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United States Environmental Protection Agency
Motor Vehicle Emission Laboratory
Certification Division
2565 Plymouth Road
Ann Arbor, Michigan 48105

COMMERCIAL MARINE VESSEL CONTRIBUTIONS TO EMISSION INVENTORIES

FINAL REPORT

Submitted by:

BOOZ•ALLEN & HAMILTON Inc
Transportation Consulting Division
523 West Sixth Street, Suite 616
Los Angeles, California 90014

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TABLE OF CONTENTS

1.0 INTRODUCTION

2.0 METHODOLOGY AND ASSUMPTIONS
- 2.1 Overview
- 2.2 Data Collection Efforts
- 2.3 Emission Factors
- 2.4 Estimating Fuel Consumption

3.0 BALTIMORE
- 3.1 Geographic Definition
- 3.2 Ocean-Going Vessels
- 3.3 Harbor Vessels
- 3.4 Fishing Vessels
- 3.5 Inventory Results

4.0 BATON ROUGE
- 4.1 Ocean-Going Vessels and River Tugs
- 4.2 Harbor Vessels
- 4.3 Fishing Vessels
- 4.4 Inventory Results

5.0 HOUSTON – GALVESTON
- 5.1 Ocean-Going Vessels
- 5.2 Harbor Vessels
- 5.3 Fishing Vessels
- 5.4 Inventory Results

6.0 NEW YORK – NEW JERSEY
- 6.1 Geographic Definition
- 6.2 Ocean-Going Vessels
- 6.3 Harbor Vessels
- 6.4 Fishing Vessels
- 6.5 Inventory Results

7.0 PHILADELPHIA
- 7.1 Ocean-Going Vessels
- 7.2 Harbor Vessels
- 7.3 Fishing Vessels
- 7.4 Inventory Results

8.0 SEATTLE/TACOMA
- 8.1 Ocean-Going Vessels
- 8.2 Harbor Vessels
- 8.3 Fishing Vessels
- 8.4 Inventory Results

9.0 SUMMARY: Emission Inventories for the Six Port Areas Investigated

APPENDIX – Data and Calculations for Estimating Inventories
- A Baltimore
- B Baton Rouge
- C Houston – Galveston
- D New York – New Jersey
- E Philadelphia
- F Seattle – Tacoma

1.0 Introduction

1.0 INTRODUCTION

The Clean Air Act Amendments of 1990 require the U.S. Environmental Protection Agency to conduct a survey of emissions from combustion engines associated with non-road vehicles and stationary sources. The purpose of this study is ". . . to determine if such emissions cause, or significantly contribute to, air pollution which may reasonably be anticipated to endanger public health or welfare." Based on the findings of this research, the EPA will determine whether non-road combustion engines and vehicles contribute significantly to the failure of any area of the country to attain National Ambient Air Quality Standards (NAAQS) for Carbon Monoxide (CO) or Ozone (O_3). Other air pollutants may be included in the study, such as Nitrogen oxides (NOx), Sulfur dioxide (SOx), and particulate matter (PM). EPA may use the results of this study to formulate regulations to control emissions from non-road combustion engine sources.

Among the emission source categories under scrutiny by the EPA are commercial marine vessels. This group of sources includes revenue vessels operated on U.S. ports and waterways in such diverse pursuits as international and domestic trade, port and ship services, offshore and coastal industry, and passenger transport. For the purposes of this study, EPA is assessing commercial marine vessel operations at selected ports around the country which are characterized by a high level of commercial marine vessel activity.

Booz·Allen has been retained by the EPA to assist in developing emission inventories from marine vessels for up to six ports which, based on vessel arrival/departure data, are believed to exhibit high levels of marine generated emissions. Booz·Allen developed a listing of the top 20 major U.S. ports in terms of total vessel activity (as measured by annual tonnage of cargo and annual vessel calls). This list is presented on the following page in Exhibit 1. From this listing, the EPA selected six Consolidated Metropolitan Statistical Areas (CMSAs) for which detailed marine vessel emission inventories were to be developed.

The major U.S. shipping ports selected by EPA for further study are:

- Baltimore
- Baton Rouge
- Houston/Galveston
- New York/New Jersey
- Philadelphia/Wilmington/Trenton
- Seattle/Tacoma.

EPA did not select any California ports since emission from all major ports in California had already been inventoried in a study by Booz·Allen for the California Air Resources Board.

EXHIBIT 1
Ranking of Ports by Annual Trips

Rank	CMSA/MSA/NON-MSA	State	Annual Trips	Annual Tonnage
1	Seattle/Tacoma	WA	106,839	91,712,387
2	Los Angeles, Anaheim/Riverside	CA	52,039	91,773,740
3	New York/N. New Jersey/Long Island	NT/NJ	46,756	161,218,154
4	Houston/Galveston/Brazoria	TX	22,692	200,187,876
5	San Francisco/Oakland/San Jose	CA	19,409	32,075,031
6	Baltimore	MD	18,378	41,925,745
7	Beaumont/Port Arthur	TX	16,630	94,966,587
8	Portland/Vancouver	WA/OR	16,320	38,605,826
9	Providence/Pawtucket/Fall River	MA/RI	15,911	13,578,666
10	Norfolk/Virginia Beach/Newport New	VA	14,850	68,263,197
11	Philadelphia/Wilmington/Trenton	PA/NJ/DE	13,524	112,866,068
12	Miami/Ft. Lauderdale	FL	13,347	18,549,141
13	Pittsburg/Beaver Valley	PA	12,847	34,373,364
14	San Diego	CA	9,693	2,016,615
15	Mobile	AL	9,108	68,158,870
16	Boston/Lawrence/Salem	MA	7,504	25,590,049
17	Baton Rouge	LA	7,426	78,857,473
18	Chicago/Gary/Lake County	IL/IN	6,597	57,386,924
19	Corpus Christi	TX	3,917	59,872,781
20	Cleveland/Akron/Lorain	OH	3,388	55,316,288
21	Tampa/St. Petersburg/Clearwater	FL	3,246	50,252,299
22	Duluth/Superior	WI	2,681	40,002,268
23	Detroit/Ann Arbor	MI	1,790	26,003,996
24	Milwaukee/Racine	WI	1,608	3,095,645
25	Valdez	AK	1,424	107,144,515
26	Buffalo/Niagara Falls	NY	398	1,796,021

Source: U S. Army Corps of Engineers: Waterborne Commerce of the United States, 1988

Because of the unique and varied nature of marine vessel operations, a specialized methodology must be utilized to characterize their activity and resultant emissions. This study estimates the amount of air pollution generated in each port by commercial marine vessels using a three-step process, assessing in sequence vessel population, activity, and emissions. First, populations are assessed for three different categories of vessels, defined for this study as ocean-going, harbor, and fishing vessels. These three categories are subdivided by vessel type, size, mode of propulsion and horsepower. The levels and types of activity associated with the vessels in each of these classifications are then defined in terms of calculated annual fuel consumption. Finally, based on the amount and type of fuel consumed and applicable emission factors, the amounts of pollutants generated by each category of vessel can be calculated. Calculated emissions are expressed in units of tons of pollutant per year and tons per day. Where sufficiently detailed data were available, the final estimates of vessel emissions are ppresented by vessel type. vessel size, and mode of propulsion.

The emission inventory associated with commercial marine vessels may be compared with that from all sources in the CMSA in which the port is located, in order to evaluate the relative significance of marine vessels as a source of air pollutants.

2.0 Methodology

2.0 METHODOLOGY

2.1 OVERVIEW

Because of the range of vessel types, their differing patterns of activity, their geographic distribution, and the number of different organizations which monitor and report on vessel activity, we segmented the commercial marine vessel population associated with each port into three categories:

- Ocean-going commercial vessels, including container ships, tankers, bulk carriers, vehicle carriers, roll-on/roll-off (RO-RO) ships, lighter-aboard-ship (LASH) carriers, and passenger liners and cruise ships.
- Harbor and Coastal Vessels, including tugs, towboats, barge-borne construction equipment, coastal freighters, dredges, pilot boats, passenger ferries, excursion vessels, and crew boats.
- Fishing vessels, including commercial fishing boats and charter boats registered to take fish commercially.

While broad in definition, these categories correspond directly to current bodies of data on vessel characteristics and operation. The study methodology therefore does not require the reconciliation of disparate information from numerous sources, and facilitates the best use of data. No single source of information exists which monitors the population and activity of all vessel types for each port, so data on each of the three classifications has been obtained from the most authoritative available sources. We have solicited data from such sources as port authorities, Lloyds exchange, local marine exchanges, bar pilot associations, maritime trade organizations, state regulatory and licensing boards, and the U.S. Army Corps of Engineers.

2.1.1 Ocean-Going Commercial Vessels

The population of ocean-going vessels at any port is not a fixed, definite number, but is continually in flux, as vessels enter, transit and leave local waters. To estimate ocean-going vessel population and activity in each of the study ports, data were obtained which describe the arrivals and departures of individual vessels over a period of one year. The functions of marine exchanges vary from port to port, but in general they serve as clearing houses and repositories of information regarding vessel movements in the area under their observation. For each vessel, the data generally include date and time of arrival and departure, propulsion type, vessel type, and deadweight tonnage, as well as flag of registry, agent, and berth. Where data provided by marine exchanges are available, a very realistic depiction of vessel activity associated with each port may be derived.

The resulting assessment of the ocean-going vessel population is expressed in units of individual vessel port calls per year. The duration of vessel calls varies, and will be represented for each of the categories as an average number of days per call. The average duration of call for each vessel category was calculated from a sample population of vessel calls at the ports observed by local marine exchanges or other authoritative sources.

Each vessel call has been categorized according to the following attributes:

- Vessel type
  - Container carriers
  - Tankers and bulk carriers
  - General cargo carriers (break-bulk) and special vessel types (RO-RO, LASH, vehicle carriers)
  - Passenger carriers
- Propulsion type
  - Steamships
  - Motorships (diesel)
- Deadweight tonnage
  - ≤ 25,000 DWT
  - 25,000 – 49,999 DWT
  - 50,000 – 74,999 DWT
  - 75,000 – 99,999 DWT
  - 100,000 ≤ DWT

2.1.2 Harbor Vessels

The population of harbor vessels operating in each of the subject port areas has been derived from the U.S. Army Corps of Engineers report, entitled *Waterborne Transportation Lines of the United States*. This annual publication lists all vessels of U.S. registry by home port, and includes the horsepower of each vessel. Owners or operators of vessels listed in this reference may be contacted to verify the types of vessels owned, their mode of employment, operating profiles, and annual days of operation.

Harbor vessels are assumed to operate within the port to which they are assigned, and are categorized according to the following attributes:

- Vessel type
  - Tug and tow boats
  - Passenger ferries, and excursion boats
  - Dredges and construction vessels
  - Crew boats, work boats, and other types
- Horsepower range
  - ≤ 500 HP
  - 500 – 1,000 HP
  - 1,000 – 1,500HP
  - 1,500– 2,000 HP
  - ≥ 2,000 HP

2.1.3 Fishing Vessels

The most complete source of data on fishing vessel populations are typically rosters of vessels registered as commercial fishermen with the state departments of fish and game or motor vehicles. Where such data were available, and information indicated that the fishing vessel fleet was relatively captive to a region near the port (e. g. Chesapeake Bay and the Port of Baltimore), the emission inventory for fishing vessels was estimated from the population and composition of the fleet, in conjunction with estimates of annual activity. Characterization of the annual levels of activity of fishing vessels associated with each port were derived from discussions with harbor masters, vessel owner/operators, commercial fishing trade organizations, and propulsion equipment manufacturers. In some port areas, such as Houston-Galveston, the fishing vessel population is highly variable, depending on the location of the species sought. Annually updated records of the catch landed at major fishing port areas are compiled and published by the National Marine Fisheries Service[1]. In these cases, fishing vessel emissions have been estimated on the basis of the pounds of catch landed at the port under investigation.

2.2 DATA COLLECTION EFFORTS

Data collection efforts were concentrated on ocean-going and harbor vessels for each of the six ports under investigation, and for fishing vessel activity in those areas where it is substantial – Puget Sound, Baltimore and Houston-Galveston. Collection of ocean-going vessel activity data has been more tedious than anticipated. Booz·Allen mailed (and faxed) data request packages to port authorities and marine exchanges in early to mid-June. Marine exchanges at some of the various ports were somewhat slow to respond to Booz·Allen's request for data. As of the time of publication of this report, all authorities or exchanges except for Baton Rouge had submitted records of activity for 1990. However, the data for Houston were in a raw, unusable format. Accordingly, for the Ports of Baton Rouge and Houston-Galveston, numbers and types of vessel calls are based on data published in *Waterborne Commerce of the United States, Calendar Year 1988*[2].

Additionally, Booz·Allen requested that data be submitted on computer disk format and that the following information be included: vessel name, flag of registry, last port of call, next port of call, propulsion type (steam vs. diesel), date and time of arrival, date and time of departure, vessel type, engine HP, and dead weight tonnage. New York/New Jersey and Seattle/Tacoma were both able to comply with the requested computer disk format, however, neither marine exchange was able to supply HP rating for vessels arriving at the port. Baltimore was unable to supply data on computer disk. The information provided by the Baltimore marine exchange was on daily log sheets which simply recorded vessel name and owner/operator of the ship. To gather the additional information needed to estimate emission inventories, vessel specific descriptive data was obtained on a 4 month sample of vessel call data. Vessel specifications were obtained using either the ARS Register or the Lloyds maritime directory. These publications provide full specifications for nearly every registered ocean-going vessel in the world. Vessel calls for one month from each season were sampled to account for any seasonality which might influence the type of ships arriving at the port. After gathering this

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1 *Fisheries of the United States, 1990 (Current Fishery Statistics No. 9000*, U. S. Department of Commerce, National Oceanic and Atmospheric Administration, National Marine Fisheries Service. U. S. Government Printing Office, Washington D. C. May 1991

2 Department of the Army, Corps of Engineers, Water Resources Support Center

information, Booz·Allen then entered the data into a computer format for further analysis. The sample data provided information on average ship size, horsepower, vessel type, and propulsion system (steam vs. diesel) that was then applied to total annual vessel calls for the Baltimore port.

This was a rather tedious process not anticipated at the start of the assignment.

2.3 EMISSION FACTORS

Total annual emissions of criteria air pollutants from commercial marine vessels were determined by estimating the amount of fuel consumed annually by vessels of each classification, and using the best available emission factors to relate emissions to fuel consumption. The emission factors used express the mass of pollutants emitted per unit of fuel consumption as pounds per thousand gallons of fuel consumed. Annual emissions have been calculated for nitrogen oxides (NOx), hydrocarbons (HC), carbon monoxide (CO), sulfur oxides (SOx), and particulate matter (PM).

The emission factors used in this study are drawn from several different sources. The 1985 U.S. Environmental Protection Agency report (AP-42) Compilation of Air Pollutant Emission Factors contains a tabulation of emission factors for most types of power plants, with particular detail given to diesel propulsion and auxiliary engines of less than 2,500 horsepower. The emission factors used for diesel propulsion plants in excess of 2,500 horsepower are those prescribed for all large marine diesel engines in the U.S. Maritime Administration's 1986 Port Vessel Emissions Model.

The emission factors listed in both AP42 and in the 1986 Port Vessel Emissions Model are based on test data that in many cases is nearly 15 to 20 years old. While there is an extremely slow turn-over of the in-use population of ocean-going marine vessels, improvements in marine diesel engine designs over the last 15 year have no doubt caused the characteristic emission factors for the average in-service ocean going vessel to change. Of particular concern is the NOx emission factor listed for the large diesel powerplants used to propel ocean-going vessels. These engines operate at very low RPM (125 or less) and produce as high as 3,000 to 5,500 HP per cylinder. The NOx emission factor for these engines listed in AP42 is 300 lbs per 1,000 gallons of fuel. This figure can be compared with more recent data on locomotive-size engines of approximately 500 lbs of NOx per 1,000 gallons of fuel[3]. Smaller automotive truck size engines yield NOx emission factors of 250 to 350 lbs of NOx per 1,000 gallons fuel.

Unfortunately, more recent information and emission test data on large slow speed diesels is quite sparse. However, interviews with engine builders and other large engine experts suggests that the average NOx emission factor for these large engines is considerably greater than 300 lbs per 1,000 gallons.

Fuel efficiency of these large low-speed diesels has improved in recent years as a result of increased BMEP, achieved through higher combustion chamber temperatures and increased turbo-pressure boost. All of these changes have likely had the effect of significantly increasing the amount of NOx produced per unit of fuel burned. [Such changes may, however, result in lower NOx per HP-HR. Test data on locomotive engines shows that recent similar changes to locomotive engines (increased BMEPs, fuel efficiency, etc.) have yielded a reduction in NOx produced per unit of power produced, but an increase in the NOx per unit of fuel consumed.]

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3 Emission factors for locomotives are comprehensively reviewed in the *Locomotive Emission Study* performed by Booz, Allen and Hamilton for the California Air Resources Board (1991).

produced per unit of power produced, but an increase in the NOx per unit of fuel consumed.]

The EPA has recently (and unofficially) suggested NOx emission factors for large slow speed diesel engines in the 350 to 550 lbs per 1,000 gallons of fuel range. Other studies have suggested NOx emission factors as high as 800 lbs per 1,000 gallons of fuel. The consensus among industry experts appears to be that the newest engines in this category may indeed yield NOx emissions in the 700 to 800 lbs per 1,000 gallons of fuel range while older in-service engines are closer to the factors listed in AP42. For purposes of this study, the NOx emission factor used for inventory purposes is 550 lbs per 1,000 gallons of fuel consumed. This assumes that approximately 1/2 of units in service are equipped with relatively new technology diesel engines. (Sources contacted included Southwest Research Institute, AVL, Ricardo, Catepillar, and EMD. Booz·Allen is currently conducting a study for the U.S. Dept. of Energy to review and prioritize heavy duty vehicle propulsion research needs to assist in developing an R&D funding plan for the D.O.E. As part of this study, a "Blue Ribbon" panel of industry experts in the areas of combustion research has been assembled. Selected members of this panel were contacted to review the issue of NOx emissions from large slow speed diesel engines. Most experts indicated that it was very difficult to predict NOx emission factors based on thermodynamic relations only and were reluctant to offer an estimate of the NOx emission factors for marine vessel engines. The majority view seemed to be that the NOx factors were probably very similar to those for locomotive size engines.)

More detail and refinement of emission factors for large diesel propulsion plants could improve the accuracy of the model used in the study.

The emission factors used for calculating emission inventories for ocean-going cargo vessels are shown in Exhibit 2. While ocean-going vessels are berthed at harbor and the main engine(s) is shut down, hotelling loads are provided for by high-speed diesel engine-driven gensets. Although emission factors for gensets rated at less than 500 kW are listed in Exhibit 2, interviews with ship captains and other experts established that almost all gensets used on ocean-going marine vessels are rated at 500kW or more. Therefore, the emission factors for 500 kW gensets were used to represent the hotelling emissions of *all* vessels. The emission factors for ocean-going vessels are used in conjunction with fuel consumption, which is estimated according to the method described below. The emission factors used to calculate harbor vessel emissions are shown in Exhibit 3. Diesel fishing vessels are assumed to have emission factors equal to those of harbor vessels. Data from the State of Washington indicate that a substantial fraction of its fishing vessel fleet is powered by gasoline engines. When power ratings for fishing vessels were available, brake specific emission factors reported in AP-42 for industrial gasoline engines were used in conjunction with a typical duty cycle to inventory gasoline fishing vessel emissions.

2.4 ESTIMATING FUEL CONSUMPTION

The *Port Vessel Emission Model* [4] provides relationships for estimating vessel fuel consumption as a function of deadweight tonnage (DWT) and horsepower rating. These are empirical functions based on statistical regressions of the characteristics of a large number of vessels of various types. Those used in this study to estimate fuel consumption are shown in Exhibit 4.

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[4] U. S. Department of Transportation, Maritime Administration, December 1986

EXHIBIT 2

AVERAGE EMISSION FACTORS
FOR
OCEAN-GOING COMMERCIAL VESSELS

POUNDS OF POLLUTANT PER THOUSAND GALLONS OF FUEL CONSUMED

OPERATING PLANT Operating Mode/Rated Output	POLLUTANT NOx	HC	CO	SOx	PM
STEAM PROPULSION					
Full power	63.6	1 72	7 27	159x(%S)	56 5
Maneuver/Cruise	55 8	0.682	3.45	159x(%S)	20
Hotelling					
- Burning residual bunker fuel	36.4	3 2	*	159x(%S)	10
- Burning distillate oil	22.2	3	4	142x(%S)	15
MOTOR PROPULSION					
All underway operating modes	550	24	61	157x(%S)	33
AUXILIARY DIESEL GENERATORS					
- 20 KW (50% Load)	477	144	53.4	27	17
- 40 KW (50% Load)	226	285	67.6	27	17
- 200 KW (50% Load)	140	17.8	62.3	27	17
- 500 KW (50% Load)	293	81.9	48.1	27	17

Notes:
1. Emission factors showing an asterisk (*) are considered negligible for these operating modes.
2. Average sulfur concentrations used are 0.8 percent for marine diesel, and 2.0 percent for bunker fuel oil.

Sources:
1. U.S. Environmental Protection Agency, Compilation of Air Pollutant Emission Factors, 1985
2. U.S. Department of Transportation, Port Vessel Emissions Model, 1986
3. California Air Resources Board, Report to the California Legislature on Air Pollutant Emissions from Marine Vessels

EXHIBIT 3

AVERAGE EMISSION FACTORS
FOR
HARBOR AND FISHING VESSELS

OPERATING PLANT Operating Mode/Rated Output	POLLUTANT NOx	HC	CO	SOx	PM
	POUNDS PER THOUSAND GALLONS OF FUEL CONSUMED				
DIESEL ENGINES					
< 500 Horsepower					
Full	275.1	21	58 5	157x(%S)	17
Cruise	389.3	51.1	47 3	157x(%S)	17
Slow	337.5	56.7	59	157x(%S)	17
500 - 1000 Horsepower					
Full	300	24	61	157x(%S)	17
Cruise	300	17.1	80.9	157x(%S)	17
Slow	167.2	16 8	62.2	157x(%S)	17
1000 - 1500 Horsepower					
Full	300	24	61	157x(%S)	17
Cruise	300	24	61	157x(%S)	17
Slow	300	24	61	157x(%S)	17
1500 - 2000 Horsepower					
Full	472	16.8	237.7	157x(%S)	17
Cruise	623.1	24	44.6	157x(%S)	17
Slow	371 3	24	122.4	157x(%S)	17
2000+ Horsepower					
Full	399 6	21.3	95.9	157x(%S)	17
Cruise	391.7	16.8	78.3	157x(%S)	17
Slow	419.6	22.6	59.8	157x(%S)	17
	NOx	HC	CO	SOx	PM
GASOLINE ENGINES	GRAMS PER BRAKE HORSEPOWER HOUR				
Exhaust Emissions - All HP Ratings	5.16	6.68	199	0.268	0 327
Evaporative Emissions		62.0	grams/hr		
Crankcase Blowby		38.3	grams/hr		

Notes: 1. Average sulfur concentration for marine diesel fuel = 0.8 percent

Sources:
1. U.S. Environmental Protection Agency, Compilation of Air Pollutant Emission Factors, 1985
2. U.S. Department of Transportation, Port Vessel Emissions Model, 1986
3. California Air Resources Board, Report to the California Legislature on Air Pollutant Emissions from Marine Vessels

EXHIBIT 4

Fuel Consumption as a Function of Vessel Deadweight and Horsepower

Vessels Powered by Steam Turbines

DWT Range	Fuel Consumption at Full Power [Metric Tons/day]
0 – 25k	(.0017)(DWT) + (.00125)(HP) + 7.9
25-50k	(-.0007)(DWT)+(.00503)(HP) + 23.6
50-75k	(-.0008)(DWT)+(.00512)(HP) + 49.6
75-100k	(-.0002)(DWT)+(.00409)(HP) + 35.2

Motor Ships: Tankers, OBO's and Bulk Carriers

DWT Range	Fuel Consumption at Full Power [Metric Tons/day]
0 – 15k	(-.000159)(DWT) + (.00315)(HP) + 1.45
15 – 25k	(.00054)(DWT)+(.00205)(HP) – 0.61
25 – 50k	(.00093)(DWT)+(.00007)(HP) + 9.10
50 – 75k	(.00018)(DWT)+(.00305)(HP) – 6.27
75 – 100k	(.00044)(DWT)+(.000105)(HP) + 30.3
Over 100k	(.00016)(DWT)+(.00311)(HP) – 16.2

Motor Ships: General Cargo, Container Carriers & Ro-Ro

DWT Range	Fuel Consumption at Full Power [Metric Tons/day]
0 – 15k	(-.00006)(DWT) + (.00334)(HP) – 0.217
15 – 25k	(.00146)(DWT)+(.00235)(HP) – 10.6
25 – 50k	(-.00044)(DWT)+(.0036)(HP) + 6.44

Average horsepower for each interval of deadweight tonnage was found from a search of Lloyd's Shipping Service's database of all registered marine vessels in the world. Averages used are shown in Exhibit 5

EXHIBIT 5

Average Ocean-Going Marine Vessel Horsepower Ratings

DWT Range		Tanker & Dry Bulk, Steam			Tanker & Dry Bulk, Diesel		
Min	Max	Population	Total HP	Av HP	Population	Total HP	Av. HP
0	24,999	39	415,850	10,663	4334	23,557,000	5,435
25,000	49,999	89	1,404,645	15,783	3144	35,762,000	11,375
50,000	74,999	71	2,149,076	30,269	1076	15,837,000	14,718
75,000	99,999	32	829,950	25,936	483	8,615,107	17,837
100,000	149,999	28	819,000	29,250	602	13,317,000	22,121
150,000	199,999	15	408,000	27,200	148	3,431,910	23,189
200,000	10,000,000	313	11,226,000	35,866	170	4,595,440	27,032
100+		356	12,453,000	34,980	920	21,344,350	23,200

DWT Range		General Cargo & Ro-Ro, Diesel			Container Diesel		
Min	Max	Population	Total HP	Av. HP	Population	Total HP	Av. HP
0	24,999	12,390	78,487,000	6,335	850	9,239,782	10,870
25,000	49,999	163	2,397,603	14,709	415	11,676,000	28,135
50,000	74,999	15	251,473	16,765	71	2,744,830	38,660
75,000	99,999	0			0		
100,000	149,999	1	21,600	21,600	0		
150,000	199,999	0			0		
200,000	10,000,000	0			0		

3.0 Baltimore

3.0 BALTIMORE

The Baltimore MSA is located at the north end of the complicated Chesapeake Bay waterway. The port area ranks among the top fifteen in the nation for tonnage.

3.1 GEOGRAPHIC DEFINITION OF VESSEL ACTIVITY

A map of the Chesapeake Bay area is shown in Exhibit 6. Two points of entry to Baltimore exist. The majority of ships sail up the Chesapeake Bay, while about ten percent of ships and many barges use the Chesapeake and Delaware (C&D) Canal to arrive from the Delaware River and the Philadelphia area.

For other ports, emissions from marine vessels have been inventoried beginning at the point at which harbor bar pilots take over control of ocean-going ships. However, for the Baltimore area Chesapeake Bay route, pilots may board ships up to 200 miles away, at a point near Cape Henry, Virginia. The total transit time for pilots may exceed ten and one half hours. It was determined that this distance is disproportionately greater than the distances used for other CMSA's, and that for methodological consistency a smaller distance should be used to assess vessel emissions in the Baltimore area. A point fifty miles from the port center was chosen which provides symmetry to the other point of entry at Chesapeake City. This is also reasonably consistent with treatment of other ports such as Puget Sound (15 – 75 miles away) and New York (25-35 miles).

3.2 OCEAN-GOING VESSELS

Transit Profiles by Port

Ships arriving at the Baltimore can proceed to several waterfront destinations, but they are all reasonably close to each other. Commodities handled include containers at the Maryland Port Administration's SEAGIRT and other terminals, and coal is exported at the Consolidated Coal terminals. Auto processing also takes place. For the purposes of assessing vessel activity, these destinations are assumed to represent a single proximate destination with three transit profiles. These profiles are due to the differences in handling bulk ships as opposed to general cargo ships, and the fact that two approaches are possible. The average transit profiles given for the time between bar pilot boarding and vessel mooring are presented below:

Route & Ship Type	Transit Time	Full	Half	Slow
Cheasapeake Entry – Bulk	5 hours	3 hrs	1hr	1hr
Cheasapeake Entry – General	4 hours	3 hrs	0 hrs	1hr
C&D Canal Entry – All Ships	6 hours	0 hrs	5 hrs	1hr

Exhibit 7 presents a summary of the ocean-going vessel emission inventory for Baltimore. Detailed data on ocean-going vessel populations their emission inventories are given in the appendix.

EXHIBIT 6
Baltimore MSA

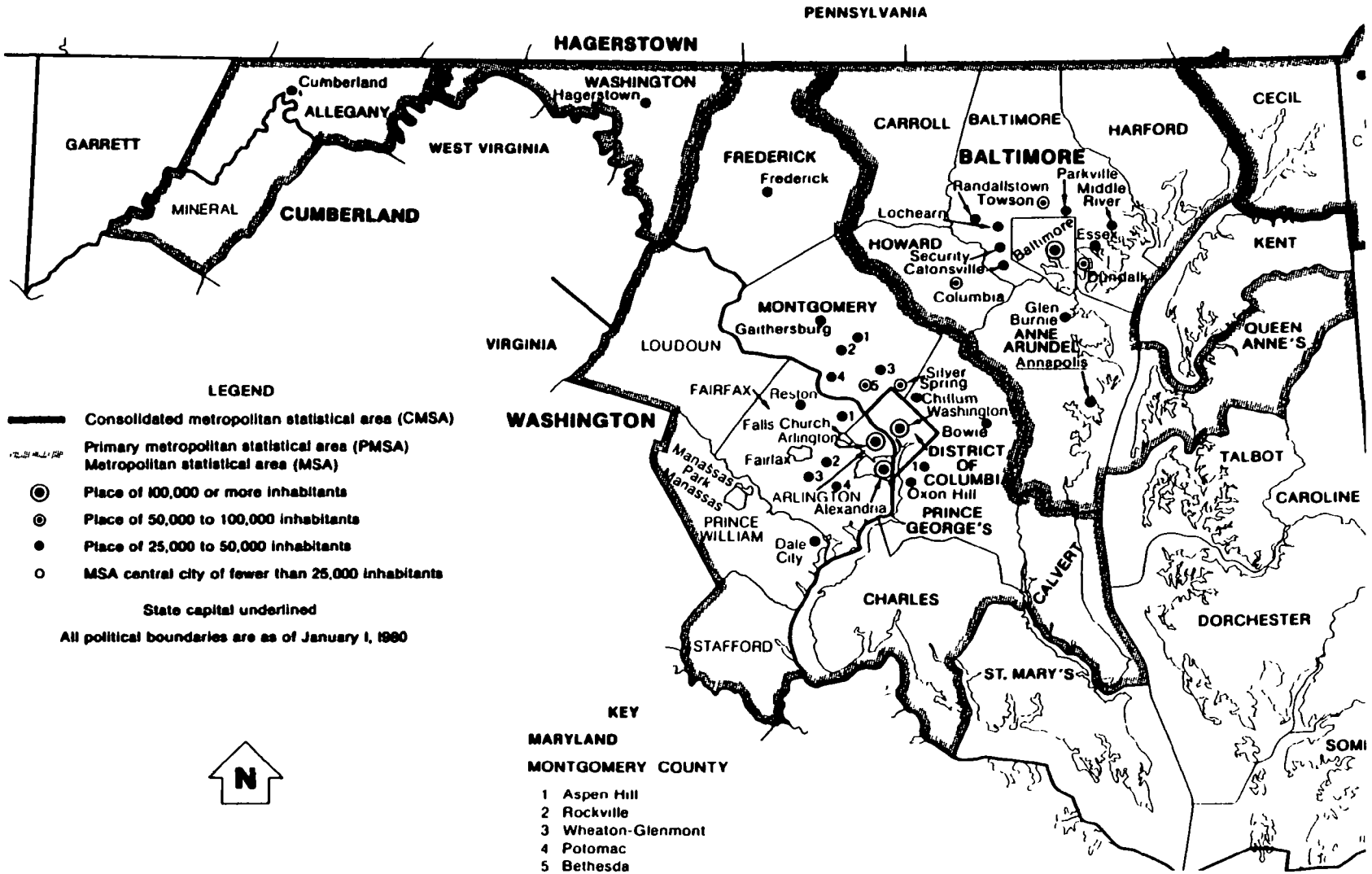

EXHIBIT 7

Ocean-Going Vessel Emissions in the Baltimore Area

Profile		Annual Fuel Consumption (gallons)	Underway Emissions (Tons/year) NOx	HC	CO	SOx	PM	Hotelling Emissions (Tons/year) NOx	HC	CO	SOx	PM
Route A	Motor Ship	4,835,186	831 05	36.26	92.17	246.72	49 86	265 63	74 25	43 61	148 03	15 41
All except	Steam Ship	298,818	5 91	0 16	0 66	29.70	5 14	1 64	0 17	0 11	12 09	0 70
Bulk Cargo	Total	5,134,004	836 96	36 42	92.84	276 41	55 00	267 27	74 42	43 72	160 12	16 11
Route A	Motor Ship	2,537,640	381 84	16 66	42.35	113.36	22 91	168 35	47 06	27 64	93 81	9 77
Bulk Cargo	Steam Ship	1,203,218	20 49	0 51	2.18	104 68	16 53	7 98	0 84	0 54	58 79	3 41
	Total	3,740,859	402.34	17 17	44 53	218 04	39 44	176 33	47 90	28 18	152 60	13 17
Route B	Motor Ship	797,046	116 74	5 09	12.95	34 66	7 00	54 58	15 26	8 96	30 41	3 17
All Vessels												
Total Port of Baltimore		9,671,909	1356.04	58 68	150.31	529.11	101.44	498.18	137.58	80 86	343 14	32 45

Total Emissions, Underway + Hotelling (tons/yr) NOx	HC	CO	SOx	PM
1,854 2	196.3	231 2	872.2	133.9

Notes: Route A refers to the approach from the SE, up the Chesapeake Bay
Route B refers to the approach from the NE, through the C & D Canal

3.3 HARBOR VESSELS

The Chesapeake Bay is one of the largest and most utilized estuarine systems in the country. Because of its popularity as a recreational resource and as a fishery and shellfish ground, it experiences a high degree of use by small motorized vessels of many types. Much of this small boat population is not within the scope of this study, however.

