Appendix E
Air Quality Calculations
List of Tables

Table	Contents	Page
Calculations Associated with Project Construction		
Table 1	Construction Emissions: Phase 1 - Assembly of Pipeline String	1
Table 2	Construction Emissions: Phase 2 - Pipeline Launching	1
Table 3	Construction Emissions: Phase 3 - Offshore Pipeline Installation	2
Table 4	Summary of Construction Emissions by Phase	2
Table 5	Construction Equipment 2007 Exhaust Emission Factors	3
Table 6	2007 Motor Vehicle Exhaust Emission Factors	4
Table 7	Motor Vehicle Entrained Paved Road PM10 Emission Factors	4
Table 8	Tug Boat Emission Factors	5
Table 9	Speed Boat Emission Factors	5
Table 10	Summary of Localized Construction Air Quality Impacts Analysis (Unmitigated)	6
Calculations Associated with Operations		
Table 11	150,000 DWT Marine Tanker Times in Operating Modes within California Waters (Scenario 1)	7
Table 12	150,000 DWT Marine Tanker Main Engine Power Output by Operating Mode	7
Table 13	150,000 DWT Marine Tanker Main Engine Energy Output by Operating Mode (Scenario 1)	7
Table 14	Maximum Daily Emissions for 150,000 DWT Marine Tanker (Scenario 1)	8
Table 15	Summary of Maximum Daily Marine Vessel Emissions for 150,000 DWT Tanker (Scenario 1)	8
Table 16	150,000 DWT Marine Tanker Times in Operating Modes within California Waters (Scenario 2)	9
Table 17	150,000 DWT Marine Tanker Main Engine Energy Output by Operating Mode (Scenario 2)	9
Table 18	Maximum Daily Emissions for 150,000 DWT Marine Tanker (Scenario 2)	10
Table 19	Summary of Maximum Daily Marine Vessel Emissions for 150,000 DWT Tanker (Scenario 2)	10
Table 20	35,000 DWT Marine Tanker Times in Operating Modes within California Waters (Scenario 1)	11
Table 21	35,000 DWT Marine Tanker Main Engine Power Output by Operating Mode	11
Table 22	35,000 DWT Marine Tanker Main Engine Energy Output by Operating Mode (Scenario 1)	11
Table 23	Maximum Daily Emissions for 35,000 DWT Marine Tanker (Scenario 1)	12
Table 24	Summary of Maximum Daily Marine Vessel Emissions for 35,000 DWT Tanker (Scenario 1)	12
Table 25	35,000 DWT Marine Tanker Times in Operating Modes within California Waters (Scenario 2)	13
Table 26	35,000 DWT Marine Tanker Main Engine Energy Output by Operating Mode (Scenario 2)	13
Table 27	Maximum Daily Emissions for 35,000 DWT Marine Tanker (Scenario 2)	14
Table 28	Summary of Maximum Daily Marine Vessel Emissions for 35,000 DWT Tanker (Scenario 2)	14
Table 29	Marine Tanker Main Engine/Boiler Emission Factors	15
Table 30	Marine Tanker Auxiliary Power Emission Factors	15
Table 31	2006 Motor Vehicle Exhaust Emission Factors	16
Table 32	Motor Vehicle Entrained Paved Road PM10 Emission Factors	16
Table 33	Daily Emissions from Employee Commute Vehicles	16
Table 34	Identification of Scenarios with Maximum Daily Emissions	17
Table 35	Summary of Maximum Daily Marine Vessel Emissions by Berth	17
Table 36	Summary of Maximum Daily Marine Vessel Emissions from Both Berths	18
Table 37	Summary of Maximum Daily Marine Terminal Emissions	18
Table 38	Summary of Maximum Daily Marine Vessel Emissions from Both Berths - Alternatives with VLCC	18
Table 39	Summary of Maximum Daily Marine Terminal Emissions - Alternatives with VLCC	18
Table 40	300,000 DWT Marine Tanker Times in Operating Modes within California Waters (Scenario 1)	19
Table 41	300,000 DWT Marine Tanker Main Engine Power Output by Operating Mode	19
Table 42	300,000 DWT Marine Tanker Main Engine Energy Output by Operating Mode (Scenario 1)	19
Table 43	Maximum Daily Emissions for 300,000 DWT Marine Tanker (Scenario 1)	20
Table 44	Summary of Maximum Daily Marine Vessel Emissions for 300,000 DWT Tanker (Scenario 1)	20
Table 45	300,000 DWT Marine Tanker Times in Operating Modes within California Waters (Scenario 2)	21
Table 46	300,000 DWT Marine Tanker Main Engine Power Output by Operating Mode	21
Table 47	300,000 DWT Marine Tanker Main Engine Energy Output by Operating Mode (Scenario 2)	21
Table 48	Maximum Daily Emissions for 300,000 DWT Marine Tanker (Scenario 2)	22
Table 49	Summary of Maximum Daily Marine Vessel Emissions for 300,000 DWT Tanker (Scenario 2)	22
Table 50	Toxic Emission Calculations	23
Table 51	Greenhouse Gas Emissions: Main Vessel Engine	24-27
Table 52	Greenhouse Gas Emissions: Non Vessel Sources	28
Table 53	Greenhouse Gas Emissions: Summary	28
Table 54	Greenhouse Gas Emissions: Main Vessel Engine - Project Year 2035	29-32
Table 55	Greenhouse Gas Emissions: Non Vessel Sources - Project Year 2035	33
Table 56	Greenhouse Gas Emissions: Summary - Project Year 2035	33
Table 57	Greenhouse Gas Emissions: Main Vessel Engine - Alternatives	34-37
Table 58	Greenhouse Gas Emissions: Non Vessel Sources - Alternatives	38
Table 59	Greenhouse Gas Emissions: Summary - Alternatives	38
Figure	DPM Cancer Contours for Current Operations	39
Sheet	ISC Modeling for DPM onshore Impacts - ISC Output File	40

Table 1
Construction Emissions: Phase 1 - Assembly of Pipeline String

Equipment	Quantity	Hours/Day	CO (lb/day)	VOC (lb/day)	NO_X (lb/day)	SO_X (lb/day)	PM10 (lb/day)	PM2.5 (lb/day)
Welder	2	6	3.79	1.40	3.42	0.00	0.43	0.38
Dozer	1	4	1.61	0.48	3.23	0.45	0.34	0.30
Sideboom	2	5	3.53	0.88	6.30	1.08	0.67	0.60
Crane	2	5	4.54	0.90	9.04	1.67	0.57	0.51
		Equipment Sub-Total	**13.47**	**3.66**	**21.99**	**3.20**	**2.01**	**1.79**

Vehicles	Quantity	Round-trip Distance (miles)	CO (lb/day)	VOC (lb/day)	NO_X (lb/day)	SO_X (lb/day)	PM10 (lb/day)	PM2.5 (lb/day)
Transport Trucks	3	50	0.83	0.18	5.35	0.01	0.25	0.12
Autos	15	50	9.62	1.04	1.02	0.01	0.83	0.19
		Vehicle Sub-Total	**10.44**	**1.22**	**6.37**	**0.01**	**1.08**	**0.30**
		Phase 1 Total	**23.92**	**4.89**	**28.35**	**3.21**	**3.09**	**2.09**

Table 2
Construction Emissions: Phase 2 - Pipeline Launching

Vessels	Quantity	Hours/Day	CO (lb/day)	VOC (lb/day)	NO_X (lb/day)	SO_X (lb/day)	PM10 (lb/day)	PM2.5 (lb/day)
Tugboats	3	8	426.26	9.39	76.17	19.30	57.39	52.80
Speed Boat	1	8	90.46	2.38	4.40	0.00	0.06	0.06
		Vessel Sub-Total	**516.72**	**11.77**	**80.57**	**19.30**	**57.46**	**52.86**

Vehicles	Quantity	Round-trip Distance (miles)	CO (lb/day)	VOC (lb/day)	NO_X (lb/day)	SO_X (lb/day)	PM10 (lb/day)	PM2.5 (lb/day)
Autos	15	50	9.62	1.04	1.02	0.01	0.83	0.19
		Vehicle Sub-Total	**9.62**	**1.04**	**1.02**	**0.01**	**0.83**	**0.19**
		Phase 2 Total	**526.34**	**12.81**	**81.59**	**19.31**	**58.28**	**53.04**

Table 3
Construction Emissions: Phase 3 - Offshore Pipeline Installation

Vessels	Quantity	Hours/Day	CO (lb/day)	VOC (lb/day)	NO_X (lb/day)	SO_X (lb/day)	PM10 (lb/day)	PM2.5 (lb/day)
Tugboats	1	8	142.09	3.13	25.39	6.43	19.13	17.60
		Vessel Sub-Total	**142.09**	**3.13**	**25.39**	**6.43**	**19.13**	**17.60**

Equipment	Quantity	Hours/Day	CO (lb/day)	VOC (lb/day)	NO_X (lb/day)	SO_X (lb/day)	PM10 (lb/day)	PM2.5 (lb/day)
Welder	1	8	2.53	0.94	2.28	0.00	0.29	0.26
Crane	1	8	3.632	0.72	7.232	1.336	0.456	0.40584
		Equipment Sub-Total	**6.16**	**1.66**	**9.51**	**1.34**	**0.74**	**0.66**

Vehicles	Quantity	Round-trip Distance (miles)	CO (lb/day)	VOC (lb/day)	NO_X (lb/day)	SO_X (lb/day)	PM10 (lb/day)	PM2.5 (lb/day)
Autos	15	50	9.62	1.04	1.02	0.01	0.83	0.19
		Vehicle Sub-Total	**9.62**	**1.04**	**1.02**	**0.01**	**0.83**	**0.19**
		Phase 3 Total	**157.86**	**5.82**	**35.92**	**7.78**	**20.70**	**18.45**

Table 4
Summary of Construction Emissions by Phase

Construction Activity	CO (lb/day)	VOC (lb/day)	NO_X (lb/day)	SO_X (lb/day)	PM10 (lb/day)	PM2.5 (lb/day)
Phase 1 - Assembly of Pipeline String						
Marine Vessels	--	--	--	--	--	--
Construction Equipment	13.5	3.7	22.0	3.2	2.0	1.8
On-Road Vehicles	10.4	1.2	6.4	0.0	1.1	0.3
Total - Phase 1	**23.9**	**4.9**	**28.4**	**3.2**	**3.1**	**2.1**
Phase 2 - Pipeline Launching						
Marine Vessels	516.7	11.8	80.6	19.3	57.5	52.9
Construction Equipment	--	--	--	--	--	--
On-Road Vehicles	9.6	1.0	1.0	0.0	0.8	0.2
Total - Phase 2	**526.3**	**12.8**	**81.6**	**19.3**	**58.3**	**53.0**
Phase 3 - Offshore Pipeline Installation						
Marine Vessels	142.1	3.1	25.4	6.4	19.1	17.6
Construction Equipment	6.2	1.7	9.5	1.3	0.7	0.7
On-Road Vehicles	9.6	1.0	1.0	0.0	0.8	0.2
Total - Phase 3	**157.9**	**5.8**	**35.9**	**7.8**	**20.7**	**18.4**
Maximum Daily Emissions	**526.3**	**12.8**	**81.6**	**19.3**	**58.3**	**53.0**
Significance Threshold	550	75	100	150	150	55
Exceeds Threshold?	NO	NO	NO	NO	NO	NO

Table 5
Construction Equipment 2007 Exhaust Emission Factors

Equipment Type	Fuel	Horsepower	ARB Off-Road Model Category	Units	CO	VOC	NO_X	SO_X	PM10	PM2.5 [b]
Dozer	D	70	Tractors/Loaders/Backhoes	lb/hr	0.403	0.120	0.807	0.112	0.085	0.076
Crane	D	175	Cranes	lb/hr	0.454	0.090	0.904	0.167	0.057	0.051
Sideboom	D	63	Cranes	lb/hr	0.353	0.088	0.630	0.108	0.067	0.060
Welder	D	29	Welders	lb/hr	0.316	0.117	0.285	0.000	0.036	0.032

[a] These are composite horsepower-based off-road emission factors for 2007 developed for the SCAQMD by CARB from its OFFROAD Model. The composite off-road emission factors were derived based on the equipment category (tractor, dozer, scraper, etc.), and average equipment age and horsepower rating within horsepower ranges for the year. The emission factors can be downloaded from http://www.aqmd.gov/ceqa/hdbk.html/offroadEF05_20.xls

[b] The emission factor for PM2.5 is assumed to be 89% of the PM10 emission factor, according to the SCAQMD in *Methodology to Calculate Particulate Matter (PM) 2.5 and PM 2.5 Significance Thresholds* (October 2006).

Table 6
2007 Motor Vehicle Exhaust Emission Factors

Passenger Vehicles (pounds/mile)		Delivery Trucks (pounds/mile)	
CO	0.01282	CO	0.0055
NOx	0.00136	NOx	0.0356
VOC	0.00138	VOC	0.0012
SOx	0.00001	SOx	0.00005
PM10	0.00008	PM10	0.00064
PM2.5	0.00007	PM2.5	0.00062

Source: SCAQMD CEQA Analysis Guidance Handbook Web Site,
http://www.aqmd.gov/ceqa/hdbk.html

Note: The emission factors were compiled by running the California Air Resources Board's EMFAC2002 (version 2.2) Burden Model. A weighted average of vehicle types was used to calculate emission factors for passenger vehicles, and emission factors for heavy heavy-duty diesel trucks were used for delivery trucks. All the emission factors account for the emissions from start, running and idling exhaust. In addition, the VOC emission factors take into account diurnal, hot soak, running and resting emissions, and PM10 emission factors take into account tire and brake wear. The PM2.5 emission factor is assumed to equal 92.8% of the PM10 emission factor for passenger vehicles, and 96.4% of the PM10 emission factor for delivery trucks, according to the SCAQMD in *Methodology to Calculate Particulate Matter (PM) 2.5 and PM 2.5 Significance Thresholds, Appendix A: Updated CEIDARS Table with PM2.5 Fractions* (October 2006).

Table 7
Motor Vehicle Entrained Paved Road PM10 Emission Factors

Vehicle Type	On-Road Average Vehicle Weight (tons)[a]	Road Type	Silt Loading (g/m^2)[b]	PM10 Emission Factor (lb/mi)[c]	PM2.5 Emission Factor (lb/mi)[d]
Autos	2.7	Collector	0.037	0.001	0.0002
Transport Trucks	2.7	Collector	0.037	0.001	0.0002

[a] Conservatively high assumption for average vehicles. On-road average vehicle weight from ARB Emission Inventory Methodology 7.9, Entrained Paved Road Dust (1997)

[b] From ARB Emission Inventory Methodology 7.9, Entrained Paved Road Dust (1997)

[c] Emission factor [g/mi] = $7.26\ (\text{Silt Loading}/2)^{0.65}\ (\text{Weight}/3)^{1.5}$,
from ARB Emission Inventory Methodology 7.9, Entrained Paved Road Dust (1997)

[d] For paved road dust, the emission factor for PM2.5 is assumed to be 16.9% of the PM10 emission factor, according to the SCAQMD in *Methodology to Calculate Particulate Matter (PM) 2.5 and PM 2.5 Significance Thresholds, Appendix A: Updated CEIDARS Table with PM2.5 Fractions* (October 2006).

Table 8
Tug Boat Emission Factors

Item	No. of Ships	No. of Tug Boats/ Ship	Maneuvering Time, hours	No. of Tug Boats	CO (lb)	VOC (lb)	NO_X (lb)	SO_X (lb)	PM10 (lb)	PM2.5 (lb) [b]
Annual [a]	23	2	1	46	817.00	18.00	146.00	37.00	110.00	--
Per Tug Boat per Hour					17.76	0.39	3.17	0.80	2.39	2.20

[a] From Mobil Torrance Refinery Reformulated Fuels Project Volume VII – Revised Draft EIR, 1998

[b] For ships, the emission factor for PM2.5 is assumed to be 92% of the PM10 emission factor, according to the SCAQMD in *Methodology to Calculate Particulate Matter (PM) 2.5 and PM 2.5 Significance Thresholds, Appendix A: Updated CEIDARS Table with PM2.5 Fractions* (October 2006).

Table 9
Speed Boat Emission Factors

Equipment Type	Units	Fuel	Hp	Load Factor [c]	CO	VOC	NO_X	SO_X	PM10	PM2.5 [a]
Recreational Boat, Inboard 4-Stroke	g/hp-hr	G	250	0.21	97.700	2.570	4.750	0.000	0.070	0.062
Recreational Boat, Inboard 4-Stroke	lb/hr	G	250	0.21	11.308	0.297	0.550	0.000	0.008	0.007

[a] The emission factor for PM2.5 is assumed to be 89% of the PM10 emission factor, according to the SCAQMD in *Methodology to Calculate Particulate Matter (PM) 2.5 and PM 2.5 Significance Thresholds* (October 2006).

[b] Source for emission factors: CARB, personal communication with Connie Dang, 10/16/06. Year of manufacture = 2007.

[c] Source for load factor: CARB, personal communication with Connie Dang, 10/16/06.

Table 10
Summary of Localized Construction Air Quality Impacts Analysis (Unmitigated)

	CO	NO_x	PM10	PM2.5
Phase 1				
Maximum Daily On-Site Emissions (lb/day)[a]	14.5	22.6	2.1	1.8
Localized Significance Threshold (lb/day) [b,c]	674	91	5	3
Threshold Exceeded?	No	No	No	No

[a] Ten percent of automobile and transport truck emissions are assumed to occur on the construction site. All off-road construction equipment emissions are assumed to occur on-site.

[b] Because neither the location nor the size of the Phase 1 construction site has been determined, the most conservative assumptions were used in the LST lookup tables (1 acre site, 25 meter receptor distance).

[c] Source: SCAQMD, *Final Localized Significance Threshold Methodology. Appendix C (* June 2003); and SCAQMD, *Methodology to Calculate Particulate Matter (PM) 2.5 and PM 2.5 Significance Thresholds. Appendix B: PM2.5 Localized Significance Threshold Look-up Tables. (October 2006).*

Max Daily Scenario No. 1: Transit for 6.6 hours, hotel for 17.4 hours, unload product for 16.4 hours.
Vessel Size = 150,000 DWT
Product Volume = 1.1 Million bbl crude oil

Table 11
150,000 DWT Marine Tanker Times in Operating Modes within California Waters (Scenario 1)

Mode[a]	Distance (nm)	Motorship		
		Speed (kts)[b]	Time (hr/transit)	Max Vessel Speed, (kts)
Cruise to AQCZ within SCAB	4.5	14.7	0.3	15
AQCZ to Pilot Boarding Area	64.1	12	5.3	15
Pilot Boarding to Berth	3	3	1.0	15
Hoteling	N/A	N/A	17.4	N/A

AQCZ = Air Quality Compliance Zone, which is within 40 nm of Pt. Fermin

Vessel parameters taken from POLA 2007 Pier 400 Project EIR

Table 12
150,000 DWT Marine Tanker Main Engine Power Output by Operating Mode

Mode	Main Engine/ Boiler Power (hp)[a]	Load Factor	Main Engine/ Boiler Power (hp)[a]	Main Engine/ Boiler Power (kw)
	Motorship	Motorship	Motorship	Motorship
Cruise to AQCZ	13000	0.94	12,235	9,128
AQCZ to Pilot Boarding Area	13000	0.51	6,656	4,965
Pilot Boarding to Berth	13000	0.01	104	78

Vessel parameters taken from POLA 2007 Pier 400 project

Load factor calculated based on propeller law of LF=(speed/max speed)^3

Power [kw] = Power [hp] x 0.746 [kw/hp]

Table 13
150,000 DWT Marine Tanker Main Engine Energy Output by Operating Mode (Scenario 1)

Mode	Main Engine/ Boiler Energy (kw-hr)
	Motorship
Cruise to AQCZ	2,794
AQCZ to Pilot Boarding Area	26,523
Pilot Boarding to Berth	78

Energy Output [kw-hr] = Power output [kw] x Time [hr/mode]

Table 14
Maximum Daily Emissions for 150,000 DWT Marine Tanker (Scenario 1)

Mode/Engine	CO (lb/day)	VOC (lb/day)	NOx (lb/day)	SOx (lb/day)	PM10 (lb/day)	PM2.5 (lb/day)
Motorship						
Cruise to AQCZ/Main Engine	8.6	3.7	110.3	65.3	9.2	8.5
Cruise to AQCZ/Auxiliary Engine	0.4	0.1	5.3	4.4	0.5	0.5
Total Cruise to AQCZ	**9.0**	**3.8**	**115.6**	**69.7**	**9.8**	**9.0**
AQCZ to Pilot Boarding Area/Main Engine	81.9	35.1	1,046.7	619.8	87.7	80.7
AQCZ to Pilot Boarding Area/Auxiliary Engine	6.9	2.5	92.8	77.6	9.5	8.7
Total AQCZ to Pilot Boarding Area	**88.8**	**37.6**	**1,139.5**	**697.5**	**97.2**	**89.4**
Pilot Boarding to Berth/Main Engine	0.2	0.3	2.4	2.0	0.3	0.2
Pilot Boarding to Berth/Auxiliary Engine	1.8	0.6	23.9	20.0	2.4	2.2
Pilot Boarding to Berth/Auxiliary Boiler	1.1	0.1	2.7	11.0	0.3	0.3
Total Pilot Boarding to Berth	**3.1**	**1.0**	**29.0**	**33.0**	**3.0**	**2.7**
Hoteling/Auxiliary Engine	24.4	8.9	326.5	273.2	33.3	30.7
Hoteling/Auxiliary Boiler	19.4	1.4	46.3	191.0	4.9	4.5
Total Hoteling	**43.9**	**10.3**	**372.9**	**464.3**	**38.2**	**35.1**
Total Motorship	**144.8**	**52.8**	**1,656.9**	**1,264.4**	**148.1**	**136.3**

Main engine emissions [lb] = Emission factor [g/kw-hr] x Energy output [kw-hr] x Time [hr] / 453.6 [g/lb]
Auxiliary engine emissions [lb] = Emission factor [lb/hr] x Time [hr]
Auxiliary boiler emissions [lb] = Emission factor [lb/hr] x Time [hr]
Main boiler emissions (non-hoteling) [lb] = Emission factor [g/kw-hr] x Energy output [kw-hr] x Time [hr] / 453.6 [g/lb]
Main boiler emissions (hoteling) [lb] = Emission factor [lb/hr] x Time [hr]

Table 15
Summary of Maximum Daily Marine Vessel Emissions for 150,000 DWT Tanker (Scenario 1)

Source	CO (lb/day)	VOC (lb/day)	NOx (lb/day)	SOx (lb/day)	PM10 (lb/day)	PM2.5 (lb/day)
Tanker Transit						
Cruise to AQCZ	9.0	3.8	115.6	69.7	9.8	9.0
AQCZ to Pilot Boarding Area	88.8	37.6	1,139.5	697.5	97.2	89.4
Pilot Boarding to Berth	3.1	1.0	29.0	33.0	3.0	2.7
Hoteling and Product Loading/Unloading						
Boiler/Auxiliary Engine Combustion	43.9	10.3	372.9	464.3	38.2	35.1
Fugitive Vapor Emissions [a]	0.0	1,635.2	0.0	0.0	0.0	0.0
Tug Boat Assistance	35.5	0.8	6.3	1.6	4.8	4.4
Total Daily Emissions	**180.4**	**1,688.8**	**1,663.2**	**1,266.1**	**152.9**	**140.7**

[a] Calculated using a VOC emission factor of 2 lb/1,000 bbl and a product loading/unloading rate of: 50,000 bph
Total product loading/unloading time is equal to hoteling time minus 1 hour for tie/untie, safety check, and other inspections.

