South Carolina Ports Authority

2017 Air Emissions Inventory

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Abbreviations

AAR	Association of American Railroads
AEI	Air Emission Inventory
AIS	Automatic Identification System
AVFT	Alternative Vehicle and Fuels Technology
BSFC	Brake Specific Fuel Consumption
BW	Break Water
CFR	Code of Federal Regulation
CO	Carbon Monoxide
CST	Columbus Street Terminal
CSX	CSX Transportation
CY	Calendar Year
DF	Deterioration Factor
DHEC	Department of Health and Environmental Control
ECA	Emission Control Area
EF	Emission Factor
EPA	Environmental Protection Agency
ERTAC	Eastern Regional Technical Advisory Committee
FY	Fiscal Year
GHG	Greenhouse Gases
HC	Hydrocarbons
HFO	Heavy Fuel Oil
ICFI	ICF International
IY	Intermodal Yard
MARPOL	the International Convention for the Prevention of Pollution from Ships
MGO	Marine Gas Oil
MLW	Mean Low Water
MMBtu	Million British Thermal Units
MOVES	Motor Vehicle Emission Simulator
MW	Megawatt
NEI	National Emissions Inventory
NO_2	Nitrogen Dioxide
NO_X	Nitrogen Oxides
NCT	North Charleston Terminal
OGV	Ocean Going Vessel
PM	Particulate Matter
PUCC	Port Utilities Commission of Charleston
RO-RO	Roll on Roll off
RSZ	Reduced Speed Zone
RTG	Rubber Tired Gantry
SC	South Carolina
SCPA	South Carolina Ports Authority
SO_2	Sulfur Dioxide
SSD	Slow-speed Diesel
STB	Surface Transportation Board
TEU	Twenty-foot equivalent unit
THC	Total Hydrocarbons
TPR	Port Terminal Railroad
U.S.	United States
U.S.ECA	U.S. Emission Control Areas

ULSD	Ultra-Low Sulfur Diesel
UPT	Union Pier Terminal
USACE	U.S. Army Corps of Engineers
VT	Veterans Terminal
WWT	Wando Welch Terminal

1. Introduction

South Carolina Ports Authority (SCPA) currently operates five (5) Port of Charleston Terminals: Columbus Street, North Charleston, Union Pier, Wando Welch and Veterans. In addition, the 280-acre Hugh Leatherman Sr. Terminal container facility is under construction, with Phase One completion expected mid-2020. As part of the port terminal expansion, SCPA has undertaken the largest environmental and community mitigation package in South Carolina to offset potential negative environmental impacts. SCPA recognizes the importance of maintaining good air quality in surrounding communities and minimizing emissions, therefore the package is one of the first in the nation to consider "people" impacts.

Included in this effort, SCPA has installed two air monitoring stations and agreed to produce mobile source emissions inventories every six years for the SC Department of Health and Environmental Control (DHEC). Previous inventories were prepared by Moffatt and Nichol for calendar years 2005 and 2011 using the protocol "Current Methodologies in Preparing Mobile Source Port-Related Emission Inventories." This 2017 air emissions inventory (AEI) was compared with previous inventories to identify trends.

SCPA terminals are located throughout Charleston Harbor, a natural tidal estuary formed around the convergence of the Cooper, Ashley, and Wando Rivers. The City of Charleston is located west of Charleston Harbor, between the Ashley and Cooper Rivers, as well as on Daniel Island between the Cooper and Wando Rivers. James Island and Morris Island are south of the harbor, with Mt. Pleasant and Sullivan's Island to the east and North Charleston to the north. The Entrance Channel accesses the Atlantic Ocean to the southeast between Morris Island and Sullivan's Island (USACE, 2015).

Ports contribute to air contaminants and emissions of greenhouse gases (GHGs) into the atmosphere, factors that can change the air quality in surrounding communities. These contaminants contribute to higher ozone and particulate matter levels which have an impact on public health. Changes in operational activities that can affect air quality include increased road, rail, and marine traffic, and use of additional equipment to move containers.

This inventory quantifies pollutants primarily from combusting fuels in mobile sources occurring directly on SCPA terminal property, as well as emissions from ships, locomotives, and trucks that occur outside the terminals but within the tri-county area.

The following pollutants are included in the inventory:

- Carbon monoxide (CO)
- Oxides of nitrogen (NO_X)
- Sulfur dioxide (SO_2)
- Particulate matter (PM_{10} and $PM_{2.5}$)
- Hydrocarbons (HC)

Note: The pollutant list aligns with the previous 2005 and 2011 inventories and therefore does not include GHG emissions.

SCPA remains the most efficient ports in North America, averaging more than 40 moves per hour per ship-to-shore crane (South Carolina Port Guide, 6th Edition, and SCPA). Once on shore, SCPA terminals operate to transfer cargo to and from container ships and land vehicles. Though most container traffic is two-way, meaning that cargo containers are transferred from container ship to land vehicles and from land vehicles to container ships, containers are also exchanged between trucks and trains at the intermodal railyards. The Terminals function as hubs for loading and unloading containers/cargo, storing of containers/cargo awaiting shipment, and directing containers/cargo to the appropriate mode of transportation.

Trade of containerized goods shipped through SCPA is increasing. Charleston experienced a 45% container growth during CY2011 - CY2015; while all other major U.S. container ports combined grew just 14% in the same period (South Carolina Port Guide, 6th Edition, SCPA). The SCPA container terminals regularly handles between 8-9,000 twenty-foot equivalent unit (TEU) per day. In FY2017, ending June 30, SCPA increased container handling by approximately 10% at 2.14 millionTEUs.

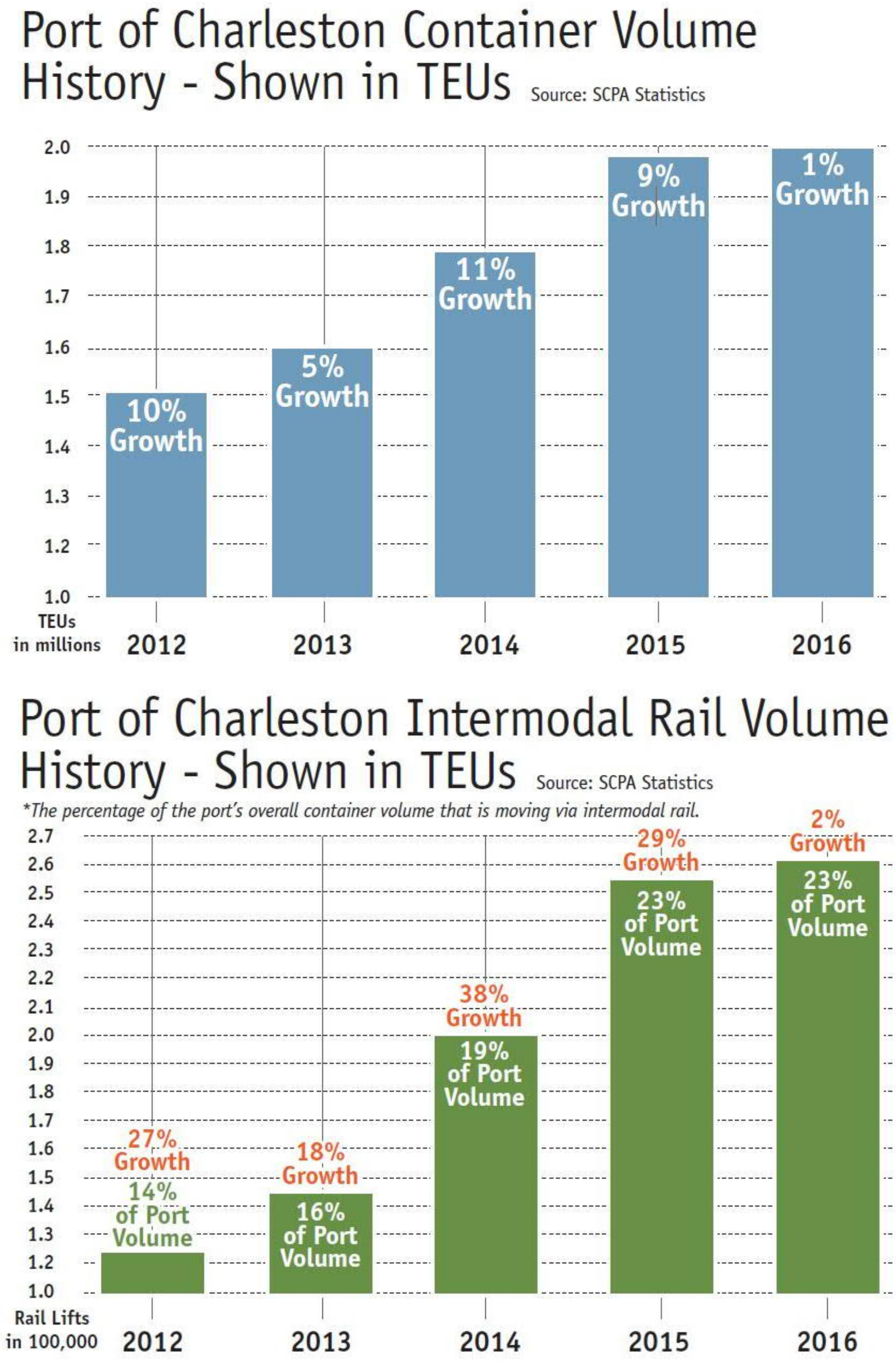


Figure 1-1. Port of Charleston TEU and Intermodal Rail Growth

2. 2017 Emissions Summary Results

2.1 Changes Since the 2011 Inventory

Since the 2011 Air Emissions Inventory, each entity of the Port contributed to emission reductions by upgrading existing equipment. The majority of reductions are due to implementations of regulatory standards.

Ocean Going Vessels

Starting January 1, 2015, the International Convention for the Prevention of Pollution from Ships (MARPOL) and the North American Emissions Control Area, requires ocean going vessels (OGV) to use marine gas oil with a maximum sulfur content of 1,000 parts per million (ppm) (0.10% sulfur). The US EPA has implemented MARPOL requirements under 40 Code of Federal Regulation Part 80. In 2014, the marine rule maximum sulfur limit was 10,000 ppm for North America and 35,000 ppm worldwide (EPA Guidance on ECA Marine Fuel, December 2014). This regulation change is an emission reduction factor for the 2017 AEI.

Since 2011, the average gross tonnage for ocean going vessels has increased approximately 30-40% due to the widening of the Panama Canal, allowing for larger Panamax vessels. The expanded canal began commercial operation on June 26, 2016. In 2011, the average ship handled 5,000 containers; Panamax ships can carry up to 14,000 containers.

For the 2017 inventory, in order to achieve more accurate time-in-mode data, Automatic Identification System (AIS) data was used to calculate average ship speeds within the reduced speed zone, as opposed to assuming average ship speeds as in past inventories. Data was averaged per vessel type at the sea buoy, Rebellion Reach, Ft. Sumter Reach, and at the Ravenel Bridge. No barge data was available within the AIS data; therefore, historical speed assumptions were used to calculate time-in-mode for these vessels.

Harbor Crafts

The Pilot Association received an EPA grant to replace the main and auxiliary engines to be Tier 2 and 3 compliant. Two main engine Tier 0 engines were replaced with Tier 2 engines in 2016. One of the four boats is Tier 3 compliant (the boats are too small for Tier 4 engines; for Tier 4 engines, the boat length is typically greater than 100 feet).

The tug companies are upgraded boat engines and are implementing other upgrades in the future. Currently all engines are EPA Tier compliant, with the most recent Tier being installed in replacement tugs. McAllister Towing and Transportation Co. is scheduled to receive a new tug, the Ava, in 2019 with Tier 4 compliant engines. Over time, tug engine sizes are expected to increase because tethered tug escorting is required for the larger Panamax ships.

Heavy Duty Vehicles

In the 2011 inventory, it was estimated that on-terminal truck idling time was 0.2 hours (12 minutes). Since then, SCPA has implemented anti-idling procedures. Trucks are shut off upon arrival, and no idling is requested during paperwork processing. During 2017, on-site trucks are estimated to spend 20-25% of their time in creep idle and 0-6% in stop idle modes (varies by terminal).

Rail

Three companies handle all the rail operations for SCPA. Palmetto Railway provides switching services to the terminals of the SCPA and other various industries in Charleston County, interchanging with CSX and Norfolk Southern (NS). Palmetto Railway rebranded from South Carolina Public Railways in 2013, and its subdivisions are Charleston (previously Port Utilities Commission of Charleston – PUCC) and North Charleston (previously Port Terminal Railroad – TPR).

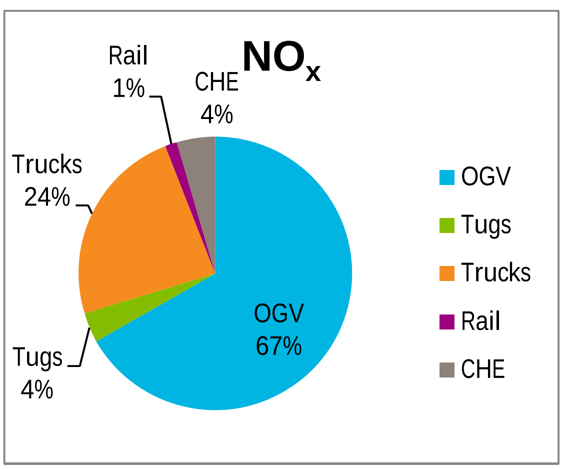
Twenty-three percent (23%) of Charleston's overall container volume now moves inland by rail, up from fourteen percent (14%) five years ago (South Carolina Port Guide, 6th Edition, SCPA). According to the Association of American Railroads (AAR), freight trains are four times more fuel efficient than trucks and greenhouse gas emissions are reduced by seventy five percent (75%). Rail companies are also seeking emission reduction strategies. For example, Palmetto Railways has recently compiled grant applications to upgrade their engines from Tier 0+ to Tier 3. As Charleston continues to expand, and with the proposed Palmetto Railways Navy Base Intermodal Facility, cargo movement transitioning from trucks to rail will continue to reduce emissions.

2.2 2017 Emissions Summary

The 2017 SCPA mobile emissions inventory results are summarized in **Table 2-1** and individual pollutants are presented in **Figure 2-1** through **Figure 2-6**. Overall emissions increased for NOx, CO, and HC and decreased for PM_{10}, $PM_{2.5}$ and SO_2. An overall increase in emissions was expected due to increased SCPA activity over the past five years. The decreases in emissions are due to the ECA sulfur content requirement change from 1.0% to 0.1% in 2015. Ocean going vessels accounted for the majority of the total emissions per pollutant (45%-95%), followed by truck operations (15%-40%). Tug, rail and container handling equipment operations contributed less than 10% per pollutant each.

Table 2-1. 2017 Emission Summary (tpy)

Source Category	NO_x	CO	PM_{10}	$PM_{2.5}$	HC	SO_2
Ocean Going Vessels	1,775.4	217.5	150.8	138.9	120.2	62.6
Tug Boats	94.0	18.7	1.9	1.9	5.9	1.8
Heavy Duty Vehicle - Trucks	633.1	173.3	32.1	29.5	37.2	1.1
Rail	37.6	6.1	0.8	0.8	2.1	0.0
Container Handling Equipment	119.7	41.0	5.3	5.2	7.9	0.2
Total	**2,659.8**	**456.5**	**190.9**	**176.3**	**173.3**	**65.7**



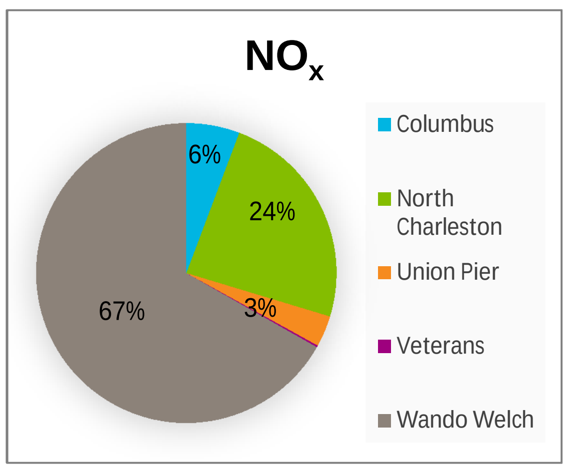


Figure 2-1. NO_x by Source Category and by Terminal

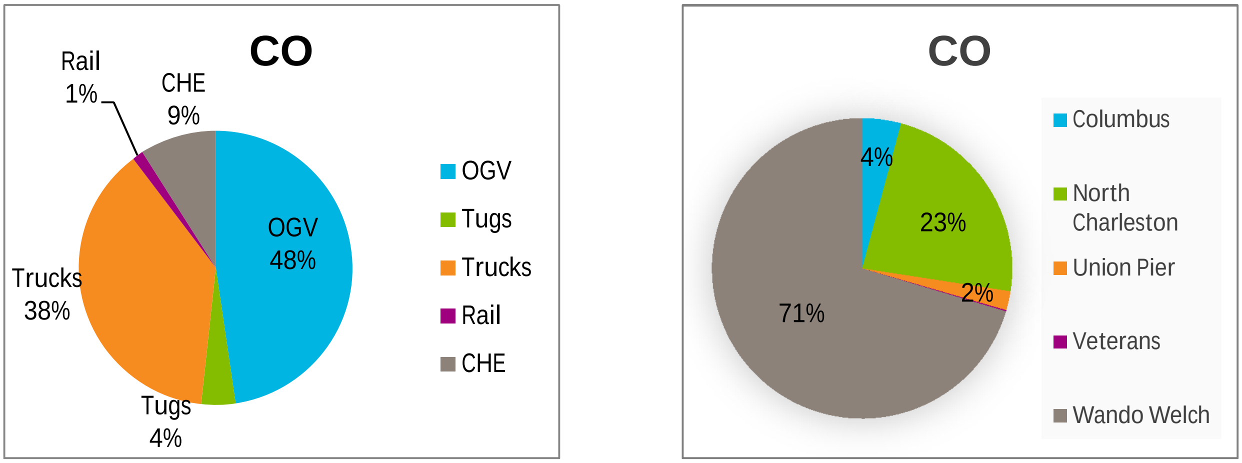


Figure 2.2. CO by Source Category and by Terminals

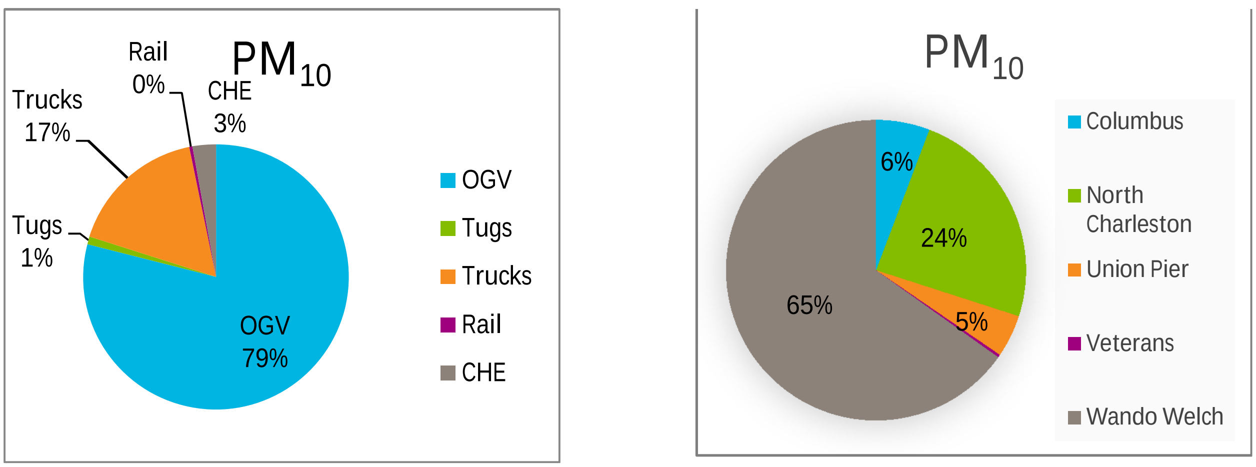


Figure 2.3. PM_{10} by Source Category and by Terminals

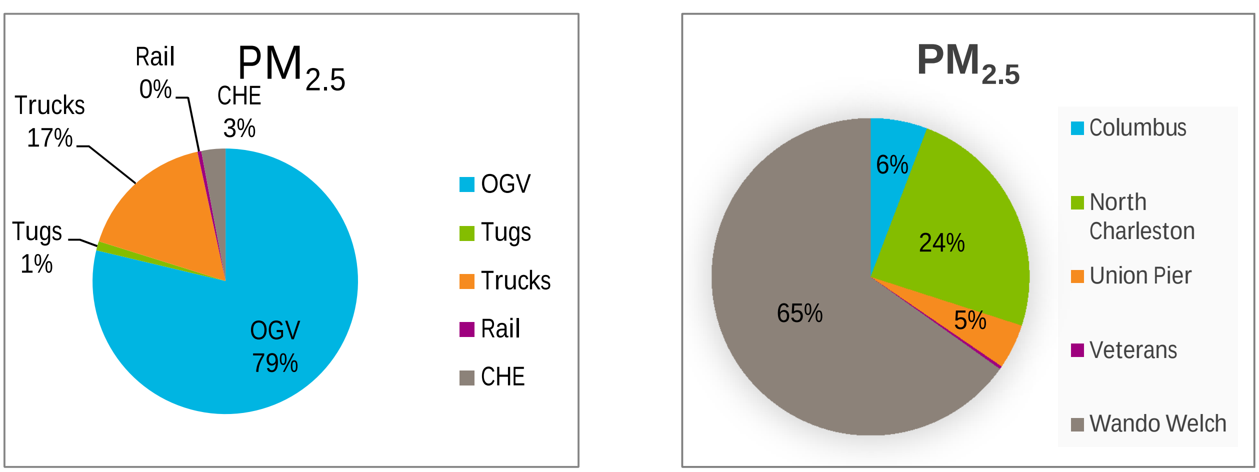


Figure 2.4. $PM_{2.5}$ by Source Category and by Terminals

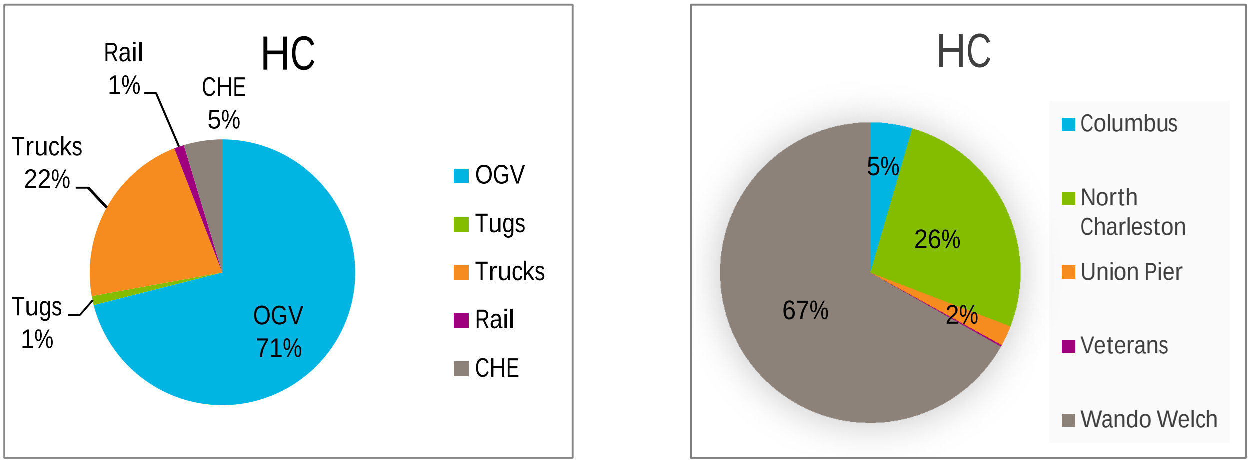


Figure 2.5. HC by Source Category and by Terminals

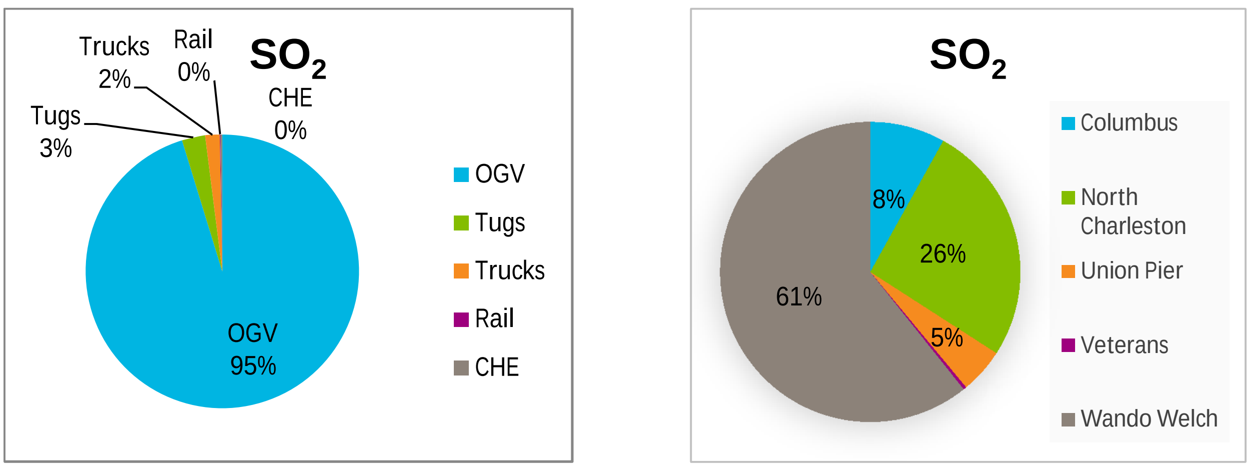


Figure 2.6. SO_2 by Source Category and by Terminals

Emissions On and Off Terminal

Ports mobile sources have two main geographic areas for activities, those that occur on the terminals and those that occur bringing cargo to and from the terminals. Off terminal activities include ocean going vessels in transit from the sea buoy to the berth, rail activity at the intermodal yards, harbor craft in transit to assist vessels, and trucking activity outside of the terminal boundaries. Activities within the terminal include ocean going vessels hoteling at berth, trucking activity within the terminal boundaries, train switching activity associated with the Columbus Street and North Charleston terminals, harbor craft assisting vessels in docking, and all cargo handling equipment activity. **Figure 2-7** below shows the breakdown per pollutant of emissions for all terminals occurring both inside and outside the terminal boundaries. **Table 2-2** shows a breakdown of emissions that occurred within the terminal boundaries versus outside the terminal boundary, but still within the geographic scope of this inventory.

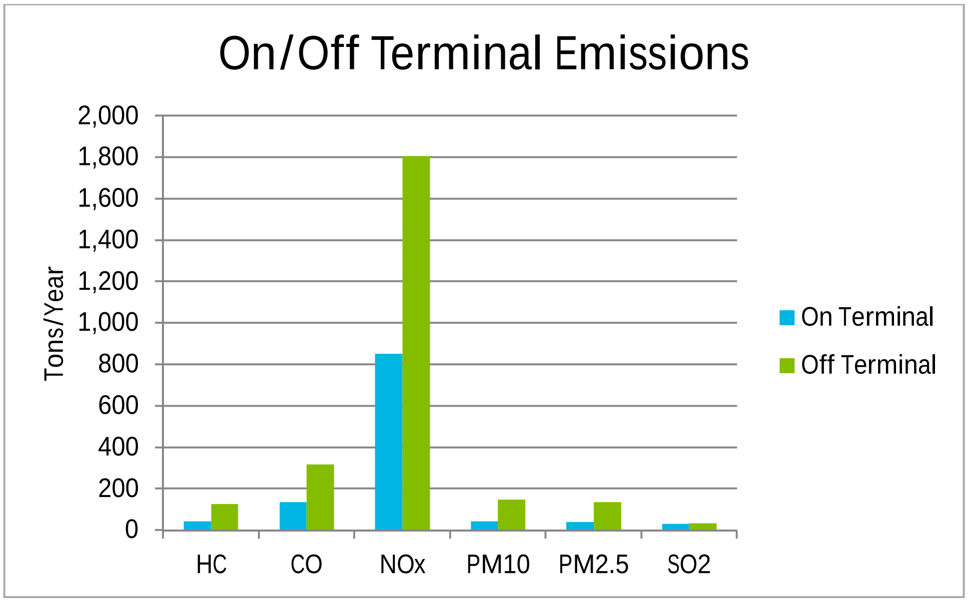


Figure 2-7: Comparison of Emissions Inside and Outside of Terminal Boudaries

Table 2-2. 2017 Activity Summary On and Off Terminal

2017 Emissions by Terminal		**Total Emissions**						**On Terminal**						**Off Terminal**					
SCPA Total		**Emissions Summary tons/year**						**Emissions Summary tons/year**						**Emissions Summary tons/year**					
Terminal		**HC**	**CO**	**NOx**	**PM_{10}**	**$PM_{2.5}$**	**SO_2**	**HC**	**CO**	**NOx**	**PM_{10}**	**$PM_{2.5}$**	**SO_2**	**HC**	**CO**	**NOx**	**PM_{10}**	**$PM_{2.5}$**	**SO_2**
Columbus	CST	7.63	19.07	152.54	11.04	10.18	5.31	2.36	7.02	57.68	3.03	2.79	2.84	5.27	12.05	94.86	8.02	7.40	2.47
North Charleston	NCT	44.55	106.21	636.88	46.15	42.63	17.10	9.52	33.26	203.87	8.49	7.88	7.31	35.03	72.95	433.01	37.66	34.76	9.78
Union Pier	UPT	3.71	9.33	89.39	8.74	8.08	3.19	0.73	2.22	19.23	0.71	0.65	0.67	2.98	7.11	70.16	8.04	7.42	2.52
Veterans	VT	0.28	0.61	5.01	0.57	0.53	0.22	0.06	0.18	1.78	0.15	0.14	0.10	0.21	0.43	3.23	0.42	0.39	0.12
Wando Welch	WWT	113.10	321.31	1775.98	124.41	114.83	39.88	29.61	94.92	569.85	30.49	28.20	19.60	83.49	226.39	1206.13	93.92	86.63	20.28
Total		**169.27**	**456.53**	**2659.81**	**190.92**	**176.25**	**65.70**	**42.29**	**137.6**	**852.4**	**42.9**	**39.6**	**30.5**	**127.0**	**318.9**	**1,807.4**	**148.1**	**136.6**	**35.2**
OGV																			
Columbus St.	CST	6.69	14.08	133.79	10.28	9.46	5.14	1.9	5.1	52.5	2.8	2.6	2.8	4.8	9.0	81.3	7.5	6.9	2.4
North Charleston	NCT	35.97	62.40	477.29	39.45	36.35	16.41	5.2	13.9	142.3	6.2	5.7	7.1	30.8	48.5	335.0	33.2	30.7	9.3
Union Pier	UPT	3.52	8.18	83.69	8.59	7.93	3.10	0.6	1.6	16.8	0.6	0.6	0.6	2.9	6.5	66.9	7.9	7.3	2.5
Veterans	VT	0.27	0.56	4.76	0.56	0.52	0.21	0.1	0.2	1.7	0.1	0.1	0.1	0.2	0.4	3.0	0.4	0.4	0.1
Wando Welch	WWT	73.78	132.23	1075.83	91.89	84.59	37.70	14.5	39.4	407.2	23.6	21.6	19.1	59.2	92.8	668.7	68.3	63.0	18.6
Total		120.24	217.46	1775.36	150.77	138.85	62.56	22.3	60.3	620.5	33.4	30.6	29.7	98.0	157.2	1,154.9	117.4	108.2	32.9
Tugs																			
Columbus St.	CST	0.11	1.21	7.09	0.13	0.13	0.15	0.04	0.41	2.42	0.04	0.04	0.05	0.07	0.80	4.67	0.08	0.08	0.10
North Charleston	NCT	0.57	5.36	25.28	0.49	0.49	0.47	0.15	1.41	6.66	0.13	0.13	0.12	0.42	3.95	18.62	0.36	0.36	0.35
Union Pier	UPT	0.06	0.70	4.43	0.11	0.11	0.09	0.02	0.25	1.56	0.04	0.04	0.03	0.04	0.46	2.88	0.07	0.07	0.06
Veterans	VT	0.00	0.05	0.25	0.01	0.01	0.01	0.00	0.01	0.07	0.00	0.00	0.00	0.00	0.04	0.19	0.01	0.01	0.00
Wando Welch	WWT	1.16	11.37	56.99	1.13	1.13	1.09	0.36	3.54	17.77	0.35	0.35	0.34	0.80	7.82	39.22	0.78	0.78	0.75
Total		1.89	18.69	94.05	1.86	1.86	1.81	0.57	5.63	28.47	0.56	0.56	0.55	1.33	13.06	65.58	1.30	1.30	1.26
Total RTG and CHE																			
Columbus	CST	0.19	0.88	0.85	0.11	0.11	0.00	0.19	0.88	0.85	0.11	0.11	0.00	0.00	0.00	0.00	0.00	0.00	0.00
North Charleston	NCT	1.80	11.61	35.93	1.40	1.36	0.05	1.80	11.61	35.93	1.40	1.36	0.05	0.00	0.00	0.00	0.00	0.00	0.00
Union Pier	UPT	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00
Veterans	VT	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00
Wando Welch	WWT	5.95	28.48	82.96	3.84	3.72	0.13	5.95	28.48	82.96	3.84	3.72	0.13	0.00	0.00	0.00	0.00	0.00	0.00
Total		7.94	40.97	119.75	5.35	5.19	0.18	7.94	40.97	119.75	5.35	5.19	0.18	0.00	0.00	0.00	0.00	0.00	0.00
HDV																			
Columbus Street	CST	0.61	2.80	10.21	0.51	0.47	0.02	0.20	0.51	1.34	0.06	0.05	0.00	0.41	2.29	8.86	0.46	0.42	0.02
North Charleston	NCT	5.81	25.62	90.88	4.65	4.27	0.16	2.23	5.97	15.76	0.69	0.64	0.02	3.58	19.65	75.12	3.96	3.64	0.14
Union Pier	UPT	0.14	0.44	1.27	0.05	0.04	0.00	0.12	0.34	0.86	0.03	0.02	0.00	0.02	0.11	0.41	0.02	0.02	0.00
Veterans	VT	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00
Wando Welch	WWT	30.60	144.46	530.73	26.89	24.74	0.96	8.75	23.46	61.96	2.71	2.50	0.07	21.85	121.00	468.77	24.18	22.24	0.88
Total		37.15	173.32	633.09	32.10	29.53	1.14	11.29	30.27	79.93	3.49	3.21	0.09	25.86	143.05	553.16	28.61	26.32	1.04
Rail Estimates by Terminal for Container and Bulk Cargo																			
Columbus St.	CST	0.03	0.10	0.60	0.01	0.01	0.00	0.03	0.10	0.60	0.01	0.01	0.00	0.00	0.00	0.00	0.00	0.00	0.00
North Charleston	NCT	0.41	1.22	7.50	0.17	0.16	0.00	0.18	0.33	3.18	0.07	0.07	0.00	0.22	0.88	4.32	0.10	0.10	0.00
Union Pier	UPT	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00
Veterans	VT	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00
Wando Welch	WWT	1.61	4.78	29.47	0.66	0.64	0.01	0.00	0.00	0.00	0.00	0.00	0.00	1.61	4.78	29.47	0.66	0.64	0.01
Total	CST	2.05	6.09	37.57	0.84	0.82	0.02	0.22	0.43	3.78	0.08	0.08	0.00	1.83	5.66	33.78	0.76	0.74	0.02

2.3 Historical Emissions Comparison

When comparing activity from year to year, the port mobile sources are primarily moving cargo in the form of containers. Containers vary in capacity, with the standard being a twenty-foot equivalent unit (TEU) and is based on the size of a 20-foot shipping container. Container ships are typically classified by TEUs for their carrying capacity. **Table 2-3** through **Table 2-5** show the number of TEUs that were handled by the port over the past three inventory years (2005, 2011 and 2017), as well as their method of transportation to and from the port terminals. **Figure 2-8** also displays data from **Table 2-3** through **Table 2-5**.

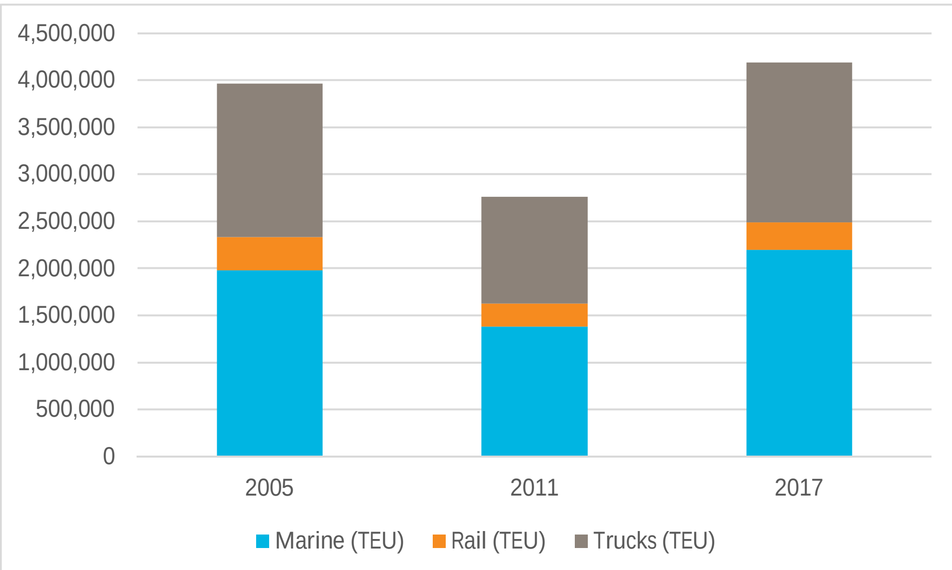


Figure 2-8. Historical TEU Activity Comparison

Table 2-3. 2017 Activity Summary

Transport Service	TEUs	Calls to Terminal per Year	Transport Capacity / Note
Marine	2,200,000	1,724 vessel calls	1,276 Average TEUs exchanged/vessel
Rail	294,186 23% of berth volume directed to rail	817 trains	360 TEU per long-haul train
Heavy Duty Vehicles	1,694,000 77% of berth volume directed to trucks	895,113 truck moves	On-terminal stop idle 6%. Creep idle 20% and moving 74%. Trip time 0.75 hour. Average truck transaction, 23 minutes; 65% of truck moves are dual transactions

Table 2-4. 2011 Activity Summary

Transport Service	TEUs	Calls to Terminal per year	Transport Capacity / Note
Marine	1,382,060	1,704 vessel calls	811 Average TEUs exchanged/vessel
Rail	248,771 18% of berth volume directed to rail	691 trains	360 TEU per long-haul train
Heavy Duty Vehicles	1,133,289 82% of berth volume directed to trucks	850,637 truck moves	On-terminal stop idle 20%. Creep idle 20% and moving 60%. Truck trip time 1 hour

Table 2-5. 2005 Activity Summary

Transport Service	TEUs	Calls to Terminal per year	Transport Capacity / Note
Marine	1,984,887	2,014 vessel calls	986 Average TEUs exchanged/vessel
Rail	348,746 18% of berth volume directed to rail	969 trains	360 TEU per long-haul train
Heavy Duty Vehicles	1,636,141 82% of berth volume directed to trucks	959,387 truck moves	On-terminal stop idle 20%. Creep idle 20% and moving 60% trip time 1 hour

Table 2-6. Emissions Summary 2005, 2011 and 2017

Source Category	NOx	CO	PM_{10}	$PM_{2.5}$	HC	SO_2
2005 Emissions Summary						
OGV	1,492.0	145.3	116.8	101.9	96.6	1,076.0
Tugs	133.9	25.7	3.1	3.0	2.8	6.5
Trucks	3024.7	1021.5	106.9	103.7	133.6	72.6
Rail	54.1	6.4	1.2	1.2	1.9	2.9
CHE	284.5	119.4	18.2	17.7	20.2	36.2
2005 Total	**4,989.2**	**1,318.5**	**246.2**	**227.5**	**255.1**	**1,194.2**
2011 Emissions Summary						
OGV	1,560.4	174.0	187.7	170.4	94.2	1,493.2
Tugs	194.2	21.8	12.3	11.9	9.4	0.1
Trucks	540.8	128.7	22.2	21.6	21.9	0.6
Rail	42.2	6.3	1.6	1.5	2.4	0.0
CHE	114.4	62.4	7.8	7.6	9.6	0.2
2011 Total	**2,451.9**	**393.1**	**231.6**	**213.0**	**137.5**	**1,494.1**
2017 Emissions Summary						
OGV	1,775.4	217.5	150.8	138.9	120.2	62.6
Tugs	94.0	18.7	1.9	1.9	5.9	1.8
Trucks	633.1	173.3	32.1	29.5	37.2	1.14
Rail	37.6	6.1	0.8	0.8	2.1	0.02
2017 Total	**2,659.8**	**456.5**	**190.9**	**176.2**	**173.3**	**65.7**

As seen in **Figures 2.9-2.10**, SCPA experienced an overall emission reduction for 2017 compared to 2011, with a 96% SO_2 reduction (primarily from OGV) and an 18% reduction in PM from OGV and Tug operations. In addition, emissions have decreased significantly since the 2005 inventory.

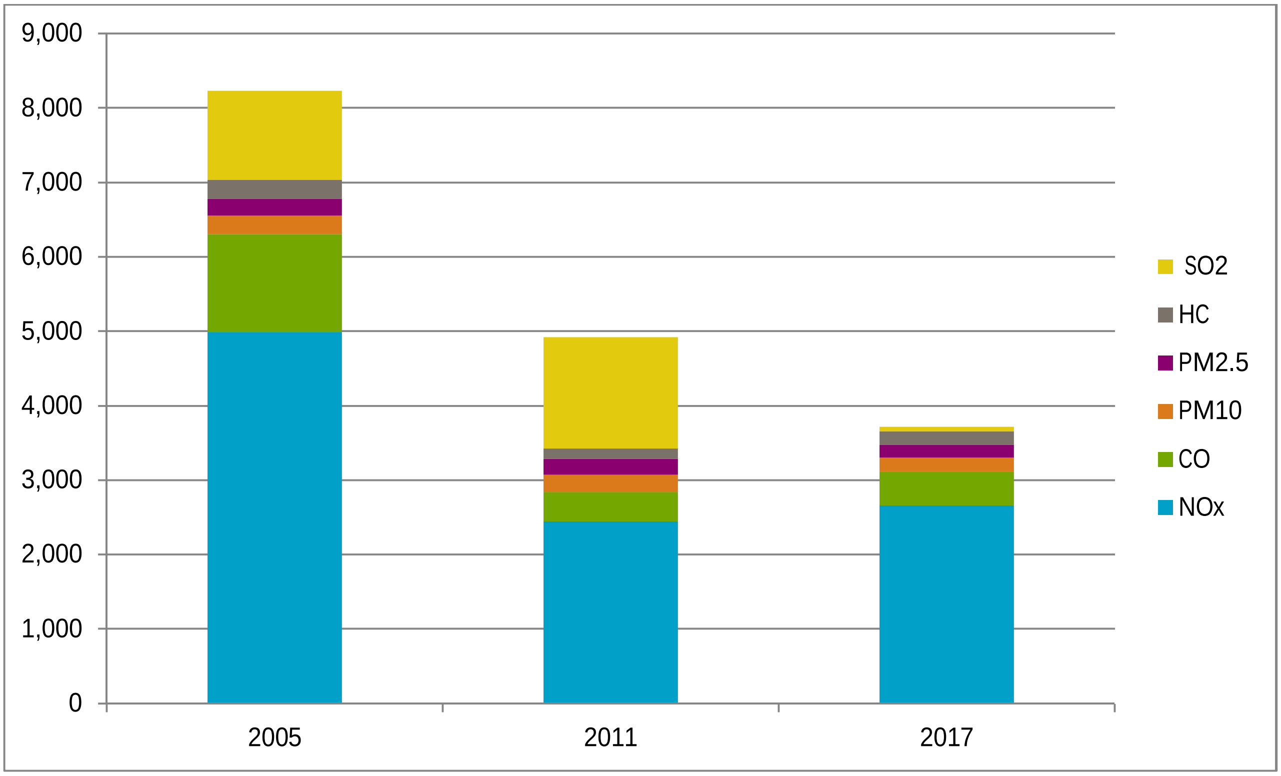


Figure 2.9 Historical Emissions Comparison

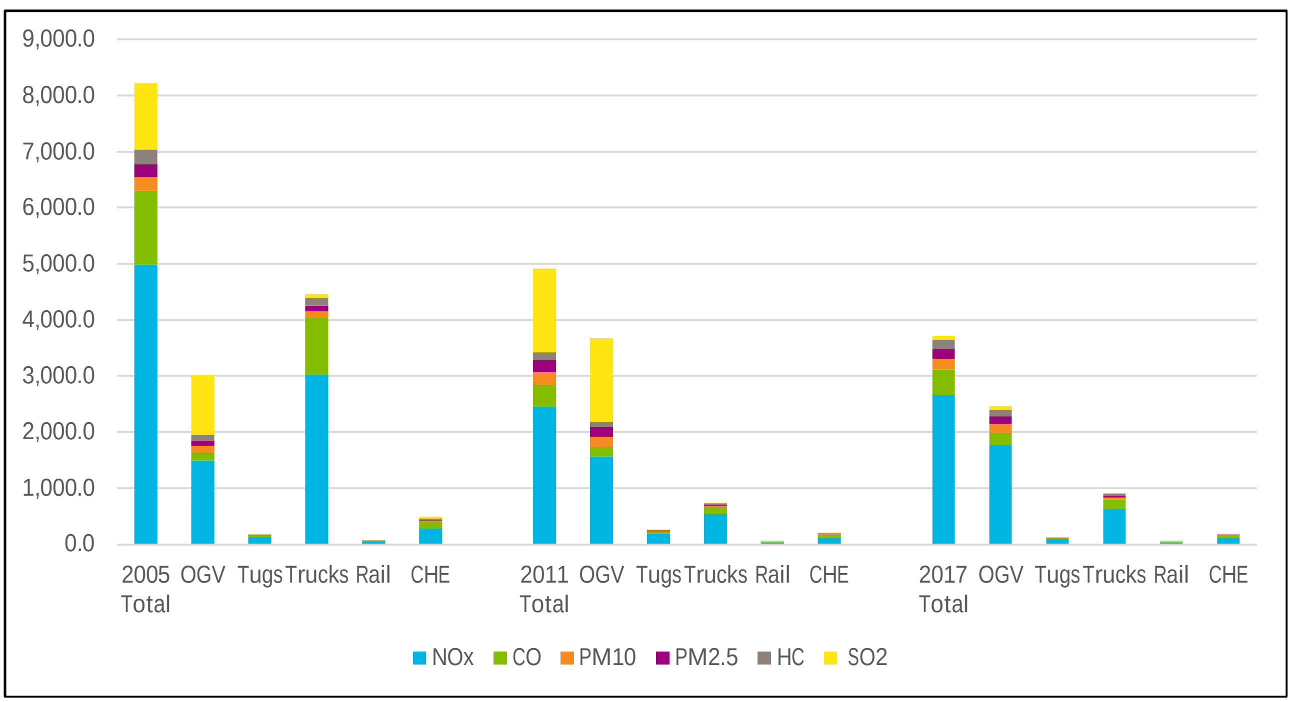


Figure 2.10. Historical Emissions by Source Category

3. Geographic Scope

The mobile air emissions inventory considered emissions from Terminal operations (Facility Emissions) and those associated with container movement to the Terminal (Supply Chain Emissions). Facility Emissions are those released within the facility boundary. Supply Chain Emissions are associated with transporting containers to and from the terminals by OGV, truck, and rail.