Also, due to the proximity of several states to the bay, and the resulting diversity of harbor craft registrations, there is no single authoritative source of data on Baltimore area vessel populations. Telephone interviews with various Maryland governmental agencies corroborated this. As stated before, *Waterborne Transportation Lines of the US* lists vessels by owner/operator, which in turn are listed by address of registration. This study has limited its examination of the database to Maryland registered operators, of which about twenty three were listed. Of these, only nineteen operated boats in the size range of harbor vessels.

Because of these reasons, the harbor vessel population of Baltimore may be underestimated. A summary of the harbor vessel population, activity rates, and emissions appears as Exhibit 8. Since it is reasonable to assume that the population of tugs and other work boats supporting ocean-going vessel activity at a port is roughly proportional to the number of ocean-going vessel calls, as a check, the ratios of calls to harbor vessel population for the other ports investigated were compared to that of Baltimore:

Port Area	Harbor Vessel Population		Fraction Being Tugs	Ocean-Going Vessel Calls	Calls/Tug
	Tugs	Total			
Baltimore	58.9145	83	0.70981	2127	36.10
Houston-Galveston	260	336	0.77381	9793	37.67
New York - New Jersey	700	990	0.70707	4667	6.67
Philadelphia	277.537	391	0.70981	2768	9.97
Seattle-Tacoma	219	335	0.65373	4560	20.82
Average excluding Baltimore	393	553.667	0.70981	5447	13.86

Comparison of Baltimore with the other ports shows that its harbor vessel population, relative to ocean-going vessel calls, is smaller than that of most of the other ports, but is not quite as small as that of Houston-Galveston. (Note that Baton Rouge's harbor vessel population was calculated indirectly, and therefore is excluded. Harbor vessels were not identified by type for Philadelphia and Baltimore, so for these ports, tugboat populations were estimated using the average fraction of the harbor vessel fleet being tugboats at the other ports.) Since there is no reason to believe that substantial undercounting of harbor vessels has occured at Houston, this comparison indicates that the population reported for Baltimore is not anomalously small.

EXHIBIT 8
Harbor Vessel Emissions in the Baltimore Area

PORT OF BALTIMORE **HARBOR VESSELS** **ANNUAL EMISSIONS**

TYPE OF VESSEL	VESSEL HORSEPOWER RANGE	NUMBER OF VESSELS	OPERATING PROFILE 20% POWER	50% POWER	80% POWER	DAILY OPERATING HOURS	OPERATING DAYS PER YEAR	FUEL CONSUMPTION (GALS/HOUR)	TOTAL FUEL CONSUMED (GALLONS)	TOTAL VESSEL EMISSIONS (POUNDS OF POLLUTANT PER YEAR) NOx	HC	CO	SOx	PM
ALL VESSELS ARE	0 - 500	17	0.30	0.50	0.20	10	200	10.40	353,498	124,050	16,530	18,753	44,399	6,009
ASSUMED TO BE	500 - 1000	23	0.30	0.50	0.20	12	250	19.86	1,370,078	397,542	25,196	97,700	172,082	23,291
WORK BOATS,	1000 - 1500	3	0.30	0.50	0.20	12	250	31.68	285,122	85,537	6,843	17,392	35,811	4,847
TUGS AND TOW BOATS	1500 - 2000	31	0.30	0.50	0.20	12	250	43.50	4,043,891	2,093,101	91,275	431,130	508,164	68,780
	2000 +	9												
									TOTAL EMISSIONS [lbs/yr]	2,700,229	139,844	564,976	760,456	102,928
									TOTAL EMISSIONS [tons/yr]	1,350	70	282	380	51

The uncertainty in the harbor vessel population in the Baltimore area could be resolved by purchasing a database of merchant vessels of the United States[5], and conducting a computer search by vessel homeport. Time and cost constraints prevented this approach for the present study.

3.4 FISHING VESSELS

Although there is no fishing vessel activity at the Port of Baltimore proper, the surrounding Chesapeake Bay Area is a major fishery. Considerable fishing vessel activity takes place at small ports and landings throughout the Bay Area. Target species are clams, oysters, fin fish, eels and crabs[6]. Vessels ported in the Baltimore area tend to operate within a radius of 50 miles of home port, since they rarely stay at sea overnight, and their maximum speed is low (15-18 kts).

Data on numbers of commercial fishing vessels registered by the State of Maryland and listed by County were obtained from the from the State Department of Natural Resources. Classified vessels (> 5 net tons) are registered by the Coast Guard and are not registered by the State. The state provided the total number of classified vessels in each county, but unlike state-registered boats, did not give a breakdown by vessel type. In 1987, the National Marine Fisheries Service compiled a list of all commercial fishing vessels operating in each state. We have used its total for Maryland as a basis for estimating the number of commercial fishing vessels in each county by assuming that the fraction of classified vessels being fishing vessels in each county is equal to that for the entire State. Numbers of fishing vessels in counties located in the Baltimore CMSA, or which are likely to contribute fishing vessel emissions to it were totaled. Fishing fleet composition and vessel operating profiles are assumed to be similar to those operating in the Puget Sound. An average emission inventory per vessel year was then calculated for Puget Sound vessels, and multiplied by the fishing vessel count in the Baltimore area to arrive at the latter's emission inventory. The results of this procedure are detailed in Exhibits 9 and 10.

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[5] *Merchant Vessels of the United States*, NTIS Catalog No. PB91-506907. Available on data tape covering all vessels in the U. S., or as selected subsets on DOS formatted diskettes.

[6] Mr. Larry Simms, president, Maryland Waterman's Association, personal communication

EXHIBIT 9

Fishing Vessel Population in the Vicinity of the Port of Baltimore

County	Boats Registered by the State of Maryland by County of Owner's Residence (1)			Documented Vessels (1)	Commercial Fishing Vessels (2)	Total Commercial Fishing
	Commercial Fishing	Pleasure Craft	Other			
Anne Arundel	394	29,351	428	3,473	658	1,052
Baltimore	327	26,367	403	628	119	446
Carroll	46	3,611	47	2		46
Harford	72	7,037	83	63	11	83
Howard	45	3,931	31	4		45
Kent	93	1,815	71	566	107	200
Queen Annes	146	4,286	78	319	60	206
Baltimore CMSA	1,123	76,398	1,141	5,055	955	2,078
Total Maryland	2,821	152,303	2,716	6,683	1,268	2,078

Notes:
(1) From licensing data provided by the State of Maryland, Department of Natural Resources. Current as of December 31. 1990.
(2) Total Fishing vessel population for the State of Maryland is from a 1987 study by the National Marine Fisheries Service. Commercial fishing vessel population by county is assumed to be proportional to that reported for all documented vessels in each county

EXHIBIT 10
Fishing Vessel Emissions in the Baltimore CMSA

Fishing Vessel Emission Factors (1)

	NOx	HC	CO	SOx	PM
Average Emissions [Tons/Fishing Vessel Yr]	1 584	0 720	14 390	0 454	0 082

Baltimore CMSA Fishing Vessel Emission Inventory

County	No. Fishing Vessels	NOx	HC	CO	SOx	PM
		Tons/Year				
Anne Arundel	1,052	1,666	757	15,138	478	86
Baltimore	446	706	321	6,418	203	37
Carroll	46	73	33	662	21	4
Harford	83	131	60	1,194	38	7
Howard	45	71	32	648	20	4
Kent	200	317	144	2,878	91	16
Queen Annes	206	326	148	2,964	94	17
Baltimore CMSA	2,078	3,291	1,495	29,903	943 6	170 8

Note: (1) Emission factors are based on averages found for fishing vessels in the Puget Sound Area

3.5 INVENTORY RESULTS

The total marine vessel emission inventory for the Baltimore Area is shown below:

BALTIMORE EMISSION INVENTORIES (Tons/Year)					
Vessel Type	NOx	HC	CO	SOx	PM
Ocean-Going					
Underway	1356.04	58.68	150.31	529.11	101.44
Hotelling	498.18	137.58	80.86	343.14	32.45
Total Ocean-Going	1,854.2	196.3	231.2	872.2	133.9
Harbor Vessels	1,350	70	282	380	51
Fishing Vessels	3,291	1,495	29,903	944	171
Total [tons/yr]	**6,496**	**1,761**	**30,416**	**2,196**	**356**
Total [tons/day]	**17.8**	**4.82**	**83.3**	**6.02**	**0.98**

4.0 BATON ROUGE

Located about 80 miles upstream of New Orleans on the Mississippi River, Baton Rouge is a major river port (See map in Exhibit 11) The river's 45 foot depth at Baton Rouge limit vessel size to about 70,000 DWT, permitting considerable container ship and general cargo movement, and approaches by moderate-size tankers. Tugboat traffic hauling barges up and down river is very heavy.

4.1 OCEAN -GOING VESSELS AND RIVER TUGS

Because Baton Rouge is more of a river port than a sea port, freight hauled by relatively small (<5000 DWT) tugboats makes up a large fraction of all cargo movements into and out of the Port. Unlike the case with the other ports examined, smaller tugboats cannot be assumed to be captive to the port area. Therefore, for Baton Rouge, calls by small tugboats are grouped along with those by larger ocean-going vessels, and given similar operating profiles. Operating profiles used are shown below:

Vessel Type	Transit Time	Full	Half	Slow
Tugboats	2 hours	2 hrs	0 hrs	0 hrs
All other Cargo and Passenger Vessels	3 hours	0 hrs	3 hrs	0 hrs

The New Orleans Board of Trade was contacted to provide data on calling vessels for 1990. No information has yet been received, so data for 1988 published in *Waterborne Commerce of the United States* has been used as the basis for the inventory. This document does not indicate whether vessels are steamships or motorships. Data from the other large ports indicate the the great majority of vessel calls are by motorships; therefore we have assumed that all ocean-going and river vessel commerce at Baton Rouge is by motorship. A summary of ocean-going vessel activity and emissions appears as Exhibit 12.

4.2 HARBOR VESSELS

The port of Baton Rouge is somewhat unique among the ports examined in that it is strictly a river port. As such, the ships used to deliver cargo to and from Baton Rouge are generally much smaller those at an ocean port. Also, much of the cargo is delivered on non-self propelled barges using tow/tugs to push the barges. In fact, there were over 5000 vessel calls made by "tows/tugs" at Baton Rouge, but only about 1000 by ocean going vessels. To calculate the emission inventory for Baton Rouge, we must take into account both the dedicated vessel calls made to the port (by both ocean going ships and by tow/tugs pushing barges) as well as emissions from the tow/tugs routinely used to help maneuver ocean going ships to port. To determine the number of tow/tug boats in operation for the purpose of assisting ocean-going vessels, a methodology different from that used for the other ports was employed. For other ports, the total number of harbor vessels was determined by simply adding together the number of active harbor vessels listed in *Waterborne Transportation lines of the United States* as being homeported in or around the port of interest. Applying this methodology to Baton Rouge, however, would result in double counting the emissions from many of the tug boats that were counted in the circa 5000 tug boat calls associated with barge movements. To resolve this issue, we established a relationship between the number of harbor vessels needed at a port and

EXHIBIT 11

Baton Rouge Area

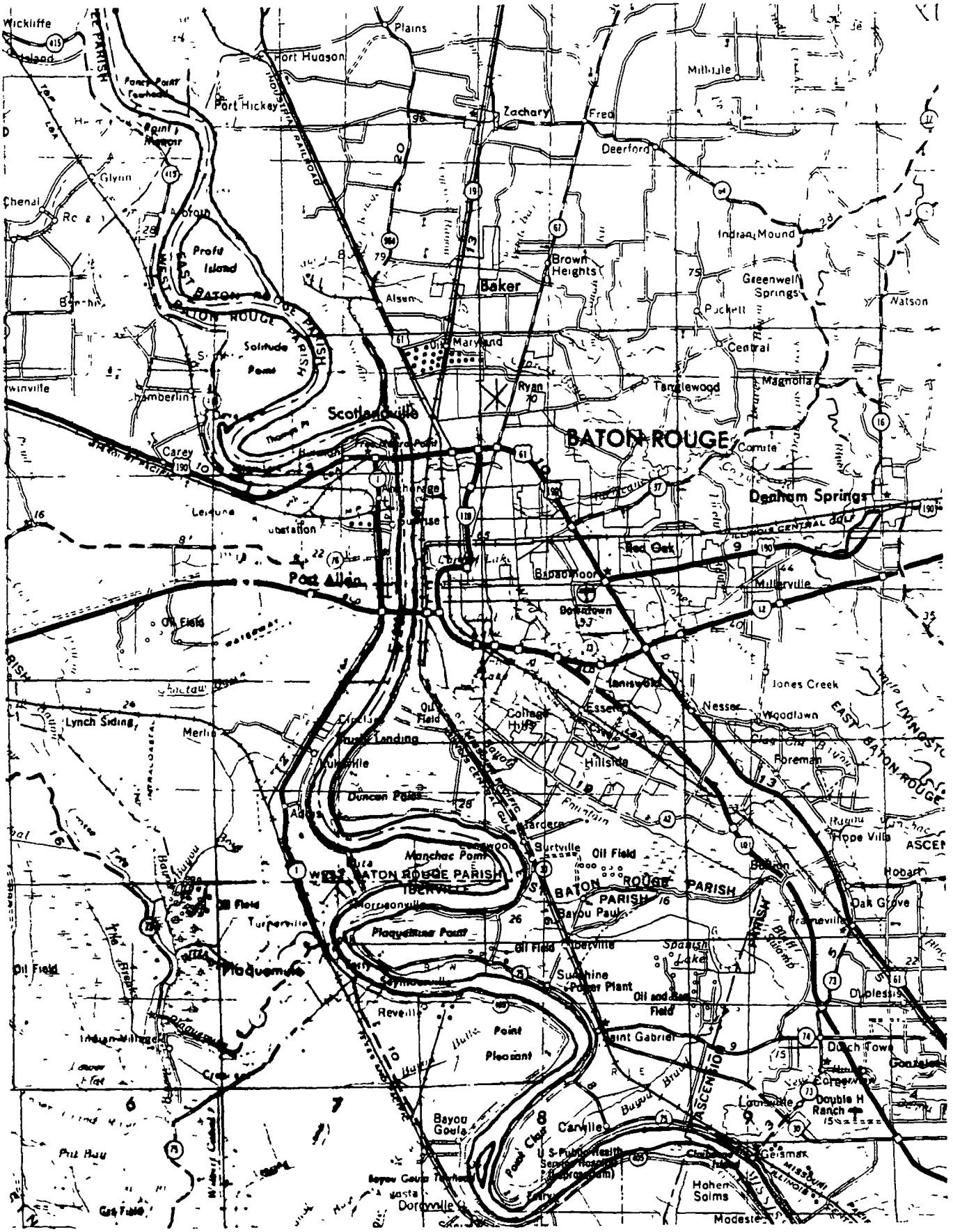


EXHIBIT 12

Ocean-Going and River Vessel Emissions in the Baton Rouge Area

Port of Baton Rouge

TYPE OF VESSEL	PROPULSION TYPE	VESSEL TONNAGE (1,000 DWT)	UNDERWAY (POUNDS OF POLLUTANT PER YEAR) NOx	HC	CO	SOx	PM	HOTELLING (POUNDS OF POLLUTANT PER YEAR) NOx	HC	CO	SOx	PM
CONTAINER SHIPS GENERAL CARGO VEHICLE CARRIERS RO-RO / LASH	ASSUMED MOTOR	0 - 25 25 - 50 50 - 75 75 - 100 100+	217,992 189,370 181,663	9,512 8,263 7,927	24,177 21,003 20,148	64,716 56,219 53,931	13,080 11,362 10,900	145,163 126,103 120,971	40,576 35,249 33,814	23,830 20,702 19,859	80,895 70,273 67,414	8,422 7,317 7,019
TANKERS	ASSUMED MOTOR	0 - 25 25 - 50 50 - 75 75 - 100 100+	100,469 104,272 50,920	4,384 4,550 2,222	11,143 11,565 5,648	29,826 30,955 15,117	6,028 6,256 3,055	107,045 111,097 54,253	29,921 31,054 15,165	17,573 18,238 8,906	59,653 61,911 30,234	6,211 6,446 3,148
		0 - 25 25 - 50	53,725	2,344	5,959	15,949	3,223	10,733	3,000	1,762	5,981	623
TOTAL MOTORSHIP EMISSIONS (Tons/year)			449.2	19.6	49.8	133.4	27.0	337.7	94.4	55.4	188.2	19.6
TOTAL EMISSIONS, UNDERWAY + HOTELLING			786.9	114.0	105.3	321.5	46.5					

the number of ocean-going vessel calls. This relationship could then be applied to the total number of ocean-going vessels that visited Baton Rouge. We chose Philadelphia to establish this relationship, since it is most like Baton Rouge with regard to the size of ships visiting the Port and because, of the other ports examined, Philadelphia is most like a river port. There, the ratio of ocean-going vessel calls to harbor vessel population is about 7:1 (See table on p. III-4). Applying this ratio to Baton Rouge, where the average number of inbound and outbound ocean-going (larger than 5, 000 DWT) vessel calls recorded was 1135, results in a total population of harbor vessels of about 162. Because Baton Rouge is a river port, the average size and HP of the harbor vessels is comparatively low. We have estimated an average of 750 HP for harbor vessels in Baton Rouge. Exhibit 13 shows the emission inventory resulting from these assumptions.

4.3 FISHING VESSELS

Management at the Port of Baton Rouge stated that no commercial fishing vessel activity exists in the Port area[7]

4.4 INVENTORY RESULTS

The total marine vessel emission inventory for the Baton Rouge Area is shown below:

BATON ROUGE EMISSION INVENTORIES (Tons/Year)					
Vessel Type	**NOx**	**HC**	**CO**	**SOx**	**PM**
Ocean-Going					
Underway	449.2	19.6	49.8	133.4	27.0
Hoteling	337.7	94.4	55.4	188.2	19.6
Total Ocean-Going	786.9	114.0	105.2	321.6	46.6
Harbor Vessels	1,400.0	88.7	344.1	606.0	82.0
Fishing Vessels	0	0	0	0	0
Total [tons/yr]	**2,186.9**	**202.7**	**449.3**	**927.6**	**128.6**
Total [tons/day]	**5.99**	**0.56**	**1.23**	**2.54**	**0.35**

7 Mr. Gus A. Duncan, Director of Planning and Development, Port of Baton Rouge

EXHIBIT 13

Harbor Vessel Emissions in the Baton Rouge Area

AVERAGE VESSEL HORSEPOWER	NUMBER OF VESSELS	OPERATING PROFILE			DAILY OPERATING HOURS	OPERATING DAYS PER YEAR
		20% POWER	50% POWER	80% POWER		
750	162	0 30	0 50	0 20	12	250

FUEL CONSUMPTION (GALS/HOUR)	TOTAL ANNUAL FUEL CONSUMPTION (GALLONS)	TOTAL VESSEL EMISSIONS (POUNDS OF POLLUTANT PER YEAR)				
		NOx	HC	CO	SOx	PM
19 86	9,650,113	2,800,077	177,466	688,150	1,212,054	164,052

TOTAL VESSEL EMISSIONS (TONS OF POLLUTANT PER YEAR)				
NOx	HC	CO	SOx	PM
1400 0	88.7	344.1	606.0	82.0

5.0 Houston – Galveston

5.0 HOUSTON - GALVESTON

Although not top ranked in number of ocean-going vessel arrivals, Houston-Galveston is the United State's busiest port in terms of annual tonnage. The port is an important center of activity for tanker traffic supporting the region's extensive petroleum and petrochemical industry.

5.1 OCEAN-GOING VESSELS

Vessels enter Galveston Bay through a gap between the bars protecting the entrance to the Bay (see Exhibit 14 for map) Three major shipping routes in the Bay are identified in "Waterborne Commerce of the United States": 1) Ships can quickly land at Galveston Harbor by proceeding through Galveston channel; 2) land at Texas City at the end of the Texas City Channel, or 3) follow the long traverse along the Houston Ship Channel to Bay Town, at the northern end of Galveston Harbor. Beyond Bay Town, smaller vessels can continue West along the ship channel to approach central Houston (See Map). Operating profiles for these routes were determined through conversations with the Houston and Galveston Harbor Pilots.

Route	Transit Time	Full	Half	Slow
Galveston Channel	1.2 hours	1.0 hr	0 hrs	0.2 hrs
Galveston Harbor	1.5 hours	1.3 hrs	0 hrs	0.2 hrs
Texas City Channel	2.0 hours	1.0 hr	0 hrs	1.0 hrs
Houston Ship Channel	6.0 hours	2.0 hrs	3.5 hrs	0.5 hrs

Our request to the Houston marine exchange for records of vessel calls during 1990 was answered with a ream of raw data sheets, with one page for each vessel call. This was unusable, given the time constraints of this study. Therefore, vessel calls recorded for 1988 in *Waterborne Commerce of the United States* were used to estimate ocean-going vessel emissions for the Houston-Galveston area. This reference does not indicate whether vessels are steamships or motorships. Data from the other large ports indicate the the great majority of vessels calling are motorships; therefore we have assumed that all ocean-going vessel commerce at Houston is by motorship. A summary of ocean-going vessel activity and emissions appears as Exhibit 15.

5.2 HARBOR VESSELS

A summary of the harbor vessel population and its emissions appears as Exhibit 16. As with several of the other port areas reviewed in this investigation, the harbor vessel population in various horsepower and service categories was found from homeport locations published in *Waterborne Transportation Lines of the United States*.. The population found is for companies with Texas addresses, owning vessels home ported in the Houston – Galveston area. Louisiana-based companies may have some vessels based in Houston-Galveston, the emissions of which are assumed to be insignificant. To the extent that this assumption is incorrect, harbor vessel emissions may be underestimated.

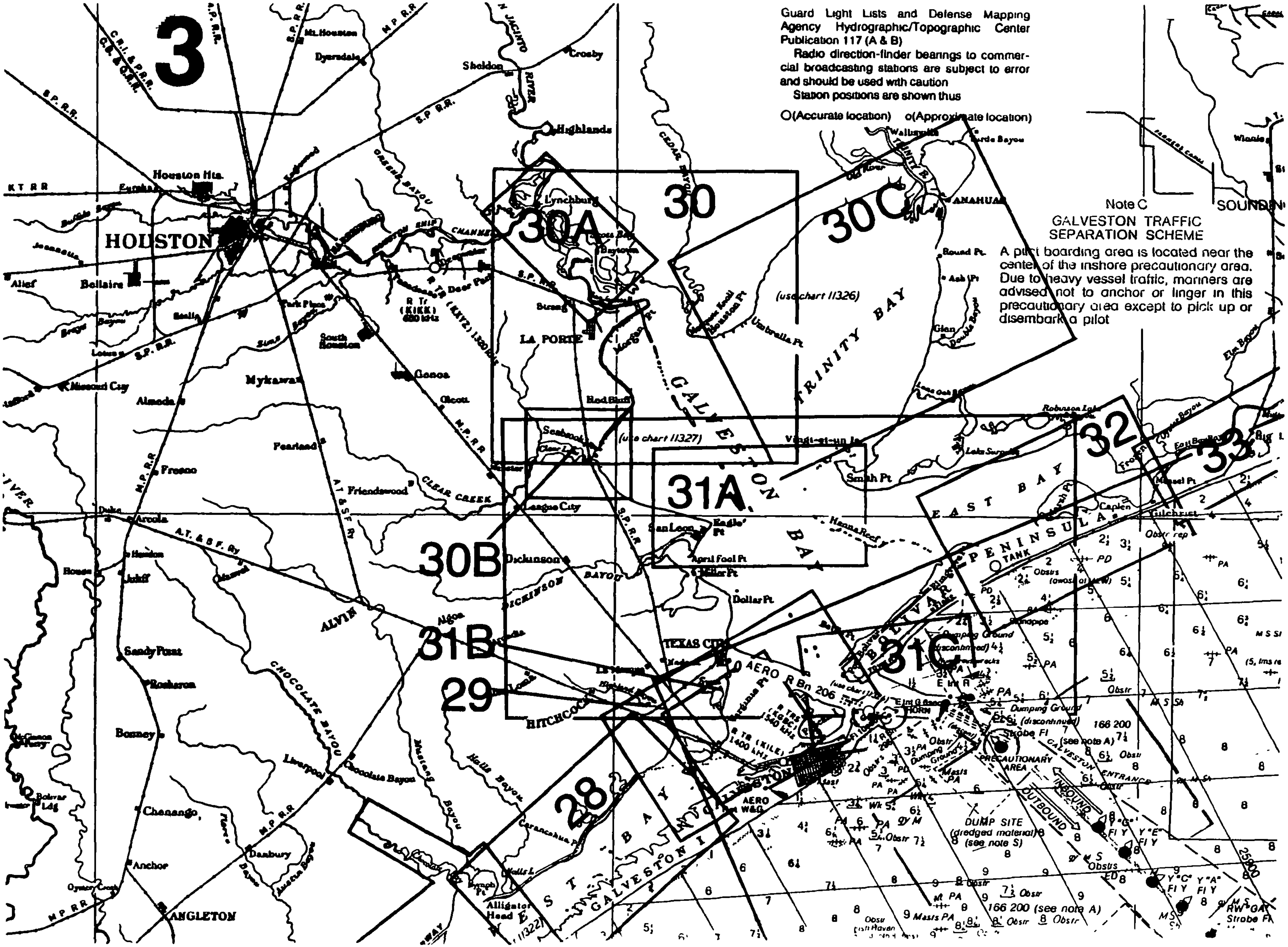

3
Guard Light Lists and Defense Mapping Agency Hydrographic/Topographic Center Publication 117 (A & B)
Radio direction-finder bearings to commercial broadcasting stations are subject to error and should be used with caution
Station positions are shown thus
O(Accurate location) o(Approximate location)
Note C
GALVESTON TRAFFIC SEPARATION SCHEME
A pilot boarding area is located near the center of the inshore precautionary area. Due to heavy vessel traffic, mariners are advised not to anchor or linger in this precautionary area except to pick up or disembark a pilot
30
30A
30B
30C
31A
31B
31C
32
33
29
28
HOUSTON
Houston Hts.
Bellaire
South Houston
Pasadena
Genoa
LA PORTE
Lynchburg
Baytown
Highlands
Crosby
Sheldon
Mykawa
Pearland
Friendswood
Almeda
Missouri City
Fresno
Arcola
Juliff
Sandy Point
Rosharon
Bonney
Chenango
Anchor
Danbury
ANGLETON
ALVIN
Dickinson
League City
Seabrook
TEXAS CITY
La Marque
HITCHCOCK
Chocolate Bayou
Liverpool
Alligator Head
TRINITY BAY
GALVESTON BAY
EAST BAY
WEST BAY
BOLIVAR PENINSULA
GALVESTON I
(use chart 11326)
(use chart 11327)
PRECAUTIONARY AREA
INBOUND
OUTBOUND
DUMP SITE (dredged material) (see note S)
166 200 (see note A)
GALVESTON ENTRANCE
SOUNDINGS

EXHIBIT 15

Sumary of Ocean-Going Marine Vessel Emissions for the Port of Houston - Galveston

Profile	Annual Fuel Consumption [gallons]	Underway Emissions [Tons/year]					Hotelling Emissions [Tons/year]				
		NOx	HC	CO	SOx	PM	NOx	HC	CO	SOx	PM
Houston Ship Channel	15,590,357	2,705.78	118.07	300.10	803.27	162.35	842 55	235.51	138.32	469 53	48 88
Galveston Channel	1,543,338	143.64	6 27	15.93	42.64	8 62	149 58	41 81	24 56	83 36	8 68
Galveston Harbor	13,771,385	1410.59	61.55	156.45	418.76	84 64	1266.05	353 89	207.84	705 53	73 46
Texas City Channel	2,569,765	223.52	9 75	24.79	66.36	13 41	257.39	71.95	42.25	143 44	14 93
Total Port of Houston-Galveston	33,474,844	4,483.53	195.64	497 26	1,331.04	269.01	2,515.57	703 16	412 97	1,401 85	145 95

Total Emissions, Underway + Hotelling [tons/year]				
NOx	HC	CO	SOx	PM
6,999	899	910	2,733	415

EXHIBIT 16

Harbor and Coastal Vessel Emissions in the *Houston – Galveston Area*

REGION: Galveston Bay — **HARBOR AND COASTAL VESSELS** — **ANNUAL EMISSIONS**

TYPE OF VESSEL	VESSEL HORSEPOWER RANGE	NUMBER OF VESSELS	OPERATING PROFILE 20% POWER	50% POWER	80% POWER	AVERAGE DAILY OPERATING HOURS	OPERATING DAYS PER YEAR	FUEL CONSUMPTION (GALS/HOUR)	TOTAL ANNUAL FUEL CONSUMPTION (GALLONS)	TOTAL VESSEL EMISSIONS (POUNDS OF POLLUTANT PER YEAR) NOx	HC	CO	SOx	PM
TUGS, TOW BOATS AND PUSH BOATS	0 - 500	56	0.30	0.50	0.20	10	200	10 40	1,164,464	408 634	54,450	61,775	146,257	19 796
	501 - 1000	116	0.30	0.50	0.20	12	250	19.86	6,909,958	2,004,993	127,074	492,749	867,891	117,469
	1001 - 1500	34	0.30	0.50	0.20	12	250	31 68	3,231,380	969,414	77,553	197,114	405 861	54 933
	1501 - 2000	21	0.30	0.50	0.20	12	250	43.50	2,740,765	1,417,907	61,832	292,056	344 240	46,593
	2001 - 4000	26	0.30	0.50	0.20	12	250	73 06	5,699,008	3,134,454	136,776	347,639	1,789,488	188,067
	>4000	7	0.30	0.50	0.20	12	250	167.66	3,520,780	1,936,429	84,499	214,768	1,105,525	116,186
PASSENGER, FERRIES AND EXCURSION	0 - 500	7	0.20	0.60	0.20	8	220	10 18	125 450	44,673	5,796	6 508	15,756	2,133
	501 - 1000	6	0.20	0.60	0.20	10	220	20.57	271,521	81,456	6,517	16,563	34,103	8 960
	1001 - 1500	1	0.20	0.60	0.20	10	220	33.55	73,818	22,146	1,772	4,503	9,272	2,436
	1501 - 2000	8	0.20	0.60	0.20	10	250	46.54	930,736	279,227	22,338	56,776	116,903	30,715
	2001 - 4000	1	0.20	0.60	0.20	10	250	79.00	197,495	108,622	4,740	12,047	62,013	6,517
	>4000		0.20	0.60	0.20	10	250	182.87						
CARGO FREIGHTERS	0 - 500	6	0.30	0.50	0.20	14	220	10 40	192,137	67,425	8,984	10,193	24 132	3,266
	501 - 1000	8	0.30	0.50	0.20	14	220	19.86	489,257	144,777	11,742	29 845	61 451	16,145
	1001 - 1500	6	0.30	0.50	0.20	14	220	31.68	585,450	175,635	14,031	35,712	73 533	19 320
	1501 - 2000	9	0.30	0.50	0.20	14	220	43.50	1,205,936	361,781	28,942	73,562	151 466	39,796
	2001 - 4000	18	0.30	0.50	0.20	14	220	73.06	4,030,679	2,227,874	97 216	247,091	1,271 913	133 672
	>4000	4	0.30	0.50	0.20	14	220	167.66	2,063,524	1,136,038	49,573	125,997	648,575	68,162
WORK BOATS CREW BOATS OTHER	0 - 500		0.30	0.50	0.20	6								
	501 - 1000	1	0.30	0.50	0.20	6	220	19.86	26,210	7,605	482	1,869	3,292	446
	1001 - 1500		0.30	0.50	0.20	6								
	1501 - 2000	1	0.30	0.50	0.20	6	220	43.50	57,426	17,228	1,378	3,503	7,213	1,895
	2001 - 4000		0.30	0.50	0.20		220	73.06						
	>4000		0.30	0.50	0.20									
									Total Tons of Pollutant per Year	7,274	390	1,115	3,569	438

6.0 New York/New Jersey

6.0 NEW YORK/NEW JERSEY

The New York CMSA represents the largest east coast shipping center. The area ranks third in the country in terms of total annual vessel calls and second in terms of annual tons of cargo. The area also is populated by a large maritime support services industry, including harbor work boats and tugs and significant ferry and tourist excursion activity.

6.1 GEOGRAPHIC DEFINITION OF VESSEL ACTIVITY

A map of the New York and New Jersey (NY&NJ) area is shown in Exhibit 18. Emissions from marine vessels have been inventoried beginning at the point at which harbor bar pilots take over control of ocean-going ships. For the New York area, two points of entry are possible. The majority of ships enter the port areas from the Atlantic Ocean, and the pilots board near a point known as Ambrose Tower. This boarding point is approximately 17 miles outside the Verazzano Bridge, off of Sandy Hook. The second point of entry as marked by the pilot boarding point is at City Island, north of New York City. Ships coming through Long Island Sound use this route.