Max Daily Scenario No. 2: Transit for 1 hour, hotel for 23 hours, unload product for 22 hours
Vessel Size = 150,000 DWT
Product Volume = 1.1 Million bbl crude oil

Table 16
150,000 DWT Marine Tanker Times in Operating Modes within California Waters (Scenario 2)

Mode[a]	Distance (nm)	Motorship	
		Speed (kts)[b]	Time (hr/transit)
Cruise to AQCZ within SCAB	0	14.7	0.0
AQCZ to Pilot Boarding Area	0	12	0.0
Pilot Boarding to Berth	3	3	1.0
Hoteling	N/A	N/A	23.0

AQCZ = Air Quality Compliance Zone, which is within 40 nm of Pt. Fermin

Vessel parameters taken from POLA 2007 Pier 400 Project EIR

Table 17
150,000 DWT Marine Tanker Main Engine Energy Output by Operating Mode (Scenario 2)

Mode	Main Engine/ Boiler Energy (kw-hr)
	Motorship
Cruise to AQCZ	0
AQCZ to Pilot Boarding Area	0
Pilot Boarding to Berth	78

Energy Output [kw-hr] = Power output [kw] x Time [hr/mode]

Table 18
Maximum Daily Emissions for 150,000 DWT Marine Tanker (Scenario 2)

Mode/Engine	CO (lb/day)	VOC (lb/day)	NOx (lb/day)	SOx (lb/day)	PM10 (lb/day)	PM2.5 (lb/day)
Motorship						
Cruise to AQCZ/Main Engine	0.0	0.0	0.0	0.0	0.0	0.0
Cruise to AQCZ/Auxiliary Engine	0.0	0.0	0.0	0.0	0.0	0.0
Total Cruise to AQCZ	**0.0**	**0.0**	**0.0**	**0.0**	**0.0**	**0.0**
AQCZ to Pilot Boarding Area/Main Engine	0.0	0.0	0.0	0.0	0.0	0.0
AQCZ to Pilot Boarding Area/Auxiliary Engine	0.0	0.0	0.0	0.0	0.0	0.0
Total AQCZ to Pilot Boarding Area	**0.0**	**0.0**	**0.0**	**0.0**	**0.0**	**0.0**
Pilot Boarding to Berth/Main Engine	0.2	0.3	2.4	2.0	0.3	0.2
Pilot Boarding to Berth/Auxiliary Engine	1.8	0.6	23.9	20.0	2.4	2.2
Pilot Boarding to Berth/Auxiliary Boiler	1.1	0.1	2.7	11.0	0.3	0.3
Total Pilot Boarding to Berth	**3.1**	**1.0**	**29.0**	**33.0**	**3.0**	**2.7**
Hoteling/Auxiliary Engine	32.4	11.8	432.8	362.2	44.2	40.6
Hoteling/Auxiliary Boiler	25.8	1.8	61.4	253.2	6.4	5.9
Total Hoteling	**58.1**	**13.6**	**494.2**	**615.4**	**50.6**	**46.6**
Total Motorship	**61.3**	**14.7**	**523.2**	**648.4**	**53.6**	**49.3**

Main engine emissions [lb] = Emission factor [g/kw-hr] x Energy output [kw-hr] x Time [hr] / 453.6 [g/lb]
Auxiliary engine emissions [lb] = Emission factor [lb/hr] x Time [hr]
Auxiliary boiler emissions [lb] = Emission factor [lb/hr] x Time [hr]
Main boiler emissions (non-hoteling) [lb] = Emission factor [g/kw-hr] x Energy output [kw-hr] x Time [hr] / 453.6 [g/lb]
Main boiler emissions (hoteling) [lb] = Emission factor [lb/hr] x Time [hr]

Table 19
Summary of Maximum Daily Marine Vessel Emissions for 150,000 DWT Tanker (Scenario 2)

Source	CO (lb/day)	VOC (lb/day)	NOx (lb/day)	SOx (lb/day)	PM10 (lb/day)	PM2.5 (lb/day)
Tanker Transit						
Cruise to AQCZ	0.0	0.0	0.0	0.0	0.0	0.0
AQCZ to Pilot Boarding Area	0.0	0.0	0.0	0.0	0.0	0.0
Pilot Boarding to Berth	3.1	1.0	29.0	33.0	3.0	2.7
Hoteling and Product Loading/Unloading						
Boiler/Auxiliary Engine Combustion	58.1	13.6	494.2	615.4	50.6	46.6
Fugitive Vapor Emissions [a]	0.0	2,200.0	0.0	0.0	0.0	0.0
Tug Boat Assistance	35.5	0.8	6.3	1.6	4.8	4.4
Total Daily Emissions	**96.8**	**2,215.4**	**529.6**	**650.0**	**58.4**	**53.7**

[a] Calculated using a VOC emission factor of 2 lb/1,000 bbl and a product loading/unloading rate of: 50,000 bph
Total product loading/unloading time is equal to hoteling time minus 2 hours for tie/untie, safety check, and other inspections.

Max Daily Scenario No. 1: Transit for 6.6 hours, hotel for 17.4 hours, load product for 16.4 hours.
Vessel Size = 35,000 DWT
Product Volume = 264,000 bbl crude oil

Table 20
35,000 DWT Marine Tanker Times in Operating Modes within California Waters (Scenario 1)

Mode[a]	Distance (nm)	Motorship		
		Speed (kts)[b]	Time (hr/transit)	Max Vessel Speed, (kts)
Cruise to AQCZ within SCAB	4.5	14.7	0.3	15
AQCZ to Pilot Boarding Area	64.1	12	5.3	15
Pilot Boarding to Berth	3	3	1.0	15
Hoteling	N/A	N/A	17.4	N/A

AQCZ = Air Quality Compliance Zone, which is within 40 nm of Pt. Fermin

Vessel parameters taken from POLA 2007 Pier 400 Project EIR

Table 21
35,000 DWT Marine Tanker Main Engine

Mode	Main Engine/ Boiler Power (hp)[a]	Load Factor	Main Engine/Boiler Power (hp)[a]	Main Engine/Boiler Power (kw)
	Motorship	Motorship	Motorship	Motorship
Cruise to AQCZ	9269	0.94	8,724	6,508
AQCZ to Pilot Boarding Area	9269	0.51	4,746	3,540
Pilot Boarding to Berth	9269	0.01	74	55

Vessel parameters taken from POLA 2007 Pier 400 project

Load factor calculated based on propeller law of LF=(speed/max speed)^3

Power [kw] = Power [hp] x 0.746 [kw/hp]

Table 22
35,000 DWT Marine Tanker Main Engine Energy Output by Operating Mode (Scenario 1)

Mode	Main Engine/Boiler Energy (kw-hr)
	Motorship
Cruise to AQCZ	1,992
AQCZ to Pilot Boarding Area	18,911
Pilot Boarding to Berth	55

Energy Output [kw-hr] = Power output [kw] x Time [hr/mode]

Table 23
Maximum Daily Emissions for 35,000 DWT Marine Tanker (Scenario 1)

Mode/Engine	CO (lb/day)	VOC (lb/day)	NOx (lb/day)	SOx (lb/day)	PM10 (lb/day)	PM2.5 (lb/day)
Motorship						
Cruise to AQCZ/Main Engine	6.1	2.6	78.6	46.6	6.6	6.1
Cruise to AQCZ/Auxiliary Engine	0.4	0.1	5.3	4.4	0.5	0.5
Total Cruise to AQCZ	**6.5**	**2.8**	**83.9**	**51.0**	**7.1**	**6.6**
AQCZ to Pilot Boarding Area/Main Engine	58.4	25.0	746.3	441.9	62.5	57.5
AQCZ to Pilot Boarding Area/Auxiliary Engine	6.9	2.5	92.8	77.6	9.5	8.7
Total AQCZ to Pilot Boarding Area	**65.3**	**27.5**	**839.1**	**519.6**	**72.0**	**66.2**
Pilot Boarding to Berth/Main Engine	0.2	0.2	1.7	1.4	0.2	0.2
Pilot Boarding to Berth/Auxiliary Engine	1.8	0.6	23.9	20.0	2.4	2.2
Pilot Boarding to Berth/Auxiliary Boiler	1.1	0.1	2.7	11.0	0.3	0.3
Total Pilot Boarding to Berth	**3.1**	**0.9**	**28.3**	**32.4**	**2.9**	**2.7**
Hoteling/Auxiliary Engine	24.4	8.9	326.5	273.2	33.3	30.7
Hoteling/Auxiliary Boiler	19.4	1.4	46.3	191.0	4.9	4.5
Total Hoteling	**43.9**	**10.3**	**372.9**	**464.3**	**38.2**	**35.1**
Total Motorship	**118.8**	**41.5**	**1,324.2**	**1,067.2**	**120.2**	**110.6**

Main engine emissions [lb] = Emission factor [g/kw-hr] x Energy output [kw-hr] x Time [hr] / 453.6 [g/lb]
Auxiliary engine emissions [lb] = Emission factor [lb/hr] x Time [hr]
Auxiliary boiler emissions [lb] = Emission factor [lb/hr] x Time [hr]
Main boiler emissions (non-hoteling) [lb] = Emission factor [g/kw-hr] x Energy output [kw-hr] x Time [hr] / 453.6 [g/lb]
Main boiler emissions (hoteling) [lb] = Emission factor [lb/hr] x Time [hr]

Table 24
Summary of Maximum Daily Marine Vessel Emissions for 35,000 DWT Tanker (Scenario 1)

Source	CO (lb/day)	VOC (lb/day)	NOx (lb/day)	SOx (lb/day)	PM10 (lb/day)	PM2.5 (lb/day)
Tanker Transit						
Cruise to AQCZ	6.5	2.8	83.9	51.0	7.1	6.6
AQCZ to Pilot Boarding Area	65.3	27.5	839.1	519.6	72.0	66.2
Pilot Boarding to Berth	3.1	0.9	28.3	32.4	2.9	2.7
Hoteling and Product Loading/Unloading						
Boiler/Auxiliary Engine Combustion	43.9	10.3	372.9	464.3	38.2	35.1
Fugitive Vapor Emissions [a]	0.0	392.5	0.0	0.0	0.0	0.0
Tug Boat Assistance	35.5	0.8	6.3	1.6	4.8	4.4
Total Daily Emissions	**154.3**	**434.8**	**1,330.5**	**1,068.9**	**125.0**	**115.0**

[a] Calculated using a VOC emission factor of 2 lb/1,000 bbl and a product loading/unloading rate of 12,000 bph
Total product loading/unloading time is equal to hoteling time minus 1 hour for tie/untie, safety check, and other inspections.

Max Daily Scenario No. 2: Transit for 1 hour, hotel for 23 hours, load product for 22 hours
Vessel Size = 35,000 DWT
Product Volume = 264,000 bbl crude oil

Table 25
35,000 DWT Marine Tanker Times in Operating Modes within California Waters (Scenario 2)

Mode[a]	Distance (nm)	Motorship	
		Speed (kts)[b]	Time (hr/transit)
Cruise to AQCZ	0	14.7	0.0
AQCZ to Pilot Boarding Area	0	12	0.0
Pilot Boarding to Berth	3	3	1.0
Hoteling	N/A	N/A	23.0

AQCZ = Air Quality Compliance Zone, which is within 40 nm of Pt. Fermin

Vessel parameters taken from POLA 2007 Pier 400 Project EIR

Table 26
35,000 DWT Marine Tanker Main Engine Energy Output by Operating Mode (Scenario 2)

Mode	Main Engine/Boiler Energy (kw-hr)
	Motorship
Cruise to AQCZ	0
AQCZ to Pilot Boarding Area	0
Pilot Boarding to Berth	55

Energy Output [kw-hr] = Power output [kw] x Time [hr/mode]

Table 27
Maximum Daily Emissions for 35,000 DWT

Mode/Engine	CO (lb/day)	VOC (lb/day)	NOx (lb/day)	SOx (lb/day)	PM10 (lb/day)	PM2.5 (lb/day)
Motorship						
Cruise to AQCZ/Main Engine	0.0	0.0	0.0	0.0	0.0	0.0
Cruise to AQCZ/Auxiliary Engine	0.0	0.0	0.0	0.0	0.0	0.0
Total Cruise to AQCZ	**0.0**	**0.0**	**0.0**	**0.0**	**0.0**	**0.0**
AQCZ to Pilot Boarding Area/Main Engine	0.0	0.0	0.0	0.0	0.0	0.0
AQCZ to Pilot Boarding Area/Auxiliary Engine	0.0	0.0	0.0	0.0	0.0	0.0
Total AQCZ to Pilot Boarding Area	**0.0**	**0.0**	**0.0**	**0.0**	**0.0**	**0.0**
Pilot Boarding to Berth/Main Engine	0.2	0.2	1.7	1.4	0.2	0.2
Pilot Boarding to Berth/Auxiliary Engine	1.8	0.6	23.9	20.0	2.4	2.2
Pilot Boarding to Berth/Auxiliary Boiler	1.1	0.1	2.7	11.0	0.3	0.3
Total Pilot Boarding to Berth	**3.1**	**0.9**	**28.3**	**32.4**	**2.9**	**2.7**
Hoteling/Auxiliary Engine	32.4	11.8	432.8	362.2	44.2	40.6
Hoteling/Auxiliary Boiler	25.8	1.8	61.4	253.2	6.4	5.9
Total Hoteling	**58.1**	**13.6**	**494.2**	**615.4**	**50.6**	**46.6**
Total Motorship	**61.2**	**14.6**	**522.5**	**647.8**	**53.5**	**49.2**

Main engine emissions [lb] = Emission factor [g/kw-hr] x Energy output [kw-hr] x Time [hr] / 453.6 [g/lb]
Auxiliary engine emissions [lb] = Emission factor [lb/hr] x Time [hr]
Auxiliary boiler emissions [lb] = Emission factor [lb/hr] x Time [hr]
Main boiler emissions (non-hoteling) [lb] = Emission factor [g/kw-hr] x Energy output [kw-hr] x Time [hr] / 453.6 [g/lb]
Main boiler emissions (hoteling) [lb] = Emission factor [lb/hr] x Time [hr]

Table 28
Summary of Maximum Daily Marine Vessel Emissions for 35,000 DWT Tanker (Scenario 2)

Source	CO (lb/day)	VOC (lb/day)	NOx (lb/day)	SOx (lb/day)	PM10 (lb/day)	PM2.5 (lb/day)
Tanker Transit						
Cruise to AQCZ	0.0	0.0	0.0	0.0	0.0	0.0
AQCZ to Pilot Boarding Area	0.0	0.0	0.0	0.0	0.0	0.0
Pilot Boarding to Berth	3.1	0.9	28.3	32.4	2.9	2.7
Hoteling and Product Loading/Unloading						
Boiler/Auxiliary Engine Combustion	58.1	13.6	494.2	615.4	50.6	46.6
Fugitive Vapor Emissions [a]	0.0	528.0	0.0	0.0	0.0	0.0
Tug Boat Assistance	35.5	0.8	6.3	1.6	4.8	4.4
Total Daily Emissions	**96.7**	**543.3**	**528.9**	**649.4**	**58.3**	**53.6**

[a] Calculated using a VOC emission factor of 2 lb/1,000 bbl and a product loading/unloading rate of: 12,000 bph
Total product loading/unloading time is equal to hoteling time minus 2 hours for tie/untie, safety check, and other inspections.

Table 29
Marine Tanker Main Engine/Boiler Emission Factors

Mode	CO (g/kw-hr)	VOC (g/kw-hr)	NOx (g/kw-hr)	SOx (g/kw-hr)	PM10 (g/kw-hr)	PM2.5 (g/kw-hr) [c]
Motorships, HFO fuel at 2.5 % sulfur						
Cruise to AQCZ[b]	1.400	0.600	17.900	10.600	1.500	1.380
AQCZ[b] to Pilot Boarding Area	1.400	0.600	17.900	10.600	1.500	1.380
Pilot Boarding to Berth	1.400	1.800	14.300	11.700	1.500	1.380

From 2005 CARB Emissions Estimation Methodology for Ocean-Going Vessels

AQCZ = Air Quality Compliance Zone

For ships, the emission factor for PM2.5 is assumed to be 92% of the PM10 emission factor, according to the SCAQMD in *Methodology to Calculate Particulate Matter (PM) 2.5 and PM 2.5 Significance Thresholds, Appendix A: Updated CEIDARS Table with PM2.5 Fractions* (October 2006).

Table 30
Marine Tanker Auxiliary Power Emission Factors

Mode	CO	VOC	Nox	Sox	PM10	PM2.5
Motorships, Auxiliary Engine, HFO fuel at 2.5% sulfur						
Emission Factors, g/kw-hr	1.1	0.4	14.7	12.3	1.5	1.38
Motorships, Auxiliary Engine, lb/hr						
Cruise to AQCZ[b]	1.300	0.473	17.370	14.534	1.772	1.631
AQCZ[b] to Pilot Boarding Area	1.300	0.473	17.370	14.534	1.772	1.631
Pilot Boarding to Berth	1.787	0.650	23.884	19.985	2.437	2.242
Hoteling	1.408	0.512	18.818	15.746	1.920	1.767
Motorships, Auxiliary Boiler, lb/hr						
Pilot Boarding to Berth	1.120	0.080	2.670	11.009	0.280	0.258
Hoteling	1.120	0.080	2.670	11.009	0.280	0.258

From 2005 CARB Emissions Estimation Methodology for Ocean-Going Vessels

AQCZ = Air Quality Compliance Zone

For ships, the emission factor for PM2.5 is assumed to be 92% of the PM10 emission factor, according to the SCAQMD in *Methodology to Calculate Particulate Matter (PM) 2.5 and PM 2.5 Significance Thresholds, Appendix A: Updated CEIDARS Table with PM2.5 Fractions* (October 2006).

Assumes auxillary engine size of -->	3000	hp	as per POLA 2007 Pier 400 project
Auxillary engine load factors:			
Hoteling	0.26	as per CARB 2005	
Maneuvering	0.33	as per CARB 2005	
Transit	0.24	as per CARB 2005	

Auxillary boiler emissions based on 1999 Marine Vessel Emissions Inventory Update

Table 31
2006 Motor Vehicle Exhaust Emission Factors

Passenger Vehicles (pounds/mile)	
CO	0.01393
NOx	0.00149
VOC	0.00150
SOx	0.00001
PM10	0.00008
PM2.5	0.00007

Source: SCAQMD CEQA Analysis Guidance Handbook Web Site, http://www.aqmd.gov/ceqa/hdbk.html

Note: The emission factors were compiled by running the California Air Resources Board's EMFAC2002 (version 2.2) Burden Model. A weighted average of vehicle types was used to calculate emission factors for passenger vehicles, and emission factors for heavy heavy-duty diesel trucks were used for delivery trucks. All the emission factors account for the emissions from start, running and idling exhaust. In addition, the VOC emission factors take into account diurnal, hot soak, running and resting emissions, and PM10 emission factors take into account tire and brake wear. The PM2.5 emission factor is assumed to equal 92.8% of the PM10 emission factor for passenger vehicles, and 96.4% of the PM10 emission factor for delivery trucks, according to the SCAQMD in *Methodology to Calculate Particulate Matter (PM) 2.5 and PM 2.5 Significance Thresholds, Appendix A: Updated CEIDARS Table with PM2.5 Fractions* (October 2006).

