PORT FOURCHON OZONE DAY PORT-RELATED EMISSIONS INVENTORY STUDY

ExxonMobil

Taking on the world's toughest energy challenges.™

Prepared by:

STARCREST CONSULTING GROUP, LLC
QUALITY ASSURANCE & ENVIRONMENTAL MANAGEMENT

LSU CENTER FOR ENERGY STUDIES

July 2010

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PREPARED FOR

EXXONMOBIL BATON ROUGE

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1.0 INTRODUCTION

Starcrest Consulting Group, LLC (Starcrest) and the Louisiana State University Center for Energy Studies (LSU CES) were retained by ExxonMobil in Baton Rouge to develop an initial oxides of nitrogen (NO_x) emissions inventory for marine and other activities related to Port Fourchon in Lafourche Parish, Louisiana. According to a 2008 study done by Dr. Loren Scott and Associates, in conjunction with the Louisiana Department of Economic Development and the South Louisiana Economic Council, this port services about 90% of all the deepwater rigs and platforms and about 45%of all shallow water rigs in the Gulf of Mexico, as well as providing 100% of the support for the Louisiana Offshore Oil Port (LOOP).

During 2007 and 2008 transport modeling activities were conducted by consultants for Louisiana Department of Environmental Quality (LDEQ) and the Baton Rouge Ozone Task Force (OTF) in preparation for an expected 2009 Non-attainment State Implementation Plan (SIP) for ozone. An analysis of some of the modeling episodes (representing days of elevated ozone in the Baton Rouge area) by Dr. Harvey Jeffries, a professor in the Department of Environmental Sciences and Engineering at University of North Carolina Gillings School of Global Public Health, indicated a potentially large source of NO_x emissions located somewhere along the Louisiana Gulf Coast that did not appear in the inventory. In Dr. Jeffries analysis, the modeled results would more closely match the results actually monitored by the LDEQ's ambient monitors if there were significant NO_x emissions from this area that were unaccounted for. In looking at the general area where Dr. Jeffries suggested these NO_x emissions might be, it was apparent to members of the OTF that Port Fourchon activities could be a contributor. The Minerals Management Service (MMS) regularly collects emissions data related to oil and gas activity in the Gulf of Mexico, but this only take into account activities in the Outer Continental Shelf (Federal waters) and does not account for near-shore state waters.

Due to the presence of large amounts of biogenic volatile organic compounds or VOC (hydrocarbons from trees and vegetation), for much of Louisiana, reducing NO_x emissions is key to reducing ground level ozone. As such, the presence of a large, unaccounted for source of NO_x was of interest to the LDEQ and the OTF. Therefore, as part of a settlement between the LDEQ and ExxonMobil, it was agreed that ExxonMobil would conduct an emissions inventory study for Port Fourchon (LDEQ Tracking No. MM-CN-05-0038 and AE-PP-08-0012). Since Starcrest has considerable experience in developing emission inventories for Ports and marine activities around the country, they and LSU CES agreed to expand the scope to include estimates for other pollutants of interest, including the primary criteria pollutants and carbon dioxide (for future GHG inventories).

Starcrest and LSU CES worked jointly to develop and complete this initial study of the marine and mobile sources associated with the operations of Port Fourchon. LSU CES's primary focus was to assist in the design of the study, gather port-related activity data, set up and catalogue ShipTracker data, and document their methods used. Starcrest's primary focus was to assist in the design of the study, support the data collection effort, data analysis, emission estimates, and develop the report. The LSU CES also developed the emission estimates for the aircraft (helicopter) source category.

This report presents initial (high level) estimates of the mobile source emissions associated with the operations of Port Fourchon, Louisiana. To the extent possible, these estimates have been prepared using data representing three separate days in 2009, chosen as the days preceding days on which ozone exceedences were documented at Baton Rouge air quality monitors. The days evaluated are 5 June 2009, 25 June 2009, and 25 August 2009. Emissions are presented separately for these days and an average daily emission rate is also presented. The group selected 2009 as a representative year for several reasons. In 2006 and 2007, the amount of activity in the Gulf was greatly increased to address damages due to Hurricanes Katrina and Rita and the Gulf activity was also significantly impacted in 2008 by Hurricanes Gustav and Ike. As a result, it was felt that 2009, without any significant storm related shutdowns, and moderating oil and gas prices, would represent a "normal" year of activity in the Gulf.

The following emission sources have been evaluated for this study:

- Marine vessels that called at Port Fourchon marine terminal berths and that passed through Port Fourchon during transits to the north or south.
- Cranes and other cargo handling equipment used at Port marine terminals.
- Heavy-duty trucks entering and leaving the Port area.
- Helicopters arrivals and departures to/from the South Lafourche Airport
- Offshore emissions as estimated and reported by the Minerals Management Service (MMS).

The primary focus of this study is the estimation of emissions of NO_x as a precursor to ozone. Where possible, the estimates include other criteria pollutants, as well as the greenhouse gas carbon dioxide (CO_2). The following pollutants are included:

- NO_x
- VOC
- Carbon monoxide (CO)
- Sulfur dioxide (SO_2)
- Particulate matter, 10 micrometers in diameter (PM_{10})
- CO_2

The activity and operational data for each of the sources varies significantly. The study's primary focus is on the most significant source category – marine vessels. ShipTracker software was used by the LSU CES to capture all vessel activity related to Port Fourchon for the three ozone days studied. The center also researched vessel characteristics such as vessel type, installed horsepower, and size (length and/or deadweight tons). Surrogate operational characteristics (such as load factors) were used by Starcrest based on data collected for other marine vessel inventory studies the company has conducted. Surveying the various vessel operators operating out of Port Fourchon is recommended in order to validate the surrogate operational assumptions. Activity data for cargo handling equipment, heavy-duty trucks, and helicopters were gathered from interviews and high level data, and represent an "order of magnitude" estimate for the contributions of these sources to area emissions. As with marine vessels, operational characteristics were derived from other published studies developed by Starcrest. Offshore emission estimates were sourced from Minerals Management Service (MMS) data and emission estimates researched by LSU CES. These offshore estimates have been included as reported by the MMS and have not been reviewed by either participating group.

The report describes data collection and emission estimation methods and provides the resulting emission estimates. It is organized into the following sections:

- Overview and Summary of Results
- Marine Vessels
- Cargo Handling Equipment
- Heavy-Duty Diesel Vehicles
- Aircraft (Helicopters)
- Offshore Sources

2.0 OVERVIEW AND SUMMARY

According to Port Fourchon's Internet website,

> "Port Fourchon was developed as a multi-use facility. It has historically been a land base for offshore oil support services as well as a land base for the Louisiana Offshore Oil Port (LOOP). In addition, Port Fourchon has served as a commercial and recreational fishing mecca, foreign cargo shipping terminal, and a unique area for recreation and tourism.
>
> The overwhelming majority (over 95%) of tonnage handled at the Port is oil and gas related. Every widget and gadget needed to support the oil and gas industry is handled as cargo. It moves through container, bulk, breakbulk, and just about every method imaginable. Approximately 30% of total tonnage travels to and from the port by inland barge before being transferred to or from an offshore supply vessel, and 70% travels to and from the port by vehicle before being transferred to or from an offshore supply vessel or helicopter."

The Port's approximately 50 terminals and other facilities receive a variety of marine vessels and operate equipment to move cargo onto and off of these vessels and to transfer it to and from on-road trucks for inland transport. Cargo and personnel are also moved through the nearby South Lafourche Airport, primarily by helicopter.

The following table presents the average daily emissions from the source categories covered by the report. The sections following this overview detail the data collection and emission estimation methods, and present more detailed view of the estimated emissions.

Table 2.1: Summary of Estimated Emissions, tons per day

Source Category	NO_x	VOC	CO	SO_2	PM_{10}	CO_2
Marine Vessels	**10.0**	0.36	1.15	0.19	0.50	617
Cargo Handling Equipment	**0.30**	0.03	0.07	0.004	0.02	19
Heavy-Duty Vehicles	**0.14**	0.01	0.03	0.000	0.00	27
Aircraft	**0.22**		0.63	0.09		28
Off-Shore Non-Platform Sources	**12.1**	2.3	2.8	1.67	0.26	674
Off-Shore Platform Sources	**7.6**	4.3	9.1	0.01	0.05	823
Total	**30.4**	**7.0**	**13.8**	**2.0**	**0.8**	**2,188**

3.0 MARINE VESSELS

This section presents a discussion of data collection and emission estimation methods for the marine vessel source category, and provides details of the estimated emissions by day and by vessel type.

3.1 Data Collection

The data collected for this effort consisted of activity data (such as vessel arrivals and departures) and vessel characteristics data (such as horsepower and length). Arrivals and departures for several days before and after each of these days were evaluated to account for all dwelling periods. Vessel characteristics were obtained for each calling vessel, including name, vessel type, year built, length, rated speed, horsepower, gross tonnage, and fuel consumption rates. Not all data were available for all vessels.

The project team selected three days for which to gather data based on possible effects to Baton Rouge area ozone levels. The distance from Port Fourchon to downtown Baton Rouge is about 108 miles. Sustained southeasterly winds at 5 mph could transport pollutants to the Baton Rouge area in about 22 hours. For this reason 24-hour periods were selected for the day before high ozone events in Baton Rouge, as well as for different days of the week, ozone levels, and wind direction, as shown below.

Table 3.1: Selected days for Port Fourchon, LA vessel activity data gathering

Date	Day of Week	Wind Direction	Wind Speed	BR Ozone Level (previous day)
6/5/09	Friday	WSW	3-5 mph	82 ppb
6/25/09	Thursday	SE	2-5 mph	84 ppb
8/25/09	Tuesday	SE	2-7 mph	86 ppb

Source: LDEQ, LSU monitor

Ship movements in and out of Port Fourchon were tallied for the data collection days above using ShipTracks data service (www.shiptracks.com). The program allows users to run reports for designated areas and receive information including vessel name and departure/arrival times. The user may also view ship travel paths for historic data as well as real time ship movements. Screen shots from the program are shown in the figures below.

Data collection boxes were drawn around Port Fourchon waterways and the entrance/exit channel leading to and from the Gulf of Mexico. Reports were also run for vessel activity at the terminals (indicated by yellow dots in screen shot) to determine the length of time vessels may have been using their auxiliary engines while docked. Additional information on vessel type, year built, length, engine horsepower, and rated speeds were obtained from a variety of sources including ShipTracks, NOAA, trade journals, and company websites.

Once the data were gathered and matched with vessel information the results were summarized for each day for subsequent analysis and emission calculations. A brief summary of the vessel data is provided below. The number of data records for August 25, 2009, was substantially lower than for the other two days but may be explained by fewer vessel movements due to weather or other conditions.

Table 3.2: Summary vessel data for Port Fourchon

Date	Data Records	Unique Vessels	GOM Entries/ Exits*	North Bayou LaFourche Entries/Exits*
6/5/2009	718	246	184	32
6/25/2009	724	237	219	36
8/25/09	270	161	n/a	n/a