6.2 OCEAN-GOING VESSELS

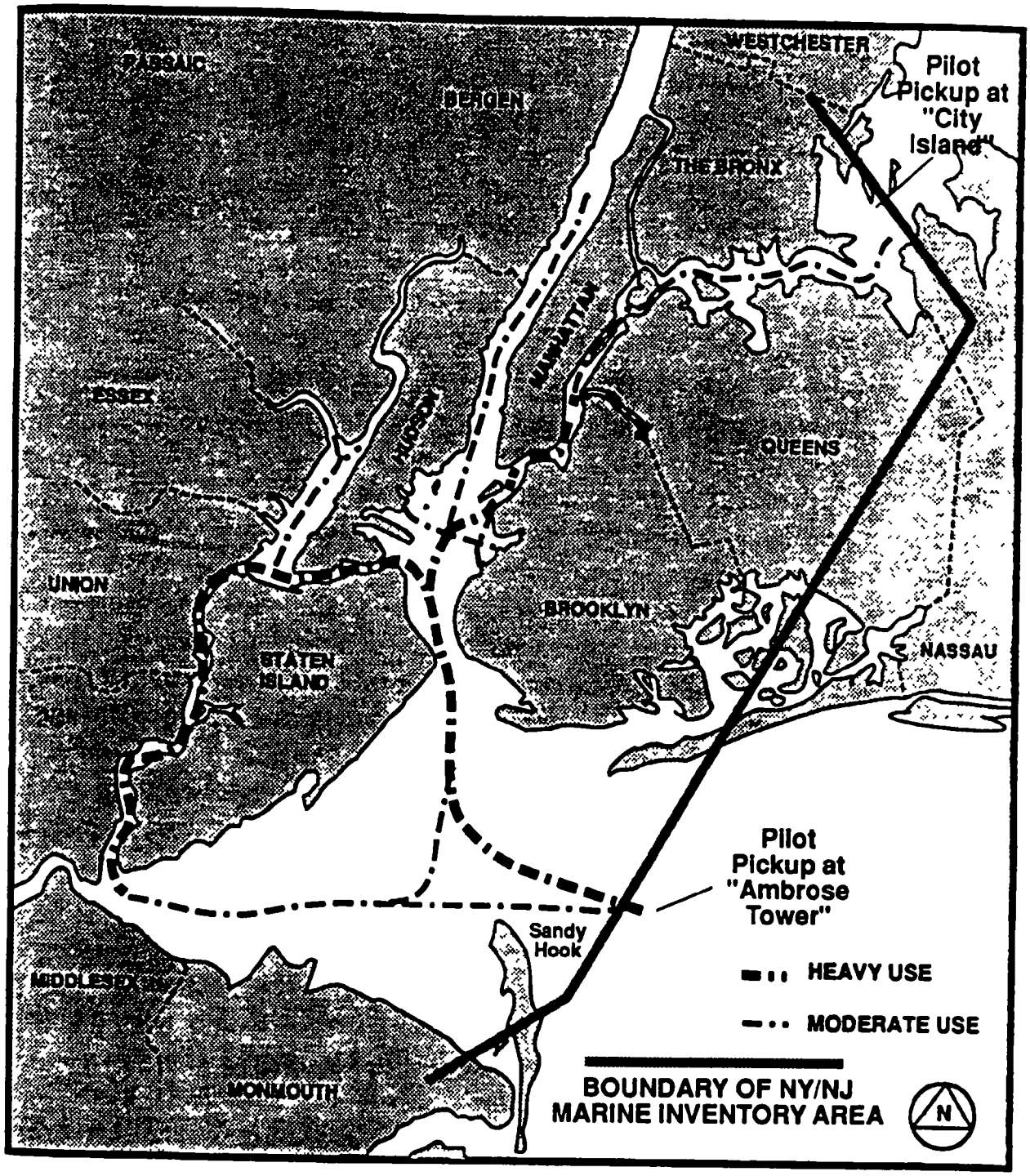
Transit Profiles by Port

Ships arriving at the New York area can proceed to several waterfront destinations, including, but not limited to Port Elizabeth, Port Newark and Red Hook. An auto port and a cruise terminal also exist, as well as many excursion boat docks. For the purposes of assessing vessel activity, these destinations are assumed to represent four transit profiles. These profiles are due to the differences in handling bulk ships as opposed to general cargo ships, and the fact that ship routes can either use the same entry and exit, or sail through the port area. Bulk ships typically have deep drafts and must proceed more cautiously than other ships, and use terminals in the Arthur Kill, which represents a longer path. The average transit profiles given for the time between bar pilot boarding and vessel mooring are presented below:

Route and Ship Type	Transit Time	Full	Half	Slow
Enter by Ambrose Tower and Exit by Ambrose Tower:				
Bulk	4.5 hours	1 hr	2 hrs	1.5 hrs
General	3.5 hours	1 hr	2 hrs	0.5 hrs
Enter by City Island and Exit by City Island – All Ships	2.5 hours	0 hrs	2 hrs	0.5 hrs
Enter and Exit by different points – All Ships	3 hours	0.5 hrs	2 hrs	0.5 hrs

A summary of ocean-going vessel emissions is shown in Exhibit 19. Detailed population assessments for ocean going vessels and their emission inventories are given in the appendix.

EXHIBIT 18



MAP SOURCE: NYC DEPT OF CITY PLANNING
NJ DEPT OF ENVIRONMENTAL PROTECTION

EXHIBIT 19

Sumary of Ocean-Going Marine Vessel Emissions for the Port of New York

Profile		Annual Fuel Consumption [gallons]	Underway Emissions [Tons/year] NOx	HC	CO	SOx	PM	Hotelling Emissions [Tons/year] NOx	HC	CO	SOx	PM
Route A,	Motor Ship	10,183,245	1515.79	66.14	168.11	450.00	90 95	684 34	191.29	112 34	381 36	39 71
All except	Steam Ship	1,353,114	22 41	0 45	1 99	119 60	14.18	8 80	0 93	0 60	64 84	3 76
Bulk Cargo	Total	11,536,359	1538.20	66.59	170.11	569.60	105.13	693 15	192.22	112.95	446.20	43.46
Route A	Motor Ship	9,516,202	752.54	32.84	83.46	223.41	45.15	993 22	277.63	163.05	553 49	57.63
Bulk Cargo	Steam Ship	1,910,626	21.76	0 42	1 90	116 54	13 44	17 25	1 83	1.18	127 07	7 36
	Total	11,426,828	774.30	33.26	85.37	339.95	58.60	1010 48	279.45	164 23	680.56	64.99
Route B	Motor Ship	16,430	2.37	0.10	0 26	0.70	0.14	1 14	0 32	0 19	0 64	0 07
All Vessels	Steam Ship	0	0	0	0	0	0	0	0	0	0	0
	Total	16,430	2.37	0.10	0.26	0.70	0.14	1 14	0.32	0 19	0 64	0 07
Route C	Motor Ship	580,054	60.59	2.64	6 72	17.99	3.64	52.70	14 73	8 65	29 37	3 06
All Vessels	Steam Ship	0	0	0	0	0	0	0	0	0	0	0
	Total	580,054	60 59	2.64	6.72	17.99	3.64	52.70	14.73	8.65	29 37	3 06
Total Port of New York		23,559,671	2,375	103	262	928	168	1,757	487	286	1,157	112

Total Emissions, Underway + Hotelling [tons/year] NOx	HC	CO	SOx	PM
4,133	589	548	2,085	279

6.3 HARBOR VESSELS

New York and New Jersey waterways, including the Hudson River, the East River, the Upper Bay and Newark Bay as well as Arthur Kill and Kill van Kull, support extensive harbor vessel activity. Over one thousand vessels of various types reside in the area. The vessel population assessment for NY&NJ followed the general methodology, relying on Waterborne Transportation Lines of the US, however this information was supplemented with data provided by the NY Department of City Planning and the NJ Dept of Environmental Protection. These agencies sponsored an extensive study of the uses of the NY&NJ waterway estuary including maritime support services assessment. Their February 1991 report updated and corroborated information gathered from Waterborne Transportation Lines. In many cases data sources did not give full descriptions of vessel characteristics including horsepower (HP) ratings. The NY&NJ population HP distribution was estimated using aggregate numbers gathered from the sources cited and applying a distribution proportional to the harbor vessel populations of California ports from the Booz, Allen-CARB study.

Population assessments for harbor vessels vessels and their emission inventory appear in Exhibit 20.

6.4 FISHING VESSEL EMISSIONS

In *Fisheries of the United States*, the National Marine Fisheries Service annually ranks the top 60 American fishing ports by weight and value of catch. New York-New Jersey does not appear on the list. Through telephone conversations, New York Port Authority officials confirmed that very little fishing vessel activity takes place in the Port area. The Port Authority attempted to develop a commercial fishing port at Erie Basin, but business was so poor (1 – 2 vessel call per month), that the development was abandoned. Activity is limited to charter boats which operate out of Sheep Head Bay and City Island. Therefore, fishing vessel emissions in the Port of New York-New Jersey are considered negligible.

6.5 INVENTORY RESULTS

The total Marine Vessel Emission Inventory for the New York/New Jersey Area is shown below:

NEW YORK/NEW JERSEY EMISSION INVENTORY (Tons/Year)					
Vessel Type	**NOx**	**HC**	**CO**	**SOx**	**PM**
Ocean-Going					
Underway	2,375	103	262	928	168
Hoteling	1,757	487	286	1,157	112
Total Ocean-Going	**4,132**	**590**	**548**	**2,085**	**280**
Harbor Vessels	10,660	687	2,199	3,547	480
Fishing Vessels	0	0	0	0	0
Total (TONS/YR)	**14,792**	**1277**	**2,747**	**5,632**	**760**
Total (TONS/DAY)	**40.5**	**3.50**	**7.53**	**15.4**	**2.08**

A detailed breakdown of ocean going emissions by vessel type, port, propulsion type and vessel size is presented in the Appendix.

EXHIBIT 20

Harbor Vessel Emission Inventory for the Port of New York – New Jersey

PORT OF NEW YORK **HARBOR VESSELS** **ANNUAL EMISSIONS**

TYPE OF VESSEL	VESSEL HORSEPOWER RANGE	NUMBER OF VESSELS	OPERATING PROFILE 20% POWER	50% POWER	80% POWER	DAILY OPERATING HOURS	OPERATING DAYS PER YEAR	FUEL CONSUMPTION (GALS/HOUR)	TOTAL FUEL CONSUMED (GALLONS)	TOTAL VESSEL EMISSIONS (POUNDS OF POLLUTANT PER YEAR) NOx	HC	CO	SOx	PM
WORK BOATS, TUGS AND TOW BOATS	0 - 500	75	0.30	0.50	0.20	10	200	10.40	1,559,550	547,273	72,925	82,734	195,879	26,512
	500 - 1000	150	0.30	0.50	0.20	12	250	19.86	8,935,290	2,592,664	164,320	637,176	1,122,272	151,900
	1000 - 1500	250	0.30	0.50	0.20	12	250	31.68	23,760,150	7,128,045	520,244	1,449,369	2,984,275	403,923
	1500 - 2000	150	0.30	0.50	0.20	12	250	43.50	19,576,890	10,127,908	441,635	2,086,113	2,458,857	332,807
	2000 +	75												
PASSENGER FERRIES EXCURSION VESSELS	0 - 500	30	0.20	0.60	0.20	8	220	10.18	537,641	191,454	24,839	27,893	67,528	9,140
	500 - 1000	20												
	1000 - 1500	10												
	1500 +	5												
DREDGES AND CONSTRUCTION	0 - 500	75	0.40	0.40	0.20	14	190	10.61	2,116,974	731,923	100,175	114,782	265,892	35,989
	500 - 1000	150												
	1000 - 1500													
	1500 +													
								TOTAL EMISSIONS [lbs/yr]		21,319,271	1,374,157	4,398,067	7,094,704	960,270
								TOTAL EMISSIONS [tons/yr]		10,660	687	2,199	3,547	480

7.0 Port of Philadelphia

7.0 PORT OF PHILADELPHIA

The port area of Philadelphia, Wilmington and Trenton ranks eleventh in the nation in annual vessel calls, and third in tonnage. Access by ocean-going vessels is gained by proceeding up the Delaware Bay to the Delaware River. Tankers call primarily at Marcus Hook, located about 15 miles downstream from the Port of Philadelphia proper. Piers at the Port of Philadelphia are strung out over several miles of waterfront on the West shore of the Delaware River (see Exhibit 21 for map).

7.1 OCEAN-GOING VESSELS

Two operating profiles are assumed for ocean-going vessels. A shorter approach is assumed for tankers than for other types of vessels, based on Marcus Hook's closer proximity to Delaware Bay:

Vessel Type	Transit Time	Full	Half	Slow
Tankers	2 hours	0 hrs	2 hrs	0 hrs
All other Cargo and Passenger Vessels	4 hours	0 hrs	4 hrs	0 hrs

A summary of the emission inventory for ocean-going vessels appears in Exhibit 22. Detailed information on vessel calls and emissions by vessel type and size may be found in the Appendix.

7.2 HARBOR VESSELS

A summary of the harbor vessel population and its emissions appears as Exhibit 23. As with several of the other port areas reviewed in this investigation, the harbor vessel population was found from homeport locations published in *Waterborne Transportation Lines of the United States*.. The population found is for Philadelphia-based vessels owned by firms or individuals with addresses in Pennsylvania. There may be some minor undercounting of vessels as a result of discounting vessels owned by persons with addresses outside Pennsylvania. The harbor vessel fleet mix at Philadelphia was assumed to consist largely of tugboats. In this respect it is then similar to that operating at Galveston. Therefore, the average annual emissions per vessel year calculated for Houston – Galveston was applied to the Philadelphia population, in order to determine its emission inventory.

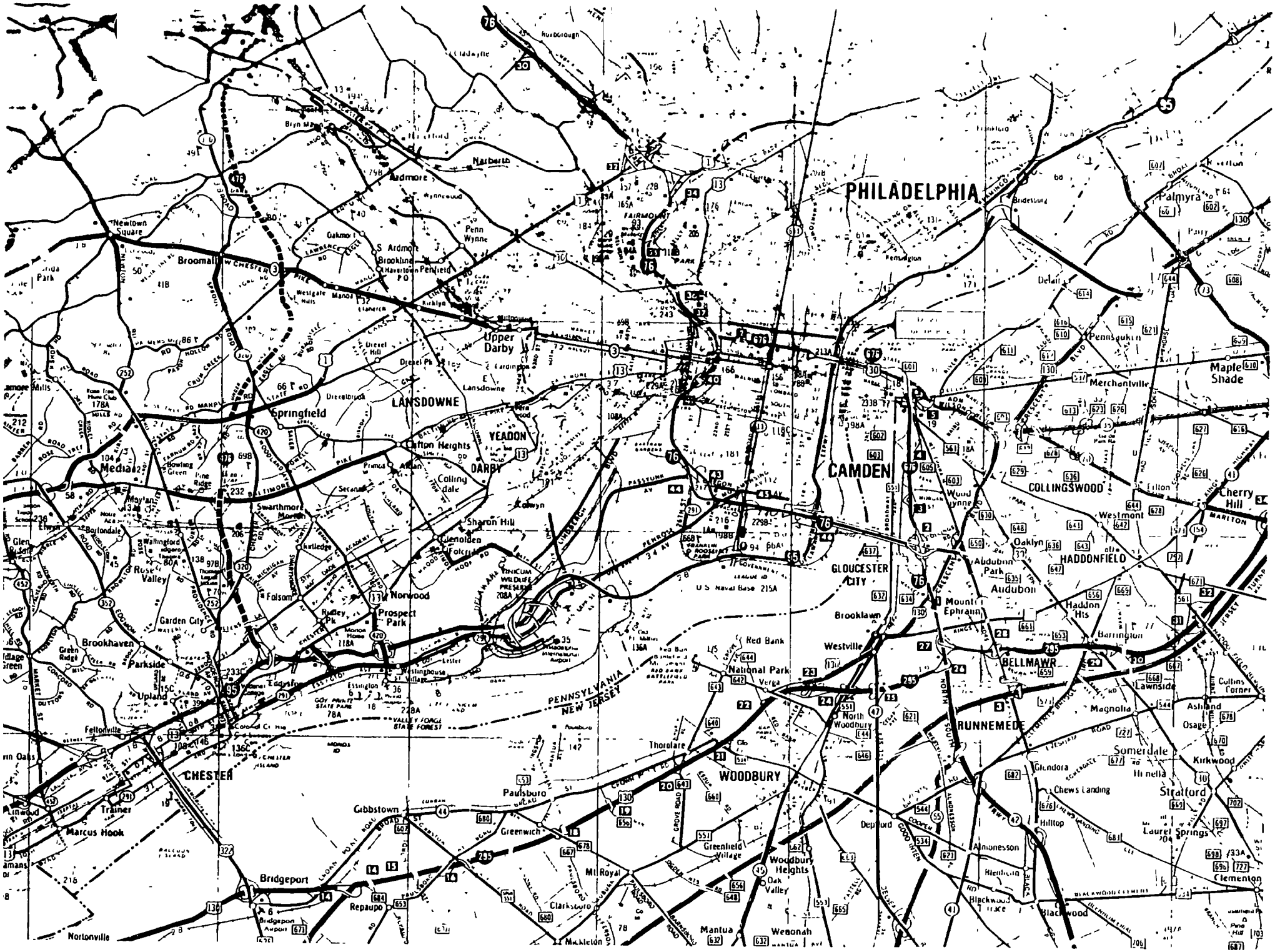

PHILADELPHIA
CAMDEN
GLOUCESTER CITY
COLLINGSWOOD
HADDONFIELD
BELLMAWR
RUNNEMEDE
WOODBURY
CHESTER
LANSDOWNE
YEADON
DARBY
Upper Darby
Springfield
Media
Broomall
Newtown Square
Ardmore
Haverford
Bryn Mawr
Penn Wynne
Drexel Hill
Collingdale
Sharon Hill
Norwood
Prospect Park
Ridley Pk
Folcroft
Glenolden
Swarthmore
Morton
Rose Valley
Brookhaven
Parkside
Upland
Garden City
Folsom
Chadds Ford
Concord Ch
Trainer
Marcus Hook
Linwood
Bridgeport
Norton ville
Gibbstown
Paulsboro
Greenwich
Mt Royal
Clarksboro
Repaupo
Thorofare
Greenfield Village
Woodbury Heights
Oak Valley
Mantua
Wenonah
Deptford
Westville
Brooklawn
Mount Ephraim
Audubon
Audubon Park
Oaklyn
Westmont
Haddon Hts
Barrington
Lawnside
Magnolia
Somerdale
Hi-nella
Chews Landing
Hilltop
Almonesson
Blackwood
Clementon
Stratford
Laurel Springs
Kirkwood
Ashland
Osage
Cherry Hill
Merchantville
Pennsauken
Maple Shade
Palmyra
Delair
Red Bank
National Park
Westville
North Woodbury
Pennsylvania
New Jersey
Valley Forge State Forest
Tinicum Wildlife Preserve
U S Naval Base 215A
Bridgeport Airport
Philadelphia International Airport
Fairmount Park
Penrose Park
Franklin D Roosevelt Park
Cobbs Creek Park
Ridley Creek State Park
Haverford College
Swarthmore College
Villanova University
Rose Tree Park
Westgate Manor
Penfield
Kirklyn
Drexelbrook
Clifton Heights
Secane
Aldan
Primos
Llanerch
Havertown
Brookline
S Ardmore
Oakmont
Narberth
Merion
Wynnewood
Ardmore
Haverford
Bryn Mawr
Penrose Ferry Bridge
Walt Whitman Bridge
Commodore Barry Bridge
Betsy Ross Bridge
Ben Franklin Bridge
Delaware River
Schuylkill River
Darby Creek
Crum Creek
Ridley Creek
Chester Creek
Cobbs Creek
Naaman's Creek
Big Timber Creek
Newton Creek
Woodbury Creek
Mantua Creek
Raccoon Creek
Oldmans Creek
Salem River
Cooper River
Pennsauken Creek
Rancocas Creek
Delaware Bay
Delaware River
Schuylkill River
Darby Creek
Crum Creek
Ridley Creek
Chester Creek
Cobbs Creek
Naaman's Creek
Big Timber Creek
Newton Creek
Woodbury Creek
Mantua Creek
Raccoon Creek
Oldmans Creek
Salem River
Cooper River
Pennsauken Creek
Rancocas Creek
Delaware Bay

EXHIBIT 22

Sumary of Ocean-Going Marine Vessel Emissions for the Port of Philadelphia

Profile	Annual Fuel Consumption [gallons]	Underway Emissions [Tons/year] NOx	HC	CO	SOx	PM	Hotelling Emissions [Tons/year] NOx	HC	CO	SOx	PM
Tankers Landing at Marcus Hook	4,422,332	304 04	13 27	33 72	90 26	18 24	485 90	135 82	79 77	270 78	28 19
All Other Vessels	5,666,802	716 44	31 26	79 23	212 69	42 99	448 52	125 37	73 63	249 95	26 02
Total Port of Philadephia	10,089,134	1,020 47	44 53	112 95	302 95	61 23	934 42	261 19	153 40	520 73	54 22

Total Emissions, Underway + Hotelling [tons/year] NOx	HC	CO	SOx	PM
1,955	306	266	824	115

EXHIBIT 23
Harbor Vessel Emissions in the Philadelphia Area

Owner	No of Vessels
Allegheny Towing, Inc.	30
Bartley, Eugene H.	1
Bartley, Eugene Jr.	1
Beaver Concrete & Gravel, Inc.	1
Campbell Transportation Co.	317
Centofanti Marine Service	1
HBC Barge, Inc.	1
Huber Launch Service	6
Johnson Towing Co	2
Lynnhaven Services, Inc.	4
Moran Towing Co.	6
River Associates	4
Sheridan Companies	8
Sulzer, Arthur H Associated	5
Turecamo Coastal & Harbor Towing Corp.	4
Total Number of Vessels	**391**

Emission Factors [Ton/Vessel Year] (1)	NOx	HC	CO	SOx	PM
	21.65	1 18	3 32	10.62	1.30
Emission Inventory [Tons/year]	**8,464.9**	**463.0**	**1,297.7**	**4,153.7**	**510.0**

Note: (1) Emission Factors are based on average emission rates, fleet composition and use for harbor vessels in Galveston Bay

7.3 FISHING VESSELS

Port officials stated that there was no commercial fishing vessel activity in the Philadelphia area.[10]

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10 Ms. Elizabeth Murphy, Director of Planning and Development, Port of Philadelphia; Ms. Mary Logan, Port Agent, Port of Salem, personal communications.

7.4 INVENTORY RESULTS

The total emission inventory for marine vessels operating in the Philadelphia area is summarized below:

PHILADELPHIA EMISSION INVENTORY (Tons/Year)					
Vessel Type	**NOx**	**HC**	**CO**	**SOx**	**PM**
Ocean-Going					
Underway	1,021	45	113	303	61
Hoteling	934	261	153	521	54
Total Ocean-Going	1,955	306	266	824	115
Harbor Vessels	8,465	463	1,298	4,154	510
Fishing Vessels	0	0	0	0	0
Total [tons/yr]	**10,420**	**769**	**1,564**	**4,978**	**625**
Total [tons/day]	**28.5**	**2.11**	**4.28**	**13.6**	**1.71**

8.0 Seattle – Tacoma

8.0 SEATTLE - TACOMA

The Seattle/Tacoma CMSA represents a major west coast shipping center. The area ranks first in the country in terms of annual vessel calls and 7th in terms of annual tons of cargo. The extensive waterways of the Puget Sound area are host to a variety of commodity movements, including crude oil at northern refinery terminals, as well as a high volume of containerized cargo through the ports of Seattle and Tacoma. Other commodities include steel, wood products and dry bulk. In addition, one of the most active ferry systems in the world moves twenty million passengers and three million autos across the sound annually, and hundreds of working harbor and recreational vessels ply the waters. The area is also well known as possessing some of the nation's most productive fisheries. A map of the Seattle/Tacoma area is shown in Exhibit 24. Emissions from marine vessels have been inventoried beginning at the point at which harbor bar pilots take over control of ocean-going ships. For the Seattle/Tacoma area, this point occurs near Port Angeles . This position is approximately 75 water-route miles from Seattle.

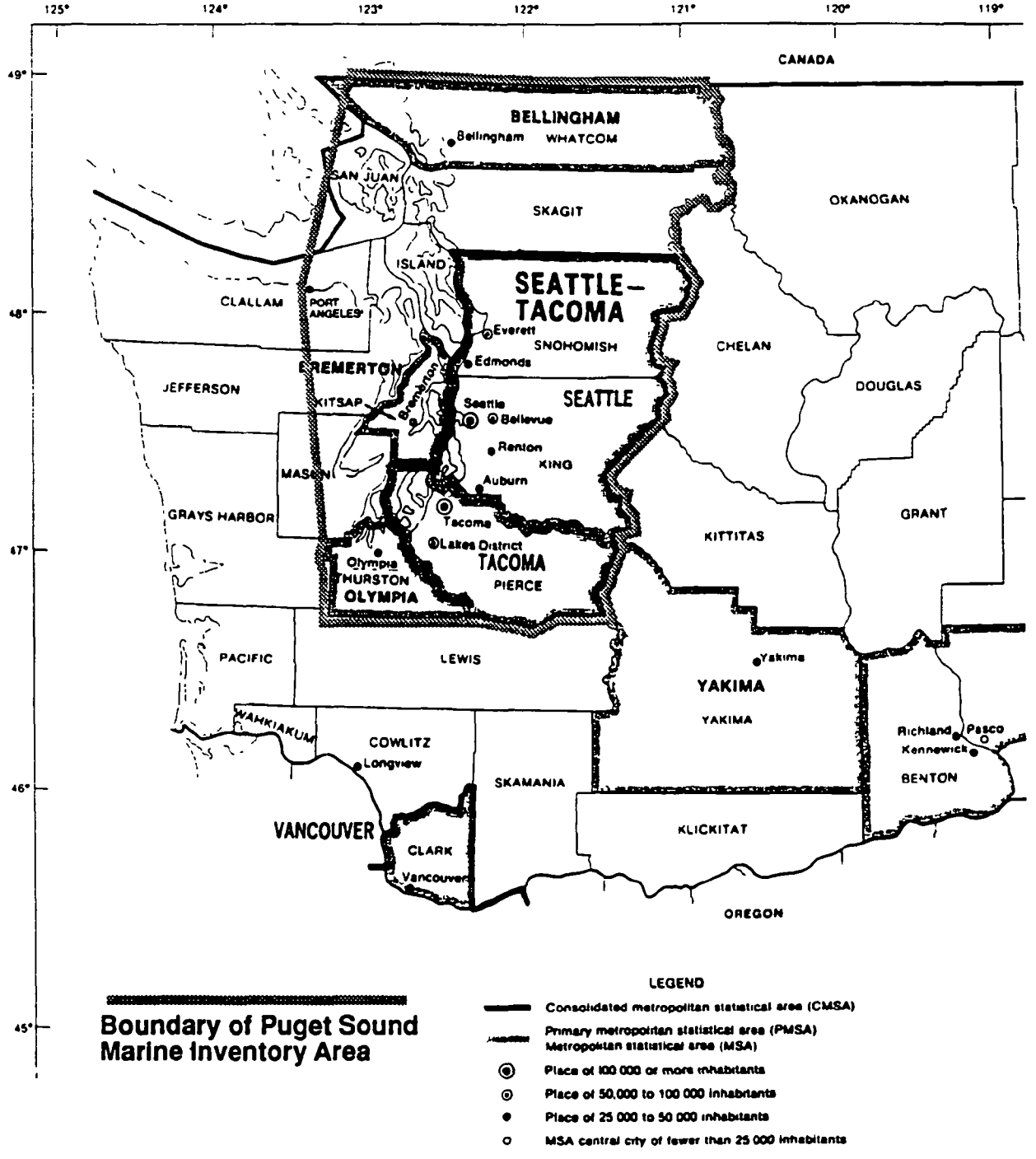
8.1 OCEAN-GOING VESSELS

Transit Profiles by Port

Ships arriving at the Seattle/Tacoma area can proceed to one of 21 different ports as recorded by the Marine Exchange of Puget Sound. Selected groups of these ports are located in close proximity to one another and therefore the transit times and profiles from the point at which the bar pilot assumes control of the ship to point at which they dock are essentially the same for each of the ports within a particular group. Unique transit profiles have been developed for each of the following groups of ports, with transit profiles given for the time between bar pilot boarding and vessel mooring, as presented below:

Port Area	Transit Time	Full	Half	Slow
Port Angeles	0.5 hours	0 hrs	0 hrs	0.5 hrs
Port Townsend	2 hours	1.5 hrs	0 hrs	0.5 hrs
Anacortes and March Point	3 hours	1.5 hrs	0.5 hrs	1 hr
Northern Destinations:	4.5 hours	1.5 hrs	2 hrs	1 hr
Bellingham				
Cherry Point				
Ferndale				
Kellet Ledge				
Sandy Point				
Vendovi Island				
Everett	4.5 hours	1.5 hrs	2.5 hrs	0.5 hrs
Edmonds and Point Wells	4 hours	1.5 hrs	2 hrs	0.5 hrs
Seattle Vicinity:	4.5 hours	2.5 hrs	1 hr	1 hr
Seattle				
Manchester				
Whidbey Island				
Tacoma	6 hours	2.5 hrs	2.5 hrs	1 hr
Olympia	8 hours	2.5 hrs	4.5 hrs	1 hr

EXHIBIT 24


125°
124°
123°
122°
121°
120°
119°
49°
48°
47°
46°
45°
CANADA
BELLINGHAM
Bellingham
WHATCOM
SAN JUAN
SKAGIT
OKANOGAN
ISLAND
SEATTLE–
TACOMA
CLALLAM
PORT
ANGELES
Everett
SNOHOMISH
CHELAN
Edmonds
BREMERTON
JEFFERSON
KITSAP
Bremerton
Seattle
SEATTLE
Bellevue
DOUGLAS
Renton
KING
MASON
Auburn
GRAYS HARBOR
Tacoma
GRANT
KITTITAS
Lakes District
Olympia
THURSTON
OLYMPIA
TACOMA
PIERCE
PACIFIC
LEWIS
Yakima
YAKIMA
YAKIMA
WAHKIAKUM
COWLITZ
Longview
Richland
Pasco
Kennewick
BENTON
SKAMANIA
VANCOUVER
CLARK
Vancouver
KLICKITAT
OREGON
Boundary of Puget Sound
Marine Inventory Area
LEGEND
Consolidated metropolitan statistical area (CMSA)
Primary metropolitan statistical area (PMSA)
Metropolitan statistical area (MSA)
Place of 100 000 or more inhabitants
Place of 50,000 to 100 000 inhabitants
Place of 25 000 to 50 000 inhabitants
MSA central city of fewer than 25 000 inhabitants

Port Area	Transit Time	Full	Half	Slow
Gray's Harbor Ports: Aberdeen Hoquiam Westport	n/a	n/a		

The last group of Gray's Harbor Ports is on the Pacific Ocean and therefore was not included in the assessment of vessel population.

A summary of ocean-going vessel emissions for the Seattle-Tacoma area is shown in Exhibit 25. Detailed population assessments for ocean going vessels and their emission inventories are given in the Appendix.

8.2 HARBOR VESSELS

The Puget Sound area is unique in the nation due to the numerous waterborne transportation avenues available for serving the area's wide distribution of population centers and industrial and recreational activities. The Washington State Ferry (WSF) system contributes a consistently high volume of traffic to the waterway system and is joined by many excursion boats, construction and dredging operations, small cargo operations, a US Naval shipyard at Bremerton, and other users. The assessment of harbor vessel activity relied heavily on *Waterborne transportation lines of the US*, since the large number of individual operators precluded performing an accurate telephone survey. A summary of the harbor vessel population and emissions appears as Exhibit 26. (A detailed list of harbor vessels by owner is included in the Appendix.) As indicated by the summary (p. 9-1), for all 6 ports investigated, Seattle – Tacoma has the largest inventory of emissions from harbor and coastal vessels.