Table 32
Motor Vehicle Entrained Paved Road PM10 Emission Factors

Vehicle Type	On-Road Average Vehicle Weight (tons)[a]	Road Type	Silt Loading (g/m^2)[b]	PM10 Emission Factor (lb/mi)[c]	PM2.5 Emission Factor (lb/mi)[d]
Autos	2.7	Collector	0.037	0.001	0.0002

[a] Conservatively high assumption for average vehicles. On-road average vehicle weight from ARB Emission Inventory Methodology 7.9, Entrained Paved Road Dust (1997)

[b] From ARB Emission Inventory Methodology 7.9, Entrained Paved Road Dust (1997)

[c] Emission factor [g/mi] = 7.26 $(\text{Silt Loading}/2)^{0.65}$ $(\text{Weight}/3)^{1.5}$, from ARB Emission Inventory Methodology 7.9, Entrained Paved Road Dust (1997)

[d] For paved road dust, the emission factor for PM2.5 is assumed to be 16.9% of the PM10 emission factor, according to the SCAQMD in *Methodology to Calculate Particulate Matter (PM) 2.5 and PM 2.5 Significance Thresholds, Appendix A: Updated CEIDARS Table with PM2.5 Fractions* (October 2006).

Table 33
Daily Emissions from Employee Commute Vehicles

Vehicles	Quantity	Round-trip Distance (miles)	CO (lb/day)	VOC (lb/day)	NO_X (lb/day)	SO_X (lb/day)	PM10 (lb/day)	PM2.5 (lb/day)
Autos	9	50	6.27	0.67	0.67	0.004	0.50	0.11

Table 34
Identification of Scenarios with Maximum Daily Emissions

Source	CO (lb/day)	VOC (lb/day)	NOx (lb/day)	SOx (lb/day)	PM10 (lb/day)	PM2.5 (lb/day)
Tanker Transit						
150,000 DWT Tanker	Scenario 1	Scenario 2	Scenario 1	Scenario 1	Scenario 1	Scenario 1
35,000 DWT Tanker	Scenario 1	Scenario 2	Scenario 1	Scenario 1	Scenario 1	Scenario 1

Table 35
Summary of Maximum Daily Marine Vessel Emissions by Berth

Source	CO (lb/day)	VOC (lb/day)	NOx (lb/day)	SOx (lb/day)	PM10 (lb/day)	PM2.5 (lb/day)
150,000 DWT Tanker (Berth 4)						
Tanker Transit and Maneuvering	101	1	1,284	800	110	101
Hoteling/Product Transfer Engine Combustion	44	14	373	464	38	35
Product Transfer Vapor Emissions	0	2,200	0	0	0	0
Tug Boat Assistance	36	1	6	2	5	4
Subtotal - 150,000 DWT Tanker	**180**	**2,215**	**1,663**	**1,266**	**153**	**141**
35,000 DWT Tanker (Berth 3)						
Tanker Transit and Maneuvering	75	1	951	603	82	75
Hoteling/Product Transfer Engine Combustion	44	14	373	464	38	35
Product Transfer Vapor Emissions	0	528	0	0	0	0
Tug Boat Assistance	36	1	6	2	5	4
Subtotal - 35,000 DWT Tanker	**154**	**543**	**1,331**	**1,069**	**125**	**115**
Total Daily Emissions	**335**	**2,759**	**2,994**	**2,335**	**278**	**256**

Table 36
Summary of Maximum Daily Marine Vessel Emissions from Both Berths

Source	CO (lb/day)	VOC (lb/day)	NOx (lb/day)	SOx (lb/day)	PM10 (lb/day)	PM2.5 (lb/day)
Tanker Transit and Maneuvering	176	2	2,235	1,403	192	177
Hoteling/Product Transfer Engine Combustion	88	27	746	929	76	70
Product Transfer Vapor Emissions	0	2,728	0	0	0	0
Tug Boat Assistance	71	2	13	3	10	9
Total Daily Emissions	**335**	**2,759**	**2,994**	**2,335**	**278**	**256**

Table 37
Summary of Maximum Daily Marine Terminal Emissions

Source	CO (lb/day)	VOC (lb/day)	NOx (lb/day)	SOx (lb/day)	PM10 (lb/day)	PM2.5 (lb/day)
Marine Vessel-Related Activities	335	2,759	2,994	2,335	278	256
Stationary Sources	0	249	0	0	0	0
Mobile Sources	6.3	0.7	0.7	0.0	0.5	0.1
Total Daily Emissions	**341**	**3,008**	**2,994**	**2,335**	**278**	**256**

Table 38
Summary of Maximum Daily Marine Vessel Emissions from Both Berths - Alternatives with VLCC

Alterantive	CO (lb/day)	VOC (lb/day)	NOx (lb/day)	SOx (lb/day)	PM10 (lb/day)	PM2.5 (lb/day)
Tanker Transit and Maneuvering	210	2	2,676	1,665	229	211
Hoteling/Product Transfer Engine Combustion	88	27	746	929	76	70
Product Transfer Vapor Emissions	0	2,728	0	0	0	0
Tug Boat Assistance	71	2	13	3	10	9
Total	369	2,759	3,435	2,597	315	290
Increase in emissions with Alt	35	0	441	261	37	34

Table 39
Summary of Maximum Daily Marine Terminal Emissions - Alternatives with VLCC

Source	CO (lb/day)	VOC (lb/day)	NOx (lb/day)	SOx (lb/day)	PM10 (lb/day)	PM2.5 (lb/day)
Marine Vessel-Related Activities	369	2,759	3,435	2,596	315	290
Stationary Sources	0	249	0	0	0	0
Mobile Sources	6.3	0.7	0.7	0.0	0.5	0.1
Total Daily Emissions	**375**	**3,009**	**3,436**	**2,596**	**315**	**290**

Max Daily Scenario No. 1: Transit for 6.6 hours, hotel for 17.4 hours, unload product for 16.4 hours.
Vessel Size = 300,000+ DWT (VLCC)
Product Volume = 1.1 Million bbl crude oil

Table 40
300,000 DWT Marine Tanker Times in Operating Modes within California Waters (Scenario 1)

Mode	Distance (nm)	Motorship		
		Speed (kts)	Time (hr/transit)	Max Vessel Speed, (kts)
Cruise to AQCZ within SCAB	4.5	15.5	0.3	16.9
AQCZ to Pilot Boarding Area	64.1	12	5.3	16.9
Pilot Boarding to Berth	3	3	1.0	16.9
Hoteling	N/A	N/A	17.4	N/A

AQCZ = Air Quality Compliance Zone, which is within 40 nm of Pt. Fermin
Vessel parameters taken from POLA 2007 Pier 400 Project EIR

Table 41
300,000 DWT Marine Tanker Main Engine Power Output by Operating Mode

Mode	Main Engine/ Boiler Power (hp)	Load Factor	Main Engine/Boiler Power (hp)	Main Engine/Boiler Power (kw)
	Motorship	Motorship	Motorship	Motorship
Cruise to AQCZ	25400	0.77	19,596	14,619
AQCZ to Pilot Boarding Area	25400	0.36	9,093	6,784
Pilot Boarding to Berth	25400	0.01	142	106

Vessel parameters taken from POLA 2007 Pier 400 project
Power [kw] = Power [hp] x 0.746 [kw/hp]
Load factor calculated based on propeller law of LF=(speed/max speed)^3

Table 42
300,000 DWT Marine Tanker Main Engine Energy Output by Operating Mode (Scenario 1)

Mode	Main Engine/Boiler Energy (kw-hr)
	Motorship
Cruise to AQCZ	4,244
AQCZ to Pilot Boarding Area	36,235
Pilot Boarding to Berth	106

Energy Output [kw-hr] = Power output [kw] x Time [hr/mode]

Table 43
Maximum Daily Emissions for 300,000 DWT Marine Tanker (Scenario 1)

Mode/Engine	CO (lb/day)	VOC (lb/day)	NOx (lb/day)	SOx (lb/day)	PM10 (lb/day)	PM2.5 (lb/day)
Motorship						
Cruise to AQCZ/Main Engine	13.1	5.6	167.5	99.2	14.0	12.9
Cruise to AQCZ/Auxiliary Engine	0.4	0.1	5.0	4.2	0.5	0.5
Total Cruise to AQCZ	**13.5**	**5.8**	**172.5**	**103.4**	**14.5**	**13.4**
AQCZ to Pilot Boarding Area/Main Engine	111.8	47.9	1,429.9	846.8	119.8	110.2
AQCZ to Pilot Boarding Area/Auxiliary Engine	6.9	2.5	92.8	77.6	9.5	8.7
Total AQCZ to Pilot Boarding Area	**118.8**	**50.5**	**1,522.7**	**924.4**	**129.3**	**119.0**
Pilot Boarding to Berth/Main Engine	0.3	0.4	3.3	2.7	0.4	0.3
Pilot Boarding to Berth/Auxiliary Engine	1.8	0.6	23.9	20.0	2.4	2.2
Pilot Boarding to Berth/Auxiliary Boiler	1.1	0.1	2.7	11.0	0.3	0.3
Total Pilot Boarding to Berth	**3.2**	**1.2**	**29.9**	**33.7**	**3.1**	**2.8**
Hoteling/Auxiliary Engine	24.5	8.9	326.8	273.5	33.4	30.7
Hoteling/Auxiliary Boiler	19.5	1.4	46.4	191.2	4.9	4.5
Total Hoteling	**43.9**	**10.3**	**373.2**	**464.7**	**38.2**	**35.2**
Total Motorship	**179.4**	**67.6**	**2,098.3**	**1,526.2**	**185.1**	**170.3**

Main engine emissions [lb] = Emission factor [g/kw-hr] x Energy output [kw-hr] x Time [hr] / 453.6 [g/lb]
Auxiliary engine emissions [lb] = Emission factor [lb/hr] x Time [hr]
Auxiliary boiler emissions [lb] = Emission factor [lb/hr] x Time [hr]
Main boiler emissions (non-hoteling) [lb] = Emission factor [g/kw-hr] x Energy output [kw-hr] x Time [hr] / 453.6 [g/lb]
Main boiler emissions (hoteling) [lb] = Emission factor [lb/hr] x Time [hr]

Table 44
Summary of Maximum Daily Marine Vessel Emissions for 300,000 DWT Tanker (Scenario 1)

Source	CO (lb/day)	VOC (lb/day)	NOx (lb/day)	SOx (lb/day)	PM10 (lb/day)	PM2.5 (lb/day)
Tanker Transit						
Cruise to AQCZ	13.5	5.8	172.5	103.4	14.5	13.4
AQCZ to Pilot Boarding Area	118.8	50.5	1,522.7	924.4	129.3	119.0
Pilot Boarding to Berth	3.2	1.2	29.9	33.7	3.1	2.8
Hoteling and Product Loading/Unloading						
Boiler/Auxiliary Engine Combustion	43.9	10.3	373.2	464.7	38.2	35.2
Fugitive Vapor Emissions [a]	0.0	1,636.8	0.0	0.0	0.0	0.0
Tug Boat Assistance	35.5	0.8	6.3	1.6	4.8	4.4
Total Daily Emissions	**214.9**	**1,705.2**	**2,104.7**	**1,527.8**	**189.9**	**174.7**

[a] Calculated using a VOC emission factor of 2 lb/1,000 bbl and a product loading/unloading rate of 50,000 bph
Total product loading/unloading time is equal to hoteling time minus 1 hour for tie/untie, safety check, and other inspections.

Max Daily Scenario No. 2: Maneuvering for 1 hours, hotel for 23 hours, unload product for 22 hours.
Vessel Size = 300,000+ DWT (VLCC)
Product Volume = 1.1 Million bbl crude oil

Table 45
300,000 DWT Marine Tanker Times in Operating Modes within California Waters (Scenario 2)

Mode	Distance (nm)	Motorship		
		Speed (kts)	Time (hr/transit)	Max Vessel Speed, (kts)
Cruise to AQCZ within SCAB	0	15.5	0.0	16.9
AQCZ to Pilot Boarding Area	0	12	0.0	16.9
Pilot Boarding to Berth	3	3	1.0	16.9
Hoteling	N/A	N/A	23.0	N/A

AQCZ = Air Quality Compliance Zone, which is within 40 nm of Pt. Fermin
Vessel parameters taken from POLA 2007 Pier 400 Project EIR

Table 46
300,000 DWT Marine Tanker Main Engine Power Output by Operating Mode

Mode	Main Engine/ Boiler Power (hp)	Load Factor	Main Engine/Boiler Power (hp)	Main Engine/Boiler Power (kw)
	Motorship	Motorship	Motorship	Motorship
Cruise to AQCZ	25400	0.77	19,596	14,619
AQCZ to Pilot Boarding Area	25400	0.36	9,093	6,784
Pilot Boarding to Berth	25400	0.01	142	106

Vessel parameters taken from POLA 2007 Pier 400 project
Power [kw] = Power [hp] x 0.746 [kw/hp]
Load factor calculated based on propeller law of LF=(speed/max speed)^3

Table 47
300,000 DWT Marine Tanker Main Engine Energy Output by Operating Mode (Scenario 2)

Mode	Main Engine/Boiler Energy (kw-hr)
	Motorship
Cruise to AQCZ	0
AQCZ to Pilot Boarding Area	0
Pilot Boarding to Berth	106

Energy Output [kw-hr] = Power output [kw] x Time [hr/mode]

Table 48
Maximum Daily Emissions for 300,000 DWT Marine Tanker (Scenario 2)

Mode/Engine	CO (lb/day)	VOC (lb/day)	NOx (lb/day)	SOx (lb/day)	PM10 (lb/day)	PM2.5 (lb/day)
Motorship						
Cruise to AQCZ/Main Engine	0.0	0.0	0.0	0.0	0.0	0.0
Cruise to AQCZ/Auxiliary Engine	0.0	0.0	0.0	0.0	0.0	0.0
Total Cruise to AQCZ	**0.0**	**0.0**	**0.0**	**0.0**	**0.0**	**0.0**
AQCZ to Pilot Boarding Area/Main Engine	0.0	0.0	0.0	0.0	0.0	0.0
AQCZ to Pilot Boarding Area/Auxiliary Engine	0.0	0.0	0.0	0.0	0.0	0.0
Total AQCZ to Pilot Boarding Area	**0.0**	**0.0**	**0.0**	**0.0**	**0.0**	**0.0**
Pilot Boarding to Berth/Main Engine	0.3	0.4	3.3	2.7	0.4	0.3
Pilot Boarding to Berth/Auxiliary Engine	1.8	0.6	23.9	20.0	2.4	2.2
Pilot Boarding to Berth/Auxiliary Boiler	1.1	0.1	2.7	11.0	0.3	0.3
Total Pilot Boarding to Berth	**3.2**	**1.2**	**29.9**	**33.7**	**3.1**	**2.8**
Hoteling/Auxiliary Engine	32.4	11.8	432.8	362.2	44.2	40.6
Hoteling/Auxiliary Boiler	25.8	1.8	61.4	253.2	6.4	5.9
Total Hoteling	**58.1**	**13.6**	**494.2**	**615.4**	**50.6**	**46.6**
Total Motorship	**61.4**	**14.8**	**524.1**	**649.1**	**53.7**	**49.4**

Main engine emissions [lb] = Emission factor [g/kw-hr] x Energy output [kw-hr] x Time [hr] / 453.6 [g/lb]
Auxiliary engine emissions [lb] = Emission factor [lb/hr] x Time [hr]
Auxiliary boiler emissions [lb] = Emission factor [lb/hr] x Time [hr]
Main boiler emissions (non-hoteling) [lb] = Emission factor [g/kw-hr] x Energy output [kw-hr] x Time [hr] / 453.6 [g/lb]
Main boiler emissions (hoteling) [lb] = Emission factor [lb/hr] x Time [hr]

Table 49
Summary of Maximum Daily Marine Vessel Emissions for 300,000 DWT Tanker (Scenario 2)

Source	CO (lb/day)	VOC (lb/day)	NOx (lb/day)	SOx (lb/day)	PM10 (lb/day)	PM2.5 (lb/day)
Tanker Transit						
Cruise to AQCZ	0.0	0.0	0.0	0.0	0.0	0.0
AQCZ to Pilot Boarding Area	0.0	0.0	0.0	0.0	0.0	0.0
Pilot Boarding to Berth	3.2	1.2	29.9	33.7	3.1	2.8
Hoteling and Product Loading/Unloading						
Boiler/Auxiliary Engine Combustion	58.1	13.6	494.2	615.4	50.6	46.6
Fugitive Vapor Emissions [a]	0.0	2,200.0	0.0	0.0	0.0	0.0
Tug Boat Assistance	35.5	0.8	6.3	1.6	4.8	4.4
Total Daily Emissions	**96.9**	**2,215.6**	**530.5**	**650.7**	**58.5**	**53.8**

[a] Calculated using a VOC emission factor of 2 lb/1,000 bbl and a product loading/unloading rate of 50,000 bph
Total product loading/unloading time is equal to hoteling time minus 1 hour for tie/untie, safety check, and other inspections.

Table 50 Toxic Impacts

DIESEL PM EMISSIONS	
From Heavy Crude Project EIR	
Onshore Impact, ug/m3	5.30E-03
Number of tankers	15
Unit risk factor	3.00E-04
Risk level, per million	1.6
Calculated for Current Operations	
based on Heavy Crude Project EIR	
Onshore Impact, ug/m3	5.30E-03
Number of tankers	347
Unit risk factor	3.00E-04
Risk level, per million	36.8
Calculated for Proposed Operations	
based on Heavy Crude Project EIR	
Onshore Impact, ug/m3	5.30E-03
Number of tankers	487
Unit risk factor	3.00E-04
Risk level	51.6
Incremental increase	14.8
Low sulfur fuel reduction percentage	64.0
Mitigated future cancer risk	18.6
DPM Acute Risk Impacts	
Acute impacts risk factor, ug/m3	5.0
Acute HI future	0.03

n-hexane estimated impact onshore based on Chevron DPM modeling

Heavy Crude project DPM	5.30E-03	Onshore Impact, ug/m3, for 15 additional tankers
Heavy crude project emissions	4143	lb/yr DPM, from heavy crude project appendix B3, additional 9 marine tankers
n-hexane, lb/yr	1314	lb/yr from speciation above
Onshore impact, n-hexane	1.68E-03	ug/m3
Chronic inhalation factor	7000	ug/m3, from consolidated table OEHHA 4/2005
HI	2.40E-07	

ISC modeling runs for n-hexane and DPM

n-Hexane Emission rate, lb/yr	1314	
Source area, m2	2500	
ISC emission rate, g/m2-sec	7.6E-06	
ISC results, ug/m3 max	1.0E-02	ratioed from DPM results below
Chronic inhalation factor	7000	ug/m3, from consolidated table OEHHA 4/2005
HI	1.45E-06	
Hoteling PM emissions, lb/hr	1.92	for auxillary engines from motorships
Annual hoteling hours	7981	assumes 23 hrs per call, 347 calls per year
DPM Emission rate, lb/yr	15324	
Source area, m2	2500	
ISC emission rate, g/m2-sec	8.8E-05	
ISC results, ug/m3 max	0.11808	ISC modeling run
Unit risk factor	3.00E-04	
Cancer risk, per million	35.4	
Future 2040 vessel calls	487	
future annual hours hoteling	11201	
Future DPM emissions, lb/yr	21505.92	
Future cancer risk	49.7	
Low sulfur fuel reduction percentage	64.0	
Mitigated future cancer risk	17.9	

NO2 emissions and Localized impacts, year 2025

Hoteling NOx emissions, lb/hr	29.42	for auxillary engines from motorships (worstcase)
Annual hoteling hours	7981	assumes 17.3 hrs per call, 347 calls per year
NOx Annual Emission rate, lb/yr	234801	
ISC modeled impact, ug/m3	1.81	ratioed from DPM annual ISC run
NO2 ug/m3 per ppm	1882	based on SCAMD LST guidance
NO2 level, ppm	0.0010	ppm

Table 51
Marine Tanker Main Engine, Aux Engine and Aux Boiler GHG Emissions - Current Operations

