449	23,556	2,049	932	836	1,402	0.01	0.09	1,430

Notes:
- Onsite emissions include hotelling only.

OGV Main Engine Usage per Round-Trip

Activity	Mode	# Escort Tugs Req'd (3)	Propulsion Max kW (1)	Speed (kn)	Load Factor (1)	Distance (nm/trip)	Duration (hr/trip)	kW-hr/ Round-Trip
Pilot Boarding (Sea Buoy) to COLREGS Line	Transit	0	13500	12	0.58	8.8	0.73	5,729
COLREGS Line to Golden Gate Bridge	Transit	1	13500	10	0.33	2.3	0.23	1,040
Golden Gate Bridge to Echo Buoy	Transit	1	13500	10	0.33	16.45	1.65	7,437
Echo Buoy to SPB Light #15	Transit	1	13500	10	0.33	7.7	0.77	3,481
SPB Light #15 to Near Shell Terminal	Transit	1	13500	8	0.17	6	0.75	1,736
Near Shell Terminal to Amorco Wharf	Transit	1	13500	5	0.04	0.5	0.10	57
At Amorco Wharf (Docking)	Maneuvering	0	13500	n/a	0.02	n/a	1.50	405
At Amorco Wharf (Hoteling and Prod. Transfer)	Hotelling	0	13500	n/a	0.00	n/a	41.02	-
At Amorco Wharf (Undocking)	Maneuvering	0	13500	n/a	0.02	n/a	1.50	405
Amorco Wharf to Near Shell Terminal	Transit	0	13500	8	0.17	0.5	0.06	145
Near Shell Terminal to SPB Light #15	Transit	0	13500	12	0.58	6	0.50	3,906
SPB Light #15 to COLREGS Line	Transit	0	13500	12	0.58	26.45	2.20	17,220
COLREGS Line to Pilot Boarding (Sea Buoy)	Transit	0	13500	12	0.58	8.8	0.73	5,729

Notes: (1) Load factor = (speed/max speed)3. Load factor of 0.02 represents minimum load factor for propulsion engines.
(2) Assume 1.5 hrs for docking and 1.5 hrs for undocking.
(3) Escort tug required to or from Golden Gate Bridge when carrying hydrocarbon.
(4) Maximum vessel speed based on Port of Los Angeles Air Emissions Inventory - 2019, Table 2.9

OGV Main Engine Emissions per Round-Trip

EF Lookup	Lb/Trip						MT/Trip			
	POC	CO	NOx	SOx	PM10	PM2.5	CO2	CH4	N2O	CO2e
OGV Main Engines	7.58	17.68	181.88	5.05	4.04	3.66	3.4	0.00	0.000	3.4
OGV Main Engines	1.38	3.21	33.01	0.92	0.73	0.66	0.6	0.00	0.000	0.6
OGV Main Engines	9.84	22.95	236.11	6.56	5.25	4.75	4.4	0.00	0.000	4.4
OGV Main Engines	4.60	10.74	110.52	3.07	2.46	2.23	2.1	0.00	0.000	2.1
OGV Main Engines	2.69	6.22	56.81	1.53	1.29	1.17	1.0	0.00	0.000	1.0
OGV Main Engines	0.54	0.81	3.80	0.05	0.12	0.11	0.0	0.00	0.000	0.0
OGV Main Engines	11.35	12.12	59.47	0.36	2.08	1.89	0.2	0.00	0.000	0.3
OGV Main Engines	0.00	0.00	0.00	0.00	0.00	0.00	0.0	0.00	0.000	0.0
OGV Main Engines	11.35	12.12	59.47	0.36	2.08	1.89	0.2	0.00	0.000	0.3
OGV Main Engines	0.22	0.52	4.73	0.13	0.11	0.10	0.1	0.00	0.000	0.1
OGV Main Engines	5.17	12.06	124.01	3.44	2.76	2.50	2.3	0.00	0.000	2.3
OGV Main Engines	22.78	53.15	546.68	15.19	12.15	11.01	10.1	0.00	0.000	10.3
OGV Main Engines	7.58	17.68	181.88	5.05	4.04	3.66	3.4	0.00	0.000	3.4

E = [EF g/kW-hr] x [Energy kW-hr] x [Low Load Factor] x [Conversion from g to lb or MT]

OGV Auxiliary Generator Usage per Round-Trip

Activity	Mode	Aux Eng. Max kW	Load Factor (1)	Hours/ Trip	kW-hr/ Round-Trip
Pilot Boarding (Sea Buoy) to COLREGS Line	Transit	2339	24%	0.73	412
COLREGS Line to Golden Gate Bridge	Transit	2339	24%	0.23	129
Golden Gate Bridge to Echo Buoy	Transit	2339	24%	1.65	923
Echo Buoy to SPB Light #15	Transit	2339	24%	0.77	432
SPB Light #15 to Near Shell Terminal	Transit	2339	24%	0.75	421
Near Shell Terminal to Amorco Wharf	Transit	2339	24%	0.10	56
At Amorco Wharf (Docking)	Maneuvering	2339	33%	1.50	1,158
At Amorco Wharf (Hoteling and Prod. Transfer)	Hotelling	2339	26%	41.02	24,948
At Amorco Wharf (Undocking)	Maneuvering	2339	33%	1.50	1,158
Amorco Wharf to Near Shell Terminal	Transit	2339	24%	0.06	35
Near Shell Terminal to SPB Light #15	Transit	2339	24%	0.50	281
SPB Light #15 to COLREGS Line	Transit	2339	24%	2.20	1,237
COLREGS Line to Pilot Boarding (Sea Buoy)	Transit	2339	24%	0.73	412

Notes: (1) California ARB, May 2011, Appendix D, Emissions Estimation Methodology for Ocean-Going Vessels, Table II-5

OGV Auxiliary Generator Emissions per Round-Trip

EF Lookup	Lb/Trip						MT/Trip			
	POC	CO	NOx	SOx	PM10	PM2.5	CO2	CH4	N2O	CO2e
OGV Auxiliary Engines	0.36	1.00	9.53	0.42	0.29	0.26	0.3	0.00	0.00	0.3
OGV Auxiliary Engines	0.11	0.31	2.99	0.13	0.09	0.08	0.1	0.00	0.00	0.1
OGV Auxiliary Engines	0.81	2.24	21.38	0.95	0.65	0.59	0.6	0.00	0.00	0.6
OGV Auxiliary Engines	0.38	1.05	10.01	0.44	0.30	0.28	0.3	0.00	0.00	0.3
OGV Auxiliary Engines	0.37	1.02	9.75	0.43	0.30	0.27	0.3	0.00	0.00	0.3
OGV Auxiliary Engines	0.05	0.14	1.30	0.06	0.04	0.04	0.0	0.00	0.00	0.0
OGV Auxiliary Engines	1.02	2.81	26.80	1.19	0.82	0.74	0.8	0.00	0.00	0.8
OGV Auxiliary Engines	22.00	60.50	577.50	25.67	17.60	15.95	17.1	0.00	0.00	17.3
OGV Auxiliary Engines	1.02	2.81	26.80	1.19	0.82	0.74	0.8	0.00	0.00	0.8
OGV Auxiliary Engines	0.03	0.09	0.81	0.04	0.02	0.02	0.0	0.00	0.00	0.0
OGV Auxiliary Engines	0.25	0.68	6.50	0.29	0.20	0.18	0.2	0.00	0.00	0.2
OGV Auxiliary Engines	1.09	3.00	28.64	1.27	0.87	0.79	0.8	0.00	0.00	0.9
OGV Auxiliary Engines	0.36	1.00	9.53	0.42	0.29	0.26	0.3	0.00	0.00	0.3

E = [EF g/kW-hr] x [Energy kW-hr] x [Conversion from g to lb or MT]

Appendix G - Transportation Emissions (Marine Vessels, Trucks, Rails)

Table 2a - Marine Vessel 2018 Emissions
Operational Marine Vessel Emissions
AfraMax Ship to Amorco - Crude

OGV Auxiliary Boiler Usage per Round-Trip

Activity	Mode	Boiler kW per Vessel (1,2)	Hours/ Transit	kW-hr/ Round-Trip
Pilot Boarding (Sea Buoy) to COLREGS Line	Transit	144	0.73	106
COLREGS Line to Golden Gate Bridge	Transit	144	0.23	33
Golden Gate Bridge to Echo Buoy	Transit	144	1.65	237
Echo Buoy to SPB Light #15	Transit	144	0.77	111
SPB Light #15 to Near Shell Terminal	Transit	144	0.75	108
Near Shell Terminal to Amorco Wharf	Transit	144	0.10	14
At Amorco Wharf (Docking)	Maneuvering	144	1.50	216
At Amorco Wharf (Hoteling and Prod. Transfer)	Hotelling	638	41.02	26,152
At Amorco Wharf (Undocking)	Maneuvering	144	1.50	216
Amorco Wharf to Near Shell Terminal	Transit	144	0.06	9
Near Shell Terminal to SPB Light #15	Transit	144	0.50	72
SPB Light #15 to COLREGS Line	Transit	144	2.20	317
COLREGS Line to Pilot Boarding (Sea Buoy)	Transit	144	0.73	106

Notes: (1) Port of Los Angeles Air Emissions Inventory - 2019 - Table 3.5 (Starcrest, 2020); Assume Tanker - Handysize
(2) Boiler load during hotelling based on engineering estimate of fuel consumption

Tugboat Usage during Escort & Assist

Engine Type	Max Hp Per Tug	Load Factor (1)	# Tugboats	Tug-Hrs/ Round-Trip (2)	hp-hr/ Round-Trip
Escort - Main Engine	5,351	0.31	See above	3.50	5,797
Escort - Auxiliary Generator	402	0.43	See above	3.50	605
Assist - Main Engine	5,351	0.31	2	9.50	15,758
Assist - Auxiliary Generator	402	0.43	2	9.50	1,643

Notes: (1) Port of Long Beach Air Emissions Inventory - 2013 - Table 3.4 (Starcrest 2014); Assume Assist tug category
(2) Time spent operating per vessel trip. Estimated assist time to account for tug movement, docking, and undocking, plus 4x30 minute trips to/from temporary tug base.
(3) If escort tug is present, it will serve as one of the two assist tugs for docking/undocking, eliminating the need for one 30 minute trip to/from temporary tug base.

OGV Auxiliary Boiler Emissions per Round-Trip

	Lb/Trip						MT/Trip			
EF Lookup	POC	CO	NOx	SOx	PM10	PM2.5	CO2	CH4	N2O	CO2e
OGV Auxiliary Boilers	0.02	0.05	0.47	0.14	0.04	0.03	0.1	0.00	0.00	0.1
OGV Auxiliary Boilers	0.01	0.01	0.15	0.04	0.01	0.01	0.0	0.00	0.00	0.0
OGV Auxiliary Boilers	0.05	0.10	1.04	0.31	0.09	0.08	0.2	0.00	0.00	0.2
OGV Auxiliary Boilers	0.02	0.05	0.49	0.15	0.04	0.04	0.1	0.00	0.00	0.1
OGV Auxiliary Boilers	0.02	0.05	0.48	0.14	0.04	0.04	0.1	0.00	0.00	0.1
OGV Auxiliary Boilers	0.00	0.01	0.06	0.02	0.01	0.00	0.0	0.00	0.00	0.0
OGV Auxiliary Boilers	0.05	0.10	0.95	0.29	0.08	0.07	0.2	0.00	0.00	0.2
OGV Auxiliary Boilers	5.77	11.53	115.31	34.59	9.80	8.65	24.1	0.00	0.00	24.7
OGV Auxiliary Boilers	0.05	0.10	0.95	0.29	0.08	0.07	0.2	0.00	0.00	0.2
OGV Auxiliary Boilers	0.00	0.00	0.04	0.01	0.00	0.00	0.0	0.00	0.00	0.0
OGV Auxiliary Boilers	0.02	0.03	0.32	0.10	0.03	0.02	0.1	0.00	0.00	0.1
OGV Auxiliary Boilers	0.07	0.14	1.40	0.42	0.12	0.10	0.3	0.00	0.00	0.3
OGV Auxiliary Boilers	0.02	0.05	0.47	0.14	0.04	0.03	0.1	0.00	0.00	0.1

Tugboat Emissions during Escort & Assist

	Lb/Trip						MT/Trip			
EF Lookup	POC	CO	NOx	SOx	PM10	PM2.5	CO2	CH4	N2O	CO2e
Tug ME (1900-3300 hp, 2009)	11.42	56.18	81.28	0.07	3.78	3.78	2.8	0.000	0.000	2.9
Tug AE (250-500 hp, 2009)	1.39	5.78	7.73	0.01	0.29	0.29	0.3	0.000	0.000	0.3
Tug ME (1900-3300 hp, 2009)	31.05	152.72	220.93	0.19	10.27	10.27	7.6	0.000	0.000	7.8
Tug AE (250-500 hp, 2009)	3.78	15.72	21.01	0.02	0.78	0.78	0.8	0.000	0.000	0.9

Emission Calculation Notes:
For OGV main & aux engines:
[Emissions (g)] = [Energy (kW-hr)] x [EF (g/kW-hr)] x LLA
For OGV aux engines:
[Emissions (g)] = [Energy (kW-hr)] x [EF (g/kW-hr)]
For OGV aux boilers:
[Emissions (g)] = [Energy (kW-hr)] x [EF (g/kW-hr)]
For tug main & aux engines:
[Emissions (g) = [Energy hp-hr] x [EFo g/bhp-hr] x (1+[Deterioration Factor] x [Engine Age]/[Useful Life])

Appendix G - Transportation Emissions (Marine Vessels, Trucks, Rails)

Table 2b - Marine Vessel 2018 Emissions
Operational Marine Vessel Emissions
PanaMax Ship to Amorco - Crude

Vessel Type	PanaMax
Berth Location	Amorco
Cargo Per Vessel (Mbbl)	500
Round Trips/Year	26
Max speed (kn)	14.9

Transfer Activities Per Round-Trip

Material	Direction	Mbbl/yr	Mbbl/trip	Transfer Rate bbl/hr	Transfer Time hrs	Escort Tug Needed?
Crude	Inbound	10,367	398.74	10,000	31.60	TRUE
	Outbound	0	0.00	6,000		FALSE

Additional Hoteling Time

Activity	Hrs
Hook-up (start)	3
Hook-up (end)	2
Bunkering (2-6 hrs on ~50% of ships)	1.5

Emissions Summary

	Emissions (Pounds)						Emissions (MT)			
	POC	CO	NOx	SOx	PM10	PM2.5	CO2	CH4	N2O	CO2e
Emissions/Round-Trip	160.88	484.85	2,738.03	113.59	85.90	79.04	88	0.00	0.005	90
Annual Total	4,183	12,606	71,189	2,953	2,233	2,055	2,293	0.03	0.130	2,334
Daily Total	11	35	195	8	6	6	6	0.00	0.000	6
Annual Onsite	958	2,530	24,278	1,791	892	802	1,219	0.01	0.07	1,242

Notes:
- Onsite emissions include hotelling only.

OGV Main Engine Usage per Round-Trip

Activity	Mode	# Escort Tugs Req'd (3)	Propulsion Max kW (1)	Speed (kn)	Load Factor (1)	Distance (nm/trip)	Duration (hr/trip)	kW-hr/ Round-Trip
Pilot Boarding (Sea Buoy) to COLREGS Line	Transit	0	11396	12	0.52	8.8	0.73	4,366
COLREGS Line to Golden Gate Bridge	Transit	1	11396	10	0.30	2.3	0.23	792
Golden Gate Bridge to Echo Buoy	Transit	1	11396	10	0.30	16.45	1.65	5,667
Echo Buoy to SPB Light #15	Transit	1	11396	10	0.30	7.7	0.77	2,653
SPB Light #15 to Near Shell Terminal	Transit	1	11396	8	0.15	6	0.75	1,323
Near Shell Terminal to Amorco Wharf	Transit	1	11396	5	0.04	0.5	0.10	43
At Amorco Wharf (Docking)	Maneuvering	0	11396	n/a	0.02	n/a	1.50	342
At Amorco Wharf (Hoteling and Prod. Transfer)	Hotelling	0	11396	n/a	0.00	n/a	38.10	-
At Amorco Wharf (Undocking)	Maneuvering	0	11396	n/a	0.02	n/a	1.50	342
Amorco Wharf to Near Shell Terminal	Transit	0	11396	8	0.15	0.5	0.06	110
Near Shell Terminal to SPB Light #15	Transit	0	11396	12	0.52	6	0.50	2,977
SPB Light #15 to COLREGS Line	Transit	0	11396	12	0.52	26.45	2.20	13,121
COLREGS Line to Pilot Boarding (Sea Buoy)	Transit	0	11396	12	0.52	8.8	0.73	4,366

Notes: (1) Load factor = (speed/max speed)3. Load factor of 0.02 represents minimum load factor for propulsion engines.
(2) Assume 1.5 hrs for docking and 1.5 hrs for undocking.
(3) Escort tug required to or from Golden Gate Bridge when carrying hydrocarbon.
(4) Maximum vessel speed based on Port of Los Angeles Air Emissions Inventory - 2019, Table 2.9

OGV Main Engine Emissions per Round-Trip

EF Lookup	Lb/Trip						MT/Trip			
	POC	CO	NOx	SOx	PM10	PM2.5	CO2	CH4	N2O	CO2e
OGV Main Engines	5.77	13.47	138.59	3.85	3.08	2.79	2.6	0.00	0.000	2.6
OGV Main Engines	1.05	2.45	25.15	0.70	0.56	0.51	0.5	0.00	0.000	0.5
OGV Main Engines	7.50	17.49	179.91	5.00	4.00	3.62	3.3	0.00	0.000	3.4
OGV Main Engines	3.51	8.19	84.21	2.34	1.87	1.70	1.6	0.00	0.000	1.6
OGV Main Engines	2.29	5.24	44.33	1.17	1.02	0.93	0.8	0.00	0.000	0.8
OGV Main Engines	0.48	0.68	3.18	0.04	0.10	0.09	0.0	0.00	0.000	0.0
OGV Main Engines	9.58	10.23	50.20	0.30	1.76	1.59	0.2	0.00	0.000	0.2
OGV Main Engines	0.00	0.00	0.00	0.00	0.00	0.00	0.0	0.00	0.000	0.0
OGV Main Engines	9.58	10.23	50.20	0.30	1.76	1.59	0.2	0.00	0.000	0.2
OGV Main Engines	0.19	0.44	3.69	0.10	0.09	0.08	0.1	0.00	0.000	0.1
OGV Main Engines	3.94	9.19	94.49	2.62	2.10	1.90	1.8	0.00	0.000	1.8
OGV Main Engines	17.36	40.50	416.56	11.57	9.26	8.39	7.7	0.00	0.000	7.8
OGV Main Engines	5.77	13.47	138.59	3.85	3.08	2.79	2.6	0.00	0.000	2.6

E = [EF g/kW-hr] x [Energy kW-hr] x [Low Load Factor] x [Conversion from g to lb or MT]

OGV Auxiliary Generator Usage per Round-Trip

Activity	Mode	Aux Eng. Max kW	Load Factor (1)	Hours/ Trip	kW-hr/ Round-Trip
Pilot Boarding (Sea Buoy) to COLREGS Line	Transit	3605	24%	0.73	634
COLREGS Line to Golden Gate Bridge	Transit	3605	24%	0.23	199
Golden Gate Bridge to Echo Buoy	Transit	3605	24%	1.65	1,423
Echo Buoy to SPB Light #15	Transit	3605	24%	0.77	666
SPB Light #15 to Near Shell Terminal	Transit	3605	24%	0.75	649
Near Shell Terminal to Amorco Wharf	Transit	3605	24%	0.10	87
At Amorco Wharf (Docking)	Maneuvering	3605	33%	1.50	1,784
At Amorco Wharf (Hoteling and Prod. Transfer)	Hotelling	3605	26%	38.10	35,711
At Amorco Wharf (Undocking)	Maneuvering	3605	33%	1.50	1,784
Amorco Wharf to Near Shell Terminal	Transit	3605	24%	0.06	54
Near Shell Terminal to SPB Light #15	Transit	3605	24%	0.50	433
SPB Light #15 to COLREGS Line	Transit	3605	24%	2.20	1,907
COLREGS Line to Pilot Boarding (Sea Buoy)	Transit	3605	24%	0.73	634

Notes: (1) California ARB, May 2011, Appendix D, Emissions Estimation Methodology for Ocean-Going Vessels, Table II-5

OGV Auxiliary Generator Emissions per Round-Trip

EF Lookup	Lb/Trip						MT/Trip			
	POC	CO	NOx	SOx	PM10	PM2.5	CO2	CH4	N2O	CO2e
OGV Auxiliary Engines	0.56	1.54	14.69	0.65	0.45	0.41	0.4	0.00	0.00	0.4
OGV Auxiliary Engines	0.18	0.48	4.61	0.20	0.14	0.13	0.1	0.00	0.00	0.1
OGV Auxiliary Engines	1.26	3.45	32.95	1.46	1.00	0.91	1.0	0.00	0.00	1.0
OGV Auxiliary Engines	0.59	1.62	15.42	0.69	0.47	0.43	0.5	0.00	0.00	0.5
OGV Auxiliary Engines	0.57	1.57	15.02	0.67	0.46	0.41	0.4	0.00	0.00	0.5
OGV Auxiliary Engines	0.08	0.21	2.00	0.09	0.06	0.06	0.1	0.00	0.00	0.1
OGV Auxiliary Engines	1.57	4.33	41.31	1.84	1.26	1.14	1.2	0.00	0.00	1.2
OGV Auxiliary Engines	31.49	86.60	826.67	36.74	25.19	22.83	24.5	0.00	0.00	24.8
OGV Auxiliary Engines	1.57	4.33	41.31	1.84	1.26	1.14	1.2	0.00	0.00	1.2
OGV Auxiliary Engines	0.05	0.13	1.25	0.06	0.04	0.03	0.0	0.00	0.00	0.0
OGV Auxiliary Engines	0.38	1.05	10.01	0.45	0.31	0.28	0.3	0.00	0.00	0.3
OGV Auxiliary Engines	1.68	4.62	44.15	1.96	1.35	1.22	1.3	0.00	0.00	1.3
OGV Auxiliary Engines	0.56	1.54	14.69	0.65	0.45	0.41	0.4	0.00	0.00	0.4

E = [EF g/kW-hr] x [Energy kW-hr] x [Conversion from g to lb or MT]

Appendix G - Transportation Emissions (Marine Vessels, Trucks, Rails)

Table 2b - Marine Vessel 2018 Emissions
Operational Marine Vessel Emissions
PanaMax Ship to Amorco - Crude

OGV Auxiliary Boiler Usage per Round-Trip

Activity	Mode	Boiler kW per Vessel (1,2)	Hours/ Transit	kW-hr/ Round-Trip
Pilot Boarding (Sea Buoy) to COLREGS Line	Transit	144	0.73	106
COLREGS Line to Golden Gate Bridge	Transit	144	0.23	33
Golden Gate Bridge to Echo Buoy	Transit	144	1.65	237
Echo Buoy to SPB Light #15	Transit	144	0.77	111
SPB Light #15 to Near Shell Terminal	Transit	144	0.75	108
Near Shell Terminal to Amorco Wharf	Transit	144	0.10	14
At Amorco Wharf (Docking)	Maneuvering	144	1.50	216
At Amorco Wharf (Hoteling and Prod. Transfer)	Hotelling	638	38.10	24,289
At Amorco Wharf (Undocking)	Maneuvering	144	1.50	216
Amorco Wharf to Near Shell Terminal	Transit	144	0.06	9
Near Shell Terminal to SPB Light #15	Transit	144	0.50	72
SPB Light #15 to COLREGS Line	Transit	144	2.20	317
COLREGS Line to Pilot Boarding (Sea Buoy)	Transit	144	0.73	106

Notes: (1) Port of Los Angeles Air Emissions Inventory - 2019 - Table 3.5 (Starcrest, 2020); Assume Tanker - Handysize
(2) Boiler load during hotelling based on engineering estimate of fuel consumption

Tugboat Usage during Escort & Assist

Engine Type	Max Hp Per Tug	Load Factor (1)	# Tugboats	Tug-Hrs/ Round-Trip (2)	hp-hr/ Round-Trip
Escort - Main Engine	5,351	0.31	See above	3.50	5,797
Escort - Auxiliary Generator	402	0.43	See above	3.50	605
Assist - Main Engine	5,351	0.31	2	9.50	15,758
Assist - Auxiliary Generator	402	0.43	2	9.50	1,643

Notes: (1) Port of Long Beach Air Emissions Inventory - 2013 - Table 3.4 (Starcrest 2014); Assume Assist tug category
(2) Time spent operating per vessel trip. Estimated assist time to account for tug movement, docking, and undocking, plus 4x30 minute trips to/from temporary tug base.
(3) If escort tug is present, it will serve as one of the two assist tugs for docking/undocking, eliminating the need for one 30 minute trip to/from temporary tug base.

OGV Auxiliary Boiler Emissions per Round-Trip

	Lb/Trip						MT/Trip			
EF Lookup	POC	CO	NOx	SOx	PM10	PM2.5	CO2	CH4	N2O	CO2e
OGV Auxiliary Boilers	0.02	0.05	0.47	0.14	0.04	0.03	0.1	0.00	0.00	0.1
OGV Auxiliary Boilers	0.01	0.01	0.15	0.04	0.01	0.01	0.0	0.00	0.00	0.0
OGV Auxiliary Boilers	0.05	0.10	1.04	0.31	0.09	0.08	0.2	0.00	0.00	0.2
OGV Auxiliary Boilers	0.02	0.05	0.49	0.15	0.04	0.04	0.1	0.00	0.00	0.1
OGV Auxiliary Boilers	0.02	0.05	0.48	0.14	0.04	0.04	0.1	0.00	0.00	0.1
OGV Auxiliary Boilers	0.00	0.01	0.06	0.02	0.01	0.00	0.0	0.00	0.00	0.0
OGV Auxiliary Boilers	0.05	0.10	0.95	0.29	0.08	0.07	0.2	0.00	0.00	0.2
OGV Auxiliary Boilers	5.35	10.71	107.10	32.13	9.10	8.03	22.4	0.00	0.00	23.0
OGV Auxiliary Boilers	0.05	0.10	0.95	0.29	0.08	0.07	0.2	0.00	0.00	0.2
OGV Auxiliary Boilers	0.00	0.00	0.04	0.01	0.00	0.00	0.0	0.00	0.00	0.0
OGV Auxiliary Boilers	0.02	0.03	0.32	0.10	0.03	0.02	0.1	0.00	0.00	0.1
OGV Auxiliary Boilers	0.07	0.14	1.40	0.42	0.12	0.10	0.3	0.00	0.00	0.3
OGV Auxiliary Boilers	0.02	0.05	0.47	0.14	0.04	0.03	0.1	0.00	0.00	0.1

Tugboat Emissions during Escort & Assist

	Lb/Trip						MT/Trip			
EF Lookup	POC	CO	NOx	SOx	PM10	PM2.5	CO2	CH4	N2O	CO2e
Tug ME (1900-3300 hp, 2009)	11.42	56.18	81.28	0.07	3.78	3.78	2.8	0.000	0.000	2.9
Tug AE (250-500 hp, 2009)	1.39	5.78	7.73	0.01	0.29	0.29	0.3	0.000	0.000	0.3
Tug ME (1900-3300 hp, 2009)	31.05	152.72	220.93	0.19	10.27	10.27	7.6	0.000	0.000	7.8
Tug AE (250-500 hp, 2009)	3.78	15.72	21.01	0.02	0.78	0.78	0.8	0.000	0.000	0.9

Emission Calculation Notes:
For OGV main & aux engines:
[Emissions (g)] = [Energy (kW-hr)] x [EF (g/kW-hr)] x LLA
For OGV aux engines:
[Emissions (g)] = [Energy (kW-hr)] x [EF (g/kW-hr)]
For OGV aux boilers:
[Emissions (g)] = [Energy (kW-hr)] x [EF (g/kW-hr)]
For tug main & aux engines:
[Emissions (g) = [Energy hp-hr] x [EFo g/bhp-hr] x (1+[Deterioration Factor] x [Engine Age]/[Useful Life])

Appendix G - Transportation Emissions (Marine Vessels, Trucks, Rails)

Table 2c - Marine Vessel 2018 Emissions
Operational Marine Vessel Emissions
SuezMax Ship to Amorco - Crude

Vessel Type	SuezMax
Berth Location	Amorco
Cargo Per Vessel (Mbbl)	1000
Round Trips/Year	19
Max speed (kn)	15.1

Transfer Activities Per Round-Trip

Material	Direction	Mbbl/yr	Mbbl/trip	Transfer Rate bbl/hr	Transfer Time hrs	Escort Tug Needed?
Crude	Inbound	8,673	456.48	10,000	35.49	TRUE
	Outbound	0	0.00	6,000		FALSE

Additional Hoteling Time

Activity	Hrs
Hook-up (start)	3
Hook-up (end)	2
Bunkering (2-6 hrs on ~50% of ships)	1.5

Emissions Summary

	Emissions (Pounds)						Emissions (MT)			
	POC	CO	NOx	SOx	PM10	PM2.5	CO2	CH4	N2O	CO2e
Emissions/Round-Trip	159.58	471.95	2,605.18	107.12	81.26	74.81	84	0.00	0.005	86
Annual Total	3,032	8,967	49,499	2,035	1,544	1,421	1,596	0.02	0.094	1,625
Daily Total	8	25	136	6	4	4	4	0.00	0.000	4
Annual Onsite	540	1,401	13,473	1,172	533	478	802	0.00	0.05	818

Notes:
- Onsite emissions include hotelling only.