8.3 FISHING VESSELS

Because fishing vessel activity in the Puget Sound area is intense, considerable effort was expended to accurately inventory their emissions. Fortunately, the Washington Department of Fisheries maintains a database of all commercial fishing boats and vessels registered in the State. This database includes horsepower, engine type (diesel or gasoline), vessel type (e. g., shellfish boat, gill net boat, etc.), and the owner's address. Fishing vessels are assumed to operate an average of 10 hours per day, 180 days per year. This activity level was used in conjunction with the database and a representative duty cycle to calculate an inventory of emissions from fishing vessels for the entire State of Washington (see Appendix for details). Since the owner's address does not necessarily correspond to vessel location, and homeport was not listed in the database, some means of separating emissions in the Seattle-Tacoma area from the statewide total is needed. Good information on the annual catch landed in the State of Washington, and in the

EXHIBIT 25

Sumary of Ocean-Going Marine Vessel Emissions in the Puget Sound Area

Port Area		Annual Fuel Consumption (gallons)	Underway Emissions (Tons/year)					Hotelling Emissions (Tons/year)				
			NOx	HC	CO	SOx	PM	NOx	HC	CO	SOx	PM
Anacortes	Motor Ship	839,072	106.41	4 64	11 80	31 59	6 38	66 24	18 51	10 87	36 91	3 84
	Steam Ship	2,493,718	40 26	0 98	4 22	206 34	31 93	17 52	1 85	1 20	129 04	7 47
	Total	3,332,791	146.67	5 62	16 02	237 94	38 31	83 76	20 37	12 07	165 95	11 32
Bellingham	Motor Ship	1,084,826	157 25	6 86	17 44	46 68	9 44	75 15	21 01	12.34	41 88	4 36
	Steam Ship	2,764,990	50 52	1 07	4 72	266 60	34 25	15 94	1 69	1 09	117 42	6 80
	Total	3,849,816	207 77	7 93	22.16	313 29	43 69	91 10	22.69	13 43	159 30	11 16
Edmonds and Point Wells	Motor Ship	11,451	1 94	0 08	0 21	0 57	0 12	0 65	0 18	0 11	0 36	0 04
	Steam Ship	346,406	7 50	0 16	0 71	39 49	5 14	1 44	0 15	0 10	10 58	0 61
	Total	357,856	9 43	0 24	0 92	40 07	5 25	2 08	0 33	0 20	10 94	0 65
Everett	Motor Ship	1,222,076	101 46	4 43	11 25	30 12	6 09	124 98	34 94	20 52	69 65	7 25
	Steam Ship	7,347	0 20	0 00	0 02	1 05	0 13	0 01	0 00	0 00	0 08	0 00
	Total	1,229,423	101.66	4 43	11 27	31 17	6 22	124 99	34 94	20 52	69 73	7 26
Olympia	Motor Ship	476,433	56.99	2 49	6 32	16 92	3 42	39 44	11 02	6 47	21.98	2 29
	Steam Ship	0	0 00	0 00	0 00	0 00	0 00	0 00	0 00	0 00	0 00	0 00
	Total	476,433	56.99	2 49	6 32	16 92	3 42	39 44	11 02	6 47	21 98	2 29
Port Angeles	Motor Ship	754,191	7 32	0 32	0 81	2 17	0 44	106 59	29 79	17 50	59 40	6 18
	Steam Ship	664,590	0 77	0 01	0 05	4 35	0 28	9 33	0 99	0 64	68 73	3 98
	Total	1,418,781	8 09	0 33	0 86	6 53	0 72	115 92	30 78	18 14	128 13	10 17
Port Townsend	Motor Ship	67,580	9 59	0 42	1 06	2 85	0 58	4 79	1 34	0 79	2 67	0 28
	Steam Ship	0	0 00	0 00	0 00	0 00	0 00	0 00	0 00	0 00	0 00	0 00
	Total	67,580	9 59	0 42	1 06	2 85	0 58	4 79	1 34	0 79	2 67	0 28
Seattle	Motor Ship	6,312,105	1137 22	49 62	126 13	337 61	68 23	318 90	89 14	52 35	177 71	18 50
	Steam Ship	1,441,611	24 94	1 21	3 17	125 26	19 90	9 53	1 56	1 23	66 23	4 42
	Total	7,753,717	1162.15	50.83	129 30	462.87	88 14	328 42	90 70	53 58	243 94	22.92
Tacoma	Motor Ship	6,177,313	1114 39	48 63	123 60	330 83	66 86	311.31	87 02	51 11	173 48	18 06
	Steam Ship	1,407,814	24 37	1 20	3 11	122 38	19 46	9 30	1 54	1 21	64 54	4 32
	Total	7,585,126	1138.77	49 83	126 71	453 21	86 32	320 61	88 55	52 32	238 03	22 38
Total Puget Sound		26,071,522	2841 1	122.1	314 6	1564 8	272.6	1111.1	300.7	177 5	1040 7	88 4

Puget Sound Area is available from the National Marine Fisheries Service[9]. This information was used with the assumption that emissions are proportional to catch to estimate the emission inventory for fishing vessels operating in the Seattle-Tacoma area (Exhibit 25).[10]

8.4 INVENTORY RESULTS

The total Marine Vessel Emission Inventory for the Seattle/Tacoma Area is shown below:

SEATTLE/TACOMA EMISSION INVENTORIES (Tons/Year)					
Vessel Type	NOx	HC	CO	SOx	PM
Ocean-Going					
Underway	2,841.1	122.1	314.6	1564.8	272.6
Hoteling	1,111.1	300.7	177.5	1,040.7	88.4
Total Ocean-Going	3,952.2	422.8	492.1	2,605.5	361.0
Harbor Vessels	11,241.4	568.3	1,481.1	5,824.7	682.8
Fishing Vessels	3,319.0	1,508.3	30,160	951.7	172.3
Total (TONS/YR)	**18,512.6**	**2,499.4**	**32,133.2**	**9,381.9**	**1216.1**
Total (TONS/DAY)	**50.7**	**6.85**	**88.0**	**25.7**	**3.33**

Comparison with the five other port areas investigated (see summary on p. 9-1) shows that Seattle – Tacoma has by far the largest inventory of marine vessel emissions. This results from the high level of activity in the region exhibited by all 3 major vessel categories – ocean-going, marine vessels, harbor vessels, and fishing vessels.

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9 *Fisheries of the United States, 1990 (Current Fishery Statistics No. 9000)*, U. S. Department of Commerce, National Oceanic and Atmospheric Administration, National Marine Fisheries Service. U. S. Government Printing Office, Washington D. C. May 1991

10

EXHIBIT 26

Puget Sound Harbor and Coastal Vessel Emissions

TYPE OF VESSEL	VESSEL HORSEPOWER RANGE	NUMBER OF VESSELS	OPERATING PROFILE 20% POWER	50% POWER	80% POWER	DAILY OPERATING HOURS	OPERATING DAYS PER YEAR	FUEL CONSUMPTION (GAL/HOUR)	TOTAL ANNUAL FUEL CONSUMPTION (GALLONS)	TOTAL VESSEL EMISSIONS (POUNDS OF POLLUTANT PER YEAR) NO_x	HC	CO	SO_2	PM
TUGS, TOW BOATS AND PUSH BOATS	0 - 300	36	0.30	0.50	0.20	10	200	10.40	1,144,666	408,854	54,450	61,715	846,257	18,794
	301 - 1000	35	0.30	0.50	0.20	12	250	19.84	2,084,501	684,955	91,341	148,474	261,864	25,443
	1001 - 1500	28	0.30	0.50	0.20	12	250	31.68	2,185,934	655,780	52,462	155,342	274,353	27,168
	1501 - 2000	29	0.30	0.50	0.20	12	250	48.50	3,784,868	1,536,862	85,587	408,315	473,379	64,343
	2001 - 4000	48	0.30	0.50	0.20	12	250	75.86	10,340,497	2,987,241	257,770	655,167	3,372,497	254,434
	>4000	27	0.30	0.50	0.20	12	250	167.68	13,398,152	7,469,884	325,934	828,389	4,264,369	448,143
FERRIES, PASSENGER VESSELS	0 - 300	14	0.20	0.40	0.20	8	220	10.18	250,899	89,343	11,592	13,817	31,519	4,265
	301 - 1000	5	0.20	0.40	0.20	10	220	20.57	226,268	67,880	5,430	13,802	38,419	2,487
	1001 - 1500	5	0.20	0.40	0.20	10	220	33.53	369,883	110,728	8,858	22,515	46,298	12,180
	1501 - 2000	12	0.20	0.40	0.20	10	220	46.56	1,305,136	418,840	33,507	85,144	173,354	44,687
	2001 - 4000	4	0.20	0.40	0.20	10	220	79.66	700,978	434,408	19,539	48,189	268,053	26,686
	>4000	12	0.20	0.40	0.20	10	220	162.67	3,406,036	3,017,252	151,644	194,652	1,722,654	161,661
CARGO/CONTAINER	0 - 300	21	0.30	0.50	0.20	14	220	10.40	1,120,797	393,310	52,408	59,459	140,772	15,054
	301 - 1000	11	0.30	0.50	0.20	14	220	20.06	472,728	201,812	14,143	42,056	84,485	22,200
	1001 - 1500	6	0.30	0.50	0.20	14	220	31.68	383,450	173,035	14,051	35,712	73,533	19,208
	1501 - 2000	2	0.30	0.50	0.20	14	220	43.30	257,566	92,304	6,432	16,347	31,050	8,044
	2001 - 4000	3	0.30	0.50	0.20	14	220	73.06	675,119	371,312	16,205	41,182	281,056	23,279
	>4000													
WORK BOATS CREW BOATS OTHER	0 - 300		0.30	0.50	0.20									
	301 - 1000	4	0.30	0.50	0.20	6	220	19.06	104,841	30,423	1,920	7,474	13,164	1,702
	1001 - 1500		0.30	0.50	0.20									
	1501 - 2000	2	0.30	0.50	0.20	6	220	43.30	164,831	54,455	2,756	7,009	14,423	3,790
	2001 - 4000	1	0.30	0.50	0.20	6	220	73.06	96,445	33,043	2,315	3,853	38,284	31,827
	>4000		0.30	0.50	0.20									
									Total Tons of Pollutant per Year	12,241	564	1,498	8,831	663

Puget Sound Area is available from the National Marine Fisheries Service[11]. This information was used with the assumption that emissions are proportional to catch to estimate the emission inventory for fishing vessels operating in the Seattle-Tacoma area (Exhibit 27).

EXHIBIT 27

Emissions from Fishing Vessels in the Seattle – Tacoma Area

Washington Fishing Vessel Emissions

Area		(tons/Year) NOx	HC	CO	SOx	PM	1990 Catch (M lbs)
Statewide	Diesel Vessels	3583 6	477 5	541 8	1282.6	173 6	Catch (M lbs
	Gasoline Vessels	1086 3	1644 7	41894 8	56 4	68 8	
	Total	4670 0	2122 3	42436 5	1339 1	242 4	137 186
Puget Sound	Total	3 319	1.508	30.160	952	172	97 5

11 *Fisheries of the United States, 1990 (Current Fishery Statistics No. 9000)*, U. S. Department of Commerce, National Oceanic and Atmospheric Administration, National Marine Fisheries Service. U. S. Government Printing Office, Washington D. C May 1991

8.4 INVENTORY RESULTS

The total Marine Vessel Emission Inventory for the Seattle/Tacoma Area is shown below:

SEATTLE/TACOMA EMISSION INVENTORIES (Tons/Year)					
Vessel Type	NOx	HC	CO	SOx	PM
Ocean-Going					
Underway	2,841.1	122.1	314.6	1564.8	272.6
Hoteling	1,111.1	300.7	177.5	1,040.7	88.4
Total Ocean-Going	3,952.2	422.8	492.1	2,605.5	361.0
Harbor Vessels	11,241.4	568.3	1,481.1	5,824.7	682.8
Fishing Vessels	3,319.0	1,508.3	30,160	951.7	172.3
Total (TONS/YR)	18,512.6	2,499.4	32,133.2	9,381.9	1216.1
Total (TONS/DAY)	50.7	6.85	88.0	25.7	3.33

Comparison with the five other port areas investigated (see summary on p.9-1) shows that Seattle – Tacoma has by far the largest inventory of marine vessel emissions. This results from the high level of activity in the region exhibited by all 3 major vessel categories – ocean-going, marine vessels, harbor vessels, and fishing vessels.

9.0 SUMMARY

Emission Inventories for the Six Port Areas Investigated

9.0 SUMMARY

Emission Inventories for the Six Port Areas Investigated

Region	Vessel Category	NOx	HC	CO	SOx	PM
		Tons/Year				
Baltimore	Ocean-Going	1,854.2	196.3	231.2	872.2	133.9
	Harbor and Coastal	1,350.1	69.9	282.5	380.2	51.5
	Fishing	3,290.7	1,495.4	29,902.7	943.6	170.8
	Total	**6,495.0**	**1,761.6**	**30,416.4**	**2,196.0**	**356.2**
Baton Rouge	Ocean & River Going	786.9	114.0	105.2	321.6	46.6
	Harbor	1,400.0	88.7	344.1	606.0	82.0
	Fishing	0.0	0.0	0.0	0.0	0.0
	Total	**2,186.9**	**202.7**	**449.3**	**927.6**	**128.6**
Houston – Galveston	Ocean-Going	6,999.1	898.8	910.2	2,732.9	415.0
	Harbor and Coastal	7,274.2	397.9	1,115.1	3,569.4	438.3
	Fishing	704.0	93.8	106.4	252.0	34.1
	Total	**14,977.3**	**1390.5**	**2,131.7**	**6,554.3**	**887.4**
New York – New Jersey	Ocean-Going	4,132.9	589.3	548.5	2,085.0	279.1
	Harbor and Coastal	10,659.6	687.1	2,199.0	3,547.4	480.1
	Fishing	0.0	0.0	0.0	0.0	0.0
	Total	**14,792.6**	**1,276.4**	**2,747.5**	**5,632.4**	**759.2**
Philadelphia	Ocean-Going	1,954.9	305.7	266.3	823.7	115.4
	Harbor and Coastal	8,464.9	463.0	1,297.7	4,153.7	510.0
	Fishing	0.0	0.0	0.0	0.0	0.0
	Total	**10,419.8**	**768.7**	**1,564.0**	**4,977.4**	**625.4**
Seattle – Tacoma	Ocean-Going	3,952.2	422.9	492.1	2,605.5	361.1
	Harbor and Coastal	11,241.4	568.3	1,481.1	5,824.7	682.8
	Fishing	3,319.0	1,508.3	30,160.2	951.7	172.3
	Total	**18,512.6**	**2,499.5**	**32,133.4**	**9,381.9**	**1,216.1**

APPENDIX A
Baltimore

Ocean Going Vessel
Emission Calculations

– Baltimore –

APPENDIX C
Houston – Galveston

Baltimore - Chesapeake Approach, Non-Bulk Cargo Vessels

TYPE OF VESSEL	PROPULSION TYPE	VESSEL TONNAGE (1,000 DWT)	AVERAGE HORSEPOWER	FUEL CONSUMPTION AT FULL POWER (TONS/DAY)	FUEL CONSUMPTION AT FULL POWER (GALS/HOUR)	ANNUAL VESSEL CALLS	MEAN HOURS/ CALL	MEAN HOURS MOORED	GALLONS OF FUEL CONSUMED PER YEAR IN EACH OPERATING MODE: FULL	HALF	SLOW	HOTEL	ANNUAL GALLONS OF FUEL CONSUMED: UNDERWAY	HOTELLING	TOTAL
CONTAINER SHIPS	MOTOR	0 - 25	10,870	35	452	85	38 00	30 00	184 348		7,681	115,218	192,030	115 218	307,247
		25 50	28,135	91	1,166	163	38 00	30 00	912,538		38 023	570 349	950 581	570 349	1 520 930
		50 75	38,660	130	1,658	6		30 00	47 754		1,990	29,846	49 744	29 846	79 590
		75 100	56,000	189	2,412										
		100+	62,000	208	2,656										
	STEAM	0 - 25	8 000	43	513	34	38 00	30 00	83 680		3 487	52,300	87,166	52,300	139 466
		25 50	15 000	73	860		38 00	30 00							
		50 - 75	19,000	89	1,050										
		75 - 100	22,000	108	1,278										
		100+	26,000	120	1,412										
GENERAL CARGO	MOTOR	0 - 25	6,335	26	335	862	38 00	30 00	1,385,290		57 720	865 807	1 443 011	865 807	2,308 817
VEHICLE CARRIERS		25 50	14,709	43	548	141	38 00	30 00	371,161		15 465	231 976	386 626	231 976	618 602
RO RO / LASH		50 75	16,765	53	678										
OCEAN-GOING TUGS		75 - 100	18 000	56	712										
		100+	21,000	64	822										
	STEAM	0 25	7 000	42	498	40	38 00	30 00	95 611		3 984	59,757	99 595	59 757	159 352
		25 - 50	16,000	78	920										
		50 - 75	19,000	89	1,050										
		75 - 100	22,000	108	1,278										
		100+	26,000	120	1,412										
PASSENGER LINERS	MOTOR	0 25	10 000	32	415										
CRUISE SHIPS		25 50	15,000	44	562										
	STEAM	0 - 25	8 000	43	513										
		25 50	15,000	73	860										
TOTAL GALLONS OF FUEL CONSUMED PER YEAR.												MOTOR	3,021,991	1,813,195	4,835,186
												STEAM	186,761	112,057	298,818

Baltimore - Chesapeake Approach, Non-Bulk Cargo Vessels

TYPE OF VESSEL	PROPULSION TYPE	VESSEL TONNAGE (1,000 DWT)	UNDERWAY (POUNDS OF POLLUTANT PER YEAR) NOx	HC	CO	SOx	PM	HOTELLING (POUNDS OF POLLUTANT PER YEAR) NOx	HC	CO	SOx	PM
CONTAINER SHIPS	MOTOR	0 - 25	105 616	4,609	11,714	31,355	6,337	33 759	9 436	5,542	18 813	1 959
		25 50	522,820	22,814	57,985	155,211	31,369	167 112	46 712	27 434	93 127	9 696
		50 75	27,359	1 194	3,034	8,122	1 642	8,745	2,444	1,436	4,873	507
		75 100										
		100+										
	STEAM	0 - 25	5,517	146	620	27,719	4,798	1 532	162	105	11 286	654
		25 50										
		50 - 75										
		75 100										
		100+										
GENERAL CARGO	MOTOR	0 - 25	793,656	34 632	88,024	235,615	47,619	253 681	70,910	41 645	141 369	14 719
VEHICLE CARRIERS		25 50	212,644	9,279	23,584	63,128	12,759	67 969	18 999	11,158	37,877	3,944
RO-RO / LASH		50 75										
OCEAN-GOING TUGS		75 - 100										
		100+										
	STEAM	0 - 25	6,303	167	709	31,671	5,482	1 751	185	120	12,896	747
		25 - 50										
		50 - 75										
		75 - 100										
		100+										
PASSENGER LINERS	MOTOR	0 25										
CRUISE SHIPS		25 50										
	STEAM	0 25										
		25 50										
TOTAL MOTORSHIP [Tons/year]			831 0	36.3	92.2	246.7	49 9	265.6	74.3	43.6	148.0	15 4
TOTAL STEAMSHIP [Tons/year]			5 91	0 16	0.66	29 70	5.14	1 64	0.17	0 11	12 09	0.70

Baltimore - Chesapeake Approach, Bulk Cargo Vessels

TYPE OF VESSEL	PROPULSION TYPE	VESSEL TONNAGE (1,000 DWT)	AVERAGE HORSEPOWER	FUEL CONSUMPTION AT FULL POWER (TONS/DAY)	FUEL CONSUMPTION AT FULL POWER (GALS/HOUR)	ANNUAL VESSEL CALLS	MEAN HOURS/ CALL	MEAN HOURS MOORED	GALLONS OF FUEL CONSUMED PER YEAR IN EACH OPERATING MODE: FULL	HALF	SLOW	HOTEL	ANNUAL GALLONS OF FUEL CONSUMED: UNDERWAY	HOTELLING	TOTAL
TANKERS	MOTOR	0 25	5 435	19	238	147	58 00	48 00	168 091	28 015	7 004	168 091	203 110	168 091	371 201
BULK CARRIERS		25 50	11,375	45	572	231	58 00	48 00	634 697	105 783	26,446	634 697	766,925	634 697	1 401 622
		50 75	14,718	50	638	56	58 00	48 00	171,393	28,565	7 141	171 393	207 100	171 393	378 492
		75 - 100	17,837	70	890	23	58 00	48 00	98 203	16 367	4,092	98 203	118 661	98 203	216,864
		100+	23,200	74	940	17	58 00	48 00	76,737	12,790	3 197	76,737	92,724	76,737	169 461
	STEAM	0 - 25	10,663	51	602	34	58 00	48 00	98 292	16,382	4 095	98 292	118 769	98 292	217 061
		25 - 50	15 783	77	907	68	58 00	48 00	295,910	49 318	12,330	295 910	357,558	295 910	653 468
		50 75	30,269	147	1,732										
		75 - 100	25,936	124	1 468										
		100+	34,980	156	1 846	17	58 00	48 00	150 652	25 109	6,277	150 652	182,038	150 652	332,689

TOTAL GALLONS OF FUEL CONSUMED PER YEAR	MOTOR	1,388,520	1,149,120	2,537,640
	STEAM	658,365	544,854	1,203,218

Baltimore - Chesapeake Approach, Bulk Cargo Vessels

TYPE OF VESSEL	PROPULSION TYPE	VESSEL TONNAGE (1,000 DWT)	UNDERWAY (POUNDS OF POLLUTANT PER YEAR)					HOTELLING (POUNDS OF POLLUTANT PER YEAR)				
			NOx	HC	CO	SOx	PM	NOx	HC	CO	SOx	PM
TANKERS	MOTOR	0 - 25	111,711	4 875	12,390	33 164	6,703	49 251	13 767	8 085	27 446	2,858
BULK CARRIERS		25 50	421,809	18 406	46,782	125 224	25 309	185 966	51 982	30 529	103 633	10,790
		50 - 75	113,905	4,970	12,633	33 815	6,834	50 218	14,037	8 244	27 985	2,914
		75 - 100	65,264	2,848	7,238	19,375	3 916	28 773	8 043	4 724	16 035	1 669
		100+	50,998	2,225	5,656	15,140	3 060	22,484	6,285	3 691	12,530	1 305
	STEAM	0 - 25	7,394	183	785	37 769	5 963	2,880	305	197	21 211	1 229
		25 50	22,260	551	2,364	113,703	17,952	8,670	917	592	63,857	3 699
		50 - 75										
		75 - 100										
		100+	11,333	281	1 204	57,888	9,140	4 414	467	301	32,511	1 883
	Total Motorship (Tons/year)		381.84	16 66	42.35	113.36	22.91	168.35	47 06	27 64	93 81	9 77
	Total Steamship (Tons/year)		28.49	0.51	2.18	104.68	16.53	7 98	0 84	0 54	58 79	3 41

Baltimore - All Vessels Aproaching Through the C & D Canal

TYPE OF VESSEL	PROPULSION TYPE	VESSEL TONNAGE (1,000 DWT)	AVERAGE HORSEPOWER	FUEL CONSUMPTION AT FULL POWER (TONS/DAY)	FUEL CONSUMPTION AT FULL POWER (GALS/HOUR)	ANNUAL VESSEL CALLS	MEAN HOURS/ CALL	MEAN HOURS MOORED	GALLONS OF FUEL CONSUMED PER YEAR IN EACH OPERATING MODE: FULL	HALF	SLOW	HOTEL	ANNUAL GALLONS OF FUEL CONSUMED: UNDERWAY	HOTELING	TOTAL
CONTAINER SHIPS	MOTOR	0 - 25	10,870	35	452										
		25 50	28,135	91	1 166	17	42.00	30 00		79 312	3 966	59 484	83 278	59 484	142,762
		50 75	38,660	130	1 658										
		75 100	56,000	189	2,412										
		100+	62,000	208	2,656										
	STEAM	0 25	8,000	43	513										
		25 - 50	15,000	73	860										
		50 75	19,000	89	1,050										
		75 - 100	22,000	108	1,278										
		100+	26,000	120	1,412										
TANKERS	MOTOR	0 - 25	5,435	19	238	11	60 00	48 00		10,482	524	12,578	11 006	12,578	23 584
BULK CARRIERS		25 50	11,375	45	572	56	60 00	48 00		128,222	6 411	153 866	134 633	153 866	288 498
		50 - 75	14,718	50	638	6	60 00	48 00		15 303	765	18 364	16 068	18 364	34 432
		75 - 100	17,837	70	890										
		100+	23,200	74	940										
	STEAM	0 - 25	10,663	51	602										
		25 50	15,783	77	907										
		50 - 75	30,269	147	1,732										
		75 100	25 936	124	1,468										
		100+	34 980	156	1,846										
GENERAL CARGO	MOTOR	0 25	6,335	26	335	90	42.00	30 00		120,530	6 026	90 397	126 556	90 397	216,954
VEHICLE CARRIERS		25 - 50	14,709	43	548	23	42.00	30 00		50,453	2,523	37 840	52,976	37 840	90,816
RO RO / LASH		50 - 75	16,765	53	678										
OCEAN-GOING TUGS		75 - 100	18,000	56	712										
		100+	21,000	64	822										
	STEAM	0 - 25	7,000	42	498										
		25 50	16,000	78	920										
		50 - 75	19,000	89	1 050										
		75 100	22,000	108	1,278										
		100+	26,000	120	1,412										
PASSENGER LINERS	MOTOR	0 25	10,000	32	415										
CRUISE SHIPS		25 - 50	15,000	44	562										
	STEAM	0 25	8,000	43	513										
		25 - 50	15,000	73	860										
									TOTAL GALLONS OF FUEL CONSUMED PER YEAR			MOTOR. STEAM	424,517	372,529	797,046

Baltimore - All Vessels Aproaching Through the C & D Canal

TYPE OF VESSEL	PROPULSION TYPE	VESSEL TONNAGE (1,000 DWT)	UNDERWAY (POUNDS OF POLLUTANT PER YEAR) NOx	HC	CO	SOx	PM	HOTELLING (POUNDS OF POLLUTANT PER YEAR) NOx	HC	CO	SOx	PM
CONTAINER SHIPS	MOTOR	0 25										
		25 50	45 803	1,999	5 080	13,598	2,748	17 429	4 872	2,861	9,713	1 011
		50 - 75										
		75 100										
		100+										
	STEAM	0 25										
		25 50										
		50 75										
		75 100										
		100+										
TANKERS	MOTOR	0 25	6,053	264	671	1,797	363	3,685	1,030	605	2,054	214
BULK CARRIERS		25 50	74,048	3,231	8 213	21,983	4 443	45 083	12,602	7,401	25 123	2,616
		50 - 75	8,837	386	980	2,624	530	5,381	1,504	883	2,998	312
		75 100										
		100+										
	STEAM	0 - 25										
		25 50										
		50 - 75										
		75 - 100										
		100+										
GENERAL CARGO	MOTOR	0 - 25	69,606	3,037	7 720	20,664	4 176	26 486	7,404	4,348	14,760	1,537
VEHICLE CARRIERS		25 - 50	29 137	1,271	3,232	8,650	1,748	11 087	3,099	1,820	6,179	643
RO-RO / LASH		50 - 75										
OCEAN-GOING TUGS		75 - 100										
		100+										
	STEAM	0 - 25										
		25 50										
		50 - 75										
		75 100										
		100+										
PASSENGER LINERS	MOTOR	0 - 25										
CRUISE SHIPS		25 - 50										
	STEAM	0 25										
		25 50										
TOTAL MOTORSHIP EMISSIONS [Tons/year]			116.74	5 09	12.95	34 66	7 00	54.58	15.26	8.96	30 41	3.17

APPENDIX B
Baton Rouge

Ocean Going Vessel Emission Calculations

– Baton Rouge –

Port of Baton Rouge

TYPE OF VESSEL	PROPULSION TYPE	VESSEL TONNAGE (1,000 DWT)	AVERAGE HORSEPOWER	FUEL CONSUMPTION AT FULL POWER (TONS/DAY)	FUEL CONSUMPTION AT FULL POWER (GALS/HOUR)	INBOUND VESSEL CALLS	OUTBOUND VESSEL CALLS	MEAN HOURS/ CALL	MEAN HOURS MOORED	GALLONS OF FUEL CONSUMED PER YEAR IN EACH OPERATING MODE: FULL	HALF	SLOW	HOTEL	ANNUAL GALLONS OF FUEL CONSUMED: UNDERWAY	HOTELLING	TOTAL
CONTAINER SHIPS	ALL	0-5	3,000	10	124	607	589	36 00	30 00							
GENERAL CARGO	ASSUMED	'5 - 25	10,870	35	452	390	341	36.00	30 00		396 349		495,436	396,349	495 436	891 786
VEHICLE CARRIERS	MOTOR	25 - 50	28,135	91	1,166	126	120	36.00	30 00		344,309		430 386	344 309	430 386	774 694
RO-RO / LASH		50 - 75	38,660	130	1,658	27	139	36 00	30 00		330 297		412,871	330 297	412,871	743 169
PASSENGER SHIPS		75 100	56,000	189	2,412			36.00	30 00							
		100+	62,000	208	2,656			36.00	30 00							
TANKERS	ALL	0-5	3,000	10	131	45	28				11,496					
	ASSUMED	5 - 25	5,435	19	238	232	407	54 00	48 00		182,671		365 341	182,671	365 341	548 012
	MOTOR	25 - 50	11,375	45	572	135	141	54 00	48 00		189,585		379 169	189 585	379 169	568 754
		50 75	14,718	50	638	95	26	54 00	48 00		92,583		185,165	92,583	185 165	277 748
		75 100	17,837	70	890			54 00	48 00							
		100+	23,200	74	940			54.00	48 00							
TOWBOAT OR	MOTOR	0 - 5	5,000	16	209	5,724	5,572	18 00	12 00	3,781,129			1 417 923			
TUGBOAT		0 25	16,000	52	671	45	46	18.00	12 00	97,681			36,630	97 681	36 630	134 312
		25 - 50	23,000	73	930			18 00	12 00							
									TOTAL GALLONS OF FUEL CONSUMED PER YEAR				MOTOR	1,633,474	2,305,000	3,938,474

Port of Baton Rouge

TYPE OF VESSEL	PROPULSION TYPE	VESSEL TONNAGE (1,000 DWT)	UNDERWAY (POUNDS OF POLLUTANT PER YEAR)					HOTELLING (POUNDS OF POLLUTANT PER YEAR)				
			NOx	HC	CO	SOx	PM	NOx	HC	CO	SOx	PM
CONTAINER SHIPS GENERAL CARGO VEHICLE CARRIERS RO-RO / LASH	ASSUMED MOTOR	0 25 25 50 50 - 75 75 - 100 100+	217,992 189,370 181,663	9,512 8,263 7,927	24,177 21,003 20,148	64,716 56,219 53,931	13 080 11,362 10,900	145 163 126,103 120,971	40 576 35 249 33,814	23 830 20 702 19,859	80 895 70,273 67,414	8 422 7 317 7 019
TANKERS	ASSUMED MOTOR	0 25 25 - 50 50 - 75 75 100 100+	100,469 104,272 50,920	4 384 4,550 2,222	11,143 11,565 5,648	29,826 30,955 15,117	6,026 6,256 3 055	107 045 111 097 54 253	29 921 31 054 15,165	17 573 18 238 8,906	59 653 61 911 30,234	6 211 6,446 3 148
		0 25 25 50	53,725	2,344	5,959	15 949	3,223	10,733	3,000	1 762	5 981	623
TOTAL MOTORSHIP EMISSIONS (Tons/year)			449.2	19 6	49.8	133 4	27 0	337 7	94.4	55 4	188.2	19 6
TOTAL EMISSIONS, UNDERWAY + HOTELLING			784 9	114 0	105.3	321 5	46.5					

Port of Baton Rouge

VESSEL TONNAGE	UNDERWAY (POUNDS OF POLLUTANT PER YEAR)					HOTELLING (POUNDS OF POLLUTANT PER YEAR)				
	NOx	HC	CO	SOx	PM	NOx	HC	CO	SOx	PM
< 25K	372,186	16,241	41,279	110 492	22,331	262,941	73 498	43 165	146,529	15 256
25 - 50 K	293,641	12,813	32,567	87,174	17,618	237,200	66 303	38,940	132,184	13,762
50 - 75 K	232,584	10,149	25,796	69,048	13,955	175,225	48 979	28,766	97,647	10,167
75 100 K										
> 100 K										

Galveston/Houston Harbor and Coastal Vessels by Owner

TEXAS VESSEL INFORMATION
DISTRICT 33 (GALVESTON/HOUSTON AREA)

OWNER	BASE PORT	VESSEL TYPE	NO. OF VESSELS IN HP RANGE					
			0 - 500	501 - 1k	1 1k - 1 5k	1 51k - 2k	2 1k - 4k	>4k
Bruney Felix								
Offshore Oil Svc Inc	Freeport	Cargo Freighter			3		1	
Miller Marine Service	Anahuac	Cargo Freighter	1					
Brazos Port Boat Leasing	Freeport	Cargo Freighter				1		
Jackson Marine Corp	Houston	Cargo Freighter				2	1	
Hastings Marine Ltd.	Galveston	Cargo Freighter						1
State Offshore Svc.	Houston	Cargo Freighter			1	3	4	
Seamaster Inc.	Freeport	Cargo Freighter			1			
Biehl Offshore	Houston	Cargo Freighter						2
Brown & Root Inc.	Anahuac	Cargo Freighter	1					
Petro-Boats Inc.	Freeport	Cargo Freighter		1				
Eagle Fleet Inc.	Houston	Cargo Freighter			1			
Crawford James P	Houston	Cargo Freighter		7				
Intermarine Inc.	Houston	Cargo Freighter					3	
Hornbeck Offshore	Galveston	Cargo Freighter				1	4	
Seal Fleet Inc.	Galveston	Cargo Freighter				2	5	1
Chevron USA Inc	Baytown	Cargo Freighter	4					
Texas State Hwy Dept.	Galveston	Ferry				4		
Shippen Marine Inc.	Freeport	Other				1		
Parker Bros. & Co.	Houston	Other		1				
C & M Boats Inc.	Freeport	Pegr./Cargo					1	
Brazos Port Boat Leasing	Freeport	Pegr /Cargo		2				
Capt. Elliots Party Boats	Freeport	Pegr./Cargo			1	1		
Freeport Crewboats Inc.	Freeport	Pegr./Cargo		1		1		
Exxon Productions	Pt Barrow	Pegr./Cargo	7	2				
Coastal Trading Corp.	Freeport	Pegr./Cargo		1				
Boat Service of Galveston	Galveston	Pegr /Cargo				2		
Fina Oil and Chemical Co.	Houston	Pushboat	1					
Dixie Carriers Inc.	Houston	Pushboat					1	
Dow Chemical Co.	Freeport	Pushboat		4				
Western Towing Co.	Houston	Pushboat	3	2				
Tug Josephine Inc.	Galveston	Pushboat	2	4				
Patton WM B. Barge Lines Inc.	Friendswood	Pushboat					1	
Gardner/B/H Const.	Houston	Pushboat	1					
General Supply & Equip. Co.	Houston	Tugboat	3					
Pace Marine Svc.	Houston	Tugboat		3				
Echo Towing	Houston	Tugboat		1				
Parker Bros. & Co	Houston	Tugboat	6	6	1	2		
Dean Damon R.	Houston	Tugboat		1				
Brown & Root Inc.	Anahuac	Tugboat	3	1	3			
G & R Tranportation Inc.	Cedar Bayou	Tugboat			2			
Pasadena Towing Co.	Houston	Tugboat	2	2				
Alamo Inland Marine Co	Houston	Tugboat	1	8	5			
Breathwit Marine Contractors	Dickinson	Tugboat	4	1				
Chico B.A. Tug Inc.	Houston	Tugboat		1				
Bludco Barge & Towing Inc.	Houston	Tugboat				1		2
Channel Bunker Svc.	Houston	Tugboat		1	2			
San Jacinto Towing Inc.	Houston	Tugboat	1					
Houston Marine Svc 's Inc.	Houston	Tugboat	1	1				
Black Swan Marine Inc.	Houston	Tugboat		2				
Captain Wick's Landing	Kemah	Tugboat		1				
Bay-Houston Towing Co.	Galveston	Tugboat				4	6	1
Capital Towing Co.	Houston	Tugboat		2	1			
Barge Tranport Co.	Houston	Tugboat	9	5	1	1		
McGinnes Indust. Maint. Corp.	Houston	Tugboat		1				
Skains Robbie E.	Dickenson	Tugboat	1					
Bulkfleet Marine Corp.	Houston	Tugboat						2
Stapp Towing Co. Inc	Dickenson	Tugboat		4	1	1		
Musgrove Towing Svc Inc.	Houston	Tugboat	2	3				