	Mode	Activities per year	Distance, nm	Max Speed (knts)	Speed (knts)	Time (hr/activity)	Engine MCR kW	Load Factor	N_2O (g/kw-hr)	CO_2 (g/kw-hr)	CH_4 (g/kw-hr)	N_2O (tons/yr)	CO_2 (tons/yr)	CH_4 (tons/yr)
VESSELS TO/FROM THE SOUTH														
VLCC	Cruise from Origin to SCAB - main engine	56	11500	16.9	15.5	740.0	25,400	0.78	0.031	620	0.012	28.012	560,244	10.843
	Cruise from Origin to SCAB - aux engine	56	11500	-	15.5	740.0	3,000	0.25	0.0279	683	0.008	0.970	23,752	0.278
	Cruise from Origin to SCAB - aux boiler	56	11500	-	15.5	740.0	3,000	0.00	0.08	970	0.002	0.000	0	0.000
	SCAB to Pilot Boarding Area - main engine	56	64.1	16.9	12	5.3	25,400	0.36	0.031	620	0.012	0.093	1,862	0.036
	SCAB to Pilot Boarding Area - aux engine	56	64.1	-	12	5.3	3,000	0.25	0.0279	683	0.008	0.007	171	0.002
	SCAB to Pilot Boarding Area - aux boiler	56	64.1	-	12	5.3	3,000	0.00	0.08	970	0.002	0.000	0	0.000
	Pilot Boarding to Berth main engine: maneuvering	56	3	16.9	3	1.0	25,400	0.01	0.031	620	0.012	0.000	5	0.000
	Pilot Boarding to Berth aux engine	56	3	-	3	1.0	3,000	0.35	0.0279	683	0.008	0.002	44	0.001
	Pilot Boarding to Berth aux boiler	56	3	-	3	1.0	3,000	0.12	0.08	970	0.002	0.002	22	0.000
	Berth main engine: hoteling	28	-	-	-	40.0	25,400	0.02	0.144	620	0.260	0.090	389	0.163
	Berth aux engine: hoteling	28	-	-	-	40.0	3,000	0.27	0.0279	683	0.008	0.028	695	0.008
	Berth aux boiler: hoteling	28	-	-	-	40.0	3,000	1.00	0.08	970	0.002	0.297	3,599	0.007
Large Vessels from Lightering Suezmax	Cruise from Origin to SCAB - main engine	210	20	15	14.7	1.4	13,000	0.94	0.031	620	0.012	0.119	2,387	0.046
	Cruise from Origin to SCAB - aux engine	210	20	-	14.7	1.4	3,000	0.25	0.0279	683	0.008	0.007	163	0.002
	Cruise from Origin to SCAB - aux boiler	210	20	-	14.7	1.4	3,000	0.00	0.08	970	0.002	0.000	0	0.000
	SCAB to Pilot Boarding Area - main engine	210	68.6	15	12	5.7	13,000	0.51	0.031	620	0.012	0.273	5,455	0.106
	SCAB to Pilot Boarding Area - aux engine	210	68.6	-	12	5.7	3,000	0.25	0.0279	683	0.008	0.028	686	0.008
	SCAB to Pilot Boarding Area - aux boiler	210	68.6	-	12	5.7	3,000	0.00	0.08	970	0.002	0.000	0	0.000
	Pilot Boarding to Berth main engine: maneuvering	210	3	15	3	1.0	13,000	0.01	0.031	620	0.012	0.001	15	0.000
	Pilot Boarding to Berth aux engine	210	3	-	3	1.0	3,000	0.35	0.0279	683	0.008	0.007	165	0.002
	Pilot Boarding to Berth aux boiler	210	3	-	3	1.0	3,000	0.12	0.08	970	0.002	0.007	83	0.000
	Berth main engine: hoteling	105	-	-	-	10.0	13,000	0.02	0.144	620	0.260	0.043	186	0.078
	Berth aux engine: hoteling	105	-	-	-	10.0	3,000	0.27	0.0279	683	0.008	0.027	650	0.008
	Berth aux boiler: hoteling	105	-	-	-	10.0	3,000	1.00	0.08	970	0.002	0.278	3,365	0.007
Large Vessels from South Amer, Afr. Panamax, Aframax, Suezmax	Cruise from Origin to SCAB - main engine	207	3500	15	14.7	238.1	13,000	0.94	0.031	620	0.012	20.584	411,684	7.968
	Cruise from Origin to SCAB - aux engine	207	3500	-	14.7	238.1	3,000	0.25	0.0279	683	0.008	1.151	28,170	0.330
	Cruise from Origin to SCAB - aux boiler	207	3500	-	14.7	238.1	3,000	0.00	0.08	970	0.002	0.000	0	0.000
	SCAB to Pilot Boarding Area - main engine	207	68.6	15	12	5.7	13,000	0.51	0.031	620	0.012	0.269	5,377	0.104
	SCAB to Pilot Boarding Area - aux engine	207	68.6	-	12	5.7	3,000	0.25	0.0279	683	0.008	0.028	676	0.008
	SCAB to Pilot Boarding Area - aux boiler	207	68.6	-	12	5.7	3,000	0.00	0.08	970	0.002	0.000	0	0.000
	Pilot Boarding to Berth main engine: maneuvering	207	3	15	3	1.0	13,000	0.01	0.031	620	0.012	0.001	15	0.000
	Pilot Boarding to Berth aux engine	207	3	-	3	1.0	3,000	0.35	0.0279	683	0.008	0.007	163	0.002
	Pilot Boarding to Berth aux boiler	207	3	-	3	1.0	3,000	0.12	0.08	970	0.002	0.007	82	0.000
	Berth main engine: hoteling	104	-	-	-	10.0	13,000	0.02	0.144	620	0.260	0.043	184	0.077
	Berth aux engine: hoteling	104	-	-	-	10.0	3,000	0.27	0.0279	683	0.008	0.026	641	0.008
	Berth aux boiler: hoteling	104	-	-	-	10.0	3,000	1.00	0.08	970	0.002	0.274	3,316	0.007
Medium Vessels sub-Panamax,	Cruise from Origin to SCAB - main engine	7	3500	15	14.7	238.1	9,269	0.94	0.031	620	0.012	0.529	10,584	0.205
	Cruise from Origin to SCAB - aux engine	7	3500	-	14.7	238.1	3,000	0.25	0.0279	683	0.008	0.041	1,016	0.012
	Cruise from Origin to SCAB - aux boiler	7	3500	-	14.7	238.1	3,000	0.00	0.08	970	0.002	0.000	0	0.000
	SCAB to Pilot Boarding Area - main engine	7	68.6	15	12	5.7	9,269	0.51	0.031	620	0.012	0.007	138	0.003
	SCAB to Pilot Boarding Area - aux engine	7	68.6	-	12	5.7	3,000	0.25	0.0279	683	0.008	0.001	24	0.000
	SCAB to Pilot Boarding Area - aux boiler	7	68.6	-	12	5.7	3,000	0.00	0.08	970	0.002	0.000	0	0.000
	Pilot Boarding to Berth main engine: maneuvering	7	3	15	3	1.0	9,269	0.01	0.031	620	0.012	0.000	0	0.000
	Pilot Boarding to Berth aux engine	7	3	-	3	1.0	3,000	0.35	0.0279	683	0.008	0.000	6	0.000
	Pilot Boarding to Berth aux boiler	7	3	-	3	1.0	3,000	0.12	0.08	970	0.002	0.000	3	0.000
	Berth main engine: hoteling	4	-	-	-	23.8	9,269	0.02	0.144	620	0.260	0.003	11	0.005
	Berth aux engine: hoteling	4	-	-	-	23.8	3,000	0.27	0.0279	683	0.008	0.002	55	0.001
	Berth aux boiler: hoteling	4	-	-	-	23.8	3,000	1.00	0.08	970	0.002	0.023	285	0.001
Small Vessels Barges	Cruise from Origin to SCAB - main engine	131	42	14	14	3.0	7,673	1.00	0.031	620	0.012	0.103	2,064	0.040
	Cruise from Origin to SCAB - aux engine	131	42	-	14	3.0	190	0.17	0.0279	683	0.008	0.000	10	0.000
	Cruise from Origin to SCAB - aux boiler	131	42	-	14	3.0	0	0.00	0.08	970	0.002	0.000	0	0.000
	SCAB to Pilot Boarding Area - main engine	131	68.6	14	12	5.7	7,673	0.63	0.031	620	0.012	0.124	2,477	0.048
	SCAB to Pilot Boarding Area - aux engine	131	68.6	-	12	5.7	190	0.17	0.0279	683	0.008	0.001	18	0.000
	SCAB to Pilot Boarding Area - aux boiler	131	68.6	-	12	5.7	0	0.00	0.08	970	0.002	0.000	0	0.000
	Pilot Boarding to Berth main engine: maneuvering	131	3	14	3	1.0	7,673	0.01	0.031	620	0.012	0.000	7	0.000
	Pilot Boarding to Berth aux engine	131	3	-	3	1.0	190	0.45	0.0279	683	0.008	0.000	8	0.000
	Pilot Boarding to Berth aux boiler	131	3	-	3	1.0	0	0.00	0.08	970	0.002	0.000	0	0.000
	Berth main engine: hoteling	66	-	-	-	6.0	7,673	0	0.144	620	0.260	0.000	0	0.000
	Berth aux engine: hoteling	66	-	-	-	6.0	190	0.22	0.0279	683	0.008	0.001	12	0.000
	Berth aux boiler: hoteling	66	-	-	-	6.0	0	0.00	0.08	970	0.002	0.000	0	0.000

Table 51 (cont.)
Marine Tanker Main Engine, Aux Engine and Aux Boiler GHG Emissions - Current operations

	Mode	Activities per year	Distance, nm	Max Speed (knts)	Speed (knts)	Time (hr/activity)	Engine MCR kW	Load Factor	N_2O (g/kw-hr)	CO_2 (g/kw-hr)	CH_4 (g/kw-hr)	N_2O (tons/yr)	CO_2 (tons/yr)	CH_4 (tons/yr)
VESSELS TO/FROM THE WEST														
VLCC	Cruise from Origin to SCAB - main engine	0	0	16.9	15.5	0.0	25,400	0.78	0.031	620	0.012	0.000	0	0.000
	Cruise from Origin to SCAB - aux engine	0	0	-	15.5	0.0	3,000	0.25	0.0279	683	0.008	0.000	0	0.000
	Cruise from Origin to SCAB - aux boiler	0	0	-	15.5	0.0	3,000	0.00	0.08	970	0.002	0.000	0	0.000
	SCAB to Pilot Boarding Area - main engine	0	27.5	16.9	12	2.3	25,400	0.36	0.031	620	0.012	0.000	0	0.000
	SCAB to Pilot Boarding Area - aux engine	0	27.5	-	12	2.3	3,000	0.25	0.0279	683	0.008	0.000	0	0.000
	SCAB to Pilot Boarding Area - aux boiler	0	27.5	-	12	2.3	3,000	0.00	0.08	970	0.002	0.000	0	0.000
	Pilot Boarding to Berth main engine: maneuvering	0	3	16.9	3	1.0	25,400	0.01	0.031	620	0.012	0.000	0	0.000
	Pilot Boarding to Berth aux engine	0	3	-	3	1.0	3,000	0.35	0.0279	683	0.008	0.000	0	0.000
	Pilot Boarding to Berth aux boiler	0	3	-	3	1.0	3,000	0.12	0.08	970	0.002	0.000	0	0.000
	Berth main engine: hoteling	0	-	-	-	40.0	25,400	0.02	0.144	620	0.260	0.000	0	0.000
	Berth aux engine: hoteling	0	-	-	-	40.0	3,000	0.27	0.0279	683	0.008	0.000	0	0.000
	Berth aux boiler: hoteling	0	-	-	-	40.0	3,000	1.00	0.08	970	0.002	0.000	0	0.000
Large Vessels	Cruise from Origin to SCAB - main engine	2	2000	15	14.7	136.1	13,000	0.94	0.031	620	0.012	0.096	1,925	0.037
Panamax,	Cruise from Origin to SCAB - aux engine	2	2000	-	14.7	136.1	3,000	0.25	0.0279	683	0.008	0.005	132	0.002
Aframax,	Cruise from Origin to SCAB - aux boiler	2	2000	-	14.7	136.1	3,000	0.00	0.08	970	0.002	0.000	0	0.000
Suezmax	SCAB to Pilot Boarding Area - main engine	2	27.5	15	12	2.3	13,000	0.51	0.031	620	0.012	0.001	18	0.000
	SCAB to Pilot Boarding Area - aux engine	2	27.5	-	12	2.3	3,000	0.25	0.0279	683	0.008	0.000	2	0.000
	SCAB to Pilot Boarding Area - aux boiler	2	27.5	-	12	2.3	3,000	0.00	0.08	970	0.002	0.000	0	0.000
	Pilot Boarding to Berth main engine: maneuvering	2	3	15	3	1.0	13,000	0.01	0.031	620	0.012	0.000	0	0.000
	Pilot Boarding to Berth aux engine	2	3	-	3	1.0	3,000	0.35	0.0279	683	0.008	0.000	1	0.000
	Pilot Boarding to Berth aux boiler	2	3	-	3	1.0	3,000	0.12	0.08	970	0.002	0.000	1	0.000
	Berth main engine: hoteling	1	-	-	-	10.0	13,000	0.02	0.144	620	0.260	0.000	2	0.001
	Berth aux engine: hoteling	1	-	-	-	10.0	3,000	0.27	0.0279	683	0.008	0.000	5	0.000
	Berth aux boiler: hoteling	1	-	-	-	10.0	3,000	1.00	0.08	970	0.002	0.002	27	0.000
Medium Vessels	Cruise from Origin to SCAB - main engine	0	0	15	14.7	0.0	9,269	0.94	0.031	620	0.012	0.000	0	0.000
sub-Panamax,	Cruise from Origin to SCAB - aux engine	0	0	-	14.7	0.0	3,000	0.25	0.0279	683	0.008	0.000	0	0.000
	Cruise from Origin to SCAB - aux boiler	0	0	-	14.7	0.0	3,000	0.00	0.08	970	0.002	0.000	0	0.000
	SCAB to Pilot Boarding Area - main engine	0	27.5	15	12	2.3	9,269	0.51	0.031	620	0.012	0.000	0	0.000
	SCAB to Pilot Boarding Area - aux engine	0	27.5	-	12	2.3	3,000	0.25	0.0279	683	0.008	0.000	0	0.000
	SCAB to Pilot Boarding Area - aux boiler	0	27.5	-	12	2.3	3,000	0.00	0.08	970	0.002	0.000	0	0.000
	Pilot Boarding to Berth main engine: maneuvering	0	3	15	3	1.0	9,269	0.01	0.031	620	0.012	0.000	0	0.000
	Pilot Boarding to Berth aux engine	0	3	-	3	1.0	3,000	0.35	0.0279	683	0.008	0.000	0	0.000
	Pilot Boarding to Berth aux boiler	0	3	-	3	1.0	3,000	0.12	0.08	970	0.002	0.000	0	0.000
	Berth main engine: hoteling	0	-	-	-	23.8	9,269	0.02	0.144	620	0.260	0.000	0	0.000
	Berth aux engine: hoteling	0	-	-	-	23.8	3,000	0.27	0.0279	683	0.008	0.000	0	0.000
	Berth aux boiler: hoteling	0	-	-	-	23.8	3,000	1.00	0.08	970	0.002	0.000	0	0.000
Small Vessels	Cruise from Origin to SCAB - main engine	0	0	14	14	0.0	7,673	1.00	0.031	620	0.012	0.000	0	0.000
Barges	Cruise from Origin to SCAB - aux engine	0	0	-	14	0.0	190	0.17	0.0279	683	0.008	0.000	0	0.000
	Cruise from Origin to SCAB - aux boiler	0	0	-	14	0.0	0	0.00	0.08	970	0.002	0.000	0	0.000
	SCAB to Pilot Boarding Area - main engine	0	27.5	14	12	2.3	7,673	0.63	0.031	620	0.012	0.000	0	0.000
	SCAB to Pilot Boarding Area - aux engine	0	27.5	-	12	2.3	190	0.17	0.0279	683	0.008	0.000	0	0.000
	SCAB to Pilot Boarding Area - aux boiler	0	27.5	-	12	2.3	0	0.00	0.08	970	0.002	0.000	0	0.000
	Pilot Boarding to Berth main engine: maneuvering	0	3	14	3	1.0	7,673	0.01	0.031	620	0.012	0.000	0	0.000
	Pilot Boarding to Berth aux engine	0	3	-	3	1.0	190	0.45	0.0279	683	0.008	0.000	0	0.000
	Pilot Boarding to Berth aux boiler	0	3	-	3	1.0	0	0.00	0.08	970	0.002	0.000	0	0.000
	Berth main engine: hoteling	0	-	-	-	6.0	7,673	0	0.144	620	0.260	0.000	0	0.000
	Berth aux engine: hoteling	0	-	-	-	6.0	190	0.22	0.0279	683	0.008	0.000	0	0.000
	Berth aux boiler: hoteling	0	-	-	-	6.0	0	0.00	0.08	970	0.002	0.000	0	0.000

Table 51 (cont.)
Marine Tanker Main Engine, Aux Engine and Aux Boiler GHG Emissions - Current operations

	Mode	Activities per year	Distance, nm	Max Speed (knts)	Speed (knts)	Time (hr/activity)	Engine MCR kW	Load Factor	N_2O (g/kw-hr)	CO_2 (g/kw-hr)	CH_4 (g/kw-hr)	N_2O (tons/yr)	CO_2 (tons/yr)	CH_4 (tons/yr)
VESSELS TO/FROM THE NORTH														
VLCC	Cruise from Origin to SCAB - main engine	0	11500	16.9	15.5	740.0	25,400	0.78	0.031	620	0.012	0.000	0	0.000
	Cruise from Origin to SCAB - aux engine	0	11500	-	15.5	740.0	3,000	0.25	0.0279	683	0.008	0.000	0	0.000
	Cruise from Origin to SCAB - aux boiler	0	11500	-	15.5	740.0	3,000	0.00	0.08	970	0.002	0.000	0	0.000
	SCAB to Pilot Boarding Area - main engine	0	26.1	16.9	12	2.2	25,400	0.36	0.031	620	0.012	0.000	0	0.000
	SCAB to Pilot Boarding Area - aux engine	0	26.1	-	12	2.2	3,000	0.25	0.0279	683	0.008	0.000	0	0.000
	SCAB to Pilot Boarding Area - aux boiler	0	26.1	-	12	2.2	3,000	0.00	0.08	970	0.002	0.000	0	0.000
	Pilot Boarding to Berth main engine: maneuvering	0	3	16.9	3	1.0	25,400	0.01	0.031	620	0.012	0.000	0	0.000
	Pilot Boarding to Berth aux engine	0	3	-	3	1.0	3,000	0.35	0.0279	683	0.008	0.000	0	0.000
	Pilot Boarding to Berth aux boiler	0	3	-	3	1.0	3,000	0.12	0.08	970	0.002	0.000	0	0.000
	Berth main engine: hoteling	0	-	-	-	40.0	25,400	0.02	0.144	620	0.260	0.000	0	0.000
	Berth aux engine: hoteling	0	-	-	-	40.0	3,000	0.27	0.0279	683	0.008	0.000	0	0.000
	Berth aux boiler: hoteling	0	-	-	-	40.0	3,000	1.00	0.08	970	0.002	0.000	0	0.000
Large Vessels	Cruise from Origin to SCAB - main engine	4	20	15	14.7	1.4	13,000	0.94	0.031	620	0.012	0.003	50	0.001
Panamax,	Cruise from Origin to SCAB - aux engine	4	20	-	14.7	1.4	3,000	0.25	0.0279	683	0.008	0.000	3	0.000
Aframax,	Cruise from Origin to SCAB - aux boiler	4	20	-	14.7	1.4	3,000	0.00	0.08	970	0.002	0.000	0	0.000
Suezmax	SCAB to Pilot Boarding Area - main engine	4	26.1	15	12	2.2	13,000	0.51	0.031	620	0.012	0.002	44	0.001
	SCAB to Pilot Boarding Area - aux engine	4	26.1	-	12	2.2	3,000	0.25	0.0279	683	0.008	0.000	5	0.000
	SCAB to Pilot Boarding Area - aux boiler	4	26.1	-	12	2.2	3,000	0.00	0.08	970	0.002	0.000	0	0.000
	Pilot Boarding to Berth main engine: maneuvering	4	3	15	3	1.0	13,000	0.01	0.031	620	0.012	0.000	0	0.000
	Pilot Boarding to Berth aux engine	4	3	-	3	1.0	3,000	0.35	0.0279	683	0.008	0.000	3	0.000
	Pilot Boarding to Berth aux boiler	4	3	-	3	1.0	3,000	0.12	0.08	970	0.002	0.000	2	0.000
	Berth main engine: hoteling	2	-	-	-	10.0	13,000	0.02	0.144	620	0.260	0.001	4	0.002
	Berth aux engine: hoteling	2	-	-	-	10.0	3,000	0.27	0.0279	683	0.008	0.001	14	0.000
	Berth aux boiler: hoteling	2	-	-	-	10.0	3,000	1.00	0.08	970	0.002	0.006	71	0.000
Medium Vessels	Cruise from Origin to SCAB - main engine	0	0	15	14.7	0.0	9,269	0.94	0.031	620	0.012	0.000	0	0.000
sub-Panamax,	Cruise from Origin to SCAB - aux engine	0	0	-	14.7	0.0	3,000	0.25	0.0279	683	0.008	0.000	0	0.000
	Cruise from Origin to SCAB - aux boiler	0	0	-	14.7	0.0	3,000	0.00	0.08	970	0.002	0.000	0	0.000
	SCAB to Pilot Boarding Area - main engine	0	26.1	15	12	2.2	9,269	0.51	0.031	620	0.012	0.000	0	0.000
	SCAB to Pilot Boarding Area - aux engine	0	26.1	-	12	2.2	3,000	0.25	0.0279	683	0.008	0.000	0	0.000
	SCAB to Pilot Boarding Area - aux boiler	0	26.1	-	12	2.2	3,000	0.00	0.08	970	0.002	0.000	0	0.000
	Pilot Boarding to Berth main engine: maneuvering	0	3	15	3	1.0	9,269	0.01	0.031	620	0.012	0.000	0	0.000
	Pilot Boarding to Berth aux engine	0	3	-	3	1.0	3,000	0.35	0.0279	683	0.008	0.000	0	0.000
	Pilot Boarding to Berth aux boiler	0	3	-	3	1.0	3,000	0.12	0.08	970	0.002	0.000	0	0.000
	Berth main engine: hoteling	0	-	-	-	23.8	9,269	0.02	0.144	620	0.260	0.000	0	0.000
	Berth aux engine: hoteling	0	-	-	-	23.8	3,000	0.27	0.0279	683	0.008	0.000	0	0.000
	Berth aux boiler: hoteling	0	-	-	-	23.8	3,000	1.00	0.08	970	0.002	0.000	0	0.000
Small Vessels	Cruise from Origin to SCAB - main engine	131	350	14	14	25.0	7,673	1.00	0.031	620	0.012	0.860	17,203	0.333
Barges	Cruise from Origin to SCAB - aux engine	131	350	-	14	25.0	190	0.17	0.0279	683	0.008	0.003	80	0.001
	Cruise from Origin to SCAB - aux boiler	131	350	-	14	25.0	0	0.00	0.08	970	0.002	0.000	0	0.000
	SCAB to Pilot Boarding Area - main engine	131	26.1	14	12	2.2	7,673	0.63	0.031	620	0.012	0.047	942	0.018
	SCAB to Pilot Boarding Area - aux engine	131	26.1	-	12	2.2	190	0.17	0.0279	683	0.008	0.000	7	0.000
	SCAB to Pilot Boarding Area - aux boiler	131	26.1	-	12	2.2	0	0.00	0.08	970	0.002	0.000	0	0.000
	Pilot Boarding to Berth main engine: maneuvering	131	3	14	3	1.0	7,673	0.01	0.031	620	0.012	0.000	7	0.000
	Pilot Boarding to Berth aux engine	131	3	-	3	1.0	190	0.45	0.0279	683	0.008	0.000	8	0.000
	Pilot Boarding to Berth aux boiler	131	3	-	3	1.0	0	0.00	0.08	970	0.002	0.000	0	0.000
	Berth main engine: hoteling	66	-	-	-	6.0	7,673	0	0.144	620	0.260	0.000	0	0.000
	Berth aux engine: hoteling	66	-	-	-	6.0	190	0.22	0.0279	683	0.008	0.001	12	0.000
	Berth aux boiler: hoteling	66	-	-	-	6.0	0	0.00	0.08	970	0.002	0.000	0	0.000