OGV Main Engine Usage per Round-Trip

Activity	Mode	# Escort Tugs Req'd (3)	Propulsion Max kW (1)	Speed (kn)	Load Factor (1)	Distance (nm/trip)	Duration (hr/trip)	kW-hr/ Round-Trip
Pilot Boarding (Sea Buoy) to COLREGS Line	Transit	0	13500	12	0.50	8.8	0.73	4,969
COLREGS Line to Golden Gate Bridge	Transit	1	13500	10	0.29	2.3	0.23	902
Golden Gate Bridge to Echo Buoy	Transit	1	13500	10	0.29	16.45	1.65	6,450
Echo Buoy to SPB Light #15	Transit	1	13500	10	0.29	7.7	0.77	3,019
SPB Light #15 to Near Shell Terminal	Transit	1	13500	8	0.15	6	0.75	1,506
Near Shell Terminal to Amorco Wharf	Transit	1	13500	5	0.04	0.5	0.10	49
At Amorco Wharf (Docking)	Maneuvering	0	13500	n/a	0.02	n/a	1.50	405
At Amorco Wharf (Hoteling and Prod. Transfer)	Hotelling	0	13500	n/a	0.00	n/a	41.99	-
At Amorco Wharf (Undocking)	Maneuvering	0	13500	n/a	0.02	n/a	1.50	405
Amorco Wharf to Near Shell Terminal	Transit	0	13500	8	0.15	0.5	0.06	125
Near Shell Terminal to SPB Light #15	Transit	0	13500	12	0.50	6	0.50	3,388
SPB Light #15 to COLREGS Line	Transit	0	13500	12	0.50	26.45	2.20	14,935
COLREGS Line to Pilot Boarding (Sea Buoy)	Transit	0	13500	12	0.50	8.8	0.73	4,969

Notes: (1) Load factor = (speed/max speed)3. Load factor of 0.02 represents minimum load factor for propulsion engines.
(2) Assume 1.5 hrs for docking and 1.5 hrs for undocking.
(3) Escort tug required to or from Golden Gate Bridge when carrying hydrocarbon.
(4) Maximum vessel speed based on Port of Los Angeles Air Emissions Inventory - 2019, Table 2.9

OGV Main Engine Emissions per Round-Trip

EF Lookup	Lb/Trip						MT/Trip			
	POC	CO	NOx	SOx	PM10	PM2.5	CO2	CH4	N2O	CO2e
OGV Main Engines	6.57	15.34	157.74	4.38	3.51	3.18	2.9	0.00	0.000	3.0
OGV Main Engines	1.19	2.78	28.63	0.80	0.64	0.58	0.5	0.00	0.000	0.5
OGV Main Engines	8.53	19.91	204.77	5.69	4.55	4.12	3.8	0.00	0.000	3.9
OGV Main Engines	3.99	9.32	95.85	2.66	2.13	1.93	1.8	0.00	0.000	1.8
OGV Main Engines	2.73	6.20	50.97	1.33	1.18	1.07	0.9	0.00	0.000	0.9
OGV Main Engines	0.57	0.81	3.75	0.04	0.12	0.11	0.0	0.00	0.000	0.0
OGV Main Engines	11.35	12.12	59.47	0.36	2.08	1.89	0.2	0.00	0.000	0.3
OGV Main Engines	0.00	0.00	0.00	0.00	0.00	0.00	0.0	0.00	0.000	0.0
OGV Main Engines	11.35	12.12	59.47	0.36	2.08	1.89	0.2	0.00	0.000	0.3
OGV Main Engines	0.23	0.52	4.25	0.11	0.10	0.09	0.1	0.00	0.000	0.1
OGV Main Engines	4.48	10.46	107.55	2.99	2.39	2.17	2.0	0.00	0.000	2.0
OGV Main Engines	19.75	46.09	474.12	13.17	10.54	9.55	8.8	0.00	0.000	8.9
OGV Main Engines	6.57	15.34	157.74	4.38	3.51	3.18	2.9	0.00	0.000	3.0

E = [EF g/kW-hr] x [Energy kW-hr] x [Low Load Factor] x [Conversion from g to lb or MT]

OGV Auxiliary Generator Usage per Round-Trip

Activity	Mode	Aux Eng. Max kW	Load Factor (1)	Hours/ Trip	kW-hr/ Round-Trip
Pilot Boarding (Sea Buoy) to COLREGS Line	Transit	2339	24%	0.73	412
COLREGS Line to Golden Gate Bridge	Transit	2339	24%	0.23	129
Golden Gate Bridge to Echo Buoy	Transit	2339	24%	1.65	923
Echo Buoy to SPB Light #15	Transit	2339	24%	0.77	432
SPB Light #15 to Near Shell Terminal	Transit	2339	24%	0.75	421
Near Shell Terminal to Amorco Wharf	Transit	2339	24%	0.10	56
At Amorco Wharf (Docking)	Maneuvering	2339	33%	1.50	1,158
At Amorco Wharf (Hoteling and Prod. Transfer)	Hotelling	2339	26%	41.99	25,534
At Amorco Wharf (Undocking)	Maneuvering	2339	33%	1.50	1,158
Amorco Wharf to Near Shell Terminal	Transit	2339	24%	0.06	35
Near Shell Terminal to SPB Light #15	Transit	2339	24%	0.50	281
SPB Light #15 to COLREGS Line	Transit	2339	24%	2.20	1,237
COLREGS Line to Pilot Boarding (Sea Buoy)	Transit	2339	24%	0.73	412

Notes: (1) California ARB, May 2011, Appendix D, Emissions Estimation Methodology for Ocean-Going Vessels, Table II-5

OGV Auxiliary Generator Emissions per Round-Trip

EF Lookup	Lb/Trip						MT/Trip			
	POC	CO	NOx	SOx	PM10	PM2.5	CO2	CH4	N2O	CO2e
OGV Auxiliary Engines	0.36	1.00	9.53	0.42	0.29	0.26	0.3	0.00	0.00	0.3
OGV Auxiliary Engines	0.11	0.31	2.99	0.13	0.09	0.08	0.1	0.00	0.00	0.1
OGV Auxiliary Engines	0.81	2.24	21.38	0.95	0.65	0.59	0.6	0.00	0.00	0.6
OGV Auxiliary Engines	0.38	1.05	10.01	0.44	0.30	0.28	0.3	0.00	0.00	0.3
OGV Auxiliary Engines	0.37	1.02	9.75	0.43	0.30	0.27	0.3	0.00	0.00	0.3
OGV Auxiliary Engines	0.05	0.14	1.30	0.06	0.04	0.04	0.0	0.00	0.00	0.0
OGV Auxiliary Engines	1.02	2.81	26.80	1.19	0.82	0.74	0.8	0.00	0.00	0.8
OGV Auxiliary Engines	22.52	61.92	591.07	26.27	18.01	16.32	17.5	0.00	0.00	17.8
OGV Auxiliary Engines	1.02	2.81	26.80	1.19	0.82	0.74	0.8	0.00	0.00	0.8
OGV Auxiliary Engines	0.03	0.09	0.81	0.04	0.02	0.02	0.0	0.00	0.00	0.0
OGV Auxiliary Engines	0.25	0.68	6.50	0.29	0.20	0.18	0.2	0.00	0.00	0.2
OGV Auxiliary Engines	1.09	3.00	28.64	1.27	0.87	0.79	0.8	0.00	0.00	0.9
OGV Auxiliary Engines	0.36	1.00	9.53	0.42	0.29	0.26	0.3	0.00	0.00	0.3

E = [EF g/kW-hr] x [Energy kW-hr] x [Conversion from g to lb or MT]

Appendix G - Transportation Emissions (Marine Vessels, Trucks, Rails)

Table 2c - Marine Vessel 2018 Emissions
Operational Marine Vessel Emissions
SuezMax Ship to Amorco - Crude

OGV Auxiliary Boiler Usage per Round-Trip

Activity	Mode	Boiler kW per Vessel (1,2)	Hours/ Transit	kW-hr/ Round-Trip
Pilot Boarding (Sea Buoy) to COLREGS Line	Transit	144	0.73	106
COLREGS Line to Golden Gate Bridge	Transit	144	0.23	33
Golden Gate Bridge to Echo Buoy	Transit	144	1.65	237
Echo Buoy to SPB Light #15	Transit	144	0.77	111
SPB Light #15 to Near Shell Terminal	Transit	144	0.75	108
Near Shell Terminal to Amorco Wharf	Transit	144	0.10	14
At Amorco Wharf (Docking)	Maneuvering	144	1.50	216
At Amorco Wharf (Hoteling and Prod. Transfer)	Hotelling	638	41.99	26,767
At Amorco Wharf (Undocking)	Maneuvering	144	1.50	216
Amorco Wharf to Near Shell Terminal	Transit	144	0.06	9
Near Shell Terminal to SPB Light #15	Transit	144	0.50	72
SPB Light #15 to COLREGS Line	Transit	144	2.20	317
COLREGS Line to Pilot Boarding (Sea Buoy)	Transit	144	0.73	106

Notes: (1) Port of Los Angeles Air Emissions Inventory - 2019 - Table 3.5 (Starcrest, 2020); Assume Tanker - Handysize
(2) Boiler load during hotelling based on engineering estimate of fuel consumption

Tugboat Usage during Escort & Assist

Engine Type	Max Hp Per Tug	Load Factor (1)	# Tugboats	Tug-Hrs/ Round-Trip (2)	hp-hr/ Round-Trip
Escort - Main Engine	5,351	0.31	See above	3.50	5,797
Escort - Auxiliary Generator	402	0.43	See above	3.50	605
Assist - Main Engine	5,351	0.31	2	9.50	15,758
Assist - Auxiliary Generator	402	0.43	2	9.50	1,643

Notes: (1) Port of Long Beach Air Emissions Inventory - 2013 - Table 3.4 (Starcrest 2014); Assume Assist tug category
(2) Time spent operating per vessel trip. Estimated assist time to account for tug movement, docking, and undocking, plus 4x30 minute trips to/from temporary tug base.
(3) If escort tug is present, it will serve as one of the two assist tugs for docking/undocking, eliminating the need for one 30 minute trip to/from temporary tug base.

OGV Auxiliary Boiler Emissions per Round-Trip

	Lb/Trip						MT/Trip			
EF Lookup	POC	CO	NOx	SOx	PM10	PM2.5	CO2	CH4	N2O	CO2e
OGV Auxiliary Boilers	0.02	0.05	0.47	0.14	0.04	0.03	0.1	0.00	0.00	0.1
OGV Auxiliary Boilers	0.01	0.01	0.15	0.04	0.01	0.01	0.0	0.00	0.00	0.0
OGV Auxiliary Boilers	0.05	0.10	1.04	0.31	0.09	0.08	0.2	0.00	0.00	0.2
OGV Auxiliary Boilers	0.02	0.05	0.49	0.15	0.04	0.04	0.1	0.00	0.00	0.1
OGV Auxiliary Boilers	0.02	0.05	0.48	0.14	0.04	0.04	0.1	0.00	0.00	0.1
OGV Auxiliary Boilers	0.00	0.01	0.06	0.02	0.01	0.00	0.0	0.00	0.00	0.0
OGV Auxiliary Boilers	0.05	0.10	0.95	0.29	0.08	0.07	0.2	0.00	0.00	0.2
OGV Auxiliary Boilers	5.90	11.80	118.02	35.41	10.03	8.85	24.7	0.00	0.00	25.3
OGV Auxiliary Boilers	0.05	0.10	0.95	0.29	0.08	0.07	0.2	0.00	0.00	0.2
OGV Auxiliary Boilers	0.00	0.00	0.04	0.01	0.00	0.00	0.0	0.00	0.00	0.0
OGV Auxiliary Boilers	0.02	0.03	0.32	0.10	0.03	0.02	0.1	0.00	0.00	0.1
OGV Auxiliary Boilers	0.07	0.14	1.40	0.42	0.12	0.10	0.3	0.00	0.00	0.3
OGV Auxiliary Boilers	0.02	0.05	0.47	0.14	0.04	0.03	0.1	0.00	0.00	0.1

Tugboat Emissions during Escort & Assist

	Lb/Trip						MT/Trip			
EF Lookup	POC	CO	NOx	SOx	PM10	PM2.5	CO2	CH4	N2O	CO2e
Tug ME (1900-3300 hp, 2009)	11.42	56.18	81.28	0.07	3.78	3.78	2.8	0.000	0.000	2.9
Tug AE (250-500 hp, 2009)	1.39	5.78	7.73	0.01	0.29	0.29	0.3	0.000	0.000	0.3
Tug ME (1900-3300 hp, 2009)	31.05	152.72	220.93	0.19	10.27	10.27	7.6	0.000	0.000	7.8
Tug AE (250-500 hp, 2009)	3.78	15.72	21.01	0.02	0.78	0.78	0.8	0.000	0.000	0.9

Emission Calculation Notes:
For OGV main & aux engines:
[Emissions (g)] = [Energy (kW-hr)] x [EF (g/kW-hr)] x LLA
For OGV aux engines:
[Emissions (g)] = [Energy (kW-hr)] x [EF (g/kW-hr)]
For OGV aux boilers:
[Emissions (g)] = [Energy (kW-hr)] x [EF (g/kW-hr)]
For tug main & aux engines:
[Emissions (g) = [Energy hp-hr] x [EFo g/bhp-hr] x (1+[Deterioration Factor] x [Engine Age]/[Useful Life])

Appendix G - Transportation Emissions (Marine Vessels, Trucks, Rails)

Table 2d - Marine Vessel 2018 Emissions
Operational Marine Vessel Emissions
Medium Range Ship to Amorco - Crude

Vessel Type	MR
Berth Location	Amorco
Cargo Per Vessel (Mbbl)	300
Round Trips/Year	12
Max speed (kn)	14.9

Transfer Activities Per Round-Trip

Material	Direction	Mbbl/yr	Mbbl/trip	Transfer Rate bbl/hr	Transfer Time hrs	Escort Tug Needed?
Crude	Inbound	2,829	235.72	10,000	29.01	TRUE
	Outbound	0	0.00	6,000		FALSE

Additional Hoteling Time

Activity	Hrs
Hook-up (start)	3
Hook-up (end)	2
Bunkering (2-6 hrs on ~50% of ships)	1.5

Emissions Summary

	Emissions (Pounds)						Emissions (MT)			
	POC	CO	NOx	SOx	PM10	PM2.5	CO2	CH4	N2O	CO2e
Emissions/Round-Trip	122.74	393.14	1,868.84	78.68	61.17	56.63	65	0.00	0.004	66
Annual Total	1,473	4,718	22,426	944	734	680	778	0.01	0.047	793
Daily Total	4	13	61	3	2	2	2	0.00	0.000	2
Annual Onsite	236	603	5,812	564	242	217	387	0.00	0.03	395

Notes:
- Onsite emissions include hotelling only.

OGV Main Engine Usage per Round-Trip

Activity	Mode	# Escort Tugs Req'd (3)	Propulsion Max kW (1)	Speed (kn)	Load Factor (1)	Distance (nm/trip)	Duration (hr/trip)	kW-hr/ Round-Trip
Pilot Boarding (Sea Buoy) to COLREGS Line	Transit	0	8607	12	0.52	8.8	0.73	3,297
COLREGS Line to Golden Gate Bridge	Transit	1	8607	10	0.30	2.3	0.23	598
Golden Gate Bridge to Echo Buoy	Transit	1	8607	10	0.30	16.45	1.65	4,280
Echo Buoy to SPB Light #15	Transit	1	8607	10	0.30	7.7	0.77	2,003
SPB Light #15 to Near Shell Terminal	Transit	1	8607	8	0.15	6	0.75	999
Near Shell Terminal to Amorco Wharf	Transit	1	8607	5	0.04	0.5	0.10	33
At Amorco Wharf (Docking)	Maneuvering	0	8607	n/a	0.02	n/a	1.50	258
At Amorco Wharf (Hoteling and Prod. Transfer)	Hotelling	0	8607	n/a	0.00	n/a	35.51	-
At Amorco Wharf (Undocking)	Maneuvering	0	8607	n/a	0.02	n/a	1.50	258
Amorco Wharf to Near Shell Terminal	Transit	0	8607	8	0.15	0.5	0.06	83
Near Shell Terminal to SPB Light #15	Transit	0	8607	12	0.52	6	0.50	2,248
SPB Light #15 to COLREGS Line	Transit	0	8607	12	0.52	26.45	2.20	9,910
COLREGS Line to Pilot Boarding (Sea Buoy)	Transit	0	8607	12	0.52	8.8	0.73	3,297

Notes: (1) Load factor = (speed/max speed)3. Load factor of 0.02 represents minimum load factor for propulsion engines.
(2) Assume 1.5 hrs for docking and 1.5 hrs for undocking.
(3) Escort tug required to or from Golden Gate Bridge when carrying hydrocarbon.
(4) Maximum vessel speed based on Port of Los Angeles Air Emissions Inventory - 2019, Table 2.9

OGV Main Engine Emissions per Round-Trip

EF Lookup	Lb/Trip						MT/Trip			
	POC	CO	NOx	SOx	PM10	PM2.5	CO2	CH4	N2O	CO2e
OGV Main Engines	4.36	10.18	104.67	2.91	2.33	2.11	1.9	0.00	0.000	2.0
OGV Main Engines	0.79	1.85	19.00	0.53	0.42	0.38	0.4	0.00	0.000	0.4
OGV Main Engines	5.66	13.21	135.88	3.77	3.02	2.74	2.5	0.00	0.000	2.6
OGV Main Engines	2.65	6.18	63.60	1.77	1.41	1.28	1.2	0.00	0.000	1.2
OGV Main Engines	1.73	3.95	33.48	0.88	0.77	0.70	0.6	0.00	0.000	0.6
OGV Main Engines	0.36	0.52	2.40	0.03	0.08	0.07	0.0	0.00	0.000	0.0
OGV Main Engines	7.23	7.73	37.91	0.23	1.33	1.20	0.2	0.00	0.000	0.2
OGV Main Engines	0.00	0.00	0.00	0.00	0.00	0.00	0.0	0.00	0.000	0.0
OGV Main Engines	7.23	7.73	37.91	0.23	1.33	1.20	0.2	0.00	0.000	0.2
OGV Main Engines	0.14	0.33	2.79	0.07	0.06	0.06	0.0	0.00	0.000	0.0
OGV Main Engines	2.97	6.94	71.37	1.98	1.59	1.44	1.3	0.00	0.000	1.3
OGV Main Engines	13.11	30.59	314.61	8.74	6.99	6.34	5.8	0.00	0.000	5.9
OGV Main Engines	4.36	10.18	104.67	2.91	2.33	2.11	1.9	0.00	0.000	2.0

E = [EF g/kW-hr] x [Energy kW-hr] x [Low Load Factor] x [Conversion from g to lb or MT]

OGV Auxiliary Generator Usage per Round-Trip

Activity	Mode	Aux Eng. Max kW	Load Factor (1)	Hours/ Trip	kW-hr/ Round-Trip
Pilot Boarding (Sea Buoy) to COLREGS Line	Transit	1799	24%	0.73	317
COLREGS Line to Golden Gate Bridge	Transit	1799	24%	0.23	99
Golden Gate Bridge to Echo Buoy	Transit	1799	24%	1.65	710
Echo Buoy to SPB Light #15	Transit	1799	24%	0.77	332
SPB Light #15 to Near Shell Terminal	Transit	1799	24%	0.75	324
Near Shell Terminal to Amorco Wharf	Transit	1799	24%	0.10	43
At Amorco Wharf (Docking)	Maneuvering	1799	33%	1.50	891
At Amorco Wharf (Hoteling and Prod. Transfer)	Hotelling	1799	26%	35.51	16,610
At Amorco Wharf (Undocking)	Maneuvering	1799	33%	1.50	891
Amorco Wharf to Near Shell Terminal	Transit	1799	24%	0.06	27
Near Shell Terminal to SPB Light #15	Transit	1799	24%	0.50	216
SPB Light #15 to COLREGS Line	Transit	1799	24%	2.20	952
COLREGS Line to Pilot Boarding (Sea Buoy)	Transit	1799	24%	0.73	317

Notes: (1) California ARB, May 2011, Appendix D, Emissions Estimation Methodology for Ocean-Going Vessels, Table II-5

OGV Auxiliary Generator Emissions per Round-Trip

EF Lookup	Lb/Trip						MT/Trip			
	POC	CO	NOx	SOx	PM10	PM2.5	CO2	CH4	N2O	CO2e
OGV Auxiliary Engines	0.28	0.77	7.33	0.33	0.22	0.20	0.2	0.00	0.00	0.2
OGV Auxiliary Engines	0.09	0.24	2.30	0.10	0.07	0.06	0.1	0.00	0.00	0.1
OGV Auxiliary Engines	0.63	1.72	16.44	0.73	0.50	0.45	0.5	0.00	0.00	0.5
OGV Auxiliary Engines	0.29	0.81	7.70	0.34	0.23	0.21	0.2	0.00	0.00	0.2
OGV Auxiliary Engines	0.29	0.79	7.50	0.33	0.23	0.21	0.2	0.00	0.00	0.2
OGV Auxiliary Engines	0.04	0.10	1.00	0.04	0.03	0.03	0.0	0.00	0.00	0.0
OGV Auxiliary Engines	0.79	2.16	20.61	0.92	0.63	0.57	0.6	0.00	0.00	0.6
OGV Auxiliary Engines	14.65	40.28	384.49	17.09	11.72	10.62	11.4	0.00	0.00	11.5
OGV Auxiliary Engines	0.79	2.16	20.61	0.92	0.63	0.57	0.6	0.00	0.00	0.6
OGV Auxiliary Engines	0.02	0.07	0.62	0.03	0.02	0.02	0.0	0.00	0.00	0.0
OGV Auxiliary Engines	0.19	0.52	5.00	0.22	0.15	0.14	0.1	0.00	0.00	0.2
OGV Auxiliary Engines	0.84	2.31	22.03	0.98	0.67	0.61	0.7	0.00	0.00	0.7
OGV Auxiliary Engines	0.28	0.77	7.33	0.33	0.22	0.20	0.2	0.00	0.00	0.2

E = [EF g/kW-hr] x [Energy kW-hr] x [Conversion from g to lb or MT]

Appendix G - Transportation Emissions (Marine Vessels, Trucks, Rails)

Table 2d - Marine Vessel 2018 Emissions
Operational Marine Vessel Emissions
Medium Range Ship to Amorco - Crude

OGV Auxiliary Boiler Usage per Round-Trip

Activity	Mode	Boiler kW per Vessel (1,2)	Hours/ Transit	kW-hr/ Round-Trip
Pilot Boarding (Sea Buoy) to COLREGS Line	Transit	144	0.73	106
COLREGS Line to Golden Gate Bridge	Transit	144	0.23	33
Golden Gate Bridge to Echo Buoy	Transit	144	1.65	237
Echo Buoy to SPB Light #15	Transit	144	0.77	111
SPB Light #15 to Near Shell Terminal	Transit	144	0.75	108
Near Shell Terminal to Amorco Wharf	Transit	144	0.10	14
At Amorco Wharf (Docking)	Maneuvering	144	1.50	216
At Amorco Wharf (Hoteling and Prod. Transfer)	Hotelling	638	35.51	22,638
At Amorco Wharf (Undocking)	Maneuvering	144	1.50	216
Amorco Wharf to Near Shell Terminal	Transit	144	0.06	9
Near Shell Terminal to SPB Light #15	Transit	144	0.50	72
SPB Light #15 to COLREGS Line	Transit	144	2.20	317
COLREGS Line to Pilot Boarding (Sea Buoy)	Transit	144	0.73	106

Notes: (1) Port of Los Angeles Air Emissions Inventory - 2019 - Table 3.5 (Starcrest, 2020); Assume Tanker - Handysize
(2) Boiler load during hotelling based on engineering estimate of fuel consumption

Tugboat Usage during Escort & Assist

Engine Type	Max Hp Per Tug	Load Factor (1)	# Tugboats	Tug-Hrs/ Round-Trip (2)	hp-hr/ Round-Trip
Escort - Main Engine	5,351	0.31	See above	3.50	5,797
Escort - Auxiliary Generator	402	0.43	See above	3.50	605
Assist - Main Engine	5,351	0.31	2	9.50	15,758
Assist - Auxiliary Generator	402	0.43	2	9.50	1,643

Notes: (1) Port of Long Beach Air Emissions Inventory - 2013 - Table 3.4 (Starcrest 2014); Assume Assist tug category
(2) Time spent operating per vessel trip. Estimated assist time to account for tug movement, docking, and undocking, plus 4x30 minute trips to/from temporary tug base.
(3) If escort tug is present, it will serve as one of the two assist tugs for docking/undocking, eliminating the need for one 30 minute trip to/from temporary tug base.