Bacon Towing Co Inc.	Houston	Tugboat	4	1				
Dethlefsen M L	Kemah	Tugboat		1				
Suderman & Young Towing Co.	Galveston	Tugboat				1	4	
Coastal Towing Inc	Houston	Tugboat		4	3	6	6	
Sullivan Enterprises Inc	Houston	Tugboat		1	1			
Hollywood Marine Inc	Houston	Tugboat	3	40	10	3		
B & B Towing Co	Houston	Tugboat		1	1			
Inter-Bay Towing Co.	Houston	Tugboat		3	1			
Anahuac Towing Co.	Anahuac	Tugboat	1					
Marine Transport Co of TX	Houston	Tugboat	2	1				
Walter & Sons Stevedoring	Houston	Tugboat	1					
Miller Marine Service	Anahuac	Tugboat	1					
Wesley T Corp	Port Bolivar	Tugboat	1		1			
G & H Towing Co.	Galveston	Tugboat			1	1	2	
American Operators Inc	Houston	Tugboat					1	
Houston Barge Line Inc.	Houston	Tugboat		1			3	2
Williams/Traylor Const.	Houston	Tugboat		1				
Meador E W Marine Transp	Baytown	Tugboat	1					
Wood Creek Towing Inc.	Lynchburg	Tugboat		2				
Grasso Marine	Galveston	Tugboat	1					
Buffalo Marine Service Inc	Houston	Tugboat		4				
Intracoastal Towing & Trans	Houston	Tugboat		1		1	2	
Wood Creek Towing Inc	Harlingen	Tugboat		1				
Wood Creek Towing Inc	Channelview	Tugboat	1					

Cargo Freighter	6	8	6	9	18	4
Ferry	0	0	0	4	0	0
Other	0	1	0	1	0	0
Pegr /Cargo	7	6	1	4	1	0
Tugboats+Pushboats	56	116	34	21	26	7

Ocean Going Vessel Emission Calculations

– Houston/Galveston –

Port of Houston - Houston Ship Channel

TYPE OF VESSEL	PROPULSION TYPE	VESSEL TONNAGE (1,000 DWT)	AVERAGE HORSEPOWER	FUEL CONSUMPTION AT FULL POWER (TONS/DAY)	FUEL CONSUMPTION AT FULL POWER (GALS/HOUR)	INBOUND VESSEL CALLS	OUTBOUND VESSEL CALLS	MEAN HOURS/ CALL	MEAN HOURS MOORED	GALLONS OF FUEL CONSUMED PER YEAR IN EACH OPERATING MODE: FULL	HALF	SLOW	HOTEL	ANNUAL GALLONS OF FUEL CONSUMED: UNDERWAY	HOTELLING	TOTAL
CONTAINER SHIPS	ALL	0 - 25	10,870	35	452	1,815	1,803	42.00	30.00	2,615,579	2,288,632	81,737	2,452,106	4,985,948	2,452,106	7,438,053
GENERAL CARGO	ASSUMED	25 - 50	28,135	91	1,166	156	192	42.00	30.00	649,428	568,249	20,295	608,838	1,237,971	608,838	1,846,810
VEHICLE CARRIERS	MOTOR	50 - 75	38,660	130	1,658			42.00	30.00							
RO-RO / LASH		75 - 100	56,000	189	2,412			42.00	30.00							
PASSENGER SHIPS		100+	62,000	208	2,656			42.00	30.00							
TANKERS	ALL	0 - 25	5,435	19	238	868	859	60.00	48.00	658,262	575,979	20,571	987,393	1,254,812	987,393	2,242,205
	ASSUMED	25 - 50	11,375	45	572	559	643	60.00	48.00	1,100,873	963,264	34,402	1,651,310	2,098,540	1,651,310	3,749,850
	MOTOR	50 - 75	14,718	50	638			60.00	48.00							
		75 - 100	17,837	70	890			60.00	48.00							
		100+	23,200	74	940			60.00	48.00							
TOWBOAT OR TUGBOAT	MOTOR	0 - 25	16,000	52	671	64	64	24.00	12.00	137,398	120,223	4,294	51,524	261,915	51,524	313,439
		25 - 50	23,000	73	930			24.00	12.00							
TOTAL GALLONS OF FUEL CONSUMED PER YEAR.													MOTOR	9,839,185	5,751,171	15,590,357

Port of Houston - Houston Ship Channel

TYPE OF VESSEL	PROPULSION TYPE	VESSEL TONNAGE (1,000 DWT)	UNDERWAY (POUNDS OF POLLUTANT PER YEAR)					HOTELLING (POUNDS OF POLLUTANT PER YEAR)				
			NOx	HC	CO	SOx	PM	NOx	HC	CO	SOx	PM
CONTAINER SHIPS GENERAL CARGO VEHICLE CARRIERS RO-RO / LASH OCEAN-GOING TUGS PASSENGER SHIPS	ASSUMED MOTOR	0 - 25 25 - 50 50 75 75 100 100+	2,742,271 680,884	119,663 29,711	304,143 75,516	814 106 202,136	164,536 40 853	718 467 178,390	200 827 49 864	117 946 29,285	400,380 99,411	41,686 10 350
TANKERS	ASSUMED MOTOR	0 25 25 50 50 75 75 100 100+	690,146 1,154,197	30,115 50,365	76,544 128,011	204 886 342,650	41,409 69 252	289 306 483 834	80 867 135 242	47,494 79 428	161,222 269 626	16 786 28 072
		0 25 25 50	144,053	6,286	15,977	42,765	8 643	15 097	4 220	2,478	8,413	876
TOTAL MOTORSHIP EMISSIONS [Tons/year]			2,705.8	118.1	300 1	803.3	162.3	842.5	235.5	138.3	469.5	48.9
TOTAL EMISSIONS, UNDERWAY + HOTELLING			3,548.3	353 6	438.4	1,272.8	211.2					

Port of Houston - Galveston Channel

TYPE OF VESSEL	PROPULSION TYPE	VESSEL TONNAGE (1,000 DWT)	AVERAGE HORSEPOWER	FUEL CONSUMPTION AT FULL POWER (TONS/DAY)	FUEL CONSUMPTION AT FULL POWER (GALS/HOUR)	INBOUND VESSEL CALLS	OUTBOUND VESSEL CALLS	MEAN HOURS/ CALL	MEAN HOURS MOORED	GALLONS OF FUEL CONSUMED PER YEAR IN EACH OPERATING MODE: FULL	HALF	SLOW	HOTEL	ANNUAL GALLONS OF FUEL CONSUMED: UNDERWAY	HOTELLING	TOTAL
CONTAINER SHIPS	ALL	0 - 25	10,870	35	452	363	300	32.33	30.00	239 653		4 993	449,349	244 646	449 349	693 995
GENERAL CARGO	ASSUMED	25 - 50	28,135	91	1,166	74	145	32.33	30.00	204 346		4 257	383,148	208 603	383 148	591 751
VEHICLE CARRIERS	MOTOR	50 - 75	38,660	130	1,658			32.33	30.00							
RO-RO / LASH		75 - 100	56,000	189	2,412			32.33	30.00							
OCEAN-GOING TUGS		100+	62,000	208	2,656			32.33	30.00							
PASSENGER SHIPS																
TANKERS	ALL	0 - 25	5,435	19	238	69	24	50.33	48.00	17 724		369	53 172	18 093	53,172	71 265
	ASSUMED	25 - 50	11,375	45	572	14	81	50.33	48.00	43,504		906	130 511	44 410	130,511	174,921
	MOTOR	50 - 75	14,718	50	638			50.33	48.00							
		75 - 100	17,837	70	890			50.33	48.00							
		100+	23,200	74	940			50.33	48.00							
TOWBOAT OR	MOTOR	0 - 25	16 000	52	671	6	6	14.33	12.00	6,441		134	4,830	6 575	4,830	11 405
TUGBOAT		25 - 50	23,000	73	930			14.33	12.00							
TOTAL GALLONS OF FUEL CONSUMED PER YEAR													MOTOR.	522,327	1,021,011	1,543,338

Port of Houston - Galveston Channel

TYPE OF VESSEL	PROPULSION TYPE	VESSEL TONNAGE (1,000 DWT)	UNDERWAY (POUNDS OF POLLUTANT PER YEAR) NOx	HC	CO	SOx	PM	HOTELLING (POUNDS OF POLLUTANT PER YEAR) NOx	HC	CO	SOx	PM
CONTAINER SHIPS	ASSUMED	0 - 25	134,555	5,871	14,923	39,946	8,073	131,659	36,802	21,614	73,370	7 639
GENERAL CARGO	MOTOR	25 50	114,732	5,006	12,725	34,061	6,884	112,262	31 380	18,429	62,560	6,314
VEHICLE CARRIERS		50 75										
RO-RO / LASH		75 100										
PASSENGER SHIPS		100+										
TANKERS	ASSUMED	0 25	9,951	434	1,104	2,954	597	15,579	4,355	2,558	8 682	904
	MOTOR	25 50	24,426	1,066	2,709	7,251	1 466	38,240	10,689	6,278	21,310	2,219
		50 75										
		75 100										
		100+										
TUGBOATS AND		0 25	3 616	158	401	1,074	217	1,415	396	232	789	82
TOWBOATS		25 50										
TOTAL MOTORSHIP EMISSIONS [Tons/year]			143.6	6.3	15 9	42.6	8.6	149 6	41.8	24.6	83 4	8.7
TOTAL EMISSIONS, UNDERWAY + HOTELLING			293.2	48 1	40.5	126.0	17.3					

Port of Houston - Galveston Harbor

TYPE OF VESSEL	PROPULSION TYPE	VESSEL TONNAGE (1,000 DWT)	AVERAGE HORSEPOWER	FUEL CONSUMPTION AT FULL POWER (TONS/DAY)	FUEL CONSUMPTION AT FULL POWER (GALS/HOUR)	INBOUND VESSEL CALLS	OUTBOUND VESSEL CALLS	MEAN HOURS/ CALL	MEAN HOURS MOORED	GALLONS OF FUEL CONSUMED PER YEAR IN EACH OPERATING MODE: FULL	HALF	SLOW	HOTEL	ANNUAL GALLONS OF FUEL CONSUMED: UNDERWAY	HOTELLING	TOTAL
CONTAINER SHIPS	ALL	0 - 25	10,870	35	452	2,266	2,063	32.93	30.00	2,034,231		32,600	2,933,987	2,066,831	2,933,987	5,000,818
GENERAL CARGO	ASSUMED	25 - 50	28,135	91	1,166	174	238	32.93	30.00	499,761		8,009	720,809	507,770	720,809	1,228,578
VEHICLE CARRIERS	MOTOR	50 - 75	38,660	130	1,658	88	134	32.93	30.00	382,826		6,135	552,153	388,961	552,153	941,115
RO-RO / LASH		75 - 100	56,000	189	2,412			32.93	30.00							
OCEAN-GOING TUGS		100+	62,000	208	2,656			32.93	30.00							
PASSENGER SHIPS																
TANKERS	ALL	0 - 25	5,435	19	238	1,150	1,100	50.93	48.00	557,445		8,933	1,286,412	566,379	1,286,412	1,852,791
	ASSUMED	25 - 50	11,375	45	572	926	1,088	50.93	48.00	1,198,963		19,214	2,766,837	1,218,177	2,766,837	3,985,014
	MOTOR	50 - 75	14,718	50	638	73	71	50.93	48.00	95,490		1,530	220,362	97,021	220,362	317,383
		75 - 100	17,837	70	890			50.93	48.00							
		100+	23,200	74	940			50.93	48.00							
TOWBOAT OR	MOTOR	0 - 25	16,000	52	671	218	183	14.93	12.00	279,787		4,484	161,416	284,271	161,416	445,686
TUGBOAT		25 - 50	23,000	73	930			14.93	12.00							
									TOTAL GALLONS OF FUEL CONSUMED PER YEAR				MOTOR	5,129,409	8,641,976	13,771,385

5.3 FISHING VESSELS

In 1990, Houston-Galveston was ranked forty-ninth among the United State's ports in value of commercial fishing landings, but did not appear on the National Marine Fisheries Service's list of top 60 ports when ranked by weight of landings. Port officials[8]state that commercial fishing activity is centered at several minor ports around Galveston Bay. Commercially important species are oysters, bay shrimp and gulf shrimp. Discussions with Texas and National Fisheries Service staff indicate that landings at gulf coast ports are extremely variable, depending on the location of the shrimp each season. Indeed, landings at Galveston bay have decreased by 40 percent during the last three years (Exhibit 17).

To estimate fishing vessel emissions for Galveston Bay, emission factors giving pounds of pollutant per dollar value of catch were calculated, based on data for all commercial fishing activity in the Gulf Coast. In 1987, the National Marine Fisheries Service conducted a national survey of commercial fishing vessels. Vessel populations obtained through this survey are listed by length and gross registered tonnage in *Fisheries of the Unted States, 1990* (See Appendix for excerpt). An expert on Gulf Coast marine vessels[9] considered length to be an adequate predictor of horsepower. Therefore, this survey, along with the assumption that fishing vessels operating in Galveston Bay are substantially similar to those operating throughout the Gulf Coast, were used to characterize the fleet operating out of Galveston Bay. Conversations with experts in the National Marine Fisheries Service indicate that the character of commercial fishing is substantially similar along the entire Gulf Coast. Accordingly, emissions of the entire Gulf Coast fishing fleet were calculated and compared with the value of the Gulf catch to obtain emission factors in terms of pounds of pollutant per dollar value of catch . These factors were then applied to the value of the 1990 catch reported for the Houston-Galveston area to obtain its emission inventory. The results are presented in Exhibit 17.

Information appearing in *Fisheries of the United States, 1990*, indicates that about 60 percent of the gulf coast shrimp catch is taken at a distance of less than 3 miles off shore, with the remainder taken at distances between 3 and 200 miles. Gulf shrimpers typically stay at sea for up to five days, in order to reach distant fishing grounds. Therefore, the inventory of fishing vessel emissions attributed to Houston-Galveston is probably somewhat overestimated, since emissions occurring far offshore should be discounted. However, this point is largely academic. Even without discounting this portion of the inventory, fishing vessel emissions account for only 5 percent of the total marine vessel NOx inventory for this area.

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8 Mr. Dick Gorini, Manager of Environmental Affairs, Port of Houston, personal communication

9 Mr. Lonny Babin, Chief Estimator, Bollinger Ship Builders, Lockport, LA, personal communication.

EXHIBIT 17

Fishing Vessel Emissions in Houston-Galveston Area

Gulf Coast Fishing Vessel Emissions

VESSEL HORSEPOWER RANGE	NUMBER OF VESSELS	OPERATING PROFILE			DAILY OPERATING HOURS	OPERATING DAYS PER YEAR	FUEL CONSUMPTION (GALS/HOUR)
		20% POWER	50% POWER	80% POWER			
0 - 499	3,569	0 30	0.50	0 20	10	160	11 46
500 - 999	2,777	0 30	0 50	0 20	12	140	18.79
1000 - 1499	881	0 30	0 50	0 20	12	130	31.68
1500 +	9	0 30	0 50	0 20	12	120	75.69

VESSEL HORSEPOWER RANGE	TOTAL FUEL CONSUMED (GALLONS)	TOTAL VESSEL EMISSIONS (TONS OF POLLUTANT PER YEAR)				
		NOx	HC	CO	SOx	PM
0 - 499	65,447,808	11,483	1,530	1,736	4,110	556
500 - 999	87,671,632	15,383	2,050	2,325	5,506	745
1000 - 1499	43,540,000	7,640	1,018	1,155	2,734	370
1500 +	980,931	172	23	26	62	8
TOTAL		**34,678**	**4,621**	**5,242**	**12,412**	**1,680**

1990 Gulf Coast Catch: 1624631000 pounds
Value of 1990 Gulf Coast Catch: 640,356,000 Dollars

	Gulf Coast Fishing Vessel Emission Factors [Pound of Pollutant per Pound of Catch]				
	NOx	HC	CO	SOx	PM
Pounds ofpollutant per pound of catch	0 0427	0 0057	0 0065	0 0153	0 0021
Pound of pollutant per Dollar value of Catch	0 10831	0 01443	0 01637	0 03877	0 00525

Fishing Vessel Emission Inventory for the Houston-Galveston Area

Year	Value of Catch
1988	$21.4 million
1989	$15.1 million
1990	$13.0 million

1990 Fishing Vessel Emission Inventory [Tons per Year]				
NOx	HC	CO	SOx	PM
704.00	**93.81**	**106.43**	**251.97**	**34.10**

5.4 INVENTORY RESULTS

The total Marine Vessel Emission Inventory for the Houston-Galveston Area is shown below:

HOUSTON-GALVESTON EMISSION INVENTORIES (Tons/Year)					
Vessel Type	**NOx**	**HC**	**CO**	**SOx**	**PM**
Ocean-Going					
Underway	4,484	196	497	1,331	269
Hotelling	2,516	703	413	1042	146
Total Ocean-Going	**6,999**	**899**	**910**	**2,733**	**415**
Harbor Vessels	7,274	398	1,115	3,569	438
Fishing Vessels	704	94	106	252	34
Total (TONS/YR)	**14,977**	**1,391**	**2,131**	**6,554**	**887**
Total (TONS/DAY)	**41.0**	**3.81**	**5.83**	**18.0**	**2.43**

Port of Houston - Galveston Harbor

TYPE OF VESSEL	PROPULSION TYPE	VESSEL TONNAGE (1,000 DWT)	UNDERWAY (POUNDS OF POLLUTANT PER YEAR)					HOTELLING (POUNDS OF POLLUTANT PER YEAR)				
			NOx	HC	CO	SOx	PM	NOx	HC	CO	SOx	PM
CONTAINER SHIPS	ASSUMED MOTOR	0 25	1,136,757	49,604	126 077	337,472	68,205	859,658	240,294	141,125	479 061	49,878
GENERAL CARGO		25 - 50	279,273	12,186	30,974	82,909	16,756	211,197	59 034	34 671	117 694	12,254
VEHICLE CARRIERS		50 - 75	213,929	9,335	23,727	63,510	12,836	161 781	45 221	26,559	90,156	9,387
RO-RO / LASH		75 100										
OCEAN-GOING TUGS		100+										
PASSENGER SHIPS												
TANKERS	ASSUMED MOTOR	0 25	311,508	13,593	34,549	92,478	18,690	376 919	105,357	61,876	210 045	21,869
		25 - 50	669,997	29,236	74,309	198,904	40,200	810 683	226,604	133,085	451,769	47,036
		50 75	53,361	2,328	5,918	15,842	3,202	64,566	18,048	10,599	35,981	3,746
		75 100										
		100+										
TUGBOATS AND TOWBOATS		0 - 25	156,349	6,822	17,341	46,416	9,381	47,295	13,220	7,764	26,356	2,744
		25 50										
TOTAL MOTORSHIP EMISSIONS [Tons/year]			1,410.6	61.6	156.4	418.8	84.6	1,266 0	353 9	207.8	705.5	73.5
TOTAL EMISSIONS, UNDERWAY + HOTELLING			2,676.6	415 4	364.3	1,124.3	158.1					

Port of Houston - Texas City Channel

TYPE OF VESSEL	PROPULSION TYPE	VESSEL TONNAGE (1,000 DWT)	AVERAGE HORSEPOWER	FUEL CONSUMPTION AT FULL POWER (TONS/DAY)	FUEL CONSUMPTION AT FULL POWER (GALS/HOUR)	INBOUND VESSEL CALLS	OUTBOUND VESSEL CALLS	MEAN HOURS/ CALL	MEAN HOURS MOORED	GALLONS OF FUEL CONSUMED PER YEAR IN EACH OPERATING MODE: FULL	HALF	SLOW	HOTEL	ANNUAL GALLONS OF FUEL CONSUMED: UNDERWAY	HOTELLING	TOTAL
CONTAINER SHIPS	ALL	0 - 25	10,870	35	452	53	50	34.00	30 00	37,231		4,654	69,808	41,885	69 808	111,693
GENERAL CARGO	ASSUMED	25 - 50	28,135	91	1,166	29	56	34 00	30 00	79 312		9,914	148,711	89 226	148 711	237,937
VEHICLE CARRIERS	MOTOR	50 - 75	38,660	130	1,658	3	3	34 00	30.00	7,959		995	14,923	8,954	14 923	23,877
RO-RO / LASH		75 - 100	56,000	189	2,412			34 00	30 00							
OCEAN-GOING TUGS		100+	62,000	208	2,656			34.00	30 00							
PASSENGER SHIPS																
TANKERS	ALL	0 - 25	5,435	19	238	211	217	52.00	48 00	81 568		10,196	244 704	91 764	244,704	336 468
	ASSUMED	25 - 50	11,375	45	572	405	419	52.00	48.00	377,338		47,167	1,132,013	424,505	1,132,013	1 556,518
	MOTOR	50 - 75	14,718	50	638	21	16	52.00	48 00	18 874		2,359	56,621	21,233	56,621	77 854
		75 - 100	17,837	70	890			52.00	48 00							
		100+	23,200	74	940			52.00	48 00							
TOWBOATS AND TUGBOATS	MOTOR	0 - 25	16,000	52	671	111	113	16.00	12 00	120 223		15,028	90,167	135,251	90 167	225 418
		25 - 50	23,000	73	930			16.00	12.00							

TOTAL GALLONS OF FUEL CONSUMED PER YEAR. **MOTOR:** **812,818** **1,756,947** **2,569,765**

Port of Houston - Texas City Channel

TYPE OF VESSEL	PROPULSION TYPE	VESSEL TONNAGE (1,000 DWT)	UNDERWAY (POUNDS OF POLLUTANT PER YEAR)					HOTELLING (POUNDS OF POLLUTANT PER YEAR)				
			NOx	HC	CO	SOx	PM	NOx	HC	CO	SOx	PM
CONTAINER SHIPS GENERAL CARGO VEHICLE CARRIERS RO-RO / LASH PASSENGER SHIPS	ASSUMED MOTOR	0 - 25 25 - 50 50 - 75 75 - 100 100+	23,037 49,074 4,925	1,005 2,141 215	2,555 5,443 546	6,839 14,569 1,462	1,382 2,944 295	20,454 43,572 4,372	5,717 12,179 1,222	3,358 7,153 718	11,398 24,281 2,437	1,187 2,528 254
TANKERS	ASSUMED MOTOR	0 - 25 25 - 50 50 - 75 75 - 100 100+	50,470 233,478 11,678	2,202 10,188 510	5,598 25,895 1,295	14,983 69,313 3,467	3,028 14,009 701	71,698 331,680 16,590	20,041 92,712 4,637	11,770 54,450 2,723	39,955 184,835 9,245	4,160 19,244 963
TOWBOATS AND TUGBOATS	MOTOR	0 - 25 25 - 50	74,388	3,246	8,250	22,084	4,463	26,419	7,385	4,337	14,723	1,533
TOTAL MOTORSHIP EMISSIONS [Tons/year]			223.5	9.8	24.8	66.4	13.4	257.4	71.9	42.3	143.4	14.9
TOTAL EMISSIONS, UNDERWAY + HOTELLING			480.9	81.7	67.0	209.8	28.3					

Census of Gulf Coast Fishing Vessels Used to Calculate Fishing Vessel Emissions for Houston-Galveston

Ocean Going Vessel Emission Calculations

– New York –

Port of New York - In Port Emissions from Ocean Going Vessels other than Bulk Cargo Ships
Route A: In and Out by Ambrose Tower

TYPE OF VESSEL	PROPULSION TYPE	VESSEL TONNAGE (1,000 DWT)	AVERAGE HORSEPOWER	FUEL CONSUMPTION AT FULL POWER (TONS/DAY)	FUEL CONSUMPTION AT FULL POWER (GALS/HOUR)	ANNUAL VESSEL CALLS	MEAN DAYS/ CALL	MEAN HOURS MOORED	GALLONS OF FUEL CONSUMED PER YEAR IN EACH OPERATING MODE: FULL	HALF	SLOW	HOTELLING	ANNUAL GALLONS OF FUEL CONSUMED: UNDERWAY	HOTELLING	TOTAL
CONTAINER SHIPS	MOTOR	0 - 25	10,870	35	452	194	1.39	29.86	140,249	140,249	8,766	261,740	289 264	261,740	551 005
		25 - 50	28,135	91	1,166	628	1 21	25.54	1,171,956	1,171,956	73,247	1,870,734	2,417,158	1 870,734	4,287,892
		50 - 75	38,660	130	1,658	219	1.38	29.62	581,005	581,005	36,313	1,075,585	1,198,322	1,075,585	2,273,907
		75 - 100	56,000	189	2,412										
		100+	62,000	208	2,656										
	STEAM	0 - 25	8,000	43	513	189	1.55	33 70	155,053	155,053	9,691	326,581	319,798	326,581	646,379
		25 - 50	15,000	73	860	46	0.89	17.86	63,302	63,302	3,956	70,661	130,561	70,661	201,222
		50 - 75	19,000	89	1,050										
		75 - 100	22,000	108	1,278										
		100+	26,000	120	1,412										
GENERAL CARGO	MOTOR	0 - 25	6,335	26	335	1,063	1.59	34.66	569,437	569,437	35,590	1,233,543	1,174,464	1,233,543	2,408,006
VEHICLE CARRIERS		25 50	14,709	43	548	146	0.95	19.30	128,108	128,108	8,007	154,530	264,222	154,530	418,752
RO-RO / LASH		50 - 75	16,765	53	678	20	0.68	12.82	21,707	21,707	1,357	17,393	44,771	17,393	62,164
OCEAN-GOING TUGS		75 - 100	18,000	56	712	2	0.73	14.02	2,278	2,278	142	1,996	4,698	1,996	6,693
		100+	21,000	64	822										
	STEAM	0 - 25	7,000	42	498	93	1 14	23.86	74,099	74,099	4,631	110,500	152,828	110,500	263,328
		25 - 50	16,000	78	920	11	2.52	56 98	16,183	16,183	1,011	57,633	33,378	57,633	91,011
		50 - 75	19,000	89	1,050										
		75 - 100	22,000	108	1,278										
		100+	26,000	120	1,412										
PASSENGER LINERS	MOTOR	0 - 25	10,000	32	415	87	0 79	15.46	57,722	57 722	3,608	55 774	119 051	55,774	174,825
CRUISE SHIPS		25 - 50	15,000	44	562										
	STEAM	0 - 25	8,000	43	513	65	0.57	10 18	53,325	53,325	3,333	33,928	109,983	33,928	143,911
		25 - 50	15,000	73	860	2	0.53	9 22	2,752	2,752	172	1,586	5,677	1,586	7,263
									TOTAL GALLONS OF FUEL CONSUMED PER YEAR			MOTOR	5,511,951	4,671,294	10,183,245
												STEAM	752,225	600,889	1,353,114

Port of New York - In Port Emissions from Ocean Going Vessels other than Bulk Cargo Ships
Route A: In and Out by Ambrose Tower

TYPE OF VESSEL	PROPULSION TYPE	VESSEL TONNAGE (1,000 DWT)	UNDERWAY (POUNDS OF POLLUTANT PER YEAR) NOx	HC	CO	SOx	PM	HOTELLING (POUNDS OF POLLUTANT PER YEAR) NOx	HC	CO	SOx	PM
CONTAINER SHIPS	MOTOR	0 - 25	159,095	6,942	17,645	47,231	9,546	76,690	21,437	12,590	42,737	4,450
		25 - 50	1,329,437	58,012	147,447	394,674	79,766	548,125	153,213	89,982	305,453	31,802
		50 - 75	659,077	28,760	73,098	195,662	39,545	315,146	88,090	51,736	175 621	18,285
		75 - 100										
		100+										
	STEAM	0 - 25	19,054	379	1,696	101,696	12,055	9,569	1,012	653	70,476	4,082
		25 - 50	7,779	155	692	41,518	4,922	2,070	219	141	15,249	883
		50 - 75										
		75 - 100										
		100+										
GENERAL CARGO	MOTOR	0 - 25	645,955	28,187	71,642	191,766	38,757	361,428	101 027	59,333	201,413	20,970
VEHICLE CARRIERS		25 - 50	145,322	6,341	16,118	43,142	8,719	45,277	12,656	7,433	25,232	2,627
RO-RO / LASH		50 - 75	24,624	1,075	2,731	7,310	1,477	5,096	1,424	837	2,840	296
OCEAN-GOING TUGS		75 - 100	2,584	113	287	767	155	585	163	96	326	34
		100+										
	STEAM	0 - 25	9,106	181	810	48,599	5,761	3,238	343	221	23,846	1,381
		25 - 50	1,989	40	177	10,614	1,258	1,689	179	115	12,437	720
		50 - 75										
		75 - 100										
		100+										
PASSENGER LINERS	MOTOR	0 25	65,478	2,857	7,262	19,439	3,929	16,342	4,568	2,683	9,107	948
CRUISE SHIPS		25 - 50										
	STEAM	0 - 25	6,553	130	583	34,975	4,146	994	105	68	7,322	424
		25 - 50	338	7	30	1,805	214	46	5	3	342	20
POUNDS OF POLLUTANT PER YEAR			3,076,392	133,178	340,217	1,139,199	210,251	1,386,295	384,442	225,891	892,401	86,923
TONS OF POLLUTANT PER YEAR			1538.2	66 6	170.1	569 6	105 1	693.1	192.2	112 9	446.2	43.5

Port of New York - In Port Emissions from Ocean Going Tankers and other Bulk Carriers
Route "A": In and out by Ambrose Tower

TYPE OF VESSEL	PROPULSION TYPE	VESSEL TONNAGE (1,000 DWT)	AVERAGE HORSEPOWER	FUEL CONSUMPTION AT FULL POWER (TONS/DAY)	FUEL CONSUMPTION AT FULL POWER (GALS/HOUR)	ANNUAL VESSEL CALLS	MEAN DAYS/ CALL	MEAN HOURS MOORED	GALLONS OF FUEL CONSUMED PER YEAR IN EACH OPERATING MODE: FULL	HALF	SLOW	HOTELLING	ANNUAL GALLONS OF FUEL CONSUMED: UNDERWAY	HOTELLING	TOTAL
TANKERS	MOTOR	0 - 25	5,435	19	238	368	2.97	66 78	140,267	140,267	26,300	585,438	306 833	585,438	892,271
BULK CARRIERS		25 - 50	11,375	45	572	743	3.61	82.14	680,490	680,490	127,592	3,493,465	1,488,572	3,493,465	4,982,037
		50 - 75	14,718	50	638	227	3 96	90.54	231,584	231,584	43,422	1,310,477	506,590	1,310,477	1,817 067
		75 - 100	17,837	70	890	129	4.88	112 62	183,596	183,596	34,424	1,292,287	401 616	1,292,287	1,693 903
		100+	23,200	74	940	10	4.53	104 22	15,046	15,046	2,821	98,009	32,914	98,009	130,923
	STEAM	0 - 25	10,663	51	602	43	1.63	34.62	41 437	41,437	7,769	89,659	90,643	89,659	180,302
		25 - 50	15,783	77	907	143	2.63	58 62	207,427	207,427	38,893	759,961	453,747	759,961	1,213,708
		50 - 75	30,269	147	1,732	19	3.05	68 70	52,644	52,644	9,871	226,038	115,158	226,038	341,196
		75 - 100	25,936	124	1,468	8	2.90	65 10	18,794	18,794	3,524	76,467	41,111	76,467	117,579
		100+	34,980	156	1,846	5	1.34	27 66	14,770	14,770	2,769	25,533	32,309	25,533	57,842
									TOTAL GALLONS OF FUEL CONSUMED PER YEAR:			MOTOR	2,736,526	6,779,676	9,516,202
												STEAM	732,968	1,177,658	1,910,626

Port of New York - In Port Emissions from Ocean Going Tankers and other Bulk Carriers
Route "A": In and out by Ambrose Tower

TYPE OF VESSEL	PROPULSION TYPE	VESSEL TONNAGE (1,000 DWT)	UNDERWAY (POUNDS OF POLLUTANT PER YEAR)					HOTELLING (POUNDS OF POLLUTANT PER YEAR)				
			NOx	HC	CO	SOx	PM	NOx	HC	CO	SOx	PM
TANKERS	MOTOR	0 - 25	168,758	7,364	18,717	50,100	10,125	171,533	47,947	28,160	95,590	9,952
BULK CARRIERS		25 - 50	818,714	35,726	90,803	243,054	49,123	1,023,585	286,115	168,036	570,413	59,389
		50 - 75	278,625	12,158	30,902	82,716	16,717	383,970	107,328	63,034	213,975	22,278
		75 - 100	220,889	9,639	24,499	65,576	13,253	378,640	105,838	62,159	211,005	21,969
		100+	18,103	790	2,008	5,374	1,086	28,717	8,027	4,714	16,003	1,666
	STEAM	0 - 25	5,381	105	471	28,824	3,325	2,627	278	179	19,348	1,121
		25 - 50	26,937	525	2,358	144,291	16,646	22,267	2,356	1,520	164,000	9,500
		50 - 75	6,836	133	598	36,620	4,225	6,623	701	452	48,779	2,825
		75 - 100	2,441	48	214	13,073	1,508	2,240	237	153	16,502	956
		100+	1,918	37	168	10,274	1,185	748	79	51	5,510	319
POUNDS OF POLLUTANT PER YEAR			1,548,602	66,524	170,737	679,904	117,195	2,020,950	558,906	328,458	1,361,124	129,975
TONS OF POLLUTANT PER YEAR			774.3	33.3	85.4	340.0	58.6	1,010.5	279.5	164.2	680 6	65.0

Port of New York - In Port Emissions from Ocean Going Vessels
Route B: In and out by City Island