**Estimated*
Source: ShipTracks, LSU CES

Figure 3.1. ShipTracks screen shot of Port Fourchon

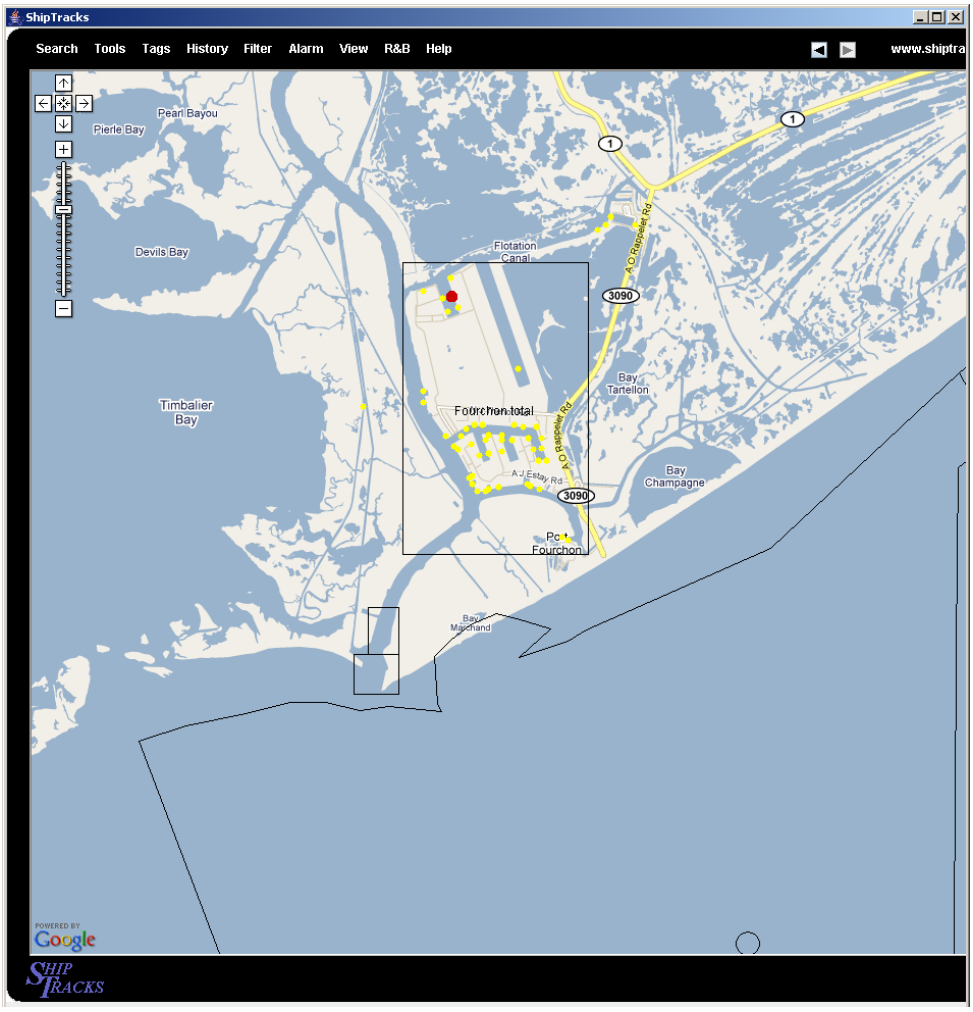
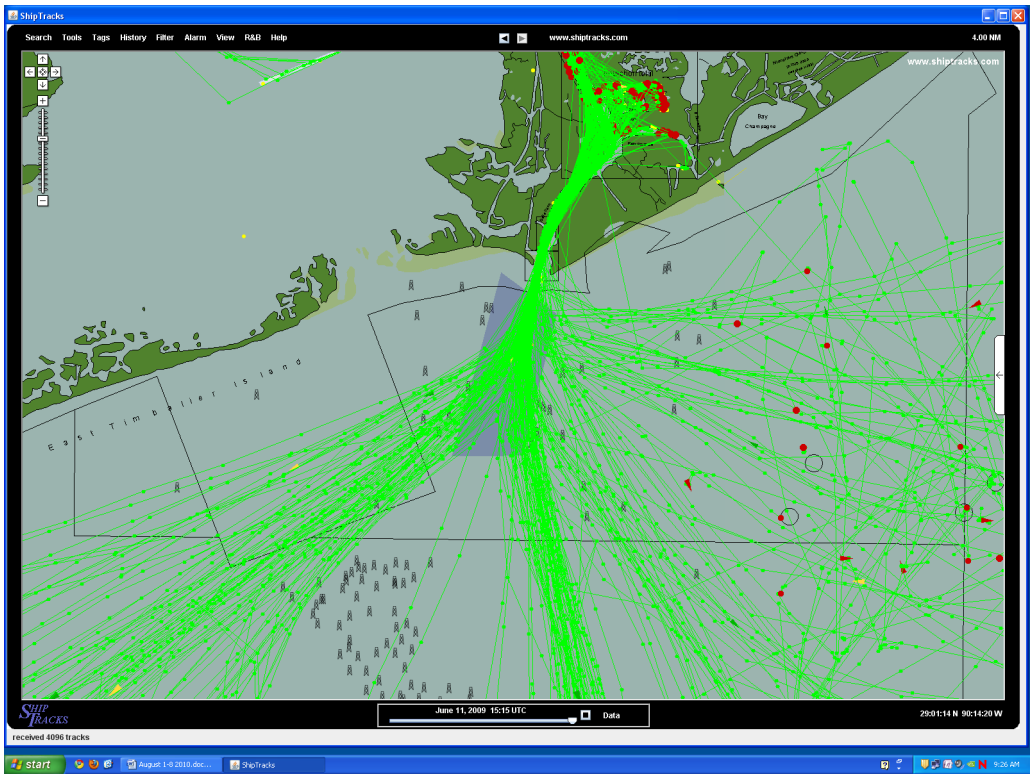


Figure 3.2: ShipTracks screen shot of Port Fourchon ship movements on June 11, 2009



3.2 Emission Estimating Methodology

The activity data was used to estimate periods of dwelling at berth, transit times in and out of Port Fourchon, and through transit times of vessels passing through but not stopping at Port Fourchon. The vessel data was used to estimate average characteristics of the vessels berthing at and passing through the Port. Vessels were classified according to type and, within certain types, were classified by size (length). Table 3.3 lists the vessel classifications that were used in the evaluation, and the average daily number of vessels present at berth during the three days that were evaluated.

Table 3.3: Vessel Type and Size Classifications

Vessel Type	Size Group (feet)	Count at Berth (avg. day)	Count Through Transit (avg. day)
Anchor handling	all	7	6
Commercial fishing	all	1	1
Crewboat - sm	< 100'	2	4
Crewboat - lg	≥ 100'	33	35
Freight ship	all	1	1
Industrial vessel	all	2	2
Mini supply	all	14	9
Offshore supply - sm	≤ 100'	11	6
Offshore supply - med	100 - 199'	74	33
Offshore supply - lg	≥ 200'	83	25
Passenger - sm	< 100'	4	3
Passenger - lg	≥ 100'	18	15
Research vessel	all	1	1
Towing vessel - sm	≤ 100'	13	8
Towing vessel - lg	> 100'	5	1
Utility	all	8	9
Not categorized	all	2	1
All vessels		**338**	**199**

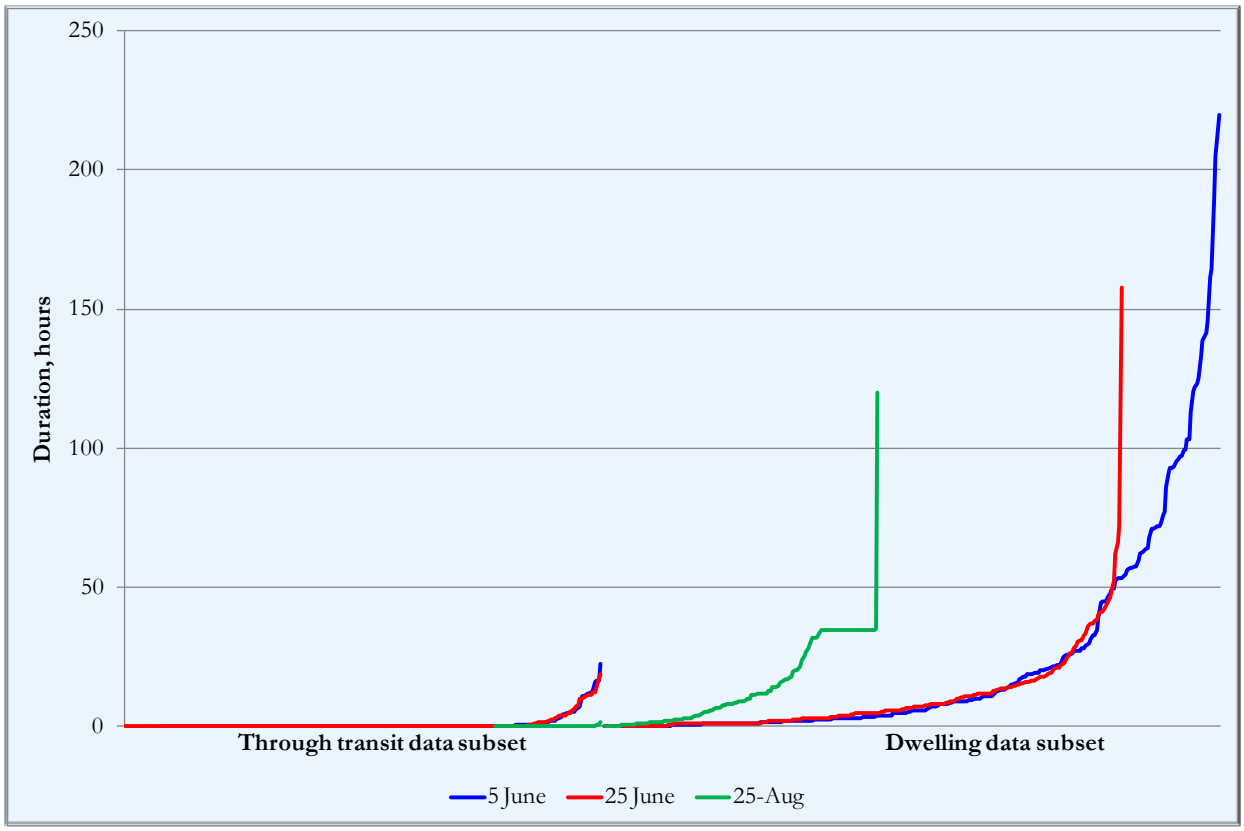
3.2.1 Activity Data Evaluation

Activity data sets for each day included entry and exit date/time, a terminal designation for vessels that made a terminal call. The data records were separated into two subsets, those with and without a terminal designation - the records containing a terminal designation were assumed to be records of terminal calls (dwelling events) and those for which there was not terminal designation were assumed to be through transits. The duration of dwelling events and the length of time taken by through transits were calculated by subtracting entry data/time from exit date/time.

Through Transit Duration Evaluation

Durations in the "through transit" data subset ranged from 0.1 to 22.7 hours, durations in the "dwelling" data subset ranged from 0.1 to 220 hours. Figure 3.3 illustrates the range of durations in the three data subsets, sorted low to high.

Figure 3.3: Durations in Through Transit and Dwelling Data Subsets (hours)



The great majority (90%) of events in the "through transit" data subset are 1 hour or less. Three possible explanations for the longer events (greater than 1 hour) are (1) they may have been dwelling events that were not identified with a terminal designation, (2) they were events in which a vessel actually spent several hours in the area but did not call at a terminal, or (3) there was an error in the data, either in the arrival or departure time. Because of the uncertainty regarding these activity records they were excluded from the averages of transit durations. It should be noted that personal observations made by ExxonMobil staff involved with this study indicates that it is fairly common for vessels to anchor in Bayou Lafourche near the terminals awaiting either a spot at a terminal or their next assignment.

The remaining transit times were evaluated for each box in terms of the number of events and the average duration of transit for each vessel type. Each day was evaluated separately, and a composite day was developed that combined the activity information for the three dates. Tables 3.4 through 3.7 provide the results of this stage of the evaluation. In these tables, "no data" means there were vessel transits but insufficient date/time information to calculate an average duration, while "na" means there were no vessels of that type on the day in question.

Table 3.4: Transit Data, 5 June 2009

Vessel Type	Box #1 Count	Box #1 Time in Box (hours)	Box #2 Count	Box #2 Time in Box (hours)	Box #3 Count	Box #3 Time in Box (hours)
Anchor handling	14	0.5	1	0.2	0	0.0
Commercial fishing	1	no data	0	na	0	0.0
Crewboat - sm	4	0.4	0	na	1	0.1
Crewboat - lg	39	0.3	16	0.1	19	0.1
Freight ship	1	no data	1	0.1	0	0.0
Industrial vessel	2	0.4	1	0.1	2	no data
Mini supply	11	0.5	5	0.2	4	0.1
Offshore supply - sm	9	0.4	2	0.2	4	0.1
Offshore supply - med	38	0.4	21	0.2	27	0.1
Offshore supply - lg	33	0.4	8	0.2	13	0.2
Passenger - sm	5	0.3	3	0.1	1	0.0
Passenger - lg	12	0.3	3	0.1	5	0.1
Research vessel	1	0.4	2	0.1	1	0.2
Towing vessel - sm	7	0.6	1	0.1	2	0.3
Towing vessel - lg	0	na	0	na	1	0.1
Utility	9	0.3	2	0.1	3	0.1
Not categorized	1	no data	1	0.1	1	0.1
All vessel types	**187**	**0.4**	**67**	**0.2**	**84**	**0.1**

Table 3.5: Transit Data, 25 June 2009

Vessel Type	Box #1 Count	Box #1 Time in Box (hours)	Box #2 Count	Box #2 Time in Box (hours)	Box #3 Count	Box #3 Time in Box (hours)
Anchor handling	3	no data	1	0.2	1	0.1
Commercial fishing	0	na	0	na	0	na
Crewboat - sm	7	0.3	4	0.2	1	0.1
Crewboat - lg	49	0.3	21	0.1	19	0.1
Freight ship	1	no data	1	0.1	0	na
Industrial vessel	1	no data	0	na	1	0.2
Mini supply	12	0.4	6	0.1	9	0.1
Offshore supply - sm	6	0.4	3	0.1	3	0.1
Offshore supply - med	43	0.4	17	0.1	20	0.1
Offshore supply - lg	32	0.2	12	0.2	15	0.2
Passenger - sm	1	no data	2	0.2	0	na
Passenger - lg	15	0.3	5	0.1	5	0.1
Research vessel	2	0.4	1	0.2	0	na
Towing vessel - sm	12	0.3	1	0.1	1	0.2
Towing vessel - lg	1	0.3	2	0.1	1	0.1
Utility	12	0.3	3	0.1	6	0.1
Not categorized	1	no data	1	0.2	0	na
All vessel types	**198**	**0.3**	**80**	**0.1**	**82**	**0.1**

Table 3.6: Transit Data, 25 August 2009

Vessel Type	Box #1 Count	Box #1 Time in Box (hours)	Box #2 Count	Box #2 Time in Box (hours)	Box #3 Count	Box #3 Time in Box (hours)
Anchor handling	0	na	0	na	0	na
Commercial fishing	0	na	0	na	0	na
Crewboat - sm	1	no data	0	na	0	na
Crewboat - lg	16	0.3	6	0.1	6	0.1
Freight ship	0	na	0	na	0	na
Industrial vessel	1	0.5	0	na	0	na
Mini supply	3	0.2	0	na	2	0.1
Offshore supply - sm	2	no data	1	0.2	0	na
Offshore supply - med	16	no data	7	0.1	3	0.2
Offshore supply - lg	8	0.4	2	0.4	6	0.1
Passenger - sm	1	0.3	1	0.1	0	na
Passenger - lg	16	0.7	5	0.1	6	0.7
Research vessel	0	na	0	na	0	na
Towing vessel - sm	5	no data	1	0.1	1	0.2
Towing vessel - lg	2	no data	0	na	0	na
Utility	4	0.8	1	0.1	1	0.1
Not categorized	0	na	0	na	0	na
All vessel types	**75**	**0.5**	**24**	**0.1**	**25**	**0.1**