OGV Auxiliary Boiler Emissions per Round-Trip

	Lb/Trip						MT/Trip			
EF Lookup	POC	CO	NOx	SOx	PM10	PM2.5	CO2	CH4	N2O	CO2e
OGV Auxiliary Boilers	0.02	0.05	0.47	0.14	0.04	0.03	0.1	0.00	0.00	0.1
OGV Auxiliary Boilers	0.01	0.01	0.15	0.04	0.01	0.01	0.0	0.00	0.00	0.0
OGV Auxiliary Boilers	0.05	0.10	1.04	0.31	0.09	0.08	0.2	0.00	0.00	0.2
OGV Auxiliary Boilers	0.02	0.05	0.49	0.15	0.04	0.04	0.1	0.00	0.00	0.1
OGV Auxiliary Boilers	0.02	0.05	0.48	0.14	0.04	0.04	0.1	0.00	0.00	0.1
OGV Auxiliary Boilers	0.00	0.01	0.06	0.02	0.01	0.00	0.0	0.00	0.00	0.0
OGV Auxiliary Boilers	0.05	0.10	0.95	0.29	0.08	0.07	0.2	0.00	0.00	0.2
OGV Auxiliary Boilers	4.99	9.98	99.82	29.95	8.48	7.49	20.9	0.00	0.00	21.4
OGV Auxiliary Boilers	0.05	0.10	0.95	0.29	0.08	0.07	0.2	0.00	0.00	0.2
OGV Auxiliary Boilers	0.00	0.00	0.04	0.01	0.00	0.00	0.0	0.00	0.00	0.0
OGV Auxiliary Boilers	0.02	0.03	0.32	0.10	0.03	0.02	0.1	0.00	0.00	0.1
OGV Auxiliary Boilers	0.07	0.14	1.40	0.42	0.12	0.10	0.3	0.00	0.00	0.3
OGV Auxiliary Boilers	0.02	0.05	0.47	0.14	0.04	0.03	0.1	0.00	0.00	0.1

Tugboat Emissions during Escort & Assist

	Lb/Trip						MT/Trip			
EF Lookup	POC	CO	NOx	SOx	PM10	PM2.5	CO2	CH4	N2O	CO2e
Tug ME (1900-3300 hp, 2009)	11.42	56.18	81.28	0.07	3.78	3.78	2.8	0.000	0.000	2.9
Tug AE (250-500 hp, 2009)	1.39	5.78	7.73	0.01	0.29	0.29	0.3	0.000	0.000	0.3
Tug ME (1900-3300 hp, 2009)	31.05	152.72	220.93	0.19	10.27	10.27	7.6	0.000	0.000	7.8
Tug AE (250-500 hp, 2009)	3.78	15.72	21.01	0.02	0.78	0.78	0.8	0.000	0.000	0.9

Emission Calculation Notes:
For OGV main & aux engines:
[Emissions (g)] = [Energy (kW-hr)] x [EF (g/kW-hr)] x LLA
For OGV aux engines:
[Emissions (g)] = [Energy (kW-hr)] x [EF (g/kW-hr)]
For OGV aux boilers:
[Emissions (g)] = [Energy (kW-hr)] x [EF (g/kW-hr)]
For tug main & aux engines:
[Emissions (g) = [Energy hp-hr] x [EFo g/bhp-hr] x (1+[Deterioration Factor] x [Engine Age]/[Useful Life])

Appendix G - Transportation Emissions (Marine Vessels, Trucks, Rails)

Table 3a - Marine Vessel 2019 Emissions
Operational Marine Vessel Emissions
Ship to Amorco - Crude

Vessel Type	AfraMax
Berth Location	Amorco
Cargo Per Vessel (Mbbl)	800
Round Trips/Year	43
Max speed (kn)	14.4

Transfer Activities Per Round-Trip

Material	Direction	Mbbl/yr	Mbbl/trip	Transfer Rate bbl/hr	Transfer Time hrs	Escort Tug Needed?
Crude	Inbound	16,860	392.09	10,000	38.95	TRUE
	Outbound	0	0.00	6,000		FALSE

Additional Hoteling Time

Activity	Hrs
Hook-up (start)	3
Hook-up (end)	2
Bunkering (2-6 hrs on ~50% of ships)	1.5

Emissions Summary

	Emissions (Pounds)						Emissions (MT)			
	POC	CO	NOx	SOx	PM10	PM2.5	CO2	CH4	N2O	CO2e
Emissions/Round-Trip	169.68	496.31	2,857.79	117.65	87.86	80.77	91	0.00	0.005	93
Annual Total	7,296	21,341	122,885	5,059	3,778	3,473	3,917	0.06	0.229	3,990
Daily Total	20	58	337	14	10	10	11	0.00	0.001	11
Annual Onsite	1,323	3,432	33,008	2,871	1,306	1,172	1,964	0.01	0.13	2,004

Notes:
- Onsite emissions include hotelling only.

OGV Main Engine Usage per Round-Trip

Activity	Mode	# Escort Tugs Req'd (3)	Propulsion Max kW (1)	Speed (kn)	Load Factor (1)	Distance (nm/trip)	Duration (hr/trip)	kW-hr/ Round-Trip
Pilot Boarding (Sea Buoy) to COLREGS Line	Transit	0	13500	12	0.58	8.8	0.73	5,729
COLREGS Line to Golden Gate Bridge	Transit	1	13500	10	0.33	2.3	0.23	1,040
Golden Gate Bridge to Echo Buoy	Transit	1	13500	10	0.33	16.45	1.65	7,437
Echo Buoy to SPB Light #15	Transit	1	13500	10	0.33	7.7	0.77	3,481
SPB Light #15 to Near Shell Terminal	Transit	1	13500	8	0.17	6	0.75	1,736
Near Shell Terminal to Amorco Wharf	Transit	1	13500	5	0.04	0.5	0.10	57
At Amorco Wharf (Docking)	Maneuvering	0	13500	n/a	0.02	n/a	1.50	405
At Amorco Wharf (Hoteling and Prod. Transfer)	Hotelling	0	13500	n/a	0.00	n/a	45.45	-
At Amorco Wharf (Undocking)	Maneuvering	0	13500	n/a	0.02	n/a	1.50	405
Amorco Wharf to Near Shell Terminal	Transit	0	13500	8	0.17	0.5	0.06	145
Near Shell Terminal to SPB Light #15	Transit	0	13500	12	0.58	6	0.50	3,906
SPB Light #15 to COLREGS Line	Transit	0	13500	12	0.58	26.45	2.20	17,220
COLREGS Line to Pilot Boarding (Sea Buoy)	Transit	0	13500	12	0.58	8.8	0.73	5,729

Notes: (1) Load factor = (speed/max speed)3. Load factor of 0.02 represents minimum load factor for propulsion engines.
(2) Assume 1.5 hrs for docking and 1.5 hrs for undocking.
(3) Escort tug required to or from Golden Gate Bridge when carrying hydrocarbon.
(4) Maximum vessel speed based on Port of Los Angeles Air Emissions Inventory - 2019, Table 2.9

OGV Main Engine Emissions per Round-Trip

EF Lookup	Lb/Trip						MT/Trip			
	POC	CO	NOx	SOx	PM10	PM2.5	CO2	CH4	N2O	CO2e
OGV Main Engines	7.58	17.68	181.88	5.05	4.04	3.66	3.4	0.00	0.000	3.4
OGV Main Engines	1.38	3.21	33.01	0.92	0.73	0.66	0.6	0.00	0.000	0.6
OGV Main Engines	9.84	22.95	236.11	6.56	5.25	4.75	4.4	0.00	0.000	4.4
OGV Main Engines	4.60	10.74	110.52	3.07	2.46	2.23	2.1	0.00	0.000	2.1
OGV Main Engines	2.69	6.22	56.81	1.53	1.29	1.17	1.0	0.00	0.000	1.0
OGV Main Engines	0.54	0.81	3.80	0.05	0.12	0.11	0.0	0.00	0.000	0.0
OGV Main Engines	11.35	12.12	59.47	0.36	2.08	1.89	0.2	0.00	0.000	0.3
OGV Main Engines	0.00	0.00	0.00	0.00	0.00	0.00	0.0	0.00	0.000	0.0
OGV Main Engines	11.35	12.12	59.47	0.36	2.08	1.89	0.2	0.00	0.000	0.3
OGV Main Engines	0.22	0.52	4.73	0.13	0.11	0.10	0.1	0.00	0.000	0.1
OGV Main Engines	5.17	12.06	124.01	3.44	2.76	2.50	2.3	0.00	0.000	2.3
OGV Main Engines	22.78	53.15	546.68	15.19	12.15	11.01	10.1	0.00	0.000	10.3
OGV Main Engines	7.58	17.68	181.88	5.05	4.04	3.66	3.4	0.00	0.000	3.4

E = [EF g/kW-hr] x [Energy kW-hr] x [Low Load Factor] x [Conversion from g to lb or MT]

OGV Auxiliary Generator Usage per Round-Trip

Activity	Mode	Aux Eng. Max kW	Load Factor (1)	Hours/ Trip	kW-hr/ Round-Trip
Pilot Boarding (Sea Buoy) to COLREGS Line	Transit	2339	24%	0.73	412
COLREGS Line to Golden Gate Bridge	Transit	2339	24%	0.23	129
Golden Gate Bridge to Echo Buoy	Transit	2339	24%	1.65	923
Echo Buoy to SPB Light #15	Transit	2339	24%	0.77	432
SPB Light #15 to Near Shell Terminal	Transit	2339	24%	0.75	421
Near Shell Terminal to Amorco Wharf	Transit	2339	24%	0.10	56
At Amorco Wharf (Docking)	Maneuvering	2339	33%	1.50	1,158
At Amorco Wharf (Hoteling and Prod. Transfer)	Hotelling	2339	26%	45.45	27,642
At Amorco Wharf (Undocking)	Maneuvering	2339	33%	1.50	1,158
Amorco Wharf to Near Shell Terminal	Transit	2339	24%	0.06	35
Near Shell Terminal to SPB Light #15	Transit	2339	24%	0.50	281
SPB Light #15 to COLREGS Line	Transit	2339	24%	2.20	1,237
COLREGS Line to Pilot Boarding (Sea Buoy)	Transit	2339	24%	0.73	412

Notes: (1) California ARB, May 2011, Appendix D, Emissions Estimation Methodology for Ocean-Going Vessels, Table II-5

OGV Auxiliary Generator Emissions per Round-Trip

EF Lookup	Lb/Trip						MT/Trip			
	POC	CO	NOx	SOx	PM10	PM2.5	CO2	CH4	N2O	CO2e
OGV Auxiliary Engines	0.36	1.00	9.53	0.42	0.29	0.26	0.3	0.00	0.00	0.3
OGV Auxiliary Engines	0.11	0.31	2.99	0.13	0.09	0.08	0.1	0.00	0.00	0.1
OGV Auxiliary Engines	0.81	2.24	21.38	0.95	0.65	0.59	0.6	0.00	0.00	0.6
OGV Auxiliary Engines	0.38	1.05	10.01	0.44	0.30	0.28	0.3	0.00	0.00	0.3
OGV Auxiliary Engines	0.37	1.02	9.75	0.43	0.30	0.27	0.3	0.00	0.00	0.3
OGV Auxiliary Engines	0.05	0.14	1.30	0.06	0.04	0.04	0.0	0.00	0.00	0.0
OGV Auxiliary Engines	1.02	2.81	26.80	1.19	0.82	0.74	0.8	0.00	0.00	0.8
OGV Auxiliary Engines	24.38	67.03	639.87	28.44	19.50	17.67	19.0	0.00	0.00	19.2
OGV Auxiliary Engines	1.02	2.81	26.80	1.19	0.82	0.74	0.8	0.00	0.00	0.8
OGV Auxiliary Engines	0.03	0.09	0.81	0.04	0.02	0.02	0.0	0.00	0.00	0.0
OGV Auxiliary Engines	0.25	0.68	6.50	0.29	0.20	0.18	0.2	0.00	0.00	0.2
OGV Auxiliary Engines	1.09	3.00	28.64	1.27	0.87	0.79	0.8	0.00	0.00	0.9
OGV Auxiliary Engines	0.36	1.00	9.53	0.42	0.29	0.26	0.3	0.00	0.00	0.3

E = [EF g/kW-hr] x [Energy kW-hr] x [Conversion from g to lb or MT]

Appendix G - Transportation Emissions (Marine Vessels, Trucks, Rails)

Table 3a - Marine Vessel 2019 Emissions
Operational Marine Vessel Emissions
Ship to Amorco - Crude

OGV Auxiliary Boiler Usage per Round-Trip

Activity	Mode	Boiler kW per Vessel (1,2)	Hours/ Transit	kW-hr/ Round-Trip
Pilot Boarding (Sea Buoy) to COLREGS Line	Transit	144	0.73	106
COLREGS Line to Golden Gate Bridge	Transit	144	0.23	33
Golden Gate Bridge to Echo Buoy	Transit	144	1.65	237
Echo Buoy to SPB Light #15	Transit	144	0.77	111
SPB Light #15 to Near Shell Terminal	Transit	144	0.75	108
Near Shell Terminal to Amorco Wharf	Transit	144	0.10	14
At Amorco Wharf (Docking)	Maneuvering	144	1.50	216
At Amorco Wharf (Hoteling and Prod. Transfer)	Hotelling	638	45.45	28,976
At Amorco Wharf (Undocking)	Maneuvering	144	1.50	216
Amorco Wharf to Near Shell Terminal	Transit	144	0.06	9
Near Shell Terminal to SPB Light #15	Transit	144	0.50	72
SPB Light #15 to COLREGS Line	Transit	144	2.20	317
COLREGS Line to Pilot Boarding (Sea Buoy)	Transit	144	0.73	106

Notes: (1) Port of Los Angeles Air Emissions Inventory - 2019 - Table 3.5 (Starcrest, 2020); Assume Tanker - Handysize
(2) Boiler load during hotelling based on engineering estimate of fuel consumption

Tugboat Usage during Escort & Assist

Engine Type	Max Hp Per Tug	Load Factor (1)	# Tugboats	Tug-Hrs/ Round-Trip (2)	hp-hr/ Round-Trip
Escort - Main Engine	5,351	0.31	See above	3.50	5,797
Escort - Auxiliary Generator	402	0.43	See above	3.50	605
Assist - Main Engine	5,351	0.31	2	9.50	15,758
Assist - Auxiliary Generator	402	0.43	2	9.50	1,643

Notes: (1) Port of Long Beach Air Emissions Inventory - 2013 - Table 3.4 (Starcrest 2014); Assume Assist tug category
(2) Time spent operating per vessel trip. Estimated assist time to account for tug movement, docking, and undocking, plus 4x30 minute trips to/from temporary tug base.
(3) If escort tug is present, it will serve as one of the two assist tugs for docking/undocking, eliminating the need for one 30 minute trip to/from temporary tug base.

OGV Auxiliary Boiler Emissions per Round-Trip

	Lb/Trip						MT/Trip			
EF Lookup	POC	CO	NOx	SOx	PM10	PM2.5	CO2	CH4	N2O	CO2e
OGV Auxiliary Boilers	0.02	0.05	0.47	0.14	0.04	0.03	0.1	0.00	0.00	0.1
OGV Auxiliary Boilers	0.01	0.01	0.15	0.04	0.01	0.01	0.0	0.00	0.00	0.0
OGV Auxiliary Boilers	0.05	0.10	1.04	0.31	0.09	0.08	0.2	0.00	0.00	0.2
OGV Auxiliary Boilers	0.02	0.05	0.49	0.15	0.04	0.04	0.1	0.00	0.00	0.1
OGV Auxiliary Boilers	0.02	0.05	0.48	0.14	0.04	0.04	0.1	0.00	0.00	0.1
OGV Auxiliary Boilers	0.00	0.01	0.06	0.02	0.01	0.00	0.0	0.00	0.00	0.0
OGV Auxiliary Boilers	0.05	0.10	0.95	0.29	0.08	0.07	0.2	0.00	0.00	0.2
OGV Auxiliary Boilers	6.39	12.78	127.76	38.33	10.86	9.58	26.7	0.00	0.00	27.4
OGV Auxiliary Boilers	0.05	0.10	0.95	0.29	0.08	0.07	0.2	0.00	0.00	0.2
OGV Auxiliary Boilers	0.00	0.00	0.04	0.01	0.00	0.00	0.0	0.00	0.00	0.0
OGV Auxiliary Boilers	0.02	0.03	0.32	0.10	0.03	0.02	0.1	0.00	0.00	0.1
OGV Auxiliary Boilers	0.07	0.14	1.40	0.42	0.12	0.10	0.3	0.00	0.00	0.3
OGV Auxiliary Boilers	0.02	0.05	0.47	0.14	0.04	0.03	0.1	0.00	0.00	0.1

Tugboat Emissions during Escort & Assist

	Lb/Trip						MT/Trip			
EF Lookup	POC	CO	NOx	SOx	PM10	PM2.5	CO2	CH4	N2O	CO2e
Tug ME (1900-3300 hp, 2009)	11.42	56.18	81.28	0.07	3.78	3.78	2.8	0.000	0.000	2.9
Tug AE (250-500 hp, 2009)	1.39	5.78	7.73	0.01	0.29	0.29	0.3	0.000	0.000	0.3
Tug ME (1900-3300 hp, 2009)	31.05	152.72	220.93	0.19	10.27	10.27	7.6	0.000	0.000	7.8
Tug AE (250-500 hp, 2009)	3.78	15.72	21.01	0.02	0.78	0.78	0.8	0.000	0.000	0.9

Emission Calculation Notes:
For OGV main & aux engines:
[Emissions (g)] = [Energy (kW-hr)] x [EF (g/kW-hr)] x LLA
For OGV aux engines:
[Emissions (g)] = [Energy (kW-hr)] x [EF (g/kW-hr)]
For OGV aux boilers:
[Emissions (g)] = [Energy (kW-hr)] x [EF (g/kW-hr)]
For tug main & aux engines:
[Emissions (g) = [Energy hp-hr] x [EFo g/bhp-hr] x (1+[Deterioration Factor] x [Engine Age]/[Useful Life])

Appendix G - Transportation Emissions (Marine Vessels, Trucks, Rails)

Table 3b - Marine Vessel 2019 Emissions
Operational Marine Vessel Emissions
PanaMax Ship to Amorco - Crude

Vessel Type	PanaMax
Berth Location	Amorco
Cargo Per Vessel (Mbbl)	500
Round Trips/Year	22
Max speed (kn)	14.9

Transfer Activities Per Round-Trip

Material	Direction	Mbbl/yr	Mbbl/trip	Transfer Rate bbl/hr	Transfer Time hrs	Escort Tug Needed?
Crude	Inbound	8,563	389.22	10,000	34.72	TRUE
	Outbound	0	0.00	6,000		FALSE

Additional Hoteling Time

Activity	Hrs
Hook-up (start)	3
Hook-up (end)	2
Bunkering (2-6 hrs on ~50% of ships)	1.5

Emissions Summary

	Emissions (Pounds)						Emissions (MT)			
	POC	CO	NOx	SOx	PM10	PM2.5	CO2	CH4	N2O	CO2e
Emissions/Round-Trip	163.90	492.83	2,814.60	119.24	88.71	81.57	92	0.00	0.005	94
Annual Total	3,606	10,842	61,921	2,623	1,952	1,794	2,025	0.03	0.115	2,061
Daily Total	10	30	170	7	5	5	6	0.00	0.000	6
Annual Onsite	877	2,316	22,227	1,639	816	735	1,116	0.01	0.07	1,137

Notes:
- Onsite emissions include hotelling only.

OGV Main Engine Usage per Round-Trip

Activity	Mode	# Escort Tugs Req'd (3)	Propulsion Max kW (1)	Speed (kn)	Load Factor (1)	Distance (nm/trip)	Duration (hr/trip)	kW-hr/ Round-Trip
Pilot Boarding (Sea Buoy) to COLREGS Line	Transit	0	11396	12	0.52	8.8	0.73	4,366
COLREGS Line to Golden Gate Bridge	Transit	1	11396	10	0.30	2.3	0.23	792
Golden Gate Bridge to Echo Buoy	Transit	1	11396	10	0.30	16.45	1.65	5,667
Echo Buoy to SPB Light #15	Transit	1	11396	10	0.30	7.7	0.77	2,653
SPB Light #15 to Near Shell Terminal	Transit	1	11396	8	0.15	6	0.75	1,323
Near Shell Terminal to Amorco Wharf	Transit	1	11396	5	0.04	0.5	0.10	43
At Amorco Wharf (Docking)	Maneuvering	0	11396	n/a	0.02	n/a	1.50	342
At Amorco Wharf (Hoteling and Prod. Transfer)	Hotelling	0	11396	n/a	0.00	n/a	41.22	-
At Amorco Wharf (Undocking)	Maneuvering	0	11396	n/a	0.02	n/a	1.50	342
Amorco Wharf to Near Shell Terminal	Transit	0	11396	8	0.15	0.5	0.06	110
Near Shell Terminal to SPB Light #15	Transit	0	11396	12	0.52	6	0.50	2,977
SPB Light #15 to COLREGS Line	Transit	0	11396	12	0.52	26.45	2.20	13,121
COLREGS Line to Pilot Boarding (Sea Buoy)	Transit	0	11396	12	0.52	8.8	0.73	4,366

Notes: (1) Load factor = (speed/max speed)3. Load factor of 0.02 represents minimum load factor for propulsion engines.
(2) Assume 1.5 hrs for docking and 1.5 hrs for undocking.
(3) Escort tug required to or from Golden Gate Bridge when carrying hydrocarbon.
(4) Maximum vessel speed based on Port of Los Angeles Air Emissions Inventory - 2019, Table 2.9

OGV Main Engine Emissions per Round-Trip

EF Lookup	Lb/Trip						MT/Trip			
	POC	CO	NOx	SOx	PM10	PM2.5	CO2	CH4	N2O	CO2e
OGV Main Engines	5.77	13.47	138.59	3.85	3.08	2.79	2.6	0.00	0.000	2.6
OGV Main Engines	1.05	2.45	25.15	0.70	0.56	0.51	0.5	0.00	0.000	0.5
OGV Main Engines	7.50	17.49	179.91	5.00	4.00	3.62	3.3	0.00	0.000	3.4
OGV Main Engines	3.51	8.19	84.21	2.34	1.87	1.70	1.6	0.00	0.000	1.6
OGV Main Engines	2.29	5.24	44.33	1.17	1.02	0.93	0.8	0.00	0.000	0.8
OGV Main Engines	0.48	0.68	3.18	0.04	0.10	0.09	0.0	0.00	0.000	0.0
OGV Main Engines	9.58	10.23	50.20	0.30	1.76	1.59	0.2	0.00	0.000	0.2
OGV Main Engines	0.00	0.00	0.00	0.00	0.00	0.00	0.0	0.00	0.000	0.0
OGV Main Engines	9.58	10.23	50.20	0.30	1.76	1.59	0.2	0.00	0.000	0.2
OGV Main Engines	0.19	0.44	3.69	0.10	0.09	0.08	0.1	0.00	0.000	0.1
OGV Main Engines	3.94	9.19	94.49	2.62	2.10	1.90	1.8	0.00	0.000	1.8
OGV Main Engines	17.36	40.50	416.56	11.57	9.26	8.39	7.7	0.00	0.000	7.8
OGV Main Engines	5.77	13.47	138.59	3.85	3.08	2.79	2.6	0.00	0.000	2.6

E = [EF g/kW-hr] x [Energy kW-hr] x [Low Load Factor] x [Conversion from g to lb or MT]

OGV Auxiliary Generator Usage per Round-Trip

Activity	Mode	Aux Eng. Max kW	Load Factor (1)	Hours/ Trip	kW-hr/ Round-Trip
Pilot Boarding (Sea Buoy) to COLREGS Line	Transit	3605	24%	0.73	634
COLREGS Line to Golden Gate Bridge	Transit	3605	24%	0.23	199
Golden Gate Bridge to Echo Buoy	Transit	3605	24%	1.65	1,423
Echo Buoy to SPB Light #15	Transit	3605	24%	0.77	666
SPB Light #15 to Near Shell Terminal	Transit	3605	24%	0.75	649
Near Shell Terminal to Amorco Wharf	Transit	3605	24%	0.10	87
At Amorco Wharf (Docking)	Maneuvering	3605	33%	1.50	1,784
At Amorco Wharf (Hoteling and Prod. Transfer)	Hotelling	3605	26%	41.22	38,640
At Amorco Wharf (Undocking)	Maneuvering	3605	33%	1.50	1,784
Amorco Wharf to Near Shell Terminal	Transit	3605	24%	0.06	54
Near Shell Terminal to SPB Light #15	Transit	3605	24%	0.50	433
SPB Light #15 to COLREGS Line	Transit	3605	24%	2.20	1,907
COLREGS Line to Pilot Boarding (Sea Buoy)	Transit	3605	24%	0.73	634

Notes: (1) California ARB, May 2011, Appendix D, Emissions Estimation Methodology for Ocean-Going Vessels, Table II-5

OGV Auxiliary Generator Emissions per Round-Trip

EF Lookup	Lb/Trip						MT/Trip			
	POC	CO	NOx	SOx	PM10	PM2.5	CO2	CH4	N2O	CO2e
OGV Auxiliary Engines	0.56	1.54	14.69	0.65	0.45	0.41	0.4	0.00	0.00	0.4
OGV Auxiliary Engines	0.18	0.48	4.61	0.20	0.14	0.13	0.1	0.00	0.00	0.1
OGV Auxiliary Engines	1.26	3.45	32.95	1.46	1.00	0.91	1.0	0.00	0.00	1.0
OGV Auxiliary Engines	0.59	1.62	15.42	0.69	0.47	0.43	0.5	0.00	0.00	0.5
OGV Auxiliary Engines	0.57	1.57	15.02	0.67	0.46	0.41	0.4	0.00	0.00	0.5
OGV Auxiliary Engines	0.08	0.21	2.00	0.09	0.06	0.06	0.1	0.00	0.00	0.1
OGV Auxiliary Engines	1.57	4.33	41.31	1.84	1.26	1.14	1.2	0.00	0.00	1.2
OGV Auxiliary Engines	34.07	93.70	894.45	39.75	27.26	24.70	26.5	0.00	0.00	26.9
OGV Auxiliary Engines	1.57	4.33	41.31	1.84	1.26	1.14	1.2	0.00	0.00	1.2
OGV Auxiliary Engines	0.05	0.13	1.25	0.06	0.04	0.03	0.0	0.00	0.00	0.0
OGV Auxiliary Engines	0.38	1.05	10.01	0.45	0.31	0.28	0.3	0.00	0.00	0.3
OGV Auxiliary Engines	1.68	4.62	44.15	1.96	1.35	1.22	1.3	0.00	0.00	1.3
OGV Auxiliary Engines	0.56	1.54	14.69	0.65	0.45	0.41	0.4	0.00	0.00	0.4

E = [EF g/kW-hr] x [Energy kW-hr] x [Conversion from g to lb or MT]

Appendix G - Transportation Emissions (Marine Vessels, Trucks, Rails)

Table 3b - Marine Vessel 2019 Emissions
Operational Marine Vessel Emissions
PanaMax Ship to Amorco - Crude

OGV Auxiliary Boiler Usage per Round-Trip

Activity	Mode	Boiler kW per Vessel (1,2)	Hours/ Transit	kW-hr/ Round-Trip
Pilot Boarding (Sea Buoy) to COLREGS Line	Transit	144	0.73	106
COLREGS Line to Golden Gate Bridge	Transit	144	0.23	33
Golden Gate Bridge to Echo Buoy	Transit	144	1.65	237
Echo Buoy to SPB Light #15	Transit	144	0.77	111
SPB Light #15 to Near Shell Terminal	Transit	144	0.75	108
Near Shell Terminal to Amorco Wharf	Transit	144	0.10	14
At Amorco Wharf (Docking)	Maneuvering	144	1.50	216
At Amorco Wharf (Hoteling and Prod. Transfer)	Hotelling	638	41.22	26,281
At Amorco Wharf (Undocking)	Maneuvering	144	1.50	216
Amorco Wharf to Near Shell Terminal	Transit	144	0.06	9
Near Shell Terminal to SPB Light #15	Transit	144	0.50	72
SPB Light #15 to COLREGS Line	Transit	144	2.20	317
COLREGS Line to Pilot Boarding (Sea Buoy)	Transit	144	0.73	106

Notes: (1) Port of Los Angeles Air Emissions Inventory - 2019 - Table 3.5 (Starcrest, 2020); Assume Tanker - Handysize
(2) Boiler load during hotelling based on engineering estimate of fuel consumption

Tugboat Usage during Escort & Assist

Engine Type	Max Hp Per Tug	Load Factor (1)	# Tugboats	Tug-Hrs/ Round-Trip (2)	hp-hr/ Round-Trip
Escort - Main Engine	5,351	0.31	See above	3.50	5,797
Escort - Auxiliary Generator	402	0.43	See above	3.50	605
Assist - Main Engine	5,351	0.31	2	9.50	15,758
Assist - Auxiliary Generator	402	0.43	2	9.50	1,643

Notes: (1) Port of Long Beach Air Emissions Inventory - 2013 - Table 3.4 (Starcrest 2014); Assume Assist tug category
(2) Time spent operating per vessel trip. Estimated assist time to account for tug movement, docking, and undocking, plus 4x30 minute trips to/from temporary tug base.
(3) If escort tug is present, it will serve as one of the two assist tugs for docking/undocking, eliminating the need for one 30 minute trip to/from temporary tug base.

