APPENDIX D
EMISSIONS AND MODELING SUMMARY

List of Summary

WesPac Pittsburg

D - 1. Construction Emission Summary - Scenario 1 and Scenario 2

Total Construction Emissions - Proposed Project

Pollutant Emissions:	POC (tons)	NOx (tons)	PM_{10} Exhaust (tons)	$PM_{2.5}$ Exhaust (tons)	PM_{10} Dust (tons)	$PM_{2.5}$ Dust (tons)
Scenario 1 (Unmitigated)	6.8	45.1	3.0	3.0	11.2	1.1
Scenario 1 (Mitigated)	11.1	31.6	1.5	1.5	11.2	1.1
Scenario 2 (Unmitigated)	12.7	54.4	3.6	3.6	7.3	0.7
Scenario 2 (Mitigated)	16.8	41.2	2.0	2.0	7.3	0.7

Total Construction Emissions - Alternative 1 Project

Pollutant Emissions:	POC (tons)	NOx (tons)	PM_{10} Exhaust (tons)	$PM_{2.5}$ Exhaust (tons)	PM_{10} Dust (tons)	$PM_{2.5}$ Dust (tons)
Scenario 1 (Unmitigated)	6.8	45.1	3.0	3.0	11.2	1.1
Scenario 1 (Mitigated)	11.1	31.6	1.5	1.5	11.2	1.1
Scenario 2 (Unmitigated)	11.5	52.0	3.4	3.4	6.1	0.6
Scenario 2 (Mitigated)	15.5	39.7	2.0	2.0	6.1	0.6

Average Daily Construction Emissions - Proposed Project

Pollutant Emissions:	POC (lb/day)	NOx (lb/day)	PM_{10} Exhaust (lb/day)	$PM_{2.5}$ Exhaust (lb/day)	PM_{10} Dust (lb/day)
Scenario 1 (Unmitigated)	37	247	17	17	61
Scenario 1 (Mitigated)	61	173	8	8	61
Scenario 2 (Unmitigated)	64	275	18	18	37
Scenario 2 (Mitigated)	85	208	10	10	37

Annual Daily Construction Emissions - Alternative 1 Project

Pollutant Emissions[2]:	POC (lb/day)	NOx (lb/day)	PM_{10} Exhaust (lb/day)	$PM_{2.5}$ Exhaust (lb/day)	PM_{10} Dust (lb/day)
Scenario 1 (Unmitigated)	37	247	17	17	61
Scenario 1 (Mitigated)	61	173	8	8	61
Scenario 2 (Unmitigated)	58	263	17	17	31
Scenario 2 (Mitigated)	78	201	10	10	31

D - 2. Vessel Emissions Summary

Proposed Project Emission Model Inputs and Results
Tanker Engine Emissions

216 vessels/yr

Vessel Operations	Engine		Maximum		Emission Factors[1,2] (g/kW-hr)									Emissions[3,4]																				
														Maximum Daily (lb/call)									Annual (tons)						Annual (metric tons)			
	Power	Load Factor																																
	kW	%	Hrs/Call	Hrs/Year	CO	NO_x	SO_2	POC	PM_{10}	$PM_{2.5}$	CO_2	CH_4	N_2O	CO	NO_x	SO_2	POC	PM_{10}	$PM_{2.5}$	CO_2	CH_4	N_2O	CO_2e	CO	NO_x	SO_2	POC	PM_{10}	$PM_{2.5}$	CO_2	CH_4	N_2O	CO_2e
Main Engine Transit Leg 1 (and out)	10,300	77%	3.31	715	1.10	17.00	0.36	0.78	0.25	0.25	588	0.07	0.008	63.91	987.69	20.92	45.32	14.52	14.52	34,162	4.07	0.44	34,386	6.90	106.67	2.26	4.89	1.57	1.57	3,347	0.398	0.0436	3,368
Main Engine Transit Leg 2 (and out)	10,300	62%	2.07	448	1.10	17.00	0.36	0.78	0.25	0.25	588	0.07	0.008	32.32	499.42	10.58	22.91	7.34	7.34	17,274	2.06	0.22	17,387	3.49	53.94	1.14	2.47	0.79	0.79	1,692	0.201	0.0220	1,703
Main Engine Transit Leg 3 (and out)	10,300	25%	2.00	432	1.10	17.00	0.36	0.78	0.25	0.25	588	0.07	0.008	12.67	195.74	4.15	8.98	2.88	2.88	6,770	0.81	0.09	6,814	1.37	21.14	0.45	0.97	0.31	0.31	663	0.079	0.0086	668
Main Engine Maneuvering Leg 4 (and out)	10,300	5.5%	2.00	432	1.10	17.00	0.36	0.78	0.25	0.25	588	0.07	0.008	9.77	73.41	1.55	10.16	1.42	1.42	2,489	0.17	0.02	2,498	1.06	7.93	0.17	1.10	0.15	0.15	244	0.017	0.0019	245
Main Engine Maneuvering Leg 5 - turn around	10,300	5.5%	0.50	108	1.10	17.00	0.36	0.78	0.25	0.25	588	0.07	0.008	2.44	18.35	0.39	2.54	0.35	0.35	622	0.04	0.00	625	0.26	1.98	0.04	0.27	0.04	0.04	61	0.004	0.0005	61
Auxiliary Engine Transit Leg 1 (and out)	2,145	28%	3.31	715	1.10	13.90	0.40	0.52	0.25	0.25	690	0.09	0.008	4.82	60.93	1.75	2.28	1.10	1.10	3,024	0.39	0.03	3,043	0.52	6.58	0.19	0.25	0.12	0.12	296	0.039	0.0033	298
Auxiliary Engine Transit Leg 2 (and out)	2,145	28%	2.07	448	1.10	13.90	0.40	0.52	0.25	0.25	690	0.09	0.008	3.02	38.17	1.10	1.43	0.69	0.69	1,895	0.25	0.02	1,907	0.33	4.12	0.12	0.15	0.07	0.07	186	0.024	0.0021	187
Auxiliary Engine Transit Leg 3 (and out)	2,145	28%	2.00	432	1.10	13.90	0.40	0.52	0.25	0.25	690	0.09	0.008	2.91	36.81	1.06	1.38	0.66	0.66	1,827	0.24	0.02	1,839	0.31	3.98	0.11	0.15	0.07	0.07	179	0.023	0.0020	180
Auxiliary Engine Maneuvering Leg 4 (and out)	2,145	28%	2.00	432	1.10	13.90	0.40	0.52	0.25	0.25	690	0.09	0.008	2.91	36.81	1.06	1.38	0.66	0.66	1,827	0.24	0.02	1,839	0.31	3.98	0.11	0.15	0.07	0.07	179	0.023	0.0020	180
Auxiliary Engine Maneuvering Leg 5 - Turn Around	2,145	28%	0.50	108	1.10	13.90	0.40	0.52	0.25	0.25	690	0.09	0.008	0.73	9.20	0.26	0.34	0.17	0.17	457	0.06	0.01	460	0.08	0.99	0.03	0.04	0.02	0.02	45	0.006	0.0005	45
Auxiliary Engine Leg 6 - Mooring	2,145	28%	1.00	216	1.10	13.90	0.40	0.52	0.25	0.25	690	0.09	0.008	1.46	18.40	0.53	0.69	0.33	0.33	914	0.12	0.01	919	0.16	1.99	0.06	0.07	0.04	0.04	89	0.012	0.0010	90
Auxiliary Engine Leg 7 - Arrival	2,145	28%	2.50	540	1.10	13.90	0.40	0.52	0.25	0.25	690	0.09	0.008	3.64	46.01	1.32	1.72	0.83	0.83	2,284	0.30	0.03	2,298	0.39	4.97	0.14	0.19	0.09	0.09	224	0.029	0.0025	225
Auxiliary Engine Leg 8 - Hotelling	2,145	55%	10.75	2,322	1.10	13.90	0.40	0.52	0.25	0.25	690	0.09	0.008	30.75	388.56	11.18	14.54	6.99	6.99	19,288	2.52	0.21	19,408	3.32	41.96	1.21	1.57	0.75	0.75	1,889	0.246	0.0210	1,901
Auxiliary Engine Leg 9 - Departure	2,145	28%	1.00	216	1.10	13.90	0.40	0.52	0.25	0.25	690	0.09	0.008	1.46	18.40	0.53	0.69	0.33	0.33	914	0.12	0.01	919	0.16	1.99	0.06	0.07	0.04	0.04	89	0.012	0.0010	90
Auxiliary Engine Leg 10 - Unmooring	2,145	28%	0.50	108	1.10	13.90	0.40	0.52	0.25	0.25	690	0.09	0.008	0.73	9.20	0.26	0.34	0.17	0.17	457	0.06	0.01	460	0.08	0.99	0.03	0.04	0.02	0.02	45	0.006	0.0005	45
TANKER ENGINES TOTAL EMISSIONS														173.54	2437.11	56.64	114.70	38.43	38.43	94,204	11.44	1.15	94,800	18.74	263.21	6.12	12.39	4.15	4.15	9,228	1.12	0.11	9,287
Max Hourly Emissions for Each Augxiliary Engine (lb/hr)														1.43				0.33	0.33														

Notes:

1. Criteria pollutant and CQ and CH_4 emission factors source: http://www.arb.ca.gov/regact/2008/fuelogv08/appdfuel.pdf; Engine speed for main engine: slow. Engine speed for auxiliary engine: medium. Fuel type: marine distillate, 0.1%S.
2. N_2O emission factor source: CCAR general reporting protocols, v.3.1. http://www.climateregistry.org/resources/docs/protocols/grp/GRP_3.1_January2009.pdf. (Page 35; Page 53 for distillate fuel)
3. Emission = Power x Load Factor x Time x Emission Factor x Low Load Adjustment Factor (for main engines); Calculation method reference: http://www.epa.gov/nonroad/marine/ci/420r09007-chap2.pdf
4. For main engines, Adj = 1 for LF>20%; For loads less than 20% then need to multiply by the Low Load Adjustment Factor. http://www.epa.gov/otaq/regs/nonroad/marine/ci/420r09007-chap1.pdf

Low Load Adjustment Factor for Main Engines:

Pollutant	Load Factor	
	Leg 4	Leg 5
	5.5%	5.5%
CO	3.57	3.57
NOx (4%-20%)	1.74	1.74
SOx (4%-20%)	1.73	1.73
HC	5.24	5.24
PM (4%-20%)	2.28	2.28
CO_2 (4%-20%)	1.70	1.70

Low Load Adjustment Factor Extrapolated Calculation Equations:

CO: $y = 0.2026x^{-0.988}$

NOx: $y = 8598.3x^4 - 4903.3x^3 + 1038.7x^2 - 99.238x + 4.7837$

SOx: $y = -519.87x^3 + 239.55x^2 - 38.161x + 3.1848$

HC: $y = 0.1026x^{1.354}$

PM: $y = 14359x^4 - 8221.7x^3 + 1750.2x^2 - 168.23x + 7.4638$

CO_2: $y = -480.74x^3 + 223.25x^2 - 35.93x + 3.0789$

Notes:

1. Reference: EPA Proposal to Desigate an Emission Control Area for Nitrogen Oxides, Sulfur Oxides and Particulate Matters, 2009, Table 2.7, http://www.epa.gov/otaq/regs/nonroad/marine/ci/420r09007-chap2.pdf
2. x is the load factor, and y is the calculated low load adjustment factor for main engines.

GHG Emission Factors and Global Warming Potential

Greenhouse Gas	Emision Factor		Gobal Warming Potential
	kg/gal	g/kW-hr	
CO_2	-	-	1
CH_4	-	-	21
N_2O	0.0001	0.008	310

Source: CCAR general reporting protocols, v.3.1.http://www.climateregistry.org/resources/docs/protocols/grp/GRP_3.1_January2009.pdf.

Alternative 1 Project Emission Model Inputs and Results
Tanker Engine Emissions

180 vessels/yr

Vessel Operations	Engine		Maximum		Emission Factors[1,2] (g/kW-hr)									Emissions[3,4]																			
														Maximum Daily (lb/call)									Annual (tons)						Annual (metric tons)			
	Power	Load Factor																															
	kW	%	Hrs/Call	Hrs/Year	CO	NO_x	SO_2	POC	PM_{10}	$PM_{2.5}$	CO_2	CH_4	N_2O	CO	NO_x	SO_2	POC	PM_{10}	$PM_{2.5}$	CO_2	CH_4	N_2O	CO_2e	CO	NO_x	SO_2	POC	PM_{10}	$PM_{2.5}$	CO_2	CH_4	N_2O	CO_2e
Main Engine Transit Leg 1 (and out)	10,300	77%	3.31	596	1.10	17.00	0.36	0.78	0.25	0.25	588	0.07	0.008	63.91	987.69	20.92	45.32	14.52	14.52	34,162	4.07	0.44	34,386	5.75	88.89	1.88	4.08	1.31	1.31	2,789	0.332	0.0363	2,807
Main Engine Transit Leg 2 (and out)	10,300	62%	2.07	373	1.10	17.00	0.36	0.78	0.25	0.25	588	0.07	0.008	32.32	499.42	10.58	22.91	7.34	7.34	17,274	2.06	0.22	17,387	2.91	44.95	0.95	2.06	0.66	0.66	1,410	0.168	0.0184	1,419
Main Engine Transit Leg 3 (and out)	10,300	25%	2.00	360	1.10	17.00	0.36	0.78	0.25	0.25	588	0.07	0.008	12.67	195.74	4.15	8.98	2.88	2.88	6,770	0.81	0.09	6,814	1.14	17.62	0.37	0.81	0.26	0.26	553	0.066	0.0072	556
Main Engine Maneuvering Leg 4 (and out)	10,300	5.5%	2.00	360	1.10	17.00	0.36	0.78	0.25	0.25	588	0.07	0.008	9.77	73.41	1.55	10.16	1.42	1.42	2,489	0.17	0.02	2,498	0.88	6.61	0.14	0.91	0.13	0.13	203	0.014	0.0016	204
Main Engine Maneuvering Leg 5 - turn around	10,300	5.5%	0.50	90	1.10	17.00	0.36	0.78	0.25	0.25	588	0.07	0.008	2.44	18.35	0.39	2.54	0.35	0.35	622	0.04	0.00	625	0.22	1.65	0.03	0.23	0.03	0.03	51	0.004	0.0004	51
Auxiliary Engine Transit Leg 1 (and out)	2,145	28%	3.31	596	1.10	13.90	0.40	0.52	0.25	0.25	690	0.09	0.008	4.82	60.93	1.75	2.28	1.10	1.10	3,024	0.39	0.03	3,043	0.43	5.48	0.16	0.21	0.10	0.10	247	0.032	0.0027	248
Auxiliary Engine Transit Leg 2 (and out)	2,145	28%	2.07	373	1.10	13.90	0.40	0.52	0.25	0.25	690	0.09	0.008	3.02	38.17	1.10	1.43	0.69	0.69	1,895	0.25	0.02	1,907	0.27	3.44	0.10	0.13	0.06	0.06	155	0.020	0.0017	156
Auxiliary Engine Transit Leg 3 (and out)	2,145	28%	2.00	360	1.10	13.90	0.40	0.52	0.25	0.25	690	0.09	0.008	2.91	36.81	1.06	1.38	0.66	0.66	1,827	0.24	0.02	1,839	0.26	3.31	0.10	0.12	0.06	0.06	149	0.019	0.0017	150
Auxiliary Engine Maneuvering Leg 4 (and out)	2,145	28%	2.00	360	1.10	13.90	0.40	0.52	0.25	0.25	690	0.09	0.008	2.91	36.81	1.06	1.38	0.66	0.66	1,827	0.24	0.02	1,839	0.26	3.31	0.10	0.12	0.06	0.06	149	0.019	0.0017	150
Auxiliary Engine Maneuvering Leg 5 - Turn Around	2,145	28%	0.50	90	1.10	13.90	0.40	0.52	0.25	0.25	690	0.09	0.008	0.73	9.20	0.26	0.34	0.17	0.17	457	0.06	0.01	460	0.07	0.83	0.02	0.03	0.01	0.01	37	0.005	0.0004	38
Auxiliary Engine Leg 6 - Mooring	2,145	28%	1.00	180	1.10	13.90	0.40	0.52	0.25	0.25	690	0.09	0.008	1.46	18.40	0.53	0.69	0.33	0.33	914	0.12	0.01	919	0.13	1.66	0.05	0.06	0.03	0.03	75	0.010	0.0008	75
Auxiliary Engine Leg 7 - Arrival	2,145	28%	2.50	450	1.10	13.90	0.40	0.52	0.25	0.25	690	0.09	0.008	3.64	46.01	1.32	1.72	0.83	0.83	2,284	0.30	0.03	2,298	0.33	4.14	0.12	0.15	0.07	0.07	186	0.024	0.0021	188
Auxiliary Engine Leg 8 - Hotelling	2,145	55%	10.75	1,935	1.10	13.90	0.40	0.52	0.25	0.25	690	0.09	0.008	30.75	388.56	11.18	14.54	6.99	6.99	19,288	2.52	0.21	19,408	2.77	34.97	1.01	1.31	0.63	0.63	1,575	0.205	0.0175	1,584
Auxiliary Engine Leg 9 - Departure	2,145	28%	1.00	180	1.10	13.90	0.40	0.52	0.25	0.25	690	0.09	0.008	1.46	18.40	0.53	0.69	0.33	0.33	914	0.12	0.01	919	0.13	1.66	0.05	0.06	0.03	0.03	75	0.010	0.0008	75
Auxiliary Engine Leg 10 - Unmooring	2,145	28%	0.50	90	1.10	13.90	0.40	0.52	0.25	0.25	690	0.09	0.008	0.73	9.20	0.26	0.34	0.17	0.17	457	0.06	0.01	460	0.07	0.83	0.02	0.03	0.01	0.01	37	0.005	0.0004	38
TANKER ENGINES TOTAL EMISSIONS														173.54	2437.11	56.64	114.70	38.43	38.43	94,204	11.44	1.15	94,800	15.62	219.34	5.10	10.32	3.46	3.46	7,690	0.93	0.09	7,739
Max Hourly Emissions for Each Augxiliary Engine (lb/hr)														1.43				0.33	0.33														

Notes:

1. Criteria pollutant and CQ and CH_4 emission factors source: http://www.arb.ca.gov/regact/2008/fuelogv08/appdfuel.pdf; Engine speed for main engine: slow. Engine speed for auxiliary engine: medium. Fuel type: marine distillate, 0.1%S.
2. N_2O emission factor source: CCAR general reporting protocols, v.3.1. http://www.climateregistry.org/resources/docs/protocols/grp/GRP_3.1_January2009.pdf. (Page 35; Page 53 for distillate fuel)
3. Emission = Power x Load Factor x Time x Emission Factor x Low Load Adjustment Factor (for main engines); Calculation method reference: http://www.epa.gov/nonroad/marine/ci/420r09007-chap2.pdf
4. For main engines, Adj = 1 for LF>20%; For loads less than 20% then need to multiply by the Low Load Adjustment Factor. http://www.epa.gov/otaq/regs/nonroad/marine/ci/420r09007-chap1.pdf

Low Load Adjustment Factor for Main Engines:

Pollutant	Load Factor	
	Leg 4	Leg 5
	5.5%	5.5%
CO	3.57	3.57
NOx (4%-20%)	1.74	1.74
SOx (4%-20%)	1.73	1.73
HC	5.24	5.24
PM (4%-20%)	2.28	2.28
CO_2 (4%-20%)	1.70	1.70

Low Load Adjustment Factor Extrapolated Calculation Equations:

CO: $y = 0.2026x^{-0.988}$

NOx: $y = 8598.3x^4 - 4903.3x^3 + 1038.7x^2 - 99.238x + 4.7837$

SOx: $y = -519.87x^3 + 239.55x^2 - 38.161x + 3.1848$

HC: $y = 0.1026x^{1.354}$

PM: $y = 14359x^4 - 8221.7x^3 + 1750.2x^2 - 168.23x + 7.4638$

CO_2: $y = -480.74x^3 + 223.25x^2 - 35.93x + 3.0789$

Notes:

1. Reference: EPA Proposal to Desigate an Emission Control Area for Nitrogen Oxides, Sulfur Oxides and Particulate Matters, 2009, Table 2.7, http://www.epa.gov/otaq/regs/nonroad/marine/ci/420r09007-chap2.pdf
2. x is the load factor, and y is the calculated low load adjustment factor for main engines.

GHG Emission Factors and Global Warming Potential

Greenhouse Gas	Emision Factor		Gobal Warming Potential
	kg/gal	g/kW-hr	
CO_2	-	-	1
CH_4	-	-	21
N_2O	0.0001	0.008	310

Source: CCAR general reporting protocols, v.3.1.http://www.climateregistry.org/resources/docs/protocols/grp/GRP_3.1_January2009.pdf.

D - 3. Boiler Emissions Summary

Proposed Project Emission Model Inputs and Results
Vessel Boiler Emissions

216 Vessels/yr

Vessel Operations	Fuel Consumption (lb/1000 bbl offloaded)	Load Factor	Boiler Inerting Savings (lb/1000 bbl offloaded)	Cargo Size (bbl)	Activity Time (hr)	Pumping Rate (bbl/hr)	Emission Factors[1,2,3] (lb/1000gal)									Emissions[4,5] Maximum Daily (lbs)									Annual (tons)						Annual (metric tons)			
							CO	NO_x	SO_2	POC	PM_{10}	$PM_{2.5}$	CO_2	CH_4	N_2O	CO	NO_x	SO_2	POC	PM_{10}	$PM_{2.5}$	CO_2	CH_4	N_2O	CO_2e	CO	NO_x	SO_2	POC	PM_{10}	$PM_{2.5}$	CO_2	CH_4	N_2O	CO_2e
Boiler Leg 4 - Manuevering	78.5	30%	N/A	325,000	1.0	33,340	5.00	20.00	14.20	0.20	2.30	1.55	22,388	3.307	0.220	0.55	2.21	1.57	0.02	0.25	0.17	2,476	0.37	0.02	2,491	0.06	0.24	0.17	0.002	0.03	0.02	243	0.04	0.002	244
Boiler Leg 5 - Turn Around	78.5	30%	N/A	325,000	0.5	33,340	5.00	20.00	14.20	0.20	2.30	1.55	22,388	3.307	0.220	0.28	1.11	0.79	0.01	0.13	0.09	1,238	0.18	0.01	1,245	0.03	0.12	0.08	0.001	0.01	0.01	121	0.02	0.001	122
Boiler Leg 6 - Mooring	78.5	30%	N/A	325,000	1.0	33,340	5.00	20.00	14.20	0.20	2.30	1.55	22,388	3.307	0.220	0.55	2.21	1.57	0.02	0.25	0.17	2,476	0.37	0.02	2,491	0.06	0.24	0.17	0.002	0.03	0.02	243	0.04	0.002	244
Boiler Leg 7 - Arrival	78.5	30%	N/A	325,000	2.5	33,340	5.00	20.00	14.20	0.20	2.30	1.55	22,388	3.307	0.220	1.38	5.53	3.93	0.06	0.64	0.43	6,189	0.91	0.06	6,227	0.15	0.60	0.42	0.006	0.07	0.05	606	0.09	0.006	610
Boiler Leg 8 - Hotelling[3]	78.5	N/A	28.06	325,000	10.7	33,340	5.00	20.00	14.20	0.20	2.30	1.55	22,388	3.307	0.220	11.54	46.18	32.79	0.46	5.31	3.58	51,690	7.64	0.51	52,008	1.25	4.99	3.54	0.050	0.57	0.39	5,064	0.75	0.050	5,095
BOILER TOTAL EMISSIONS																14.31	57.24	40.64	0.57	6.58	4.44	64,069	9.46	0.63	64,463	1.55	6.18	4.39	0.06	0.71	0.48	6,276	0.93	0.06	6,315
Max Hourly Boiler Emissions (lb/hr)																1.07				0.49	0.33														

Notes:

1. Criteria pollutant emission factors were obtained from EPA AP-42 fuel oil combustions (industrial boilers and distillate oil fired for CO, NOx, SO, HC, PM_{10}, and $PM_{2.5}$); http://www.epa.gov/ttn/chief/ap42/ch01/final/c01s03.pdf
2. PM_{10} and $PM_{2.5}$ EFs for boiler emissions were obtained by each summing the corresponding condensable PM_{10} EF and $PM_{2.5}$ EF from AP42 Table 1.3-2 and the corresponding filterable PM10 EF and PM2.5 EF from AP42 Table 1.3-6.
3. Greenhouse gases (CO_2, CH_4, N_2O) emission factor source: CCAR general reporting protocols, v.3.1. http://www.climateregistry.org/resources/docs/protocols/grp/GRP_3.1._January2009.pdf. (Page 35 and Page 53 for distillate fuel)
4. Emission = Fuel Consumption x Load Factor x Pumping Rate x Time x Emission Factor
5. Emission (hoteling) = (Fuel Consumption - Inerting Savings) x Cargo Size x Emission Factor

GHG Emission Factors

Greenhouse Gas	Emision Factor kg/gallon	Emision Factor lb/1000gal	Gobal Warming Potential
CO2	10.155	22388	1
CH4	0.0015	3.307	21
N_2O	0.0001	0.220	310

Source: CCAR general reporting protocols, v.3.1.http://www.climateregistry.org/resources/docs/protocols/grp/GRP_3.1._January2

Alternative 1 Project Emission Model Inputs and Results
Vessel Boiler Emissions

180 Vessels/yr

Vessel Operations	Fuel Consumption (lb/1000 bbl offloaded)	Load Factor	Boiler Inerting Savings (lb/1000 bbl offloaded)	Cargo Size (bbl)	Activity Time (hr)	Pumping Rate (bbl/hr)	Emission Factors[1,2,3] (lb/1000gal)								
							CO	NO_x	SO_2	POC	PM_{10}	$PM_{2.5}$	CO_2	CH_4	N_2O
Boiler Leg 4 - Manuevering	78.5	30%	N/A	325,000	1.0	33,340	5.00	20.00	14.20	0.20	2.30	1.55	22,388	3.307	0.220
Boiler Leg 5 - Turn Around	78.5	30%	N/A	325,000	0.5	33,340	5.00	20.00	14.20	0.20	2.30	1.55	22,388	3.307	0.220
Boiler Leg 6 - Mooring	78.5	30%	N/A	325,000	1.0	33,340	5.00	20.00	14.20	0.20	2.30	1.55	22,388	3.307	0.220
Boiler Leg 7 - Arrival	78.5	30%	N/A	325,000	2.5	33,340	5.00	20.00	14.20	0.20	2.30	1.55	22,388	3.307	0.220
Boiler Leg 8 - Hotelling[3]	78.5	N/A	28.06	325,000	10.7	33,340	5.00	20.00	14.20	0.20	2.30	1.55	22,388	3.307	0.220

Vessel Operations	Emissions[4,5] Maximum Daily (lbs)									
	CO	NO_x	SO_2	POC	PM_{10}	$PM_{2.5}$	CO_2	CH_4	N_2O	CO_2e
Boiler Leg 4 - Manuevering	0.55	2.21	1.57	0.02	0.25	0.17	2,476	0.37	0.02	2,491
Boiler Leg 5 - Turn Around	0.28	1.11	0.79	0.01	0.13	0.09	1,238	0.18	0.01	1,245
Boiler Leg 6 - Mooring	0.55	2.21	1.57	0.02	0.25	0.17	2,476	0.37	0.02	2,491
Boiler Leg 7 - Arrival	1.38	5.53	3.93	0.06	0.64	0.43	6,189	0.91	0.06	6,227
Boiler Leg 8 - Hotelling[3]	11.54	46.18	32.79	0.46	5.31	3.58	51,690	7.64	0.51	52,008
BOILER TOTAL EMISSIONS	14.31	57.24	40.64	0.57	6.58	4.44	64,069	9.46	0.63	64,463
Max Hourly Boiler Emissions (lb/hr)	1.07				0.49	0.33				

Vessel Operations	Emissions[4,5] Annual (tons)					
	CO	NO_x	SO_2	POC	PM_{10}	$PM_{2.5}$
Boiler Leg 4 - Manuevering	0.05	0.20	0.14	0.002	0.02	0.02
Boiler Leg 5 - Turn Around	0.02	0.10	0.07	0.001	0.01	0.01
Boiler Leg 6 - Mooring	0.05	0.20	0.14	0.002	0.02	0.02
Boiler Leg 7 - Arrival	0.12	0.50	0.35	0.005	0.06	0.04
Boiler Leg 8 - Hotelling[3]	1.04	4.16	2.95	0.042	0.48	0.32
BOILER TOTAL EMISSIONS	1.29	5.15	3.66	0.05	0.59	0.40

Vessel Operations	Emissions[4,5] Annual (metric tons)			
	CO_2	CH_4	N_2O	CO_2e
Boiler Leg 4 - Manuevering	202	0.03	0.002	203
Boiler Leg 5 - Turn Around	101	0.01	0.001	102
Boiler Leg 6 - Mooring	202	0.03	0.002	203
Boiler Leg 7 - Arrival	505	0.07	0.005	508
Boiler Leg 8 - Hotelling[3]	4,220	0.62	0.042	4,246
BOILER TOTAL EMISSIONS	5,230	0.77	0.05	5,262

Notes:

1. Criteria pollutant emission factors were obtained from EPA AP-42 fuel oil combustions (industrial boilers and distillate oil fired for CO, NOx, SOx, POC, PM_{10}, and $PM_{2.5}$); http://www.epa.gov/ttn/chief/ap42/ch01/final/c01s03.pdf
2. PM_{10} and $PM_{2.5}$ EFs for boiler emissions were obtained by each summing the corresponding condensable PM EF and $PM_{2.5}$ EF from AP42 Table 1.3-2 and the corresponding filterable PM10 EF and PM2.5 EF from AP42 Table 1.3-6.
3. Greenhouse gases (CO_2, CH_4, N_2O) emission factor source: CCAR general reporting protocols, v.3.1. http://www.climateregistry.org/resources/docs/protocols/grp/GRP_3.1_January2009.pdf. (Page 35 and Page 53 for distillate fuel)
4. Emission = Fuel Consumption x Load Factor x Pumping Rate x Time x Emission Factor
5. Emission (hoteling) = (Fuel Consumption - Inerting Savings) x Cargo Size x Emission Factor

GHG Emission Factors			
Greenhouse Gas	Emision Factor		Gobal Warming Potential
	kg/gallon	lb/1000ga	
CO2	10.155	22388	1
CH4	0.0015	3.307	21
N_2O	0.0001	0.220	310
Source: CCAR general reporting protocols, v.3.1.http://www.climateregistry.org/resources/docs/protocols/grp/GRP_3.1_Ja			