Table 3.7: Transit Data, 3-Day Composite

Vessel Type	Box #1 Count	Box #1 Time in Box (hours)	Box #2 Count	Box #2 Time in Box (hours)	Box #3 Count	Box #3 Time in Box (hours)
Anchor handling	17	0.5	2	0.2	1	0.1
Commercial fishing	1	no data	0	na	0	0.0
Crewboat - sm	12	0.3	4	0.2	2	0.1
Crewboat - lg	104	0.3	43	0.1	44	0.1
Freight ship	2	no data	2	0.1	0	0.0
Industrial vessel	4	0.4	1	0.1	3	0.2
Mini supply	26	0.4	11	0.1	15	0.1
Offshore supply - sm	17	0.4	6	0.2	7	0.1
Offshore supply - med	97	0.4	45	0.1	50	0.1
Offshore supply - lg	73	0.3	22	0.2	34	0.2
Passenger - sm	7	0.3	6	0.1	1	0.0
Passenger - lg	43	0.4	13	0.1	16	0.3
Research vessel	3	0.4	3	0.1	1	0.2
Towing vessel - sm	24	0.4	3	0.1	4	0.3
Towing vessel - lg	3	0.3	2	0.1	2	0.1
Utility	25	0.4	6	0.1	10	0.1
Not categorized	2	no data	2	0.2	1	0.1
All vessel types	**460**	**0.4**	**171**	**0.1**	**191**	**0.1**

Dwelling Duration Evaluation

For the dwelling time analysis, the count of vessels and the average time within the area represented by Box 1 were calculated for each vessel type. The results for each day and as a composite representing the three days are presented in Table 3.8. Because these dwelling times are based on entry and exit times related to the box drawn around Port Fourchon (Box 1), they represent a certain amount of transit time as well as the time spent at dock. These times have been assumed to be equal to the time taken to traverse Box 1, because the distance from the Gulf of Mexico entry to the terminals at the Port is similar to the distance of the route taken by vessels transiting past the Port within Box 1 (refer to Attachment 1). In addition, and for the same reason, the transit times for through transits (vessels that did not stop at a Port terminal) are assumed to have been two times the averages within Box 1.

A further adjustment was made to the hours for several vessel types in the 5 June data, which was also reflected in the composite period. The data for this day indicated some vessels had stayed at berth for more than 24 hours (the data collection period extended before and after the designated day in order to capture arrivals and/or departures outside the designated day). Because the time period of the inventory is one 24-hour day, hours in excess of 24 represent activity that took place either before or after day being evaluated. The times were adjusted so that total time within the area was no more than 24 hours, and only one transit was included for those vessel types that exceeded 24 hours. It was assumed that the vessel either entered the area or left the area during the 24-hour period, with the remainder of the period being dwelling time.

Table 3.8: Dwelling Periods, Time in Area (hours)

	5 June 2009		25 June 2009		26 August 2009		3-day Composite	
Vessel Type	**Count**	**avg hours in area**	**Count**	**avg hours in area**	**Count**	**avg hours in area**	**Count**	**avg hours in area**
Anchor handling	7	4.9	5	3.7	8	21.8	20	11.4
Commercial fishing	2	10.5	0	0.0	0	0.0	2	10.5
Crewboat - sm	0	0.0	4	6.1	0	0.0	4	6.1
Crewboat - lg	46	10.8	37	6.6	15	8.8	98	8.9
Freight ship	0	0.0	1	5.8	0	0.0	1	5.8
Industrial vessel	4	1.6	0	0.0	1	8.0	5	2.9
Mini supply	13	26.6	24	5.9	4	18.3	41	13.7
Offshore supply - sm	7	39.1	20	8.9	5	9.3	32	15.6
Offshore supply - med	98	28.3	86	12.7	36	11.4	220	19.4
Offshore supply - lg	111	28.8	89	12.8	49	16.5	249	20.7
Passenger - sm	6	3.4	4	4.1	0	0.0	10	3.7
Passenger - lg	20	16.8	20	10.1	12	19.0	52	14.7
Research vessel	1	0.8	0	0.0	0	0.0	1	0.8
Towing vessel - sm	15	24.7	15	7.2	9	15.1	39	15.8
Towing vessel - lg	7	2.0	4	1.7	3	18.4	14	5.4
Utility	11	10.6	9	1.9	3	15.0	23	7.8
Not categorized	1	92.8	2	6.9	1	34.9	4	35.4
All vessels	**349**	**23.4**	**320**	**9.9**	**146**	**14.7**	**815**	**16.5**

The transit times associated with dwelling events have been subtracted from the average times for each vessel type in the dwelling data subset to estimate the average dwelling times for each vessel type. Total dwelling times for all vessels of each type have been calculated by multiplying the number of vessels at berth each day by the average dwelling time for each vessel type; the same has been done for total transit time associated with these dwelling events. All dwelling and transit time estimates are presented in Tables 3.9 through 3.16; for each day and for an average day based on data from the three days, there is a table presenting the dwelling estimates and the through transit estimates.

Table 3.9: At-Berth and Transit Times, 5 June 2009

Vessel Type	Size Group (feet)	Count	Per Vessel, Port Dwelling Events			Dwelling Event Totals	
			Transit in (hours)	At Berth (hours)	Transit out (hours)	At Berth (hours)	Transit (hours)
Anchor handling		7	0.5	3.9	0.5	27	7
Commercial fishing		2	0.4	9.7	0.4	19	2
Crewboat - sm	< 100'	0	na	na	na	na	na
Crewboat - lg	≥ 100'	46	0.3	10.2	0.3	469	28
Freight ship		0	na	na	na	na	na
Industrial vessel		4	0.4	0.8	0.4	3	3
Mini supply		13	0.0	23.5	0.5	306	7
Offshore supply - sm	≤ 100'	7	0.0	23.6	0.4	165	3
Offshore supply - mec	100 - 199'	98	0.0	23.6	0.4	2,313	39
Offshore supply - lg	≥ 200'	111	0.0	23.6	0.4	2,620	44
Passenger - sm	< 100'	6	0.3	2.8	0.3	17	4
Passenger - lg	≥ 100'	20	0.3	16.2	0.3	324	12
Research vessel		1	0.4	0.0	0.4	0	1
Towing vessel - sm	≤ 100'	15	0.0	23.4	0.6	351	9
Towing vessel - lg	> 100'	7	0.4	1.2	0.4	8	6
Utility		11	0.3	10.0	0.3	110	7
Not categorized		1	0.0	23.6	0.4	24	0
All vessels		**349**	**0.3**	**22.8**	**0.3**	**6,756**	**170**

Table 3.10: At-Berth and Transit Times, 25 June 2009

Vessel Type	Size Group (feet)	Count	Per Vessel, Port Dwelling Events			Dwelling Event Totals	
			Transit in (hours)	At Berth (hours)	Transit out (hours)	At Berth (hours)	Transit (hours)
Anchor handling		5	0.3	3.1	0.3	16	3
Commercial fishing		0	na	na	na	na	na
Crewboat - sm	< 100'	4	0.3	5.5	0.3	22	2
Crewboat - lg	≥ 100'	37	0.3	6.0	0.3	222	22
Freight ship		1	0.3	5.2	0.3	5	1
Industrial vessel		0	na	na	na	na	na
Mini supply		24	0.4	5.1	0.4	122	19
Offshore supply - sm	≤ 100'	20	0.4	8.1	0.4	162	16
Offshore supply - me	100 - 199'	86	0.4	11.9	0.4	1,023	69
Offshore supply - lg	≥ 200'	89	0.2	12.4	0.2	1,104	36
Passenger - sm	< 100'	4	0.3	3.5	0.3	14	2
Passenger - lg	≥ 100'	20	0.3	9.5	0.3	190	12
Research vessel		0	na	na	na	na	na
Towing vessel - sm	≤ 100'	15	0.3	6.6	0.3	99	9
Towing vessel - lg	> 100'	4	0.3	1.1	0.3	4	2
Utility		9	0.3	1.3	0.3	12	5
Not categorized		2	0.3	6.3	0.3	13	1
All vessels		**320**	**0.3**	**9.3**	**0.3**	**3,008**	**200**

Table 3.11: At-Berth and Transit Times, 25 August 2009

Vessel Type	Size Group (feet)	Count	Per Vessel, Port Dwelling Events			Dwelling Event Totals	
			Transit in (hours)	At Berth (hours)	Transit out (hours)	At Berth (hours)	Transit (hours)
Anchor handling		8	0.5	20.8	0.5	166	8
Commercial fishing		0	na	na	na	na	na
Crewboat - sm	< 100'	0	na	na	na	na	na
Crewboat - lg	≥ 100'	15	0.3	8.2	0.3	123	9
Freight ship		0	na	na	na	na	na
Industrial vessel		1	0.5	7	0.5	7	1
Mini supply		4	0.2	17.9	0.2	72	2
Offshore supply - sm	≤ 100'	5	0.5	8.3	0.5	42	5
Offshore supply - me	100 - 199'	36	0.5	10.4	0.5	374	36
Offshore supply - lg	≥ 200'	49	0.4	15.7	0.4	769	39
Passenger - sm	< 100'	0	na	na	na	na	na
Passenger - lg	≥ 100'	12	0.7	17.6	0.7	211	17
Research vessel		0	na	na	na	na	na
Towing vessel - sm	≤ 100'	9	0.5	14.1	0.5	127	9
Towing vessel - lg	> 100'	3	0.5	17.4	0.5	52	3
Utility		3	0.8	13.4	0.8	40	5
Not categorized		1	0.5	23	0.5	23	1
All vessels		**146**	**0.5**	**13.7**	**0.5**	**2,007**	**134**

Table 3.12: At-Berth and Transit Times, Composite Day

Vessel Type	Size Group (feet)	Count (avg. day)	Per Vessel, Port Dwelling Events			Dwelling Event Totals	
			Transit in (hours)	At Berth (hours)	Transit out (hours)	At Berth (hours)	Transit (hours)
Anchor handling		7	0.5	10.4	0.5	73	7
Commercial fishing		1	0.4	9.7	0.4	10	1
Crewboat - sm	< 100'	2	0.3	5.5	0.3	11	1
Crewboat - lg	≥ 100'	33	0.3	8.3	0.3	274	20
Freight ship		1	0.4	5.0	0.4	5	1
Industrial vessel		2	0.4	2.1	0.4	4	2
Mini supply		14	0.4	12.9	0.4	180	11
Offshore supply - sm	≤ 100'	11	0.4	14.8	0.4	162	9
Offshore supply - med	100 - 199'	74	0.4	18.6	0.4	1,379	59
Offshore supply - lg	≥ 200'	83	0.3	20.1	0.3	1,665	50
Passenger - sm	< 100'	4	0.3	3.1	0.3	12	2
Passenger - lg	≥ 100'	18	0.4	13.9	0.4	251	14
Research vessel		1	0.4	0.0	0.4	0	1
Towing vessel - sm	≤ 100'	13	0.4	15.0	0.4	194	10
Towing vessel - lg	> 100'	5	0.3	4.8	0.3	24	3
Utility		8	0.4	7.0	0.4	56	6
Not categorized		2	0.4	23.2	0.4	46	2
All vessels		**279**	**0.4**		**0.4**	**4,347**	**199**

Table 3.13: Through Transit Times, 5 June 2009

Vessel Type	Size Group (feet)	Count	Per Vessel Transit (hours)	Total Transit (hours)
Anchor handling		14	1.0	14
Commercial fishing		1	0.8	1
Crewboat - sm	< 100'	4	0.8	3
Crewboat - lg	≥ 100'	39	0.6	23
Freight ship		1	0.8	1
Industrial vessel		2	0.8	2
Mini supply		11	1.0	11
Offshore supply - sm	≤ 100'	9	0.8	7
Offshore supply - med	100 - 199'	38	0.8	30
Offshore supply - lg	≥ 200'	33	0.8	26
Passenger - sm	< 100'	5	0.6	3
Passenger - lg	≥ 100'	12	0.6	7
Research vessel		1	0.8	1
Towing vessel - sm	≤ 100'	7	1.2	8
Towing vessel - lg	> 100'	0	na	na
Utility		9	0.6	5
Not categorized		1	0.8	1
All vessels		**187**	**0.8**	**144**

Table 3.14: Through Transit Times, 25 June 2009

Vessel Type	Size Group (feet)	Count	Per Vessel Transit (hours)	Total Transit (hours)
Anchor handling		3	0.6	2
Commercial fishing		0	na	na
Crewboat - sm	< 100'	7	0.6	4
Crewboat - lg	≥ 100'	49	0.6	29
Freight ship		1	0.6	1
Industrial vessel		1	0.6	1
Mini supply		12	0.8	10
Offshore supply - sm	≤ 100'	6	0.8	5
Offshore supply - med	100 - 199'	43	0.8	34
Offshore supply - lg	≥ 200'	32	0.4	13
Passenger - sm	< 100'	1	0.6	1
Passenger - lg	≥ 100'	15	0.6	9
Research vessel		2	0.8	2
Towing vessel - sm	≤ 100'	12	0.6	7
Towing vessel - lg	> 100'	1	0.6	1
Utility		12	0.6	7
Not categorized		1	0.6	1
All vessels		**198**	**0.6**	**125**

