

**Economic and Benefits Analysis of
the Proposed Vessel General Permit (VGP)**

Developed for:

**Office of Wastewater Management
U.S. Environmental Protection Agency**

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Table of Contents

1	Acknowledgments	i
	List of Tables	vi
	Acronyms	ix
	Executive Summary	xi
2	Introduction	1
2.1	Background.....	1
2.2	Organization within the Analysis.....	1
3	Population of Affected Vessels	3
3.1	Domestic Vessel Population.....	3
3.2	Foreign Vessel Population.....	5
3.3	Vessels Subject to the Ballast Water Management Requirements.....	6
3.4	Uncertainties and Limitations.....	7
4	Permit Overlap with Existing Regulations	8
4.1	Ballast Water and Invasive Species Management.....	8
4.2	Graywater.....	10
4.3	Anti-fouling Hull Coatings.....	11
4.4	Bilgewater Discharges.....	11
4.5	Overlap with Existing Clean Water Act Provisions.....	11
4.6	Issues and Uncertainties.....	12
5	Profile of the Water Transportation and Fishing Industries	13
5.1	Introduction.....	13
5.1.1	Data Sources Used.....	13
5.1.2	Organization of This Chapter.....	13
5.2	Overview of the Water Transportation and Fishing Industries.....	14
5.2.1	Definition of the Water Transportation and Fishing Industries.....	14
5.2.2	Water Transportation.....	14
5.2.3	Fishing.....	18
5.2.4	Number of Water Transport Vessels by Industry Sector.....	18
5.3	Recent Trends in the Water Transportation Industry.....	19
5.3.1	Number of Vessels by Industry Sector.....	20
5.3.2	Number of Establishments by Industry Sector.....	20

5.3.3	Establishment and Employment Births and Deaths	21
5.3.4	Financial Performance.....	22
5.4	Industry Market Structure.....	23
5.4.1	Establishments and Revenues.....	23
5.4.2	Small Businesses	25
5.4.3	Employment and Payroll	26
6	Cost of Best Management Practices.....	29
6.1	Summary	29
6.2	Cost of Individual BMPs	29
6.2.1	Discharges of Deck Washdown and Runoff.....	30
6.2.2	Discharges of Bilgewater	34
6.2.3	Discharges of Ballast Water – Pacific Nearshore Vessels.....	35
6.2.4	Discharges of Ballast Water – Vessels with Empty Tanks.....	41
6.2.5	Anti-fouling Hull Coatings.....	45
6.2.6	Aqueous Film-Forming Foam	46
6.2.7	Boiler/Economizer Blowdown	50
6.2.8	Cathodic Protection	50
6.2.9	Chain Locker Effluent.....	53
6.2.10	Controllable Pitch Propeller Hydraulic Fluid.....	55
6.2.11	Distillation and Reverse Osmosis Brine.....	59
6.2.12	Elevator Pit Effluent.....	59
6.2.13	Firemain Systems	60
6.2.14	Freshwater Layup	61
6.2.15	Gas Turbine Wash Water	61
6.2.16	Graywater	62
6.2.17	Motor Gasoline and Compensating Discharge.....	63
6.2.18	Non-Oily Machinery Wastewater.....	64
6.2.19	Refrigeration and Air Condensate Discharge.....	64
6.2.20	Rudder Bearing Lubrication Discharge.....	64
6.2.21	Seawater Cooling Overboard Discharge	65
6.2.22	Seawater Piping Biofouling Prevention	65
6.2.23	Small Boat Engine Wet Exhaust	66
6.2.24	Sonar Dome Discharge.....	67
6.2.25	Stern Tube Oily Discharge	67

6.2.26	Underwater Ship Husbandry Discharges.....	67
6.2.27	Weldeck Discharges.....	69
6.2.28	Graywater Mixed with Sewage from Vessels.....	69
6.2.29	Exhaust Gas Scrubber Washwater Discharge.....	70
6.3	Per-Vessel Costs for Vessel-Specific Requirements.....	70
6.3.1	Large and Medium Cruise Ships.....	70
6.3.2	Large Ferries.....	75
6.3.3	Barges.....	76
6.3.4	Oil Tankers or Petroleum Tankers.....	77
6.3.5	Research Vessels.....	78
6.3.6	Rescue Boats.....	79
6.3.7	Vessels Employing Experimental Ballast Water Treatment Systems.....	79
6.3.8	Uncertainties and Limitations.....	81
6.4	Permit Paperwork Burden.....	81
6.5	Analysis of Total National Costs.....	85
7	Analysis of Impacts on Firm Revenues and Financial Performance.....	88
7.1	Methodology.....	88
7.1.1	Assign Each Vessel to a NAICS Code.....	88
7.1.2	Estimate the Number of Vessels per Firm.....	89
7.1.3	Estimate the Distribution of Costs per Vessel.....	89
7.1.4	Compare Costs to Revenues.....	90
7.2	Small Entity Analysis.....	91
7.3	Issues and Uncertainties.....	98
8	Benefits Analysis.....	99
8.1	Ballast Water Exchange and Invasive Species Impacts.....	99
8.1.1	Introduction and Background.....	99
8.1.2	ANS Impacts.....	100
8.1.3	Efficacy of Ballast Water Exchange and Saltwater Flushing.....	104
8.1.4	Benefits of Reducing ANS Introductions.....	105
8.2	Benefits of Reduced Pollutant Discharges from Vessels.....	107
8.2.1	Introduction and Background.....	107
8.2.2	Pollutants Commonly Found in Vessel Discharges.....	107
8.2.3	Pollutant Impacts.....	110
8.2.4	Benefits of Reducing Pollutant Discharges.....	113

References.....	116
Appendix A: Survey Questionnaires.....	126
Individual BMP Survey	126
Cruise Ship Survey	138
Appendix B: Summary of Survey Responses	145
Individual BMP Survey	145
Cruise Ship Survey	152

List of Tables

Table 3-1: Domestic Vessel Population.....	4
Table 3-2: Foreign Vessel Population.....	6
Table 3-3: Oceangoing Arrivals.....	6
Table 3-4: Pacific Nearshore Arrivals	7
Table 4-1: Summary Crosswalk between Current Ballast Requirements and EPA Permit Requirements	9
Table 4-2: Summary Crosswalk between Current Cruise Ship Requirements and EPA Permit Requirements	11
Table 5-1: Relevant 2002 NAICS Codes and Descriptions	14
Table 5-2: Number of Vessels and Establishments by Industry Sector, 2002	19
Table 5-3: Number of Vessels in the WTLUS Database, 2001-2005	20
Table 5-4: Number of Establishments by Industry Sector, 1997 and 2002	21
Table 5-5: Establishment Births and Deaths, Five-Year Average: 1998–2003	22
Table 5-6: Net Change in Employment: Five-Year Average, 1998-2003	22
Table 5-7: Revenues by Industry Sector, 1997 and 2002	23
Table 5-8: Establishments and Revenues by Employment Size, 2002	24
Table 5-9: Number of Firms According to Revenue Size.....	25
Table 5-10: Small Businesses in the Water Transportation and Fishing Industries.....	26
Table 5-11: Employment in the Water Transportation and Fishing Industries, 1997-2002.....	27
Table 5-12: Payroll in the Water Transportation and Fishing Industries, 1997-2002.....	28
Table 6-1: Vessel Counts for BMPs Applicable to Deck Runoff.....	30
Table 6-2: Per-Vessel Costs for BMPs Associated with Deck Runoff.....	32
Table 6-3: Deck Runoff Sensitivity Analysis	33
Table 6-4: Unit Cost Inputs for Ballast Water Practices - Pacific Nearshore Vessels.....	37
Table 6-5: Annual Maintenance Cost Estimates for Pacific Nearshore Vessels.....	38
Table 6-6: Summary of Costs of Ballast Water Exchanges for Vessels Engaged in Pacific Nearshore Voyages: Domestic Flag.....	39
Table 6-7: Summary of Costs of Ballast Water Exchanges for Vessels Engaged in Pacific Nearshore Voyages: Foreign Flag.....	40
Table 6-8: Unit Cost Inputs for Ballast Water Practices – Vessels with Empty Ballast Tanks	42
Table 6-9: Summary of Costs of Saltwater Flushing for Oceangoing Vessels with Ballast Tanks Empty: Domestic Flag	44
Table 6-10: Summary of Costs of Saltwater Flushing for Oceangoing Vessels with Ballast Tanks Empty: Foreign Flag	44
Table 6-11: Vessel Counts for AFFF BMPs.....	46

Table 6-12: Per-Vessel Costs for BMPs Associated with AFFF	47
Table 6-13: Aqueous Film-Forming Foam Sensitivity Analysis	49
Table 6-14: Vessel Counts for Cathodic Protection ^b BMPs	50
Table 6-15: Cathodic Protection Installation Cost Estimates	52
Table 6-16: Cathodic Protection Sensitivity Analysis, Purchase of a Cathodic Protection System	53
Table 6-17: Vessel Counts for Chain Locker Effluent BMPs.....	53
Table 6-18: Per Vessel Costs for BMPs Associated with Chain Locker Effluent	54
Table 6-19: Chain Locker Effluent Sensitivity Analysis, Wash Down Anchor Chain.....	55
Table 6-20: Vessel Counts for Controllable Pitch Propeller Hydraulic Fluid BMPs	56
Table 6-21: Per-Vessel Costs for BMPs Associated with Controllable Pitch Propeller Hydraulic Fluid.....	56
Table 6-22: Controllable Pitch Propeller Hydraulic Fluid Sensitivity Analysis.....	58
Table 6-23: Vessel Counts for Elevator Pit Effluent BMPs	59
Table 6-24: Vessel Counts for Firemain Systems BMPs.....	60
Table 6-25: Vessel Counts for Graywater BMPs.....	62
Table 6-26: Vessel Counts for Underwater Ship Husbandry BMPs.....	68
Table 6-27: Cruise Ship Counts	71
Table 6-28: Cruise Ship Costs Associated with the Purchase of a Graywater Treatment System.....	73
Table 6-29: Cruise Ship Costs Associated with Sampling.....	74
Table 6-30: Vessel Counts for BMPs Associated with River Barges	76
Table 6-31: Vessel Counts for BMPs Associated with Oil or Petroleum Tankers	77
Table 6-32: Vessel Counts for BMPs Associated with Research Vessels	78
Table 6-33: Vessel Class Breakdown	82
Table 6-34: Recordkeeping Burden	82
Table 6-35: NOI Burden	83
Table 6-36: Routine Inspection Burden	83
Table 6-37: Annual Inspection Burden	84
Table 6-38: One-Time Report Burden	84
Table 6-39: Total Annual Compliance Costs for All BMPs by Vessel Type	85
Table 6-40: Total Annual Incremental Cost for Cruise Ships.....	85
Table 6-41: Total Permit Recordkeeping Burden Cost.....	86
Table 6-42: Total Annual Incremental Cost	87
Table 7-1: Estimated Median and 5th and 95th Percentile Firm Costs by NAICS Code	92
Table 7-2: Results of the Small Entity Impact Analysis	96
Table 8-1: Estimates of Invasive Species in Several Major Water Systems.....	100

Table 8-2: Estimates of Invasive Species Damages by Type of Species	101
Table 8-3: Pollutants Found in Vessel Discharges ^a	108
Table 8-4: Types of Pollutants Found in Graywater Discharges	109
Table 8-5: Impairment Status of the Top 20 Ports by Annual Vessel Calls	113
Table 8-6: Potential Daily Reduction in Loadings of Pollutants from Graywater Discharges by a Large Cruise Ship in U.S. Territorial Waters	114
Table 8-7: Benefits of Reducing Pollutants Found in Vessel Discharges.....	115
Survey Responses Regarding Labor Rates ^a	145
Survey Responses Regarding Deck Runoff	146
Survey Responses Regarding AFFF	147
Survey Responses Regarding Graywater	147
Survey Responses Regarding Underwater Hull Husbandry	148
Survey Responses Regarding Cathodic Protection	148
Survey Responses Regarding Chain Locker Effluent.....	149
Survey Responses Regarding Controllable Pitch Propeller Hydraulic Fluid.....	150
Survey Responses Regarding Elevator Pit Effluent.....	150
Survey Responses Regarding Firemain Discharges.....	151
Survey Responses Regarding Cruise Ships	152

Acronyms

ACSI	Alaska Cruise Ship Initiative
ADEC	Alaska Department of Environmental Conservation
AFFF	Aqueous film-forming foam
AMSA	Australian Maritime Safety Authority
ANS	Aquatic non-indigenous species
ANSTF	Aquatic Nuisance Species Task Force
APPS	Act to Prevent Pollution from Ships
BMP	Best management practice
BOD	Biochemical oxygen demand
CCC	Criterion Continuous Concentration
CDC	Centers for Disease Control
CLIA	Cruise Line International Association
CMC	Criterion Maximum Concentration
COTP	Captain of the Port
CPI	Consumer Price Index
CWA	Clean Water Act
DOD	Department of Defense
EEZ	Exclusive Economic Zone
FIFRA	Federal Insecticide, Fungicide, and Rodenticide Act
GESAMP	Joint Group of Experts on the Scientific Aspects of Marine Environmental Protection
GLERL	Great Lakes Environmental Research Laboratory
GSMFC	Gulf States Marine Fisheries Commission
ICCP	Impressed Current Cathodic Protection
ICST	International Classification of Ships by Type
IDNR	Indiana Department of Natural Resources
IMO	International Maritime Organization
ISA	Infectious salmon anemia
MARPOL	International Convention for the Prevention of Marine Pollution from Ships
MISLE	Marine Information for Safety and Law Enforcement
NAICS	North American Industry Classification System
NANCPA	Nonindigenous Aquatic Nuisance Prevention and Control Act of 1990
NBIC	National Ballast Information Clearinghouse
NDC	Navigation Data Center
NISA	National Invasive Species Act
NMFS	National Marine Fisheries Service
NOAA	National Oceanic and Atmospheric Administration
NoBOB	No ballast on board
NOI	Notice of Intent
NPDES	National Pollutant Discharge Elimination System
NRDC	National Resources Defense Council
NRWQC	National recommended water quality criteria
OTA	Office of Technology Assessment
PAH	Polycyclic aromatic hydrocarbon
PFOA	Perfluorooctanoic acid
PFOS	Perfluorooctane sulfonate

POC	Pollutant of concern
RFA	Regulatory Flexibility Act
RO-RO	Roll-on/roll-off
RTF	Ruffe Task Force
SAB	Science Advisory Board
SBA	Small Business Administration
SBAC	Small Business Advocacy Chair
SBREFA	Small Business Regulatory Enforcement and Fairness Act
SIC	Standard Industrial Classification
TBT	Tributyl tin
USACE	U.S. Army Corps of Engineers
USCG	U.S. Coast Guard
USDA	U.S. Department of Agriculture
USDOJ	U.S. Department of Justice
USGS	U.S. Geological Survey
VDS	Vessel Documentation System
VESDOC	Merchant Vessels of the United States
VHS	Viral hemorrhagic septicemia
VTCC	Vessel Type, Construction, and Characteristics
WCSC	Waterborne Commerce Statistics Center
WHOI	Woods Hole Oceanographic Institute
WTLUS	Waterborne Transportation Lines of the United States

Executive Summary

EPA is currently developing new permitting requirements for discharges incidental to the normal operation of a vessel into inland waters or the territorial sea of the United States under the National Pollutant Discharge Elimination System (NPDES).

This report presents EPA's economic and benefits analysis of the Commercial Vessel General Permit's impact on all affected vessels. Though the issuance of this Permit is not a Federal regulation, EPA is conducting this analysis due to the potential impacts of this Permit. The Executive Summary provides an overview of the costs and benefits of the regulation.

The Vessel General Permit for Discharges Incidental to the Normal Operation of Non-Recreational Vessels and Large Recreational Vessels (herein referred to as the Commercial Vessel General Permit or VGP) covers non-recreational vessels and recreational vessels at least 79 feet long. The Commercial Vessel General Permit defines effluent limits for 28 discharge categories as well as specifying certain practices for various vessel categories.

All vessels operating in a capacity of transportation are eligible for coverage under the Commercial Vessel General Permit. The types of vessels covered under the Commercial Vessel General Permit include cruise ships, ferries, barges, oil tankers or petroleum tankers, bulk carriers, cargo ships, container ships, other cargo freighters, refrigerant ships, research vessels, and emergency response vessels, including firefighting and police vessels, select recreational vessels (either at least 79 feet in length or weighing at least 300 gross tons), and any other vessel operating in a capacity of transportation. Vessels of the armed forces of the United States and recreational vessels less than 79 feet in length are not eligible for coverage by this Permit. EPA estimates that 90,713 domestic flag and 7,932 foreign flag vessels will be affected by the VGP requirements. Chapter 3 of this report, *Population of Affected Vessels*, presents EPA's assessment of the numbers and types of vessels likely to be impacted by the new permitting requirements.

Water transportation accounts for a majority of the vessels sailing on U.S. waters and thus affected by VGP. The water transportation industry is a \$34 billion industry that employs nearly 150,000 people on a payroll of just over \$6 billion. Overall, the industry has experienced mild growth in the number of establishments, revenues, and payroll, but a decline in the number of employees. The fishing industry is responsible for slightly more than a quarter of all commercial vessels in the United States. This industry is much smaller, with total revenues of \$1.65 billion, employing just over 6,500 people on a payroll of \$253 million. The fishing industry is experiencing more of a decline, although it still shows some revenue growth despite declines in the number of establishments and employees, and in total payroll. On the whole, both industries contain more than 90 percent small businesses. Of the 5,037 firms in the water transportation industry, 4,717 (93.7 percent) are small. In the fishing industry, 1,843 (96.2 percent) of the 1,916 firms are small. Chapter 5: *Profile of the Water Transportation and Fishing Industries* provides an economic profile of these industries.

To estimate the effect of the Permit on an industry as a whole, EPA's analysis takes into account previous conditions and determines how the industry would act in the future in the absence of the Permit. The baseline for this analysis is full industry compliance with existing federal and state regulations; and current industry practices or standards that exceed current regulations to the extent that they can be empirically observed. In addition, a number of laws and associated regulations (including the National Invasive Species Act; the Act to Prevent Pollution from Ships; the Comprehensive Environmental Response, Compensation, and Liability Act; the Organotin Anti-fouling Paint Control Act; and others) already cover certain discharges that would be subject to the new permitting regime. In analyzing economic impacts of the vessel vacatur of the NPDES requirements, EPA has assumed that the entities subject to existing regulations will not incur significant incremental costs. Chapter 4, *Permit Overlap with Existing Regulations*, summarizes laws and associated regulations that already cover certain discharges that would be subject to the new permitting regime.

Overall, EPA finds that the Permit has modest economic impacts on the water transportation and fishing industries. The total annual incremental costs range from \$7.09 to \$25.0 million annually (2007\$). This includes the paperwork burden costs and the sum of the ballast water management costs, the costs of all other BMPs, and the costs to cruise ships. The estimated total costs of the paperwork burden (including recordkeeping, Notice of Intent (NOI) filing, routine inspections, annual inspections, and a one-time report) range from \$0.7 to \$5.1 million. The estimated VGP compliance costs (excluding \$1.1 million for ballast water practices for foreign vessels) range from \$5.6 to \$19.1 million (2007\$). Chapter 6: *Cost of Best Management Practices* presents EPA's analysis of compliance costs to commercial vessels associated with each of the BMPs identified and the paperwork burden costs.

To evaluate economic impacts of VGP requirements on the water transportation and fishing industries, EPA performed the firm-level analysis. The firm-level analysis examines the impact of the introduced BMP costs per vessel on model firms that represent the financial conditions of "typical" businesses in each of the examined industry sectors. Since more than 90 percent of the firms in the water transportation and fishing industries are small, it is unlikely that firm-level impacts would be material among large firms in this industry. Therefore, a firm-level analysis focuses on assessment of impacts on small businesses, as required by the Regulatory Flexibility Act and the Small Business Regulatory Enforcement and Fairness Act (SBREFA). To evaluate the potential impact of the Commercial Vessel General Permit on small entities, EPA used a cost-to-revenue test to evaluate the potential severity of economic impact on vessels and facilities owned by small entities. The test calculates annualized pre-tax compliance cost as a percentage of total revenues and uses a threshold of 1 and 3 percent to identify facilities that would be significantly impacted as a result of this Permit.

The firm-level analysis shows that the "rule is presumed not to have a significant economic impact on a substantial number of small entities." The total number of small entities in the *fishing industry* that are expected to exceed the 1 percent cost-to-revenue threshold is 36 (or 0.1 percent) under the low end cost assumptions and 72 (or 0.3 percent) under the high end cost assumptions. The total number of small entities in the *water transportation industry* sectors that are expected to exceed the 1 percent cost-to-revenue threshold is 249 under the low end cost assumptions and 326 under the high end cost assumptions. *Chapter 7 Analysis of Impacts on Firm Revenues and Financial Performance* details EPA's assessment of the cost and economic impact of regulatory requirements on firms in the shipping industry, and the implications of the Permit in terms of financial viability of shipping industry firms subject to the Permit.

Although EPA was unable to evaluate the expected benefits of the Permit in dollar terms due to data limitations, the Agency collected and developed relevant information to enable qualitative consideration of ecological benefits and to assess the importance of the ecological gains from the Permit. EPA expects that reductions in vessel discharges will benefit society in two broad categories: (1) enhanced water quality from reduced pollutant discharges and (2) reduced risk of invasive species introduction.

The Permit covers many discharges and contains special provisions for numerous vessel types (see EPA (2008b) for information on the affected discharges and provisions by vessel type). Many of the discharges regulated by EPA's Commercial Vessel General Permit (2008b) were previously regulated under only certain select circumstances covering a small fraction of total discharges, if at all. Nonetheless, several discharges are associated with a wide variety of harmful pollutants in substantial concentrations. For example, untreated graywater may contain pathogenic bacteria, toxic and carcinogenic organic and inorganic compounds, nutrients, and metals (EPA, 2007a). Because many of the nation's busiest ports are considered to be impaired by a variety of pollutants found in vessel discharges, the Permit is expected to have benefits associated with the reduction of concentrations of nutrients, metals, oil, grease, and toxics in waters with high levels of vessel traffic. These impacts will be particularly significant in those nutrient-impaired areas frequented by cruise ships (e.g., San Francisco Bay and Chesapeake Bay), which can discharge large volumes of graywater and are subject to stringent discharge requirements under the Permit.

The ballast water provisions of EPA's proposed Commercial Vessel General Permit are expected to reduce the number of introductions of aquatic non-indigenous species (ANS) and thus may prevent significant future damages to fisheries, tourism, recreation, infrastructure, and human health, as well as further stresses on native biodiversity and ecosystems. Although estimating the monetary value of benefits from preventing future invasions with a reasonable degree of certainty would not be possible due to the lack of data on rates of invasive species introduction associated with ballast water releases, the type of species introduced in the future and the range of potential economic impacts associated with each species type is very large. The potential benefits of preventing the introduction of even one harmful ANS could be substantial.

2 Introduction

2.1 Background

EPA is currently developing new permitting requirements for discharges incidental to the normal operation of a vessel into inland waters or the 3 mile territorial sea of the United States under the National Pollutant Discharge Elimination System (NPDES). EPA will incorporate these requirements into the existing NPDES framework.

The Vessel General Permit for Discharges Incidental to the Normal Operation of Non-Recreational Vessels and Large Recreational Vessels (herein referred to as the Commercial Vessel General Permit or VGP) covers non-recreational vessels and recreational vessels at least 79 feet long.¹ To obtain authorization under the Commercial Vessel General Permit:

- Vessel operators must meet the Commercial Vessel General Permit eligibility requirements.
- Operators of some vessels will have to submit NOIs. If a vessel weighs at least 300 gross tons or has the capacity to discharge more than 8 cubic meters of ballast water, the operator must submit a complete and accurate NOI. For operators required to submit NOIs, submission must meet specified submission deadlines. If the vessel is not in one of the aforementioned categories, it automatically receives permit coverage under the Commercial Vessel General Permit and is authorized to discharge in accordance with Permit conditions.
- Vessel operators must implement the effluent limits according to the requirements in Part 2 of the Commercial Vessel General Permit, and document the implementation as part of their recordkeeping documentation. If the vessel is equipped to carry ballast water or carries ballast water at any time, it must have a ballast water management plan consistent with part 33 CFR 151.2035(a)(7).