3.1 Facility

The SCPA port activity includes both import and export products related to natural resources such as paper, pulp, kraft liner board, logs, lumber, agricultural commodities and clay. The current infrastructure includes the five terminals, with rail switching activities managed by Palmetto Railways, and two intermodal yards managed by CSX and Norfolk Southern. Charleston also has fourteen private terminals for federal facilities, fuel storage, bulk, yachts, chemical, ship yard and scrap steel. This inventory focuses on the SCPA facilities and associated sources for cargo movement.

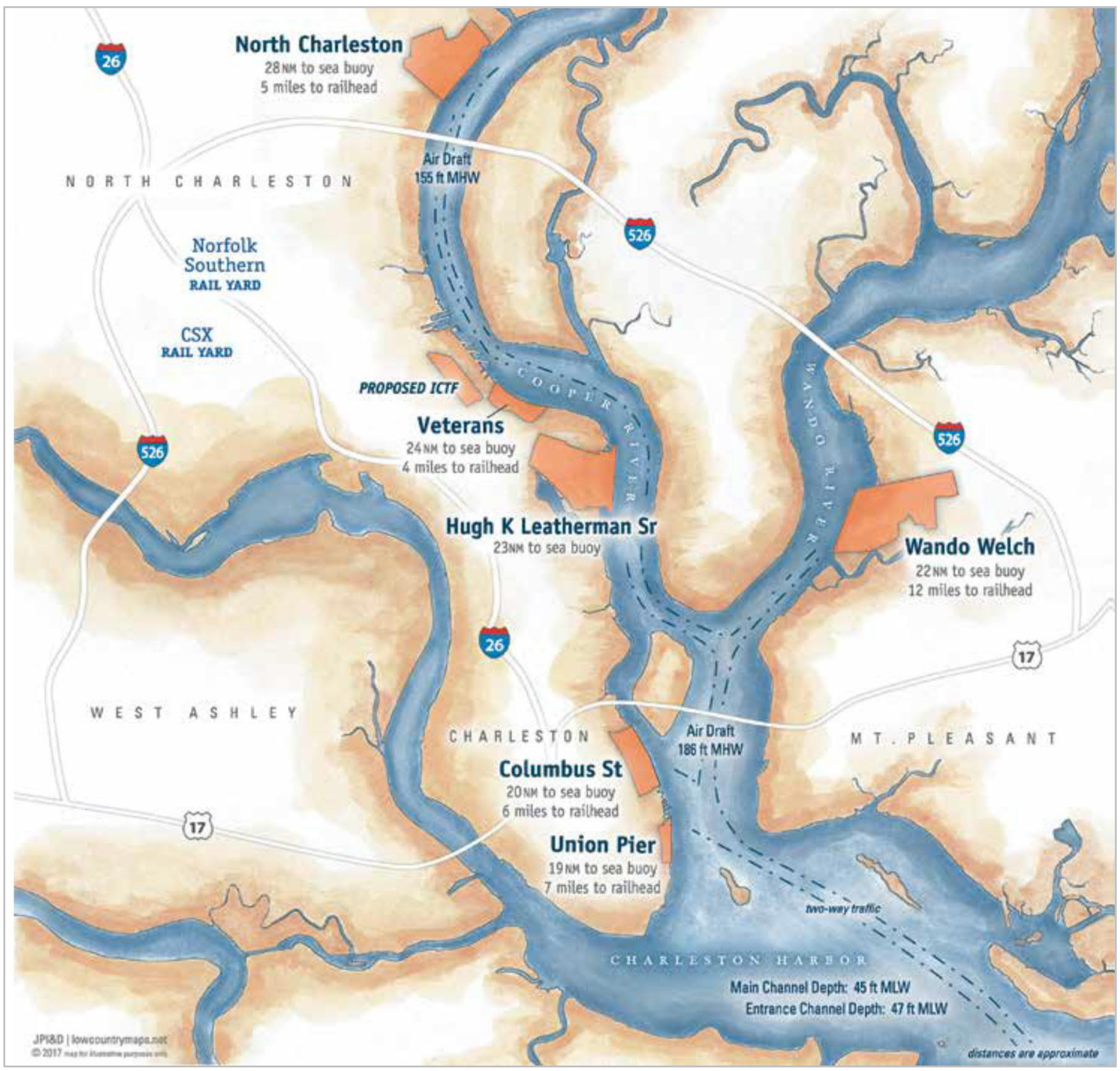


Figure 3-1. Charleston Terminal Locations

Columbus Street

The Columbus Street Terminal (CST) is located on the Cooper River side of the Charleston peninsula, downriver of the US Highway 17 bridge at 30 Johnson Street. The terminal is 14.4 nautical miles from the Charleston Harbor entrance.

CST is Charleston's premier combination breakbulk and RO-RO cargo terminal. Columbus Street offers non-container clients berth space for up to five ships, direct lift capabilities between rail and the vessel, on-dock rail-served warehouses, access to cranes capable of lifting up to 700 net tons, and ample open storage for vehicles, equipment, and project cargo. The terminal covers a total of 155 acres, of which 115 acres are used between wharf, RO-RO, breakbulk, heavy lifting and rail yard.

The terminal has 3,500 feet of continuous berth with a maintained depth of -45 feet mean low water (MLW) at Berth 1 and 2, and -35 feet MLW for Berths 3, 4 and 5. The terminal has an on-dock rail service by CSX and Norfolk Southern. Switching operations are conducted by Palmetto Rail.

Figure 3-2. Columbus Street Terminal

North Charleston

The North Charleston Terminal (NCT) is located on the Cooper River north of I-526, downriver from the Naval Weapons Station and upriver from the KapStone Paper Mill at 1000 Remount Road. The terminal is 22 nm from the Charleston Harbor entrance. The terminal covers a total of 201 acres, of which 132 acres are container yard. It has 11,316 grounded and 2,854 wheeled container slots, 538 reefer slots, and 14 interchange lanes.

The terminal has 2,500 feet of continuous berth with a maintained depth of -45 feet MLW. The terminal has six cranes, including post-Panamax container cranes, an on-terminal container freight station and an on-terminal rail yard.

Majority of the containers are either trucked out of the Tri-County area or taken by Palmetto Rail switch trains to CSX or NS lines.

Figure 3-3. North Charleston Terminal

Union Pier

The Union Pier Terminal (UPT) is one of Charleston's dedicated breakbulk handling facilities and main cruise terminal. The terminal is located on the Cooper River side of the Charleston peninsula at 32 Washington Street. The terminal is 14.2 nm from the Charleston Harbor entrance. The terminal has over 500,000 square feet of sprinkler-protected transit sheds.

The terminal has 2,470 continuous feet of berth space with a maintained depth of -35 feet MLW.

UPT handles traditional non-container freight such as forest products, metals, equipment, and project cargo. Buildings 318 and 322 are designed to handle paper being moved between ships and rail cars.

Multiple rail lines serve the warehouses and dockside open storage. They are operated by Palmetto Rail and connect to the CSX and Norfolk Southern Lines.

Wando Welch

The Wando Welch Terminal (WWT) is located on the east side of the Wando River at 400 Long Point Road, Mount Pleasant. Access between the terminal and I-526 is provided by Long Point Road. The terminal is 16.6 nm from the Charleston Harbor entrance. The terminal covers a total of 689 acres of which 245 acres are container yard. It has 28,768 grounded and 4,707 wheeled container slots, 1,325 reefer slots, and 27 interchange lanes.

The terminal has 3,800 feet of continuous berth with a maintained depth of -45 feet MLW and four container ship berths. In 2017, the terminal had ten container cranes, with two new 155-foot container cranes installed in 2018.

The majority of containers are either trucked out of the Tri-County area or trucked to the CSX or NS intermodal facilities.

Veterans

Veterans Terminal (VT) is located on the Cooper River south of I-526 at 1150 North Port Drive. The terminal covers a total of 110 acre fully secured dedicated bulk, break-bulk, roll-on roll-off (RO-RO), and project cargo.

Figure 3-4. Wando Welch Terminal

The terminal has a maintained depth of -45 feet MLW and four piers ranging from 952 to 1,250 feet in length.

The majority of containers are either trucked out of the Tri-County area, with the interstate freeway I-26 1.5 miles from the terminal or taken by Palmetto Rail switch trains to CSX or NS lines, which are 6.4 and 6.3 miles respectively.

3.2 Facility Emissions

As per the Current Methodologies in Preparing Mobile Source Port-Related Emission Inventory guidelines, Facility Emissions capture all of the sources of emissions, including all marine, non-road, on-highway and stationary sources within the geographic boundary selected. SCPA has selected the Charleston Tri-County area as the geographic boundary, depicted in **Figure 3-2**. The seaside boundary begins at the sea buoy, approximately 12 nautical miles from the Charleston Harbor jetties. The Facility Emission sources included in the air emissions inventory are listed in **Table 3-1**.

The Charleston Tri-County Area, Berkley, Charleston and Dorchester counties are better than national standards/attainment/unclassifiable for the standards except for the portion of Charleston County within section of Charleston just west of south end of US Naval Station, which does not meet the total suspended particulate standards under 40 CFR Part 81.341.

Figure 3-5. Charleston Harbor

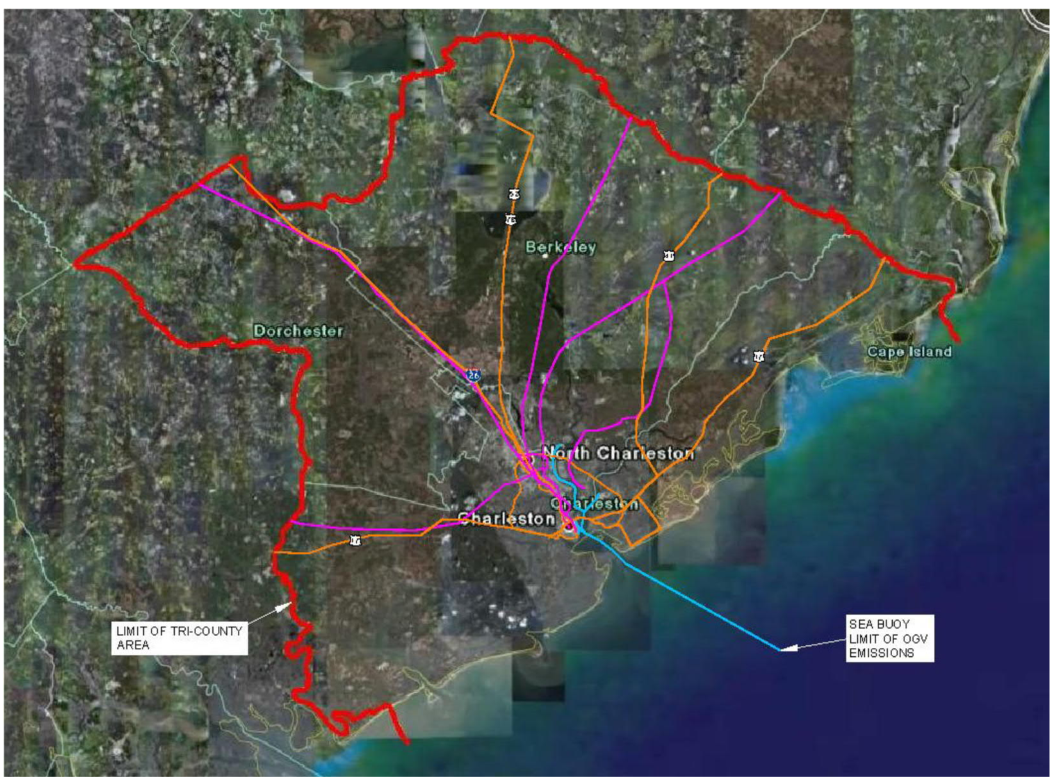


Figure 3-6 Charleston Tri-County Boundary

Table 3-1. Facility Emission Sources and Boundaries

	Sources	Geographic Boundary
Facility	Container handling equipment Rubber tired gantry cranes Forklifts and other small miscellaneous equipment	Site Boundary
	Vessels Assisting tugs Harbor crafts	Maneuvering zone for tugs and OGVs Ships at berth
	Heavy duty trucks	Site Boundary Truck staging area
	Train switching Train long haul Container handling equipment	Site Boundary Intermodal Yard (On-site rail)

3.3 Supply Chain

Supply Chain Emissions include marine, commercial vehicle, and rail emissions that are associated with the facility, but occur outside the facility boundary. The Supply Chain Emission sources included in the AEI are listed in **Table 3-2**.

Table 3-2. Supply Chain Emission Sources and Boundaries

	Sources	Geographic Boundary
Supply Chain	OGVs transiting to SCPA	Between the sea buoy and the five terminals within the Charleston Harbor, Cooper River and Wando Welch River.
	Heavy Duty trucks	To and from the truck gates to Highway 17, I-526 and I-26 to the intermodal yards and Charleston Tri-County Boundary.
	Rail	To and from the Charleston Tri-County Boundary to the Norfolk Southern Seven Mile and CSX Bennett intermodal yards.

4. Emissions Sources

Emission sources vary from year to year as the port expands. This inventory does not include the following sources, to align with the 2005 and 2011 inventories.

- On-road passenger vehicles;
- Military vessel or equipment operations;
- Pilot or crew boats;
- Yard trucks/facility vehicles;
- Recreational boating;
- Commercial fishing or other waterfront activity not associated within the operation of SCPA terminals;
- Coastwise vessels not calling on SCPA terminals in Charleston; and
- Dredging or construction equipment.

4.1 Primary Sources

Table 4-1. Primary Emission Sources

Primary Source	Equipment Type	Count	Age – Tier	Fuel / Energy	Rated Power as Applicable
Marine	OGVs	1,724 Calls per year:	Varies; main and auxiliary engine sizes based on Sea Web Ship Details	Marine Gas Oil (MGO)	Main – 43,378 kW Aux – 1,854 kW Boiler – 506 kW
	Tug	2 Tugs per OGV call 11,227 Main Engine Hours	Tier 2	Diesel	Main – 2x1920 kW Aux – 2x107 kW
Rail	Locomotive	Switching Locomotives; Long-haul Locomotives	Tier 0+	Diesel	Switch – 1,923 hp Long – 4,000 hp
On-road	Heavy Duty Vehicles/ Trucks, Container and Break Bulk	895,113 Truck Arrivals	Default US EPA MOVES Characterization: Combination Long Haul Trucks	Diesel	Default US EPA MOVES Characterization: Combination Long Haul Trucks
	Shuttle Rides	15,449	Total number of embark/debark shuttle rides per year	Diesel	Default US EPA MOVES Characterization: Buses
Non-Road	Forklifts	6	NA	Diesel	155 hp
	RTG Cranes	2	T1	Diesel	405 hp
		14	T2	Diesel	524 hp
		24	T3	Diesel	558 hp
		14	T4F	Diesel	646 hp
	CHE	8	T1	Diesel	213 hp
		10	T2	Diesel	290 hp
		55	T3	Diesel	273 hp

4.2 Emissions Variability

SCPA container facilities operates 12 hours per day, 6 days per week and breakbulk facilities operate 8 hours a day, 5 days per week. Vessels operate 24 hours per day, 7 days per week. SCPA gates are typically closed on Sunday unless requested by a vessel. Sunday operations are limited to ship to shore cranes and necessary yard equipment. Emissions vary with the level of activity at each terminal, which varies throughout the day and week. There are no seasonal operational changes that will cause the emissions to vary season-to-season or month-to-month.

Emissions are lower from 6 p.m. to 6 a.m. Monday through Saturday, and all day Sunday, as no heavy-duty commercial vehicles (heavy duty trucks) pass through the terminals at those times. OGV emissions will vary based on time hotelling and number of ships at berth. Larger OGVs are required to hotel longer, as they have more containers to load and unload to and from the container handling terminals. Rail emissions occur daily in and out of the boundary area. Non-road and mobile equipment emissions vary based on their required utilization and activities. The emissions of individual equipment types vary based on their activity; activity-based variability is described for each equipment type in **Section 6**.

4.3 Contaminants of Concern

Contaminants considered in this inventory for determining effects on air quality were selected because they are by-products of hydrocarbon combustion. All criteria air emissions from the Facility and Supply Chain are the result of fuel combustion. The GHG pollutants, including CO_2, CH_4, and N_2O, were not included in inventory for historical comparison to the 2005 and 2011 inventories. The following contaminants were considered for this inventory:

- Nitrogen Oxides, NO_X;
- Carbon Monoxide, CO;
- Hydrocarbons (HC);
- Particulate matter 10 micrometres or less in diameter, PM_{10};
- Particulate matter 2.5 micrometres or less in diameter, $PM_{2.5}$; and
- Sulfur Dioxides, SO_2.

5. Emissions Estimates

Emissions were estimated in tons-per-year, in accordance with methodologies specified in the U.S. Environmental Protection Agency Current Methodologies in Preparing Mobile Source Port-Related Emission Inventories (U.S EPA, 2009), and through consultation with SCPA. In general, equipment type, counts, and activities were sourced from the terminal operators, and emission factors were sourced from appropriate literature sources; specific methodology is provided in **Section 6**. As a result of the low percent of vessels calling at the terminals proceeding to anchorage, according to pilots and tug operators, emissions associated with anchorage were excluded from the assessment.

5.1 2017 Emissions Summary

The annual emissions estimates for 2017 are provided below in **Table 5.1**; the assumptions and methodologies supporting this table are provided in **Section 6**.

Table 5-1. 2017 Emissions Summary by Terminal

		Total Emissions				
SCPA Total	Emissions Summary tons/year					
Terminal	**HC**	**CO**	**NOx**	**PM_{10}**	**$PM_{2.5}$**	**SO_2**
Columbus	7.63	19.07	152.54	11.04	10.18	5.31
North Charleston	44.55	106.21	636.88	46.15	42.63	17.10
Union Pier	3.71	9.33	89.39	8.74	8.08	3.19
Veterans	0.28	0.61	5.01	0.57	0.53	0.22
Wando Welch	113.10	321.31	1,775.98	124.41	114.83	39.88
Total	169.27	456.53	2,659.81	190.92	176.25	65.70

6. Estimation Methodologies

Estimates were developed for annual emissions and hourly emissions in accordance with methodologies specified in the Current Methodologies in Preparing Mobile Source Port-Related Emission Inventories (U.S EPA, 2009), and direction from SCPA. In general, equipment type, counts, and activities were sourced from the terminal operator, and emission factors were sourced from appropriate literature sources. Specific methodology is provided below.

The annual emission rate estimates are based on annual activity with:

- Berth/hotelling hours associated with annual OGV calls;
- Maneuvering hours associated with annual OGV calls;
- Operational hours associated with assist tugs and pilot boats corresponding to annual OGV calls;
- Annual trains estimated, and associated switching requirements;
- Container trucks operating 12 hr/day, 6 days/week and breakbulk trucks operating 8 hr/day, 5 days/week over the year; and
- Annual hours of operation for all non-road equipment.

6.1 Marine – OGV

OGVs arrive at Charleston and travel to one of the five SCPA terminals or fourteen private terminals. The vessel types included are auto carrier, barge, bulk carrier, container ship, cruise ship and roll-on roll off (RoRo) vessel. For this inventory, the OGV call count includes ships to the SCPA terminals. Travel time round trip from the sea buoy to the terminal is approximately 2 hours for Columbus Street and Union Pier, and approximately 2.5 hours for North Charleston and Wando Welch. Travel time varies depending on conditions such as current, wind and other vessel activities. Depending on the terminal, multiple vessels may be berthed simultaneously while cranes transfer containers between the vessels and the container trucks.

The OGV main engine, auxiliary engine, and boilers are the primary sources of emissions from OGVs and are considered in the assessment. Facility Emissions from OGVs occur while ships are hotelling at berth and are maneuvering into berth at slow engine speeds (with assistance from tugs), while Supply Chain Emissions include emissions associated with OGVs transiting to and from the sea buoy at reduced engine speeds. In both cases, auxiliary engines and boilers operate at the load associated with their activity (maneuvering or at berth) as described below. Auxiliary engines and boilers are primarily for electricity generation, heating and steam production. Main engines will operate during transit and maneuvering, with emissions at different loads based on engine speeds.

OGVs operate in one of four different modes:

- Cruising mode: Considered to be 94 percent of maximum speed, outside of the port boundary. Since reduced speeds occur beginning at the sea buoy, ships do not operate in cruising mode within the boundary.
- Reduced speed zone (RSZ): This is when the vessel is operating at less than cruising speed and greater than maneuvering (9-12 knots), typically within the Charleston Harbor, Cooper River and Wando River.
- Maneuvering: This occurs when the vessel is close to the dock maneuvering into or out of berth (approximately 4 knots), typically with assist tugs.
- Hotelling mode: This is when the vessel is at berth typically working cargo to and from the port. The main engines are turned off and the vessel is operating on auxiliary engines.

OGV deadweight, main engine size and auxiliary engine size was obtained by Lloyd's Register number from the Maritime Sea-Web Online Ship Register, Ship Detail data (IHS, 2018). All Ship Details provided the propulsion (main) engine data. For those with missing auxiliary engine data, engine capacity was estimated from sister ships of similar dead weight tonnage and propulsion engine size, or the auxiliary engine was estimated to be 5% of the propulsion engine according to the Marine Fuel Choice for Ocean Going Vessels within Emissions Control Areas (U.S.EIA, 2015).

Auxiliary boilers are typically used when the main engine load is less than approximately 20%. When operating at greater than 20%, vessels operate heat recovery systems to produce heat while the ship is cruising. Boiler data is typically not available in ship registers. Therefore, boiler loads are based on average values for each ship type, and are based on all boilers used, rather than for each individual boiler.

Activity-level and vessel movement was based on ship call data, AIS data, and discussions with the SCPA Berthing Department and Pilot Association. Ship call data provided the dock and departure time for sailing. The dock time is initiated at cargo unloading and departure time is typically thirty minutes after the last container is removed. The average travel time to each terminal per ship type is based on AIS data for CY2017. AIS data provided ship speeds, per ship type, at various points in the Charleston Harbor, including Rebellion Reach, Ft. Sumter Reach, and the Ravenel Bridge. The average ship speed per ship type was taken in each straight which provided accurate data for movement within reduced speed zones. Discussions with the Pilot Association and tug companies determined an average maneuvering speed for all vessels of approximately 4 knots.

Figure 6.1 Container Ships in Charleston Harbor

6.1.1 Emission Factors

Emissions factors were sourced from the US EPA Current Methodologies in Preparing Mobile Source Port-Related Emission Inventories and are identified in **Table 6.1** (U.S EPA, 2009). Propulsion engines were assumed to operate on residual oil, while auxiliary engines operate on both residual and marine diesel fuel, as determined from ship data from the Maritime Sea-Web Online Ship Register. Boilers were assumed to operate on heavy fuel oil (HFO). Steam turbine emission factors were utilized for ship boiler emissions (ICFI, 2009). Slow engine speeds and the "maneuvering" mode of operation were selected for both transiting and maneuvering emissions within the facility and supply chain boundaries.

Table 6-1. OGV Main Engine Emission Factors

Engine Type	Fuel Type	Sulfur (%)	Emission Factors (g/kWh)					
			NO_X	PM_{10}	$PM_{2.5}$	HC[3]	CO	SO_2[1,2]
Main SSD	Residual	0.10	14.52	1.42	1.31	0.60	1.40	0.38
Main MSD	Residual	1.00	11.23	1.43	1.32	0.50	1.10	0.42
Aux Engine	Residual	0.10	11.8	1.44	1.32	0.40	1.10	0.44
	Distillate	1.00	11.2	0.25	0.23	0.40	1.10	0.42
ST[4]	Residual	0.10	2.10	1.47	1.35	0.10	0.20	0.60
	Distillate	0.10	2.00	0.58	0.53	0.10	0.20	0.57

Notes:

[1] *SO_2 emission factors for residual oil from Table 2-9 (ICFRI, 2009) are 10.29, 11,24 and 11,98 g/kWh for Main SSD, Main MSD, and Aux engines, respectively and are based on fuel sulfur content of 2.7%. For use in this assessment, it was adjusted for the International Maritime Organization fuel standard (0.1% S) as of January 1, 2015.* (International Maritime Organization, 2017).

[2] *SO_2 emission factors for distillate oil from Table 2-9 (ICFRI, 2009) are 3.62, 3.97, and 4.24 g/kWh for Main SSD, Main MSD, and Aux engines, respectively, and are based on fuel sulfur content of 1%. For use in this assessment, it was adjusted for the International Maritime Organization fuel standard (0.1% S) as of January 1, 2015.* (International Maritime Organization, 2017).

[3] *HC emissions are based on Hydrocarbon emission rates specified in Table 2-9 (ICFRI, 2009).*

[4] *For boiler emission factors, it is assumed that vessels switch boiler fuel feed to low-sulfur HFO (0.1% S) while in the modeling domain, as it is within the North American Emission Control Area. The Table 2-9 (ICFRI, 2009) SO_2 emission factor of 5.67 g/kWh was adjusted according to the International Maritime Organization fuel standard (0.1% S) as of January 1, 2015. (International Maritime Organization, 2017).*

If the vessel is traveling at speeds likely to produce a load of less than 20% (i.e., maneuvering speed or hotelling), the maneuvering boiler load defaults by kW in **Table 6-2** are used. Within the harbor, ships are assumed to be operating in maneuvering and hotel modes during boiler operations.

Table 6-2. OGV Boiler Energy Defaults

Ship Type	Maneuver (kW)[1]	Hotel (kW)[1]
Auto Carrier	371	371
Breakbulk	109	109
Container	506	506
Cruise	1,000	1,000
General Cargo	106	106
Miscellaneous	371	371
OG Tug	0	0
Ro-Ro	109	109
Reefer	464	464
Tanker	371	3,000
Tanker-ED	346	346

Notes:

[1] *Boiler sizing data from ICFI, 2009, Table 2-17.*

6.1.2 Activity Characterization

The annual emission estimates were calculated based on the activities listed in **Table 6-3**. The SCPA 2017 ship call data included vessel identification, name, shipping line, arrival date and time, departure date and time and terminal. There were 1,724 ship calls made in 2017. Transiting and maneuvering time estimates were calculated using the AIS average speeds per zone for each vessel type, and distances between the sea buoy and each respective terminal.

Vessel speeds outside the breakwater were determined from AIS data at Ft. Sumter Reach. Vessel speeds inside the breakwater were determined using AIS data at two different locations, based on vessel type and their destination terminals. For auto carrier, container, and RO-RO vessel types, average speeds were calculated at the Ravenel Bridge. For cruise and breakbulk vessel types, average speeds were determined at Rebellion Reach.

Average maneuvering speeds were verified by interviews with the tug operators. Within the Charleston Harbor and rivers to the ports, ships are not permitted to meet cruising speeds. Therefore, average cruise speeds from the previous inventories were utilized. Hotelling time at dock was determined by the ship call arrival and departure time. During dock working time, a ship’s auxiliary engines remain running.

Table 6-3. OGV Movement Activity

Terminal	Vessel Type	Distance (naut miles)				Speed (knts)				Time in Mode - Round Trip (hrs)			
			Reduced Speed Zone				Reduced Speed Zone				Reduced Speed Zone		
		Cruise	Outside BW	Inside BW	Maneuver	Cruise	Outside BW	Inside BW	Maneuver	Cruise	Outside BW	Inside BW	Maneuver
Union Pier	Auto Carrier	0	12.3	7.2	2.0	19.6	13.6	9.2	4.0	0.0	1.8	1.6	1.0
	Container					24.2	13.2	8.4	4.0	0.0	1.9	1.7	1.0
	Barge					14.5	9.0	6.0	4.0	0.0	2.7	2.4	1.0
	Ro-Ro					15.7	11.6	9.0	4.0	0.0	2.1	1.6	1.0
	Cruise					18.6	14.3	11.2	4.0	0.0	1.7	1.3	1.0
	Breakbulk					15.5	12.4	10.3	4.0	0.0	2.0	1.4	1.0
Columbus Street	Auto Carrier	0	12.3	7.9	2.0	19.6	13.6	9.2	4.0	0.0	1.8	1.7	1.0
	Container					24.2	13.2	8.4	4.0	0.0	1.9	1.9	1.0
	Barge					14.5	9.0	6.0	4.0	0.0	2.7	2.6	1.0
	Ro-Ro					15.7	11.6	9.0	4.0	0.0	2.1	1.8	1.0
	Cruise					18.6	14.3	11.2	4.0	0.0	1.7	1.4	1.0
	Breakbulk					15.5	12.4	10.3	4.0	0.0	2.0	1.5	1.0
Wando Welch	Auto Carrier	0	12.3	10.3	2.0	19.6	13.6	9.2	4.0	0.0	1.8	2.2	1.0
	Container					24.2	13.2	8.4	4.0	0.0	1.9	2.4	1.0
	Barge					14.5	9.0	6.0	4.0	0.0	2.7	3.4	1.0
	Ro-Ro					15.7	11.6	9.0	4.0	0.0	2.1	2.3	1.0
	Cruise					18.6	14.3	11.2	4.0	0.0	1.7	1.8	1.0
	Breakbulk					15.5	12.4	10.3	4.0	0.0	2.0	2.0	1.0
North Charleston	Auto Carrier	0	12.3	15.4	2.0	19.6	13.6	9.2	4.0	0.0	1.8	3.3	1.0
	Container					24.2	13.2	8.4	4.0	0.0	1.9	3.7	1.0
	Barge					14.5	9.0	6.0	4.0	0.0	2.7	5.1	1.0
	Ro-Ro					15.7	11.6	9.0	4.0	0.0	2.1	3.4	1.0
	Cruise					18.6	14.3	11.2	4.0	0.0	1.7	2.8	1.0
	Breakbulk					15.5	12.4	10.3	4.0	0.0	2.0	3.0	1.0
Veteran's	Auto Carrier	0	12.3	15.4	2.0	19.6	13.6	9.2	4.0	0.0	1.8	3.3	1.0
	Container					24.2	13.2	8.4	4.0	0.0	1.9	3.7	1.0
	Barge					14.5	9.0	6.0	4.0	0.0	2.7	5.1	1.0
	Ro-Ro					15.7	11.6	9.0	4.0	0.0	2.1	3.4	1.0
	Cruise					18.6	14.3	11.2	4.0	0.0	1.7	2.8	1.0
	Breakbulk					15.5	12.4	10.3	4.0	0.0	2.0	3.0	1.0

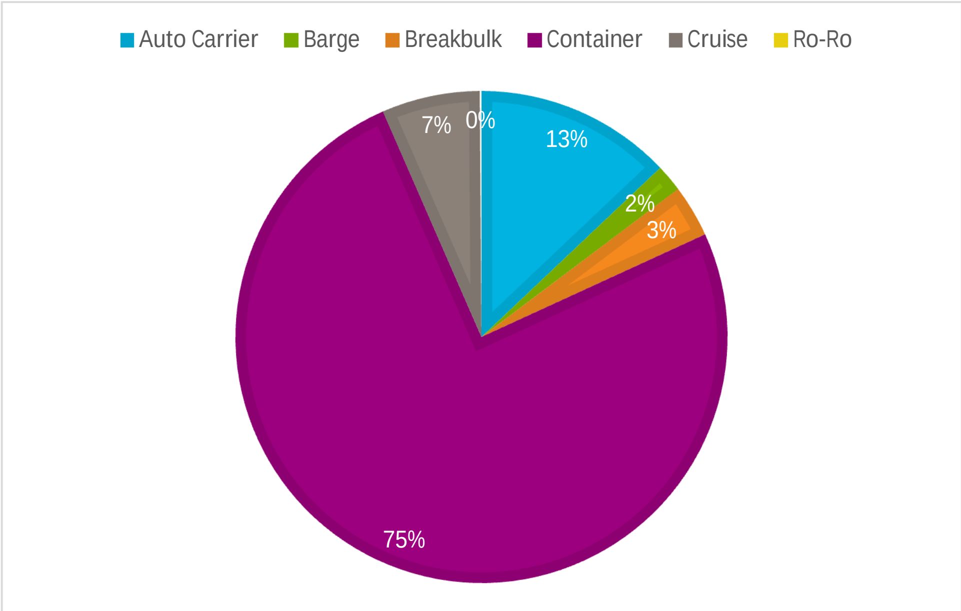


Figure 6-2. 2017 Calls by Vessel Type

Load factors for propulsion engines were calculated using the Propeller Law as shown below (ICFI, 2009).

$$Load\ Factor = \left(\frac{Actual\ Speed}{Maximum\ Speed}\right)^3$$

For propulsion engine loads calculated to be less than 20%, additional low load adjustment factors were applied to the load factor. Low load adjustment factors can be seen in **Table 6-4** (ICFI, 2009).

Table 6-4. Low Load Adjustment Factors

Load	NO_x	PM_{10}	$PM_{2.5}$	HC	CO	SO_2
1%	11.47	19.17	19.17	59.28	19.32	5.99
2%	4.63	7.29	7.29	21.18	9.68	3.36
3%	2.92	4.33	4.33	11.68	6.46	2.49
4%	2.21	3.09	3.09	7.71	4.86	2.05
5%	1.83	2.44	2.44	5.61	3.89	1.79
6%	1.60	2.04	2.04	4.35	3.25	1.61
7%	1.45	1.79	1.79	3.52	2.79	1.49
8%	1.35	1.61	1.61	2.95	2.45	1.39
9%	1.27	1.48	1.48	2.52	2.18	1.32
10%	1.22	1.38	1.38	2.20	1.96	1.26
11%	1.17	1.30	1.30	1.96	1.79	1.21
12%	1.14	1.24	1.24	1.76	1.64	1.18
13%	1.11	1.19	1.19	1.60	1.52	1.14
14%	1.08	1.15	1.15	1.47	1.41	1.11
15%	1.06	1.11	1.11	1.36	1.32	1.09
16%	1.05	1.08	1.08	1.26	1.24	1.07
17%	1.03	1.06	1.06	1.18	1.17	1.05
18%	1.02	1.04	1.04	1.11	1.11	1.03
19%	1.01	1.02	1.02	1.05	1.05	1.01
20%	1.00	1.00	1.00	1.00	1.00	1.00

For auxiliary engines, load factors were calculated using Table 2-7 of US EPA Current Methodologies in Preparing Mobile Source Port-Related Emission Inventories, and can be seen in **Table 6-5**. (ICFI, 2009).

Table 6-5. Auxiliary Engine Load Factors

Vessel Type	Auxiliary Engine Load Factors			
	Cruise	RSZ	Maneuver	Hotel
Auto Carrier	0.15	0.30	0.45	0.26
Container	0.13	0.25	0.48	0.19
Barge	0.17	0.27	0.45	0.22
RO-RO	0.15	0.30	0.45	0.26
Cruise	0.80	0.80	0.80	0.64
Breakbulk	0.17	0.27	0.45	0.10

Example Calculations

The annual emission estimates were based on a combination of information from **Table 6-3 - Table 6-5**. Data for container ships docking at the Wando Terminal are included in **Table 6-6**, followed by a sample calculation for NO_X. Please note that for purposes of a sample calculation, data is averaged, including berthing time and rated power, therefore, emissions in sample calculations do not necessarily represent actual emissions.

Table 6-6. OGV Annual Emission Example Calculation

# Calls	Mode	Source	Hours in Mode per Call (Round Trip)	Rated Power (kW)	Load Factor	Low Load Adjustment Factor	NO_X Emission Factor (g/kWh)	Annual Tons
845	Outside Breakwater	Main	1.9	54,760	0.16	1.05	14.5	236.4
		Auxiliary		2,346	0.25	1.00	11.8	12.3
		Boiler		506	0.00	1.00	2.1	0.0
	Inside Breakwater	Main	2.4	54,760	0.04	2.21	14.5	157.1
		Auxiliary		2,346	0.25	1.00	11.8	15.5
		Boiler		506	0.00	1.00	2.1	0.0
	Maneuvering	Main	1.0	54,760	0.01	11.47	14.5	84.9
		Auxiliary		2,346	0.48	1.00	11.8	12.4
		Boiler		506	1.00	1.00	2.1	1.0
	Berth	Auxiliary	15.9	2,346	0.19	1.00	11.8	78.2
		Boiler		506	1.00	1.00	2.1	15.7

$$Annual\ Emissions\ = \frac{Vessel\ Calls}{Year} \times \frac{Hours\ in\ Mode}{Call} \times Engine\ Size\ \times Load\ Factor$$
$$\times\ Low\ Load\ Adjustment\ Factor\ \times Emission\ Factor \times \times\ (1\ lb)/(453.5\ g)$$
$$\times\ (1\ ton)/(2{,}000\ lb)$$

$$= \left(\frac{845\ Vessel\ Calls}{Year} \times \frac{1.9\ Hours\ in\ Mode}{Call} \times 54{,}760 kW \times 16\% \times 1.05 \times 14.5 \frac{g}{kW - hr}\right) \times \frac{1\ lb}{453.5\ g}$$
$$\times \frac{1\ ton}{2{,}000\ lb}$$

$$Annual\ Emissions\ (tpy)\ =\ 236.4\ tons/year$$

6.2 Marine – Harbor Crafts

Harbor crafts associated with SCPA include pilot boats and tugboats (tugs) that assist the OGVs docking at, and departing from SCPA terminals. The Pilots Association uses one of its four boats to meet the OGV, and tugs accompany each vessel during near-berth maneuvering upon arrival and departure from the terminals. The most active times per day for harbor crafts are from 2-5 am and 4-7 pm. The pilots provide insight for vessel maneuvering operations within the port. Runs within the harbor to port terminals range from 20-40 nmi.

Figure 6-3. Tug Assist Operations

6.2.1 Emission Factors

Emission factors are sourced, when available from the EPA certification testing by manufacturer engine model; otherwise they are sourced from the *US EPA Current Methodologies in Preparing Mobile Source Port-Related Emission Inventories* (ICFI, 2009) or Table 1 and Table 2 of 40 Code of Federal Regulation (CFR) Part 1042 - Control of Emissions from New and in-Use Marine Compression-Ignition Engines and Vessels (for Tier 3 engines) as shown in **Table 6-8***.* Engines are assumed to operate on ultra-low sulfur diesel.

In the previous 2005 and 2011 inventories, only the EPA Port Mobile Source Guide was utilized for emission factors. Using the actual engine inventory and applying emission factors based on engine tier, cylinder displacement and kW reduced the average emission factor for each pollutant, compared in **Table 6-7**.

Table 6-7. Historical Harbor Craft Emission Factors

Emission Factors (g/kw-hr)						
Pollutant	HC	CO	NO_X	PM_{10}	$PM_{2.5}$	SO_2
2011 Report	0.475	1.100	9.800	0.619	0.601	0.007
2017 Average	0.249	1.569	7.368	0.195	0.189	0.007

Table 6-8. Harbor Craft Emission Factors (ULSD)

Engine Data						Emission Factors (g/kw-hr) - assuming 1.5% S						
Engine Manuf	Engine Model	Type	Tier	Displacement per Cylinder (L)	Engine Category	HC	CO	NO_X	PM_{10}	$PM_{2.5}$	SO_2	Source
MTU	16V4000, M61	Main	2	2.0	1	0.19	1.10	6.00	0.11	0.11	0.0065	Table 3-5 (ICFI, 2009).
John Deere	6068	Auxiliary	2	1.1	1	0.05	0.60	3.40	0.12	0.11	0.0065	EPA MOVES ignition archive 1996-2011; Model year 2011. SO_2 (ICFI, 2009).
MTU	16V4000, M63	Main	2	4.8	1	0.19	1.10	6.00	0.11	0.11	0.0065	Table 3-5 (ICFI, 2009).
EMD	16-645E7B	Main	0	10.6	2	0.13	2.48	13.36	0.28	0.27	0.0065	Table 3-5 (ICFI, 2009).
John Deere	4045	Auxiliary	3	1.1	1	0.32	0.90	2.55	0.10	0.10	0.0065	MOVES ignition 2011-present for 2012 model year, ultra-low sulfur diesel (average) (PM and NO_X); Table 3-5 (CO, HC). Tier 2 actual data is lower than the Tier 3 emission limits.
ABS EMD	8-710G7C	Main	3	11.6	2	0.13	2.00	6.20	0.12	0.12	0.0065	Table 3-5 (HC, CO) (ICFI, 2009). Table 2 (PM, NO_X) (40 CFR 1042.101).
John Deere	4045AFM85	Auxiliary	3	0.9	1	0.32	0.80	5.40	0.10	0.10	0.0065	Table 3-5 (HC, CO) (ICFI, 2009). Table 1 (PM, NO_X) (40 CFR 1042.101).
Caterpillar	3516 B-HD	Main	1	4.3	3	0.29	1.07	7.85	0.15	0.15	0.0065	EPA MOVES ignition archive 1996-2011 (CO, NO_X, PM).
Caterpillar	3304	Auxiliary	-	-	-	0.25	2.30	7.30	0.20	0.19	0.0065	EPA MOVES ignition archive 1996-2011 (CO, NO_X, PM).
EMD	12-645-F7B	Main	0	9.3	2	0.13	2.48	13.36	0.28	0.27	0.0065	Table 3-5 (ICFI, 2009).
EMD	16-645 ES Turbo	Main	0	9.3	2	0.13	2.48	13.36	0.28	0.27	0.0065	Table 3-5 (ICFI, 2009).
Northern Lights	12V2000CR	Main	2	2.2	1	0.19	1.10	6.00	0.11	0.11	0.0065	Table 3-5 (ICFI, 2009).
Northern Lights	M944W3	Auxiliary	3	0.8	1	0.41	1.60	5.40	0.12	0.12	0.0065	Table 3-5, Tier 2 actual data is lower than the Tier 3 emission limits (HC, CO) (ICFI, 2009). Table 1 (PM, NO_X) (40 CFR 1042.101).
522 kW	Tier 3 Main	Main	3	NA	NA	0.41	1.60	5.80	0.12	0.12	0.0065	Table 3-5, the Tier 2 main engine max g/kw-hr was used since cylinder displacement unknown, and Tier 2 actual data is lower than the Tier 3

Engine Data						Emission Factors (g/kw-hr) - assuming 1.5% S						
Engine Manuf	**Engine Model**	**Type**	**Tier**	**Displacement per Cylinder (L)**	**Engine Category**	**HC**	**CO**	**NO_X**	**PM_{10}**	**$PM_{2.5}$**	**SO_2**	**Source**
												emission limits (HC, CO) (ICFI, 2009). The max for commercial engines with kW/L ≤ 35, Table 1 (PM, NO_X) (40 CFR 1042.101).
300 kW	Tier 2 Main	Main	2	NA	NA	0.41	1.60	6.10	0.20	0.19	0.0065	Table 3-5, For each pollutant, the Tier 2 main engine max g/kw-hr was used since cylinder displacement unknown (ICFI, 2009).
Multiple	Tier 1 Aux	Auxiliary	1	NA	NA	0.41	2.00	9.80	0.72	0.70	0.0065	Table 3-5, For each pollutant, the Tier 1 aux engine max g/kw-hr was used since cylinder displacement unknown (ICFI, 2009).