OGV Auxiliary Boiler Emissions per Round-Trip

	Lb/Trip						MT/Trip			
EF Lookup	POC	CO	NOx	SOx	PM10	PM2.5	CO2	CH4	N2O	CO2e
OGV Auxiliary Boilers	0.02	0.05	0.47	0.14	0.04	0.03	0.1	0.00	0.00	0.1
OGV Auxiliary Boilers	0.01	0.01	0.15	0.04	0.01	0.01	0.0	0.00	0.00	0.0
OGV Auxiliary Boilers	0.05	0.10	1.04	0.31	0.09	0.08	0.2	0.00	0.00	0.2
OGV Auxiliary Boilers	0.02	0.05	0.49	0.15	0.04	0.04	0.1	0.00	0.00	0.1
OGV Auxiliary Boilers	0.02	0.05	0.48	0.14	0.04	0.04	0.1	0.00	0.00	0.1
OGV Auxiliary Boilers	0.00	0.01	0.06	0.02	0.01	0.00	0.0	0.00	0.00	0.0
OGV Auxiliary Boilers	0.05	0.10	0.95	0.29	0.08	0.07	0.2	0.00	0.00	0.2
OGV Auxiliary Boilers	5.79	11.59	115.88	34.76	9.85	8.69	24.2	0.00	0.00	24.8
OGV Auxiliary Boilers	0.05	0.10	0.95	0.29	0.08	0.07	0.2	0.00	0.00	0.2
OGV Auxiliary Boilers	0.00	0.00	0.04	0.01	0.00	0.00	0.0	0.00	0.00	0.0
OGV Auxiliary Boilers	0.02	0.03	0.32	0.10	0.03	0.02	0.1	0.00	0.00	0.1
OGV Auxiliary Boilers	0.07	0.14	1.40	0.42	0.12	0.10	0.3	0.00	0.00	0.3
OGV Auxiliary Boilers	0.02	0.05	0.47	0.14	0.04	0.03	0.1	0.00	0.00	0.1

Tugboat Emissions during Escort & Assist

	Lb/Trip						MT/Trip			
EF Lookup	POC	CO	NOx	SOx	PM10	PM2.5	CO2	CH4	N2O	CO2e
Tug ME (1900-3300 hp, 2009)	11.42	56.18	81.28	0.07	3.78	3.78	2.8	0.000	0.000	2.9
Tug AE (250-500 hp, 2009)	1.39	5.78	7.73	0.01	0.29	0.29	0.3	0.000	0.000	0.3
Tug ME (1900-3300 hp, 2009)	31.05	152.72	220.93	0.19	10.27	10.27	7.6	0.000	0.000	7.8
Tug AE (250-500 hp, 2009)	3.78	15.72	21.01	0.02	0.78	0.78	0.8	0.000	0.000	0.9

Emission Calculation Notes:
For OGV main & aux engines:
[Emissions (g)] = [Energy (kW-hr)] x [EF (g/kW-hr)] x LLA
For OGV aux engines:
[Emissions (g)] = [Energy (kW-hr)] x [EF (g/kW-hr)]
For OGV aux boilers:
[Emissions (g)] = [Energy (kW-hr)] x [EF (g/kW-hr)]
For tug main & aux engines:
[Emissions (g) = [Energy hp-hr] x [EFo g/bhp-hr] x (1+[Deterioration Factor] x [Engine Age]/[Useful Life])

Appendix G - Transportation Emissions (Marine Vessels, Trucks, Rails)

Table 3c - Marine Vessel 2019 Emissions
Operational Marine Vessel Emissions
SuezMax Ship to Amorco - Crude

Vessel Type	SuezMax
Berth Location	Amorco
Cargo Per Vessel (Mbbl)	1000
Round Trips/Year	16
Max speed (kn)	15.1

Transfer Activities Per Round-Trip

Material	Direction	Mbbl/yr	Mbbl/trip	Transfer Rate bbl/hr	Transfer Time hrs	Escort Tug Needed?
Crude	Inbound	7,775	485.91	10,000	42.64	TRUE
	Outbound	0	0.00	6,000		FALSE

Additional Hoteling Time

Activity	Hrs
Hook-up (start)	3
Hook-up (end)	2
Bunkering (2-6 hrs on ~50% of ships)	1.5

Emissions Summary

	Emissions (Pounds)						Emissions (MT)			
	POC	CO	NOx	SOx	PM10	PM2.5	CO2	CH4	N2O	CO2e
Emissions/Round-Trip	164.43	484.51	2,726.00	117.63	86.04	79.10	91	0.00	0.005	93
Annual Total	2,631	7,752	43,616	1,882	1,377	1,266	1,459	0.02	0.086	1,486
Daily Total	7	21	119	5	4	3	4	0.00	0.000	4
Annual Onsite	532	1,381	13,279	1,155	525	471	790	0.00	0.05	806

Notes:
- Onsite emissions include hotelling only.

OGV Main Engine Usage per Round-Trip

Activity	Mode	# Escort Tugs Req'd (3)	Propulsion Max kW (1)	Speed (kn)	Load Factor (1)	Distance (nm/trip)	Duration (hr/trip)	kW-hr/ Round-Trip
Pilot Boarding (Sea Buoy) to COLREGS Line	Transit	0	13500	12	0.50	8.8	0.73	4,969
COLREGS Line to Golden Gate Bridge	Transit	1	13500	10	0.29	2.3	0.23	902
Golden Gate Bridge to Echo Buoy	Transit	1	13500	10	0.29	16.45	1.65	6,450
Echo Buoy to SPB Light #15	Transit	1	13500	10	0.29	7.7	0.77	3,019
SPB Light #15 to Near Shell Terminal	Transit	1	13500	8	0.15	6	0.75	1,506
Near Shell Terminal to Amorco Wharf	Transit	1	13500	5	0.04	0.5	0.10	49
At Amorco Wharf (Docking)	Maneuvering	0	13500	n/a	0.02	n/a	1.50	405
At Amorco Wharf (Hoteling and Prod. Transfer)	Hotelling	0	13500	n/a	0.00	n/a	49.14	-
At Amorco Wharf (Undocking)	Maneuvering	0	13500	n/a	0.02	n/a	1.50	405
Amorco Wharf to Near Shell Terminal	Transit	0	13500	8	0.15	0.5	0.06	125
Near Shell Terminal to SPB Light #15	Transit	0	13500	12	0.50	6	0.50	3,388
SPB Light #15 to COLREGS Line	Transit	0	13500	12	0.50	26.45	2.20	14,935
COLREGS Line to Pilot Boarding (Sea Buoy)	Transit	0	13500	12	0.50	8.8	0.73	4,969

Notes: (1) Load factor = (speed/max speed)3. Load factor of 0.02 represents minimum load factor for propulsion engines.
(2) Assume 1.5 hrs for docking and 1.5 hrs for undocking.
(3) Escort tug required to or from Golden Gate Bridge when carrying hydrocarbon.
(4) Maximum vessel speed based on Port of Los Angeles Air Emissions Inventory - 2019, Table 2.9

OGV Main Engine Emissions per Round-Trip

EF Lookup	Lb/Trip						MT/Trip			
	POC	CO	NOx	SOx	PM10	PM2.5	CO2	CH4	N2O	CO2e
OGV Main Engines	6.57	15.34	157.74	4.38	3.51	3.18	2.9	0.00	0.000	3.0
OGV Main Engines	1.19	2.78	28.63	0.80	0.64	0.58	0.5	0.00	0.000	0.5
OGV Main Engines	8.53	19.91	204.77	5.69	4.55	4.12	3.8	0.00	0.000	3.9
OGV Main Engines	3.99	9.32	95.85	2.66	2.13	1.93	1.8	0.00	0.000	1.8
OGV Main Engines	2.73	6.20	50.97	1.33	1.18	1.07	0.9	0.00	0.000	0.9
OGV Main Engines	0.57	0.81	3.75	0.04	0.12	0.11	0.0	0.00	0.000	0.0
OGV Main Engines	11.35	12.12	59.47	0.36	2.08	1.89	0.2	0.00	0.000	0.3
OGV Main Engines	0.00	0.00	0.00	0.00	0.00	0.00	0.0	0.00	0.000	0.0
OGV Main Engines	11.35	12.12	59.47	0.36	2.08	1.89	0.2	0.00	0.000	0.3
OGV Main Engines	0.23	0.52	4.25	0.11	0.10	0.09	0.1	0.00	0.000	0.1
OGV Main Engines	4.48	10.46	107.55	2.99	2.39	2.17	2.0	0.00	0.000	2.0
OGV Main Engines	19.75	46.09	474.12	13.17	10.54	9.55	8.8	0.00	0.000	8.9
OGV Main Engines	6.57	15.34	157.74	4.38	3.51	3.18	2.9	0.00	0.000	3.0

E = [EF g/kW-hr] x [Energy kW-hr] x [Low Load Factor] x [Conversion from g to lb or MT]

OGV Auxiliary Generator Usage per Round-Trip

Activity	Mode	Aux Eng. Max kW	Load Factor (1)	Hours/ Trip	kW-hr/ Round-Trip
Pilot Boarding (Sea Buoy) to COLREGS Line	Transit	2339	24%	0.73	412
COLREGS Line to Golden Gate Bridge	Transit	2339	24%	0.23	129
Golden Gate Bridge to Echo Buoy	Transit	2339	24%	1.65	923
Echo Buoy to SPB Light #15	Transit	2339	24%	0.77	432
SPB Light #15 to Near Shell Terminal	Transit	2339	24%	0.75	421
Near Shell Terminal to Amorco Wharf	Transit	2339	24%	0.10	56
At Amorco Wharf (Docking)	Maneuvering	2339	33%	1.50	1,158
At Amorco Wharf (Hoteling and Prod. Transfer)	Hotelling	2339	26%	49.14	29,884
At Amorco Wharf (Undocking)	Maneuvering	2339	33%	1.50	1,158
Amorco Wharf to Near Shell Terminal	Transit	2339	24%	0.06	35
Near Shell Terminal to SPB Light #15	Transit	2339	24%	0.50	281
SPB Light #15 to COLREGS Line	Transit	2339	24%	2.20	1,237
COLREGS Line to Pilot Boarding (Sea Buoy)	Transit	2339	24%	0.73	412

Notes: (1) California ARB, May 2011, Appendix D, Emissions Estimation Methodology for Ocean-Going Vessels, Table II-5

OGV Auxiliary Generator Emissions per Round-Trip

EF Lookup	Lb/Trip						MT/Trip			
	POC	CO	NOx	SOx	PM10	PM2.5	CO2	CH4	N2O	CO2e
OGV Auxiliary Engines	0.36	1.00	9.53	0.42	0.29	0.26	0.3	0.00	0.00	0.3
OGV Auxiliary Engines	0.11	0.31	2.99	0.13	0.09	0.08	0.1	0.00	0.00	0.1
OGV Auxiliary Engines	0.81	2.24	21.38	0.95	0.65	0.59	0.6	0.00	0.00	0.6
OGV Auxiliary Engines	0.38	1.05	10.01	0.44	0.30	0.28	0.3	0.00	0.00	0.3
OGV Auxiliary Engines	0.37	1.02	9.75	0.43	0.30	0.27	0.3	0.00	0.00	0.3
OGV Auxiliary Engines	0.05	0.14	1.30	0.06	0.04	0.04	0.0	0.00	0.00	0.0
OGV Auxiliary Engines	1.02	2.81	26.80	1.19	0.82	0.74	0.8	0.00	0.00	0.8
OGV Auxiliary Engines	26.35	72.47	691.78	30.75	21.08	19.11	20.5	0.00	0.00	20.8
OGV Auxiliary Engines	1.02	2.81	26.80	1.19	0.82	0.74	0.8	0.00	0.00	0.8
OGV Auxiliary Engines	0.03	0.09	0.81	0.04	0.02	0.02	0.0	0.00	0.00	0.0
OGV Auxiliary Engines	0.25	0.68	6.50	0.29	0.20	0.18	0.2	0.00	0.00	0.2
OGV Auxiliary Engines	1.09	3.00	28.64	1.27	0.87	0.79	0.8	0.00	0.00	0.9
OGV Auxiliary Engines	0.36	1.00	9.53	0.42	0.29	0.26	0.3	0.00	0.00	0.3

E = [EF g/kW-hr] x [Energy kW-hr] x [Conversion from g to lb or MT]

Appendix G - Transportation Emissions (Marine Vessels, Trucks, Rails)

Table 3c - Marine Vessel 2019 Emissions
Operational Marine Vessel Emissions
SuezMax Ship to Amorco - Crude

OGV Auxiliary Boiler Usage per Round-Trip

Activity	Mode	Boiler kW per Vessel (1,2)	Hours/ Transit	kW-hr/ Round-Trip
Pilot Boarding (Sea Buoy) to COLREGS Line	Transit	144	0.73	106
COLREGS Line to Golden Gate Bridge	Transit	144	0.23	33
Golden Gate Bridge to Echo Buoy	Transit	144	1.65	237
Echo Buoy to SPB Light #15	Transit	144	0.77	111
SPB Light #15 to Near Shell Terminal	Transit	144	0.75	108
Near Shell Terminal to Amorco Wharf	Transit	144	0.10	14
At Amorco Wharf (Docking)	Maneuvering	144	1.50	216
At Amorco Wharf (Hoteling and Prod. Transfer)	Hotelling	638	49.14	31,327
At Amorco Wharf (Undocking)	Maneuvering	144	1.50	216
Amorco Wharf to Near Shell Terminal	Transit	144	0.06	9
Near Shell Terminal to SPB Light #15	Transit	144	0.50	72
SPB Light #15 to COLREGS Line	Transit	144	2.20	317
COLREGS Line to Pilot Boarding (Sea Buoy)	Transit	144	0.73	106

Notes: (1) Port of Los Angeles Air Emissions Inventory - 2019 - Table 3.5 (Starcrest, 2020); Assume Tanker - Handysize
(2) Boiler load during hotelling based on engineering estimate of fuel consumption

Tugboat Usage during Escort & Assist

Engine Type	Max Hp Per Tug	Load Factor (1)	# Tugboats	Tug-Hrs/ Round-Trip (2)	hp-hr/ Round-Trip
Escort - Main Engine	5,351	0.31	See above	3.50	5,797
Escort - Auxiliary Generator	402	0.43	See above	3.50	605
Assist - Main Engine	5,351	0.31	2	9.50	15,758
Assist - Auxiliary Generator	402	0.43	2	9.50	1,643

Notes: (1) Port of Long Beach Air Emissions Inventory - 2013 - Table 3.4 (Starcrest 2014); Assume Assist tug category
(2) Time spent operating per vessel trip. Estimated assist time to account for tug movement, docking, and undocking, plus 4x30 minute trips to/from temporary tug base.
(3) If escort tug is present, it will serve as one of the two assist tugs for docking/undocking, eliminating the need for one 30 minute trip to/from temporary tug base.

OGV Auxiliary Boiler Emissions per Round-Trip

	Lb/Trip						MT/Trip			
EF Lookup	POC	CO	NOx	SOx	PM10	PM2.5	CO2	CH4	N2O	CO2e
OGV Auxiliary Boilers	0.02	0.05	0.47	0.14	0.04	0.03	0.1	0.00	0.00	0.1
OGV Auxiliary Boilers	0.01	0.01	0.15	0.04	0.01	0.01	0.0	0.00	0.00	0.0
OGV Auxiliary Boilers	0.05	0.10	1.04	0.31	0.09	0.08	0.2	0.00	0.00	0.2
OGV Auxiliary Boilers	0.02	0.05	0.49	0.15	0.04	0.04	0.1	0.00	0.00	0.1
OGV Auxiliary Boilers	0.02	0.05	0.48	0.14	0.04	0.04	0.1	0.00	0.00	0.1
OGV Auxiliary Boilers	0.00	0.01	0.06	0.02	0.01	0.00	0.0	0.00	0.00	0.0
OGV Auxiliary Boilers	0.05	0.10	0.95	0.29	0.08	0.07	0.2	0.00	0.00	0.2
OGV Auxiliary Boilers	6.91	13.81	138.13	41.44	11.74	10.36	28.9	0.00	0.00	29.6
OGV Auxiliary Boilers	0.05	0.10	0.95	0.29	0.08	0.07	0.2	0.00	0.00	0.2
OGV Auxiliary Boilers	0.00	0.00	0.04	0.01	0.00	0.00	0.0	0.00	0.00	0.0
OGV Auxiliary Boilers	0.02	0.03	0.32	0.10	0.03	0.02	0.1	0.00	0.00	0.1
OGV Auxiliary Boilers	0.07	0.14	1.40	0.42	0.12	0.10	0.3	0.00	0.00	0.3
OGV Auxiliary Boilers	0.02	0.05	0.47	0.14	0.04	0.03	0.1	0.00	0.00	0.1

Tugboat Emissions during Escort & Assist

	Lb/Trip						MT/Trip			
EF Lookup	POC	CO	NOx	SOx	PM10	PM2.5	CO2	CH4	N2O	CO2e
Tug ME (1900-3300 hp, 2009)	11.42	56.18	81.28	0.07	3.78	3.78	2.8	0.000	0.000	2.9
Tug AE (250-500 hp, 2009)	1.39	5.78	7.73	0.01	0.29	0.29	0.3	0.000	0.000	0.3
Tug ME (1900-3300 hp, 2009)	31.05	152.72	220.93	0.19	10.27	10.27	7.6	0.000	0.000	7.8
Tug AE (250-500 hp, 2009)	3.78	15.72	21.01	0.02	0.78	0.78	0.8	0.000	0.000	0.9

Emission Calculation Notes:
For OGV main & aux engines:
[Emissions (g)] = [Energy (kW-hr)] x [EF (g/kW-hr)] x LLA
For OGV aux engines:
[Emissions (g)] = [Energy (kW-hr)] x [EF (g/kW-hr)]
For OGV aux boilers:
[Emissions (g)] = [Energy (kW-hr)] x [EF (g/kW-hr)]
For tug main & aux engines:
[Emissions (g) = [Energy hp-hr] x [EFo g/bhp-hr] x (1+[Deterioration Factor] x [Engine Age]/[Useful Life])

Appendix G - Transportation Emissions (Marine Vessels, Trucks, Rails)

Table 3d - Marine Vessel 2019 Emissions
Operational Marine Vessel Emissions
Medium Range Ship to Amorco - Crude

Vessel Type	MR
Berth Location	Amorco
Cargo Per Vessel (Mbbl)	300
Round Trips/Year	13
Max speed (kn)	14.9

Transfer Activities Per Round-Trip

Material	Direction	Mbbl/yr	Mbbl/trip	Transfer Rate bbl/hr	Transfer Time hrs	Escort Tug Needed?
Crude	Inbound	2,505	192.73	10,000	31.37	TRUE
	Outbound	0	0.00	6,000		FALSE

Additional Hoteling Time

Activity	Hrs
Hook-up (start)	3
Hook-up (end)	2
Bunkering (2-6 hrs on ~50% of ships)	1.5

Emissions Summary

	Emissions (Pounds)						Emissions (MT)			
	POC	CO	NOx	SOx	PM10	PM2.5	CO2	CH4	N2O	CO2e
Emissions/Round-Trip	124.05	396.48	1,901.06	81.81	62.51	57.84	67	0.00	0.004	68
Annual Total	1,613	5,154	24,714	1,063	813	752	871	0.01	0.052	887
Daily Total	4	14	68	3	2	2	2	0.00	0.000	2
Annual Onsite	272	697	6,715	652	280	251	447	0.00	0.03	457

Notes:
- Onsite emissions include hotelling only.

OGV Main Engine Usage per Round-Trip

Activity	Mode	# Escort Tugs Req'd (3)	Propulsion Max kW (1)	Speed (kn)	Load Factor (1)	Distance (nm/trip)	Duration (hr/trip)	kW-hr/ Round-Trip
Pilot Boarding (Sea Buoy) to COLREGS Line	Transit	0	8607	12	0.52	8.8	0.73	3,297
COLREGS Line to Golden Gate Bridge	Transit	1	8607	10	0.30	2.3	0.23	598
Golden Gate Bridge to Echo Buoy	Transit	1	8607	10	0.30	16.45	1.65	4,280
Echo Buoy to SPB Light #15	Transit	1	8607	10	0.30	7.7	0.77	2,003
SPB Light #15 to Near Shell Terminal	Transit	1	8607	8	0.15	6	0.75	999
Near Shell Terminal to Amorco Wharf	Transit	1	8607	5	0.04	0.5	0.10	33
At Amorco Wharf (Docking)	Maneuvering	0	8607	n/a	0.02	n/a	1.50	258
At Amorco Wharf (Hoteling and Prod. Transfer)	Hotelling	0	8607	n/a	0.00	n/a	37.87	-
At Amorco Wharf (Undocking)	Maneuvering	0	8607	n/a	0.02	n/a	1.50	258
Amorco Wharf to Near Shell Terminal	Transit	0	8607	8	0.15	0.5	0.06	83
Near Shell Terminal to SPB Light #15	Transit	0	8607	12	0.52	6	0.50	2,248
SPB Light #15 to COLREGS Line	Transit	0	8607	12	0.52	26.45	2.20	9,910
COLREGS Line to Pilot Boarding (Sea Buoy)	Transit	0	8607	12	0.52	8.8	0.73	3,297

Notes: (1) Load factor = (speed/max speed)3. Load factor of 0.02 represents minimum load factor for propulsion engines.
(2) Assume 1.5 hrs for docking and 1.5 hrs for undocking.
(3) Escort tug required to or from Golden Gate Bridge when carrying hydrocarbon.
(4) Maximum vessel speed based on Port of Los Angeles Air Emissions Inventory - 2019, Table 2.9

OGV Main Engine Emissions per Round-Trip

EF Lookup	Lb/Trip						MT/Trip			
	POC	CO	NOx	SOx	PM10	PM2.5	CO2	CH4	N2O	CO2e
OGV Main Engines	4.36	10.18	104.67	2.91	2.33	2.11	1.9	0.00	0.000	2.0
OGV Main Engines	0.79	1.85	19.00	0.53	0.42	0.38	0.4	0.00	0.000	0.4
OGV Main Engines	5.66	13.21	135.88	3.77	3.02	2.74	2.5	0.00	0.000	2.6
OGV Main Engines	2.65	6.18	63.60	1.77	1.41	1.28	1.2	0.00	0.000	1.2
OGV Main Engines	1.73	3.95	33.48	0.88	0.77	0.70	0.6	0.00	0.000	0.6
OGV Main Engines	0.36	0.52	2.40	0.03	0.08	0.07	0.0	0.00	0.000	0.0
OGV Main Engines	7.23	7.73	37.91	0.23	1.33	1.20	0.2	0.00	0.000	0.2
OGV Main Engines	0.00	0.00	0.00	0.00	0.00	0.00	0.0	0.00	0.000	0.0
OGV Main Engines	7.23	7.73	37.91	0.23	1.33	1.20	0.2	0.00	0.000	0.2
OGV Main Engines	0.14	0.33	2.79	0.07	0.06	0.06	0.0	0.00	0.000	0.0
OGV Main Engines	2.97	6.94	71.37	1.98	1.59	1.44	1.3	0.00	0.000	1.3
OGV Main Engines	13.11	30.59	314.61	8.74	6.99	6.34	5.8	0.00	0.000	5.9
OGV Main Engines	4.36	10.18	104.67	2.91	2.33	2.11	1.9	0.00	0.000	2.0

E = [EF g/kW-hr] x [Energy kW-hr] x [Low Load Factor] x [Conversion from g to lb or MT]

OGV Auxiliary Generator Usage per Round-Trip

Activity	Mode	Aux Eng. Max kW	Load Factor (1)	Hours/ Trip	kW-hr/ Round-Trip
Pilot Boarding (Sea Buoy) to COLREGS Line	Transit	1799	24%	0.73	317
COLREGS Line to Golden Gate Bridge	Transit	1799	24%	0.23	99
Golden Gate Bridge to Echo Buoy	Transit	1799	24%	1.65	710
Echo Buoy to SPB Light #15	Transit	1799	24%	0.77	332
SPB Light #15 to Near Shell Terminal	Transit	1799	24%	0.75	324
Near Shell Terminal to Amorco Wharf	Transit	1799	24%	0.10	43
At Amorco Wharf (Docking)	Maneuvering	1799	33%	1.50	891
At Amorco Wharf (Hoteling and Prod. Transfer)	Hotelling	1799	26%	37.87	17,715
At Amorco Wharf (Undocking)	Maneuvering	1799	33%	1.50	891
Amorco Wharf to Near Shell Terminal	Transit	1799	24%	0.06	27
Near Shell Terminal to SPB Light #15	Transit	1799	24%	0.50	216
SPB Light #15 to COLREGS Line	Transit	1799	24%	2.20	952
COLREGS Line to Pilot Boarding (Sea Buoy)	Transit	1799	24%	0.73	317

Notes: (1) California ARB, May 2011, Appendix D, Emissions Estimation Methodology for Ocean-Going Vessels, Table II-5

OGV Auxiliary Generator Emissions per Round-Trip

EF Lookup	Lb/Trip						MT/Trip			
	POC	CO	NOx	SOx	PM10	PM2.5	CO2	CH4	N2O	CO2e
OGV Auxiliary Engines	0.28	0.77	7.33	0.33	0.22	0.20	0.2	0.00	0.00	0.2
OGV Auxiliary Engines	0.09	0.24	2.30	0.10	0.07	0.06	0.1	0.00	0.00	0.1
OGV Auxiliary Engines	0.63	1.72	16.44	0.73	0.50	0.45	0.5	0.00	0.00	0.5
OGV Auxiliary Engines	0.29	0.81	7.70	0.34	0.23	0.21	0.2	0.00	0.00	0.2
OGV Auxiliary Engines	0.29	0.79	7.50	0.33	0.23	0.21	0.2	0.00	0.00	0.2
OGV Auxiliary Engines	0.04	0.10	1.00	0.04	0.03	0.03	0.0	0.00	0.00	0.0
OGV Auxiliary Engines	0.79	2.16	20.61	0.92	0.63	0.57	0.6	0.00	0.00	0.6
OGV Auxiliary Engines	15.62	42.96	410.07	18.23	12.50	11.33	12.2	0.00	0.00	12.3
OGV Auxiliary Engines	0.79	2.16	20.61	0.92	0.63	0.57	0.6	0.00	0.00	0.6
OGV Auxiliary Engines	0.02	0.07	0.62	0.03	0.02	0.02	0.0	0.00	0.00	0.0
OGV Auxiliary Engines	0.19	0.52	5.00	0.22	0.15	0.14	0.1	0.00	0.00	0.2
OGV Auxiliary Engines	0.84	2.31	22.03	0.98	0.67	0.61	0.7	0.00	0.00	0.7
OGV Auxiliary Engines	0.28	0.77	7.33	0.33	0.22	0.20	0.2	0.00	0.00	0.2

E = [EF g/kW-hr] x [Energy kW-hr] x [Conversion from g to lb or MT]

Appendix G - Transportation Emissions (Marine Vessels, Trucks, Rails)

Table 3d - Marine Vessel 2019 Emissions
Operational Marine Vessel Emissions
Medium Range Ship to Amorco - Crude

OGV Auxiliary Boiler Usage per Round-Trip

Activity	Mode	Boiler kW per Vessel (1,2)	Hours/ Transit	kW-hr/ Round-Trip
Pilot Boarding (Sea Buoy) to COLREGS Line	Transit	144	0.73	106
COLREGS Line to Golden Gate Bridge	Transit	144	0.23	33
Golden Gate Bridge to Echo Buoy	Transit	144	1.65	237
Echo Buoy to SPB Light #15	Transit	144	0.77	111
SPB Light #15 to Near Shell Terminal	Transit	144	0.75	108
Near Shell Terminal to Amorco Wharf	Transit	144	0.10	14
At Amorco Wharf (Docking)	Maneuvering	144	1.50	216
At Amorco Wharf (Hoteling and Prod. Transfer)	Hotelling	638	37.87	24,144
At Amorco Wharf (Undocking)	Maneuvering	144	1.50	216
Amorco Wharf to Near Shell Terminal	Transit	144	0.06	9
Near Shell Terminal to SPB Light #15	Transit	144	0.50	72
SPB Light #15 to COLREGS Line	Transit	144	2.20	317
COLREGS Line to Pilot Boarding (Sea Buoy)	Transit	144	0.73	106

Notes: (1) Port of Los Angeles Air Emissions Inventory - 2019 - Table 3.5 (Starcrest, 2020); Assume Tanker - Handysize
(2) Boiler load during hotelling based on engineering estimate of fuel consumption

Tugboat Usage during Escort & Assist

Engine Type	Max Hp Per Tug	Load Factor (1)	# Tugboats	Tug-Hrs/ Round-Trip (2)	hp-hr/ Round-Trip
Escort - Main Engine	5,351	0.31	See above	3.50	5,797
Escort - Auxiliary Generator	402	0.43	See above	3.50	605
Assist - Main Engine	5,351	0.31	2	9.50	15,758
Assist - Auxiliary Generator	402	0.43	2	9.50	1,643

Notes: (1) Port of Long Beach Air Emissions Inventory - 2013 - Table 3.4 (Starcrest 2014); Assume Assist tug category
(2) Time spent operating per vessel trip. Estimated assist time to account for tug movement, docking, and undocking, plus 4x30 minute trips to/from temporary tug base.
(3) If escort tug is present, it will serve as one of the two assist tugs for docking/undocking, eliminating the need for one 30 minute trip to/from temporary tug base.