Table 51 Notes

Total Annual Vessel visits,	347	2006 average vessel calls
VLCC offloading rate, bph	50,000	based on tanker pumps
Large vessel offloading rate, bph	50,000	based on tanker pumps
Medium vessel offloading rate, bph	8,400	based on Berth 3 pumping rate
Small vessel offloading rate, bph	8,400	based on Berth 3 pumping rate
VLCC size, bbls	2,000,000	based on minimum size for VLCC
Large vessel size, bbls	500,000	based on Panamax size
Medium vessel size, bbls	200,000	estimated
Small vessel size, bbls	50,000	estimated

AQCZ = Air Quality Compliance Zone

GHG emission factors from POLA Inventory of Air Emissions 2007

Cruise and maneuvering includes both in and out (twice for each vessel call)

Load factor calculated based on propeller law of LF=(speed/max speed)^3

Hoteling main engine emission factor increased by low load adjustment factor (POLA 2007)

Auxillary engine size and load factor based on Tankers:general from POLA 2007

Emissions based on auxillary engines burning MDO 0.5% sulfur (affects N2O emissions)

Vessel parameters taken from Pier 400 and POLA 2007

Origin distances: VLCC to/from Persian Gulf, Large vessels to/from Alaska or Ecuador, medium vessels: to/from Mexico, Small vessels: to/from California ports (50% N to SF and 50% S to SD), approx. as per 1996 EIR

VLCC miles is the travel to the lightering location (assumed 20 nm outside of SCAB)

Direction of travel breakdown, based on 1996 EIR and 2004 volumes imported

	Traffic Direction, fraction of MT calls			
Vessel Size	South before Lightering	South after Lightering	West	North
VLCC	0.08	0.00	0.00	0.00
Large >500k lightering only	0.00	0.30	0.00	0.00
Large >500k	0.00	0.30	0.00	0.01
Medium >200k	0.00	0.01	0.00	0.00
Small/barge	0.00	0.19	0.00	0.19

Estimated Fuel Use within SCAB

40,728,222	Total Annual Kwhr use within SCAB
0.056	Gallons fuel oil per kwh, based on 180 grams fuel per kwh
2,271,602	Gallons of fuel annually

Table 52
Marine Terminal non-Vessel GHG Emissions - Current operations

Mode		Number	Size, kw	Load Factor	Hours per visit	Number of visits	N_2O (g/kw-hr)	CO_2 (g/kw-hr)	CH_4 (g/kw-hr)	N_2O (tons/yr)	CO_2 (tons/yr)	CH_4 (tons/yr)
Tug Assistance												
	Tugs for large,medium vessels	2	4800	0.5	6	216	0.00636	645	0.089	0.043	4,404	0.608
	Tugs for small/barge vessels	1	4800	0.5	6	131	0.00636	645	0.089	0.013	1,343	0.185
Fugitive Emissions		**VOC Emission Factor, lbs/unit**	**Annual units**	**Units**	**Annual VOC Emissions, tons**	**Vapors VOC fraction**	**Vapors CH4 fraction**	**Vapor CO2 fraction**		**N_2O (tons/yr)**	**CO_2 (tons/yr)**	**CH_4 (tons/yr)**
	Fugitive emissions from loading/unloading	2	8.00E+04	kbbls unloaded	80.0	0.5	0.1	0.05		0	8.0	16.0
	Fugitive emissions from Marine Terminal onshore components	-	-	-	10	0.5	0.1	0.05		0	1.0	2.0
	Fugitive emissions from tankage	-	-	-	45.4425	0.5	0.1	0.05		0	4.5	9.1
Electrical Generation		**Annual Electrical Use, MWh**					**N_2O (tons/MWh)**	**CO_2 (tons/MWh)**	**CH_4 (tons/MWh)**	**N_2O (tons/yr)**	**CO_2 (tons/yr)**	**CH_4 (tons/yr)**
	Pump electrical power requirements	6,738					0	0.3425	0	0	2,308	0
Offsite Vehicles		**Number of trips/day**	**RT distance, miles**	**Days/ year**	**Total Annual Miles**		**N_2O (g/mile)**	**CO_2 (kg/gallon)**	**CH_4 (g/mile)**	**N_2O (tons/yr)**	**CO_2 (tons/yr)**	**CH_4 (tons/yr)**
	Marine Terminal employees	9	50	365	164,250		0.0083	8.55	0.0145	0.0015	69	0.00262

Notes

Tug characteristics and GHG EF from Pier 400 EIR

Tug hours per visit based on arrival and departure, from pilot area to berth

VOC, Methane and CH4 fractions of fugitive emissions based on MT SCAQMD annual reporting

Electric power GHG emission factor, tons per MWhr, from eGRID and CalISO with modifications to removed closed power plants (such as Mojave)

Offsite vehicle gas milage, mpg (EMFAC2007 LDA all, avg speed 25 mph, 63F, 75RH, LA Area) *22.5*

Offsite vehicle GHG EF based on ARB compendium of emission factors, appendix A, model year 2004

Tug fuel use, annual gallons, using 180 g/kwh BSFC --> *453,605*

Table 53
Marine Terminal GHG Emissions Summary - Current operations

Activity	N_2O (tons/yr)	CO_2 (tons/yr)	CH_4 (tons/yr)
Within SCAB			
Vessel movements - engines/boilers	2.1	32,069	0.7
Tug assistance	0.06	5,747	0.8
MT fugitive emissions (loading/offloading, components, tanks)	0.0	13.5	27.1
MT Indirect (electrical and offsite)	0.001	2,376	0.003
Totals, tons/year	2.1	40,206	28.6
Total, CO2E equivalent, metric tonnes per year	37,317		
Within California			
Vessel movements - engines/boilers	3.0	51,426	1.1
Tug assistance	0.06	5,747	0.8
MT fugitive emissions (loading/offloading, components, tanks)	0.0	14	27.1
MT Indirect (electrical and offsite)	0.001	2,376	0.003
Totals, tons/year	3.1	59,563	29.0
Total, CO2E equivalent, metric tonnes per year	55,014		
Outside of SCAB and California - Worldwide			
Vessel movements - engines/boilers	51.5	1,040,109	19.7
Total, CO2E equivalent, metric tonnes per year	950,845		

Notes: emissions from barges traveling along the California coast are assumed to be entirely within California

Table 54
Marine Tanker Main Engine, Aux Engine and Aux Boiler GHG Emissions - Proposed Project

	Mode	Activities per year	Distance, nm	Max Speed (knts)	Speed (knts)	Time (hr/activity)	Engine MCR kW	Load Factor	N_2O (g/kw-hr)	CO_2 (g/kw-hr)	CH_4 (g/kw-hr)	N_2O (tons/yr)	CO_2 (tons/yr)	CH_4 (tons/yr)
VESSELS TO/FROM THE SOUTH														
VLCC	Cruise from Origin to SCAB - main engine	79	11500	16.9	15.5	740.0	25,400	0.78	0.031	620	0.012	39.314	786,279	15.218
	Cruise from Origin to SCAB - aux engine	79	11500	-	15.5	740.0	3,000	0.25	0.0279	683	0.008	1.362	33,334	0.390
	Cruise from Origin to SCAB - aux boiler	79	11500	-	15.5	740.0	3,000	0.00	0.08	970	0.002	0.000	0	0.000
	SCAB to Pilot Boarding Area - main engine	79	64.1	16.9	12	5.3	25,400	0.36	0.031	620	0.012	0.131	2,613	0.051
	SCAB to Pilot Boarding Area - aux engine	79	64.1	-	12	5.3	3,000	0.25	0.0279	683	0.008	0.010	241	0.003
	SCAB to Pilot Boarding Area - aux boiler	79	64.1	-	12	5.3	3,000	0.00	0.08	970	0.002	0.000	0	0.000
	Pilot Boarding to Berth main engine: maneuvering	79	3	16.9	3	1.0	25,400	0.01	0.031	620	0.012	0.000	8	0.000
	Pilot Boarding to Berth aux engine	79	3	-	3	1.0	3,000	0.35	0.0279	683	0.008	0.003	62	0.001
	Pilot Boarding to Berth aux boiler	79	3	-	3	1.0	3,000	0.12	0.08	970	0.002	0.003	31	0.000
	Berth main engine: hoteling	39	-	-	-	40.0	25,400	0.02	0.144	620	0.260	0.127	547	0.229
	Berth aux engine: hoteling	39	-	-	-	40.0	3,000	0.27	0.0279	683	0.008	0.040	976	0.011
	Berth aux boiler: hoteling	39	-	-	-	40.0	3,000	1.00	0.08	970	0.002	0.417	5,051	0.010
Large Vessels from Lightering Suezmax	Cruise from Origin to SCAB - main engine	295	20	15	14.7	1.4	13,000	0.94	0.031	620	0.012	0.167	3,350	0.065
	Cruise from Origin to SCAB - aux engine	295	20	-	14.7	1.4	3,000	0.25	0.0279	683	0.008	0.009	229	0.003
	Cruise from Origin to SCAB - aux boiler	295	20	-	14.7	1.4	3,000	0.00	0.08	970	0.002	0.000	0	0.000
	SCAB to Pilot Boarding Area - main engine	295	68.6	15	12	5.7	13,000	0.51	0.031	620	0.012	0.383	7,657	0.148
	SCAB to Pilot Boarding Area - aux engine	295	68.6	-	12	5.7	3,000	0.25	0.0279	683	0.008	0.039	963	0.011
	SCAB to Pilot Boarding Area - aux boiler	295	68.6	-	12	5.7	3,000	0.00	0.08	970	0.002	0.000	0	0.000
	Pilot Boarding to Berth main engine: maneuvering	295	3	15	3	1.0	13,000	0.01	0.031	620	0.012	0.001	21	0.000
	Pilot Boarding to Berth aux engine	295	3	-	3	1.0	3,000	0.35	0.0279	683	0.008	0.009	232	0.003
	Pilot Boarding to Berth aux boiler	295	3	-	3	1.0	3,000	0.12	0.08	970	0.002	0.010	117	0.000
	Berth main engine: hoteling	148	-	-	-	10.0	13,000	0.02	0.144	620	0.260	0.061	262	0.110
	Berth aux engine: hoteling	148	-	-	-	10.0	3,000	0.27	0.0279	683	0.008	0.037	912	0.011
	Berth aux boiler: hoteling	148	-	-	-	10.0	3,000	1.00	0.08	970	0.002	0.389	4,722	0.010
Large Vessels from South Amer, Afr. Panamax, Aframax, Suezmax	Cruise from Origin to SCAB - main engine	291	3500	15	14.7	238.1	13,000	0.94	0.031	620	0.012	28.889	577,781	11.183
	Cruise from Origin to SCAB - aux engine	291	3500	-	14.7	238.1	3,000	0.25	0.0279	683	0.008	1.615	39,535	0.463
	Cruise from Origin to SCAB - aux boiler	291	3500	-	14.7	238.1	3,000	0.00	0.08	970	0.002	0.000	0	0.000
	SCAB to Pilot Boarding Area - main engine	291	68.6	15	12	5.7	13,000	0.51	0.031	620	0.012	0.377	7,547	0.146
	SCAB to Pilot Boarding Area - aux engine	291	68.6	-	12	5.7	3,000	0.25	0.0279	683	0.008	0.039	949	0.011
	SCAB to Pilot Boarding Area - aux boiler	291	68.6	-	12	5.7	3,000	0.00	0.08	970	0.002	0.000	0	0.000
	Pilot Boarding to Berth main engine: maneuvering	291	3	15	3	1.0	13,000	0.01	0.031	620	0.012	0.001	21	0.000
	Pilot Boarding to Berth aux engine	291	3	-	3	1.0	3,000	0.35	0.0279	683	0.008	0.009	228	0.003
	Pilot Boarding to Berth aux boiler	291	3	-	3	1.0	3,000	0.12	0.08	970	0.002	0.009	115	0.000
	Berth main engine: hoteling	145	-	-	-	10.0	13,000	0.02	0.144	620	0.260	0.060	258	0.108
	Berth aux engine: hoteling	145	-	-	-	10.0	3,000	0.27	0.0279	683	0.008	0.037	899	0.011
	Berth aux boiler: hoteling	145	-	-	-	10.0	3,000	1.00	0.08	970	0.002	0.384	4,654	0.010
Medium Vessels sub-Panamax,	Cruise from Origin to SCAB - main engine	10	3500	15	14.7	238.1	9,269	0.94	0.031	620	0.012	0.743	14,854	0.287
	Cruise from Origin to SCAB - aux engine	10	3500	-	14.7	238.1	3,000	0.25	0.0279	683	0.008	0.058	1,426	0.017
	Cruise from Origin to SCAB - aux boiler	10	3500	-	14.7	238.1	3,000	0.00	0.08	970	0.002	0.000	0	0.000
	SCAB to Pilot Boarding Area - main engine	10	68.6	15	12	5.7	9,269	0.51	0.031	620	0.012	0.010	194	0.004
	SCAB to Pilot Boarding Area - aux engine	10	68.6	-	12	5.7	3,000	0.25	0.0279	683	0.008	0.001	34	0.000
	SCAB to Pilot Boarding Area - aux boiler	10	68.6	-	12	5.7	3,000	0.00	0.08	970	0.002	0.000	0	0.000
	Pilot Boarding to Berth main engine: maneuvering	10	3	15	3	1.0	9,269	0.01	0.031	620	0.012	0.000	1	0.000
	Pilot Boarding to Berth aux engine	10	3	-	3	1.0	3,000	0.35	0.0279	683	0.008	0.000	8	0.000
	Pilot Boarding to Berth aux boiler	10	3	-	3	1.0	3,000	0.12	0.08	970	0.002	0.000	4	0.000
	Berth main engine: hoteling	5	-	-	-	23.8	9,269	0.02	0.144	620	0.260	0.004	16	0.007
	Berth aux engine: hoteling	5	-	-	-	23.8	3,000	0.27	0.0279	683	0.008	0.003	77	0.001
	Berth aux boiler: hoteling	5	-	-	-	23.8	3,000	1.00	0.08	970	0.002	0.033	400	0.001
Small Vessels Barges	Cruise from Origin to SCAB - main engine	185	42	14	14	3.0	7,673	1.00	0.031	620	0.012	0.145	2,897	0.056
	Cruise from Origin to SCAB - aux engine	185	42	-	14	3.0	190	0.17	0.0279	683	0.008	0.001	13	0.000
	Cruise from Origin to SCAB - aux boiler	185	42	-	14	3.0	0	0.00	0.08	970	0.002	0.000	0	0.000
	SCAB to Pilot Boarding Area - main engine	185	68.6	14	12	5.7	7,673	0.63	0.031	620	0.012	0.174	3,477	0.067
	SCAB to Pilot Boarding Area - aux engine	185	68.6	-	12	5.7	190	0.17	0.0279	683	0.008	0.001	26	0.000
	SCAB to Pilot Boarding Area - aux boiler	185	68.6	-	12	5.7	0	0.00	0.08	970	0.002	0.000	0	0.000
	Pilot Boarding to Berth main engine: maneuvering	185	3	14	3	1.0	7,673	0.01	0.031	620	0.012	0.000	10	0.000
	Pilot Boarding to Berth aux engine	185	3	-	3	1.0	190	0.45	0.0279	683	0.008	0.000	12	0.000
	Pilot Boarding to Berth aux boiler	185	3	-	3	1.0	0	0.00	0.08	970	0.002	0.000	0	0.000
	Berth main engine: hoteling	92	-	-	-	6.0	7,673	0	0.144	620	0.260	0.000	0	0.000
	Berth aux engine: hoteling	92	-	-	-	6.0	190	0.22	0.0279	683	0.008	0.001	17	0.000
	Berth aux boiler: hoteling	92	-	-	-	6.0	0	0.00	0.08	970	0.002	0.000	0	0.000

Table 54 (cont.)
Marine Tanker Main Engine, Aux Engine and Aux Boiler GHG Emissions - Proposed Project