Category 1: Rated power >= 37 kW; Engine displacement <5 L/cyl

Category 2: Engine displacement between 5 L/cyl and 30 L/cyl

Category 3: Engine displacement greater than 30 L/cyl

SO_2 emission factors

[1] *Tier was selected based on definitions in US EPA Current Methodologies in Preparing Mobile Source Port-Related Emission Inventories (2009)* (ICFI, 2009).

[2] *The engine type, cylinder displacement and tier were used to select the correct emission factor from US EPA Current Methodologies in Preparing Mobile Source Port-Related Emission Inventories (2009), Table 3-5.* (ICFI, 2009).

[3] *SO_2 and PM_{10} emission rates were adjusted for ultra-low Sulfur diesel (15 ppm S) based on guidance from SCPA and US EPA Current Methodologies in Preparing Mobile Source Port-Related Emission Inventories (2009),* (ICFI, 2009) *Section 3.1 and Table 3-9; SO_2 adjustment: 0.005 (unadjusted emission factor: 1.3 g/kWh); PM_{10} adjustment: 0.86 (unadjusted emission factor: 0.3 g/kWh).*

[4] *$PM_{2.5}$ was calculated as a fraction of PM_{10} according to direction provided in US EPA Current Methodologies in Preparing Mobile Source Port-Related Emission Inventories (2009)* (ICFI, 2009), *Section 3.4.2; $PM_{2.5}$ is 97% of PM_{10}.*

6.2.2 Activity Characterization

Tug boats (tugs) operations are conducted by two tug companies, Moran and McAlister. Each company assist with approximately 40 ship calls per week. Arrivals and departures are separate jobs. On average, 180-200 jobs are completed a month, with 50% supporting SCPA operations with remaining operations to private terminals. Meetup locations with OGV vary depending on the terminal destination as show in **Table 6-9** below.

The Pilot Association boats average 7,000 hours per year with approximately 70% of annual operations supporting SCPA. Travel distance to meet the OGV is 20 nmi. The travel speed varies depending on weather, dredging conditions and other port activities. When pilots board the ship, they typically operate at 10-12 knots.

Table 6-9. Tug Meetup Locations

Meeting Location	Destination Terminal
Rebellion Reach	Columbus Street
Horse Reach	Wando Welch
Drum Island Reach	Veterans
North Charleston Reach	North Charleston

During maneuvering, both the auxiliary and propulsion engines are in operation. Full power occurs when working the vessel in and out of the dock, or for pilots when they are boarding the vessel. The third engine type is fire pump engines, which are either minimally used, run off the propulsion engines or are electric. Therefore fire pump activities were excluded from the inventory.

The annual emission estimates were calculated based on the activities listed in **Table 6-10** and **Table 6-11**. Annual hours of operation were provided by the Pilot Association, McAllister Towing and Transportation Co. and Moran Towing Co. In the previous inventories, tug main engine operations were estimated based on average maneuvering, tug time and number of ship calls. Therefore an activity comparison for main engine tugboats was provided to compare with previous inventories.

Table 6-10. Harbor Craft Annual Activities

Organization	Main Engine Hours	Auxiliary Engine Hours	Total Hours	Estimate Diesel (gal)
Pilot Association	11,065	4,667	15,732	300,000
McAllister Towing	5,891	6,764	12,655	240,000
Moran Towing	8,359	8,359	16,718	476,334
Total	25,315	19,789	45,104	1,016,334

Reporting Year	Hour Type	Annual Hours	Engine kW
2017 Tugs	Main Engine	14,250	3,840
2011 Tugs	Sail/ Dock	14,253	3,357
2005 Tugs	Sail/ Dock	13,699	3,357

For 2017, the tug median engine size and count were used.

Table 6-11. Tugs Activity Characterizations

Vessel	Main Engine Load Factor[1]	Main Engine kW[2]	Auxiliary Engine Load Factor[1]	Auxiliary Engine kW[2]
Mark	28%	1,902	28%	99
James	32%	2,237	32%	99
Elizabeth[3]	30%	2,289	30%	99
Jeffrey	40%	1,864	30%	99
Moira	46%	1,864	35%	124
Patrick[4]	36%	1,920	30%	114
Donal[4]	25%	2,237	15%	114
Fort Sumter	45%	969	45%	30
Fort Moultrie	45%	969	45%	30
Fort Ripley	45%	522	45%	30
Fort Johnson	45%	298	45%	-

Notes:

[1] Load factor for tug operations are based on actual engine load software data. The pilot association loads are based on alternative approach presented in US EPA Current Methodologies in Preparing Mobile Source Port-Related Emission Inventories (2009) (ICFI, 2009), Table 3-4. Table 3-3 presents load factors generalized for harbor craft that have not been considered.

[2] Engine size is based on actual data provided by each organization.

[3] The Elizabeth load estimate is the average of the Mark and the James per Moran.

[4] Patrick and Donal - Auxiliary engine data was not available, kW estimated from other McAllister tug boats.

6.2.3 Example Calculations

The annual emission estimates were based on a combination of information from **Table 6-10** and **Table 6-11**. An example for Baseline Case NO_X is presented in **Table 6-12**, followed by a sample calculation.

Table 6-12. Tugs Annual Emissions Example Calculation

Vessel	Mode	Source	Engine Count	Total Annual Hours	Engine Size kW	Load Factor	NO_X Emission Factor	Annual Ton
Jeffrey	Assisting	Main	2	2,617	1,864	40%	6.2 g/kWh	13.3
		Aux	2	3,154	99	30%	5.8 g/kWh	0.60

$$Annual\ Emissions = \frac{Hours\ per\ Engine}{Year} \times Engine\ Size \times Load\ Factor \times Emission\ Factor \times \frac{1\ ton}{907{,}185\ g}$$

$$Annual\ Main\ Engine\ Emissions = \left(\frac{2{,}617\ Hours}{Year} \times 1{,}864 kW \times 40\% \times 6.2 \frac{g}{kW-hr} \times \frac{1\ ton}{907{,}185\ g}\right)$$

$$Annual\ Main\ Engine\ Emissions\ \left(\frac{t}{y}\right) = 13.3\ tons/year$$

6.3 Rail

Trains transit between the terminals and the intermodal rail yards are involved with switching operations (short line rail) which is managed by Palmetto Railways. Palmetto Railways maintains the largest transport yard, Cosgrove, Norfolk Southern operates the Seven Mile Yard (switching and line haul), and CSX operates the Bennett Yard (line haul).

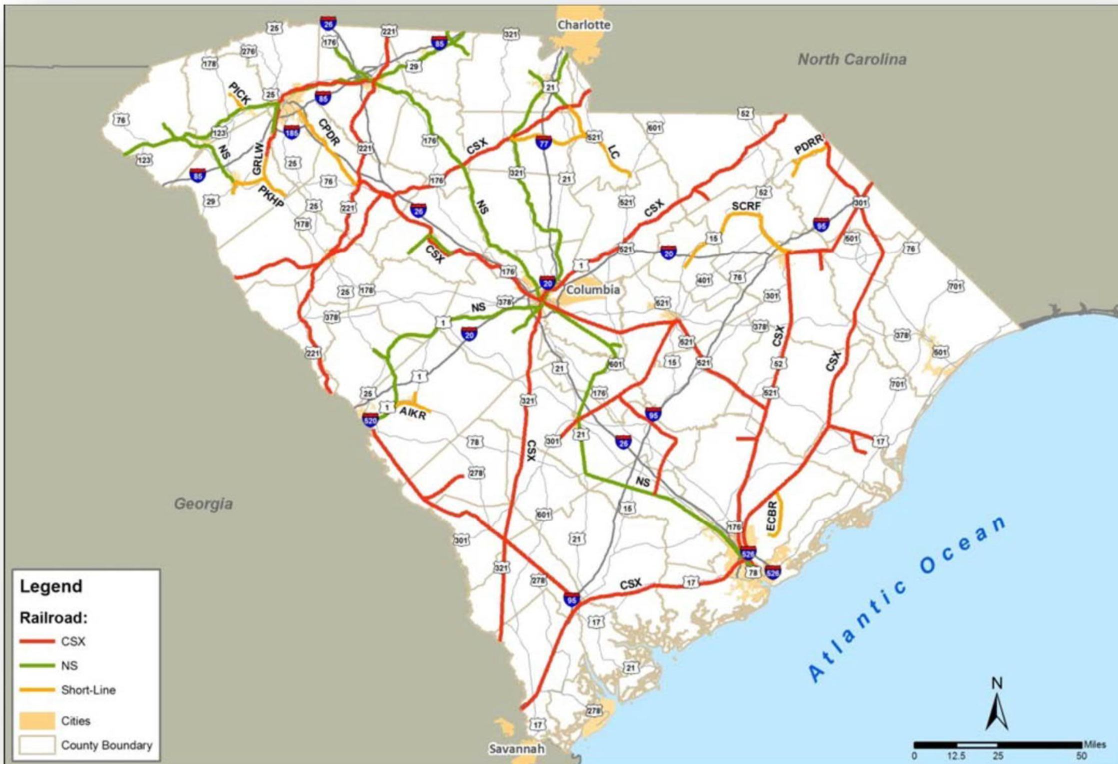


Figure 6-4. South Carolina State Rail Map

6.3.1 South Carolina Multimodal Transportation Plan

The most recent Eastern Regional Technical Advisory Committee (ERTAC) Rail Locomotive Emissions Inventory for the United States report defines Class I line-haul locomotives as newer, larger locomotives used to move trains over long distances (e.g., between major cities). Class I switching locomotives (or, "switchers") are generally older, smaller locomotives that are primarily used at railyards to sort rail cars and build trains for various destinations. Short line railroads often utilize smaller, older locomotives than are used by the Class I's. While locomotives are generally segregated by type of service (line-haul versus switching), individual locomotives can be utilized for both line-haul and switching activities (Environmental Protection Agency, 2017).

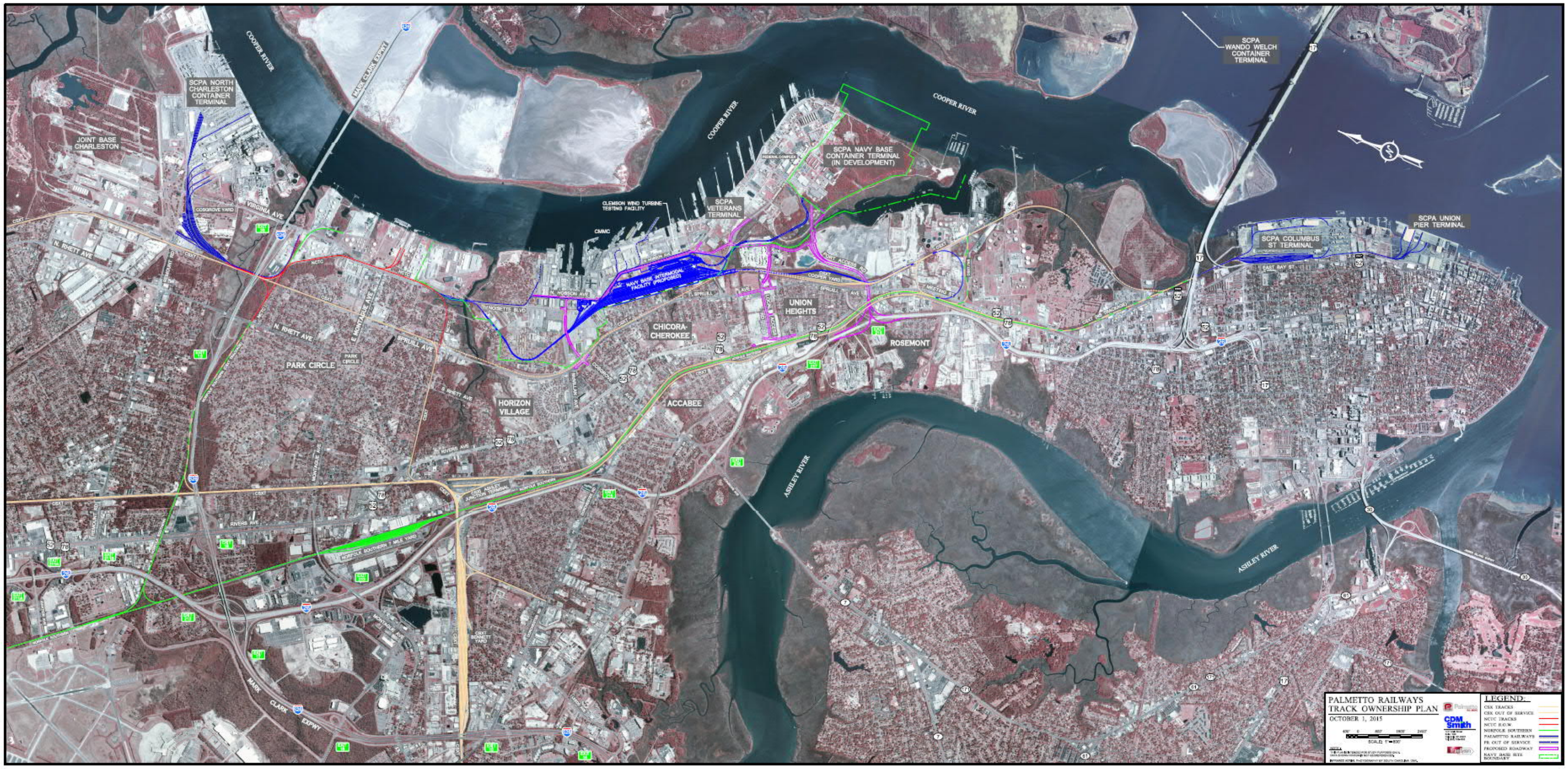


Figure 6-5. Palmetto Railways Track Ownership Plan

According to NS and CSX, the locomotives vary transit and switching operations. Trains may arrive at the intermodal yards with or without containers, and may leave with or without containers. All companies verified engines are operated on ultra-low sulfur diesel. Locomotive engine information for 2017 was obtained from the 2017 Surface Transportation Board R-1 data.

Train emissions are based on long haul operations to and from the intermodal rail yards to the Tri-County boundary line, a distance of approximately 35 mi or a time of 1-hour in each direction, and assumes that trains service the intermodal yards 6 days per week according to the Port of Charleston Intermodal Rail Schedules. Currently CSX and Norfolk Southern each operate 1 to 2 trains per day through the yards, and AECOM assumed the historical standard of 360 containers/TEUs per train.

Facility Emissions include switching operations. Emissions associated with switching are based on hours of operation. Palmetto Railways estimate 3 hours per day per train, and CSX and NS annual hours per switch engine were based on the national averages from the 2017 Surface Transportation Board (STB) R-1 data which provided the nation-wide switch engine train inventory and hours per rail company.

6.3.2 Emission Factors

Emission factors are sourced from Emission Factors for Locomotives Office of Transportation and Air Quality, EPA-420-F-09-025 (EPA, 2009) and the 2014 ERTAC Rail Locomotive Emission Inventories for the United States (EPA, 2014 ERTAC Rail Locomotive Emission Inventories for the United States, 2017). These emission factors are based on fuel consumption rates, and are provided in **Table 6-13.**

Table 6-13. Rail Emission Factors

Locomotive Type		Emission Factors (g/bhp-hr)[1]					
Operation	**Tier**	**NO_x**	**PM_{10}[2]**	**$PM_{2.5}$[3]**	**HC**	**CO**	**SO_2[4]**
Line Haul[5]	0/0+	7.20	0.14	0.14	0.30	1.28	0.005
Switcher	No Tier	17.40	0.38	0.37	1.01	1.83	0.005
Switcher	0	12.60	0.38	0.37	1.01	1.83	0.005
Switcher	0+	10.60	0.17	0.16	0.57	1.83	0.005

Notes:

[1] Emission Factors for Locomotives, Office of Transportation and Air Quality, EPA-420-F-09-025, April 2009 unless otherwise noted.

[2] EPA estimates that the PM_{10} emission rate for locomotives operating on nominally 15 ppm sulfur fuel will be 0.06 g/bhp-hr lower than the PM_{10} emission rate for locomotives operating on 3,000 ppm sulfur fuel, respectively (ICFI, 2009).

[3] $PM_{2.5}$ emission factors can be calculated by assuming that they represent 97% of PM_{10} emissions (ICFI, 2009).

[4] SO_2 emission factor is 0.093888 g/gal based on the nationwide adoption of 15 ppm ultra-low sulfur diesel (ULSD) fuel by the rail industry (ERTAC, 2017).

[5] Emission factors for Tier 0 were applied since the percent of Tier 0 versus Tier 0+ data was unavailable from rail companies.

6.3.3 Activity Characterization

The annual emission estimates were calculated based on the activities listed in **Table 6-14** and **Table 6-15.**

Table 6-14. Container to Rail Activities

Container Movement	Description
2,200,000	SCPA containers moved in CY17 (TEUs)
23%	Percent of Containers to Intermodal (Palmetto Rail)
1.72	Factor for the mix between 20', 40', and 45' containers for unit number (Palmetto Rail)
294,186	Total sent to trains (TEU)
40	Line Haul Average Speed (mph)
35	Line Haul Average Dist To Tri-County Border (mi)

Table 6-15. Rail Activities

Inventory and Operational Data									
Locomotive	Activity Type	Average Hp[1]	Engine Load[2]	Engine Build Date[1]	EPA Tier Certification	Number of Containers[3]	Engine per Train[4]	Train Count Estimate[4]	Hours[5,6]
Charleston Yard	Switching	1,000	11%	1975/1977	0+	23,472	1	1	936
North Charleston Yard	Switching	1,667	11%	1952	No Tier	736	1	1	936
Bennett Yard	Switching	2,026	11%	1970s	0	97,500	4	1	3,197
Bennett Yard	Long-haul	3,502	28%	1990/2000s	0/0+		4	271	948
Seven Mile Yard	Switching	3,000	11%	Multiple	0/0+	196,686	1	1	476
Seven Mile Yard	Long-haul	4,500	28%	Multiple	0/0+		3	546	1,434

Note:

[1] *Average horsepower and engine manufacture date provided by representatives from Palmetto Rail, CSX and Norfolk Southern.*

[2] *Average line-haul locomotive load factor from Table 5-2 (ICFI, 2009) and switch engine the load average determined from time per notched Table 5-6 (ICFI, 2009) and % average hp from SCPA 2011 AEI.*

[3] *Estimate annual rail cars/number of containers based on data from SCPA, Palmetto Rail and CSX.*

[4] *Number of trains or engines per train are not publically released; the 2005 and 2011 SCPA AEIs estimated an average of 360 containers and 4 locomotives per train for long haul.*

[5] *Palmetto Rail switch locomotives average daily operations 3 hours per train, 6 days per week. Each yard has two trains, typically only 1 in operation.*

[6] *For CSX and NS the national average for switch locomotive hours were determined from the 2017 Surface Transportation Board (STB) R-1 Data, 710 train inventory and 755 operational hours.*

For estimating the switch engine load factor, the load per notch typically does not vary year to year, therefore the 2005/2011 load per notch and the average percent of time per notch from Table 5-6 of the EPA Port Mobile Source Guide were utilized (United States Environmental Protection Agency, 2009a). The duty cycle loads are provided in **Table 6-16.**

Table 6-16. Switch Rail Duty Cycle and Load Factors

Notch	% of Rated Power bph[1] M&N	% of Time in this Mode Switcher	Load Factor % per Mode
DB	4.3%	0.0%	0.0%
Idle	0.9%	59.8%	0.5%
1	4.9%	12.4%	0.6%
2	16.2%	12.3%	2.0%
3	29.4%	5.8%	1.7%
4	44.0%	3.6%	1.6%
5	58.5%	3.6%	2.1%
6	73.5%	1.5%	1.1%
7	90.9%	0.2%	0.2%
8	106.0%	0.8%	0.8%
		Sum	**10.6%**

The sum of the product of the duty cycle and the load for each notch level provides a weighted load of 10.6% that is used for the switching operations.

$$weighted\ load\ factor = \sum_{i=1}^{10}(Rated\ Power\ in\ Mode_i \times Time\ in\ Mode_i)$$
$$weighted\ load\ factor = 10.6\%$$

6.3.4 Example Calculations

The annual emission estimates were based on a combination of information from **Table 6-15** and **Table 6-16**. An example for Baseline Case NO_x is included in **Table 6-17**.

Table 6-17. Rail Line Haul Annual Emissions Example Calculation

Number of Trains	Engines per Train	Boundary Distance (mi)	Average Speed (mph)	Average Hp	Average Engine Load %	NO_x Emission Factor (g/bhp-hr)	Annual Emission (Ton)
271	4	35	40	3,502	28%	7.20	7.4

$$Annual\ Emissions = number\ of\ trains \times engines\ per\ train\ \times hours\ (\frac{mi}{mph}) \times horsepower \times engine\ load \times emission\ factor \times \frac{1\ ton}{907{,}185\ g}$$

$$Annual\ Emissions = \frac{271\ trains}{year} \times 4\frac{engines}{train} \times \frac{\left(\frac{35\ mi}{40\ mph}\right)hr}{train} \times 3{,}502 \times 28\% \times 7.20\frac{g}{bhp-hr} \times \frac{1\ tonne}{907{,}185\ g}$$

$$Annual\ Emissions\left(\frac{t}{y}\right) = 7.4\ tons/year$$

6.4 On-Road – Heavy Duty Vehicles

The majority of container movement from the SCPA terminals is by on-road heavy duty vehicles (HDV), with approximately 77% of containers moved by commercial trucks and 100% for breakbulk items. In 2017, a total of 895,113 containers and breakbulk items were trucked from the ports with an average turn-time of 38-45 minutes per truck (varies by terminal). Over half of containers and breakbulk movement goes outside of the Charleston Tri-County area.

All trucks serving the terminals are street trucks capable of pulling any road-legal chassis combination. Due to the highly varied nature of the Flex Time Gate System that is in operation at the terminals, a varied mix of truck operators serves the terminals each day as seen in **Table 6-18**.

Table 6-18. Container Truck Type by Terminal

Type by Terminal	Columbus St.	North Charleston	Wando Welch
Truck Type		Percent	
Bobtails	1%	12%	5%
Chassis	1%	15%	5%
Loads & Empties	98%	73%	90%

The variables listed below were used to assess heavy duty truck emissions. Distance estimates were based on the site layout. The number of trucks, movement and idle breakdown were provided by SCPA operations departments as listed in Table 6-19.

1. The number of truck trips annually;
2. The average time and distance traveled;
3. The on-site movement and idle time; and
4. The distance traveled to and from the main trucking routes to the Tri-County boundary.

This data set along with emission factors from MOVES2014a were used to develop an emission inventory for heavy-duty vehicles at the ports. Container trucks operate 12 hours per day, from 06:00 to 18:00, 6 days per week. No trucks are on-site on Sundays.

Table 6-19. Truck Turn time and Operations

Operation	Container	Breakbulk
Engine Off	0%	70%
Creep Idle	20%	25%
Stop Idle	6%	0%
Moving (10mph)	74%	5%

Idle time is kept to a minimum at all terminals, with container terminals limited to the few minutes trucks are loading/unloading containers, while breakbulk terminals request trucks to shut off engines during paperwork and loading/unloading cargo. Trucks must stay on at container terminals once they past the kiosk for continuous movement and safety concerns.

In addition to heavy duty trucking operations, passenger bus trips are provided by privately owned companies at Union Pier for cruise ships. The distance from the parking lot to the ship is approximately one (1) mile, with an average of 10 idle minutes per round trip. In 2017, there were 12 buses (10 mini buses and 2 motor coaches) that provided a total of 15,449 embark and debark shuttle rides for 79 cruise calls.

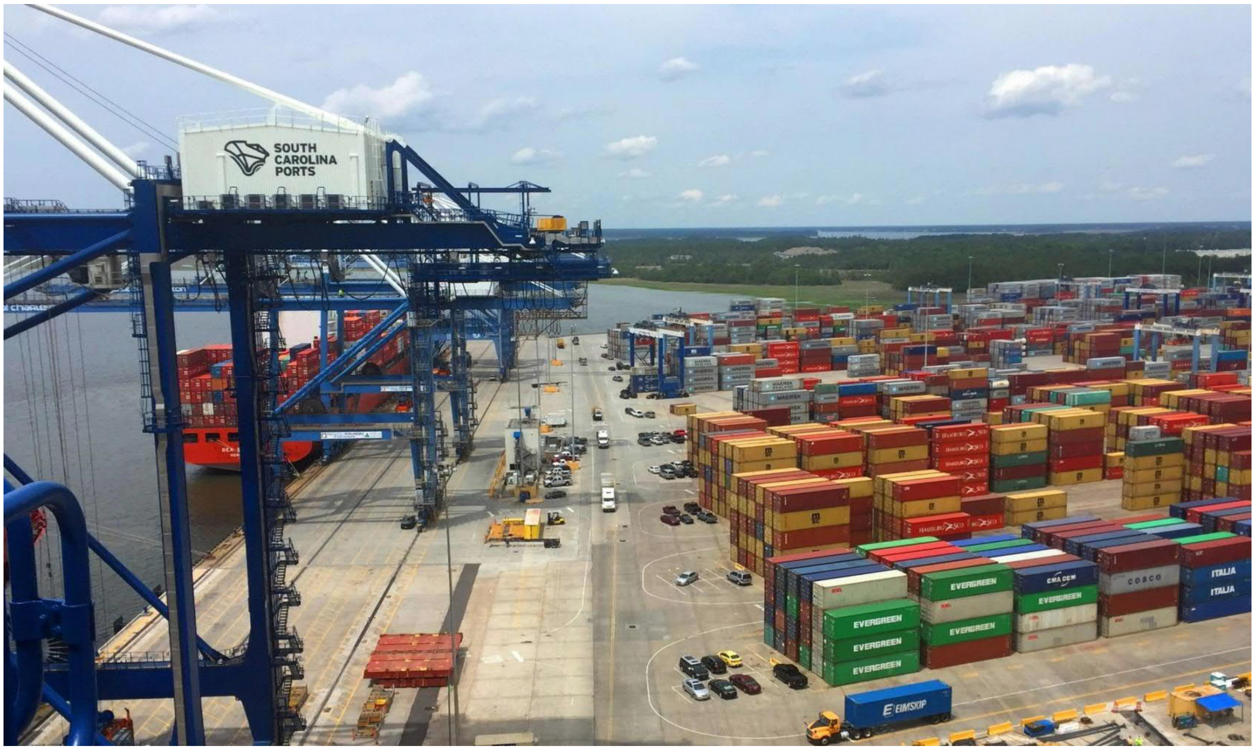


Figure 6-6. Wando Welch Terminal Crane to Container Trucks

6.4.1 Emission Factors

Emission factors were developed using the most recent EPA on-road vehicle emission estimation model, US EPA Motor Vehicle Emission Simulator (MOVES 2014a). The model outputs are in g/mile and g/hour emission factors that address both driving and idling emissions, respectivley.

The emissions are estimated for a single hour rather than a one-year period. The MOVES2014a model was run for a January morning hour and a July afternoon hour to cover the typical coolest to warmest temperature range. The results of the two runs were averaged for the hourly idling emissions estimate. MOVES2014a contains default nationwide data. In order to generate the most accurate emission factors possible, detailed inputs were obtained. The State of South Carolina provided the US EPA with detailed inputs as part of the 2014 National Emissions Inventory (NEI). These inputs were obtained from the US EPA and utilized in the MOVES2014a processing. The US EPA used reference counties to reduce the number of runs performed. They determined that Greenville County represents most of the counties in the State, including the Tri-County area.

For idle and non-idle operations, MOVES2014a was applied using the following specifications:

- Geographic Bounds – Greenville County as a surrogate for Berkeley, Charleston, and Dorchester counties;
- Vehicle Type – Diesel Fuel Combination Long-Haul Truck (for Container and Breakbulk trucks) and Transit Buses (for Shuttle Buses);
- Road type – urban restricted and urban unrestricted; and
- US EPA 2014 NEI county data for fuel supply, fuel formulation, fuel usage fraction, and Alternative Vehicle Fuels and Technology (AVFT).

MOVES2014a was run assuming a variety of speeds, including 0 mile/hr (idle), 10 mile/hr within the port boundaries, and varying speeds outside of port boundaries depending on the posted speed limit, road type, and traffic flow.

MOVES2014a was run using the relative humidity and temperature for January and July provided in the US EPA 2014 NEI MOVES inputs (**Table 6- 20)**, and those numbers were averaged to create an emission factor.

Table 6-20. Average Relative Humidity and Temperature

Parameter	January	July
Relative Humidity[1]	71%	32%
Temperature[1]	-15 ºF	115 ºF

Note:

[1] Meteorological data taken from US EPA 2014 NEI inputs.

6.4.2 Activity Characterization

The annual emission estimates were calculated based on the activities listed in **Table 6-21**.

Table 6-21. Heavy Duty Annual Activities

Activity Variable		Baseline Case
Truck Moves/Year		895,113
Working days/week		6
Trucks/hour, (averages for WWT and NCT)		150-250
Facility	In-Gate Queuing (minutes)	6-8
	Distance Kiosk to Loading (ft)	300
	Idling (%)	6
	Facility Transit Total (min)	38-45
Supply Chain	Round trip to boundary (mi)	40

Each truck is estimated to travel 3 miles while within the facility boundary, and an average of 40 miles to the Tri-County boundary, depending on terminal location and vicinity to I-26 and Highway 17 as listed in **Table 6-25**.

Table 6-22. Heavy Duty Annual Activities by Terminal and Truck Type

Terminal	# of Container Truck Arrivals/Year	# of Breakbulk Arrivals/Year
Columbus Street	-	14,341
North Charleston	178,387	116
Union Pier	-	641
Veterans	-	-
Wando Welch	701,398	230

Note. Container and breakbulk activity provided by the SCPA Terminal Optimization Department and Breakbulk, RO-RO Department respectively.

Table 6-23. Cruise Ship Shuttle Operations

Activity	Mini Bus (Embark)	Motor Coach Bus (Debark)
Cruise Ship Calls	79	
Average Shuttle Ride per Call	106	90
Shuttle Ride per Year	8,339	7,110
Total Embark/Debark	15,449	

Note. Cruise ship shuttle averages and totals were provided by the SCPA Cruise Operations Department.

Table 6-24. Heavy Duty Destination by Truck Type

Truck Type		% Split	Origin/Destination
Containerized	Loads & Empties	23.0%	Offsite Railyards
		16.1%	Local Charleston
		60.9%	Out of Tri-County
	Bobtails	100.0%	Ashley P west of 26
	Chassis	100.0%	Offsite Railyards
Breakbulk	Breakbulk	0.0%	Offsite Railyards
		50.0%	Local Charleston
		50.0%	Out of Tri-County

Note. Container and breakbulk split by destination verified and updated accordingly by the SCPA Terminal Optimization Department and Breakbulk, RO-RO Department respectively.

Table 6-25. Heavy Duty Travel Distance to Off-Site Destination

Destination	Distance (miles) to/from Terminal				
Terminal	**Union Pier**	**Columbus St.**	**North Charleston**	**Wando Welch**	**Veterans**
Offsite Railyards	7.00	6.00	5.50	12.75	-
Local Charleston	15.30	14.30	9.75	16.50	-
Out of Tri-County	51.00	50.00	40.00	52.00	-
Ashley P west of 26	12.30	11.30	6.75	13.50	-
Offsite Railyards	7.00	6.00	5.50	12.75	-
Offsite Railyards	7.00	6.00	5.50	12.75	4.00
Local Charleston	15.30	14.30	9.75	16.50	25.00
Out of Tri-County	51.00	50.00	40.00	52.00	45.00
Typical Routes from Terminal to Tri-County Boundary	Morrison Drive to I-26 W	Via I-26 West	Virginia Ave to I-526, merges with Highway 17A and I-26	I-526 to I-26, with approximately 3-5% taking Hwy 17	Rivers Ave to I-26

Note: There were no significant route changes since the 2011 SCPA AEI, therefore travel distances from the 2011 SCPA AEI were utilized.

6.4.3 Example Calculations

Annual emissions were calculated by combining the emission factors generated by MOVES2014a with the activity data for each port. Example calculations are provided below for idle and non-idle operations.

Example Calculation, On-Port Non-Idle Operations:
For on-port non-idle operations, the annual vehicle miles traveled (VMT) were determined from the number of trucks traveling through the port and the distance traveled on port. The VMT are then multiplied by an emission factor for the assumed road type and speed for the port.

$$Emissions\ (\ tpy) = Annual\ VMT \times Emission\ Factor\ (\frac{g}{VMT}) \times \frac{1\ pound}{453.592\ g} \times \frac{1\ ton}{2{,}000\ pounds}$$

At Wando Welch Terminal, a 3 mile round trip is estimated for 701,398 truck visits for a total of 2,104,194 VMT.

$$Emissions\ (\ tpy) = 2{,}104{,}194 \times 15.23\ \left(\frac{g\ NOx}{VMT}\right) \times \frac{1\ pound}{453.592\ g} \times \frac{1\ ton}{2{,}000\ pounds} = 35.3\ tpy\ NOx$$

Example Calculation, Idle Operations:
For on-port idle operations, the annual idling hours were determined from the number of trucks and the amount of time they are expected to idle for each trip through the port. These idle hours are then multiplied by an idling emission factor.

$$Emissions\ (\ tpy) = Idle\ Time\ (hrs) \times Emission\ Factor(\frac{g}{hr}) \times \frac{1\ pound}{453.592\ g} \times \frac{1\ ton}{2{,}000\ pounds}$$

At Wando Welch Terminal, a truck runs 20% of the time at creep and 6% stop idle for an average truck trip of 38 minutes (0.63 hours). For 701,398 truck visits, this results in 115,345 hours.

$$Emissions\ (\ tpy) = \times\ 115{,}345\ hours\ \times 209.2\ \left(\frac{g\ NOx}{hr}\right) \times \frac{1\ pound}{453.592\ g} \times \frac{1\ ton}{2{,}000\ pounds} = 26.6\ tpy\ NOx$$

Example Calculation, Off-Port Non-Idle Operations:

For off-port non-idle operations, the annual vehicle miles traveled (VMT) was determined for each type of truck and each destination. Arrival and departure times were divided throughout the day for weekday morning rush, evening rush and non-rush, at an estimate of 15%, 10% and 75% respectively. The VMT is then multiplied by an emission factor for the assumed road type and speed for each segment of the trip.

At Wando Welch Terminal, 1,402,796 round truck trips occurred with 90% being load/empty operations. Of these, it was estimated that 75% traveled during non-rush hour traffic, and 23% traveled 9.75 miles to the rail intermodal yard for a total of 2,122,496 miles.

$$Emissions\ (\ tpy) = \times\ 2{,}122{,}496\ VMT\ \times 8.35\ \left(\frac{g\ NOx}{VMT}\right) \times \frac{1\ pound}{453.592\ g} \times \frac{1\ ton}{2{,}000\ pounds} = 19.5\ tpy\ NOx$$

6.5 Non-Road – RTG Cranes and CHE

RTG cranes and CHE are used to move containers in container and intermodal yards. Majority of the RTG cranes and CHE diesel engines are EPA compliant with Tier 2 (RTG 26%, CHE 14%), Tier 3 (RTG 44%, CHE 75%) and Tier 4 (RTG 26%) of the inventory. Scheduled maintenance is performed on the engines as recommended by the manufacturer, such as oil changes every 300 hours of operation.

RTG Crane and CHE equipment inventory data collected included engine manufacturer, EPA tier (provided in place of model year), model, if the engine was previously replaced, hp, fuel type, operating hours and fuel consumption. The majority of data fields were provided with few equipment missing fields. Estimates were made if engine model was unknown based on the same equipment type (for example all Forklifts 36K were estimated at 155 hp). Container cranes are electric power and not included in this inventory because no emissions are associated with electric equipment.

The emissions were determined using data from the 2017 operational year. The annual operating hours along with emission factors from EPA engine certification results, or when engine specific data was unavailable, the MOVES methodology, were used to develop the emission inventory.

6.5.1 Emissions from EPA Engine Certifications

The EPA provides engine certification data within two time frames: 1996 – 2011 and post 2011. As part of the certification process, data is generated to demonstrate compliance with federal regulations. Since the EPA Tier was provided in place of the equipment model year for each equipment, an average emission factor was taken for each engine model for the EPA Tier year range.

6.5.2 Emissions from Non-Road Equipment (MOVES calculation methodology)

If the engine model and tier were not available, emission factors and emissions from non-road equipment (mobile, portable, and stationary fuel-burning equipment) were estimated using EPA's Motor Vehicle Emission Simulator (MOVES) 2014a model methodology. MOVES2014a includes NONROAD2008, EPA's non-road emissions model.

The applicable Source Description for equipment was chosen based on engine duty and horsepower. This cross reference allowed AECOM to match equipment from the MOVES data files which contain the steady state emission factors and load factors. The MOVES emission factors have the deterioration factor built into them, rather than requiring a separate calculation.

6.5.2.1 Calculating Emissions

Annual non-road emissions are estimated using the following equation.

$$E = EF \times HP \times Hours \times Load\ Factor \times \frac{lb}{453.592g} \times \frac{t}{2000lb}$$

Where: *E* = Annual emissions in tons
EF = Emission factor (g/hp-hr)
HP = Rated horsepower hp
Hours = Annual operating hours of the equipment
Load Factor = fraction of available rated power

The load factor is an adjustment included in the model to avoid grossly over counting emissions. It is the average fraction of the rated power of an engine that is expected to be actually used in annual operation. This factor takes into account idling, partial load operation, and transient operation. These factors were based on surveys of equipment users and summarized in the MOVES guidance documents.

6.5.3 Emission Factors

The engine manufacturer, model number and tier were provided for majority of the equipment, allowing for the engine specific EPA engine certification test results to be applied.

Table 6-26. EPA Engine Certification Emission Factors

Engine Data				Emission Factors (g/Bhp-hr)[1]				
Engine Manuf	Engine Model Number	TIER	BHP	HC	CO	NOx	PM	PM_{10}
Cat	3208	-	252	0.36	1.3	5.7	0.31	0.30
Cat	C9	3	275	0.18	1.3	2.5	0.11	0.10
Cat	C13	1	276	0.00	1.6	1.0	0.00	0.00
Cummins	6CT	1	275	0.31	0.5	5.7	0.11	0.11
Cummins	6CT	2	275	0.31	0.5	5.7	0.11	0.11
Cummins	M11	1	335	0.22	1.2	6.6	0.12	0.12
Cummins	QSB 6.7 (164 BHP)	3	164	0.09	0.7	2.7	0.09	0.09
Cummins	QSB 6.7 (220 BHP)	3	220	0.13	0.9	2.6	0.11	0.11
Cummins	QSM11	2	335	0.21	1.0	2.8	0.08	0.08
Cummins	QSM11	3	350	0.11	0.6	2.6	0.07	0.07
Cummins	QSX15	4F	350	0.00	0.0	0.1	0.00	0.00
Detroit Diesel	Series 60 11.1 L	0	365	0.09	2.0	0.0	0.09	0.09
Volvo	TWD1240VE	2	343	0.24	0.4	4.3	0.10	0.09
Volvo	TWD731VE	1	187	0.31	0.5	6.4	0.15	0.14
Volvo	TAD1353GE	3	558	0.06	1.04	2.73	0.12	0.12
Volvo	TAD1352GE	3	558	0.06	1.0	2.7	0.12	0.12
Volvo	TAD1242GE	2	524	0.00	0.5	4.3	0.09	0.09

Tier 1 standards were published as a final rule on June 5, 1991 and phased-in progressively between 1994 and 1997.

Engine Data				Emission Factors (g/Bhp-hr)[1]				
Engine Manuf	Engine Model Number	TIER	BHP	HC	CO	NOx	PM	PM_{10}

Tier 2 standards were adopted on December 21, 1999, with a phase-in implementation schedule from 2004 to 2009.
Tier 3 standards were finalized on March 3, 2014, to be phased-in between 2017 and 2025.
PM_{10} was estimated to be 97% of PM.

US EPA MOVES methodology was used to develop the emission factors based on the equipment type and horsepower. Default MOVES data was used for Charleston County, SC. All default data was the same across the Tri-County area. Average emission factors are provided in Table 6-27.

Table 6-27. MOVES Average Emission Factors

MOVES2014a NONROAD Category	Emission Factors (g/Bhp-day)[1]							
	BHP	HC	CO	NO_X	PM	PM_{10}	$PM_{2.5}$	SO_2
Cranes	631	0.18	0.72	2.57	0.10	0.10	0.10	0.003
Rubber Tire Loaders	384	0.17	0.70	1.87	0.12	0.12	0.12	0.003
Forklifts	198	0.14	0.21	0.64	0.03	0.03	0.03	0.003

6.5.4 Activity Characterization

Calculations of annual emissions estimates were based on the activities listed in **Table 6-28**. Activity data for SCPA were based on information reported by the Crane and Equipment Maintenance Department and due to confidentiality, estimates were provided from the railway companies. Load factors were based on **Table 4-5**, CHE Useful Life and Load Factors or US EPA MOVES depending on the emission factor set utilized for the equipment (USEPA, 2009a).

Table 6-28. RTG Crane and CHE Annual Activities

Equipment	Equipment Count	Tier Median	BHP Average	2017 Hours Average	2017 Diesel Use Average (gal)
SCPA					
Container Handler, Empty Count	32	3	206	1,626	3,337
Container Handler, Full Count	42	3	316	2,353	9,161
Crane, RTG Count	50	3	577	2,067	13,192
Crane, Truck Count	4	3	440	1,170	2,302
Forklift 36K Count	13	-	155	742	1,460
Forklift 55K Count	3	-	202	244	68
Railway Companies					
Machine Lift	6	3	380	4,160	-
Reach Stacker	4	-	300	4,160	-
Side Loader	1	-	155	4,160	-
Fork Lift	2	-	155	4,160	-

6.5.5 Example Calculations

Annual emissions were based on a combination of information from annual activities, EPA emission factors and MOVES2014a emission factors. An example for NO_x is included in **Table 6-30**, followed by a sample calculation.

Table 6-29. RTG Crane and CHE Example Calculation

Equipment	ID	Tier	Annual Hours	Rated Power (hp)	Load Factor for EPA EF	MOVES NO_X Emission Factor (g/hp-hr)	Annual Ton
RTG Crane	H-41-009	3	3,285	558	0.43	2.58	2.24

$$Annual\ Emissions = Annual\ Hours\ per\ Equipment \times Rated\ hp \times load\ factor \times emission\ factor \times \frac{1\ ton}{907{,}185\ g}$$

$$Annual\ Emissions = 3{,}285\frac{hr}{year} \times 558\ hp \times 43\% \times 2.58\frac{g}{hp-hr} \times \frac{1\ ton}{907{,}185\ g}$$

$$Annual\ Emissions\left(\frac{t}{y}\right) = 2.24\ tons/year$$

7. References

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Appendix 1

2017 Emissions Calculations

AECOM

Appendix 2

Port Emissions in Regional Context

Port Emissions in Regional Context

Estimates of port emissions were also examined in a regional context in several different ways. First the SCPA emission estimates were compared to the USEPA's 2014 National Emissions Inventory (NEI) version 2 for the Tri-County area. Next, the changes in SCPA emission estimates from 2011 to 2017 were compared to the changes in monitored values from Charleston area ambient air quality monitors. Finally, the change in emission estimates for the Wando Welch Terminal was compared to the change in monitored values from the Wando Welch Terminal monitor.

Comparison to the NEI

The USEPA releases a new NEI every three years. The latest available inventory is for 2014. The change in SCPA emissions from 2011 to 2017 were compared to the change in NEI emissions from 2011 to 2014 for port related emission sectors in order to compare trends.

Table 1 below presents this comparison. The Tri-County area shows a decrease in port related emissions for all pollutants of concern. The difference in SCPA emission estimates shows a decrease in $PM_{2.5}$, PM_{10}, and SO_2 emissions, but a small increase in CO and NO_x emissions. By examining the sectors, it appears that SCPA on-road diesel trucks emissions for these two pollutants have increased, while overall Tri-County area emissions of these trucks have decreased. This is most likely due to the increase in truck visits of almost 60,000 to SCPA ports from 2011 to 2017.

Comparison to Area Monitors

There are several State-run ambient monitors in the Charleston area. SC DHEC operates one $PM_{2.5}$ monitor at the Charleston Public Works (AQS ID 45-019-0049) just to the west of downtown Charleston. SC DHEC also operates one NO_2 and one SO_2 monitor in North Charleston on Jenkins Avenue (AQS ID 45-019-0003). The locations of these monitors with respect to the ports are shown in Figure 1 below.

Table 2 below presents the percent change in estimated emissions from 2011 to 2017 for all SCPA ports compared to the percent change in average annual ambient concentrations at the monitors listed above. A negative value indicates that emissions or concentrations in 2017 are less than 2011 values. The trends are similar for both emissions and concentrations.

Comparison to Wando Welch Terminal Monitor

An ambient monitor that measures NO_2, SO_2, and $PM_{2.5}$ has been operating at the Wando Welch Terminal since May 2011. Since the monitor is located at the port terminal, it is necessary to estimate a background concentration for the monitor. This background concentration would be due to other sources in the area not associated with the port. To do this, the cumulative frequency of the 1-hour daily maximums of NO_2 and SO_2, and the daily average $PM_{2.5}$ were calculated and plotted (Figures 2 to 4). The estimated background concentration was taken from the point on the plot where the concentrations began to increase sharply, where a transition from regional sources to local sources can be identified. Due to the subjective methodology, some local influence may remain in the selected background concentrations, but the largest influence would be regional.