Based on an analysis of several vessel data sources (described in *Section 3*), EPA created a population of vessels affected by the NPDES requirements. The total count of the domestic flag vessel population is 90,713. The foreign flag vessel population falls at 7,932.

The Commercial Vessel General Permit defines effluent limits for 28 discharge categories as well as specifying certain practices for various vessel categories. This report presents EPA's economic and benefits analyses of the Commercial Vessel General Permit's impact on all affected vessels. Though the issuance of this permit is not a Federal regulation, EPA is conducting these analyses due to the potential impacts of this permit. These analyses are consistent with the Regulatory Flexibility Act as amended by the Small Business Regulatory Enforcement Fairness Act of 1996 (RFA/SBREFA). Though this permit is not a rule, EPA is conducting an economic analysis consistent with a Regulatory Flexibility Analysis to evaluate the costs associated with this permit.

2.2 Organization within the Analysis

This report is organized in seven chapters and two appendices, as follows:

Chapter 3: *Population of Affected Vessels* presents an assessment of the numbers and types of vessels likely to be impacted by the new permitting requirements.

Chapter 4: *Permit Overlap with Existing Regulations* summarizes laws and associated regulations that already cover certain discharges that would be subject to the new permitting regime.

Chapter 5: *Profile of the Water Transportation and Fishing Industries* provides an economic profile of the water transportation and fishing industries.

¹ The descriptions of permitting requirements in this report are based upon the March 18, 2008 Draft Permit provided by EPA.

Chapter 6: *Cost of Best Management Practices* presents EPA's analysis of compliance costs to commercial vessels associated with each of the BMPs identified by EPA in the Permit at the vessel level. This chapter also presents an estimation of national-level industry compliance costs in the aggregate.

Chapter 7: *Analysis of Impacts on Firm Revenues and Financial Performance* presents EPA's assessment of the cost and economic impact of regulatory requirements on firms in the shipping industry, and the implications of a Permit in terms of financial viability of shipping industry firms subject to the Permit.

Chapter 8: *Benefits Analysis* presents EPA's assessment of the environmental effects associated with vessel discharges and the benefits of reducing these discharges.

Appendix A presents the questionnaires sent to the industry representatives.

Appendix B presents a summary of responses from the industry questionnaires.

3 Population of Affected Vessels

The Commercial Vessel General Permit is applicable to discharges incidental to the normal operation of a vessel into the navigable waters within the meaning of the Clean Water Act (CWA) Section 502(7). All vessels operating in a capacity of transportation are eligible for coverage under the Commercial Vessel General Permit. The types of vessels covered under the Commercial Vessel General Permit include cruise ships, ferries, barges, oil tankers or petroleum tankers, bulk carriers, cargo ships, container ships, other cargo freighters, refrigerant ships, research vessels, and emergency response vessels, including firefighting and police vessels, select recreational vessels (either at least 79 feet in length), and any other vessel operating in a capacity of transportation. Vessels of the armed forces of the United States and recreational vessels less than 79 feet in length are not eligible for coverage by this permit.

EPA used the following data sources to estimate the population of affected vessels:

- *Domestic flag vessels:* The Waterborne Transportation Lines of the United States (WTLUS) and Merchant Vessels of the United States (VESDOC) databases provided information on the number and type of domestic flag vessels subject to the Commercial Vessel General Permit.
- *Foreign flag vessels:* The Foreign Vessel Traffic Entrance and Clearance records of U.S. Customs and Border Protection provided information on the number and type of foreign flag vessels operating in the navigable waters of the United States.
- *Vessels subject to ballast water management requirements:* The National Ballast Information Clearinghouse (NBIC) provided data on U.S. port calls, traffic patterns, ballast capacity, whether a vessel declared ballast water on board, and whether ballast water exchange was performed.

In addition, the Cruise Line International Association (CLIA) provided information on the number and size of cruise ships operating in U.S. waters.

3.1 Domestic Vessel Population

EPA used two data sources to determine the population of domestic flag vessels: (1) the WTLUS data file compiled by the Waterborne Commerce Statistics Center (WCSC) of the U.S. Army Corps of Engineers (USACE) Navigation Data Center (NDC) (USACE, 2005a, 2005b, and 2005c) and (2) the VESDOC data file compiled by the U.S. Coast Guard (USCG, 2007).

WTLUS is a three-volume annual product that provides both an inventory of vessel companies, along with their American flag vessels operating in the transportation of freight and passengers, and a national summary of all vessels. The database lists the vessel companies in alphabetical sequence and provides each vessel's name and number; Coast Guard number; net tonnage; Vessel Type, Construction, and Characteristics (VTCC) code and International Classification of Ships by Type (ICST) code; register and overall length and breadth; loaded and light draft; horsepower; carrying capacity in short tons or units of cargo and number of passengers; height of fixed superstructures; cargo handling equipment; operating headquarters; and year built or rebuilt. Detailed vessel characteristics may not be available for all vessels included in the total WTLUS vessel inventory (USACE NDC, 2008). The data files for the WTLUS vessel characteristics and operator names were downloaded directly from the USACE NDC website on December 5, 2007, and loaded into a Microsoft® Access file (USACE NDC, 2007). The data cover vessels available for operation as of December 31, 2005.

VESDOC is a data file of merchant and recreational vessels documented under the laws of the United States by the U.S. Coast Guard. The source for this file is the U.S. Coast Guard's Marine Information for Safety and Law Enforcement (MISLE) and Vessel Documentation System (VDS) databases, a comprehensive system serving

many Coast Guard marine safety units, including the National Vessel Documentation Center. The data file of merchant vessels has been specifically prepared from several data tables contained in MISLE and VDS. Vessel specific data include vessel name, call sign, official number (Coast Guard number), International Maritime Organization (IMO) number, hull number, vessel service type, flag, self-propelled indicator, registered gross and net tons, length, breadth, depth, measuring organization name, hailing port and state, numerous trade indicators, vessel builder and managing owner information, horsepower, propulsion type, and hull construction material and configuration. Vessels in this file have a valid Certificate of Documentation (U.S. Bureau of Transportation Statistics, 2008). These data were downloaded from the Bureau of Transportation Statistics' Maritime Data Working Group website as a zipped Access file on November 28, 2007, and extracted the same day (U.S. Bureau of Transportation Statistics, 2008). The file contains updated data through July 7, 2007.

To estimate the domestic vessel population subject to the Commercial Vessel General Permit, EPA created a master database by combining the WTLUS and VESDOC data files. The combined database allowed the Agency to obtain a comprehensive estimate of the vessel population and to minimize the number of missing data fields. The Coast Guard number, which serves as the unique vessel identifier, was used to merge the two databases. EPA used the WTLUS data as the base of the population and, as a general rule, used the majority of the data fields contained therein, inputting similar data attributes from VESDOC into this format. As shown in *Table 3-1*, the estimated number of domestic flag vessels subject to the Commercial Vessel General Permit is 90,713.

Vessel Class	Total Domestic Vessels		Domestic Vessels Required to Submit NOI ^a	
	Count	Percentage of Total	Count	Percentage of Total
Commercial Fishing	28,875	32	1,688	4
Freight Barge	32,842	36	30,961	70
Freight Ship	698	1	469	1
Passenger Vessel	11,520	13	1,270	3
Recreational Vessel	926	1	926	2
Tank Barge	4,944	5	4,808	11
Tank Ship	147	<1	117	<1
Utility Vessel	10,761	12	4,124	9
Total	90,713	100	44,363	100

^a The count of vessels required to submit an NOI is a conservative estimate since data on gross tonnage are not complete. Thus, this count is based on the number of vessels that are either >78' in length or >299 Gross Tons.

This analysis will examine the following vessel population groups, defined by USACE WTLUS and USCG VESDOC categorizations:

- *Commercial Fishing*. Includes commercial fishing vessels.
- *Freight Barge*. Includes open and covered hopper barges, car floats, flat/deck barges, pontoon barges, open and covered dry cargo barges, container barges, lash barges, and convertible barges.
- *Freight Ship*. Includes general cargo freighters, break bulk carriers, roll-on/roll-off (RO-RO) carriers, container ships, partial container ships, and vehicle carriers.
- *Passenger Vessel*. Includes cruise ships, combination passenger and cargo ships, ferries, railroad car ferries, excursion and sightseeing vessels, and passenger barges.
- *Recreational Vessel*. Includes recreational vessels greater than or equal to 300 gross registered tons.
- *Tank Ship*. Includes petroleum, chemical, and liquid gas carriers, and liquid bulk tankers.
- *Tank Barge*. Includes liquid cargo barges that are single hull, double hull, double sided only, and double bottom only.

- *Utility Vessel.* Includes crew boats, offshore supply vessels, industrial vessels, oil recovery vessels, research vessels, school ships, push boats, and tug/towing vessels.

As shown in *Table 3-1*, freight barges (36 percent) and commercial fishing vessels (32 percent) account for the majority of domestic vessels. *Table 3-1* also provides the number of vessels required to provide a Notice of Intent (NOI) to EPA (i.e., vessels at least 79 feet long or weighing at least 300 gross tons). Of the 90,713 domestic flagged commercial vessels subject to the Commercial Vessel General Permit, 44,363 are required to submit a NOI.

3.2 Foreign Vessel Population

The Foreign Traffic Vessel Entrances and Clearances database provides information on foreign vessels entering or clearing U.S. Customs ports in calendar year 2005 (U.S. Customs and Border Protection, 2007). The data are collected by U.S. Customs and Border Protection and include entrance/clearance characteristics such as the date a vessel made entry into or cleared the U.S. Customs port or waterway, as well as vessel characteristics such as the name, type by rig or ICST code, flag of registry, last (for entrances) or next (for clearances) port of call, whether foreign or domestic, Net and Gross Registered Tonnage, and draft in feet. The database includes both foreign flagged and domestic vessels. However, only foreign flagged vessels are included in the estimate of the foreign vessel population. The estimate of the foreign vessel population also excludes recreational boats (weighing less than 300 gross tons) and several other Permit-exempt boats.² EPA estimates that 7,932 foreign flagged vessels are subject to the Commercial Vessel General Permit requirements.

EPA used ICST codes to group foreign flagged vessels into the classes used in the analysis of the domestic vessel population. (This classification scheme is described in the preceding section.) *Table 3-2* presents the number of foreign flagged vessels by vessel class. As shown in *Table 3-2*, the majority of foreign flagged vessels entering U.S. ports are freight ships (65 percent), followed by tank ships (22 percent). Of the 7,932 foreign flagged vessels, 7,834 are required to provide an NOI to EPA (i.e., they weigh at least 300 gross registered tons).

The foreign flagged vessels were excluded from the analysis of the total costs of best management practices (BMPs) because the cost to foreign flagged vessels does not have a direct impact on the U.S. firms. There is also considerable uncertainty regarding management practices employed by these vessels under the baseline scenario. The only exception is ballast water management, for which sufficient data were available to estimate incremental costs of the Commercial Vessel General Permit to both domestic and foreign flagged vessels (see *Sections 6.2.3: Discharges of Ballast Water – Pacific Nearshore Vessels* and *6.2.4: Discharges of Ballast Water – Vessels with Empty Tanks*).

² The database does not provide vessel length. Therefore, the length limit was not used in analyzing the population of foreign vessels subject to the Commercial Vessel General Permit.

Vessel Class	Total Foreign Vessels		Foreign Required to Submit NOI	
	Count	Percentage of Total	Count	Percentage of Total
Commercial Fishing	2	<1	1	<1
Freight Barge	127	2	125	2
Freight Ship	5,610	71	5,577	71
Passenger Vessel	146	2	146	2
Recreational Ship	3	<1	3	<1
Tank Barge	30	<1	30	<1
Tank Ship	1,896	24	1,891	24
Utility Vessel	118	1	61	1
Total	7,932	100	7,834	100

a The count of vessels required to submit an NOI is based on gross registered tonnage.

3.3 Vessels Subject to the Ballast Water Management Requirements

The analysis of national costs and impacts from the ballast water management requirements relies on the USCG National Ballast Information Clearinghouse. The database (NBIC, 2005) compiles information from ballast water reports submitted to the USCG by all ballast tank-equipped vessels entering U.S. waters. The information provided by the NBIC database includes vessel name and type, port, state, arrival date, the last port the vessel called at, information on ballast water management practices (i.e., ballast capacity, volume discharged, whether ballast water exchange was performed, and treatment methods). This analysis is based on information on foreign and domestic flag arrivals to U.S. ports during calendar year 2005. For the purpose of this analysis, NBIC provided two data files to EPA: “Oceangoing Arrivals” and “Pacific Nearshore Arrivals.”

The Commercial Vessel General Permit requires that all vessels entering from outside the 200-nautical mile (nm) U.S. Exclusive Economic Zone (EEZ) with at least one ballast water tank empty must flush all empty tanks with saltwater or seal them off while they remain in the EEZ. The Oceangoing Arrivals dataset captures all arrivals of ballast-capable vessels to U.S. ports, where the vessel’s last port of call was foreign (non-Canadian). The dataset includes 38,912 arrivals by 6,857 vessels, of which 60 arrivals by 37 vessels entered a Great Lakes or Upper Hudson River port. These freshwater arrivals are excluded from costing, however, due to coverage under existing regulations in those jurisdictions (70 CFR 168). *Table 3-2* summarizes the number of vessels and arrivals by water body type (marine or freshwater) and flag (i.e., foreign vs. domestic).

Vessel Flag	All Saltwater Ports		Great Lakes and Upper Hudson Ports	
	Vessel Count	Arrival Count	Vessel Count	Arrival Count
Domestic	336	3,443	3	3
Foreign	6,484	35,409	34	57
Total	6,820	38,852	37	60

EPA used the Pacific Nearshore Arrivals dataset in analyzing impacts of the Commercial Vessel General Permit requirements that vessels engaged in Pacific nearshore voyages while operating inside 200 nm from shore must now conduct ballast water exchanges at 50 nm from shore before arrival. Prior federal regulations required that exchanges be conducted only upon entrance into the U.S. EEZ, and not upon crossing Captain of the Port (COTP) zones. The dataset includes all arrivals to ports in California, Oregon, Washington, and Alaska that originated in North, Central, or South America or the Caribbean. The total number captured is 11,006 arrivals made by 1,314 vessels. Existing state regulations in California and Washington overlap with the Commercial Vessel General Permit requirements for vessels engaged in Pacific nearshore voyages; thus, arrivals to these states will incur no

additional costs. Excluding the California and Washington arrivals yields 2,468 arrivals by 328 vessels that are likely to incur additional ballast water management cost due to the Commercial Vessel General Permit (see *Table 3-4*).

Table 3-4: Pacific Nearshore Arrivals				
Vessel Flag	All Pacific Ports		Oregon and Alaskan Ports	
	Vessel Count	Arrival Count	Vessel Count	Arrival Count
Domestic	218	3,350	121	946
Foreign	1,096	7,656	207	1,522
Total	1,314	11,006	328	2,468

3.4 Uncertainties and Limitations

This section discusses limitations and uncertainties in the estimation of the affected vessel population. Whether these limitations and uncertainties, taken together, are likely to lead to an understatement or overstatement of the estimated vessel population is not known.

- The domestic vessel population was estimated using WTLUS and VESDOC databases. The main limitations of these data sources are:
 - *Missing data fields.* Even after merging both databases and using methods to maximize the amount of available data, several data fields remained with non-negligible deficiencies. Some but not all of these fields were populated using assumptions.
 - *Conflicting vessel classifications.* A relatively small number of vessels were found to be classified by WTLUS and VESDOC differently. In these cases EPA used the WTLUS classification and ignored the VESDOC.
- The estimated number of vessels affected by the ballast water management requirements is based on the NBIC data. The main sources of uncertainty in this analysis are:
 - *Self-reporting of ballast management practices.* The NBIC system for gathering and organizing information on ballast-related activities calls for vessels to self-report with limited oversight. This may result in some vessels conducting incomplete reporting or failing to report altogether. The exact margin of this uncertainty is unknown, but will likely have a relatively low impact on total costs.
 - *Vessel classification.* The vessels in the NBIC database were coded primarily by IMO number, not Coast Guard number as was the case with the WTLUS, VESDOC, and U.S. Customs vessels. Although NBIC did provide a vessel class table that corresponded to the Oceangoing and Pacific Nearshore Arrivals datasets, the classification scheme was slightly different from the one that was used in the domestic and foreign vessel populations. A manual lookup approach was finally employed in order to typecast unidentified vessels. This may result in some uncertainty around estimated number of vessels by class.

Finally, the estimate of the population of affected vessels is also subject to the reporting accuracy of the data providers. Typographical errors and incorrect entries exist to an unknown extent. Those that were discovered were amended.

4 Permit Overlap with Existing Regulations

Several categories of best management practices outlined in the Commercial Vessel General Permit overlap with existing regulations and statutes at the federal and state level. In accordance with these regulations, some vessels have adopted BMPs required under the Commercial Vessel General Permit. This chapter cross-references existing regulations affecting vessel discharges and BMP requirements under the Commercial Vessel General Permit. EPA used the analysis of the overlap to adjust the number of vessels that are likely to incur incremental costs as a result of the Commercial Vessel General Permit implementation.

4.1 Ballast Water and Invasive Species Management

Certain provisions of the new Permit applying to all vessels with ballast tanks are incorporated from a previous U.S. Coast Guard regulation, last revised in the July 2004 Final Rulemaking for the Mandatory Ballast Water Management Program for U.S. Waters (codified in 33 CFR 151), issued under the authority of the National Invasive Species Act (NISA). Thus, these provisions will not be associated with any additional costs to vessel owners or operators, nor will they accrue any additional benefits to society. These requirements specify that masters, owners, operators, or persons-in-charge of all vessels equipped with ballast water tanks that operate in U.S. waters must:

- Avoid the discharge or uptake of ballast water in areas within or that may directly affect marine sanctuaries, marine preserves, marine parks, or coral reefs or in waters listed in Part 12.1 of the Permit.
- Minimize or avoid uptake of ballast water in the following areas and situations:
 - In areas known to have infestations or populations of harmful organisms and pathogens (e.g., toxic algal blooms).
 - In areas near sewage outfalls.
 - In areas near dredging operations.
 - In areas where tidal flushing is known to be poor or at times when a tidal stream is known to be more turbid.
 - In darkness, when bottom-dwelling organisms may rise up in the water column.
 - In shallow water or where propellers may stir up the sediment.
 - In areas with pods of whales, convergence zones, and boundaries of major currents.
- Clean the ballast tanks regularly to remove sediments. Clean the tanks in mid-ocean, under controlled arrangements in port, or at dry dock. Dispose of sediments in accordance with local, state, and federal regulations.
- Discharge only the minimal amount of ballast water essential for vessel operations while in the waters of the United States.
- Rinse anchors and anchor chains when retrieving the anchor to remove organisms and sediments at their place of origin.
- Remove fouling organisms from hull, piping, and tanks on a regular basis and dispose of any removed substances in accordance with local, state, and federal regulations.

- Maintain a ballast water management plan developed specifically for the vessel that will allow those responsible for the plan’s implementation to understand and follow the vessel’s ballast water management strategy.

Provisions of the Commercial Vessel General Permit requiring ballast water exchanges for vessels operating outside the U.S. EEZ are also preserved from the July 2004 U.S. Coast Guard Mandatory Ballast Water Management Program for U.S. Waters, with the exception of the stipulation that exchanges should be conducted as early in the voyage as possible (33 CFR 151). Therefore, oceangoing vessels that travel outside of the U.S. EEZ would not incur any incremental costs associated with ballast water exchanges. The regulatory specifications did not include small vessels that, in their voyage track, were not expected to exceed a distance of 200 nm or vessels that do not carry a sufficient amount of ballast water. The U.S. Coast Guard estimates that 7,420 vessels entering U.S. waters would conduct a ballast water exchange.

The new Permit contains several provisions for ballast water management that the Mandatory Ballast Water Management Program does not cover. The first specifies that vessels engaged in Pacific nearshore voyages must conduct ballast water exchanges at least 50 nm from shore between ballasting events, even if their voyage track is not expected to exceed a distance of 200 nm. The second Permit provision requires vessels with empty ballast tanks or tanks containing only residual unpumpable ballast water to conduct saltwater flushing. However, there is some overlap between these provisions and existing state regulations, summarized in *Table 4-1*. In addition, the Permit specifies that vessels must conduct ballast water exchange as early as possible. The Permit also allows vessel operators not to exchange ballast water (or conduct saltwater flushing if applicable) if the vessel uses a USCG approved technology to treat ballast water or shore treatment (if readily available). The incremental cost of the latter two provisions is expected to be negligible and thus it is not included in subsequent analyses.

Table 4-1: Summary Crosswalk between Current Ballast Requirements and EPA Permit Requirements

EPA Permit Requirements	Overlap with USCG Regulations	Overlap with State Regulations ^a
Mandatory BMPs for all vessels taking up or discharging ballast water	Yes	-----
Mandatory ballast exchange for vessels traveling outside the U.S. EEZ	Yes	-----
Mandatory reporting and provisions for ballast water management	Yes ^b	-----
Mandatory saltwater flushing for vessels declaring empty ballast tanks and no ballast on board (NoBOB)	No	OR ^c
Mandatory ballast water exchanges for vessels engaged in Pacific nearshore voyages	No	CA, WA, OR ^d
Requirements for vessels entering the Great Lakes	Yes	-----

a Though Maryland and Virginia have ballast water regulations, these regulations overlap with the 2004 U.S. Coast Guard rule to such an extent that they will not impact this analysis. Michigan’s ballast treatment regulation is also excluded from this table because it sets a treatment standard for discharges of ballast, which only affects provisions of the Commercial Vessel General Permit already excluded due to overlap with USCG regulations.

b Mandatory reporting and provisions for ballast water management of the 2004 USCG rule did not apply to tankers engaged in Pacific nearshore voyages, but will apply to these vessels under the new EPA rule.

c Current Oregon law prohibits discharge of ballast water mixed with sediments from other regions.

d State-approved treatment options are also authorized as an alternative to ballast water exchange in the listed states, and while treatment options will be authorized under the new Permit, they must first be authorized by USCG, and no such options are yet authorized. Thus, any vessels currently opting to treat their ballast water to comply with the regulations of these states will incur additional compliance costs.

California and Washington’s Ballast Water Management Laws, passed in 2003 and 2004, respectively, mandate ballast exchange for vessels engaged in Pacific nearshore voyages (Cal. Pub. Res. Code 71200-71271 and Wash. Admin. Code 77-120-030).³ Thus, vessels engaged in Pacific nearshore voyages that make calls at ports in Washington and California will not incur additional costs under this Permit. Oregon’s Ballast Water Management Rule, established in 2002, also requires ballast exchange for vessels engaged in Pacific nearshore voyages, but

³ California’s regulations use only a tonnage criterion (300 gross weight tons) to establish applicability, so vessels longer than 79 feet but weighing less than 300 tons will incur incremental costs under the Commercial Vessel General Permit.

exempts vessels traveling only between 40 and 50 degrees latitude (Or. Admin. R. 340-143-0010). Therefore, vessels engaged in Pacific nearshore voyages calling at ports in Oregon traveling within this range but passing through more than one COTP zone will incur additional costs; those vessels traveling outside this range will not incur additional costs.

An existing regulation in Oregon prohibits the discharge of ballast water mixed with foreign sediments into its territorial waters, so vessels with empty ballast water tanks calling at ports in Oregon will not incur any additional costs under the Commercial Vessel General Permit (340 OAR 143).