OGV Auxiliary Boiler Emissions per Round-Trip

	Lb/Trip						MT/Trip			
EF Lookup	POC	CO	NOx	SOx	PM10	PM2.5	CO2	CH4	N2O	CO2e
OGV Auxiliary Boilers	0.02	0.05	0.47	0.14	0.04	0.03	0.1	0.00	0.00	0.1
OGV Auxiliary Boilers	0.01	0.01	0.15	0.04	0.01	0.01	0.0	0.00	0.00	0.0
OGV Auxiliary Boilers	0.05	0.10	1.04	0.31	0.09	0.08	0.2	0.00	0.00	0.2
OGV Auxiliary Boilers	0.02	0.05	0.49	0.15	0.04	0.04	0.1	0.00	0.00	0.1
OGV Auxiliary Boilers	0.02	0.05	0.48	0.14	0.04	0.04	0.1	0.00	0.00	0.1
OGV Auxiliary Boilers	0.00	0.01	0.06	0.02	0.01	0.00	0.0	0.00	0.00	0.0
OGV Auxiliary Boilers	0.05	0.10	0.95	0.29	0.08	0.07	0.2	0.00	0.00	0.2
OGV Auxiliary Boilers	5.32	10.65	106.46	31.94	9.05	7.98	22.3	0.00	0.00	22.8
OGV Auxiliary Boilers	0.05	0.10	0.95	0.29	0.08	0.07	0.2	0.00	0.00	0.2
OGV Auxiliary Boilers	0.00	0.00	0.04	0.01	0.00	0.00	0.0	0.00	0.00	0.0
OGV Auxiliary Boilers	0.02	0.03	0.32	0.10	0.03	0.02	0.1	0.00	0.00	0.1
OGV Auxiliary Boilers	0.07	0.14	1.40	0.42	0.12	0.10	0.3	0.00	0.00	0.3
OGV Auxiliary Boilers	0.02	0.05	0.47	0.14	0.04	0.03	0.1	0.00	0.00	0.1

Tugboat Emissions during Escort & Assist

	Lb/Trip						MT/Trip			
EF Lookup	POC	CO	NOx	SOx	PM10	PM2.5	CO2	CH4	N2O	CO2e
Tug ME (1900-3300 hp, 2009)	11.42	56.18	81.28	0.07	3.78	3.78	2.8	0.000	0.000	2.9
Tug AE (250-500 hp, 2009)	1.39	5.78	7.73	0.01	0.29	0.29	0.3	0.000	0.000	0.3
Tug ME (1900-3300 hp, 2009)	31.05	152.72	220.93	0.19	10.27	10.27	7.6	0.000	0.000	7.8
Tug AE (250-500 hp, 2009)	3.78	15.72	21.01	0.02	0.78	0.78	0.8	0.000	0.000	0.9

Emission Calculation Notes:
For OGV main & aux engines:
[Emissions (g)] = [Energy (kW-hr)] x [EF (g/kW-hr)] x LLA
For OGV aux engines:
[Emissions (g)] = [Energy (kW-hr)] x [EF (g/kW-hr)]
For OGV aux boilers:
[Emissions (g)] = [Energy (kW-hr)] x [EF (g/kW-hr)]
For tug main & aux engines:
[Emissions (g) = [Energy hp-hr] x [EFo g/bhp-hr] x (1+[Deterioration Factor] x [Engine Age]/[Useful Life])

Table 20f Mobile Source - Marine Vessel Transport Project Summary
Project Summary

S-55 (Amorco) Post-Project Emissions

Annual - Post-Project Emissions

Transport Method	# Trips	BAAQMD Criteria Pollutant Emissions (TPY)						Statewide GHG Emissions (Metric Tons/Year)			
		POC	SO_2	NOx	CO	PM_{10}	$PM_{2.5}$	CO_2	CH_4	N_2O	CO_2e
Amorco Vessels	40	2.22	1.53	31.20	7.18	1.09	1.01	2,543	0.03	0.165	2,595
Avon Vessels	364	6.69	2.02	80.93	33.75	2.72	2.61	12,059	0.20	0.598	12,248
Total Post-Project		8.91	3.55	112.13	40.93	3.81	3.62	14,602	0.23	0.763	14,844

Onsite Annual - Post-Project Emissions

Transport Method	# Trips	Onsite Criteria Pollutant Emissions (TPY)						Onsite GHG Emissions (Metric Tons/Year)			
		POC	SO_2	NOx	CO	PM_{10}	$PM_{2.5}$	CO_2	CH_4	N_2O	CO_2e
Amorco Vessels	40	0.30	1.02	7.15	0.74	0.37	0.33	1,408	0.01	0.104	1,440
Avon Vessels	364	0.52	1.06	10.82	3.96	0.40	0.36	2,438	0.02	0.148	2,484
Total Post-Project	404	0.83	2.08	17.97	4.70	0.77	0.69	3,846	0.02	0.253	3,925

Appendix G - Transportation Emissions (Marine Vessels, Trucks, Rails)

Table 20f-1 Mobile Source - Marine Vessel Post-Project Emissions

Operational Marine Vessel Emissions

Ship from Amorco - Renewable Diesel

Vessel Type	HandyMax Tanker
Berth Location	Amorco
Cargo Per Vessel (Mbbl)	260
Round Trips/Year	40
Max speed (kn)	15.1

Transfer Activities Per Round-Trip

Material	Direction	Mbbl/yr	Mbbl/trip	Transfer Rate	Transfer Time	Escort Tug Needed?
	Inbound	0	0.00	10,000	0.00	FALSE
Renewable Diesel	Outbound	10,147	253.68	6,000	42.28	TRUE

Additional Hoteling Time

Activity	Hrs
Hook-up (start)	3
Hook-up (end)	2
Bunkering (2-6 hrs on ~50% of ships)	1.5

Emissions Summary

	Emissions (Pounds)						Emissions (MT)			
	POC	CO	NOx	SO_2	PM10	PM2.5	CO2	CH4	N2O	CO2e
Emissions/Round-Trip	111.13	359.13	1,559.98	76.53	54.70	50.67	64	0.00	0.004	65
Annual Total	4,445	14,365	62,399	3,061	2,188	2,027	2,543	0.03	0.165	2,595
Daily Total	12	39	171	8	6	6	7	0.00	0.000	7
Annual Onsite	610	1,471	14,292	2,037	735	655	1,408	0.01	0.10	1,440

Notes:
- Onsite emissions include hotelling only.

OGV Main Engine Usage per Round-Trip

Activity	Mode	# Escort Tugs Req'd [3]	Propulsion Max kW [1]	Speed (kn)	Load Factor [1]	Distance (nm/trip)	Duration (hr/trip)	kW-hr/ Round-Trip
Pilot Boarding (Sea Buoy) to COLREGS Line	Transit	0	9000	12	0.50	8.8	0.73	3,313
COLREGS Line to Golden Gate Bridge	Transit	0	9000	10	0.29	2.3	0.23	601
Golden Gate Bridge to Echo Buoy	Transit	0	9000	10	0.29	16.45	1.65	4,300
Echo Buoy to SPB Light #15	Transit	0	9000	10	0.29	7.7	0.77	2,013
SPB Light #15 to Near Shell Terminal	Transit	0	9000	8	0.15	6	0.75	1,004
Near Shell Terminal to Amorco Wharf	Transit	0	9000	5	0.04	0.5	0.10	33
At Amorco Wharf (Docking)	Maneuvering	0	9000	n/a	0.02	n/a	1.50	270
At Amorco Wharf (Hoteling and Prod. Trans	Hotelling	0	9000	n/a	0.00	n/a	48.78	-
At Amorco Wharf (Undocking)	Maneuvering	0	9000	n/a	0.02	n/a	1.50	270
Amorco Wharf to Near Shell Terminal	Transit	1	9000	8	0.15	0.5	0.06	84
Near Shell Terminal to SPB Light #15	Transit	1	9000	10	0.29	6	0.60	1,568
SPB Light #15 to COLREGS Line	Transit	1	9000	10	0.29	26.45	2.65	6,914
COLREGS Line to Pilot Boarding (Sea Buoy)	Transit	0	9000	12	0.50	8.8	0.73	3,313

Notes: (1) Load factor = (speed/max speed)^3. Load factor of 0.02 represents minimum load factor for propulsion engines.
(2) Assume 1.5 hrs for docking and 1.5 hrs for undocking.
(3) Escort tug required to or from Golden Gate Bridge when carrying hydrocarbon.
(4) Maximum vessel speed based on Port of Los Angeles Air Emissions Inventory - 2019, Table 2.9

OGV Main Engine Emissions per Round-Trip

EF Lookup	Lb/Trip						MT/Trip			
	POC	CO	NOx	SO_2	PM10	PM2.5	CO2	CH4	N2O	CO2e
OGV Main Engines	4.38	10.22	105.16	2.92	2.34	2.12	2.0	0.00	0.000	2.0
OGV Main Engines	0.80	1.86	19.09	0.53	0.42	0.38	0.4	0.00	0.000	0.4
OGV Main Engines	5.69	13.27	136.51	3.79	3.03	2.75	2.5	0.00	0.000	2.6
OGV Main Engines	2.66	6.21	63.90	1.77	1.42	1.29	1.2	0.00	0.000	1.2
OGV Main Engines	1.82	4.13	33.98	0.89	0.79	0.72	0.6	0.00	0.000	0.6
OGV Main Engines	0.38	0.54	2.50	0.03	0.08	0.07	0.0	0.00	0.000	0.0
OGV Main Engines	7.56	8.08	39.64	0.24	1.39	1.26	0.2	0.00	0.000	0.2
OGV Main Engines	0.00	0.00	0.00	0.00	0.00	0.00	0.0	0.00	0.000	0.0
OGV Main Engines	7.56	8.08	39.64	0.24	1.39	1.26	0.2	0.00	0.000	0.2
OGV Main Engines	0.15	0.34	2.83	0.07	0.07	0.06	0.0	0.00	0.000	0.1
OGV Main Engines	2.07	4.84	49.79	1.38	1.11	1.00	0.9	0.00	0.000	0.9
OGV Main Engines	9.15	21.34	219.50	6.10	4.88	4.42	4.1	0.00	0.000	4.1
OGV Main Engines	4.38	10.22	105.16	2.92	2.34	2.12	2.0	0.00	0.000	2.0

E = [EF g/kW-hr] x [Energy kW-hr] x [Low Load Factor] x [Conversion from g to lb or MT]

OGV Auxiliary Generator Usage per Round-Trip

Activity	Mode	Aux Eng. Max kW	Load Factor [1]	Hours/ Trip	kW-hr/ Round-Trip
Pilot Boarding (Sea Buoy) to COLREGS Line	Transit	750	24%	0.73	132
COLREGS Line to Golden Gate Bridge	Transit	750	24%	0.23	41
Golden Gate Bridge to Echo Buoy	Transit	750	24%	1.65	296
Echo Buoy to SPB Light #15	Transit	750	24%	0.77	139
SPB Light #15 to Near Shell Terminal	Transit	750	24%	0.75	135
Near Shell Terminal to Amorco Wharf	Transit	750	24%	0.10	18
At Amorco Wharf (Docking)	Maneuvering	750	33%	1.50	371
At Amorco Wharf (Hoteling and Prod. Trans	Hotelling	750	26%	48.78	9,512
At Amorco Wharf (Undocking)	Maneuvering	750	33%	1.50	371
Amorco Wharf to Near Shell Terminal	Transit	750	24%	0.06	11
Near Shell Terminal to SPB Light #15	Transit	750	24%	0.60	108
SPB Light #15 to COLREGS Line	Transit	750	24%	2.65	476
COLREGS Line to Pilot Boarding (Sea Buoy)	Transit	750	24%	0.73	132

Notes: (1) California ARB, May 2011, Appendix D, Emissions Estimation Methodology for Ocean-Going Vessels, Table II-5

OGV Auxiliary Generator Emissions per Round-Trip

EF Lookup	Lb/Trip						MT/Trip			
	POC	CO	NOx	SO_2	PM10	PM2.5	CO2	CH4	N2O	CO2e
OGV Auxiliary Engines	0.12	0.32	3.06	0.14	0.09	0.08	0.1	0.00	0.00	0.1
OGV Auxiliary Engines	0.04	0.10	0.96	0.04	0.03	0.03	0.0	0.00	0.00	0.0
OGV Auxiliary Engines	0.26	0.72	6.85	0.30	0.21	0.19	0.2	0.00	0.00	0.2
OGV Auxiliary Engines	0.12	0.34	3.21	0.14	0.10	0.09	0.1	0.00	0.00	0.1
OGV Auxiliary Engines	0.12	0.33	3.13	0.14	0.10	0.09	0.1	0.00	0.00	0.1
OGV Auxiliary Engines	0.02	0.04	0.42	0.02	0.01	0.01	0.0	0.00	0.00	0.0
OGV Auxiliary Engines	0.33	0.90	8.59	0.38	0.26	0.24	0.3	0.00	0.00	0.3
OGV Auxiliary Engines	8.39	23.07	220.19	9.79	6.71	6.08	6.5	0.00	0.00	6.6
OGV Auxiliary Engines	0.33	0.90	8.59	0.38	0.26	0.24	0.3	0.00	0.00	0.3
OGV Auxiliary Engines	0.01	0.03	0.26	0.01	0.01	0.01	0.0	0.00	0.00	0.0
OGV Auxiliary Engines	0.10	0.26	2.50	0.11	0.08	0.07	0.1	0.00	0.00	0.1
OGV Auxiliary Engines	0.42	1.15	11.02	0.49	0.34	0.30	0.3	0.00	0.00	0.3
OGV Auxiliary Engines	0.12	0.32	3.06	0.14	0.09	0.08	0.1	0.00	0.00	0.1

E = [EF g/kW-hr] x [Energy kW-hr] x [Conversion from g to lb or MT]

Table 20f-1 Mobile Source - Marine Vessel Post-Project Emissions

Operational Marine Vessel Emissions

Ship from Amorco - Renewable Diesel

OGV Auxiliary Boiler Usage per Round-Trip

Activity	Mode	Boiler kW per Vessel [1,2]	Hours/ Transit	kW-hr/ Round-Trip
Pilot Boarding (Sea Buoy) to COLREGS Line	Transit	144	0.73	106
COLREGS Line to Golden Gate Bridge	Transit	144	0.23	33
Golden Gate Bridge to Echo Buoy	Transit	144	1.65	237
Echo Buoy to SPB Light #15	Transit	144	0.77	111
SPB Light #15 to Near Shell Terminal	Transit	144	0.75	108
Near Shell Terminal to Amorco Wharf	Transit	144	0.10	14
At Amorco Wharf (Docking)	Maneuvering	144	1.50	216
At Amorco Wharf (Hoteling and Prod. Trans	Hotelling	638	48.78	31,097
At Amorco Wharf (Undocking)	Maneuvering	144	1.50	216
Amorco Wharf to Near Shell Terminal	Transit	144	0.06	9
Near Shell Terminal to SPB Light #15	Transit	144	0.60	86
SPB Light #15 to COLREGS Line	Transit	144	2.65	381
COLREGS Line to Pilot Boarding (Sea Buoy)	Transit	144	0.73	106

Notes: (1) Port of Los Angeles Air Emissions Inventory - 2019 - Table 3.5 (Starcrest, 2020); Assume Tanker - Handysize
(2) Boiler load during hotelling based on engineering estimate of fuel consumption

Tugboat Usage during Escort & Assist

Engine Type	Max Hp Per Tug	Load Factor [1]	# Tugboats	Tug-Hrs/ Round-Trip [2]	hp-hr/ Round-Trip
Escort - Main Engine	5,351	0.31	See above	3.31	5,486
Escort - Auxiliary Generator	402	0.43	See above	3.31	572
Assist - Main Engine	5,351	0.31	2	9.50	15,758
Assist - Auxiliary Generator	402	0.43	2	9.50	1,643

Notes: (1) Port of Long Beach Air Emissions Inventory - 2013 - Table 3.4 (Starcrest 2014); Assume Assist tug category
(2) Time spent operating per vessel trip. Estimated assist time to account for tug movement, docking, and undocking, plus 4x30 minute trips to/from temporary tug base.
(3) If escort tug is present, it will serve as one of the two assist tugs for docking/undocking, eliminating the need for one 30 minute trip to/from temporary tug base.

OGV Auxiliary Boiler Emissions per Round-Trip

	Lb/Trip						MT/Trip			
EF Lookup	POC	CO	NOx	SO_2	PM10	PM2.5	CO2	CH4	N2O	CO2e
OGV Auxiliary Boilers	0.02	0.05	0.47	0.14	0.04	0.03	0.1	0.00	0.00	0.1
OGV Auxiliary Boilers	0.01	0.01	0.15	0.04	0.01	0.01	0.0	0.00	0.00	0.0
OGV Auxiliary Boilers	0.05	0.10	1.04	0.31	0.09	0.08	0.2	0.00	0.00	0.2
OGV Auxiliary Boilers	0.02	0.05	0.49	0.15	0.04	0.04	0.1	0.00	0.00	0.1
OGV Auxiliary Boilers	0.02	0.05	0.48	0.14	0.04	0.04	0.1	0.00	0.00	0.1
OGV Auxiliary Boilers	0.00	0.01	0.06	0.02	0.01	0.00	0.0	0.00	0.00	0.0
OGV Auxiliary Boilers	0.05	0.10	0.95	0.29	0.08	0.07	0.2	0.00	0.00	0.2
OGV Auxiliary Boilers	6.86	13.71	137.11	41.13	11.65	10.28	28.7	0.00	0.00	29.4
OGV Auxiliary Boilers	0.05	0.10	0.95	0.29	0.08	0.07	0.2	0.00	0.00	0.2
OGV Auxiliary Boilers	0.00	0.00	0.04	0.01	0.00	0.00	0.0	0.00	0.00	0.0
OGV Auxiliary Boilers	0.02	0.04	0.38	0.11	0.03	0.03	0.1	0.00	0.00	0.1
OGV Auxiliary Boilers	0.08	0.17	1.68	0.50	0.14	0.13	0.4	0.00	0.00	0.4
OGV Auxiliary Boilers	0.02	0.05	0.47	0.14	0.04	0.03	0.1	0.00	0.00	0.1

Tugboat Emissions during Escort & Assist

	Lb/Trip						MT/Trip			
EF Lookup	POC	CO	NOx	SO_2	PM10	PM2.5	CO2	CH4	N2O	CO2e
Tug ME (1900-3300 hp, 2009)	10.81	53.17	76.92	0.07	3.58	3.58	2.7	0.000	0.000	2.7
Tug AE (250-500 hp, 2009)	1.31	5.47	7.31	0.01	0.27	0.27	0.3	0.000	0.000	0.3
Tug ME (1900-3300 hp, 2009)	31.05	152.72	220.93	0.19	10.27	10.27	7.6	0.000	0.000	7.8
Tug AE (250-500 hp, 2009)	3.78	15.72	21.01	0.02	0.78	0.78	0.8	0.000	0.000	0.9

Emission Calculation Notes:

For OGV main & aux engines:
[Emissions (g)] = [Energy (kW-hr)] x [EF (g/kW-hr)] x LLA

For OGV aux engines:
[Emissions (g)] = [Energy (kW-hr)] x [EF (g/kW-hr)]

For OGV aux boilers:
[Emissions (g)] = [Energy (kW-hr)] x [EF (g/kW-hr)]

For tug main & aux engines:
[Emissions (g) = [Energy hp-hr] x [EFo g/bhp-hr] x (1+[Deterioration Factor] x [Engine Age]/[Useful Life])

Appendix G - Transportation Emissions (Marine Vessels, Trucks, Rails)

Table 20f-2 Mobile Source - Marine Vessel Post-Project Emissions

Operational Marine Vessel Emissions

Ship to/From Avon - Gasoline / Renewable Naphtha

Vessel Type	HandyMax Tanker
Berth Location	Avon
Cargo Per Vessel (Mbbl)	285
Round Trips/Year	36
Max speed (kn)	15.1

Transfer Activities Per Round-Trip

Material	Direction	Mbbl/yr	Mbbl/trip	Transfer Rate	Transfer Time	Escort Tug Needed?
Gasoline	Inbound	10,220	283.89	10,000	28.39	TRUE
Renewable Naphtha	Outbound	365	10.14	6,000	1.69	TRUE

Additional Hoteling Time

Activity	Hrs
Hook-up (start)	3
Hook-up (end)	2
Bunkering (2-6 hrs on ~50% of ships)	1.5

Emissions Summary

	Emissions (Pounds)						Emissions (MT)			
	POC	CO	NOx	SO_2	PM10	PM2.5	CO2	CH4	N2O	CO2e
Emissions/Round-Trip	121.18	413.67	1,586.36	64.75	54.77	51.18	58	0.00	0.004	60
Annual Total	4,362	14,892	57,109	2,331	1,972	1,842	2,103	0.03	0.132	2,145
Daily Total	12	41	156	6	5	5	6	0.00	0.000	6
Annual Onsite	412	993	9,646	1,375	496	442	950	0.00	0.07	972

Notes:
- Onsite emissions include hotelling only.

OGV Main Engine Usage per Round-Trip

Activity	Mode	# Escort Tugs Req'd	Propulsion Max kW (1)	Speed (kn)	Load Factor (1)	Distance (nm/trip)	Duration (hr/trip)	kW-hr/ Round-Trip
Pilot Boarding (Sea Buoy) to COLREGS Line	Transit	0	9000	12	0.50	8.8	0.73	3,313
COLREGS Line to Golden Gate Bridge	Transit	1	9000	10	0.29	2.3	0.23	601
Golden Gate Bridge to Echo Buoy	Transit	1	9000	10	0.29	16.45	1.65	4,300
Echo Buoy to SPB Light #15	Transit	1	9000	10	0.29	7.7	0.77	2,013
SPB Light #15 to Near Plains Terminal	Transit	1	9000	8	0.15	7.9	0.99	1,322
Near Plains Terminal to Avon Wharf	Transit	1	9000	5	0.04	0.5	0.10	33
At Avon Wharf (Docking)	Maneuvering	0	9000	n/a	0.02	n/a	1.50	270
At Avon Wharf (Hoteling and Prod. Transfer	Hotelling	0	9000	n/a	0.00	n/a	36.58	-
At Avon Wharf (Undocking)	Maneuvering	0	9000	n/a	0.02	n/a	1.50	270
Avon Wharf to Near Plains Terminal	Transit	1	9000	8	0.15	0.5	0.06	84
Near Plains Terminal to SPB Light #15	Transit	1	9000	10	0.29	7.9	0.79	2,065
SPB Light #15 to COLREGS Line	Transit	1	9000	10	0.29	26.45	2.65	6,914
COLREGS Line to Pilot Boarding (Sea Buoy)	Transit	0	9000	12	0.50	8.8	0.73	3,313

Notes: (1) Load factor = (speed/max speed)^3. Load factor of 0.02 represents minimum load factor for propulsion engines.
(2) Assume 1.5 hrs for docking and 1.5 hrs for undocking.
(3) Escort tug required to or from Golden Gate Bridge when carrying hydrocarbon.
(4) Maximum vessel speed based on Port of Los Angeles Air Emissions Inventory - 2019, Table 2.9

OGV Main Engine Emissions per Round-Trip

EF Lookup	Lb/Trip						MT/Trip			
	POC	CO	NOx	SO_2	PM10	PM2.5	CO2	CH4	N2O	CO2e
OGV Main Engines	4.38	10.22	105.16	2.92	2.34	2.12	2.0	0.00	0.000	2.0
OGV Main Engines	0.80	1.86	19.09	0.53	0.42	0.38	0.4	0.00	0.000	0.4
OGV Main Engines	5.69	13.27	136.51	3.79	3.03	2.75	2.5	0.00	0.000	2.6
OGV Main Engines	2.66	6.21	63.90	1.77	1.42	1.29	1.2	0.00	0.000	1.2
OGV Main Engines	2.39	5.44	44.74	1.17	1.04	0.94	0.8	0.00	0.000	0.8
OGV Main Engines	0.38	0.54	2.50	0.03	0.08	0.07	0.0	0.00	0.000	0.0
OGV Main Engines	7.56	8.08	39.64	0.24	1.39	1.26	0.2	0.00	0.000	0.2
OGV Main Engines	0.00	0.00	0.00	0.00	0.00	0.00	0.0	0.00	0.000	0.0
OGV Main Engines	7.56	8.08	39.64	0.24	1.39	1.26	0.2	0.00	0.000	0.2
OGV Main Engines	0.15	0.34	2.83	0.07	0.07	0.06	0.0	0.00	0.000	0.1
OGV Main Engines	2.73	6.37	65.56	1.82	1.46	1.32	1.2	0.00	0.000	1.2
OGV Main Engines	9.15	21.34	219.50	6.10	4.88	4.42	4.1	0.00	0.000	4.1
OGV Main Engines	4.38	10.22	105.16	2.92	2.34	2.12	2.0	0.00	0.000	2.0

E = [EF g/kW-hr] x [Energy kW-hr] x [Low Load Factor] x [Conversion from g to lb or MT]

OGV Auxiliary Generator Usage per Round-Trip

Activity	Mode	Aux Eng. Max kW	Load Factor (1)	Hours/ Trip	kW-hr/ Round-Trip
Pilot Boarding (Sea Buoy) to COLREGS Line	Transit	750	24%	0.73	132
COLREGS Line to Golden Gate Bridge	Transit	750	24%	0.23	41
Golden Gate Bridge to Echo Buoy	Transit	750	24%	1.65	296
Echo Buoy to SPB Light #15	Transit	750	24%	0.77	139
SPB Light #15 to Near Plains Terminal	Transit	750	24%	0.99	178
Near Plains Terminal to Avon Wharf	Transit	750	24%	0.10	18
At Avon Wharf (Docking)	Maneuvering	750	33%	1.50	371
At Avon Wharf (Hoteling and Prod. Transfer	Hotelling	750	26%	36.58	7,133
At Avon Wharf (Undocking)	Maneuvering	750	33%	1.50	371
Avon Wharf to Near Plains Terminal	Transit	750	24%	0.06	11
Near Plains Terminal to SPB Light #15	Transit	750	24%	0.79	142
SPB Light #15 to COLREGS Line	Transit	750	24%	2.65	476
COLREGS Line to Pilot Boarding (Sea Buoy)	Transit	750	24%	0.73	132

Notes: (1) California ARB, May 2011, Appendix D, Emissions Estimation Methodology for Ocean-Going Vessels, Table II-5

OGV Auxiliary Generator Emissions per Round-Trip

EF Lookup	Lb/Trip						MT/Trip			
	POC	CO	NOx	SO_2	PM10	PM2.5	CO2	CH4	N2O	CO2e
OGV Auxiliary Engines	0.12	0.32	3.06	0.14	0.09	0.08	0.1	0.00	0.00	0.1
OGV Auxiliary Engines	0.04	0.10	0.96	0.04	0.03	0.03	0.0	0.00	0.00	0.0
OGV Auxiliary Engines	0.26	0.72	6.85	0.30	0.21	0.19	0.2	0.00	0.00	0.2
OGV Auxiliary Engines	0.12	0.34	3.21	0.14	0.10	0.09	0.1	0.00	0.00	0.1
OGV Auxiliary Engines	0.16	0.43	4.11	0.18	0.13	0.11	0.1	0.00	0.00	0.1
OGV Auxiliary Engines	0.02	0.04	0.42	0.02	0.01	0.01	0.0	0.00	0.00	0.0
OGV Auxiliary Engines	0.33	0.90	8.59	0.38	0.26	0.24	0.3	0.00	0.00	0.3
OGV Auxiliary Engines	6.29	17.30	165.12	7.34	5.03	4.56	4.9	0.00	0.00	5.0
OGV Auxiliary Engines	0.33	0.90	8.59	0.38	0.26	0.24	0.3	0.00	0.00	0.3
OGV Auxiliary Engines	0.01	0.03	0.26	0.01	0.01	0.01	0.0	0.00	0.00	0.0
OGV Auxiliary Engines	0.13	0.34	3.29	0.15	0.10	0.09	0.1	0.00	0.00	0.1
OGV Auxiliary Engines	0.42	1.15	11.02	0.49	0.34	0.30	0.3	0.00	0.00	0.3
OGV Auxiliary Engines	0.12	0.32	3.06	0.14	0.09	0.08	0.1	0.00	0.00	0.1

E = [EF g/kW-hr] x [Energy kW-hr] x [Conversion from g to lb or MT]

Table 20f-2 Mobile Source - Marine Vessel Post-Project Emissions

Operational Marine Vessel Emissions

Ship to/From Avon - Gasoline / Renewable Naphtha

OGV Auxiliary Boiler Usage per Round-Trip

Activity	Mode	Boiler kW per Vessel [1,2]	Hours/ Transit	kW-hr/ Round-Trip
Pilot Boarding (Sea Buoy) to COLREGS Line	Transit	144	0.73	106
COLREGS Line to Golden Gate Bridge	Transit	144	0.23	33
Golden Gate Bridge to Echo Buoy	Transit	144	1.65	237
Echo Buoy to SPB Light #15	Transit	144	0.77	111
SPB Light #15 to Near Plains Terminal	Transit	144	0.99	142
Near Plains Terminal to Avon Wharf	Transit	144	0.10	14
At Avon Wharf (Docking)	Maneuvering	144	1.50	216
At Avon Wharf (Hoteling and Prod. Transfer	Hotelling	638	36.58	23,319
At Avon Wharf (Undocking)	Maneuvering	144	1.50	216
Avon Wharf to Near Plains Terminal	Transit	144	0.06	9
Near Plains Terminal to SPB Light #15	Transit	144	0.79	114
SPB Light #15 to COLREGS Line	Transit	144	2.65	381
COLREGS Line to Pilot Boarding (Sea Buoy)	Transit	144	0.73	106

Notes: (1) Port of Los Angeles Air Emissions Inventory - 2019 - Table 3.5 (Starcrest, 2020); Assume Tanker - Handysize
(2) Boiler load during hotelling based on engineering estimate of fuel consumption

Tugboat Usage during Escort & Assist

Engine Type	Max Hp Per Tug	Load Factor [1]	# Tugboats	Tug-Hrs/ Round-Trip [2]	hp-hr/ Round-Trip
Escort - Main Engine	5,351	0.31	See above	7.23	11,992
Escort - Auxiliary Generator	402	0.43	See above	7.23	1,251
Assist - Main Engine	5,351	0.31	2	9.00	14,928
Assist - Auxiliary Generator	402	0.43	2	9.00	1,557

Notes: (1) Port of Long Beach Air Emissions Inventory - 2013 - Table 3.4 (Starcrest 2014); Assume Assist tug category
(2) Time spent operating per vessel trip. Estimated assist time to account for tug movement, docking, and undocking, plus 4x30 minute trips to/from temporary tug base.
(3) If escort tug is present, it will serve as one of the two assist tugs for docking/undocking, eliminating the need for one 30 minute trip to/from temporary tug base.