To determine the percent change in concentrations, the estimated background value was subtracted from the design value (DV) for each year. Then the percent change was calculated. The DVs were calculated as:

- NO_2 DV equals the 98th percentile of the 1-hour daily maximums,

- SO_2 DV equals the 99th percentile of the 1-hour daily maximums, and
- $PM_{2.5}$ DV equals the 98th percentile of the daily averages.

An example calculation for determining the percent change in NO_2 concentrations is provided below. Given that the 2017 DV is 59 ppb and the 2017 estimated background is 38 ppb, and the 2011 DV is 42 ppb and the 2011 background is 28 ppb, the percent change would be:

$$\frac{(59-38)-(42-28)}{\left(\frac{(59-38)+(42-28)}{2}\right)} \times 100 = 40\%$$

This percent change in concentrations was then compared to the percent change in estimated emissions for the Wando Welch Terminal (Table 3).

For SO_2 and NO_2, the change in the Wando Welch Terminal emission estimates and the monitored concentrations show similar tends. The change in emission estimates of $PM_{2.5}$ show a small decrease; however, the monitored concentrations show an increase. One possible cause in this difference in trends could be due to road dust. The emission estimates of $PM_{2.5}$ only include engine emissions, while the monitor concentrations include all $PM_{2.5}$.

Table 1. Comparison of 2017 and 2011 SCPA Emissions Differences to 2014 and 2011 NEI Emissions Differences

Pollutant	SCPA Source Type	2017-2011 SCPA Emissions Difference (tpy)	NEI Source Type	2014-2011 NEI Tri-County Emissions Difference (tpy)
CO	OGV + Tugs	40	Commercial Marine Vessels	304
	Trucks	45	On-Road – Diesel Heavy Duty	-855
	Rail	0	Locomotives	-72
	CHE	-21	Non-Road - Diesel	-236
	Total	**64**		**-859**
NO_x	OGV + Tugs	115	Commercial Marine Vessels	2576
	Trucks	92	On-Road – Diesel Heavy Duty	-2757
	Rail	-5	Locomotives	-646
	CHE	5	Non-Road - Diesel	-363
	Total	**207**		**-1190**
$PM_{2.5}$	OGV + Tugs	-42	Commercial Marine Vessels	-62
	Trucks	8	On-Road – Diesel Heavy Duty	-168
	Rail	-1	Locomotives	-20
	CHE	-2	Non-Road - Diesel	-33
	Total	**-37**		**-283**
PM_{10}	OGV + Tugs	-47	Commercial Marine Vessels	-72
	Trucks	10	On-Road – Diesel Heavy Duty	-205
	Rail	-1	Locomotives	-21
	CHE	-2	Non-Road - Diesel	-34
	Total	**-40**		**-332**
SO_2	OGV + Tugs	-1429	Commercial Marine Vessels	-622
	Trucks	1	On-Road – Diesel Heavy Duty	-3
	Rail	0	Locomotives	-12
	CHE	0	Non-Road - Diesel	-2
	Total	**-1428**		**-638**

Table 2. Percent Change in
Estimated SCPA Emissions and Charleston Area Monitored Concentrations

Pollutant	% Change in Estimated SCPA Emissions	% Change in Average Annual Monitored Concentrations
NO_2	8%	4%
SO_2	-183%	-58%
$PM_{2.5}$	-19%	-34%

Table 3. Percent Change in
Estimated Emissions and Monitored Concentrations at Wando Welch Terminal

Pollutant	% Change in Estimated Emissions	2017		2011		% Change in Monitored Concentrations
		Design Value	Background	Design Value	Background	
NO_2	21%	59 ppb	38 ppb	42 ppb	28 ppb	40%
SO_2	-182%	7 ppb	5 ppb	70 ppb	30 ppb	-181%
$PM_{2.5}$	-7%	37 µg/m^3	24 µg/m^3	25 µg/m^3	15 µg/m^3	26%

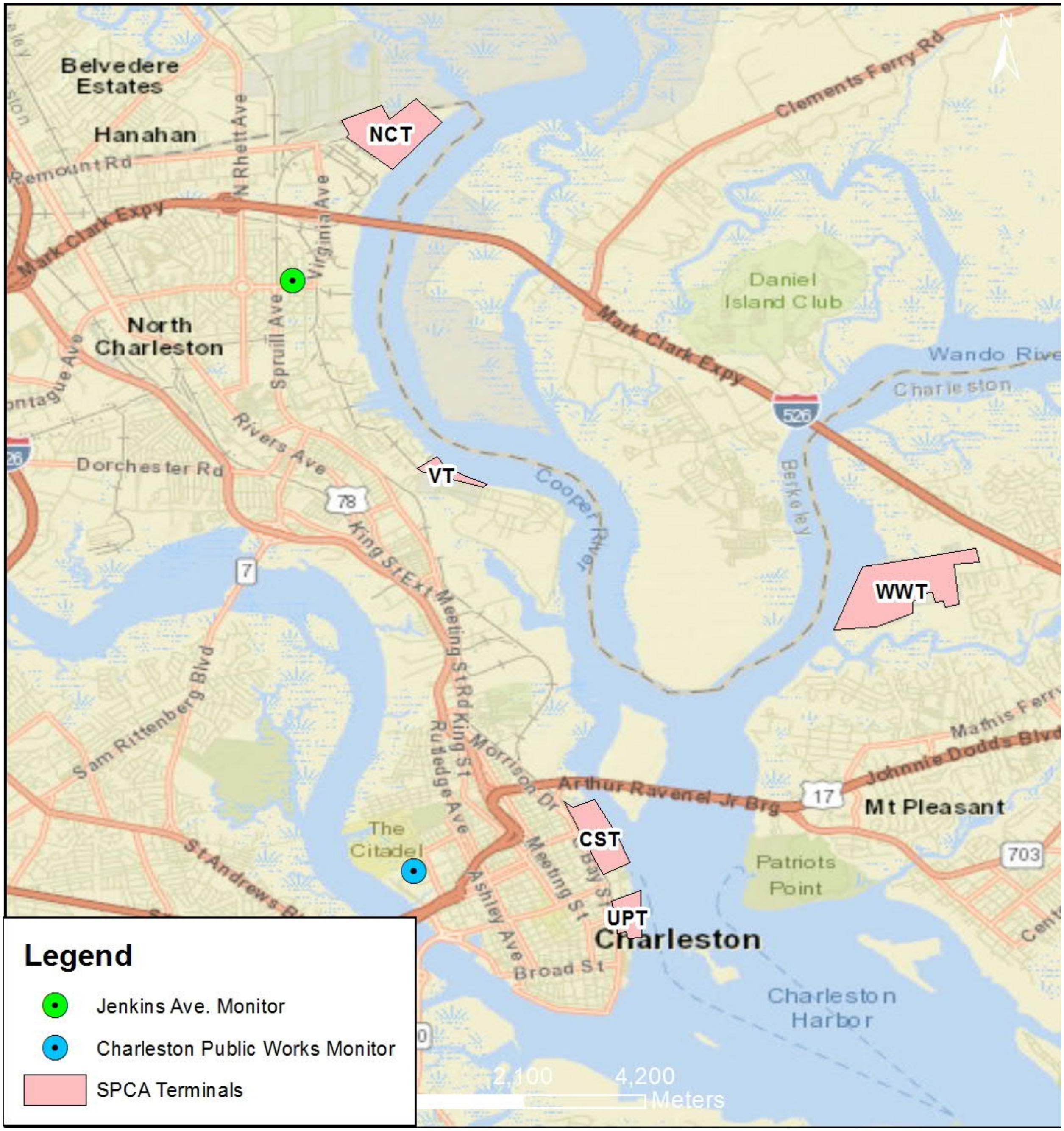

Figure 1. Location of Ambient Monitors

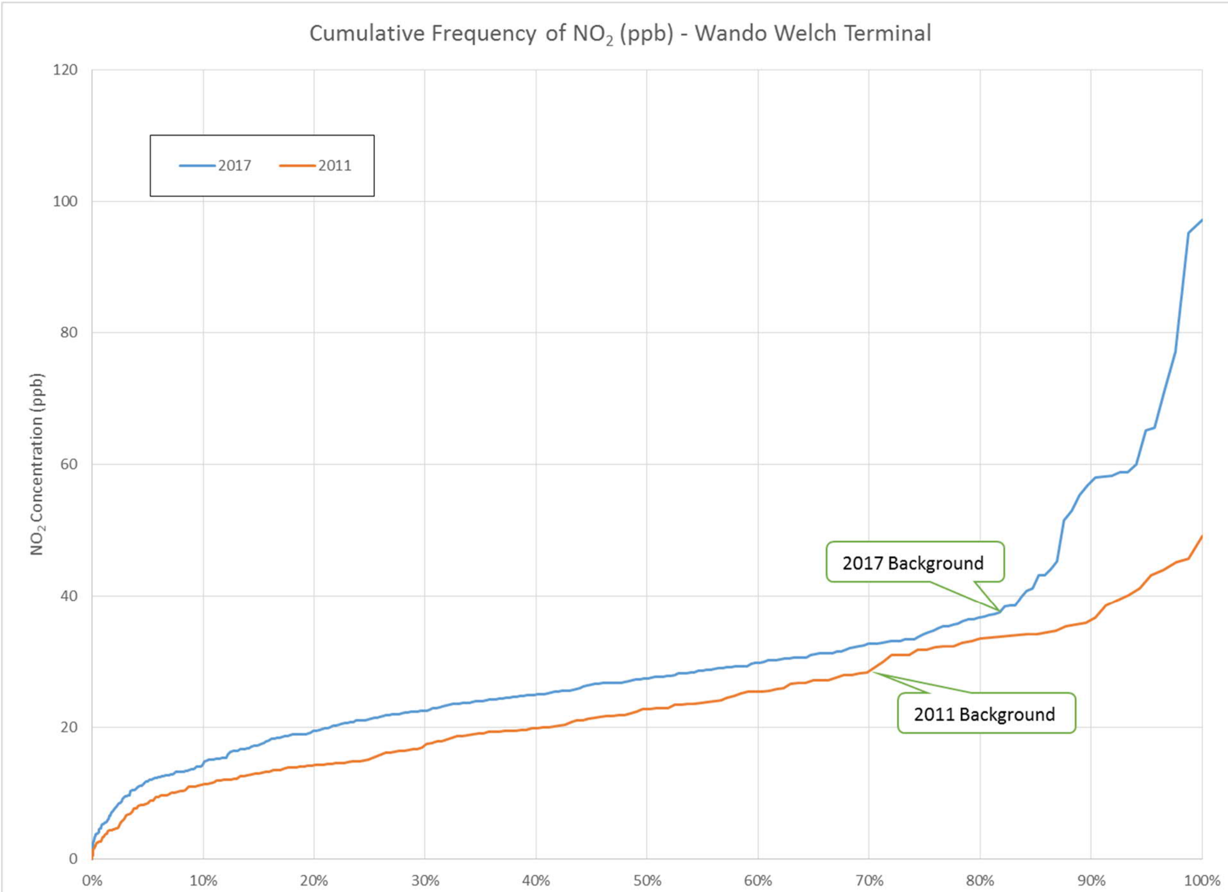

Figure 2. NO_2 Cumulative Frequency Plot

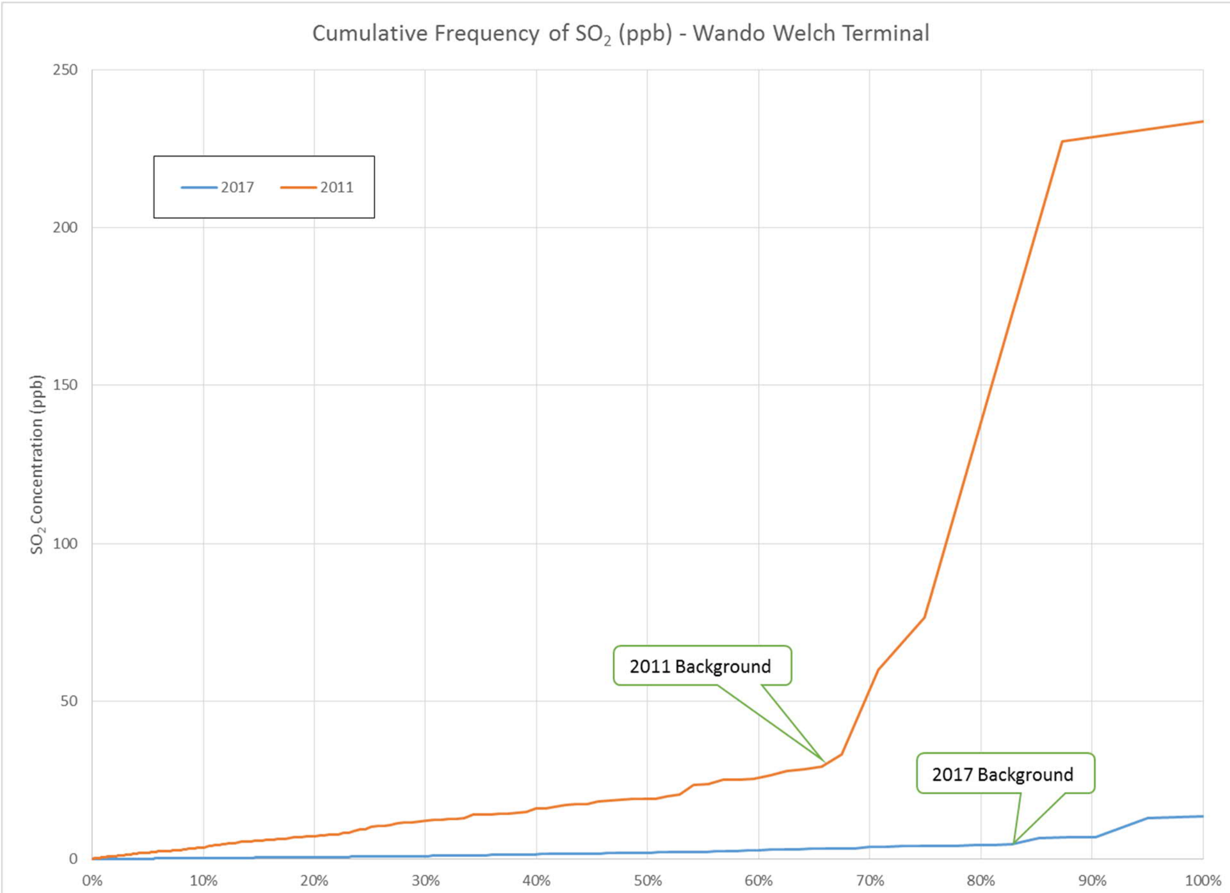

Figure 3. SO_2 Cumulative Frequency Plot

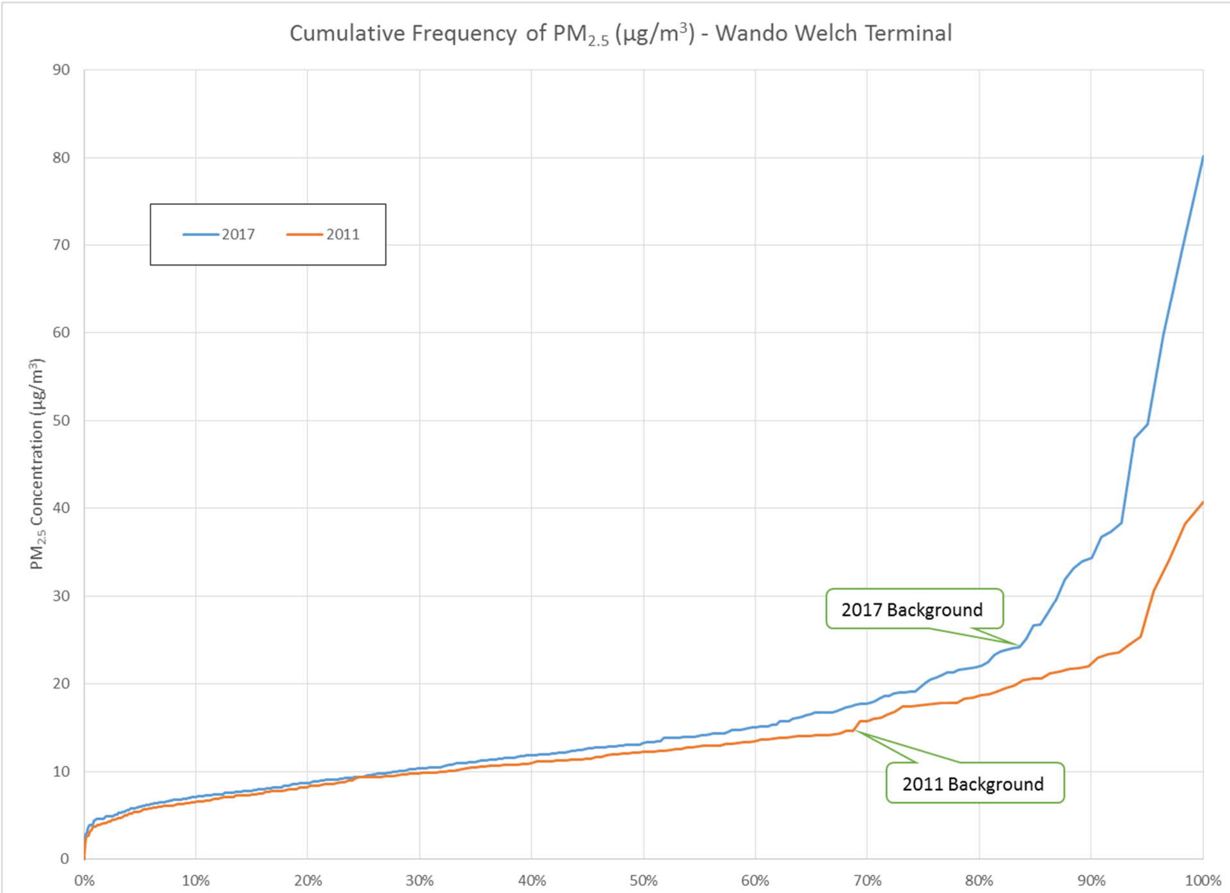

Figure 4. $PM_{2.5}$ Cumulative Frequency Plot

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Appendix 1

2017 Emissions Calculations

Ocean Going Vessels

2017 Emissions Calculations

South Carolina Ports Authority
2017 Air Emissions Inventory Update

		Columbus St.	North Charleston	Union Pier	Wando Welch	Veterans	Total
		Total	Total	Total	Total	Total	
Auto Carrier	NO_x	111.7	0	0	0	0	111.7
	PM_{10}	8.34	0	0	0	0	8.34
	$PM_{2.5}$	7.68	0	0	0	0	7.68
	HC	5.62	0	0	0	0	5.62
	CO	11.81	0	0	0	0	11.81
	SO_2	4.25	0	0	0	0	4.25
Container	NO_x	2.14	477.3	0	1,076	0	1,555
	PM_{10}	0.15	39.45	0	91.89	0	131.5
	$PM_{2.5}$	0.14	36.35	0	84.59	0	121.1
	HC	0.14	35.97	0	73.78	0	109.89
	CO	0.26	62.40	0	132.2	0	194.9
	SO_2	0.07	16.4	0	37.7	0	54.19
Barge	NO_x	0.60	0	0	0	3.59	4.19
	PM_{10}	0.08	0	0	0	0.49	0.56
	$PM_{2.5}$	0.07	0	0	0	0.45	0.52
	HC	0.03	0	0	0	0.23	0.26
	CO	0.06	0	0	0	0.44	0.51
	SO_2	0.02	0	0	0	0.13	0.16
Ro-Ro	NO_x	0.96	0	0	0	0	0.96
	PM_{10}	0.06	0	0	0	0	0.06
	$PM_{2.5}$	0.05	0	0	0	0	0.05
	HC	0.04	0	0	0	0	0.04
	CO	0.10	0	0	0	0	0.10
	SO_2	0.04	0	0	0	0	0.04
Cruise	NO_x	0.72	0	83.7	0	0	84.4
	PM_{10}	0.08	0	8.59	0	0	8.67
	$PM_{2.5}$	0.08	0	7.93	0	0	8.00
	HC	0.03	0	3.52	0	0	3.55
	CO	0.07	0	8.18	0	0	8.25
	SO_2	0.03	0	3.10	0	0	3.13
Breakbulk	NO_x	17.65	0	0	0	1.16	18.81
	PM_{10}	1.56	0	0	0	0.08	1.64
	$PM_{2.5}$	1.44	0	0	0	0.07	1.51
	HC	0.83	0	0	0	0.05	0.88
	CO	1.79	0	0	0	0.12	1.90
	SO_2	0.73	0	0	0	0.08	0.81
Total	NO_x	133.8	477.3	83.7	1,076	4.76	**1,775**
	PM_{10}	10.28	39.45	8.59	91.89	0.56	**150.8**
	$PM_{2.5}$	9.46	36.35	7.93	84.59	0.52	**138.9**
	HC	6.69	35.97	3.52	73.78	0.27	**120.24**
	CO	14.08	62.40	8.18	132.2	0.56	**217.5**
	SO_2	5.14	16.4	3.10	37.7	0.21	**62.56**

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		Off Terminal			On Terminal	
		Transit	Maneuver	Subtotal Off Terminal	Hotel	Total
Columbus Street	NO_x	68.3	13.1	81.3	52.5	133.8
	PM_{10}	6.1	1.4	7.5	2.8	10.3
	$PM_{2.5}$	5.6	1.3	6.9	2.6	9.5
	HC	3.1	1.7	4.8	1.9	6.7
	CO	7.2	1.7	9.0	5.1	14.1
	SO_2	2.0	0.3	2.4	2.8	5.1
North Charleston	NO_x	274.3	60.7	335.0	142.3	477.3
	PM_{10}	26.5	6.8	33.2	6.2	39.5
	$PM_{2.5}$	24.4	6.2	30.7	5.7	36.4
	HC	22.1	8.7	30.8	5.2	36.0
	CO	40.2	8.3	48.5	13.9	62.4
	SO_2	7.9	1.4	9.3	7.1	16.4
Union Pier	NO_x	64.9	1.9	66.9	16.8	83.7
	PM_{10}	7.8	0.1	7.9	0.6	8.6
	$PM_{2.5}$	7.2	0.1	7.3	0.6	7.9
	HC	2.9	0.1	2.9	0.6	3.5
	CO	6.4	0.2	6.5	1.6	8.2
	SO_2	2.4	0.1	2.5	0.6	3.1
Veteran's	NO_x	2.7	0.3	3.0	1.7	4.8
	PM_{10}	0.4	0.1	0.4	0.1	0.6
	$PM_{2.5}$	0.3	0.0	0.4	0.1	0.5
	HC	0.2	0.0	0.2	0.1	0.3
	CO	0.3	0.0	0.4	0.2	0.6
	SO_2	0.1	0.0	0.1	0.1	0.2
Wando Welch	NO_x	522.5	146.2	668.7	407.2	1,075.8
	PM_{10}	51.4	16.9	68.3	23.6	91.9
	$PM_{2.5}$	47.4	15.6	63.0	21.6	84.6
	HC	38.9	20.3	59.2	14.5	73.8
	CO	73.1	19.7	92.8	39.4	132.2
	SO_2	15.2	3.5	18.6	19.1	37.7
Total	NO_x	932.6	222.2	1,154.9	620.5	1,775.4
	PM_{10}	92.2	25.2	117.4	33.4	150.8
	$PM_{2.5}$	85.0	23.2	108.2	30.6	138.9
	HC	67.2	30.8	98.0	22.3	120.2
	CO	127.2	30.0	157.2	60.3	217.5
	SO_2	27.6	5.3	32.9	29.7	62.6

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Emission Factors for OGV Main Engines, adjusted to 0.1% Sulfur (g/kWh)[1]

Engine Type	Fuel Type	Sulfur (%)	Emission Factors (g/kWh)					
			NO_x[2]	PM_{10}	$PM_{2.5}$	HC	CO	SO_x[3]
SSD	Residual	0.10	14.52	1.42	1.31	0.60	1.40	0.38
MSD	Residual	0.10	11.23	1.43	1.32	0.50	1.10	0.42

1 Emission factors from ICFI, 2009, Table 2-9.

2 NO_x emission factors adjusted for IMO standard reduction, ICFI, 2009 Table 2-12. Analysis year 2015 applied for CY2017 emissions.

3 SO_x emission factors adjusted for sulfur content of 0.1%, per International Maritime Organization fuel standard.

3 PM emission factors for distillate oil from Emissions Estimation Methodology for Ocean-Going Vessels, May 2011, California Air Resources Board, Planning and Technical Support Division.

Emission Factors for OGV Main Engines, per ICFI, 2009 (g/kWh)[1]

Engine Type	Fuel Type	Sulfur (%)	Emission Factors (g/kWh)					
			NO_x	PM_{10}	$PM_{2.5}$	HC	CO	SO_x
SSD	Residual	2.70	18.10	1.42	1.31	0.60	1.40	10.29
	Distillate	1.00	17.00	0.45	0.42	0.60	1.40	3.62
MSD	Residual	2.70	14.00	1.43	1.32	0.50	1.10	11.24
	Distillate	1.00	13.20	0.47	0.43	0.50	1.10	3.97

1 Emission factors from ICFI, 2009, Table 2-9.

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2017 Air Emissions Inventory Update

Auxiliary Engine Emission Factors, g/kWh

Fuel Type	Sulfur (%)	Emission Factors (g/kWh)					
		NOx^2	PM_{10}	$PM_{2.5}$	HC	CO	$SO_x{}^3$
Residual	0.10	11.8	1.44	1.32	0.40	1.10	0.44
Distillate	0.10	11.2	0.25	0.23	0.40	1.10	0.42

1 Emission factors from ICFI, 2009, Table 2-16.

2 NO_x emission factors adjusted for IMO standard reduction, ICFI, 2009 Table 2-12. Analysis year 2015 applied for CY2017 emissions.

3 SO_x emission factors adjusted for sulfur content of 0.1%, per International Maritime Organization fuel standard.

4 PM emission factors for distillate oil from Emissions Estimation Methodology for Ocean-Going Vessels, May 2011, California Air Resources Board, Planning and Technical Support Division.

Auxiliary Engine Emission Factors, g/kWh

Fuel Type	Sulfur (%)	Emission Factors (g/kWh)					
		NO_x	PM_{10}	$PM_{2.5}$	HC	CO	SO_x
Residual	2.70	14.7	1.44	1.32	0.40	1.10	11.98
Distillate	1.00	13.9	0.49	0.45	0.40	1.10	4.24

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2017 Air Emissions Inventory Update

Boiler Emission Factors[1,2]

Engine Type	Fuel Type	Sulfur (%)	Emission Factors (g/kWh)					
			NO_x	PM_{10}	$PM_{2.5}$	HC	CO	SO_x[3]
ST	Residual	0.10	2.10	1.47	1.35	0.10	0.20	0.60
	Distillate	0.10	2.00	0.58	0.53	0.10	0.20	0.57

1 Emission factors for steam turbines used for boiler emissions calculations, per ICFI, 2009, Chapter 2. Emission factors from ICFI, 2009, Table 2-9.
2 Assume all auxiliary boilers burned distillate fuel only.
3 SO_x emission factors adjusted for sulfur content of 0.1%, per International Maritime Organization fuel standard.

Auxiliary Boiler Energy Defaults, kW[1]

Ship Type	Cruise	RSZ	Maneuver	Hotel
Auto Carrier	0	0	371	371
Breakbulk	0	0	109	109
Container	0	0	506	506
Cruise	0	0	1,000	1,000
General Cargo	0	0	106	106
Miscellaneous	0	0	371	371
OG Tug	0	0	0	0
Ro-Ro	0	0	109	109
Reefer	0	0	464	464
Tanker	0	0	371	3,000
Tanker-ED	0	0	346	346

1 Boiler sizing data from ICFI, 2009, Table 2-17.

Boiler Emission Factors[1,2]

Engine Type	Fuel Type	Sulfur (%)	Emission Factors (g/kWh)					
			NO_x	PM_{10}	$PM_{2.5}$	VOC	CO	SO_x
ST	Residual	2.70	2.10	1.47	1.35	0.10	0.20	16.10
	Distillate	1.00	2.00	0.58	0.53	0.10	0.20	5.67

Low Load Multiplicative Adjustment Factors[1]

Load	NO_x	PM_{10}	$PM_{2.5}$	VOC	CO	SO_x
1%	11.47	19.17	19.17	59.28	19.32	5.99
2%	4.63	7.29	7.29	21.18	9.68	3.36
3%	2.92	4.33	4.33	11.68	6.46	2.49
4%	2.21	3.09	3.09	7.71	4.86	2.05
5%	1.83	2.44	2.44	5.61	3.89	1.79
6%	1.60	2.04	2.04	4.35	3.25	1.61
7%	1.45	1.79	1.79	3.52	2.79	1.49
8%	1.35	1.61	1.61	2.95	2.45	1.39
9%	1.27	1.48	1.48	2.52	2.18	1.32
10%	1.22	1.38	1.38	2.20	1.96	1.26
11%	1.17	1.30	1.30	1.96	1.79	1.21
12%	1.14	1.24	1.24	1.76	1.64	1.18
13%	1.11	1.19	1.19	1.60	1.52	1.14
14%	1.08	1.15	1.15	1.47	1.41	1.11
15%	1.06	1.11	1.11	1.36	1.32	1.09
16%	1.05	1.08	1.08	1.26	1.24	1.07
17%	1.03	1.06	1.06	1.18	1.17	1.05
18%	1.02	1.04	1.04	1.11	1.11	1.03
19%	1.01	1.02	1.02	1.05	1.05	1.01
20%	1.00	1.00	1.00	1.00	1.00	1.00

1 Low load factors from ICFI, 2009, Table 2-15.

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Vessel Movement Data

Terminal	Vessel Type	Distance (naut miles)				Speed (knts)				Time in Mode - Round Trip (hrs)				Auxiliary Engine Load Factors			
			Reduced Speed Zone				Reduced Speed Zone				Reduced Speed Zone						
		Cruise	Outside BW	Inside BW	Maneuver	Cruise	Outside BW	Inside BW	Maneuver	Cruise	Outside BW	Inside BW	Maneuver	Cruise	RSZ	Maneuver	Hotel
Union Pier	Auto Carrier	0	12.3	7.2	2.0	19.6	13.6	9.2	4.0	0.0	1.8	1.6	1.0	0.15	0.30	0.45	0.26
	Container					24.2	13.2	8.4	4.0	0.0	1.9	1.7	1.0	0.13	0.25	0.48	0.19
	Barge					14.5	9.0	6.0	4.0	0.0	2.7	2.4	1.0	0.17	0.27	0.45	0.22
	Ro-Ro					15.7	11.6	9.0	4.0	0.0	2.1	1.6	1.0	0.15	0.30	0.45	0.26
	Cruise					18.6	14.3	11.2	4.0	0.0	1.7	1.3	1.0	0.80	0.80	0.80	0.64
	Breakbulk					15.5	12.4	10.3	4.0	0.0	2.0	1.4	1.0	0.17	0.27	0.45	0.10
Columbus Street	Auto Carrier	0	12.3	7.9	2.0	19.6	13.6	9.2	4.0	0.0	1.8	1.7	1.0	0.15	0.30	0.45	0.26
	Container					24.2	13.2	8.4	4.0	0.0	1.9	1.9	1.0	0.13	0.25	0.48	0.19
	Barge					14.5	9.0	6.0	4.0	0.0	2.7	2.6	1.0	0.17	0.27	0.45	0.22
	Ro-Ro					15.7	11.6	9.0	4.0	0.0	2.1	1.8	1.0	0.15	0.30	0.45	0.26
	Cruise					18.6	14.3	11.2	4.0	0.0	1.7	1.4	1.0	0.80	0.80	0.80	0.64
	Breakbulk					15.5	12.4	10.3	4.0	0.0	2.0	1.5	1.0	0.17	0.27	0.45	0.10
Wando Welch	Auto Carrier	0	12.3	10.3	2.0	19.6	13.6	9.2	4.0	0.0	1.8	2.2	1.0	0.15	0.30	0.45	0.26
	Container					24.2	13.2	8.4	4.0	0.0	1.9	2.4	1.0	0.13	0.25	0.48	0.19
	Barge					14.5	9.0	6.0	4.0	0.0	2.7	3.4	1.0	0.17	0.27	0.45	0.22
	Ro-Ro					15.7	11.6	9.0	4.0	0.0	2.1	2.3	1.0	0.15	0.30	0.45	0.26
	Cruise					18.6	14.3	11.2	4.0	0.0	1.7	1.8	1.0	0.80	0.80	0.80	0.64
	Breakbulk					15.5	12.4	10.3	4.0	0.0	2.0	2.0	1.0	0.17	0.27	0.45	0.10
North Charleston	Auto Carrier	0	12.3	15.4	2.0	19.6	13.6	9.2	4.0	0.0	1.8	3.3	1.0	0.15	0.30	0.45	0.26
	Container					24.2	13.2	8.4	4.0	0.0	1.9	3.7	1.0	0.13	0.25	0.48	0.19
	Barge					14.5	9.0	6.0	4.0	0.0	2.7	5.1	1.0	0.17	0.27	0.45	0.22
	Ro-Ro					15.7	11.6	9.0	4.0	0.0	2.1	3.4	1.0	0.15	0.30	0.45	0.26
	Cruise					18.6	14.3	11.2	4.0	0.0	1.7	2.8	1.0	0.80	0.80	0.80	0.64
	Breakbulk					15.5	12.4	10.3	4.0	0.0	2.0	3.0	1.0	0.17	0.27	0.45	0.10
Veteran's	Auto Carrier	0	12.3	15.4	2.0	19.6	13.6	9.2	4.0	0.0	1.8	3.3	1.0	0.15	0.30	0.45	0.26
	Container					24.2	13.2	8.4	4.0	0.0	1.9	3.7	1.0	0.13	0.25	0.48	0.19
	Barge					14.5	9.0	6.0	4.0	0.0	2.7	5.1	1.0	0.17	0.27	0.45	0.22
	Ro-Ro					15.7	11.6	9.0	4.0	0.0	2.1	3.4	1.0	0.15	0.30	0.45	0.26
	Cruise					18.6	14.3	11.2	4.0	0.0	1.7	2.8	1.0	0.80	0.80	0.80	0.64
	Breakbulk					15.5	12.4	10.3	4.0	0.0	2.0	3.0	1.0	0.17	0.27	0.45	0.10

Notes:
1 Distances for Outside Breakwater, Inside Breakwater, and Maneuvering Zone from 2011 SCPA Air Emissions Inventory.
2 Vessel speeds Outside Breakwater from 2017 AIS data at Ft. Sumter Reach.
3 Vessel speeds Inside Breakwater for Auto Carrier, Container, and Ro-Ro vessel types from 2017 AIS data at Ravenel Bridge.
4 Vessel speeds Inside Breakwater for Cruise and Breakbulk vessel types from 2017 AIS data at Rebellion Reach.
5 Load factors are from ICFI, 2009, Table 2-7.

Harbor Craft

2017 Emissions Calculations

South Carolina Ports Authority
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Harbor Craft Emissions

Harbor Craft	Main Engine(s)				Emissions (lbs/yr)						
Vessel ID	Engine Tier	kW	Load Factor (%)	Annual Operation (hrs)	HC	CO	NO_X	PM	PM_{10}	$PM_{2.5}$	SO_2
Mark	2	1,902	28%	2,313	516	2,987	16,290	304	304	304	294
James	2	2,237	32%	3,194	957	5,538	30,207	563	563	563	546
Elizabeth[2]	2	2,289	30%	2,852	578	10,702	57,653	1,188	1,188	1,188	1,152
Jeffrey	3	1,864	40%	2,617	577	8,605	26,674	518	518	518	502
Moira	2	1,864	46%	1,483	804	2,967	21,770	420	420	420	407
Patrick[3]	1	1,920	36%	1,488	306	5,663	30,507	628	628	628	610
Donal[3]	1	2,237	25%	303	50	927	4,991	103	103	103	100
Fort Sumter	2	969	45%	4,040	738	4,274	23,315	434	434	434	421
Fort Moultrie	2	969	45%	2,408	440	2,547	13,895	259	259	259	251
Fort Ripley	3	522	45%	3,287	698	2,723	9,871	205	205	205	199
Fort Johnson	3	298	45%	1,330	161	630	2,401	78	78	78	76
Total (lbs/yr)					5,825	47,563	237,575	4,699	4,699	4,699	4,558
Total Tug Boats (tons/yr)					1.89	18.69	94.05	1.86	1.86	1.86	1.81
Total Pilot Boats (ton/yr)					1.02	5.09	24.74	0.49	0.49	0.49	0.47
Total (tons/yr)					**2.91**	**23.78**	**118.79**	**2.35**	**2.35**	**2.35**	**2.28**

1 ULSD 15 ppm used in all Harbor Crafts
2 The Elizabeth load estimate is the average of the Mark and the James per Moran.
3 Patrick and Donal - Auxilliary engine data was not available, HP/kW estimated from other McAllister tug boats.
4 Pilot Association - Data was not available for average load/rpm, the load factor came from the EPA Current Methodologies Report (ICFI, 2009).

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Harbor Craft Emissions

Harbor Craft	Main Engine(s)				Auxiliary Engine(s)				Emissions (lbs/yr)						
Vessel ID	Engine Tier	kW	Load Factor (%)	Annual Operation (hrs)	Engine Tier	kW	Load Factor (%)	Annual Operation (hrs)	HC	CO	NO_X	PM	PM_{10}	$PM_{2.5}$	SO_2
Mark	2	1,902	28%	2,313	2	99	28%	2,313	523	3,071	16,771	320	320	320	310
James	2	2,237	32%	3,194	2	99	32%	3,194	968	5,672	30,965	588	588	588	571
Elizabeth[2]	2	2,289	30%	2,852	3	99	30%	2,852	638	10,851	58,129	1,207	1,207	1,207	1,171
Jeffrey	3	1,864	40%	2,617	3	99	30%	3,154	643	8,770	27,789	539	539	539	523
Moira	2	1,864	46%	1,483	2	124	35%	1,892	849	3,383	23,089	456	456	456	442
Patrick[3]	1	1,920	36%	1,488	1	114	30%	1,456	351	5,883	31,583	708	708	708	687
Donal[3]	1	2,237	25%	303	1	114	15%	262	54	946	5,088	110	110	110	107
Fort Sumter	2	969	45%	4,040	3	30	45%	2,204	765	4,379	23,669	442	442	442	429
Fort Moultrie	2	969	45%	2,408	3	30	45%	1,260	455	2,607	14,098	263	263	263	256
Fort Ripley	3	522	45%	3,287	3	30	45%	1203	712	2,780	10,065	209	209	209	203
Fort Johnson	3	298	45%	1,330	-	-	-	-	161	630	2,283	47	47	47	46
								Total (lbs/yr)	**6,120**	**48,973**	**243,528**	**4,890**	**4,890**	**4,890**	**4,743**
								Total (tons/yr)	**3.06**	**24.49**	**121.76**	**2.44**	**2.44**	**2.44**	**2.37**

1 ULSD 15 ppm used in all Harbor Crafts
2 The Elizabeth load estimate is the average of the Mark and the James per Moran.
3 Patrick and Donal - Auxilliary engine data was not available, HP/kW estimated from other McAllister tug boats.
4 Pilot Association - Data was not available for average load/rpm, the load factor came from the EPA Current Methodologies Report (ICFI, 2009).

South Carolina Ports Authority
2017 Air Emissions Inventory Update

Harbor Craft Inventory and Operation

Harbor Craft			Percentage of Time in Mode			Main Engine(s)							Auxiliary Engine(s)						Fuel
Company	Vessel ID	Vessel Year	Idle	Half Power	Full Power	Engine Count	Engine Model Year	Engine Tier	HP	kW	Load Factor (%)	Annual Operation (hrs)	Engine Count	Engine Tier	HP	kW	Load Factor (%)	Annual Operation (hrs)	Annual Fuel Estimates (gal)
Moran	Mark	2012	22%	77%	1%	2	2012	2	2,550	1,902	28%	2,313	2	2	133	99	28%	2,313	114,782
Moran	James	2011	14%	82%	3%	2	2011	2	3,000	2,237	32%	3,194	2	2	133	99	32%	3,194	166,635
Moran	Elizabeth[2]	NA	18%	80%	2%	2	1998	2	3,070	2,289	30%	2,852	2	3	133	99	30%	2,852	194,917
McAlister	Jeffrey	2017	25%	60%	15%	2	2017	3	2,500	1,864	40%	2,617	2	3	133	99	30%	3,154	60,000
McAlister	Moira	2003	25%	55%	20%	2	2003	2	2,500	1,864	46%	1,483	2	2	166	124	35%	1,892	60,000
McAlister	Patrick[3]	1974	20%	65%	15%	2	2002	1	2,575	1,920	36%	1,488	2	1	153	114	30%	1,456	60,000
McAlister	Donal[3]	1970	25%	70%	5%	1	2002	1	3,000	2,237	25%	303	2	1	153	114	15%	262	60,000
Pilots Association[4]	Fort Sumter	2000	-	-	-	2	2013	2	1,300	969	45%	4,040	2	3	40	30	45%	2,204	119,071
Pilots Association	Fort Moultrie	2000	-	-	-	2	2013	2	1,300	969	45%	2,408	2	3	40	30	45%	1,260	69,947
Pilots Association	Fort Ripley	NA	-	-	-	3	NA	3	700	522	45%	3,287	2	3	40	30	45%	1203	85,619
Pilots Association	Fort Johnson	NA	-	-	-	2	NA	3	400	298	45%	1,330	-	-	-	-	45%	-	25,363

70% Hour Distribution Approximately 30% of pilot/harbor craft operations are Non-SCPA (for SCPA emissions only account for 70% of annual operating hours)
50% Hour Distribution Approximately 50% of Tug operations are Non-SCPA (for SCPA emissions only account for 50% of annual operating hours)
0.746 Hp to kW conversion

1 ULSD 15 ppm used in all Harbor Crafts
2 The Elizabeth load estimate is the average of the Mark and the James per Moran.
3 Patrick and Donal - Auxilliary engine data was not available, kW estimated from other McAllister tug boats.
4 Pilot Association - Data was not available for average load/rpm, the load factor came from the EPA Current Methodologies Report (ICFI, 2009).

South Carolina Ports Authority

2017 Air Emissions Inventory Update

Harbor Craft Emission Factors (Adjusted to ULSD)

Engine Data						Emission Factors (g/kw-hr) - assuming 1.5% S						
Engine Manuf	Engine Model	Type	Tier	Displacement per Cylinder (L)	Category	HC	CO	NO_X	PM_{10}	$PM_{2.5}$	SO_2	Source
MTU	16V4000, M61	Main	2	2.0	1	0.19	1.10	6.00	0.11	0.11	0.0065	Table 3-5 (ICFI, 2009).
John Deere	6068	Auxillary	2	1.1	1	0.05	0.60	3.40	0.12	0.11	0.0065	EPA nonroad ignition archive 1996-2011; Model year 2011. SO_2 (ICFI, 2009).
MTU	16V4000, M63	Main	2	4.8	1	0.19	1.10	6.00	0.11	0.11	0.0065	Table 3-5 (ICFI, 2009).
EMD	16-645E7B	Main	0	10.6	2	0.13	2.48	13.36	0.28	0.27	0.0065	Table 3-5 (ICFI, 2009).
John Deere	4045	Auxillary	3	1.1	1	0.32	0.80	2.55	0.10	0.10	0.0065	Nonroad ignition 2011-present for 2012 model year, ultra low sulfur diesel (average) (PM and NOx); Table 3-5 (CO, HC). Tier 2 actual data is lower than the Tier 3 emission limits.
ABS EMD	8-710G7C	Main	3	11.6	2	0.13	2.00	6.20	0.12	0.12	0.0065	Table 3-5 (HC, CO) (ICFI, 2009). Table 2 (PM, NOx) (40 CFR 1042.101).
John Deere	4045AFM85	Auxillary	3	0.9	1	0.32	0.80	5.40	0.10	0.10	0.0065	Table 3-5 (HC, CO) (ICFI, 2009). Table 1 (PM, NOx) (40 CFR 1042.101).
Caterpillar	3516 B-HD	Main	1	4.3	3	0.29	1.07	7.85	0.15	0.15	0.0065	EPA nonroad ignition archive 1996-2011 (CO, NOx, PM).
Caterpillar	3304	Auxillary	-	-	-	0.25	2.30	7.30	0.20	0.19	0.0065	EPA nonroad ignition archive 1996-2011 (CO, NOx, PM).
EMD	12-645-F7B	Main	0	9.3	2	0.13	2.48	13.36	0.28	0.27	0.0065	Table 3-5 (ICFI, 2009).
EMD	16-645 ES Turbo	Main	0	9.3	2	0.13	2.48	13.36	0.28	0.27	0.0065	Table 3-5 (ICFI, 2009).
Northern Lights	12V2000CR	Main	2	2.2	1	0.19	1.10	6.00	0.11	0.11	0.0065	Table 3-5 (ICFI, 2009).
Northern Lights	M944W3	Auxillary	3	0.8	1	0.41	1.60	5.40	0.12	0.12	0.0065	Table 3-5, Tier 2 actual data is lower than the Tier 3 emission limits (HC, CO) (ICFI, 2009). Table 1 (PM, NOx) (40 CFR 1042.101).
522 kW	Tier 3 Main	Main	3	NA	NA	0.41	1.60	5.80	0.12	0.12	0.0065	Table 3-5, the Tier 2 main engine max g/kw-hr was used since cylinder displacement unknown, and Tier 2 actual data is lower than the Tier 3 emission limits (HC, CO) (ICFI, 2009). The max for commercial engines with kW/L ≤ 35, Table 1 (PM, NOx) (40 CFR 1042.101).
300 kW	Tier 2 Main	Main	2	NA	NA	0.41	1.60	6.10	0.20	0.19	0.0065	Table 3-5, For each pollutant, the Tier 2 main engine max g/kw-hr was used since cylinder displacement unknown (ICFI, 2009).
Multiple	Tier 1 Aux	Auxillary	1	NA	NA	0.41	2.00	9.80	0.72	0.70	0.0065	Table 3-5, For each pollutant, the Tier 1 aux engine max g/kw-hr was used since cylinder displacement unknown (ICFI, 2009).