	Mode	Activities per year	Distance, nm	Max Speed (knts)	Speed (knts)	Time (hr/activity)	Engine MCR kW	Load Factor	N_2O (g/kw-hr)	CO_2 (g/kw-hr)	CH_4 (g/kw-hr)	N_2O (tons/yr)	CO_2 (tons/yr)	CH_4 (tons/yr)
VESSELS TO/FROM THE WEST														
VLCC	Cruise from Origin to SCAB - main engine	0	0	16.9	15.5	0.0	25,400	0.78	0.031	620	0.012	0.000	0	0.000
	Cruise from Origin to SCAB - aux engine	0	0	-	15.5	0.0	3,000	0.25	0.0279	683	0.008	0.000	0	0.000
	Cruise from Origin to SCAB - aux boiler	0	0	-	15.5	0.0	3,000	0.00	0.08	970	0.002	0.000	0	0.000
	SCAB to Pilot Boarding Area - main engine	0	27.5	16.9	12	2.3	25,400	0.36	0.031	620	0.012	0.000	0	0.000
	SCAB to Pilot Boarding Area - aux engine	0	27.5	-	12	2.3	3,000	0.25	0.0279	683	0.008	0.000	0	0.000
	SCAB to Pilot Boarding Area - aux boiler	0	27.5	-	12	2.3	3,000	0.00	0.08	970	0.002	0.000	0	0.000
	Pilot Boarding to Berth main engine: maneuvering	0	3	16.9	3	1.0	25,400	0.01	0.031	620	0.012	0.000	0	0.000
	Pilot Boarding to Berth aux engine	0	3	-	3	1.0	3,000	0.35	0.0279	683	0.008	0.000	0	0.000
	Pilot Boarding to Berth aux boiler	0	3	-	3	1.0	3,000	0.12	0.08	970	0.002	0.000	0	0.000
	Berth main engine: hoteling	0	-	-	-	40.0	25,400	0.02	0.144	620	0.260	0.000	0	0.000
	Berth aux engine: hoteling	0	-	-	-	40.0	3,000	0.27	0.0279	683	0.008	0.000	0	0.000
	Berth aux boiler: hoteling	0	-	-	-	40.0	3,000	1.00	0.08	970	0.002	0.000	0	0.000
Large Vessels	Cruise from Origin to SCAB - main engine	2	2000	15	14.7	136.1	13,000	0.94	0.031	620	0.012	0.135	2,702	0.052
Panamax,	Cruise from Origin to SCAB - aux engine	2	2000	-	14.7	136.1	3,000	0.25	0.0279	683	0.008	0.008	185	0.002
Aframax,	Cruise from Origin to SCAB - aux boiler	2	2000	-	14.7	136.1	3,000	0.00	0.08	970	0.002	0.000	0	0.000
Suezmax	SCAB to Pilot Boarding Area - main engine	2	27.5	15	12	2.3	13,000	0.51	0.031	620	0.012	0.001	25	0.000
	SCAB to Pilot Boarding Area - aux engine	2	27.5	-	12	2.3	3,000	0.25	0.0279	683	0.008	0.000	3	0.000
	SCAB to Pilot Boarding Area - aux boiler	2	27.5	-	12	2.3	3,000	0.00	0.08	970	0.002	0.000	0	0.000
	Pilot Boarding to Berth main engine: maneuvering	2	3	15	3	1.0	13,000	0.01	0.031	620	0.012	0.000	0	0.000
	Pilot Boarding to Berth aux engine	2	3	-	3	1.0	3,000	0.35	0.0279	683	0.008	0.000	2	0.000
	Pilot Boarding to Berth aux boiler	2	3	-	3	1.0	3,000	0.12	0.08	970	0.002	0.000	1	0.000
	Berth main engine: hoteling	1	-	-	-	10.0	13,000	0.02	0.144	620	0.260	0.000	2	0.001
	Berth aux engine: hoteling	1	-	-	-	10.0	3,000	0.27	0.0279	683	0.008	0.000	7	0.000
	Berth aux boiler: hoteling	1	-	-	-	10.0	3,000	1.00	0.08	970	0.002	0.003	38	0.000
Medium Vessels	Cruise from Origin to SCAB - main engine	0	0	15	14.7	0.0	9,269	0.94	0.031	620	0.012	0.000	0	0.000
sub-Panamax,	Cruise from Origin to SCAB - aux engine	0	0	-	14.7	0.0	3,000	0.25	0.0279	683	0.008	0.000	0	0.000
	Cruise from Origin to SCAB - aux boiler	0	0	-	14.7	0.0	3,000	0.00	0.08	970	0.002	0.000	0	0.000
	SCAB to Pilot Boarding Area - main engine	0	27.5	15	12	2.3	9,269	0.51	0.031	620	0.012	0.000	0	0.000
	SCAB to Pilot Boarding Area - aux engine	0	27.5	-	12	2.3	3,000	0.25	0.0279	683	0.008	0.000	0	0.000
	SCAB to Pilot Boarding Area - aux boiler	0	27.5	-	12	2.3	3,000	0.00	0.08	970	0.002	0.000	0	0.000
	Pilot Boarding to Berth main engine: maneuvering	0	3	15	3	1.0	9,269	0.01	0.031	620	0.012	0.000	0	0.000
	Pilot Boarding to Berth aux engine	0	3	-	3	1.0	3,000	0.35	0.0279	683	0.008	0.000	0	0.000
	Pilot Boarding to Berth aux boiler	0	3	-	3	1.0	3,000	0.12	0.08	970	0.002	0.000	0	0.000
	Berth main engine: hoteling	0	-	-	-	23.8	9,269	0.02	0.144	620	0.260	0.000	0	0.000
	Berth aux engine: hoteling	0	-	-	-	23.8	3,000	0.27	0.0279	683	0.008	0.000	0	0.000
	Berth aux boiler: hoteling	0	-	-	-	23.8	3,000	1.00	0.08	970	0.002	0.000	0	0.000
Small Vessels	Cruise from Origin to SCAB - main engine	0	0	14	14	0.0	7,673	1.00	0.031	620	0.012	0.000	0	0.000
Barges	Cruise from Origin to SCAB - aux engine	0	0	-	14	0.0	190	0.17	0.0279	683	0.008	0.000	0	0.000
	Cruise from Origin to SCAB - aux boiler	0	0	-	14	0.0	0	0.00	0.08	970	0.002	0.000	0	0.000
	SCAB to Pilot Boarding Area - main engine	0	27.5	14	12	2.3	7,673	0.63	0.031	620	0.012	0.000	0	0.000
	SCAB to Pilot Boarding Area - aux engine	0	27.5	-	12	2.3	190	0.17	0.0279	683	0.008	0.000	0	0.000
	SCAB to Pilot Boarding Area - aux boiler	0	27.5	-	12	2.3	0	0.00	0.08	970	0.002	0.000	0	0.000
	Pilot Boarding to Berth main engine: maneuvering	0	3	14	3	1.0	7,673	0.01	0.031	620	0.012	0.000	0	0.000
	Pilot Boarding to Berth aux engine	0	3	-	3	1.0	190	0.45	0.0279	683	0.008	0.000	0	0.000
	Pilot Boarding to Berth aux boiler	0	3	-	3	1.0	0	0.00	0.08	970	0.002	0.000	0	0.000
	Berth main engine: hoteling	0	-	-	-	6.0	7,673	0	0.144	620	0.260	0.000	0	0.000
	Berth aux engine: hoteling	0	-	-	-	6.0	190	0.22	0.0279	683	0.008	0.000	0	0.000
	Berth aux boiler: hoteling	0	-	-	-	6.0	0	0.00	0.08	970	0.002	0.000	0	0.000

Table 54 (cont.)
Marine Tanker Main Engine, Aux Engine and Aux Boiler GHG Emissions - Proposed Project

	Mode	Activities per year	Distance, nm	Max Speed (knts)	Speed (knts)	Time (hr/activity)	Engine MCR kW	Load Factor	N_2O (g/kw-hr)	CO_2 (g/kw-hr)	CH_4 (g/kw-hr)	N_2O (tons/yr)	CO_2 (tons/yr)	CH_4 (tons/yr)
VESSELS TO/FROM THE NORTH														
VLCC	Cruise from Origin to SCAB - main engine	0	11500	16.9	15.5	740.0	25,400	0.78	0.031	620	0.012	0.000	0	0.000
	Cruise from Origin to SCAB - aux engine	0	11500	-	15.5	740.0	3,000	0.25	0.0279	683	0.008	0.000	0	0.000
	Cruise from Origin to SCAB - aux boiler	0	11500	-	15.5	740.0	3,000	0.00	0.08	970	0.002	0.000	0	0.000
	SCAB to Pilot Boarding Area - main engine	0	26.1	16.9	12	2.2	25,400	0.36	0.031	620	0.012	0.000	0	0.000
	SCAB to Pilot Boarding Area - aux engine	0	26.1	-	12	2.2	3,000	0.25	0.0279	683	0.008	0.000	0	0.000
	SCAB to Pilot Boarding Area - aux boiler	0	26.1	-	12	2.2	3,000	0.00	0.08	970	0.002	0.000	0	0.000
	Pilot Boarding to Berth main engine: maneuvering	0	3	16.9	3	1.0	25,400	0.01	0.031	620	0.012	0.000	0	0.000
	Pilot Boarding to Berth aux engine	0	3	-	3	1.0	3,000	0.35	0.0279	683	0.008	0.000	0	0.000
	Pilot Boarding to Berth aux boiler	0	3	-	3	1.0	3,000	0.12	0.08	970	0.002	0.000	0	0.000
	Berth main engine: hoteling	0	-	-	-	40.0	25,400	0.02	0.144	620	0.260	0.000	0	0.000
	Berth aux engine: hoteling	0	-	-	-	40.0	3,000	0.27	0.0279	683	0.008	0.000	0	0.000
	Berth aux boiler: hoteling	0	-	-	-	40.0	3,000	1.00	0.08	970	0.002	0.000	0	0.000
Large Vessels	Cruise from Origin to SCAB - main engine	6	20	15	14.7	1.4	13,000	0.94	0.031	620	0.012	0.004	70	0.001
Panamax,	Cruise from Origin to SCAB - aux engine	6	20	-	14.7	1.4	3,000	0.25	0.0279	683	0.008	0.000	5	0.000
Aframax,	Cruise from Origin to SCAB - aux boiler	6	20	-	14.7	1.4	3,000	0.00	0.08	970	0.002	0.000	0	0.000
Suezmax	SCAB to Pilot Boarding Area - main engine	6	26.1	15	12	2.2	13,000	0.51	0.031	620	0.012	0.003	61	0.001
	SCAB to Pilot Boarding Area - aux engine	6	26.1	-	12	2.2	3,000	0.25	0.0279	683	0.008	0.000	8	0.000
	SCAB to Pilot Boarding Area - aux boiler	6	26.1	-	12	2.2	3,000	0.00	0.08	970	0.002	0.000	0	0.000
	Pilot Boarding to Berth main engine: maneuvering	6	3	15	3	1.0	13,000	0.01	0.031	620	0.012	0.000	0	0.000
	Pilot Boarding to Berth aux engine	6	3	-	3	1.0	3,000	0.35	0.0279	683	0.008	0.000	5	0.000
	Pilot Boarding to Berth aux boiler	6	3	-	3	1.0	3,000	0.12	0.08	970	0.002	0.000	2	0.000
	Berth main engine: hoteling	3	-	-	-	10.0	13,000	0.02	0.144	620	0.260	0.001	5	0.002
	Berth aux engine: hoteling	3	-	-	-	10.0	3,000	0.27	0.0279	683	0.008	0.001	19	0.000
	Berth aux boiler: hoteling	3	-	-	-	10.0	3,000	1.00	0.08	970	0.002	0.008	99	0.000
Medium Vessels	Cruise from Origin to SCAB - main engine	0	0	15	14.7	0.0	9,269	0.94	0.031	620	0.012	0.000	0	0.000
sub-Panamax,	Cruise from Origin to SCAB - aux engine	0	0	-	14.7	0.0	3,000	0.25	0.0279	683	0.008	0.000	0	0.000
	Cruise from Origin to SCAB - aux boiler	0	0	-	14.7	0.0	3,000	0.00	0.08	970	0.002	0.000	0	0.000
	SCAB to Pilot Boarding Area - main engine	0	26.1	15	12	2.2	9,269	0.51	0.031	620	0.012	0.000	0	0.000
	SCAB to Pilot Boarding Area - aux engine	0	26.1	-	12	2.2	3,000	0.25	0.0279	683	0.008	0.000	0	0.000
	SCAB to Pilot Boarding Area - aux boiler	0	26.1	-	12	2.2	3,000	0.00	0.08	970	0.002	0.000	0	0.000
	Pilot Boarding to Berth main engine: maneuvering	0	3	15	3	1.0	9,269	0.01	0.031	620	0.012	0.000	0	0.000
	Pilot Boarding to Berth aux engine	0	3	-	3	1.0	3,000	0.35	0.0279	683	0.008	0.000	0	0.000
	Pilot Boarding to Berth aux boiler	0	3	-	3	1.0	3,000	0.12	0.08	970	0.002	0.000	0	0.000
	Berth main engine: hoteling	0	-	-	-	23.8	9,269	0.02	0.144	620	0.260	0.000	0	0.000
	Berth aux engine: hoteling	0	-	-	-	23.8	3,000	0.27	0.0279	683	0.008	0.000	0	0.000
	Berth aux boiler: hoteling	0	-	-	-	23.8	3,000	1.00	0.08	970	0.002	0.000	0	0.000
Small Vessels	Cruise from Origin to SCAB - main engine	185	350	14	14	25.0	7,673	1.00	0.031	620	0.012	1.207	24,143	0.467
Barges	Cruise from Origin to SCAB - aux engine	185	350	-	14	25.0	190	0.17	0.0279	683	0.008	0.005	112	0.001
	Cruise from Origin to SCAB - aux boiler	185	350	-	14	25.0	0	0.00	0.08	970	0.002	0.000	0	0.000
	SCAB to Pilot Boarding Area - main engine	185	26.1	14	12	2.2	7,673	0.63	0.031	620	0.012	0.066	1,323	0.026
	SCAB to Pilot Boarding Area - aux engine	185	26.1	-	12	2.2	190	0.17	0.0279	683	0.008	0.000	10	0.000
	SCAB to Pilot Boarding Area - aux boiler	185	26.1	-	12	2.2	0	0.00	0.08	970	0.002	0.000	0	0.000
	Pilot Boarding to Berth main engine: maneuvering	185	3	14	3	1.0	7,673	0.01	0.031	620	0.012	0.000	10	0.000
	Pilot Boarding to Berth aux engine	185	3	-	3	1.0	190	0.45	0.0279	683	0.008	0.000	12	0.000
	Pilot Boarding to Berth aux boiler	185	3	-	3	1.0	0	0.00	0.08	970	0.002	0.000	0	0.000
	Berth main engine: hoteling	92	-	-	-	6.0	7,673	0	0.144	620	0.260	0.000	0	0.000
	Berth aux engine: hoteling	92	-	-	-	6.0	190	0.22	0.0279	683	0.008	0.001	17	0.000
	Berth aux boiler: hoteling	92	-	-	-	6.0	0	0.00	0.08	970	0.002	0.000	0	0.000

Table 54 Notes

Total Annual Vessel visits,	487	2040 average vessel calls
VLCC offloading rate, bph	50,000	based on tanker pumps
Large vessel offloading rate, bph	50,000	based on tanker pumps
Medium vessel offloading rate, bph	8,400	based on Berth 3 pumping rate
Small vessel offloading rate, bph	8,400	based on Berth 3 pumping rate
VLCC size, bbls	2,000,000	based on minimum size for VLCC
Large vessel size, bbls	500,000	based on Panamax size
Medium vessel size, bbls	200,000	estimated
Small vessel size, bbls	50,000	estimated
Max Speed within SCAB	12	knots

AQCZ = Air Quality Compliance Zone

GHG emission factors from POLA Inventory of Air Emissions 2007

Cruise and maneuvering includes both in and out (twice for each vessel call)

Load factor calculated based on propeller law of LF=(speed/max speed)^3

Hoteling main engine emission factor increased by low load adjustment factor (POLA 2007)

Auxillary engine size and load factor based on Tankers:general from POLA 2007

Emissions based on auxillary engines burning MDO 0.5% sulfur (affects N2O emissions)

Vessel parameters taken from Pier 400 and POLA 2007

Origin distances: VLCC to/from Persian Gulf, Large vessels to/from Alaska or Ecuador, medium vessels: to/from Mexico, Small vessels: to/from California ports (50% N to SF and 50% S to SD), approx. as per 1996 EIR

VLCC miles is the travel to the lightering location (assumed 20 nm outside of SCAB)

Direction of travel breakdown, based on 1996 EIR and 2004 volumes imported

	Traffic Direction, fraction of MT calls			
Vessel Size	South before Lightering	South after Lightering	West	North
VLCC	0.08	0.00	0.00	0.00
Large >500k lightering only	0.00	0.30	0.00	0.00
Large >500k	0.00	0.30	0.00	0.01
Medium >200k	0.00	0.01	0.00	0.00
Small/barge	0.00	0.19	0.00	0.19

Estimated Fuel Use within SCAB

57,160,357 Total Annual Kwhr use within SCAB

0.056 Gallons fuel oil per kwh, based on 180 grams fuel per kwh

3,188,099 Gallons of fuel annually

Table 55
Marine Terminal non-Vessel GHG Emissions - Proposed Project Year 2040

Mode		Number	Size, kw	Load Factor	Hours per visit	Number of visits	N_2O (g/kw-hr)	CO_2 (g/kw-hr)	CH_4 (g/kw-hr)	N_2O (tons/yr)	CO_2 (tons/yr)	CH_4 (tons/yr)
Tug Assistance												
	Tugs for large,medium vessels	2	4800	0.5	6	302	0.00636	645	0.089	0.061	6,180	0.853
	Tugs for small/barge vessels	1	4800	0.5	6	185	0.00636	645	0.089	0.019	1,885	0.260
Fugitive Emissions		**VOC Emission Factor, lbs/unit**	**Annual units**	**Units**	**Annual VOC Emissions, tons**	**Vapors VOC fraction**	**Vapors CH4 fraction**	**Vapor CO2 fraction**		**N_2O (tons/yr)**	**CO_2 (tons/yr)**	**CH_4 (tons/yr)**
	Fugitive emissions from loading/unloading	2	1.18E+05	kbbls unloaded	118.2	0.5	0.1	0.05		0	11.8	23.6
	Fugitive emissions from Marine Terminal onshore components	-	-	-	10	0.5	0.1	0.05		0	1.0	2.0
	Fugitive emissions from tankage	-	-	-	45.4	0.5	0.1	0.05		0	4.5	9.1
Electrical Generation		**Annual Electrical Use, MWh**					**N_2O (tons/MWh)**	**CO_2 (tons/MWh)**	**CH_4 (tons/MWh)**	**N_2O (tons/yr)**	**CO_2 (tons/yr)**	**CH_4 (tons/yr)**
	Pump electrical power requirements	9,456					0	0.3425	0	0	3,239	0
Offsite Vehicles		**Number of trips/day**	**RT distance, miles**	**Days/ year**	**Total Annual Miles**		**N_2O (g/mile)**	**CO_2 (kg/gallon)**	**CH_4 (g/mile)**	**N_2O (tons/yr)**	**CO_2 (tons/yr)**	**CH_4 (tons/yr)**
	Marine Terminal employees	9	50	365	164,250		0.0083	8.55	0.0145	0.0015	69	0.00262

Notes

Tug characteristics and GHG EF from Pier 400 EIR

Tug hours per visit based on arrival and departure, from pilot area to berth

VOC, Methane and CH4 fractions of fugitive emissions based on MT SCAQMD annual reporting

Electric power GHG emission factor, tons per MWhr, from eGRID and CalISO with modifications to removed closed power plants (such as Mojave)

Offsite vehicle gas milage, mpg (EMFAC2007 LDA all, avg speed 25 mph, 63F, 75RH, LA Area) *22.5*

Offshire vehicle GHG EF based on ARB compendium of emission factors, appendix A, model year 2004

Tug fuel use, annual gallons, using 180 g/kwh BSFC --> *636,616*

Annual electrical usage increased by estimated increase in vessel visits in 2040

Table 56
Marine Terminal GHG Emissions Summary - Proposed Project Year 2040

Activity	N_2O (tons/yr)	CO_2 (tons/yr)	CH_4 (tons/yr)
Within SCAB			
Vessel movements - engines/boilers	2.9	45,008	1.0
Tug assistance	0.08	8,066	1.1
MT fugitive emissions (loading/offloading, components, tanks)	0.0	17.4	34.7
MT Indirect (electrical and offsite)	0.001	3,307	0.003
Totals, tons/year	3.0	56,398	36.8
Total, CO2E equivalent, metric tonnes per year	52,284		
Current CO2E, metric tonnes	37,317		
Increase	14,967		
Within California			
Vessel movements - engines/boilers	4.2	72,174	1.5
Tug assistance	0.08	8,066	1.1
MT fugitive emissions (loading/offloading, components, tanks)	0.0	17	34.7
MT Indirect (electrical and offsite)	0.001	3,307	0.003
Totals, tons/year	4.3	83,564	37.4
Total, CO2E equivalent, metric tonnes per year	77,122		
Current CO2E, metric tonnes	55,014		
Increase	22,107		
Outside of SCAB and California - Worldwide			
Vessel movements - engines/boilers	72.3	1,459,750	27.7
Total, CO2E equivalent, metric tonnes per year	1,334,471		
Current	950,845		
Increase	383,626		

Notes: emissions from barges traveling along the California coast are assumed to be entirely within California

Table 57
Marine Tanker Main Engine, Aux Engine and Aux Boiler GHG Emissions - Alternatives