D - 4. Boiler Speciated Emissions Summary

Proposed Project Emission Model Inputs and Results
Boiler Emissions Speciated

Vessel Operations	Fuel Consumption (lb/1000 bbl offloaded)	Load Factor	Boiler Inerting Savings (lb/1000 bbl offloaded)	Cargo Size (bbl)	Activity Time (hr)	Pumping Rate (bbl/hr)	Benzene	Ethylbenzene	Formaldehyde	Naphthalene	1,1,1-Trichloroethane	Toluene	o-Xylene
Boiler Leg 4 - Manuevering	79	30%	N/A	325,000	1.00	33,340	2.37E-05	7.03E-06	3.65E-03	1.25E-04	2.61E-05	6.86E-04	1.21E-05
Boiler Leg 5 - Turn Around	79	30%	N/A	325,000	0.50	33,340	1.18E-05	3.52E-06	1.82E-03	6.25E-05	1.30E-05	3.43E-04	6.03E-06
Boiler Leg 6 - Mooring	79	30%	N/A	325,000	1.00	33,340	2.37E-05	7.03E-06	3.65E-03	1.25E-04	2.61E-05	6.86E-04	1.21E-05
Boiler Leg 7 - Arrival	79	30%	N/A	325,000	2.50	33,340	5.92E-05	1.76E-05	9.12E-03	3.12E-04	6.52E-05	1.71E-03	3.01E-05
Boiler Leg 8 - Hotelling	79	N/A	28.1	325,000	10.7	33,340	4.94E-04	1.47E-04	7.62E-02	2.61E-03	5.45E-04	1.43E-02	2.52E-04
						Toxic? Either Cancer, Chronic or Acute	Y	Y	Y	Y	Y	Y	Y
						BOILER TOXIC EMISSIONS							

Boiler Toxic Emissions - Leg 6, 7, 8 (lb/yr)
Boiler Toxic Emissions - Leg 5 (lb/yr)
Boiler Toxic Emissions - 1/16 of 14.3% of Leg 4 (lb/yr)
Boiler Max Hourly Toxic Emissions - Leg 8 (lb/hr)

Vessel Operations	Fuel Consumption (lb/1000 bbl offloaded)	Load Factor	Boiler Inerting Savings (lb/1000 bbl offloaded)	Cargo Size (bbl)	Activity Time (hr)	Pumping Rate (bbl/hr)	Antimony	Arsenic	Barium	Beryllium	Cadmium	Chloride	Chromium
Boiler Leg 4 - Manuevering	79	30%	N/A	325,000	1.00	33,340	5.81E-04	1.46E-04	2.84E-04	3.07E-06	4.40E-05	3.84E-02	9.34E-05
Boiler Leg 5 - Turn Around	79	30%	N/A	325,000	0.50	33,340	2.90E-04	7.30E-05	1.42E-04	1.54E-06	2.20E-05	1.92E-02	4.67E-05
Boiler Leg 6 - Mooring	79	30%	N/A	325,000	1.00	33,340	5.81E-04	1.46E-04	2.84E-04	3.07E-06	4.40E-05	3.84E-02	9.34E-05
Boiler Leg 7 - Arrival	79	30%	N/A	325,000	2.50	33,340	1.45E-03	3.65E-04	7.11E-04	7.69E-06	1.10E-04	9.59E-02	2.34E-04
Boiler Leg 8 - Hotelling	79	N/A	28.1	325,000	10.7	33,340	1.21E-02	3.05E-03	5.93E-03	6.42E-05	9.19E-04	8.01E-01	1.95E-03
						Toxic? Either Cancer, Chronic or Acute	N	Y	N	Y	Y	Y	N
						BOILER TOXIC EMISSIONS							

Boiler Toxic Emissions - Leg 6, 7, 8 (lb/yr)
Boiler Toxic Emissions - Leg 5 (lb/yr)
Boiler Toxic Emissions - 1/16 of 14.3% of Leg 4 (lb/yr)
Boiler Max Hourly Toxic Emissions - Leg 8 (lb/hr)

Vessel Operations	Maximum Daily Emissions (lb/day)										
	Acenaphthene	Acenaphthylene	Anthracene	Benz(a)anthracene	Benzo(b,k)fluoranthene	Benzo(g,h,i)perylene	Chrysene	Dibenzo(a,h) anthracene	Fluoranthene	Fluorene	Indo(1,2,3-cd)pyrene
Boiler Leg 4 - Manuevering	2.33E-06	2.80E-08	1.35E-07	4.43E-07	1.64E-07	2.50E-07	2.63E-07	1.85E-07	5.35E-07	4.94E-07	2.37E-07
Boiler Leg 5 - Turn Around	1.17E-06	1.40E-08	6.75E-08	2.22E-07	8.18E-08	1.25E-07	1.32E-07	9.23E-08	2.68E-07	2.47E-07	1.18E-07
Boiler Leg 6 - Mooring	2.33E-06	2.80E-08	1.35E-07	4.43E-07	1.64E-07	2.50E-07	2.63E-07	1.85E-07	5.35E-07	4.94E-07	2.37E-07
Boiler Leg 7 - Arrival	5.83E-06	6.99E-08	3.37E-07	1.11E-06	4.09E-07	6.25E-07	6.58E-07	4.62E-07	1.34E-06	1.24E-06	5.92E-07
Boiler Leg 8 - Hotelling	4.87E-05	5.84E-07	2.82E-06	9.26E-06	3.42E-06	5.22E-06	5.50E-06	3.86E-06	1.12E-05	1.03E-05	4.94E-06
	N	N	N	Y	Y	N	Y	Y	N	N	Y

Boiler Toxic Emissions - Leg 6, 7, 8 (lb/yr)
Boiler Toxic Emissions - Leg 5 (lb/yr)
Boiler Toxic Emissions - 1/16 of 14.3% of Leg 4
Boiler Max Hourly Toxic Emissions - Leg 8

Vessel Operations	Maximum Daily Emissions (lb/day)										
	Chromium VI	Cobalt	Copper	Fluoride	Lead	Manganese	Mercury	Molybdenum	Nickel	Phosphorous	Selenium
Boiler Leg 4 - Manuevering	2.74E-05	6.66E-04	1.95E-04	4.12E-03	1.67E-04	3.32E-04	1.25E-05	8.70E-05	9.34E-03	1.05E-03	7.55E-05
Boiler Leg 5 - Turn Around	1.37E-05	3.33E-04	9.73E-05	2.06E-03	8.35E-05	1.66E-04	6.25E-06	4.35E-05	4.67E-03	5.23E-04	3.78E-05
Boiler Leg 6 - Mooring	2.74E-05	6.66E-04	1.95E-04	4.12E-03	1.67E-04	3.32E-04	1.25E-05	8.70E-05	9.34E-03	1.05E-03	7.55E-05
Boiler Leg 7 - Arrival	6.86E-05	1.66E-03	4.87E-04	1.03E-02	4.17E-04	8.29E-04	3.12E-05	2.18E-04	2.34E-02	2.62E-03	1.89E-04
Boiler Leg 8 - Hotelling	5.73E-04	1.39E-02	4.06E-03	8.61E-02	3.49E-03	6.93E-03	2.61E-04	1.82E-03	1.95E-01	2.18E-02	1.58E-03
	Y	N	Y	Y	Y	Y	Y	N	Y	N	Y

Boiler Toxic Emissions - Leg 6, 7, 8 (lb/yr)
Boiler Toxic Emissions - Leg 5 (lb/yr)
Boiler Toxic Emissions - 1/16 of 14.3% of Leg 4
Boiler Max Hourly Toxic Emissions - Leg 8

Vessel Operations															Annual E
	Phenanthrene	Pyrene	OCDD	Benzene	Ethylbenzene	Formaldehyde	Naphthalene	1,1,1-Trichloroethane	Toluene	o-Xylene	Acenaphthene	Acenaphthylene	Anthracene	Benz(a)anthracene	
Boiler Leg 4 - Manuevering	1.16E-06	4.70E-07	3.43E-10	2.56E-06	7.60E-07	3.94E-04	1.35E-05	2.82E-06	7.40E-05	1.30E-06	2.52E-07	3.02E-09	1.46E-08	4.79E-08	
Boiler Leg 5 - Turn Around	5.81E-07	2.35E-07	1.71E-10	1.28E-06	3.80E-07	1.97E-04	6.75E-06	1.41E-06	3.70E-05	6.51E-07	1.26E-07	1.51E-09	7.29E-09	2.39E-08	
Boiler Leg 6 - Mooring	1.16E-06	4.70E-07	3.43E-10	2.56E-06	7.60E-07	3.94E-04	1.35E-05	2.82E-06	7.40E-05	1.30E-06	2.52E-07	3.02E-09	1.46E-08	4.79E-08	
Boiler Leg 7 - Arrival	2.90E-06	1.17E-06	8.57E-10	6.39E-06	1.90E-06	9.85E-04	3.37E-05	7.05E-06	1.85E-04	3.25E-06	6.30E-07	7.55E-09	3.64E-08	1.20E-07	
Boiler Leg 8 - Hotelling	2.42E-05	9.81E-06	7.16E-09	5.34E-05	1.59E-05	8.23E-03	2.82E-04	5.88E-05	1.55E-03	2.72E-05	5.26E-06	6.31E-08	3.04E-07	1.00E-06	
	N	N	Y	Y	Y	Y	Y	Y	Y	Y	N	N	N	Y	
				6.61E-05	1.97E-05	1.02E-02	3.49E-04	7.29E-05	1.92E-03	3.37E-05	6.52E-06	7.82E-08	3.77E-07	1.24E-06	
Boiler Toxic Emissions - Leg 6, 7, 8 (lb/yr)				1.25E-01	3.70E-02	1.92E+01	6.58E-01	1.37E-01	3.61E+00	6.35E-02	1.23E-02	1.47E-04	7.10E-04	2.34E-03	
Boiler Toxic Emissions - Leg 5 (lb/yr)				2.56E-03	7.60E-04	3.94E-01	1.35E-02	2.82E-03	7.40E-02	1.30E-03	2.52E-04	3.02E-06	1.46E-05	4.79E-05	
Boiler Toxic Emissions - 1/16 of 14.3% of Leg 4 (lb/yr)				4.57E-05	1.36E-05	7.05E-03	2.41E-04	5.04E-05	1.32E-03	2.33E-05	4.50E-06	5.40E-08	2.60E-07	8.56E-07	
Boiler Max Hourly Toxic Emissions - Leg 8 (lb/hr)				4.60E-05	1.37E-05	7.09E-03	2.43E-04	5.07E-05	1.33E-03	2.34E-05	4.53E-06	5.43E-08	2.62E-07	8.61E-07	

Vessel Operations														Annual Emiss
	Vanadium	Zinc		Antimony	Arsenic	Barium	Beryllium	Cadmium	Chloride	Chromium	Chromium VI	Cobalt	Copper	Fluoride
Boiler Leg 4 - Manuevering	3.52E-03	3.22E-03		6.27E-05	1.58E-05	3.07E-05	3.32E-07	4.75E-06	4.14E-03	1.01E-05	2.96E-06	7.19E-05	2.10E-05	4.45E-04	
Boiler Leg 5 - Turn Around	1.76E-03	1.61E-03		3.14E-05	7.88E-06	1.53E-05	1.66E-07	2.38E-06	2.07E-03	5.05E-06	1.48E-06	3.59E-05	1.05E-05	2.23E-04	
Boiler Leg 6 - Mooring	3.52E-03	3.22E-03		6.27E-05	1.58E-05	3.07E-05	3.32E-07	4.75E-06	4.14E-03	1.01E-05	2.96E-06	7.19E-05	2.10E-05	4.45E-04	
Boiler Leg 7 - Arrival	8.79E-03	8.05E-03		1.57E-04	3.94E-05	7.67E-05	8.30E-07	1.19E-05	1.04E-02	2.52E-05	7.40E-06	1.80E-04	5.26E-05	1.11E-03	
Boiler Leg 8 - Hotelling	7.34E-02	6.72E-02		1.31E-03	3.29E-04	6.41E-04	6.93E-06	9.92E-05	8.65E-02	2.11E-04	6.18E-05	1.50E-03	4.39E-04	9.30E-03	
	Y	N		N	Y	N	Y	Y	Y	N	Y	N	Y	Y	
				1.62E-03	4.08E-04	7.94E-04	8.59E-06	1.23E-04	1.07E-01	2.61E-04	7.67E-05	1.86E-03	5.44E-04	1.15E-02	
Boiler Toxic Emissions - Leg 6, 7, 8 (lb/yr)				3.06E+00	7.69E-01	1.50E+00	1.62E-02	2.32E-01	2.02E+02	4.92E-01	1.44E-01	3.51E+00	1.02E+00	2.17E+01	
Boiler Toxic Emissions - Leg 5 (lb/yr)				6.27E-02	1.58E-02	3.07E-02	3.32E-04	4.75E-03	4.14E+00	1.01E-02	2.96E-03	7.19E-02	2.10E-02	4.45E-01	
Boiler Toxic Emissions - 1/16 of 14.3% of Leg 4 (lb/yr)				1.12E-03	2.82E-04	5.49E-04	5.93E-06	8.50E-05	7.41E-02	1.80E-04	5.29E-05	1.29E-03	3.76E-04	7.96E-03	
Boiler Max Hourly Toxic Emissions - Leg 8 (lb/hr)				1.13E-03	2.84E-04	5.52E-04	5.97E-06	8.55E-05	7.45E-02	1.82E-04	5.33E-05	1.29E-03	3.78E-04	8.01E-03	

essel Operations	Emissions (tpy)									
	Benzo(b,k)fluoranthene	Benzo(g,h,i)perylene	Chrysene	Dibenzo(a,h) anthracene	Fluoranthene	Fluorene	Indo(1,2,3-cd)pyrene	Phenanthrene	Pyrene	OCDD
Boiler Leg 4 - Manuevering	1.77E-08	2.70E-08	2.84E-08	1.99E-08	5.78E-08	5.34E-08	2.56E-08	1.25E-07	5.08E-08	3.70E-11
Boiler Leg 5 - Turn Around	8.84E-09	1.35E-08	1.42E-08	9.97E-09	2.89E-08	2.67E-08	1.28E-08	6.27E-08	2.54E-08	1.85E-11
Boiler Leg 6 - Mooring	1.77E-08	2.70E-08	2.84E-08	1.99E-08	5.78E-08	5.34E-08	2.56E-08	1.25E-07	5.08E-08	3.70E-11
Boiler Leg 7 - Arrival	4.42E-08	6.75E-08	7.11E-08	4.99E-08	1.45E-07	1.33E-07	6.39E-08	3.14E-07	1.27E-07	9.26E-11
Boiler Leg 8 - Hotelling	3.69E-07	5.64E-07	5.93E-07	4.16E-07	1.21E-06	1.11E-06	5.34E-07	2.62E-06	1.06E-06	7.73E-10
	Y	N	Y	Y	N	N	Y	N	N	Y
	4.57E-07	6.99E-07	7.36E-07	5.16E-07	1.50E-06	1.38E-06	6.61E-07	3.25E-06	1.31E-06	9.58E-10
Boiler Toxic Emissions - Leg 6, 7, 8 (lb/yr)	8.62E-04	1.32E-03	1.39E-03	9.72E-04	2.82E-03	2.60E-03	1.25E-03	6.11E-03	2.47E-03	1.81E-06
Boiler Toxic Emissions - Leg 5 (lb/yr)	1.77E-05	2.70E-05	2.84E-05	1.99E-05	5.78E-05	5.34E-05	2.56E-05	1.25E-04	5.08E-05	3.70E-08
Boiler Toxic Emissions - 1/16 of 14.3% of Leg 4	3.16E-07	4.82E-07	5.08E-07	3.57E-07	1.03E-06	9.54E-07	4.57E-07	2.24E-06	9.07E-07	6.62E-10
Boiler Max Hourly Toxic Emissions - Leg 8	3.18E-07	4.85E-07	5.11E-07	3.59E-07	1.04E-06	9.60E-07	4.60E-07	2.26E-06	9.13E-07	6.66E-10

Vessel Operations	ions (tpy)								
	Lead	Manganese	Mercury	Molybdenum	Nickel	Phosphorous	Selenium	Vanadium	Zinc
Boiler Leg 4 - Manuevering	1.80E-05	3.58E-05	1.35E-06	9.40E-06	1.01E-03	1.13E-04	8.16E-06	3.80E-04	3.48E-04
Boiler Leg 5 - Turn Around	9.02E-06	1.79E-05	6.75E-07	4.70E-06	5.05E-04	5.65E-05	4.08E-06	1.90E-04	1.74E-04
Boiler Leg 6 - Mooring	1.80E-05	3.58E-05	1.35E-06	9.40E-06	1.01E-03	1.13E-04	8.16E-06	3.80E-04	3.48E-04
Boiler Leg 7 - Arrival	4.51E-05	8.96E-05	3.37E-06	2.35E-05	2.52E-03	2.82E-04	2.04E-05	9.49E-04	8.69E-04
Boiler Leg 8 - Hotelling	3.77E-04	7.48E-04	2.82E-05	1.96E-04	2.11E-02	2.36E-03	1.70E-04	7.93E-03	7.26E-03
	Y	Y	Y	N	Y	N	Y	Y	N
	4.67E-04	9.27E-04	3.49E-05	2.43E-04	2.61E-02	2.92E-03	2.11E-04	9.83E-03	8.99E-03
Boiler Toxic Emissions - Leg 6, 7, 8 (lb/yr)	8.79E-01	1.75E+00	6.58E-02	4.58E-01	4.92E+01	5.51E+00	3.98E-01	1.85E+01	1.69E+01
Boiler Toxic Emissions - Leg 5 (lb/yr)	1.80E-02	3.58E-02	1.35E-03	9.40E-03	1.01E+00	1.13E-01	8.16E-03	3.80E-01	3.48E-01
Boiler Toxic Emissions - 1/16 of 14.3% of Leg 4	3.22E-04	6.40E-04	2.41E-05	1.68E-04	1.80E-02	2.02E-03	1.46E-04	6.79E-03	6.21E-03
Boiler Max Hourly Toxic Emissions - Leg 8	3.24E-04	6.44E-04	2.43E-05	1.69E-04	1.82E-02	2.03E-03	1.47E-04	6.83E-03	6.25E-03

Alternative 1 Project Emission Model Inputs and Results
Boiler Emissions Speciated

180 vessels per year

Vessel Operations	Fuel Consumption (lb/1000 bbl offloaded)	Load Factor	Boiler Inerting Savings (lb/1000 bbl offloaded)	Cargo Size (bbl)	Activity Time (hr)	Pumping Rate (bbl/hr)	Benzene	Ethylbenzene	Formaldehyde	Naphthalene	1,1,1-Trichloroethane	Toluene	o-Xylene	Acenaphthene
Boiler Leg 4 - Manuevering	79	30%	N/A	325,000	1.00	33,340	2.37E-05	7.03E-06	3.65E-03	1.25E-04	2.61E-05	6.86E-04	1.21E-05	2.33E-06
Boiler Leg 5 - Turn Around	79	30%	N/A	325,000	0.50	33,340	1.18E-05	3.52E-06	1.82E-03	6.25E-05	1.30E-05	3.43E-04	6.03E-06	1.17E-06
Boiler Leg 6 - Mooring	79	30%	N/A	325,000	1.00	33,340	2.37E-05	7.03E-06	3.65E-03	1.25E-04	2.61E-05	6.86E-04	1.21E-05	2.33E-06
Boiler Leg 7 - Arrival	79	30%	N/A	325,000	2.50	33,340	5.92E-05	1.76E-05	9.12E-03	3.12E-04	6.52E-05	1.71E-03	3.01E-05	5.83E-06
Boiler Leg 8 - Hotelling	79	N/A	28.1	325,000	10.7	33,340	4.94E-04	1.47E-04	7.62E-02	2.61E-03	5.45E-04	1.43E-02	2.52E-04	4.87E-05
						Toxic? Either Cancer, Chronic or Acute	Y	Y	Y	Y	Y	Y	Y	N
						BOILER TOXIC EMISSIONS								

Boiler Toxic Emissions - Leg 6, 7, 8 (lb/yr)
Boiler Toxic Emissions - Leg 5 (lb/yr)
Boiler Toxic Emissions - 1/16 of 14.3% of Leg 4 (lb/yr)
Boiler Max Hourly Toxic Emissions - Leg 8 (lb/hr)

Vessel Operations	Fuel Consumption (lb/1000 bbl offloaded)	Load Factor	Boiler Inerting Savings (lb/1000 bbl offloaded)	Cargo Size (bbl)	Activity Time (hr)	Pumping Rate (bbl/hr)	Antimony	Arsenic	Barium	Beryllium	Cadmium	Chloride	Chromium	Chromium VI
Boiler Leg 4 - Manuevering	79	30%	N/A	325,000	1.00	33,340	5.81E-04	1.46E-04	2.84E-04	3.07E-06	4.40E-05	3.84E-02	9.34E-05	2.74E-05
Boiler Leg 5 - Turn Around	79	30%	N/A	325,000	0.50	33,340	2.90E-04	7.30E-05	1.42E-04	1.54E-06	2.20E-05	1.92E-02	4.67E-05	1.37E-05
Boiler Leg 6 - Mooring	79	30%	N/A	325,000	1.00	33,340	5.81E-04	1.46E-04	2.84E-04	3.07E-06	4.40E-05	3.84E-02	9.34E-05	2.74E-05
Boiler Leg 7 - Arrival	79	30%	N/A	325,000	2.50	33,340	1.45E-03	3.65E-04	7.11E-04	7.69E-06	1.10E-04	9.59E-02	2.34E-04	6.86E-05
Boiler Leg 8 - Hotelling	79	N/A	28.1	325,000	10.7	33,340	1.21E-02	3.05E-03	5.93E-03	6.42E-05	9.19E-04	8.01E-01	1.95E-03	5.73E-04
						Toxic? Either Cancer, Chronic or Acute	N	Y	N	Y	Y	Y	N	Y
						BOILER TOXIC EMISSIONS								

Boiler Toxic Emissions - Leg 6, 7, 8 (lb/yr)
Boiler Toxic Emissions - Leg 5 (lb/yr)
Boiler Toxic Emissions - 1/16 of 14.3% of Leg 4 (lb/yr)
Boiler Max Hourly Toxic Emissions - Leg 8 (lb/hr)

Alternative 1 Project Emissions Model Inputs and Results
Boiler Emissions Speciated

Vessel Operations	Maximum Daily Emissions (lb/day)										
	Acenaphthylene	Anthracene	Benz(a)anthracene	Benzo(b,k)fluoranthene	Benzo(g,h,i)perylene	Chrysene	Dibenzo(a,h) anthracene	Fluoranthene	Fluorene	Indo(1,2,3-cd)pyrene	Phenanthrene
Boiler Leg 4 - Manuevering	2.80E-08	1.35E-07	4.43E-07	1.64E-07	2.50E-07	2.63E-07	1.85E-07	5.35E-07	4.94E-07	2.37E-07	1.16E-06
Boiler Leg 5 - Turn Around	1.40E-08	6.75E-08	2.22E-07	8.18E-08	1.25E-07	1.32E-07	9.23E-08	2.68E-07	2.47E-07	1.18E-07	5.81E-07
Boiler Leg 6 - Mooring	2.80E-08	1.35E-07	4.43E-07	1.64E-07	2.50E-07	2.63E-07	1.85E-07	5.35E-07	4.94E-07	2.37E-07	1.16E-06
Boiler Leg 7 - Arrival	6.99E-08	3.37E-07	1.11E-06	4.09E-07	6.25E-07	6.58E-07	4.62E-07	1.34E-06	1.24E-06	5.92E-07	2.90E-06
Boiler Leg 8 - Hotelling	5.84E-07	2.82E-06	9.26E-06	3.42E-06	5.22E-06	5.50E-06	3.86E-06	1.12E-05	1.03E-05	4.94E-06	2.42E-05
	N	N	Y	Y	N	Y	Y	N	N	Y	N

Boiler Toxic Emissions - Leg 6, 7, 8 (lb/yr)
Boiler Toxic Emissions - Leg 5 (lb/yr)
Boiler Toxic Emissions - 1/16 of 14.3% of Leg 4
Boiler Max Hourly Toxic Emissions - Leg 8

Vessel Operations	Maximum Daily Emissions (lb/day)										
	Cobalt	Copper	Fluoride	Lead	Manganese	Mercury	Molybdenum	Nickel	Phosphorous	Selenium	Vanadium
Boiler Leg 4 - Manuevering	6.66E-04	1.95E-04	4.12E-03	1.67E-04	3.32E-04	1.25E-05	8.70E-05	9.34E-03	1.05E-03	7.55E-05	3.52E-03
Boiler Leg 5 - Turn Around	3.33E-04	9.73E-05	2.06E-03	8.35E-05	1.66E-04	6.25E-06	4.35E-05	4.67E-03	5.23E-04	3.78E-05	1.76E-03
Boiler Leg 6 - Mooring	6.66E-04	1.95E-04	4.12E-03	1.67E-04	3.32E-04	1.25E-05	8.70E-05	9.34E-03	1.05E-03	7.55E-05	3.52E-03
Boiler Leg 7 - Arrival	1.66E-03	4.87E-04	1.03E-02	4.17E-04	8.29E-04	3.12E-05	2.18E-04	2.34E-02	2.62E-03	1.89E-04	8.79E-03
Boiler Leg 8 - Hotelling	1.39E-02	4.06E-03	8.61E-02	3.49E-03	6.93E-03	2.61E-04	1.82E-03	1.95E-01	2.18E-02	1.58E-03	7.34E-02
	N	Y	Y	Y	Y	Y	N	Y	N	Y	Y

Boiler Toxic Emissions - Leg 6, 7, 8 (lb/yr)
Boiler Toxic Emissions - Leg 5 (lb/yr)
Boiler Toxic Emissions - 1/16 of 14.3% of Leg 4
Boiler Max Hourly Toxic Emissions - Leg 8

Alternative 1 Project Emissions Modeling Inputs and Results
Boiler Emissions Speciated

VIbessel Operations													Annual E
	Pyrene	OCDD	Benzene	Ethylbenzene	Formaldehyde	Naphthalene	1,1,1-Trichloroethane	Toluene	o-Xylene	Acenaphthene	Acenaphthylene	Anthracene	Benz(a)anthracene
Boiler Leg 4 - Manuevering	4.70E-07	3.43E-10	2.13E-06	6.33E-07	3.28E-04	1.12E-05	2.35E-06	6.17E-05	1.08E-06	2.10E-07	2.52E-09	1.21E-08	3.99E-08
Boiler Leg 5 - Turn Around	2.35E-07	1.71E-10	1.06E-06	3.16E-07	1.64E-04	5.62E-06	1.17E-06	3.09E-05	5.42E-07	1.05E-07	1.26E-09	6.07E-09	2.00E-08
Boiler Leg 6 - Mooring	4.70E-07	3.43E-10	2.13E-06	6.33E-07	3.28E-04	1.12E-05	2.35E-06	6.17E-05	1.08E-06	2.10E-07	2.52E-09	1.21E-08	3.99E-08
Boiler Leg 7 - Arrival	1.17E-06	8.57E-10	5.32E-06	1.58E-06	8.21E-04	2.81E-05	5.87E-06	1.54E-04	2.71E-06	5.25E-07	6.30E-09	3.04E-08	9.98E-08
Boiler Leg 8 - Hotelling	9.81E-06	7.16E-09	4.45E-05	1.32E-05	6.86E-03	2.35E-04	4.90E-05	1.29E-03	2.27E-05	4.38E-06	5.26E-08	2.54E-07	8.33E-07
	N	Y	Y	Y	Y	Y	Y	Y	Y	N	N	N	Y
			5.51E-05	1.64E-05	8.50E-03	2.91E-04	6.08E-05	1.60E-03	2.81E-05	5.43E-06	6.52E-08	3.14E-07	1.03E-06
Boiler Toxic Emissions - Leg 6, 7, 8 (lb/yr)			1.04E-01	3.09E-02	1.60E+01	5.48E-01	1.15E-01	3.01E+00	5.29E-02	1.02E-02	1.23E-04	5.92E-04	1.95E-03
Boiler Toxic Emissions - Leg 5 (lb/yr)			2.13E-03	6.33E-04	3.28E-01	1.12E-02	2.35E-03	6.17E-02	1.08E-03	2.10E-04	2.52E-06	1.21E-05	3.99E-05
Boiler Toxic Emissions - 1/16 of 14.3% of Leg 4 (lb/yr)			3.81E-05	1.13E-05	5.87E-03	2.01E-04	4.20E-05	1.10E-03	1.94E-05	3.75E-06	4.50E-08	2.17E-07	7.13E-07
Boiler Max Hourly Toxic Emissions - Leg 8 (lb/hr)			4.60E-05	1.37E-05	7.09E-03	2.43E-04	5.07E-05	1.33E-03	2.34E-05	4.53E-06	5.43E-08	2.62E-07	8.61E-07

Vessel Operations													Annual Emiss
	Zinc		Antimony	Arsenic	Barium	Beryllium	Cadmium	Chloride	Chromium	Chromium VI	Cobalt	Copper	Fluoride
Boiler Leg 4 - Manuevering	3.22E-03		5.23E-05	1.31E-05	2.56E-05	2.77E-07	3.96E-06	3.45E-03	8.41E-06	2.47E-06	5.99E-05	1.75E-05	3.71E-04
Boiler Leg 5 - Turn Around	1.61E-03		2.61E-05	6.57E-06	1.28E-05	1.38E-07	1.98E-06	1.73E-03	4.21E-06	1.23E-06	3.00E-05	8.76E-06	1.86E-04
Boiler Leg 6 - Mooring	3.22E-03		5.23E-05	1.31E-05	2.56E-05	2.77E-07	3.96E-06	3.45E-03	8.41E-06	2.47E-06	5.99E-05	1.75E-05	3.71E-04
Boiler Leg 7 - Arrival	8.05E-03		1.31E-04	3.28E-05	6.39E-05	6.92E-07	9.90E-06	8.63E-03	2.10E-05	6.17E-06	1.50E-04	4.38E-05	9.28E-04
Boiler Leg 8 - Hotelling	6.72E-02		1.09E-03	2.74E-04	5.34E-04	5.78E-06	8.27E-05	7.21E-02	1.76E-04	5.15E-05	1.25E-03	3.66E-04	7.75E-03
	N		N	Y	N	Y	Y	Y	N	Y	N	Y	Y
			1.35E-03	3.40E-04	6.62E-04	7.16E-06	1.03E-04	8.94E-02	2.18E-04	6.39E-05	1.55E-03	4.53E-04	9.61E-03
Boiler Toxic Emissions - Leg 6, 7, 8 (lb/yr)			2.55E+00	6.41E-01	1.25E+00	1.35E-02	1.93E-01	1.68E+02	4.10E-01	1.20E-01	2.92E+00	8.54E-01	1.81E+01
Boiler Toxic Emissions - Leg 5 (lb/yr)			5.23E-02	1.31E-02	2.56E-02	2.77E-04	3.96E-03	3.45E+00	8.41E-03	2.47E-03	5.99E-02	1.75E-02	3.71E-01
Boiler Toxic Emissions - 1/16 of 14.3% of Leg 4 (lb/yr)			9.34E-04	2.35E-04	4.57E-04	4.95E-06	7.08E-05	6.17E-02	1.50E-04	4.41E-05	1.07E-03	3.13E-04	6.64E-03
Boiler Max Hourly Toxic Emissions - Leg 8 (lb/hr)			1.13E-03	2.84E-04	5.52E-04	5.97E-06	8.55E-05	7.45E-02	1.82E-04	5.33E-05	1.29E-03	3.78E-04	8.01E-03

Alternative 1 Project Emissions Modeling Inputs and Results
Boiler Emissions Speciated