The Nonindigenous Aquatic Nuisance Prevention and Control Act of 1990 (NANCPA), the predecessor regulation to NISA, established mandatory ballast management procedures for the Great Lakes and portions of the Hudson River. The only Great Lakes vessels covered by this regulation that will incur additional ballast-related costs under the new Permit are those with ballast tanks that are empty or contain only unpumpable residual ballast, as detailed above. These vessels, which are estimated to constitute 75–95 percent of the total number of vessels entering the Great Lakes and Upper Hudson, are subject to voluntary BMPs under the U.S. Coast Guard’s 2005 Notice of Policy for Ballast Water Management for Vessels Entering the Great Lakes That Declare No Ballast on Board (70 FR 168). These voluntary BMPs are similar to the requirements of the new Permit. Additionally, saltwater flushing is already required by Canadian ports on the Great Lakes. Furthermore, a recently promulgated regulation from the St. Lawrence Seaway System (33 CFR Part 401.30) requires all oceangoing vessels to conduct saltwater flushing of ballast water tanks 200 nautical miles from any shore before entering either the U.S. or Canadian waters of the Seaway System, which serves as the gateway to the Great Lakes. Therefore, a percentage of Great Lakes NOBOB vessels will not incur additional costs under the Commercial Vessel General Permit, dependent upon degree of implementation of voluntary BMPs.

4.2 Graywater

Graywater is defined in the Commercial Vessel General Permit as the discharge derived from “galley, bath and shower water, as well as wastewater from lavatory sinks, laundry, and water fountains” (EPA, 2008b). The new Commercial Vessel General Permit under NPDES contains a number of special provisions applying to discharges of graywater from cruise ships, specifying treatment standards for graywater discharges in port or within 1 nm of shore, and requiring that releases between 1 and 3 nm of shore occur only when traveling at a speed of at least 6 knots. These requirements are based on the U.S. Coast Guard Limitations on Discharge of Treated Sewage or Graywater in Alaska, established in 2001 (33 CFR 159). Cruise ships traveling in the territorial waters of Alaska therefore will not incur any additional costs under the new Permit requirements.

Several other states have existing requirements that will diminish incremental costs associated with these provisions of the new Permit:

- Maine has adopted Alaska’s discharge requirements for vessels with passenger capacities of at least 250 under the 2003 Act to Protect Maine’s Coastal Waters, so vessels traveling in its territorial waters will not incur additional costs under the Commercial Vessel General Permit (Me. Rev. Stat. Ann. tit. 38, 423D).
- The California Clean Coast Act, enacted in 2004, prohibits cruise ships from discharging any graywater into California’s territorial waters; therefore, vessels will not incur any additional costs when making port calls in California (Cal. Pub. Res. Code. 72420-72425).

Several states, including Washington, Hawaii, and Florida, have voluntary memoranda of understanding with the cruise ship industry that discourage the discharge of untreated graywater in port or within 4 nm of shore, and claim a high level of operator compliance with these provisions.⁴ Vessels already in compliance with these

⁴ See ICCL (2001), Washington Dept. of Ecology (2007), and Maehara (2004).

memoranda of understanding will not incur additional costs under the Commercial Vessel General Permit. Applicable state regulations are summarized in *Table 4-2*.

Table 4-2: Summary Crosswalk between Current Cruise Ship Requirements and EPA Permit Requirements

EPA Permit Requirements	Overlap with State-Level Regulations ^a	Overlap with State MOUs
Treatment standards for graywater discharges	AK, ME	None
Limits on discharges within 3 nm of shore	AK, ME, CA	FL, HI, WA

^a The term "State-Level Regulations" includes both state and federal regulations for Alaska.

Also relevant to graywater discharges are two other federal regulations. First, under Section 312(a) of the CWA, graywater discharges from vessels in the Great Lakes region are currently treated as sewage and thus are excluded from the scope of the new Permit. Second, the National Marine Sanctuaries Act authorizes the National Oceanic and Atmospheric Administration (NOAA) to designate National Marine Sanctuaries wherein certain discharges, including graywater, may be restricted to protect sensitive ecosystems.

4.3 Anti-fouling Hull Coatings

The new Commercial Vessel General Permit under NPDES prohibits the use of organotin-based anti-fouling hull coatings. The Organotin Anti-fouling Paint Control Act of 1988 already prohibits the use of these compounds on vessels under 25 feet in length; therefore, these vessels will not incur any additional costs under this provision (33 USC 2401–2410). Furthermore, the United States recently ratified the 2001 International Convention on the Control of Harmful Anti-fouling Systems on Ships, which bans the use of all organotin compounds, although it has not amended the Act to reflect these new treaty obligations to date. As a result, the long-run costs of the organotin provisions of the Commercial Vessel General Permit are assumed to be zero, but EPA will acknowledge the possibility of some incremental costs if the Commercial Vessel General Permit comes into effect before legislation implementing the anti-fouling treaty.

4.4 Bilgewater Discharges

The new Commercial Vessel General Permit under NPDES reinforces several of the requirements of the Act to Prevent Pollution from Ships (APPS), the U.S. implementation of the 1973/78 International Convention for the Prevention of Marine Pollution from Ships (MARPOL), regarding discharges of oily bilgewater. Additionally, the Commercial Vessel General Permit prohibits the discharge of bilgewater by vessels weighing more than 400 tons within 1 nm of shore except during emergencies, and requires that vessels discharging bilgewater between 1 and 3 nm from shore only do so when underway at a speed of at least 6 knots. It also requires vessels weighing less than 400 tons to minimize discharges of bilgewater.

These Permit requirements complement current requirements found in the USCG regulations governing Oily Mixture (Bilge Slops) Discharges on Oceangoing Ships Over 400 Tons, implemented under the authority of APPS and last amended in 1999. These regulations require the use of oily-water separators on discharges of bilgewater by vessels larger than 400 tons (33 CFR 155). While the new Permit requirements will be associated with additional costs for most subject vessel operators, the requirements consistent with APPS will not.

4.5 Overlap with Existing Clean Water Act Provisions

Certain discharges are exempt from the NPDES requirements under the Clean Water Act; the vessel vacatur therefore does not apply to them. Discharges occurring more than 3 nm from shore and discharges by Armed Forces vessels are exempt from the previous 122.3(a) exclusion, and are therefore excluded from the requirements

of this permit. Sewage/blackwater is covered by performance standards for sanitation equipment, and is excluded from the definition of pollutant contained in Section 502(6)(A) of the CWA and thus is not subject to NPDES permitting. These discharges, as well as discharges from vessels not functioning as a means of transportation, are outside the scope of this analysis.

EPA's 1996 revisions to its Regulations of the Discharge of Oil, implemented under the authority of the CWA, prohibit the discharge of bilge slops containing sufficient oil to create a film or sheen in the territorial waters of the United States (40 CFR 110). This requirement regarding oil levels in bilgewater for non-MARPOL vessels remains the same in the new Permit.

4.6 Issues and Uncertainties

There exists some degree of overlap between the Commercial Vessel General Permit and the graywater provisions of the National Marine Sanctuaries Act. However, since the areas affected by this Act are relatively small, EPA will assume that vessels' graywater discharges were simply retained on board in designated sanctuaries and discharged outside these areas, and therefore incremental costs will remain the same.

5 Profile of the Water Transportation and Fishing Industries

5.1 Introduction

The water transportation and fishing industries consist of the establishments that own and operate the commercial vessels that will be subject to the Vessel General Permit for Discharges Incidental to the Normal Operation of Commercial Vessels and Large Recreational Vessels.

The water transportation industry is a \$34 billion industry that employs nearly 150,000 people on a payroll of just over \$6 billion. The fishing industry is much smaller, with total revenues of \$1.65 billion, employing just over 6,500 people on a payroll of \$253 million.

Water transportation accounts for a majority of the vessels sailing on U.S. waters and is made up of several industry sectors, described in *Section 5.2.2: Water Transportation*. Overall, the industry has experienced mild growth in the number of establishments, revenues, and payroll, but a decline in the number of employees.

The fishing industry, responsible for slightly more than a quarter of all commercial vessels in the United States, is experiencing more of a decline, although it still shows some revenue growth despite declines in the number of establishments and employees, and in total payroll.

5.1.1 Data Sources Used

Overviews of the various industry sectors were created using information from industry groups, trade associations, and other reference sources.

Data for numbers of firms, establishments, revenues, and employment were obtained from the U.S. Census Bureau, with the exception of data for North American Industry Classification System (NAICS) code 11411-Fishing, because it is not covered by the Economic Census. In this case, the data come from the U.S. Small Business Administration (SBA).

Data for the number of vessels were extracted from the combined vessel information of WTLUS and VESDOC (detailed further in *Section 3.1: Domestic Vessel Population*). NAICS codes were assigned to vessels according to the NAICS codes of their owner/operators, which were obtained from the Dun & Bradstreet (2006) and ReferenceUSA (2006) databases. Where owner/operator information was unavailable or no corresponding company was found in these databases, the most likely NAICS code was assigned to a vessel using information on vessel type and area of operation.

5.1.2 Organization of This Chapter

This chapter presents an overview of the water transportation and fishing industries. *Section 5.2* provides definitions and overviews of the industries and their sectors, as well as the number of vessels associated with each industry, as classified by NAICS.

Section 5.3 summarizes recent trends in these industries, including changes in the number of establishments and financial performance.

Section 5.4 describes the industries' market structures, including details of performance according to employment size, numbers and percentages of small businesses, employment trends, and payroll trends.

5.2 Overview of the Water Transportation and Fishing Industries

5.2.1 Definition of the Water Transportation and Fishing Industries

The water transportation industry, for the purpose of this chapter, includes NAICS codes 483-Water Transportation; 4872-Scenic and Sightseeing Transportation, Water; and 4883-Support Activities for Water Transportation.

The fishing industry includes NAICS 11411-Fishing.

Table 5-1 lists the relevant NAICS codes for the water transportation and fishing industries.

Table 5-1: Relevant 2002 NAICS Codes and Descriptions	
2002 NAICS Code	Meaning of 2002 NAICS Code
Water Transportation Industry	
4831	Deep Sea, Coastal, and Great Lakes Water Transportation
➤ 483111	Deep Sea Freight Transportation
➤ 483112	Deep Sea Passenger Transportation
➤ 483113	Coastal and Great Lakes Freight Transportation
➤ 483114	Coastal and Great Lakes Passenger Transportation
4832	Inland Water Transportation
➤ 483211	Inland Waterways Freight Transportation
➤ 483212	Inland Waterways Passenger Transportation
4872	Scenic and Sightseeing Transportation, Water
4883	Support Activities for Water Transportation
➤ 488310	Port and Harbor Operations
➤ 488320	Marine Cargo Handling
➤ 488330	Navigational Services to Shipping and Salvage
➤ 488390	Other Support Activities for Water Transportation
Fishing Industry	
1141	Fishing

Source: U.S. Census Bureau, 2002

5.2.2 Water Transportation

Establishments in the water transportation industry provide water transportation of passengers and cargo using watercraft, such as ships, barges, and boats. The industry is composed of two industry groups: (1) one for deep sea, coastal, and Great Lakes water transportation; and (2) one for inland water transportation. This split typically reflects the difference in equipment used (U.S. Census Bureau, 2002).

Scenic and sightseeing water transportation services are also included under this industry heading, as are support activities for water transportation. These two industry groups are technically classified under different NAICS codes by the Census Bureau, but will be included under water transportation for the purposes of this chapter.

Total waterborne commerce in the United States has increased rather steadily over the past 50 years, fueled mostly by growth in foreign commerce, which overtook domestic shipments (in terms of weight) in the mid-1990s. Foreign commerce accounted for nearly 60 percent of total waterborne commerce by weight in 2005 (USACE, 2005a).

Deep Sea, Coastal, and Great Lakes Water Transportation

This industry group comprises establishments primarily engaged in providing deep sea, coastal, and Great Lakes water transportation, as well as transportation via the St. Lawrence Seaway. Marine transportation establishments using the facilities of the St. Lawrence Seaway Authority Commission are considered to be using the Great Lakes Water Transportation System (U.S. Census Bureau, 2002). Firms in this NAICS grouping are further classified based on their area of operation (deep sea or coastal/Great Lakes) and payload type (cargo or passengers).

The Jones Act of 1920 requires that all domestic waterborne trade (between two points in the United States) be conducted on vessels built in the United States, documented in the United States, and owned by U.S. citizens or companies (Transportation Institute, undated). Thus, many vessels operating in the Coastal and Great Lakes Freight Transportation sector are subject to this law.

Deep Sea Freight Transportation

The businesses in this industry sector are primarily engaged in providing deep sea transportation of cargo to or from foreign ports. This sector encompasses oceangoing barges, oil tankers, and other large freight vessels (U.S. Census Bureau, 2002). A large portion of U.S. foreign trade merchandise (1.2 billion metric tons) is transported via water, making this sector the cornerstone of U.S. international trade (Transportation Institute, undated).

Because of its close relationship to international trade, deep sea freight transportation has been increasing steadily over the past 20 years, driven by increasing imports to the United States from foreign ports. Outbound freight has not grown substantially over this period, now accounting for less than a third of cargo carried between U.S. and foreign ports (USACE, 2005a).

Over the last half-century, the United States' merchant fleet has declined in number, as increasingly strict regulations have prompted the registration of vessels under foreign flags to limit liability. Though the U.S. vessel fleet has shrunk, it has also become more efficient, with today's merchant vessels carrying 40 percent more cargo and requiring fewer crew members (Transportation Institute, undated).

Deep Sea Passenger Transportation

Establishments in this sector are primarily engaged in providing deep sea transportation of passengers to or from foreign ports (U.S. Census Bureau, 2002). The most common type of deep sea passenger transportation is the cruise ship. Starting in the 1990s, there has been a reversal to the decline this industry sector had been facing since the 1960s, with steady growth in the number of passengers over the last 10 years (Cruise Lines International Association, 2006).

Currently, several cruise line corporations are planning additions to their fleets in anticipation of increased demand for cruises in the next decade (Transportation Institute, undated). Cruise Lines International Association indicates that 48 million Americans say they intend to take a cruise in the next three years, nearly double the number that took a cruise in the three preceding years. This industry is thus one of the strongest sources of growth in the water transportation industry, a trend that is expected to continue.

Coastal and Great Lakes Freight Transportation

Firms transporting cargo in coastal waters; the Great Lakes System (including the St. Lawrence Seaway); or deep seas between ports of the United States, Puerto Rico, and U.S. island possessions or protectorates fall into this NAICS code classification (U.S. Census Bureau, 2002).

The vessels in this sector are similar to those used for deep sea freight transport, though less numerous. The majority of the vessels in this sector are barges, though the sector also contains other freight transport vessels, as well as tugboats (Transportation Institute, undated).

Coastal domestic trade to and from Alaska, Hawaii, and U.S. Territories consists mainly of the shipment of petroleum and petroleum products, chemicals, and agricultural products. The primary products transported on the Great Lakes System are coal, limestone, and iron ore (Transportation Institute, undated).

Coastal and Great Lakes freight transportation accounts for about 30 percent of all U.S. domestic waterborne shipments by weight. Great Lakes freight transportation has remained relatively constant over the past 20 years, hovering around 150 million tons per year (approximately two-thirds domestic and one-third foreign cargo). Coastal freight transportation has grown over the same period, from around 1.1 billion tons per year to more than 1.6 billion tons in 2005, as a result of increased foreign shipments (USACE, 2005).

Coastal and Great Lakes Passenger Transportation

This industry sector contains establishments primarily engaged in providing water transportation of passengers in coastal waters, the Great Lakes System (including the St. Lawrence Seaway), or deep seas between ports of the United States, Puerto Rico, and United States island possessions and protectorates. This industry sector includes many coastal and Great Lakes ferries used to travel short distances between coastal ports, or from shores to nearby islands, as well as larger vessels used on the Alaska Marine Highway, which travels between ports on the southern coast of Alaska and northwestern Canada (Reference for Business, 2007c).

Inland Water Transportation

Businesses primarily engaged in providing inland water transportation of passengers and cargo on lakes, rivers, or intracoastal waterways (except on the Great Lakes System) are classified under this NAICS grouping, and are further classified between freight and passenger transportation (U.S. Census Bureau, 2002).

As required by the Jones Act, all vessels in this industry sector are domestic flagged and owned.

Inland Waterways Freight Transportation

The companies in this industry sector are primarily engaged in providing inland water transportation of cargo on lakes, rivers, or intracoastal waterways (except on the Great Lakes System) (U.S. Census Bureau, 2002). This sector contains a large portion of the vessels in the United States, as it encompasses river barges, as well as the tug and towboats that propel them. The vast majority of boats in this sector are barges, which outnumber other inland freight vessels by about 10 to 1 (Transportation Institute, undated).

The products carried by this industry sector include more than half of U.S. grain shipments, a quarter of chemical and petroleum exports, and a fifth of domestic coal shipments (Transportation Institute, undated). Barges account for 79 percent of domestic waterborne freight.

Inland waterways freight transportation, similar to Great Lakes and coastal water transportation, has remained stagnant over the past two decades in terms of total tonnage transported, with a modest increase in the mid-1980s. Nevertheless, it accounts for more than 50 percent of all domestic waterborne freight shipments (U.S. Army Corps of Engineers, 2005).

Inland Waterways Passenger Transportation

This industry sector provides inland water transportation of passengers on lakes, rivers, or intracoastal waterways (except on the Great Lakes System) (U.S. Census Bureau, 2002). This sector includes water taxis and ferries (except coastal and Great Lakes ferries), usually traveling short distances between inland ports, such as in New York harbor or in San Francisco Bay.

The ferry industry has been rebounding from historic lows in the 1970s, and short-distance ferries in urban areas have become alternatives to crowded highways and urban transit systems. In 2000, the 677 ferries operating in the

United States served 578 destinations along 352 routes, transporting 113 million passengers (these figures include coastal and Great Lakes ferries) (Reference for Business, 2007c).

Scenic and Sightseeing Transportation, Water

This industry group comprises establishments primarily engaged in providing scenic and sightseeing transportation on water. The services provided are usually local and involve same-day return to place of origin (U.S. Census Bureau, 2002).

This sector encompasses a wide variety of vessel types, from small “swamp buggies” used to tour the Florida Everglades to chartered dinner cruisers to larger whale-watching boats. The range of services offered has continued to expand over the past decade, with gambling boats becoming popular in Indiana and Iowa, and similar gaming “cruises-to-nowhere” becoming popular in Florida (Reference for Business, 2007d).

This leisure-based industry sector is more vulnerable to economic fluctuations, since its revenues draw on discretionary consumer spending.

Support Activities for Water Transportation

This NAICS grouping includes establishments classified in the following NAICS industries: 48831, Port and Harbor Operations; 48832, Marine Cargo Handling; 48833, Navigational Services to Shipping and Salvage; and 48839, Other Support Activities for Water Transportation (U.S. Census Bureau, 2002).

Businesses in this industry sector are the link between a vessel’s load (cargo or passengers) and that load’s final destination. This sector provides the highest percentage of employment in the industry, as many of these services are labor-intensive.

Port and Harbor Operations

Businesses in this industry sector operate ports, harbors (including docking and pier facilities), or canals (U.S. Census Bureau, 2002). The vessels in this industry sector are likely to be smaller, auxiliary vessels as opposed to the large container ships and barges that they serve.

Marine Cargo Handling

This industry comprises establishments primarily engaged in providing stevedoring and other marine cargo handling services (except warehousing) (U.S. Census Bureau, 2002). This sector contains only a small number of vessels, as most of its business is land-based.

This particular industry sector, along with port and harbor operations, has been growing over the last decade or two as a result of the increase in foreign trade, mostly with Asian countries. Marine cargo handling and port and harbor operations on the Pacific Coast account for about half of all such operations in the United States (Reference for Business, 2007e).

Despite the increase in volume of shipments handled, employment in marine cargo handling, as well as in port and harbor operations, has been on the decline in recent years, due to increased automation of tasks and other technological advances that reduce the need for manual labor. The industry’s unions, the International Longshoremen’s Association and the International Longshore and Warehouse Union, are nevertheless still strong and maintain high membership rates (Reference for Business, 2007e).

Navigational Services to Shipping and Salvage

This NAICS classification includes two main types of businesses: navigational services to shipping and marine salvage (U.S. Census Bureau, 2002).

Vessels in this industry do not typically carry passengers or cargo, but rather assist larger vessels in entering and leaving port, or in other operations. The salvage subsector of this industry sector includes maintenance vessels that prepare ships for salvage and scrap.

Other Support Activities for Water Transportation

Other auxiliary services of the water transportation industry are grouped into this category, which includes maintenance and repair of vessels, inspections, security, and other operations. The strong growth in this industry between 1997 and 2001 may be attributable to the rapid increase in cargo security since the terrorist attacks of September 11, 2001 (Reference for Business, 2007f).

5.2.3 Fishing

The fishing industry includes commercial catching or taking of finfish, shellfish, or miscellaneous marine products from a natural habitat, such as the catching of bluefish, eels, salmon, tuna, clams, crabs, lobsters, mussels, oysters, shrimp, frogs, sea urchins, and turtles (U.S. Census Bureau, 2002).

Since the 1990s, finfish volume has been declining, due to severely depleted fisheries in the Atlantic and loss of breeding grounds to pollution, as well as to increasingly strict regulations aimed at preventing these problems (Reference for Business, 2007a, b). Demand has not been strong enough to prevent declines in the value of the catches. Shellfish volume has remained relatively constant, with the total value of the catch increasing slightly. Fish and seafood imports have increased over the same period, intensifying the competition in this industry (National Marine Fisheries Service, 2003).

Alaska leads the nation in both volume and value of fish caught, followed by Louisiana in both measures. California ranks third in volume of fish caught, while Massachusetts takes third place in terms of value (National Marine Fisheries Service, 2003).

5.2.4 Number of Water Transport Vessels by Industry Sector

Table 5-2 summarizes the number of vessels, establishments, and average number of vessels per establishment⁵ for each industry sector in 2002. In this table and in Table 5-3: *Number of Vessels in the WTLUS Database, 2001-2005*, the Deep Sea Freight Transportation and Coastal and Great Lakes Freight Transportation sectors are considered together, due to the difficulties of determining which vessels fall under which NAICS code based on the information provided by the VESDOC and WTLUS databases. The same is true for the Deep Sea Passenger Transportation and Coastal and Great Lakes Passenger Transportation sectors. The distinctions between these industry sectors will be maintained for the rest of this analysis.

There were approximately 90,000 commercial vessels operating in U.S. waters in 2002. Of these, more than 32,000 were involved in inland water transportation, which includes barges, ferries, and water taxis. The inland water transportation industry group also contains the highest concentration of vessels per establishment, nearly 270. This may be due to the fact that each barge counts as a separate vessel, and a single barge company may own a large number of barges. The Inland Waterways Passenger Transportation sector also contains a relatively high concentration of vessels, at an average of 27 per establishment.

The deep sea, coastal, and Great Lakes water transportation industry group shows much lower figures for the number of vessels, and much higher figures for the number of establishments. This may be a consequence of the definition of an establishment (a single location of doing business): if a single shipping company has many locations, which may be likely given the nature of shipping, each is counted separately.

⁵ An establishment is a single physical location at which business is conducted. It is not necessarily identical to a company or enterprise, which may consist of one establishment or more (U.S. Census Bureau, 2002b).

Passenger transportation vessels accounted for about 11,000 vessels, freight transportation for about 38,000, and support activities for the remaining 12,000 vessels classified under the water transportation industry.

Fishing vessels make up the remainder of commercial vessels, with nearly 29,000.

Table 5-2: Number of Vessels and Establishments by Industry Sector, 2002

Industry Sector	Vessels in database	Establishments	Average Vessels per Establishment
Water Transportation Industry			
Deep Sea, Coastal, and Great Lakes Water Transportation			
Deep Sea, Coastal, and Great Lakes Freight Transportation	7,768	2,458	3
Deep Sea, Coastal, and Great Lakes Passenger Transportation	9,128	2,003	5
Subtotal-Deep sea, Coastal, and Great Lakes	16,896	4,461	4
Inland Water Transportation			
Inland Waterways Freight Transportation	30,483	114	267
Inland Waterways Passenger Transportation	1,674	63	27
Subtotal-Inland	32,157	177	182
Scenic and Sightseeing Transportation, Water			
Scenic and Sightseeing Transportation, Water	546	76	7
Support Activities for Water Transportation			
Port and Harbor Operations	3,402	760	4
Marine Cargo Handling	183	966	0
Navigational Services to Shipping and Salvage	7,315	233	31
Other Support Activities for Water Transportation	1,007	567	2
Subtotal-Support Activities	11,907	2,526	5
TOTAL-Water Transportation	61,506	7,240	8
Fishing Industry			
Fishing	28,867	1,916	15

Source: U.S. Census Bureau, 2002a,b

5.3 Recent Trends in the Water Transportation Industry

This section reviews the recent trends in the water transportation and fishing industries in terms of number of firms, numbers of vessels, and financial performance.