Table 3.15: Through Transit Times, 25 August 2009

Vessel Type	Size Group (feet)	Count	Per Vessel Transit (hours)	Total Transit (hours)
Anchor handling		0	na	na
Commercial fishing		0	na	na
Crewboat - sm	< 100'	1	1.0	1
Crewboat - lg	≥ 100'	16	0.6	10
Freight ship		0	na	na
Industrial vessel		1	1.0	1
Mini supply		3	0.4	1
Offshore supply - sm	≤ 100'	2	1.0	2
Offshore supply - med	100 - 199'	16	1.0	16
Offshore supply - lg	≥ 200'	8	0.8	6
Passenger - sm	< 100'	1	0.6	1
Passenger - lg	≥ 100'	16	1.4	22
Research vessel		0	na	na
Towing vessel - sm	≤ 100'	5	1.0	5
Towing vessel - lg	> 100'	2	1.0	2
Utility		4	1.6	6
Not categorized		0	na	na
All vessels		**75**	**1.0**	**74**

Table 3.16: Through Transit Times, Composite Day

Vessel Type	Size Group (feet)	Count	Per Vessel Transit (hours)	Total Transit (hours)
Anchor handling		6	1.0	6
Commercial fishing		1	0.8	1
Crewboat - sm	< 100'	4	0.6	2
Crewboat - lg	≥ 100'	35	0.6	21
Freight ship		1	0.8	1
Industrial vessel		2	0.8	2
Mini supply		9	0.8	7
Offshore supply - sm	≤ 100'	6	0.8	5
Offshore supply - med	100 - 199'	33	0.8	26
Offshore supply - lg	≥ 200'	25	0.6	15
Passenger - sm	< 100'	3	0.6	2
Passenger - lg	≥ 100'	15	0.8	12
Research vessel		1	0.8	1
Towing vessel - sm	≤ 100'	8	0.8	6
Towing vessel - lg	> 100'	1	0.6	1
Utility		9	0.8	7
Not categorized		1	0.8	1
All vessels		**160**	**0.8**	**116**

Vessel Data Evaluation

Data were obtained for a total of 421 vessels that were present on one or more of the days for which activity data were obtained. The data on some or all vessels includes name, vessel type, year built, length, rated speed, horsepower, gross tonnage, and fuel consumption rates. Not all data were available for all vessels. Besides vessel name, which was complete, the type, year of build and length were most complete, being available for 99% of the vessels. Gross tonnage was fairly complete at 87% of vessels, while rated speed and horsepower were less common at 27% and 35%, respectively, and fuel consumption information was least readily available at 12 - 14%. However, it was possible to calculate averages for the most common vessel types, offshore supply vessels and crewboats. Table 3.17 illustrates the average characteristics of each of the vessel types, covering all vessels that were present during at least one of the days covered. Blanks in the table indicate that no data points were available for the vessel type and parameter.

Table 3.17: Vessel Type Characteristics

Vessel Type	Count	Year Built (average)	Length (average)	Speed (average)	HP (average)	Gross Tonnage (average)	Fuel burn gpm (max) (average)	Fuel burn gpm (econ.) (average)
Anchor handling	11	2000	211	12	11,465	2,410		
Commercial fishing	1	1953	52			32		
Crewboat - sm	4	1983	71		400	68		
Crewboat - lg	47	2000	151	26	6,329	99	331	245
Freight ship	1	1977	88			98		
Industrial vessel	5	1988	200	13	4,000	1,247	170	90
Mini supply	24	1998	144	11	1,851	98	123	100
Offshore supply - sm	23	1980	87			249		
Offshore supply - mec	109	1996	159	12	3,724	398	131	102
Offshore supply - lg	102	2000	235	12	5,649	2,184	199	119
Passenger - sm	6	1984	75			77		
Passenger - lg	26	1999	138		7,200	95		
Research vessel	2	1966	116			195		
Towing vessel - sm	30	1982	66		9,000	103		
Towing vessel - lg	9	1979	116		13,000	165		
Utility	16	1980	109	10	1,122	94		50
Not categorized	5	1992	245		6,000	5,960		
All vessel types	**421**	**1995**	**160**	**15**	**4,789**	**726**	**212**	**120**

Emission Estimating Methodology and Assumptions

The basic method of estimating emissions is to calculate energy in horsepower-hours (hp-hr) using an engine's rated horsepower, a load factor representing the average operating percentage of full power, and the engine's hours of operation over the period of interest. The energy usage is then multiplied by an emission factor having units of mass per unit of energy, such as grams per horsepower-hour (g/hp-hr). This can be expressed as the following equation:

$$E = hp \times LF \times hours \times EF$$

where:

E = emissions
hp = rated horsepower (or other unit power)
LF = load factor
hours = hours of operation (engine on)
EF = emission factor in units compatible with the power rating

As noted in Table 16, horsepower values were not available for many of the vessel types included in the study. To fill in missing data, assumptions were made regarding the relative sizes (length and gross tonnage) of vessels for which horsepower values were available. This introduces a considerable level of uncertainty to the resulting estimates.

The types of vessels included in the study are typically equipped with a relatively small auxiliary engine that generates ship-board electricity to power instrumentation and electric engines used on board; these are usually the only engines that run while a vessel is at berth. The data collected on the vessels that visited Port Fourchon does not include information on auxiliary engines, so information from a Houston-area vessel emissions inventory[1] was used to derive estimated auxiliary engine power for different vessel types.

Load factors for vessel engines were obtained from the Houston emissions inventory report and another released by the Port of Los Angeles.[2] A summary of the power and load factor information and assumptions is presented in Table 3.18.

Table 3.18: Vessel Power and Load Assumptions

Vessel Type	Size Group	Propulsion Engines		Auxiliary Engines	
	(feet)	HP	LF	HP	LF
Anchor handling		11,465	0.45	300	0.43
Commercial fishing		2,034	0.27	167	0.43
Crewboat - sm	< 100'	450	0.45	167	0.43
Crewboat - lg	≥ 100'	6,329	0.45	167	0.43
Freight ship		975	0.45	167	0.43
Industrial vessel		2,994	0.45	300	0.43
Mini supply		1,851	0.45	167	0.43
Offshore supply - sm	≤ 100'	2,025	0.45	167	0.43
Offshore supply - med	100 - 199'	3,724	0.45	167	0.43
Offshore supply - lg	≥ 200'	5,649	0.45	300	0.43
Passenger - sm	< 100'	800	0.42	167	0.43
Passenger - lg	≥ 100'	7,200	0.42	167	0.43
Research vessel		3,042	0.45	167	0.43
Towing vessel - sm	≤ 100'	1,623	0.68	167	0.43
Towing vessel - lg	> 100'	3,481	0.68	167	0.43
Utility		1,122	0.45	167	0.43
Not categorized		4,789	0.45	167	0.43

[1] *2007 Goods Movement Air Emissions Inventory at the Port of Houston.* Final Draft, January 2009
[2] *Port of Los Angeles Inventory of Air Emissions - 2009.* June 2010

The emission factors used in the calculations were also obtained from the Houston emissions inventory, as listed in Table 3.19. Main engines are assumed to be Category 2 engines (a size category) and auxiliary engines are assumed to be Category 1, a generally smaller category. Main engines are assumed to meet either Tier 0 or Tier 1 emission standards, depending on the year built, with 2004 and newer builds assumed to be lower emissions Tier 1 engines. The Tier level difference between Tier 0 and Tier 1 only affects emissions of NO_x. To the extent that older vessels have been repowered with newer engines, this may represent a slight overestimate of NO_x emissions. Auxiliary engines are classed as to their assumed size (horsepower), with the difference only affecting emissions of CO. The difference in NO_x emissions between Tier 0 and Tier 1 is insubstantial for auxiliary (Category 1) engines and has not been included in these estimates.

Table 3.19: Emission Factor Assumptions

Engine Type	NO_x	VOC	CO	SO_2	PM_{10}	CO_2
Main engines - Tier 0	9.8	0.37	0.8	0.16	0.5	515
Main engines - Tier 1	7.3	0.37	0.8	0.16	0.5	515
Aux. engines - 167 hp	7.5	0.20	1.3	0.16	0.3	515
Aux. engines - 300 hp	7.5	0.20	1.1	0.16	0.3	515

Emission Estimates

Using the equation and the assumptions discussed above, daily emissions have been estimated for dwelling events and for through transits. The dwelling events include auxiliary engine emissions for the dwelling period, and main and auxiliary emissions from vessels transiting to and from the berth (labeled as "In/out - main" and "In/out - auxiliary"). The through transit emissions include main and auxiliary emissions. Emissions have been estimated for each of the three days for which detailed data was obtained, and an average day has been estimated to represent a composite of the three days of data. A summary of these estimates is presented in Table 3.20. A detailed breakdown is provided in Attachment 2.

Table 3.20: Emission Estimates, tons per day

Period/Activity	NO_x	VOC	CO	SO_2	PM_{10}	CO_2
5 June 2009						
Dwelling - auxiliary	5.26	0.14	0.84	0.11	0.21	361
In/out - main	3.66	0.15	0.33	0.07	0.21	211
In/out - auxiliary	0.13	0.00	0.02	0.00	0.01	9
Through transit - main	3.11	0.13	0.28	0.06	0.17	178
Through transit - aux.	0.11	0.00	0.02	0.00	0.00	7
Total - tons per day	**12.26**	**0.43**	**1.48**	**0.24**	**0.60**	**767**
25 June 2009						
Dwelling - auxiliary	2.31	0.06	0.37	0.05	0.09	159
In/out - main	3.67	0.15	0.33	0.07	0.21	212
In/out - auxiliary	0.14	0.00	0.02	0.00	0.01	9
Through transit - main	2.36	0.10	0.21	0.04	0.13	137
Through transit - aux.	0.08	0.00	0.01	0.00	0.00	6
Total - tons per day	**8.56**	**0.32**	**0.95**	**0.16**	**0.44**	**523**
25 August 2009						
Dwelling - auxiliary	1.64	0.04	0.26	0.03	0.07	112
In/out - main	3.02	0.13	0.27	0.05	0.17	174
In/out - auxiliary	0.10	0.00	0.02	0.00	0.00	7
Through transit - main	1.52	0.06	0.14	0.03	0.09	89
Through transit - aux.	0.05	0.00	0.01	0.00	0.00	3
Total - tons per day	**6.33**	**0.24**	**0.69**	**0.12**	**0.33**	**385**
Average						
Dwelling - auxiliary	3.40	0.09	0.54	0.07	0.14	234
In/out - main	4.03	0.17	0.36	0.07	0.23	233
In/out - auxiliary	0.15	0.00	0.02	0.00	0.01	10
Through transit - main	2.35	0.10	0.21	0.04	0.13	136
Through transit - aux.	0.08	0.00	0.01	0.00	0.00	5
Total - tons per day	**10.01**	**0.36**	**1.15**	**0.19**	**0.50**	**617**

4.0 CARGO HANDLING EQUIPMENT

This section presents a discussion of data collection and emission estimation methods for the cargo handling equipment (CHE) source category, and provides details of the estimated average daily emissions by type of equipment.

4.1 Data Collection

A complete inventory of cargo handling equipment at the port was not available from port staff or terminal operators. Internet searches of terminal names and operators yielded the following list of cranes, derricks, and forklifts at the port.

Table 4.1: Cargo handling equipment at Port Fourchon, LA

Terminal/Facility Name	Qty.	Equipment
Allison Marine	1	Grua Grande 500-ton derrick & hoist
Ambar Lone Star Drilling Fluids	1	100 ton crane with 100-ft. boom
Bollinger Fourchon	1	888 crane with 115-ton capacity
	1	75-ton cherry picker
	2	12-ton extended boom forklifts
	1	12-ton cherry picker
DelMar Systems	1	4600 Manitowoc ringer crane rated at 650 tons
	1	150-ton crawler crane
	2	52,000-lb. heavy lift forklifts
Heerema Marine	1	Kobelco CKE2500 250-ton crawler crane
	1	Balderis 2,700-ton capacity port crane
	1	Balderis 3,600 ton starboard crane
Hornbeck Offshore Services	1	Clyde 5-50 TC 300 ton crane
	--	Crane barges
Intermoor	1	880-ton revolving ringer crane
	1	300-ton crawler crane with 160-ft. main boom
	1	200-ton crawler model with 110-ft. main boom
	--	Heavy-duty forklifts
	1	4,000-ton hydraulic swaging machine
	7	Spooling units w/ handling capacity up to 300,000 lbs.
Rowan Marine Services	3	150-ton crawler crane paths
	2	50-ton Le Tourneau electric cranes

Source: Company websites

In addition to the equipment information listed above, the Port Director, Chad Chiasson, noted that a reasonable estimate would be that each terminal has at least one crane, and pointed out that one terminal uses electric cranes. Based on this information, one crane was added to the equipment list for each terminal, and the cranes at the terminal using electric cranes were not included in the emission estimates. The final equipment list includes 52 cranes, 3 forklifts, and two cherry pickers (referred to as aerial platform lifts in the tables below).