Vessel Operations	Emissions (tpy)									
	Benzo(b,k)fluoranthene	Benzo(g,h,i)perylene	Chrysene	Dibenzo(a,h) anthracene	Fluoranthene	Fluorene	Indo(1,2,3-cd)pyrene	Phenanthrene	Pyrene	OCDD
Boiler Leg 4 - Manuevering	1.47E-08	2.25E-08	2.37E-08	1.66E-08	4.82E-08	4.45E-08	2.13E-08	1.05E-07	4.23E-08	3.09E-11
Boiler Leg 5 - Turn Around	7.36E-09	1.12E-08	1.18E-08	8.31E-09	2.41E-08	2.22E-08	1.06E-08	5.23E-08	2.11E-08	1.54E-11
Boiler Leg 6 - Mooring	1.47E-08	2.25E-08	2.37E-08	1.66E-08	4.82E-08	4.45E-08	2.13E-08	1.05E-07	4.23E-08	3.09E-11
Boiler Leg 7 - Arrival	3.68E-08	5.62E-08	5.92E-08	4.16E-08	1.20E-07	1.11E-07	5.32E-08	2.61E-07	1.06E-07	7.71E-11
Boiler Leg 8 - Hotelling	3.08E-07	4.70E-07	4.95E-07	3.47E-07	1.01E-06	9.29E-07	4.45E-07	2.18E-06	8.83E-07	6.44E-10
	Y	N	Y	Y	N	N	Y	N	N	Y
	3.81E-07	5.82E-07	6.13E-07	4.30E-07	1.25E-06	1.15E-06	5.51E-07	2.70E-06	1.09E-06	7.98E-10
Boiler Toxic Emissions - Leg 6, 7, 8 (lb/yr)	7.18E-04	1.10E-03	1.15E-03	8.10E-04	2.35E-03	2.17E-03	1.04E-03	5.10E-03	2.06E-03	1.50E-06
Boiler Toxic Emissions - Leg 5 (lb/yr)	1.47E-05	2.25E-05	2.37E-05	1.66E-05	4.82E-05	4.45E-05	2.13E-05	1.05E-04	4.23E-05	3.09E-08
Boiler Toxic Emissions - 1/16 of 14.3% of Leg 4	2.63E-07	4.02E-07	4.23E-07	2.97E-07	8.61E-07	7.95E-07	3.81E-07	1.87E-06	7.56E-07	5.52E-10
Boiler Max Hourly Toxic Emissions - Leg 8	3.18E-07	4.85E-07	5.11E-07	3.59E-07	1.04E-06	9.60E-07	4.60E-07	2.26E-06	9.13E-07	6.66E-10

Vessel Operations	ions (tpy)								
	Lead	Manganese	Mercury	Molybdenum	Nickel	Phosphorous	Selenium	Vanadium	Zinc
Boiler Leg 4 - Manuevering	1.50E-05	2.99E-05	1.12E-06	7.83E-06	8.41E-04	9.42E-05	6.80E-06	3.16E-04	2.90E-04
Boiler Leg 5 - Turn Around	7.51E-06	1.49E-05	5.62E-07	3.92E-06	4.21E-04	4.71E-05	3.40E-06	1.58E-04	1.45E-04
Boiler Leg 6 - Mooring	1.50E-05	2.99E-05	1.12E-06	7.83E-06	8.41E-04	9.42E-05	6.80E-06	3.16E-04	2.90E-04
Boiler Leg 7 - Arrival	3.76E-05	7.46E-05	2.81E-06	1.96E-05	2.10E-03	2.35E-04	1.70E-05	7.91E-04	7.24E-04
Boiler Leg 8 - Hotelling	3.14E-04	6.23E-04	2.35E-05	1.64E-04	1.76E-02	1.97E-03	1.42E-04	6.61E-03	6.05E-03
	Y	Y	Y	N	Y	N	Y	Y	N
	3.89E-04	7.73E-04	2.91E-05	2.03E-04	2.18E-02	2.44E-03	1.76E-04	8.19E-03	7.50E-03
Boiler Toxic Emissions - Leg 6, 7, 8 (lb/yr)	7.33E-01	1.46E+00	5.48E-02	3.82E-01	4.10E+01	4.59E+00	3.31E-01	1.54E+01	1.41E+01
Boiler Toxic Emissions - Leg 5 (lb/yr)	1.50E-02	2.99E-02	1.12E-03	7.83E-03	8.41E-01	9.42E-02	6.80E-03	3.16E-01	2.90E-01
Boiler Toxic Emissions - 1/16 of 14.3% of Leg 4	2.69E-04	5.34E-04	2.01E-05	1.40E-04	1.50E-02	1.68E-03	1.22E-04	5.66E-03	5.18E-03
Boiler Max Hourly Toxic Emissions - Leg 8	3.24E-04	6.44E-04	2.43E-05	1.69E-04	1.82E-02	2.03E-03	1.47E-04	6.83E-03	6.25E-03

D - 5. Tugboat Emissions Summary

Proposed Project Emission Model Inputs and Results
18 Vessels per Month & 2007 Engine Year Tugboats
Tugboat Emissions

216 Vessel Trips per year

Tugboat Operations	Engine				Emission Factors[2,3]									Emissions[5]																				
	Power	Load Factor	Maximum Time		(g/hp-hr)		(ppm)	(g/hp-hr)						Maximum Daily (lb/call)									Annual (tons)						Annual (metric tons)			
	(hp)	(%)	(hr/call)[1]	(hr/yr)	CO	NO_x	SO_2	POC	PM_{10}	$PM_{2.5}$	CO_2	CH_4	N_2O	CO	NO_x	SO_2[4]	POC	PM_{10}	$PM_{2.5}$	CO_2	CH_4	N_2O	CO_2e	CO	NO_x	SO_2	POC	PM_{10}	$PM_{2.5}$	CO_2	CH_4	N_2O	CO_2e
Tugboat Main Engine Transit Leg 2 (and out)	5,000	30%	2.07	448	3.73	5.53	15	0.68	0.20	0.20	580	0.09	0.006	25.58	37.93	0.04	4.66	1.37	1.37	3,979	0.59	0.04	4,004	2.76	4.10	0.00	0.50	0.15	0.15	390	0.06	0.00	392
Tugboat Main Engine Transit Leg 3 (and out)	5,000	30%	2.00	432	3.73	5.53	15	0.68	0.20	0.20	580	0.09	0.006	24.67	36.57	0.04	4.50	1.32	1.32	3,837	0.57	0.04	3,861	2.66	3.95	0.00	0.49	0.14	0.14	376	0.06	0.00	378
Tugboat Main Engine Maneuvering Leg 4 (and out)	5,000	50%	4.00	864	3.73	5.53	15	0.68	0.20	0.20	580	0.09	0.006	82.23	121.91	0.12	14.99	4.41	4.41	12,791	1.89	0.13	12,869	8.88	13.17	0.01	1.62	0.48	0.48	1,253	0.19	0.01	1,261
Tugboat Main Engine Maneuvering Leg 5 - turn around	5,000	50%	1.00	216	3.73	5.53	15	0.68	0.20	0.20	580	0.09	0.006	20.56	30.48	0.03	3.75	1.10	1.10	3,198	0.47	0.03	3,217	2.22	3.29	0.00	0.40	0.12	0.12	313	0.05	0.00	315
Tugboat Main Engine Leg 6 - Mooring	5,000	50%	2.00	432	3.73	5.53	15	0.68	0.20	0.20	580	0.09	0.006	41.12	60.96	0.06	7.50	2.20	2.20	6,395	0.94	0.06	6,435	4.44	6.58	0.01	0.81	0.24	0.24	626	0.09	0.01	630
Tugboat Main Engine Leg 10 - Unmooring	5,000	60%	0.50	108	3.73	5.53	15	0.68	0.20	0.20	580	0.09	0.006	12.33	18.29	0.02	2.25	0.66	0.66	1,919	0.28	0.02	1,930	1.33	1.98	0.00	0.24	0.07	0.07	188	0.03	0.00	189
Tugboat Auxiliary Engine Transit Leg 2 (and out)	520	31%	2.07	448	3.73	5.10	15	0.81	0.15	0.15	580	0.09	0.006	2.75	3.76	0.00	0.60	0.11	0.11	428	0.06	0.00	430	0.30	0.41	0.00	0.06	0.01	0.01	42	0.01	0.00	42
Tugboat Auxiliary Engine Transit Leg 3 (and out)	520	31%	2.00	432	3.73	5.10	15	0.81	0.15	0.15	580	0.09	0.006	2.65	3.62	0.00	0.58	0.11	0.11	412	0.06	0.00	415	0.29	0.39	0.00	0.06	0.01	0.01	40	0.01	0.00	41
Tugboat Auxiliary Engine Maneuvering Leg 4 (and out)	520	31%	4.00	864	3.73	5.10	15	0.81	0.15	0.15	580	0.09	0.006	5.30	7.25	0.01	1.15	0.21	0.21	825	0.12	0.01	830	0.57	0.78	0.00	0.12	0.02	0.02	81	0.01	0.00	81
Tugboat Auxiliary Engine Maneuvering Leg 5 - turn around	520	31%	1.00	216	3.73	5.10	15	0.81	0.15	0.15	580	0.09	0.006	1.33	1.81	0.00	0.29	0.05	0.05	206	0.03	0.00	207	0.14	0.20	0.00	0.03	0.01	0.01	20	0.00	0.00	20
Tugboat Auxiliary Engine Leg 6 - Mooring	520	31%	2.00	432	3.73	5.10	15	0.81	0.15	0.15	580	0.09	0.006	2.65	3.62	0.00	0.58	0.11	0.11	412	0.06	0.00	415	0.29	0.39	0.00	0.06	0.01	0.01	40	0.01	0.00	41
Tugboat Auxiliary Engine Leg 10 - Unmooring	520	31%	0.50	108	3.73	5.10	15	0.81	0.15	0.15	580	0.09	0.006	0.66	0.91	0.00	0.14	0.03	0.03	103	0.02	0.00	104	0.07	0.10	0.00	0.02	0.00	0.00	10	0.00	0.00	10
TUGBOAT TOTAL EMISSIONS														221.83	327.12	0.33	40.98	11.69	11.69	34,505	5.10	0.34	34,718	23.96	35.33	0.04	4.43	1.26	1.26	3,380	0.50	0.03	3,401

Notes:
1. For the in-and-out legs maximum tugboat operation hours are twice of the leg time to account for the whole trip; In addition, for leg 4, 5, and 6, the maximum tugboat operation hours are twice (four times for leg 4 for the whole trip) of the leg time to account for the additional tugboat required during these three legs.
2. Source for criteria pollutant emission factors: www.arb.ca.gov/regact/2007/chc07/appb.pdf; Emission factors for P_{10} and $PM_{2.5}$ are assumed to be the same. Emission factor for SQ is assumed to be 15ppm based on current regulatory requirements for sulfur content in fue
3. Source for greenhouse gas (CQ,CH_4, and N_2O) emission factors: CCAR general reporting protocols, www.climateregistry.org/resources/docs/protocols/grp/GRP_3.1_January2009.pdf (Page 35; Page 53 for distillate fu
4. SO_2 (g/hp-hr) = (X ppm /1,000,000) x (2 g SO_2/g S) x (Brake Specific Fuel Consumption F) ; 2 is the molecular weight ratio of SQ_2 to S
5. Emission = Power x Load Factor x Time x Emission Factor

Emission Factors From other source			
Greenhouse Gas	Emision Factor		Gobal Warming Potential
	kg/gallon	g/hp-hr	
CO2	10.155	580.185	1
CH4	0.0015	0.086	21
N_2O	0.0001	0.006	310
Source: CCAR general reporting protocols, v.3.1.http://www.climateregistry.org/resources/docs/protocols/grp/GRP_3.1_January2009.pdf. (Page			

Proposed Project Emission Model Inputs and Results
18 Vessels per Month & 2016 Engine Year Tugboats
Tugboat Emissions

216 Vessel Trips per year

Tugboat Operations	Engine				Emission Factors[2,3]									Emissions[5]																					
	Power	Load Factor	Maximum Time		(g/hp-hr)		(ppm)	(g/hp-hr)						Maximum Daily (lb/call)									Annual (tons)						Annual (metric tons)			
	(hp)	(%)	(hr/call)[1]	(hr/yr)	CO	NO_x	SO_2	POC	PM_{10}	$PM_{2.5}$	CO_2	CH_4	N_2O	CO	NO_x	SO_2[4]	POC	PM_{10}	$PM_{2.5}$	CO_2	CH_4	N_2O	CO_2e	CO	NO_x	SO_2	POC	PM_{10}	$PM_{2.5}$	CO_2	CH_4	N_2O	CO_2e
Tugboat Main Engine Transit Leg 2 (and out)	5,000	30%	2.07	448	3.73	1.30	15	0.18	0.03	0.03	580	0.09	0.006	25.58	8.92	0.038	1.23	0.21	0.21	3,979	0.59	0.04	4,004	2.76	0.96	0.00	0.13	0.02	0.02	390	0.06	0.00	392
Tugboat Main Engine Transit Leg 3 (and out)	5,000	30%	2.00	432	3.73	1.30	15	0.18	0.03	0.03	580	0.09	0.006	24.67	8.60	0.037	1.19	0.20	0.20	3,837	0.57	0.04	3,861	2.66	0.93	0.00	0.13	0.02	0.02	376	0.06	0.00	378
Tugboat Main Engine Maneuvering Leg 4 (and out)	5,000	50%	4.00	864	3.73	1.30	15	0.18	0.03	0.03	580	0.09	0.006	82.23	28.66	0.122	3.97	0.66	0.66	12,791	1.89	0.13	12,869	8.88	3.10	0.01	0.43	0.07	0.07	1,253	0.19	0.01	1,261
Tugboat Main Engine Maneuvering Leg 5 - turn around	5,000	50%	1.00	216	3.73	1.30	15	0.18	0.03	0.03	580	0.09	0.006	20.56	7.16	0.030	0.99	0.17	0.17	3,198	0.47	0.03	3,217	2.22	0.77	0.00	0.11	0.02	0.02	313	0.05	0.00	315
Tugboat Main Engine Leg 6 - Mooring	5,000	50%	2.00	432	3.73	1.30	15	0.18	0.03	0.03	580	0.09	0.006	41.12	14.33	0.061	1.98	0.33	0.33	6,395	0.94	0.06	6,435	4.44	1.55	0.01	0.21	0.04	0.04	626	0.09	0.01	630
Tugboat Main Engine Leg 10 - Unmooring	5,000	60%	0.50	108	3.73	1.30	15	0.18	0.03	0.03	580	0.09	0.006	12.33	4.30	0.018	0.60	0.10	0.10	1,919	0.28	0.02	1,930	1.33	0.46	0.00	0.06	0.01	0.01	188	0.03	0.00	189
Tugboat Auxiliary Engine Transit Leg 2 (and out)	520	31%	2.07	448	3.73	3.99	15	0.81	0.08	0.08	580	0.09	0.006	2.75	2.94	0.004	0.60	0.06	0.06	428	0.06	0.00	430	0.30	0.32	0.00	0.06	0.01	0.01	42	0.01	0.00	42
Tugboat Auxiliary Engine Transit Leg 3 (and out)	520	31%	2.00	432	3.73	3.99	15	0.81	0.08	0.08	580	0.09	0.006	2.65	2.84	0.004	0.58	0.06	0.06	412	0.06	0.00	415	0.29	0.31	0.00	0.06	0.01	0.01	40	0.01	0.00	41
Tugboat Auxiliary Engine Maneuvering Leg 4 (and out)	520	31%	4.00	864	3.73	3.99	15	0.81	0.08	0.08	580	0.09	0.006	5.30	5.67	0.008	1.15	0.11	0.11	825	0.12	0.01	830	0.57	0.61	0.00	0.12	0.01	0.01	81	0.01	0.00	81
Tugboat Auxiliary Engine Maneuvering Leg 5 - turn around	520	31%	1.00	216	3.73	3.99	15	0.81	0.08	0.08	580	0.09	0.006	1.33	1.42	0.002	0.29	0.03	0.03	206	0.03	0.00	207	0.14	0.15	0.00	0.03	0.00	0.00	20	0.00	0.00	20
Tugboat Auxiliary Engine Leg 6 - Mooring	520	31%	2.00	432	3.73	3.99	15	0.81	0.08	0.08	580	0.09	0.006	2.65	2.84	0.004	0.58	0.06	0.06	412	0.06	0.00	415	0.29	0.31	0.00	0.06	0.01	0.01	40	0.01	0.00	41
Tugboat Auxiliary Engine Leg 10 - Unmooring	520	31%	0.50	108	3.73	3.99	15	0.81	0.08	0.08	580	0.09	0.006	0.66	0.71	0.001	0.14	0.01	0.01	103	0.02	0.00	104	0.07	0.08	0.00	0.02	0.00	0.00	10	0.00	0.00	10
													TUGBOAT TOTAL EMISSIONS	221.83	88.38	0.33	13.30	1.99	1.99	34,505	5.10	0.34	34,718	23.96	9.54	0.04	1.44	0.21	0.21	3,380	0.50	0.03	3,401

Notes:

1. For the in-and-out legs maximum tugboat operation hours are twice of the leg time to account for the whole trip; In addition, for leg 4, 5, and 6, the maximum tugboat operation hours are twice (four times for leg 4 for the whole trip) of the leg time to account for the additional tugboat required during these three legs.
2. Source for criteria pollutant emission factors: www.arb.ca.gov/regact/2007/chc07/appb.pdf; Emission factors for P_{10} and $PM_{2.5}$ are assumed to be the same. Emission factor for SO_2 is assumed to be 15ppm based on current regulatory requirements for sulfur content in fue
3. Source for greenhouse gas (CO_2,CH_4, and N_2O) emission factors: CCAR general reporting protocols, www.climateregistry.org/resources/docs/protocols/grp/GRP_3.1_January2009.pdf (Page 35; Page 53 for distillate fi
4. SO_2 (g/hp-hr) = (X ppm /1,000,000) x (2 g SO_2/g S) x (Brake Specific Fuel Consumption F) ; 2 is the molecular weight ratio of SO_2 to S
5. Emission = Power x Load Factor x Time x Emission Factor

Emission Factors From other source

Greenhouse Gas	Emision Factor		Gobal Warming Potential
	kg/gallon	g/hp-hr	
CO2	10.155	580.185	1
CH4	0.0015	0.086	21
N_2O	0.0001	0.006	310

Source: CCAR general reporting protocols, v.3.1.http://www.climateregistry.org/resources/docs/protocols/grp/GRP_3.1_January2009.pdf. (Page

Alternative 1 Project Emission Model Inputs and Results
15 Vessels per Month & 2007 Engine Year Tugboats
Tugboat Emissions

180 Vessel Trips per year

Tugboat Operations	Engine				Emission Factors[2,3]									Emissions[5]																					
	Power	Load Factor	Maximum Time		(g/hp-hr)		(ppm)	(g/hp-hr)						Maximum Daily (lb/call)									Annual (tons)						Annual (metric tons)			
	(hp)	(%)	(hr/call)[1]	(hr/yr)	CO	NO_x	SO_2	POC	PM_{10}	$PM_{2.5}$	CO_2	CH_4	N_2O	CO	NO_x	SO_2[4]	POC	PM_{10}	$PM_{2.5}$	CO_2	CH_4	N_2O	CO_2e	CO	NO_x	SO_2	POC	PM_{10}	$PM_{2.5}$	CO_2	CH_4	N_2O	CO_2e
Tugboat Main Engine Transit Leg 2 (and out)	5,000	30%	2.07	373	3.73	5.53	15	0.68	0.20	0.20	580	0.09	0.006	25.58	37.93	0.038	4.66	1.37	1.37	3,979	0.59	0.04	4,004	2.30	3.41	0.00	0.42	0.12	0.12	325	0.05	0.00	327
Tugboat Main Engine Transit Leg 3 (and out)	5,000	30%	2.00	360	3.73	5.53	15	0.68	0.20	0.20	580	0.09	0.006	24.67	36.57	0.037	4.50	1.32	1.32	3,837	0.57	0.04	3,861	2.22	3.29	0.00	0.40	0.12	0.12	313	0.05	0.00	315
Tugboat Main Engine Maneuvering Leg 4 (and out)	5,000	50%	4.00	720	3.73	5.53	15	0.68	0.20	0.20	580	0.09	0.006	82.23	121.91	0.122	14.99	4.41	4.41	12,791	1.89	0.13	12,869	7.40	10.97	0.01	1.35	0.40	0.40	1,044	0.15	0.01	1,051
Tugboat Main Engine Maneuvering Leg 5 - turn around	5,000	50%	1.00	180	3.73	5.53	15	0.68	0.20	0.20	580	0.09	0.006	20.56	30.48	0.030	3.75	1.10	1.10	3,198	0.47	0.03	3,217	1.85	2.74	0.00	0.34	0.10	0.10	261	0.04	0.00	263
Tugboat Main Engine Leg 6 - Mooring	5,000	50%	2.00	360	3.73	5.53	15	0.68	0.20	0.20	580	0.09	0.006	41.12	60.96	0.061	7.50	2.20	2.20	6,395	0.94	0.06	6,435	3.70	5.49	0.01	0.67	0.20	0.20	522	0.08	0.01	525
Tugboat Main Engine Leg 10 - Unmooring	5,000	60%	0.50	90	3.73	5.53	15	0.68	0.20	0.20	580	0.09	0.006	12.33	18.29	0.018	2.25	0.66	0.66	1,919	0.28	0.02	1,930	1.11	1.65	0.00	0.20	0.06	0.06	157	0.02	0.00	158
Tugboat Auxiliary Engine Transit Leg 2 (and out)	520	31%	2.07	373	3.73	5.10	15	0.81	0.15	0.15	580	0.09	0.006	2.75	3.76	0.004	0.60	0.11	0.11	428	0.06	0.00	430	0.25	0.34	0.00	0.05	0.01	0.01	35	0.01	0.00	35
Tugboat Auxiliary Engine Transit Leg 3 (and out)	520	31%	2.00	360	3.73	5.10	15	0.81	0.15	0.15	580	0.09	0.006	2.65	3.62	0.004	0.58	0.11	0.11	412	0.06	0.00	415	0.24	0.33	0.00	0.05	0.01	0.01	34	0.00	0.00	34
Tugboat Auxiliary Engine Maneuvering Leg 4 (and out)	520	31%	4.00	720	3.73	5.10	15	0.81	0.15	0.15	580	0.09	0.006	5.30	7.25	0.008	1.15	0.21	0.21	825	0.12	0.01	830	0.48	0.65	0.00	0.10	0.02	0.02	67	0.01	0.00	68
Tugboat Auxiliary Engine Maneuvering Leg 5 - turn around	520	31%	1.00	180	3.73	5.10	15	0.81	0.15	0.15	580	0.09	0.006	1.33	1.81	0.002	0.29	0.05	0.05	206	0.03	0.00	207	0.12	0.16	0.00	0.03	0.00	0.00	17	0.00	0.00	17
Tugboat Auxiliary Engine Leg 6 - Mooring	520	31%	2.00	360	3.73	5.10	15	0.81	0.15	0.15	580	0.09	0.006	2.65	3.62	0.004	0.58	0.11	0.11	412	0.06	0.00	415	0.24	0.33	0.00	0.05	0.01	0.01	34	0.00	0.00	34
Tugboat Auxiliary Engine Leg 10 - Unmooring	520	31%	0.50	90	3.73	5.10	15	0.81	0.15	0.15	580	0.09	0.006	0.66	0.91	0.001	0.14	0.03	0.03	103	0.02	0.00	104	0.06	0.08	0.00	0.01	0.00	0.00	8	0.00	0.00	8
													TUGBOAT TOTAL EMISSIONS	221.83	327.12	0.33	40.98	11.69	11.69	34,505	5.10	0.34	34,718	19.97	29.44	0.03	3.69	1.05	1.05	2,817	0.42	0.03	2,834

Notes:

1. For the in-and-out legs maximum tugboat operation hours are twice of the leg time to account for the whole trip; In addition, for leg 4, 5, and 6, the maximum tugboat operation hours are twice (four times for leg 4 for the whole trip) of the leg time to account for the additional tugboat required during these three legs.
2. Source for criteria pollutant emission factors: www.arb.ca.gov/regact/2007/chc07/appb.pdf; Emission factors for P_{10} and $PM_{2.5}$ are assumed to be the same. Emission factor for SO is assumed to be 15ppm based on current regulatory requirements for sulfur content in fue
3. Source for greenhouse gas (CO_2,CH_4, and N_2O) emission factors: CCAR general reporting protocols, www.climateregistry.org/resources/docs/protocols/grp/GRP_3.1_January2009.pdf (Page 35; Page 53 for distillate fu
4. SO_2 (g/hp-hr) = (X ppm /1,000,000) x (2 g SO_2/g S) x (Brake Specific Fuel Consumption F) ; 2 is the molecular weight ratio of SO to S
5. Emission = Power x Load Factor x Time x Emission Factor

Emission Factors From other source			
Greenhouse Gas	Emision Factor		Gobal Warming Potential
	kg/gallon	g/hp-hr	
CO2	10.155	580.185	1
CH4	0.0015	0.086	21
N_2O	0.0001	0.006	310
Source: CCAR general reporting protocols, v.3.1.http://www.climateregistry.org/resources/docs/protocols/grp/GRP_3.1_January2009.pdf. (Page			

Alternative 1 Project Emission Model Inputs and Results
15 Vessels per Month & 2016 Engine Year Tugboats
Tugboat Emissions

180 Vessel Trips per year

Tugboat Operations	Engine				Emission Factors[2,3]									Emissions[5]																				
	Power	Load Factor	Maximum Time		(g/hp-hr)		(ppm)	(g/hp-hr)						Maximum Daily (lb/call)									Annual (tons)						Annual (metric tons)			
	(hp)	(%)	(hr/call)[1]	(hr/yr)	CO	NO_x	SO_2	POC	PM_{10}	$PM_{2.5}$	CO_2	CH_4	N_2O	CO	NO_x	SO_2[4]	POC	PM_{10}	$PM_{2.5}$	CO_2	CH_4	N_2O	CO_2e	CO	NO_x	SO_2	POC	PM_{10}	$PM_{2.5}$	CO_2	CH_4	N_2O	CO_2e
Tugboat Main Engine Transit Leg 2 (and out)	5,000	30%	2.07	373	3.73	1.30	15	0.18	0.03	0.03	580	0.09	0.006	25.58	8.92	0.038	1.23	0.21	0.21	3,979	0.59	0.04	4,004	2.30	0.80	0.0034	0.11	0.02	0.02	325	0.0480	0.0032	327
Tugboat Main Engine Transit Leg 3 (and out)	5,000	30%	2.00	360	3.73	1.30	15	0.18	0.03	0.03	580	0.09	0.006	24.67	8.60	0.037	1.19	0.20	0.20	3,837	0.57	0.04	3,861	2.22	0.77	0.0033	0.11	0.02	0.02	313	0.0463	0.0031	315
Tugboat Main Engine Maneuvering Leg 4 (and out)	5,000	50%	4.00	720	3.73	1.30	15	0.18	0.03	0.03	580	0.09	0.006	82.23	28.66	0.122	3.97	0.66	0.66	12,791	1.89	0.13	12,869	7.40	2.58	0.0110	0.36	0.06	0.06	1,044	0.1542	0.0103	1,051
Tugboat Main Engine Maneuvering Leg 5 - turn around	5,000	50%	1.00	180	3.73	1.30	15	0.18	0.03	0.03	580	0.09	0.006	20.56	7.16	0.030	0.99	0.17	0.17	3,198	0.47	0.03	3,217	1.85	0.64	0.0027	0.09	0.01	0.01	261	0.0386	0.0026	263
Tugboat Main Engine Leg 6 - Mooring	5,000	50%	2.00	360	3.73	1.30	15	0.18	0.03	0.03	580	0.09	0.006	41.12	14.33	0.061	1.98	0.33	0.33	6,395	0.94	0.06	6,435	3.70	1.29	0.0055	0.18	0.03	0.03	522	0.0771	0.0051	525
Tugboat Main Engine Leg 10 - Unmooring	5,000	60%	0.50	90	3.73	1.30	15	0.18	0.03	0.03	580	0.09	0.006	12.33	4.30	0.018	0.60	0.10	0.10	1,919	0.28	0.02	1,930	1.11	0.39	0.0016	0.05	0.01	0.01	157	0.0231	0.0015	158
Tugboat Auxiliary Engine Transit Leg 2 (and out)	520	31%	2.07	373	3.73	3.99	15	0.81	0.08	0.08	580	0.09	0.006	2.75	2.94	0.004	0.60	0.06	0.06	428	0.06	0.00	430	0.25	0.26	0.0004	0.05	0.01	0.01	35	0.0052	0.0003	35
Tugboat Auxiliary Engine Transit Leg 3 (and out)	520	31%	2.00	360	3.73	3.99	15	0.81	0.08	0.08	580	0.09	0.006	2.65	2.84	0.004	0.58	0.06	0.06	412	0.06	0.00	415	0.24	0.26	0.0004	0.05	0.01	0.01	34	0.0050	0.0003	34
Tugboat Auxiliary Engine Maneuvering Leg 4 (and out)	520	31%	4.00	720	3.73	3.99	15	0.81	0.08	0.08	580	0.09	0.006	5.30	5.67	0.008	1.15	0.11	0.11	825	0.12	0.01	830	0.48	0.51	0.0007	0.10	0.01	0.01	67	0.0099	0.0007	68
Tugboat Auxiliary Engine Maneuvering Leg 5 - turn around	520	31%	1.00	180	3.73	3.99	15	0.81	0.08	0.08	580	0.09	0.006	1.33	1.42	0.002	0.29	0.03	0.03	206	0.03	0.00	207	0.12	0.13	0.0002	0.03	0.00	0.00	17	0.0025	0.0002	17
Tugboat Auxiliary Engine Leg 6 - Mooring	520	31%	2.00	360	3.73	3.99	15	0.81	0.08	0.08	580	0.09	0.006	2.65	2.84	0.004	0.58	0.06	0.06	412	0.06	0.00	415	0.24	0.26	0.0004	0.05	0.01	0.01	34	0.0050	0.0003	34
Tugboat Auxiliary Engine Leg 10 - Unmooring	520	31%	0.50	90	3.73	3.99	15	0.81	0.08	0.08	580	0.09	0.006	0.66	0.71	0.001	0.14	0.01	0.01	103	0.02	0.00	104	0.06	0.06	0.0001	0.01	0.00	0.00	8	0.0012	0.0001	8
													TUGBOAT TOTAL EMISSIONS	221.83	88.38	0.33	13.30	1.99	1.99	34,505	5.10	0.34	34,718	19.97	7.95	0.03	1.20	0.18	0.18	2,817	0.42	0.03	2,834

Notes:

1. For the in-and-out legs maximum tugboat operation hours are twice of the leg time to account for the whole trip; In addition, for leg 4, 5, and 6, the maximum tugboat operation hours are twice (four times for leg 4 for the whole trip) of the leg time to account for the additional tugboat required during these three legs.
2. Source for criteria pollutant emission factors: www.arb.ca.gov/regact/2007/chc07/appb.pdf; Emission factors for P_{10} and $PM_{2.5}$ are assumed to be the same. Emission factor for SO is assumed to be 15ppm based on current regulatory requirements for sulfur content in fue
3. Source for greenhouse gas (CO_2,CH_4, and N_2O) emission factors: CCAR general reporting protocols, www.climateregistry.org/resources/docs/protocols/grp/GRP_3.1_January2009.pdf (Page 35; Page 53 for distillate fu
4. SO_2 (g/hp-hr) = (X ppm /1,000,000) x (2 g SO_2/g S) x (Brake Specific Fuel Consumption F) ; 2 is the molecular weight ratio of SO to S
5. Emission = Power x Load Factor x Time x Emission Factor