Overall, there were slight upward trends in the water transportation industry in terms of number of vessels, firms, and total revenues; however, the fishing industry experienced declines in the number of firms and in revenues (no data were available for its number of vessels).

The reference period is from 1997 through 2002, the years of the two most recent Economic Censuses, except for the number of vessels. Changes in the number of vessels are measured between 2001 and 2005, the largest range of years available for these data. There were no changes to the NAICS codes for these industries between these years.

Employment, establishment, and payroll data for the Fishing Industry are from 1998, as 1997 data was classified by SIC code and was not comparable. Where Fishing Industry data was not available from the Census Bureau, it was taken from the SBA.

5.3.1 Number of Vessels by Industry Sector

Table 5-3 shows changes in the number of vessels in the 2001 and 2005 versions of the WTLUS database.⁶ Over this period, the WTLUS database recorded a loss of 1.1 percent in the total number of vessels. Though most sectors of the water transportation industry actually experienced increases in the number of vessels, inland water freight transportation, the sector with the largest number of vessels (as it accounts for a large number of barges), lost more than 1,000 vessels over this period.

The number of deep sea, coastal, and great lakes passenger transportation vessels (including cruise ships) grew by 143, an increase of more than 20 percent. Scenic and sightseeing transportation added 125 new vessels over this period, for a nearly 40 percent increase. Port and harbor operations and navigational services to shipping and salvage both added more than 350 vessels to their ranks, representing increases of 26 percent and 8 percent, respectively.

Table 5-3: Number of Vessels in the WTLUS Database, 2001-2005			
Industry Sector	2001	2005	% Change
Water Transportation Industry			
Deep Sea, Coastal, and Great Lakes Water Transportation			
Deep Sea, Coastal, and Great Lakes Freight Transportation	4,779	5,083	6.4%
Deep Sea, Coastal, and Great Lakes Passenger Transportation	678	821	21.1%
Subtotal-Deep Sea, Coastal, and Great Lakes	5,457	5,904	8.2%
Inland Water Transportation			
Inland Waterways Freight Transportation	28,338	27,239	-3.9%
Inland Waterways Passenger Transportation	242	267	10.3%
Subtotal- Inland	28,580	27,506	-3.8%
Scenic and Sightseeing Transportation, Water			
Scenic and Sightseeing Transportation, Water	333	458	37.5%
Support Activities for Water Transportation			
Port and Harbor Operations	1,389	1,753	26.2%
Marine Cargo Handling	73	86	17.8%
Navigational Services to Shipping and Salvage	4,868	5,251	7.9%
Other Support Activities for Water Transportation	19	15	-21.1%
Subtotal-Support Activities	6,349	7,105	11.9%
TOTAL-Water Transportation^a	41,481	41,028	-1.1%

Source: U.S. Army Corps of Engineers, 2001 and 2005d.
 Note: Data for the number of fishing vessels in 2001 were not available.
 a Totals include vessels for which no NAICS code was able to be determined.

5.3.2 Number of Establishments by Industry Sector

Table 5-4 summarizes the changes in numbers of establishments for each sector of the water transport and fishing industries between 1997 and 2002. The water transportation industry experienced a slight increase of 0.2 percent in the number of establishments over this period, though several sectors, notably deep sea freight transportation, inland waterways freight transportation, and navigational services to shipping and salvage, saw a decline in the number of establishments. The increase is less dramatic than the overall U.S. increase of 4.4 percent in the number of establishments over this period (U.S. SBA, 2004).

⁶ These vessel totals only include vessels in the WTLUS database, and do not encompass those vessels listed only in VESDOC. A version of VESDOC was not available for 2001.

The largest increase in the number of establishments was in port and harbor operations, with a nearly 39 percent change in the number of establishments over the five-year period.

Deep sea passenger transportation, which includes cruise ships, also grew by about 9 percent in number of establishments, and inland waterways passenger transportation experienced a 17 percent increase in this area.

Conversely, the fishing industry experienced a decline of 9.3 percent in the number of establishments between 1998 and 2002.

Table 5-4: Number of Establishments by Industry Sector, 1997 and 2002			
NAICS Description	1997	2002	% Change
Water Transportation Industry			
Deep Sea, Coastal, and Great Lakes Water Transportation			
Deep Sea Freight Transportation	487	456	-6.4%
Deep Sea Passenger Transportation	80	87	8.8%
Coastal and Great Lakes Freight Transportation	616	677	9.9%
Coastal and Great Lakes Passenger Transportation	125	114	-8.8%
Subtotal-Deep Sea, Coastal, Great Lakes	1,308	1,334	2.0%
Inland Water Transportation			
Inland Waterways Freight Transportation	383	321	-16.2%
Inland Waterways Passenger Transportation	230	269	17.0%
Subtotal Inland	613	590	-3.8%
Scenic and Sightseeing Transportation			
Scenic and Sightseeing Transportation, Water	1,692	1,726	2.0%
Support Activities for Water Transportation			
Port and Harbor Operations	168	233	38.7%
Marine Cargo Handling	623	567	-9.0%
Navigational Services to Shipping and Salvage	865	778	-10.1%
Other Support Activities for Water Transportation	869	924	6.3%
Subtotal-Support Activities	2,525	2,502	-0.9%
TOTAL-Water Transportation	6,138	6,152	0.2%
Fishing Industry			
Fishing	2,113	1,916	-9.3%

Source: U.S. Census Bureau, 1997, 1998, 2002a, 2002b

5.3.3 Establishment and Employment Births and Deaths

Table 5-5 summarizes average establishment birth and death rates for each industry sector for which these data were available. The reference period for these trends is 1998–2003, as data before 1998 are classified according to the Standard Industry Classification (SIC) system. Average birth and death rates in the water transportation and fishing industries fall between 10 and 15 percent of their total numbers of establishments.

In general, deaths outnumber births over this period for all industry sectors except for inland water transportation, where the average net change was close to five establishment births per year. The largest average net change came in support activities for water transportation, with an average of nearly 25 establishment deaths per year.

The fishing industry averaged a net change of close to two establishment births per year between 1998 and 2003.

Table 5-5: Establishment Births and Deaths, Five-Year Average: 1998–2003			
Industry Sector	Net Change	Births	Deaths
Water Transportation Industry			
Deep Sea, Coastal, and Great Lakes Water Transportation	-19.0	122.8	141.8
Inland Water Transportation	4.8	67.7	62.8
Scenic and Sightseeing Transportation, Water	-13.7	171.5	185.2
Support Activities for Water Transportation	-24.5	203.0	227.5
Water Transportation Industry Average	-13.3	141.3	154.3
Fishing Industry			
Fishing	1.7	227.3	225.7

Source: U.S. SBA, 2004

Table 5-6 summarizes the net change in employment (difference between births and deaths) for each industry sector for which these data are available. Specific information on job creation and elimination was not available for many industry sectors.

Deep sea, coastal, and Great Lakes water transportation averaged the largest change in employment per year, with an average of 665 jobs eliminated per year. Scenic and sightseeing transportation also averaged more than 500 jobs eliminated per year between 1998 and 2003. Inland water transportation and support activities for water transportation averaged net job creation rates of 136 and 156 employees per year, respectively.

The fishing industry averaged a reduction of 130 jobs per year over the same period.

Table 5-6: Net Change in Employment: Five-Year Average, 1998-2003	
Industry Sector	Net Change
Water Transportation Industry	
Deep Sea, Coastal, and Great Lakes Water Transportation	-665.0
Inland Water Transportation	136.4
Scenic and Sightseeing Transportation, Water	-517.0
Support Activities for Water Transportation	156.2
Water Transportation Industry Average	-222.4
Fishing Industry	
Fishing	-129.4

Source: U.S. SBA, 2004

5.3.4 Financial Performance

Overall, the water transportation industry experienced growth of almost 4 percent over the period 1997–2002 (see Table 5-7), which is less robust than the overall U.S. economy's growth of nearly 25 percent during this period (U.S. Bureau of Economic Analysis, 2007). There was much variability in the performance of the various industry sectors, with revenues dropping by 41 percent in deep sea freight transportation and by 37 percent in inland waterways freight transportation.

Conversely, deep sea passenger transportation, which encompasses cruise ships, posted the strongest growth throughout this period, more than doubling revenues in the five years from 1997 to 2002. Revenues for inland waterways passenger transportation also increased by 22 percent over this period.

Revenues from freight and passenger transportation in the Great Lakes increased by 20 percent and 17 percent, respectively.

In the fishing industry, revenues declined by nearly 5 percent over the same period. Fishing industry data are from the U.S. Small Business Administration because they are not included in the Economic Census.

Table 5-7: Revenues by Industry Sector, 1997 and 2002

Industry Sector	1997 (\$ millions)	2002 (\$ millions)	Percent Change
Water Transportation Industry			
Deep Sea, Coastal, and Great Lakes Water Transportation			
Deep Sea Freight Transportation	11,571	6,731	-41.8%
Deep Sea Passenger Transportation	3,908	8,081	106.8%
Coastal and Great Lakes Freight Transportation	4,678	5,607	19.9%
Coastal and Great Lakes Passenger Transportation	182	212	16.6%
Subtotal-Deep Sea, Coastal, and Great Lakes	20,339	20,631	1.4%
Inland Water Transportation			
Inland Waterways Freight Transportation	3,387	2,134	-37.0%
Inland Waterways Passenger Transportation	293	359	22.3%
Subtotal-Inland	3,680	2,493	-32.3%
Scenic and Sightseeing Transportation, Water			
Scenic and Sightseeing Transportation, Water	1,129	964	-14.6%
Support Activities for Water Transportation			
Port and Harbor Operations	889	1,463	64.5%
Marine Cargo Handling	4,456	4,748	6.5%
Navigational Services to Shipping and Salvage	1,513	2,150	42.1%
Other Support Activities for Water Transportation	656	1,441	119.6%
Subtotal-Support activities	7,515	9,801	30.4%
TOTAL-Water Transportation	32,663	33,890	3.8%
Fishing Industry			
Fishing ^a	1,739	1,655	-4.8%

Source: U.S. Census Bureau, 1997, 2002b; U.S. SBA, 1997, 2002b
^a 1997 Fishing revenue data according to SIC code, which also included plant aquaculture. Percent change is thus exaggerated.

5.4 Industry Market Structure

Both the water transportation and fishing industries are comprised of a large number of small businesses, whether classified by employment size or by annual revenues. The vast majorities of firms in both these industries employ fewer than 100 people and earn revenues of less than \$1 million per year.

This large concentration of small firms earning relatively low amounts of revenue may make both the water transportation and fishing industries more sensitive to changes in operating costs.

5.4.1 Establishments and Revenues

Table 5-8 details the number of firms and revenues by employment size in 2002. In the water transportation industry, 56 percent of firms employ fewer than 20 people, though these firms only account for 7 percent of the industry's revenue. Large firms employing more than 500 people, on the other hand, account for only 1 percent of businesses in the industry, but earn nearly half of its revenue.

The fishing industry also contains a large percentage of firms employing fewer than 20 people (60 percent), though in this industry they account for a larger share of total industry revenue (36 percent). The large firms in the fishing industry account for less than 1 percent of total firms, and earn 15 percent of the industry's revenue.

Firms not operating the entire year do not report employment data, and are classified under "NR" in the table. There are large numbers of these in both the water transportation and fishing industries.

Number of Employees	Number of Establishments					Revenues (\$ millions)				
	1-19	20-99	100-499	500+	NR	1-19	20-99	100-499	500+	NR
Water Transportation										
Deep Sea, Coastal, and Great Lakes Water Transportation										
Deep Sea Freight Transportation	127	42	20	6	35	\$478	\$1,492	\$2,636	\$0	\$29
Deep Sea Passenger Transportation	52	8	6	4	13	\$63	\$57	\$461	\$7,333	\$5
Coastal and Great Lakes Freight Transportation	274	108	40	8	64	\$468	\$802	\$1,904	\$1,853	\$38
Coastal and Great Lakes Passenger Transportation	46	21	5	1	36	\$39	\$116	\$0	\$0	\$18
Subtotal-Deep Sea, Coastal, Great Lakes	493	174	69	17	148	\$959	\$2,411	\$5,084	\$11,243	\$90
Inland Water Transportation										
Inland Waterways Freight Transportation	148	53	29	6	66	\$66	\$379	\$1,019	\$0	\$50
Inland Waterways Passenger Transportation	138	24	6	0	63	\$304	\$88	\$0	\$0	\$13
Subtotal-Inland	286	77	35	6	129	\$194	\$468	\$1,220	\$0	\$62
Scenic and Sightseeing Transportation, Water										
Scenic and Sightseeing Transportation, Water	882	112	10	2	708	\$304	\$332	\$103	\$0	\$160
Support Activities for Water Transportation										
Port and Harbor Operations	95	29	15	1	26	\$141	\$296	\$0	\$0	\$33
Marine Cargo Handling	175	85	37	17	55	\$202	\$623	\$890	\$2,568	\$49
Navigational Services to Shipping and Salvage	461	85	23	1	117	\$396	\$588	\$299	\$0	\$45
Other Support Activities for Water Transportation	467	93	14	5	106	\$233	\$425	\$350	\$0	\$18
Subtotal-Support activities	1,198	292	89	24	304	\$937	\$1,806	\$2,150	\$3,777	\$142
TOTAL-Water Transportation	2,859	655	203	49	1,289	\$2,395	\$5,016	\$8,557	\$15,020	\$454
Percentage of Industry	56%	13%	4%	1%	25%	7%	15%	26%	45%	1%
Fishing										
Fishing	1145	41	12	7	696	\$593	\$309	\$327	\$241	\$185
Percentage of Industry	60%	2%	0.6%	0.4%	37%	36%	19%	20%	15%	11%

Source: U.S. Census Bureau, 2002b; U.S. SBA, 2002a

Table 5-9 details the number of firms according to annual revenue in each sector of the water transportation and fishing industries. Firms earning less than \$1 million per year account for 65 percent of the industry’s firms, and firms earning between \$1 and \$5 million add another 21 percent. A large majority (86 percent) of firms are thus earning revenues less than \$5 million.

In the fishing industry, this trait is even more pronounced, with 90 percent of all firms earning less than \$1 million in revenues, and 99 percent earning less than \$5 million.

Table 5-9: Number of Firms According to Revenue Size					
Revenues (millions of dollars)	Number of Firms				
	<1	1-5	5-25	25-100	100+
Water Transportation					
Deep Sea, Coastal, and Great Lakes Water Transportation					
Deep Sea Freight Transportation	67	50	36	23	19
Deep Sea Passenger Transportation	34	22	5	3	6
Coastal and Great Lakes Freight Transportation	212	108	71	29	10
Coastal and Great Lakes Passenger Transportation	36	22	14	1	0
Subtotal-Deep Sea, Coastal, and Great Lakes	349	202	126	56	35
Inland Water Transportation					
Inland Waterways Freight Transportation	115	59	37	18	7
Inland Waterways Passenger Transportation	124	33	8	3	0
Subtotal-Inland	239	92	45	21	7
Scenic and Sightseeing Transportation, Water					
Scenic and Sightseeing Transportation, Water	851	122	30	3	0
Support Activities for Water Transportation					
Port and Harbor Operations	61	43	27	6	3
Marine Cargo Handling	133	96	56	18	11
Navigational Services to Shipping and Salvage	384	119	53	13	1
Other Support Activities for Water Transportation	423	108	38	7	3
Subtotal-Support	1001	366	174	44	18
TOTAL-Water Transportation	2440	782	375	124	60
Percentage of Industry	65%	21%	10%	3%	2%
Fishing Industry					
Fishing	1674	169	26	13	10
Percentage of Industry	90%	9.0%	1.4%	0.7%	0.5%

Source: U.S. Census Bureau 2002b; U.S. SBA, 2002b

5.4.2 Small Businesses

The U.S. SBA defines small businesses for the various sectors of these industries as follows:

- Deep sea, coastal, and Great Lakes water transportation; inland water transportation – fewer than 500 employees
- Scenic and sightseeing transportation; navigational services to shipping and salvage; other support activities for water transportation – revenues less than \$6.5 million
- Port and harbor operations; marine cargo handling – revenues less than \$23.5 million
- Fishing – revenues less than \$4 million (U.S. SBA, 2006).

Table 5-10 summarizes the number of small businesses in each sector of the water transportation and fishing industries. On the whole, both industries contain more than 90 percent small businesses. Inland waterways freight transportation, the industry sector encompassing barges, has the lowest number of small businesses, which may also contribute to its high number of vessels per establishment.

These percentages were calculated based on the number of firms operating the entire year, as employment figures are not available for firms operating only part of the year.

Table 5-10: Small Businesses in the Water Transportation and Fishing Industries				
Industry Sector	Small Business Threshold	Firms Operated Entire Year	Small Businesses	Percent Small Business
Water Transportation Industry				
Deep Sea, Coastal, and Great Lakes Water Transportation				
Deep Sea Freight Transportation	500 Employees	195	189	96.9%
Deep Sea Passenger Transportation	500 Employees	70	66	94.3%
Coastal and Great Lakes Freight Transportation	500 Employees	430	422	98.1%
Coastal and Great Lakes Passenger Transportation	500 Employees	73	72	98.6%
Subtotal-Deep Sea, Coastal, and Great Lakes		768	749	97.5%
Inland Water Transportation				
Inland Waterways Freight Transportation	500 Employees	278	230	82.7%
Inland Waterways Passenger Transportation	500 Employees	168	168	100.0%
Subtotal-Inland		446	398	89.2%
Scenic and Sightseeing Transportation, Water				
Scenic and Sightseeing Transportation, Water	\$6.5 million	1006	973	96.7%
Support Activities for Water Transportation				
Port and Harbor Operations	\$23.5 million	140	131	93.6%
Marine Cargo Handling	\$23.5 million	314	285	90.8%
Navigational Services to Shipping and Salvage	\$6.5 million	570	503	88.2%
Other Support Activities for Water Transportation	\$6.5 million	579	531	91.7%
Subtotal-Support Activities		1603	1450	90.5%
TOTAL-Water Transportation		5037	4717	93.7%
Fishing Industry				
Fishing	\$4 million	1916	1843	96.2%

Source: U.S. Census Bureau, 2002b; U.S. SBA, 2002a

5.4.3 Employment and Payroll

Employment in the water transportation and fishing industries declined over the period between 1997 and 2002, by 8 percent and 9 percent, respectively (see *Table 5-11*). However, payroll in both industries managed to increase despite this decline in employment numbers. The only exception is the marine cargo handling sector, where payroll dropped by 25 percent.

In all industry sectors where employment and payroll moved together, changes in payroll were less extreme than changes in employment, implying that the employees remaining in the industry saw an increase in the average salary. The only exception is the marine cargo handling sector, where payroll dropped by 25 percent while employment dropped by only 22 percent.

Total Number of Employees by Industry Sector

In 2002, the water transportation industry employed about 146,000 people. Nearly half of these people were employed by businesses providing support activities for water transportation. Another third worked in the deep sea, coastal, and Great Lakes water transportation sector, with the remaining 20 percent being split almost evenly between inland water transportation and scenic and sightseeing transportation on water. The fishing industry employed about 6,500 people in 2002.

Overall, the water transportation industry saw an 8.2 percent decline in its number of employees between 1997 and 2002. The fishing industry experienced a similar decline in employment of 9.3 percent. This contrasts with the overall 6.7 percent increase in employment in the U.S. economy (U.S. SBA, 2004).

The largest drops in employment numbers came in deep sea freight transportation and inland waterways freight transportation, industry sectors that also experienced revenue declines over this period. Scenic and sightseeing transportation on water, which also experienced a decline in revenue, had a milder decrease of 18.5 percent in employment.

Despite its strong performance in terms of revenues, deep sea passenger transportation employed 6.3 percent fewer people in 2002 than in 1997.

The strongest growth in employment came from other support activities for water transportation, which more than doubled its number of employees between 1997 and 2002. This sector now accounts for nearly 9 percent of all employees in the water transportation industry.

Table 5-11: Employment in the Water Transportation and Fishing Industries, 1997-2002

Meaning of 2002 NAICS code	1997 Number of Employees	2002 Number of Employees	Percent Change
Water Transportation Industry			
Deep Sea, Coastal, and Great Lakes Water Transportation			
Deep Sea Freight Transportation	18,542	13,803	-25.6%
Deep Sea Passenger Transportation	12,266	11,491	-6.3%
Coastal and Great Lakes Freight Transportation	21,690	24,333	12.2%
Coastal and Great Lakes Passenger Transportation	1,802	2,382	32.2%
Subtotal-Deep Sea, Coastal, and Great Lakes	54,300	52,009	-4.2%
Inland Water Transportation			
Inland Waterways Freight transportation	15,663	10,040	-35.9%
Inland Waterways Passenger Transportation	2,894	3,277	13.2%
Subtotal-Inland	18,557	13,317	-28.2%
Scenic and Sightseeing Transportation, Water			
Scenic and Sightseeing Transportation, Water	14,185	11,557	-18.5%
Support Activities for Water Transportation			
Port and Harbor Operations	6,802	5,593	-17.8%
Marine Cargo Handling	48,463	37,707	-22.2%
Navigational Services to Shipping and Salvage	10,800	13,157	21.8%
Other Support Activities for Water Transportation	6,415	13,112	104.4%
Subtotal-Support activities	72,480	69,569	-4.0%
TOTAL-Water Transportation	159,522	146,452	-8.2%
Fishing Industry			
Fishing	7,206	6,537	-9.3%

Source: U.S. Census Bureau, 1997, 1998, 2002a, 2002b

Payroll by Industry Sector

Despite the decreases in employment between 1997 and 2002, payroll in the water transportation and fishing industries rose by 3 percent and 0.2 percent, respectively, over the same period (see Table 5-12).

In general, those sectors that experienced a decline in employment also saw lower payrolls. Two notable exceptions are deep sea passenger transportation, which increased its payroll by 17 percent while having 6 percent fewer employees, and port and harbor operations, which saw a mild 2.5 percent increase in payroll while employment declined by nearly 18 percent.

The fishing industry's payroll rose by a modest 0.2 percent, despite a relatively large 9.3 percent decrease in its employment base.

Table 5-12: Payroll in the Water Transportation and Fishing Industries, 1997-2002

Industry Sector	1997 Annual Payroll (\$ millions)	2002 Annual Payroll (\$ millions)	Percent Change
Water Transportation Industry			
Deep Sea, Coastal, and Great Lakes Water Transportation			
Deep Sea Freight Transportation	\$842	\$735	-12.7%
Deep Sea Passenger Transportation	\$380	\$445	16.9%
Coastal and Great Lakes Freight Transportation	\$925	\$1,189	28.4%
Coastal and Great Lakes Passenger Transportation	\$50	\$69	37.9%
Subtotal-Deep sea, Coastal, and Great Lakes	\$2,198	\$2,438	10.9%
Inland Water Transportation			
Inland Waterways Freight Transportation	\$552	\$482	-12.8%
Inland Waterways Passenger Transportation	\$84	\$112	33.8%
Subtotal-Inland	\$637	\$594	-6.6%
Scenic and Sightseeing Transportation, Water			
Scenic and Sightseeing Transportation, Water	\$283	\$267	-5.7%
Support Activities for Water Transportation			
Port and Harbor Operations	\$238	\$244	2.5%
Marine Cargo Handling	\$1,941	\$1,452	-25.2%
Navigational Services to Shipping and Salvage	\$377	\$577	53.2%
Other Support Activities for Water Transportation	\$207	\$491	136.9%
Subtotal-Support activities	\$2,763	\$2,764	0.03%
TOTAL-Water Transportation	\$5,880	\$6,063	3.1%
Fishing Industry			
Fishing	\$252	\$253	0.2%

Source: U.S. Census Bureau, 1997, 1998, 2002a, 2002b

6 Cost of Best Management Practices

6.1 Summary

The first step in assessing costs of the new NPDES permitting requirements was determining the population of vessels that will be affected by the Permit. As detailed in *Section 3*, the total population of domestic vessels is 90,713, and the total population of foreign vessels is 7,932. NPDES requirements for discharges incidental to the normal operation of a vessel will impact virtually every non-military vessel in use in a capacity of transportation entering U.S. territorial waters. However, some vessels will be subject only to certain BMPs because some discharges are not applicable to all vessel types. For example, practices associated with graywater discharges are not applicable to barges since this vessel class does not produce this type of discharge. Practices associated with aqueous film-forming foam (AFFF) discharges are only applicable to some utility vessels and to freight and tank ships since other vessel classes do not have a firefighting system.