TYPE OF VESSEL	PROPULSION TYPE	VESSEL TONNAGE (1,000 DWT)	AVERAGE HORSEPOWER	FUEL CONSUMPTION AT FULL POWER (TONS/DAY)	FUEL CONSUMPTION AT FULL POWER (GALS/HOUR)	ANNUAL VESSEL CALLS	MEAN DAYS/ CALL	MEAN HOURS MOORED	GALLONS OF FUEL CONSUMED PER YEAR IN EACH OPERATING MODE: FULL	HALF	SLOW	HOTEL	ANNUAL GALLONS OF FUEL CONSUMED: UNDERWAY	HOTELLING	TOTAL
CONTAINER SHIPS	MOTOR	0 - 25	10,870	35	452										
		25 - 50	28,135	91	1,166										
		50 - 75	38,660	130	1,658										
		75 - 100	56,000	189	2,412										
		100+	62,000	208	2,656										
	STEAM	0 - 25	8,000	43	513										
		25 - 50	15,000	73	860										
		50 - 75	19,000	89	1,050										
		75 - 100	22,000	108	1,278										
		100+	26,000	120	1,412										
TANKERS	MOTOR	0 25	5,435	19	238										
BULK CARRIERS		25 - 50	11,375	45	572	1	1.65	34.60	2,290	916	57	1,981	3,263	1 981	5,243
		50 - 75	14,718	50	638										
		75 - 100	17,837	70	890										
		100+	23,200	74	940	1	2.79	61 96	3,762	1,505	94	5,827	5,360	5,827	11,187
	STEAM	0 - 25	10,663	51	602										
		25 - 50	15,783	77	907										
		50 - 75	30,269	147	1,732										
		75 - 100	25,936	124	1,468										
		100+	34,980	156	1,846										
GENERAL CARGO	MOTOR	0 - 25	6,335	26	335										
VEHICLE CARRIERS		25 - 50	14,709	43	548										
RO-RO / LASH		50 - 75	16,765	53	678										
OCEAN-GOING TUGS		75 - 100	18,000	56	712										
		100+	21,000	64	822										
PASSENGER LINERS	MOTOR	0 - 25	10,000	33	419										
CRUISE SHIPS		25 - 50	15,000	49	624										
	STEAM	0 - 25	8,000	48	564										
		25 - 50	15,000	78	920										
									TOTAL GALLONS OF FUEL CONSUMED PER YEAR			MOTOR:	8,623	7,807	16,430

Port of New York - In Port Emissions from Ocean Going Vessels
Route B: In and out by City Island

TYPE OF VESSEL	PROPULSION TYPE	VESSEL TONNAGE (1,000 DWT)	UNDERWAY (POUNDS OF POLLUTANT PER YEAR) NOx	HC	CO	SOx	PM	HOTELLING (POUNDS OF POLLUTANT PER YEAR) NOx	HC	CO	SOx	PM
CONTAINER SHIPS	MOTOR	0 - 25										
		25 - 50										
		50 - 75										
		75 - 100										
		100+										
	STEAM	0 - 25										
		25 - 50										
		50 - 75										
		75 - 100										
		100+										
TANKERS	MOTOR	0 - 25										
BULK CARRIERS		25 - 50	1,795	78	199	533	108	580	162	95	323	34
		50 - 75										
		75 - 100										
		100+	2,948	129	327	875	177	1,707	477	280	951	99
	STEAM	0 - 25										
		25 - 50										
		50 - 75										
		75 - 100										
		100+										
GENERAL CARGO	MOTOR	0 - 25										
VEHICLE CARRIERS		25 - 50										
RO-RO / LASH		50 - 75										
OCEAN-GOING TUGS		75 - 100										
		100+										
PASSENGER LINERS	MOTOR	0 - 25										
CRUISE SHIPS		25 - 50										
	STEAM	0 - 25										
		25 - 50										
POUNDS OF POLLUTANT PER YEAR			4,743	207	526	1,408	285	2,288	639	376	1,275	133
TONS OF POLLUTANT PER YEAR			2.37	0.10	0.26	0.70	0.14	1.14	0.32	0.19	0.64	0.07

Port of New York - In Port Emissions from Ocean Going Vessels
Route C: In by Ambrose Tower and Out by City Island, or vice versa

TYPE OF VESSEL	PROPULSION TYPE	VESSEL TONNAGE (1,000 DWT)	AVERAGE HORSEPOWER	FUEL CONSUMPTION AT FULL POWER (TONS/DAY)	(GALS/HOUR)	ANNUAL VESSEL CALLS	MEAN DAYS/ CALL	MEAN HOURS MOORED	GALLONS OF FUEL CONSUMED PER YEAR IN EACH OPERATING MODE: FULL	HALF	SLOW	HOTEL	ANNUAL GALLONS OF FUEL CONSUMED: UNDERWAY	HOTELLING	TOTAL
CONTAINER SHIPS	MOTOR	0 - 25	10,870	35	452	3	1 44	31.56	1,084	2,169	136	4 278	3,389	4,278	7,667
		25 - 50	28,135	91	1,166	5	1.88	42.12	4,665	9,331	583	24,563	14,579	24,563	39,143
		50 - 75	38,660	130	1,658										
		75 - 100	56,000	189	2,412										
		100+	62,000	208	2,656										
	STEAM	0 - 25	8,000	43	513										
		25 - 50	15,000	73	860										
		50 - 75	19,000	89	1,050										
		75 - 100	22,000	108	1,278										
		100+	26,000	120	1,412										
TANKERS	MOTOR	0 - 25	5,435	19	238	31	2.59	59 16	5,908	11,816	738	43,689	18,462	43,689	62,152
BULK CARRIERS		25 - 50	11,375	45	572	57	1.98	44.52	26,102	52,204	3,263	145,259	81,569	145,259	226,828
		50 - 75	14,718	50	638	13	3.00	69.00	6,631	13,263	829	57,195	20,723	57,195	77,917
		75 - 100	17,837	70	890										
		100+	23,200	74	940										
	STEAM	0 - 25	10,663	51	602										
		25 - 50	15,783	77	907										
		50 - 75	30,269	147	1,732										
		75 - 100	25,936	124	1,468										
		100+	34,980	156	1,846										
GENERAL CARGO	MOTOR	0 - 25	6,335	26	335	93	1 12	23.88	24,910	49,819	3,114	74,355	77,842	74 355	152,197
VEHICLE CARRIERS		25 - 50	14,709	43	548	2	3.87	89.88	877	1,755	110	9,858	2,742	9,858	12,600
RO-RO / LASH		50 - 75	16,765	53	678										
OCEAN-GOING TUGS		75 - 100	18,000	56	712										
		100+	21,000	64	822										
PASSENGER LINERS	MOTOR	0 - 25	10,000	32	415	1	0.64	12.36	332	663	41	513	1,037	513	1,549
CRUISE SHIPS		25 - 50	15,000	44	562										
	STEAM	0 - 25	8,000	43	513										
		25 - 50	15,000	73	860										
									TOTAL GALLONS OF FUEL CONSUMED PER YEAR			MOTOR.	220,344	359,710	580,054

Port of New York - In Port Emissions from Ocean Going Vessels
Route C: In by Ambrose Tower and Out by City Island, or vice versa

TYPE OF VESSEL	PROPULSION TYPE	VESSEL TONNAGE (1,000 DWT)	UNDERWAY (POUNDS OF POLLUTANT PER YEAR) NOx	HC	CO	SOx	PM	HOTELLING (POUNDS OF POLLUTANT PER YEAR) NOx	HC	CO	SOx	PM
CONTAINER SHIPS	MOTOR	0 - 25	1,864	81	207	553	112	1,253	350	206	699	73
		25 - 50	8,019	350	889	2,381	481	7,197	2,012	1,182	4,011	418
		50 75										
		75 - 100										
		100+										
	STEAM	0 - 25										
		25 - 50										
		50 - 75										
		75 - 100										
		100+										
TANKERS	MOTOR	0 - 25	10,154	443	1,126	3,015	609	12,801	3,578	2,101	7,134	743
BULK CARRIERS		25 - 50	44,863	1,958	4,976	13,319	2,692	42,561	11,897	6,987	23,718	2,469
		50 - 75	11,397	497	1,264	3,384	684	16,758	4,684	2,751	9,339	972
		75 - 100										
		100+										
	STEAM	0 - 25										
		25 - 50										
		50 - 75										
		75 - 100										
		100+										
GENERAL CARGO	MOTOR	0 - 25	42,813	1,868	4,748	12,710	2,569	21,786	6,090	3,576	12,141	1,264
VEHICLE CARRIERS		25 - 50	1,508	66	167	448	90	2,888	807	474	1,610	168
RO-RO / LASH		50 - 75										
OCEAN-GOING TUGS		75 - 100										
		100+										
PASSENGER LINERS	MOTOR	0 - 25	570	25	63	169	34	150	42	25	84	9
CRUISE SHIPS		25 - 50										
	STEAM	0 - 25										
		25 - 50										
POUNDS OF POLLUTANT PER YEAR			121,189	5,288	13,441	35,978	7,271	105,395	29,460	17,302	58,733	6,115
TONS OF POLLUTANT PER YEAR			60.59	2 64	6.72	17 99	3 64	52.70	14.73	8.65	29.37	3.06

APPENDIX E
Philadelphia

Ocean Going Vessel Emission Calculations

– Philadelphia –

Port of Philadelphia - Ocean-Going Vessels Except for Tankers

TYPE OF VESSEL	PROPULSION TYPE	VESSEL TONNAGE (1,000 DWT)	AVERAGE HORSEPOWER	FUEL CONSUMPTION AT FULL POWER (TONS/DAY)	(GALS/HOUR)	ANNUAL VESSEL CALLS	MEAN HOURS/ CALL	MEAN HOURS MOORED	GALLONS OF FUEL CONSUMED PER YEAR IN EACH OPERATING MODE FULL	HALF	SLOW	HOTEL	ANNUAL GALLONS OF FUEL CONSUMED UNDERWAY	HOTELLING	TOTAL
CONTAINER SHIPS	MOTOR	0 - 25	10,870	35	452	264	38 00	30 00		381,710		357,853	381,710	357,853	739,563
		25 - 50	28,135	91	1,166	122	38 00	30 00		455,346		426,887	455 346	426,887	882,232
		50 - 75	38,660	130	1,658	2	38.00	30 00		10,612		9,949	10,612	9,949	20,561
		75 - 100	56,000	189	2,412		38.00	30 00							
		100+	62,000	208	2,656		38.00	30 00							
	STEAM	0 - 25	8,000	43	513										
		25 - 50	15,000	73	860										
		50 - 75	19,000	89	1,050										
		75 - 100	22,000	108	1,278										
		100+	26,000	120	1,412										
TANKERS	MOTOR	0 - 25	5,435	19	238	340	56.00	48 00		259,188		388,782	259,188	388,782	647,971
BULK CARRIERS		25 - 50	11,375	45	572	347	56.00	48 00		635,612		953,419	635,612	953,419	1,589,031
		50 - 75	14,718	50	638	66	56.00	48 00		134,666		201,999	134,666	201,999	336,664
		75 - 100	17,837	70	890	28	56.00	48 00		79,701		119,551	79,701	119,551	199,252
		100+	23,200	74	940	8	56.00	48 00		24,074		36,112	24 074	36,112	60,186
	STEAM	0 - 25	10,663	51	602										
		25 - 50	15,783	77	907										
		50 - 75	30,269	147	1,732										
		75 - 100	25,936	124	1,468										
		100+	34,980	156	1,846										
GENERAL CARGO	MOTOR	0 - 25	6,335	26	335	547	38 00	30.00		586,043		549,416	586,043	549,416	1,135,459
VEHICLE CARRIERS		25 - 50	14,709	43	548	2	38 00	30 00		3,510		3,290	3,510	3,290	6,800
RO-RO / LASH		50 - 75	16,765	53	678										
OCEAN-GOING TUGS		75 - 100	18,000	56	712	1	38.00	30 00		2,278		2,135	2,278	2,135	4,413
		100+	21,000	64	822										
	STEAM	0 - 25	7,000	42	498										
		25 - 50	16,000	78	920										
		50 - 75	19,000	89	1,050										
		75 - 100	22,000	108	1,278										
		100+	26,000	120	1,412										
PASSENGER LINERS	MOTOR	0 - 25	10,000	32	415	15	20 00	12.00		19,904		7,464	19,904	7,464	27,368
CRUISE SHIPS		25 - 50	15,000	44	562	7	20.00	12.00		12,584		4,719	12,584	4,719	17,303
	STEAM	0 - 25	8,000	43	513										
		25 - 50	15,000	73	860										

TOTAL GALLONS OF FUEL CONSUMED PER YEAR

MOTOR	2,605,228	3,061,575	5,666,802
STEAM			

Port of Philadelphia - Ocean-Going Vessels Except for Tankers

TYPE OF VESSEL	PROPULSION TYPE	VESSEL TONNAGE (1,000 DWT)	UNDERWAY (POUNDS OF POLLUTANT PER YEAR)					HOTELLING (POUNDS OF POLLUTANT PER YEAR)				
			NOx	HC	CO	SOx	PM	NOx	HC	CO	SOx	PM
CONTAINER SHIPS	MOTOR	0 - 25	209,940	9,161	23,284	62,326	12,596	104,851	29,308	17,213	58,430	6,083
		25 - 50	250,440	10,928	27,776	74,349	15,026	125,078	34,962	20,533	69,702	7,257
		50 - 75	5,837	255	647	1,733	350	2,915	815	479	1,624	169
		75 100										
		100+										
	STEAM	0 - 25										
		25 - 50										
		50 - 75										
		75 - 100										
		100+										
BULK CARRIERS	MOTOR	0 - 25	142,554	6,221	15,810	42,320	8,553	113,913	31,841	18,700	63,480	6 609
		25 - 50	349,587	15,255	38,772	103,783	20,975	279,352	78,085	45,859	155,674	16,208
		50 - 75	74,066	3,232	8,215	21,988	4,444	59,186	16,544	9,716	32,982	3,434
		75 - 100	43,835	1,913	4,862	13,014	2,630	35,028	9,791	5,750	19,520	2,032
		100+	13,241	578	1,469	3,931	794	10,581	2,958	1,737	5,896	614
	STEAM	0 - 25										
		25 - 50										
		50 - 75										
		75 - 100										
		100+										
GENERAL CARGO	MOTOR	0 - 25	322,324	14,065	35,749	95,689	19,339	160,979	44,997	26,427	89,709	9,340
VEHICLE CARRIERS		25 - 50	1,930	84	214	573	116	964	269	158	537	56
RO-RO / LASH		50 - 75										
OCEAN-GOING TUGS		75 - 100	1,253	55	139	372	75	626	175	103	349	36
		100+										
	STEAM	0 - 25										
		25 50										
		50 - 75										
		75 - 100										
		100+										
PASSENGER LINERS	MOTOR	0 - 25	10,947	478	1,214	3,250	657	2,187	611	359	1,219	127
CRUISE SHIPS		25 - 50	6,921	302	302	2,055	415	1,383	386	227	771	80
	STEAM	0 - 25										
		25 - 50										
TOTAL MOTORSHIP EMISSIONS [Tons/year]			716.44	31.26	79.23	212.69	42.99	448.52	125.37	73.63	249 95	26 02

Port of Philadelphia - Tanker Calls at Marcus Hook

TYPE OF VESSEL	PROPULSION TYPE	VESSEL TONNAGE (1,000 DWT)	AVERAGE HORSEPOWER	FUEL CONSUMPTION AT FULL POWER (TONS/DAY)	FUEL CONSUMPTION AT FULL POWER (GALS/HOUR)	ANNUAL VESSEL CALLS	MEAN HOURS/ CALL	MEAN HOURS MOORED	GALLONS OF FUEL CONSUMED PER YEAR IN EACH OPERATING MODE FULL	HALF	SLOW	HOTEL	ANNUAL GALLONS OF FUEL CONSUMED UNDERWAY	HOTELLING	TOTAL
TANKERS	MOTOR	0 - 25	5,435	19	238	192	52.00	48 00		73,183		219,548	73,183	219,548	292,730
		25 - 50	11,375	45	572	224	52.00	48.00		205,154		615,463	205,154	615,463	820,618
		50 - 75	14,718	50	638	135	52 00	48 00		137,726		413,179	137,726	413 179	550,905
		75 - 100	17,837	70	890	180	52 00	48.00		256,181		768,542	256,181	768 542	1 024 722
		100+	23,200	74	940	288	52.00	48.00		433,339		1,300,017	433,339	1,300,017	1,733,356
	STEAM	0 - 25	10,663	51	602		52.00	48 00							
		25 - 50	15,783	77	907		52.00	48.00							
		50 - 75	30,269	147	1,732										
		75 - 100	25,936	124	1,468										
		100+	34,980	156	1,846		52 00	48 00							
									TOTAL GALLONS OF FUEL CONSUMED PER YEAR			MOTOR	1,105,583	3,316,749	4,422,332
												STEAM			

Port of Philadelphia - Tanker Calls at Marcus Hook

TYPE OF VESSEL	PROPULSION TYPE	VESSEL TONNAGE (1,000 DWT)	UNDERWAY (POUNDS OF POLLUTANT PER YEAR)					HOTELLING (POUNDS OF POLLUTANT PER YEAR)				
			NOx	HC	CO	SOx	PM	NOx	HC	CO	SOx	PM
TANKERS	MOTOR	0 - 25	40,250	1,756	4,464	11,949	2,415	64,327	17,981	10,560	35 848	3,732
		25 - 50	112,835	4,924	12,514	33,498	6,770	180,331	50,406	29,604	100,493	10,463
		50 - 75	75,749	3,305	8,401	22,488	4,545	121,061	33,839	19,874	67,464	7,024
		75 - 100	140,899	6,148	15,627	41,829	8,454	225,183	62,944	36,967	125,487	13,065
		100+	238,336	10,400	26,434	70,756	14,300	380,905	106,471	62,531	212,267	22,100
	STEAM	0 - 25										
		25 50										
		50 - 75										
		75 100										
		100+										
	Total Motorship [Tons/year]		304.04	13.27	33.72	90.26	18.24	485.90	135.82	79.77	270 78	28 19
	Total Steamship [Tons/year]											

APPENDIX F
Seattle – Tacoma

Puget Sound Harbor and Coastal Vessels by Owner

Puget Sound Harbor and Coastal Vessels

Owner	Base Port	Vessel Type	No of Vessels in HP Range					
			0-500	51-1k	1 1-1 5k	1 51-2k	2 1-4k	>4k
Manson Const. & Engr	Seattle	Barge				1		
Kemp Pacific Fisheries	Seattle	Cargo Freighter			1			
Marine Management, Inc.	Seattle	Cargo Freighter			1			
Puget Sound Tug & Barge	Seattle	Cargo Freighter		1				
Tender Excursion Co	Seattle	Cargo Freighter	1					
Ward's Cove Packing Co	Seattle	Cargo Freighter	28	2				
Western Pioneer, Inc	Seattle	Cargo Freighter	1	6		1	2	
Alaska Marine Charter	Seattle	Cargo Frighter			1			
Alaska Outport Trans.	Seattle	Cargo Frighter			1			
Alaska Pacific Fisheries	Seattle	Cargo Frighter		1		1		
All Alaskan Seafoods	Seattle	Cargo Frighter					1	
Bendiksen Co.	Seattle	Cargo Frighter	3					
Coastal Transportation	Seattle	Cargo Frighter		1	2			
Sea Wolf Charters	Seattle	Crew Boat		1				
Togiak Fisheries, Inc.	Seattle	Crew Boat		1				
Daniel, Charles D	Tacoma	Crew Boat				1		
Skagit County	Anacortes	Ferry		1				
Whatcom County	Bellingham	Ferry		1				
Washington State Ferry	Seattle	Ferry		1	1	5	4	12
Alaska Marine Charter	Steilacoom	Ferry	1	1				
Palmer, Thomas E.	Tacoma	Ferry				1		
Island Ferry & Barge, Inc	Anacortes	Ferry, Vehicle	1					
Cloverleaf	Seattle	Other		1				
Puget Sound Tug & Barge	Seattle	Other					1	
Cruises, Inc	Seattle	Psgr	1					
Exploration Cruise Lines	Seattle	Psgr			1	2		
Gray Line Sightseeing	Seattle	Psgr	1					
Horluck Transportation Co	Seattle	Psgr	5					
Johnson, Wesley M.	Seattle	Psgr			1			
Puget Sound Tug & Barge	Seattle	Psgr		1				
Seattle Harbor Tours	Seattle	Psgr	2			4		
Virginia V Foundation	Seattle	Psgr	1					
Hat Island Community, Inc.	Everett	Psgr & Cargo	2					
Clipper Fisheries	Seattle	Psgr & Cargo			2			
Alaska Marine Charter	Seattle	Pushboat				1		
Tiny Tankers, Inc.	Seattle	Tanker	2					
Culbertson, Roland	Anacortes	Tugboat	1					
Filbert Towing Co.	Bellingham	Tugboat	1					
Foss Maritime Co.	Bellingham	Tugboat	1				4	
American Const. Co	Everell	Tugboat	1					
Dunlap Towing Company	Everett	Tugboat	5				2	
Foss Maritime Co.	Everett	Tugboat	3					
Geddes Marine Services	Everett	Tugboat	1					
Northland Services, Inc.	Everett	Tugboat		1				
Tate Towboat Co.	Everett	Tugboat	2					
Dunlap Towing Company	La Conner	Tugboat	1	1				
Chadwick Log Patrol Co.	Marysville	Tugboat	5					
Foss Maritime Co.	Port Angeles	Tugboat	2	1				
Foss Maritime Co.	Port Gamble	Tugboat		1				
Pope & Talbot, Inc.	Port Gamble	Tugboat	2					
Star Marine, Inc.	Port Townsend	Tugboat	1					
Coast Line Pacific	Seattle	Tugboat				1		
Duff Towboat Co.	Seattle	Tugboat	1					
Foss Maritime Co.	Seattle	Tugboat		2	5	4	13	
Freemont Boat Co.	Seattle	Tugboat	3	1				
General Construction Co.	Seattle	Tugboat		1				
Harbor Towing Service	Seattle	Tugboat	2					
Horluck Transportation Co	Seattle	Tugboat	1					
Hurlen Const. Co.	Seattle	Tugboat		1				

Puget Sound Harbor and Coastal Vessels

Owner	Base Port	Vessel Type	No of Vessels in HP Range					
			0-500	51-1k	1 1-1 5k	1 51-2k	2 1-4k	>4k
Inlet Towing, Inc.	Seattle	Tugboat	1	2		1		
Island Tug & Barge	Seattle	Tugboat		3	1	1		
J TC, Inc	Seattle	Tugboat	1					
Kenco Marine Services	Seattle	Tugboat			1			
Kitsap Barging, Inc.	Seattle	Tugboat	1					
Knappton Corporation	Seattle	Tugboat				1		
Knappton Maritime	Seattle	Tugboat		1	1	1	3	
Little, John L.	Seattle	Tugboat	2					
Manson Const. & Engr.	Seattle	Tugboat	1	2	1	1		
Mogul Ocean Towing, Inc.	Seattle	Tugboat					1	
Northland Services, Inc	Seattle	Tugboat		1	1			
Northwest Diesel Repair	Seattle	Tugboat			1			
Pacific Western Lines	Seattle	Tugboat					1	
Pioneer Towing Co	Seattle	Tugboat	1					
Puget Sound Freight Lines	Seattle	Tugboat			2		1	
Puget Sound Tug & Barge	Seattle	Tugboat	3	5	3	7	10	20
Roulstone & Associates	Seattle	Tugboat	1					
Samoan Maritime, LTD	Seattle	Tugboat	1					
Sea Coast Towing	Seattle	Tugboat			1			
Simmons Marine Towing	Seattle	Tugboat				1		
Simmons Tugboat Co.	Seattle	Tugboat		1				
Sinclair Towboat Co	Seattle	Tugboat	1					
Smith Boatworks	Seattle	Tugboat	1					
Stabbert & Assoc	Seattle	Tugboat					1	
Star Marine, Inc	Seattle	Tugboat	1					
Thompson Pile Driving	Seattle	Tugboat	1					
United Marine Tug & Barge	Seattle	Tugboat		1	2	6	7	7
Vessel Engr & Devel Co	Seattle	Tugboat				1		
Victory Towing, Inc	Seattle	Tugboat					2	
Ward's Cove Packing Co	Seattle	Tugboat		1				
Western Marine Const.	Seattle	Tugboat		1				
Western Sea Resources	Seattle	Tugboat			1			
Western Towboat Co	Seattle	Tugboat		2		2	4	
Wick Towing, Inc.	Seattle	Tugboat	1	2				
Dunlap Towing Company	Swinomish Channe	Tugboat	3	2	1			
Foss Maritime Co	Tacoma	Tugboat	1		1	1		
Powers, Albert H	Tacoma	Tugboat		1				
Wright's Marine Towing	Tacoma	Tugboat	2	1				
Boyer Towing, Inc.	Winslow	Tugboat			1			
Honeywell, Inc.	Seattle	Undefined		1				
Total			105	55	34	45	57	39
	TOTALS	Tugboat	56	35	23	29	49	27
		Psgr & Ferry	14	5	5	12	4	12
		Cargo Freighter	35	11	6	2	3	0
		Crew Boats & Other	0	4	0	2	1	0

Ocean Going Vessel
Emission Calculations

– Puget Sound –

Anacortes & March Pt. - In Port Emissions from Ocean Going Vessels

TYPE OF VESSEL	PROPULSION TYPE	VESSEL TONNAGE (1,000 DWT)	AVERAGE HORSEPOWER	FUEL CONSUMPTION AT FULL POWER (TONS/DAY)	FUEL CONSUMPTION AT FULL POWER (GALS/HOUR)	ANNUAL VESSEL CALLS	MEAN HOURS/ CALL	MEAN HOURS MOORED	GALLONS OF FUEL CONSUMED PER YEAR IN EACH OPERATING MODE: FULL	HALF	SLOW	HOTEL	ANNUAL GALLONS OF FUEL CONSUMED: UNDERWAY	HOTELLING	TOTAL
CONTAINER SHIPS	MOTOR	0 - 25	10,870	35	452										
		25 - 50	28,135	91	1,166										
		50 - 75	38,660	130	1,658										
		75 - 100	56,000	189	2,412										
		100+	62,000	208	2,656										
	STEAM	0 - 25	8,000	43	513										
		25 - 50	15,000	73	860										
		50 - 75	19,000	89	1,050										
		75 - 100	22,000	108	1,278										
		100+	26,000	120	1,412										
TANKERS	MOTOR	0 - 25	5,435	19	238	26	73 20	67 20	14,865	2,478	1,239	41,623	18,582	41,623	60,204
BULK CARRIERS		25 - 50	11,375	45	572	46	57 12	51 12	63,195	10,532	5,266	134,605	78,994	134,605	213,599
		50 - 75	14,718	50	638	70	37.68	31.68	107,120	17,853	8,927	141,399	133,901	141,399	275,300
		75 - 100	17,837	70	890	19	37.20	31 20	40,562	6,760	3,380	52,731	50,702	52,731	103,433
		100+	23,200	74	940	35	27.84	21.84	78,994	13,166	6,583	71,885	98,743	71,885	170,627
	STEAM	0 - 25	10,663	51	602	5	36 00	30.00	7,227	1,205	602	9,034	9,034	9,034	18,068
		25 - 50	15,783	77	907	38	39 12	33 12	82,681	13,780	6,890	114,099	103,351	114,099	217,450
		50 - 75	30,269	147	1,732	69	34.56	28.56	286,769	47,795	23,897	341,255	358,461	341,255	699,716
		75 - 100	25,936	124	1,468	106	36 72	30 72	373,526	62,254	31,127	478,113	466,908	478,113	945,021
		100+	34,980	156	1,846	65	27 12	21 12	288,011	48,002	24,001	253,449	360,013	253,449	613,463
GENERAL CARGO	MOTOR	0 - 25	6,335	26	335	6	55.20	49 20	4,821	804	402	9,883	6,026	9,883	15,910
VEHICLE CARRIERS		25 - 50	14,709	43	548										
RO-RO / LASH		50 - 75	16,765	53	678										
OCEAN-GOING TUGS		75 - 100	18,000	56	712										
		100+	21,000	64	822										
	STEAM	0 - 25	7,000	42	498										
		25 - 50	16,000	78	920										
		50 - 75	19,000	89	1,050										
		75 - 100	22,000	108	1,278										
		100+	26,000	120	1,412										
PASSENGER LINERS	MOTOR	0 - 25	10,000	32	415										
CRUISE SHIPS		25 - 50	15,000	44	562										
	STEAM	0 - 25	8,000	43	513										
		25 - 50	15,000	73	860										

TOTAL GALLONS OF FUEL CONSUMED PER YEAR	MOTOR	386,947	452,125	839,072
	STEAM	1,297,767	1,195,951	2,493 718

Anacortes & March Pt. - In Port Emissions from Ocean Going Vessels

TYPE OF VESSEL	PROPULSION TYPE	VESSEL TONNAGE (1,000 DWT)	UNDERWAY (POUNDS OF POLLUTANT PER YEAR) NOx	HC	CO	SOx	PM	HOTELLING (POUNDS OF POLLUTANT PER YEAR) NOx	HC	CO	SOx	PM
CONTAINER SHIPS	MOTOR	0 - 25										
		25 - 50										
		50 - 75										
		75 - 100										
		100+										
	STEAM	0 - 25										
		25 - 50										
		50 - 75										
		75 - 100										
		100+										
TANKERS	MOTOR	0 - 25	10,220	446	1,133	3,034	613	12,195	3,409	2,002	6,796	708
BULK CARRIERS		25 - 50	43,446	1,896	4,819	12,898	2,607	39,439	11,024	6,475	21,978	2,288
		50 - 75	73,645	3,214	8,168	21,863	4,419	41,430	11,581	6,801	23,088	2,404
		75 - 100	27,886	1,217	3,093	8,279	1,673	15,450	4,319	2,536	8,610	896
		100+	54,308	2,370	6,023	16,123	3,259	21,062	5,887	3,458	11,737	1,222
	STEAM	0 - 25	560	14	59	2,873	444	265	28	18	1,950	113
		25 - 50	6,412	156	672	32,866	5,085	3,343	354	228	24,623	1,426
		50 - 75	22,239	542	2,332	113,991	17,636	9,999	1,058	683	73,643	4,266
		75 - 100	28,967	706	3,038	148,477	22,972	14,009	1,482	956	103,177	5,976
		100+	22,335	544	2,342	114,484	17,713	7,426	786	507	54,694	3,168
GENERAL CARGO	MOTOR	0 - 25	3,315	145	368	984	199	2,896	809	475	1,614	168
VEHICLE CARRIERS		25 - 50										
RO-RO / LASH		50 - 75										
OCEAN-GOING TUGS		75 - 100										
		100+										
	STEAM	0 - 25										
		25 - 50										
		50 - 75										
		75 - 100										
		100+										
PASSENGER LINERS	MOTOR	0 - 25										
CRUISE SHIPS		25 - 50										
	STEAM	0 - 25										
		25 - 50										
POUNDS OF POLLUTANT PER YEAR			293,334	11,249	32,047	475,871	76,619	167,514	40,737	24,139	331,909	22,636

Anacortes & March Pt. - In Port Emissions from Ocean Going Vessels

VESSEL TONNAGE	UNDERWAY (POUNDS OF POLLUTANT PER YEAR)					HOTELLING (POUNDS OF POLLUTANT PER YEAR)				
	NOx	HC	CO	SOx	PM	NOx	HC	CO	SOx	PM
< 25K	14,095	604	1,560	6,891	1,257	15,356	4,246	2,496	10,359	989
25 - 50 K	49,858	2,052	5,491	45,764	7,692	42,782	11,378	6,703	46,601	3,715
50 - 75 K	95,884	3,756	10,500	135,854	22,055	51,429	12,638	7,484	96,730	6,669
75 - 100 K	56,853	1,923	6,131	156,755	24,645	29,459	5,801	3,493	111,787	6,873
> 100 K	76,644	2,914	8,366	130,607	20,971	28,488	6,673	3,965	66,432	4,390
TOTAL	293,334	11,249	32,047	475,871	76,619	167,514	40,737	24,139	331,909	22,636

Bellingham and Nearby Ports - In Port Emissions from Ocean Going Vessels

TYPE OF VESSEL	PROPULSION TYPE	VESSEL TONNAGE (1,000 DWT)	AVERAGE HORSEPOWER	FUEL CONSUMPTION AT FULL POWER (TONS/DAY)	FUEL CONSUMPTION AT FULL POWER (GALS/HOUR)	ANNUAL VESSEL CALLS	MEAN HOURS/ CALL	MEAN HOURS MOORED	GALLONS OF FUEL CONSUMED PER YEAR IN EACH OPERATING MODE: FULL	HALF	SLOW	HOTEL	ANNUAL GALLONS OF FUEL CONSUMED: UNDERWAY	HOTELLING	TOTAL
CONTAINER SHIPS	MOTOR	0 - 25	10,870	35	452										
		25 - 50	28,135	91	1,166										
		50 - 75	38,660	130	1,658										
		75 - 100	56,000	189	2,412										
		100+	62,000	208	2,656										
	STEAM	0 - 25	8,000	43	513										
		25 - 50	15,000	73	860										
		50 - 75	19,000	89	1,050										
		75 - 100	22,000	108	1,278										
		100+	26,000	120	1,412										
TANKERS	MOTOR	0 - 25	5,435	19	238	34	29.88	20.88	19,439	12,959	1,620	16,912	34,018	16,912	50,930
BULK CARRIERS		25 - 50	11,375	45	572	119	54.84	45.84	163,482	108,988	13,624	312,251	286,094	312,251	598,346
		50 - 75	14,718	50	638	9	41 16	32.16	13,773	9,182	1,148	18,455	24,102	18,455	42,557
		75 - 100	17,837	70	890	20	33 72	24 72	42,697	28,465	3,558	43,978	74,719	43,978	118,697
		100+	23,200	74	940	38	40.20	31.20	85,765	57,177	7,147	111,495	150,089	111,495	261,583
	STEAM	0 - 25	10,663	51	602	5	35 16	26 16	7,227	4,818	602	7,878	12,648	7,878	20 526
		25 - 50	15,783	77	907	35	39 72	30 72	76,153	50,769	6,346	97,476	133,268	97,476	230,745
		50 - 75	30,269	147	1,732	36	39.24	30.24	149,618	99,746	12,468	188,519	261,832	188,519	450,352
		75 - 100	25,936	124	1,468	31	34.68	25.68	109,239	72,826	9,103	116,885	191,168	116,885	308,053
		100+	34,980	156	1,846	139	35.40	26.40	615,900	410,600	51,325	677,490	1,077,825	677,490	1,755,315
GENERAL CARGO	MOTOR	0 - 25	6,335	26	335	2	156.84	147.84	1,607	1,071	134	9,900	2,812	9,900	12,712
VEHICLE CARRIERS		25 - 50	14,709	43	548										
RO-RO / LASH		50 - 75	16,765	53	678										
OCEAN-GOING TUGS		75 - 100	18,000	56	712										
		100+	21,000	64	822										
	STEAM	0 - 25	7,000	42	498										
		25 - 50	16,000	78	920										
		50 - 75	19,000	89	1,050										
		75 - 100	22,000	108	1,278										
		100+	26,000	120	1,412										
PASSENGER LINERS	MOTOR	0 - 25	10,000	32	415										
CRUISE SHIPS		25 - 50	15,000	44	562										
	STEAM	0 - 25	8,000	43	513										
		25 - 50	15,000	73	860										