OGV Auxiliary Boiler Emissions per Round-Trip

	Lb/Trip						MT/Trip			
EF Lookup	POC	CO	NOx	SO_2	PM10	PM2.5	CO2	CH4	N2O	CO2e
OGV Auxiliary Boilers	0.02	0.05	0.47	0.14	0.04	0.03	0.1	0.00	0.00	0.1
OGV Auxiliary Boilers	0.01	0.01	0.15	0.04	0.01	0.01	0.0	0.00	0.00	0.0
OGV Auxiliary Boilers	0.05	0.10	1.04	0.31	0.09	0.08	0.2	0.00	0.00	0.2
OGV Auxiliary Boilers	0.02	0.05	0.49	0.15	0.04	0.04	0.1	0.00	0.00	0.1
OGV Auxiliary Boilers	0.03	0.06	0.63	0.19	0.05	0.05	0.1	0.00	0.00	0.1
OGV Auxiliary Boilers	0.00	0.01	0.06	0.02	0.01	0.00	0.0	0.00	0.00	0.0
OGV Auxiliary Boilers	0.05	0.10	0.95	0.29	0.08	0.07	0.2	0.00	0.00	0.2
OGV Auxiliary Boilers	5.14	10.28	102.82	30.85	8.74	7.71	21.5	0.00	0.00	22.0
OGV Auxiliary Boilers	0.05	0.10	0.95	0.29	0.08	0.07	0.2	0.00	0.00	0.2
OGV Auxiliary Boilers	0.00	0.00	0.04	0.01	0.00	0.00	0.0	0.00	0.00	0.0
OGV Auxiliary Boilers	0.03	0.05	0.50	0.15	0.04	0.04	0.1	0.00	0.00	0.1
OGV Auxiliary Boilers	0.08	0.17	1.68	0.50	0.14	0.13	0.4	0.00	0.00	0.4
OGV Auxiliary Boilers	0.02	0.05	0.47	0.14	0.04	0.03	0.1	0.00	0.00	0.1

Tugboat Emissions during Escort & Assist

	Lb/Trip						MT/Trip			
EF Lookup	POC	CO	NOx	SO_2	PM10	PM2.5	CO2	CH4	N2O	CO2e
Tug ME (1900-3300 hp, 2009)	23.63	116.23	168.14	0.15	7.82	7.82	5.8	0.000	0.000	5.9
Tug AE (250-500 hp, 2009)	2.87	11.96	15.99	0.02	0.59	0.59	0.6	0.000	0.000	0.6
Tug ME (1900-3300 hp, 2009)	29.41	144.68	209.30	0.18	9.73	9.73	7.2	0.000	0.000	7.3
Tug AE (250-500 hp, 2009)	3.58	14.89	19.90	0.02	0.74	0.74	0.8	0.000	0.000	0.8

Emission Calculation Notes:

For OGV main & aux engines:
[Emissions (g)] = [Energy (kW-hr)] x [EF (g/kW-hr)] x LLA

For OGV aux engines:
[Emissions (g)] = [Energy (kW-hr)] x [EF (g/kW-hr)]

For OGV aux boilers:
[Emissions (g)] = [Energy (kW-hr)] x [EF (g/kW-hr)]

For tug main & aux engines:
[Emissions (g) = [Energy hp-hr] x [EFo g/bhp-hr] x (1+[Deterioration Factor] x [Engine Age]/[Useful Life])

Table 20f-3 Mobile Source - Marine Vessel Post-Project Emissions

Operational Marine Vessel Emissions

Ship to Avon - RD Fd Stock

Vessel Type	HandyMax Tanker
Berth Location	Avon
Cargo Per Vessel (Mbbl)	260
Round Trips/Year	22
Max speed (kn)	15.1

Transfer Activities Per Round-Trip

Material	Direction	Mbbl/yr	Mbbl/trip	Transfer Rate	Transfer Time	Escort Tug Needed?
RD Fd Stock	Inbound	5,475	248.86	10,000	24.89	FALSE
	Outbound	0	0.00	6,000	0.00	FALSE

Additional Hoteling Time

Activity	Hrs
Hook-up (start)	3
Hook-up (end)	2
Bunkering (2-6 hrs on ~50% of ships)	1.5

Emissions Summary

	Emissions (Pounds)						Emissions (MT)			
	POC	CO	NOx	SO_2	PM10	PM2.5	CO2	CH4	N2O	CO2e
Emissions/Round-Trip	101.83	311.20	1,512.34	62.46	48.24	44.62	51	0.00	0.003	52
Annual Total	2,240	6,846	33,272	1,374	1,061	982	1,129	0.02	0.070	1,151
Daily Total	6	19	91	4	3	3	3	0.00	0.000	3
Annual Onsite	216	521	5,058	721	260	232	498	0.00	0.04	510

Notes:
- Onsite emissions include hotelling only.

OGV Main Engine Usage per Round-Trip

Activity	Mode	# Escort Tugs Req'd	Propulsion Max kW [1]	Speed (kn)	Load Factor [1]	Distance (nm/trip)	Duration (hr/trip)	kW-hr/ Round-Trip
Pilot Boarding (Sea Buoy) to COLREGS Line	Transit	0	9000	12	0.50	8.8	0.73	3,313
COLREGS Line to Golden Gate Bridge	Transit	0	9000	10	0.29	2.3	0.23	601
Golden Gate Bridge to Echo Buoy	Transit	0	9000	10	0.29	16.45	1.65	4,300
Echo Buoy to SPB Light #15	Transit	0	9000	10	0.29	7.7	0.77	2,013
SPB Light #15 to Near Plains Terminal	Transit	0	9000	8	0.15	7.9	0.99	1,322
Near Plains Terminal to Avon Wharf	Transit	0	9000	5	0.04	0.5	0.10	33
At Avon Wharf (Docking)	Maneuvering	0	9000	n/a	0.02	n/a	1.50	270
At Avon Wharf (Hoteling and Prod. Transfer	Hotelling	0	9000	n/a	0.00	n/a	31.39	-
At Avon Wharf (Undocking)	Maneuvering	0	9000	n/a	0.02	n/a	1.50	270
Avon Wharf to Near Plains Terminal	Transit	0	9000	8	0.15	0.5	0.06	84
Near Plains Terminal to SPB Light #15	Transit	0	9000	12	0.50	7.9	0.66	2,974
SPB Light #15 to COLREGS Line	Transit	0	9000	12	0.50	26.45	2.20	9,956
COLREGS Line to Pilot Boarding (Sea Buoy)	Transit	0	9000	12	0.50	8.8	0.73	3,313

Notes: (1) Load factor = (speed/max speed)^3. Load factor of 0.02 represents minimum load factor for propulsion engines.
(2) Assume 1.5 hrs for docking and 1.5 hrs for undocking.
(3) Escort tug required to or from Golden Gate Bridge when carrying hydrocarbon.
(4) Maximum vessel speed based on Port of Los Angeles Air Emissions Inventory - 2019, Table 2.9

OGV Main Engine Emissions per Round-Trip

EF Lookup	Lb/Trip						MT/Trip			
	POC	CO	NOx	SO_2	PM10	PM2.5	CO2	CH4	N2O	CO2e
OGV Main Engines	4.38	10.22	105.16	2.92	2.34	2.12	2.0	0.00	0.000	2.0
OGV Main Engines	0.80	1.86	19.09	0.53	0.42	0.38	0.4	0.00	0.000	0.4
OGV Main Engines	5.69	13.27	136.51	3.79	3.03	2.75	2.5	0.00	0.000	2.6
OGV Main Engines	2.66	6.21	63.90	1.77	1.42	1.29	1.2	0.00	0.000	1.2
OGV Main Engines	2.39	5.44	44.74	1.17	1.04	0.94	0.8	0.00	0.000	0.8
OGV Main Engines	0.38	0.54	2.50	0.03	0.08	0.07	0.0	0.00	0.000	0.0
OGV Main Engines	7.56	8.08	39.64	0.24	1.39	1.26	0.2	0.00	0.000	0.2
OGV Main Engines	0.00	0.00	0.00	0.00	0.00	0.00	0.0	0.00	0.000	0.0
OGV Main Engines	7.56	8.08	39.64	0.24	1.39	1.26	0.2	0.00	0.000	0.2
OGV Main Engines	0.15	0.34	2.83	0.07	0.07	0.06	0.0	0.00	0.000	0.1
OGV Main Engines	3.93	9.18	94.41	2.62	2.10	1.90	1.8	0.00	0.000	1.8
OGV Main Engines	13.17	30.73	316.08	8.78	7.02	6.37	5.9	0.00	0.000	6.0
OGV Main Engines	4.38	10.22	105.16	2.92	2.34	2.12	2.0	0.00	0.000	2.0

E = [EF g/kW-hr] x [Energy kW-hr] x [Low Load Factor] x [Conversion from g to lb or MT]

OGV Auxiliary Generator Usage per Round-Trip

Activity	Mode	Aux Eng. Max kW	Load Factor [1]	Hours/ Trip	kW-hr/ Round-Trip
Pilot Boarding (Sea Buoy) to COLREGS Line	Transit	750	24%	0.73	132
COLREGS Line to Golden Gate Bridge	Transit	750	24%	0.23	41
Golden Gate Bridge to Echo Buoy	Transit	750	24%	1.65	296
Echo Buoy to SPB Light #15	Transit	750	24%	0.77	139
SPB Light #15 to Near Plains Terminal	Transit	750	24%	0.99	178
Near Plains Terminal to Avon Wharf	Transit	750	24%	0.10	18
At Avon Wharf (Docking)	Maneuvering	750	33%	1.50	371
At Avon Wharf (Hoteling and Prod. Transfer	Hotelling	750	26%	31.39	6,120
At Avon Wharf (Undocking)	Maneuvering	750	33%	1.50	371
Avon Wharf to Near Plains Terminal	Transit	750	24%	0.06	11
Near Plains Terminal to SPB Light #15	Transit	750	24%	0.66	119
SPB Light #15 to COLREGS Line	Transit	750	24%	2.20	397
COLREGS Line to Pilot Boarding (Sea Buoy)	Transit	750	24%	0.73	132

Notes: (1) California ARB, May 2011, Appendix D, Emissions Estimation Methodology for Ocean-Going Vessels, Table II-5

OGV Auxiliary Generator Emissions per Round-Trip

EF Lookup	Lb/Trip						MT/Trip			
	POC	CO	NOx	SO_2	PM10	PM2.5	CO2	CH4	N2O	CO2e
OGV Auxiliary Engines	0.12	0.32	3.06	0.14	0.09	0.08	0.1	0.00	0.00	0.1
OGV Auxiliary Engines	0.04	0.10	0.96	0.04	0.03	0.03	0.0	0.00	0.00	0.0
OGV Auxiliary Engines	0.26	0.72	6.85	0.30	0.21	0.19	0.2	0.00	0.00	0.2
OGV Auxiliary Engines	0.12	0.34	3.21	0.14	0.10	0.09	0.1	0.00	0.00	0.1
OGV Auxiliary Engines	0.16	0.43	4.11	0.18	0.13	0.11	0.1	0.00	0.00	0.1
OGV Auxiliary Engines	0.02	0.04	0.42	0.02	0.01	0.01	0.0	0.00	0.00	0.0
OGV Auxiliary Engines	0.33	0.90	8.59	0.38	0.26	0.24	0.3	0.00	0.00	0.3
OGV Auxiliary Engines	5.40	14.84	141.68	6.30	4.32	3.91	4.2	0.00	0.00	4.3
OGV Auxiliary Engines	0.33	0.90	8.59	0.38	0.26	0.24	0.3	0.00	0.00	0.3
OGV Auxiliary Engines	0.01	0.03	0.26	0.01	0.01	0.01	0.0	0.00	0.00	0.0
OGV Auxiliary Engines	0.10	0.29	2.74	0.12	0.08	0.08	0.1	0.00	0.00	0.1
OGV Auxiliary Engines	0.35	0.96	9.18	0.41	0.28	0.25	0.3	0.00	0.00	0.3
OGV Auxiliary Engines	0.12	0.32	3.06	0.14	0.09	0.08	0.1	0.00	0.00	0.1

E = [EF g/kW-hr] x [Energy kW-hr] x [Conversion from g to lb or MT]

Table 20f-3 Mobile Source - Marine Vessel Post-Project Emissions

Operational Marine Vessel Emissions

Ship to Avon - RD Fd Stock

OGV Auxiliary Boiler Usage per Round-Trip

Activity	Mode	Boiler kW per Vessel [1,2]	Hours/ Transit	kW-hr/ Round-Trip
Pilot Boarding (Sea Buoy) to COLREGS Line	Transit	144	0.73	106
COLREGS Line to Golden Gate Bridge	Transit	144	0.23	33
Golden Gate Bridge to Echo Buoy	Transit	144	1.65	237
Echo Buoy to SPB Light #15	Transit	144	0.77	111
SPB Light #15 to Near Plains Terminal	Transit	144	0.99	142
Near Plains Terminal to Avon Wharf	Transit	144	0.10	14
At Avon Wharf (Docking)	Maneuvering	144	1.50	216
At Avon Wharf (Hoteling and Prod. Transfer	Hotelling	638	31.39	20,009
At Avon Wharf (Undocking)	Maneuvering	144	1.50	216
Avon Wharf to Near Plains Terminal	Transit	144	0.06	9
Near Plains Terminal to SPB Light #15	Transit	144	0.66	95
SPB Light #15 to COLREGS Line	Transit	144	2.20	317
COLREGS Line to Pilot Boarding (Sea Buoy)	Transit	144	0.73	106

Notes: (1) Port of Los Angeles Air Emissions Inventory - 2019 - Table 3.5 (Starcrest, 2020); Assume Tanker - Handysize
(2) Boiler load during hotelling based on engineering estimate of fuel consumption

Tugboat Usage during Escort & Assist

Engine Type	Max Hp Per Tug	Load Factor [1]	# Tugboats	Tug-Hrs/ Round-Trip [2]	hp-hr/ Round-Trip
Escort - Main Engine	5,351	0.31	See above	0.00	-
Escort - Auxiliary Generator	402	0.43	See above	0.00	-
Assist - Main Engine	5,351	0.31	2	10.00	16,587
Assist - Auxiliary Generator	402	0.43	2	10.00	1,730

Notes: (1) Port of Long Beach Air Emissions Inventory - 2013 - Table 3.4 (Starcrest 2014); Assume Assist tug category
(2) Time spent operating per vessel trip. Estimated assist time to account for tug movement, docking, and undocking, plus 4x30 minute trips to/from temporary tug base.
(3) If escort tug is present, it will serve as one of the two assist tugs for docking/undocking, eliminating the need for one 30 minute trip to/from temporary tug base.

OGV Auxiliary Boiler Emissions per Round-Trip

	Lb/Trip						MT/Trip			
EF Lookup	POC	CO	NOx	SO_2	PM10	PM2.5	CO2	CH4	N2O	CO2e
OGV Auxiliary Boilers	0.02	0.05	0.47	0.14	0.04	0.03	0.1	0.00	0.00	0.1
OGV Auxiliary Boilers	0.01	0.01	0.15	0.04	0.01	0.01	0.0	0.00	0.00	0.0
OGV Auxiliary Boilers	0.05	0.10	1.04	0.31	0.09	0.08	0.2	0.00	0.00	0.2
OGV Auxiliary Boilers	0.02	0.05	0.49	0.15	0.04	0.04	0.1	0.00	0.00	0.1
OGV Auxiliary Boilers	0.03	0.06	0.63	0.19	0.05	0.05	0.1	0.00	0.00	0.1
OGV Auxiliary Boilers	0.00	0.01	0.06	0.02	0.01	0.00	0.0	0.00	0.00	0.0
OGV Auxiliary Boilers	0.05	0.10	0.95	0.29	0.08	0.07	0.2	0.00	0.00	0.2
OGV Auxiliary Boilers	4.41	8.82	88.22	26.47	7.50	6.62	18.4	0.00	0.00	18.9
OGV Auxiliary Boilers	0.05	0.10	0.95	0.29	0.08	0.07	0.2	0.00	0.00	0.2
OGV Auxiliary Boilers	0.00	0.00	0.04	0.01	0.00	0.00	0.0	0.00	0.00	0.0
OGV Auxiliary Boilers	0.02	0.04	0.42	0.13	0.04	0.03	0.1	0.00	0.00	0.1
OGV Auxiliary Boilers	0.07	0.14	1.40	0.42	0.12	0.10	0.3	0.00	0.00	0.3
OGV Auxiliary Boilers	0.02	0.05	0.47	0.14	0.04	0.03	0.1	0.00	0.00	0.1

Tugboat Emissions during Escort & Assist

	Lb/Trip						MT/Trip			
EF Lookup	POC	CO	NOx	SO_2	PM10	PM2.5	CO2	CH4	N2O	CO2e
Tug ME (1900-3300 hp, 2009)	0.00	0.00	0.00	0.00	0.00	0.00	0.0	0.000	0.000	0.0
Tug AE (250-500 hp, 2009)	0.00	0.00	0.00	0.00	0.00	0.00	0.0	0.000	0.000	0.0
Tug ME (1900-3300 hp, 2009)	32.68	160.76	232.56	0.20	10.81	10.81	8.0	0.000	0.000	8.2
Tug AE (250-500 hp, 2009)	3.98	16.54	22.11	0.02	0.82	0.82	0.9	0.000	0.000	0.9

Emission Calculation Notes:

For OGV main & aux engines:
[Emissions (g)] = [Energy (kW-hr)] x [EF (g/kW-hr)] x LLA

For OGV aux engines:
[Emissions (g)] = [Energy (kW-hr)] x [EF (g/kW-hr)]

For OGV aux boilers:
[Emissions (g)] = [Energy (kW-hr)] x [EF (g/kW-hr)]

For tug main & aux engines:
[Emissions (g) = [Energy hp-hr] x [EFo g/bhp-hr] x (1+[Deterioration Factor] x [Engine Age]/[Useful Life])

Table 20f-4 Mobile Source - Marine Vessel Post-Project Emissions
Operational Marine Vessel Emissions
Rail to Barge to Avon (Brownwater (1-2 barge tow)) - RD Fd Stock

Vessel Type	Barge
Berth Location	Avon
Average Cargo Per Trip (Mbb	32.4
Round Trips/Year	306
Max speed (kn)	n/a

Transfer Activities Per Round-Trip

Material	Location	Mbbl/yr	Mbbl/trip	Transfer Rate bbl/hr	Transfer Time	Escort Tug Needed?
RD Fd Stock	Stockton				9.79	FALSE
RD Fd Stock	Avon				15.49	FALSE

Additional Hoteling Time

Location	Hrs
Stockton	4.2
Avon	2.6

Transit Time	Hrs
Transit One-way	7.2

Emissions Summary

		Emissions (Pounds)						Emissions (MT)			
		POC	CO	NOx	SO_2	PM10	PM2.5	CO2	CH4	N2O	CO2e
Emissions/Round-Trip		40.17	263.03	405.33	1.32	14.03	14.01	29	0.00	0.001	29
Annual Total (BAAQMD)	BAAQMD	6,774	45,761	71,485	329	2,399	2,392	5,475	0.09	0.245	5,553
Annual Total (SJVAPCD)	SJVAPCD	5,516	34,726	52,546	75	1,896	1,896	3,351	0.06	0.150	3,399
Annual Total		12,291	80,487	124,031	404	4,294	4,287	8,827	0.15	0.395	8,953
Daily Total (BAAQMD)	BAAQMD	19	125	196	1	7	7	15	0.00	0.001	15
Daily Total (SJVAPCD)	SJVAPCD	15	95	144	0	5	5	9	0.00	0.000	9
Daily Total		34	221	340	1	12	12	24	0.00	0.001	25
Annual Onsite	BAAQMD	422	6,407	6,943	21	49	49	990	0.01	0.04	1,003

Notes: - Onsite emissions include hotelling only.

Propulsion Tug Main Engine Usage per Round-Trip

Propulsion tug main engine, hp 1500
Propulsion tug # main engines used 2

Activity	Mode	Air District	# Escort Tugs Req'd	Duration (hr/trip)	Load Factor [1]	hp-hr/ Transit
At Stockton (Hoteling and Prod. Transfer)	Hotelling	SJVAPCD	0	14.01	0.00	-
At Stockton (Undocking)	Maneuvering	SJVAPCD	0	1.00	0.45	1,350
Wait After (fleeting)	Fleeting	SJVAPCD	0	3.22	0.00	-
Cruise - SJVAPCD	Transit	SJVAPCD	0	2.55	0.45	3,444
Cruise - BAAQMD	Transit	BAAQMD	0	4.65	0.45	6,276
Wait Before (fleeting)	Fleeting	BAAQMD	0	18.52	0.00	-
At Avon Wharf (Docking)	Maneuvering	BAAQMD	0	1.00	0.45	1,350
At Avon Wharf (Hoteling and Prod. Transfer	Hotelling	BAAQMD	0	18.06	0.00	-
At Avon Wharf (Undocking)	Maneuvering	BAAQMD	0	1.00	0.45	1,350
Wait After (fleeting)	Fleeting	BAAQMD	0	2.60	0.00	-
Cruise - BAAQMD	Transit	BAAQMD	0	4.65	0.45	6,276
Cruise - SJVAPCD	Transit	SJVAPCD	0	2.55	0.45	3,444
Wait Before (fleeting)	Fleeting	SJVAPCD	0	11.67	0.00	-
At Stockton (Docking)	Maneuvering	SJVAPCD	0	1.00	0.45	1,350

Notes: Load Factors from CARB, Appendix C Updates on the Emissions Inventory for Commercial Harbor Craft Operating in California, Table 3

Propulsion Tug Main Engine Emissions per Round-Trip

EF Lookup	Lb/Trip						MT/Trip			
	POC	CO	NOx	SO_2	PM10	PM2.5	CO2	CH4	N2O	CO2e
Propulsion Tug Main Engine	0.00	0.00	0.00	0.00	0.00	0.00	0.0	0.00	0.00	0.0
Propulsion Tug Main Engine	0.44	3.10	7.80	0.02	0.24	0.24	0.8	0.00	0.00	0.8
Propulsion Tug Main Engine	0.00	0.00	0.00	0.00	0.00	0.00	0.0	0.00	0.00	0.0
Propulsion Tug Main Engine	1.13	7.91	19.91	0.04	0.62	0.62	2.0	0.00	0.00	2.0
Propulsion Tug Main Engine	2.06	14.41	36.28	0.08	1.12	1.12	3.6	0.00	0.00	3.6
Propulsion Tug Main Engine	0.00	0.00	0.00	0.00	0.00	0.00	0.0	0.00	0.00	0.0
Propulsion Tug Main Engine	0.44	3.10	7.80	0.02	0.24	0.24	0.8	0.00	0.00	0.8
Propulsion Tug Main Engine	0.00	0.00	0.00	0.00	0.00	0.00	0.0	0.00	0.00	0.0
Propulsion Tug Main Engine	0.44	3.10	7.80	0.02	0.24	0.24	0.8	0.00	0.00	0.8
Propulsion Tug Main Engine	0.00	0.00	0.00	0.00	0.00	0.00	0.0	0.00	0.00	0.0
Propulsion Tug Main Engine	2.06	14.41	36.28	0.08	1.12	1.12	3.6	0.00	0.00	3.6
Propulsion Tug Main Engine	1.13	7.91	19.91	0.04	0.62	0.62	2.0	0.00	0.00	2.0
Propulsion Tug Main Engine	0.00	0.00	0.00	0.00	0.00	0.00	0.0	0.00	0.00	0.0
Propulsion Tug Main Engine	0.44	3.10	7.80	0.02	0.24	0.24	0.8	0.00	0.00	0.8

Barge Auxiliary Generator Usage per Round-Trip

Propulsion tug aux gen engine, hp 140

Activity	Mode	Air District	# Engines Operating	Duration (hr/trip)	Load Factor	hp-hr/ Transit
At Stockton (Hoteling and Prod. Transfer)	Hotelling	SJVAPCD	1	14.01	0.75	1,471
At Stockton (Undocking)	Maneuvering	SJVAPCD	1	1.00	0.75	105
Wait After (fleeting)	Fleeting	SJVAPCD	1	3.22	0.75	339
Cruise - SJVAPCD	Transit	SJVAPCD	1	2.55	0.75	268
Cruise - BAAQMD	Transit	BAAQMD	1	4.65	0.75	488
Wait Before (fleeting)	Fleeting	BAAQMD	1	18.52	0.75	1,944
At Avon Wharf (Docking)	Maneuvering	BAAQMD	1	1.00	0.75	105
At Avon Wharf (Hoteling and Prod. Transfer	Hotelling	BAAQMD	1	18.06	0.75	1,896
At Avon Wharf (Undocking)	Maneuvering	BAAQMD	1	1.00	0.75	105
Wait After (fleeting)	Fleeting	BAAQMD	1	2.60	0.75	272
Cruise - BAAQMD	Transit	BAAQMD	1	4.65	0.75	488
Cruise - SJVAPCD	Transit	SJVAPCD	1	2.55	0.75	268
Wait Before (fleeting)	Fleeting	SJVAPCD	1	11.67	0.75	1,226
At Stockton (Docking)	Maneuvering	SJVAPCD	1	1.00	0.75	105

Notes: (1) Port of Los Angeles Air Emissions Inventory - 2019 - Table 3.2 (Starcrest, 2020); Assume Tanker - Handysize