To estimate the effect of the Permit on the industry as a whole, a baseline must be identified from which to measure this effect. The baseline takes into account previous conditions and determines how the industry would act in the future in the absence of the Permit. The baseline for this analysis is full industry compliance with existing federal and state regulations; and current industry practices or standards that exceed current regulations to the extent that they can be empirically observed.

A number of laws and associated regulations (including NISA; APPS; the Comprehensive Environmental Response, Compensation, and Liability Act; the Organotin Anti-fouling Paint Control Act; and others) already cover certain discharges that would be subject to the new permitting regime. In analyzing economic impacts of the Vessel Vacatur of the NPDES requirements, EPA has assumed that the entities subject to existing regulations will not incur significant incremental costs.

The second step in assessing costs of the new NPDES permitting requirements is establishing per-vessel (or per-firm) costs for each BMP. The majority of these costs are derived from industry communication and survey responses. Additional cost inputs are also derived from manufacturers, field experts, and the NBIC database for the ballast water cost analysis. Per-vessel costs are established for the BMP categories in which vessels are expected to incur incremental costs. The annual per-vessel cost of each BMP is estimated based on the per-instance cost of performing each practice the number of times per year the BMP needs to be performed.

Several BMP categories were not analyzed for incremental costs because (1) the industry is already practicing these BMPs or (2) the expected cost of the relevant BMP is negligible.

Finally, the total annual cost per BMP category is estimated by multiplying the BMP cost per vessel by the number of vessels expected to incur incremental costs due to the Permit requirements.

6.2 Cost of Individual BMPs

Most of the BMPs involve a change in customary operating practices and additional labor hours. For these BMPs, EPA has used labor rates and hourly estimates provided by the questionnaire responses to estimate the total cost for the specific BMP. If any of the BMPs have more specific requirements (e.g., involving equipment purchase and use) these costs have also been added to the labor-based cost estimates. Most of the cost estimates for the individual BMPs are dependent upon industry communications; some are also derived from outside research as well as additional data sources. EPA contacted five industry representatives for information regarding population estimates, current practices, and estimated costs. The five industries contacted represent (1) commercial fishing vessels, (2) passenger vessels, (3) towing vessels and barges, (4) freight and tank ships, and (5) cruise ships. The population of vessels that are subject to each BMP within a discharge category is dependent upon the type of

vessel and whether certain vessels already practice the BMPs required by the Permit. Personnel from different industry organizations provided information regarding which discharge categories were applicable to their member vessel types. Every category of vessel (except for large recreational vessels) is accounted for by an industry representative. The Agency assumed that large recreational vessels held the same applicable discharge categories as did passenger vessels. Furthermore, survey responses have determined the percentage of vessels that already practice a specific BMP requirement within all discharge categories.

The following analysis of BMP costs (including per vessel cost and the population of vessels expected to incur additional costs) relies on industry survey responses and additional information from manufacturers and field experts. Appendix A provides a copy of the questionnaire administered to the industry representatives. Appendix B summarizes industry responses.

6.2.1 Discharges of Deck Washdown and Runoff

Affected Vessel Population

Based on the description of practices within this discharge category, deck washdown and runoff is the only discharge category that is potentially applicable to all 90,713 vessels.

However, based on review of public comment documents and preliminary survey responses, vessels already generally practice the BMPs listed below. The American Waterways Operators, an industry organization representing barges and towing vessels, provided information regarding vessel practices within the public comments. All their member tank barges currently use drip pans on machinery, and all perform drip pan cleaning and/or draining. Furthermore, towing vessels currently clear decks of debris, garbage, residue, and spills before conducting deck washdowns, and all currently use environmentally friendly cleaners. Additionally, based on preliminary responses from industry representatives, most deck runoff BMPs are already practiced by other vessels: (1) deck cleanup is currently performed prior to deck washdowns, and (2) passenger vessels and commercial fishing vessels are assumed to practice deck cleanup prior to departing from port. However, most towing vessel/barge companies responded that it is not as common to perform deck cleanup prior to departing from port.

The population potentially affected by BMPs applicable to the deck runoff discharge category is shown in *Table 6-1*.

Vessel Class	Vessel Count
Commercial Fishing	28,875
Freight Barges	32,842
Freight Ships	697
Passenger Vessels	11,521
Recreational Ships ^a	926
Tank Barges	4,944
Tank Ships	147
Utility Vessels	10,761
TOTAL	90,713

^a Includes only recreational ships ≥79 feet in length or ≥300 in gross tonnage.

Permit Requirements

Permit Text:

Vessel owner/operators must clear their vessels' decks of debris, garbage, residue and spills prior to conducting deck washdowns and prior to departing from port to prevent these constituents from entering any waste stream. When required by their class societies (e.g., oil tankers) or flag Administrations, vessels must be fitted with and use perimeter spill rails and scuppers to collect the runoff for treatment. Machinery on deck must have coamings or drip pans to collect any oily water from machinery and prevent spills. The drip pans must be drained to a waste container for proper disposal and/or periodically wiped and cleaned. The discharges from deck washdowns must be free from floating solids, visible foam, halogenated phenol compounds, and dispersants, or surfactants. Vessel operators must minimize deck washdowns while in port.

Vessel operators must maintain their topside surface to minimize the discharge of rust (and other corrosion by-products), cleaning compounds, paint chips, non-skid material fragments, and other materials associated with exterior topside surface preservation.

If deck washdowns will result in a discharge, they must be conducted with non-toxic and phosphate free cleaners and detergents. Furthermore, cleaners and detergents should not be caustic or only minimally caustic and should be biodegradable.

Estimates of Cost

Preliminary responses from industry representatives determined that deck cleanup is currently performed prior to deck washdowns. Also, based on the survey responses, passenger vessels and commercial fishing vessels are assumed to practice deck cleanup prior to departing from port, while most towing vessel/barge companies responded that it is not as common to perform deck cleanup prior to departing from port. Thus, EPA determined that all vessel classes except commercial fishing and passenger vessels will incur this cost. However, since this cleanup *is* practiced but only for a percentage of departures, the incremental cost is only incurred for a small percentage of these vessels' departures from port. The baseline assumptions detail the percentages used.

EPA has assumed that performing cleanup before a deck washdown takes significantly more time as compared to performing cleanup prior to departing from port. Cleanup prior to a deck washdown would entail moving all pieces of machinery and cargo so as to clean the entire deck. However, cleanup prior to departing from port would only require clearing loose items from the deck. Survey responses indicated a wide range of cleanup time necessary prior to conducting a deck washdown: from 1 to 6 hours. EPA has estimated that it would only take 30 minutes to perform cleanup prior to departing from port. In the sensitivity analysis, the Agency estimated a potential low and high incremental cost associated with deck cleanup prior to departing from port. These low and high estimates are based upon the percentage of departures from port prior to which a vessel performs deck cleanup.

Survey responses also determined that it is common for all vessels to have drip pans installed for every piece of machinery on deck. However, there may be a small population of older vessels that need to install drip pans. It is also common practice for vessels to perform regular drip pan cleaning and/or draining. However, EPA did receive one response from a towing vessel/barge company that stated that it "rarely" performs drip pan cleaning. Thus, the Agency performed a sensitivity analysis to examine the potential cost to older vessels that may have to install drip pans and for those that may need to perform cleaning and/or draining.

Furthermore, based upon online research of these products and communication with a manufacturer, EPA has found that the incremental cost of purchasing a gallon of non-/low-phosphorus cleaner compared to standard cleaners is negligible due to the variability among cleaners. There are varied prices among high- and low-end products. However, there is enough variability among prices that a vessel could opt for a standard non-/low-phosphorus cleaner in lieu of a high-end phosphorus cleaner.

Sensitivity Analysis

The cost input values are shown in *Table 6-2*, and the estimates/assumptions derived for each practice are described below.

BMP	Labor Hours	Unit Cost	Cost Description
Performing deck cleanup prior to departing from port	0.5	\$8.27 ^a	Per Instance
Draining and/or wiping and cleaning the drip pans or coamings	1.5	\$424.80 ^b	Per Instance
Installing drip pans or coamings for every piece of machinery on deck	N/A	\$161.17	Annualized Cost of a One-time Installation

a Unit cost is estimated by multiplying the labor hours by the average hourly labor rate of \$16.53.
b Includes additional cost of \$400 per instance to dispose of drip pan waste.

➤ Deck Cleanup

- *Average Labor Hours:* Since most towing vessel/barge companies estimated a per-instance cleanup time within the range of 1 to 6 hours, EPA has taken the median of 3.5 hours to estimate the time it would take to perform deck cleanup prior to conducting a deck washdown. However, the time requirement to perform cleanup prior to departing from port is assumed to be significantly less: around 30 minutes.
- *Average Labor Rate:* A weighted average labor rate of \$16.53 was calculated from the industry responses from the towing vessel/barge companies. The same labor rate is applied to all other vessel classes except for commercial fishing and passenger vessels, which are assumed to already perform cleanup prior to departing from port. Appendix B summarizes the industry responses regarding labor rates.
- *Annual Number of Instances:* The number of times that a vessel departs from port ranges from 4 to 30 times per month. EPA has estimated an average of 15 times per month, thus 180 times per year.
- *Baseline:*
 - Low End Assumption: Deck cleanup prior to departing from port is currently practiced 100 percent of the time by passenger and commercial fishing vessels and 95 percent of the time for all other vessel classes.
 - High End Assumption: Deck cleanup prior to departing from port is currently practiced 100 percent of the time by passenger and commercial fishing vessels and 90 percent of the time for all other vessel classes.

➤ Drip Pan Cleaning

- *Average Labor Hours:* Preliminary industry responses provided an estimate of 1 to 2 hours required per instance of cleaning. EPA has taken the average of 1.5 hours.
- *Average Labor Rate:* The same weighted average labor rate of \$16.53 was calculated from the industry responses from the towing vessel/barge companies. The same labor rate is applied to all other vessel classes except for commercial fishing vessels, which are assumed to already practice drip pan cleaning prior to departing from port. This BMP is assumed not to be applicable to passenger vessels. Appendix B summarizes the industry responses regarding labor rates.

- *Additional Cost:* Most survey respondents provided an additional cost for drip pan waste disposal ranging from \$200 to \$1,200 per instance. EPA estimated an additional average cost per instance of \$400.
 - *Annual Number of Instances:* The number of times that a vessel cleans and/or drains its drip pans ranges from 1 to 4 times per month. EPA estimated an average of 2 times per month, thus 24 times per year.
 - *Baseline:*
 - Low End Assumption: Drip pan cleaning is currently practiced 100 percent of the time.
 - High End Assumption: Drip pan cleaning is currently practiced 99 percent of the time.
- **Installation of Drip Pans/Coamings**
- *One-time Installation Cost:* Preliminary industry responses provided ranges for the total one-time cost per installation estimate for all machinery on deck of \$500 to \$8,000. EPA has estimated an average one-time cost of \$2,000. Annualized over 30 years at a 7 percent discount rate, the cost is \$161.17.
 - *Baseline:*
 - Low End Assumption: 100 percent of vessels already have drip pans/coamings installed.
 - High End Assumption: 99 percent of vessels already have drip pans/coamings installed. EPA is assuming that older vessels may need to install drip pans. Thus, the remaining 1 percent of vessels may incur this incremental cost.

The cost per vessel for each BMP and the total cost associated with all vessels is listed in *Table 6-3*. At the low end, approximately \$3.7 million is a potential annual incremental cost. At the high end, approximately \$15.7 million is a potential annual incremental cost.

Table 6-3: Deck Runoff Sensitivity Analysis				
Vessel Class	Vessel Count	% Vessels Applicable to BMP	Annual Cost per Vessel^b	Total Annual Cost
Low End Estimate				
Deck Cleanup				
Commercial Fishing	28,875	0%	\$0.00	\$0.00
Freight Barges	32,842	100%	\$74.40	\$2,443,360.87
Freight Ships	697	100%	\$74.40	\$51,855.02
Passenger Vessels	11,521	0%	\$0.00	\$0.00
Recreational Ships ^a	926	100%	\$74.40	\$68,892.03
Tank Barges	4,944	100%	\$74.40	\$367,820.97
Tank Ships	147	100%	\$74.40	\$10,936.42
Utility Vessels	10,761	100%	\$74.40	\$800,590.90
Deck Cleanup TOTAL	90,713			\$3,743,456.21
Drip Pan Cleaning TOTAL	90,713	100%	\$0.00	\$0.00
Installation of Drip Pans/Coamings TOTAL	90,713	100%	\$0.00	\$0.00
Low End TOTAL				\$3,743,456.21
High End Estimate				
Deck Cleanup				
Commercial Fishing	28,875	0%	\$0.00	\$0.00
Freight Barges	32,842	100%	\$148.79	\$4,886,721.74
Freight Ships	697	100%	\$148.79	\$103,710.04
Passenger Vessels	11,521	0%	\$0.00	\$0.00
Recreational Ships ^a	926	100%	\$148.79	\$137,784.07

Table 6-3: Deck Runoff Sensitivity Analysis

Vessel Class	Vessel Count	% Vessels Applicable to BMP	Annual Cost per Vessel ^b	Total Annual Cost
Tank Barges	4,944	100%	\$148.79	\$735,641.93
Tank Ships	147	100%	\$148.79	\$21,872.85
Utility Vessels	10,761	100%	\$148.79	\$1,601,181.80
Deck Cleanup TOTAL	90,713			\$7,486,912.43
Drip Pan Cleaning				
Commercial Fishing	28,875	100%	\$101.95	\$2,943,858.10
Freight Barges	32,842	100%	\$101.95	\$3,348,300.87
Freight Ships	697	100%	\$101.95	\$71,060.40
Passenger Vessels	11,521	0%	\$0.00	\$0.00
Recreational Ships ^a	926	100%	\$101.95	\$94,407.36
Tank Barges	4,944	100%	\$101.95	\$504,049.68
Tank Ships	147	100%	\$101.95	\$14,986.91
Utility Vessels	10,761	100%	\$101.95	\$1,097,103.27
Drip Pan Cleaning TOTAL	90,713			\$8,073,766.59
Installation of Drip Pans/Coamings				
Commercial Fishing	28,875	1%	\$161.17	\$46,538.65
Freight Barges	32,842	1%	\$161.17	\$52,932.37
Freight Ships	697	1%	\$161.17	\$1,123.37
Passenger Vessels	11,521	0%	\$0.00	\$0.00
Recreational Ships ^a	926	1%	\$161.17	\$1,492.46
Tank Barges	4,944	1%	\$161.17	\$7,968.38
Tank Ships	147	1%	\$161.17	\$236.92
Utility Vessels	10,761	1%	\$161.17	\$17,343.81
Installation of Drip Pans/Coamings TOTAL	90,713			\$127,635.97
High End TOTAL				\$15,688,314.99

a Includes only recreational ships ≥79 feet in length or ≥300 in gross tonnage.

b Cost for the installation of drip pans/coamings is annualized at a 7% discount rate over 30 years.

6.2.2 Discharges of Bilgewater

Affected Vessel Population

There is overlap in this discharge category between the Permit and existing regulations: the Act to Prevent Pollution from Ships (APPS) 33 CFR 155.310-380, 33CFR155.410-440, 33 CFR151.10, and section 311 of the Clean Water Act. The vessel population that applies to this Permit is already in compliance since all vessels are covered under these existing regulations. Thus, there is no incremental cost under this Permit for these discharge category BMPs.

Permit Requirements

Permit Text:

- All bilgewater discharges must be in compliance with the regulations in 40 CFR Part 110 (Discharge of Oil), 116 (Designation of Hazardous Substances), and 117 (Determination of Reportable Quantities for Hazardous Substances) and 33 CFR §151.10 (Control of Oil Discharges). In addition:
- Vessel operators may not use dispersants, detergents, emulsifiers, chemicals or other substances to remove the appearance of a visible sheen in their bilgewater discharges.

- *Vessel operators may not add substances that drain to the bilgewater that are not produced in the normal operation of a vessel.*
- *All vessels must minimize the discharge of bilgewater into waters subject to this permit. This can be done by minimizing the production of bilgewater, disposing of bilgewater on shore where adequate facilities exist, or discharging into waters not subject to this permit (i.e., more than 3 nm from shore) for vessels that regularly travel into such waters. Though not regulated under this permit, EPA notes that discharges of bilgewater outside waters subject to this permit (i.e. more than 3 nm from shore) are regulated under Annex I of the International Convention for the Prevention of Pollution from Ships as implemented by the Act to Prevent Pollution from Ships and U.S. Coast Guard regulations found in 33 CFR 151.09.*
- *Vessels greater than 400 gross registered tons shall not discharge untreated bilgewater into waters subject to this permit.*
- *Vessels greater than 400 gross registered tons that regularly sail outside the territorial sea (at least once per month) shall not discharge treated bilgewater within 1 nautical mile (nm) of shore unless the discharge is necessary to maintain the safety and stability of the ship. Any discharge which is made for safety reasons must be documented as part of the requirements in Part 4.2.*
- *Vessels greater than 400 gross registered tons shall not discharge treated bilgewater into waters referenced in Part 12.1 unless the discharge is necessary to maintain the safety and stability of the ship. Any discharge of bilgewater into these waters must be documented as part of the recordkeeping requirements in Part 4.2 and vessel operators must document whether this bilgewater discharge was made for safety reasons.*
- *For vessels greater than 400 gross registered tons that regularly sail outside the territorial sea (at least once per month), if treated bilgewater is discharged into waters subject to this permit, it must be discharged when vessels are underway (sailing at speeds greater than 6 knots), unless doing so would threaten the safety and stability of the ship. EPA notes that vessel operators may also choose to dispose of bilgewater on shore where adequate facilities exist. Any discharge which is made for safety reasons must be documented as part of the requirements in Part 4.2.*

Estimates of Cost

No requirements within this discharge category require cost analysis because these practices are already covered by the abovementioned regulations or EPA assumes there is no cost associated with holding the vessel's bilgewater in certain waters.

6.2.3 Discharges of Ballast Water – Pacific Nearshore Vessels

Affected Vessel Population

EPA has estimated the population of and cost to vessels engaged in Pacific nearshore voyages that must exchange ballast water or flush empty ballast water. The population comes directly from the NBIC database.

Other regulations, including the National Invasive Species Act (NISA), its predecessor NANCPA, and associated regulations (33CFR151 subparts 15, 20) apply to all other vessels.

Permit Requirements

Specific Ballast Water Discharge Sections within the Permit:

Ballast Water Management Plans

All owner/operators of vessels equipped with ballast water tanks must maintain a ballast water management plan that has been developed specifically for the vessel that will allow those responsible for the plan's implementation to understand and follow the vessel's ballast water management strategy. Owner/operators must make that plan available upon request to any EPA representative. Vessel owner/operators must assure that the master and crew understand and follow the management strategy laid out in the plan.

Pacific nearshore vessel requirements for vessels carrying Ballast Water and for those with Ballast Water Tanks but certify No Ballast on Board (NoBOB) or Partial NoBOB

Unless the vessel is exempted, any vessel engaged in Pacific near shore voyages that travels through more than one Captain of the Port Zone (COTP) zone as listed in 33 CFR Part 3 must carry out an exchange of ballast water before discharging from any tanks that carry ballast water into waters subject to this permit. This exchange must occur in waters more than 50 nautical miles from any Pacific (US or otherwise) shore, and in waters more than 200 meters deep, prior to discharging ballast water into waters subject to this permit. Exchange should occur as far from the shore, major estuary and oceanic river plumes, subsurface physical features (e.g. seamounts), and known fishery habitats as practicable. This requirement applies to all vessels carrying Ballast Water that will enter any US Port in the states of Alaska, California, Oregon, or Washington and that travels through more than one COTP zone and to all other vessels that sail from foreign, Atlantic, or Gulf of Mexico ports, which do not sail further than 200 nm (370 kilometers [km] or 230 statutory miles [mi]) from any shore, and that discharge or will discharge ballast water into the territorial sea or inland waters of Alaska or of the west coast of the continental United States.

For owner/operators of vessels engaged in Pacific Near Shore Voyages which either certified No Ballast on Board in accordance with Coast Guard regulations or which have any ballast water Tank that is empty or contains unpumpable residual water, you must follow the applicable requirements in Part 2.2.3.6 for those tanks with ballast water. For those tanks which are empty or contain unpumpable residual water, you must either seal the tank so that there is no discharge or uptake and subsequent discharge of ballast water within waters subject to this permit or conduct saltwater flushing of such tanks in an area 50 nautical miles from any shore and in waters at least 200 meters deep prior to the discharge or uptake and subsequent discharge or uptake of any ballast water to or from any waters subject to this permit, unless you meet one of the exemptions in Part 2.2.3.11. For these voyages, saltwater flushing means the addition of water from the "coastal exchange zone" to empty ballast water tanks; the mixing of the flush water with residual water and sediment through the motion of the vessel; and the discharge of the mixed water, such that the resultant residual water remaining in the tank must obtain either a minimum salinity of 30 parts per thousand (ppt) or a value equal to the ambient salinity at the location of the flushing. In order to conduct saltwater flushing, the vessel should take on as much coastal exchange zone water into each tank as is safe (for the vessel and crew). These requirements apply to all vessels carrying ballast water that will enter any US Port in the states of Alaska, California, Oregon, or Washington and that travels through more than COTP zone.

For all vessel owner/operators subject to this section that contain some empty ballast water tanks and some full ballast water tanks, if you elect to seal those empty tanks, you must not allow water from the full tanks to commingle with waters from the empty tanks if it will subsequently be discharged into waters subject to this permit.

Estimates of Cost

This cost estimate relies on previous estimates of ballast water exchange presented in USCG's *Regulatory Evaluation for the Mandatory Ballast Water Management Program for U.S. Waters* (USCG, 2004a), NBIC data, and WTLUS/VESDOC populations. The USCG's Regulatory Evaluation provided cost estimates that were extrapolated to 2007 dollars and used to estimate exchange and saltwater flushing costs. The cost inputs used to

determine total ballast water exchange costs to Pacific nearshore vessels are shown in *Table 6-4*. Saltwater flushing costs to Pacific nearshore vessels are estimated in Section 6.2.4: *Discharges of Ballast Water – Vessels with Empty Tanks*.

Unit Cost Input	Unit Cost
Pumping 1 cubic meter of ballast water	\$0.014/m ³
Annual maintenance to the ballast pumps	See <i>Table 6-5</i>
Annual addition of saltwater flushing practices to the ballast water management plan	\$109.90 ^a
Recordkeeping per instance of exchange	\$18.32 ^b

a Based on a labor rate of \$109.90 and 1 hour.
b Based on a labor rate of \$109.90 and 10 minutes of labor required per exchange.