Emission Factors From other source			
Greenhouse Gas	Emision Factor		Gobal Warming Potential
	kg/gallon	g/hp-hr	
CO2	10.155	580.185	1
CH4	0.0015	0.086	21
N_2O	0.0001	0.006	310
Source: CCAR general reporting protocols, v.3.1.http://www.climateregistry.org/resources/docs/protocols/grp/GRP_3.1_January2009.pdf. (Page			

D - 6. Rail Emissions Summary

Wespac Pittsburg
Transportation Emissions - Orwood to Pittsburg (2014 - 2026)

Number of main line-haul locomotives Inbound	3	
Number of main line-haul locomotives Outbound	2	
Distance per trip (mi)	15	
Travel Time (hour/event)	0.30	
Max Rail Trip frequency (per year)	365	From RFI: begin with one train every other day, then one train per day at maximum
ES-44 Horsepower	4400	

INBOUND to Pittsburg

Assume ES44 Tier II locomotive model[1]

Throttle Position	Percent Time in Notch[2]	Fuel Consumption (lb/hr)	Tier 2 Emission Factors[1] (g/hr)					Emission Factors[4] (g/hp-hr)			Adjusted Emission Factors[3,5] (lb/hr)							
			NOx	CO	HC	PM[2]	SO2[3]	CO_2	CH_4	N_2O	NOx	CO[4]	HC	PM[4]	SO_2[6]	CO_2	CH_4	N_2O
Idle	8.5%	32	329	30	24	7.7	0.44	494	0.040	0.013	0.69	0.06	0.05	0.01	0.001	4,788	0.388	0.126
DB (dynamic brake)	11.0%	103	657	120	65	42.0	1.40	494	0.040	0.013	1.37	0.26	0.14	0.07	0.003	4,788	0.388	0.126
1	8.3%	55	1,135	142	62	69.3	0.75	494	0.040	0.013	2.38	0.30	0.14	0.11	0.002	4,788	0.388	0.126
2	6.1%	137	2,730	239	120	145.8	1.87	494	0.040	0.013	5.71	0.51	0.27	0.23	0.004	4,788	0.388	0.126
3	8.3%	226	5,310	607	220	304.3	3.08	494	0.040	0.013	11.11	1.30	0.49	0.49	0.007	4,788	0.388	0.126
4	10.4%	331	7,246	806	224	365.0	4.51	494	0.040	0.013	15.16	1.72	0.50	0.59	0.010	4,788	0.388	0.126
5	3.5%	442	9,612	479	311	405.2	6.02	494	0.040	0.013	20.11	1.02	0.69	0.65	0.013	4,788	0.388	0.126
6	3.2%	567	13,455	537	408	418.4	7.72	494	0.040	0.013	28.15	1.15	0.91	0.67	0.017	4,788	0.388	0.126
7	5.0%	710	16,005	790	488	513.5	9.67	494	0.040	0.013	33.49	1.69	1.09	0.83	0.021	4,788	0.388	0.126
8	35.7%	854	18,566	1,034	619	607.5	11.63	494	0.040	0.013	38.85	2.21	1.38	0.98	0.026	4,788	0.388	0.126
	100.0%																	

OUTBOUND to Orword

Assume ES44 Tier II locomotive model[1]

Throttle Position	Percent Time in Notch[2]	Fuel Consumption (lb/hr)	Tier 2 Emission Factors[1] (g/hr)					Emission Factors[4] (g/hp-hr)			Adjusted Emission Factors[3,5] (lb/hr)							
			NOx	CO	HC	PM[2]	SO2[3]	CO_2	CH_4	N_2O	NOx	CO[4]	HC	PM[4]	SO_2[6]	CO_2	CH_4	N_2O
Idle	4.4%	32	329	30	24	7.7	0.44	494	0.040	0.013	0.69	0.06	0.05	0.01	0.001	4,788	0.388	0.126
DB (dynamic brake)	7.8%	103	657	120	65	42.0	1.40	494	0.040	0.013	1.37	0.26	0.14	0.07	0.003	4,788	0.388	0.126
1	2.2%	55	1,135	142	62	69.3	0.75	494	0.040	0.013	2.38	0.30	0.14	0.11	0.002	4,788	0.388	0.126
2	1.9%	137	2,730	239	120	145.8	1.87	494	0.040	0.013	5.71	0.51	0.27	0.23	0.004	4,788	0.388	0.126
3	1.8%	226	5,310	607	220	304.3	3.08	494	0.040	0.013	11.11	1.30	0.49	0.49	0.007	4,788	0.388	0.126
4	24.2%	331	7,246	806	224	365.0	4.51	494	0.040	0.013	15.16	1.72	0.50	0.59	0.010	4,788	0.388	0.126
5	35.0%	442	9,612	479	311	405.2	6.02	494	0.040	0.013	20.11	1.02	0.69	0.65	0.013	4,788	0.388	0.126
6	14.0%	567	13,455	537	408	418.4	7.72	494	0.040	0.013	28.15	1.15	0.91	0.67	0.017	4,788	0.388	0.126
7	2.5%	710	16,005	790	488	513.5	9.67	494	0.040	0.013	33.49	1.69	1.09	0.83	0.021	4,788	0.388	0.126
8	6.2%	854	18,566	1,034	619	607.5	11.63	494	0.040	0.013	38.85	2.21	1.38	0.98	0.026	4,788	0.388	0.126
	100.0%																	

Notes:

1. According to BNSF, locomotive with Tier 2 engines would be likely to serve for the transload area. Based on BNSF locomotive fleet statistics for 2009, the most common locomotive model is the ES44 model.
2. Percent time in different notch settings were provided by Michael Stanfill with BNSF. (email 6/7/13)
3. Ful comsumption factors and emission factors for NOx, CO, HC and PM were obtained from Port of Oakland 2005 EI. http://www.portofoakland.com/pdf/airEmissions_Inventory.pdf
4. GHG Emission Factors are from POLB Emission Inventory, 2011 http://www.polb.com/civica/filebank/blobdload.asp?BlobID=10194
5. Emission factors were adjusted based on percent changes (-5% for NOx, -3% for CO, +1% for HC, and -27% for PM) from 3198ppm sulfur diesel fuel to 50ppm sulfur diesel fuel. Source: Table 1 of Diesel Fuel Effects on Locomotive Exhaust Emissions at http://www.arb.ca.gov/fuels/diesel/102000swri_dslemssn.pdf
6. SO_2 EF is calculated based on 15 ppm sulfur content; EF = Fuel Consumption*(15ppm)*(2 SO_2/S)
7. Emissions = EF x Travel Time x Percent Time in Notch

D - 6. Rail Emissions Summary

Wespac Pittsburg
Transportation Emissions - Orwood to Pittsburg (2014-2026)

Number of main line-haul locomotives Inbound	3
Number of main line-haul locomotives Outbound	2
Distance per trip (mi)	15
Travel Time (hour/event)	0.30
Max Rail Trip frequency (per year)	365
ES-44 Horsepower	4400

INBOUND to Pittsburg

Assume ES44 Tier II locomotive model[1]

Throttle Position	Percent Time in Notch[2]	Emissions per Event[7] (lb/event)								Annual Emissions (lb/yr)								Annual Emissions (tons/yr)					Annual Emissions (metric tons/yr)		
		NOx	CO	HC	PM	SO2	CO_2	CH_4	N_2O	NOx	CO	HC	PM	SO2	CO_2	CH_4	N_2O	NOx	CO	HC	PM	SO2	CO_2	CH_4	N_2O
Idle	8.5%	0.053	0.005	0.004	0.001	0.000	366.3	0.030	0.010	19	2	1	0	0.03	133,684	11	4	0.01	0.001	0.001	0.000	0.000	61	0.005	0.002
DB (dynamic brake)	11.0%	0.136	0.025	0.014	0.007	0.000	474.0	0.038	0.012	50	9	5	2	0.11	173,002	14	5	0.02	0.005	0.003	0.001	0.000	78	0.006	0.002
1	8.3%	0.177	0.023	0.010	0.008	0.000	357.6	0.029	0.009	65	8	4	3	0.04	130,538	11	3	0.03	0.004	0.002	0.002	0.000	59	0.005	0.002
2	6.1%	0.314	0.028	0.015	0.013	0.000	262.8	0.021	0.007	114	10	5	5	0.08	95,938	8	3	0.06	0.005	0.003	0.002	0.000	44	0.004	0.001
3	8.3%	0.830	0.097	0.037	0.037	0.001	357.6	0.029	0.009	303	35	13	13	0.18	130,538	11	3	0.15	0.018	0.007	0.007	0.000	59	0.005	0.002
4	10.4%	1.419	0.161	0.047	0.055	0.001	448.1	0.036	0.012	518	59	17	20	0.34	163,566	13	4	0.26	0.029	0.009	0.010	0.000	74	0.006	0.002
5	3.5%	0.634	0.032	0.022	0.021	0.000	150.8	0.012	0.004	231	12	8	7	0.15	55,046	4	1	0.12	0.006	0.004	0.004	0.000	25	0.002	0.001
6	3.2%	0.811	0.033	0.026	0.019	0.000	137.9	0.011	0.004	296	12	10	7	0.18	50,328	4	1	0.15	0.006	0.005	0.004	0.000	23	0.002	0.001
7	5.0%	1.507	0.076	0.049	0.037	0.001	215.4	0.017	0.006	550	28	18	14	0.35	78,637	6	2	0.28	0.014	0.009	0.007	0.000	36	0.003	0.001
8	35.7%	12.482	0.710	0.442	0.314	0.008	1,538.3	0.125	0.040	4,556	259	161	115	3.00	561,471	45	15	2.28	0.130	0.081	0.057	0.002	255	0.021	0.007
Total Inbound Emissions		**18.4**	**1.2**	**0.7**	**0.5**	**0.012**	**4,308.9**	**0.3**	**0.1**	**6,702**	**434**	**243**	**187**	**4.5**	**1,572,748**	**127**	**41**	**3.35**	**0.22**	**0.12**	**0.09**	**0.002**	**713**	**0.058**	**0.019**

OUTBOUND to Orword

Assume ES44 Tier II locomotive model[1]

Throttle Position	Percent Time in Notch[2]	Emissions per Event[7] (lb/event)								Annual Emissions (lb/yr)								Annual Emissions (tons/yr)					Annual Emissions (metric tons/yr)		
		NOx	CO	HC	PM	SO2	CO_2	CH_4	N_2O	NOx	CO	HC	PM	SO2	CO_2	CH_4	N_2O	NOx	CO	HC	PM	SO2	CO_2	CH_4	N_2O
Idle	4.4%	0.018	0.002	0.001	0.000	0.000	126.4	0.010	0.003	7	1	1	0	0.01	46,134	4	1	0.00	0.000	0.000	0.000	0.000	20.92	0.002	0.001
DB (dynamic brake)	7.8%	0.064	0.012	0.007	0.003	0.000	224.1	0.018	0.006	23	4	2	1	0.05	81,783	7	2	0.01	0.002	0.001	0.001	0.000	37.09	0.003	0.001
1	2.2%	0.031	0.004	0.002	0.001	0.000	63.2	0.005	0.002	11	1	1	1	0.01	23,067	2	1	0.01	0.001	0.000	0.000	0.000	10.46	0.001	0.000
2	1.9%	0.065	0.006	0.003	0.003	0.000	54.6	0.004	0.001	24	2	1	1	0.02	19,921	2	1	0.01	0.001	0.001	0.000	0.000	9.03	0.001	0.000
3	1.8%	0.120	0.014	0.005	0.005	0.000	51.7	0.004	0.001	44	5	2	2	0.03	18,873	2	0	0.02	0.003	0.001	0.001	0.000	8.56	0.001	0.000
4	24.2%	2.202	0.250	0.072	0.085	0.001	695.2	0.056	0.018	804	91	26	31	0.53	253,737	21	7	0.40	0.046	0.013	0.016	0.000	115.07	0.009	0.003
5	35.0%	4.224	0.215	0.145	0.137	0.003	1,005.4	0.081	0.026	1,542	78	53	50	1.02	366,975	30	10	0.77	0.039	0.027	0.025	0.001	166.43	0.013	0.004
6	14.0%	2.365	0.096	0.076	0.057	0.001	402.2	0.033	0.011	863	35	28	21	0.52	146,790	12	4	0.43	0.018	0.014	0.010	0.000	66.57	0.005	0.002
7	2.5%	0.502	0.025	0.016	0.012	0.000	71.8	0.006	0.002	183	9	6	5	0.12	26,212	2	1	0.09	0.005	0.003	0.002	0.000	11.89	0.001	0.000
8	6.2%	1.445	0.082	0.051	0.036	0.001	178.1	0.014	0.005	527	30	19	13	0.35	65,007	5	2	0.26	0.015	0.009	0.007	0.000	29.48	0.002	0.001
Total Outbound Emissions		**11.0**	**0.7**	**0.4**	**0.3**	**0.007**	**2,872.6**	**0.2**	**0.1**	**4,028**	**258**	**139**	**124**	**2.6**	**1,048,499**	**85**	**28**	**2.01**	**0.13**	**0.07**	**0.06**	**0.001**	**476**	**0.039**	**0.013**
TOTAL EMISSIONS		**29.4**	**1.9**	**1.0**	**0.9**	**0.020**	**7,181**	**0.6**	**0.2**	**10,731**	**692**	**382**	**311**	**7.1**	**2,621,247**	**212**	**69**	**5.37**	**0.35**	**0.19**	**0.16**	**0.004**	**1,189**	**0.096**	**0.031**

1. According to BNSF, locomotive with Tier 2 engines would be likely to serve for the transload area. Based on BNSF locomotive fleet statistics for 2009, the most common locomotive model is the ES44 model.
2. Percent time in different notch settings were provided by Michael Stanfill with BNSF. (email 6/7/13)
3. Ful comsumption factors and emission factors for NOx, CO, HC and PM were obtained from Port of Oakland 2005 EI. http://www.portofoakland.com/pdf/airEmissions_Inventory.pdf
4. GHG Emission Factors are from POLB Emission Inventory, 2011 http://www.polb.com/civica/filebank/blobdload.asp?BlobID=10194

5. Emission factors were adjusted based on percent changes (-5% for NOx, -3% for CO, +1% for HC, and -27% for PM) from 3198ppm sulfur diesel fuel to 50ppm sulfur diesel fuel. Source: Table 1 of Diesel Fuel Effects on Locomotive Exhaust Emissions at http://www.arb.ca.gov/fuels/diesel/102000swri_dslemssn.pdf

6. SO_2 EF is calculated based on 15 ppm sulfur content; EF = Fuel Consumption*(15ppm)*(2 SØS)
7. Emissions = EF x Travel Time x Percent Time in Notch

Wespac Pittsburg
Transportation Emissions - Pittsburg to Richmond (2014-2026)

Number of main line-haul locomotives to Richmond (Outbound)	1	
Number of main line-haul locomotives to Pittsbug (Inbound)	2	
Distance per trip (mi)	33	
Travel Time Outbound (hour/event)	0.83	
Travel Time Inbound (hour/event)	1.28	
Max Rail Trip frequency (per year)	365	From RFI: begin with one train every other day, then one train per day at maximum
ES-44 Horsepower	4400	

OUTBOUND to Richmond

Assume ES44 Tier II locomotive model[1]

Throttle Position	Percent Time in Notch[2]	Fuel Consumption (lb/hr)	Tier 2 Emission Factors[1] (g/hr)					Emission Factors[4] (g/hp-hr)			Adjusted Emission Factors[3,5] (lb/hr)							
			NOx	CO	HC	PM[2]	SO2[3]	CO_2	CH_4	N_2O	NOx	CO[4]	HC	PM[4]	SO_2[6]	CO_2	CH_4	N_2O
Idle	8.9%	32	329	30	24	7.7	0.44	494	0.040	0.013	0.69	0.06	0.05	0.01	0.001	4,788	0.388	0.126
DB (dynamic brake)	33.0%	103	657	120	65	42.0	1.40	494	0.040	0.013	1.37	0.26	0.14	0.07	0.003	4,788	0.388	0.126
1	10.6%	55	1,135	142	62	69.3	0.75	494	0.040	0.013	2.38	0.30	0.14	0.11	0.002	4,788	0.388	0.126
2	11.0%	137	2,730	239	120	145.8	1.87	494	0.040	0.013	5.71	0.51	0.27	0.23	0.004	4,788	0.388	0.126
3	5.2%	226	5,310	607	220	304.3	3.08	494	0.040	0.013	11.11	1.30	0.49	0.49	0.007	4,788	0.388	0.126
4	13.8%	331	7,246	806	224	365.0	4.51	494	0.040	0.013	15.16	1.72	0.50	0.59	0.010	4,788	0.388	0.126
5	12.0%	442	9,612	479	311	405.2	6.02	494	0.040	0.013	20.11	1.02	0.69	0.65	0.013	4,788	0.388	0.126
6	0.2%	567	13,455	537	408	418.4	7.72	494	0.040	0.013	28.15	1.15	0.91	0.67	0.017	4,788	0.388	0.126
7	0.2%	710	16,005	790	488	513.5	9.67	494	0.040	0.013	33.49	1.69	1.09	0.83	0.021	4,788	0.388	0.126
8	5.1%	854	18,566	1,034	619	607.5	11.63	494	0.040	0.013	38.85	2.21	1.38	0.98	0.026	4,788	0.388	0.126

OUTBOUND to Orword

Assume ES44 Tier II locomotive model[1]

Throttle Position	Percent Time in Notch[2]	Fuel Consumption (lb/hr)	Tier 2 Emission Factors[1] (g/hr)					Emission Factors[4] (g/hp-hr)			Adjusted Emission Factors[3,5] (lb/hr)							
			NOx	CO	HC	PM[2]	SO2[3]	CO_2	CH_4	N_2O	NOx	CO[4]	HC	PM[4]	SO_2[6]	CO_2	CH_4	N_2O
Idle	25.3%	32	329	30	24	7.7	0.44	494	0.040	0.013	0.69	0.06	0.05	0.01	0.001	4,788	0.388	0.126
DB (dynamic brake)	20.4%	103	657	120	65	42.0	1.40	494	0.040	0.013	1.37	0.26	0.14	0.07	0.003	4,788	0.388	0.126
1	12.2%	55	1,135	142	62	69.3	0.75	494	0.040	0.013	2.38	0.30	0.14	0.11	0.002	4,788	0.388	0.126
2	12.4%	137	2,730	239	120	145.8	1.87	494	0.040	0.013	5.71	0.51	0.27	0.23	0.004	4,788	0.388	0.126
3	5.9%	226	5,310	607	220	304.3	3.08	494	0.040	0.013	11.11	1.30	0.49	0.49	0.007	4,788	0.388	0.126
4	3.5%	331	7,246	806	224	365.0	4.51	494	0.040	0.013	15.16	1.72	0.50	0.59	0.010	4,788	0.388	0.126
5	7.4%	442	9,612	479	311	405.2	6.02	494	0.040	0.013	20.11	1.02	0.69	0.65	0.013	4,788	0.388	0.126
6	10.9%	567	13,455	537	408	418.4	7.72	494	0.040	0.013	28.15	1.15	0.91	0.67	0.017	4,788	0.388	0.126
7	1.9%	710	16,005	790	488	513.5	9.67	494	0.040	0.013	33.49	1.69	1.09	0.83	0.021	4,788	0.388	0.126
8	0.1%	854	18,566	1,034	619	607.5	11.63	494	0.040	0.013	38.85	2.21	1.38	0.98	0.026	4,788	0.388	0.126

Notes:

1. According to BNSF, locomotive with Tier 2 engines would be likely to serve for the transload area. Based on BNSF locomotive fleet statistics for 2009, the most common locomotive model is the ES44 model.
2. Percent time in different notch settings were provided by Michael Stanfill with BNSF. (email 6/20/13)
3. Ful comsumption factors and emission factors for NOx, CO, HC and PM were obtained from Port of Oakland 2005 EI. http://www.portofoakland.com/pdf/airEmissions_Inventory.pdf
4. GHG Emission Factors are from POLB Emission Inventory, 2011 http://www.polb.com/civica/filebank/blobdload.asp?BlobID=10194
5. Emission factors were adjusted based on percent changes (-5% for NOx, -3% for CO, +1% for HC, and -27% for PM) from 3198ppm sulfur diesel fuel to 50ppm sulfur diesel fuel. Source: Table 1 of Diesel Fuel Effects on Locomotive Exhaust Emissions at http://www.arb.ca.gov/fuels/diesel/102000swri_dslemssn.pdf
6. SO_2 EF is calculated based on 15 ppm sulfur content; EF = Fuel Consumption*(15ppm)*(2 SO_2/S)
7. Emissions = EF x Travel Time x Percent Time in Notch

Wespac Pittsburg
Transportation Emissions - Pittsburg to Richmond (2014 - 2026)

Number of main line-haul locomotives to Richmond (Outbound)	1
Number of main line-haul locomotives to Pittsbug (Inbound)	2
Distance per trip (mi)	33
Travel Time Outbound (hour/event)	0.83
Travel Time Inbound (hour/event)	1.28
Max Rail Trip frequency (per year)	365
ES-44 Horsepower	4400

OUTBOUND to Richmond

Assume ES44 Tier II locomotive model[1]

Throttle Position	Percent Time in Notch[2]	Emissions per Event[7] (lb/event)								Annual Emissions (lb/yr)								Annual Emissions (tons/yr)					Annual Emissions (metric tons/yr)		
		NOx	CO	HC	PM	SO2	CO_2	CH_4	N_2O	NOx	CO	HC	PM	SO2	CO_2	CH_4	N_2O	NOx	CO	HC	PM	SO2	CO_2	CH_4	N_2O
Idle	8.9%	0.051	0.005	0.004	0.001	0.000	355.1	0.029	0.009	19	2	1	0	0.03	129,606	10	3	0.01	0.001	0.001	0.000	0.000	59	0.005	0.002
DB (dynamic brake)	33.0%	0.378	0.071	0.040	0.019	0.001	1,316.6	0.107	0.035	138	26	15	7	0.31	480,562	39	13	0.07	0.013	0.007	0.003	0.000	218	0.018	0.006
1	10.6%	0.210	0.027	0.012	0.010	0.000	422.9	0.034	0.011	77	10	4	4	0.05	154,362	12	4	0.04	0.005	0.002	0.002	0.000	70	0.006	0.002
2	11.0%	0.524	0.047	0.024	0.021	0.000	438.9	0.036	0.012	191	17	9	8	0.14	160,187	13	4	0.10	0.009	0.004	0.004	0.000	73	0.006	0.002
3	5.2%	0.481	0.056	0.021	0.021	0.000	207.5	0.017	0.005	176	21	8	8	0.11	75,725	6	2	0.09	0.010	0.004	0.004	0.000	34	0.003	0.001
4	13.8%	1.744	0.198	0.057	0.067	0.001	550.6	0.045	0.014	636	72	21	25	0.42	200,962	16	5	0.32	0.036	0.010	0.012	0.000	91	0.007	0.002
5	12.0%	2.011	0.102	0.069	0.065	0.001	478.8	0.039	0.013	734	37	25	24	0.48	174,750	14	5	0.37	0.019	0.013	0.012	0.000	79	0.006	0.002
6	0.2%	0.047	0.002	0.002	0.001	0.000	8.0	0.001	0.000	17	1	1	0	0.01	2,912	0	0	0.01	0.000	0.000	0.000	0.000	1	0.000	0.000
7	0.2%	0.056	0.003	0.002	0.001	0.000	8.0	0.001	0.000	20	1	1	1	0.01	2,912	0	0	0.01	0.001	0.000	0.000	0.000	1	0.000	0.000
8	5.1%	1.651	0.094	0.059	0.042	0.001	203.5	0.016	0.005	603	34	21	15	0.40	74,269	6	2	0.30	0.017	0.011	0.008	0.000	34	0.003	0.001
Total Inbound Emissions		**7.2**	**0.6**	**0.3**	**0.2**	**0.005**	**3,989.7**	**0.3**	**0.1**	**2,611**	**220**	**106**	**91**	**2.0**	**1,456,248**	**118**	**38**	**1.31**	**0.11**	**0.05**	**0.05**	**0.001**	**660**	**0.053**	**0.017**

OUTBOUND to Orword

Assume ES44 Tier II locomotive model[1]

Throttle Position	Percent Time in Notch[2]	Emissions per Event[7] (lb/event)								Annual Emissions (lb/yr)								Annual Emissions (tons/yr)					Annual Emissions (metric tons/yr)		
		NOx	CO	HC	PM	SO2	CO_2	CH_4	N_2O	NOx	CO	HC	PM	SO2	CO_2	CH_4	N_2O	NOx	CO	HC	PM	SO2	CO_2	CH_4	N_2O
Idle	25.3%	0.447	0.042	0.035	0.008	0.001	3,109.0	0.252	0.082	163	15	13	3	0.23	1,134,767	92	30	0.08	0.008	0.006	0.001	0.000	514.63	0.042	0.014
DB (dynamic brake)	20.4%	0.720	0.134	0.076	0.035	0.002	2,506.8	0.203	0.066	263	49	28	13	0.59	914,990	74	24	0.13	0.024	0.014	0.006	0.000	414.96	0.034	0.011
1	12.2%	0.744	0.095	0.043	0.035	0.001	1,499.2	0.121	0.039	271	35	16	13	0.19	547,200	44	14	0.14	0.017	0.008	0.006	0.000	248.16	0.020	0.007
2	12.4%	1.818	0.163	0.085	0.075	0.001	1,523.8	0.123	0.040	664	59	31	27	0.48	556,170	45	15	0.33	0.030	0.016	0.014	0.000	252.23	0.020	0.007
3	5.9%	1.683	0.196	0.074	0.074	0.001	725.0	0.059	0.019	614	72	27	27	0.37	264,629	21	7	0.31	0.036	0.014	0.014	0.000	120.01	0.010	0.003
4	3.5%	1.362	0.155	0.045	0.053	0.001	430.1	0.035	0.011	497	56	16	19	0.33	156,984	13	4	0.25	0.028	0.008	0.010	0.000	71.19	0.006	0.002
5	7.4%	3.820	0.194	0.131	0.124	0.003	909.3	0.074	0.024	1,394	71	48	45	0.92	331,908	27	9	0.70	0.035	0.024	0.023	0.000	150.53	0.012	0.004
6	10.9%	7.877	0.321	0.254	0.188	0.005	1,339.4	0.108	0.035	2,875	117	93	69	1.74	488,892	40	13	1.44	0.059	0.046	0.034	0.001	221.72	0.018	0.006
7	1.9%	1.633	0.082	0.053	0.040	0.001	233.5	0.019	0.006	596	30	19	15	0.38	85,220	7	2	0.30	0.015	0.010	0.007	0.000	38.65	0.003	0.001
8	0.1%	0.100	0.006	0.004	0.003	0.000	12.3	0.001	0.000	36	2	1	1	0.02	4,485	0	0	0.02	0.001	0.001	0.000	0.000	2.03	0.000	0.000
Total Outbound Emissions		**20.2**	**1.4**	**0.8**	**0.6**	**0.014**	**12,288.3**	**1.0**	**0.3**	**7,374**	**507**	**292**	**232**	**5.2**	**4,485,244**	**363**	**118**	**3.69**	**0.25**	**0.15**	**0.12**	**0.003**	**2,034**	**0.165**	**0.054**
TOTAL EMISSIONS		**27.4**	**2.0**	**1.1**	**0.9**	**0.020**	**16,278.1**	**1.3**	**0.4**	**9,985**	**727**	**398**	**322**	**7.2**	**5,941,493**	**481**	**156**	**4.99**	**0.36**	**0.20**	**0.16**	**0.004**	**2,695**	**0.218**	**0.071**

Notes:

1. According to BNSF, locomotive with Tier 2 engines would be likely to serve for the transload area. Based on BNSF locomotive fleet statistics for 2009, the most common locomotive model is the ES44 model.
2. Percent time in different notch settings were provided by Michael Stanfill with BNSF. (email 6/20/13)
3. Ful comsumption factors and emission factors for NOx, CO, HC and PM were obtained from Port of Oakland 2005 EI. http://www.portofoakland.com/pdf/airEmissions_Inventory.pdf
4. GHG Emission Factors are from POLB Emission Inventory, 2011 http://www.polb.com/civica/filebank/blobdload.asp?BlobID=10194
5. Emission factors were adjusted based on percent changes (-5% for NOx, -3% for CO, +1% for HC, and -27% for PM) from 3198ppm sulfur diesel fuel to 50ppm sulfur diesel fuel. Source: Table 1 of Diesel Fuel Effects on Locomotive Exhaust Emissions at http://www.arb.ca.gov/fuels/diesel/102000swri_dslemssn.pdf
6. SO_2 EF is calculated based on 15 ppm sulfur content; EF = Fuel Consumption*(15ppm)*(2 SO_2/S)
7. Emissions = EF x Travel Time x Percent Time in Notch

Wespac Rail Option - Rough Emission Estimates - Transload Area Only (2014-2026)

Number of main line-haul locomotives	1
Rail Speed (mph)	35
Total Time at Facility[1] (hour/event)	2.25
Total Rail Operation Time (hour/event)	2.25
Maximum Offloading Events[2] (per year)	365
ES-44 Horsepower	4400
Area of Transload Facility (ft^2)	264,000

Notes:

1. Information provided by BNSF: 65 minutes upon arrival and about 70 minutes on departure
2. Information provided by project proponent: begin with one train every other day, then one train per day at maximum

Assume ES44 Tier II locomotive model[1]

Throttle Position	Percent Time in Notch[2]	Fuel Consumption (lb/hr)[3]	Tier 2 Emission Factors[1] (g/hr)					Emission Factors[4] (g/hp-hr)			Adjusted Emission Factors[3,5] (lb/hr)							
			NOx	CO	HC	PM	SO2	CO_2	CH_4	N_2O	NOx	CO[4]	HC	PM[4]	SO_2[6]	CO_2	CH_4	N_2O
Idle	40.0%	20	329	30	24	7.7	0.3	494	0.040	0.013	0.69	0.06	0.05	0.01	0.001	4,788	0.388	0.126
DB (dynamic brake)	0.0%	44	657	120	65	42.0	0.6	494	0.040	0.013	1.37	0.26	0.14	0.07	0.001	4,788	0.388	0.126
1	13.0%	102	1,135	142	62	69.3	1.4	494	0.040	0.013	2.38	0.30	0.14	0.11	0.003	4,788	0.388	0.126
2	23.0%	209	2,730	239	120	145.8	2.8	494	0.040	0.013	5.71	0.51	0.27	0.23	0.006	4,788	0.388	0.126
3	18.0%	447	5,310	607	220	304.3	6.1	494	0.040	0.013	11.11	1.30	0.49	0.49	0.013	4,788	0.388	0.126
4	6.0%	612	7,246	806	224	365.0	8.3	494	0.040	0.013	15.16	1.72	0.50	0.59	0.018	4,788	0.388	0.126
5	0.0%	825	9,612	479	311	405.2	11.2	494	0.040	0.013	20.11	1.02	0.69	0.65	0.025	4,788	0.388	0.126
6	0.0%	1060	13,455	537	408	418.4	14.4	494	0.040	0.013	28.15	1.15	0.91	0.67	0.032	4,788	0.388	0.126
7	0.0%	1310	16,005	790	488	513.5	17.8	494	0.040	0.013	33.49	1.69	1.09	0.83	0.039	4,788	0.388	0.126
8	0.0%	1598	18,566	1,034	619	607.5	21.8	494	0.040	0.013	38.85	2.21	1.38	0.98	0.048	4,788	0.388	0.126