4.2 Emission Estimating Methodology

Given the limited level of detail that is available on the CHE the method chosen to estimate emissions from this source category was to develop emission rates per piece of equipment, by type, from an existing, published port emissions inventory, the Port of Houston's Goods Movement Emissions Inventory (GMEI).[3] To do this, the overall annual emissions by type of equipment reported in the GMEI was divided by the number of pieces of equipment (population) of each type - this provided an estimate of annual emissions for each type of equipment. The annual emissions were divided by 365 days per year and multiplied by 2,000 pounds per ton to estimate a daily emission rate in pounds per day. Table 4.2 illustrates the results of these steps for the three general types of equipment in use at Port Fourchon terminals, aerial lifts, cranes, and forklifts.

Table 4.2: Estimated Emissions per Type of Equipment

Equipment Type	PHA GMEI Population	NO_x	VOC	CO	SO_2	PM_{10}	CO_2
tons per year							
Aerial platform lift	9	0.4	0.1	0.4	0	0.1	45
Crane	25	51.5	4.7	12.6	0.6	4.2	3,146
Forklift	451	334.3	28.3	159.2	7.7	23.4	38,613
tons per year per piece of equipment							
Aerial platform lift		0.044	0.011	0.044	0.0000	0.011	5
Crane		2.060	0.188	0.504	0.0240	0.168	126
Forklift		0.741	0.063	0.353	0.0171	0.052	86
pounds per day per piece of equipment							
Aerial platform lift		0.244	0.061	0.244	0.0000	0.061	27
Crane		11.288	1.030	2.762	0.1315	0.921	690
Forklift		4.062	0.344	1.934	0.0936	0.284	469

To estimate Port Fourchon CHE emissions, the estimated equipment type population was multiplied by the daily emission rate derived from the Port of Houston GMEI, and the resulting estimates of pounds per day were converted to tons. Table 4.3 presents the results of these calculations.

[3] *2007 Goods Movement Air Emissions Inventory at the Port of Houston.* Final Draft, January 2009

Table 4.3: Estimated Emissions per Type of Equipment, tons per day

Equipment Type	Port Fourchon Population	NO_x	VOC	CO	SO_2	PM_{10}	CO_2
Aerial platform lift	2	0.0002	0.0001	0.0002	0.0000	0.0001	0.03
Crane	52	0.293	0.027	0.072	0.0034	0.024	17.94
Forklift	3	0.006	0.001	0.003	0.0001	0.000	0.70
Total	**57**	**0.300**	**0.027**	**0.075**	**0.004**	**0.024**	**19**

5.0 HEAVY-DUTY VEHICLES

This section presents a discussion of data collection and emission estimation methods for the Heavy-Duty Vehicle (HDV) source category, and provides details of the estimated emissions by average day.

5.1 Data Collection

Traffic data were obtained from Port Fourchon for the LA 1 toll bridge where it crosses Bayou LaFourche near Leeville, LA. Port personnel estimated that about 90% of vehicle traffic turns onto LA 3090 to Port Fourchon and 10% continues on LA 1 to Grand Isle. The toll bridge traffic counting device collects two-way traffic data for "long vehicles" over 30 feet in length and "non-long vehicles." Monthly average daily traffic counts for May to August 2009 are shown below. The "long vehicles" are assumed to be heavy-duty vehicles, for which emissions have been estimated.

Table 5.1: Average daily two-way traffic for LA-1 toll bridge, Leeville, LA

Month	ADT	Port ADT
May 2009	8,102	7,292
June 2009	8,308	7,477
July 2009	9,148	8,233
August 2009	7,641	6,877

Source: Port Fourchon IT Department

Individual daily counts were not available for June 5 and June 25, 2009. Hourly counts were available for August so the data for August 25, 2009, represents the traffic count for that 24-hour period. Hourly traffic data from February and August 2009 showed a vehicle split of 10% LVs and 90% NLV which were applied to the June average daily traffic. Traffic counts for the selected data days are shown below.

Table 5.2: Port Fourchon vehicle traffic counts for selected data days

Date	LV	NLV	Total
5-Jun-09	748	6,729	7,477
25-Jun-09	748	6,729	7,477
25-Aug-09	823	6,371	7,194

Source: Port Fourchon; June vehicle split 10%/90% LV/NLV

5.2 Emission Estimating Methodology

Emissions were estimated using EPA's on-road emission estimating model MOBILE 6.2, which provides emission factors in grams per mile (g/mi), and an estimate of vehicle miles travelled (VMT) within 20 miles of Port Fourchon. The distance was chosen for consistency with the off-shore emissions component, which goes out 20 miles from the Port into the Gulf. Emission factors were developed for 45 mile-per-hour travel, the speed limit in the area. The daily emissions for each day of the evaluation, and an average daily rate, were estimated by multiplying the daily mileage rate (miles per day) by the g/mi emission factor, and converting grams to tons. The results of these calculations are presented in Table 5.3.

Table 5.3: Estimated Emissions from HDVs, tons per day

Date	NO_x	VOC	CO	SO_2	PM_{10}	CO_2
5 June 09	0.14	0.006	0.028	0.0003	0.004	27
25 June 09	0.14	0.006	0.028	0.0003	0.004	27
25 August 09	0.15	0.007	0.031	0.0003	0.004	29
Average day	**0.14**	**0.006**	**0.029**	**0.0003**	**0.004**	**27**

6.0 AIRCRAFT

This section presents a discussion of data collection and emission estimation methods for the aircraft source category, represented by helicopters (which are used frequently in the Gulf of Mexico to transport personnel and supplies to platforms and vessels) and provides details of the estimated emissions by average day.

6.1 Data Collection and Activity Estimates

Detailed helicopter data was available for October 2007 to April 2008 from one of the Port Fourchon helicopter operators. Emissions calculated here are for landings and takeoffs at Port Fourchon helicopter locations. Flight legs with a Port Fourchon arrival or departure were tallied for each month to arrive at an average number of landings/takeoffs per day (see table below).

Table 6.1: Port Fourchon helicopter departures and arrivals (sample data)

Month	Departures	Arrivals	Total	# days per mo.	Avg. per day
Oct-07	828	819	1,647	31	53
Nov-07	663	660	1,323	30	44
Dec-07	657	649	1,306	31	42
Jan-08	619	626	1,245	31	40
Feb-08	711	708	1,419	29	49
Mar-08	733	738	1,471	31	47
Apr-08	510	507	1,017	30	34
		Total	**9,428**	**213**	**44.26**

Source: LSU CES

According to FAA records six helicopter bases currently operate from Port Fourchon with a total of 37 aircraft. The company used for the sample data has 12 aircraft so the multiplier for total Port Fourchon trips would be 37/12 = 3.08. Total annual departures and arrivals were calculated using the following formula:

Total trips/yr = sample data average trips/day x days/year x multiplier

The above formula yielded an estimated 49,814 helicopter trips per year to and from Port Fourchon. Departures for October 2007 were then analyzed to determine the distribution of types of helicopters which were then grouped by engine type (see tables below).

Table 6.2: Helicopter type for October 2007 departures and arrivals (sample data)

Aircraft	Maker	Engine	Type	Count
A 109	AgustaWestland	Twin	Light	29
A 119	AgustaWestland	Single	Light	262
AB 139	Agusta Bell	Twin	Medium	155
AS 350	Agusta Bell	Single	Light	10
Bell 412	Bell	Twin	Medium	2
BO-105-5	Eurocopter	Twin	Light	108
EC 135	Eurocopter	Twin	Light	13
S-61N	Sikorsky	Twin	Medium	91
S-76A++	Sikorsky	Twin	Medium	122
S-76C++	Sikorsky	Twin	Medium	36
Total				**828**

Table 6.3. Helicopter engine type summary (October 2007 sample data):

Engine Type	Count	Percent
Single Light	272	33%
Twin Light	150	18%
Twin Medium	406	49%
Total	**828**	**100%**

6.2 Emission Estimating Methodology

Emissions for landings and takeoffs were calculated using MMS report emission factors per the equation below.

$$\mathbf{E_i = EF_i / 2000 \times LTO_i}$$

where:

E_i = Helicopter emissions for helicopter type i (tons per year)
EF_i = Helicopter emission factor for helicopter type i (pounds/LTO)
LTO_i = Landing and takeoff cycle for helicopter type i (cycles per year)
i = Helicopter type (i.e., single, light, or medium)
2000 = Conversion factor pounds per ton

Emission factors and total emissions are summarized in the tables below.

Table 6.4: Helicopter Emission Factors by Helicopter Type

Engine Type	NO_x lb/LTO	CO lb/LTO	SO_2 lb/LTO	CO_2 lb/LTO
Single Light	0.289	5.745	0.032	58.8
Twin Light	2.235	9.602	0.96	268.869
Twin Medium	5.676	11.372	2.455	689.261

LTO = landing/takeoff
Source: "Year 2005 Gulfwide Emission Inventory Study," MMS, 2007

Table 6.5: Estimated Annual Port Fourchon Helicopter Emissions

Engine Type	Trips/ yr	NO_x tpy	CO tpy	SO_2 tpy	CO_2 tpy
Single Light	16,439	2.4	47.2	0.3	483.3
Twin Light	8,967	10.0	43.0	4.3	1,205.4
Twin Medium	24,409	69.3	138.8	30.0	8,412.1
Total (tons/year)		**81.7**	**229.1**	**34.5**	**10,100.8**
Total (tons/day)		**0.22**	**0.63**	**0.09**	**27.67**

Total NO_x emissions were 81.7 tons per year or slightly less than one quarter ton per day (0.22 tons/day). These emissions account for landings and takeoffs at Port Fourchon and do not include emissions from in-transit travel or offshore landings/takeoffs. The latter were estimated in the MMS 2005 emission inventory and are included in report section "Offshore Emission Sources." Other emission estimates were 0.63 tons/day CO_2 0.09 tons/day SO_2, and 27.67 tons/day CO_2.

7.0 OFFSHORE EMISSION SOURCES

This section presents a discussion of data obtained from the Minerals Management Service (MMS) related to emissions in the Gulf of Mexico. The MMS (now the Bureau of Ocean Energy Management, Regulation, and Enforcement) conducted an air emissions inventory for the Gulf of Mexico in 2005. Inventory results are available on the Internet at:

http://www.gomr.mms.gov/homepg/regulate/environ/airquality/gulfwide_emission_inventory/2005GulfwideEmissionInventory.html.

7.1 MMS Emissions Inventory Information

Air emissions were calculated based on usage and equipment data for offshore oil and natural gas platforms and non-platform sources, which are noted below.

Non-platform oil/gas production sources:

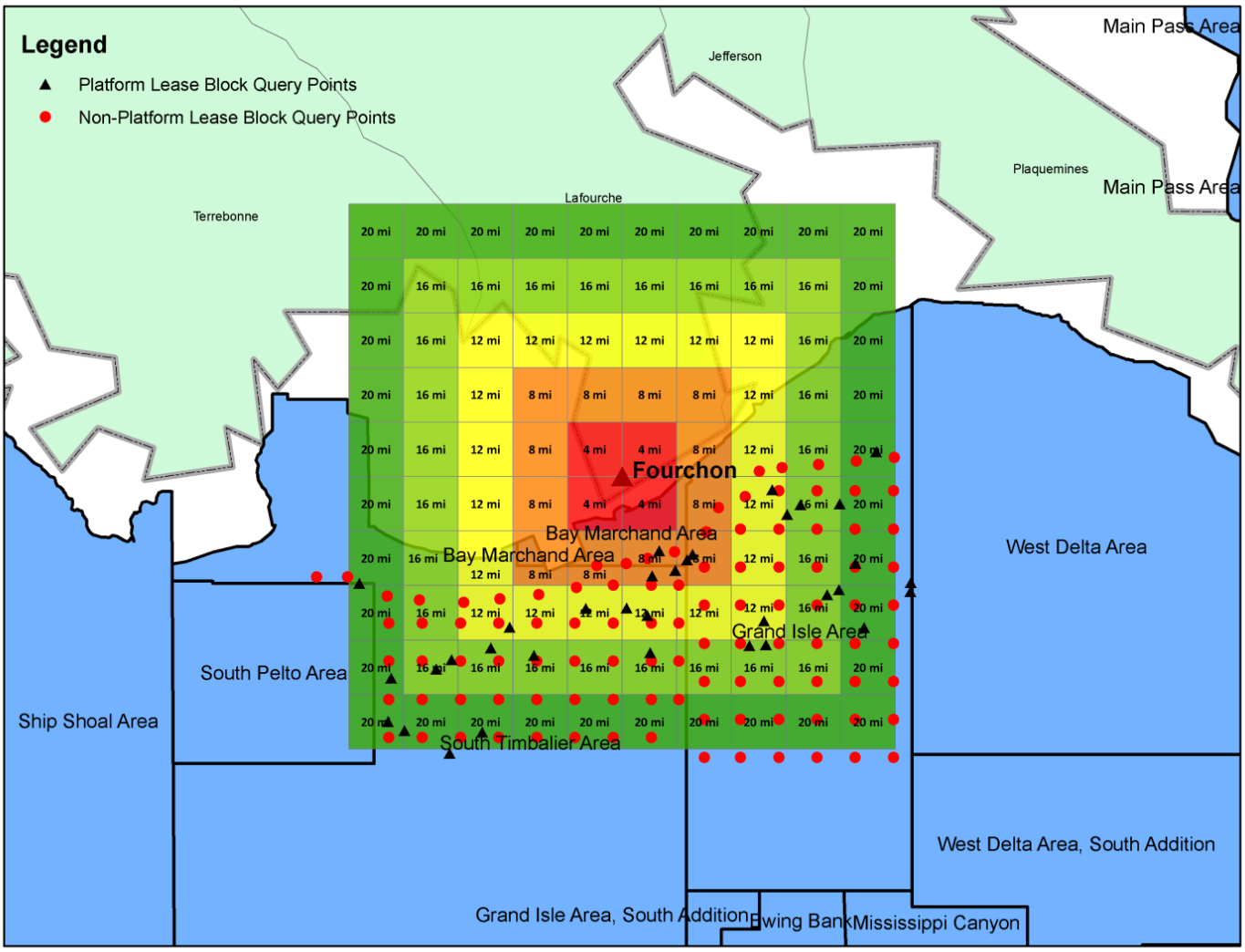
- Drilling vessels
- Pipelaying operations
- Support helicopters
- Support vessels
- Survey vessels

Non-platform non-oil/gas production sources:

- Biogenic and geogenic sources
- Commercial fishing vessels
- Commercial marine vessels
- Louisiana Offshore Oil Platform (LOOP)
- Military vessels (Coast Guard/Navy)
- Vessel lightering

A 20-mile square area was identified to limit emissions to the Port Fourchon vicinity. MMS located platforms using latitude/longitude coordinates, and assigned non-platform emissions to the centroid of the nearest lease block (see Figure 7-1).