The total annual cost of ballast water exchange for Pacific nearshore vessels is also based on the following data and assumptions:

- **Population:** The population of vessels was determined by the NBIC database. EPA queried the database for both domestic and foreign ballast-capable vessels that called at ports in Oregon and Alaska at least once during 2005. Vessels calling at Washington and California were excluded due to existing state permits that matched or exceeded the NPDES requirements.
- **Number of Exchanges:** Arrivals data were also produced by the NBIC database. The number of exchanges that occur was determined by querying the database for all arrivals where the vessel had at least 1 full ballast tank. The previous USCG analysis was used to determine the percentage of time that safety and weather claims are made to prevent ballast water exchange. From these data, 61 percent was determined as the percentage of time that an exchange would occur. Weather conditions were assumed to prevent the other 39 percent of exchanges.
- **Ballast Tank Capacity:** The average number of full ballast water tanks that vessels are carrying upon arrival is multiplied by the average capacity of each tank, yielding an average, per arrival, measure of ballast water that is further broken down by vessel class. Expressed in metric tons, this measure represents the average volume of water that arriving vessels must exchange.
- **Ballast Exchange Method:** The method (i.e., sequential or flow-through exchange) is dependent upon ship type and determines the water volume multiplier. The flow-through exchange method, used by tank and freight ships, requires the pumping of three times the volume of water being exchanged. The sequential exchange method, used by all other vessel types, requires the pumping of two times the volume of water being exchanged.
- **Pumping Cost:** A uniform cost for pumping 1 cubic meter of ballast water is estimated at (\$0.014/m³).⁷ The USCG analysis developed unit cost estimates of ballast water exchange based on personal communication with the industry.
- **Maintenance Cost:** Annual maintenance costs are equal to 10 percent of the ballast water system's capital cost. These costs were derived from the USCG analysis. *Table 6-5* lists the average annual maintenance costs for each vessel class.

⁷ One cubic meter (m³) of water = 1 metric ton.

Vessel Class	Annual Maintenance Cost	Number of Domestic Vessels	Number of Foreign Vessels
Commercial Fishing	\$1,500	16	0
Freight Barges	\$1,500	16	0
Freight Ships	\$2,000	13	9
Tank Barges	\$1,500	13	0
Tank Ships	\$3,000	12	16
Utility Vessels	\$1,500	27	1
TOTAL		97	26

- **Management Plan:** A ballast water management plan is already required for all vessels equipped with ballast tanks under NISA (33 CFR 151). Thus, there is no incremental cost associated with general management plan development. However, EPA is assuming that since vessels are now required to conduct saltwater flushing for empty tanks, vessel operators will need to incorporate their saltwater flushing plan into the ballast water management plan. EPA has assumed that this will represent a 1-hour annual burden for all oceangoing vessels. The hourly labor rate of \$100 provided in the previous USCG analysis was prorated to 2007 dollars (\$109.90) and was verified by industry contacts. The relatively high labor rate is due to the level of senior personnel involved in ballast water management decisions and activities.
- **Recordkeeping Costs:** The same hourly labor rate of \$109.90 was used for the recordkeeping cost estimate. EPA assumes that 10 minutes is required to perform recordkeeping per instance of exchange and saltwater flushing.

The annual cost of the ballast water exchange requirements per vessel is a sum of the estimated pumping, maintenance, addition to the management plan, and recordkeeping costs. Summary tables for both domestic and foreign vessels that represent the cost calculations and the derived total costs are shown in *Table 6-6* and *Table 6-7*.

Table 6-6: Summary of Costs of Ballast Water Exchanges for Vessels Engaged in Pacific Nearshore Voyages: Domestic Flag

Vessel Type	Number of Vessels	Annual Number of Ballast Water Exchanges/ Flushes ^{a,b}	Average Cost per Exchange ^c	Records, Management and Maintenance Cost ^{d,e}	Total Annual Cost
Ballast Water Exchanges					
Commercial Fishing	17	14	\$5.99	\$24,421.36	\$24,505.97
Freight Barges	20	23	\$42.60	\$24,696.16	\$25,690.10
Freight Ships	18	151	\$200.98	\$30,506.72	\$60,863.00
Tank Barges	13	23	\$69.75	\$20,177.84	\$21,762.49
Tank Ships	22	107	\$1,482.68	\$39,187.68	\$197,591.04
Utility Vessels	31	26	\$3.69	\$41,287.76	\$41,385.08
Exchange TOTAL	121	344		\$180,278	\$371,798
Saltwater Flushing					
Commercial Fishing	26	28	\$0.08	\$3,132.20	\$3,134.56
Freight Barges	34	217	\$0.58	\$6,612.84	\$6,739.06
Freight Ships	62	569	\$0.85	\$8,627.48	\$9,112.18
Tank Barges	15	271	\$1.22	\$3,627.06	\$3,956.84
Tank Ships	37	628	\$5.63	\$7,253.98	\$10,789.90
Utility Vessels	44	213	\$0.04	\$7,821.76	\$7,830.18
Flushing TOTAL	218	1,925		\$37,075	\$41,563
TOTAL		2,269		\$217,353	\$413,360

a Only includes Alaska and Oregon arrivals. California and Washington arrivals were excluded due to existing state regulations.

b A 61% probability of performing saltwater flushing is applied to vessels with empty ballast tanks. This probability is equal to the probability of conducting ballast water exchange.

c The average cost per saltwater flushing is a weighted average of the average cost determined for NoBOB and partial NoBOB vessels.

d The recordkeeping cost is only applied to full ballast and NoBOB vessels.

e Management plan and maintenance costs are only applied to non-oceangoing vessels that conduct exchange, or 80% of the exchange vessel total.

Table 6-7: Summary of Costs of Ballast Water Exchanges for Vessels Engaged in Pacific Nearshore Voyages: Foreign Flag					
Vessel Type	Number of Vessels	Annual Number of Ballast Water Exchanges/ Flushes^{ab}	Average Cost per Exchange^c	Records, Management and Maintenance Cost^{de}	Total Annual Cost
Ballast Water Exchanges					
Freight Ships	160	155	\$309.76	\$22,616.64	\$70,545.12
Passenger Vessels	29	617	\$26.74	\$18,411.60	\$34,909.86
Tank Ships	17	12	\$518.50	\$3,348.08	\$9,396.86
Utility Vessels	1	1	\$30.52	\$18.32	\$37.06
Exchange TOTAL	207	784		\$44,395	\$114,889
Saltwater Flushing					
Freight Ships	870	1,765	\$1.47	\$96,217.56	\$98,804.63
Passenger Vessels	36	1,063	\$0.55	\$7,620.40	\$8,202.00
Recreational Ships	3	2	\$0.02	\$329.70	\$329.73
Tank Barges	1	0	\$0.00	\$109.90	\$109.90
Tank Ships	183	449	\$4.69	\$21,723.86	\$23,828.40
Utility Vessels	3	6	\$3.27	\$421.30	\$441.69
Flushing TOTAL	1,096	3,285		\$126,423	\$131,716
TOTAL		4,069		\$171,916	\$246,605

a Only includes Alaska and Oregon arrivals. California and Washington arrivals were excluded due to existing state regulations.

b A 61% probability of performing saltwater flushing is applied to vessels with empty ballast tanks. This probability is equal to the probability of conducting ballast water exchange.

c The average cost per saltwater flushing is a weighted average of the average cost determined for NoBOB and partial NoBOB vessels.

d The recordkeeping cost is only applied to full ballast and NoBOB vessels.

e Management plan and maintenance costs are only applied to non-oceangoing vessels that conduct exchange, or 80% of the exchange vessel total.

To arrive at these estimates, EPA made some critical assumptions and dealt with certain data limitations. These are addressed below:

- Due to the nature of the NBIC data, the number of vessels engaged in Pacific nearshore voyages is most likely understated. The NBIC system for gathering and organizing information on ballast-related activities calls for vessels to self-report with limited oversight. This inevitably results in some vessels conducting incomplete reporting or failing to report altogether. The exact margin of this uncertainty is unknown, but will likely have a relatively low impact on total costs.
- The probability of ballast water exchange is a flat figure across all vessels. It is calculated by using an adjusted average of the USCG Regulatory Evaluation’s weighted probability figures, which are primarily for freight and tank ships of varying types and sizes. The USCG’s figures are calculated to estimate the likelihood of exchange, taking into account weather, sea state, and the previous requirement that exchanges could only take place beyond 200 nm from shore. In our analysis, the vessel population includes more vessel types and does not break down by size. Also, the NPDES requirement has withdrawn the 200 nm line to 50 nm for Pacific Coast arrivals, making safe exchanges significantly more likely. However, no data are available that provide specific probabilities for ballast water exchange within the 50 nm zone. With these critical differences, EPA has opted to average the USCG results and adjust this average by a multiple of 1.5 to represent the 150 nm reduction in the exchange restriction zone. Thus, we assume that vessels are less likely to encounter conditions that lessen the likelihood of exchange. This is a conservative assumption and thus may overestimate the number of exchanges that may actually occur.
- Maintenance costs are also based on USCG findings, where yearly upkeep is estimated at 10 percent of the total capital cost of the ballast water pump system itself. Again, USCG breakdowns for this cost do

not correlate directly to EPA's vessel classification scheme, so the Agency used the mode of all cost estimates for each of its vessel classes, except for its freight ships and tank ships vessel groups, where the mode of freight ship and tank ship cost estimates was used to obtain greater specificity.

6.2.4 Discharges of Ballast Water – Vessels with Empty Tanks

Affected Vessel Population

EPA has estimated the population of and cost to all oceangoing vessels with empty ballast water tanks that must perform saltwater flushing. The population comes directly from the NBIC database. EPA has not estimated the cost to all Great Lakes vessels. The cost is negligible for these vessels since only three domestic flag vessels subject to the saltwater flushing requirement exist in the ballast water database, and they already perform this practice on a voluntary basis.

Other regulations, including NISA, its predecessor NANCPA, and associated regulations (33 CFR 151 subparts 15, 20), apply to all other vessels.

Permit Requirements

Specific Ballast Water Discharge Sections within the Permit:

Vessels entering the Great Lakes

In addition to complying with the requirements of this permit, all vessels that are equipped to carry ballast water and enter the Great Lakes must comply with 33 CFR Part 151, Subpart C titled: "Ballast Water Management for Control of Nonindigenous Species in the Great Lakes and Hudson River." Vessels that operate outside the EEZ and more than 200 nm from any shore and then enter the Great Lakes via the Saint Lawrence Seaway System must also comply with 33 CFR Part 401.30, which requires oceangoing vessels to conduct saltwater flushing of ballast water tanks 200 nautical miles from any shore before entering either the U.S. or Canadian waters of the Seaway System..

Vessels with any Ballast Water Tanks that are empty or have unpumpable residual water

For vessels that travel between more than one COTP Zone while undertaking voyages described in Part 2.2.3.5 and which either certified No Ballast on Board in accordance with Coast Guard regulations or which have any ballast water tank that is empty or contains unpumpable residual water, you must follow the applicable requirements in Part 2.2.3.5 for those tanks with ballast water. For those tanks which are empty or contain unpumpable residual water, you must either seal the tank so that there is no discharge or uptake and subsequent discharge of ballast water within waters subject to this permit or conduct saltwater flushing of such tanks in an area 200 nautical miles from any shore and in waters at least 200 meters deep prior to the discharge or uptake and subsequent discharge of any ballast water to any U.S. waters subject to this permit, unless you meet one of the exemptions in Part 2.2.3.11. Saltwater flushing means the addition of mid-ocean water to empty ballast water tanks; the mixing of the flush water with residual water and sediment through the motion of the vessel; and the discharge of the mixed water, such that the resultant residual water remaining in the tank must obtain either a minimum salinity of 30 parts per thousand (ppt) or a value equal to the ambient salinity at the location of the flushing, whichever is lower. In order to conduct saltwater flushing, the vessel should take on as much mid-ocean water into each tank as is safe (for the vessel and crew).

For all vessel owner/operators subject to this section that contain some empty ballast water tanks and some full ballast water tanks, if you elect to seal those empty tanks, you must not allow water that will be discharged into

waters subject to this permit to commingle with waters from the empty tanks if you have not conducted saltwater flushing as specified above.

Estimates of Cost

The Permit requires all oceangoing vessels with empty ballast tanks either to seal the tanks or to conduct saltwater flushing of such tanks in an area 200 nm from any shore prior to the discharge or uptake of any ballast water to or from any U.S. waters. Saltwater flushing costs were the only option estimated within this analysis. Costs of saltwater flushing were estimated in a similar manner to ballast water exchange costs. However, because current regulations (33 CFR 151.2035 and 33 CFR 151.2045) already require implementation of a management plan for all vessels (excluding Pacific nearshore vessels), the only additional cost was the annual 1-hour burden to supplement the management plan with saltwater flushing practices. Also, EPA assumes that recordkeeping is already performed when the vessel exchanges one or more ballast water tanks. Thus, recordkeeping costs were added into the estimates only for NoBOB vessels since partial NoBOB vessels are already assumed to conduct recordkeeping during ballast water exchange. *Table 6-8* shows the annual cost inputs of saltwater flushing for vessels with empty ballast tanks.

Table 6-8: Unit Cost Inputs for Ballast Water Practices – Vessels with Empty Ballast Tanks

Unit Cost Input	Unit Cost
Pumping 1 cubic meter of ballast water	\$0.014/m ³
Annual addition of saltwater flushing practices to the ballast water management plan	\$109.90 ^a
Recordkeeping per instance of saltwater flushing for partial NoBOB vessels	\$18.32 ^b

a Based on a labor rate of \$109.90 and 1 hour.
 b Based on a labor rate of \$109.90 and 10 minutes of labor required per exchange.

The total annual cost of saltwater flushing for all oceangoing and Pacific nearshore vessels is also based on the following data and assumptions:

- **Population:** The population of vessels was determined by the NBIC database. EPA queried the database for both domestic and foreign ballast-capable vessels that called at U.S. ports at least once during 2005. Vessels calling at Great Lakes and Upper Hudson River ports were excluded due to existing permits that matched or exceeded the NPDES requirements. Reporting numbers for these regions were very low (37 vessels) for 2005, due to the lack of a data exchange program with Canadian St. Lawrence Seaway reporting agencies, which was established in 2006.
- **Number of Exchanges:** The NBIC database also produced arrivals data providing for the number of saltwater flushes that should occur. This was done for the two arrival types: vessels arriving with zero metric tons of ballast water (NoBOB) and those arriving with at least one tank empty (partial NoBOB). Based on personal communication with the USCG, the risk involved in performing saltwater flushing based on weather concerns is significantly less than the risk involved in performing ballast water exchange (Cummins, 2007). However, no estimates of the percentage of time that safety or weather claims prevent saltwater flushing are currently available. Thus, EPA has assumed that it is generally safe to conduct saltwater flushing regardless of weather conditions. This assumption may result in an overstatement of saltwater flushing costs if weather prevents saltwater flushing. However, for partial NoBOB vessels, it was assumed that saltwater flushing occurs only if ballast water exchange is performed. EPA used the same probability as was used for ballast water exchange (61 percent). For NoBOB vessels, it was assumed that flushing occurs 100 percent of the time.

- **Ballast Tank Capacity:** Estimates of the ballast capacities that pertain to saltwater flushing for the vessels subject to the Permit requirements were derived from additional NBIC data queries. For NoBOB arrivals EPA used average total ballast capacity. For partial NoBOB vessel arrivals EPA multiplied the average capacity per ballast water tank by the average number of tanks that are reported empty, similar to the water volume calculation for ballast exchange described above for Pacific nearshore voyages. This provides a realistic, per vessel class, average measure of water volume on which to base flushing costs in cases where a vessel may not report NoBOB yet still have empty ballast tanks to manage. To estimate the cost of saltwater flushing, EPA adjusted the estimated capacity of empty tanks to reflect the capacity that would be sufficient for performing saltwater flushing. Based on personal communication with a ship expert, an average empty ballast water tank contains approximately 0.5 percent to 1 percent of residual water (this may be a crude estimate because of the number of variables that determine the residual percentage, e.g., ship age, design, type). However, approximately two times the amount of residual water is required in order to complete saltwater flushing. This would produce an estimate of around 1.5 percent of average total ballast capacity that would be sufficient for saltwater flushing practices (Jenkins, 2007).
- **Pumping Cost:** The same uniform cost for pumping 1 cubic meter of ballast water is applied to these vessels, estimated at (\$0.014/m³).⁸
- **Management Plan:** A ballast water management plan is already required for all vessels equipped with ballast tanks under NISA (33 CFR 151). Thus, there is no incremental cost associated with general management plan development. However, EPA is assuming that since vessels are now required to conduct saltwater flushing for empty tanks, vessel operators will need to incorporate their saltwater flushing plan into the ballast water management plan. The Agency has assumed that this will represent a 1-hour annual burden for all oceangoing vessels. The hourly labor rate of \$100 provided in the previous USCG analysis was prorated to 2007 dollars (\$109.90) and was verified by industry contacts. The relatively high labor rate is due to the level of senior personnel involved in ballast water management decisions and activities.
- **Recordkeeping Cost:** Again, the hourly labor rate of \$109.90 was used for the recordkeeping cost estimate. EPA assumes that 10 minutes is required to perform recordkeeping per instance of saltwater flushing. Recordkeeping costs are only attributed to NoBOB vessels since partial NoBOB vessels already perform recordkeeping during exchange.

The annual cost of the ballast water saltwater flushing requirements per vessel is a sum of the estimated pumping, management plan, and recordkeeping costs. Summary tables for both domestic and foreign vessels that represent the cost calculations and the derived total costs are shown in *Table 6-9* and *Table 6-10*.

⁸ One cubic meter (m³) of water = 1 metric ton.

Table 6-9: Summary of Costs of Saltwater Flushing for Oceangoing Vessels with Ballast Tanks Empty: Domestic Flag

Vessel Type	Number of Vessels	Annual Number of Saltwater Flushings ^a	Average Cost Per Saltwater Flushing ^b	Records and Management Cost ^c	Total Annual Cost
Freight Barges	36	478	\$1.19	\$12,090.48	\$12,659.40
Freight Ships	167	1,797	\$0.71	\$18,628.10	\$19,902.05
Passenger Vessels	2	1	\$0.02	\$238.12	\$238.14
Tank Barges	17	188	\$1.62	\$4,781.18	\$5,085.14
Tank Ships	40	212	\$3.07	\$6,154.72	\$6,805.85
Utility Vessels	74	303	\$0.04	\$10,184.44	\$10,196.55
TOTAL	336	2,979		\$52,077	\$54,887

a A 61% probability of performing saltwater flushing is applied to vessels with some empty ballast tanks. This probability is equal to the probability of conducting ballast water exchange.

b The average cost per saltwater flushing is a weighted average of the average cost determined for NoBOB and partial NoBOB vessels.

c The recordkeeping cost is only applied to NoBOB vessels.

Table 6-10: Summary of Costs of Saltwater Flushing for Oceangoing Vessels with Ballast Tanks Empty: Foreign Flag

Vessel Type	Number of Vessels	Annual Number of Saltwater Flushings ^a	Average Cost Per Saltwater Flushing ^b	Records and Management Cost ^c	Total Annual Cost
Freight Barges	3	4	\$4.81	\$348.02	\$367.28
Freight Ships	4,451	18,277	\$1.13	\$521,151.62	\$541,838.84
Passenger Vessels	166	4,389	\$0.53	\$24,179.08	\$26,505.63
Recreational Ships	2	2	\$0.02	\$219.80	\$219.84
Tank Barges	5	5	\$3.10	\$604.46	\$619.98
Tank Ships	1,824	8,999	\$5.31	\$271,667.44	\$319,436.51
Utility Vessels	33	33	\$0.41	\$3,809.90	\$3,823.36
TOTAL	6,484	31,709		\$821,980	\$892,811

a A 61% probability of performing saltwater flushing is applied to vessels with some empty ballast tanks. This probability is equal to the probability of conducting ballast water exchange.

b The average cost per saltwater flushing is a weighted average of the average cost determined for NoBOB and partial NoBOB vessels.

c The recordkeeping cost is only applied to NoBOB vessels.

As with the cost estimation of ballast water exchange for Pacific nearshore voyages, some significant data shortcomings existed, and some key assumptions were made. These are addressed below:

- Due to the nature of the NBIC data, the number of vessels requiring saltwater flushing of ballast tanks is most likely understated. The NBIC system for gathering and organizing information on ballast-related activities calls for vessels to self-report with limited oversight. This inevitably results in some vessels conducting incomplete reporting or failing to report altogether. The exact margin of this uncertainty is unknown, but will likely have a relatively low impact on total costs.
- The probability of saltwater flushing for vessels arriving with any empty tanks, as with an exchange, is a flat figure across all vessels. It is calculated by using an adjusted average of the USCG Regulatory Evaluation’s weighted probability figures, which are primarily for freight and tank ships of varying types and sizes. The USCG’s figures are calculated to estimate the likelihood of exchange, taking into account weather, sea state, and the previous requirement that exchange could only take place beyond 200 nm from shore. In our analysis, the vessel population includes more vessel types and does not break down by size. Also, the NPDES requirement has withdrawn the 200 nm line to 50 nm for Pacific Coast arrivals, making safe exchanges and flushing significantly more likely. EPA can presume that for the other coasts where the 200 nm line still holds, some vessels will opt to flush their empty tanks, even when safe exchanges are

not feasible. With these critical differences, the Agency has opted to average the USCG results and adjust this average by a multiple of 1.5 to represent the 150 nm reduction in the exchange restriction zone.

6.2.5 Anti-fouling Hull Coatings

Affected Vessel Population

EPA is assuming that the Global Anti-fouling System Treaty will be ratified before the Permit goes into effect. Thus, the requirements of the TBT restriction on the vessel population that would apply to this Permit is null since all vessels are covered under the proposed Treaty. Few, if any, vessels still use TBT on their hulls.

Permit Requirements

Permit Text:

- *All anti-fouling hull coatings subject to registration under FIFRA (see 40 CFR 152.15) must be registered, sold or distributed, applied, maintained, and removed in a manner consistent with applicable requirements on the coatings' FIFRA label.*
- *For anti-fouling hull coatings not subject to FIFRA registration (i.e. not produced for sale and distribution in the United States), hull coatings must not contain any biocides or toxic materials banned for use in the United States. This requirement applies to all vessels, including those registered and painted outside the United States.*

At the time of initial application or scheduled reapplication of anti-fouling coatings, you must give consideration, as appropriate for vessel class and vessel operations, to the use of hull coatings with the lowest effective biocide release rates, rapidly biodegradable components, or non-biocidal alternatives, such as silicone coatings.

Some ports and harbors are impaired by copper. These waters include Shelter Island Yacht Basin in San Diego, California and waters in and around the ports of Los Angeles/Long Beach. A complete list of such waters may be found at www.epa.gov/npdes/vessels. When vessels spend considerable time in these waters (defined as spending more than 30 days per year), or use these waters as their home port (i.e. ferries or rescue vessels), vessel owner/operators shall consider using antifouling coatings that rely on a rapidly biodegradable biocide or another alternative rather than copper based coatings. If after consideration of alternative biocides, vessel operators continue to use copper based antifoulant paints, they must document in their recordkeeping documentation how this decision was reached.

The discharge of Tributyltin (TBT) is prohibited by this permit. Therefore, vessel operators covered by this permit have a zero discharge standard for TBT. You may not use an antifoulant coating containing TBT. If the vessel has previously been covered with a hull coating containing TBT, vessels must be effectively overcoated so that no TBT leaches from the vessel hull or the TBT coating must have been removed from the vessel's hull.

Estimates of Cost

No requirements within this discharge category for TBT require cost analysis because these practices will be under the authority of the Global Anti-fouling System Treaty. EPA has assumed that the requirements for other anti-fouling paints are negligible for this permit.

6.2.6 Aqueous Film-Forming Foam

Affected Vessel Population

Based on the Permit's description of practices in this discharge category, aqueous film-forming foam (AFFF) practices apply only to a subset of the total population of vessels. Freight ships, tank ships, and various utility vessels are the only vessel classes to which this discharge category applies. Other vessel classes are not expected to have a firefighting system on board. Furthermore, separate population estimates were produced for oceangoing and non-oceangoing vessels since separate practices are applicable to each type of vessel.