Category 1: Rated power >= 37 kW; Engine displacement <5 L/cyl

Category 2: Engine displacement between 5 L/cyl and 30 L/cyl

Category 3: Engine displacement greater than 30 L/cyl

$PM_{2.5}$ emission factors are estimated to be 97 percent of PM_{10} emissions for both Category 1 and Category 2 engines.

SO_2 emission factors

Rail

2017 Emissions Calculations

South Carolina Ports Authority
2017 Air Emissions Inventory Update

Locomotive Container Activity

Container Movement	Description
2,200,000	SCPA containers moved in CY17 (TEUs)
23%	Percentage of Containers to Intermodal (Palmetto Rail)
1.72	Factor for the mix between 20', 40', and 45' containers for unit number (Palmetto Rail)
294,186	Total sent to trains (TEU)
40	Line Haul Avgerage Speed (mph)
35	Line Haul Avgerage Dist To Tri-County Border (mi)

Locomotive Inventory

Inventory and Operational Data										Emissions (tons)					
Locomotive	Activity Type	Average Hp[1]	Engine Load[2]	Engine Build Date[1]	EPA Tier Certification	Number of Containers[3]	Engine per Train[4]	Train Count Estimate[4]	Hours[5,6]	NO_x	PM_{10}	$PM_{2.5}$	HC	CO	SO_2
Charleston Yard	Switching	1,000	11%	1975/1977	0+	23,472	1	1	936	1.16	0.02	0.02	0.06	0.20	0.000
North Charleston Yard	Switching	1,667	11%	1952	No Tier	736	1	1	936	3.18	0.07	0.07	0.18	0.33	0.00
Bennett Yard	Switching	2,026	11%	1970s	0	97,500	4	1	3,197	9.6	0.3	0.3	0.8	1.4	0.0
Bennett Yard	Longhaul	3,502	28%	1990/2000s	0/0+		4	271	948	7.4	0.1	0.1	0.3	1.3	0.005
Seven Mile Yard	Switching	3,000	11%	Multiple	0/0+	196,686	1	1	476	1.9	0.0	0.0	0.1	0.3	0.001
Seven Mile Yard	Longhaul	4,500	28%	Multiple	0/0+		3	546	1,434	14.3	0.3	0.3	0.6	2.5	0.009
									Total Line Haul	21.7	0.4	0.4	0.9	3.9	0.014
									Total Switcher	15.8	0.4	0.4	1.1	2.2	0.005
									Total	**37.6**	**0.8**	**0.8**	**2.1**	**6.1**	**0.019**

1 Average horsepower and engine manufacture date provided by representatives from Palmetto Rail, CSX and Norfolk Southern.
2 Average line-haul locomotovie load factor from Table 5-2 (ICFI, 2009) and switch engine the load average determined from time per notched Table 5-6 (ICFI, 2009) and % average hp from SCPA 2011 AEI.
3 Estimate annual rail cars/number of containers based on data from SCPA, Palmetto Rail and CSX.
4 Number of trains or engines per train are not publically relased; The 2005 and 2011 SCPA AEIs estimated an average of 360 containers and 4 locomotives per train for long haul. 360 units/train
5 Palmetto Rail switch locomotives average daily operations 3 hours per train, 6 days per week. Each yard has two trains, typically only 1 in operation.
6 For CSX and NS the national average for switch locomotive hours were determined from the 2017 Surface Transportation Board (STB) R-1 Data, 710 train inventory and 755 operational hours.
Emission reduction, retrofit and idling device data unavailable for trains.
All trains use ULSD.

South Carolina Ports Authority

2017 Air Emissions Inventory Update

Emission Factors

Locomototive Type		Emission Factors (g/bhp-hr)[1]					
Operation	Tier	NO_x	PM_{10}[2]	$PM_{2.5}$[3]	HC	CO	SO_2[4]
Line Haul[5]	0/0+	7.20	0.14	0.14	0.30	1.28	0.005
Switcher	No Tier	17.40	0.38	0.37	1.01	1.83	0.005
Switcher	0	12.60	0.38	0.37	1.01	1.83	0.005
Switcher	0+	10.60	0.17	0.16	0.57	1.83	0.005

1 Emission Factors for Locomotovies, Office of Transportation and Air Quality, EPA-420-F-09-025, April 2009 unless otherwise noted.

2 EPA estimates that the PM_{10} emission rate for locomotives operating on nominally 15 ppm sulfur fuel will be 0.06 g/bhp-hr lower than the PM_{10} emission rate for locomotives operating on 3,000 ppm sulfur fuel, respectively (ICFI, 2009).

3 $PM_{2.5}$ emission factors can be calculated by assuming that they represent 97% of PM_{10} emissions (ICFI, 2009).

4 SO_2 emission factor is 0.093888 g/gal based on the nationwide adoption of 15 ppm ultra-low sulfur diesel (ULSD) fuel by the rail industry (ERTAC, 2017).

5 Emission factors for Tier 0 were applied since the percentage of Tier 0 versus Tier 0+ data was unavailable from rail companies.

Switch Load Factors

Notch	% of Rated Power bph[1]	% of Time in this Mode	Load Factor % per Mode
	M&N	Switcher	
DB	4.3%	0.0%	0.0%
Idle	0.9%	59.8%	0.5%
1	4.9%	12.4%	0.6%
2	16.2%	12.3%	2.0%
3	29.4%	5.8%	1.7%
4	44.0%	3.6%	1.6%
5	58.5%	3.6%	2.1%
6	73.5%	1.5%	1.1%
7	90.9%	0.2%	0.2%
8	106.0%	0.8%	0.8%
		Sum	10.6%

1 Assumed switch engines use same load per notch as 2011 SCPA AEI.

2 Table 5-6 (ICFI, 2009).

On Road - Heavy Duty Vehicles

2017 Emissions Calculations

South Carolina Ports Authority

2017 Air Emissions Inventory Update

HDV Emissions (tpy)

Port	Truck Type	NOx	PM10	PM2.5	HC	SO2	CO
Columbus Street	Containers	0.00	0.00	0.00	0.00	0.00	0.00
	Breakbulk	10.21	0.51	0.47	0.61	0.02	2.80
	Port Total	10.21	0.51	0.47	0.61	0.02	2.80
North Charleston	Containers	90.81	4.64	4.27	5.81	0.16	25.60
	Breakbulk	0.07	0.00	0.00	0.00	0.00	0.02
	Port Total	90.88	4.65	4.27	5.81	0.16	25.62
Union Pier	Containers	0.00	0.00	0.00	0.00	0.00	0.00
	Breakbulk	0.47	0.02	0.02	0.03	0.00	0.13
	Shuttles	0.80	0.02	0.02	0.11	0.00	0.32
	Port Total	1.27	0.05	0.04	0.14	0.00	0.44
Veterans	Containers	0.00	0.00	0.00	0.00	0.00	0.00
	Breakbulk	0.00	0.00	0.00	0.00	0.00	0.00
	Port Total	0.00	0.00	0.00	0.00	0.00	0.00
Wando Welch	Containers	530.56	26.88	24.73	30.59	0.96	144.41
	Breakbulk	0.17	0.01	0.01	0.01	0.00	0.05
	Port Total	530.73	26.89	24.74	30.60	0.96	144.46
SCPA Total		**633.09**	**32.10**	**29.53**	**37.15**	**1.14**	**173.32**

South Carolina Ports Authority 2017 AEI
Heavy Duty Vehicles

Assumed 0 for data not provided

Terminal	# of Container Truck Arrivals/Year	Container Truck Turn Time (hours)	Distance from Kiosk to Loading ft	# of Breakbulk Arrivals/Year	Breakbulk Truck Turn Time (hours)
Columbus Street		0.75	300	14,341	0.75
North Charleston	178,387	0.63	300	116	0.63
Union Pier	0	NA	300	641	0.75
Veterans			300		0.00
Wando Welch	701,398	0.63	300	230	0.63

Container truck arraival data obtained from the 2017 Gate Moves by Load.

Container Truck On-Terminal Turn Time

Creep Idle	20%
stop idle	6%
moving (10mph)	74%

Breakbulk Truck On-Terminal Turn Time

Engine Off	70%	*engine shut off while loading
Creep Idle	25%	this is high due to trucks using more air suspensions to level/raise flatbeds. The truck is idle, not moving
Stop Idle	0%	
Moving (10mph)	5%	entering and leaving the terminal

Container Truck Off-Terminal Type		Union Pier Shuttle Rides		Columbus St.		North Charleston		Wando Welch		Veterans	
Truck Type	Percentage	Percentage	Count	Percentage	Count	Percentage	Count	Percentage	Count	Percentage	Count
Bobtails	20%	0%	0	1%	143	12%	66,653	5%	72,308	1%	0
Chassis	20%	0%	0	1%	143	15%	77,860	5%	72,308	1%	0
Loads & Empties	60%	0%	0	98%	14,054	73%	389,562	90%	1,296,057	98%	0
Total	100%	0%	15,449	100%	14,341	100%	534,075	100%	1,440,673	100%	0

Truck type counts were obtained from 2017 Truck Arrival Bobtail - Bare Chassis and are used to determine percentage by truck type.

Travel Distances Applied to Trucktrips

				Distance (miles) to/from Terminal				
	Truck Type	% Split	Origin/Destination	Union Pier	Columbus St.	North Charleston	Wando Welch	Veterans
Containerized	Loads & Empties	23.0%	Offsite Railyards	7.00	6.00	5.50	12.75	
		16.1%	Local Charleston	15.30	14.30	9.75	16.50	
		60.9%	Out of Tri-County	51.00	50.00	40.00	52.00	
	Bobtails	100.0%	Ashley P west of 26	12.30	11.30	6.75	13.50	
	Chassis	100.0%	Offsite Railyards	7.00	6.00	5.50	12.75	
Breakbulk	Breakbulk	0.0%	Offsite Railyards	7.00	6.00	5.50	12.75	
		50.0%	Local Charleston	15.30	14.30	9.75	16.50	
		50.0%	Out of Tri-County	51.00	50.00	40.00	52.00	

Columbus Street Heavy Duty Vehicles

Container Truck Visits per Year	0	<- from cargo / truck trip analysis
Container Truck Trips	0	
On-Terminal Miles	3	

Breakbulk Visits	14,341	<- from cargo / truck trip analysis
Breakbulk Truck Trips	28,682	
On-Terminal Miles	3	

Road Trucks on-terminal

						Emission Factors						Emissions (short tons)					
						NOx	PM10	PM2.5	VOC	SO2	CO	NOx	PM10	PM2.5	VOC	SO2	CO
Container Truck Turn Time		0.75 hrs		Arriving Trucks	annual hrs	(g/hr)	(g/hr)	(g/hr)	(g/hr)	(g/hr)	(g/hr)	(tpy)	(tpy)	(tpy)	(tpy)	(tpy)	(tpy)
Creep Idle	20%	0.15	hrs/truck arrival	0	0	209.20	3.57	3.29	45.57	0.08	88.09	0.00	0.00	0.00	0.00	0.00	0.00
stop idle	6%	0.05	hrs/truck arrival	0	0	209.20	3.57	3.29	45.57	0.08	88.09	0.00	0.00	0.00	0.00	0.00	0.00
					annual VMT	(g/VMT)	(g/VMT)	(g/VMT)	(g/VMT)	(g/VMT)	(g/VMT)						
moving (10mph)	74%	0.56	hrs/truck arrival	0	0	15.23	0.97	0.90	1.27	0.03	5.28	0.00	0.00	0.00	0.00	0.00	0.00
Total per truck arrival (truck visit)		0.75	Truck Turn time	0								0.00	0.00	0.00	0.00	0.00	0.00

						Emission Factors						Emissions (short tons)					
						NOx	PM10	PM2.5	VOC	SO2	CO	NOx	PM10	PM2.5	VOC	SO2	CO
Breakbulk Truck Turn Time		0.75 hrs		Arriving Trucks	annual hrs	(g/hr)	(g/hr)	(g/hr)	(g/hr)	(g/hr)	(g/hr)	(tpy)	(tpy)	(tpy)	(tpy)	(tpy)	(tpy)
Creep Idle	25%	0.19	hrs/truck arrival	14,341	2,689	209.20	3.57	3.29	45.57	0.08	88.09	6.20E-01	1.06E-02	9.74E-03	1.35E-01	2.33E-04	2.61E-01
stop idle	0%	0.00	hrs/truck arrival	14,341	0	209.20	3.57	3.29	45.57	0.08	88.09	0.00	0.00	0.00	0.00	0.00	0.00
					annual VMT	(g/VMT)	(g/VMT)	(g/VMT)	(g/VMT)	(g/VMT)	(g/VMT)						
moving (10mph)	5%	0.04	hrs/truck arrival	14,341	43,023	15.23	0.97	0.90	1.27	0.03	5.28	7.22E-01	4.62E-02	4.25E-02	6.04E-02	1.30E-03	2.50E-01
Total per truck arrival (truck visit)		0.23	Truck Turn time	14,341								1.34E+00	5.68E-02	5.22E-02	1.95E-01	1.54E-03	5.12E-01
											Total On Terminal	1.34	0.06	0.05	0.20	0.00	0.51

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Columbus Street Heavy Duty Vehicles

Road Truck Trips (off-terminal) 28,682

Truck Trips	Truck Trips	Truck Type	Time Period		# Trips per Year		% of trips		Dist (mi)	Avg Speed	VMT	Speed Specific Emission Factors NOx (g/VMT)	PM10 (g/VMT)	PM2.5 (g/VMT)	VOC (g/VMT)	SO2 (g/VMT)	CO (g/VMT)	Emissions (short tons) NOx (tpy)	PM10 (tpy)	PM2.5 (tpy)	VOC (tpy)	SO2 (tpy)	CO (tpy)
0	0	1% Bobtails	1 Weekday AM Rush Hour - 15%	Arriving / Departing	0	Path BA1	100%	Seg 1	3.00	15	0	13.01	0.85	0.78	0.87	0.02	4.12	0.00	0.00	0.00	0.00	0.00	0.00
								Seg 2	8.30	45	0	8.54	0.45	0.42	0.39	0.02	2.20	0.00	0.00	0.00	0.00	0.00	0.00
						Path BA2	0%	Seg 1	0.00	20	0	11.46	0.75	0.69	0.67	0.02	3.40	0.00	0.00	0.00	0.00	0.00	0.00
								Seg 2	0.00	40	0	8.67	0.48	0.44	0.42	0.02	2.32	0.00	0.00	0.00	0.00	0.00	0.00
						Path BA3	0%	Seg 1	0.00	20	0	11.46	0.75	0.69	0.67	0.02	3.40	0.00	0.00	0.00	0.00	0.00	0.00
								Seg 2	0.00	40	0	8.67	0.48	0.44	0.42	0.02	2.32	0.00	0.00	0.00	0.00	0.00	0.00
			2 Weekday PM Rush Hour - 10%	Arriving / Departing	0	Path BA1	100%	Seg 1	3.00	15	0	13.01	0.85	0.78	0.87	0.02	4.12	0.00	0.00	0.00	0.00	0.00	0.00
								Seg 2	8.30	45	0	8.54	0.45	0.42	0.39	0.02	2.20	0.00	0.00	0.00	0.00	0.00	0.00
						Path BA2	0%	Seg 1	0.00	20	0	11.46	0.75	0.69	0.67	0.02	3.40	0.00	0.00	0.00	0.00	0.00	0.00
								Seg 2	0.00	40	0	8.67	0.48	0.44	0.42	0.02	2.32	0.00	0.00	0.00	0.00	0.00	0.00
						Path BA3	0%	Seg 1	0.00	20	0	11.46	0.75	0.69	0.67	0.02	3.40	0.00	0.00	0.00	0.00	0.00	0.00
								Seg 2	0.00	40	0	8.67	0.48	0.44	0.42	0.02	2.32	0.00	0.00	0.00	0.00	0.00	0.00
			3 Weekday Non-Rush Hour - 75%	Arriving / Departing	0	Path BA1	100%	Seg 1	3.00	20	0	11.46	0.75	0.69	0.67	0.02	3.40	0.00	0.00	0.00	0.00	0.00	0.00
								Seg 2	8.30	50	0	8.35	0.41	0.37	0.37	0.02	2.09	0.00	0.00	0.00	0.00	0.00	0.00
						Path BA2	0%	Seg 1	0.00	30	0	10.19	0.65	0.60	0.49	0.02	2.80	0.00	0.00	0.00	0.00	0.00	0.00
								Seg 2	0.00	50	0	8.35	0.41	0.37	0.37	0.02	2.09	0.00	0.00	0.00	0.00	0.00	0.00
						Path BA3	0%	Seg 1	0.00	30	0	10.19	0.65	0.60	0.49	0.02	2.80	0.00	0.00	0.00	0.00	0.00	0.00
								Seg 2	0.00	50	0	8.35	0.41	0.37	0.37	0.02	2.09	0.00	0.00	0.00	0.00	0.00	0.00
	0	1% Chassis	1 Weekday AM Rush Hour - 15%	Arriving / Departing	0	OFSRL	100%	Seg 1	3.00	15	0	13.01	0.85	0.78	0.87	0.02	4.12	0.00	0.00	0.00	0.00	0.00	0.00
								Seg 2	3.00	35	0	8.84	0.51	0.47	0.45	0.02	2.46	0.00	0.00	0.00	0.00	0.00	0.00
						Path CA2	0%	Seg 1	0.00	20	0	11.46	0.75	0.69	0.67	0.02	3.40	0.00	0.00	0.00	0.00	0.00	0.00
								Seg 2	0.00	40	0	8.67	0.48	0.44	0.42	0.02	2.32	0.00	0.00	0.00	0.00	0.00	0.00
						Path CA3	0%	Seg 1	0.00	20	0	11.46	0.75	0.69	0.67	0.02	3.40	0.00	0.00	0.00	0.00	0.00	0.00
								Seg 2	0.00	40	0	8.67	0.48	0.44	0.42	0.02	2.32	0.00	0.00	0.00	0.00	0.00	0.00
			2 Weekday PM Rush Hour - 10%	Arriving / Departing	0	OFSRL	100%	Seg 1	3.00	15	0	13.01	0.85	0.78	0.87	0.02	4.12	0.00	0.00	0.00	0.00	0.00	0.00
								Seg 2	3.00	35	0	8.84	0.51	0.47	0.45	0.02	2.46	0.00	0.00	0.00	0.00	0.00	0.00
						Path CA2	0%	Seg 1	0.00	20	0	11.46	0.75	0.69	0.67	0.02	3.40	0.00	0.00	0.00	0.00	0.00	0.00
								Seg 2	0.00	40	0	8.67	0.48	0.44	0.42	0.02	2.32	0.00	0.00	0.00	0.00	0.00	0.00
						Path CA3	0%	Seg 1	0.00	20	0	11.46	0.75	0.69	0.67	0.02	3.40	0.00	0.00	0.00	0.00	0.00	0.00
								Seg 2	0.00	40	0	8.67	0.48	0.44	0.42	0.02	2.32	0.00	0.00	0.00	0.00	0.00	0.00
			3 Weekday Non-Rush Hour - 75%	Arriving / Departing	0	OFSRL	100%	Seg 1	3.00	20	0	11.46	0.75	0.69	0.67	0.02	3.40	0.00	0.00	0.00	0.00	0.00	0.00
								Seg 2	3.00	40	0	8.67	0.48	0.44	0.42	0.02	2.32	0.00	0.00	0.00	0.00	0.00	0.00
						Path CA2	0%	Seg 1	0.00	30	0	10.19	0.65	0.60	0.49	0.02	2.80	0.00	0.00	0.00	0.00	0.00	0.00
								Seg 2	0.00	50	0	8.35	0.41	0.37	0.37	0.02	2.09	0.00	0.00	0.00	0.00	0.00	0.00
						Path CA3	0%	Seg 1	0.00	30	0	10.19	0.65	0.60	0.49	0.02	2.80	0.00	0.00	0.00	0.00	0.00	0.00
								Seg 2	0.00	50	0	8.35	0.41	0.37	0.37	0.02	2.09	0.00	0.00	0.00	0.00	0.00	0.00
	0	98% Loads & Empties	1 Weekday AM Rush Hour - 15%	Arriving / Departing	0	OFSRL	23.0%	Seg 1	3.0	15	0	13.01	0.85	0.78	0.87	0.02	4.12	0.00	0.00	0.00	0.00	0.00	0.00
								Seg 2	3.0	45	0	8.54	0.45	0.42	0.39	0.02	2.20	0.00	0.00	0.00	0.00	0.00	0.00
						LOCAL	16.1%	Seg 1	3.0	15	0	13.01	0.85	0.78	0.87	0.02	4.12	0.00	0.00	0.00	0.00	0.00	0.00
								Seg 2	11.3	45	0	8.54	0.45	0.42	0.39	0.02	2.20	0.00	0.00	0.00	0.00	0.00	0.00
						Path LA3	60.9%	Seg 1	3.0	15	0	13.01	0.85	0.78	0.87	0.02	4.12	0.00	0.00	0.00	0.00	0.00	0.00
								Seg 2	47.0	45	0	8.54	0.45	0.42	0.39	0.02	2.20	0.00	0.00	0.00	0.00	0.00	0.00
			2 Weekday PM Rush Hour - 10%	Arriving / Departing	0	OFSRL	23.0%	Seg 1	3.00	15	0	13.01	0.85	0.78	0.87	0.02	4.12	0.00	0.00	0.00	0.00	0.00	0.00
								Seg 2	3.00	45	0	8.54	0.45	0.42	0.39	0.02	2.20	0.00	0.00	0.00	0.00	0.00	0.00
						LOCAL	16.1%	Seg 1	3.00	15	0	13.01	0.85	0.78	0.87	0.02	4.12	0.00	0.00	0.00	0.00	0.00	0.00
								Seg 2	11.30	45	0	8.54	0.45	0.42	0.39	0.02	2.20	0.00	0.00	0.00	0.00	0.00	0.00
						Path LA3	60.9%	Seg 1	3.00	15	0	13.01	0.85	0.78	0.87	0.02	4.12	0.00	0.00	0.00	0.00	0.00	0.00
								Seg 2	47.00	45	0	8.54	0.45	0.42	0.39	0.02	2.20	0.00	0.00	0.00	0.00	0.00	0.00
			3 Weekday Non-Rush Hour - 75%	Arriving / Departing	0	OFSRL	23.0%	Seg 1	3.00	20	0	11.46	0.75	0.69	0.67	0.02	3.40	0.00	0.00	0.00	0.00	0.00	0.00
								Seg 2	3.00	50	0	8.35	0.41	0.37	0.37	0.02	2.09	0.00	0.00	0.00	0.00	0.00	0.00
						LOCAL	16.1%	Seg 1	3.00	20	0	11.46	0.75	0.69	0.67	0.02	3.40	0.00	0.00	0.00	0.00	0.00	0.00
								Seg 2	11.30	50	0	8.35	0.41	0.37	0.37	0.02	2.09	0.00	0.00	0.00	0.00	0.00	0.00
						Path LA3	60.9%	Seg 1	3.00	20	0	11.46	0.75	0.69	0.67	0.02	3.40	0.00	0.00	0.00	0.00	0.00	0.00
								Seg 2	47.00	50	0	8.35	0.41	0.37	0.37	0.02	2.09	0.00	0.00	0.00	0.00	0.00	0.00

South Carolina Ports Authority
2017 Air Emissions Inventory Update

Columbus Street Heavy Duty Vehicles

28,682	28,682	Breakbulk Trips	1 Weekday AM Rush Hour - 15%	Arriving / Departing	4,302	OFSRL	0.0%	Seg 1	3.0	15	0	13.01	0.85	0.78	0.87	0.02	4.12	0.00E+00	0.00E+00	0.00E+00	0.00E+00	0.00E+00	0.00E+00
								Seg 2	3.0	45	0	8.54	0.45	0.42	0.39	0.02	2.20	0.00E+00	0.00E+00	0.00E+00	0.00E+00	0.00E+00	0.00E+00
						LOCAL	50.0%	Seg 1	3.0	15	6,453	13.01	0.85	0.78	0.87	0.02	4.12	9.25E-02	6.04E-03	5.56E-03	6.20E-03	1.75E-04	2.93E-02
								Seg 2	11.3	45	24,308	8.54	0.45	0.42	0.39	0.02	2.20	2.29E-01	1.21E-02	1.11E-02	1.04E-02	4.34E-04	5.90E-02
						Path LA3	50.0%	Seg 1	3.0	15	6,453	13.01	0.85	0.78	0.87	0.02	4.12	9.25E-02	6.04E-03	5.56E-03	6.20E-03	1.75E-04	2.93E-02
								Seg 2	47.0	45	101,104	8.54	0.45	0.42	0.39	0.02	2.20	9.51E-01	5.04E-02	4.63E-02	4.34E-02	1.81E-03	2.46E-01
			2 Weekday PM Rush Hour - 10%	Arriving / Departing	2,868	OFSRL	0.0%	Seg 1	3.00	15	0	13.01	0.85	0.78	0.87	0.02	4.12	0.00E+00	0.00E+00	0.00E+00	0.00E+00	0.00E+00	0.00E+00
								Seg 2	3.00	45	0	8.54	0.45	0.42	0.39	0.02	2.20	0.00E+00	0.00E+00	0.00E+00	0.00E+00	0.00E+00	0.00E+00
						LOCAL	50.0%	Seg 1	3.00	15	4,302	13.01	0.85	0.78	0.87	0.02	4.12	6.17E-02	4.03E-03	3.70E-03	4.14E-03	1.16E-04	1.95E-02
								Seg 2	11.30	45	16,205	8.54	0.45	0.42	0.39	0.02	2.20	1.53E-01	8.07E-03	7.43E-03	6.96E-03	2.90E-04	3.94E-02
						Path LA3	50.0%	Seg 1	3.00	15	4,302	13.01	0.85	0.78	0.87	0.02	4.12	6.17E-02	4.03E-03	3.70E-03	4.14E-03	1.16E-04	1.95E-02
								Seg 2	47.00	45	67,403	8.54	0.45	0.42	0.39	0.02	2.20	6.34E-01	3.36E-02	3.09E-02	2.90E-02	1.20E-03	1.64E-01
			3 Weekday Non-Rush Hour - 75%	Arriving / Departing	21,512	OFSRL	0.0%	Seg 1	3.00	20	0	11.46	0.75	0.69	0.67	0.02	3.40	0.00E+00	0.00E+00	0.00E+00	0.00E+00	0.00E+00	0.00E+00
								Seg 2	3.00	50	0	8.35	0.41	0.37	0.37	0.02	2.09	0.00E+00	0.00E+00	0.00E+00	0.00E+00	0.00E+00	0.00E+00
						LOCAL	50.0%	Seg 1	3.00	20	32,267	11.46	0.75	0.69	0.67	0.02	3.40	4.08E-01	2.66E-02	2.45E-02	2.37E-02	7.70E-04	1.21E-01
								Seg 2	11.30	50	121,540	8.35	0.41	0.37	0.37	0.02	2.09	1.12E+00	5.43E-02	5.00E-02	4.96E-02	2.10E-03	2.80E-01
						Path LA3	50.0%	Seg 1	3.00	20	32,267	11.46	0.75	0.69	0.67	0.02	3.40	4.08E-01	2.66E-02	2.45E-02	2.37E-02	7.70E-04	1.21E-01
								Seg 2	47.00	50	505,520	8.35	0.41	0.37	0.37	0.02	2.09	4.65E+00	2.26E-01	2.08E-01	2.06E-01	8.75E-03	1.16E+00
					28,682						922,126							8.86	0.46	0.42	0.41	0.02	2.29

	OFF TERMINAL									ON TERMINAL								TOTAL					
	# Trips	Avg Dist	VMT	NOx	PM10	PM2.5	VOC	SO2	CO	# Visits (1/2 trips)	Hrs/Visit	NOx	PM10	PM2.5	VOC	SO2	CO	NOx	PM10	PM2.5	VOC	SO2	CO
Loads & Empties	0	34.1	0	0.00	0.00	0.00	0.00	0.00	0.00														
Bobtails	0	11.3	0	0.00	0.00	0.00	0.00	0.00	0.00														
Chassis	0	6.0	0	0.00	0.00	0.00	0.00	0.00	0.00														
Subtotal Containers	0	#DIV/0!	0	0.00	0.00	0.00	0.00	0.00	0.00	0	0.75	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00
Subtotal Breakbulk	28,682	32.2	922,126	8.86	0.46	0.42	0.41	0.02	2.29	14,341	0.75	1.34E+00	5.68E-02	5.22E-02	1.95E-01	1.54E-03	5.12E-01	10.21	0.51	0.47	0.61	0.02	2.80
Total	28,682	21.6	922,126	8.86	0.46	0.42	0.41	0.02	2.29	14,341		1.34	0.06	0.05	0.20	0.00	0.51	10.21	0.51	0.47	0.61	0.02	2.80

North Charleston Heavy Duty Vehicles

Container Truck Visits per Year	178,387	<- from cargo / truck trip analysis
Container Truck Trips	356,774	
On-Terminal Miles	3	

Breakbulk Visits	116	<- from cargo / truck trip analysis
Breakbulk Truck Trips	232	
On-Terminal Miles	3	

Road Trucks on-terminal

						Emission Factors						Emissions (short tons)					
						NOx	PM10	PM2.5	VOC	SO2	CO	NOx	PM10	PM2.5	VOC	SO2	CO
Container Truck Turn Time		0.63	hrs	Arriving Trucks	annual hrs	(g/hr)	(g/hr)	(g/hr)	(g/hr)	(g/hr)	(g/hr)	(tpy)	(tpy)	(tpy)	(tpy)	(tpy)	(tpy)
Creep Idle	20%	0.13	hrs/truck arrival	178,387	22,566	209.20	3.57	3.29	45.57	0.08	88.09	5.20	0.09	0.08	1.13	0.00	2.19
stop idle	6%	0.04	hrs/truck arrival	178,387	6,770	209.20	3.57	3.29	45.57	0.08	88.09	1.56	0.03	0.02	0.34	0.00	0.66
					annual VMT	(g/VMT)	(g/VMT)	(g/VMT)	(g/VMT)	(g/VMT)	(g/VMT)						
moving (10mph)	74%	0.47	hrs/truck arrival	178,387	535,161	15.23	0.97	0.90	1.27	0.03	5.28	8.99	0.57	0.53	0.75	0.02	3.12
Total per truck arrival (truck visit)		0.63	Truck Turn time	178,387								15.75	0.69	0.63	2.22	0.02	5.96

						Emission Factors						Emissions (short tons)					
						NOx	PM10	PM2.5	VOC	SO2	CO	NOx	PM10	PM2.5	VOC	SO2	CO
Breakbulk Truck Turn Time		0.63	hrs	Arriving Trucks	annual hrs	(g/hr)	(g/hr)	(g/hr)	(g/hr)	(g/hr)	(g/hr)	(tpy)	(tpy)	(tpy)	(tpy)	(tpy)	(tpy)
Creep Idle	25%	0.16	hrs/truck arrival	116	18	209.20	3.57	3.29	45.57	0.08	88.09	4.23E-03	7.22E-05	6.65E-05	9.22E-04	1.59E-06	1.78E-03
stop idle	0%	0.00	hrs/truck arrival	116	0	209.20	3.57	3.29	45.57	0.08	88.09	0.00	0.00	0.00	0.00	0.00	0.00
					annual VMT	(g/VMT)	(g/VMT)	(g/VMT)	(g/VMT)	(g/VMT)	(g/VMT)						
moving (10mph)	5%	0.03	hrs/truck arrival	116	348	15.23	0.97	0.90	1.27	0.03	5.28	5.84E-03	3.73E-04	3.44E-04	4.88E-04	1.05E-05	2.03E-03
Total per truck arrival (truck visit)		0.19	Truck Turn time	116								1.01E-02	4.46E-04	4.10E-04	1.41E-03	1.21E-05	3.81E-03
											Total On Terminal	15.76	0.69	0.64	2.23	0.02	5.97

Road Truck Trips (off-terminal) 357,006

												Speed Specific Emission Factors						Emissions (short tons)					
												NOx	PM10	PM2.5	VOC	SO2	CO	NOx	PM10	PM2.5	VOC	SO2	CO
Trips	Trips	Truck Type	Time Period		# Trips per Year		% of trips		Dist (mi)	Avg Speed	VMT	(g/VMT)	(g/VMT)	(g/VMT)	(g/VMT)	(g/VMT)	(g/VMT)	(tpy)	(tpy)	(tpy)	(tpy)	(tpy)	(tpy)
	44,526	12% Bobtails	1 Weekday AM Rush Hour - 15%	Arriving / Departing	6,679	Path BA1	100%	Seg 1	3.00	15	20,037	13.01	0.85	0.78	0.87	0.02	4.12	0.29	0.02	0.02	0.02	0.00	0.09
								Seg 2	3.75	45	25,046	8.54	0.45	0.42	0.39	0.02	2.20	0.24	0.01	0.01	0.01	0.00	0.06
						Path BA2	0%	Seg 1	0.00	20	0	11.46	0.75	0.69	0.67	0.02	3.40	0.00	0.00	0.00	0.00	0.00	0.00
								Seg 2	0.00	40	0	8.67	0.48	0.44	0.42	0.02	2.32	0.00	0.00	0.00	0.00	0.00	0.00
						Path BA3	0%	Seg 1	0.00	20	0	11.46	0.75	0.69	0.67	0.02	3.40	0.00	0.00	0.00	0.00	0.00	0.00
								Seg 2	0.00	40	0	8.67	0.48	0.44	0.42	0.02	2.32	0.00	0.00	0.00	0.00	0.00	0.00
			2 Weekday PM Rush Hour - 10%	Arriving / Departing	4,453	Path BA1	100%	Seg 1	3.00	15	13,358	13.01	0.85	0.78	0.87	0.02	4.12	0.19	0.01	0.01	0.01	0.00	0.06
								Seg 2	3.75	45	16,697	8.54	0.45	0.42	0.39	0.02	2.20	0.16	0.01	0.01	0.01	0.00	0.04
						Path BA2	0%	Seg 1	0.00	20	0	11.46	0.75	0.69	0.67	0.02	3.40	0.00	0.00	0.00	0.00	0.00	0.00
								Seg 2	0.00	40	0	8.67	0.48	0.44	0.42	0.02	2.32	0.00	0.00	0.00	0.00	0.00	0.00
						Path BA3	0%	Seg 1	0.00	20	0	11.46	0.75	0.69	0.67	0.02	3.40	0.00	0.00	0.00	0.00	0.00	0.00
								Seg 2	0.00	40	0	8.67	0.48	0.44	0.42	0.02	2.32	0.00	0.00	0.00	0.00	0.00	0.00
			3 Weekday Non-Rush Hour - 75%	Arriving / Departing	33,394	Path BA1	100%	Seg 1	3.00	20	100,183	11.46	0.75	0.69	0.67	0.02	3.40	1.27	0.08	0.08	0.07	0.00	0.38
								Seg 2	3.75	50	125,229	8.35	0.41	0.37	0.37	0.02	2.09	1.15	0.06	0.05	0.05	0.00	0.29
						Path BA2	0%	Seg 1	0.00	30	0	10.19	0.65	0.60	0.49	0.02	2.80	0.00	0.00	0.00	0.00	0.00	0.00
								Seg 2	0.00	50	0	8.35	0.41	0.37	0.37	0.02	2.09	0.00	0.00	0.00	0.00	0.00	0.00
						Path BA3	0%	Seg 1	0.00	30	0	10.19	0.65	0.60	0.49	0.02	2.80	0.00	0.00	0.00	0.00	0.00	0.00
								Seg 2	0.00	50	0	8.35	0.41	0.37	0.37	0.02	2.09	0.00	0.00	0.00	0.00	0.00	0.00

North Charleston Heavy Duty Vehicles

356,774	52,012	15% Chassis	1 Weekday AM Rush Hour - 15%	Arriving / Departing	7,802	OFSRL	100%	Seg 1	3.00	15	23,405	13.01	0.85	0.78	0.87	0.02	4.12	0.34	0.02	0.02	0.02	0.00	0.11
								Seg 2	2.50	35	19,505	8.84	0.51	0.47	0.45	0.02	2.46	0.19	0.01	0.01	0.01	0.00	0.05
						Path CA2	0%	Seg 1	0.00	20	0	11.46	0.75	0.69	0.67	0.02	3.40	0.00	0.00	0.00	0.00	0.00	0.00
								Seg 2	0.00	40	0	8.67	0.48	0.44	0.42	0.02	2.32	0.00	0.00	0.00	0.00	0.00	0.00
						Path CA3	0%	Seg 1	0.00	20	0	11.46	0.75	0.69	0.67	0.02	3.40	0.00	0.00	0.00	0.00	0.00	0.00
								Seg 2	0.00	40	0	8.67	0.48	0.44	0.42	0.02	2.32	0.00	0.00	0.00	0.00	0.00	0.00
			2 Weekday PM Rush Hour - 10%	Arriving / Departing	5,201	OFSRL	100%	Seg 1	3.00	15	15,604	13.01	0.85	0.78	0.87	0.02	4.12	0.22	0.01	0.01	0.01	0.00	0.07
								Seg 2	2.50	35	13,003	8.84	0.51	0.47	0.45	0.02	2.46	0.13	0.01	0.01	0.01	0.00	0.04
						Path CA2	0%	Seg 1	0.00	20	0	11.46	0.75	0.69	0.67	0.02	3.40	0.00	0.00	0.00	0.00	0.00	0.00
								Seg 2	0.00	40	0	8.67	0.48	0.44	0.42	0.02	2.32	0.00	0.00	0.00	0.00	0.00	0.00
						Path CA3	0%	Seg 1	0.00	20	0	11.46	0.75	0.69	0.67	0.02	3.40	0.00	0.00	0.00	0.00	0.00	0.00
								Seg 2	0.00	40	0	8.67	0.48	0.44	0.42	0.02	2.32	0.00	0.00	0.00	0.00	0.00	0.00
			3 Weekday Non-Rush Hour - 75%	Arriving / Departing	39,009	OFSRL	100%	Seg 1	3.00	20	117,027	11.46	0.75	0.69	0.67	0.02	3.40	1.48	0.10	0.09	0.09	0.00	0.44
								Seg 2	2.50	40	97,523	8.67	0.48	0.44	0.42	0.02	2.32	0.93	0.05	0.05	0.04	0.00	0.25
						Path CA2	0%	Seg 1	0.00	30	0	10.19	0.65	0.60	0.49	0.02	2.80	0.00	0.00	0.00	0.00	0.00	0.00
								Seg 2	0.00	50	0	8.35	0.41	0.37	0.37	0.02	2.09	0.00	0.00	0.00	0.00	0.00	0.00
						Path CA3	0%	Seg 1	0.00	30	0	10.19	0.65	0.60	0.49	0.02	2.80	0.00	0.00	0.00	0.00	0.00	0.00
								Seg 2	0.00	50	0	8.35	0.41	0.37	0.37	0.02	2.09	0.00	0.00	0.00	0.00	0.00	0.00
	260,236	73% Loads & Empties	1 Weekday AM Rush Hour - 15%	Arriving / Departing	39,035	OFSRL	23.0%	Seg 1	3.00	15	26,934	13.01	0.85	0.78	0.87	0.02	4.12	0.39	0.03	0.02	0.03	0.00	0.12
								Seg 2	2.50	45	22,445	8.54	0.45	0.42	0.39	0.02	2.20	0.21	0.01	0.01	0.01	0.00	0.05
						LOCAL	16.1%	Seg 1	3.00	15	18,854	13.01	0.85	0.78	0.87	0.02	4.12	0.27	0.02	0.02	0.02	0.00	0.09
								Seg 2	6.75	45	42,422	8.54	0.45	0.42	0.39	0.02	2.20	0.40	0.02	0.02	0.02	0.00	0.10
						Path LA3	60.9%	Seg 1	3.00	15	71,318	13.01	0.85	0.78	0.87	0.02	4.12	1.02	0.07	0.06	0.07	0.00	0.32
								Seg 2	37.00	45	879,585	8.54	0.45	0.42	0.39	0.02	2.20	8.28	0.44	0.40	0.38	0.02	2.14
			2 Weekday PM Rush Hour - 10%	Arriving / Departing	26,024	OFSRL	23.0%	Seg 1	3.00	15	17,956	13.01	0.85	0.78	0.87	0.02	4.12	0.26	0.02	0.02	0.02	0.00	0.08
								Seg 2	2.50	45	14,964	8.54	0.45	0.42	0.39	0.02	2.20	0.14	0.01	0.01	0.01	0.00	0.04
						LOCAL	16.1%	Seg 1	3.00	15	12,569	13.01	0.85	0.78	0.87	0.02	4.12	0.18	0.01	0.01	0.01	0.00	0.06
								Seg 2	6.75	45	28,281	8.54	0.45	0.42	0.39	0.02	2.20	0.27	0.01	0.01	0.01	0.00	0.07
						Path LA3	60.9%	Seg 1	3.00	15	47,545	13.01	0.85	0.78	0.87	0.02	4.12	0.68	0.04	0.04	0.05	0.00	0.22
								Seg 2	37.00	45	586,390	8.54	0.45	0.42	0.39	0.02	2.20	5.52	0.29	0.27	0.25	0.01	1.42
			3 Weekday Non-Rush Hour - 75%	Arriving / Departing	195,177	OFSRL	23.0%	Seg 1	3.00	20	134,672	11.46	0.75	0.69	0.67	0.02	3.40	1.70	0.11	0.10	0.10	0.00	0.50
								Seg 2	2.50	50	112,227	8.35	0.41	0.37	0.37	0.02	2.09	1.03	0.05	0.05	0.05	0.00	0.26
						LOCAL	16.1%	Seg 1	3.00	20	94,271	11.46	0.75	0.69	0.67	0.02	3.40	1.19	0.08	0.07	0.07	0.00	0.35
								Seg 2	6.75	50	212,109	8.35	0.41	0.37	0.37	0.02	2.09	1.95	0.09	0.09	0.09	0.00	0.49
						Path LA3	60.9%	Seg 1	3.00	20	356,589	11.46	0.75	0.69	0.67	0.02	3.40	4.50	0.29	0.27	0.26	0.01	1.34
								Seg 2	37.00	50	4,397,925	8.35	0.41	0.37	0.37	0.02	2.09	40.49	1.97	1.81	1.80	0.08	10.12
232	232	Breakbulk Trips	1 Weekday AM Rush Hour - 15%	Arriving / Departing	35	OFSRL	0.0%	Seg 1	3.00	15	0	13.01	0.85	0.78	0.87	0.02	4.12	0.00E+00	0.00E+00	0.00E+00	0.00E+00	0.00E+00	0.00E+00
								Seg 2	2.50	45	0	8.54	0.45	0.42	0.39	0.02	2.20	0.00E+00	0.00E+00	0.00E+00	0.00E+00	0.00E+00	0.00E+00
						LOCAL	50.0%	Seg 1	3.00	15	52	13.01	0.85	0.78	0.87	0.02	4.12	7.49E-04	4.88E-05	4.49E-05	5.02E-05	1.41E-06	2.37E-04
								Seg 2	6.75	45	117	8.54	0.45	0.42	0.39	0.02	2.20	1.11E-03	5.85E-05	5.38E-05	5.05E-05	2.10E-06	2.85E-04
						Path LA3	50.0%	Seg 1	3.00	15	52	13.01	0.85	0.78	0.87	0.02	4.12	7.49E-04	4.88E-05	4.49E-05	5.02E-05	1.41E-06	2.37E-04
								Seg 2	37.00	45	644	8.54	0.45	0.42	0.39	0.02	2.20	6.06E-03	3.21E-04	2.95E-04	2.77E-04	1.15E-05	1.56E-03
			2 Weekday PM Rush Hour - 10%	Arriving / Departing	23	OFSRL	0.0%	Seg 1	3.00	15	0	13.01	0.85	0.78	0.87	0.02	4.12	0.00E+00	0.00E+00	0.00E+00	0.00E+00	0.00E+00	0.00E+00
								Seg 2	2.50	45	0	8.54	0.45	0.42	0.39	0.02	2.20	0.00E+00	0.00E+00	0.00E+00	0.00E+00	0.00E+00	0.00E+00
						LOCAL	50.0%	Seg 1	3.00	15	35	13.01	0.85	0.78	0.87	0.02	4.12	4.99E-04	3.26E-05	3.00E-05	3.35E-05	9.42E-07	1.58E-04
								Seg 2	6.75	45	78	8.54	0.45	0.42	0.39	0.02	2.20	7.37E-04	3.90E-05	3.59E-05	3.36E-05	1.40E-06	1.90E-04
						Path LA3	50.0%	Seg 1	3.00	15	35	13.01	0.85	0.78	0.87	0.02	4.12	4.99E-04	3.26E-05	3.00E-05	3.35E-05	9.42E-07	1.58E-04
								Seg 2	37.00	45	429	8.54	0.45	0.42	0.39	0.02	2.20	4.04E-03	2.14E-04	1.97E-04	1.84E-04	7.67E-06	1.04E-03
			3 Weekday Non-Rush Hour - 75%	Arriving / Departing	174	OFSRL	0.0%	Seg 1	3.00	20	0	11.46	0.75	0.69	0.67	0.02	3.40	0.00E+00	0.00E+00	0.00E+00	0.00E+00	0.00E+00	0.00E+00
								Seg 2	2.50	50	0	8.35	0.41	0.37	0.37	0.02	2.09	0.00E+00	0.00E+00	0.00E+00	0.00E+00	0.00E+00	0.00E+00
						LOCAL	50.0%	Seg 1	3.00	20	261	11.46	0.75	0.69	0.67	0.02	3.40	3.30E-03	2.15E-04	1.98E-04	1.92E-04	6.22E-06	9.78E-04
								Seg 2	6.75	50	587	8.35	0.41	0.37	0.37	0.02	2.09	5.41E-03	2.62E-04	2.41E-04	2.40E-04	1.02E-05	1.35E-03
						Path LA3	50.0%	Seg 1	3.00	20	261	11.46	0.75	0.69	0.67	0.02	3.40	3.30E-03	2.15E-04	1.98E-04	1.92E-04	6.22E-06	9.78E-04
								Seg 2	37.00	50	3,219	8.35	0.41	0.37	0.37	0.02	2.09	2.96E-02	1.44E-03	1.32E-03	1.31E-03	5.57E-05	7.41E-03
					357,006						7,669,442							75.12	3.96	3.64	3.58	0.14	19.65