Figure 7.1: MMS platform and non-platform sources within 20 miles of Port Fourchon



Source: LSU CES

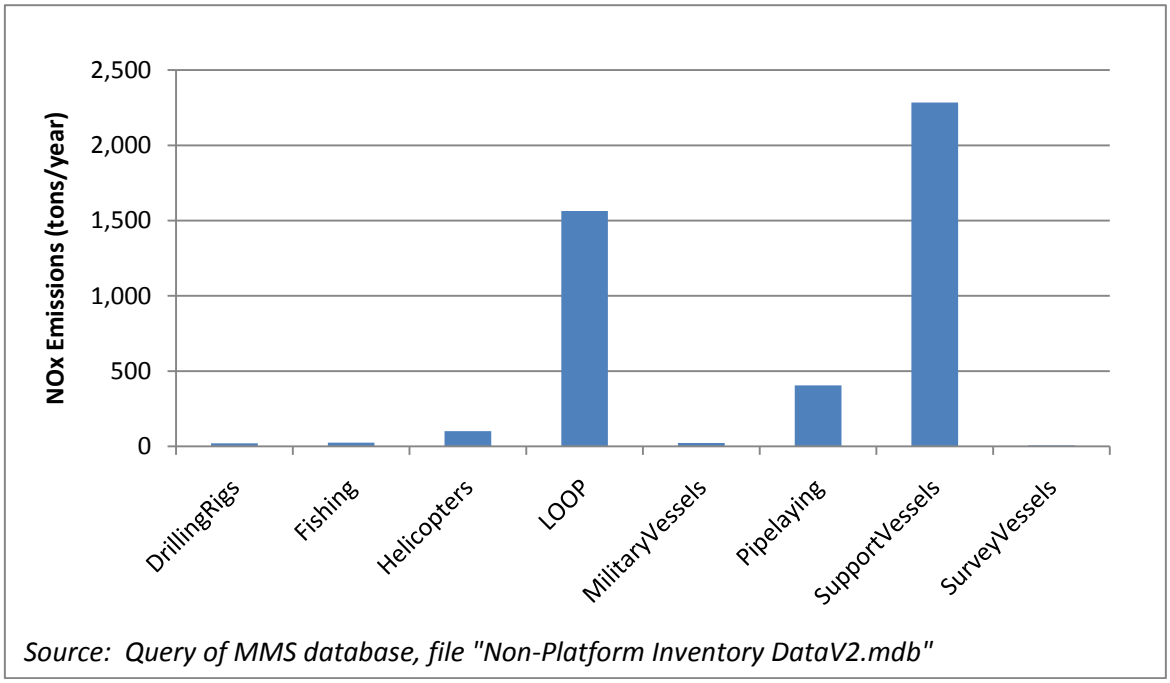
Data points were queried from the Gulf-wide emissions database using lease block numbers located within the 20-mile square. These included South Timbalier and Bay Marchand Blocks 1-59 and Grand Isle Blocks 1-67. Platform NO_x emissions were 2,778 tons per year from 82 platforms. Non-platform NO_x emissions totaled 4,425 tons per year and are shown by source below.

Table 7.1: 2005 offshore non-platform NO_x emissions within 20 miles of Port Fourchon

Non-Platform Source	NO_x (tpy)
Drilling Rigs	20.08
Fishing Vessels	23.82
Helicopters	100.43
LOOP	1,563.92
Military Vessels	21.99
Pipelaying	404.74
Support Vessels	2,283.99
Survey Vessels	6.24
Total	**4,425.21**

Source: Query of MMS database, file "Non-Platform Inventory DataV2.mdb"

Figure 7.2: 2005 non-platform NO_x emissions within 20 miles of Port Fourchon, by source type



Source: Query of MMS database, file "Non-Platform Inventory DataV2.mdb"

As shown above the largest single non-platform source of NOx emissions is support vessels. These emissions are for offshore vessels in federal waters, and vessel emissions estimated in Section 3 are for the immediate Port Fourchon vicinity. Air emission estimates for Louisiana state waters were not readily available. Platform and non-platform emissions are available by latitude and longitude if needed for air modeling purposes. See table below for additional emission estimates for offshore sources within 20 miles of Port Fourchon.

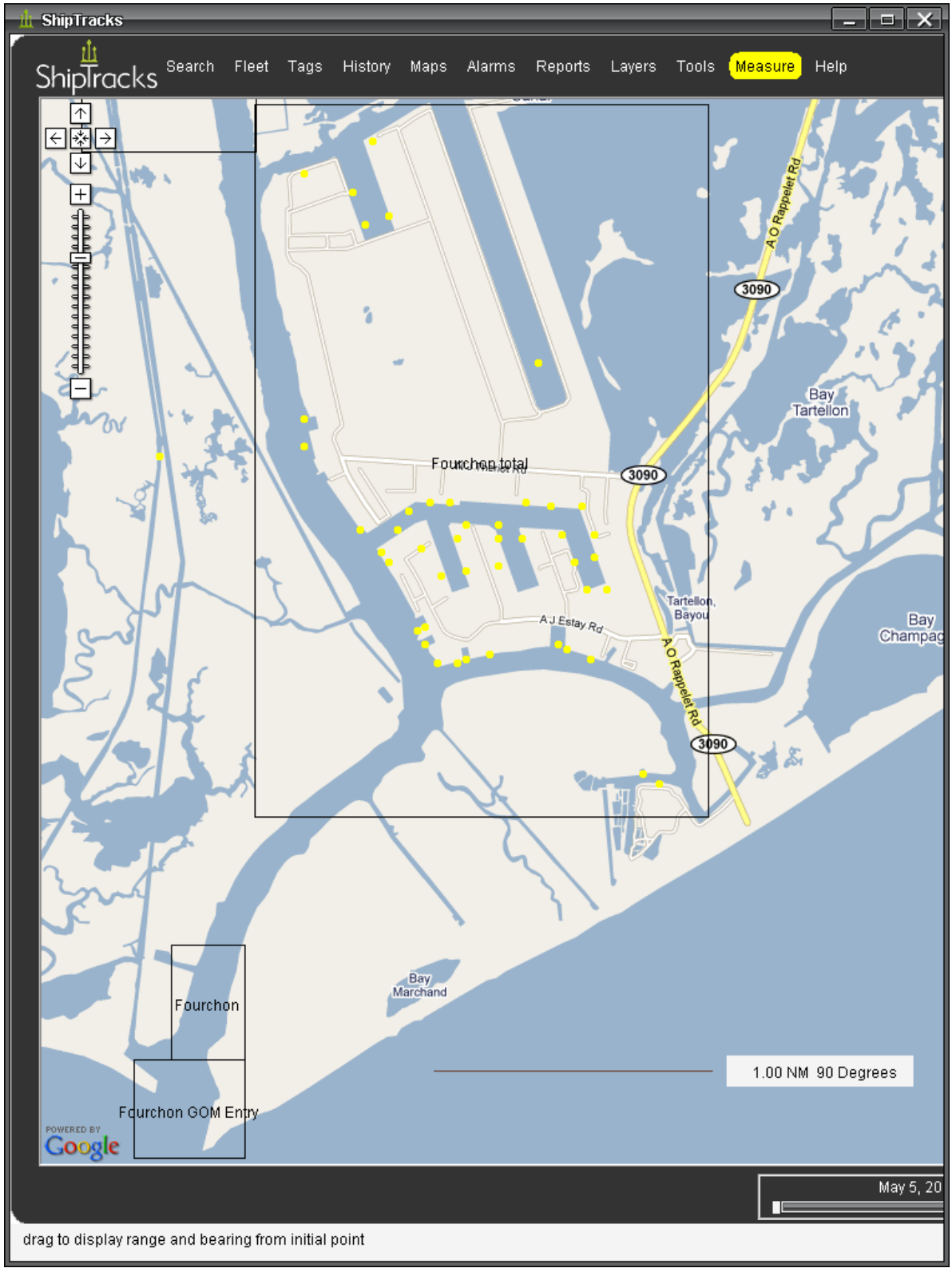
Table 7.2: Estimated Emissions for Offshore Sources, tons per day

Source Category	NO_x	VOC	CO	SO_2	PM_{10}	CO_2
Platform Sources	7.6	4.3	9.1	0.01	0.05	823
Non-Platform Sources	12.1	2.3	2.8	1.67	0.26	674
Total	**19.7**	**6.7**	**11.9**	**1.7**	**0.3**	**1,497**

Source: MMS database files "2005-GOADS-NIF-v1.mdb" and "Non-Platform Inventory DataV2.mdb"

ATTACHMENT 1

SHIPTRACKS LOCATION BOXES FOR PORT FOURCHON


ShipTracks
ShipTracks
Search
Fleet
Tags
History
Maps
Alarms
Reports
Layers
Tools
Measure
Help
A O Rappelet Rd
3090
Bay
Tartellon
Fourchon total
3090
A J Estay Rd
Tartellon
Bayou
Bay
Champag
A O Rappelet Rd
3090
Bay
Marchand
Fourchon
Fourchon GOM Entry
1.00 NM 90 Degrees
POWERED BY
Google
May 5, 20
drag to display range and bearing from initial point

ATTACHMENT 2

DETAILED VESSEL EMISSION ESTIMATES

Attachment 2 - Detailed Vessel Emission Estimates

Dwelling emissions - auxiliary only - tons per day

5 June

Vessel Type	NO_x	VOC	CO	SO_2	PM_{10}	CO_2
Anchor handling	0.029	0.001	0.004	0.0006	0.001	2
Commercial fishing	0.012	0.000	0.002	0.0002	0.000	1
Crewboat - sm	0.000	0.000	0.000	0.0000	0.000	0
Crewboat - lg	0.279	0.007	0.048	0.0059	0.011	19
Freight ship	0.000	0.000	0.000	0.0000	0.000	0
Industrial vessel	0.003	0.000	0.001	0.0001	0.000	0
Mini supply	0.181	0.005	0.031	0.0039	0.007	12
Offshore supply - sm	0.098	0.003	0.017	0.0021	0.004	7
Offshore supply - med	1.373	0.037	0.238	0.0293	0.055	94
Offshore supply - lg	2.794	0.075	0.410	0.0596	0.112	192
Passenger - sm	0.010	0.000	0.002	0.0002	0.000	1
Passenger - lg	0.192	0.005	0.033	0.0041	0.008	13
Research vessel	0.000	0.000	0.000	0.0000	0.000	0
Towing vessel - sm	0.208	0.006	0.036	0.0044	0.008	14
Towing vessel - lg	0.005	0.000	0.001	0.0001	0.000	0
Utility	0.065	0.002	0.011	0.0014	0.003	4
Not categorized	0.014	0.000	0.002	0.0003	0.001	1
All vessels	5.264	0.140	0.837	0.112	0.211	361

25 June

Vessel Type	NO_x	VOC	CO	SO_2	PM_{10}	CO_2
Anchor handling	0.017	0.000	0.002	0.0004	0.001	1
Commercial fishing	0.000	0.000	0.000	0.0000	0.000	0
Crewboat - sm	0.013	0.000	0.002	0.0003	0.001	1
Crewboat - lg	0.132	0.004	0.023	0.0028	0.005	9
Freight ship	0.003	0.000	0.001	0.0001	0.000	0
Industrial vessel	0.000	0.000	0.000	0.0000	0.000	0
Mini supply	0.073	0.002	0.013	0.0016	0.003	5
Offshore supply - sm	0.096	0.003	0.017	0.0021	0.004	7
Offshore supply - med	0.608	0.016	0.105	0.0130	0.024	42
Offshore supply - lg	1.177	0.031	0.173	0.0251	0.047	81
Passenger - sm	0.008	0.000	0.001	0.0002	0.000	1
Passenger - lg	0.113	0.003	0.020	0.0024	0.005	8
Research vessel	0.000	0.000	0.000	0.0000	0.000	0
Towing vessel - sm	0.059	0.002	0.010	0.0013	0.002	4
Towing vessel - lg	0.003	0.000	0.000	0.0001	0.000	0
Utility	0.007	0.000	0.001	0.0001	0.000	0
Not categorized	0.007	0.000	0.001	0.0002	0.000	1
All vessels	2.315	0.062	0.369	0.049	0.093	159