The population potentially affected by BMPs applicable to the AFFF discharge category is shown in *Table 6-11*.

Vessel Class	Non-Oceangoing Vessel Count ^b	Oceangoing Vessel Count	Total Vessel Count
Commercial Fishing	0	0	0
Freight Barges	0	0	0
Freight Ships	112	555	667
Passenger Vessels	0	0	0
Recreational Ships ^a	0	0	0
Tank Barges	0	0	0
Tank Ships	13	129	142
Utility Vessels	5,697	4,990	10,687
TOTAL	5,822	5,674	11,496

a Includes only recreational ships ≥79 feet in length or ≥300 in gross tonnage.
b Includes vessels operating on the Great Lakes, Mississippi River, and intracoastal waterways.

Permit Requirements

Permit Text:

Discharges of AFFF are authorized for emergency purposes when needed to ensure the safety and security of the vessel and her crew.

For all vessels that sail outside of the territorial sea more than once per month, maintenance and training discharges of AFFF are not authorized within waters subject to this permit. (Any such discharges should be collected and stored for onshore disposal or scheduled when the vessel is outside such waters.) Discharge volumes associated with regulatory certification and inspection must be minimized and a substitute foaming agent (i.e. non-fluorinated) must be used if possible within waters subject to this permit.

For vessels that do not leave the territorial sea more than once per month, if maintenance and training discharges are required, AFFF must be collected and stored for onshore disposal unless the vessel uses non-fluorinated or alternative foaming agent. Training should be conducted as far from shore as is practicable. Maintenance and training discharges are not allowed in port.

For all vessels, AFFF discharges may not occur in or within 1 nm of a water referenced in Part 12.1 unless they are discharged:

- *For emergency purposes*
- *By rescue vessels such as fireboats for firefighting purposes,*

- *By vessels owned or under contract to do business exclusively in or within 1 nm of those protected areas by the United States government or state or local governments.*

If AFFF discharge occurs in waters in Part 12.1 for emergency purposes, a written explanation must be kept in the ship's log or other vessel recordkeeping documentation consistent with Part 4.2 of this permit.

Estimates of Cost

Cost estimates of non-fluorinated foams are in the sensitivity analysis section, as these foams are not required for vessels. Within the sensitivity analysis EPA has estimated a potential low and high incremental cost associated with AFFF practices. These low and high estimates are based upon the percentage of vessels that would purchase non-fluorinated foams and a foam aspirating device, and the percentage of time that a vessel documents an emergency discharge.

Other BMPs are not included in the sensitivity analysis since cost estimates and applicable vessel populations are not currently known.

Sensitivity Analysis

Cost estimates are based upon assumptions and communication with a foam manufacturer as to the incremental cost per gallon of non-fluorinated foams and the cost of the non-fluorinated foaming device compared to the standard AFFF and device. The cost input values are shown in *Table 6-12*, and the estimates/assumptions derived for each practice are described below.

Table 6-12: Per-Vessel Costs for BMPs Associated with AFFF

BMP	Labor Hours	Unit Cost	Cost Description
Purchase of non-fluorinated foaming agents and the aspirating device	N/A	\$3.94	Annual cost of purchasing foams and device
▫ Non-fluorinated foams	N/A	-\$125	Annual cost of purchasing 20 gallons of foam
▫ Non-fluorinated foam aspirating device	N/A	\$128.94	Annual cost of purchasing device
Documentation of an emergency discharge taking place in waters listed in Part 12.1 [waters federally protected wholly or in part for conservation purposes] in VGP	0.16	\$5.06 ^a	Assumption of cost per instance
Collection and storage of maintenance and training discharges from non-oceangoing vessels	N/A	Unknown Cost	One-time installation cost

^a A unit cost is estimated by multiplying the labor hours by the average hourly labor rate of \$31.61.

- **Purchase of Non-Fluorinated Foams:** Foams are typically not changed out of ships any more frequently than 5 years (respondents provided a range of 5 to 25 years in which foams may need to be replaced). AFFF is by far the most frequent foam used by vessels; some vessels also use protein and polar solvent foams. The type of foam that is carried onboard is dependent on the type of cargo. The amount of foam in the tanks ranges from 300 to 6,000 gallons, dependent on ship type. We have estimated that an annual amount of 100 gallons of foam would regularly be purchased. Furthermore, since non-fluorinated foams may be required in a greater volume, we have assumed that an additional 30 gallons of non-fluorinated foam would need to be purchased annually. The population of vessels that currently use non-fluorinated foams is unknown. However, a cost is determined by estimating an average incremental cost and assuming that a low percentage of vessels will purchase the non-fluorinated foams.
 - *Gallons of Foam Purchased:* An average vessel purchases 100 gallons of AFFF per year. It was assumed that an additional 30 gallons of non-fluorinated foam would need to be purchased annually.

- *Incremental Cost of Non-Fluorinated Foams:* There is a cost savings per gallon achieved from purchasing non-fluorinated foams versus the typical AFFF. Based upon communication with a foam manufacturer, the average cost of AFFF is approximately \$11/gallon, whereas the average cost of a non-fluorinated foam is approximately \$7.50/gallon, a cost savings of \$3.50/gallon.
- *Incremental Cost of Non-Fluorinated System:* There is an additional annual cost per vessel of \$128.94 for the special device that is required for non-fluorinated foam use. This device is expected to last for the lifetime of the vessel. The total incremental cost of the device is approximately \$1,600, annualized at a 7 percent discount rate over 30 years.
- *Baseline:*
 - Low End Assumption: 95 percent of vessels already use non-fluorinated foams and have the necessary device.
 - High End Assumption: 90 percent of vessels already use non-fluorinated foams and have the necessary device.
- ***Documentation of Emergency AFFF Discharge within 1 nm of in waters listed in Part 12.1 [waters federally protected wholly or in part for Conservation Purposes] in the Vessel General Permit:*** The per-instance cost of this practice as well as the population of vessels that currently document these emergency discharges is unknown. However, by estimating an average documentation time and assuming that these discharges are infrequent, a low end and high end cost estimate can be determined.
 - *Average Labor Hours Assumption:* 10 minutes is required for documentation.
 - *Average Labor Rate:* Since this discharge category is primarily applicable to freight ships, tank ships, and utility vessels and these industries have not provided this information, a weighted average labor rate of \$31.61 was calculated from all the industry responses. Appendix B summarizes the industry responses regarding labor rates.
 - *Annual Number of Instances Assumption:* Emergency discharges of AFFF occur within these waters, on average, once every two years.
 - *Baseline:*
 - Low End Assumption: Vessels document the discharge 95 percent of the time.
 - High End Assumption: Vessels document the discharge 90 percent of the time.
- ***Collect and Store All AFFF Maintenance and Training Discharges:*** This requirement is applicable to non-oceangoing vessels only. This cost estimate is based upon required technology (i.e., holding tanks and a pump system). The one-time installation cost of this system as well as the population of vessels that currently have this system installed is unknown until further information is received from industry representatives.
- In general, we are aware that it is not standard to have the technology to collect and store maintenance/training discharges of foams. It is common practice to wash the foam over the side of the ship. However, it is uncommon to perform these maintenance/training discharges while in inland waters. Most vessels perform these discharges while at sea.

The cost per vessel for each BMP and the total cost associated with all vessels is listed in *Table 6-13*. At the low end, approximately \$3,700 is a potential annual incremental cost. At the high end, approximately \$7,400 is a potential annual incremental cost.

Table 6-13: Aqueous Film-Forming Foam Sensitivity Analysis

Vessel Class	Vessels	% Vessels Applicable to BMP	Annual Cost per Vessel ^c	Total Annual Cost
Low End Estimate				
Purchase Non-Fluorinated Foams and System				
Commercial Fishing	0	0%	\$0.00	\$0.00
Freight Barges	0	0%	\$0.00	\$0.00
Freight Ships	667	5%	\$3.94	\$131.34
Passenger Vessels	0	0%	\$0.00	\$0.00
Recreational Ships ^a	0	0%	\$0.00	\$0.00
Tank Barges	0	0%	\$0.00	\$0.00
Tank Ships	142	5%	\$3.94	\$27.96
Utility Vessels	10,687	5%	\$3.94	\$2,104.40
Foam Purchase TOTAL	11,496			\$2,263.70
Document Emergency Discharge				
Commercial Fishing	0	0%	\$0.00	\$0.00
Freight Barges	0	0%	\$0.00	\$0.00
Freight Ships	667	100%	\$0.13	\$84.35
Passenger Vessels	0	0%	\$0.00	\$0.00
Recreational Ships ^a	0	0%	\$0.00	\$0.00
Tank Barges	0	0%	\$0.00	\$0.00
Tank Ships	142	100%	\$0.13	\$17.96
Utility Vessels	10,687	100%	\$0.13	\$1,351.46
Documentation TOTAL	11,496			\$1,453.77
Low End TOTAL				\$3,717.47
High End Estimate				
Purchase Non-Fluorinated Foams and System				
Commercial Fishing	0	0%	\$0.00	\$0.00
Freight Barges	0	0%	\$0.00	\$0.00
Freight Ships	667	10%	\$3.94	\$262.68
Passenger Vessels	0	0%	\$0.00	\$0.00
Recreational Ships ^a	0	0%	\$0.00	\$0.00
Tank Barges	0	0%	\$0.00	\$0.00
Tank Ships	142	10%	\$3.94	\$55.92
Utility Vessels	10,687	10%	\$3.94	\$4,208.80
Foam Purchase TOTAL	11,496			\$4,527.47
Document Emergency Discharge				
Commercial Fishing	0	0%	\$0.00	\$0.00
Freight Barges	0	0%	\$0.00	\$0.00
Freight Ships	667	100%	\$0.25	\$168.70
Passenger Vessels	0	0%	\$0.00	\$0.00
Recreational Ships ^a	0	0%	\$0.00	\$0.00
Tank Barges	0	0%	\$0.00	\$0.00
Tank Ships	142	100%	\$0.25	\$35.91
Utility Vessels	10,687	100%	\$0.25	\$2,702.92
Documentation TOTAL	11,496			\$2,907.53
High End TOTAL				\$7,434.94

a Includes only recreational ships ≥ 79 feet in length or ≥ 300 in gross tonnage.

b Includes vessels operating on the Great Lakes, Mississippi River, and intracoastal waterways.

c Cost for the non-fluorinated foaming system is annualized at a 7% discount rate over 30 years.

6.2.7 Boiler/Economizer Blowdown

Affected Vessel Population

The costs incurred in this discharge category are assumed to be negligible and/or the industry is assumed to currently practice the Permit requirements. Thus, the vessel population that would apply to this Permit was not estimated since no vessels will experience any cost.

Permit Requirements

Permit Text:

Minimize the discharge of boiler/economizer blowdown in port if chemicals or other additives are used to reduce impurities or prevent scale formation. For vessels greater than 400 gross registered tons which leave the territorial sea at least once per week, boiler/economizer blowdown may not be discharged in waters subject to this permit except for safety purposes, and should be discharged as far from shore as possible. For all vessels, Boiler/Economizer blowdown may not be discharged in or within 1 nm of waters referenced in part 12.1 except for safety purposes.

Estimates of Cost

No requirements in this discharge category require cost analysis because these practices are assumed to have negligible costs and/or the industry is assumed to currently practice the Permit requirements.

6.2.8 Cathodic Protection

Affected Vessel Population

Based on the description of practices within this discharge category, all vessel classes are subject to the cathodic protection BMPs. However, only vessels that have steel hulls are applicable to this discharge category. Thus, the total count of domestic vessels applicable to this discharge category is nearly 60 percent of the total domestic count.

The population potentially affected by BMPs applicable to the cathodic protection discharge category is shown in Table 6-14.

Vessel Class	Vessel Count
Commercial Fishing	5,817
Freight Barges	32,646
Freight Ships	552
Passenger Vessels	1,724
Recreational Ships ^a	133
Tank Barges	4,927
Tank Ships	141
Utility Vessels	9,053
TOTAL	54,993

^a Includes only recreational ships ≥79 feet in length or ≥300 in gross tonnage.
^b Applies to steel hulled vessels only

Permit Requirements

Permit Text:

Cathodic protection must be maintained to prevent the corrosion of the ship's hull. The discharge of zinc, magnesium, and aluminum are expected from properly functioning cathodic protection sacrificial electrodes. However, vessel operators must minimize the flaking of large, corroded portions of these anodes. Sacrificial anodes must not be used more than necessary. Vessel operators must appropriately clean and/or replace these anodes in periods of maintenance (such as drydocking), so that release of these metals to waters is minimized.

Vessel operators should be cognizant that magnesium is less toxic than aluminum, which is less toxic than zinc. If vessel operators use sacrificial electrodes, they must use the metals that are less toxic to the extent technologically feasible and economically practicable and achievable. .

EPA recommends the use of Impressed Current Cathodic Protection (ICCP) in place of sacrificial electrodes. If vessel operators use ICCP, they must maintain dielectric shields to prevent flaking. Newly constructed vessels (those vessels which have been designed and contracted for after [insert date of FR notice for final permit] which use Cathodic Protection must use ICCP if technologically feasible.

Estimates of Cost

Based upon communication with a maritime engineer from the U.S. Maritime Administration (Ghosh, 2008) as well as preliminary industry responses, there is no incremental cost to vessels for these specific BMPs. As a baseline, all steel hulled vessels currently have either an ICCP or a sacrificial electrodes system of cathodic protection. Furthermore, the cost of either type of cathodic protection system is the same. There is no additional cost for using a less toxic metal such as aluminum in lieu of a more toxic metal such as zinc. In addition, in EPA's discussions with a representative from a cathodic protection manufacturing company (Peters, 2008), magnesium is not recommended over either of these metals because magnesium has a higher potential and could cause damage to the hull paint coating, thus allowing for a faster rate of dissolution.

A sensitivity analysis was performed to estimate potential costs of cathodic protection installation for vessels that will opt to purchase an ICCP system in accordance with the Permit recommendations. In the sensitivity analysis EPA has estimated a potential low and high incremental cost associated with cathodic protection installation. These low and high estimates are based upon the percentage of vessels that may need to install an updated system. BMPs associated with maintenance and replacement of the cathodic protection system will not incur incremental costs, and no sensitivity analysis will be performed since these practices are regularly performed when deemed necessary.

Sensitivity Analysis

Costs of installing either an ICCP or a sacrificial electrodes system of cathodic protection were estimated based upon communication with a cathodic protection manufacturing company.

The cost input values of cathodic protection system installation are shown in *Table 6-15*, and the estimates/assumptions derived for each practice are described below.

Vessel Class	Low End Installation Cost	High End Installation Cost	Average Installation Cost
Commercial Fishing	\$8,000	\$10,000	\$9,000
Freight Barges	\$10,000	\$11,000	\$10,500
Freight Ships	\$15,000	\$18,000	\$16,500
Tank Barges	\$15,000	\$18,000	\$16,500
Tank Ships	\$24,000	\$28,000	\$26,000
Utility Vessels	\$15,000	\$18,000	\$16,500
Recreational Ships	\$10,000	\$12,000	\$11,000
Passenger Vessels	\$20,000	\$25,000	\$22,500

- *Installation Costs:* a representative from a cathodic protection manufacturing company provided cost estimates for a system. The figures are dependent upon the area of steel on the hull as well as other minor components. The cost estimates that were provided are shown in *Table 6-15*.
- *Baseline:*
 - Low End Assumption: 2.5 percent of vessels will install an ICCP system due to the Permit recommendations.
 - High End Assumption: 5 percent of vessels will need to install an ICCP system due to the Permit recommendations.

The average installation cost was taken for each vessel class. This system is expected to last for the lifetime of the vessel. Thus, the total incremental cost of the device is annualized at a 7 percent discount rate over 30 years to yield the annual cost per vessel presented in *Table 6-16*.

The cost per vessel and the total cost associated with all vessels is listed in *Table 6-16*. At the low end, if 2.5 percent of vessels install an ICCP system, approximately \$1.4 million is a potential incremental cost. At the high end, if 5 percent install an ICCP system, approximately \$2.7 million is a potential incremental cost.

Table 6-16: Cathodic Protection Sensitivity Analysis, Purchase of a Cathodic Protection System				
Vessel Class	Total Number of Vessels^a	% of Vessels Need to Purchase System	Annual Cost per Vessel^c	Total Annual Cost
Low End Estimate				
Commercial Fishing	5,817	2.5%	\$725.28	\$105,473.50
Freight Barges	32,646	2.5%	\$846.16	\$690,591.23
Freight Ships	552	2.5%	\$1,329.68	\$18,349.52
Passenger Vessels	1,724	2.5%	\$1,813.19	\$78,148.66
Recreational Ships ^b	133	2.5%	\$886.45	\$2,947.45
Tank Barges	4,927	2.5%	\$1,329.68	\$163,782.80
Tank Ships	141	2.5%	\$2,095.25	\$7,385.74
Utility Vessels	9,053	2.5%	\$1,329.68	\$300,938.84
Low End TOTAL	54,993			\$1,367,617.75
High End Estimate				
Commercial Fishing	5,817	5%	\$725.28	\$210,947.00
Freight Barges	32,646	5%	\$846.16	\$1,381,182.46
Freight Ships	552	5%	\$1,329.68	\$36,699.05
Passenger Vessels	1,724	5%	\$1,813.19	\$156,297.33
Recreational Ships ^b	133	5%	\$886.45	\$5,894.90
Tank Barges	4,927	5%	\$1,329.68	\$327,565.60
Tank Ships	141	5%	\$2,095.25	\$14,771.49
Utility Vessels	9,053	5%	\$1,329.68	\$601,877.69
High End TOTAL	54,993			\$2,735,235.50

a Applies to steel hulled vessels only.

b Includes only recreational ships ≥79 feet in length or ≥300 in gross tonnage.

c Annualized at a 7% discount rate over 30 years.

6.2.9 Chain Locker Effluent

Affected Vessel Population

Based on the description of practices within this discharge category, a subset of vessel classes is applicable to the chain locker effluent discharge category. Freight ships, large recreational vessels, tank ships, and various utility vessels are the vessel classes that are applicable to this discharge category. Other vessel classes are not applicable to this discharge category because their anchors are rarely or never deployed or other equipment is used (e.g., anchor cable). The population potentially affected by BMPs applicable to the chain locker effluent discharge category is shown in *Table 6-17*.

Table 6-17: Vessel Counts for Chain Locker Effluent BMPs	
Vessel Class	Vessel Count
Commercial Fishing	0
Freight Barges	0
Freight Ships	697
Passenger Vessels	0
Recreational Ships ^a	926
Tank Barges	0
Tank Ships	147
Utility Vessels	10,761
TOTAL	12,531

a Includes only recreational ships ≥79 feet in length or ≥300 in gross tonnage.

Permit Requirements

Permit Text:

The anchor chain must be carefully and thoroughly washed down (i.e., more than a cursory rinse) as it is being hauled out of the water to remove sediment and marine organisms. In addition, chain lockers must be cleaned thoroughly during dry docking to eliminate accumulated sediments and any potential accompanying pollutants. For vessels that regularly sail outside waters subject to this permit, if technically feasible, periodically clean, rinse, and/or pump out the space beneath the chain locker prior to entering waters subject to this permit (preferably mid ocean) if the anchor has been lowered into any nearshore waters. Furthermore, for vessels that leave waters subject to this permit at least once per month, chain lockers may not be rinsed or pumped out in waters subject to this permit, unless not emptying them would compromise safety. Such a safety claim must be documented in the vessel's recordkeeping documentation.

Estimates of Cost

Based on preliminary survey responses, most BMPs in the chain locker effluent discharge category are already practiced by the industry. While in drydock (which occurs very infrequently, e.g., once every two years), the chain lockers are *always* cleaned. Rinsing or pumping of the space beneath the chain locker within 3 nm from shore is *never* performed. Furthermore, while the vessel is being hauled out of the water, the anchor chain is *nearly always* washed down. However, the BMP that is not common practice for any of the vessel classes included in the vessel population is inspection, cleaning, and pumping out of the space beneath the chain locker prior to entering nearshore waters. An industry representative commented that chain lockers are typically cleaned during drydocks and not in the deep sea or in nearshore waters because the locker is full of the anchor chain. The potential cost of this BMP was not estimated since this practice is only required if technically feasible.

EPA has performed a sensitivity analysis only for the potential incremental costs associated with washing down the anchor chain as it is being hauled out of the water. In the sensitivity analysis EPA has estimated a potential low and high incremental cost associated with washing down the anchor chain. These low and high estimates are based upon the percentage of time that a vessel washes down the anchor chain while hauling it out of the water.

Sensitivity Analysis

These cost estimates were based upon industry communication (via survey response). The cost input values are shown in *Table 6-18*, and the estimates/assumptions derived for this practice are described below.

BMP	Labor Hours	Unit Cost	Cost Description
Washing down the anchor chain as it is being hauled out of the water	0.75	\$23.71 ^a	Per Instance
Rinsing out the space beneath the chain locker prior to entering nearshore waters	Unknown	Unknown	Per Instance

^a A unit cost is estimated by multiplying the labor hours by the average hourly labor rate of \$31.61.

➤ *Washing Down the Anchor Chain:*

- *Average Labor Hours Assumption:* Since most towing vessel/barge companies estimated a per-instance washdown time within the range of 0.5 to 1 hour, EPA took the average of 0.75 hours to estimate the time it would take to wash down the anchor chain as it is being hauled out of the water.

- *Average Labor Rate:* Since this discharge category is primarily applicable to freight ships, tank ships, recreational ships, and utility vessels and these industries have not provided this information, a weighted average labor rate of \$31.61 was calculated from all the industry responses. Appendix B summarizes the industry responses regarding labor rates.
- *Annual Number of Instances Assumption:* The number of times that a vessel hauls the anchor chain out of the water ranges from 12 to 50 times per year. EPA estimated an average of 20 times per year.
- *Baseline:*
 - Low End Assumption: The vessel currently washes down the anchor chain as the chain is hauled out of the water 100 percent of the time.
 - High End Assumption: The vessel currently washes down the anchor chain as the chain is hauled out of the water 99 percent of the time.

The annual incremental cost per vessel and the total cost associated with all vessels for washing down the anchor chain is listed in *Table 6-19*.

Table 6-19: Chain Locker Effluent Sensitivity Analysis, Wash Down Anchor Chain				
Vessel Class	Vessels	% Vessels Applicable to BMP	Annual Cost per Vessel	Total Annual Cost
High End Estimate				
Commercial Fishing	0	0%	\$0.00	\$0.00
Freight Barges	0	0%	\$0.00	\$0.00
Freight Ships	697	100%	\$4.74	\$3,305.31
Passenger Vessels	0	0%	\$0.00	\$0.00
Recreational Ships ^a	926	100%	\$4.74	\$4,391.27
Tank Barges	0	0%	\$0.00	\$0.00
Tank Ships	147	100%	\$4.74	\$697.10
Utility Vessels	10,761	100%	\$4.74	\$51,030.69
Wash Anchor Chain, High End TOTAL	12,531			\$59,424.37

^a Includes only recreational ships ≥79 feet in length or ≥300 in gross tonnage.

6.2.10 Controllable Pitch Propeller Hydraulic Fluid

Affected Vessel Population

Based on the description of practices within this discharge category, a subset of vessel classes is applicable to the discharge category of controllable pitch propeller hydraulic fluid. Commercial fishing vessels, freight ships, large recreational ships, tank ships, and various utility vessels have the potential to produce this discharge. No other vessel classes are expected to operate controllable pitch propellers.

The population potentially affected by BMPs applicable to this discharge category is shown in *Table 6-20*.

Vessel Class	Vessel Count
Commercial Fishing	28,875
Freight Barges	0
Freight Ships	697
Passenger Vessels	0
Recreational Ships ^a	926
Tank Barges	0
Tank Ships	147
Utility Vessels	10,761
TOTAL	41,406

^a Includes only recreational ships ≥79 feet in length or ≥300 in gross tonnage.