North Charleston Heavy Duty Vehicles

	OFF TERMINAL									ON TERMINAL								TOTAL					
	# Trips	Avg Dist	VMT	NOx	PM10	PM2.5	VOC	SO2	CO	# Visits (1/2 trips)	Hrs/Visit	NOx	PM10	PM2.5	VOC	SO2	CO	NOx	PM10	PM2.5	VOC	SO2	CO
Loads & Empties	260,236	27.2	7,077,056	68.49	3.56	3.28	3.22	0.13	17.77														
Bobtails	44,526	6.8	300,548	3.29	0.19	0.18	0.17	0.01	0.92														
Chassis	52,012	5.5	286,067	3.29	0.20	0.19	0.18	0.01	0.95														
Subtotal Containers	356,774	21.5	7,663,671	75.06	3.95	3.64	3.58	0.14	19.64	178,387	0.63	15.75	0.69	0.63	2.22	0.02	5.96	90.81	4.64	4.27	5.81	0.16	25.60
Subtotal Breakbulk	232	24.9	5,771	0.056	0.003	0.003	0.003	0.000	0.015	116	0.63	1.01E-02	4.46E-04	4.10E-04	1.41E-03	1.21E-05	3.81E-03	0.07	0.00	0.00	0.00	0.00	0.02
Total	357,006	21.5	7,669,442	75.12	3.96	3.64	3.58	0.14	19.65	178,503		15.76	0.69	0.64	2.23	0.02	5.97	90.88	4.65	4.27	5.81	0.16	25.62

South Carolina Ports Authority
2017 Air Emissions Inventory Update

Union Pier Heavy Duty Vehicles

Container Truck Visits per Year	0	<- from cargo / truck trip analysis		Breakbulk Visits	641	<- from cargo / truck trip analysis
Container Truck Trips	0			Breakbulk Truck Trips	1,282	
On-Terminal Miles	3			On-Terminal Miles	3	

Road Trucks on-terminal

						Emission Factors						Emissions (short tons)					
						NOx (g/hr)	PM10 (g/hr)	PM2.5 (g/hr)	VOC (g/hr)	SO2 (g/hr)	CO (g/hr)	NOx (tpy)	PM10 (tpy)	PM2.5 (tpy)	VOC (tpy)	SO2 (tpy)	CO (tpy)
Container Truck Turn Time		0.00	hrs	Arriving Trucks	annual hrs												
Creep Idle	20%	0.00	hrs/truck arrival	0	0	209.20	3.57	3.29	45.57	0.08	88.09	0.00	0.00	0.00	0.00	0.00	0.00
stop idle	6%	0.00	hrs/truck arrival	0	0	209.20	3.57	3.29	45.57	0.08	88.09	0.00	0.00	0.00	0.00	0.00	0.00
					annual VMT	(g/VMT)	(g/VMT)	(g/VMT)	(g/VMT)	(g/VMT)	(g/VMT)						
moving (10mph)	74%	0.00	hrs/truck arrival	0	0	15.23	0.97	0.90	1.27	0.03	5.28	0.00	0.00	0.00	0.00	0.00	0.00
Total per truck arrival (truck visit)		0.00	Truck Turn time	0								0.00	0.00	0.00	0.00	0.00	0.00

					Emission Factors						Emissions (short tons)					
					NOx (g/hr)	PM10 (g/hr)	PM2.5 (g/hr)	VOC (g/hr)	SO2 (g/hr)	CO (g/hr)	NOx (tpy)	PM10 (tpy)	PM2.5 (tpy)	VOC (tpy)	SO2 (tpy)	CO (tpy)
Shuttle Buses			Shuttle Trips	annual hrs												
Pick-up/Drop-off Idle	0.08	hrs/shuttle trip	15,449	1,287	209.20	3.57	3.29	45.57	0.08	88.09	0.30	0.01	0.00	0.06	0.00	0.13
				annual VMT	(g/VMT)	(g/VMT)	(g/VMT)	(g/VMT)	(g/VMT)	(g/VMT)						
moving (10mph)	1.00	miles/trip	15,449	15,449	29.58	1.03	0.94	2.60	0.02	11.16	0.50	0.02	0.02	0.04	0.00	0.19
			15,449								0.80	0.02	0.02	0.11	0.00	0.32

						Emission Factors						Emissions (short tons)					
						NOx (g/hr)	PM10 (g/hr)	PM2.5 (g/hr)	VOC (g/hr)	SO2 (g/hr)	CO (g/hr)	NOx (tpy)	PM10 (tpy)	PM2.5 (tpy)	VOC (tpy)	SO2 (tpy)	CO (tpy)
Breakbulk Truck Turn Time		0.75	hrs	Arriving Trucks	annual hrs												
Creep Idle	25%	0.19	hrs/truck arrival	641	120	209.20	3.57	3.29	45.57	0.08	88.09	2.77E-02	4.73E-04	4.35E-04	6.04E-03	1.04E-05	1.17E-02
stop idle	0%	0.00	hrs/truck arrival	641	0	209.20	3.57	3.29	45.57	0.08	88.09	0.00	0.00	0.00	0.00	0.00	0.00
					annual VMT	(g/VMT)	(g/VMT)	(g/VMT)	(g/VMT)	(g/VMT)	(g/VMT)						
moving (10mph)	5%	0.04	hrs/truck arrival	641	1,923	15.23	0.97	0.90	1.27	0.03	5.28	3.23E-02	2.06E-03	1.90E-03	2.70E-03	5.82E-05	1.12E-02
Total per truck arrival (truck visit)		0.23	Truck Turn time	641								6.00E-02	2.54E-03	2.33E-03	8.74E-03	6.86E-05	2.29E-02
										Total On Terminal		0.86	0.03	0.02	0.12	0.00	0.34

Road Truck Trips (off-terminal) 1,282

Truck Trips	Truck Trips	Truck Type	Time Period		# Trips per Year	Path	% of trips	Seg	Dist (mi)	Avg Speed	VMT	NOx (g/VMT)	PM10 (g/VMT)	PM2.5 (g/VMT)	VOC (g/VMT)	SO2 (g/VMT)	CO (g/VMT)	NOx (tpy)	PM10 (tpy)	PM2.5 (tpy)	VOC (tpy)	SO2 (tpy)	CO (tpy)
	0	0% Bobtails	1 Weekday AM Rush Hour - 15%	Arriving / Departing	0	Path BA1	100%	Seg 1	3.00	15	0	13.01	0.85	0.78	0.87	0.02	4.12	0.00	0.00	0.00	0.00	0.00	0.00
								Seg 2	3.75	45	0	8.54	0.45	0.42	0.39	0.02	2.20	0.00	0.00	0.00	0.00	0.00	0.00
						Path BA2	0%	Seg 1	0.00	20	0	11.46	0.75	0.69	0.67	0.02	3.40	0.00	0.00	0.00	0.00	0.00	0.00
								Seg 2	0.00	40	0	8.67	0.48	0.44	0.42	0.02	2.32	0.00	0.00	0.00	0.00	0.00	0.00
						Path BA3	0%	Seg 1	0.00	20	0	11.46	0.75	0.69	0.67	0.02	3.40	0.00	0.00	0.00	0.00	0.00	0.00
								Seg 2	0.00	40	0	8.67	0.48	0.44	0.42	0.02	2.32	0.00	0.00	0.00	0.00	0.00	0.00
			2 Weekday PM Rush Hour - 10%	Arriving / Departing	0	Path BA1	100%	Seg 1	3.00	15	0	13.01	0.85	0.78	0.87	0.02	4.12	0.00	0.00	0.00	0.00	0.00	0.00
								Seg 2	3.75	45	0	8.54	0.45	0.42	0.39	0.02	2.20	0.00	0.00	0.00	0.00	0.00	0.00
						Path BA2	0%	Seg 1	0.00	20	0	11.46	0.75	0.69	0.67	0.02	3.40	0.00	0.00	0.00	0.00	0.00	0.00
								Seg 2	0.00	40	0	8.67	0.48	0.44	0.42	0.02	2.32	0.00	0.00	0.00	0.00	0.00	0.00
						Path BA3	0%	Seg 1	0.00	20	0	11.46	0.75	0.69	0.67	0.02	3.40	0.00	0.00	0.00	0.00	0.00	0.00
								Seg 2	0.00	40	0	8.67	0.48	0.44	0.42	0.02	2.32	0.00	0.00	0.00	0.00	0.00	0.00
			3 Weekday Non-Rush Hour - 75%	Arriving / Departing	0	Path BA1	100%	Seg 1	3.00	20	0	11.46	0.75	0.69	0.67	0.02	3.40	0.00	0.00	0.00	0.00	0.00	0.00
								Seg 2	3.75	50	0	8.35	0.41	0.37	0.37	0.02	2.09	0.00	0.00	0.00	0.00	0.00	0.00
						Path BA2	0%	Seg 1	0.00	30	0	10.19	0.65	0.60	0.49	0.02	2.80	0.00	0.00	0.00	0.00	0.00	0.00
								Seg 2	0.00	50	0	8.35	0.41	0.37	0.37	0.02	2.09	0.00	0.00	0.00	0.00	0.00	0.00
						Path BA3	0%	Seg 1	0.00	30	0	10.19	0.65	0.60	0.49	0.02	2.80	0.00	0.00	0.00	0.00	0.00	0.00
								Seg 2	0.00	50	0	8.35	0.41	0.37	0.37	0.02	2.09	0.00	0.00	0.00	0.00	0.00	0.00

Union Pier Heavy Duty Vehicles

0	0	0% Chassis	1 Weekday AM Rush Hour - 15%	Arriving / Departing	0	OFSRL	100%	Seg 1	3.00	15	0	13.01	0.85	0.78	0.87	0.02	4.12	0.00	0.00	0.00	0.00	0.00	0.00
								Seg 2	2.50	35	0	8.84	0.51	0.47	0.45	0.02	2.46	0.00	0.00	0.00	0.00	0.00	0.00
						Path CA2	0%	Seg 1	0.00	20	0	11.46	0.75	0.69	0.67	0.02	3.40	0.00	0.00	0.00	0.00	0.00	0.00
								Seg 2	0.00	40	0	8.67	0.48	0.44	0.42	0.02	2.32	0.00	0.00	0.00	0.00	0.00	0.00
						Path CA3	0%	Seg 1	0.00	20	0	11.46	0.75	0.69	0.67	0.02	3.40	0.00	0.00	0.00	0.00	0.00	0.00
								Seg 2	0.00	40	0	8.67	0.48	0.44	0.42	0.02	2.32	0.00	0.00	0.00	0.00	0.00	0.00
			2 Weekday PM Rush Hour - 10%	Arriving / Departing	0	OFSRL	100%	Seg 1	3.00	15	0	13.01	0.85	0.78	0.87	0.02	4.12	0.00	0.00	0.00	0.00	0.00	0.00
								Seg 2	2.50	35	0	8.84	0.51	0.47	0.45	0.02	2.46	0.00	0.00	0.00	0.00	0.00	0.00
						Path CA2	0%	Seg 1	0.00	20	0	11.46	0.75	0.69	0.67	0.02	3.40	0.00	0.00	0.00	0.00	0.00	0.00
								Seg 2	0.00	40	0	8.67	0.48	0.44	0.42	0.02	2.32	0.00	0.00	0.00	0.00	0.00	0.00
						Path CA3	0%	Seg 1	0.00	20	0	11.46	0.75	0.69	0.67	0.02	3.40	0.00	0.00	0.00	0.00	0.00	0.00
								Seg 2	0.00	40	0	8.67	0.48	0.44	0.42	0.02	2.32	0.00	0.00	0.00	0.00	0.00	0.00
			3 Weekday Non-Rush Hour - 75%	Arriving / Departing	0	OFSRL	100%	Seg 1	3.00	20	0	11.46	0.75	0.69	0.67	0.02	3.40	0.00	0.00	0.00	0.00	0.00	0.00
								Seg 2	2.50	40	0	8.67	0.48	0.44	0.42	0.02	2.32	0.00	0.00	0.00	0.00	0.00	0.00
						Path CA2	0%	Seg 1	0.00	30	0	10.19	0.65	0.60	0.49	0.02	2.80	0.00	0.00	0.00	0.00	0.00	0.00
								Seg 2	0.00	50	0	8.35	0.41	0.37	0.37	0.02	2.09	0.00	0.00	0.00	0.00	0.00	0.00
						Path CA3	0%	Seg 1	0.00	30	0	10.19	0.65	0.60	0.49	0.02	2.80	0.00	0.00	0.00	0.00	0.00	0.00
								Seg 2	0.00	50	0	8.35	0.41	0.37	0.37	0.02	2.09	0.00	0.00	0.00	0.00	0.00	0.00
	0	0% Loads & Empties	1 Weekday AM Rush Hour - 15%	Arriving / Departing	0	OFSRL	23.0%	Seg 1	3.00	15	0	13.01	0.85	0.78	0.87	0.02	4.12	0.00	0.00	0.00	0.00	0.00	0.00
								Seg 2	2.50	45	0	8.54	0.45	0.42	0.39	0.02	2.20	0.00	0.00	0.00	0.00	0.00	0.00
						LOCAL	16.1%	Seg 1	3.00	15	0	13.01	0.85	0.78	0.87	0.02	4.12	0.00	0.00	0.00	0.00	0.00	0.00
								Seg 2	6.75	45	0	8.54	0.45	0.42	0.39	0.02	2.20	0.00	0.00	0.00	0.00	0.00	0.00
						Path LA3	60.9%	Seg 1	3.00	15	0	13.01	0.85	0.78	0.87	0.02	4.12	0.00	0.00	0.00	0.00	0.00	0.00
								Seg 2	37.00	45	0	8.54	0.45	0.42	0.39	0.02	2.20	0.00	0.00	0.00	0.00	0.00	0.00
			2 Weekday PM Rush Hour - 10%	Arriving / Departing	0	OFSRL	23.0%	Seg 1	3.00	15	0	13.01	0.85	0.78	0.87	0.02	4.12	0.00	0.00	0.00	0.00	0.00	0.00
								Seg 2	2.50	45	0	8.54	0.45	0.42	0.39	0.02	2.20	0.00	0.00	0.00	0.00	0.00	0.00
						LOCAL	16.1%	Seg 1	3.00	15	0	13.01	0.85	0.78	0.87	0.02	4.12	0.00	0.00	0.00	0.00	0.00	0.00
								Seg 2	6.75	45	0	8.54	0.45	0.42	0.39	0.02	2.20	0.00	0.00	0.00	0.00	0.00	0.00
						Path LA3	60.9%	Seg 1	3.00	15	0	13.01	0.85	0.78	0.87	0.02	4.12	0.00	0.00	0.00	0.00	0.00	0.00
								Seg 2	37.00	45	0	8.54	0.45	0.42	0.39	0.02	2.20	0.00	0.00	0.00	0.00	0.00	0.00
			3 Weekday Non-Rush Hour - 75%	Arriving / Departing	0	OFSRL	23.0%	Seg 1	3.00	20	0	11.46	0.75	0.69	0.67	0.02	3.40	0.00	0.00	0.00	0.00	0.00	0.00
								Seg 2	2.50	50	0	8.35	0.41	0.37	0.37	0.02	2.09	0.00	0.00	0.00	0.00	0.00	0.00
						LOCAL	16.1%	Seg 1	3.00	20	0	11.46	0.75	0.69	0.67	0.02	3.40	0.00	0.00	0.00	0.00	0.00	0.00
								Seg 2	6.75	50	0	8.35	0.41	0.37	0.37	0.02	2.09	0.00	0.00	0.00	0.00	0.00	0.00
						Path LA3	60.9%	Seg 1	3.00	20	0	11.46	0.75	0.69	0.67	0.02	3.40	0.00	0.00	0.00	0.00	0.00	0.00
								Seg 2	37.00	50	0	8.35	0.41	0.37	0.37	0.02	2.09	0.00	0.00	0.00	0.00	0.00	0.00
1,282	1,282	Breakbulk Trips	1 Weekday AM Rush Hour - 15%	Arriving / Departing	192	OFSRL	0.0%	Seg 1	3.00	15	0	13.01	0.85	0.78	0.87	0.02	4.12	0.00E+00	0.00E+00	0.00E+00	0.00E+00	0.00E+00	0.00E+00
								Seg 2	4.00	45	0	8.54	0.45	0.42	0.39	0.02	2.20	0.00E+00	0.00E+00	0.00E+00	0.00E+00	0.00E+00	0.00E+00
						LOCAL	50.0%	Seg 1	3.00	15	288	13.01	0.85	0.78	0.87	0.02	4.12	4.14E-03	2.70E-04	2.48E-04	2.77E-04	7.81E-06	1.31E-03
								Seg 2	12.30	45	1,183	8.54	0.45	0.42	0.39	0.02	2.20	1.11E-02	5.89E-04	5.42E-04	5.08E-04	2.11E-05	2.87E-03
						Path LA3	50.0%	Seg 1	3.00	15	288	13.01	0.85	0.78	0.87	0.02	4.12	4.14E-03	2.70E-04	2.48E-04	2.77E-04	7.81E-06	1.31E-03
								Seg 2	48.00	45	4,615	8.54	0.45	0.42	0.39	0.02	2.20	4.34E-02	2.30E-03	2.12E-03	1.98E-03	8.25E-05	1.12E-02
			2 Weekday PM Rush Hour - 10%	Arriving / Departing	128	OFSRL	0.0%	Seg 1	3.00	15	0	13.01	0.85	0.78	0.87	0.02	4.12	0.00E+00	0.00E+00	0.00E+00	0.00E+00	0.00E+00	0.00E+00
								Seg 2	4.00	45	0	8.54	0.45	0.42	0.39	0.02	2.20	0.00E+00	0.00E+00	0.00E+00	0.00E+00	0.00E+00	0.00E+00
						LOCAL	50.0%	Seg 1	3.00	15	192	13.01	0.85	0.78	0.87	0.02	4.12	2.76E-03	1.80E-04	1.66E-04	1.85E-04	5.20E-06	8.72E-04
								Seg 2	12.30	45	788	8.54	0.45	0.42	0.39	0.02	2.20	7.42E-03	3.93E-04	3.61E-04	3.39E-04	1.41E-05	1.91E-03
						Path LA3	50.0%	Seg 1	3.00	15	192	13.01	0.85	0.78	0.87	0.02	4.12	2.76E-03	1.80E-04	1.66E-04	1.85E-04	5.20E-06	8.72E-04
								Seg 2	48.00	45	3,077	8.54	0.45	0.42	0.39	0.02	2.20	2.90E-02	1.53E-03	1.41E-03	1.32E-03	5.50E-05	7.47E-03
			3 Weekday Non-Rush Hour - 75%	Arriving / Departing	962	OFSRL	0.0%	Seg 1	3.00	20	0	11.46	0.75	0.69	0.67	0.02	3.40	0.00E+00	0.00E+00	0.00E+00	0.00E+00	0.00E+00	0.00E+00
								Seg 2	4.00	50	0	8.35	0.41	0.37	0.37	0.02	2.09	0.00E+00	0.00E+00	0.00E+00	0.00E+00	0.00E+00	0.00E+00
						LOCAL	50.0%	Seg 1	3.00	20	1,442	11.46	0.75	0.69	0.67	0.02	3.40	1.82E-02	1.19E-03	1.09E-03	1.06E-03	3.44E-05	5.40E-03
								Seg 2	12.30	50	5,913	8.35	0.41	0.37	0.37	0.02	2.09	5.44E-02	2.64E-03	2.43E-03	2.41E-03	1.02E-04	1.36E-02
						Path LA3	50.0%	Seg 1	3.00	20	1,442	11.46	0.75	0.69	0.67	0.02	3.40	1.82E-02	1.19E-03	1.09E-03	1.06E-03	3.44E-05	5.40E-03
								Seg 2	48.00	50	23,076	8.35	0.41	0.37	0.37	0.02	2.09	2.12E-01	1.03E-02	9.49E-03	9.42E-03	3.99E-04	5.31E-02
					1,282						42,498							0.41	0.02	0.02	0.02	0.00	0.11

Union Pier Heavy Duty Vehicles

	OFF TERMINAL									ON TERMINAL								TOTAL					
	# Trips	Avg Dist	VMT	NOx	PM10	PM2.5	VOC	SO2	CO	# Visits (1/2 trips)	Hrs/Visit	NOx	PM10	PM2.5	VOC	SO2	CO	NOx	PM10	PM2.5	VOC	SO2	CO
Loads & Empties	0	35.1	0	0.00	0.00	0.00	0.00	0.00	0.00														
Bobtails	0	12.3	0	0.00	0.00	0.00	0.00	0.00	0.00														
Chassis	0	7.0	0	0.00	0.00	0.00	0.00	0.00	0.00														
Subtotal Containers	0	#DIV/0!	0	0.00	0.00	0.00	0.00	0.00	0.00	0	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00
Subtotal Shuttles										15,449		0.80	0.02	0.02	0.11	0.00	0.32	0.80	0.02	0.02	0.11	0.00	0.32
Subtotal Breakbulk	1,282	33.2	42,498	0.408	0.021	0.019	0.019	0.001	0.105	641	0.75	6.00E-02	2.54E-03	2.33E-03	8.74E-03	6.86E-05	2.29E-02	0.47	0.02	0.02	0.03	0.00	0.13
Total	1,282	33.2	42,498	0.41	0.02	0.02	0.02	0.00	0.11	641		0.86	0.03	0.02	0.12	0.00	0.34	1.27	0.05	0.04	0.14	0.00	0.44

Veterans Heavy Duty Vehicles

Container Truck Visits per Year	0	<- from cargo / truck trip analysis
Container Truck Trips	0	
On-Terminal Miles	3	

Breakbulk Visits	0	<- from cargo / truck trip analysis
Breakbulk Truck Trips	0	
On-Terminal Miles	3	

Road Trucks on-terminal

						Emission Factors						Emissions (short tons)					
						NOx	PM10	PM2.5	VOC	SO2	CO	NOx	PM10	PM2.5	VOC	SO2	CO
Container Truck Turn Time		0.00	hrs	Arriving Trucks	annual hrs	(g/hr)	(g/hr)	(g/hr)	(g/hr)	(g/hr)	(g/hr)	(tpy)	(tpy)	(tpy)	(tpy)	(tpy)	(tpy)
Creep Idle	20%	0.00	hrs/truck arrival	0	0	209.20	3.57	3.29	45.57	0.08	88.09	0.00	0.00	0.00	0.00	0.00	0.00
stop idle	6%	0.00	hrs/truck arrival	0	0	209.20	3.57	3.29	45.57	0.08	88.09	0.00	0.00	0.00	0.00	0.00	0.00
					annual VMT	(g/VMT)	(g/VMT)	(g/VMT)	(g/VMT)	(g/VMT)	(g/VMT)						
moving (10mph)	74%	0.00	hrs/truck arrival	0	0	15.23	0.97	0.90	1.27	0.03	5.28	0.00	0.00	0.00	0.00	0.00	0.00
Total per truck arrival (truck visit)		0.00	Truck Turn time	0								0.00	0.00	0.00	0.00	0.00	0.00

						Emission Factors						Emissions (short tons)					
						NOx	PM10	PM2.5	VOC	SO2	CO	NOx	PM10	PM2.5	VOC	SO2	CO
Breakbulk Truck Turn Time		0.00	hrs	Arriving Trucks	annual hrs	(g/hr)	(g/hr)	(g/hr)	(g/hr)	(g/hr)	(g/hr)	(tpy)	(tpy)	(tpy)	(tpy)	(tpy)	(tpy)
Creep Idle	25%	0.00	hrs/truck arrival	0	0	209.20	3.57	3.29	45.57	0.08	88.09	0.00E+00	0.00E+00	0.00E+00	0.00E+00	0.00E+00	0.00E+00
stop idle	0%	0.00	hrs/truck arrival	0	0	209.20	3.57	3.29	45.57	0.08	88.09	0.00	0.00	0.00	0.00	0.00	0.00
					annual VMT	(g/VMT)	(g/VMT)	(g/VMT)	(g/VMT)	(g/VMT)	(g/VMT)						
moving (10mph)	5%	0.00	hrs/truck arrival	0	0	15.23	0.97	0.90	1.27	0.03	5.28	0.00E+00	0.00E+00	0.00E+00	0.00E+00	0.00E+00	0.00E+00
Total per truck arrival (truck visit)		0.00	Truck Turn time	0								0.00E+00	0.00E+00	0.00E+00	0.00E+00	0.00E+00	0.00E+00
											Total On Terminal	0.00	0.00	0.00	0.00	0.00	0.00

Road Truck Trips (off-terminal) 0

												Speed Specific Emission Factors						Emissions (short tons)					
												NOx	PM10	PM2.5	VOC	SO2	CO	NOx	PM10	PM2.5	VOC	SO2	CO
Trips	Trips	Truck Type	Time Period		# Trips per Year		% of trips		Dist (mi)	Avg Speed	VMT	(g/VMT)	(g/VMT)	(g/VMT)	(g/VMT)	(g/VMT)	(g/VMT)	(tpy)	(tpy)	(tpy)	(tpy)	(tpy)	(tpy)
	0	1% Bobtails	1 Weekday AM Rush Hour - 15%	Arriving / Departing	0	Path BA1	100%	Seg 1	3.00	15	0	13.01	0.85	0.78	0.87	0.02	4.12	0.00	0.00	0.00	0.00	0.00	0.00
								Seg 2	3.75	45	0	8.54	0.45	0.42	0.39	0.02	2.20	0.00	0.00	0.00	0.00	0.00	0.00
						Path BA2	0%	Seg 1	0.00	20	0	11.46	0.75	0.69	0.67	0.02	3.40	0.00	0.00	0.00	0.00	0.00	0.00
								Seg 2	0.00	40	0	8.67	0.48	0.44	0.42	0.02	2.32	0.00	0.00	0.00	0.00	0.00	0.00
						Path BA3	0%	Seg 1	0.00	20	0	11.46	0.75	0.69	0.67	0.02	3.40	0.00	0.00	0.00	0.00	0.00	0.00
								Seg 2	0.00	40	0	8.67	0.48	0.44	0.42	0.02	2.32	0.00	0.00	0.00	0.00	0.00	0.00
			2 Weekday PM Rush Hour - 10%	Arriving / Departing	0	Path BA1	100%	Seg 1	3.00	15	0	13.01	0.85	0.78	0.87	0.02	4.12	0.00	0.00	0.00	0.00	0.00	0.00
								Seg 2	3.75	45	0	8.54	0.45	0.42	0.39	0.02	2.20	0.00	0.00	0.00	0.00	0.00	0.00
						Path BA2	0%	Seg 1	0.00	20	0	11.46	0.75	0.69	0.67	0.02	3.40	0.00	0.00	0.00	0.00	0.00	0.00
								Seg 2	0.00	40	0	8.67	0.48	0.44	0.42	0.02	2.32	0.00	0.00	0.00	0.00	0.00	0.00
						Path BA3	0%	Seg 1	0.00	20	0	11.46	0.75	0.69	0.67	0.02	3.40	0.00	0.00	0.00	0.00	0.00	0.00
								Seg 2	0.00	40	0	8.67	0.48	0.44	0.42	0.02	2.32	0.00	0.00	0.00	0.00	0.00	0.00
			3 Weekday Non-Rush Hour - 75%	Arriving / Departing	0	Path BA1	100%	Seg 1	3.00	20	0	11.46	0.75	0.69	0.67	0.02	3.40	0.00	0.00	0.00	0.00	0.00	0.00
								Seg 2	3.75	50	0	8.35	0.41	0.37	0.37	0.02	2.09	0.00	0.00	0.00	0.00	0.00	0.00
						Path BA2	0%	Seg 1	0.00	30	0	10.19	0.65	0.60	0.49	0.02	2.80	0.00	0.00	0.00	0.00	0.00	0.00
								Seg 2	0.00	50	0	8.35	0.41	0.37	0.37	0.02	2.09	0.00	0.00	0.00	0.00	0.00	0.00
						Path BA3	0%	Seg 1	0.00	30	0	10.19	0.65	0.60	0.49	0.02	2.80	0.00	0.00	0.00	0.00	0.00	0.00
								Seg 2	0.00	50	0	8.35	0.41	0.37	0.37	0.02	2.09	0.00	0.00	0.00	0.00	0.00	0.00

South Carolina Ports Authority
2017 Air Emissions Inventory Update

Veterans Heavy Duty Vehicles

0	0	1% Chassis	1 Weekday AM Rush Hour - 15%	Arriving / Departing	0	OFSRL	100%	Seg 1	3.00	15	0	13.01	0.85	0.78	0.87	0.02	4.12	0.00	0.00	0.00	0.00	0.00	0.00
								Seg 2	2.50	35	0	8.84	0.51	0.47	0.45	0.02	2.46	0.00	0.00	0.00	0.00	0.00	0.00
						Path CA2	0%	Seg 1	0.00	20	0	11.46	0.75	0.69	0.67	0.02	3.40	0.00	0.00	0.00	0.00	0.00	0.00
								Seg 2	0.00	40	0	8.67	0.48	0.44	0.42	0.02	2.32	0.00	0.00	0.00	0.00	0.00	0.00
						Path CA3	0%	Seg 1	0.00	20	0	11.46	0.75	0.69	0.67	0.02	3.40	0.00	0.00	0.00	0.00	0.00	0.00
								Seg 2	0.00	40	0	8.67	0.48	0.44	0.42	0.02	2.32	0.00	0.00	0.00	0.00	0.00	0.00
			2 Weekday PM Rush Hour - 10%	Arriving / Departing	0	OFSRL	100%	Seg 1	3.00	15	0	13.01	0.85	0.78	0.87	0.02	4.12	0.00	0.00	0.00	0.00	0.00	0.00
								Seg 2	2.50	35	0	8.84	0.51	0.47	0.45	0.02	2.46	0.00	0.00	0.00	0.00	0.00	0.00
						Path CA2	0%	Seg 1	0.00	20	0	11.46	0.75	0.69	0.67	0.02	3.40	0.00	0.00	0.00	0.00	0.00	0.00
								Seg 2	0.00	40	0	8.67	0.48	0.44	0.42	0.02	2.32	0.00	0.00	0.00	0.00	0.00	0.00
						Path CA3	0%	Seg 1	0.00	20	0	11.46	0.75	0.69	0.67	0.02	3.40	0.00	0.00	0.00	0.00	0.00	0.00
								Seg 2	0.00	40	0	8.67	0.48	0.44	0.42	0.02	2.32	0.00	0.00	0.00	0.00	0.00	0.00
			3 Weekday Non-Rush Hour - 75%	Arriving / Departing	0	OFSRL	100%	Seg 1	3.00	20	0	11.46	0.75	0.69	0.67	0.02	3.40	0.00	0.00	0.00	0.00	0.00	0.00
								Seg 2	2.50	40	0	8.67	0.48	0.44	0.42	0.02	2.32	0.00	0.00	0.00	0.00	0.00	0.00
						Path CA2	0%	Seg 1	0.00	30	0	10.19	0.65	0.60	0.49	0.02	2.80	0.00	0.00	0.00	0.00	0.00	0.00
								Seg 2	0.00	50	0	8.35	0.41	0.37	0.37	0.02	2.09	0.00	0.00	0.00	0.00	0.00	0.00
						Path CA3	0%	Seg 1	0.00	30	0	10.19	0.65	0.60	0.49	0.02	2.80	0.00	0.00	0.00	0.00	0.00	0.00
								Seg 2	0.00	50	0	8.35	0.41	0.37	0.37	0.02	2.09	0.00	0.00	0.00	0.00	0.00	0.00
	0	98% Loads & Empties	1 Weekday AM Rush Hour - 15%	Arriving / Departing	0	OFSRL	23.0%	Seg 1	3.00	15	0	13.01	0.85	0.78	0.87	0.02	4.12	0.00	0.00	0.00	0.00	0.00	0.00
								Seg 2	2.50	45	0	8.54	0.45	0.42	0.39	0.02	2.20	0.00	0.00	0.00	0.00	0.00	0.00
						LOCAL	16.1%	Seg 1	3.00	15	0	13.01	0.85	0.78	0.87	0.02	4.12	0.00	0.00	0.00	0.00	0.00	0.00
								Seg 2	6.75	45	0	8.54	0.45	0.42	0.39	0.02	2.20	0.00	0.00	0.00	0.00	0.00	0.00
						Path LA3	60.9%	Seg 1	3.00	15	0	13.01	0.85	0.78	0.87	0.02	4.12	0.00	0.00	0.00	0.00	0.00	0.00
								Seg 2	37.00	45	0	8.54	0.45	0.42	0.39	0.02	2.20	0.00	0.00	0.00	0.00	0.00	0.00
			2 Weekday PM Rush Hour - 10%	Arriving / Departing	0	OFSRL	23.0%	Seg 1	3.00	15	0	13.01	0.85	0.78	0.87	0.02	4.12	0.00	0.00	0.00	0.00	0.00	0.00
								Seg 2	2.50	45	0	8.54	0.45	0.42	0.39	0.02	2.20	0.00	0.00	0.00	0.00	0.00	0.00
						LOCAL	16.1%	Seg 1	3.00	15	0	13.01	0.85	0.78	0.87	0.02	4.12	0.00	0.00	0.00	0.00	0.00	0.00
								Seg 2	6.75	45	0	8.54	0.45	0.42	0.39	0.02	2.20	0.00	0.00	0.00	0.00	0.00	0.00
						Path LA3	60.9%	Seg 1	3.00	15	0	13.01	0.85	0.78	0.87	0.02	4.12	0.00	0.00	0.00	0.00	0.00	0.00
								Seg 2	37.00	45	0	8.54	0.45	0.42	0.39	0.02	2.20	0.00	0.00	0.00	0.00	0.00	0.00
			3 Weekday Non-Rush Hour - 75%	Arriving / Departing	0	OFSRL	23.0%	Seg 1	3.00	20	0	11.46	0.75	0.69	0.67	0.02	3.40	0.00	0.00	0.00	0.00	0.00	0.00
								Seg 2	2.50	50	0	8.35	0.41	0.37	0.37	0.02	2.09	0.00	0.00	0.00	0.00	0.00	0.00
						LOCAL	16.1%	Seg 1	3.00	20	0	11.46	0.75	0.69	0.67	0.02	3.40	0.00	0.00	0.00	0.00	0.00	0.00
								Seg 2	6.75	50	0	8.35	0.41	0.37	0.37	0.02	2.09	0.00	0.00	0.00	0.00	0.00	0.00
						Path LA3	60.9%	Seg 1	3.00	20	0	11.46	0.75	0.69	0.67	0.02	3.40	0.00	0.00	0.00	0.00	0.00	0.00
								Seg 2	37.00	50	0	8.35	0.41	0.37	0.37	0.02	2.09	0.00	0.00	0.00	0.00	0.00	0.00
0	0	Breakbulk Trips	1 Weekday AM Rush Hour - 15%	Arriving / Departing	0	OFSRL	0.0%	Seg 1	3.00	15	0	13.01	0.85	0.78	0.87	0.02	4.12	0.00E+00	0.00E+00	0.00E+00	0.00E+00	0.00E+00	0.00E+00
								Seg 2	2.50	45	0	8.54	0.45	0.42	0.39	0.02	2.20	0.00E+00	0.00E+00	0.00E+00	0.00E+00	0.00E+00	0.00E+00
						LOCAL	50.0%	Seg 1	3.00	15	0	13.01	0.85	0.78	0.87	0.02	4.12	0.00E+00	0.00E+00	0.00E+00	0.00E+00	0.00E+00	0.00E+00
								Seg 2	6.75	45	0	8.54	0.45	0.42	0.39	0.02	2.20	0.00E+00	0.00E+00	0.00E+00	0.00E+00	0.00E+00	0.00E+00
						Path LA3	50.0%	Seg 1	3.00	15	0	13.01	0.85	0.78	0.87	0.02	4.12	0.00E+00	0.00E+00	0.00E+00	0.00E+00	0.00E+00	0.00E+00
								Seg 2	37.00	45	0	8.54	0.45	0.42	0.39	0.02	2.20	0.00E+00	0.00E+00	0.00E+00	0.00E+00	0.00E+00	0.00E+00
			2 Weekday PM Rush Hour - 10%	Arriving / Departing	0	OFSRL	0.0%	Seg 1	3.00	15	0	13.01	0.85	0.78	0.87	0.02	4.12	0.00E+00	0.00E+00	0.00E+00	0.00E+00	0.00E+00	0.00E+00
								Seg 2	2.50	45	0	8.54	0.45	0.42	0.39	0.02	2.20	0.00E+00	0.00E+00	0.00E+00	0.00E+00	0.00E+00	0.00E+00
						LOCAL	50.0%	Seg 1	3.00	15	0	13.01	0.85	0.78	0.87	0.02	4.12	0.00E+00	0.00E+00	0.00E+00	0.00E+00	0.00E+00	0.00E+00
								Seg 2	6.75	45	0	8.54	0.45	0.42	0.39	0.02	2.20	0.00E+00	0.00E+00	0.00E+00	0.00E+00	0.00E+00	0.00E+00
						Path LA3	50.0%	Seg 1	3.00	15	0	13.01	0.85	0.78	0.87	0.02	4.12	0.00E+00	0.00E+00	0.00E+00	0.00E+00	0.00E+00	0.00E+00
								Seg 2	37.00	45	0	8.54	0.45	0.42	0.39	0.02	2.20	0.00E+00	0.00E+00	0.00E+00	0.00E+00	0.00E+00	0.00E+00
			3 Weekday Non-Rush Hour - 75%	Arriving / Departing	0	OFSRL	0.0%	Seg 1	3.00	20	0	11.46	0.75	0.69	0.67	0.02	3.40	0.00E+00	0.00E+00	0.00E+00	0.00E+00	0.00E+00	0.00E+00
								Seg 2	2.50	50	0	8.35	0.41	0.37	0.37	0.02	2.09	0.00E+00	0.00E+00	0.00E+00	0.00E+00	0.00E+00	0.00E+00
						LOCAL	50.0%	Seg 1	3.00	20	0	11.46	0.75	0.69	0.67	0.02	3.40	0.00E+00	0.00E+00	0.00E+00	0.00E+00	0.00E+00	0.00E+00
								Seg 2	6.75	50	0	8.35	0.41	0.37	0.37	0.02	2.09	0.00E+00	0.00E+00	0.00E+00	0.00E+00	0.00E+00	0.00E+00
						Path LA3	50.0%	Seg 1	3.00	20	0	11.46	0.75	0.69	0.67	0.02	3.40	0.00E+00	0.00E+00	0.00E+00	0.00E+00	0.00E+00	0.00E+00
								Seg 2	37.00	50	0	8.35	0.41	0.37	0.37	0.02	2.09	0.00E+00	0.00E+00	0.00E+00	0.00E+00	0.00E+00	0.00E+00
					0						0							0.00	0.00	0.00	0.00	0.00	0.00

Veterans Heavy Duty Vehicles

	OFF TERMINAL									ON TERMINAL								TOTAL					
	# Trips	Avg Dist	VMT	NOx	PM10	PM2.5	VOC	SO2	CO	# Visits (1/2 trips)	Hrs/Visit	NOx	PM10	PM2.5	VOC	SO2	CO	NOx	PM10	PM2.5	VOC	SO2	CO
Loads & Empties	0	27.2	0	0.00	0.00	0.00	0.00	0.00	0.00														
Bobtails	0	6.8	0	0.00	0.00	0.00	0.00	0.00	0.00														
Chassis	0	5.5	0	0.00	0.00	0.00	0.00	0.00	0.00														
Subtotal Containers	0	#DIV/0!	0	0.00	0.00	0.00	0.00	0.00	0.00	0	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00
Subtotal Breakbulk	0	24.9	0	0.000	0.000	0.000	0.000	0.000	0.000	0	0.00	0.00E+00	0.00E+00	0.00E+00	0.00E+00	0.00E+00	0.00E+00	0.00	0.00	0.00	0.00	0.00	0.00
Total	0	#DIV/0!	0	0.00	0.00	0.00	0.00	0.00	0.00	0		0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00

Wando Welch Heavy Duty Vehicles

Container Truck Visits per Year	701,398	<- from cargo / truck trip analysis
Container Truck Trips	1,402,796	
On-Terminal Miles	3	

Breakbulk Visits	230	<- from cargo / truck trip analysis
Breakbulk Truck Trips	460	
On-Terminal Miles	3	

Road Trucks on-terminal

				Arriving Trucks	115,345 annual hrs	road type	speed bin	Emission Factors NOx (g/hr)	PM10 (g/hr)	PM2.5 (g/hr)	VOC (g/hr)	SO2 (g/hr)	CO (g/hr)	Emissions (short tons) NOx (tpy)	PM10 (tpy)	PM2.5 (tpy)	VOC (tpy)	SO2 (tpy)	CO (tpy)
Container Truck Turn Time		0.63	hrs																
Creep Idle	20%	0.13	hrs/truck arrival	701,398	88,727			209.20	3.57	3.29	45.57	0.08	88.09	20.46	0.35	0.32	4.46	0.01	8.62
stop idle	6%	0.04	hrs/truck arrival	701,398	26,618			209.20	3.57	3.29	45.57	0.08	88.09	6.14	0.10	0.10	1.34	0.00	2.59
					annual VMT			(g/VMT)	(g/VMT)	(g/VMT)	(g/VMT)	(g/VMT)	(g/VMT)						
moving (10m	74%	0.47	hrs/truck arrival	701,398	2,104,194	5	3	15.23	0.97	0.90	1.27	0.03	5.28	35.34	2.26	2.08	2.95	0.06	12.25
Total per truck arrival (truck visit)		0.63	ruck Turn time	701,398										61.94	2.71	2.50	8.75	0.07	23.45

				Arriving Trucks	annual hrs			Emission Factors NOx (g/hr)	PM10 (g/hr)	PM2.5 (g/hr)	VOC (g/hr)	SO2 (g/hr)	CO (g/hr)	Emissions (short tons) NOx (tpy)	PM10 (tpy)	PM2.5 (tpy)	VOC (tpy)	SO2 (tpy)	CO (tpy)
Breakbulk Truck Turn Time		0.63	hrs																
Creep Idle	25%	0.16	hrs/truck arrival	230	36			209.20	3.57	3.29	45.57	0.08	88.09	8.39E-03	1.43E-04	1.32E-04	1.83E-03	3.15E-06	3.53E-03
stop idle	0%	0.00	hrs/truck arrival	230	0			209.20	3.57	3.29	45.57	0.08	88.09	0.00	0.00	0.00	0.00	0.00	0.00
					annual VMT			(g/VMT)	(g/VMT)	(g/VMT)	(g/VMT)	(g/VMT)	(g/VMT)						
moving (10m	5%	0.03	hrs/truck arrival	230	690	5	3	15.23	0.97	0.90	1.27	0.03	5.28	1.16E-02	7.40E-04	6.81E-04	9.68E-04	2.09E-05	4.02E-03
Total per truck arrival (truck visit)		0.19	ruck Turn time	230										2.00E-02	8.84E-04	8.13E-04	2.80E-03	2.40E-05	7.55E-03
													Total On Terminal	61.96	2.71	2.50	8.75	0.07	23.46