Notes:

1. According to BNSF, locomotive with Tier 2 engines would be likely to serve for the transload area. Based on BNSF locomotive fleet statistics for 2009, the most common locomotive model is the ES44 model.
2. Percent time in different notch settings were provided by Michael Stanfill with BNSF. (email 3/25/13)
3. Ful comsumption factors and emission factors for NOx, CO, HC and PM were obtained from Port of Oakland 2005 EI. http://www.portofoakland.com/pdf/airEmissions_Inventory.pdf
4. GHG Emission Factors are from POLB Emission Inventory, 2011 http://www.polb.com/civica/filebank/blobdload.asp?BlobID=10194
5. Emission factors were adjusted based on percent changes (-5% for NOx, -3% for CO, +1% for HC, and -27% for PM) from 3198ppm sulfur diesel fuel to 50ppm sulfur diesel fuel.
Source: Table 1 of Diesel Fuel Effects on Locomotive Exhaust Emissions at http://www.arb.ca.gov/fuels/diesel/102000swri_dslemssn.pdf
6. SO_2 EF is calculated based on 15 ppm sulfur content; EF = Fuel Consumption*(15ppm)*(2 SO_2/S)
7. Emissions = EF x Operation Time x Percent Time in Notch

Wespac Rail Option - Rough Emission Estimates - Transload Area Only (2014-2026)

Number of main line-haul locomotives	1
Rail Speed (mph)	35
Total Time at Facility[1] (hour/event)	2.25
Total Rail Operation Time (hour/event)	2.25
Maximum Offloading Events[2] (per year)	365
ES-44 Horsepower	4400
Area of Transload Facility (ft^2)	264,000

Notes:

1. Information provided by BNSF: 65 minutes upon arrival and about 70 minutes on departure
2. Information provided by project proponent: begin with one train every other day, then one train per day at maximum

Assume ES44 Tier II locomotive model[1]

Throttle Position	Percent Time in Notch[2]	Emissions per Event[7] (lb/event)								Annual Emissions (lb/yr)								Annual Emissions (tons/yr)					Annual Emissions (metric tons/yr)		
		NOx	CO	HC	PM	SO_2	CO_2	CH_4	N_2O	NOx	CO	HC	PM	SO_2	CO_2	CH_4	N_2O	NOx	CO	HC	PM	SO_2	CO_2	CH_4	N_2O
Idle	40.0%	0.62	0.06	0.05	0.01	0.001	4,309	0	0	226	21	18	4	0.2	1,572,748	127	41	0.11	0.01	0.01	0.00	0.0001	515,895	41.77	13.58
DB (dynamic brake)	0.0%	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-
1	13.0%	0.69	0.09	0.04	0.03	0.001	1,400	0	0	254	32	15	12	0.3	511,143	41	13	0.13	0.02	0.01	0.01	0.0002	167,666	13.58	4.41
2	23.0%	2.96	0.26	0.14	0.12	0.003	2,478	0	0	1,079	96	50	44	1.2	904,330	73	24	0.54	0.05	0.03	0.02	0.0006	296,640	24.02	7.81
3	18.0%	4.50	0.53	0.20	0.20	0.005	1,939	0	0	1,643	192	72	72	2.0	707,737	57	19	0.82	0.10	0.04	0.04	0.0010	232,153	18.80	6.11
4	6.0%	2.05	0.23	0.07	0.08	0.002	646	0	0	747	85	25	29	0.9	235,912	19	6	0.37	0.04	0.01	0.01	0.0005	77,384	6.27	2.04
5	0.0%	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-
6	0.0%	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-
7	0.0%	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-
8	0.0%	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-
Total Emissions		**11**	**1.2**	**0.5**	**0.4**	**0.013**	**10,772.2**	**0.9**	**0.3**	**3,948**	**426**	**180**	**161**	**5**	**3,931,870**	**318.4**	**103.5**	**1.97**	**0.21**	**0.09**	**0.08**	**0.0023**	**1,289,738**	**104.43**	**33.94**
										Emisions (lb/yr/ft^2)		**1.62E-03**		**6.12E-04**											
										Emisions (lb/hr/ft^2)		**1.84E-07**		**6.98E-08**											

Notes:

1. According to BNSF, locomotive with Tier 2 engines would be likely to serve for the transload area. Based on BNSF locomotive fleet statistics for 2009, the most common locomotive model is the ES44 model.
2. Percent time in different notch settings were provided by Michael Stanfill with BNSF. (email 3/25/13)
3. Ful comsumption factors and emission factors for NOx, CO, HC and PM were obtained from Port of Oakland 2005 EI. http://www.portofoakland.com/pdf/airEmissions_Inventory.pdf
4. GHG Emission Factors are from POLB Emission Inventory, 2011 http://www.polb.com/civica/filebank/blobdload.asp?BlobID=10194
5. Emission factors were adjusted based on percent changes (-5% for NOx, -3% for CO, +1% for HC, and -27% for PM) from 3198ppm sulfur diesel fuel to 50ppm sulfur diesel fuel. Source: Table 1 of Diesel Fuel Effects on Locomotive Exhaust Emissions at http://www.arb.ca.gov/fuels/diesel/102000swri_dslemssn.pdf
6. SO_2 EF is calculated based on 15 ppm sulfur content; EF = Fuel Consumption*(15ppm)*(2 SO_2/S)
7. Emissions = EF x Operation Time x Percent Time in Notch

Wespac Pittsburg
Transportation Emissions - Orwood to Pittsburg (2027 - 2085)

Number of main line-haul locomotives Inbound	3	
Number of main line-haul locomotives Outbound	2	
Distance per trip (mi)	15	
Travel Time (hour/event)	0.30	
Max Rail Trip frequency (per year)	365	From RFI: begin with one train every other day, then one train per day at maximum
ES-44 Horsepower	4400	

INBOUND to Pittsburg

Assume ES44 Tier II locomotive model[1]

Throttle Position	Percent Time in Notch[2]	Fuel Consumption (lb/hr)	Tier 4 Emission Factors[1] (g/hr)					Emission Factors[4] (g/hp-hr)			Adjusted Emission Factors[3,5] (lb/hr)							
			NOx	CO	HC	PM[2]	SO2[3]	CO_2	CH_4	N_2O	NOx	CO[4]	HC	PM[4]	SO_2[6]	CO_2	CH_4	N_2O
Idle	8.5%	32	79	30	11	2.3	0.44	494	0.040	0.013	0.17	0.06	0.03	0.00	0.001	4,788	0.388	0.126
DB (dynamic brake)	11.0%	103	158	120	31	12.6	1.40	494	0.040	0.013	0.33	0.26	0.07	0.02	0.003	4,788	0.388	0.126
1	8.3%	55	272	142	29	20.8	0.75	494	0.040	0.013	0.57	0.30	0.06	0.03	0.002	4,788	0.388	0.126
2	6.1%	137	655	239	56	43.7	1.87	494	0.040	0.013	1.37	0.51	0.13	0.07	0.004	4,788	0.388	0.126
3	8.3%	226	1,274	607	103	91.3	3.08	494	0.040	0.013	2.67	1.30	0.23	0.15	0.007	4,788	0.388	0.126
4	10.4%	331	1,739	806	105	109.5	4.51	494	0.040	0.013	3.64	1.72	0.23	0.18	0.010	4,788	0.388	0.126
5	3.5%	442	2,307	479	146	121.6	6.02	494	0.040	0.013	4.83	1.02	0.33	0.20	0.013	4,788	0.388	0.126
6	3.2%	567	3,229	537	192	125.5	7.72	494	0.040	0.013	6.76	1.15	0.43	0.20	0.017	4,788	0.388	0.126
7	5.0%	710	3,841	790	229	154.1	9.67	494	0.040	0.013	8.04	1.69	0.51	0.25	0.021	4,788	0.388	0.126
8	35.7%	854	4,456	1,034	291	182.3	11.63	494	0.040	0.013	9.32	2.21	0.65	0.29	0.026	4,788	0.388	0.126

OUTBOUND to Orword

Assume ES44 Tier II locomotive model[1]

Throttle Position	Percent Time in Notch[2]	Fuel Consumption (lb/hr)	Tier 4 Emission Factors[1] (g/hr)					Emission Factors[4] (g/hp-hr)			Adjusted Emission Factors[3,5] (lb/hr)							
			NOx	CO	HC	PM[2]	SO2[3]	CO_2	CH_4	N_2O	NOx	CO[4]	HC	PM[4]	SO_2[6]	CO_2	CH_4	N_2O
Idle	4.4%	32	79	30	11	2.3	0.44	494	0.040	0.013	0.17	0.06	0.03	0.00	0.001	4,788	0.388	0.126
DB (dynamic brake)	7.8%	103	158	120	31	12.6	1.40	494	0.040	0.013	0.33	0.26	0.07	0.02	0.003	4,788	0.388	0.126
1	2.2%	55	272	142	29	20.8	0.75	494	0.040	0.013	0.57	0.30	0.06	0.03	0.002	4,788	0.388	0.126
2	1.9%	137	655	239	56	43.7	1.87	494	0.040	0.013	1.37	0.51	0.13	0.07	0.004	4,788	0.388	0.126
3	1.8%	226	1,274	607	103	91.3	3.08	494	0.040	0.013	2.67	1.30	0.23	0.15	0.007	4,788	0.388	0.126
4	24.2%	331	1,739	806	105	109.5	4.51	494	0.040	0.013	3.64	1.72	0.23	0.18	0.010	4,788	0.388	0.126
5	35.0%	442	2,307	479	146	121.6	6.02	494	0.040	0.013	4.83	1.02	0.33	0.20	0.013	4,788	0.388	0.126
6	14.0%	567	3,229	537	192	125.5	7.72	494	0.040	0.013	6.76	1.15	0.43	0.20	0.017	4,788	0.388	0.126
7	2.5%	710	3,841	790	229	154.1	9.67	494	0.040	0.013	8.04	1.69	0.51	0.25	0.021	4,788	0.388	0.126
8	6.2%	854	4,456	1,034	291	182.3	11.63	494	0.040	0.013	9.32	2.21	0.65	0.29	0.026	4,788	0.388	0.126

Notes:

1. According to BNSF, locomotive with Tier 2 engines would be likely to serve for the transload area. Based on BNSF locomotive fleet statistics for 2009, the most common locomotive model is the ES44 model. Tier 4 emission factors will be used since 2016.
2. Percent time in different notch settings were provided by Michael Stanfill with BNSF. (email 6/7/13)
3. Ful comsumption factors and emission factors for NOx, CO, HC and PM were obtained from Port of Oakland 2005 EI. http://www.portofoakland.com/pdf/airEmissions_Inventory.pdf
4. GHG Emission Factors are from POLB Emission Inventory, 2011 http://www.polb.com/civica/filebank/blobdload.asp?BlobID=10194
5. Tier 2 emission factors were adjusted based on percent changes (-5% for NOx, -3% for CO, +1% for HC, and -27% for PM) from 3198ppm sulfur diesel fuel to 50ppm sulfur diesel fuel. Source: Table 1 of Diesel Fuel Effects on Locomotive Exhaust Emissions at http://www.arb.ca.gov/fuels/diesel/102000swri_dslemssn.pdf
6. Tier 4 emission factors were adjusted from Tier 2 emission factors based on the reduction ratio of EPA locomotive emission stanards: http://www.epa.gov/otaq/standards/nonroad/locomotives.htm
7. SO_2 EF is calculated based on 15 ppm sulfur content; EF = Fuel Consumption*(15ppm)*(2 SO_2/S)
8. Emissions = EF x Travel Time x Percent Time in Notch

Wespac Pittsburg
Transportation Emissions - Orwood to Pittsburg (2027 - 2085)

haul locomotives Inbound	3
haul locomotives Outbound	2
Distance per trip (mi)	15
(hour/event)	0.30
frequency (per year)	365
ES-44 Horsepower	4400

INBOUND to Pittsburg

Assume ES44 Tier II locomotive model[1]

Throttle Position	Percent Time in Notch[2]	Emissions per Event[7] (lb/event)								Annual Emissions (lb/yr)								Annual Emissions (tons/yr)					Annual Emissions (metric tons/yr)		
		NOx	CO	HC	PM	SO2	CO_2	CH_4	N_2O	NOx	CO	HC	PM	SO2	CO_2	CH_4	N_2O	NOx	CO	HC	PM	SO2	CO_2	CH_4	N_2O
Idle	8.5%	0.013	0.005	0.002	0.000	0.000	366.3	0.030	0.010	5	2	1	0	0.03	133,684	11	4	0.00	0.001	0.000	0.000	0.000	61	0.005	0.002
DB (dynamic brake)	11.0%	0.033	0.025	0.007	0.002	0.000	474.0	0.038	0.012	12	9	2	1	0.11	173,002	14	5	0.01	0.005	0.001	0.000	0.000	78	0.006	0.002
1	8.3%	0.043	0.023	0.005	0.002	0.000	357.6	0.029	0.009	16	8	2	1	0.04	130,538	11	3	0.01	0.004	0.001	0.000	0.000	59	0.005	0.002
2	6.1%	0.075	0.028	0.007	0.004	0.000	262.8	0.021	0.007	27	10	3	1	0.08	95,938	8	3	0.01	0.005	0.001	0.001	0.000	44	0.004	0.001
3	8.3%	0.199	0.097	0.017	0.011	0.001	357.6	0.029	0.009	73	35	6	4	0.18	130,538	11	3	0.04	0.018	0.003	0.002	0.000	59	0.005	0.002
4	10.4%	0.341	0.161	0.022	0.016	0.001	448.1	0.036	0.012	124	59	8	6	0.34	163,566	13	4	0.06	0.029	0.004	0.003	0.000	74	0.006	0.002
5	3.5%	0.152	0.032	0.010	0.006	0.000	150.8	0.012	0.004	56	12	4	2	0.15	55,046	4	1	0.03	0.006	0.002	0.001	0.000	25	0.002	0.001
6	3.2%	0.195	0.033	0.012	0.006	0.000	137.9	0.011	0.004	71	12	4	2	0.18	50,328	4	1	0.04	0.006	0.002	0.001	0.000	23	0.002	0.001
7	5.0%	0.362	0.076	0.023	0.011	0.001	215.4	0.017	0.006	132	28	8	4	0.35	78,637	6	2	0.07	0.014	0.004	0.002	0.000	36	0.003	0.001
8	35.7%	2.996	0.710	0.208	0.094	0.008	1,538.3	0.125	0.040	1,093	259	76	34	3.00	561,471	45	15	0.55	0.130	0.038	0.017	0.002	255	0.021	0.007
Total Inbound Emissions		**4.4**	**1.2**	**0.3**	**0.2**	**0.012**	**4,308.9**	**0.3**	**0.1**	**1,609**	**434**	**114**	**56**	**4.5**	**1,572,748**	**127**	**41**	**0.80**	**0.22**	**0.06**	**0.03**	**0.002**	**713**	**0.058**	**0.019**

OUTBOUND to Orword

Assume ES44 Tier II locomotive model[1]

Throttle Position	Percent Time in Notch[2]	Emissions per Event[7] (lb/event)								Annual Emissions (lb/yr)								Annual Emissions (tons/yr)					Annual Emissions (metric tons/yr)		
		NOx	CO	HC	PM	SO2	CO_2	CH_4	N_2O	NOx	CO	HC	PM	SO2	CO_2	CH_4	N_2O	NOx	CO	HC	PM	SO2	CO_2	CH_4	N_2O
Idle	4.4%	0.004	0.002	0.001	0.000	0.000	126.4	0.010	0.003	2	1	0	0	0.01	46,134	4	1	0.00	0.000	0.000	0.000	0.000	20.92	0.002	0.001
DB (dynamic brake)	7.8%	0.015	0.012	0.003	0.001	0.000	224.1	0.018	0.006	6	4	1	0	0.05	81,783	7	2	0.00	0.002	0.001	0.000	0.000	37.09	0.003	0.001
1	2.2%	0.008	0.004	0.001	0.000	0.000	63.2	0.005	0.002	3	1	0	0	0.01	23,067	2	1	0.00	0.001	0.000	0.000	0.000	10.46	0.001	0.000
2	1.9%	0.016	0.006	0.001	0.001	0.000	54.6	0.004	0.001	6	2	1	0	0.02	19,921	2	1	0.00	0.001	0.000	0.000	0.000	9.03	0.001	0.000
3	1.8%	0.029	0.014	0.002	0.002	0.000	51.7	0.004	0.001	11	5	1	1	0.03	18,873	2	0	0.01	0.003	0.000	0.000	0.000	8.56	0.001	0.000
4	24.2%	0.528	0.250	0.034	0.026	0.001	695.2	0.056	0.018	193	91	12	9	0.53	253,737	21	7	0.10	0.046	0.006	0.005	0.000	115.07	0.009	0.003
5	35.0%	1.014	0.215	0.068	0.041	0.003	1,005.4	0.081	0.026	370	78	25	15	1.02	366,975	30	10	0.19	0.039	0.012	0.007	0.001	166.43	0.013	0.004
6	14.0%	0.568	0.096	0.036	0.017	0.001	402.2	0.033	0.011	207	35	13	6	0.52	146,790	12	4	0.10	0.018	0.007	0.003	0.000	66.57	0.005	0.002
7	2.5%	0.121	0.025	0.008	0.004	0.000	71.8	0.006	0.002	44	9	3	1	0.12	26,212	2	1	0.02	0.005	0.001	0.001	0.000	11.89	0.001	0.000
8	6.2%	0.347	0.082	0.024	0.011	0.001	178.1	0.014	0.005	127	30	9	4	0.35	65,007	5	2	0.06	0.015	0.004	0.002	0.000	29.48	0.002	0.001
Total Outbound Emissions		**2.6**	**0.7**	**0.2**	**0.1**	**0.007**	**2,872.6**	**0.2**	**0.1**	**967**	**258**	**65**	**37**	**2.6**	**1,048,499**	**85**	**28**	**0.48**	**0.13**	**0.03**	**0.02**	**0.001**	**476**	**0.039**	**0.013**
TOTAL EMISSIONS		**7.1**	**1.9**	**0.5**	**0.3**	**0.020**	**7,181.5**	**0.6**	**0.2**	**2,575**	**692**	**179**	**93**	**7.1**	**2,621,247**	**212**	**69**	**1.29**	**0.35**	**0.09**	**0.05**	**0.004**	**1,189**	**0.096**	**0.031**

Notes:

1. According to BNSF, locomotive with Tier 2 engines would be likely to serve for the transload area. Based on BNSF locomotive fleet statistics for 2009, the most common locomotive model is the ES44 model. Tier 4 emission factors will be used since 2016.

2. Percent time in different notch settings were provided by Michael Stanfill with BNSF. (email 6/7/13)
3. Ful comsumption factors and emission factors for NOx, CO, HC and PM were obtained from Port of Oakland 2005 EI. http://www.portofoakland.com/pdf/airEmissions_Inventory.pdf
4. GHG Emission Factors are from POLB Emission Inventory, 2011 http://www.polb.com/civica/filebank/blobdload.asp?BlobID=10194
5. Tier 2 emission factors were adjusted based on percent changes (-5% for NOx, -3% for CO, +1% for HC, and -27% for PM) from 3198ppm sulfur diesel fuel to 50ppm sulfur diesel fuel. Source: Table 1 of Diesel Fuel Effects on Locomotive Exhaust Emissions at http://www.arb.ca.gov/fuels/diesel/102000swri_dslemssn.pdf
6. Tier 4 emission factors were adjusted from Tier 2 emission factors based on the reduction ratio of EPA locomotive emission stanards: http://www.epa.gov/otaq/standards/nonroad/locomotives.htm
7. SO_2 EF is calculated based on 15 ppm sulfur content; EF = Fuel Consumption*(15ppm)*(2 SO_2/S)
8. Emissions = EF x Travel Time x Percent Time in Notch

Wespac Pittsburg
Transportation Emissions - Pittsburg to Richmond (2027 - 2085)

Number of main line-haul locomotives to Richmond (Outbound)	1	
Number of main line-haul locomotives to Pittsbug (Inbound)	2	
Distance per trip (mi)	25	
Travel Time Outbound (hour/event)	0.83	
Travel Time Inbound (hour/event)	1.28	From RFI: begin with one train every other day, then one train per day at maximum
Max Rail Trip frequency (per year)	365	
ES-44 Horsepower	4400	

OUTBOUND to Richmond

Assume ES44 Tier II locomotive model[1]

Throttle Position	Percent Time in Notch[2]	Fuel Consumption (lb/hr)	Emission Factors[1] (g/hr)					Emission Factors[4] (g/hp-hr)			Adjusted Emission Factors[3,5] (lb/hr)							
			NOx	CO	HC	PM[2]	SO2[3]	CO_2	CH_4	N_2O	NOx	CO[4]	HC	PM[4]	SO_2[6]	CO_2	CH_4	N_2O
Idle	8.9%	32	79	30	11	2.3	0.44	494	0.040	0.013	0.17	0.06	0.03	0.00	0.001	4,788	0.388	0.126
DB (dynamic brake)	33.0%	103	158	120	31	12.6	1.40	494	0.040	0.013	0.33	0.26	0.07	0.02	0.003	4,788	0.388	0.126
1	10.6%	55	272	142	29	20.8	0.75	494	0.040	0.013	0.57	0.30	0.06	0.03	0.002	4,788	0.388	0.126
2	11.0%	137	655	239	56	43.7	1.87	494	0.040	0.013	1.37	0.51	0.13	0.07	0.004	4,788	0.388	0.126
3	5.2%	226	1,274	607	103	91.3	3.08	494	0.040	0.013	2.67	1.30	0.23	0.15	0.007	4,788	0.388	0.126
4	13.8%	331	1,739	806	105	109.5	4.51	494	0.040	0.013	3.64	1.72	0.23	0.18	0.010	4,788	0.388	0.126
5	12.0%	442	2,307	479	146	121.6	6.02	494	0.040	0.013	4.83	1.02	0.33	0.20	0.013	4,788	0.388	0.126
6	0.2%	567	3,229	537	192	125.5	7.72	494	0.040	0.013	6.76	1.15	0.43	0.20	0.017	4,788	0.388	0.126
7	0.2%	710	3,841	790	229	154.1	9.67	494	0.040	0.013	8.04	1.69	0.51	0.25	0.021	4,788	0.388	0.126
8	5.1%	854	4,456	1,034	291	182.3	11.63	494	0.040	0.013	9.32	2.21	0.65	0.29	0.026	4,788	0.388	0.126

INBOUND to Pittsburg

Assume ES44 Tier II locomotive model[1]

Throttle Position	Percent Time in Notch[2]	Fuel Consumption (lb/hr)	Emission Factors[1] (g/hr)					Emission Factors[4] (g/hp-hr)			Adjusted Emission Factors[3,5] (lb/hr)							
			NOx	CO	HC	PM[2]	SO2[3]	CO_2	CH_4	N_2O	NOx	CO[4]	HC	PM[4]	SO_2[6]	CO_2	CH_4	N_2O
Idle	25.3%	32	79	30	11	2.3	0.44	494	0.040	0.013	0.17	0.06	0.03	0.00	0.001	4,788	0.388	0.126
DB (dynamic brake)	20.4%	103	158	120	31	12.6	1.40	494	0.040	0.013	0.33	0.26	0.07	0.02	0.003	4,788	0.388	0.126
1	12.2%	55	272	142	29	20.8	0.75	494	0.040	0.013	0.57	0.30	0.06	0.03	0.002	4,788	0.388	0.126
2	12.4%	137	655	239	56	43.7	1.87	494	0.040	0.013	1.37	0.51	0.13	0.07	0.004	4,788	0.388	0.126
3	5.9%	226	1,274	607	103	91.3	3.08	494	0.040	0.013	2.67	1.30	0.23	0.15	0.007	4,788	0.388	0.126
4	3.5%	331	1,739	806	105	109.5	4.51	494	0.040	0.013	3.64	1.72	0.23	0.18	0.010	4,788	0.388	0.126
5	7.4%	442	2,307	479	146	121.6	6.02	494	0.040	0.013	4.83	1.02	0.33	0.20	0.013	4,788	0.388	0.126
6	10.9%	567	3,229	537	192	125.5	7.72	494	0.040	0.013	6.76	1.15	0.43	0.20	0.017	4,788	0.388	0.126
7	1.9%	710	3,841	790	229	154.1	9.67	494	0.040	0.013	8.04	1.69	0.51	0.25	0.021	4,788	0.388	0.126
8	0.1%	854	4,456	1,034	291	182.3	11.63	494	0.040	0.013	9.32	2.21	0.65	0.29	0.026	4,788	0.388	0.126

Notes:

1. According to BNSF, locomotive with Tier 2 engines would be likely to serve for the transload area. Based on BNSF locomotive fleet statistics for 2009, the most common locomotive model is the ES44 model. Tier 4 emission factors will be used.

2. Percent time in different notch settings were provided by Michael Stanfill with BNSF. (email 6/7/13)
3. Ful comsumption factors and emission factors for NOx, CO, HC and PM were obtained from Port of Oakland 2005 EI. http://www.portofoakland.com/pdf/airEmissions_Inventory.pdf

4. GHG Emission Factors are from POLB Emission Inventory, 2011 http://www.polb.com/civica/filebank/blobdload.asp?BlobID=10194

5. Emission factors were adjusted based on percent changes (-5% for NOx, -3% for CO, +1% for HC, and -27% for PM) from 3198ppm sulfur diesel fuel to 50ppm sulfur diesel fuel. Source: Table 1 of Diesel Fuel Effects on Locomotive Exhaust Emissions at http://www.arb.ca.gov/fuels/diesel/102000swri_dslemssn.pdf

6. SO_2 EF is calculated based on 15 ppm sulfur content; EF = Fuel Consumption*(15ppm)*(2 SO_2/S)

7. Emissions = EF x Travel Time x Percent Time in Notch

Wespac Pittsburg
Transportation Emissions - Pittsburg to Richmond (2027 - 2085)

Number of main line-haul locomotives to Richmond (Outbound)	1
Number of main line-haul locomotives to Pittsbug (Inbound)	2
Distance per trip (mi)	25
Travel Time Outbound (hour/event)	0.83
Travel Time Inbound (hour/event)	1.28
Max Rail Trip frequency (per year)	365
ES-44 Horsepower	4400

OUTBOUND to Richmond

Assume ES44 Tier II locomotive model[1]

Throttle Position	Percent Time in Notch[2]	Emissions per Event[7] (lb/event)								Annual Emissions (lb/yr)								Annual Emissions (tons/yr)					Annual Emissions (metric tons/yr)		
		NOx	CO	HC	PM	SO2	CO_2	CH_4	N_2O	NOx	CO	HC	PM	SO2	CO_2	CH_4	N_2O	NOx	CO	HC	PM	SO2	CO_2	CH_4	N_2O
Idle	8.9%	0.012	0.005	0.002	0.000	0.000	355.1	0.029	0.009	4	2	1	0	0.03	129,606	10	3	0.00	0.001	0.000	0.000	0.000	59	0.005	0.002
DB (dynamic brake)	33.0%	0.091	0.071	0.019	0.006	0.001	1,316.6	0.107	0.035	33	26	7	2	0.31	480,562	39	13	0.02	0.013	0.003	0.001	0.000	218	0.018	0.006
1	10.6%	0.050	0.027	0.006	0.003	0.000	422.9	0.034	0.011	18	10	2	1	0.05	154,362	12	4	0.01	0.005	0.001	0.001	0.000	70	0.006	0.002
2	11.0%	0.126	0.047	0.012	0.006	0.000	438.9	0.036	0.012	46	17	4	2	0.14	160,187	13	4	0.02	0.009	0.002	0.001	0.000	73	0.006	0.002
3	5.2%	0.116	0.056	0.010	0.006	0.000	207.5	0.017	0.005	42	21	4	2	0.11	75,725	6	2	0.02	0.010	0.002	0.001	0.000	34	0.003	0.001
4	13.8%	0.418	0.198	0.027	0.020	0.001	550.6	0.045	0.014	153	72	10	7	0.42	200,962	16	5	0.08	0.036	0.005	0.004	0.000	91	0.007	0.002
5	12.0%	0.483	0.102	0.033	0.020	0.001	478.8	0.039	0.013	176	37	12	7	0.48	174,750	14	5	0.09	0.019	0.006	0.004	0.000	79	0.006	0.002
6	0.2%	0.011	0.002	0.001	0.000	0.000	8.0	0.001	0.000	4	1	0	0	0.01	2,912	0	0	0.00	0.000	0.000	0.000	0.000	1	0.000	0.000
7	0.2%	0.013	0.003	0.001	0.000	0.000	8.0	0.001	0.000	5	1	0	0	0.01	2,912	0	0	0.00	0.001	0.000	0.000	0.000	1	0.000	0.000
8	5.1%	0.396	0.094	0.028	0.012	0.001	203.5	0.016	0.005	145	34	10	5	0.40	74,269	6	2	0.07	0.017	0.005	0.002	0.000	34	0.003	0.001
Total Inbound Emissions		**1.7**	**0.6**	**0.1**	**0.1**	**0.005**	**3,989.7**	**0.3**	**0.1**	**627**	**220**	**50**	**27**	**2.0**	**1,456,248**	**118**	**38**	**0.31**	**0.11**	**0.02**	**0.01**	**0.001**	**660**	**0.053**	**0.017**

INBOUND to Pittsburg

Assume ES44 Tier II locomotive model[1]

Throttle Position	Percent Time in Notch[2]	Emissions per Event[7] (lb/event)								Annual Emissions (lb/yr)								Annual Emissions (tons/yr)					Annual Emissions (metric tons/yr)		
		NOx	CO	HC	PM	SO2	CO_2	CH_4	N_2O	NOx	CO	HC	PM	SO2	CO_2	CH_4	N_2O	NOx	CO	HC	PM	SO2	CO_2	CH_4	N_2O
Idle	25.3%	0.107	0.042	0.016	0.002	0.001	3,109.0	0.252	0.082	39	15	6	1	0.23	1,134,767	92	30	0.02	0.008	0.003	0.000	0.000	514.63	0.042	0.014
DB (dynamic brake)	20.4%	0.173	0.134	0.036	0.011	0.002	2,506.8	0.203	0.066	63	49	13	4	0.59	914,990	74	24	0.03	0.024	0.006	0.002	0.000	414.96	0.034	0.011
1	12.2%	0.178	0.095	0.020	0.010	0.001	1,499.2	0.121	0.039	65	35	7	4	0.19	547,200	44	14	0.03	0.017	0.004	0.002	0.000	248.16	0.020	0.007
2	12.4%	0.436	0.163	0.040	0.022	0.001	1,523.8	0.123	0.040	159	59	15	8	0.48	556,170	45	15	0.08	0.030	0.007	0.004	0.000	252.23	0.020	0.007
3	5.9%	0.404	0.196	0.035	0.022	0.001	725.0	0.059	0.019	147	72	13	8	0.37	264,629	21	7	0.07	0.036	0.006	0.004	0.000	120.01	0.010	0.003
4	3.5%	0.327	0.155	0.021	0.016	0.001	430.1	0.035	0.011	119	56	8	6	0.33	156,984	13	4	0.06	0.028	0.004	0.003	0.000	71.19	0.006	0.002
5	7.4%	0.917	0.194	0.062	0.037	0.003	909.3	0.074	0.024	335	71	23	14	0.92	331,908	27	9	0.17	0.035	0.011	0.007	0.000	150.53	0.012	0.004
6	10.9%	1.890	0.321	0.119	0.056	0.005	1,339.4	0.108	0.035	690	117	44	21	1.74	488,892	40	13	0.35	0.059	0.022	0.010	0.001	221.72	0.018	0.006
7	1.9%	0.392	0.082	0.025	0.012	0.001	233.5	0.019	0.006	143	30	9	4	0.38	85,220	7	2	0.07	0.015	0.005	0.002	0.000	38.65	0.003	0.001
8	0.1%	0.024	0.006	0.002	0.001	0.000	12.3	0.001	0.000	9	2	1	0	0.02	4,485	0	0	0.00	0.001	0.000	0.000	0.000	2.03	0.000	0.000
Total Outbound Emissions		**4.8**	**1.4**	**0.4**	**0.2**	**0.014**	**12,288.3**	**1.0**	**0.3**	**1,770**	**507**	**137**	**69**	**5.2**	**4,485,244**	**363**	**118**	**0.88**	**0.25**	**0.07**	**0.03**	**0.003**	**2,034**	**0.165**	**0.054**
TOTAL EMISSIONS		**6.6**	**2.0**	**0.5**	**0.3**	**0.020**	**16,278.1**	**1.3**	**0.4**	**2,396**	**727**	**187**	**97**	**7.2**	**5,941,493**	**481**	**156**	**1.20**	**0.36**	**0.09**	**0.05**	**0.004**	**2,695**	**0.218**	**0.071**

Notes:

1. According to BNSF, locomotive with Tier 2 engines would be likely to serve for the transload area. Based on BNSF locomotive fleet statistics for 2009, the most common locomotive model is the ES44 model. Tier 4 emission factors will be used.