	Mode	Activities per year	Distance, nm	Max Speed (knts)	Speed (knts)	Time (hr/activity)	Engine MCR kW	Load Factor	N_2O (g/kw-hr)	CO_2 (g/kw-hr)	CH_4 (g/kw-hr)	N_2O (tons/yr)	CO_2 (tons/yr)	CH_4 (tons/yr)
VESSELS TO/FROM THE SOUTH														
VLCC	Cruise from Origin to SCAB - main engine	96	11500	16.9	15.5	740.0	25,400	0.78	0.031	620	0.012	47.700	954,010	18.465
	Cruise from Origin to SCAB - aux engine	96	11500	-	15.5	740.0	3,000	0.25	0.0279	683	0.008	1.652	40,445	0.474
	Cruise from Origin to SCAB - aux boiler	96	11500	-	15.5	740.0	3,000	0.00	0.08	970	0.002	0.000	0	0.000
	SCAB to Pilot Boarding Area - main engine	96	64.1	16.9	12	5.3	25,400	0.36	0.031	620	0.012	0.159	3,171	0.061
	SCAB to Pilot Boarding Area - aux engine	96	64.1	-	12	5.3	3,000	0.25	0.0279	683	0.008	0.012	292	0.003
	SCAB to Pilot Boarding Area - aux boiler	96	64.1	-	12	5.3	3,000	0.00	0.08	970	0.002	0.000	0	0.000
	Pilot Boarding to Berth main engine: maneuvering	96	3	16.9	3	1.0	25,400	0.01	0.031	620	0.012	0.000	9	0.000
	Pilot Boarding to Berth aux engine	96	3	-	3	1.0	3,000	0.35	0.0279	683	0.008	0.003	75	0.001
	Pilot Boarding to Berth aux boiler	96	3	-	3	1.0	3,000	0.12	0.08	970	0.002	0.003	38	0.000
	Berth main engine: hoteling	48	-	-	-	40.0	25,400	0.02	0.144	620	0.260	0.154	663	0.278
	Berth aux engine: hoteling	48	-	-	-	40.0	3,000	0.27	0.0279	683	0.008	0.048	1,184	0.014
	Berth aux boiler: hoteling	48	-	-	-	40.0	3,000	1.00	0.08	970	0.002	0.505	6,128	0.013
Large Vessels from Lightering Suezmax	Cruise from Origin to SCAB - main engine	0	20	15	14.7	1.4	13,000	0.94	0.031	620	0.012	0.000	0	0.000
	Cruise from Origin to SCAB - aux engine	0	20	-	14.7	1.4	3,000	0.25	0.0279	683	0.008	0.000	0	0.000
	Cruise from Origin to SCAB - aux boiler	0	20	-	14.7	1.4	3,000	0.00	0.08	970	0.002	0.000	0	0.000
	SCAB to Pilot Boarding Area - main engine	0	68.6	15	12	5.7	13,000	0.51	0.031	620	0.012	0.000	0	0.000
	SCAB to Pilot Boarding Area - aux engine	0	68.6	-	12	5.7	3,000	0.25	0.0279	683	0.008	0.000	0	0.000
	SCAB to Pilot Boarding Area - aux boiler	0	68.6	-	12	5.7	3,000	0.00	0.08	970	0.002	0.000	0	0.000
	Pilot Boarding to Berth main engine: maneuvering	0	3	15	3	1.0	13,000	0.01	0.031	620	0.012	0.000	0	0.000
	Pilot Boarding to Berth aux engine	0	3	-	3	1.0	3,000	0.35	0.0279	683	0.008	0.000	0	0.000
	Pilot Boarding to Berth aux boiler	0	3	-	3	1.0	3,000	0.12	0.08	970	0.002	0.000	0	0.000
	Berth main engine: hoteling	0	-	-	-	10.0	13,000	0.02	0.144	620	0.260	0.000	0	0.000
	Berth aux engine: hoteling	0	-	-	-	10.0	3,000	0.27	0.0279	683	0.008	0.000	0	0.000
	Berth aux boiler: hoteling	0	-	-	-	10.0	3,000	1.00	0.08	970	0.002	0.000	0	0.000
Large Vessels from South Amer, Afr. Panamax, Aframax, Suezmax	Cruise from Origin to SCAB - main engine	353	3500	15	14.7	238.1	13,000	0.94	0.031	620	0.012	35.052	701,034	13.568
	Cruise from Origin to SCAB - aux engine	353	3500	-	14.7	238.1	3,000	0.25	0.0279	683	0.008	1.959	47,969	0.562
	Cruise from Origin to SCAB - aux boiler	353	3500	-	14.7	238.1	3,000	0.00	0.08	970	0.002	0.000	0	0.000
	SCAB to Pilot Boarding Area - main engine	353	68.6	15	12	5.7	13,000	0.51	0.031	620	0.012	0.458	9,156	0.177
	SCAB to Pilot Boarding Area - aux engine	353	68.6	-	12	5.7	3,000	0.25	0.0279	683	0.008	0.047	1,152	0.013
	SCAB to Pilot Boarding Area - aux boiler	353	68.6	-	12	5.7	3,000	0.00	0.08	970	0.002	0.000	0	0.000
	Pilot Boarding to Berth main engine: maneuvering	353	3	15	3	1.0	13,000	0.01	0.031	620	0.012	0.001	25	0.000
	Pilot Boarding to Berth aux engine	353	3	-	3	1.0	3,000	0.35	0.0279	683	0.008	0.011	277	0.003
	Pilot Boarding to Berth aux boiler	353	3	-	3	1.0	3,000	0.12	0.08	970	0.002	0.012	140	0.000
	Berth main engine: hoteling	176	-	-	-	10.0	13,000	0.02	0.144	620	0.260	0.072	313	0.131
	Berth aux engine: hoteling	176	-	-	-	10.0	3,000	0.27	0.0279	683	0.008	0.045	1,091	0.013
	Berth aux boiler: hoteling	176	-	-	-	10.0	3,000	1.00	0.08	970	0.002	0.466	5,647	0.012
Medium Vessels sub-Panamax,	Cruise from Origin to SCAB - main engine	13	3500	15	14.7	238.1	9,269	0.94	0.031	620	0.012	0.901	18,022	0.349
	Cruise from Origin to SCAB - aux engine	13	3500	-	14.7	238.1	3,000	0.25	0.0279	683	0.008	0.071	1,730	0.020
	Cruise from Origin to SCAB - aux boiler	13	3500	-	14.7	238.1	3,000	0.00	0.08	970	0.002	0.000	0	0.000
	SCAB to Pilot Boarding Area - main engine	13	68.6	15	12	5.7	9,269	0.51	0.031	620	0.012	0.012	235	0.005
	SCAB to Pilot Boarding Area - aux engine	13	68.6	-	12	5.7	3,000	0.25	0.0279	683	0.008	0.002	42	0.000
	SCAB to Pilot Boarding Area - aux boiler	13	68.6	-	12	5.7	3,000	0.00	0.08	970	0.002	0.000	0	0.000
	Pilot Boarding to Berth main engine: maneuvering	13	3	15	3	1.0	9,269	0.01	0.031	620	0.012	0.000	1	0.000
	Pilot Boarding to Berth aux engine	13	3	-	3	1.0	3,000	0.35	0.0279	683	0.008	0.000	10	0.000
	Pilot Boarding to Berth aux boiler	13	3	-	3	1.0	3,000	0.12	0.08	970	0.002	0.000	5	0.000
	Berth main engine: hoteling	6	-	-	-	23.8	9,269	0.02	0.144	620	0.260	0.004	19	0.008
	Berth aux engine: hoteling	6	-	-	-	23.8	3,000	0.27	0.0279	683	0.008	0.004	94	0.001
	Berth aux boiler: hoteling	6	-	-	-	23.8	3,000	1.00	0.08	970	0.002	0.040	485	0.001
Small Vessels Barges	Cruise from Origin to SCAB - main engine	224	42	14	14	3.0	7,673	1.00	0.031	620	0.012	0.176	3,515	0.068
	Cruise from Origin to SCAB - aux engine	224	42	-	14	3.0	190	0.17	0.0279	683	0.008	0.001	16	0.000
	Cruise from Origin to SCAB - aux boiler	224	42	-	14	3.0	0	0.00	0.08	970	0.002	0.000	0	0.000
	SCAB to Pilot Boarding Area - main engine	224	68.6	14	12	5.7	7,673	0.63	0.031	620	0.012	0.211	4,218	0.082
	SCAB to Pilot Boarding Area - aux engine	224	68.6	-	12	5.7	190	0.17	0.0279	683	0.008	0.001	31	0.000
	SCAB to Pilot Boarding Area - aux boiler	224	68.6	-	12	5.7	0	0.00	0.08	970	0.002	0.000	0	0.000
	Pilot Boarding to Berth main engine: maneuvering	224	3	14	3	1.0	7,673	0.01	0.031	620	0.012	0.001	12	0.000
	Pilot Boarding to Berth aux engine	224	3	-	3	1.0	190	0.45	0.0279	683	0.008	0.001	14	0.000
	Pilot Boarding to Berth aux boiler	224	3	-	3	1.0	0	0.00	0.08	970	0.002	0.000	0	0.000
	Berth main engine: hoteling	112	-	-	-	6.0	7,673	0	0.144	620	0.260	0.000	0	0.000
	Berth aux engine: hoteling	112	-	-	-	6.0	190	0.22	0.0279	683	0.008	0.001	21	0.000
	Berth aux boiler: hoteling	112	-	-	-	6.0	0	0.00	0.08	970	0.002	0.000	0	0.000

Table 57 (cont.)
Marine Tanker Main Engine, Aux Engine and Aux Boiler GHG Emissions - Alternatives

	Mode	Activities per year	Distance, nm	Max Speed (knts)	Speed (knts)	Time (hr/activity)	Engine MCR kW	Load Factor	N_2O (g/kw-hr)	CO_2 (g/kw-hr)	CH_4 (g/kw-hr)	N_2O (tons/yr)	CO_2 (tons/yr)	CH_4 (tons/yr)
VESSELS TO/FROM THE WEST														
VLCC	Cruise from Origin to SCAB - main engine	0	0	16.9	15.5	0.0	25,400	0.78	0.031	620	0.012	0.000	0	0.000
	Cruise from Origin to SCAB - aux engine	0	0	-	15.5	0.0	3,000	0.25	0.0279	683	0.008	0.000	0	0.000
	Cruise from Origin to SCAB - aux boiler	0	0	-	15.5	0.0	3,000	0.00	0.08	970	0.002	0.000	0	0.000
	SCAB to Pilot Boarding Area - main engine	0	27.5	16.9	12	2.3	25,400	0.36	0.031	620	0.012	0.000	0	0.000
	SCAB to Pilot Boarding Area - aux engine	0	27.5	-	12	2.3	3,000	0.25	0.0279	683	0.008	0.000	0	0.000
	SCAB to Pilot Boarding Area - aux boiler	0	27.5	-	12	2.3	3,000	0.00	0.08	970	0.002	0.000	0	0.000
	Pilot Boarding to Berth main engine: maneuvering	0	3	16.9	3	1.0	25,400	0.01	0.031	620	0.012	0.000	0	0.000
	Pilot Boarding to Berth aux engine	0	3	-	3	1.0	3,000	0.35	0.0279	683	0.008	0.000	0	0.000
	Pilot Boarding to Berth aux boiler	0	3	-	3	1.0	3,000	0.12	0.08	970	0.002	0.000	0	0.000
	Berth main engine: hoteling	0	-	-	-	40.0	25,400	0.02	0.144	620	0.260	0.000	0	0.000
	Berth aux engine: hoteling	0	-	-	-	40.0	3,000	0.27	0.0279	683	0.008	0.000	0	0.000
	Berth aux boiler: hoteling	0	-	-	-	40.0	3,000	1.00	0.08	970	0.002	0.000	0	0.000
Large Vessels	Cruise from Origin to SCAB - main engine	3	2000	15	14.7	136.1	13,000	0.94	0.031	620	0.012	0.164	3,278	0.063
Panamax,	Cruise from Origin to SCAB - aux engine	3	2000	-	14.7	136.1	3,000	0.25	0.0279	683	0.008	0.009	224	0.003
Aframax,	Cruise from Origin to SCAB - aux boiler	3	2000	-	14.7	136.1	3,000	0.00	0.08	970	0.002	0.000	0	0.000
Suezmax	SCAB to Pilot Boarding Area - main engine	3	27.5	15	12	2.3	13,000	0.51	0.031	620	0.012	0.002	30	0.001
	SCAB to Pilot Boarding Area - aux engine	3	27.5	-	12	2.3	3,000	0.25	0.0279	683	0.008	0.000	4	0.000
	SCAB to Pilot Boarding Area - aux boiler	3	27.5	-	12	2.3	3,000	0.00	0.08	970	0.002	0.000	0	0.000
	Pilot Boarding to Berth main engine: maneuvering	3	3	15	3	1.0	13,000	0.01	0.031	620	0.012	0.000	0	0.000
	Pilot Boarding to Berth aux engine	3	3	-	3	1.0	3,000	0.35	0.0279	683	0.008	0.000	2	0.000
	Pilot Boarding to Berth aux boiler	3	3	-	3	1.0	3,000	0.12	0.08	970	0.002	0.000	1	0.000
	Berth main engine: hoteling	1	-	-	-	10.0	13,000	0.02	0.144	620	0.260	0.001	3	0.001
	Berth aux engine: hoteling	1	-	-	-	10.0	3,000	0.27	0.0279	683	0.008	0.000	9	0.000
	Berth aux boiler: hoteling	1	-	-	-	10.0	3,000	1.00	0.08	970	0.002	0.004	46	0.000
Medium Vessels	Cruise from Origin to SCAB - main engine	0	0	15	14.7	0.0	9,269	0.94	0.031	620	0.012	0.000	0	0.000
sub-Panamax,	Cruise from Origin to SCAB - aux engine	0	0	-	14.7	0.0	3,000	0.25	0.0279	683	0.008	0.000	0	0.000
	Cruise from Origin to SCAB - aux boiler	0	0	-	14.7	0.0	3,000	0.00	0.08	970	0.002	0.000	0	0.000
	SCAB to Pilot Boarding Area - main engine	0	27.5	15	12	2.3	9,269	0.51	0.031	620	0.012	0.000	0	0.000
	SCAB to Pilot Boarding Area - aux engine	0	27.5	-	12	2.3	3,000	0.25	0.0279	683	0.008	0.000	0	0.000
	SCAB to Pilot Boarding Area - aux boiler	0	27.5	-	12	2.3	3,000	0.00	0.08	970	0.002	0.000	0	0.000
	Pilot Boarding to Berth main engine: maneuvering	0	3	15	3	1.0	9,269	0.01	0.031	620	0.012	0.000	0	0.000
	Pilot Boarding to Berth aux engine	0	3	-	3	1.0	3,000	0.35	0.0279	683	0.008	0.000	0	0.000
	Pilot Boarding to Berth aux boiler	0	3	-	3	1.0	3,000	0.12	0.08	970	0.002	0.000	0	0.000
	Berth main engine: hoteling	0	-	-	-	23.8	9,269	0.02	0.144	620	0.260	0.000	0	0.000
	Berth aux engine: hoteling	0	-	-	-	23.8	3,000	0.27	0.0279	683	0.008	0.000	0	0.000
	Berth aux boiler: hoteling	0	-	-	-	23.8	3,000	1.00	0.08	970	0.002	0.000	0	0.000
Small Vessels	Cruise from Origin to SCAB - main engine	0	0	14	14	0.0	7,673	1.00	0.031	620	0.012	0.000	0	0.000
Barges	Cruise from Origin to SCAB - aux engine	0	0	-	14	0.0	190	0.17	0.0279	683	0.008	0.000	0	0.000
	Cruise from Origin to SCAB - aux boiler	0	0	-	14	0.0	0	0.00	0.08	970	0.002	0.000	0	0.000
	SCAB to Pilot Boarding Area - main engine	0	27.5	14	12	2.3	7,673	0.63	0.031	620	0.012	0.000	0	0.000
	SCAB to Pilot Boarding Area - aux engine	0	27.5	-	12	2.3	190	0.17	0.0279	683	0.008	0.000	0	0.000
	SCAB to Pilot Boarding Area - aux boiler	0	27.5	-	12	2.3	0	0.00	0.08	970	0.002	0.000	0	0.000
	Pilot Boarding to Berth main engine: maneuvering	0	3	14	3	1.0	7,673	0.01	0.031	620	0.012	0.000	0	0.000
	Pilot Boarding to Berth aux engine	0	3	-	3	1.0	190	0.45	0.0279	683	0.008	0.000	0	0.000
	Pilot Boarding to Berth aux boiler	0	3	-	3	1.0	0	0.00	0.08	970	0.002	0.000	0	0.000
	Berth main engine: hoteling	0	-	-	-	6.0	7,673	0	0.144	620	0.260	0.000	0	0.000
	Berth aux engine: hoteling	0	-	-	-	6.0	190	0.22	0.0279	683	0.008	0.000	0	0.000
	Berth aux boiler: hoteling	0	-	-	-	6.0	0	0.00	0.08	970	0.002	0.000	0	0.000

Table 57 (cont.)
Marine Tanker Main Engine, Aux Engine and Aux Boiler GHG Emissions - Alternatives

	Mode	Activities per year	Distance, nm	Max Speed (knts)	Speed (knts)	Time (hr/activity)	Engine MCR kW	Load Factor	N_2O (g/kw-hr)	CO_2 (g/kw-hr)	CH_4 (g/kw-hr)	N_2O (tons/yr)	CO_2 (tons/yr)	CH_4 (tons/yr)
VESSELS TO/FROM THE NORTH														
VLCC	Cruise from Origin to SCAB - main engine	0	11500	16.9	15.5	740.0	25,400	0.78	0.031	620	0.012	0.000	0	0.000
	Cruise from Origin to SCAB - aux engine	0	11500	-	15.5	740.0	3,000	0.25	0.0279	683	0.008	0.000	0	0.000
	Cruise from Origin to SCAB - aux boiler	0	11500	-	15.5	740.0	3,000	0.00	0.08	970	0.002	0.000	0	0.000
	SCAB to Pilot Boarding Area - main engine	0	26.1	16.9	12	2.2	25,400	0.36	0.031	620	0.012	0.000	0	0.000
	SCAB to Pilot Boarding Area - aux engine	0	26.1	-	12	2.2	3,000	0.25	0.0279	683	0.008	0.000	0	0.000
	SCAB to Pilot Boarding Area - aux boiler	0	26.1	-	12	2.2	3,000	0.00	0.08	970	0.002	0.000	0	0.000
	Pilot Boarding to Berth main engine: maneuvering	0	3	16.9	3	1.0	25,400	0.01	0.031	620	0.012	0.000	0	0.000
	Pilot Boarding to Berth aux engine	0	3	-	3	1.0	3,000	0.35	0.0279	683	0.008	0.000	0	0.000
	Pilot Boarding to Berth aux boiler	0	3	-	3	1.0	3,000	0.12	0.08	970	0.002	0.000	0	0.000
	Berth main engine: hoteling	0	-	-	-	40.0	25,400	0.02	0.144	620	0.260	0.000	0	0.000
	Berth aux engine: hoteling	0	-	-	-	40.0	3,000	0.27	0.0279	683	0.008	0.000	0	0.000
	Berth aux boiler: hoteling	0	-	-	-	40.0	3,000	1.00	0.08	970	0.002	0.000	0	0.000
Large Vessels	Cruise from Origin to SCAB - main engine	0	20	15	14.7	1.4	13,000	0.94	0.031	620	0.012	0.000	0	0.000
Panamax,	Cruise from Origin to SCAB - aux engine	0	20	-	14.7	1.4	3,000	0.25	0.0279	683	0.008	0.000	0	0.000
Aframax,	Cruise from Origin to SCAB - aux boiler	0	20	-	14.7	1.4	3,000	0.00	0.08	970	0.002	0.000	0	0.000
Suezmax	SCAB to Pilot Boarding Area - main engine	0	26.1	15	12	2.2	13,000	0.51	0.031	620	0.012	0.000	0	0.000
	SCAB to Pilot Boarding Area - aux engine	0	26.1	-	12	2.2	3,000	0.25	0.0279	683	0.008	0.000	0	0.000
	SCAB to Pilot Boarding Area - aux boiler	0	26.1	-	12	2.2	3,000	0.00	0.08	970	0.002	0.000	0	0.000
	Pilot Boarding to Berth main engine: maneuvering	0	3	15	3	1.0	13,000	0.01	0.031	620	0.012	0.000	0	0.000
	Pilot Boarding to Berth aux engine	0	3	-	3	1.0	3,000	0.35	0.0279	683	0.008	0.000	0	0.000
	Pilot Boarding to Berth aux boiler	0	3	-	3	1.0	3,000	0.12	0.08	970	0.002	0.000	0	0.000
	Berth main engine: hoteling	0	-	-	-	10.0	13,000	0.02	0.144	620	0.260	0.000	0	0.000
	Berth aux engine: hoteling	0	-	-	-	10.0	3,000	0.27	0.0279	683	0.008	0.000	0	0.000
	Berth aux boiler: hoteling	0	-	-	-	10.0	3,000	1.00	0.08	970	0.002	0.000	0	0.000
Medium Vessels	Cruise from Origin to SCAB - main engine	0	0	15	14.7	0.0	9,269	0.94	0.031	620	0.012	0.000	0	0.000
sub-Panamax,	Cruise from Origin to SCAB - aux engine	0	0	-	14.7	0.0	3,000	0.25	0.0279	683	0.008	0.000	0	0.000
	Cruise from Origin to SCAB - aux boiler	0	0	-	14.7	0.0	3,000	0.00	0.08	970	0.002	0.000	0	0.000
	SCAB to Pilot Boarding Area - main engine	0	26.1	15	12	2.2	9,269	0.51	0.031	620	0.012	0.000	0	0.000
	SCAB to Pilot Boarding Area - aux engine	0	26.1	-	12	2.2	3,000	0.25	0.0279	683	0.008	0.000	0	0.000
	SCAB to Pilot Boarding Area - aux boiler	0	26.1	-	12	2.2	3,000	0.00	0.08	970	0.002	0.000	0	0.000
	Pilot Boarding to Berth main engine: maneuvering	0	3	15	3	1.0	9,269	0.01	0.031	620	0.012	0.000	0	0.000
	Pilot Boarding to Berth aux engine	0	3	-	3	1.0	3,000	0.35	0.0279	683	0.008	0.000	0	0.000
	Pilot Boarding to Berth aux boiler	0	3	-	3	1.0	3,000	0.12	0.08	970	0.002	0.000	0	0.000
	Berth main engine: hoteling	0	-	-	-	23.8	9,269	0.02	0.144	620	0.260	0.000	0	0.000
	Berth aux engine: hoteling	0	-	-	-	23.8	3,000	0.27	0.0279	683	0.008	0.000	0	0.000
	Berth aux boiler: hoteling	0	-	-	-	23.8	3,000	1.00	0.08	970	0.002	0.000	0	0.000
Small Vessels	Cruise from Origin to SCAB - main engine	224	350	14	14	25.0	7,673	1.00	0.031	620	0.012	1.465	29,293	0.567
Barges	Cruise from Origin to SCAB - aux engine	224	350	-	14	25.0	190	0.17	0.0279	683	0.008	0.006	136	0.002
	Cruise from Origin to SCAB - aux boiler	224	350	-	14	25.0	0	0.00	0.08	970	0.002	0.000	0	0.000
	SCAB to Pilot Boarding Area - main engine	224	26.1	14	12	2.2	7,673	0.63	0.031	620	0.012	0.080	1,605	0.031
	SCAB to Pilot Boarding Area - aux engine	224	26.1	-	12	2.2	190	0.17	0.0279	683	0.008	0.000	12	0.000
	SCAB to Pilot Boarding Area - aux boiler	224	26.1	-	12	2.2	0	0.00	0.08	970	0.002	0.000	0	0.000
	Pilot Boarding to Berth main engine: maneuvering	224	3	14	3	1.0	7,673	0.01	0.031	620	0.012	0.001	12	0.000
	Pilot Boarding to Berth aux engine	224	3	-	3	1.0	190	0.45	0.0279	683	0.008	0.001	14	0.000
	Pilot Boarding to Berth aux boiler	224	3	-	3	1.0	0	0.00	0.08	970	0.002	0.000	0	0.000
	Berth main engine: hoteling	112	-	-	-	6.0	7,673	0	0.144	620	0.260	0.000	0	0.000
	Berth aux engine: hoteling	112	-	-	-	6.0	190	0.22	0.0279	683	0.008	0.001	21	0.000
	Berth aux boiler: hoteling	112	-	-	-	6.0	0	0.00	0.08	970	0.002	0.000	0	0.000