Road Truck Trips (off-terminal) 1,403,256

Truck Trips	Truck Trips	Truck Type	Time Period		# Trips per Year		% of trips		Dist (mi)	Avg Speed			VMT	Speed Specific Emission Factors NOx (g/VMT)	PM10 (g/VMT)	PM2.5 (g/VMT)	VOC (g/VMT)	SO2 (g/VMT)	CO (g/VMT)	Emissions (short tons) NOx (tpy)	PM10 (tpy)	PM2.5 (tpy)	VOC (tpy)	SO2 (tpy)	CO (tpy)
1,402,796	70,407	5% Bobtails	1 Weekday AM Rush Hour - 15%	Arriving / Departing	10,561	Path BA1	100%	Seg 1	3.00	15	5	4	31,683	13.01	0.85	0.78	0.87	0.02	4.12	0.45	0.03	0.03	0.03	0.00	0.14
								Seg 2	10.50	45	4	10	110,891	8.54	0.45	0.42	0.39	0.02	2.20	1.04	0.06	0.05	0.05	0.00	0.27
						Path BA2	0%	Seg 1	0.00	20	5	5	0	11.46	0.75	0.69	0.67	0.02	3.40	0.00	0.00	0.00	0.00	0.00	0.00
								Seg 2	0.00	40	4	9	0	8.67	0.48	0.44	0.42	0.02	2.32	0.00	0.00	0.00	0.00	0.00	0.00
						Path BA3	0%	Seg 1	0.00	20	5	5	0	11.46	0.75	0.69	0.67	0.02	3.40	0.00	0.00	0.00	0.00	0.00	0.00
								Seg 2	0.00	40	4	9	0	8.67	0.48	0.44	0.42	0.02	2.32	0.00	0.00	0.00	0.00	0.00	0.00
			2 Weekday PM Rush Hour - 10%	Arriving / Departing	7,041	Path BA1	100%	Seg 1	3.00	15	5	4	21,122	13.01	0.85	0.78	0.87	0.02	4.12	0.30	0.02	0.02	0.02	0.00	0.10
								Seg 2	10.50	45	4	10	73,927	8.54	0.45	0.42	0.39	0.02	2.20	0.70	0.04	0.03	0.03	0.00	0.18
						Path BA2	0%	Seg 1	0.00	20	5	5	0	11.46	0.75	0.69	0.67	0.02	3.40	0.00	0.00	0.00	0.00	0.00	0.00
								Seg 2	0.00	40	4	9	0	8.67	0.48	0.44	0.42	0.02	2.32	0.00	0.00	0.00	0.00	0.00	0.00
						Path BA3	0%	Seg 1	0.00	20	5	5	0	11.46	0.75	0.69	0.67	0.02	3.40	0.00	0.00	0.00	0.00	0.00	0.00
								Seg 2	0.00	40	4	9	0	8.67	0.48	0.44	0.42	0.02	2.32	0.00	0.00	0.00	0.00	0.00	0.00
			3 Weekday Non-Rush Hour - 75%	Arriving / Departing	52,805	Path BA1	100%	Seg 1	3.00	20	5	5	158,416	11.46	0.75	0.69	0.67	0.02	3.40	2.00	0.13	0.12	0.12	0.00	0.59
								Seg 2	10.50	50	4	11	554,455	8.35	0.41	0.37	0.37	0.02	2.09	5.10	0.25	0.23	0.23	0.01	1.28
						Path BA2	0%	Seg 1	0.00	30	5	7	0	10.19	0.65	0.60	0.49	0.02	2.80	0.00	0.00	0.00	0.00	0.00	0.00
								Seg 2	0.00	50	4	11	0	8.35	0.41	0.37	0.37	0.02	2.09	0.00	0.00	0.00	0.00	0.00	0.00
						Path BA3	0%	Seg 1	0.00	30	5	7	0	10.19	0.65	0.60	0.49	0.02	2.80	0.00	0.00	0.00	0.00	0.00	0.00
								Seg 2	0.00	50	4	11	0	8.35	0.41	0.37	0.37	0.02	2.09	0.00	0.00	0.00	0.00	0.00	0.00
	70,407	5% Chassis	1 Weekday AM Rush Hour - 15%	Arriving / Departing	10,561	OFSRL	100%	Seg 1	3.00	15	5	4	31,683	13.01	0.85	0.78	0.87	0.02	4.12	0.45	0.03	0.03	0.03	0.00	0.14
								Seg 2	9.75	35	4	8	102,970	8.84	0.51	0.47	0.45	0.02	2.46	1.00	0.06	0.05	0.05	0.00	0.28
						Path CA2	0%	Seg 1	0.00	20	5	5	0	11.46	0.75	0.69	0.67	0.02	3.40	0.00	0.00	0.00	0.00	0.00	0.00
								Seg 2	0.00	40	4	9	0	8.67	0.48	0.44	0.42	0.02	2.32	0.00	0.00	0.00	0.00	0.00	0.00
						Path CA3	0%	Seg 1	0.00	20	5	5	0	11.46	0.75	0.69	0.67	0.02	3.40	0.00	0.00	0.00	0.00	0.00	0.00
								Seg 2	0.00	40	4	9	0	8.67	0.48	0.44	0.42	0.02	2.32	0.00	0.00	0.00	0.00	0.00	0.00
			2 Weekday PM Rush Hour - 10%	Arriving / Departing	7,041	OFSRL	100%	Seg 1	3.00	15	5	4	21,122	13.01	0.85	0.78	0.87	0.02	4.12	0.30	0.02	0.02	0.02	0.00	0.10
								Seg 2	9.75	35	4	8	68,647	8.84	0.51	0.47	0.45	0.02	2.46	0.67	0.04	0.04	0.03	0.00	0.19
						Path CA2	0%	Seg 1	0.00	20	5	5	0	11.46	0.75	0.69	0.67	0.02	3.40	0.00	0.00	0.00	0.00	0.00	0.00
								Seg 2	0.00	40	4	9	0	8.67	0.48	0.44	0.42	0.02	2.32	0.00	0.00	0.00	0.00	0.00	0.00
						Path CA3	0%	Seg 1	0.00	20	5	5	0	11.46	0.75	0.69	0.67	0.02	3.40	0.00	0.00	0.00	0.00	0.00	0.00
								Seg 2	0.00	40	4	9	0	8.67	0.48	0.44	0.42	0.02	2.32	0.00	0.00	0.00	0.00	0.00	0.00
			3 Weekday Non-Rush Hour - 75%	Arriving / Departing	52,805	OFSRL	100%	Seg 1	3.00	20	5	5	158,416	11.46	0.75	0.69	0.67	0.02	3.40	2.00	0.13	0.12	0.12	0.00	0.59
								Seg 2	9.75	40	4	9	514,851	8.67	0.48	0.44	0.42	0.02	2.32	4.92	0.27	0.25	0.24	0.01	1.31
						Path CA2	0%	Seg 1	0.00	30	5	7	0	10.19	0.65	0.60	0.49	0.02	2.80	0.00	0.00	0.00	0.00	0.00	0.00
								Seg 2	0.00	50	4	11	0	8.35	0.41	0.37	0.37	0.02	2.09	0.00	0.00	0.00	0.00	0.00	0.00
						Path CA3	0%	Seg 1	0.00	30	5	7	0	10.19	0.65	0.60	0.49	0.02	2.80	0.00	0.00	0.00	0.00	0.00	0.00
								Seg 2	0.00	50	4	11	0	8.35	0.41	0.37	0.37	0.02	2.09	0.00	0.00	0.00	0.00	0.00	0.00

Wando Welch Heavy Duty Vehicles

	1,261,982	90% Loads & Empties	1 Weekday AM Rush Hour - 15%	Arriving / Departing	189,297	OFSRL	23.0%	Seg 1	3.00	15	5	4	130,615	13.01	0.85	0.78	0.87	0.02	4.12	1.87	0.12	0.11	0.13	0.00	0.59
								Seg 2	9.75	45	4	10	424,499	8.54	0.45	0.42	0.39	0.02	2.20	3.99	0.21	0.19	0.18	0.01	1.03
						LOCAL	16.1%	Seg 1	3.00	15	5	4	91,431	13.01	0.85	0.78	0.87	0.02	4.12	1.31	0.09	0.08	0.09	0.00	0.41
								Seg 2	13.50	45	4	10	411,438	8.54	0.45	0.42	0.39	0.02	2.20	3.87	0.21	0.19	0.18	0.01	1.00
						Path LA3	60.9%	Seg 1	3.00	15	5	4	345,846	13.01	0.85	0.78	0.87	0.02	4.12	4.96	0.32	0.30	0.33	0.01	1.57
								Seg 2	49.00	45	4	10	5,648,821	8.54	0.45	0.42	0.39	0.02	2.20	53.16	2.81	2.59	2.43	0.10	13.72
			2 Weekday PM Rush Hour - 10%	Arriving / Departing	126,198	OFSRL	23.0%	Seg 1	3.00	15	5	4	87,077	13.01	0.85	0.78	0.87	0.02	4.12	1.25	0.08	0.07	0.08	0.00	0.39
								Seg 2	9.75	45	4	10	282,999	8.54	0.45	0.42	0.39	0.02	2.20	2.66	0.14	0.13	0.12	0.01	0.69
						LOCAL	16.1%	Seg 1	3.00	15	5	4	60,954	13.01	0.85	0.78	0.87	0.02	4.12	0.87	0.06	0.05	0.06	0.00	0.28
								Seg 2	13.50	45	4	10	274,292	8.54	0.45	0.42	0.39	0.02	2.20	2.58	0.14	0.13	0.12	0.00	0.67
						Path LA3	60.9%	Seg 1	3.00	15	5	4	230,564	13.01	0.85	0.78	0.87	0.02	4.12	3.31	0.22	0.20	0.22	0.01	1.05
								Seg 2	49.00	45	4	10	3,765,881	8.54	0.45	0.42	0.39	0.02	2.20	35.44	1.88	1.73	1.62	0.07	9.15
			3 Weekday Non-Rush Hour - 75%	Arriving / Departing	946,487	OFSRL	23.0%	Seg 1	3.00	20	5	5	653,076	11.46	0.75	0.69	0.67	0.02	3.40	8.25	0.54	0.50	0.48	0.02	2.45
								Seg 2	9.75	50	4	11	2,122,496	8.35	0.41	0.37	0.37	0.02	2.09	19.54	0.95	0.87	0.87	0.04	4.88
						LOCAL	16.1%	Seg 1	3.00	20	5	5	457,153	11.46	0.75	0.69	0.67	0.02	3.40	5.77	0.38	0.35	0.34	0.01	1.71
								Seg 2	13.50	50	4	11	2,057,189	8.35	0.41	0.37	0.37	0.02	2.09	18.94	0.92	0.85	0.84	0.04	4.73
						Path LA3	60.9%	Seg 1	3.00	20	5	5	1,729,231	11.46	0.75	0.69	0.67	0.02	3.40	21.84	1.43	1.31	1.27	0.04	6.48
								Seg 2	49.00	50	4	11	28,244,106	8.35	0.41	0.37	0.37	0.02	2.09	260.03	12.62	11.61	11.53	0.49	64.99
460	460	Breakbulk Trips	1 Weekday AM Rush Hour - 15%	Arriving / Departing	69	OFSRL	0.0%	Seg 1	3.00	15	5	4	0	13.01	0.85	0.78	0.87	0.02	4.12	0.00E+00	0.00E+00	0.00E+00	0.00E+00	0.00E+00	0.00E+00
								Seg 2	9.75	45	4	10	0	8.54	0.45	0.42	0.39	0.02	2.20	0.00E+00	0.00E+00	0.00E+00	0.00E+00	0.00E+00	0.00E+00
						LOCAL	50.0%	Seg 1	3.00	15	5	4	104	13.01	0.85	0.78	0.87	0.02	4.12	1.48E-03	9.69E-05	8.91E-05	9.95E-05	2.80E-06	4.69E-04
								Seg 2	13.50	45	4	10	466	8.54	0.45	0.42	0.39	0.02	2.20	4.38E-03	2.32E-04	2.14E-04	2.00E-04	8.32E-06	1.13E-03
						Path LA3	50.0%	Seg 1	3.00	15	5	4	104	13.01	0.85	0.78	0.87	0.02	4.12	1.48E-03	9.69E-05	8.91E-05	9.95E-05	2.80E-06	4.69E-04
								Seg 2	49.00	45	4	10	1,691	8.54	0.45	0.42	0.39	0.02	2.20	1.59E-02	8.42E-04	7.75E-04	7.26E-04	3.02E-05	4.11E-03
			2 Weekday PM Rush Hour - 10%	Arriving / Departing	46	OFSRL	0.0%	Seg 1	3.00	15	5	4	0	13.01	0.85	0.78	0.87	0.02	4.12	0.00E+00	0.00E+00	0.00E+00	0.00E+00	0.00E+00	0.00E+00
								Seg 2	9.75	45	4	10	0	8.54	0.45	0.42	0.39	0.02	2.20	0.00E+00	0.00E+00	0.00E+00	0.00E+00	0.00E+00	0.00E+00
						LOCAL	50.0%	Seg 1	3.00	15	5	4	69	13.01	0.85	0.78	0.87	0.02	4.12	9.90E-04	6.46E-05	5.94E-05	6.63E-05	1.87E-06	3.13E-04
								Seg 2	13.50	45	4	10	311	8.54	0.45	0.42	0.39	0.02	2.20	2.92E-03	1.55E-04	1.42E-04	1.33E-04	5.55E-06	7.54E-04
						Path LA3	50.0%	Seg 1	3.00	15	5	4	69	13.01	0.85	0.78	0.87	0.02	4.12	9.90E-04	6.46E-05	5.94E-05	6.63E-05	1.87E-06	3.13E-04
								Seg 2	49.00	45	4	10	1,127	8.54	0.45	0.42	0.39	0.02	2.20	1.06E-02	5.62E-04	5.17E-04	4.84E-04	2.01E-05	2.74E-03
			3 Weekday Non-Rush Hour - 75%	Arriving / Departing	345	OFSRL	0.0%	Seg 1	3.00	20	5	5	0	11.46	0.75	0.69	0.67	0.02	3.40	0.00E+00	0.00E+00	0.00E+00	0.00E+00	0.00E+00	0.00E+00
								Seg 2	9.75	50	4	11	0	8.35	0.41	0.37	0.37	0.02	2.09	0.00E+00	0.00E+00	0.00E+00	0.00E+00	0.00E+00	0.00E+00
						LOCAL	50.0%	Seg 1	3.00	20	5	5	518	11.46	0.75	0.69	0.67	0.02	3.40	6.54E-03	4.27E-04	3.93E-04	3.80E-04	1.23E-05	1.94E-03
								Seg 2	13.50	50	4	11	2,329	8.35	0.41	0.37	0.37	0.02	2.09	2.14E-02	1.04E-03	9.57E-04	9.51E-04	4.03E-05	5.36E-03
						Path LA3	50.0%	Seg 1	3.00	20	5	5	518	11.46	0.75	0.69	0.67	0.02	3.40	6.54E-03	4.27E-04	3.93E-04	3.80E-04	1.23E-05	1.94E-03
								Seg 2	49.00	50	4	11	8,453	8.35	0.41	0.37	0.37	0.02	2.09	7.78E-02	3.78E-03	3.47E-03	3.45E-03	1.46E-04	1.94E-02
					1,403,256								48,881,605							468.77	24.18	22.24	21.85	0.88	121.00

	OFF TERMINAL									ON TERMINAL								TOTAL					
	# Trips	Avg Dist	VMT	NOx	PM10	PM2.5	VOC	SO2	CO	# Visits (1/2 trips)	Hrs/Visit	NOx	PM10	PM2.5	VOC	SO2	CO	NOx	PM10	PM2.5	VOC	SO2	CO
Loads & Empties	1,261,982	37.3	47,017,668	449.67	23.10	21.25	20.88	0.85	115.79														
Bobtails	70,407	13.5	950,494	9.60	0.52	0.48	0.47	0.02	2.56														
Chassis	70,407	12.8	897,688	9.35	0.55	0.50	0.49	0.02	2.61														
Subtotal Containers	1,402,796	34.8	48,865,850	468.62	24.17	22.24	21.84	0.88	120.96	701,398	0.63	61.94	2.71	2.50	8.75	0.07	23.45	530.56	26.88	24.73	30.59	0.96	144.41
Subtotal Breakbulk	460	34.3	15,755	0.151	0.008	0.007	0.007	0.000	0.039	230	0.63	2.00E-02	8.84E-04	8.13E-04	2.80E-03	2.40E-05	7.55E-03	0.17	0.01	0.01	0.01	0.00	0.05
Total	1,403,256	34.8	48,881,605	468.77	24.18	22.24	21.85	0.88	121.00	701,628		61.96	2.71	2.50	8.75	0.07	23.46	530.73	26.89	24.74	30.60	0.96	144.46

Idling

	Emission Factors (g/hr)		
	January	July	Average
NOx	237.0	181.4	209.2
PM10	3.6	3.6	3.6
PM2.5	3.3	3.3	3.3
VOC	45.6	45.6	45.6
SO2	0.1	0.1	0.1
CO	88.1	88.1	88.1

Combination Long-Haul Trucks

	Emission Factors (g/VMT)				
	Road Type	Speed Bin	January	July	Average
NOx	4	3	17.1	13.1	15.1
NOx	4	4	14.5	11.1	12.8
NOx	4	5	12.7	9.8	11.3
NOx	4	6	11.7	8.9	10.3
NOx	4	7	11.4	8.7	10.1
NOx	4	8	10.0	7.7	8.8
NOx	4	9	9.8	7.5	8.7
NOx	4	10	9.7	7.4	8.5
NOx	4	11	9.5	7.2	8.4
NOx	5	3	17.3	13.2	15.2
NOx	5	4	14.7	11.3	13.0
NOx	5	5	13.0	9.9	11.5
NOx	5	6	11.8	9.1	10.4
NOx	5	7	11.6	8.8	10.2
NOx	5	8	10.0	7.7	8.9
NOx	5	9	9.8	7.5	8.6
NOx	5	10	9.6	7.3	8.5
NOx	5	11	9.3	7.2	8.2
PM10	4	3	1.0	1.0	1.0
PM10	4	4	0.8	0.8	0.8
PM10	4	5	0.7	0.7	0.7
PM10	4	6	0.7	0.7	0.7
PM10	4	7	0.6	0.6	0.6
PM10	4	8	0.5	0.5	0.5
PM10	4	9	0.5	0.5	0.5
PM10	4	10	0.5	0.5	0.5
PM10	4	11	0.4	0.4	0.4
PM10	5	3	1.0	1.0	1.0
PM10	5	4	0.8	0.8	0.8
PM10	5	5	0.7	0.7	0.7
PM10	5	6	0.7	0.7	0.7
PM10	5	7	0.6	0.6	0.6
PM10	5	8	0.5	0.5	0.5
PM10	5	9	0.5	0.5	0.5
PM10	5	10	0.4	0.4	0.4
PM10	5	11	0.4	0.4	0.4
PM2.5	4	3	0.9	0.9	0.9
PM2.5	4	4	0.8	0.8	0.8
PM2.5	4	5	0.7	0.7	0.7
PM2.5	4	6	0.6	0.6	0.6
PM2.5	4	7	0.6	0.6	0.6
PM2.5	4	8	0.5	0.5	0.5
PM2.5	4	9	0.4	0.4	0.4
PM2.5	4	10	0.4	0.4	0.4
PM2.5	4	11	0.4	0.4	0.4
PM2.5	5	3	0.9	0.9	0.9
PM2.5	5	4	0.8	0.8	0.8
PM2.5	5	5	0.7	0.7	0.7
PM2.5	5	6	0.6	0.6	0.6
PM2.5	5	7	0.6	0.6	0.6
PM2.5	5	8	0.5	0.5	0.5
PM2.5	5	9	0.4	0.4	0.4
PM2.5	5	10	0.4	0.4	0.4
PM2.5	5	11	0.3	0.3	0.3
VOC	4	3	1.3	1.3	1.3
VOC	4	4	0.9	0.9	0.9
VOC	4	5	0.7	0.7	0.7
VOC	4	6	0.6	0.6	0.6
VOC	4	7	0.5	0.5	0.5
VOC	4	8	0.4	0.4	0.4
VOC	4	9	0.4	0.4	0.4
VOC	4	10	0.4	0.4	0.4
VOC	4	11	0.4	0.4	0.4
VOC	5	3	1.3	1.3	1.3

Transit Buses

	Emission Factors (g/VMT)				
	Road Type	Speed Bin	January	July	Average
NOx	5	3	33.5	25.6	29.6
PM10	5	3	1.0	1.0	1.0
PM2.5	5	3	0.9	0.9	0.9
VOC	5	3	2.6	2.6	2.6
SO2	5	3	1.86E-02	2.25E-02	2.06E-02
CO	5	3	11.16	11.16	11.16

VOC	5	4	0.9	0.9	0.9
VOC	5	5	0.7	0.7	0.7
VOC	5	6	0.6	0.6	0.6
VOC	5	7	0.5	0.5	0.5
VOC	5	8	0.5	0.5	0.5
VOC	5	9	0.4	0.4	0.4
VOC	5	10	0.4	0.4	0.4
VOC	5	11	3.74E-01	3.74E-01	3.74E-01
SO2	4	3	2.46E-02	2.98E-02	2.72E-02
SO2	4	4	2.19E-02	2.60E-02	2.40E-02
SO2	4	5	1.95E-02	2.29E-02	2.12E-02
SO2	4	6	1.82E-02	2.13E-02	1.97E-02
SO2	4	7	1.80E-02	2.08E-02	1.94E-02
SO2	4	8	1.54E-02	1.79E-02	1.67E-02
SO2	4	9	1.52E-02	1.76E-02	1.64E-02
SO2	4	10	1.51E-02	1.73E-02	1.62E-02
SO2	4	11	1.46E-02	1.68E-02	1.57E-02
SO2	5	3	2.49E-02	3.01E-02	2.75E-02
SO2	5	4	2.25E-02	2.66E-02	2.45E-02
SO2	5	5	1.99E-02	2.34E-02	2.16E-02
SO2	5	6	1.85E-02	2.16E-02	2.01E-02
SO2	5	7	1.82E-02	2.11E-02	1.97E-02
SO2	5	8	1.54E-02	1.79E-02	1.66E-02
SO2	5	9	1.51E-02	1.74E-02	1.62E-02
SO2	5	10	1.48E-02	1.70E-02	1.59E-02
SO2	5	11	1.43E-02	1.64E-02	1.53E-02
CO	4	3	5.24	5.24	5.24
CO	4	4	4.06	4.06	4.06
CO	4	5	3.37	3.37	3.37
CO	4	6	3.03	3.03	3.03
CO	4	7	2.78	2.78	2.78
CO	4	8	2.46	2.46	2.46
CO	4	9	2.32	2.32	2.32
CO	4	10	2.20	2.20	2.20
CO	4	11	2.09	2.09	2.09
CO	5	3	5.28	5.28	5.28
CO	5	4	4.12	4.12	4.12
CO	5	5	3.40	3.40	3.40
CO	5	6	3.05	3.05	3.05
CO	5	7	2.80	2.80	2.80
CO	5	8	2.46	2.46	2.46
CO	5	9	2.31	2.31	2.31
CO	5	10	2.19	2.19	2.19
CO	5	11	2.07	2.07	2.07

	Emission Factors (g/VMT)				
Average			January	July	Average
NOx			11.9	9.1	10.5
PM10			0.6	0.6	0.6
PM2.5			0.6	0.6	0.6
VOC			0.6	0.6	0.6
SO2			3.69E-02	3.98E-02	3.83E-02
CO			3.07	3.07	3.07

Non Road - RTG and CHE

2017 Emissions Calculations

South Carolina Ports Authority

2017 Air Emissions Inventory Update

Rubber Tired Gantry		Emissions Summary tons/year						
Terminal		**HC**	**CO**	**NOx**	**PM**	**PM_{10}**	**$PM_{2.5}$**	**SO_2**
Columbus Street	CST	0.18	0.87	0.82	0.11	0.11	0.11	0.00
North Charleston	NCT	0.42	4.73	18.28	0.71	0.71	0.69	0.02
Wando Welch	WWT	2.73	13.30	42.59	1.97	1.97	1.91	0.06
Total		**3.34**	**18.90**	**61.69**	**2.79**	**2.79**	**2.71**	**0.09**

Cargo Handling Equipment		Emissions Summary tons/year						
Terminal		**HC**	**CO**	**NOx**	**PM**	**PM_{10}**	**$PM_{2.5}$**	**SO_2**
Columbus Street	CST	0.01	0.01	0.04	0.00	0.00	0.00	0.00
North Charleston	NCT	1.38	6.88	17.64	0.69	0.69	0.67	0.02
Union Pier	UPT	0.00	0.00	0.00	0.00	0.00	0.00	0.00
Veterans	VT	0.00	0.00	0.00	0.00	0.00	0.00	0.00
Wando Welch	WWT	3.22	15.18	40.37	1.87	1.87	1.81	0.06
Total		**4.60**	**22.07**	**58.06**	**2.56**	**2.56**	**2.48**	**0.09**

Total RTG and CHE		Emissions Summary tons/year						
Terminal		**HC**	**CO**	**NOx**	**PM**	**PM_{10}**	**$PM_{2.5}$**	**SO_2**
Columbus Street	CST	0.19	0.88	0.85	0.11	0.11	0.11	0.00
North Charleston	NCT	1.80	11.61	35.93	1.40	1.40	1.36	0.05
Union Pier	UPT	0.00	0.00	0.00	0.00	0.00	0.00	0.00
Veterans	VT	0.00	0.00	0.00	0.00	0.00	0.00	0.00
Wando Welch	WWT	5.95	28.48	82.96	3.84	3.84	3.72	0.13
Total		**7.94**	**40.97**	**119.75**	**5.35**	**5.35**	**5.19**	**0.18**

South Carolina Ports Authority

2017 Air Emissions Inventory Update

Total by Equipment Type	Emissions Summary tons/year						
Equipment	**HC**	**CO**	**NOx**	**PM**	**PM_{10}**	**$PM_{2.5}$**	**SO_2**
Container Handler, Full	3.65	18.07	46.53	1.84	1.84	1.79	0.07
Container Handler, Empty	0.88	3.88	11.17	0.69	0.69	0.67	0.02
Crane, RTG	3.16	18.02	60.88	2.68	2.68	2.60	0.09
Crane, Truck	0.18	0.87	0.82	0.11	0.11	0.11	0.00
Forklift 33.5K	0.00	0.00	0.00	0.00	0.00	0.00	0.00
Forklift 36K	0.07	0.11	0.32	0.02	0.02	0.02	0.00
Forklift 55K	0.01	0.01	0.03	0.00	0.00	0.00	0.00
Total	**7.94**	**40.97**	**119.75**	**5.35**	**5.35**	**5.19**	**0.18**

Cargo Handling Equipment	Emissions Summary tons/year						
Railway Companies	**HC**	**CO**	**NOx**	**PM**	**PM_{10}**	**$PM_{2.5}$**	**SO_2**
Total	**3.50**	**15.66**	**37.99**	**2.41**	**2.41**	**2.34**	**0.06**

South Carolina Ports Authority
2017 Air Emissions Inventory Update

Rubber Tired Gantry

Equipment Inventory									Operation		Emissions (lb/yr)						
Equip	Equipment Type	Equip. No.	Terminal	Engine Replaced	TIER	BHP	Fuel	Load	2017 Hours	2017 Fuel Use (gal)	HC	CO	NOx	PM	PM_{10}	$PM_{2.5}$	SO_2
H-41-009	Crane, RTG	H-41-009	NCT	Y	3	558	ULSD	0.43	3,285	20,713	104	1,160	4,488	174	174	169	5
H-41-010	Crane, RTG	H-41-010	NCT	Y	3	558	ULSD	0.43	3,025	18,955	95	1,069	4,134	160	160	156	5
H-41-011	Crane, RTG	H-41-011	NCT	Y	3	558	ULSD	0.43	3,372	22,086	106	1,191	4,607	179	179	173	6
H-41-012	Crane, RTG	H-41-012	NCT	Y	3	558	ULSD	0.43	3,370	20,987	106	1,190	4,604	179	179	173	6
H-41-013	Crane, RTG	H-41-013	NCT	Y	3	558	ULSD	0.43	3,266	21,035	103	1,154	4,462	173	173	168	5
H-41-014	Crane, RTG	H-41-014	NCT	Y	3	558	ULSD	0.43	3,292	20,865	104	1,163	4,498	175	175	169	5
H-41-022	Crane, RTG	H-41-022	NCT	Y	3	558	ULSD	0.43	3,092	20,915	98	1,092	4,224	164	164	159	5
H-41-023	Crane, RTG	H-41-023	NCT	Y	3	558	ULSD	0.43	3,391	22,244	107	1,198	4,633	180	180	174	6
H-41-024	Crane, RTG	H-41-024	NCT	Y	3	558	ULSD	0.43	330	2,259	10	117	451	18	18	17	1
H-41-025	Crane, RTG	H-41-025	NCT	Y	3	558	ULSD	0.43	342	2,058	11	121	467	18	18	18	1
H-41-030	Crane, RTG	H-41-030	WWT	N	2	524	ULSD	0.43	1,473	10,359	131	382	1,890	65	65	63	2
H-41-031	Crane, RTG	H-41-031	WWT	N	2	524	ULSD	0.43	2,334	15,864	207	605	2,995	104	104	101	4
H-41-035	Crane, RTG	H-41-035	WWT	N	2	524	ULSD	0.43	2,834	19,319	252	735	3,637	126	126	122	4
H-41-036	Crane, RTG	H-41-036	WWT	N	2	524	ULSD	0.43	2,998	21,039	266	777	3,847	133	133	129	5
H-41-037	Crane, RTG	H-41-037	WWT	N	2	524	ULSD	0.43	2,957	21,264	263	767	3,794	131	131	128	5
H-41-038	Crane, RTG	H-41-038	WWT	N	2	524	ULSD	0.43	2,832	17,733	251	734	3,634	126	126	122	4
H-41-039	Crane, RTG	H-41-039	WWT	N	2	524	ULSD	0.43	2,385	16,089	212	618	3,060	106	106	103	4
H-41-040	Crane, RTG	H-41-040	WWT	N	2	524	ULSD	0.43	2,881	20,189	256	747	3,697	128	128	124	4
H-41-041	Crane, RTG	H-41-041	WWT	N	2	524	ULSD	0.43	3,021	22,063	268	783	3,876	134	134	130	5
H-41-043	Crane, RTG	H-41-043	WWT	N	2	524	ULSD	0.43	2,752	19,724	244	714	3,531	122	122	119	4
H-41-044	Crane, RTG	H-41-044	WWT	N	2	524	ULSD	0.43	2,227	15,328	198	578	2,858	99	99	96	3
H-41-045	Crane, RTG	H-41-045	WWT	N	2	524	ULSD	0.43	2,743	18,347	243	711	3,520	122	122	118	4
H-41-046	Crane, RTG	H-41-046	WWT	N	2	524	ULSD	0.43	2,616	19,108	232	678	3,357	116	116	113	4
H-41-047	Crane, RTG	H-41-047	WWT	N	2	524	ULSD	0.43	2,106	16,005	187	546	2,702	94	94	91	3
H-41-018	Crane, RTG	H-41-018	WWT	Y	3	558	ULSD	0.43	1,111	7,791	35	392	1,518	59	59	57	2
H-41-019	Crane, RTG	H-41-019	WWT	Y	3	558	ULSD	0.43	1,629	10,013	51	575	2,226	86	86	84	3
H-41-020	Crane, RTG	H-41-020	WWT	Y	3	558	ULSD	0.43	2,078	13,599	66	734	2,840	110	110	107	3
H-41-021	Crane, RTG	H-41-021	WWT	Y	3	558	ULSD	0.43	725	5,202	23	256	990	38	38	37	1
H-41-024	Crane, RTG	H-41-024	WWT	Y	3	558	ULSD	0.43	717	4,384	23	253	979	38	38	37	1
H-41-025	Crane, RTG	H-41-025	WWT	Y	3	558	ULSD	0.43	627	3,493	20	221	857	33	33	32	1
H-41-026	Crane, RTG	H-41-026	WWT	Y	3	558	ULSD	0.43	1,323	8,594	42	467	1,808	70	70	68	2
H-41-029	Crane, RTG	H-41-029	WWT	Y	3	558	ULSD	0.43	2,785	18,446	88	984	3,806	148	148	143	5
H-41-032	Crane, RTG	H-41-032	WWT	Y	3	558	ULSD	0.43	2,672	19,994	84	944	3,650	142	142	137	4
H-41-033	Crane, RTG	H-41-033	WWT	Y	3	558	ULSD	0.43	2,191	14,680	69	774	2,993	116	116	113	4
H-41-034	Crane, RTG	H-41-034	WWT	Y	3	558	ULSD	0.43	3,070	19,086	97	1,084	4,195	163	163	158	5
H-41-042	Crane, RTG	H-41-042	WWT	Y	3	558	ULSD	0.43	3,243	22,172	102	1,146	4,432	172	172	167	5
H-41-048	Crane, RTG	H-41-048	WWT	Y	3	558	ULSD	0.43	2,617	19,509	83	925	3,576	139	139	135	4
H-41-049	Crane, RTG	H-41-049	WWT	Y	3	558	ULSD	0.43	3,294	22,757	104	1,164	4,501	175	175	170	5
H-41-050	Crane, RTG	H-41-050	WWT	N	4F	675	ULSD	0.43	1,184	4,169	131	699	40	80	80	78	2
H-41-051	Crane, RTG	H-41-051	WWT	N	4F	675	ULSD	0.43	1,142	3,850	127	674	38	78	78	75	2
H-41-052	Crane, RTG	H-41-052	WWT	N	4F	675	ULSD	0.43	1,117	4,259	124	659	37	76	76	74	2
H-41-053	Crane, RTG	H-41-053	WWT	N	4F	675	ULSD	0.43	1,310	4,581	145	773	44	89	89	86	3
H-41-054	Crane, RTG	H-41-054	WWT	N	4F	675	ULSD	0.43	1,284	5,321	142	758	43	87	87	85	3
H-41-055	Crane, RTG	H-41-055	WWT	N	4F	675	ULSD	0.43	1,328	5,389	147	784	44	90	90	88	3
H-41-056	Crane, RTG	H-41-056	WWT	N	4F	675	ULSD	0.43	897	2,807	99	530	30	61	61	59	2
H-41-057	Crane, RTG	H-41-057	WWT	N	4F	675	ULSD	0.43	744	3,116	82	439	25	51	51	49	1

South Carolina Ports Authority
2017 Air Emissions Inventory Update

Rubber Tired Gantry

Equipment Inventory									Operation		Emissions (lb/yr)						
Equip	Equipment Type	Equip. No.	Terminal	Engine Replaced	TIER	BHP	Fuel	Load	2017 Hours	2017 Fuel Use (gal)	HC	CO	NOx	PM	PM_{10}	$PM_{2.5}$	SO_2
H-41-058	Crane, RTG	H-41-058	WWT	N	4F	675	ULSD	0.43	832	3,011	92	491	28	57	57	55	2
H-41-059	Crane, RTG	H-41-059	WWT	N	4F	675	ULSD	0.43	848	2,775	94	500	28	58	58	56	2
H-41-060	Crane, RTG	H-41-060	WWT	N	4F	675	ULSD	0.43	777	2,619	86	459	26	53	53	51	2
H-41-061	Crane, RTG	H-41-061	WWT	N	4F	675	ULSD	0.43	901	3,453	100	532	30	61	61	59	2
GROVE RT880E	Crane, Truck	232915	CST	N	4F	275	ULSD	0.43	530	NA	18	51	231	10	10	10	0
LinkBelt HTC86100	Crane, Truck	N3K3-3145	CST	N	4F	675	ULSD	0.43	1,820	2,734	202	1,074	61	124	124	120	4
LinkBelt HTC8690	Crane, Truck	N3J79393	CST	N	1	445	ULSD	0.43	1,563	2,719	118	440	659	66	66	64	2
LinkBelt HTC8670	Crane, Truck	F2I8-8722	CST	N	1	365	ULSD	0.43	767	1,455	24	177	686	24	24	23	1
Total Hours, Fuel and Emissions (tons/yr)									**108,051**	**666,527**	**3.34**	**18.90**	**61.69**	**2.79**	**2.79**	**2.71**	**0.09**

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Cargo Handling Equipment

Equipment Inventory								Operation		Emissions (lb/yr)						
Equip ID	Equipment Type	Equip. No.	Terminal	TIER	BHP	Fuel	Load	2017 Hours	2017 Fuel Use (gal)	HC	CO	NOx	PM	PM_{10}	$PM_{2.5}$	SO_2
H-01-057	Container Handler, Full	H-01-057	CST	N/A	252	ULSD	0.59	13	75	1	2	7	0	0	0	0
M-75-180	Forklift 55K	M-75-180	CST	N/A	215	ULSD	0.30	125	203	2	3	11	0	0	0	0
M-75-190	Forklift 55K	M-75-190	CST	N/A	215	ULSD	0.30	369	0	7	8	32	1	1	1	0
M-75-167	Forklift 55K	M-75-167	CST	N/A	234	ULSD	0.30	237	0	5	6	22	1	1	1	0
H-01-065	Container Handler, Empty	H-01-065	NCT	1	160	ULSD	0.59	10	0	0	2	4	0	0	0	0
H-01-090	Container Handler, Empty	H-01-090	NCT	1	187	ULSD	0.59	541	836	22	69	210	14	14	13	0
H-01-151	Container Handler, Empty	H-01-151	NCT	3	220	ULSD	0.59	1,948	4,418	72	302	892	58	58	56	2
H-01-089	Container Handler, Full	H-01-089	NCT	1	335	ULSD	0.59	0	0	0	0	0	0	0	0	0
H-01-103	Container Handler, Full	H-01-103	NCT	2	335	ULSD	0.59	1,118	4,614	85	472	1,168	40	40	39	2
H-01-104	Container Handler, Full	H-01-104	NCT	2	335	ULSD	0.59	428	3,096	33	181	447	15	15	15	1
H-01-106	Container Handler, Full	H-01-106	NCT	2	343	ULSD	0.59	340	1,401	26	68	364	15	15	14	0
H-01-108	Container Handler, Full	H-01-108	NCT	2	343	ULSD	0.59	119	619	9	24	127	5	5	5	0
H-01-112	Container Handler, Full	H-01-112	NCT	2	343	ULSD	0.59	139	755	11	28	149	6	6	6	0
H-01-059	Container Handler, Full	H-01-059	NCT	3	275	ULSD	0.59	3	0	0	1	2	0	0	0	0
H-01-062	Container Handler, Full	H-01-062	NCT	3	275	ULSD	0.59	917	3,764	55	178	525	34	34	33	1
H-01-068	Container Handler, Full	H-01-068	NCT	3	275	ULSD	0.59	162	603	10	31	93	6	6	6	0
H-01-095	Container Handler, Full	H-01-095	NCT	3	275	ULSD	0.59	1,317	4,889	79	255	753	49	49	47	1
H-01-096	Container Handler, Full	H-01-096	NCT	3	275	ULSD	0.59	1,396	2,482	84	271	799	52	52	50	1
H-01-097	Container Handler, Full	H-01-097	NCT	3	275	ULSD	0.59	1,109	4,428	67	215	635	41	41	40	1
H-01-099	Container Handler, Full	H-01-099	NCT	3	275	ULSD	0.59	555	5,557	33	108	317	21	21	20	1
H-01-101	Container Handler, Full	H-01-101	NCT	3	275	ULSD	0.59	816	2,889	49	158	467	30	30	29	1
H-01-102	Container Handler, Full	H-01-102	NCT	3	275	ULSD	0.59	875	3,233	53	170	501	32	32	31	1
H-01-123	Container Handler, Full	H-01-123	NCT	3	350	ULSD	0.59	3,270	12,882	260	1,443	3,570	122	122	118	5
H-01-124	Container Handler, Full	H-01-124	NCT	3	350	ULSD	0.59	3,286	14,307	261	1,450	3,588	123	123	119	5
H-01-125	Container Handler, Full	H-01-125	NCT	3	350	ULSD	0.59	3,324	11,996	264	1,467	3,629	124	124	120	5
H-01-126	Container Handler, Full	H-01-126	NCT	3	350	ULSD	0.59	3,292	13,659	262	1,453	3,594	123	123	119	5
H-01-132	Container Handler, Full	H-01-132	NCT	3	350	ULSD	0.59	2,839	10,430	226	1,253	3,099	106	106	103	4
H-01-133	Container Handler, Full	H-01-133	NCT	3	350	ULSD	0.59	3,196	14,508	254	1,410	3,489	119	119	116	5
H-01-138	Container Handler, Full	H-01-138	NCT	3	350	ULSD	0.59	2,983	12,025	237	1,316	3,256	111	111	108	4
H-01-139	Container Handler, Full	H-01-139	NCT	3	350	ULSD	0.59	3,064	13,211	244	1,352	3,345	114	114	111	4
M-75-159	Forklift 36K	M-75-159	NCT	N/A	155	ULSD	0.30	7	0	0	0	0	0	0	0	0
M-75-181	Forklift 36K	M-75-181	NCT	N/A	155	ULSD	0.30	104	0	1	2	7	0	0	0	0
M-75-210	Forklift 36K	M-75-210	NCT	N/A	155	ULSD	0.30	1,500	2,431	21	35	99	5	5	5	0
M-75-218	Forklift 36K	M-75-218	NCT	N/A	155	ULSD	0.30	2,380	2,174	33	55	158	9	9	8	1
M-75-148	Forklift 36K	M-75-148	UPT	N/A	155	ULSD	0.30	33	0	0	1	2	0	0	0	0
M-75-160	Forklift 36K	M-75-160	UPT	N/A	155	ULSD	0.30	61	0	1	1	4	0	0	0	0
M-75-171	Forklift 33.5K	M-75-171	VT	N/A	152	ULSD	0.30	60	0	1	1	4	0	0	0	0

South Carolina Ports Authority
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Cargo Handling Equipment

Equipment Inventory								Operation		Emissions (lb/yr)						
Equip ID	Equipment Type	Equip. No.	Terminal	TIER	BHP	Fuel	Load	2017 Hours	2017 Fuel Use (gal)	HC	CO	NOx	PM	PM_{10}	$PM_{2.5}$	SO_2
H-01-086	Container Handler, Empty	H-01-086	WWT	1	187	ULSD	0.59	986	2,082	40	125	384	25	25	24	1
H-01-087	Container Handler, Empty	H-01-087	WWT	1	187	ULSD	0.59	1,366	3,521	56	173	531	34	34	33	1
H-01-088	Container Handler, Empty	H-01-088	WWT	1	187	ULSD	0.59	1,024	2,677	42	130	398	26	26	25	1
H-01-091	Container Handler, Empty	H-01-091	WWT	1	187	ULSD	0.59	2,299	4,861	94	292	894	58	58	56	2
H-01-094	Container Handler, Empty	H-01-094	WWT	1	275	ULSD	0.59	340	998	20	59	195	13	13	12	0
H-01-105	Container Handler, Empty	H-01-105	WWT	2	154	ULSD	0.59	277	1,055	10	41	96	10	10	9	0
H-01-109	Container Handler, Empty	H-01-109	WWT	2	154	ULSD	0.59	280	2,053	10	41	97	10	10	9	0
H-01-110	Container Handler, Empty	H-01-110	WWT	2	275	ULSD	0.59	321	590	19	56	183	12	12	12	0
H-01-111	Container Handler, Empty	H-01-111	WWT	2	275	ULSD	0.59	110	625	7	19	63	4	4	4	0
H-01-116	Container Handler, Empty	H-01-116	WWT	3	164	ULSD	0.59	2,117	4,351	40	303	783	40	40	39	1
H-01-117	Container Handler, Empty	H-01-117	WWT	3	164	ULSD	0.59	2,128	4,247	41	305	787	41	41	39	1
H-01-120	Container Handler, Empty	H-01-120	WWT	3	164	ULSD	0.59	2,776	6,623	53	397	1,027	53	53	51	2
H-01-121	Container Handler, Empty	H-01-121	WWT	3	164	ULSD	0.59	2,741	3,598	52	392	1,014	52	52	51	2
H-01-122	Container Handler, Empty	H-01-122	WWT	3	164	ULSD	0.59	2,951	7,072	56	423	1,092	56	56	55	2
H-01-140	Container Handler, Empty	H-01-140	WWT	3	220	ULSD	0.59	3,032	6,360	113	470	1,388	90	90	87	3
H-01-142	Container Handler, Empty	H-01-142	WWT	3	220	ULSD	0.59	2,941	6,059	109	456	1,346	87	87	84	2
H-01-143	Container Handler, Empty	H-01-143	WWT	3	220	ULSD	0.59	2,825	5,567	105	438	1,293	84	84	81	2
H-01-144	Container Handler, Empty	H-01-144	WWT	3	220	ULSD	0.59	2,780	5,321	103	431	1,273	82	82	80	2
H-01-145	Container Handler, Empty	H-01-145	WWT	3	220	ULSD	0.59	2,683	5,047	100	416	1,228	79	79	77	2
H-01-146	Container Handler, Empty	H-01-146	WWT	3	220	ULSD	0.59	2,592	4,460	96	402	1,186	77	77	74	2
H-01-147	Container Handler, Empty	H-01-147	WWT	3	220	ULSD	0.59	1,393	2,016	52	216	638	41	41	40	1
H-01-148	Container Handler, Empty	H-01-148	WWT	3	220	ULSD	0.59	2,661	4,686	99	413	1,218	79	79	76	2
H-01-149	Container Handler, Empty	H-01-149	WWT	3	220	ULSD	0.59	2,328	4,221	87	361	1,066	69	69	67	2
H-01-150	Container Handler, Empty	H-01-150	WWT	3	220	ULSD	0.59	2,183	4,207	81	339	999	65	65	63	2
H-01-152	Container Handler, Empty	H-01-152	WWT	3	220	ULSD	0.59	2,421	4,130	90	375	1,108	72	72	69	2
H-01-153	Container Handler, Empty	H-01-153	WWT	3	220	ULSD	0.59	261	666	10	41	120	8	8	8	0
H-0+3:801-154	Container Handler, Empty	H-01-154	WWT	3	220	ULSD	0.59	302	817	11	47	138	9	9	9	0
H-01-113	Container Handler, Empty	H-01-113	WWT	3	236	ULSD	0.59	974	462	50	162	479	31	31	30	1
H-01-114	Container Handler, Empty	H-01-114	WWT	3	236	ULSD	0.59	432	3,158	22	72	212	14	14	13	0
H-01-107	Container Handler, Full	H-01-107	WWT	2	343	ULSD	0.59	1,209	4,727	94	241	1,294	52	52	51	2
H-01-060	Container Handler, Full	H-01-060	WWT	3	275	ULSD	0.59	1,546	6,648	93	300	885	57	57	55	2
H-01-066	Container Handler, Full	H-01-066	WWT	3	275	ULSD	0.59	2,231	3,362	134	433	1,277	83	83	80	2