2. Percent time in different notch settings were provided by Michael Stanfill with BNSF. (email 6/7/13)
3. Ful comsumption factors and emission factors for NOx, CO, HC and PM were obtained from Port of Oakland 2005 EI. http://www.portofoakland.com/pdf/airEmissions_Inventory.pdf

4. GHG Emission Factors are from POLB Emission Inventory, 2011 http://www.polb.com/civica/filebank/blobdload.asp?BlobID=10194

5. Emission factors were adjusted based on percent changes (-5% for NOx, -3% for CO, +1% for HC, and -27% for PM) from 3198ppm sulfur diesel fuel to 50ppm sulfur diesel fuel. Source: Table 1 of Diesel Fuel Effects on Locomotive Exhaust Emissions at http://www.arb.ca.gov/fuels/diesel/102000swri_dslemssn.pdf

6. SO_2 EF is calculated based on 15 ppm sulfur content; EF = Fuel Consumption*(15ppm)*(2 SO_2/S)
7. Emissions = EF x Travel Time x Percent Time in Notch

Wespac Rail Option - Rough Emission Estimates - Transload Area Only (2027 - 2085)

Number of main line-haul locomotives	1
Rail Speed (mph)	35
Total Time at Facility[1] (hour/event)	2.25
Total Rail Operation Time (hour/event)	2.25
Maximum Offloading Events[2] (per year)	365
ES-44 Horsepower	4400
Area of Transload Facility (ft^2)	264,000

Notes:

1. Information provided by BNSF: 65 minutes upon arrival and about 70 minutes on departure
2. Information provided by project proponent: begin with one train every other day, then one train per day at maximum

Assume ES44 Tier II locomotive model[1]

Throttle Position	Percent Time in Notch[2]	Fuel Consumption (lb/hr)[3]	Emission Factors[1] (g/hr)					Emission Factors[4] (g/hp-hr)			Adjusted Emission Factors[3,5] (lb/hr)							
			NOx	CO	HC	PM	SO2	CO_2	CH_4	N_2O	NOx	CO[4]	HC	PM[4]	SO_2[5]	CO_2	CH_4	N_2O
Idle	40.0%	20	79	30	11	2.3	0.27	494	0.040	0.013	0.17	0.06	0.03	0.00	0.001	4,788	0.388	0.126
DB (dynamic brake)	0.0%	44	158	120	31	12.6	0.60	494	0.040	0.013	0.33	0.26	0.07	0.02	0.001	4,788	0.388	0.126
1	13.0%	102	272	142	29	20.8	1.39	494	0.040	0.013	0.57	0.30	0.06	0.03	0.003	4,788	0.388	0.126
2	23.0%	209	655	239	56	43.7	2.85	494	0.040	0.013	1.37	0.51	0.13	0.07	0.006	4,788	0.388	0.126
3	18.0%	447	1,274	607	103	91.3	6.09	494	0.040	0.013	2.67	1.30	0.23	0.15	0.013	4,788	0.388	0.126
4	6.0%	612	1,739	806	105	109.5	8.34	494	0.040	0.013	3.64	1.72	0.23	0.18	0.018	4,788	0.388	0.126
5	0.0%	825	2,307	479	146	121.6	11.24	494	0.040	0.013	4.83	1.02	0.33	0.20	0.025	4,788	0.388	0.126
6	0.0%	1060	3,229	537	192	125.5	14.44	494	0.040	0.013	6.76	1.15	0.43	0.20	0.032	4,788	0.388	0.126
7	0.0%	1310	3,841	790	229	154.1	17.84	494	0.040	0.013	8.04	1.69	0.51	0.25	0.039	4,788	0.388	0.126
8	0.0%	1598	4,456	1,034	291	182.3	21.76	494	0.040	0.013	9.32	2.21	0.65	0.29	0.048	4,788	0.388	0.126

Notes:

1. According to BNSF, locomotive with Tier 2 engines would be likely to serve for the transload area. Based on BNSF locomotive fleet statistics for 2009, the most common locomotive model is the ES44 model. Tier 4 emission factors will be used.
2. Percent time in different notch settings were provided by Michael Stanfill with BNSF. (email 3/25/13)
3. Ful comsumption factors and emission factors for NOx, CO, HC and PM were obtained from Port of Oakland 2005 EI. http://www.portofoakland.com/pdf/airEmissions_Inventory.pdf
4. GHG Emission Factors are from POLB Emission Inventory, 2011 http://www.polb.com/civica/filebank/blobdload.asp?BlobID=10194
5. Emission factors were adjusted based on percent changes (-5% for NOx, -3% for CO, +1% for HC, and -27% for PM) from 3198ppm sulfur diesel fuel to 50ppm sulfur diesel fuel. Source: Table 1 of Diesel Fuel Effects on Locomotive Exhaust Emissions at http://www.arb.ca.gov/fuels/diesel/102000swri_dslemssn.pdf
6. SO_2 EF is calculated based on 15 ppm sulfur content; EF = Fuel Consumption*(15ppm)*(2 SO_2/S)
7. Emissions = EF x Operation Time x Percent Time in Notch

Wespac Rail Option - Rough Emission Estimates - Transload Area Only (2027 - 2085)

Number of main line-haul locomotives	1
Rail Speed (mph)	35
Total Time at Facility[1] (hour/event)	2.25
Total Rail Operation Time (hour/event)	2.25
Maximum Offloading Events[2] (per year)	365
ES-44 Horsepower	4400
Area of Transload Facility (ft^2)	264,000

Notes:

1. Information provided by BNSF: 65 minutes upon arrival and about 70 minutes on departure
2. Information provided by project proponent: begin with one train every other day, then one train per day at maximum

Assume ES44 Tier II locomotive model[1]

Throttle Position	Percent Time in Notch[2]	Emissions per Event[7] (lb/event)								Annual Emissions (lb/yr)								Annual Emissions (tons/yr)							
		NOx	CO	HC	PM	SO_2	CO_2	CH_4	N_2O	NOx	CO	HC	PM	SO_2	CO_2	CH_4	N_2O	NOx	CO	HC	PM	SO_2	CO_2	CH_4	N_2O
Idle	40.0%	0.15	0.06	0.02	0.00	0.001	4,309	0	0	54	21	8	1	0.2	1,572,748	127	41	0.03	0.01	0.00	0.00	0.0001	515,895	41.77	13.58
DB (dynamic brake)	0.0%	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-
1	13.0%	0.17	0.09	0.02	0.01	0.001	1,400	0	0	61	32	7	4	0.3	511,143	41	13	0.03	0.02	0.00	0.00	0.0002	167,666	13.58	4.41
2	23.0%	0.71	0.26	0.06	0.04	0.003	2,478	0	0	259	96	24	13	1.2	904,330	73	24	0.13	0.05	0.01	0.01	0.0006	296,640	24.02	7.81
3	18.0%	1.08	0.53	0.09	0.06	0.005	1,939	0	0	394	192	34	22	2.0	707,737	57	19	0.20	0.10	0.02	0.01	0.0010	232,153	18.80	6.11
4	6.0%	0.49	0.23	0.03	0.02	0.002	646	0	0	179	85	12	9	0.9	235,912	19	6	0.09	0.04	0.01	0.00	0.0005	77,384	6.27	2.04
5	0.0%	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-
6	0.0%	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-
7	0.0%	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-
8	0.0%	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-
TOTAL EMISSIONS		**3**	**1.2**	**0.2**	**0.1**	**0.013**	**10,772.2**	**0.9**	**0.3**	**948**	**426**	**84**	**48**	**5**	**3,931,870**	**318.4**	**103.5**	**0.47**	**0.21**	**0.04**	**0.02**	**0.0023**	**1,289,738**	**104.43**	**33.94**
										Emisions (lb/yr/ft^2)		**1.62E-03**		**1.84E-04**											
										Emissions (lb/hr/ft^2)		**1.84E-07**		**2.09E-08**											

Notes:

1. According to BNSF, locomotive with Tier 2 engines would be likely to serve for the transload area. Based on BNSF locomotive fleet statistics for 2009, the most common locomotive model is the ES44 model. Tier 4 emission factors will be used.
2. Percent time in different notch settings were provided by Michael Stanfill with BNSF. (email 3/25/13)
3. Ful comsumption factors and emission factors for NOx, CO, HC and PM were obtained from Port of Oakland 2005 EI. http://www.portofoakland.com/pdf/airEmissions_Inventory.pdf
4. GHG Emission Factors are from POLB Emission Inventory, 2011 http://www.polb.com/civica/filebank/blobdload.asp?BlobID=10194
5. Emission factors were adjusted based on percent changes (-5% for NOx, -3% for CO, +1% for HC, and -27% for PM) from 3198ppm sulfur diesel fuel to 50ppm sulfur diesel fuel. Source: Table 1 of Diesel Fuel Effects on Locomotive Exhaust Emissions at http://www.arb.ca.gov/fuels/diesel/102000swri_dslemssn.pdf
6. SO_2 EF is calculated based on 15 ppm sulfur content; EF = Fuel Consumption*(15ppm)*(2 SO_2/S)
7. Emissions = EF x Operation Time x Percent Time in Notch

D - 7. Storage Tank Emissions Summary

Wespac Pittsburg
Storage Tank Emissions - Proposed Project

VOC Properties		
Vapor Pressure	11	RVP
Benzene	3	wt%
Hexane	1.38	wt%
Toluene	1.54	wt%
Xylene	1.43	wt%

Assume	162k IFR	500k IFR	200k IFR - 1	200k IFR - 3	54k EFR
Working capacity (bbl)	146,000	450,000	180,000	180,000	49,000
No. of tanks	6	5	1	3	1
Throughput (bbl)	2,078,000	6,414,000	18,250,000	8,517,000	600,000
Diameter (ft)	160	273	175	175	120
Height (ft)	48	48	48	48	50
Sigma Y (dia/4.3) (m)	11.34	19.36	12.41	12.41	8.51
Sigma Z (ht/2.15) (m)	6.81	6.81	6.81	6.81	7.09
Volume (gal)	6,132,000	18,900,000	7,560,000	7,560,000	2,058,000

Notes: All assumptions used for tank emission calculations were provided by the project proponent.

Emissions from Storage Tanks							
	Emissions (lb/year)					Total Storage Tank Emissions	
Compoent	162k IFR	500k IFR	200k IFR - 1	200k IFR - 3	54k EFR	(lb/yr)	(tpy)
POC	1,568	3,898	5,847	3,357	2,391	47,209	23.6
Benzene	34.04	80.68	159.99	85.3	43.07		
Toluene	11.27	24.14	74.78	36.44	8.45		
Hexane	20.62	50.93	79.47	45.12	30.73		
Xylene	8.82	17.84	67.49	31.88	4.23		

Emissions from Storage Tanks					
	Emissions (lb/hr)				
Compoent	162k IFR	500k IFR	200k IFR - 1	200k IFR - 3	54k EFR
POC	1.79E-01	4.45E-01	6.67E-01	3.83E-01	2.73E-01
Benzene	3.89E-03	9.21E-03	1.83E-02	9.74E-03	4.92E-03
Toluene	1.29E-03	2.76E-03	8.54E-03	4.16E-03	9.65E-04
Hexane	2.35E-03	5.81E-03	9.07E-03	5.15E-03	3.51E-03
Xylene	1.01E-03	2.04E-03	7.70E-03	3.64E-03	4.83E-04

Wespac Pittsburg
Storage Tank Emissions - Alternative 1 Project

VOC Properties		
Vapor Pressure	11	RVP
Benzene	3	wt%
Hexane	1.38	wt%
Toluene	1.54	wt%
Xylene	1.43	wt%

Assume	162k IFR	500k IFR	200k IFR - 1	200k IFR - 3	54k EFR
Working capacity (bbl)	146,000	450,000	180,000	180,000	49,000
No. of tanks	0	5	1	3	1
Throughput (bbl)	0	6,414,000	18,250,000	8,517,000	600,000
Diameter (ft)	160	273	175	175	120
Height (ft)	48	48	48	48	50
Sigma Y (dia/4.3) (m)	11.34	19.36	12.41	12.41	8.51
Sigma Z (ht/2.15) (m)	6.81	6.81	6.81	6.81	7.09
Volume (gal)	0	18,900,000	7,560,000	7,560,000	2,058,000

Notes: All assumptions used for tank emission calculations were provided by the project proponent.

Emissions from Storage Tanks							
	Emissions (lb/year)					Total Storage Tank Emissions	
Compoent	162k IFR	500k IFR	200k IFR - 1	200k IFR - 3	54k EFR	(lb/yr)	(tpy)
POC	0	3897.62	5847.04	3357.46	2390.81	37798	18.9
Benzene	0	80.68	159.99	85.3	43.07		
Toluene	0	24.14	74.78	36.44	8.45		
Hexane	0	50.93	79.47	45.12	30.73		
Xylene	0	17.84	67.49	31.88	4.23		

Emissions from Storage Tanks					
	Emissions (lb/hr)				
Compoent	162k IFR	500k IFR	200k IFR - 1	200k IFR - 3	54k EFR
POC	0.00E+00	4.45E-01	6.67E-01	3.83E-01	2.73E-01
Benzene	0.00E+00	9.21E-03	1.83E-02	9.74E-03	4.92E-03
Toluene	0.00E+00	2.76E-03	8.54E-03	4.16E-03	9.65E-04
Hexane	0.00E+00	5.81E-03	9.07E-03	5.15E-03	3.51E-03
Xylene	0.00E+00	2.04E-03	7.70E-03	3.64E-03	4.83E-04

D - 8. Thermal Oxidizer Emissions

Wespac Pittsburg
Thermal Oxidizer Emissions - Proposed Project and Alternative 1

Given			
Size	67	MMBtu/hr	
Usage	440	hr/yr	
NO_x Emission Factor[1]	15	ppmv at 3%O2	per Rule 9-7-307.3
CO Emission Factor[1]	400	ppmv at 3%O2	per Rule 9-7-307.3
VM = Molar volume	385	dscf/mole	
NO_2 Molecular Weight	46	lb/lbmol	
CO Molecular Weight	28	lb/lbmol	
Fd for Crude Oil[2,3]	9,190	dscf/MMBtu	
Stack Diameter	29.5	in	
Stack Height	278	in	
Stack Velocity	98	ft/s	
Stack Temperature	2,100	F	
Natural Gas Supplement	187	scfm	
Thermal Oxidizer Efficiency	99.5%		
Number of Loading Events	2	per month	
Size of Loaded Vessel	325,000	bbl	

Calculated		
Stack cross-section	4.75	ft^2
Flow Rate (ft3/hr)	1674557.24	ft^3/hr
Stack Temp	1422	K
NOx EF (BAAQMD)[4]	5.91E-03	mg/L
CO EF (BAAQMD)[4]	9.60E-02	mg/L
Oxygen Correction	3.03E+00	
POC Loading Loss	1.76	lb/1000 gal
POC Loading Loss after control	0.37	lb/1000bbl loaded
Loading Loss: LL = 12.46 SPM/T (From AP-42 Chap 5.2 Eqn 1: http://www.epa.gov/ttn/chief/ap42/ch05/final/c05s02.pdf)		
Saturation Factor (S)	0.2	unitless
TVP (P)	7.35	psia
MW (M)	50	lb/lbmol
Temperature (T)	520	^0R
Loading Loss (LL)	1.76	lb/1000 gal
Thermal Oxidizer Efficiency	99.5%	%
Loading Loss after control ($LL_{controlled}$)	0.0088	lb/1000gal
Total Crude Vapor Loss	5.77E+05	lb/yr
Crude Vapor Density[4]	6.59E-02	lb/ft^3
Crude Vapor Volume to Inlet of Combust	8.76E+06	ft^3/yr

NOx and CO Emissions (from Crude Vapor and Natural Gas Combustion)

Criteria Pollutants	Emission Factors (ppmv at 3% O_2)	Emission Factors[6] (lb/MMBtu at 21% O_2)	Thermal Oxidizer Emissions (One Oxidizer) Annual (lb/yr)	Max Hourly (lb/hr)
NOx (total)[5]	15	1.92E-02	566	1.29E+00
CO (total)[5]	400	3.12E-01	9,195	2.09E+01

Other Emissions from Crude Vapors

Loading Loss of Crude Vapor

Criteria Pollutant	Annual Loading (bbl loaded/yr)	Emission Factors (lb/1000bbl loaded)	Crude Vapor Emissions (After-Control from Loading Loss) Annual (lb/yr)	Max Hourly (lb/hr)
POC	7,800,000	0.37	2.88E+03	6.56E+00

Component of Crude Vapor (POC)	POC Emissions Annual (lb/yr)	Vapor Mass Fraction (%)	Crude Vapor Emissions (After-Control from Loading Loss) Annual (lb/yr)	Max Hourly (lb/hr)
Benzene	2.88E+03	1.77%	51.06	1.16E-01
Hexane	2.88E+03	1.34%	38.66	8.79E-02
Toluene	2.88E+03	0.26%	7.50	1.70E-02
Xylene	2.88E+03	0.07%	2.02	4.59E-03

Criteria Pollutants from Crude Vapor Combustion

Criteria and Greenhouse Gas Pollutants	Emission Factors[8] (lb/10^6 scf)	Emission Factors[9] (lb/MMBtu)	Crude Vapor Emissions (from Combustion) Annual (lb/yr)	Max Hourly (lb/hr)
PM_{10}[7]	7.6	7.45E-03	66.58	1.51E-01
SO_2[7]	0.6	5.88E-04	5.26	1.19E-02

Other Emissions from Natural Gas Combustion

Criteria pollutants and Green house gas

Criteria and Greenhouse Gas Pollutants	Emission Factors[8] (lb/10^6 scf)	Emission Factors[9] (lb/MMBtu)	Thermal Oxidizer Emissions (One Oxidizer)[10] Annual (lb/yr)	Max Hourly (lb/hr)
POC	5.5	5.39E-03	27.15	6.17E-02
SO_2	0.6	5.88E-04	2.96	6.73E-03
PM_{10}[11]	7.6	7.45E-03	37.52	8.53E-02
$PM_{2.5}$[11]	7.6	7.45E-03	37.52	8.53E-02
CO_2	120000	1.18E+02	592,416	1.35E+03
CH_4	2.3	2.25E-03	11.35	2.58E-02
N_2O	2.2	2.16E-03	10.86	2.47E-02
CO_2e[12]	-	-	596,021	1.35E+03

Speciated Organic Compounds

Pollutants	Emission Factors[8] (lb/10^6 scf)	Emission Factors[9] (lb/MMBtu)	Thermal Oxidizer Emissions (One Oxidizer)[10] Annual (lb/yr)	Max Hourly (lb/hr)
2-Methylnaphthalene	2.40E-05	2.35E-08	1.18E-04	2.69E-07
3-Methylchloranthrene	1.80E-06	1.76E-09	8.89E-06	2.02E-08
7,12-Dimethylbenz(a)anthracene	1.60E-05	1.57E-08	7.90E-05	1.80E-07
Acenaphthene	1.80E-06	1.76E-09	8.89E-06	2.02E-08
Acenaphthylene	1.80E-06	1.76E-09	8.89E-06	2.02E-08
Anthracene	2.40E-06	2.35E-09	1.18E-05	2.69E-08
Benz(a)anthracene	1.80E-06	1.76E-09	8.89E-06	2.02E-08
Benzene	2.10E-03	2.06E-06	1.04E-02	2.36E-05
Benzo(a)pyrene	1.20E-06	1.18E-09	5.92E-06	1.35E-08
Benzo(b)fluoranthene	1.80E-06	1.76E-09	8.89E-06	2.02E-08
Benzo(g,h,i)perylene	1.20E-06	1.18E-09	5.92E-06	1.35E-08
Benzo(k)fluoranthene	1.80E-06	1.76E-09	8.89E-06	2.02E-08
Butane	2.10E+00	2.06E-03	1.04E+01	2.36E-02
Chrysene	1.80E-06	1.76E-09	8.89E-06	2.02E-08
Dibenzo(a,h)anthracene	1.20E-06	1.18E-09	5.92E-06	1.35E-08
Dichlorobenzene	1.20E-03	1.18E-06	5.92E-03	1.35E-05
Ethane	3.10E+00	3.04E-03	1.53E+01	3.48E-02
Fluoranthene	3.00E-06	2.94E-09	1.48E-05	3.37E-08
Fluorene	2.80E-06	2.75E-09	1.38E-05	3.14E-08
Formaldehyde	7.50E-02	7.35E-05	3.70E-01	8.42E-04
Hexane	1.80E+00	1.76E-03	8.89E+00	2.02E-02
Indeno(1,2,3-cd)pyrene	1.80E-06	1.76E-09	8.89E-06	2.02E-08
Naphthalene	6.10E-04	5.98E-07	3.01E-03	6.84E-06
Pentane	2.60E+00	2.55E-03	1.28E+01	2.92E-02
Phenanathrene	1.70E-05	1.67E-08	8.39E-05	1.91E-07
Propane	1.60E+00	1.57E-03	7.90E+00	1.80E-02
Pyrene	5.00E-06	4.90E-09	2.47E-05	5.61E-08
Toluene	3.40E-03	3.33E-06	1.68E-02	3.81E-05

Metals

Pollutants	Emission Factors[8] (lb/10^6 scf)	Emission Factors[9] (lb/MMBtu)	Thermal Oxidizer Emissions (One Oxidizer)[10] Annual (lb/yr)	Max Hourly (lb/hr)
Arsenic	2.00E-04	1.96E-07	9.87E-04	2.24E-06
Barium	4.40E-03	4.31E-06	2.17E-02	4.94E-05
Beryllium	1.20E-05	1.18E-08	5.92E-05	1.35E-07
Cadmium	1.10E-03	1.08E-06	5.43E-03	1.23E-05
Chromium	1.40E-03	1.37E-06	6.91E-03	1.57E-05
Cobalt	8.40E-05	8.24E-08	4.15E-04	9.42E-07
Copper	8.50E-04	8.33E-07	4.20E-03	9.54E-06
Manganese	3.80E-04	3.73E-07	1.88E-03	4.26E-06
Mercury	2.60E-04	2.55E-07	1.28E-03	2.92E-06
Molybdenum	1.10E-03	1.08E-06	5.43E-03	1.23E-05
Nickel	2.10E-03	2.06E-06	1.04E-02	2.36E-05
Selenium	2.40E-05	2.35E-08	1.18E-04	2.69E-07
Vanadium	2.30E-03	2.25E-06	1.14E-02	2.58E-05
Zinc	2.90E-02	2.84E-05	1.43E-01	3.25E-04

Notes:

1. NOx and CO emission factors are based on BAAQMD Rule 9-7-307.3
2. Fd was obtained from http://www.epa.gov/ttn/emc/promgate/m-19.pdf
3. All other assumptions on thermal oxidizer operations were provided by project proponent.
4. Crude Vapor Density was calculated using the following equation available at http://www.arb.ca.gov/vapor/ast/astemissionfactorapproach.pdf

   $W_V = M_V P_{VA} / RT_{LA}$

   Where:

   W_V = Vapor density, lb/ft^3

   M_V = Vapor molecular weight, lb/lb-mole

   R = Ideal gas constant, 10.731 psiaft^3/lb-mole·°R = 8.3144 J/mol-K

   P_{VA} = Vapor pressure at daily average liquid-surface temperature, for atompheric pressure 101.325 psia

   T_{LA} = Average liquid surface temperature, °R

5. Emissions (NOx & CO) = Emission Factor * Size of Thermal Oxidizer * Usage;
6. EF(lb/MMBTU) = ppmmeasured/1e6*[(21-0)/(21-%O2 measured)] *(MW)* Fd /VM
7. Assumed the same PM_{10} and SO_2 emission factors as natural gas
8. Emission factors were obtained from US EPA AP 42 Chapter 1.4
9. To convert "lb/1$0^6$scf" to "lb/MMBtu", use equation: lb/MMBTu = (lb/1$0^6$scf) / (1020 MMBtu/1$0^6$scf for natural gas)
10. Assume only 187 scfm natural gas combustion for 440 hours, natural gas emissions (except for NOx and CO) = EF * Usage * size
11. Emision factor assumed to be less than 1.0 micrometer in diameter. Therefore, the PM emission factors presented here are used to estimate $PM_{10}$and $PM_{2.5}$.
12. Global warming potential: CO_2 = 1; CH_4 = 21; N_2O = 310; Source: ource: CCAR general reporting protocols (v.3.1); http://www.climateregistry.org/resources/docs/protocols/grp/GRP_3.1_January2009.pdf. (Page 35)

D - 9. Heater Emissions Summary

Wespac Pittsburg
Large Heater Emissions - Proposed Project and Alternative 1

Given			
No. of Crude Oil Heater	2		
Size	12	MMBtu/hr	
Usage	4,400	hr/yr	
NO_x Emission Factor[1]	15	ppmv at 3%O2	per Rule 9-7-307.3
CO Emission Factor[1]	400	ppmv at 3%O2	per Rule 9-7-307.3
VM = Molar volume	385	dscf/mole	
NO_2 Molecular Weight	46	lb/lbmol	
CO Molecular Weight	28	lb/lbmol	
Fd for Natural Gas[2,3]	8,710	dscf/MMBtu	
Stack Diameter	24	in	
Stack Height	189	in	
Stack Velocity	35	ft/s	
Stack Temperature	430	^{0}F	

Natural Gas Combustion Emissions

Criteria pollutants and Green house gas

Criteria pollutants	Emission Factors (ppmv at 3% O_2)	Emission Factors[4] (lb/MMBtu at 21% O_2)	Heater Emissions (One Large Heater)[5] Annual (lb/yr)	Max Hourly (lb/hr)
NO_x	15	1.82E-02	9.62E+02	2.19E-01
CO	400	2.96E-01	1.56E+04	3.55E+00

Criteria and Greenhouse Gas Pollutants	Emission Factors[6] (lb/10^6 scf)	Emission Factors[7] (lb/MMBtu)	Heater Emissions (One Large Heater)[5] Annual (lb/yr)	Max Hourly (lb/hr)
POC	5.5	5.39E-03	2.85E+02	6.47E-02
SO2	0.6	5.88E-04	3.11E+01	7.06E-03
PM_{10}[8]	7.6	7.45E-03	3.93E+02	8.94E-02
$PM_{2.5}$[8]	7.6	7.45E-03	3.93E+02	8.94E-02
CO_2	120000	1.18E+02	6.21E+06	1.41E+03
CH_4	2.3	2.25E-03	1.19E+02	2.71E-02
N_2O	2.2	2.16E-03	1.14E+02	2.59E-02
CO_2e[9]	-	-	6.25E+06	1.42E+03

Speciated Organic Compounds

Pollutants	Emission Factors[6] (lb/10^6 scf)	Emission Factors[7] (lb/MMBtu)	Heater Emissions (One Large Heater)[5] Annual (lb/yr)	Max Hourly (lb/hr)
2-Methylnaphthalene	2.40E-05	2.35E-08	1.24E-03	2.82E-07
3-Methylchloranthrene	1.80E-06	1.76E-09	9.32E-05	2.12E-08
7,12-Dimethylbenz(a)anthracene	1.60E-05	1.57E-08	8.28E-04	1.88E-07
Acenaphthene	1.80E-06	1.76E-09	9.32E-05	2.12E-08
Acenaphthylene	1.80E-06	1.76E-09	9.32E-05	2.12E-08
Anthracene	2.40E-06	2.35E-09	1.24E-04	2.82E-08
Benz(a)anthracene	1.80E-06	1.76E-09	9.32E-05	2.12E-08
Benzene	2.10E-03	2.06E-06	1.09E-01	2.47E-05
Benzo(a)pyrene	1.20E-06	1.18E-09	6.21E-05	1.41E-08
Benzo(b)fluoranthene	1.80E-06	1.76E-09	9.32E-05	2.12E-08
Benzo(g,h,i)perylene	1.20E-06	1.18E-09	6.21E-05	1.41E-08
Benzo(k)fluoranthene	1.80E-06	1.76E-09	9.32E-05	2.12E-08
Butane	2.10E+00	2.06E-03	1.09E+02	2.47E-02
Chrysene	1.80E-06	1.76E-09	9.32E-05	2.12E-08
Dibenzo(a,h)anthracene	1.20E-06	1.18E-09	6.21E-05	1.41E-08
Dichlorobenzene	1.20E-03	1.18E-06	6.21E-02	1.41E-05
Ethane	3.10E+00	3.04E-03	1.60E+02	3.65E-02

Speciated Organic Compounds				
Pollutants	**Emission Factors[6] (lb/10^6 scf)**	**Emission Factors[7] (lb/MMBtu)**	**Heater Emissions (One Large Heater)[5] Annual (lb/yr)**	**Max Hourly (lb/hr)**
Fluoranthene	3.00E-06	2.94E-09	1.55E-04	3.53E-08
Fluorene	2.80E-06	2.75E-09	1.45E-04	3.29E-08
Formaldehyde	7.50E-02	7.35E-05	3.88E+00	8.82E-04
Hexane	1.80E+00	1.76E-03	9.32E+01	2.12E-02
Indeno(1,2,3-cd)pyrene	1.80E-06	1.76E-09	9.32E-05	2.12E-08
Naphthalene	6.10E-04	5.98E-07	3.16E-02	7.18E-06
Pentane	2.60E+00	2.55E-03	1.35E+02	3.06E-02
Phenanathrene	1.70E-05	1.67E-08	8.80E-04	2.00E-07
Propane	1.60E+00	1.57E-03	8.28E+01	1.88E-02
Pyrene	5.00E-06	4.90E-09	2.59E-04	5.88E-08
Toluene	3.40E-03	3.33E-06	1.76E-01	4.00E-05