Barge Auxiliary Generator Emissions per Round-Trip

EF Lookup	Lb/Trip						MT/Trip			
	POC	CO	NOx	SO_2	PM10	PM2.5	CO2	CH4	N2O	CO2e
Propulsion Tug Aux Gen Engine	0.42	9.63	7.98	0.02	0.04	0.04	0.8	0.00	0.00	0.8
Propulsion Tug Aux Gen Engine	0.03	0.69	0.57	0.00	0.00	0.00	0.1	0.00	0.00	0.1
Propulsion Tug Aux Gen Engine	0.10	2.22	1.84	0.00	0.01	0.01	0.2	0.00	0.00	0.2
Propulsion Tug Aux Gen Engine	0.08	1.75	1.45	0.00	0.01	0.01	0.2	0.00	0.00	0.2
Propulsion Tug Aux Gen Engine	0.14	3.20	2.65	0.01	0.01	0.01	0.3	0.00	0.00	0.3
Propulsion Tug Aux Gen Engine	0.55	12.73	10.55	0.02	0.05	0.05	1.1	0.00	0.00	1.1
Propulsion Tug Aux Gen Engine	0.03	0.69	0.57	0.00	0.00	0.00	0.1	0.00	0.00	0.1
Propulsion Tug Aux Gen Engine	0.54	12.42	10.29	0.02	0.05	0.05	1.1	0.00	0.00	1.1
Propulsion Tug Aux Gen Engine	0.03	0.69	0.57	0.00	0.00	0.00	0.1	0.00	0.00	0.1
Propulsion Tug Aux Gen Engine	0.08	1.78	1.48	0.00	0.01	0.01	0.2	0.00	0.00	0.2
Propulsion Tug Aux Gen Engine	0.14	3.20	2.65	0.01	0.01	0.01	0.3	0.00	0.00	0.3
Propulsion Tug Aux Gen Engine	0.08	1.75	1.45	0.00	0.01	0.01	0.2	0.00	0.00	0.2
Propulsion Tug Aux Gen Engine	0.35	8.02	6.65	0.01	0.03	0.03	0.7	0.00	0.00	0.7
Propulsion Tug Aux Gen Engine	0.03	0.69	0.57	0.00	0.00	0.00	0.1	0.00	0.00	0.1

Table 20f-4 Mobile Source - Marine Vessel Post-Project Emissions
Operational Marine Vessel Emissions
Rail to Barge to Avon (Brownwater (1-2 barge tow)) - RD Fd Stock

E = [EF g/kW-hr] x [Energy kW-hr] x [Conversion from g to lb or MT]

Barge Offload Pump Usage per Round-Trip

Barge aux pump engine, hp 345

Activity	Mode	Air District	# Engines Operaing	Duration (hr/trip)	Load Factor	hp-hr/ Transit
At Avon Wharf (Hoteling and Prod. Transfer	Hotelling	BAAQMD	1	15.49	0.71	3,795

Notes: (1) Port of Los Angeles Air Emissions Inventory - 2019 - Table 3.5 (Starcrest, 2020); Assume Tanker - Handysize

Barge Offload Pump Emissions per Round-Trip

	Lb/Trip						MT/Trip			
EF Lookup	POC	CO	NOx	SO_2	PM10	PM2.5	CO2	CH4	N2O	CO2e
Barge Aux Pump Engine	0.84	8.52	12.40	0.05	0.11	0.11	2.2	0.00	0.00	2.2

Barge Circulation Pump Usage per Round-Trip

Barge circ pump engine, hp 140

Activity	Mode	Air District	# Engines Operaing	Duration (hr/trip)	Load Factor	hp-hr/ Transit
Near Avon Wharf	Fleeting	BAAQMD	1	0.22	0.71	22

Notes: Load Factor from CARB, Appendix C Updates on the Emissions Inventory for Commercial Harbor Craft Operating in California, Table 3

Barge Circulation Pump Emissions per Round-Trip

	Lb/Trip						MT/Trip			
EF Lookup	POC	CO	NOx	SO_2	PM10	PM2.5	CO2	CH4	N2O	CO2e
Barge Circ Pump Engine	0.01	0.15	0.12	0.00	0.00	0.00	0.0	0.00	0.00	0.0

Barge Circulation Heater Usage per Round-Trip

Barge circ heater, MMBtu/hr 8

Activity	Mode	Air District	# Heaters Operaing	Duration (hr/trip)	Load Factor	kW-hr/ Transit
Near Avon Wharf	Fleeting	BAAQMD	1	0.22	1	521

Notes: Load factor not known

Barge Circulation Heater Emissions per Round-Trip

	Lb/Trip						MT/Trip			
EF Lookup	POC	CO	NOx	SO_2	PM10	PM2.5	CO2	CH4	N2O	CO2e
OGV Auxiliary Boilers	0.11	0.23	2.30	0.69	0.20	0.17	0.5	0.00	0.00	0.5

Tugboat Usage during Escort & Assist

Engine Type	# Tugboats	Air District	Max HP per Tug	Load Factor [1]	Tug-Hours/ Round-Trip [2]	hp-hr/ Round-Trip
Escort - Main Engine (BAAQMD)	See above	BAAQMD	5,351	0.31	0.00	-
Escort - Auxiliary Generator (BAAQMD)	See above	BAAQMD	402	0.43	0.00	-
Escort - Main Engine (SJVAPCD)	See above	SJVAPCD	5,000	0.31	0.00	-
Escort - Auxiliary Generator (SJVAPCD)	See above	SJVAPCD	402	0.43	0.00	-
Assist - Main Engine (BAAQMD)	1	BAAQMD	5,351	0.31	4.00	6,635
Assist - Auxiliary Generator (BAAQMD)	1	BAAQMD	402	0.43	4.00	692
Assist - Main Engine (SJVAPCD)	1	SJVAPCD	5,000	0.31	4.00	6,200
Assist - Auxiliary Generator (SJVAPCD)	1	SJVAPCD	402	0.43	4.00	692

Notes: (1) Port of Long Beach Air Emissions Inventory - 2013 - Table 3.4 (Starcrest 2014), Assist Tug categor

(2) Time spent operating per vessel trip. Estimated assist time to account for tug movement, docking, and undocking plus 4x30 minute trips to/from temporary tug base.

(3) If escort tug is present, it will serve as an assist tug for docking/undocking.

Tugboat Emissions during Escort & Assist

	Lb/Trip						MT/Trip			
EF Lookup	POC	CO	NOx	SO_2	PM10	PM2.5	CO2	CH4	N2O	CO2e
Tug ME (1900-3300 hp, 2009)	0.00	0.00	0.00	0.00	0.00	0.00	0.0	0.000	0.000	0.0
Tug AE (250-500 hp, 2009)	0.00	0.00	0.00	0.00	0.00	0.00	0.0	0.000	0.000	0.0
Tug ME (1900-3300 hp, 2009)	0.00	0.00	0.00	0.00	0.00	0.00	0.0	0.000	0.000	0.0
Tug AE (250-500 hp, 2009)	0.00	0.00	0.00	0.00	0.00	0.00	0.0	0.000	0.000	0.0
Tug ME (1900-3300 hp, 2009)	13.07	64.30	93.02	0.08	4.33	4.33	3.2	0.000	0.000	3.3
Tug AE (250-500 hp, 2009)	1.59	6.62	8.85	0.01	0.33	0.33	0.4	0.000	0.000	0.4
Tug ME (1900-3300 hp, 2009)	12.22	60.09	86.93	0.08	4.04	4.04	3.0	0.000	0.000	3.0
Tug AE (250-500 hp, 2009)	1.59	6.62	8.85	0.01	0.33	0.33	0.4	0.000	0.000	0.4

Emission Calculation Notes:

For propulsion tug main & aux engines:

[Emissions (g) = [Energy hp-hr] x [EFo g/bhp-hr] x (1+[Deterioration Factor] x [Engine Age]/[Useful Life])

For tug main & aux engines:

[Emissions (g) = [Energy hp-hr] x [EFo g/bhp-hr] x (1+[Deterioration Factor] x [Engine Age]/[Useful Life])

Table 20f-5 Mobile Source - Marine Vessel Emission Factors for OGV

Operational Marine Vessel Emissions

Marine Vessel Emission Factors

Emission Factors for OGV

Engine Type	Assumed Fuel Type	Assumed Fuel Use Application	EF Units	POC	CO	NOx	SO_2	PM10	PM2.5	CO2	CH4	N2O	Source
OGV Main Engines	MGO (0.1% S)	Tier 2, Slow	g/kW-hr	0.60	1.40	14.40	0.40	0.32	0.29	589	0.012	0.029	(1,4)
OGV Auxiliary Engines	MGO (0.1% S)	Tier 2	g/kW-hr	0.40	1.10	10.50	0.47	0.32	0.29	686	0.008	0.029	(2,4)
OGV Auxiliary Boilers	MGO (0.1% S)	All	g/kW-hr	0.10	0.20	2.00	0.60	0.17	0.15	922	0.002	0.075	(3,4)

Notes: (1) Port of Long Beach Air Emissions Inventory - 2013 - Tables 2.5, 2.6. (Starcrest 2014)
(2) Port of Long Beach Air Emissions Inventory - 2013 - Tables 2.10, 2.11. (Starcrest 2014)
(3) Port of Long Beach Air Emissions Inventory - 2013 - Table 2.14, 2.15. (Starcrest 2014)
(4) MGO (0.3% S) emission factors were calculated from HFO (2.7% S) emission factors in the Long Beach 2013 document by applying fuel correction factors per Table 2.17. MGO (0.3% S) SO2 emission factors were converted to MGO (0.1% S) emission factors by scaling the emission factor with the relative sulfur contents.
(5) Low-load adjustment factors are calculated for each leg of transit based on OGV speed/engine load, using the low-load adjustment regression factors from Port of Long Beach Air Emissions Inventory - 2013 - Table 2.7 (Starcrest 2014)

MGO OGV Fuel Correction Factors

Actual Fuel	PM10	PM2.5	NOx	SO_2	CO	POC	CO2	N2O	CH4
MGO (0.3%)	0.21	0.21	0.94	1	1	1	0.95	0.94	1

Notes: (1) Port of Long Beach Air Emissions Inventory - 2013 - Table 2.17. (Starcrest 2014)

Low-Load Emission Factor Regression Factors for OGV Main Propulsion Engines

Variable	POC	CO	NOx	SO_2	PM10	PM2.5	CO2	CH4	N2O
Exponent	1.5	1	1.5	0	1.5	1.5	0	1.5	1.5
Intercept	0.3859	0.1458	10.4496	0	0.2551	0.2551	0	0.3859	10.4496
Coefficient	0.0667	0.8378	0.1255	1	0.0059	0.0059	1	0.0667	0.1255
Ref. EF @ 20% Loa	1.132	4.335	11.853	1	0.321	0.321	1	1.132	11.853

Notes: (1) Port of Long Beach Air Emissions Inventory - 2013 - Table 2.7. (Starcrest 2014)

Table 20f-6 Mobile Source - Marine Vessel Emission Factors for Tugs

Operational Marine Vessel Emissions

Marine Vessel Emission Factors

Emission Factors for OGV

Engine Type	Assumed Fuel Type	Assumed Fuel Use Application		EF Units	POC	CO	NOx	SO_2	PM10	PM2.5	CO2	CH4	N2O	Source
Tug ME (1900-3300 hp, 2009)	CARB (15 ppm S)	2009	2675 hp	g/bhp-hr	0.89	4.40	6.36	0.01	0.30	0.30	483.96	0.01	0.02	
Zero-hr EF				g/bhp-hr	0.68	3.73	5.53	0.006	0.20	0.20	484	0.007	0.022	(1,2,3)
Deterioration Factor				-	0.44	0.25	0.21	0.00	0.67	0.67	0.00	0.44	0.21	(6)
Age				yrs	15	15	15	15	15	15	15	15	15	(7)
Useful Life				yrs	21	21	21	21	21	21	21	21	21	(8)
Tug AE (250-500 hp, 2009)	CARB (15 ppm S)	2009	402 hp	g/bhp-hr	1.04	4.34	5.80	0.01	0.22	0.22	511.55	0.01	0.02	
Zero-hr EF				g/bhp-hr	0.81	3.73	5.10	0.006	0.15	0.15	512	0.006	0.022	(1,2,4)
Deterioration Factor				-	0.44	0.25	0.21	0.00	0.67	0.67	0.00	0.44	0.21	(6)
Age				yrs	15	15	15	15	15	15	15	15	15	(7)
Useful Life				yrs	23	23	23	23	23	23	23	23	23	(8)
Tug ME (1900-3300 hp, Tier 3)	CARB (15 ppm S)	2014	3356 hp	g/bhp-hr	0.82	4.17	5.43	0.01	0.33	0.33	483.96	0.01	0.02	
Zero-hr EF				g/bhp-hr	0.68	3.73	4.94	0.006	0.25	0.25	484	0.007	0.022	(1,2,3)
Deterioration Factor				-	0.44	0.25	0.21	0.00	0.67	0.67	0.00	0.44	0.21	(6)
Age				yrs	10	10	10	10	10	10	10	10	10	(7)
Useful Life				yrs	21	21	21	21	21	21	21	21	21	(8)
Tug AE (250-500 hp, Tier 3)	CARB (15 ppm S)	2014	288 hp	g/bhp-hr	0.96	4.14	4.35	0.01	0.10	0.10	511.55	0.01	0.02	
Zero-hr EF				g/bhp-hr	0.81	3.73	3.99	0.006	0.08	0.08	512	0.006	0.022	(1,2,4)
Deterioration Factor				-	0.44	0.25	0.21	0.00	0.67	0.67	0.00	0.44	0.21	(6)
Age				yrs	10	10	10	10	10	10	10	10	10	(7)
Useful Life				yrs	23	23	23	23	23	23	23	23	23	(8)

Notes:
(1) Emission Estimation Methodology for Commericial Harbor Craft Operating in California, Appendix B. (CARB 2007)
(2) For SOx EF Calculation, BSFC = 184 g/bhp-hr, per Port of Long Beach Air Emissions Inventory - 2013 (Starcrest 2014)
(3) CH4 & N2O EFs - Main Engines: Port of Long Beach Air Emissions Inventory - 2013 - Table 2.6. (Starcrest 2014)
(4) CH4 & N2O EFs - Aux Engines: Port of Long Beach Air Emissions Inventory - 2013 - Table 2.11. (Starcrest 2014)
(5) Fuel correction factors were not applied as outlined in section 3.5.5 of Port of Long Beach Air Emissions Inventory - 2013, as a conservative estimate, since engines may have been certified on ULSD.
(6) Deterioration Factors: Emission Estimation Methodology for Commericial Harbor Craft Operating in California, Appendix B, Table II-5. (CARB 2007)
(7) Age determined as of: 2024
(8) Useful LIfe: Port of Long Beach Air Emissions Inventory - 2013 - Table 3.6. (Starcrest 2014)
(9) [EF (g/bhp-hr)] = [EF_o g/bhp-hr] x (1+[Deterioration Factor] x [Engine Age]/[Useful Life])

Table 20f-7 Mobile Source - Marine Vessel Emission Factors for Barges

Operational Marine Vessel Emissions

Barge Engine Emission Factors

Emission Factors for Barge Engines

Engine Type	Assumed Fuel Type	Assumed Fuel Use Application		EF Units	POC	CO	NOx	SO_2	PM10	PM2.5	CO2	CH4	N2O	Source
Propulsion Tug Main Engine	CARB (15 ppm S)	2015	1500 hp	g/bhp-hr	0.15	1.04	2.62	0.006	0.08	0.08	568.30	0.01	0.02	
Zero-hr EF				g/bhp-hr	0.12	0.92	2.36	0.006	0.06	0.06	568.30	0.009	0.022	(1,2,3)
Deterioration Factor				-	0.44	0.25	0.21	0.00	0.67	0.67	0.00	0.44	0.21	(1)
Age				yrs	9	9	9	9	9	9	9	9	9	(6)
Useful Life				yrs	17	17	17	17	17	17	17	17	17	(7)
Propulsion Tug Aux Gen Engine	CARB (15 ppm S)	2015	140 hp	g/bhp-hr	0.13	2.97	2.46	0.006	0.01	0.01	568.30	0.01	0.02	
Zero-hr EF				g/bhp-hr	0.11	2.70	2.27	0.006	0.01	0.01	568.30	0.006	0.022	(1,2,4)
Deterioration Factor				-	0.44	0.25	0.21	0.00	0.67	0.67	0.00	0.44	0.21	(1)
Age				yrs	9	9	9	9	9	9	9	9	9	(6)
Useful Life				yrs	22.5	22.5	22.5	22.5	22.5	22.5	22.5	22.5	22.5	(7)
Barge Aux Pump Engine	CARB (15 ppm S)	2015	345 hp	g/bhp-hr	0.10	1.02	1.48	0.006	0.01	0.01	568.30	0.01	0.02	
Zero-hr EF				g/bhp-hr	0.08	0.92	1.36	0.006	0.01	0.01	568.30	0.006	0.022	(1,2,4)
Deterioration Factor				-	0.44	0.25	0.21	0.00	0.67	0.67	0.00	0.44	0.21	(1)
Age				yrs	9	9	9	9	9	9	9	9	9	(6)
Useful Life				yrs	21.00	21	21	21	21	21	21	21	21	(7)
Barge Circ Pump Engine	CARB (15 ppm S)	2015	140 hp	g/bhp-hr	0.13	2.99	2.47	0.006	0.01	0.01	568.30	0.01	0.02	
Zero-hr EF				g/bhp-hr	0.11	2.70	2.27	0.006	0.01	0.01	568.30	0.006	0.022	(1,2,4)
Deterioration Factor				-	0.44	0.25	0.21	0.00	0.67	0.67	0.00	0.44	0.21	(1)
Age				yrs	9	9	9	9	9	9	9	9	9	(6)
Useful Life				yrs	21.00	21	21	21	21	21	21	21	21	(7)

Notes:
(1) Zero-hr EFs: CARB, California Barge and Dredge Emissions Inventory Database (2011) http://www.arb.ca.gov/msei/categories.htm
(2) For SOx EF Calculation, BSFC = 184 g/bhp-hr, per Port of Long Beach Air Emissions Inventory - 2013 (Starcrest 2014)
(3) CH4 & N2O EFs - Main Engines: Port of Long Beach Air Emissions Inventory - 2013 - Table 2.6. (Starcrest 2014)
(4) CH4 & N2O EFs - Aux Engines: Port of Long Beach Air Emissions Inventory - 2013 - Table 2.11. (Starcrest 2014)
(5) Fuel correction factors were not applied as outlined in section 3.5.5 of Port of Long Beach Air Emissions Inventory - 2013, as a conservative estimate, since engines may have been certified on ULSD.
(6) Age determined as of: 2024
(7) Useful LIfe: CARB, Appendix C, Updates on the Emissions Inventory for Commercial Harbor Craft Operating in California, Table 3
(8) [EF (g/bhp-hr)] = [EF_o g/bhp-hr] x (1+[Deterioration Factor] x [Engine Age]/[Useful Life])

Marathon - Martinez
Renewable Fuels Project

Mobile Source - Truck Transport Project Summary
BAAQMD Item #50

Daily Emissions

				Fugitive Dust (lb/day)	
Scenario	**Region**	**Average Daily Number of Trucks**	**Average Daily Miles Travelled**	**PM_{10}**	**$PM_{2.5}$**
Pre-Project Average	Onsite	205	692	10.44	1.57
Post-Project	Onsite	181	602	9.08	1.36
Delta:	Onsite	**-24**	**-90**	**-1.36**	**-0.20**

Annual Emissions

				Fugitive Dust (TPY)	
Scenario	**Region**	**Total Number of Trucks**	**Total Miles Travelled**	**PM_{10}**	**$PM_{2.5}$**
Pre-Project Average	Onsite	74,784	252,629	1.91	0.29
Post-Project	Onsite	65,894	219,720	1.66	0.25
Delta:	Onsite	**-8,890**	**-32,910**	**-0.25**	**-0.04**

Notes:
1. Pre-Project Average Annual emissions have been adjusted based on truck activity from October 2015 - September 2020.
2. Pre-Project and post-project emissions are based on 2022 - 2024 average emission factors.

Marathon - Martinez
Renewable Fuels Project

Mobile Source - Truck Transport Pre-Project Fugitive Dust Emissions - Onsite

Operating Year: Baseline Average

Daily Emissions

Region	Road Type	Daily Average Trips:	Daily Average Miles:	Fugitive Dust (lb/day) PM_{10}	Fugitive Dust (lb/day) $PM_{2.5}$
Gasoline LR_North	Local	31	8	0.11	0.02
Gasoline LR_South	Local	47	245	3.70	0.56
Misc	Local	103	392	5.92	0.89
Chem Plant	Local	11	40	0.60	0.09
LNG LR	Local	12	7	0.11	0.02
DMDS	Local	-	-	--	--
WWT	Local	-	-	--	--
Total Daily:				**10.44**	**1.57**

Annual Emissions

Region	Type	Total Annual Trips:	Total Annual Miles:	Fugitive Dust (Tons/Yr) PM_{10}	Fugitive Dust (Tons/Yr) $PM_{2.5}$
Gasoline LR_North	Local	11,482	2,756	0.02	3.12E-03
Gasoline LR_South	Local	17,222	89,556	0.68	1.01E-01
Misc	Local	37,667	143,135	1.08	1.62E-01
Chem Plant	Local	4,045	14,562	0.11	1.65E-02
LNG LR	Local	4,368	2,621	0.02	2.97E-03
DMDS	Local	-	-	--	0.00E+00
WWT	Local	-	-	--	0.00E+00
Total Annual:				**1.91**	**0.29**

On-road Vehicle Paved Road Dust Entrainment Emission Factors (pounds/mile):

Parameter	Road Type	ADT	Reference	Symbol	Value	Unit	PM_{10}	$PM_{2.5}$
PM_{10} particle size multiplier			CARB - 2018 EI	k	0.0022	lb/vmt		
$PM_{2.5}$ particle size multiplier			CARB - 2018 EI	k	0.00033	lb/vmt	lb/mile	lb/mile
Road silt loading - Freeway	Freeway	>10,000	EPA - AP42	sL	0.015	g/m^2	5.26E-04	7.88E-05
Road silt loading - Local	Local	< 500	EPA - AP42	sL	0.600	g/m^2	1.51E-02	2.26E-03
Average vehicle weight			CalTrans WIM Data	W	10.41	tons		

Paved Road Dust Entrainment

$$Ef = k(sL)^{0.91} \times W^{1.02}$$

Marathon - Martinez

Renewable Fuels Project

Mobile Source - Truck Transport Post-Project Fugitive Dust Emissions - Onsite

Daily Emissions				Fugitive Dust (Pounds/Day)	
Region	Road Type	Daily Average Trips:	Daily Average Miles:	PM_{10}	$PM_{2.5}$
Gasoline LR_North	Local	58	14	0.21	0.03
Gasoline LR_South	Local	87	454	6.85	1.03
Misc	Local	34	127	1.92	0.29
Chem Plant	Local	-	-	--	--
LNG LR	Local	-	-	--	--
DMDS	Local	0	0	0.01	0.00
WWT	Local	1	6	0.09	0.01
Total Onsite Daily:				**9.08**	**1.36**

Annual Emissions				Fugitive Dust (Tons/Yr)	
Region	Road Type	Total Annual Trips:	Total Annual Miles:	PM_{10}	$PM_{2.5}$
Gasoline LR_North	Local	21,244	5,099	0.04	0.01
Gasoline LR_South	Local	31,866	165,703	1.25	0.19
Misc	Local	12,236	46,497	0.35	0.05
Chem Plant	Local	-	-	--	--
LNG LR	Local	-	-	--	--
DMDS	Local	45	158	0.00	0.00
WWT	Local	503	2,264	0.02	0.00
Total Onsite Annual:				1.66	0.25

On-road Vehicle Paved Road Dust Entrainment Emission Factors (pounds/mile):

Parameter	Type	ADT	Reference	Symbol	Value	Unit	PM_{10}	$PM_{2.5}$
PM_{10} particle size multiplier			CARB - 2018 EI	k	0.0022	lb/vmt		
$PM_{2.5}$ particle size multiplier			CARB - 2018 EI	k	0.00033	lb/vmt	lb/mile	lb/mile
Road silt loading - Freeway	Freeway	>10,000	EPA - AP42	sL	0.015	g/m^2	5.26E-04	7.88E-05
Road silt loading - Local	Local	< 500	EPA - AP42	sL	0.600	g/m^2	1.51E-02	2.26E-03
Average vehicle weight			CalTrans WIM Data	W	10.41	tons		

Paved Road Dust Entrainment

$$Ef = k(sL)^{0.91} \times W^{1.02}$$

Marathon - Martinez

Renewable Fuels Project

Mobile Source - Truck Transport Post-Project Fugitive Dust Emissions - Onsite

Notes:

1. Trip distances assume:
   a. Estimated distances to various locations of commodity transport with estimated percentage of total commodity transport to each location.
   b. Onsite distances estimated based on locations products are delivered to within the facility.
2. Fleet size is estimated based on projected volumes of each commodity to be transported during post-project operations.

3. Equation for calculating on-road vehicle paved road dust entrainment emissions: U.S. Environmental Protection Agency, *Compilation of Air Pollutant Emission Factors (AP-42), Section 13.2.1 Paved Roads, Equation 1.*
   a. Silt loading factors are as defined by EPA, Table 13.2.1-2 of *Compilation of Air Pollutant Emission Factors (AP-42), Section 13.2.1 Paved Roads* .
   b. Particle size multipliers and average vehicle weight as defined by CARB in Section 7.9 of the Emissions Inventory Guidance Document - Entrained Road Travel, Paved Road Dust (March 2018). https://www.arb.ca.gov/ei/areasrc/fullpdf/full7-9_2018.pdf

4. Average vehicle weight based on weight in motion (WIM) monitoring stations installed by CalTrans in regions surrounding the facility's major truck transport routes (Contra Costa, San Joaquin, Alamdea, and Fresno counties). Based on available data from 2019 to establish a reasonable average vehicle weight representative of major roadway sections.

5. Conversion factors:
Global warming potential for methane: 21
Global warming potential for nitrous oxide: 310
2,000 pounds/ton
0.45359 kilograms/pound)
1,000 kilograms/metric ton

Marathon - Martinez
Renewable Fuels Project

Mobile Source - Rail Transport Project Summary
BAAQMD Incompleteness Response #51

Daily Emissions

				Criteria Pollutant Emissions (Pounds/Day)					
Scenario	**Region**	**Daily Average Railcars**	**Daily Average bhp-hours**	**NOx**	**SO_2**	**CO**	**POC**	**PM_{10}**	**$PM_{2.5}$**
Pre-Project Average	BAAQMD	7	1,018	9.06	0.01	2.87	0.28	0.20	0.19
	On-Site			0.32	0.00	0.11	0.01	0.01	0.01
Post-Project	BAAQMD	17	813	7.24	0.01	2.30	0.23	0.16	0.15
	On-Site			0.42	0.00	0.14	0.02	0.01	0.01
Delta:	BAAQMD + On-Site	**10**	**(204)**	**-1.714**	**-0.002**	**-0.541**	**-0.053**	**-0.038**	**-0.035**

Annual Emissions

				Criteria Pollutant Emissions (Tons/Yr)						Emissions (Metric Tons/Year)			
Scenario	**Region**	**Total Number of Railcars**	**Total bhp-hours**	**NOx**	**SO_2**	**CO**	**POC**	**PM_{10}**	**$PM_{2.5}$**	**CO_2**	**CH_4**	**N_2O**	**CO_2e**
Pre-Project Average	BAAQMD	2,520	371,456	1.65	0.00	0.52	0.05	0.04	0.03	182.34	0.01	0.00	184.05
	On-Site			0.06	0.00	0.02	0.00	0.00	0.00	6.23	0.00	0.00	6.23
Post-Project	BAAQMD	6,334	296,875	1.32	0.00	0.42	0.04	0.03	0.03	145.73	0.01	0.00	147.09
	On-Site			0.08	0.00	0.03	0.00	0.00	0.00	8.31	0.00	0.00	8.31
Delta:	BAAQMD + On-Site	**3,814**	**(74,581)**	**-0.313**	**0.000**	**-0.099**	**-0.010**	**-0.007**	**-0.006**	**-34.535**	**-0.003**	**-0.001**	**-34.878**

Notes:

1. Criteria Pollutant Emissions based on rail travel within Bay Area Air Quality Management District (BAAQMD) to the facility. Commodities transported via rail to another facility with final receipt via truck are not in
2. "BAAQMD" emissions are assumed to equal off-site travel to the facility. On-Site travel is added separately to the "off-site" BAAQMD totals.
3. Pre-Project Average Annual emissions have been adjusted based on rail activity from October 2015 - September 2020.
4. Post-project emissions are based on anticipated post-project operations.