Dwelling emissions - auxiliary only - tons per day

25 August

Vessel Type	NO_x	VOC	CO	SO_2	PM_{10}	CO_2
Anchor handling	0.177	0.005	0.026	0.0038	0.007	12
Commercial fishing	0.000	0.000	0.000	0.0000	0.000	0
Crewboat - sm	0.000	0.000	0.000	0.0000	0.000	0
Crewboat - lg	0.073	0.002	0.013	0.0016	0.003	5
Freight ship	0.000	0.000	0.000	0.0000	0.000	0
Industrial vessel	0.007	0.000	0.001	0.0002	0.000	1
Mini supply	0.043	0.001	0.007	0.0009	0.002	3
Offshore supply - sm	0.025	0.001	0.004	0.0005	0.001	2
Offshore supply - med	0.222	0.006	0.039	0.0047	0.009	15
Offshore supply - lg	0.820	0.022	0.120	0.0175	0.033	56
Passenger - sm	0.000	0.000	0.000	0.0000	0.000	0
Passenger - lg	0.125	0.003	0.022	0.0027	0.005	9
Research vessel	0.000	0.000	0.000	0.0000	0.000	0
Towing vessel - sm	0.075	0.002	0.013	0.0016	0.003	5
Towing vessel - lg	0.031	0.001	0.005	0.0007	0.001	2
Utility	0.024	0.001	0.004	0.0005	0.001	2
Not categorized	0.014	0.000	0.002	0.0003	0.001	1
All vessels	1.637	0.044	0.257	0.035	0.065	112

Composite, three days

Vessel Type	NO_x	VOC	CO	SO_2	PM_{10}	CO_2
Anchor handling	0.077	0.002	0.011	0.0016	0.003	5
Commercial fishing	0.006	0.000	0.001	0.0001	0.000	0
Crewboat - sm	0.007	0.000	0.001	0.0001	0.000	0
Crewboat - lg	0.163	0.004	0.028	0.0035	0.007	11
Freight ship	0.003	0.000	0.001	0.0001	0.000	0
Industrial vessel	0.004	0.000	0.001	0.0001	0.000	0
Mini supply	0.107	0.003	0.019	0.0023	0.004	7
Offshore supply - sm	0.096	0.003	0.017	0.0021	0.004	7
Offshore supply - med	0.819	0.022	0.142	0.0175	0.033	56
Offshore supply - lg	1.776	0.047	0.260	0.0379	0.071	122
Passenger - sm	0.007	0.000	0.001	0.0002	0.000	1
Passenger - lg	0.149	0.004	0.026	0.0032	0.006	10
Research vessel	0.000	0.000	0.000	0.0000	0.000	0
Towing vessel - sm	0.115	0.003	0.020	0.0025	0.005	8
Towing vessel - lg	0.014	0.000	0.002	0.0003	0.001	1
Utility	0.033	0.001	0.006	0.0007	0.001	2
Not categorized	0.028	0.001	0.005	0.0006	0.001	2
All vessels	3.404	0.091	0.541	0.073	0.136	234

Attachment 2

Transit associated with dwelling events - main engines - tons per day

5 June

Vessel Type	NO_x	VOC	CO	SO_2	PM_{10}	CO_2
Anchor handling	0.372	0.015	0.032	0.0064	0.020	21
Commercial fishing	0.009	0.000	0.001	0.0002	0.000	0
Crewboat - sm	0.000	0.000	0.000	0.0000	0.000	0
Crewboat - lg	0.743	0.032	0.069	0.0139	0.043	45
Freight ship	0.000	0.000	0.000	0.0000	0.000	0
Industrial vessel	0.047	0.002	0.004	0.0008	0.002	2
Mini supply	0.052	0.002	0.005	0.0010	0.003	3
Offshore supply - sm	0.028	0.001	0.002	0.0004	0.001	1
Offshore supply - med	0.650	0.027	0.058	0.0116	0.036	37
Offshore supply - lg	1.097	0.046	0.100	0.0199	0.062	64
Passenger - sm	0.013	0.000	0.001	0.0002	0.001	1
Passenger - lg	0.346	0.015	0.032	0.0064	0.020	21
Research vessel	0.012	0.000	0.001	0.0002	0.001	1
Towing vessel - sm	0.105	0.004	0.009	0.0018	0.005	6
Towing vessel - lg	0.139	0.005	0.012	0.0023	0.007	8
Utility	0.036	0.001	0.003	0.0006	0.002	2
Not categorized	0.009	0.000	0.001	0.0002	0.000	0
All vessels	3.659	0.152	0.328	0.066	0.205	211

25 June

Vessel Type	NO_x	VOC	CO	SO_2	PM_{10}	CO_2
Anchor handling	0.159	0.006	0.014	0.0027	0.009	9
Commercial fishing	0.000	0.000	0.000	0.0000	0.000	0
Crewboat - sm	0.005	0.000	0.000	0.0001	0.000	0
Crewboat - lg	0.598	0.026	0.056	0.0112	0.035	36
Freight ship	0.003	0.000	0.000	0.0000	0.000	0
Industrial vessel	0.000	0.000	0.000	0.0000	0.000	0
Mini supply	0.154	0.007	0.014	0.0028	0.009	9
Offshore supply - sm	0.157	0.006	0.013	0.0026	0.008	8
Offshore supply - med	1.141	0.047	0.102	0.0203	0.064	65
Offshore supply - lg	0.880	0.037	0.080	0.0160	0.050	51
Passenger - sm	0.009	0.000	0.001	0.0001	0.000	0
Passenger - lg	0.346	0.015	0.032	0.0064	0.020	21
Research vessel	0.000	0.000	0.000	0.0000	0.000	0
Towing vessel - sm	0.105	0.004	0.009	0.0018	0.005	6
Towing vessel - lg	0.060	0.002	0.005	0.0010	0.003	3
Utility	0.029	0.001	0.002	0.0005	0.002	2
Not categorized	0.028	0.001	0.002	0.0005	0.001	1
All vessels	3.675	0.152	0.330	0.066	0.206	212

Transit associated with dwelling events - main engines - tons per day

25 August

Vessel Type	NO_x	VOC	CO	SO_2	PM_{10}	CO_2
Anchor handling	0.425	0.017	0.036	0.0073	0.023	23
Commercial fishing	0.000	0.000	0.000	0.0000	0.000	0
Crewboat - sm	0.000	0.000	0.000	0.0000	0.000	0
Crewboat - lg	0.242	0.010	0.023	0.0045	0.014	15
Freight ship	0.000	0.000	0.000	0.0000	0.000	0
Industrial vessel	0.015	0.001	0.001	0.0002	0.001	1
Mini supply	0.013	0.001	0.001	0.0002	0.001	1
Offshore supply - sm	0.049	0.002	0.004	0.0008	0.003	3
Offshore supply - med	0.597	0.025	0.053	0.0106	0.033	34
Offshore supply - lg	0.969	0.041	0.088	0.0176	0.055	57
Passenger - sm	0.000	0.000	0.000	0.0000	0.000	0
Passenger - lg	0.484	0.021	0.045	0.0090	0.028	29
Research vessel	0.000	0.000	0.000	0.0000	0.000	0
Towing vessel - sm	0.105	0.004	0.009	0.0018	0.005	6
Towing vessel - lg	0.075	0.003	0.006	0.0013	0.004	4
Utility	0.026	0.001	0.002	0.0004	0.001	1
Not categorized	0.023	0.001	0.002	0.0004	0.001	1
All vessels	3.023	0.125	0.270	0.054	0.169	174

Composite, three days

Vessel Type	NO_x	VOC	CO	SO_2	PM_{10}	CO_2
Anchor handling	0.372	0.015	0.032	0.0064	0.020	21
Commercial fishing	0.005	0.000	0.000	0.0001	0.000	0
Crewboat - sm	0.003	0.000	0.000	0.0000	0.000	0
Crewboat - lg	0.533	0.023	0.050	0.0099	0.031	32
Freight ship	0.004	0.000	0.000	0.0001	0.000	0
Industrial vessel	0.023	0.001	0.002	0.0004	0.001	1
Mini supply	0.090	0.004	0.008	0.0016	0.005	5
Offshore supply - sm	0.087	0.003	0.007	0.0014	0.004	5
Offshore supply - med	0.981	0.040	0.087	0.0175	0.055	56
Offshore supply - lg	1.231	0.052	0.112	0.0223	0.070	72
Passenger - sm	0.009	0.000	0.001	0.0001	0.000	0
Passenger - lg	0.415	0.018	0.038	0.0077	0.024	25
Research vessel	0.012	0.000	0.001	0.0002	0.001	1
Towing vessel - sm	0.122	0.005	0.010	0.0020	0.006	7
Towing vessel - lg	0.075	0.003	0.006	0.0013	0.004	4
Utility	0.035	0.001	0.003	0.0006	0.002	2
Not categorized	0.037	0.001	0.003	0.0006	0.002	2
All vessels	4.033	0.167	0.361	0.072	0.226	233

Transit associated with dwelling events - auxiliary engines - tons per day

5 June

Vessel Type	NO_x	VOC	CO	SO_2	PM_{10}	CO_2
Anchor handling	0.007	0.000	0.001	0.0002	0.000	1
Commercial fishing	0.001	0.000	0.000	0.0000	0.000	0
Crewboat - sm	0.000	0.000	0.000	0.0000	0.000	0
Crewboat - lg	0.016	0.000	0.003	0.0003	0.001	1
Freight ship	0.000	0.000	0.000	0.0000	0.000	0
Industrial vessel	0.003	0.000	0.001	0.0001	0.000	0
Mini supply	0.004	0.000	0.001	0.0001	0.000	0
Offshore supply - sm	0.002	0.000	0.000	0.0000	0.000	0
Offshore supply - med	0.023	0.001	0.004	0.0005	0.001	2
Offshore supply - lg	0.047	0.001	0.007	0.0010	0.002	3
Passenger - sm	0.002	0.000	0.000	0.0000	0.000	0
Passenger - lg	0.007	0.000	0.001	0.0002	0.000	0
Research vessel	0.000	0.000	0.000	0.0000	0.000	0
Towing vessel - sm	0.005	0.000	0.001	0.0001	0.000	0
Towing vessel - lg	0.003	0.000	0.001	0.0001	0.000	0
Utility	0.004	0.000	0.001	0.0001	0.000	0
Not categorized	0.000	0.000	0.000	0.0000	0.000	0
All vessels	0.127	0.003	0.020	0.003	0.005	9

25 June

Vessel Type	NO_x	VOC	CO	SO_2	PM_{10}	CO_2
Anchor handling	0.003	0.000	0.000	0.0001	0.000	0
Commercial fishing	0.000	0.000	0.000	0.0000	0.000	0
Crewboat - sm	0.001	0.000	0.000	0.0000	0.000	0
Crewboat - lg	0.013	0.000	0.002	0.0003	0.001	1
Freight ship	0.000	0.000	0.000	0.0000	0.000	0
Industrial vessel	0.000	0.000	0.000	0.0000	0.000	0
Mini supply	0.011	0.000	0.002	0.0002	0.000	1
Offshore supply - sm	0.009	0.000	0.002	0.0002	0.000	1
Offshore supply - med	0.041	0.001	0.007	0.0009	0.002	3
Offshore supply - lg	0.038	0.001	0.006	0.0008	0.002	3
Passenger - sm	0.001	0.000	0.000	0.0000	0.000	0
Passenger - lg	0.007	0.000	0.001	0.0002	0.000	0
Research vessel	0.000	0.000	0.000	0.0000	0.000	0
Towing vessel - sm	0.005	0.000	0.001	0.0001	0.000	0
Towing vessel - lg	0.001	0.000	0.000	0.0000	0.000	0
Utility	0.003	0.000	0.001	0.0001	0.000	0
Not categorized	0.001	0.000	0.000	0.0000	0.000	0
All vessels	0.137	0.004	0.023	0.003	0.005	9

Transit associated with dwelling events - auxiliary engines - tons per day

25 August

Vessel Type	NO_x	VOC	CO	SO_2	PM_{10}	CO_2
Anchor handling	0.009	0.000	0.001	0.0002	0.000	1
Commercial fishing	0.000	0.000	0.000	0.0000	0.000	0
Crewboat - sm	0.000	0.000	0.000	0.0000	0.000	0
Crewboat - lg	0.005	0.000	0.001	0.0001	0.000	0
Freight ship	0.000	0.000	0.000	0.0000	0.000	0
Industrial vessel	0.001	0.000	0.000	0.0000	0.000	0
Mini supply	0.001	0.000	0.000	0.0000	0.000	0
Offshore supply - sm	0.003	0.000	0.001	0.0001	0.000	0
Offshore supply - med	0.021	0.001	0.004	0.0005	0.001	1
Offshore supply - lg	0.042	0.001	0.006	0.0009	0.002	3
Passenger - sm	0.000	0.000	0.000	0.0000	0.000	0
Passenger - lg	0.010	0.000	0.002	0.0002	0.000	1
Research vessel	0.000	0.000	0.000	0.0000	0.000	0
Towing vessel - sm	0.005	0.000	0.001	0.0001	0.000	0
Towing vessel - lg	0.002	0.000	0.000	0.0000	0.000	0
Utility	0.003	0.000	0.000	0.0001	0.000	0
Not categorized	0.001	0.000	0.000	0.0000	0.000	0
All vessels	0.103	0.003	0.016	0.002	0.004	7