Metals				
Pollutants	**Emission Factors[6] (lb/10^6 scf)**	**Emission Factors[7] (lb/MMBtu)**	**Heater Emissions (One Large Heater)[5] Annual (lb/yr)**	**Max Hourly (lb/hr)**
Arsenic	2.00E-04	1.96E-07	1.04E-02	2.35E-06
Barium	4.40E-03	4.31E-06	2.28E-01	5.18E-05
Beryllium	1.20E-05	1.18E-08	6.21E-04	1.41E-07
Cadmium	1.10E-03	1.08E-06	5.69E-02	1.29E-05
Chromium	1.40E-03	1.37E-06	7.25E-02	1.65E-05
Cobalt	8.40E-05	8.24E-08	4.35E-03	9.88E-07
Copper	8.50E-04	8.33E-07	4.40E-02	1.00E-05
Manganese	3.80E-04	3.73E-07	1.97E-02	4.47E-06
Mercury	2.60E-04	2.55E-07	1.35E-02	3.06E-06
Molybdenum	1.10E-03	1.08E-06	5.69E-02	1.29E-05
Nickel	2.10E-03	2.06E-06	1.09E-01	2.47E-05
Selenium	2.40E-05	2.35E-08	1.24E-03	2.82E-07
Vanadium	2.30E-03	2.25E-06	1.19E-01	2.71E-05
Zinc	2.90E-02	2.84E-05	1.50E+00	3.41E-04

Notes:

1. Emission factors for NOx and CO were obtained from BAAQMD Rule 9-7-307.3
2. Source: http://www.epa.gov/ttn/emc/promgate/m-19.pdf
3. All other information on heater operations were provided by project proponent.
4. To convert "ppm" to "lb/MMBTU", use equation: lb/MMBTU = ppmmeasured/1e6*[(21-0)/(21-%O2 measured)] *(MW)* Fd /VM
5. Emissions = Emission Factor * Heater Size * Usage;
6. Emission factors were obtained from US EPA AP 42 Chapter 1.4: http://www.epa.gov/ttn/chief/ap42/ch01/final/c01s04.pdf
7. To convert "lb/10^{6}scf" to "lb/MMBTu", use equation: lb/MMBTu = (lb/10^{6}scf) / (1020 MMBtu/10^{6}scf for natural gas)
8. Emision factor assumed to be less than 1.0 micrometer in diameter. Therefore, the PM emission factors presented here are used to estimate PM_{10} and $PM_{2.5}$.
9. Global warming potential: CO_2 = 1; CH_4 = 21; N_2O = 310; Source: ource: CCAR general reporting protocols (v.3.1); http://www.climateregistry.org/resources/docs/protocols/grp/GRP_3.1_January2009.pdf. (Page 35)

Wespac Pittsburg
Small Heater Emissions - Proposed Project

Given			
No. of Crude Oil Heater	3		
Size	3.4	MMBtu/hr	
Usage	4,400	hr/yr	
NO_x Emission Factor[1]	15	ppmv at 3%O2	per Rule 9-7-307.3
CO Emission Factor[1]	400	ppmv at 3%O2	per Rule 9-7-307.3
VM = Molar volume	385	dscf/mole	
NO_2 Molecular Weight	46	lb/lbmol	
CO Molecular Weight	28	lb/lbmol	
Fd for Natural Gas[2,3]	8,710	dscf/MMBtu	
Stack Diameter	24	in	
Stack Height	189	in	
Stack Velocity	35	ft/s	
Stack Temperature	430	^{0}F	

Natural Gas Combustion Emissions

Criteria pollutants and Green house gas

Criteria pollutants	Emission Factors (ppmv at 3% O2)	Emission Factors[4] (lb/MMBtu at 21% O2)	Heater Emissions (One Large Heater)[5] Annual (lb/yr)	Max Hourly (lb/hr)
NO_x	15	1.82E-02	2.72E+02	6.19E-02
CO	400	2.96E-01	4.42E+03	1.01E+00

Criteria and Greenhouse Gas Pollutants	Emission Factors[6] ($lb/10^6$ scf)	Emission Factors[7] (lb/MMBtu)	Heater Emissions (One Large Heater)[5] Annual (lb/yr)	Max Hourly (lb/hr)
POC	5.5	5.39E-03	8.07E+01	1.83E-02
SO2	0.6	5.88E-04	8.80E+00	2.00E-03
PM_{10}[8]	7.6	7.45E-03	1.11E+02	2.53E-02
$PM_{2.5}$[8]	7.6	7.45E-03	1.11E+02	2.53E-02
CO_2	120000	1.18E+02	1.76E+06	4.00E+02
CH_4	2.3	2.25E-03	3.37E+01	7.67E-03
N_2O	2.2	2.16E-03	3.23E+01	7.33E-03
CO_2e[9]	-	-	1.77E+06	4.02E+02

Speciated Organic Compounds

Pollutants	Emission Factors[6] ($lb/10^6$ scf)	Emission Factors[7] (lb/MMBtu)	Heater Emissions (One Large Heater)[5] Annual (lb/yr)	Max Hourly (lb/hr)
2-Methylnaphthalene	2.40E-05	2.35E-08	3.52E-04	8.00E-08
3-Methylchloranthrene	1.80E-06	1.76E-09	2.64E-05	6.00E-09
7,12-Dimethylbenz(a)anthracene	1.60E-05	1.57E-08	2.35E-04	5.33E-08
Acenaphthene	1.80E-06	1.76E-09	2.64E-05	6.00E-09
Acenaphthylene	1.80E-06	1.76E-09	2.64E-05	6.00E-09
Anthracene	2.40E-06	2.35E-09	3.52E-05	8.00E-09
Benz(a)anthracene	1.80E-06	1.76E-09	2.64E-05	6.00E-09
Benzene	2.10E-03	2.06E-06	3.08E-02	7.00E-06
Benzo(a)pyrene	1.20E-06	1.18E-09	1.76E-05	4.00E-09
Benzo(b)fluoranthene	1.80E-06	1.76E-09	2.64E-05	6.00E-09
Benzo(g,h,i)perylene	1.20E-06	1.18E-09	1.76E-05	4.00E-09
Benzo(k)fluoranthene	1.80E-06	1.76E-09	2.64E-05	6.00E-09
Butane	2.10E+00	2.06E-03	3.08E+01	7.00E-03
Chrysene	1.80E-06	1.76E-09	2.64E-05	6.00E-09
Dibenzo(a,h)anthracene	1.20E-06	1.18E-09	1.76E-05	4.00E-09
Dichlorobenzene	1.20E-03	1.18E-06	1.76E-02	4.00E-06
Ethane	3.10E+00	3.04E-03	4.55E+01	1.03E-02
Fluoranthene	3.00E-06	2.94E-09	4.40E-05	1.00E-08
Fluorene	2.80E-06	2.75E-09	4.11E-05	9.33E-09
Formaldehyde	7.50E-02	7.35E-05	1.10E+00	2.50E-04
Hexane	1.80E+00	1.76E-03	2.64E+01	6.00E-03
Indeno(1,2,3-cd)pyrene	1.80E-06	1.76E-09	2.64E-05	6.00E-09
Naphthalene	6.10E-04	5.98E-07	8.95E-03	2.03E-06

Speciated Organic Compounds				
Pollutants	**Emission Factors[6] (lb/10^6 scf)**	**Emission Factors[7] (lb/MMBtu)**	**Heater Emissions (One Large Heater)[5] Annual (lb/yr)**	**Max Hourly (lb/hr)**
Pentane	2.60E+00	2.55E-03	3.81E+01	8.67E-03
Phenanathrene	1.70E-05	1.67E-08	2.49E-04	5.67E-08
Propane	1.60E+00	1.57E-03	2.35E+01	5.33E-03
Pyrene	5.00E-06	4.90E-09	7.33E-05	1.67E-08
Toluene	3.40E-03	3.33E-06	4.99E-02	1.13E-05

Metals				
Pollutants	**Emission Factors[6] (lb/10^6 scf)**	**Emission Factors[7] (lb/MMBtu)**	**Heater Emissions (One Large Heater)[5] Annual (lb/yr)**	**Max Hourly (lb/hr)**
Arsenic	2.00E-04	1.96E-07	2.93E-03	6.67E-07
Barium	4.40E-03	4.31E-06	6.45E-02	1.47E-05
Beryllium	1.20E-05	1.18E-08	1.76E-04	4.00E-08
Cadmium	1.10E-03	1.08E-06	1.61E-02	3.67E-06
Chromium	1.40E-03	1.37E-06	2.05E-02	4.67E-06
Cobalt	8.40E-05	8.24E-08	1.23E-03	2.80E-07
Copper	8.50E-04	8.33E-07	1.25E-02	2.83E-06
Manganese	3.80E-04	3.73E-07	5.57E-03	1.27E-06
Mercury	2.60E-04	2.55E-07	3.81E-03	8.67E-07
Molybdenum	1.10E-03	1.08E-06	1.61E-02	3.67E-06
Nickel	2.10E-03	2.06E-06	3.08E-02	7.00E-06
Selenium	2.40E-05	2.35E-08	3.52E-04	8.00E-08
Vanadium	2.30E-03	2.25E-06	3.37E-02	7.67E-06
Zinc	2.90E-02	2.84E-05	4.25E-01	9.67E-05

Notes:

1. Emission factors for NOx and CO were obtained from BAAQMD Rule 9-7-307.3
2. Source: http://www.epa.gov/ttn/emc/promgate/m-19.pdf
3. All other information on heater operations were provided by project proponent.
4. To convert "ppm" to "lb/MMBTU", use equation: lb/MMBTU = ppmmeasured/1e6*[(21-0)/(21-%O2 measured)] *(MW)* Fd /VM
5. Emissions = Emission Factor * Heater Size * Usage;
6. Emission factors were obtained from US EPA AP 42 Chapter 1.4: http://www.epa.gov/ttn/chief/ap42/ch01/final/c01s04.pdf
7. To convert "lb/10^{6}scf" to "lb/MMBTu", use equation: lb/MMBTu = (lb/10^{6}scf) / (1020 MMBtu/10^{6}scf for natural gas)
8. Emision factor assumed to be less than 1.0 micrometer in diameter. Therefore, the PM emission factors presented here are used to estimate PM_{10} and $PM_{2.5}$.
9. Global warming potential: CO_2 = 1; CH_4 = 21; N_2O = 310; Source: ource: CCAR general reporting protocols (v.3.1); http://www.climateregistry.org/resources/docs/protocols/grp/GRP_3.1_January2009.pdf. (Page 35)

D - 10. Fugitive Emissions Summary

Wespac Pittsburg
Fugitive Emissions - Storage Terminal (Proposed Project)

POC Fugitive Emissions from Miscellaneous Sources

Component	No. of Components	Component Type	Service Type	Emission Factor[1] (kg/hr/source)	Emissions[2] (lb/yr)
Flanged Valves (10" and above)	195	Valves	Light liquid	1.50E-05	56.4
Process pumps	20	Pump seals	Light liquid	2.40E-04	92.5
Meters & Other	3	Others (compressors and others)	Light liquid	2.40E-05	1.4
Fittings (flanges)	478	Fittings (connectors and flanges)	Light liquid	7.20E-06	66.3
				TOTAL POC EMISSIONS	217

Notes:

1. Emission factor source: http://www.epa.gov/ttnchie1/efdocs/equiplks.pdf, Table 2-7, <10,000 ppmv THC (no leaking)
2. Emissions = NO. of Component * Emission Factor * Time

TAC Fugitive Emissions from Miscellaneous Sources

TAC in Crude Oil	Percent by Weight (%)	TAC emissions[1] (lb/yr)	TAC emissions[3] (lb/yr/ft2)	TAC emissions[3] (lb/hr/ft2)
Benzene	3.00%	6.5	1.19E-06	1.36E-10
Toluene	1.54%	3.3	6.13E-07	6.99E-11
Hexane	1.38%	3.0	5.49E-07	6.27E-11
Xylene	1.43%	3.1	5.69E-07	6.49E-11

Notes:

1. Percent by weight in POC from crude vapor
2. Emissions = POC emissions * Percent by Weight
3. Total area is approximately 125 acres

Wespac Pittsburg
Fugitive Emissions - Storage Terminal (Alternative 1 Project)

POC Fugitive Emissions from Miscellaneous Sources

Component	No. of Components	Component Type	Service Type	Emission Factor[1] (kg/hr/source)	Emissions[2] (lb/yr)
Flanged Valves (10" and above)	130	Valves	Light liquid	1.50E-05	37.58
Process pumps	15	Pump seals	Light liquid	2.40E-04	69.38
Meters & Other	2	Others (compressors and others)	Light liquid	2.40E-05	0.93
Fittings (flanges)	320	Fittings (connectors and flanges)	Light liquid	7.20E-06	44.40
				TOTAL POC EMISSIONS	152

Notes:

1. Emission factor source: http://www.epa.gov/ttnchie1/efdocs/equiplks.pdf, Table 2-7, <10,000 ppmv THC (no leaking)
2. Emissions = NO. of Component * Emission Factor * Time

TAC Fugitive Emissions from Miscellaneous Sources

TAC in Crude Oil	Percent by Weight (%)	TAC emissions[1] (lb/yr)	TAC emissions[3] (lb/yr/ft2)	TAC emissions[3] (lb/hr/ft2)
Benzene	3.00%	4.6	1.05E-06	1.20E-10
Toluene	1.54%	2.3	5.38E-07	6.15E-11
Hexane	1.38%	2.1	4.82E-07	5.51E-11
Xylene	1.43%	2.2	5.00E-07	5.71E-11

Notes:

1. Percent by weight in POC from crude vapor
2. Emissions = POC emissions * Percent by Weight
3. Total area is approximately 100 acres

Wespac Pittsburg

Fugitive Emissions - Rail (Proposed Project and Alternative 1 Project)

POC Fugitive Emissions from Miscellaneous Sources

No. of Components	Component Type	Service Type	Emission Factor[1] (kg/hr/source)	Emissions[2] (lb/yr)
104	Valves	Light liquid	1.50E-05	30.1
1	Pump seals	Light liquid	2.40E-04	4.6
0	Others (compressors and others)	Light liquid	2.40E-05	0.0
664	Fittings (connectors and flanges)	Light liquid	7.20E-06	92.1
			TOTAL POC EMISSIONS	127

Notes:

1. Emission factor source: http://www.epa.gov/ttnchie1/efdocs/equiplks.pdf, Table 2-7, <10,000 ppmv THC (no leaking)
2. Emissions = NO. of Component * Emission Factor * Time

TAC Fugitive Emissions from Miscellaneous Sources

TAC in Crude Oil	Percent by Weight (%)	TAC emissions[1] (lb/yr)	TAC emissions[3] (lb/yr/ft2)	TAC emissions[3] (lb/hr/ft2)
Benzene	3.00%	3.8	1.44E-05	1.65E-09
Toluene	1.54%	2.0	7.40E-06	8.45E-10
Hexane	1.38%	1.8	6.63E-06	7.57E-10
Xylene	1.43%	1.8	6.87E-06	7.84E-10

Notes:

1. Percent by weight in POC from crude vapor
2. Emissions = POC emissions * Percent by Weight
3. Total area is 264,000 ft^2

D - 11. Vehicle Emissions Summary

Wespac Pittsburg
Vehicle Emissions (Proposed Project and Alternative 1 Project)

Vehicle Emissions

Annual Emissions (tons)*						Annual Emissions (metric tons)			
CO	NO_x	SO_2	POC	PM_{10}	$PM_{2.5}$	CO_2	CH_4	N_2O	CO_2e
0.43	0.04	0.00	0.04	3.81	0.38	74.28	0.00	0.00	74.34

*Vehicle emissions are calculated by CalEEMod model.

D - 12. Operational Emissions Summary

Wesapc Pittsburg
Proposed Project Emission Model Inputs and Results
18 Vessels per Month & 2007 Engine Year Tugboats
Total Emissions

Project Total Operaional Emissions

Emission Source	Emissions (lb/yr)									
	CO	NO_x	SO_2	POC	PM_{10}	$PM_{2.5}$	CO_2	CH_4	N_2O	CO_2e
Engines (Main & Auxiliary Engines)	37,484	526,415	12,233	24,775	8,302	8,302	20,348,163	2,470	248	20,476,840
Boilers	3,091	12,363	8,778	124	1,422	958	13,838,851	2,044	136	13,924,023
Tugboats	47,916	70,657	71	8,851	2,525	2,525	7,453,124	1,101	73	7,498,995
Thermal Oxidizer	9,195	566	8.2	2,912	104	104	592,416	11.4	10.9	596,021
Large Heaters	31,217	1,923	62	569	787	787	12,423,529	238	228	12,499,137
Small Heaters	13,267	817	26	242	334	334	5,280,000	101	97	5,312,133
Tanks				47,209						
Fugitives				217						
Rail Fugitives				127						
Rail Mobile	692	10,731	7	382	311	311	2,621,247	212	69	2,647,088
Rail Mobile Servicing	727	9,985	7	398	322	322	5,941,493	481	156	6,000,066
Transload	426	3,948	5	180	161	161	3,931,870	318	103	3,970,632
Vehicle	860	80	0	80	7,620	760	163,787	0	0	163,920
TOTAL (lb/yr)	144,875	637,487	21,198	86,064	21,888	14,565	72,594,480	6,978	1,122	73,088,854
TOTAL (TPY)	**72.4**	**318.7**	**10.6**	**43.0**	**10.9**	**7.3**				
TOTAL (MT/YR)							**32,923**	**3.2**	**0.5**	**33,147**

Wespac Pittsburg
Proposed Project Emission Model Inputs and Results
18 Vessels per Month & 2016 Engine Year Tugboats
Total Emissions

Project Total Operaional Emissions

Emission Source	Emissions (lb/yr)									
	CO	NO_x	SO_2	POC	PM_{10}	$PM_{2.5}$	CO_2	CH_4	N_2O	CO_2e
Engines (Main & Auxiliary Engines)	37,484	526,415	12,233	24,775	8,302	8,302	20,348,163	2,470	248	20,476,840
Boilers	3,091	12,363	8,778	124	1,422	958	13,838,851	2,044	136	13,924,023
Tugboats	47,916	19,090	71	2,872	430	430	7,453,124	1,101	73	7,498,995
Thermal Oxidizer	9,195	566	8.2	2,912	104	104	592,416	11.4	10.9	596,021
Large Heaters	31,217	1,923	62	569	787	787	12,423,529	238	228	12,499,137
Small Heaters	13,267	817	26	242	334	334	5,280,000	101	97	5,312,133
Tanks				47,209						
Fugitives				217						
Rail Fugitives				127						
Rail Mobile	692	2,575	7	179	93	93	2,621,247	212	69	2,647,088
Rail Mobile Servicing	727	2,396	7	187	97	97	5,941,493	481	156	6,000,066
Transload	426	948	5	84	48	48	3,931,870	318	103	3,970,632
Vehicle	860	80	0	80	7,620	760	163,787	0	0	163,920
TOTAL (lb/yr)	144,875	567,175	21,198	79,578	19,237	11,913	72,594,480	6,978	1,122	73,088,854
TOTAL (TPY)	**72.4**	**283.6**	**10.6**	**39.8**	**9.6**	**6.0**				
TOTAL (MT/YR)							**32,923**	**3.2**	**0.5**	**33,147**

Wespac Pittsburg
Alternative 1 Project Emission Model Inputs and Results
15 Vessels per Month & 2007 Engine Year Tugboats
Total Emissions

Project Total Operaional Emissions

Emission Source	Emissions (lb/yr)									
	CO	NO_x	SO_2	POC	PM_{10}	$PM_{2.5}$	CO_2	CH_4	N_2O	CO_2e
Engines (Main & Auxiliary Engines)	31,237	438,679	10,194	20,646	6,918	6,918	16,956,803	2,059	206	17,064,034
Boilers	2,576	10,302	7,315	103	1,185	798	11,532,375	1,703	114	11,603,353
Tugboats	39,930	58,881	59	7,376	2,104	2,104	6,210,936	917	61	6,249,162
Thermal Oxidizer	9,195	566	8.2	2,912	104	104	592,416	11.4	10.9	596,021
Large Heaters	31,217	1,923	62	569	787	787	12,423,529	238	228	12,499,137
Small Heaters	0	0	0	0	0	0	0	0	0	0
Tanks				37,798						
Fugitives				152						
Rail Fugitives				127						
Rail Mobile	692	10,731	7	382	311	311	2,621,247	212	69	2,647,088
Rail Mobile Servicing	727	9,985	7	398	322	322	5,941,493	481	156	6,000,066
Transload	426	3,948	5	180	161	161	3,931,870	318	103	3,970,632
Vehicle	860	80	0	80	7,620	760	163,787	0	0	163,920
TOTAL (lb/yr)	116,859	535,097	17,657	70,722	19,512	12,266	60,374,457	5,941	949	60,793,411
TOTAL (TPY)	**58.4**	**267.5**	**8.8**	**35.4**	**9.8**	**6.1**				
TOTAL (MT/YR)							**27,381**	**2.7**	**0.4**	**27,571**

Wespac Pittsburg
Alternative 1 Project Emission Model Inputs and Results
15 Vessels per Month & 2016 Engine Year Tugboats
Total Emissions

Project Total Operaional Emissions

Emission Source	Emissions (lb/yr)									
	CO	NO_x	SO_2	POC	PM_{10}	$PM_{2.5}$	CO_2	CH_4	N_2O	CO_2e
Engines (Main & Auxiliary Engines)	31,237	438,679	10,194	20,646	6,918	6,918	16,956,803	2,059	206	17,064,034
Boilers	2,576	10,302	7,315	103	1,185	798	11,532,375	1,703	114	11,603,353
Tugboats	39,930	15,908	59	2,393	358	358	6,210,936	917	61	6,249,162
Thermal Oxidizer	9,195	566	8.2	2,912	104	104	592,416	11.4	10.9	596,021
Large Heaters	31,217	1,923	62	569	787	787	12,423,529	238	228	12,499,137
Small Heaters	0	0	0	0	0	0	0	0	0	0
Tanks				37,798						
Fugitives				152						
Rail Fugitives				127						
Rail Mobile	692	2,575	7	179	93	93	2,621,247	212	69	2,647,088
Rail Mobile Servicing	727	2,396	7	187	97	97	5,941,493	481	156	6,000,066
Transload	426	948	5	84	48	48	3,931,870	318	103	3,970,632
Vehicle	860	80	0	80	7,620	760	163,787	0	0	163,920
TOTAL (lb/yr)	116,859	473,379	17,657	65,232	17,210	9,964	60,374,457	5,941	949	60,793,411
TOTAL (TPY)	**58.4**	**236.7**	**8.8**	**32.6**	**8.6**	**5.0**				
TOTAL (MT/YR)							**27,381**	**2.7**	**0.4**	**27,571**

D - 13. Construction Modeling Inputs - Onsite Construction Emissions

Wespac Pittsburg
Scenario 1 (October 2013 to September 2014)

Annual Onsite Emission Inputs

Proposed Project_Unmitigated Annual

Construction Phase	Area (ft^2)	CO (ton)	PM_{10} (ton)	$PM_{2.5}$ (ton)	CO ($lb/yr/ft^2$)	PM_{10} ($lb/yr/ft^2$)	$PM_{2.5}$ ($lb/yr/ft^2$)
Phase 1A: Transload Facility Construction	426,888	6.92	0.48	0.48	3.24E-02	2.25E-03	2.25E-03
Phase 1A: Storage Terminal Modifications	636,387	10.43	0.75	0.75	3.28E-02	2.36E-03	2.36E-03
Phase 1B:Pipeline Construction	265,374	5.44	0.38	0.38	8.20E-02	5.73E-03	5.73E-03
Phase 2A:Marine Work - Excludes Dredging	468,062	4.51	0.26	0.26	1.93E-02	1.11E-03	1.11E-03
Phase 2A:Marine Work - Dredging	1,215,276	9.16	0.53	0.53	1.51E-02	8.77E-04	8.77E-04
Phase 2B:Storage Tank Retrofit	1,545,043	2.76	0.22	0.22	3.57E-03	2.88E-04	2.88E-04
Phase 2C:Storage Terminal construction	115,165	5.25	0.39	0.39	9.12E-02	6.78E-03	6.78E-03

Proposed Project_Mitigated Annual

Construction Phase	Area (ft^2)	CO (ton)	PM_{10} (ton)	$PM_{2.5}$ (ton)	CO ($lb/yr/ft^2$)	PM_{10} ($lb/yr/ft^2$)	$PM_{2.5}$ ($lb/yr/ft^2$)
Phase 1A: Transload Facility Construction	426,888	3.13	0.17	0.17	1.47E-02	7.96E-04	7.96E-04
Phase 1A: Storage Terminal Modifications	636,387	4.80	0.29	0.29	1.51E-02	9.21E-04	9.21E-04
Phase 1B:Pipeline Construction	265,374	2.39	0.14	0.14	3.60E-02	2.11E-03	2.11E-03
Phase 2A:Marine Work - Excludes Dredging	468,062	3.41	0.19	0.19	1.46E-02	8.30E-04	8.30E-04
Phase 2A:Marine Work - Dredging	1,215,276	7.55	0.44	0.44	1.24E-02	7.22E-04	7.22E-04
Phase 2B:Storage Tank Retrofit	1,545,043	1.40	0.09	0.09	1.81E-03	1.10E-04	1.10E-04
Phase 2C:Storage Terminal construction	115,165	2.45	0.15	0.15	4.26E-02	2.63E-03	2.63E-03

Alternative 1_Unmitigated Annual

Construction Phase	Area (ft^2)	CO (ton)	PM_{10} (ton)	$PM_{2.5}$ (ton)	CO ($lb/yr/ft^2$)	PM_{10} ($lb/yr/ft^2$)	$PM_{2.5}$ ($lb/yr/ft^2$)
Phase 1A: Transload Facility Construction	426,888	6.92	0.48	0.48	3.24E-02	2.25E-03	2.25E-03
Phase 1A: Storage Terminal Modifications	636,387	10.43	0.75	0.75	3.28E-02	2.36E-03	2.36E-03
Phase 1B:Pipeline Construction	265,374	5.44	0.38	0.38	8.20E-02	5.73E-03	5.73E-03
Phase 2A:Marine Work - Excludes Dredging	468,062	4.51	0.26	0.26	1.93E-02	1.11E-03	1.11E-03
Phase 2A:Marine Work - Dredging	1,215,276	9.16	0.53	0.53	1.51E-02	8.77E-04	8.77E-04
Phase 2B:Storage Tank Retrofit	1,545,043	2.76	0.22	0.22	3.57E-03	2.88E-04	2.88E-04
Phase 2C:Storage Terminal construction	115,165	5.25	0.39	0.39	9.12E-02	6.78E-03	6.78E-03

Alternative 1_Mitigated Annual

Construction Phase	Area (ft^2)	CO (ton)	PM_{10} (ton)	$PM_{2.5}$ (ton)	CO ($lb/yr/ft^2$)	PM_{10} ($lb/yr/ft^2$)	$PM_{2.5}$ ($lb/yr/ft^2$)
Phase 1A: Transload Facility Construction	426,888	3.13	0.17	0.17	1.47E-02	7.96E-04	7.96E-04
Phase 1A: Storage Terminal Modifications	636,387	4.80	0.29	0.29	1.51E-02	9.21E-04	9.21E-04
Phase 1B:Pipeline Construction	265,374	2.39	0.14	0.14	3.60E-02	2.11E-03	2.11E-03
Phase 2A:Marine Work - Excludes Dredging	468,062	3.41	0.19	0.19	1.46E-02	8.30E-04	8.30E-04
Phase 2A:Marine Work - Dredging	1,215,276	7.55	0.44	0.44	1.24E-02	7.22E-04	7.22E-04
Phase 2B:Storage Tank Retrofit	1,545,043	1.40	0.09	0.09	1.81E-03	1.10E-04	1.10E-04
Phase 2C:Storage Terminal construction	115,165	2.45	0.15	0.15	4.26E-02	2.63E-03	2.63E-03

Wespac Pittsburg
Scenario 2 (October 2014 to October 2015)

Annual Onsite Emission Inputs

Proposed Project_Unmitigated Annual

Construction Phase	Area (ft^2)	CO (ton)	PM_{10} (ton)	$PM_{2.5}$ (ton)	CO ($lb/yr/ft^2$)	PM_{10} ($lb/yr/ft^2$)	$PM_{2.5}$ ($lb/yr/ft^2$)
Phase 1A: Transload Facility Construction	426,888	0.00	0.00	0.00	0.00E+00	0.00E+00	0.00E+00
Phase 1A: Storage Terminal Modifications	636,387	4.64	0.34	0.34	1.46E-02	1.06E-03	1.06E-03
Phase 1B:Pipeline Construction	265,374	0.00	0.00	0.00	0.00E+00	0.00E+00	0.00E+00
Phase 2A:Marine Work - Excludes Dredging	468,062	13.80	0.83	0.83	5.90E-02	3.55E-03	3.55E-03
Phase 2A:Marine Work - Dredging	1,215,276	14.22	0.83	0.83	2.34E-02	1.36E-03	1.36E-03
Phase 2B:Storage Tank Retrofit	1,545,043	5.35	0.44	0.44	6.93E-03	5.67E-04	5.67E-04
Phase 2C:Storage Terminal construction	115,165	15.55	1.13	1.13	2.70E-01	1.96E-02	1.96E-02

Proposed Project_Mitigated Annual

Construction Phase	Area (ft^2)	CO (ton)	PM_{10} (ton)	$PM_{2.5}$ (ton)	CO ($lb/yr/ft^2$)	PM_{10} ($lb/yr/ft^2$)	$PM_{2.5}$ ($lb/yr/ft^2$)
Phase 1A: Transload Facility Construction	426,888	0.00	0.00	0.00	0.00E+00	0.00E+00	0.00E+00
Phase 1A: Storage Terminal Modifications	636,387	2.15	0.14	0.14	6.74E-03	4.31E-04	4.31E-04
Phase 1B:Pipeline Construction	265,374	0.00	0.00	0.00	0.00E+00	0.00E+00	0.00E+00
Phase 2A:Marine Work - Excludes Dredging	468,062	10.97	0.64	0.64	4.69E-02	2.72E-03	2.72E-03
Phase 2A:Marine Work - Dredging	1,215,276	11.72	0.68	0.68	1.93E-02	1.12E-03	1.12E-03
Phase 2B:Storage Tank Retrofit	1,545,043	2.73	0.18	0.18	3.53E-03	2.27E-04	2.27E-04
Phase 2C:Storage Terminal construction	115,165	7.17	0.43	0.43	1.24E-01	7.44E-03	7.44E-03

Alternative 1_Unmitigated Annual

Construction Phase	Area (ft^2)	CO (ton)	PM_{10} (ton)	$PM_{2.5}$ (ton)	CO ($lb/yr/ft^2$)	PM_{10} ($lb/yr/ft^2$)	$PM_{2.5}$ ($lb/yr/ft^2$)
Phase 1A: Transload Facility Construction	426,888	0.00	0.00	0.00	0.00E+00	0.00E+00	0.00E+00
Phase 1A: Storage Terminal Modifications	636,387	4.64	0.34	0.34	1.46E-02	1.06E-03	1.06E-03
Phase 1B:Pipeline Construction	265,374	0.00	0.00	0.00	0.00E+00	0.00E+00	0.00E+00
Phase 2A:Marine Work - Excludes Dredging	468,062	13.80	0.83	0.83	5.90E-02	3.55E-03	3.55E-03
Phase 2A:Marine Work - Dredging	1,215,276	14.22	0.83	0.83	2.34E-02	1.36E-03	1.36E-03
Phase 2B:Storage Tank Retrofit	1,545,043	3.08	0.25	0.25	3.99E-03	3.21E-04	3.21E-04
Phase 2C:Storage Terminal construction	115,165	15.55	1.13	1.13	2.70E-01	1.96E-02	1.96E-02