Marathon - Martinez

Renewable Fuels Project

Mobile Source - Rail Transport Pre-Project Product Transportation Estimates

Operating Year: Baseline October 2015 - September 2020

Rail Transportation

					Transportation Characteristics					
		Throughput								Miles/Round Trip
Commodity	Track	Units / Day	Units / Year	Units	Receipt / Deliveries	Fraction of Total Commodity	Railcars/ Year	Railcar Load (Unit/Railcar)	Train Routing	BAAQMD
Propane	E/F	115	41,916	bbl	Deliveries	0.25	58	720	MTZ - Rocklin	60
Propane	E/F	345	125,748	bbl	Deliveries	0.75	175	720	MTZ - Bakersfield	250
Propylene	E/F	1,027	374,962	bbl	Deliveries	1.00	521	720	MTZ - LA	251
Butane/Mixed Butanes	E/F	1,548	564,973	bbl	Deliveries	1.00	785	720	OOS - MTZ - UP	61
Butane/Mixed Butanes	E/F	1,226	447,478	bbl	Receipt	1.00	621	720	OOS - MTZ - UP	61
Iso-Butane	E/F	709	258,909	bbl	Receipt	0.25	360	720	Rodeo - MTZ	31
Iso-Butane	E/F	2,128	776,727	bbl	Receipt	0.75	1,079	720	MTZ - LA	251

Notes:

1. Pre-Project average refinery throughputs and feedstock/product sources and destinations as provided by facility based on actual rail operations from October 2015 - September 2020.
2. For sources and destinations located within the Bay Area Air Quality Management District, Miles/Round Trip based on estimated round trip mileage within the air basin to the facility.
3. Fraction of Total Commodity represents that volume of each commodity that is received from, or delivered to multiple locations, in order to account for the rail mileage associated with the different train routes taken.
4. Trips are assumed to haved occured daily, 365 days per year.
5. Railcar Load represents the volume of commodity that can be transported in a single railcar.

Marathon - Martinez
Renewable Fuels Project

Mobile Source - Rail Transport Pre-Project Operational Estimates - Process Rate Data
Operating Year: Baseline October 2015 - September 2020

Off-site Activity (Main Line).

Component	MTZ - Bakersfield	MTZ - Rocklin	MTZ - LA	OOS - MTZ - UP	Rodeo - MTZ	**Total**
Round Trip Miles[2]						
BAAQMD	250 miles	60 miles	251 miles	61 miles	31 miles	
Average Travel Speed[3]						
BAAQMD	54.7 miles/hour	55.0 miles/hour	54.7 miles/hour	55.0 miles/hour	32.0 miles/hour	
Trip Travel Time:						
BAAQMD	4.6 hours	1.1 hours	4.6 hours	1.1 hours	1.0 hours	
Line Locomotives per Train[4]	4 locomotives	4 locomotives	4 locomotives	4 locomotives	4 locomotives	
Engine Power per Locomotive[5]	4,400 horsepower	4,400 horsepower	4,400 horsepower	4,400 horsepower	4,400 horsepower	
Engine Load Factor[6]	27.1%	27.1%	27.1%	27.1%	27.1%	
Per Trip Line Haul Engine Power:						
BAAQMD	21,837 bhp-hours	5,186 bhp-hours	21,923 bhp-hours	5,273 bhp-hours	4,657 bhp-hours	
Unit Train Equivalents/Year[4]	**1 trains**	**0 trains**	**12 trains**	**11 trains**	**3 trains**	
Total Annual Line Haul Engine Power:						**Total**
BAAQMD	29,396 bhp-hours	2,314 bhp-hours	269,826 bhp-hours	57,025 bhp-hours	12,896 bhp-hours	**371,456 bhp-hours**

On-site Activity (Avon Tracks):

Component	MTZ - Bakersfield	MTZ - Rocklin	MTZ - LA	OOS - MTZ - UP	Rodeo - MTZ	**On-Site**
Avon Track	E/F	E/F	E/F	E/F	E/F	
Line Haul Hours/Full Track[7]	1.52 hours	1.52 hours	1.52 hours	1.52 hours	1.52 hours	
Line Haul Hours/Year[8]	29 hours	10 hours	269 hours	237 hours	61 hours	
Line Locomotives per Train for Offloading	1 locomotive	1 locomotive	1 locomotive	1 locomotive	1 locomotive	
Engine Power per Locomotive[5]	4,400 horsepower	4,400 horsepower	4,400 horsepower	4,400 horsepower	4,400 horsepower	
Average Line Haul Load Factor	0.43%	0.43%	0.43%	0.43%	0.43%	
Line Haul	553 bhp-hours	183 bhp-hours	5,055 bhp-hours	4,442 bhp-hours	1,137 bhp-hours	**11,370 bhp-hours**
Switcher Hours/Full Track[7]	1.60 hours	1.60 hours	1.60 hours	1.60 hours	1.60 hours	
Switcher Hours/Year[8]	31 hours	10 hours	284 hours	249 hours	64 hours	
Switcher per Train for Offloading	1 locomotive	1 locomotive	1 locomotive	1 locomotive	1 locomotive	
Engine Power per Locomotive[5]	204 horsepower	204 horsepower	204 horsepower	204 horsepower	204 horsepower	
Average Switcher Load Factor	1.02%	1.02%	1.02%	1.02%	1.02%	
Switcher	65 bhp-hours	21 bhp-hours	590 bhp-hours	519 bhp-hours	133 bhp-hours	**1,328 bhp-hours**

Total Locomotive Engine Power:

Component	MTZ - Bakersfield	MTZ - Rocklin	MTZ - LA	OOS - MTZ - UP	Rodeo - MTZ	**Total**
Annual Line Haul + Onsite						
BAAQMD	30,013 bhp-hours	2,518 bhp-hours	275,471 bhp-hours	61,986 bhp-hours	14,166 bhp-hours	**384,154 bhp-hours**

Notes:

1. Pre-Project Emissions estimated based on volumes transferred via railcar in averaged from October 2015 - September 2020.
2. Source: Pre-Project Transportation Estimates, documented separately.
3. Source: Separate tables documenting maximum unit train travel distance and speed from specified routes.

Marathon - Martinez
Renewable Fuels Project

Mobile Source - Rail Transport Pre-Project Operational Estimates - Process Rate Data
Operating Year: Baseline October 2015 - September 2020

4. Unit train locomotive power requirements for a 130-car unit train, per POLB 2013 Air Emissions Inventory.

5. Line Haul Locomotive: assumed to be 4,400 horsepower, similar to a GE AC4400CW or GE Dash 9-44CW.
On-Site Switch Locomotive: one RailKing 330 Mobile Railcar Mover, Tier 3 Cummins QSB 6.7 204 bhp engine

6. Source for EPA load factors by throttle notch:
Locomotive Emission Standards Regulatory Support Document (Locomotive RSD), Document No. EPA-420-R-98-101, U.S. Environmental Protection Agency, April 1998, Table 5-2 - Typical Power Distribution by Notch, page 78, available at:
https://www.epa.gov/regulations-emissions-vehicles-and-engines/final-rule-emission-standards-locomotives-and-locomotive,

7. Onsite Line Haul Hours/Train is estimated based on the movement of the line haul locomotive up to the Mainline Foul Point, an idle period to transition to the switcher, and then movement back to the Mainline.
Onsite Switcher Hours/Train is estimated based on the movement of the switcher to the Mainline Foul Point to pick up the railcars, an idle period to transition the cars to the switcher, and then the movement of the railcars t

8. Onsite Line Haul Hours/Year applies the Onsite Line Haul Hours/Train, where the "Train" is defined by the total number of railcars that one of the Avon track sections can accommodate in a given day, which is described in the
The Onsite Switcher Hours/Year assumes a "Train" is defined by the maximum number of railcars that one of the Avon track sections can accommodate, which is described in the Onsite Operating Period table.

Marathon - Martinez

Renewable Fuels Project

Mobile Source - Rail Transport Pre-Project Emissions

Operating Year: Baseline October 2015 - September 2020

Daily Emissions

Region		Average Daily BHP-Hours	Criteria Pollutant Emissions (Pounds/Day)						GHG Emissions (Pounds/Day)			
			POC	SO_2	NOx	CO	PM_{10}	$PM_{2.5}$	CO_2	CH_4	N_2O	CO_2e
BAAQMD	Total	1,018	0.28	0.01	9.06	2.87	0.20	0.19				
Delivery	On-Site	31	0.01	0.00	0.28	0.09	0.01	0.01				
Switcher	On-Site	4	0.00	0.00	0.04	0.02	0.00	0.00				
Total Daily - BAAQMD			**0.30**	**0.01**	**9.38**	**2.98**	**0.21**	**0.19**	**Not Applicable**			

Annual Emissions

Region		Annual Total BHP-Hours	Criteria Pollutant Emissions (TPY)						Emissions (Metric Tons/Year)			
			POC	SO_2	NOx	CO	PM_{10}	$PM_{2.5}$	CO_2	CH_4	N_2O	CO_2e
BAAQMD	Total	371,456	0.05	0.00	1.65	0.52	0.04	0.03	182.34	0.01	0.00	184.05
Delivery	On-Site	11,370	0.002	0.000	0.051	0.016	0.001	0.001	5.58	0.00	0.00	5.58
Switcher	On-Site	1,328	0.001	0.000	0.007	0.004	0.000	0.000	0.65	0.00	0.00	0.65
Total Annual - BAAQMD			**0.05**	**0.00**	**1.71**	**0.54**	**0.04**	**0.03**	**188.57**	**0.01**	**0.00**	**190.28**

Locomotive Emission Factors

			Emission Factors									
	Basis	Unit	TOG	POC	SOx	NOx	CO	PM_{10}	$PM_{2.5}$	CO_2	CH_4	N_2O
Switch	Tier 3	g/bhp-hr		0.60	0.00	5.00	2.40	0.10	0.09	490.87	0.038	0.012
Line Haul	2022-24 Avg	g/bhp-hr	0.14	0.13	0.005	4.04	1.28	0.09	0.08	490.87	0.038	0.012
Line Haul	2022	g/gal	3.20			89		2.00				
Line Haul	2023	g/gal	3.00			84		1.90		10,210	0.798	0.255
Line Haul	2024	g/gal	2.8	2.46		79		1.7				

Marathon - Martinez

Renewable Fuels Project

Mobile Source - Rail Transport Pre-Project Emissions

Notes:

1. Rail transportation (locomotive) emission calculations are based on the following:
   a. Annual rail transportation (locomotive) brake horsepower-hours (Bhp-Hours) for the pre-project operations are based on volumes of commodity transported via rail in 2019.
   b. Average daily rail transportation bhp-hours for the pre-project operations assume operation 365 days per year.
   c. Rail transportation assumes two one-way trips per round trip.
   d. The incoming trip assumes full railcars, requiring 4 locomotives to haul the train. The outbound/return trip assumes empty railcars requiring 2 locomotives to haul the empty railcars.

2. Criteria pollutant emissions (ROG, NOx, PM_{10}, $PM_{2.5}$, CO, and SO_2) are calculated based on two-way rail travel within the Bay Area Air Quality Management District.

3. Greenhouse gas emissions (CO_2, CH_4, N_2O, and CO_2e) are calculated based on two-way rail travel within California.

4. Line Haul Locomotive Emission Factors:
   a. Source for HC, NOx, and PM10 emission factors in grams/gallon: Emission Factors for Locomotives (Document No. EPA-420-F-09-025), U.S. Environmental Protection Agency, April 2009, Tables 5 to 7 (expected fleet average emission factors by calendar year for large line-haul locomotives). These factors are converted to grams/brake horsepower-hour (grams/bhp-hr) by dividing by the brake specific fuel consumption factor of 20.8 bhp-hr/gallon (source: Emission Factors for Locomotives). TOG is assumed to equal HC.

   b. The POC emission factor utilizes the California Air Resources Board's ROG weight fraction of 0.8785 X TOG (profile no. 818) for compression-ignition diesel-fired internal combustion engines. available at https://www.arb.ca.gov/ei/speciate/speciate.htm#specprof (accessed March 7, 2018).

   c. The $PM_{2.5}$ emission factor utilizes the California Air Resources Board's $PM_{2.5}$ weight fraction of 0.92 X PM and PM_{10} weight fraction of 1 X PM (profile no. 425) for diesel vehicle exhaust, available at diesel-fired internal combustion engines, available at https://www.arb.ca.gov/ei/speciate/speciate.htm#specprof (accessed March 7, 2018).

5. Onsite Switch Locomotive Emission Factors:
   Facility maintains a RailKing 330 Mobile Railcar Mover, Tier 3 Cummins QSB 6.7 204 bhp engine. Emission factors applied are consistent with EPA Locomotive Exhaust Emission Standards for Switch Duty-Cycle engines. Found at: https://nepis.epa.gov/Exe/ZyPDF.cgi?Dockey=P100OA09.pdf

6. The CO emission factor of 1.28 grams/bhp-hr is from *Emission Factors for Locomotives* , Table 1 (Line-Haul Emission Factors, g/bhp-hr).

7. The SOx (as SO_2) emission factor is based on an assumed sulfur content of 15 parts per million diesel as follows:
   (15 lbs S/million lbs diesel) X (7.05 lb/gal diesel) X (1 gal diesel/20.8 bhp-hr) X (64 lb-mol SO_2/32 lb-mol S) X (453.59 g/lb) = 0.005 g SOx/bhp-hr.
   This assumes that California lower sulfur on-highway diesel fuel is used by locomotives. Source for locomotive brake specific fuel consumption factor of 20.8 bhp-hr/gallon: *Emission Factors for Locomotives* , Table 3 Factors, bhp-hr/gal), large line-haul and passenger locomotives.

8. Sources for CO_2 emission factors:
   The Climate Registry, The Climate Registry's 2020 Default Emission Factors, Table 2.1 (US Default Factors for Calculating CO2 Emissions from Combustion of Transport Fuels)

9. Sources for CH_4, and N_2O emission factors:
   The Climate Registry, The Climate Registry's 2020 Default Emission Factors, Table 2.7 (US Default Factors for Calculating CH4 and N20 Emissions from Non-Highway Vehicles) Factors (in kg/gallon or g/gallon are converted to g/bhp-hr by using the brake specific fuel consumption factor of 20.8 bhp-hr/gallon for large line-haul and passenger locomotives (source: Emission Factors for Locomotives).

10. Conversion factors:

20.8 bhp-hr/gallon	1,000,000 grams/metric ton
453.59 grams/pound	Global warming potential for methane: 21
2,000 pounds/ton	Global warming potential for nitrous oxide: 310

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Mobile Source - Rail Transport Post-Project Product Transportation Estimates

Rail Transportation

		Throughput			Transportation Characteristics					
Commodity	**Track**	**Units / Day**	**Units / Year**	**Units**	**Receipt / Deliveries**	**Fraction of Total Commodity**	**Railcars/ Year**	**Railcar Load (Bbls/Railcar)**	**Train Routing**	**Miles/Round Trip BAAQMD**
RD Fd Stock	A/B/C	6,500	2,372,500	bbl	Receipt	0.20	3,889	610	OOS - MTZ - UP	61
Ethanol	None	800	292,000	bbl	Receipt	1.00	429	680	OOS - Richmond	80
Bio Diesel	None	100	36,500	bbl	Receipt	1.00	51	720	OOS - Richmond	80
Propane	E/F	138	50,400	bbl	Receipt	1.00	70	720	OOS - MTZ - UP	61
Propane	E/F	935	341,100	bbl	Deliveries	0.25	474	720	MTZ - Bakersfield	250
Propane	E/F	2,804	1,023,300	bbl	Deliveries	0.75	1,421	720	MTZ - Rocklin	60

Notes:

1. Source for RTP Project throughputs and feedstock/product sources/destinations: Marathon, RTP project application to the BAAQMD.
2. For sources and destinations located within the Bay Area Air Quality Management District, Miles/Round Trip based on estimated round trip mileage within the air basin to the facility.
3. Average Line-Haul train carries 130 railcars on a peak day. Port of Long Beach 2013 Air Emission Inventory.

130 Unit Train

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Renewable Fuels Project

Mobile Source - Rail Transport Post-Project Operational Estimates - Process Rate Data
Post-Project Scenario[1]

Off-site Activity (Main Line).

Route	OOS - MTZ - UP	OOS - MTZ - UP	MTZ - Bakersfield	MTZ - Rocklin	**Total**
Round Trip Miles[2]					
BAAQMD	61 miles	61 miles	250 miles	60 miles	
Average Travel Speed[3]					
BAAQMD	55.0 miles/hour	55.0 miles/hour	54.7 miles/hour	55.0 miles/hour	
Trip Travel Time:					
BAAQMD	1.1 hours	1.1 hours	4.6 hours	1.1 hours	
Line Locomotives per Train[4]	4 locomotives	4 locomotives	4 locomotives	4 locomotives	
Engine Power per Locomotive[5]	4,400 horsepower	4,400 horsepower	4,400 horsepower	4,400 horsepower	
Engine Load Factor[6]	27.1%	27.1%	27.1%	27.1%	
Per Trip Line Haul Engine Power:					
BAAQMD	5,273 bhp-hours	5,273 bhp-hours	21,837 bhp-hours	5,186 bhp-hours	
Unit Train Equivalents/Year[4]	**30 trains**	**1 trains**	**4 trains**	**11 trains**	
Total Annual Line Haul Engine Power:					**Total**
BAAQMD	157,731 bhp-hours	2,839 bhp-hours	79,620 bhp-hours	56,685 bhp-hours	**296,875 bhp-hours**

On-site Activity (Avon Tracks):

Component	OOS - MTZ - UP	OOS - MTZ - UP	MTZ - Bakersfield	MTZ - Rocklin	**On-Site**
Avon Track	A/B/C	E/F	E/F	E/F	
Line Haul Hours/Full Track[7]	2.02 hours	1.52 hours	1.52 hours	1.52 hours	
Line Haul Hours/Year[8]	560 hours	12 hours	80 hours	239 hours	
Line Locomotives per Train for Offloading	1 locomotive	1 locomotive	1 locomotive	1 locomotive	
Engine Power per Locomotive[5]	4,400 horsepower	4,400 horsepower	4,400 horsepower	4,400 horsepower	
Average Line Haul Load Factor	0.36%	0.43%	0.43%	0.43%	
Annual Line Haul Locomotive Engine Power	8,968 bhp-hours	221 bhp-hours	1,497 bhp-hours	4,489 bhp-hours	**15,176 bhp-hours**
Switcher Hours/Full Track[7]	2.09 hours	1.60 hours	1.60 hours	1.60 hours	
Switcher Hours/Year[8]	581 hours	12 hours	84 hours	252 hours	
Switcher per Train for Offloading	1 locomotive	2 locomotive	1 locomotive	1 locomotive	
Engine Power per Locomotive[5]	204 horsepower	204 horsepower	204 horsepower	204 horsepower	
Average Switcher Load Factor	0.84%	1.02%	1.02%	1.02%	
Annual Switcher Engine Power	997.3 bhp-hours	51.6 bhp-hours	174.9 bhp-hours	524.2 bhp-hours	**1,748 bhp-hours**

Total Locomotive Engine Power:

Component	OOS - MTZ - UP	OOS - MTZ - UP	MTZ - Bakersfield	MTZ - Rocklin	**Total**
Annual Line Haul + Onsite					
BAAQMD	167,696 bhp-hours	3,112 bhp-hours	81,292 bhp-hours	61,699 bhp-hours	**313,799 bhp-hours**

Marathon - Martinez
Renewable Fuels Project

Mobile Source - Rail Transport Post-Project Operational Estimates - Process Rate Data
Post-Project Scenario[1]

1. Post-Project emissions estimated based on estimated production.

2. Source: Post-Project Transportation Estimates, documented separately. Noted that the "OOS - Stockton" and "OOS - Richmond" routes will not bring a products onsite to Martinez via rail, as such on-site

3. Source: Separate tables documenting maximum unit train travel distance and speed from specified routes

4. Unit train locomotive power requirements for a 130-car unit train, per POLB 2013 Air Emissions Inventory

5. Line Haul Locomotive: assumed to be 4,400 horsepower, similar to a GE AC4400CW or GE Dash 9-44CW.
   On-Site Switch Locomotive: one RailKing 330 Mobile Railcar Mover, Tier 3 Cummins QSB 6.7 204 bhp engine

6. Source for EPA load factors by throttle notch:
   Locomotive Emission Standards Regulatory Support Document (Locomotive RSD), Document No. EPA-420-R-98-101, U.S. Environmental Protection Agency, April 1998, Table 5-2 - Typical Power Distribution by Notch, page 78, available at: https://www.epa.gov/regulations-emissions-vehicles-and-engines/final-rule-emission-standards-locomotives-and-locomotive

7. Onsite Line Haul Hours/Train assume is estimated based on the movement of the line haul locomotive up to the Mainline Foul Point, an idle period to transition to the switcher, and then movement back t
   Onsite Switcher Hours/Train is estimated based on the movement of the switcher to the Mainline Foul Point to pick up the railcars, an idle period to transition the cars to the switcher, and then the mover

8. Onsite Line Haul Hours/Year applies the Onsite Line Haul Hours/Train, where the "Train" is defined by the total number railcars that one of the Avon track sections can accommodate in a given day, which
   The Onsite Switcher Hours/Year assumes a "Train" is defined by the maximum number of railcars that one of the Avon track sections can accommodate, which is described in the Onsite Operating Period

Marathon - Martinez
Renewable Fuels Project

Mobile Source - Rail Transport Post-Project Emissions

Daily Emissions												
		Average Daily	**Criteria Pollutant Emissions (Pounds/Day)**						**GHG Emissions (Pounds/Day)**			
Region		**BHP-Hours**	**POC**	**SO_2**	**NOx**	**CO**	**PM_{10}**	**$PM_{2.5}$**	**CO_2**	**CH_4**	**N_2O**	**CO_2e**
BAAQMD	Total	813	0.23	0.01	7.24	2.30	0.16	0.15				
Delivery	On-Site	42	0.01	0.00	0.37	0.12	0.01	0.01				
Switcher	On-Site	5	0.01	0.00	0.05	0.03	0.00	0.00				
Total Daily - BAAQMD			**0.25**	**0.01**	**7.66**	**2.44**	**0.17**	**0.16**	**Not Applicable**			

Annual Emissions												
		Annual Total	**Criteria Pollutant Emissions (TPY)**						**Emissions (Metric Tons/Year)**			
Region		**BHP-Hours**	**POC**	**SO_2**	**NOx**	**CO**	**PM_{10}**	**$PM_{2.5}$**	**CO_2**	**CH_4**	**N_2O**	**CO_2e**
BAAQMD	Total	296,875	0.04	0.00	1.32	0.42	0.03	0.03	145.73	0.01	0.00	147.09
Delivery	On-Site	15,176	0.00	0.00	0.07	0.02	0.00	0.00	7.45	0.00	0.00	7.45
Switcher	On-Site	1,748	0.00	0.00	0.01	0.00	0.00	0.00	0.86	0.00	0.00	0.86
Total Annual - BAAQMD			**0.04**	**0.00**	**1.40**	**0.44**	**0.03**	**0.03**	**154.03**	**0.01**	**0.00**	**155.40**

Locomotive Emission Factors

			Emission Factors									
	Basis	Unit	TOG	POC	SOx	NOx	CO	PM_{10}	$PM_{2.5}$	CO_2	CH_4	N_2O
Switch	Tier 3	g/bhp-hr		0.60	0.00	5.00	2.40	0.10	0.09	490.87	0.038	0.012
Line Haul	2022-24 Avg	g/bhp-hr	0.14	0.13	0.005	4.04	1.28	0.09	0.08	490.87	0.038	0.012
Line Haul	2022	g/gal	3.20			89		2.00				
Line Haul	2023	g/gal	3.00			84		1.90		10,210	0.798	0.255
Line Haul	2024	g/gal	2.8	2.46		79		1.7				

Marathon - Martinez
Renewable Fuels Project

Mobile Source - Rail Transport Post-Project Emissions

Notes:

1. Rail transportation (locomotive) emission calculations are based on the following:
   a. Annual rail transportation (locomotive) brake horsepower-hours (Bhp-Hours) for the proposed project are based on the Rail Transportation Operational Estimates Process Rate Data, documented separately.
   b. Average daily rail transportation Bhp-Hours for the proposed project assume operation 365 days per year.
   c. Rail transportation assumes two one-way trips per round trip.
   d. The incoming trip assumes full railcars, requiring 4 locomotives to haul the train. The outbound/return trip assumes empty railcars requiring 2 locomotives to haul the empty railcars.

2. Criteria pollutant emissions (ROG, NOx, PM_{10}, $PM_{2.5}$, CO, and SO_2) are calculated based on two-way rail travel within the Bay Area Air Quality Management District.

3. Greenhouse gas emissions (CO_2, CH_4, N_2O, and CO_2e) are calculated based on two-way rail travel within California.

4. Line Haul Locomotive Emission Factors:
   a. Source for HC, NOx, and PM10 emission factors in grams/gallon: Emission Factors for Locomotives (Document No. EPA-420-F-09-025), U.S. Environmental Protection Agency, April 2009, Tables 5 to 7 (expected fleet average emission factors by calendar year for large line-haul locomotives). These factors are converted to grams/brake horsepower-hour (grams/bhp-hr) by dividing by the brake specific fuel consumption factor of 20.8 bhp-hr/gallon (source: Emission Factors for Locomotives). TOG is assumed to equal HC.

   b. The POC emission factor utilizes the California Air Resources Board's ROG weight fraction of 0.8785 X TOG (profile no. 818) for compression-ignition diesel-fired internal combustion engines. available at https://www.arb.ca.gov/ei/speciate/speciate.htm#specprof (accessed March 7, 2018).

   c. The $PM_{2.5}$ emission factor utilizes the California Air Resources Board's $PM_{2.5}$ weight fraction of 0.92 X PM and PM_{10} weight fraction of 1 X PM (profile no. 425) for diesel vehicle exhaust, available at https://www.arb.ca.gov/ei/speciate/speciate.htm#specprof (accessed March 7, 2018).

5. Onsite Switch Locomotive Emission Factors:
   Facility maintains a RailKing 330 Mobile Railcar Mover, Tier 3 Cummins QSB 6.7 204 bhp engine. Emission factors applied are consistent with EPA Locomotive Exhaust Emission Standards for Switch Duty-Cycle engines. Found at: https://nepis.epa.gov/Exe/ZyPDF.cgi?Dockey=P100OA09.pdf

6. The CO emission factor of 1.28 grams/bhp-hr is from *Emission Factors for Locomotives* , Table 1 (Line-Haul Emission Factors, g/bhp-hr).

7. The SOx (as SO_2) emission factor is based on an assumed sulfur content of 15 parts per million diesel as follows:
   (15 lbs S/million lbs diesel) X (7.05 lb/gal diesel) X (1 gal diesel/20.8 bhp-hr) X (64 lb-mol SO_2/32 lb-mol S) X (453.59 g/lb) = 0.005 g SOx/bhp-hr.
   This assumes that California lower sulfur on-highway diesel fuel is used by locomotives. Source for locomotive brake specific fuel consumption factor of 20.8 bhp-hr/gallon: *Emission Factors for Locomotives* , Table 3 Factors, bhp-hr/gal), large line-haul and passenger locomotives.

8. Sources for CO_2 emission factors:
   The Climate Registry, The Climate Registry's 2020 Default Emission Factors, Table 2.1 (US Default Factors for Calculating CO2 Emissions from Combustion of Transport Fuels)
   https://www.theclimateregistry.org/wp-content/uploads/2020/04/The-Climate-Registry-2020-Default-Emission-Factor-Document.pdf

9. Sources for CH_4, and N_2O emission factors:
   The Climate Registry, The Climate Registry's 2020 Default Emission Factors, Table 2.7 (US Default Factors for Calculating CH4 and N20 Emissions from Non-Highway Vehicles) Factors (in kg/gallon or g/gallon are converted to g/bhp-hr by using the brake specific fuel consumption factor of 20.8 bhp-hr/gallon for large line-haul and passenger locomotives (source: Emission Factors for Locomotives).

10. Conversion factors:

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