Composite, three days

Vessel Type	NO_x	VOC	CO	SO_2	PM_{10}	CO_2
Anchor handling	0.007	0.000	0.001	0.0002	0.000	1
Commercial fishing	0.000	0.000	0.000	0.0000	0.000	0
Crewboat - sm	0.001	0.000	0.000	0.0000	0.000	0
Crewboat - lg	0.012	0.000	0.002	0.0003	0.000	1
Freight ship	0.000	0.000	0.000	0.0000	0.000	0
Industrial vessel	0.002	0.000	0.000	0.0000	0.000	0
Mini supply	0.007	0.000	0.001	0.0001	0.000	0
Offshore supply - sm	0.005	0.000	0.001	0.0001	0.000	0
Offshore supply - med	0.035	0.001	0.006	0.0007	0.001	2
Offshore supply - lg	0.053	0.001	0.008	0.0011	0.002	4
Passenger - sm	0.001	0.000	0.000	0.0000	0.000	0
Passenger - lg	0.009	0.000	0.001	0.0002	0.000	1
Research vessel	0.000	0.000	0.000	0.0000	0.000	0
Towing vessel - sm	0.006	0.000	0.001	0.0001	0.000	0
Towing vessel - lg	0.002	0.000	0.000	0.0000	0.000	0
Utility	0.004	0.000	0.001	0.0001	0.000	0
Not categorized	0.001	0.000	0.000	0.0000	0.000	0
All vessels	0.146	0.004	0.024	0.003	0.006	10

Through transits - main engines - tons per day

5 June

Vessel Type	NO_x	VOC	CO	SO_2	PM_{10}	CO_2
Anchor handling	0.744	0.029	0.064	0.0127	0.040	41
Commercial fishing	0.005	0.000	0.000	0.0001	0.000	0
Crewboat - sm	0.007	0.000	0.001	0.0001	0.000	0
Crewboat - lg	0.630	0.027	0.059	0.0118	0.037	38
Freight ship	0.004	0.000	0.000	0.0001	0.000	0
Industrial vessel	0.023	0.001	0.002	0.0004	0.001	1
Mini supply	0.088	0.004	0.008	0.0016	0.005	5
Offshore supply - sm	0.071	0.003	0.006	0.0012	0.004	4
Offshore supply - med	0.504	0.021	0.045	0.0090	0.028	29
Offshore supply - lg	0.652	0.027	0.059	0.0118	0.037	38
Passenger - sm	0.011	0.000	0.001	0.0002	0.001	1
Passenger - lg	0.208	0.009	0.019	0.0038	0.012	12
Research vessel	0.012	0.000	0.001	0.0002	0.001	1
Towing vessel - sm	0.098	0.004	0.008	0.0016	0.005	5
Towing vessel - lg	0.000	0.000	0.000	0.0000	0.000	0
Utility	0.029	0.001	0.002	0.0005	0.002	2
Not categorized	0.019	0.001	0.002	0.0003	0.001	1
All vessels	3.105	0.128	0.277	0.055	0.173	178

25 June

Vessel Type	NO_x	VOC	CO	SO_2	PM_{10}	CO_2
Anchor handling	0.096	0.004	0.008	0.0016	0.005	5
Commercial fishing	0.000	0.000	0.000	0.0000	0.000	0
Crewboat - sm	0.009	0.000	0.001	0.0002	0.000	0
Crewboat - lg	0.792	0.034	0.074	0.0148	0.046	48
Freight ship	0.003	0.000	0.000	0.0000	0.000	0
Industrial vessel	0.009	0.000	0.001	0.0001	0.000	0
Mini supply	0.077	0.003	0.007	0.0014	0.004	5
Offshore supply - sm	0.047	0.002	0.004	0.0008	0.002	2
Offshore supply - med	0.570	0.024	0.051	0.0102	0.032	33
Offshore supply - lg	0.316	0.013	0.029	0.0057	0.018	18
Passenger - sm	0.002	0.000	0.000	0.0000	0.000	0
Passenger - lg	0.259	0.011	0.024	0.0048	0.015	15
Research vessel	0.024	0.001	0.002	0.0004	0.001	1
Towing vessel - sm	0.084	0.003	0.007	0.0014	0.004	5
Towing vessel - lg	0.015	0.001	0.001	0.0003	0.001	1
Utility	0.039	0.001	0.003	0.0006	0.002	2
Not categorized	0.014	0.001	0.001	0.0002	0.001	1
All vessels	2.357	0.098	0.213	0.043	0.133	137

Through transits - main engines - tons per day

25 August

Vessel Type	NO_x	VOC	CO	SO_2	PM_{10}	CO_2
Anchor handling	0.000	0.000	0.000	0.0000	0.000	0
Commercial fishing	0.000	0.000	0.000	0.0000	0.000	0
Crewboat - sm	0.002	0.000	0.000	0.0000	0.000	0
Crewboat - lg	0.258	0.011	0.024	0.0048	0.015	16
Freight ship	0.000	0.000	0.000	0.0000	0.000	0
Industrial vessel	0.015	0.001	0.001	0.0002	0.001	1
Mini supply	0.010	0.000	0.001	0.0002	0.001	1
Offshore supply - sm	0.020	0.001	0.002	0.0003	0.001	1
Offshore supply - med	0.265	0.011	0.024	0.0047	0.015	15
Offshore supply - lg	0.158	0.007	0.014	0.0029	0.009	9
Passenger - sm	0.002	0.000	0.000	0.0000	0.000	0
Passenger - lg	0.646	0.028	0.060	0.0119	0.037	38
Research vessel	0.000	0.000	0.000	0.0000	0.000	0
Towing vessel - sm	0.059	0.002	0.005	0.0010	0.003	3
Towing vessel - lg	0.050	0.002	0.004	0.0008	0.003	3
Utility	0.035	0.001	0.003	0.0006	0.002	2
Not categorized	0.000	0.000	0.000	0.0000	0.000	0
All vessels	1.519	0.064	0.138	0.028	0.086	89

Composite, three days

Vessel Type	NO_x	VOC	CO	SO_2	PM_{10}	CO_2
Anchor handling	0.319	0.013	0.027	0.0055	0.017	18
Commercial fishing	0.005	0.000	0.000	0.0001	0.000	0
Crewboat - sm	0.005	0.000	0.000	0.0001	0.000	0
Crewboat - lg	0.565	0.024	0.053	0.0105	0.033	34
Freight ship	0.004	0.000	0.000	0.0001	0.000	0
Industrial vessel	0.023	0.001	0.002	0.0004	0.001	1
Mini supply	0.058	0.002	0.005	0.0011	0.003	3
Offshore supply - sm	0.047	0.002	0.004	0.0008	0.002	2
Offshore supply - med	0.438	0.018	0.039	0.0078	0.024	25
Offshore supply - lg	0.371	0.016	0.034	0.0067	0.021	22
Passenger - sm	0.007	0.000	0.001	0.0001	0.000	0
Passenger - lg	0.346	0.015	0.032	0.0064	0.020	21
Research vessel	0.012	0.000	0.001	0.0002	0.001	1
Towing vessel - sm	0.075	0.003	0.006	0.0012	0.004	4
Towing vessel - lg	0.015	0.001	0.001	0.0003	0.001	1
Utility	0.039	0.001	0.003	0.0006	0.002	2
Not categorized	0.019	0.001	0.002	0.0003	0.001	1
All vessels	2.347	0.097	0.211	0.042	0.132	136

Through transits - auxiliary engines - tons per day

5 June

Vessel Type	NO_x	VOC	CO	SO_2	PM_{10}	CO_2
Anchor handling	0.015	0.000	0.002	0.0003	0.001	1
Commercial fishing	0.000	0.000	0.000	0.0000	0.000	0
Crewboat - sm	0.002	0.000	0.000	0.0000	0.000	0
Crewboat - lg	0.014	0.000	0.002	0.0003	0.001	1
Freight ship	0.000	0.000	0.000	0.0000	0.000	0
Industrial vessel	0.002	0.000	0.000	0.0000	0.000	0
Mini supply	0.007	0.000	0.001	0.0001	0.000	0
Offshore supply - sm	0.004	0.000	0.001	0.0001	0.000	0
Offshore supply - me	0.018	0.000	0.003	0.0004	0.001	1
Offshore supply - lg	0.028	0.001	0.004	0.0006	0.001	2
Passenger - sm	0.002	0.000	0.000	0.0000	0.000	0
Passenger - lg	0.004	0.000	0.001	0.0001	0.000	0
Research vessel	0.000	0.000	0.000	0.0000	0.000	0
Towing vessel - sm	0.005	0.000	0.001	0.0001	0.000	0
Towing vessel - lg	0.000	0.000	0.000	0.0000	0.000	0
Utility	0.003	0.000	0.001	0.0001	0.000	0
Not categorized	0.000	0.000	0.000	0.0000	0.000	0
All vessels	0.106	0.003	0.017	0.002	0.004	7

25 June

Vessel Type	NO_x	VOC	CO	SO_2	PM_{10}	CO_2
Anchor handling	0.002	0.000	0.000	0.0000	0.000	0
Commercial fishing	0.000	0.000	0.000	0.0000	0.000	0
Crewboat - sm	0.002	0.000	0.000	0.0001	0.000	0
Crewboat - lg	0.017	0.000	0.003	0.0004	0.001	1
Freight ship	0.000	0.000	0.000	0.0000	0.000	0
Industrial vessel	0.001	0.000	0.000	0.0000	0.000	0
Mini supply	0.006	0.000	0.001	0.0001	0.000	0
Offshore supply - sm	0.003	0.000	0.000	0.0001	0.000	0
Offshore supply - me	0.020	0.001	0.004	0.0004	0.001	1
Offshore supply - lg	0.014	0.000	0.002	0.0003	0.001	1
Passenger - sm	0.000	0.000	0.000	0.0000	0.000	0
Passenger - lg	0.005	0.000	0.001	0.0001	0.000	0
Research vessel	0.001	0.000	0.000	0.0000	0.000	0
Towing vessel - sm	0.004	0.000	0.001	0.0001	0.000	0
Towing vessel - lg	0.000	0.000	0.000	0.0000	0.000	0
Utility	0.004	0.000	0.001	0.0001	0.000	0
Not categorized	0.000	0.000	0.000	0.0000	0.000	0
All vessels	0.081	0.002	0.014	0.002	0.003	6

Through transits - auxiliary engines - tons per day

25 August

Vessel Type	NO_x	VOC	CO	SO_2	PM_{10}	CO_2
Anchor handling	0.000	0.000	0.000	0.0000	0.000	0
Commercial fishing	0.000	0.000	0.000	0.0000	0.000	0
Crewboat - sm	0.001	0.000	0.000	0.0000	0.000	0
Crewboat - lg	0.006	0.000	0.001	0.0001	0.000	0
Freight ship	0.000	0.000	0.000	0.0000	0.000	0
Industrial vessel	0.001	0.000	0.000	0.0000	0.000	0
Mini supply	0.001	0.000	0.000	0.0000	0.000	0
Offshore supply - sm	0.001	0.000	0.000	0.0000	0.000	0
Offshore supply - me	0.009	0.000	0.002	0.0002	0.000	1
Offshore supply - lg	0.007	0.000	0.001	0.0001	0.000	0
Passenger - sm	0.000	0.000	0.000	0.0000	0.000	0
Passenger - lg	0.013	0.000	0.002	0.0003	0.001	1
Research vessel	0.000	0.000	0.000	0.0000	0.000	0
Towing vessel - sm	0.003	0.000	0.001	0.0001	0.000	0
Towing vessel - lg	0.001	0.000	0.000	0.0000	0.000	0
Utility	0.004	0.000	0.001	0.0001	0.000	0
Not categorized	0.000	0.000	0.000	0.0000	0.000	0
All vessels	0.047	0.001	0.008	0.001	0.002	3

Composite, three days

Vessel Type	NO_x	VOC	CO	SO_2	PM_{10}	CO_2
Anchor handling	0.006	0.000	0.001	0.0001	0.000	0
Commercial fishing	0.000	0.000	0.000	0.0000	0.000	0
Crewboat - sm	0.001	0.000	0.000	0.0000	0.000	0
Crewboat - lg	0.012	0.000	0.002	0.0003	0.000	1
Freight ship	0.000	0.000	0.000	0.0000	0.000	0
Industrial vessel	0.002	0.000	0.000	0.0000	0.000	0
Mini supply	0.004	0.000	0.001	0.0001	0.000	0
Offshore supply - sm	0.003	0.000	0.000	0.0001	0.000	0
Offshore supply - me	0.016	0.000	0.003	0.0003	0.001	1
Offshore supply - lg	0.016	0.000	0.002	0.0003	0.001	1
Passenger - sm	0.001	0.000	0.000	0.0000	0.000	0
Passenger - lg	0.007	0.000	0.001	0.0002	0.000	0
Research vessel	0.000	0.000	0.000	0.0000	0.000	0
Towing vessel - sm	0.004	0.000	0.001	0.0001	0.000	0
Towing vessel - lg	0.000	0.000	0.000	0.0000	0.000	0
Utility	0.004	0.000	0.001	0.0001	0.000	0
Not categorized	0.000	0.000	0.000	0.0000	0.000	0
All vessels	0.079	0.002	0.013	0.002	0.003	5