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Cargo Handling Equipment

Equipment Inventory								Operation		Emissions (lb/yr)						
Equip ID	Equipment Type	Equip. No.	Terminal	TIER	BHP	Fuel	Load	2017 Hours	2017 Fuel Use (gal)	HC	CO	NOx	PM	PM_{10}	$PM_{2.5}$	SO_2
H-01-082	Container Handler, Full	H-01-082	WWT	3	275	ULSD	0.59	2,822	9,272	170	547	1,615	104	104	101	3
H-01-083	Container Handler, Full	H-01-083	WWT	3	275	ULSD	0.59	2,843	14,050	171	551	1,627	105	105	102	3
H-01-084	Container Handler, Full	H-01-084	WWT	3	275	ULSD	0.59	2,544	9,072	153	493	1,456	94	94	91	3
H-01-092	Container Handler, Full	H-01-092	WWT	3	275	ULSD	0.59	2,902	10,456	174	563	1,660	107	107	104	3
H-01-093	Container Handler, Full	H-01-093	WWT	3	275	ULSD	0.59	3,216	12,163	193	624	1,841	119	119	115	3
H-01-100	Container Handler, Full	H-01-100	WWT	3	275	ULSD	0.59	3,028	11,134	182	587	1,733	112	112	109	3
H-01-127	Container Handler, Full	H-01-127	WWT	3	350	ULSD	0.59	4,922	17,172	391	2,172	5,374	184	184	178	7
H-01-128	Container Handler, Full	H-01-128	WWT	3	350	ULSD	0.59	5,219	24,133	415	2,303	5,698	195	195	189	7
H-01-129	Container Handler, Full	H-01-129	WWT	3	350	ULSD	0.59	3,546	15,010	282	1,565	3,871	132	132	128	5
H-01-130	Container Handler, Full	H-01-130	WWT	3	350	ULSD	0.59	4,813	17,300	383	2,124	5,254	180	180	174	7
H-01-131	Container Handler, Full	H-01-131	WWT	3	350	ULSD	0.59	4,747	17,105	377	2,095	5,183	177	177	172	7
H-01-134	Container Handler, Full	H-01-134	WWT	3	350	ULSD	0.59	5,285	18,797	420	2,333	5,770	197	197	191	8
H-01-135	Container Handler, Full	H-01-135	WWT	3	350	ULSD	0.59	3,968	18,884	315	1,751	4,332	148	148	144	6
H-01-136	Container Handler, Full	H-01-136	WWT	3	350	ULSD	0.59	4,514	18,421	359	1,992	4,928	169	169	164	6
H-01-137	Container Handler, Full	H-01-137	WWT	3	350	ULSD	0.59	4,892	15,624	389	2,159	5,341	183	183	177	7
M-75-175	Forklift 36K	M-75-175	WWT	N/A	155	ULSD	0.30	52	4,497	1	1	3	0	0	0	0
M-75-205	Forklift 36K	M-75-205	WWT	N/A	155	ULSD	0.30	172	0	2	4	11	1	1	1	0
M-75-209	Forklift 36K	M-75-209	WWT	N/A	155	ULSD	0.30	2,058	4,112	29	48	136	7	7	7	1
M-75-219	Forklift 36K	M-75-219	WWT	N/A	155	ULSD	0.30	2,202	5,770	31	51	146	8	8	8	1
M-75-206	Forklift 36K	M-75-206	WWT	N/A	*155*	ULSD	0.30	0	0	0	0	0	0	0	0	0
M-75-207	Forklift 36K	M-75-207	WWT	N/A	*155*	ULSD	0.30	1,019	0	14	24	67	4	4	4	0
Total Hours, Fuel and Emissions (tons/yr)								**161,212**	**510,723**	**4.60**	**22.07**	**58.06**	**2.56**	**2.56**	**2.48**	**0.09**

South Carolina Ports Authority
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Railway Cargo Handling Equipment

Equipment Data						Emissions (lb/yr)						
Equipment Type	Equip. No.	TIER	HP[1]	Fuel	Annual Operation (Hours)[2]	HC	CO	NOx	PM	PM_{10}	$PM_{2.5}$	SO_2
Machine Lift, Taylor 950	3	2	425	ULSD	12,480	2,041	11,383	28,041	1,573	1,573	1,526	37
Machine Lift, Taylor 974	3	3	335	ULSD	12,480	1,609	8,973	22,103	1,240	1,240	1,203	29
Reach Stacker	4	NA	*300*	ULSD	*16,640*	1,849	5,965	17,606	1,138	1,138	1,104	33
Side Loader	1	NA	*155*	ULSD	*4,160*	1,119	4,345	6,389	768	768	745	5
Fork Lift	2	NA	*155*	ULSD	*8,320*	388	646	1,837	101	101	98	8
Total Hours and Emissions (tons/yr)					**54,080**	**3.50**	**15.66**	**37.99**	**2.41**	**2.41**	**2.34**	**0.06**

1 Horsepower was not provided, estimated based on RTG and CH equipment data provided by SCPA.

2 One rail company provided 80 hours/week per equipment. The estimate was applied to all rail CHE.

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Railway Cargo Handling Equipment

Emission Factors (g/hp-hr)						
HC	CO	NOx	PM_{10}	$PM_{2.5}$	SO_2	CO_2
0.17	0.97	2.40	0.13	0.13	0.003	536.28
0.17	0.97	2.40	0.13	0.13	0.003	536.28
0.17	0.54	1.60	0.10	0.10	0.003	536.30
0.79	3.06	4.49	0.54	0.52	0.004	624.08
0.14	0.23	0.65	0.04	0.03	0.003	536.40

South Carolina Ports Authority
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Non-Road Diesel Equipment Manufacturer Emission Factors

Engine Data				Emission Factors (g/Bhp-hr)[1]					
Engine Manuf	Engine Model Number	TIER	BHP	HC	CO	NOx	PM	PM_{10}	$PM_{2.5}$
Cat	3208	-	252	0.36	1.3	5.7	0.31	0.31	0.30
Cat	C9	3	275	0.18	1.3	2.5	0.11	0.11	0.10
Cat	C13	1	276	0.00	1.6	1.0	0.00	0.00	0.00
Cummins	6CT	1	275	0.31	0.5	5.7	0.11	0.11	0.11
Cummins	6CT	2	275	0.31	0.5	5.7	0.11	0.11	0.11
Cummins	M11	1	335	0.22	1.2	6.6	0.12	0.12	0.12
Cummins	QSB 6.7 (164 BHP)	3	164	0.09	0.7	2.7	0.09	0.09	0.09
Cummins	QSB 6.7 (220 BHP)	3	220	0.13	0.9	2.6	0.11	0.11	0.11
Cummins	QSM11	2	335	0.21	1.0	2.8	0.08	0.08	0.08
Cummins	QSM11	3	350	0.11	0.6	2.6	0.07	0.07	0.07
Cummins	QSX15	4F	350	0.00	0.0	0.1	0.00	0.00	0.00
Detroit Diesel	Series 60 11.1 L	0	365	0.09	2.0	0.0	0.09	0.09	0.09
Volvo	TWD1240VE	2	343	0.24	0.4	4.3	0.10	0.10	0.09
Volvo	TWD731VE	1	187	0.31	0.5	6.4	0.15	0.15	0.14
Volvo	TAD1353GE	3	558	0.06	1.04	2.73	0.12	0.12	0.12
Volvo	TAD1352GE	3	558	0.06	1.0	2.7	0.12	0.12	0.12
Volvo	TAD1242GE	2	524	0.00	0.5	4.3	0.09	0.09	0.09

1 Manufacture specific engine data obtained from the EPA Certification results.

Tier 1 standards were published as a final rule on June 5, 1991 and phased-in progressively between 1994 and 1997.
Tier 2 standards were adopted on December 21, 1999, with a phase-in implementation schedule from 2004 to 2009.
Tier 3 standards were finalized on March 3, 2014, to be phased-in between 2017 and 2025.

MOVES2014a NONROAD Category	Emission Factors (g/Bhp-hr)[1]							
	BHP	HC	CO	NOx	PM	PM_{10}	$PM_{2.5}$	SO_2
Cranes	631	0.18	0.72	2.57	0.10	0.10	0.10	0.003
Rubber Tire Loaders	384	0.17	0.70	1.87	0.12	0.12	0.12	0.003
Forklifts	198	0.14	0.21	0.64	0.03	0.03	0.03	0.003

PM is equivalent to PM_{10}.

Appendix 2

Port Emissions in Regional Context

Port Emissions in Regional Context

Estimates of port emissions were also examined in a regional context in several different ways. First the SCPA emission estimates were compared to the USEPA's 2014 National Emissions Inventory (NEI) version 2 for the Tri-County area. Next, the changes in SCPA emission estimates from 2011 to 2017 were compared to the changes in monitored values from Charleston area ambient air quality monitors. Finally, the change in emission estimates for the Wando Welch Terminal was compared to the change in monitored values from the Wando Welch Terminal monitor.

Comparison to the NEI

The USEPA releases a new NEI every three years. The latest available inventory is for 2014. The change in SCPA emissions from 2011 to 2017 were compared to the change in NEI emissions from 2011 to 2014 for port related emission sectors in order to compare trends.

Table 1 below presents this comparison. The Tri-County area shows a decrease in port related emissions for all pollutants of concern. The difference in SCPA emission estimates shows a decrease in $PM_{2.5}$, PM_{10}, and SO_2 emissions, but a small increase in CO and NO_x emissions. By examining the sectors, it appears that SCPA on-road diesel trucks emissions for these two pollutants have increased, while overall Tri-County area emissions of these trucks have decreased. This is most likely due to the increase in truck visits of almost 60,000 to SCPA ports from 2011 to 2017.

Comparison to Area Monitors

There are several State-run ambient monitors in the Charleston area. SC DHEC operates one $PM_{2.5}$ monitor at the Charleston Public Works (AQS ID 45-019-0049) just to the west of downtown Charleston. SC DHEC also operates one NO_2 and one SO_2 monitor in North Charleston on Jenkins Avenue (AQS ID 45-019-0003). The locations of these monitors with respect to the ports are shown in Figure 1 below.

Table 2 below presents the percent change in estimated emissions from 2011 to 2017 for all SCPA ports compared to the percent change in average annual ambient concentrations at the monitors listed above. A negative value indicates that emissions or concentrations in 2017 are less than 2011 values. The trends are similar for both emissions and concentrations.

Comparison to Wando Welch Terminal Monitor

An ambient monitor that measures NO_2, SO_2, and $PM_{2.5}$ has been operating at the Wando Welch Terminal since May 2011. Since the monitor is located at the port terminal, it is necessary to estimate a background concentration for the monitor. This background concentration would be due to other sources in the area not associated with the port. To do this, the cumulative frequency of the 1-hour daily maximums of NO_2 and SO_2, and the daily average $PM_{2.5}$ were calculated and plotted (Figures 2 to 4). The estimated background concentration was taken from the point on the plot where the concentrations began to increase sharply, where a transition from regional sources to local sources can be identified. Due to the subjective methodology, some local influence may remain in the selected background concentrations, but the largest influence would be regional.

To determine the percent change in concentrations, the estimated background value was subtracted from the design value (DV) for each year. Then the percent change was calculated. The DVs were calculated as:

- NO_2 DV equals the 98th percentile of the 1-hour daily maximums,

- SO_2 DV equals the 99th percentile of the 1-hour daily maximums, and
- $PM_{2.5}$ DV equals the 98th percentile of the daily averages.

An example calculation for determining the percent change in NO_2 concentrations is provided below. Given that the 2017 DV is 59 ppb and the 2017 estimated background is 38 ppb, and the 2011 DV is 42 ppb and the 2011 background is 28 ppb, the percent change would be:

$$\frac{(59-38)-(42-28)}{\left(\frac{(59-38)+(42-28)}{2}\right)} \text{ x } 100 = 40\%$$

This percent change in concentrations was then compared to the percent change in estimated emissions for the Wando Welch Terminal (Table 3).

For SO_2 and NO_2, the change in the Wando Welch Terminal emission estimates and the monitored concentrations show similar tends. The change in emission estimates of $PM_{2.5}$ show a small decrease; however, the monitored concentrations show an increase. One possible cause in this difference in trends could be due to road dust. The emission estimates of $PM_{2.5}$ only include engine emissions, while the monitor concentrations include all $PM_{2.5}$.

Table 1. Comparison of 2017 and 2011 SCPA Emissions Differences to 2014 and 2011 NEI Emissions Differences

Pollutant	SCPA Source Type	2017-2011 SCPA Emissions Difference (tpy)	NEI Source Type	2014-2011 NEI Tri-County Emissions Difference (tpy)
CO	OGV + Tugs	40	Commercial Marine Vessels	304
	Trucks	45	On-Road – Diesel Heavy Duty	-855
	Rail	0	Locomotives	-72
	CHE	-21	Non-Road - Diesel	-236
	Total	**64**		**-859**
NO_x	OGV + Tugs	115	Commercial Marine Vessels	2576
	Trucks	92	On-Road – Diesel Heavy Duty	-2757
	Rail	-5	Locomotives	-646
	CHE	5	Non-Road - Diesel	-363
	Total	**207**		**-1190**
$PM_{2.5}$	OGV + Tugs	-42	Commercial Marine Vessels	-62
	Trucks	8	On-Road – Diesel Heavy Duty	-168
	Rail	-1	Locomotives	-20
	CHE	-2	Non-Road - Diesel	-33
	Total	**-37**		**-283**
PM_{10}	OGV + Tugs	-47	Commercial Marine Vessels	-72
	Trucks	10	On-Road – Diesel Heavy Duty	-205
	Rail	-1	Locomotives	-21
	CHE	-2	Non-Road - Diesel	-34
	Total	**-40**		**-332**
SO_2	OGV + Tugs	-1429	Commercial Marine Vessels	-622
	Trucks	1	On-Road – Diesel Heavy Duty	-3
	Rail	0	Locomotives	-12
	CHE	0	Non-Road - Diesel	-2
	Total	**-1428**		**-638**

Table 2. Percent Change in
Estimated SCPA Emissions and Charleston Area Monitored Concentrations

Pollutant	% Change in Estimated SCPA Emissions	% Change in Average Annual Monitored Concentrations
NO_2	8%	4%
SO_2	-183%	-58%
$PM_{2.5}$	-19%	-34%

Table 3. Percent Change in
Estimated Emissions and Monitored Concentrations at Wando Welch Terminal

Pollutant	% Change in Estimated Emissions	2017		2011		% Change in Monitored Concentrations
		Design Value	Background	Design Value	Background	
NO_2	21%	59 ppb	38 ppb	42 ppb	28 ppb	40%
SO_2	-182%	7 ppb	5 ppb	70 ppb	30 ppb	-181%
$PM_{2.5}$	-7%	37 μg/m^3	24 μg/m^3	25 μg/m^3	15 μg/m^3	26%

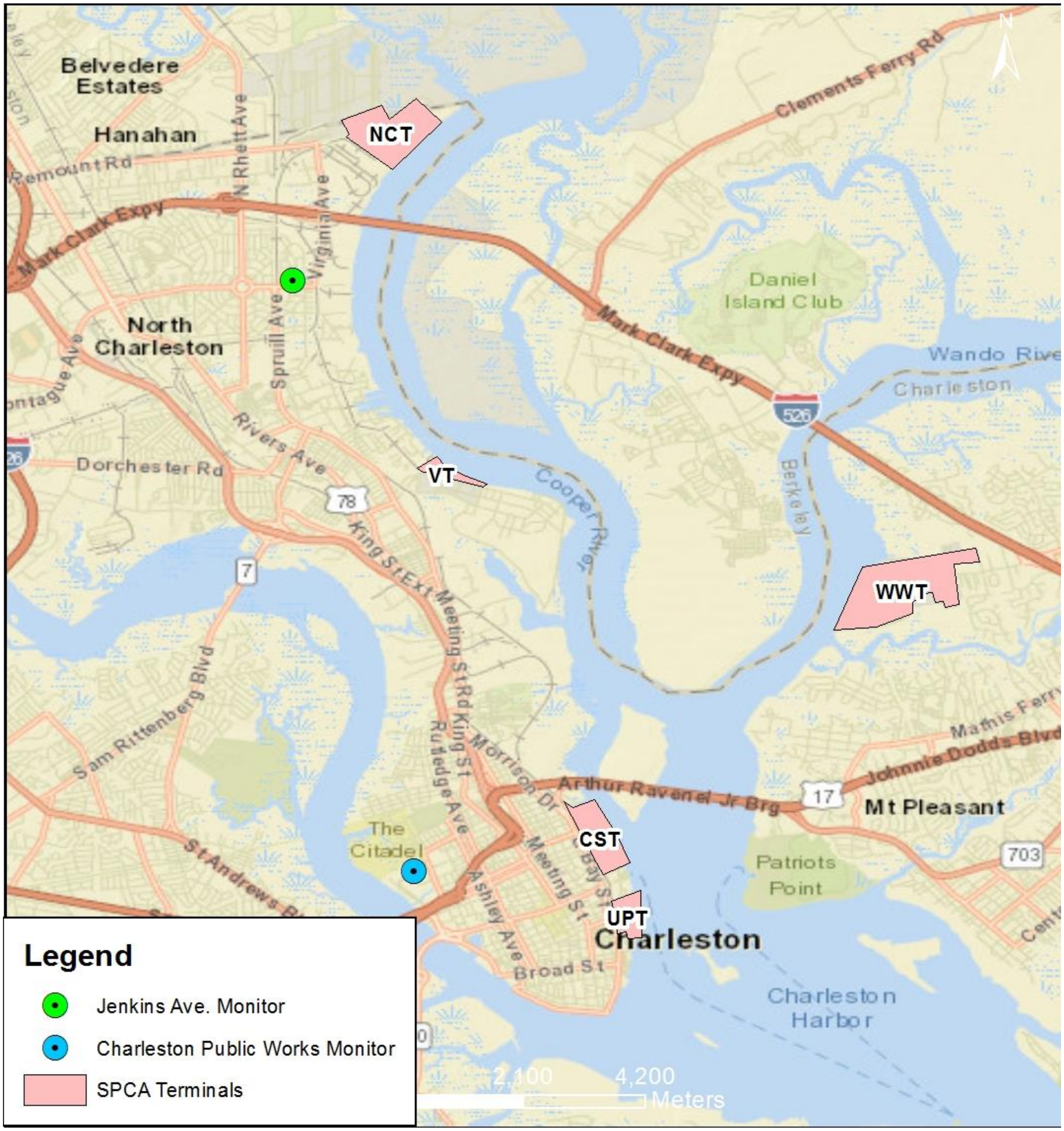

Figure 1. Location of Ambient Monitors

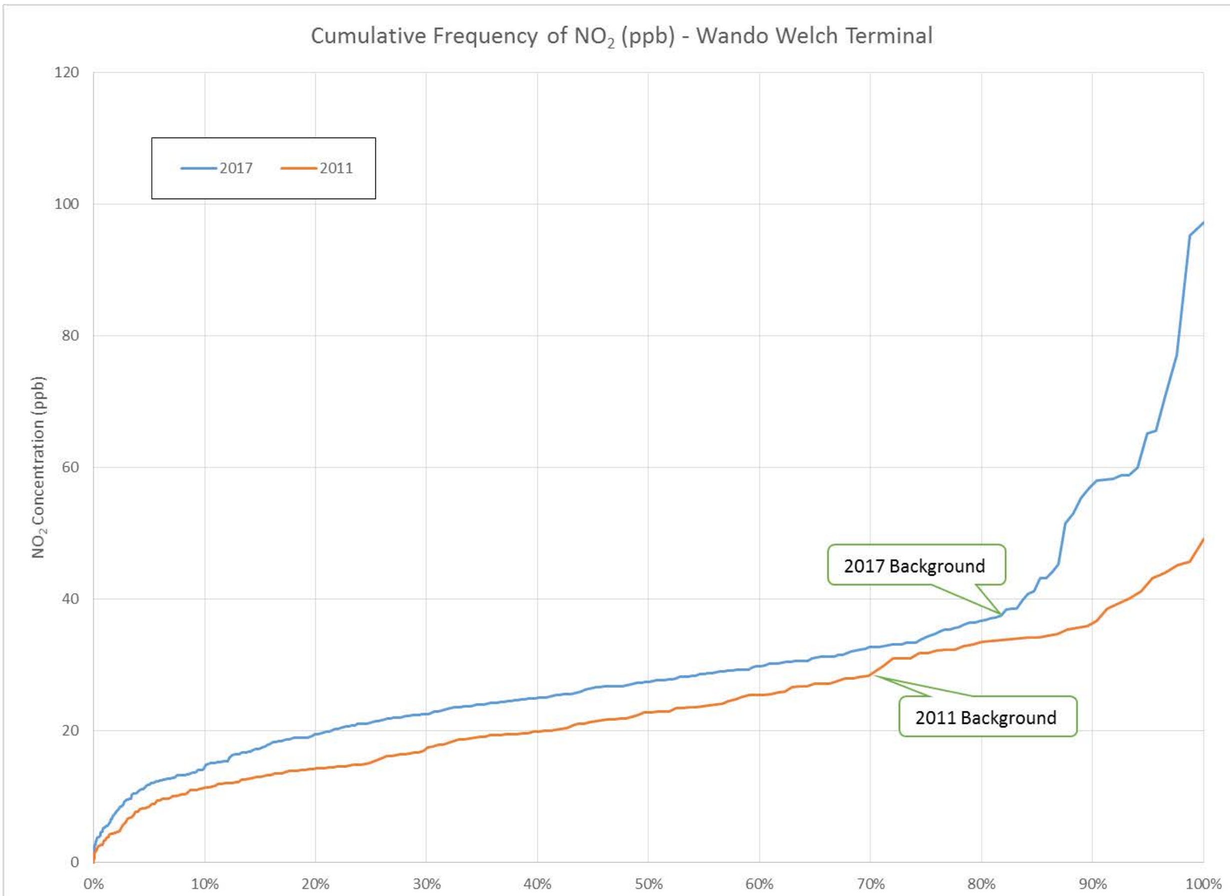

Figure 2. NO_2 Cumulative Frequency Plot

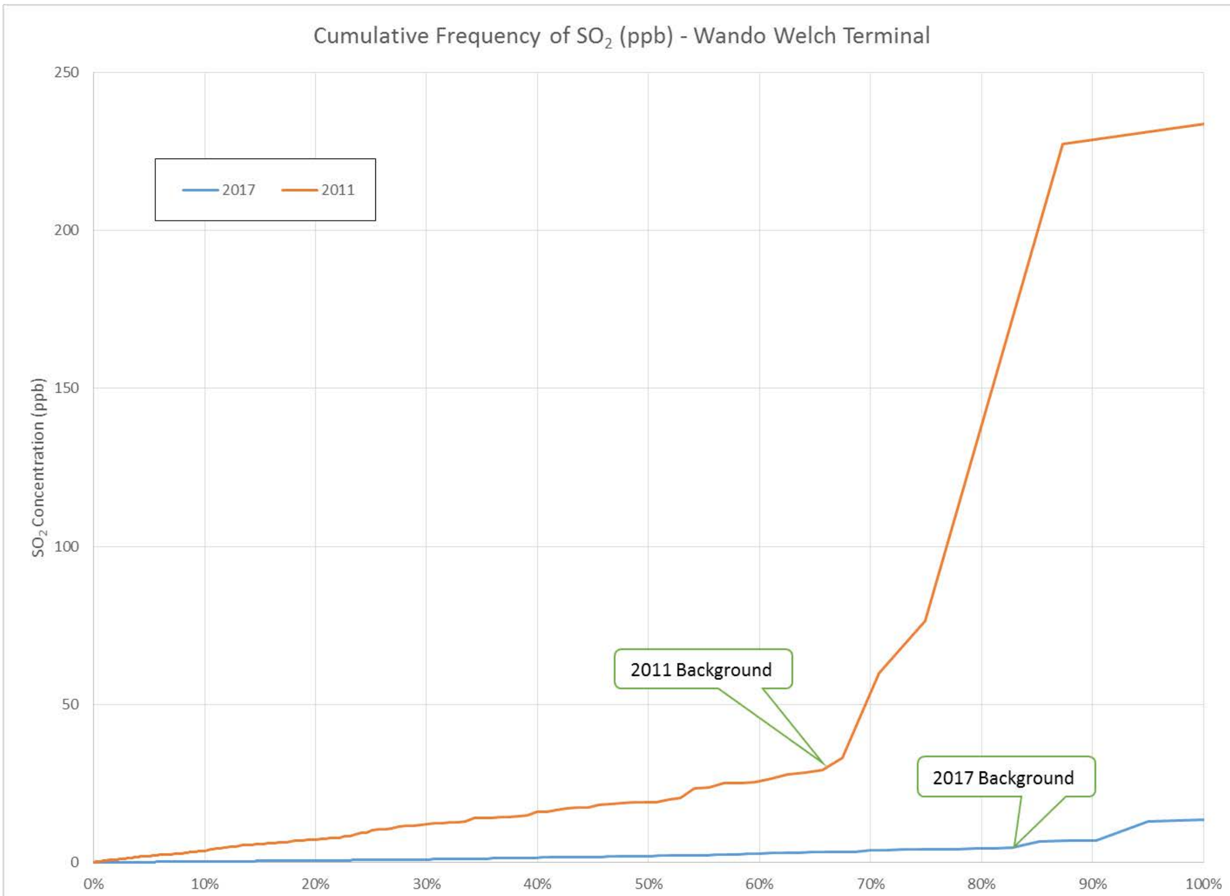

Figure 3. SO_2 Cumulative Frequency Plot

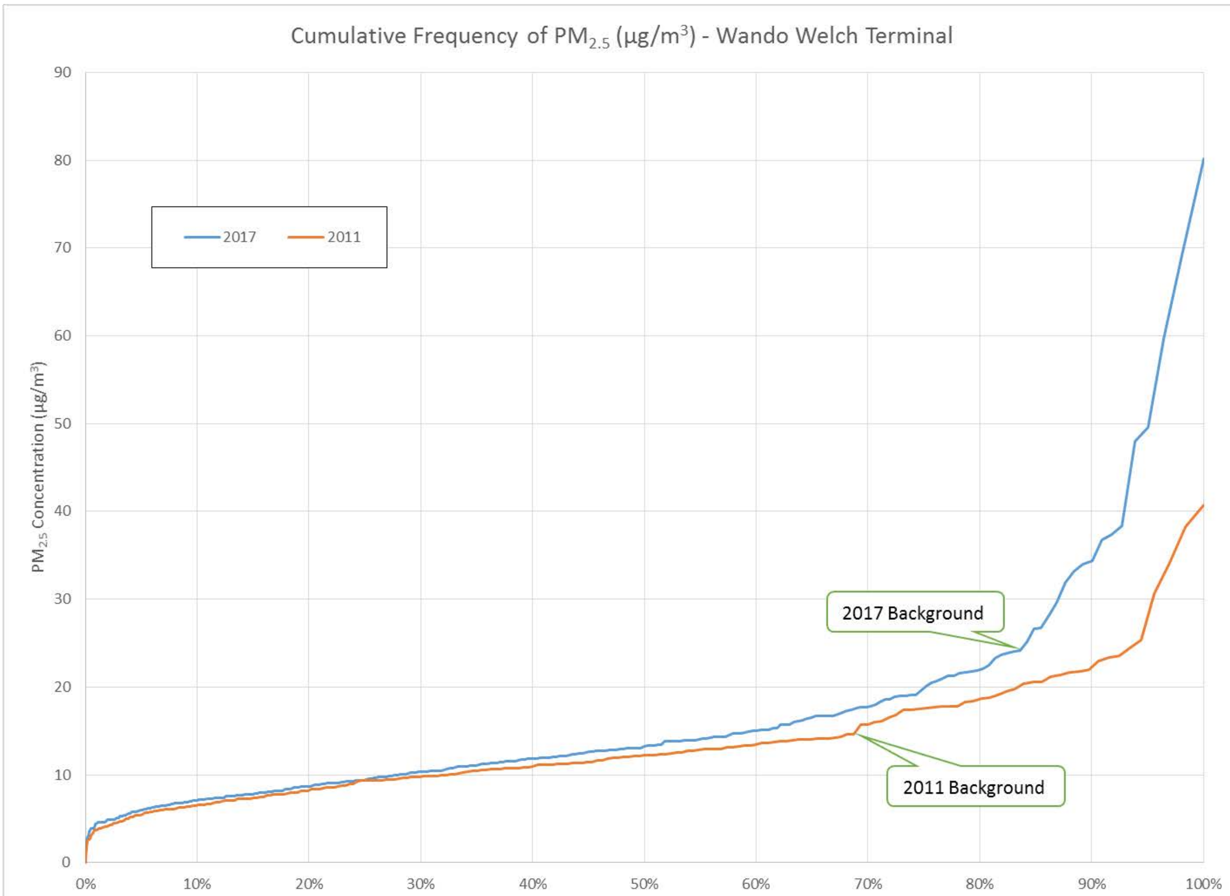

Figure 4. $PM_{2.5}$ Cumulative Frequency Plot

Appendix 3

Evaluation of Emissions Reduction Opportunities

South Carolina Ports Authority

Evaluation of Emissions Reduction Opportunities

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Abbreviations

AIS	Automatic Identification System
BAT	Best Available Technology
CO	Carbon monoxide
CHE	Container Handling Equipment
ECA	Emission Control Area
EF	Emission factor
HC	Hydrocarbons
NO_X	Oxides of nitrogen
OGV	Ocean Going Vessel
$PM_{2.5}$	Particulate matter (less than 2.5 μm)
PM_{10}	Particulate matter (less than 10 μm)
RTG	Rubber Tired Gantry
SO_2	Sulphur Dioxide
TEUs	Twenty-foot equivalent unit containers
US EPA	US Environmental Protection Agency
US gal/hr	US gallon per hour

Emissions Reduction Opportunities

South Carolina Ports Authority (SCPA) currently operates five Port of Charleston Terminals: Columbus Street, North Charleston, Union Pier, Wando Welch and Veterans. In addition, the 280-acre Hugh Leatherman Sr. Terminal container facility is under construction, with Phase One completion expected mid-2020. SCPA has quantified mobile source air emissions from the five existing terminals during 2005, 2011, and 2017, and has evaluated the effects of various operational changes on emissions and nearby ambient monitors. This report examines the opportunities SCPA has to further reduce emissions from its terminals. Candidate emissions reduction technologies that have been implemented or considered at other similar facilities were reviewed for applicability to SCPA's operations. This document does not include emissions reduction opportunities for off terminal emissions outside of SCPA control.

Best available technology (BAT) for reducing emissions from container processing operations involves emission reduction devices, electrification of terminal operations, changing to hybridized power systems, and operating equipment using the cleanest diesel engines. Many of these technologies are costly to implement, and therefore a site-specific cost analysis is recommended to determine operating cost per ton of emissions reduced.

Switching to low-emissions technologies to power terminal equipment will reduce the reliance on diesel power engines and, in turn, reduce emissions from these sources. Potential mitigation measures and their potential application are discussed below. It is important to note that potential effects discussed in this section highlight what was considered but may not necessarily be feasible to reduce emissions.

The use of BAT to reduce SCPA terminals emissions is discussed below and, when applicable, emission reductions were estimated based on the 2017 SCPA Air Emissions Inventory summarized in Table 1.1. All BAT solutions are assessed in the context of environmental benefits, applicability in the context of the SCPA terminals, suitability to implement at the terminals, established industry technology, expense of implementation, and return on investment.

Table 1.1 Comparison of 2017 SCPA Emissions to 2014 NEI Emissions by Source Category

Pollutant	Port Source Type	2017 SCPA Emissions (tpy)	% Total SCPA Emissions	2014 NEI Source Type	Charleston County (tpy)	Berkeley County (tpy)	Dorchester County (tpy)	Total Regional	% Total Regional Emissions
NO_x	OGV + Tugs	1,869	70%	Commercial Marine Vessels	4,703	79	NA	4,782	44%
	Trucks	633	24%	On-Road – Diesel Heavy Duty	1,824	857	870	3,551	32%
	Rail	38	1%	Locomotives	377	186	73	636	6%
	CHE	120	5%	Non-Road - Diesel	1,356	359	270	1,985	18%
	Total	**2,660**	**100%**		**8,260**	**1,481**	**1,214**	**10,955**	**100%**

1.1 Ocean Going Vessels and Harbor Craft

For the 2017 Air Emissions Inventory, ocean going vessels (OGV) were the primary source of emissions while at the same time being the highest contributor to recent emissions reductions of particulate matter (PM) and sulfur dioxide (SO_2). The primary reason for these emissions reductions was the International Convention for the Prevention of Pollution from Ships (MARPOL) and the North American Emissions Control Area, which (starting in 2015) required OGVs to use marine gas oil with a maximum sulfur content of 1,000 parts per million (ppm) (0.10%

sulfur). The North America Emission Control Area (ECA) limit is not scheduled to reduce sulfur content further, but the current global sulfur limit of 35,000 ppm will decrease to 5,000 ppm by 2020. There are discussions about converting vessels to liquid natural gas (LPG) since LPG is a cleaner burning fuel and meets the ECA limits. The infrastructure and ship conversion cost analysis is currently being conducted by the California Air Resources Board.

The other main contributor to the emissions reductions observed from 2011 to 2017 was that the average containers per ship call increased with Panamax Ships. Even though container movement increased by 60% from 2011 to 2017, SCPA vessels only increased by 20 calls. According to the National Port Strategy Assessment: Reducing Air Pollution and Greenhouse Gases at U.S. Ports, it is estimated that bigger Panamax size ships that currently call at U.S. ports will dominate world trade and represent 62% of total container ship capacity by 2030 (EPA, 2016). Therefore as container movement increases through SCPA, there is a potential for the number of vessel calls (and therefore emissions) to decrease. Note that SCPA does not have direct control over implementation of these emission reduction opportunities on OGV.

1.1.1 On Port Emissions Reduction Opportunities

Shore Power
During hoteling time at port, vessels operate auxiliary diesel engines as the primary contributor to emissions. The average hoteling time for 2017 vessels was 16 hours. Shore power is an option for emission reductions where the vessel plugs into the local electricity grid while hoteling, allowing for auxiliary engines to shut down. According to the Shore Power Technology Assessment at U.S. Ports, shore power can reduce emissions up to 98% (depending on the mix of local energy sources) (EPA, 2017). It is most effective at terminals with returning vessels such as cruise and container ships because the vessel must have shipside equipment to connect to shore power. In 2017, SCPA received over 500 different vessels, with 300 of those going to the Wando Welch terminal. The percentage of vessels calling to SCPA with ship side equipment is unknown.

Shore power would only be beneficial if at least 50-60% of vessels arriving at SCPA have shipside equipment. Currently, the initial cost of implementing shore power is $1 to $5 million per berth and between $150,000 and $1 million in equipment cost per vessel. Therefore, shore power is not cost effective compared to alternative methods (CARB, 2007). The Shore Power Emissions Calculator is a tool that may be used to estimate the emission benefits from implementation of shore power and is located at: https://www.epa.gov/ports-initiative/shore-power-technology-assessment-us-ports#assessment.

Bonnets
Barged based and shore based bonnets are being reviewed by California regulators for hoteling emissions control to further reduce PM, NO_x and SO_2 by 95% and hydrocarbons by 60% (ACTI, 2018). The bonnets vacuum and treat vessel stack emissions while the ships are at port. Because the bonnets can be applied to multiple stack types and do not require the ships to install additional equipment, implementation is typically more cost effective than shore power. Currently there are two barge based bonnet systems available on the market, the Marine Exhaust Treatment System-1 developed by Clean Air Engineering Maritime, Inc. and the Advanced Marine Emissions Control System (AMECS) developed by Advanced Cleanup Technologies, Inc. (CARB, 2018).

Applying bonnet emission reductions to 2017 hoteling emissions, Table 1.2 provides emissions reduction in tons. A site specific cost analysis would have to be performed to determine if this emissions reduction option is cost effective.

Table 1.2 Comparison of 2017 Hoteling Emissions with Emission Reduction Technology Applied

Emissions (tpy)					
Pollutant	**NO_x**	**PM_{10}**	**$PM_{2.5}$**	**HC**	**SO_2**
2017 Actual Emissions	620.5	33.4	30.6	22.3	29.7
Emission Reduction	589.5	31.7	28.2	13.4	28.2
Estimated Emissions	31.0	1.7	2.4	8.9	1.5

1.1.2 Off Port Emissions Reduction Opportunities

Within Charleston Harbor, vessels only travel at reduced speeds inside and outside the breakwaters. 2017 Automatic Identification System (AIS) data was obtained from the United States Army Corps of Engineers. The median vessel speed was approximately 13 knots outside the breakwater. If a speed reduction policy is implemented and speeds are reduced (even by 1 knot) to 12 knots, the 2017 off terminal emissions would decrease for NO_x, PM and SO_2 as seen in Table 1.3.

Table 1.3 Comparison of 2017 Off Terminal Emissions with Speed Limit Applied

Pollutant	Limit 12 knots	2017 AEI	Difference tons	Difference Percent
NO_x	1,111.0	1,154.9	43.9	-4%
PM_{10}	113.6	117.4	3.8	-3%
$PM_{2.5}$	104.8	108.2	3.5	-3%
HC	99.8	98.0	-1.8	2%
CO	159.3	157.2	-2.1	1%
SO_2	31.7	32.9	1.1	-3%

1.1.3 Pilot and Tug Boats

The tug companies and pilot associations that support SCPA are in the process of replacing older boats and engines with newer EPA Tier compliant engines. McAllister Towing and Transportation Co. is scheduled to receive a new tug, the Ava, in 2019 with Tier 4 compliant engines. Shore power has been implemented by Moran Towing and when boats are not operating the main engine, annual shore power time is estimated to be 50% of the remaining annual hours. During the 2017 AEI data collection, all companies indicated continued implementation of these types of emission reduction strategies. Note that SCPA does not have direct control over implementation of these emission reduction opportunities on pilot and tug boats.

1.2 RTG Cranes and Cargo Handling Equipment

SCPA has already begun the process of replacing older rubber tired gantry (RTG) and container handling equipment (CHE) with newer EPA Compliant Tier engines with the inventory containing Tier 2 (RTG 26%, CHE 14%), Tier 3 (RTG 44%, CHE 75%) and Tier 4 (RTG 26%). Since a large percentage of equipment is already Tier 3 compliant, it is not economically feasible to replace Tier 3 with Tier 4 units for at least another decade.

As older equipment continues to be replaced, there are three primary options moving forward: EPA Tier 4, electrification and hybridization. For electrification or hybridization, pilot studies are recommended to determine economic feasibility and provide appropriate solutions as the existing fleet is replaced.

1.2.1 Non-Road Tier 4 Engines

SCPA should install EPA Tier 4 engines to replace existing engines below Tier 3 standards at the end of their useful life or if SCPA implements an emissions reduction goal targeted toward these sources. Compared to Tier 1, Tier 4 engines reduce emissions for NO_x by 80%, PM by 90%, and SO_2 by 99% (using ULSD). With SCPA current inventory, if RTG Tier 1 and Tier 2 equipment was replaced by Tier 4 (estimate based on Cummins model QSX15), NOx emissions would be reduced by 37% (23 tons for the 2017 AEI). The estimated CHE NO_x emissions reduction is less significant at only 6% (4 tons) because much of the equipment is already Tier 3 compliant.

1.2.2 Electrification

Electrification of RTG cranes would entail replacement of existing diesel powered RTG cranes with full electrical power. Power could be provided either by trailing cable reel, or by a conductor rail adjacent to the RTG cranes. Switching to electrified RTG cranes would remove the diesel engines currently used, and the associated emissions from these engines. However, this option is not always operationally feasible due to the need for flexibility in movement of equipment and containers.

Due to the need to establish power connections to the RTG cranes (by either a cable reel or a conductor rail), the operating space needed to support electrified RTG cranes will increase the effective width of the RTG crane, and it is possible the RTGs would no longer fit within the established cross section of the terminals. More study would be necessary to fully evaluate the feasibility of electrification of this equipment. Terminal infrastructure projects for electrification range from $0.5 to over $1 billion dollars, and the average electricified RTG is generally 10-20% higher than diesel equipment (CARB, 2015).

1.2.3 Hybridization

Converting the existing fleet of RTG cranes to hybrid power systems may present opportunities to reduce fuel consumption associated with the operation of RTG cranes. There are a variety of hybrids depending to meet end use requirements. The fuel type is typically diesel with electric, hydraulic or fuel cell-electric as options. Manufacturer data suggest that fuel savings for hybrid power RTG cranes could be in the order of 60% to 65% (PBA, 2012). The cost of hybrid equipment is generally 10-20% higher than diesel equipment, which is returned by fuel use reduction of 50-74%, improved efficiency and extended brake life (CARB, 2015). This option could be evaluated for cost effectiveness at the end of the current RTG cranes equipment life.

1.3 On-Terminal Trucks – Electrification

The electrification of terminal ground vehicles and yard trucks, through the use of exchangeable battery systems, exists and is in operation at other container terminals in North America. However, yard trucks electrified through the use of battery systems require additional support buildings for vehicle battery charging and swap-out.

New, fully electrified, plug-in yard tractors are starting to emerge onto the market as both after-market retrofits and custom built tractor units. These tractors are capable of operating in excess of 12 hours per charge, and require electrical infrastructure that supports plug-in vehicles.

In both cases, the switch to electrified yard trucks would reduce the emissions from these vehicles. Over a 6,000 hr operating cycle, and compared to a 2.5 US gal/hr, Tier 3 yard truck, the annual emissions eliminated per vehicle are estimated to be 1.7 ton NO_X, 1.6 ton CO, 81.5 kg PM, and 166 ton CO_2 (Orange EV, 2017). Similar to hybrids, the cost of electrified equipment is typicaly 10-20% higher than diesel equipment.

Should the available technology be considered viable, a pilot program is recommended to assess the operational effectiveness and benefits.

1.4 Drayage Trucks and Rail Operations

Drayage trucks (heavy duty vehicles) and rail operations are managed by non-SCPA public and private entities. Drayage truck emissions for NO_x and PM are expected to decrease as older diesel trucks are replaced by newer trucks meeting EPA standards. SCPA has already implemented anti-idling policies to reduce emissions for on-terminal truck operations. Rail companies are contributing by replacing locomotive engines to be newer tier compliant engines. Norfolk Southern has adopted an aggressive goal to improve locomotive fuel-efficiency by nearly 9 percent by 2020 (NS, 2018). CSX plan to reduce the company's greenhouse gas (GHG) emissions intensity 6 to 8 percent over 2011 levels by 2020 (CSX 2018).

Based on emission results from 2017 and the most recent National Emissions Inventory (USEPA 2014), trucks are the second largest contributor of emissions, with truck NO_x representing 24% of 2017 SCPA emissions and 32% of the 2014 NEI, while rail NO_x emissions only accounted for 1% and 6% respectively. In the 2017 SCPA AEI, rail emissions were 35% of trucks tons of NO_x per twenty-foot equivalent unit containers (TEU).

SCPA can further reduce emissions by increased use of rail to move containers out of Charleston. Palmetto Railway is currently underway as part of the expansion plans for the cargo yard in North Charleston with the final environmental impact statement released in July 2018. With the facility construction, Palmetto Rail aims to reduce highway congestion since a train can carry the equivalent of 280 trucks (Palmetto Rail, 2018).

2. Application of Best Available Technology

The compact nature of the terminals limits the viability of many potential BAT solutions. Available space for the introduction of additional electrical infrastructure is difficult to provide on most terminals, with any available space used for terminal operations.

All equipment selections and mitigation measures should be considered in the context of return on investment, the ability to implement, the cost of implementation and effect on terminal capacity.

Beyond changing equipment power systems, the biggest change that can be made to reduce emissions at the terminals is to minimize the number of times a container is moved and restacked on-site. Each time a container is moved there is some form of fuel consumption and, therefore, air emissions. Optimizing the configuration of the terminal is the main mitigation measure by which facility emissions associated with container movement can be reduced. In addition to terminal optimization, when mobile equipment is replaced as part of ongoing capital replacement, the equipment will adhere to increasingly stringent US EPA standards for diesel engines.

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