Alternative 1_Mitigated Annual

Construction Phase	Area (ft^2)	CO (ton)	PM_{10} (ton)	$PM_{2.5}$ (ton)	CO ($lb/yr/ft^2$)	PM_{10} ($lb/yr/ft^2$)	$PM_{2.5}$ ($lb/yr/ft^2$)
Phase 1A: Transload Facility Construction	426,888	0.00	0.00	0.00	0.00E+00	0.00E+00	0.00E+00
Phase 1A: Storage Terminal Modifications	636,387	2.15	0.14	0.14	6.74E-03	4.31E-04	4.31E-04
Phase 1B:Pipeline Construction	265,374	0.00	0.00	0.00	0.00E+00	0.00E+00	0.00E+00
Phase 2A:Marine Work - Excludes Dredging	468,062	10.97	0.64	0.64	4.69E-02	2.72E-03	2.72E-03
Phase 2A:Marine Work - Dredging	1,215,276	11.72	0.68	0.68	1.93E-02	1.12E-03	1.12E-03
Phase 2B:Storage Tank Retrofit	1,545,043	1.58	0.11	0.11	2.05E-03	1.36E-04	1.36E-04
Phase 2C:Storage Terminal construction	115,165	7.17	0.43	0.43	1.24E-01	7.44E-03	7.44E-03

Maximum Hourly Onsite Emission Inputs

Maximum Hourly Emission Inputs - SCENARIO 1 (Proposed Project and Alternative 1 Project)

Unmitigated Max Hourly

Construction Phase	Area (ft^2)	CO (lb/hr)	PM10 (lb/hr)	PM2.5 (lb/hr)	CO ($lb/hr/ft^2$)	PM_{10} ($lb/hr/ft^2$)	$PM_{2.5}$ ($lb/hr/ft^2$)
Phase 1A: Transload Facility Construction	426,888	4.69	0.35	0.35	1.10E-05	8.20E-07	8.20E-07
Phase 1A: Storage Terminal Modifications	636,387	12.27	0.90	0.90	1.93E-05	1.41E-06	1.41E-06
Phase 1B:Pipeline Construction	265,374	15.93	1.09	1.09	6.00E-05	4.12E-06	4.12E-06
Phase 2A:Marine Work - Excludes Dredging	468,062	24.03	1.39	1.39	5.13E-05	2.98E-06	2.98E-06
Phase 2A:Marine Work - Dredging	1,215,276	44.97	2.61	2.61	3.70E-05	2.15E-06	2.15E-06
Phase 2B:Storage Tank Retrofit	1,545,043	4.51	0.37	0.37	2.92E-06	2.36E-07	2.36E-07
Phase 2C:Storage Terminal construction	115,165	12.27	0.90	0.90	1.07E-04	7.77E-06	7.77E-06

Mitigated Max Hourly

Construction Phase	Area (ft^2)	CO (lb/hr)	PM10 (lb/hr)	PM2.5 (lb/hr)	CO ($lb/hr/ft^2$)	PM_{10} ($lb/hr/ft^2$)	$PM_{2.5}$ ($lb/hr/ft^2$)
Phase 1A: Transload Facility Construction	426,888	2.20	0.13	0.13	5.15E-06	3.05E-07	3.05E-07
Phase 1A: Storage Terminal Modifications	636,387	5.66	0.34	0.34	8.89E-06	5.34E-07	5.34E-07
Phase 1B:Pipeline Construction	265,374	6.97	0.42	0.42	2.62E-05	1.56E-06	1.56E-06
Phase 2A:Marine Work - Excludes Dredging	468,062	17.44	1.01	1.01	3.73E-05	2.16E-06	2.16E-06
Phase 2A:Marine Work - Dredging	1,215,276	37.06	2.15	2.15	3.05E-05	1.77E-06	1.77E-06
Phase 2B:Storage Tank Retrofit	1,545,043	2.29	0.14	0.14	1.48E-06	9.26E-08	9.26E-08
Phase 2C:Storage Terminal construction	115,165	5.66	0.34	0.34	4.91E-05	2.95E-06	2.95E-06

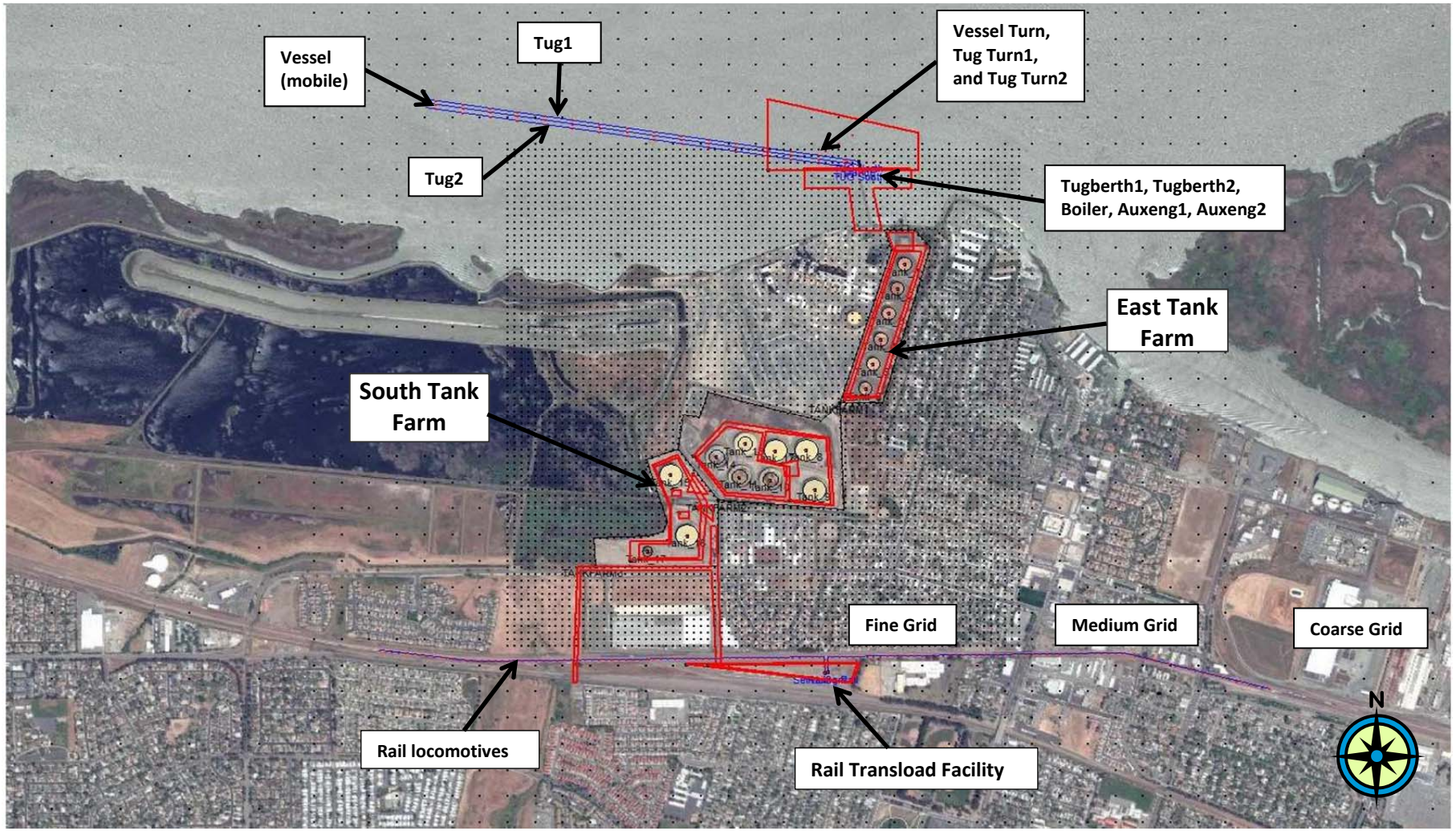
Maximum Hourly Emission Inputs - SCENARIO 2 (Proposed Project and Alternative 1 Project)

Unmitigated Max Hourly

Construction Phase	Area (ft^2)	CO (lb/hr)	PM10 (lb/hr)	PM2.5 (lb/hr)	CO ($lb/hr/ft^2$)	PM_{10} ($lb/hr/ft^2$)	$PM_{2.5}$ ($lb/hr/ft^2$)
Phase 1A: Transload Facility Construction	426,888	0.00	0.00	0.00	0.00E+00	0.00E+00	0.00E+00
Phase 1A: Storage Terminal Modifications	636,387	13.36	1.00	1.00	2.10E-05	1.57E-06	1.57E-06
Phase 1B:Pipeline Construction	265,374	0.00	0.00	0.00	0.00E+00	0.00E+00	0.00E+00
Phase 2A:Marine Work - Excludes Dredging	468,062	18.74	1.09	1.09	4.00E-05	2.32E-06	2.32E-06
Phase 2A:Marine Work - Dredging	1,215,276	44.97	2.61	2.61	3.70E-05	2.15E-06	2.15E-06
Phase 2B:Storage Tank Retrofit	1,545,043	4.51	0.37	0.37	2.92E-06	2.36E-07	2.36E-07
Phase 2C:Storage Terminal construction	115,165	12.27	0.90	0.90	1.07E-04	7.77E-06	7.77E-06

Mitigated Max Hourly

Construction Phase	Area (ft^2)	CO (lb/hr)	PM10 (lb/hr)	PM2.5 (lb/hr)	CO ($lb/hr/ft^2$)	PM_{10} ($lb/hr/ft^2$)	$PM_{2.5}$ ($lb/hr/ft^2$)
Phase 1A: Transload Facility Construction	426,888	0.00	0.00	0.00	0.00E+00	0.00E+00	0.00E+00
Phase 1A: Storage Terminal Modifications	636,387	6.32	0.39	0.39	9.93E-06	6.08E-07	6.08E-07
Phase 1B:Pipeline Construction	265,374	0.00	0.00	0.00	0.00E+00	0.00E+00	0.00E+00
Phase 2A:Marine Work - Excludes Dredging	468,062	15.44	0.90	0.90	3.30E-05	1.91E-06	1.91E-06
Phase 2A:Marine Work - Dredging	1,215,276	37.06	2.15	2.15	3.05E-05	1.77E-06	1.77E-06
Phase 2B:Storage Tank Retrofit	1,545,043	2.29	0.14	0.14	1.48E-06	9.26E-08	9.26E-08
Phase 2C:Storage Terminal construction	115,165	5.66	0.34	0.34	4.91E-05	2.95E-06	2.95E-06



Blue line: line source for the tugs and vessel

Thick red line: area sources for construction and fugitives

Purple line: line source for rail locomotives

Red dots: point sources for the heaters and thermal oxidizer

Red dot with black circle: volume source for the tank

Black dots = receptor locations*

*Note:

- Fine grid is 25m spacing extending 300m from project fenceline.
- Medium grid is 100m spacing extending 300m to 1,000m.
- Course grid is 250m spacing extending 1,000m to 2,500m.

TRC

City of Pittsburg

WesPac Pittsburg Energy Infrastructure Project

Modeling Point Location Map

Date: July 2013

D - 14. Modeling Inputs - Operational Emissions

WesPac Pittsburg
Proposed Project Emission Model Inputs and Results
18 Vessels per Month & 2007 Engine Year Tugboats
Modeling Inputs of Line Sources*

		Annual Emissions (lb/yr)		
Sources	**Leg**	**CO**	**DPM**	**$PM_{2.5}$**
mobile 1-16	1/16 of 14.3% of leg 4	25.56	4.50	4.34
tug 1 1-16	1/16 of 14.3% of leg 4	84.49	4.46	4.46
tug 2 1-16	1/16 of 14.3% of leg 4	84.49	4.46	4.46
vesturn	5	744.8	139.7	130.8
tugturn1	half of leg 5	2363.4	124.8	124.8
tugturn2	half of leg 5	2363.4	124.8	124.8
tugberth1	leg 6, 10	7534.2	398.2	398.2
tugberth2	leg 6	4726.8	249.6	249.6
boiler	6, 7, 8	2911.6		
auxend1	half of 6, 7, 8, 9, 10	4107.5	933.5	933.5
auxeng2	half of 6, 7, 8, 9, 10	4107.5	933.5	933.5
rail 1-68	1/68 of 6.7%	0.682	0.306	0.306
rail servicing 1-68	1/68 of 3.0%	0.321	0.142	0.142

* Line sources include vessels, tugboats, and rail.

1600m of leg 4 are included in the model = 0.86 nm/6nm = 14.3%

1600m of rail are included in the model = 1mi/15mi = 6.7%

1600m of servicing rail are included in the model = 1mi/33mi = 3.0%

		Maximum Hourly Emissions (lb/hr)		
Sources	**Leg**	**CO**	**DPM**	**$PM_{2.5}$**
boiler	6, 7, 8	1.07		0.33
auxend1	half of 6, 7, 8, 9, 10	1.43	0.33	0.33
auxeng2	half of 6, 7, 8, 9, 10	1.43	0.33	0.33

WesPac Pittsburg
Proposed Project Emission Model Inputs and Results
18 Vessels per Month & 2016 Engine Year Tugboats
Modeling Input Emissions of Line Sources*

		Annual Emissions (lb/yr)		
Sources	**Leg**	**CO**	**DPM**	**$PM_{2.5}$**
mobile 1-16	1/16 of 14.3% of leg 4	25.6	4.5	4.3
tug 1 1-16	1/16 of 14.3% of leg 4	84.5	0.7	0.7
tug 2 1-16	1/16 of 14.3% of leg 4	84.5	0.7	0.7
vesturn	5	744.8	139.7	130.8
tugturn1	half of leg 5	2363.4	20.9	20.9
tugturn2	half of leg 5	2363.4	20.9	20.9
tugberth1	leg 6, 10	7534.2	66.4	66.4
tugberth2	leg 6	4726.8	41.9	41.9
boiler	6, 7, 8	2911.6		
auxend1	half of 6, 7, 8, 9, 10	4107.5	933.5	933.5
auxeng2	half of 6, 7, 8, 9, 10	4107.5	933.5	933.5
rail 1-68	1/68 of 6.7%	0.682	0.092	0.092
rail servicing 1-68	1/68 of 3.0%	0.321	0.043	0.043

* Line sources include vessels, tugboats, and rail.

1600m of leg 4 are included in the model = 0.86 nm/6nm = 14.3%

1600m of rail are included in the model = 1mi/15mi = 6.7%

1600m of servicing rail are included in the model = 1mi/33mi = 3.0%

		Maximum Hourly Emissions (lb/hr)		
Sources	**Leg**	**CO**	**DPM**	**$PM_{2.5}$**
boiler	6, 7, 8	1.07		0.33
auxend1	half of 6, 7, 8, 9, 10	1.43	0.33	0.33
auxeng2	half of 6, 7, 8, 9, 10	1.43	0.33	0.33

WesPac Pittsburg
Alternative 1 Project Emission Model Inputs and Results
15 Vessels per Month & 2007 Engine Year Tugboats
Modeling Input Emissions of Line Sources*

		Annual Emissions (lb/yr)		
Sources	**Leg**	**CO**	**DPM**	**$PM_{2.5}$**
mobile 1-16	1/16 of 14.3% of leg 4	21.30	3.75	3.62
tug 1 1-16	1/16 of 14.3% of leg 4	70.41	3.72	3.72
tug 2 1-16	1/16 of 14.3% of leg 4	70.41	3.72	3.72
vesturn	5	620.7	116.4	109.0
tugturn1	half of leg 5	1969.5	104.0	104.0
tugturn2	half of leg 5	1969.5	104.0	104.0
tugberth1	leg 6, 10	6278.5	331.9	331.9
tugberth2	leg 6	3939.0	208.0	208.0
boiler	6, 7, 8	2426.3		
auxend1	half of 6, 7, 8, 9, 10	3422.9	777.9	777.9
auxeng2	half of 6, 7, 8, 9, 10	3422.9	777.9	777.9
rail 1-68	1/68 of 6.7%	0.682	0.306	0.306
rail servicing 1-68	1/68 of 3.0%	0.321	0.142	0.142

* Line sources include vessels, tugboats, and rail.

1600m of leg 4 are included in the model = 0.86 nm/6nm = 14.3%

1600m of rail are included in the model = 1mi/15mi = 6.7%

1600m of servicing rail are included in the model = 1mi/33mi = 3.0%

		Maximum Hourly Emissions (lb/hr)		
Sources	**Leg**	**CO**	**DPM**	**$PM_{2.5}$**
boiler	6, 7, 8	1.07		0.33
auxend1	half of 6, 7, 8, 9, 10	1.43	0.33	0.33
auxeng2	half of 6, 7, 8, 9, 10	1.43	0.33	0.33

WesPac Pittsburg
Alternative 1 Project Emission Model Inputs and Results
15 Vessels per Month & 2016 Engine Year Tugboats
Modeling Input Emissions of Line Sources*

		Annual Emissions (lb/yr)		
Sources	**Leg**	**CO**	**DPM**	**$PM_{2.5}$**
mobile 1-16	1/16 of 14.3% of leg 4	21.30	3.75	3.62
tug 1 1-16	1/16 of 14.3% of leg 4	70.41	0.623	0.623
tug 2 1-16	1/16 of 14.3% of leg 4	70.41	0.623	0.623
vesturn	5	620.7	116.4	109.0
tugturn1	half of leg 5	1969.5	17.4	17.4
tugturn2	half of leg 5	1969.5	17.4	17.4
tugberth1	leg 6, 10	6278.5	55.3	55.3
tugberth2	leg 6	3939.0	34.9	34.9
boiler	6, 7, 8	2426.3		
auxend1	half of 6, 7, 8, 9, 10	3422.9	777.9	777.9
auxeng2	half of 6, 7, 8, 9, 10	3422.9	777.9	777.9
rail 1-68	1/68 of 6.7%	0.682	0.092	0.092
rail servicing 1-68	1/68 of 3.0%	0.321	0.043	0.043

* Line sources include vessel, tugboats, and rail

1600m of leg 4 are included in the model = 0.86 nm/6nm = 14.3%
1600m of rail are included in the model = 1mi/15mi = 6.7%
1600m of servicing rail are included in the model = 1mi/33mi = 3.0%

		Maximum Hourly Emissions (lb/hr)		
Sources	**Leg**	**CO**	**DPM**	**$PM_{2.5}$**
boiler	6, 7, 8	1.07		0.33
auxend1	half of 6, 7, 8, 9, 10	1.43	0.33	0.33
auxeng2	half of 6, 7, 8, 9, 10	1.43	0.33	0.33

D-15. Construction Health Risk Modeling Summary

WesPac Pittsburg

Construction Risk Summary - Scenario 1

Scenario 1 - 1 year of construction; 69 years of absence of construction

(Unmitigated) Proposed Project / Alternative 1 Project

	Raw Risk	CRAF	No. of Years	Risk	Chronic	PM2.5 (ug/m3)	CO (ug/m3)	Resident Location
Construction (Unmitigated)	15.9	10	1	4.37	0.010	0.050	0.718	#271 - 596975E, 4209375N
		1.6	69	0.00				
		Total	70	**4.37**	**0.010**	**0.050**	**0.718**	

(Mitigated) Proposed Project / Alternative 1 Project

	Raw Risk	CRAF	No. of Years	Risk	Chronic	PM2.5 (ug/m3)	CO (ug/m3)	Resident Location
Construction (Mitigated)	5.7	10	1	1.58	0.004	0.018	0.33	#271 - 596975E, 4209375N
		1.6	69	0.00				
		Total	70	**1.58**	**0.004**	**0.018**	**0.330**	

Change the breathing rate from adult to children for construction risk per the BAAQMD.

adult breathing rate	302	L/kg-day
child breathing rate	581	L/kg-day

WesPac Pittsburg

Construction Risk Summary - Scenario 2

Scenario 2 (Proposed Project) - 1 year of construction and 70 years of 4 tanks and rail operating
Scenario 2 (Alternative 1 Project) - 1 year of construction and 70 years of 4 tanks and rail operating

Construction Risk - Project (Unmitigated)

	Raw Risk	CRAF	No. of Years	Risk	Chronic	Acute	PM2.5 (ug/m3)	CO (ug/m3)
Construction (Unmitigated)	0.69	10	1	0.19	0.000432	0	0.00216	0.0330
4 tanks operating	5.10	1.7	70	8.62	0.00316	0.0717	0.0158	0.0382
Project (Unmitigated)				**8.80**	**0.0036**	**0.072**	**0.0180**	**0.071**

Construction Risk - Project (Mitigated)

	Raw Risk	CRAF	No. of Years	Risk	Chronic	Acute	PM2.5 (ug/m3)	CO (ug/m3)
Construction (Mitigated)	0.42	10	1	0.11	0.000262	0	0.00131	0.0221
4 tanks operating	5.10	1.7	70	8.62	0.00316	0.0717	0.0158	0.0382
Project (Mitigated)				**8.73**	**0.0034**	**0.072**	**0.0171**	**0.060**

Construction Risk - Alternative 1 Project (Unmitigated)

	Raw Risk	CRAF	No. of Years	Risk	Chronic	Acute	PM2.5 (ug/m3)	CO (ug/m3)
Construction (Unmitigated)	0.65	10	1	0.18	0.000409	0	0.00204	0.0316
4 tanks operating	5.10	1.7	70	8.62	0.00316	0.0717	0.0158	0.0382
Alternative 1 Project (Unmitigated)				**8.79**	**0.0036**	**0.072**	**0.0178**	**0.070**

Construction Risk - Alternative 1 Project (Mitigated)

	Raw Risk	CRAF	No. of Years	Risk	Chronic	Acute	PM2.5 (ug/m3)	CO (ug/m3)
Construction (Mitigated)	0.40	10	1	0.11	0.000254	0	0.00127	0.0214
4 tanks operating	5.10	1.7	70	8.62	0.00316	0.0717	0.0158	0.0382
Alternative 1 Project (Mitigated)				**8.73**	**0.0034**	**0.072**	**0.0171**	**0.060**

*All modeling results were obtained from Resident Location #284 (597300E, 4209375N)

Changed the breathing rate from adult to children for construction risk per the BAAQMD.

adult breathing rate	302	L/kg-day
child breathing rate	581	L/kg-day

D - 16. Operational Health Risk Assessment Summary

WesPac Pittsburg
Health Risk Modeling Summary - Full Operation

Proposed Project Scenario:

Tug Year	Raw Risk	CRAF	No. of Years	Risk	# vessels/ month	Age of Tug at Start	Tug Start Year	Chronic	Acute	PM2.5
2007	6.85	4.3	12	5.06	18	8	2015	0.0134	0.0881	0.0182
2016	4.70	1.1	58	4.47	18	11	2027	0.0120	0.0883	0.01
TOTAL		**1.7**	**70**	**9.53**						

NOTE: Maximum Point occurs at 597625E, 4210750N - residential near the marina (#3820)

Alternative 1 Project Scenario:

Tug Year	Raw Risk	CRAF	No. of Years	Risk	# vessels/ month	Age of Tug at Start	Tug Start Year	Chronic	Acute	PM2.5
2007	5.38	4.3	12	3.98	15	8	2015	0.0105	0.0867	0.0153
2016	3.49	1.1	58	3.32	15	11	2027	0.0093	0.0867	0.01
TOTAL		**1.7**	**70**	**7.29**						

NOTE: Maximum Point occurs at 597625E, 4210750N - residential near the marina (#3820)

CO max 1hr occurs at 596900, 4210275 which is 156.5 ug/m3 = 0.137 ppm
CO max 8hr occurs at 597112, 4210064 which is 85.4 ug/m3 = 0.075 ppm
These locations are on the fenceline.

D - 17. Cumulative Analysis Summary

Wespac Pittsburg

Risk Summary - Cumulative Analysis within 1000 Feet

Information Obtained from Bay Area District Staff Regarding Facilities within 1000 feet from the Project Site

Table B Section 1: Requestor fills out these columns based on Google Earth data				Table B Section 2: BAAQMD returns form with additional information in these columns as needed															
Distance from Receptor (feet)	Plant # or Gas Dispensary #	Facility Name	Street Address	Screening Level Cancer Risk (1)	Screening Level Hazard Index (1)	Screening Level $PM_{2.5}$ (1)	Permit #s (2)	Source #s (2)	Fuel Code (3)	Type of Source(s) (4)	HRSA Ap # (5)	HRSA Date (6)	HRSA Engineer (7)	HRSA Cancer Risk in a million	Age Sensitivity Factor (8)	HRSA Adjusted Cancer Risk	HRSA Chronic Health (9)	HRSA $PM_{2.5}$ Risk	Status/Comments
825	12930	Delta Diablo Sanitation	7th St and Montezuma St	124.19	0.044	0.220		1		Standby diesel engine	N/A	N/A	N/A	N/A	N/A	N/A	N/A	N/A	See footnote 10a.
740	14552	PG&E	690 W 10th St Pittsburg	22.51	0.008	0.040		1		Standby diesel engine	N/A	N/A	N/A	N/A	N/A	N/A	N/A	N/A	See footnote 10a.
650	13190	Stripping Workshop	564 W. 10th St Pittsburg	67.50	0.094	0.000		1		Solvent cleaning	2955	9/6/2001	BFB	9.4	1.7	15.98	Not included	0.050094	This HRSA includes all sources.
695	G8533	Redwood Painting Co.	620 W 10th St Pittsburg	N/A	N/A	N/A					N/A	N/A	N/A	N/A	N/A	N/A	N/A	N/A	See foonote 10f- this gas station is non-retail and exempt.
740	G8348	PG&E	696 W 10th St Pittsburg	N/A	N/A	N/A					N/A	N/A	N/A	N/A	N/A	N/A	N/A	N/A	This gas station is non-retail.

Note:
10 a. Sources that only include diesel internal combustion engines can be adjusted using the BAAQMD's Diesel Multiplier worksheet.

Using the BAAQMD's Diesel Multiplier Worksheet - Calculations of Risks of Other Sources within 1000 feet from the Project Site

Distance from Receptor (meter)	Plant # or Gas Dispensary #	Facility Name	Street Address	Multiplier	Cancer Risk (in a million)[1]	Chronic Health Risk[3]	PM2.5 Concentrations (ug/m^3)[5]	Comments
252	12930	Delta Diablo Sanitation	7th St and Montezuma St	0.06	7.451	0.003	0.013	Adjusted based on distance (Use Mutiplier)
226	14552	PG&E	690 W 10th St Pittsburg	1	22.51	0.008	0.040	Not adjusted since this is the neigboring facility
198	13190	Stripping Workshop[2,4,6]	564 W. 10th St Pittsburg	N/A	15.98	0.094	0.050	HRSA performed
2		Major Roadway[7]	W. 10th St		1.73		0.061	Annual average daily traffic is between 10,000 to 20,000
Total of Other Sources within 1000 ft					**47.7**	**0.105**	**0.164**	

Notes:
1. Cancer risk (for Delta Diablo Sanitation and PG&E) = mutiplier x screening level cancer risk
2. Cancer risk (for Stripping workshop) = HRSA adjusted Cancer Risk
3. Chronic health risk (for Delta Diablo Sanitation and PG&E) = mutiplier x screening level hazard index
4. Chronic health risk (for Stripping workshop) = screening level hazard index
5. $PM_{2.5}$ concentration (for Delta Diablo Sanitation and PG&E) = mutiplier x screening level $PM_{2.5}$
6. $PM_{2.5}$ concentration (for Stripping workshop)= HRSA $PM_{2.5}$ Risk

7. Lifetime cancer risk and PM2.5 concentration was determined by 1) obtaining the annual average daily traffic through the California Environmental Health Tracking Program website at http://www.ehib.org/traffic_tool.jsp; 2) obtaining the cancer risk and $PM_{2.5}$ concentration corresponding to the estimated annual average daily traffic from Contra Costa County PM2.5 Concentrations and Caner Risks Generated from Surface Streets at http://www.baaqmd.gov/~/media/Files/Planning%20and%20Research/CEQA/County%20Surface%20Street%20Screening%20Tables%20Dec%202011.ashx?la=en

Cumulative Analysis Summary - Construction and Operation

Operations - Proposed Project

Source	Cancer Risk (in a million)	Chronic Health Risk	PM2.5 Concentrations (ug/m^3)
Maximum of Proposed Project (2007 tug year)	9.529	0.0134	0.0182
Total of Other Sources within 1000 ft	47.674	0.105	0.164
Cumulative TOTAL	**57.2**	**0.118**	**0.182**

Operations - Alternative 1

Source	Cancer Risk (in a million)	Chronic Health Risk	PM2.5 Concentrations (ug/m^3)
Maximum of Reduced Project (2007 tug year)	7.293	0.0105	0.0153
Total of Other Sources within 1000 ft	47.674	0.105	0.164
Cumulative TOTAL	**55.0**	**0.115**	**0.179**

Construction - Proposed Project

Source		Cancer Risk (in a million)	Chronic Health Risk	PM2.5 Concentrations (ug/m^3)
Total of Other Sources within 1000 ft		47.674	0.105	0.164
Construction Scenario 1	Project Unmitigated	4.37	0.00996	0.0498
	Cumulative Unmitigated TOTAL	**52.0**	**0.115**	**0.214**
	Project Mitigated	1.58	0.0036	0.018
	Cumulative Mitigated TOTAL	**49.3**	**0.109**	**0.182**
Construction Scenario 2	Prject Unmitigated	8.80	0.003592	0.01796
	Cumulative Unmitigated TOTAL	**56.5**	**0.109**	**0.182**
	Project Mitigated	8.73	0.003422	0.01711
	Cumulative Mitigated TOTAL	**56.4**	**0.108**	**0.181**

Construction - Alternative 1

Source		Cancer Risk (in a million)	Chronic Health Risk	PM2.5 Concentrations (ug/m^3)
Total of Other Sources within 1000 ft		47.674	0.105	0.164
Construction Scenario 2	Project Unmitigated	8.79	0.0036	0.0178
	Cumulative Unmitigated TOTAL	**56.5**	**0.108**	**0.182**
	Project Mitigated	8.73	0.0034	0.0171
	Cumulative Mitigated TOTAL	**56.4**	**0.108**	**0.181**

D - 18. Indirect Greenhouse Gas Emissions Summary

Wesapc Pittsburg

Indirect Greenhouse Gas (GHG) Emissions Summary - Proposed Project

Category	Emissions (MT/YR)			
	CO_2*	CH_4	N_2O	CO_2e
Energy	2,272	0.10	0.04	2,286
Waste	0.00	0.29	0.00	6.05
Water	1.08	0.02	0.00	1.67
TOTAL	2,273	0.41	0.04	2,294

*Biogenic CO_2 emissions were not included in the quantification of GHG emissions for the project, as recommended by the BAAQMD CEQA Guideline.
**GHG emissions from vehicular traffic and other direct GHG emissions are summarized in D-12.

Indirect Greenhouse Gas (GHG) Emissions Summary - Alternative 1

Category	Emissions (MT/YR)			
	CO_2*	CH_4	N_2O	CO_2e
Energy	1,927	0.09	0.03	1,939
Waste	0.00	0.29	0.00	6.05
Water	1.08	0.02	0.00	1.67
TOTAL	1,928	0.40	0.03	1,947

*Biogenic CO_2 emissions were not included in the quantification of GHG emissions for the project, as recommended by the BAAQMD CEQA Guideline.
**GHG emissions from vehicular traffic and other direct GHG emissions are summarized in D-12.

table 5-3

33147 35,441

table 5-5

27571 29,518