Table 57 Notes

Total Annual Vessel visits,	456	2040 average vessel calls with no lightering vesssels
VLCC offloading rate, bph	50,000	based on tanker pumps
Large vessel offloading rate, bph	50,000	based on tanker pumps
Medium vessel offloading rate, bph	8,400	based on Berth 3 pumping rate
Small vessel offloading rate, bph	8,400	based on Berth 3 pumping rate
VLCC size, bbls	2,000,000	based on minimum size for VLCC
Large vessel size, bbls	500,000	based on Panamax size
Medium vessel size, bbls	200,000	estimated
Small vessel size, bbls	50,000	estimated

AQCZ = Air Quality Compliance Zone

GHG emission factors from POLA Inventory of Air Emissions 2007

Cruise and maneuvering includes both in and out (twice for each vessel call)

Load factor calculated based on propeller law of LF=(speed/max speed)^3

Hoteling main engine emission factor increased by low load adjustment factor (POLA 2007). No cold ironing assumed (shore-side electricity)

Auxillary engine size and load factor based on Tankers:general from POLA 2007

Emissions based on auxillary engines burning MDO 0.5% sulfur (affects N2O emissions)

Vessel parameters taken from Pier 400 and POLA 2007

Origin distances: VLCC to/from Persian Gulf, Large vessels to/from Alaska or Ecuador, medium vessels: to/from Mexico, Small vessels: to/from California ports (50% N to SF and 50% S to SD), approx. as per 1996 EIR

VLCC miles is the travel to the lightering location (assumed 20 nm outside of SCAB)

Direction of travel breakdown, based on 1996 EIR and 2004 volumes imported

	Traffic Direction, fraction of MT calls			
Vessel Size	South before Lightering	South after Lightering	West	North
VLCC	0.10	0.10	0.00	0.00
Large >500k lightering only	0.00	0.00	0.00	0.00
Large >500k	0.00	0.39	0.00	0.00
Medium >200k	0.00	0.01	0.00	0.00
Small/barge	0.00	0.25	0.00	0.25

Estimated Fuel Use within SCAB

46,038,948 Total Annual Kwhr use within SCAB

0.056 Gallons fuel oil per kwh, based on 180 grams fuel per kwh

2,567,806 Gallons of fuel annually

Table 58
Marine Terminal non-Vessel GHG Emissions - Year 2040 Alternative Berth location

Mode		Number	Size, kw	Load Factor	Hours per visit	Number of visits	N_2O (g/kw-hr)	CO_2 (g/kw-hr)	CH_4 (g/kw-hr)	N_2O (tons/yr)	CO_2 (tons/yr)	CH_4 (tons/yr)
Tug Assistance												
	Tugs for large,medium vessels	2	4800	0.5	6	232	0.00636	645	0.089	0.047	4,742	0.654
	Tugs for small/barge vessels	1	4800	0.5	6	224	0.00636	645	0.089	0.023	2,288	0.316
Fugitive Emissions		**VOC Emission Factor, lbs/unit**	**Annual units**	**Units**	**Annual VOC Emissions, tons**	**Vapors VOC fraction**	**Vapors CH4 fraction**	**Vapor CO2 fraction**		**N_2O (tons/yr)**	**CO_2 (tons/yr)**	**CH_4 (tons/yr)**
	Fugitive emissions from loading/unloading	2	1.18E+05	kbbls unloaded	118.2	0.5	0.1	0.05		0	11.8	23.6
	Fugitive emissions from Marine Terminal onshore components	-	-	-	10	0.5	0.1	0.05		0	1.0	2.0
	Fugitive emissions from tankage	-	-	-	45.4	0.5	0.1	0.05		0	4.5	9.1
Electrical Generation		**Annual Electrical Use, MWh**					**N_2O (tons/MWh)**	**CO_2 (tons/MWh)**	**CH_4 (tons/MWh)**	**N_2O (tons/yr)**	**CO_2 (tons/yr)**	**CH_4 (tons/yr)**
	Pump electrical power requirements	9,456					0	0.3425	0	0	3,239	0
Offsite Vehicles		**Number of trips/day**	**RT distance, miles**	**Days/ year**	**Total Annual Miles**		**N_2O (g/mile)**	**CO_2 (kg/gallon)**	**CH_4 (g/mile)**	**N_2O (tons/yr)**	**CO_2 (tons/yr)**	**CH_4 (tons/yr)**
	Marine Terminal employees	9	50	365	164,250		0.0083	8.55	0.0145	0.0015	69	0.00262

Notes

Tug characteristics and GHG EF from Pier 400 EIR

Tug hours per visit based on arrival and departure, from pilot area to berth

VOC, Methane and CH4 fractions of fugitive emissions based on MT SCAQMD annual reporting

Electric power GHG emission factor, tons per MWhr, from eGRID and CalISO with modifications to removed closed power plants (such as Mojave)

Offsite vehicle gas milage, mpg (EMFAC2007 LDA all, avg speed 25 mph, 63F, 75RH, LA Area) *22.5*

Offshire vehicle GHG EF based on ARB compendium of emission factors, appendix A, model year 2004

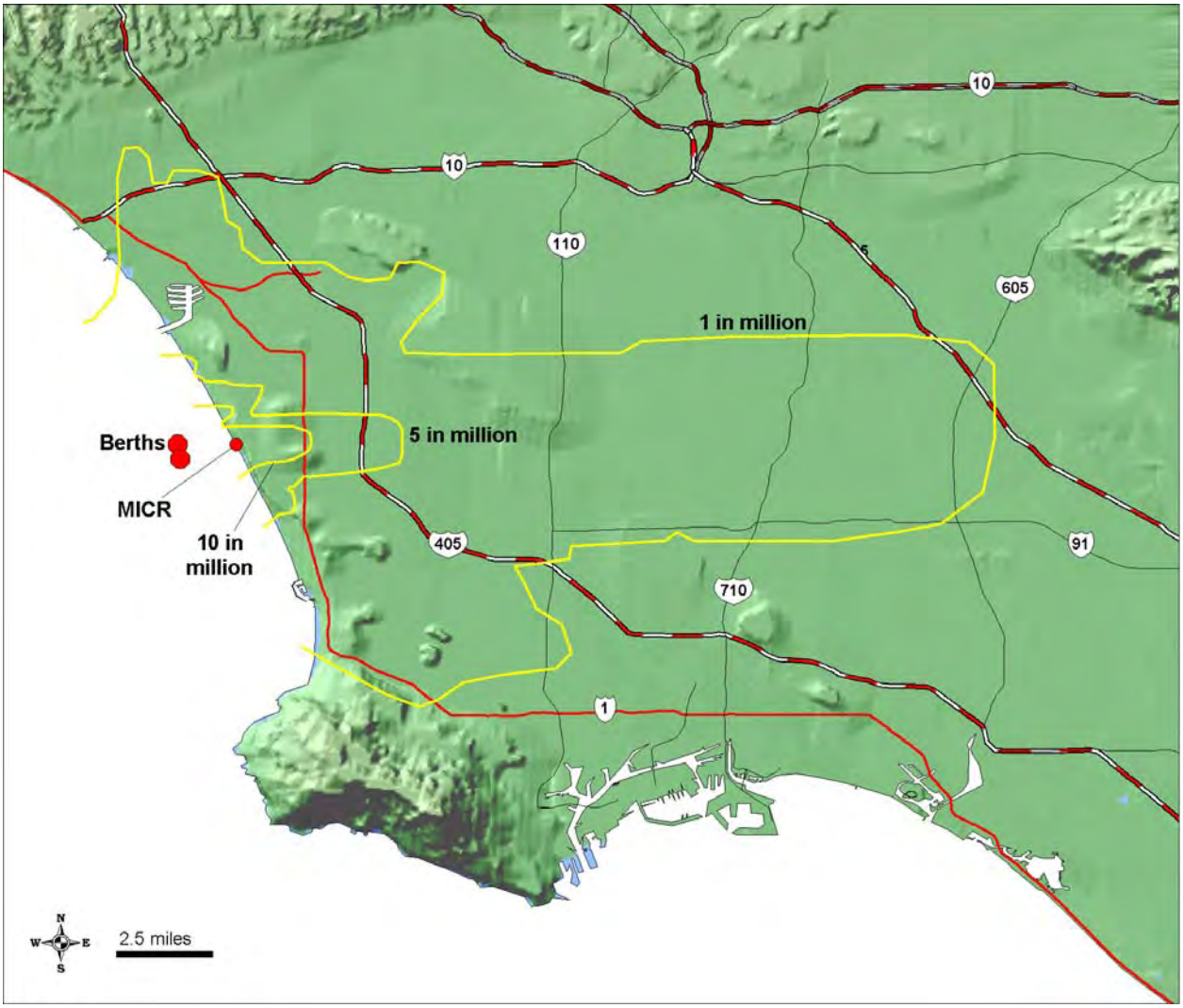
Tug fuel use, annual gallons, using 180 g/kwh BSFC --> *554,873*

Table 59
Marine Terminal GHG Emissions Summary - Year 2040 Alternative Berth location

Activity		N_2O (tons/yr)	CO_2 (tons/yr)	CH_4 (tons/yr)
Within SCAB				
Vessel movements - engines/boilers		2.4	36,306	0.9
Tug assistance		0.07	7,030	1.0
MT fugitive emissions (loading/offloading, components, tanks)		0.0	17.4	34.7
MT Indirect (electrical and offsite)		0.001	3,307	0.003
Totals, tons/year		2.4	46,661	36.5
Total, CO2E equivalent, metric tonnes per year		43,364		
Current CO2E, metric tonnes		37,317		
Increase		6,047		
Within California				
Vessel movements - engines/boilers		4.0	69,267	1.5
Tug assistance		0.07	7,030	1.0
MT fugitive emissions (loading/offloading, components, tanks)		0.0	17	34.7
MT Indirect (electrical and offsite)		0.001	3,307	0.003
Totals, tons/year		4.1	79,622	37.2
Total, CO2E equivalent, metric tonnes per year		73,501		
Current CO2E, metric tonnes		55,014		
Increase		18,486		
Outside of SCAB and California - Worldwide				
Vessel movements - engines/boilers		87.5	1,766,713	33.5
Total, CO2E equivalent, metric tonnes per year		1,615,090		
Current		950,845		
Increase		664,245		

Notes: emissions from barges traveling along the California coast are assumed to be entirely within California

DPM Cancer Contours for Current Operations



```
** ISC input file generated by GCC
** Date: 4/9/2009

CO STARTING

   TITLEONE EL SEGUNDO MARINE TERMINAL EMISSIONS
   TITLETWO OPERATIONS DPM ANNUAL ANALYSIS
   MODELOPT DFAULT CONC URBAN  NOCALM
   AVERTIME period
   POLLUTID PM
   TERRHGTS ELEV
   RUNORNOT RUN
   ERRORFIL e:\isc\ISC_CO.ERR
   FLAGPOLE 0.0

CO FINISHED
** UTMZONE  11

** SRCPARAM  LOCATION - g/M2sec - height - x width - y width
SO STARTING

   ELEVUNIT  FEET

   LOCATION  1  AREA  365675  3753282  0
   SRCPARAM  1  8.0E-05  20  50  50

   SRCGROUP 1 1

SO FINISHED


RE STARTING

   ELEVUNIT  FEET

100 meter grid spacing onshore only


RE FINISHED


ME STARTING
```

```
   INPUTFIL e:\isc\lennox.asc

   ANEMHGHT 10  METERS

   SURFDATA 52118  81  LosAngeles

   UAIRDATA 91919  81  LosAngeles

   STARTEND 81  1  1  81  12  31


ME FINISHED


OU STARTING


   POSTFILE period 1 plot isc_els.pst


OU FINISHED

 *** Message Summary For ISC3 Model Setup ***

 --------- Summary of Total Messages --------

A Total of            0 Fatal Error Message(s)
A Total of            2 Warning Message(s)
A Total of            0 Informational Message(s)

   ******** FATAL ERROR MESSAGES ********
              ***  NONE  ***

   ********   WARNING MESSAGES   ********
ME W360  2581 SET_WI:2-Digit Year Specified: Valid for Range 1950-2049  SURFDATA
CO W206     8 MODOPT:Regulatory DFAULT Overrides Non-DFAULT Option For  NOCALM

***********************************
*** SETUP Finishes Successfully ***
***********************************

• *** ISCST3 - VERSION 02035 ***    *** EL SEGUNDO MARINE TERMINAL EMISSIONS                                ***
       04/14/09
                                   *** OPERATIONS DPM ANNUAL ANALYSIS                                ***
      11:42:55
**MODELOPTs:
      PAGE   1
CONC                    URBAN ELEV  FLGPOL DFAULT


                                           ***     MODEL SETUP OPTIONS SUMMARY       ***
- - - - - - - - - - - - - - - - - - - - - - - - - - - - - - - - - - - - - - - - - - - - - - - - - - - - - - - - -
- - - - - - -

**Intermediate Terrain Processing is Selected

**Model Is Setup For Calculation of Average CONCentration Values.

  --  SCAVENGING/DEPOSITION LOGIC --
**Model Uses NO DRY DEPLETION.  DDPLETE =  F
**Model Uses NO WET DEPLETION.  WDPLETE =  F
**NO WET SCAVENGING Data Provided.
**NO GAS DRY DEPOSITION Data Provided.
**Model Does NOT Use GRIDDED TERRAIN Data for Depletion Calculations

**Model Uses URBAN Dispersion.

**Model Uses Regulatory DEFAULT Options:
           1. Final Plume Rise.
           2. Stack-tip Downwash.
           3. Buoyancy-induced Dispersion.
           4. Use Calms Processing Routine.
           5. Not Use Missing Data Processing Routine.
           6. Default Wind Profile Exponents.
           7. Default Vertical Potential Temperature Gradients.
```

```
          8. "Upper Bound" Values for Supersquat Buildings.
          9. No Exponential Decay for URBAN/Non-SO2

**Model Accepts Receptors on ELEV Terrain.

**Model Accepts FLAGPOLE Receptor Heights.

**Model Calculates PERIOD Averages Only

**This Run Includes:     1 Source(s);      1 Source Group(s); and    2535 Receptor(s)

**The Model Assumes A Pollutant Type of:  PM

**Model Set To Continue RUNning After the Setup Testing.

**Output Options Selected:
         Model Outputs Tables of PERIOD Averages by Receptor
         Model Outputs External File(s) of Concurrent Values for Postprocessing (POSTFILE Keyword)

**NOTE:  The Following Flags May Appear Following CONC Values:  c for Calm Hours
                                                                m for Missing Hours
                                                                b for Both Calm and Missing Hours

**Misc. Inputs:  Anem. Hgt. (m) =    10.00 ;    Decay Coef. =    0.000     ;    Rot. Angle =     0.0
                 Emission Units = GRAMS/SEC                                ;  Emission Rate Unit Factor =
0.10000E+07
                 Output Units   = MICROGRAMS/M**3

**Approximate Storage Requirements of Model =     1.3 MB of RAM.

**Input Runstream File:          isc_els.inp

**Output Print File:             isc_els.out

**Detailed Error/Message File:   e:\isc\ISC_CO.ERR

• *** ISCST3 - VERSION 02035 ***    *** EL SEGUNDO MARINE TERMINAL EMISSIONS                                  ***
       04/14/09
                                    *** OPERATIONS DPM ANNUAL ANALYSIS                                       ***
      11:42:55
**MODELOPTs:
      PAGE   2
CONC                    URBAN ELEV  FLGPOL DFAULT



                                                   *** AREA SOURCE DATA ***

             NUMBER EMISSION RATE  COORD (SW CORNER)  BASE     RELEASE  X-DIM     Y-DIM    ORIENT.    INIT.
EMISSION RATE
   SOURCE     PART.  (GRAMS/SEC       X        Y      ELEV.    HEIGHT  OF AREA   OF AREA   OF AREA     SZ
SCALAR VARY
     ID       CATS.   /METER**2)   (METERS) (METERS) (METERS) (METERS) (METERS)  (METERS)   (DEG.)  (METERS)
 BY
- - - - - - - - - - - - - - - - - - - - - - - - - - - - - - - - - - - - - - - - - - - - - - - - - - - - - - - - - - -
- - - - - - -

  1             0   0.80000E-04  365675.0 3753282.0     0.0    20.00     50.00     50.00      0.00     0.00

• *** ISCST3 - VERSION 02035 ***    *** EL SEGUNDO MARINE TERMINAL EMISSIONS                                  ***
       04/14/09
                                    *** OPERATIONS DPM ANNUAL ANALYSIS                                       ***
      11:42:55
**MODELOPTs:
      PAGE   3
CONC                    URBAN ELEV  FLGPOL DFAULT



CONC                    URBAN ELEV  FLGPOL DFAULT

                                             *** THE SUMMARY OF MAXIMUM PERIOD (  8760 HRS) RESULTS ***

                                        ** CONC OF PM       IN MICROGRAMS/M**3                          **

                                                                                                   NETWORK
GROUP ID                      AVERAGE CONC                RECEPTOR  (XR, YR, ZELEV, ZFLAG)   OF TYPE  GRID-ID
- - - - - - - - - - - - - - - - - - - - - - - - - - - - - - - - - - - - - - - - - - - - - - - - - - - - - - - - - - -
- - - -

1        1ST HIGHEST VALUE IS       0.10685 AT (  368104.00,  3753253.00,      0.00,      2.00)  DC      NA
```

```
         2ND HIGHEST VALUE IS       0.10141 AT (  368104.00,  3753503.00,      0.00,      2.00)  DC      NA
         3RD HIGHEST VALUE IS       0.09188 AT (  368354.00,  3753253.00,      0.00,      2.00)  DC      NA
         4TH HIGHEST VALUE IS       0.08819 AT (  368354.00,  3753503.00,      0.00,      2.00)  DC      NA
         5TH HIGHEST VALUE IS       0.08481 AT (  368354.00,  3753003.00,      0.00,      2.00)  DC      NA
         6TH HIGHEST VALUE IS       0.08021 AT (  368604.00,  3753253.00,      0.00,      2.00)  DC      NA
         7TH HIGHEST VALUE IS       0.07760 AT (  368604.00,  3753503.00,      0.00,      2.00)  DC      NA
         8TH HIGHEST VALUE IS       0.07531 AT (  368604.00,  3753003.00,      0.00,      2.00)  DC      NA
         9TH HIGHEST VALUE IS       0.07386 AT (  368104.00,  3753753.00,      0.00,      2.00)  DC      NA
        10TH HIGHEST VALUE IS       0.07089 AT (  368854.00,  3753253.00,      0.00,      2.00)  DC      NA


 *** RECEPTOR TYPES:  GC = GRIDCART
                      GP = GRIDPOLR
                      DC = DISCCART
                      DP = DISCPOLR
                      BD = BOUNDARY
• *** ISCST3 - VERSION 02035 ***    *** EL SEGUNDO MARINE TERMINAL EMISSIONS                                  ***
       04/14/09
                                   *** OPERATIONS DPM ANNUAL ANALYSIS                                        ***
      11:42:55
**MODELOPTs:
      PAGE  68
CONC                    URBAN ELEV  FLGPOL DFAULT


*** Message Summary : ISCST3 Model Execution ***

 --------- Summary of Total Messages --------

A Total of            0 Fatal Error Message(s)
A Total of            2 Warning Message(s)
A Total of         1120 Informational Message(s)

A Total of         1120 Calm Hours Identified


   ******** FATAL ERROR MESSAGES ********
              ***  NONE  ***


   ********   WARNING MESSAGES   ********
ME W360  2581 SET_WI:2-Digit Year Specified: Valid for Range 1950-2049  SURFDATA
CO W206     8 MODOPT:Regulatory DFAULT Overrides Non-DFAULT Option For  NOCALM

   ************************************
   *** ISCST3 Finishes Successfully ***
   ************************************
```