TOTAL GALLONS OF FUEL CONSUMED PER YEAR.				
	MOTOR	571,835	512,991	1,084,826
	STEAM	1,676,741	1,088,249	2,764,990

Bellingham and Nearby Ports - In Port Emissions from Ocean Going Vessels

TYPE OF VESSEL	PROPULSION TYPE	VESSEL TONNAGE (1,000 DWT)	UNDERWAY (POUNDS OF POLLUTANT PER YEAR)					HOTELLING (POUNDS OF POLLUTANT PER YEAR)				
			NOx	HC	CO	SOx	PM	NOx	HC	CO	SOx	PM
CONTAINER SHIPS	MOTOR	0 - 25										
		25 - 50										
		50 - 75										
		75 - 100										
		100+										
	STEAM	0 - 25										
		25 - 50										
		50 - 75										
		75 - 100										
		100+										
TANKERS	MOTOR	0 - 25	18,710	816	2,075	5,555	1,123	4,955	1,385	813	2,761	288
BULK CARRIERS		25 - 50	157,352	6,866	17,452	46,713	9,441	91,490	25,573	15,019	50,984	5,308
		50 - 75	13,256	578	1,470	3,935	795	5,407	1,511	888	3,013	314
		75 - 100	41,096	1,793	4,558	12,200	2,466	12,885	3,602	2,115	7,181	748
		100+	82,549	3,602	9,155	24,506	4,953	32,668	9,131	5,363	18,205	1,895
	STEAM	0 - 25	762	16	71	4,022	517	231	24	16	1,700	98
		25 - 50	8,030	170	751	42,379	5,445	2,856	302	195	21,035	1,218
		50 - 75	15,777	334	1,475	83,263	10,698	5,524	584	377	40,682	2,356
		75 - 100	11,519	244	1,077	60,791	7,811	3,425	362	234	25,224	1,461
		100+	64,947	1,374	6,071	342,748	44,037	19,850	2,100	1,355	146,202	8,469
GENERAL CARGO	MOTOR	0 - 25	1,547	67	172	459	93	2,901	811	476	1 616	168
VEHICLE CARRIERS		25 - 50										
RO-RO / LASH		50 - 75										
OCEAN-GOING TUGS		75 - 100										
		100+										
	STEAM	0 - 25										
		25 - 50										
		50 - 75										
		75 - 100										
		100+										
PASSENGER LINERS	MOTOR	0 - 25										
CRUISE SHIPS		25 - 50										
	STEAM	0 - 25										
		25 - 50										
POUNDS OF POLLUTANT PER YEAR			415,545	15,862	44,327	626,573	87,377	182,192	45,387	26,851	318,605	22,324

Bellingham and Nearby Ports - In Port Emissions from Ocean Going Vessels

VESSEL TONNAGE	UNDERWAY (POUNDS OF POLLUTANT PER YEAR)					HOTELLING (POUNDS OF POLLUTANT PER YEAR)				
	NOx	HC	CO	SOx	PM	NOx	HC	CO	SOx	PM
< 25K	21,019	900	2,318	10,036	1,732	8,087	2,220	1,305	6,078	554
25 - 50 K	165,382	7,036	18,202	89,093	14,886	94,346	25,876	15,214	72,020	6,527
50 - 75 K	29,033	912	2,945	87,198	11,493	10,931	2,096	1,265	43,696	2,670
75 - 100 K	52,615	2,037	5,635	72,992	10,276	16,310	3,964	2,349	32,405	2,209
> 100 K	147,495	4,977	15,227	367,255	48,990	52,518	11,232	6,718	164,407	10,364
TOTAL	415,545	15,862	44,327	626,573	87,377	182,192	45,387	26,851	318,605	22,324

Edmonds and Point Wells - In Port Emissions from Ocean Going Vessels

TYPE OF VESSEL	PROPULSION TYPE	VESSEL TONNAGE (1,000 DWT)	AVERAGE HORSEPOWER	FUEL CONSUMPTION AT FULL POWER (TONS/DAY)	FUEL CONSUMPTION AT FULL POWER (GALS/HOUR)	ANNUAL VESSEL CALLS	MEAN HOURS/ CALL	MEAN HOURS MOORED	GALLONS OF FUEL CONSUMED PER YEAR IN EACH OPERATING MODE: FULL	HALF	SLOW	HOTEL	ANNUAL GALLONS OF FUEL CONSUMED: UNDERWAY	HOTELLING	TOTAL
CONTAINER SHIPS	MOTOR	0 25	10,870	35	452										
		25 - 50	28,135	91	1,166										
		50 - 75	38,660	130	1,658										
		75 - 100	56,000	189	2,412										
		100+	62,000	208	2,656										
	STEAM	0 - 25	8,000	43	513										
		25 - 50	15,000	73	860										
		50 - 75	19,000	89	1,050										
		75 - 100	22,000	108	1,278										
		100+	26,000	120	1,412										
TANKERS	MOTOR	0 - 25	5,435	19	238										
BULK CARRIERS		25 - 50	11,375	45	572	3	33 68	25.68	4,121	2,748	172	4,410	7 041	4,410	11,451
		50 - 75	14,718	50	638										
		75 - 100	17,837	70	890										
		100+	23,200	74	940										
	STEAM	0 - 25	10,663	51	602										
		25 - 50	15,783	77	907	63	23.84	15.84	137,076	91,384	5,711	90,470	234,171	90 470	324 642
		50 - 75	30,269	147	1,732	2	29.84	21.84	8,312	5,541	346	7,564	14,200	7,564	21,764
		75 - 100	25,936	124	1,468										
		100+	34,980	156	1,846										
GENERAL CARGO	MOTOR	0 - 25	6,335	26	335										
VEHICLE CARRIERS		25 - 50	14,709	43	548										
RO-RO / LASH		50 - 75	16,765	53	678										
OCEAN-GOING TUGS		75 - 100	18,000	56	712										
		100+	21,000	64	822										
	STEAM	0 - 25	7,000	42	498										
		25 - 50	16,000	78	920										
		50 - 75	19,000	89	1,050										
		75 - 100	22,000	108	1,278										
		100+	26,000	120	1,412										
PASSENGER LINERS	MOTOR	0 - 25	10,000	32	415										
CRUISE SHIPS		25 - 50	15,000	44	562										
	STEAM	0 - 25	8,000	43	513										
		25 - 50	15,000	73	860										

TOTAL GALLONS OF FUEL CONSUMED PER YEAR.

MOTOR	7 041	4,410	11 451
STEAM	248,371	98,034	346,406

Edmonds and Point Wells - In Port Emissions from Ocean Going Vessels

TYPE OF VESSEL	PROPULSION TYPE	VESSEL TONNAGE (1,000 DWT)	UNDERWAY (POUNDS OF POLLUTANT PER YEAR) NOx	HC	CO	SOx	PM	HOTELLING (POUNDS OF POLLUTANT PER YEAR) NOx	HC	CO	SOx	PM
CONTAINER SHIPS	MOTOR	0 - 25										
		25 - 50										
		50 - 75										
		75 - 100										
		100+										
	STEAM	0 - 25										
		25 - 50										
		50 - 75										
		75 - 100										
		100+										
TANKERS	MOTOR	0 - 25										
BULK CARRIERS		25 - 50	3,872	169	429	1,150	232	1,292	361	212	720	75
		50 - 75										
		75 - 100										
		100+										
	STEAM	0 - 25										
		25 - 50	14,136	302	1,332	74,467	9,687	2,651	280	181	19,523	1,131
		50 - 75	857	18	81	4,516	587	222	23	15	1,632	95
		75 - 100										
		100+										
GENERAL CARGO	MOTOR	0 - 25										
VEHICLE CARRIERS		25 - 50										
RO-RO / LASH		50 - 75										
OCEAN-GOING TUGS		75 - 100										
		100+										
	STEAM	0 - 25										
		25 - 50										
		50 - 75										
		75 - 100										
		100+										
PASSENGER LINERS	MOTOR	0 - 25										
CRUISE SHIPS		25 - 50										
	STEAM	0 - 25										
		25 - 50										
POUNDS OF POLLUTANT PER YEAR			18,866	489	1,842	80,132	10,506	4,165	665	408	21,876	1,300

Edmonds and Point Wells - In Port Emissions from Ocean Going Vessels

VESSEL TONNAGE	UNDERWAY (POUNDS OF POLLUTANT PER YEAR)					HOTELLING (POUNDS OF POLLUTANT PER YEAR)				
	NOx	HC	CO	SOx	PM	NOx	HC	CO	SOx	PM
< 25K										
25 - 50 K	18,008	471	1,761	75,616	9,919	3,943	642	393	20,244	1,206
50 - 75 K	857	18	81	4,516	587	222	23	15	1,632	95
75 - 100 K										
> 100 K										
TOTAL	18,866	489	1,842	80,132	10,506	4,165	665	408	21,876	1,300

Everett - In Port Emissions from Ocean Going Vessels

TYPE OF VESSEL	PROPULSION TYPE	VESSEL TONNAGE (1,000 DWT)	AVERAGE HORSEPOWER	FUEL CONSUMPTION AT FULL POWER (TONS/DAY)	FUEL CONSUMPTION AT FULL POWER (GALS/HOUR)	ANNUAL VESSEL CALLS	MEAN HOURS/ CALL	MEAN HOURS MOORED	GALLONS OF FUEL CONSUMED PER YEAR IN EACH OPERATING MODE: FULL	HALF	SLOW	HOTEL	ANNUAL GALLONS OF FUEL CONSUMED: UNDERWAY	HOTELLING	TOTAL
CONTAINER SHIPS	MOTOR	0 - 25	10,870	35	452										
		25 - 50	28,135	91	1,166										
		50 - 75	38,660	130	1,658										
		75 - 100	56,000	189	2,412										
		100+	62,000	208	2,656										
	STEAM	0 - 25	8,000	43	513										
		25 - 50	15,000	73	860										
		50 - 75	19,000	89	1,050										
		75 - 100	22,000	108	1,278										
		100+	26,000	120	1,412										
TANKERS	MOTOR	0 - 25	5,435	19	238	23	117.96	108 96	13,150	10,958	548	59,701	24,656	59,701	84,357
BULK CARRIERS		25 - 50	11,375	45	572	125	113.88	104 88	171,725	143,104	7,155	750,439	321,985	750,439	1,072,424
		50 - 75	14,718	50	638										
		75 - 100	17,837	70	890										
		100+	23,200	74	940	1	42.60	33 60	2,257	1,881	94	3,160	4,232	3,160	7,392
	STEAM	0 - 25	10,663	51	602										
		25 - 50	15,783	77	907										
		50 - 75	30,269	147	1,732										
		75 - 100	25,936	124	1,468	1	14 04	5.04	3,524	2,937	147	740	6,607	740	7,347
		100+	34,980	156	1,846										
GENERAL CARGO	MOTOR	0 - 25	6,335	26	335	12	108 12	99 12	9,642	8,035	402	39,823	18,079	39,823	57,903
VEHICLE CARRIERS		25 - 50	14,709	43	548										
RO-RO / LASH		50 - 75	16,765	53	678										
OCEAN-GOING TUGS		75 - 100	18,000	56	712										
		100+	21,000	64	822										
	STEAM	0 - 25	7,000	42	498										
		25 - 50	16,000	78	920										
		50 - 75	19,000	89	1,050										
		75 - 100	22,000	108	1,278										
		100+	26,000	120	1,412										
PASSENGER LINERS	MOTOR	0 - 25	10,000	32	415										
CRUISE SHIPS		25 - 50	15,000	44	562										
	STEAM	0 - 25	8,000	43	513										
		25 - 50	15,000	73	860										

TOTAL GALLONS OF FUEL CONSUMED PER YEAR.	MOTOR	368,952	853,123	1,222,076
	STEAM	6,607	740	7,347

Everett - In Port Emissions from Ocean Going Vessels

TYPE OF VESSEL	PROPULSION TYPE	VESSEL TONNAGE (1,000 DWT)	UNDERWAY (POUNDS OF POLLUTANT PER YEAR) NOx	HC	CO	SOx	PM	HOTELLING (POUNDS OF POLLUTANT PER YEAR) NOx	HC	CO	SOx	PM
CONTAINER SHIPS	MOTOR	0 - 25										
		25 - 50										
		50 - 75										
		75 - 100										
		100+										
	STEAM	0 - 25										
		25 - 50										
		50 - 75										
		75 - 100										
		100+										
TANKERS	MOTOR	0 - 25	13,561	592	1,504	4,026	814	17,492	4,890	2,872	9,748	1,015
BULK CARRIERS		25 - 50	177,092	7,728	19,641	52,574	10,626	219,879	61,461	36,096	122,532	12,757
		50 - 75										
		75 - 100										
		100+	2,328	102	258	691	140	926	259	152	516	54
	STEAM	0 - 25										
		25 50										
		50 - 75										
		75 - 100	396	8	36	2,101	261	22	2	1	160	9
		100+										
GENERAL CARGO	MOTOR	0 - 25	9,944	434	1,103	2,952	597	11,608	3,262	1,915	6,502	677
VEHICLE CARRIERS		25 - 50										
RO-RO / LASH		50 - 75										
OCEAN-GOING TUGS		75 - 100										
		100+										
	STEAM	0 - 25										
		25 - 50										
		50 - 75										
		75 - 100										
		100+										
PASSENGER LINERS	MOTOR	0 - 25										
CRUISE SHIPS		25 - 50										
	STEAM	0 - 25										
		25 - 50										
POUNDS OF POLLUTANT PER YEAR			203,320	8,863	22,542	62,344	12,436	249,987	69,873	41,037	139,458	14,512

Everett - In Port Emissions from Ocean Going Vessels

VESSEL TONNAGE	UNDERWAY (POUNDS OF POLLUTANT PER YEAR)					HOTELLING (POUNDS OF POLLUTANT PER YEAR)				
	NOx	HC	CO	SOx	PM	NOx	HC	CO	SOx	PM
< 25K	23,505	1,026	2,607	6,978	1,410	29,161	8,151	4,787	16,250	1,692
25 - 50 K	177,092	7,728	19,641	52,574	10,626	219,879	61,461	36,096	122,532	12,757
50 - 75 K										
75 - 100 K	396	8	36	2,101	261	22	2	1	160	9
> 100 K	2,328	102	258	691	140	926	259	152	516	54
TOTAL	203,320	8,863	22,542	62,344	12,436	249,987	69,873	41,037	139,458	14,512

Olympia - In Port Emissions from Ocean Going Vessels

TYPE OF VESSEL	PROPULSION TYPE	VESSEL TONNAGE (1,000 DWT)	AVERAGE HORSEPOWER	FUEL CONSUMPTION AT FULL POWER (TONS/DAY)	FUEL CONSUMPTION AT FULL POWER (GALS/HOUR)	ANNUAL VESSEL CALLS	MEAN HOURS/ CALL	MEAN HOURS MOORED	GALLONS OF FUEL CONSUMED PER YEAR IN EACH OPERATING MODE: FULL	HALF	SLOW	HOTEL	ANNUAL GALLONS OF FUEL CONSUMED: UNDERWAY	HOTELLING	TOTAL
CONTAINER SHIPS	MOTOR	0 - 25	10,870	35	452										
		25 - 50	28,135	91	1,166										
		50 - 75	38,660	130	1,658										
		75 100	56,000	189	2,412										
		100+	62,000	208	2,636										
	STEAM	0 - 25	8,000	43	513										
		25 - 50	15,000	73	860										
		50 - 75	19,000	89	1,050										
		75 - 100	22,000	108	1,278										
		100+	26,000	120	1,412										
TANKERS	MOTOR	0 - 25	5,435	19	238	17	89 20	73.20	16,199	14,579	810	29,645	31,589	29,645	61,233
BULK CARRIERS		25 - 50	11,375	45	572	37	125 92	109.92	84 718	76,246	4,236	232,804	165,200	232,804	398,004
		50 - 75	14,718	50	638										
		75 - 100	17,837	70	890										
		100+	23,200	74	940										
	STEAM	0 - 25	10,663	51	602										
		25 - 50	15,783	77	907										
		50 - 75	30,269	147	1,732										
		75 - 100	25,936	124	1,468										
		100+	34,980	156	1,846										
GENERAL CARGO	MOTOR	0 - 25	6,335	26	335	4	66.40	50.40	5 357	4,821	268	6,750	10,446	6,750	17 196
VEHICLE CARRIERS		25 - 50	14,709	43	548										
RO-RO / LASH		50 - 75	16,765	53	678										
OCEAN-GOING TUGS		75 - 100	18,000	56	712										
		100+	21,000	64	822										
	STEAM	0 - 25	7,000	42	498										
		25 - 50	16,000	78	920										
		50 - 75	19,000	89	1,050										
		75 - 100	22,000	108	1,278										
		100+	26,000	120	1,412										
PASSENGER LINERS	MOTOR	0 - 25	10,000	32	415										
CRUISE SHIPS		25 - 50	13,000	44	562										
	STEAM	0 - 25	8,000	43	513										
		25 - 50	15,000	73	860										
									TOTAL GALLONS OF FUEL CONSUMED PER YEAR			MOTOR	207,234	269,199	476,433
												STEAM			

Olympia - In Port Emissions from Ocean Going Vessels

TYPE OF VESSEL	PROPULSION TYPE	VESSEL TONNAGE (1,000 DWT)	UNDERWAY (POUNDS OF POLLUTANT PER YEAR) NOx	HC	CO	SOx	PM	HOTELLING (POUNDS OF POLLUTANT PER YEAR) NOx	HC	CO	SOx	PM
CONTAINER SHIPS	MOTOR	0 - 25										
		25 - 50										
		50 - 75										
		75 - 100										
		100+										
	STEAM	0 - 25										
		25 - 50										
		50 - 75										
		75 - 100										
		100+										
TANKERS	MOTOR	0 - 25	17,374	758	1,927	5,158	1,042	8,686	2,428	1,426	4 840	504
BULK CARRIERS		25 - 50	90,860	3,965	10,077	26,974	5,452	68,212	19,067	11,198	38,012	3,958
		50 - 75										
		75 - 100										
		100+										
	STEAM	0 - 25										
		25 50										
		50 - 75										
		75 - 100										
		100+										
GENERAL CARGO	MOTOR	0 - 25	5,745	251	637	1,706	345	1,978	553	325	1,102	115
VEHICLE CARRIERS		25 - 50										
RO-RO / LASH		50 - 75										
OCEAN-GOING TUGS		75 - 100										
		100+										
	STEAM	0 - 25										
		25 - 50										
		50 - 75										
		75 - 100										
		100+										
PASSENGER LINERS	MOTOR	0 - 25										
CRUISE SHIPS		25 - 50										
	STEAM	0 - 25										
		25 - 50										
POUNDS OF POLLUTANT PER YEAR			113,979	4,974	12,641	33,837	6,839	78,875	22,047	12,948	43,955	4,576

Olympia - In Port Emissions from Ocean Going Vessels

VESSEL TONNAGE	UNDERWAY (POUNDS OF POLLUTANT PER YEAR)					HOTELLING (POUNDS OF POLLUTANT PER YEAR)				
	NOx	HC	CO	SOx	PM	NOx	HC	CO	SOx	PM
< 25K	23,119	1,009	2,564	6,863	1,387	10,664	2,981	1,751	5,942	619
25 - 50 K	90,860	3,965	10,077	26,974	5,452	68,212	19,067	11,198	38,012	3,958
50 - 75 K										
75 - 100 K										
> 100 K										
TOTAL	113,979	4,974	12,641	33,837	6,839	78,875	22,047	12,948	43,955	4,576

Port Angeles - In Port Emissions from Ocean Going Vessels

TYPE OF VESSEL	PROPULSION TYPE	VESSEL TONNAGE (1,000 DWT)	UNDERWAY (POUNDS OF POLLUTANT PER YEAR) NOx	HC	CO	SOx	PM	HOTELLING (POUNDS OF POLLUTANT PER YEAR) NOx	HC	CO	SOx	PM
CONTAINER SHIPS	MOTOR	0 - 25										
		25 - 50										
		50 - 75										
		75 - 100										
		100+										
	STEAM	0 - 25										
		25 - 50										
		50 - 75										
		75 - 100										
		100+										
TANKERS	MOTOR	0 - 25	825	36	92	245	50	14,564	4,071	2,391	8,116	845
BULK CARRIERS		25 - 50	8,815	385	978	2,617	529	143,138	40,010	23,498	79,766	8,305
		50 - 75	1,894	83	210	562	114	16,949	4,738	2,782	9,445	983
		75 - 100	342	15	38	102	21	4,028	1,126	661	2,245	234
		100+	1,397	61	155	415	84	15,534	4,342	2,550	8,657	901
	STEAM	0 - 25	7	0	0	38	2	289	31	20	2,127	123
		25 - 50	91	1	6	519	33	1,308	138	89	9,635	558
		50 - 75	425	5	26	2,423	152	4,715	499	322	34,727	2,012
		75 - 100	303	4	19	1,728	109	3,171	335	216	23,353	1,353
		100+	701	9	43	3,992	251	9,181	971	627	67,622	3,917
GENERAL CARGO	MOTOR	0 - 25	460	20	51	137	28	3,002	839	493	1,673	174
VEHICLE CARRIERS		25 - 50	905	39	100	269	54	15,965	4,463	2,621	8,897	926
RO-RO / LASH		50 - 75										
OCEAN-GOING TUGS		75 - 100										
		100+										
	STEAM	0 - 25										
		25 - 50	5	0	0	29	2	4	0	0	30	2
		50 - 75										
		75 - 100										
		100+										
PASSENGER LINERS	MOTOR	0 - 25										
CRUISE SHIPS		25 - 50										
	STEAM	0 - 25										
		25 - 50										
POUNDS OF POLLUTANT PER YEAR			16,170	657	1,718	13,075	1,427	231,848	61,564	36,271	256,293	20,333

Port Angeles - In Port Emissions from Ocean Going Vessels

TYPE OF VESSEL	PROPULSION TYPE	VESSEL TONNAGE (1,000 DWT)	AVERAGE HORSEPOWER	FUEL CONSUMPTION AT FULL POWER (TONS/DAY)	FUEL CONSUMPTION AT FULL POWER (GALS/HOUR)	ANNUAL VESSEL CALLS	MEAN HOURS/ CALL	MEAN HOURS MOORED	GALLONS OF FUEL CONSUMED PER YEAR IN EACH OPERATING MODE: FULL	HALF	SLOW	HOTEL	ANNUAL GALLONS OF FUEL CONSUMED: UNDERWAY	HOTELLING	TOTAL
CONTAINER SHIPS	MOTOR	0 - 25	10,870	35	452										
		25 - 50	28,135	91	1,166										
		50 - 75	38,660	130	1,658										
		75 - 100	56,000	189	2,412										
		100+	62,000	208	2,656										
	STEAM	0 - 25	8,000	43	513										
		25 - 50	15,000	73	860										
		50 - 75	19,000	89	1,050										
		75 - 100	22,000	108	1,278										
		100+	26,000	120	1,412										
TANKERS	MOTOR	0 - 25	5,435	19	238	63	34 12	33 12			1,501	49,707	1,501	49,707	51,208
BULK CARRIERS		25 - 50	11,375	45	572	280	31 48	30 48			16,028	488,524	16,028	488,524	504,552
		50 - 75	14,718	50	638	54	17 80	16 80			3,443	57,845	3,443	57,845	61,288
		75 - 100	17,837	70	890	7	23 08	22 08			623	13,748	623	13,748	14,371
		100+	23,200	74	940	27	21 88	20 88			2,539	53,016	2,539	53,016	55,555
	STEAM	0 - 25	10,663	51	602	2	82 84	81 84			120	9,858	120	9,858	9,979
		25 - 50	15,783	77	907	18	28 36	27 36			1,632	44,648	1,632	44,648	46,279
		50 - 75	30,269	147	1,732	44	22 12	21 12			7,619	160,923	7,619	160,923	168,542
		75 - 100	25,936	124	1,468	37	20 92	19 92			5,433	108,217	5,433	108,217	113,649
		100+	34,980	156	1,846	68	25 96	24 96			12,554	313,356	12,554	313,356	325,910
GENERAL CARGO	MOTOR	0 - 25	6,335	26	335	25	13 24	12 24			837	10,245	837	10,245	11,082
VEHICLE CARRIERS		25 - 50	14,709	43	548	30	34 12	33 12			1,645	54,490	1,645	54,490	56,135
RO-RO / LASH		50 - 75	18,765	53	678										
OCEAN-GOING TUGS		75 - 100	18,000	56	712										
		100+	21,000	64	822										
	STEAM	0 - 25	7,000	42	498										
		25 - 50	16,000	78	920	1	2 50	1 50			92	138	92	138	230
		50 - 75	19,000	89	1,050										
		75 - 100	22,000	108	1,278										
		100+	26,000	120	1,412										
PASSENGER LINERS	MOTOR	0 - 25	10,000	32	415										
CRUISE SHIPS		25 - 50	15,000	44	562										
	STEAM	0 - 25	8,000	43	513										
		25 - 50	15,000	73	860										

TOTAL GALLONS OF FUEL CONSUMED PER YEAR				
	MOTOR:	26,616	727,575	754,191
	STEAM	27,451	637,139	664,590

Port Angeles - In Port Emissions from Ocean Going Vessels

VESSEL TONNAGE	UNDERWAY (POUNDS OF POLLUTANT PER YEAR)					HOTELLING (POUNDS OF POLLUTANT PER YEAR)				
	NOx	HC	CO	SOx	PM	NOx	HC	CO	SOx	PM
< 25K	1,293	56	143	420	80	17,855	4,941	2,903	11,916	1,142
25 - 50 K	9,816	425	1,084	3,434	618	160,415	44,612	26,209	98,328	9,789
50 - 75 K	2,319	88	236	2,985	266	21,664	5,236	3,104	44,172	2,995
75 - 100 K	648	19	57	1,829	129	7,199	1,461	878	25,598	1,586
> 100 K	2,097	70	198	4,407	335	24,715	5,313	3,177	76,279	4,818
TOTAL	16,170	657	1,718	13,075	1,427	231,848	61,564	36,271	256,293	20,331

Port Townsend - In Port Emissions from Ocean Going Vessels

TYPE OF VESSEL	PROPULSION TYPE	VESSEL TONNAGE (1,000 DWT)	AVERAGE HORSEPOWER	FUEL CONSUMPTION AT FULL POWER (TONS/DAY)	FUEL CONSUMPTION AT FULL POWER (GALS/HOUR)	ANNUAL VESSEL CALLS	MEAN HOURS/ CALL	MEAN HOURS MOORED	GALLONS OF FUEL CONSUMED PER YEAR IN EACH OPERATING MODE: FULL	HALF	SLOW	HOTEL	ANNUAL GALLONS OF FUEL CONSUMED: UNDERWAY	HOTELLING	TOTAL
CONTAINER SHIPS	MOTOR	0 - 25	10,870	35	452										
		25 - 50	28,135	91	1,166										
		50 - 75	38,660	130	1,658										
		75 - 100	56,000	189	2,412										
		100+	62,000	208	2,656										
	STEAM	0 - 25	8,000	43	513										
		25 - 50	15,000	73	860										
		50 - 75	19,000	89	1,050										
		75 - 100	22,000	108	1,278										
		100+	26,000	120	1,412										
TANKERS	MOTOR	0 - 25	5,435	19	238	9	37.36	33.36	5,146		214	7,152	5,360	7,152	12,513
BULK CARRIERS		25 - 50	11,375	45	572	16	17.68	13.68	21,981		916	12,529	22,897	12,529	35,426
		50 - 75	14,718	50	638										
		75 - 100	17,837	70	890										
		100+	23,200	74	940										
	STEAM	0 - 25	10,663	51	602										
		25 - 50	15,783	77	907										
		50 - 75	30,269	147	1,732										
		75 - 100	25,936	124	1,468										
		100+	34,980	156	1,846										
GENERAL CARGO	MOTOR	0 - 25	6,335	26	335	3	23 92	19 92	2,411		100	2,001	2,511	2,001	4,512
VEHICLE CARRIERS		25 - 50	14,709	43	548	3	70 96	66.96	3,949		165	11,016	4,113	11,016	15,129
RO-RO / LASH		50 - 75	16,765	53	678										
OCEAN-GOING TUGS		75 - 100	18,000	56	712										
		100+	21,000	64	822										
	STEAM	0 - 25	7,000	42	498										
		25 - 50	16,000	78	920										
		50 - 75	19,000	89	1,050										
		75 - 100	22,000	108	1,278										
		100+	26,000	120	1,412										
PASSENGER LINERS	MOTOR	0 - 25	10,000	32	415										
CRUISE SHIPS		25 - 50	15,000	44	562										
	STEAM	0 - 25	8,000	43	513										
		25 - 50	15,000	73	860										
						TOTAL GALLONS OF FUEL CONSUMED PER YEAR						MOTOR	34,881	32,699	67,580
												STEAM			

Port Townsend - In Port Emissions from Ocean Going Vessels

TYPE OF VESSEL	PROPULSION TYPE	VESSEL TONNAGE (1,000 DWT)	UNDERWAY (POUNDS OF POLLUTANT PER YEAR) NOx	HC	CO	SOx	PM	HOTELLING (POUNDS OF POLLUTANT PER YEAR) NOx	HC	CO	SOx	PM
CONTAINER SHIPS	MOTOR	0 - 25										
		25 - 50										
		50 - 75										
		75 - 100										
		100+										
	STEAM	0 - 25										
		25 - 50										
		50 - 75										
		75 - 100										
		100+										
TANKERS	MOTOR	0 - 25	2,948	129	327	875	177	2,096	586	344	1,168	122
BULK CARRIERS		25 - 50	12,593	550	1,397	3,739	756	3,671	1,026	603	2,046	213
		50 - 75										
		75 - 100										
		100+										
	STEAM	0 - 25										
		25 - 50										
		50 - 75										
		75 - 100										
		100+										
GENERAL CARGO	MOTOR	0 - 25	1,381	60	153	410	83	586	164	96	327	34
VEHICLE CARRIERS		25 - 50	2,262	99	251	672	136	3,228	902	530	1,799	187
RO-RO / LASH		50 - 75										
OCEAN-GOING TUGS		75 - 100										
		100+										
	STEAM	0 - 25										
		25 - 50										
		50 - 75										
		75 - 100										
		100+										
PASSENGER LINERS	MOTOR	0 - 25										
CRUISE SHIPS		25 - 50										
	STEAM	0 - 25										
		25 - 50										
POUNDS OF POLLUTANT PER YEAR			19,184	837	2,128	5,695	1,151	9,581	2,678	1,573	5,339	556

Port Townsend - In Port Emissions from Ocean Going Vessels

VESSEL TONNAGE	UNDERWAY (POUNDS OF POLLUTANT PER YEAR)					HOTELLING (POUNDS OF POLLUTANT PER YEAR)				
	NOx	HC	CO	SOx	PM	NOx	HC	CO	SOx	PM
< 25K	4,329	189	480	1,285	260	2,682	750	440	1,495	156
25 - 50 K	14,855	648	1,648	4,410	891	6,899	1,928	1,133	3,845	400
50 - 75 K										
75 - 100 K										
> 100 K										
TOTAL	19,184	837	2,128	5,695	1,151	9,581	2,678	1,573	5,339	556

Seattle (Including Manchester) - In Port Emissions from Ocean Going Vessels

TYPE OF VESSEL	PROPULSION TYPE	VESSEL TONNAGE (1,000 DWT)	AVERAGE HORSEPOWER	FUEL CONSUMPTION AT PULL POWER (TONS/DAY)	FUEL CONSUMPTION AT PULL POWER (GALS/HOUR)	ANNUAL VESSEL CALLS	MEAN HOURS/ CALL	MEAN HOURS MOORED	GALLONS OF FUEL CONSUMED PER YEAR IN EACH OPERATING MODE: PULL	HALF	SLOW	HOTEL	ANNUAL GALLONS OF FUEL CONSUMED: UNDERWAY	HOTELLING	TOTAL
CONTAINER SHIPS	MOTOR	0 - 25	10,870	35	452	142	13 49	4.49	256,642	51,328	12,832	28,795	320,802	28,795	349,598
		25 - 50	28,135	91	1,166	424	30.96	21 96	1,978,142	395,628	98,907	1,086,000	2,472,677	1,086,000	3,558,677
		50 - 75	38,660	130	1,658										
		75 - 100	56,000	189	2,412										
		100+	62,000	208	2,656										
	STEAM	0 - 25	8,000	43	513	12	51.00	42.00	24,612	4,922	1,231	25,842	30,765	25,842	56,607
		25 - 50	15,000	73	860	114	42.36	33 36	392,198	78,440	19,610	327,094	490,248	327,094	817,342
		50 - 75	19,000	89	1,050										
		75 - 100	22,000	108	1,278										
		100+	26,000	120	1,412										
TANKERS	MOTOR	0 - 25	5,435	19	238	77	51.96	42.96	73,373	14,675	3,669	78,803	91,716	78,803	170,519
BULK CARRIERS		25 - 50	11,375	45	572	252	46.57	37 57	576,997	115,399	28,850	541,965	721,246	541,965	1,263,211
		50 - 75	14,718	50	638	47	60.84	51 84	119,873	23,975	5,994	155,355	149,841	155,355	305,196
		75 - 100	17,837	70	890	2	55.32	46.32	7,116	1,423	356	8,240	8,895	8,240	17,136
		100+	23,200	74	940										
	STEAM	0 - 25	10,663	51	602										
		25 - 50	15,783	77	907	26	31 69	22.69	94,285	18,857	4,714	53,481	117,856	53,481	171,338
		50 - 75	30,269	147	1,732	5	45.00	36.00	34,634	6,927	1,732	31,171	43,292	31,171	74,463
		75 - 100	25,936	124	1,468	11	90.12	81 12	64,604	12,921	3,230	131,016	80,754	131,016	211,771
		100+	34,980	156	1,846	2	93 00	84 00	14,770	2,954	738	31,017	18,462	31,017	49,479
GENERAL CARGO	MOTOR	0 - 25	6,335	26	335	182	47.40	38 40	243,738	48,748	12,187	233,989	304 673	233,989	538 662
VEHICLE CARRIERS		25 - 50	14,709	43	548	12	26.76	17 76	26,323	5,265	1,316	11,688	32,904	11,688	44,592
RO-RO / LASH		50 - 75	16,765	53	678										
OCEAN-GOING TUGS		75 - 100	18,000	56	712	1	17 16	8 16	2,847	569	142	581	3,559	581	4,140
		100+	21,000	64	822										
	STEAM	0 - 25	7,000	42	498	8	83.40	74 40	15,935	3,187	797	29,639	19,919	29,639	49,558
		25 - 50	16,000	78	920										
		50 - 75	19,000	89	1,050										
		75 - 100	22,000	108	1,278										
		100+	26,000	120	1,412										
PASSENGER LINERS	MOTOR	0 - 25	10,000	32	415	14	63 00	54 00	23,221	4,644	1,161	31,349	29,027	31,349	60,376
CRUISE SHIPS		25 - 50	15,000	44	562										
	STEAM	0 - 25	8,000	43	513	1	174.60	165 60	2,051	410	103	8,491	2,564	8,491	11,055
		25 - 50	15,000	73	860										

TOTAL GALLONS OF FUEL CONSUMED PER YEAR	MOTOR	4,135,341	2,176,764	6,312,105
	STEAM	803,861	637,751	1,441,611

Seattle (Including Manchester) - In Port Emissions from Ocean Going Vessels

TYPE OF VESSEL	PROPULSION TYPE	VESSEL TONNAGE (1,000 DWT)	UNDERWAY (POUNDS OF POLLUTANT PER YEAR)					HOTELLING (POUNDS OF POLLUTANT PER YEAR)				
			NOx	HC	CO	SOx	PM	NOx	HC	CO	SOx	PM
CONTAINER SHIPS	MOTOR	0 - 25	176,441	7,699	19,569	52,381	10,586	8,437	2,358	1,385	4,702	490
		25 - 50	1,359,972	59,344	150,833	403,739	81,598	318,198	88,943	52,237	177,322	18,462
		50 - 75										
		75 - 100										
		100+										
	STEAM	0 - 25	1,909	47	200	9,783	1,514	757	80	52	5,577	323
		25 - 50	30,415	741	3,190	155,899	24,120	9,584	1,014	654	70,587	4,089
		50 - 75										
		75 - 100										
		100+										
TANKERS	MOTOR	0 - 25	50,444	2,201	5,595	14,975	3,027	23,089	6,454	3,790	12,867	1,340
BULK CARRIERS		25 - 50	396,685	17,310	43,996	117,765	23,801	158,796	44,387	26,069	88,492	9,213
		50 - 75	82,413	3,596	9,140	24,466	4,945	45,519	12,724	7,473	25,366	2,641
		75 - 100	4,892	213	543	1,452	294	2,414	675	396	1,346	140
		100+										
	STEAM	0 - 25										
		25 - 50	7,312	178	767	37,478	5,799	1,567	166	107	11,541	669
		50 - 75	2,686	65	282	13,767	2,130	913	97	62	6,727	390
		75 - 100	5,010	122	525	25,680	3,973	3,839	406	262	28,273	1,638
		100+	1,145	28	120	5,871	908	909	96	62	6,693	388
GENERAL CARGO	MOTOR	0 - 25	167,570	7,312	18,585	49,747	10,054	68,559	19,164	11,255	38,206	3,978
VEHICLE CARRIERS		25 - 50	18,097	790	2,007	5,373	1,086	3,424	957	562	1,908	199
RO-RO / LASH		50 - 75										
OCEAN-GOING TUGS		75 - 100	1,957	85	217	581	117	170	48	28	95	10
		100+										
	STEAM	0 - 25	1,236	30	130	6,334	980	868	92	59	6,396	370
		25 - 50										
		50 - 75										
		75 - 100										
		100+										
PASSENGER LINERS	MOTOR	0 - 25	15,965	697	1,771	4,739	958	9,185	2,567	1,508	5,119	533
CRUISE SHIPS		25 - 50										
	STEAM	0 - 25	159	4	17	815	126	249	26	17	1,832	106
		25 50										
POUNDS OF POLLUTANT PER YEAR			2,324,309	100,464	257,486	930,846	176,016	656,478	180,254	105,978	493,049	44,977

Seattle (Including Manchester) - In Port Emissions from Ocean Going Vessels

VESSEL TONNAGE	UNDERWAY (POUNDS OF POLLUTANT PER YEAR)					HOTELLING (POUNDS OF POLLUTANT PER YEAR)				
	NOx	HC	CO	SOx	PM	NOx	HC	CO	SOx	PM
< 25K	413,724	17,990	45,866	138,775	27,245	111,145	30,742	18,066	74,698	6,769
25 - 50 K	1,812,482	78,364	200,793	720,254	136,404	491,569	135,467	79,628	349,850	32,631
50 - 75 K	85,098	3,662	9,422	38,233	7,075	46,432	12,820	7,535	32,093	3,031
75 - 100 K	11,860	421	1,285	27,713	4,384	6,423	1,129	686	29,714	1,788
> 100 K	1,145	28	120	5,871	908	909	96	62	6,693	388
TOTAL	2,324,309	100,464	257,486	930,846	176,016	656,478	180,254	105,978	493,049	44,606

Tacoma - In Port Emissions from Ocean Going Vessels

TYPE OF VESSEL	PROPULSION TYPE	VESSEL TONNAGE (1,000 DWT)	AVERAGE HORSEPOWER	FUEL CONSUMPTION AT FULL POWER (TONS/DAY)	FUEL CONSUMPTION AT FULL POWER (GALS/HOUR)	ANNUAL VESSEL CALLS	MEAN HOURS/ CALL	MEAN HOURS MOORED	GALLONS OF FUEL CONSUMED PER YEAR IN EACH OPERATING MODE: FULL	HALF	SLOW	HOTEL	ANNUAL GALLONS OF FUEL CONSUMED: UNDERWAY	HOTELLING	TOTAL
CONTAINER SHIPS	MOTOR	0 - 25	10,870	35	452	142	13.49	4 49	256,642	51,328	12,832	28,795	320 802	28,795	349,598
		25 50	28,135	91	1,166	424	30.96	21.96	1,978,142	395,628	98,907	1,086,000	2,472,677	1,086,000	3,558,677
		50 - 75	38,660	130	1,658										
		75 - 100	56,000	189	2,412										
		100+	62,000	208	2,656										
	STEAM	0 - 25	8,000	43	513	12	51.00	42.00	24,612	4,922	1,231	25,842	30,765	25,842	56,607
		25 - 50	15,000	73	860	114	42.36	33.36	392,198	78,440	19,610	327,094	490,248	327,094	817,342
		50 - 75	19,000	89	1,050										
		75 - 100	22,000	108	1,278										
		100+	26,000	120	1,412										
TANKERS	MOTOR	0 - 25	5,435	19	238	77	51.96	42.96	73,373	14,675	3,669	78,803	91,716	78,803	170,519
BULK CARRIERS		25 - 50	11,375	45	572	223	47.40	38 40	510,596	102,119	25,530	490,173	638,246	490,173	1,128,418
		50 - 75	14,718	50	638	47	60.84	51.84	119,873	23,975	5,994	155,355	149,841	155,355	305,196
		75 - 100	17,837	70	890	2	55.32	46.32	7,116	1,423	356	8,240	8,895	8,240	17,136
		100+	23,200	74	940										
	STEAM	0 - 25	10,663	51	602										
		25 - 50	15,783	77	907	22	27.96	18.96	79,780	15,956	3,989	37,816	99,725	37,816	137,540
		50 - 75	30,269	147	1,732	5	45.00	36.00	34,634	6,927	1,732	31,171	43,292	31,171	74,463
		75 - 100	25,936	124	1,468	11	90 12	81 12	64,604	12,921	3,230	131,016	80,754	131,016	211,771
		100+	34,980	156	1,846	2	93.00	84.00	14,770	2,954	738	31,017	18,462	31,017	49,479
GENERAL CARGO	MOTOR	0 25	6,335	26	335	182	47.40	38.40	243,738	48,748	12,187	233,989	304,673	233,989	538,662
VEHICLE CARRIERS		25 - 50	14,709	43	548	12	26 76	17 76	26,323	5,265	1,316	11,688	32,904	11,688	44,592
RO-RO / LASH		50 - 75	16,765	53	678										
OCEAN-GOING TUGS		75 - 100	18,000	56	712	1	17 16	8 16	2,847	569	142	581	3,559	581	4,140
		100+	21,000	64	822										
	STEAM	0 - 25	7,000	42	498	8	83.40	74.40	15,935	3,187	797	29,639	19,919	29,639	49,558
		25 - 50	16,000	78	920										
		50 - 75	19,000	89	1,050										
		75 - 100	22,000	108	1,278										
		100+	26,000	120	1,412										
PASSENGER LINERS	MOTOR	0 - 25	10,000	32	415	14	63 00	54.00	23,221	4,644	1,161	31,349	29,027	31,349	60,376
CRUISE SHIPS		25 - 50	15,000	44	562										
	STEAM	0 - 25	8,000	43	513	1	174 60	165 60	2,051	410	103	8,491	2,564	8,491	11,055
		25 - 50	15,000	73	860										

TOTAL GALLONS OF FUEL CONSUMED PER YEAR	MOTOR:	4,052,340	2,124,972	6,177,313
	STEAM.	785,729	622,085	1,407,814

Tacoma - In Port Emissions from Ocean Going Vessels

TYPE OF VESSEL	PROPULSION TYPE	VESSEL TONNAGE (1,000 DWT)	UNDERWAY (POUNDS OF POLLUTANT PER YEAR)					HOTELLING (POUNDS OF POLLUTANT PER YEAR)				
			NOx	HC	CO	SOx	PM	NOx	HC	CO	SOx	PM
CONTAINER SHIPS	MOTOR	0 - 25	176,441	7,699	19,569	52,381	10,586	8,437	2,358	1,385	4 702	490
		25 - 50	1,359,972	59,344	150,833	403,739	81,598	318,198	88,943	52,237	177,322	18,462
		50 - 75										
		75 - 100										
		100+										
	STEAM	0 - 25	1,909	47	200	9,783	1,514	757	80	52	5,577	323
		25 - 50	30,415	741	3,190	155,899	24,120	9,584	1,014	654	70,587	4,089
		50 - 75										
		75 - 100										
		100+										
TANKERS	MOTOR	0 - 25	50,444	2,201	5,595	14,975	3,027	23,089	6,454	3,790	12,867	1,340
BULK CARRIERS		25 - 50	351,035	15,318	38,933	104,213	21,062	143,621	40,145	23,577	80,035	8,333
		50 - 75	82,413	3,596	9,140	24,466	4,945	45,519	12,724	7,473	25,366	2,641
		75 - 100	4,892	213	543	1,452	294	2,414	675	396	1,346	140
		100+										
	STEAM	0 - 25										
		25 - 50	6,187	151	649	31,712	4,906	1,108	117	76	8,161	473
		50 - 75	2,686	65	282	13,767	2,130	913	97	62	6,727	390
		75 - 100	5,010	122	525	25,680	3,973	3,839	406	262	28,273	1,638
		100+	1,145	28	120	5,871	908	909	96	62	6,693	388
GENERAL CARGO	MOTOR	0 - 25	167,570	7,312	18,585	49,747	10,054	68,559	19,164	11,255	38,206	3,978
VEHICLE CARRIERS		25 - 50	18,097	790	2,007	5,373	1,086	3,424	957	562	1,908	199
RO-RO / LASH		50 - 75										
OCEAN-GOING TUGS		75 - 100	1,957	85	217	581	117	170	48	28	95	10
		100+										
	STEAM	0 - 25	1,236	30	130	6,334	980	868	92	59	6,396	370
		25 - 50										
		50 - 75										
		75 - 100										
		100+										
PASSENGER LINERS	MOTOR	0 - 25	15,965	697	1,771	4,739	958	9,185	2,567	1,508	5,119	533
CRUISE SHIPS		25 - 50										
	STEAM	0 - 25	159	4	17	815	126	249	26	17	1,832	106
		25 - 50										
POUNDS OF POLLUTANT PER YEAR			2,277,534	98,445	252,305	911,528	172,385	640,844	175,964	103,455	481,211	43,901

Tacoma - In Port Emissions from Ocean Going Vessels

VESSEL TONNAGE	UNDERWAY (POUNDS OF POLLUTANT PER YEAR)					HOTELLING (POUNDS OF POLLUTANT PER YEAR)				
	NOx	HC	CO	SOx	PM	NOx	HC	CO	SOx	PM
< 25K	413,724	17,990	45,866	138,775	27,245	111,145	30,742	18,066	74,698	6,769
25 - 50 K	1,765,707	76,344	195,612	700,935	132,773	475,935	131,177	77,106	338,013	31,555
50 - 75 K	85,098	3,662	9,422	38,233	7,075	46,432	12,820	7,535	32,093	3,031
75 - 100 K	11,860	421	1,285	27,713	4,384	6,423	1,129	686	29,714	1,788
> 100 K	1,145	28	120	5,871	908	909	96	62	6,693	388
TOTAL	2,277,534	98,445	252,305	911,528	172,385	640,844	175,964	103,455	481,211	43,530

Washington Fishing Vessel Emissions

HP	No. Diesel	No Gasoline	Type Unspecified (Assumed Diesel)	DIESEL FUEL CONSUMPTION (GALS/HOUR)	Annual Consumption (GALLONS)	DIESEL VESSEL EMISSIONS (POUNDS OF POLLUTANT PER YEAR)					GASOLINE VESSEL EMISSIONS (POUNDS OF POLLUTANT PER YEAR)				
						NOx	HC	CO	SOx	PM	NOx	Exhaust HC	CO	SOx	PM
5	1	4		2.24	3,582	1,257	167	190	450	61	171	221	6,592	9	11
6	0	2		2.26	0	0	0	0	0	0	103	133	3,955	5	6
7	2	0		2.29	7,314	2,567	342	388	919	124	0	0	0	0	0
8	0	4		2.31	0	0	0	0	0	0	274	354	10,548	14	17
10	7	9		2.36	26,395	9,262	1,234	1,400	3,315	449	769	996	29,666	40	49
15	0	9		2.47	0	0	0	0	0	0	1,154	1,494	44,499	60	73
18	0	2		2.55	0	0	0	0	0	0	308	398	11,866	16	19
20	2	7		2.59	8,298	2,912	388	440	1,042	141	1,197	1,549	46,147	62	76
22	2	0		2.64	8,449	2,965	395	448	1,061	144	0	0	0	0	0
23	4	0		2.66	17,050	5,983	797	905	2,142	290	0	0	0	0	0
25	2	17		2.71	8,676	3,045	406	460	1,090	148	3,632	4,702	140,089	189	230
30	1	4		2.83	4,527	1,589	212	240	569	77	1,026	1,328	39,555	53	65
33	1	1		2.90	4,641	1,629	217	246	583	79	282	365	10,877	15	18
35	7	0		2.95	33,016	11,586	1,544	1,752	4,147	561	0	0	0	0	0
36	4			2.97	19,018	6,674	889	1,009	2,389	323	0	0	0	0	0
40	7	19		3.07	34,341	12,051	1,606	1,822	4,313	584	6,496	8,409	250,512	337	412
41		1		3.09	0	0	0	0	0	0	350	454	13,514	18	22
42	1	3		3.11	4,981	1,748	233	264	626	85	1,077	1,394	41,532	56	68
45	2	3		3.18	10,190	3,576	476	541	1,280	173	1,154	1,494	44,499	60	73
48	0	4		3.26	0	0	0	0	0	0	1,641	2,124	63,287	85	104
50	3	19		3.30	15,852	5,563	741	841	1,991	269	8,120	10,511	313,140	422	515
51	1	0		3.33	5,322	1,868	249	282	668	90	0	0	0	0	0
55	2	12		3.42	10,947	3,841	512	581	1,375	186	5,641	7,303	217,550	293	357
56	0	1		3.44	0	0	0	0	0	0	479	620	18,459	25	30
60	20	11		3.54	113,251	39,742	5,296	6,008	14,224	1,925	5,641	7,303	217,550	293	357
62	2	1		3.59	11,476	4,027	537	609	1,441	195	530	686	20,437	28	34
65	3	10		3.66	17,555	6,160	821	931	2,205	298	5,556	7,192	214,254	289	352
67	5	0		3.70	29,637	10,400	1,386	1,572	3,722	504	0	0	0	0	0
68	1	0		3.73	5,965	2,093	279	316	749	101	0	0	0	0	0
70	6	46		3.78	36,245	12,719	1,695	1,923	4,552	616	27,521	35,628	1,061,380	1,429	1,744
71	1	0		3.80	6,079	2,133	284	322	763	103	0	0	0	0	0
74	1	0		3.87	6,192	2,173	290	328	778	105	0	0	0	0	0
75	6	14		3.89	37,380	13,118	1,748	1,983	4,695	635	8,974	11,618	346,102	466	569
78	1			3.96	6,344	2,226	297	337	797	108	0	0	0	0	0
80	16	10		4.01	102,708	36,042	4,803	5,449	12,900	1,746	6,838	8,852	263,697	355	433
81	1			4.04	6,457	2,266	302	343	811	110	0	0	0	0	0
82	2			4.06	12,990	4,558	607	689	1,632	221	0	0	0	0	0
83	1			4.08	6,533	2,292	305	347	821	111	0	0	0	0	0
85	9	11		4.13	59,476	20,871	2,781	3,155	7,470	1,011	7,991	10,345	308,196	415	506
88	0	14		4.20	0	0	0	0	0	0	10,530	13,632	406,093	547	667
90	10	30		4.25	67,976	23,854	3,179	3,606	8,538	1,156	23,077	29,875	889,977	1,199	1,462
92	3			4.30	20,620	7,236	964	1,094	2,590	351	0	0	0	0	0
94	1			4.34	6,949	2,439	325	369	873	118	0	0	0	0	0
95	3	1		4.37	20,960	7,355	980	1,112	2,633	356	812	1,051	31,314	42	51
96	1			4.39	7,025	2,465	328	373	882	119	0	0	0	0	0
97	1			4.41	7,062	2,478	330	375	887	120	0	0	0	0	0
100	35	13		4.49	251,160	88,137	11,744	13,324	31,546	4,270	11,111	14,384	428,507	577	704
101	2			4.51	14,428	5,063	675	765	1,812	245	0	0	0	0	0
104	4			4.58	29,309	10,285	1,371	1,555	3,681	498	0	0	0	0	0
105	9	3		4.60	66,287	23,261	3,100	3,517	8,326	1,127	2,692	3,485	103,831	140	171
108	1			4.67	7,479	2,624	350	397	939	127	0	0	0	0	0
110	28	13		4.72	211,522	74,227	9,891	11,221	26,567	3,596	12,222	15,822	471,358	635	775
112	1			4.77	7,630	2,678	357	405	958	130	0	0	0	0	0
113	1			4.79	7,668	2,691	359	407	963	130	0	0	0	0	0
115	18	34	5	4.84	178,102	62,499	8,328	9,448	22,370	3,028	33,419	43,263	1,288,819	1,736	2,118

HP	No. Diesel	No Gasoline	Type Unspecified (Assumed Diesel)	DIESEL FUEL CONSUMPTION (GALS/HOUR)	Annual Consumption (GALLONS)	DIESEL VESSEL EMISSIONS (POUNDS OF POLLUTANT PER YEAR)					GASOLINE VESSEL EMISSIONS (POUNDS OF POLLUTANT PER YEAR)				
						NOx	HC	CO	SOx	PM	NOx	Exhaust HC	CO	SOx	PM
120	46	38	1	4 96	372,839	130,837	17,434	19,779	46,829	6,338	38,974	50,455	1,503,072	2,024	2,470
124	1			5.05	8,084	2,837	378	429	1,015	137	0	0	0	0	0
125	12	23	1	5 08	105,585	37,052	4,937	5,601	13,261	1,795	24,573	31,811	947,661	1,276	1,557
130	27	11	1	5 19	232,711	81,663	10,882	12,345	29,228	3,956	12,222	15,822	471,358	635	775
131		3		5.22	0	0	0	0	0	0	3,359	4,348	129,541	174	213
135	21	5	1	5.31	187,006	65,624	8,744	9,921	23,488	3,179	5,769	7,469	222,494	300	366
140	30	45		5.43	260,684	91,479	12,190	13,829	32,742	4,432	53,846	69,707	2,076,613	2,797	3,412
144	2			5.53	17,682	6,205	827	938	2,221	301	0	0	0	0	0
145	16			5.55	142,058	49,851	6,643	7,536	17,843	2,415	0	0	0	0	0
148	1			5.62	8,992	3,156	420	477	1,129	153	0	0	0	0	0
150	32	38		5.67	290,171	101,827	13,568	15,394	36,445	4,933	48,718	63,069	1,878,841	2,530	3,087
151		4		5.69	0	0	0	0	0	0	5,162	6,683	199,091	268	327
155	2	8	1	5 79	27,771	9,745	1,299	1,473	3,488	472	10,598	13,720	408,730	550	672
160	52	14	1	5 90	500,649	175,688	23,410	26,559	62,882	8,511	19,145	24,785	738,351	994	1,213
162	1			5.95	9,522	3,341	445	505	1,196	162	0	0	0	0	0
165	85	41	2	6.02	838,279	294,169	39,198	44,471	105,288	14,251	57,820	74,852	2,229,887	3,003	3,664
170	9	26	2	6.14	108,070	37,924	5,053	5,733	13,574	1,837	37,778	48,906	1,456,925	1,962	2,394
174	2			6.23	19,952	7,002	933	1,058	2,506	339	0	0	0	0	0
175	19	16		6.26	190,261	66,767	8,897	10,093	23,897	3,234	23,931	30,981	922,939	1,243	1,517
176	1			6.28	10,052	3,527	470	533	1,262	171	0	0	0	0	0
180	17	3	1	6.38	183,653	64,448	8,588	9,743	23,067	3,122	4,615	5,975	177,995	240	292
185	11	18		6.50	114,313	40,115	5,345	6,064	14,358	1,943	28,461	36,845	1,097,638	1,478	1,804
188		20		6.57	0	0	0	0	0	0	32,137	41,603	1,239,376	1,669	2,037
190	10	10		6.61	105,813	37,132	4,948	5,613	13,290	1,799	16,239	21,023	626,280	843	1,029
195	3			6.73	32,311	11,339	1,511	1,714	4,058	549	0	0	0	0	0
196	1			6.76	10,808	3,793	505	573	1,358	184	0	0	0	0	0
197	1			6.78	10,846	3,806	507	575	1,362	184	0	0	0	0	0
198		1		6.80	0	0	0	0	0	0	1,692	2,191	65,265	88	107
200	104	67	2	6.85	1,161,726	407,673	54,322	61,630	145,913	19,749	114,529	148,267	4,416,923	5,948	7,258
205	3	5		6.97	33,447	11,737	1,564	1,774	4,201	569	8,761	11,341	337,862	455	555
210	30	13	1	7.09	351,479	123,341	16,435	18,646	44,146	5,975	23,333	30,207	899,866	1,212	1,479
211		3		7 11	0	0	0	0	0	0	5,410	7,004	208,650	281	343
213		2		7 16	0	0	0	0	0	0	3,641	4,714	140,419	189	231
215	12	1		7.20	138,327	48,542	6,468	7,338	17,374	2,352	1,838	2,379	70,869	95	116
216		1		7.23	0	0	0	0	0	0	1,846	2,390	71,198	96	117
218	1			7.28	11,641	4,085	544	618	1,462	198	0	0	0	0	0
220	30	14	1	7.32	363,209	127,457	16,984	19,268	45,619	6,175	26,325	34,079	1,015,233	1,367	1 668
225	20	68	1	7 44	250,018	87,736	11,691	13,263	31,402	4,250	130,768	169,289	5,043,204	6,792	8 287
228	0	9	1	7.51	12,019	4,218	562	638	1,510	204	17,538	22,705	676,383	911	1,111
230	16	10	1	7.56	205,611	72,153	9,614	10,908	25,825	3,495	19,658	25,449	758,129	1,021	1,246
231		1		7.58	0	0	0	0	0	0	1,974	2,556	76,142	103	125
233		5		7.63	0	0	0	0	0	0	9,957	12,890	384,009	517	631
235	2	21		7.68	24,568	8,621	1,149	1,303	3,086	418	42,179	54,604	1,626,680	2,191	2,673
240	11	15		7.80	137,205	48,148	6,416	7,279	17,233	2,332	30,769	39,833	1,186,636	1,598	1,950
243	1			7.87	12,587	4,417	589	668	1,581	214	0	0	0	0	0
245	6	1	2	7.91	101,299	35,548	4,737	5,374	12,723	1,722	2,094	2,711	80,757	109	133
250	65	75	1	8.03	848,200	297,650	39,662	44,997	106,534	14,419	160,256	207,463	6,180,396	8,323	10,156
256	1			8 17	13,079	4,590	612	694	1,643	222	0	0	0	0	0
260	5	44	2	8.27	92,609	32,498	4,330	4,913	11,632	1,574	97,777	126,580	3,770,866	5,078	6,196
262		2		8.32	0	0	0	0	0	0	4,479	5,798	172,721	233	284
265	5	1		8.39	67,095	23,545	3,137	3,559	8,427	1,141	2,265	2,932	87,350	118	144
270	11	17		8.51	149,691	52,530	7,000	7,941	18,801	2,545	39,231	50,787	1,512,961	2,038	2,486
271		12		8.53	0	0	0	0	0	0	27,795	35,982	1,071,928	1,444	1,761
275	4	7	1	8 62	68,987	24,209	3,226	3,660	8,665	1,173	16,453	21,299	634,521	855	1,043
276		1		8 65	0	0	0	0	0	0	2,359	3,054	90,975	123	149
280	14	19		8 74	195,813	68,715	9,156	10,388	24,594	3,329	45,470	58,864	1,753,584	2,362	2,882

HP	No. Diesel	No Gasoline	Type Unspecified (Assumed Diesel)	DIESEL FUEL CONSUMPTION (GALS/HOUR)	Annual Consumption (GALLONS)	DIESEL VESSEL EMISSIONS (POUNDS OF POLLUTANT PER YEAR) NOx	HC	CO	SOx	PM	GASOLINE VESSEL EMISSIONS (POUNDS OF POLLUTANT PER YEAR) NOx	Exhaust HC	CO	SOx	PM
283		1		8.81	0	0	0	0	0	0	2,419	3,131	93,283	126	153
285	1	7		8.86	14,176	4,975	663	752	1,780	241	17,051	22,074	657,594	886	1,081
290	3	4		8.98	43,095	15,123	2,015	2,286	5,413	733	9,914	12,835	382,361	515	628
294		2		9.07	0	0	0	0	0	0	5,026	6,506	193,817	261	318
298	2			9.17	29,335	10,294	1,372	1,556	3,685	499	0	0	0	0	0
300	37	28	1	9.21	560,248	196,602	26,197	29,721	70,367	9,524	71,794	92,943	2,768,818	3,729	4,550
301		1		9.24	0	0	0	0	0	0	2,573	3,330	99,216	134	163
302		1		9.26	0	0	0	0	0	0	2,581	3,342	99,546	134	164
305		1		9.33	0	0	0	0	0	0	2,607	3,375	100,534	135	165
307		3		9.38	0	0	0	0	0	0	7,872	10,191	303,581	409	499
308	2			9.40	30,092	10,560	1,407	1,596	3,780	512	0	0	0	0	0
310	2			9.45	30,243	10,613	1,414	1,604	3,799	514	0	0	0	0	0
315	1	1		9.57	15,311	5,373	716	812	1,923	260	2,692	3,485	103,831	140	171
318	5	1	2	9.64	107,971	37,889	5,049	5,728	13,561	1,836	2,718	3,519	104,820	141	172
320	9	2		9.69	139,501	48,954	6,523	7,401	17,521	2,372	5,470	7,081	210,958	284	347
325	10	1		9.81	156,893	55,057	7,336	8,323	19,706	2,667	2,778	3,596	107,127	144	176
327		3		9.85	0	0	0	0	0	0	8,385	10,854	323,358	435	531
330	5	68		9.92	79,392	27,860	3,712	4,212	9,972	1,350	191,794	248,291	7,396,699	9,961	12,154
335	1	2		10.04	16,068	5,638	751	852	2,018	273	5,726	7,413	220,846	297	363
340	8	10		10.16	130,055	45,639	6,081	6,899	16,335	2,211	29,060	37,620	1,120,712	1,509	1,842
350	25	60		10.40	415,880	145,941	19,447	22,062	52,235	7,070	179,486	232,358	6,922,044	9,322	11,374
351	1	4	5	10.42	100,038	35,105	4,678	5,307	12,565	1,701	12,000	15,535	462,788	623	760
358	4		4	10.59	135,503	47,551	6,336	7,188	17,019	2,304	0	0	0	0	0
360	16	1	17	10.63	561,448	197,023	26,253	29,785	70,518	9,545	3,077	3,983	118,664	160	195
365	17		17	10.75	584,894	205,251	27,350	31,029	73,463	9,943	0	0	0	0	0
370	1	2	3	10.87	69,568	24,413	3,253	3,691	8,738	1,183	6,325	8,188	243,920	328	401
371	2		2	10.89	69,719	24,466	3,260	3,699	8,757	1,185	0	0	0	0	0
375	6		6	10.99	210,973	74,035	9,865	11,192	26,498	3,587	0	0	0	0	0
380	3	4	7	11.11	177,703	62,360	8,309	9,427	22,320	3,021	12,991	16,818	501,024	675	823
390		1	1	11.34	18,149	6,369	849	963	2,279	309	3,333	4,315	128,552	173	211
400	20	10	30	11.58	926,352	325,075	43,316	49,143	116,350	15,748	34,188	44,259	1,318,485	1,776	2,167
413	1			11.89	19,019	6,674	889	1,009	2,389	323					
420	11			12.05	212,122	74,438	9,919	11,253	26,642	3,606					
425	5			12.17	97,365	34,167	4,553	5,165	12,229	1,655					
430	3			12.29	58,986	20,700	2,758	3,129	7,409	1,003					
435	5			12.41	99,257	34,831	4,641	5,266	12,467	1,687					
436	2			12.43	39,778	13,959	1,860	2,110	4,996	676					
440	10			12.53	200,405	70,326	9,371	10,631	25,171	3,407					
450	11			12.76	224,608	78,819	10,503	11,915	28,211	3,818					
452	1			12.81	20,495	7,192	958	1,087	2,574	348					
454	5			12.86	102,851	36,093	4,809	5,456	12,918	1,748					
455	1			12.88	20,608	7,232	964	1,093	2,588	350					
458	1			12.95	20,722	7,272	969	1,099	2,603	352					
460	4			13.00	83,189	29,193	3,890	4,413	10,449	1,414					
471	1			13.26	21,213	7,444	992	1,125	2,664	361					
475	1			13.35	21,365	7,497	999	1,133	2,683	363					
490	1			13.71	21,932	7,697	1,026	1,164	2,755	373					
500	18			13.94	401,593	140,927	18,778	21,305	50,440	6,827					
510	13			14.18	294,958	103,507	13,792	15,648	37,047	5,014					
520	14			14.42	322,944	113,328	15,101	17,132	40,562	5,490					
525	1			14.54	23,257	8,161	1,087	1,234	2,921	395					
540	5			14.89	119,121	41,802	5,570	6,319	14,962	2,025					
550	2			15.13	48,405	16,986	2,263	2,568	6,080	823					
560	1			15.36	24,581	8,626	1,149	1,304	3,087	418					
600	9			16.31	234,850	82,413	10,982	12,459	29,497	3,992					
604	1			16.40	26,246	9,210	1,227	1,392	3,296	446					

Census of Gulf Coast Fishing Vessels

Length [Feet]		HP			Number of Vessels
min	max	min	max	average	
20	29	150	350	250	191
30	39	250	400	325	1627
40	49	250	700	475	1751
50	59	400	850	625	999
60	69	500	1000	750	1778
70	79	750	1250	1000	671
80	89	750	1250	1000	88
90	99	1000	1500	1250	19
100	109	1000	1500	1250	4
110	119	1000	1500	1250	5
120	129	1000	1500	1250	4
130	139	1000	1500	1250	13
140	149	1000	1500	1250	12
150	159	1000	1500	1250	10
160	169	1000	1500	1250	55
170	179	1000	1500	1250	0
180	189	1500	3500	2500	0
190	199	1500	3500	2500	4
200	209	1500	3500	2500	2
250	259	1500	3500	2500	1
260	269	1500	3500	2500	0
550	559	3500	7000	5250	1
640	649	3500	7000	5250	1
		Total			7236

Sources:
Vessel populations in length intervals are from a special survey of fishing vessels conducted by the National Marine Fisheries Service, reported in Fisheries of the United States, 1990.
Horsepower data are based on a conversation with Mr. Lonny Babin Chief Estimatior at Bollinger Ship Builders, Lockport, Louisana.

APPENDIX D
New York – New Jersey