Permit Requirements

Permit Text:

The protective seals on controllable pitch propellers must be maintained in good operating order to prevent the leaking of hydraulic oil. If possible, maintenance activities on controllable pitch propellers should be conducted when a vessel is in drydock. If maintenance must occur when the vessel is in water, an oil boom must be used to contain any hydraulic oil leakage. Operators of the vessel must have appropriate equipment such as oil absorbent pads on hand to clean any potential oil spills.

Estimates of Cost

Based upon the preliminary industry responses, maintenance of the controllable pitch propeller is already performed when in drydock and, when applicable, oil booms and oil absorbent pads are purchased and are in use. However, a sensitivity analysis will be performed to account for the potential incremental cost associated with purchasing an oil boom and oil absorbent pads. In the sensitivity analysis EPA has estimated a potential low and high incremental cost associated with the purchase of an oil boom and oil absorbent pads. These low and high estimates are based upon the percentage of vessels that need to purchase this equipment.

Sensitivity Analysis

Cost estimates were based upon communication with an oil boom manufacturer (Dawg, 2008) as to the cost of purchasing an oil boom as well as oil absorbent pads. The cost input values are shown in *Table 6-21*, and the estimates/assumptions derived for each practice are described below.

BMP	Unit Cost		Cost Description
	Low End	High End	
Purchase (and use) of an oil boom for containing any hydraulic oil leakage during underwater maintenance of the controllable pitch propeller	\$44.48 for <50 ft width vessels \$80.67 for >50 ft width vessels		Annualized Cost of Purchasing an Oil Boom
Purchase of oil absorbent pads to clean any potential oil spills	\$10.24	\$16.00	Annualized Cost of Purchasing Oil Absorbent Pads

➤ **Purchase and Use of an Oil Boom:**

- *Oil Boom Cost:* a representative from a vessel oil boom manufacturer provided the cost estimates for an oil boom. From communication with a vessel oil boom manufacturer, a 50-foot oil boom can be purchased for \$552, and a 100-foot oil boom can be purchased for \$1,001. Since the rear

of the vessel is where the oil boom would be necessary, the length of boom that is required for a vessel is dependent upon the width of the vessel. Most vessels classes have an average width less than or around 50 feet, thus requiring only the 50-foot purchase. However, tank ships hold an average width of 78 feet and would therefore require the 100-foot purchase. The oil boom is expected to last for the lifetime of the vessel. The total incremental cost of the device is annualized at a 7 percent discount rate over 30 years.

□ *Baseline:*

- Low End Assumption: 99 percent of vessels already have and use an oil boom.
- High End Assumption: 95 percent of vessels already have and use an oil boom.

➤ ***Purchase of Oil Absorbent Pads:***

□ *Cost of Oil Absorbent Pads:* a representative from a vessel oil boom manufacturer also provided the cost estimates for oil absorbent pads. The cost ranges from \$34 to \$50 for 100 oil absorbent pads. EPA took the average cost of \$42 per purchase. The oil absorbent pads are assumed to be purchased every three or five years. Thus, for the low end estimate, the total incremental cost of the device is annualized at a 7 percent discount rate over five years. For the high end estimate, the total incremental cost of the device is annualized at a 7 percent discount rate over three years.

□ *Baseline:*

- Low End Assumption: Oil absorbent pads need to be purchased every five years, and 99 percent of vessels already have oil absorbent pads.
- High End Assumption: Oil absorbent pads need to be purchased every three years, and 95 percent of vessels already have oil absorbent pads.

The cost per vessel for each BMP and the total cost associated with all vessels is listed in *Table 6-22*.

Table 6-22: Controllable Pitch Propeller Hydraulic Fluid Sensitivity Analysis

Vessel Class	Vessels	% Vessels Applicable to BMP	Annual Cost per Vessel ^b	Total Annual Cost
Low End Estimate				
Purchase an Oil Boom				
Commercial Fishing	28,875	1%	\$44.48	\$12,844.67
Freight Barges	0	0%	\$0.00	\$0.00
Freight Ships	697	1%	\$44.48	\$310.05
Passenger Vessels	0	0%	\$0.00	\$0.00
Recreational Ships ^a	926	1%	\$44.48	\$411.92
Tank Barges	0	0%	\$0.00	\$0.00
Tank Ships	147	1%	\$80.67	\$118.58
Utility Vessels	10,761	1%	\$44.48	\$4,786.89
Oil Boom Purchase TOTAL	41,406			\$18,472.11
Purchase Oil Absorbent Pads				
Commercial Fishing	28,875	1%	\$10.24	\$2,957.78
Freight Barges	0	0%	\$0.00	\$0.00
Freight Ships	697	1%	\$10.24	\$71.40
Passenger Vessels	0	0%	\$0.00	\$0.00
Recreational Ships ^a	926	1%	\$10.24	\$94.85
Tank Barges	0	0%	\$0.00	\$0.00
Tank Ships	147	1%	\$10.24	\$15.06
Utility Vessels	10,761	1%	\$10.24	\$1,102.29
Oil Pads Purchase TOTAL	41,406			\$4,241.39
Low End TOTAL				\$22,713.49
High End Estimate				
Perform Maintenance on the Controllable Pitch Propeller when Drydocked				
Purchase an Oil Boom				
Commercial Fishing	28,875	5%	\$44.48	\$64,223.33
Freight Barges	0	0%	\$0.00	\$0.00
Freight Ships	697	5%	\$44.48	\$1,550.26
Passenger Vessels	0	0%	\$0.00	\$0.00
Recreational Ships ^a	926	5%	\$44.48	\$2,059.60
Tank Barges	0	0%	\$0.00	\$0.00
Tank Ships	147	5%	\$80.67	\$592.90
Utility Vessels	10,761	5%	\$44.48	\$23,934.45
Oil Boom Purchase TOTAL	41,406			\$92,360.54
Purchase Oil Absorbent Pads				
Commercial Fishing	28,875	5%	\$16.00	\$23,106.02
Freight Barges	0	0%	\$0.00	\$0.00
Freight Ships	697	5%	\$16.00	\$557.75
Passenger Vessels	0	0%	\$0.00	\$0.00
Recreational Ships ^a	926	5%	\$16.00	\$740.99
Tank Barges	0	0%	\$0.00	\$0.00
Tank Ships	147	5%	\$16.00	\$117.63
Utility Vessels	10,761	5%	\$16.00	\$8,611.04
Oil Pads Purchase TOTAL	41,406			\$33,133.43
High End TOTAL				\$125,493.97

a Includes only recreational ships ≥ 79 feet in length or ≥ 300 in gross tonnage.

b Cost for the oil boom is annualized at a 7% discount rate over 30 years. Low end cost for oil absorbent pads is annualized at a 7% discount rate over five years. High end cost for oil absorbent pads is annualized at a 7% discount rate over three years.

6.2.11 Distillation and Reverse Osmosis Brine

Affected Vessel Population

The costs incurred in this discharge category are assumed to be negligible and/or the industry is assumed to currently practice the Permit requirements. Thus, the vessel population that would apply to this Permit was not estimated since no vessels will experience any cost.

Permit Requirements

Permit Text:

Brine from the distillation system and reverse osmosis reject water shall not contain or come in contact with machinery or industrial equipment, toxic or hazardous materials, or wastes .

Estimates of Cost

No requirements within this discharge category require cost analysis because these practices are assumed to have negligible costs and/or the industry is assumed to currently practice the Permit requirements.

6.2.12 Elevator Pit Effluent

Affected Vessel Population

Based on the description of practices within this discharge category, a small subset of vessel classes is applicable to the elevator pit effluent discharge category. Only freight ships and tank ships have the potential to produce this discharge since no other vessels are expected to have exposed elevators. Passenger vessels do not produce this discharge because they are expected to have enclosed elevators.

The population potentially affected by BMPs applicable to discharges in the elevator pit effluent category is shown in *Table 6-23*.

Vessel Class	Vessel Count
Commercial Fishing	0
Freight Barges	0
Freight Ships	697
Passenger Vessels	0
Recreational Ships ^a	0
Tank Barges	0
Tank Ships	147
Utility Vessels	0
TOTAL	844

^a Includes only recreational ships ≥79 feet in length or ≥300 in gross tonnage.

Permit Requirements

Permit Text:

Discharge of elevator pit effluent is not authorized within waters subject to this permit except in cases of emergency. If an emergency discharge is required in waters subject to this permit, Elevator Pit Effluent must be treated with an oily-water separator and may be discharged with an oil content below 15 ppm as measured by EPA Method 1664. Emergency discharges must be documented in the ship’s log or other vessel recordkeeping documentation.

Estimates of Cost

Based on survey responses, discharge of elevator pit effluent never occurs in either normal or emergency situations. Thus, there is no incremental cost associated with onshore disposal or for the use of an oily-water separator to ensure an oil content of less than 15 parts per million (ppm). No sensitivity analysis will be performed.

6.2.13 Firemain Systems

Affected Vessel Population

Based on the description of practices within this discharge category, a subset of vessel classes is applicable to the firemain systems discharge category. Only freight ships, passenger vessels, and tank ships have the potential to produce this discharge. Other vessel classes do not produce this discharge because it is associated with ballast water, and the other vessel classes are not expected to hold ballast.

The population potentially affected by BMPs applicable to the firemain systems discharge category is shown in Table 6-24.

Vessel Class	Vessel Count
Commercial Fishing	0
Freight Barges	0
Freight Ships	697
Passenger Vessels	11,521
Recreational Ships ^a	0
Tank Barges	0
Tank Ships	147
Utility Vessels	0
TOTAL	12,365

^a Includes only recreational ships ≥79 feet in length or ≥300 in gross tonnage.

Permit Requirements

Permit Text:

Discharges from firemain systems are authorized for emergency purposes when needed to ensure the safety and security of the vessel and her crew.

Minimize the discharge from the firemain system while in port. Do not discharge firemain systems in waters of in waters listed in Part 12.1 [waters federally protected wholly or in part for Conservation Purposes] in the Vessel

General Permit except in emergency situations or when washing down the anchor chain to comply with anchor wash down requirements when pulling the anchor and anchor chain from waters.

Estimates of Cost

Based on survey responses, discharges from the firemain system does not occur in normal situation. Though the industry responses to EPA's questionnaire indicate that discharges from firemain systems do not occur in emergency situations, EPA assumes that there are occasional discharges from the firemain systems in cases of fire emergency, training, or other situations.

6.2.14 Freshwater Layup

Affected Vessel Population

Based on EPA's survey results, the vessel population that would apply to this Permit may be null since this discharge category may not apply to any commercial vessels. EPA included this provision in the permit based on information from MARAD marine engineers that these vessel discharges may occur.

Permit Requirements

Permit Text:

Minimize the amount of disinfection agents used in freshwater layup to the minimum required to prevent aquatic growth.

Estimates of Cost

No requirements within this discharge category require cost analysis because this discharge is not applicable to commercial vessels or it is assumed vessel operators currently perform these practices.

6.2.15 Gas Turbine Wash Water

Affected Vessel Population

The vessel population that would apply to this Permit may be null since this discharge category may not apply to any commercial vessels. Only CLIA indicated that their vessels may have this vessel discharge type in their public comments.

Permit Requirements

Permit Text:

Gas turbine wash water must not be discharged within waters subject to this permit. Where feasible, such washwater must be prevented from co-mingling with bilge water that will be discharged in waters subject to this permit, for example by collecting it separately and properly disposing of it on-shore...Under no circumstances may oils, including oily mixtures, from Gas Turbine Wash Water be discharged in waters subject to this permit in quantities that may be harmful as determined in accordance with 40 CFR Part 110.

Estimates of Cost

No requirements within this discharge category require cost analysis because this discharge may not be applicable to commercial vessels and it was assumed that vessel operators could easily comply with these permit terms if these requirements are applicable.

6.2.16 Graywater

Affected Vessel Population

Based on the description of practices within this discharge category, graywater discharges are applicable to every vessel class except for freight barges and tank barges. However, there is some overlap with the Clean Water Act's existing provisions and with 33 CFR159.309, as well as overlap regarding the number of vessels that currently practice specific BMPs. The American Waterways Operators, within the public comments, stated that all towing vessels currently use environmentally friendly detergents.

The population potentially affected by BMPs applicable to the graywater discharge category is shown in *Table 6-25*.

Vessel Class	Non-Oceangoing Vessel Count ^b	Oceangoing Vessel Count	Total Vessel Count
Commercial Fishing	2,197	25,814	28,011
Freight Barges	0	0	0
Freight Ships	112	555	667
Passenger Vessels	1,688	9,682	11,370
Recreational Ships ^a	278	643	921
Tank Barges	0	0	0
Tank Ships	13	129	142
Utility Vessels	5,697	4,990	10,687
TOTAL	9,985	41,813	51,798

a Includes only recreational ships ≥ 79 feet in length or ≥ 300 in gross tonnage.
b Includes vessels operating on the Great Lakes, Mississippi River, and intracoastal waterways.

Permit Requirements

Permit Text:

All vessels must minimize the discharge of graywater while in Port. For those vessels that cannot store graywater, the owner or operator and their crews should minimize the production of graywater in Port. All vessels that have the capacity to store graywater shall not discharge that graywater in waters of exceptional value. For vessels that cannot store graywater, vessel operators must minimize the production of graywater while in waters of exceptional value.

For vessels greater than 400 gross registered tons that regularly travel more than 1 nm from shore that have the capacity to store graywater for a sufficient period, graywater must be discharged greater than 1 nm from shore while the vessel is underway. Additional specific requirements for Graywater apply to Cruise Vessels and Large Ferries.

If graywater will be discharged in waters subject to this permit, the introduction of kitchen oils must be minimized to the graywater system. When cleaning dishes, you must remove as much food and oil residue as practicable

before rinsing dishes. Oils used in cooking shall not be added to the graywater system. Oil from the galley and scullery shall not be discharged in quantities that may be harmful

Vessel owner/operators must use phosphate free and non-toxic soaps and detergents for any purpose if they will be discharged into waters subject to this permit. These detergents must be free from toxic or bioaccumulative compounds and not lead to extreme shifts in receiving water pH.

If you are underway in a nutrient impaired water, or a water that is impaired as a result of nutrient enrichment (such as waters listed as impaired for phosphorus, nitrogen, or for hypoxia or anoxia (low dissolved oxygen concentrations)) you must follow the following additional steps:

When the vessel has adequate graywater storage capacity, the vessel owner/operator shall not discharge graywater into nutrient impaired waters subject to this permit (e.g., the Chesapeake Bay or Puget Sound). A complete list of such waters can be found at www.epa.gov/npdes/vessels. Where the vessel does not have adequate storage capacity to eliminate such discharges, graywater production and discharge must be minimized in such waters. Any such discharge must be conducted while the vessel is underway in areas with significant circulation to the extent feasible. Graywater stored while in such waters can later be disposed of on shore or discharged in accordance with the other requirements of this permit.

Estimates of Cost

Based upon survey responses, practices associated with graywater involve no incremental cost. The majority of vessels (excluding passenger vessels) produce little to no graywater. Thus, they are not able to store their graywater in appropriate tanks. Instead, they produce and discharge graywater simultaneously. Commercial fishing vessels, unable to store graywater, discharge while underway and usually while in waters with an ability to dilute concentrations of detergents, soaps, and pathogens. A survey response from a ferry company indicated that the company's vessels discharge all graywater onshore at appropriate facilities.

Furthermore, based upon outside research and communication with a vendor, there is no incremental cost associated with the purchase of phosphate free soaps or detergents. There are varied prices among high and low end products. However, there is enough variability among prices that a vessel could opt for a standard phosphate free product in lieu of a high end non-phosphate free product.

6.2.17 Motor Gasoline and Compensating Discharge

Affected Vessel Population

The costs incurred in this discharge category are assumed to be negligible and/or the industry is assumed to currently practice the Permit requirements. Thus, the vessel population that would apply to this Permit was not estimated since no vessels are expected to experience any cost.

Permit Requirements

Permit Text:

The discharge of motor gasoline and compensating effluent must have oil concentrations of less than 15 ppm as measured by EPA Method 1664. Minimize discharge of motor gasoline and compensating discharge in port. Vessels shall not discharge motor gasoline and compensating discharge in waters of exceptional value.

Estimates of Cost

No requirements within this discharge category require cost analysis because these practices are assumed to have negligible costs and/or the industry is assumed to currently practice the Permit requirements.

6.2.18 Non-Oily Machinery Wastewater

Affected Vessel Population

The costs incurred in this discharge category are assumed to be negligible and/or the industry is assumed to currently practice the Permit requirements. Thus, the vessel population that would apply to this Permit was not estimated since no vessels are expected to experience any cost.

Permit Requirements

Permit Text:

The discharge must be free from oils and any additives that are toxic or bioaccumulative in nature.

Estimates of Cost

No requirements within this discharge category require cost analysis because these practices are assumed to have negligible costs and/or the industry is assumed to currently practice the Permit requirements.

6.2.19 Refrigeration and Air Condensate Discharge

Affected Vessel Population

The costs incurred in this discharge category are assumed to be negligible and/or the industry is assumed to currently practice the Permit requirements. Thus, the vessel population that would apply to this Permit was not estimated since no vessels are expected to experience any cost.

Permit Requirements

Permit Text:

You must not allow refrigeration and air condensate discharge to come into contact with oily or toxic materials.

Estimates of Cost

No requirements within this discharge category require cost analysis because these practices are assumed to have negligible costs and/or the industry is assumed to currently practice the Permit requirements.

6.2.20 Rudder Bearing Lubrication Discharge

Affected Vessel Population

The costs incurred in this discharge category are assumed to be negligible and/or the industry is assumed to currently practice the Permit requirements. Thus, the vessel population that would apply to this Permit was not estimated since no vessels are expected to experience any cost.

Permit Requirements

Permit Text:

The protective hull seal on rudder bearings must be maintained in good operating order to prevent the leaking of lubricating oil.

Estimates of Cost

No requirements within this discharge category require cost analysis because these practices are assumed to have negligible costs and/or the industry is assumed to currently practice the Permit requirements.

6.2.21 Seawater Cooling Overboard Discharge

Affected Vessel Population

The costs incurred in this discharge category are assumed to be negligible and/or the industry is assumed to currently practice the Permit requirements. Thus, the vessel population that would apply to this Permit was not estimated since no vessels are expected to experience any cost.

Permit Requirements

Permit Text:

When possible, seawater cooling overboard should be discharged when the vessel is underway so that any thermal impacts are dispersed.

EPA recommends that vessel owner/operators use shore based power when the vessel is in port if:

- *Shore power is readily available for vessel owner/operators from utilities or port authorities;*
- *Shore based power supply systems are capable of providing all needed electricity required for vessel operations; and*
- *The vessel is equipped to connect to shore-based power and such systems are compatible with the available shore power.*

Maintenance of all piping and seawater cooling systems must meet the requirements.

Estimates of Cost

No requirements within this discharge category require cost analysis because these practices are assumed to have negligible costs and/or the industry is assumed to currently practice the Permit requirements.

6.2.22 Seawater Piping Biofouling Prevention

Affected Vessel Population

The costs incurred in this discharge category are assumed to be negligible and/or the industry is assumed to currently practice the Permit requirements. Thus, the vessel population that would apply to this Permit was not estimated since no vessels are expected to experience any cost.

Permit Requirements

Permit Text:

Seawater piping biofouling chemicals subject to FIFRA registration (see 40 CFR 152.15) must be used in accordance with their FIFRA label. No pesticides or chemicals banned for use in the United States may be discharged into waters subject to this permit.

Vessel owner/operators must use the minimum amount of biofouling chemicals needed to keep fouling under control. Discharges containing active agents must contain as little chlorine as possible.

Vessel owner/operators must remove fouling organisms from seawater piping on a regular basis and dispose of removed substances in accordance with local, State, and federal regulations. Removed fouling organisms shall not be discharged into waters subject to this permit and EPA recommends that if discharged into waters, should be discharged more than 50 nm from shore. Vessel owner/operators should remove any organisms while at sea to reduce the risk of invasive species introduction in ports.

Estimates of Cost

No requirements within this discharge category require cost analysis because these practices are assumed to have negligible costs and/or the industry is assumed to currently practice the Permit requirements.

6.2.23 Small Boat Engine Wet Exhaust

Affected Vessel Population

The costs incurred in this discharge category are assumed to be negligible and/or the industry is assumed to currently practice the Permit requirements. Thus, the vessel population that would apply to this Permit was not estimated since no vessels are expected to experience any cost.

Permit Requirements

Permit Text:

Vessels generating wet exhaust must be maintained in good operating order, well tuned, and functioning according to manufacturer specifications to decrease pollutant contributions to wet exhaust. Vessel owner/operators should use low sulfur or alternative fuels for their vessels to reduce the concentration of pollutants in their discharge.

EPA encourages vessel operators to consider four stroke versus two stroke engines for vessels covered under this permit. Use of a four stroke engine may minimize the discharge of pollutants to US waters.

Estimates of Cost

No requirements within this discharge category require cost analysis because these practices are assumed to have negligible costs and/or the industry is assumed to currently practice the Permit requirements.

6.2.24 Sonar Dome Discharge

Affected Vessel Population

The costs incurred in this discharge category are assumed to be negligible and/or the industry is assumed to currently practice the Permit requirements. Thus, the vessel population that would apply to this Permit was not estimated since no vessels are expected to experience any cost.

Permit Requirements

Permit Text:

The water inside the sonar dome shall not be discharged within waters subject to this permit for maintenance purposes. Vessel operators should not use biofouling chemicals that are bioaccumulative for the exterior of sonar domes when other viable alternatives are available.

Estimates of Cost

No requirements within this discharge category require cost analysis because these practices are assumed to have negligible costs and/or the industry is assumed to currently practice the Permit requirements.

6.2.25 Stern Tube Oily Discharge

Affected Vessel Population

The costs incurred in this discharge category are assumed to be negligible and/or the industry is assumed to currently practice the Permit requirements. Thus, the vessel population that would apply to this Permit was not estimated since no vessels are expected to experience any cost.

Permit Requirements

Permit Text:

You must maintain your sterntube seals so that there is no leakage of lubricating oil into the surrounding waters. Minimize maintenance activities on sterntube seals when a vessel is outside of drydock. If emergency repair must occur when the vessel is in water, an oil boom must be used to contain any lubricating oil leakage. Operators of the vessel must have appropriate equipment such as oil absorbent pads on hand to clean any potential oil spills.

Estimates of Cost

No requirements within this Discharge category require cost analysis because these practices are assumed to have negligible costs and/or the industry is assumed to currently practice the Permit requirements.

6.2.26 Underwater Ship Husbandry Discharges

Affected Vessel Population

Based on the description of practices within this discharge category, the subset of vessels that would apply to practices in underwater ship husbandry was determined. The industry is assumed to currently practice the Permit

requirements. However, the vessel population that would apply to this Permit was estimated since some of these vessels may follow the recommendation to use vacuum control technologies.

The population potentially affected by BMPs applicable to discharges in the underwater ship husbandry category is shown in *Table 6-26*.

Vessel Class	Vessel Count
Commercial Fishing	0
Freight Barges	0
Freight Ships	0
Passenger Vessels	11,521
Recreational Ships ^a	926
Tank Barges	0
Tank Ships	0
Utility Vessels	0
TOTAL	12,447

^a Includes only recreational ships ≥79 feet in length or ≥300 in gross tonnage.

Permit Requirements

Permit Text:

Vessel owner/operators must minimize the transport of attached living organisms when they travel into U.S. waters from outside the U.S. economic zone or when traveling between COTP zones.

Whenever possible, hull-cleaning activities should take place in drydock, or another land-based facility where the removal of fouling organisms or spent antifouling coatings paint can be contained. If water-pressure based systems are used to clean the hull and remove old paint, use facilities which treat the washwater prior to discharge to remove the antifouling compound(s) and fouling growth from the washwater.

Vessel owner/operators who remove fouling organisms from hulls while the vessel is waterborne must employ methods that minimize the discharge of fouling organisms and antifouling hull coatings. These shall include:

- *Selection of appropriate cleaning brush or sponge rigidity to minimize removal of antifouling coatings and biocide releases into the water column.*
- *Limiting use of hard brushes and surfaces to the removal of hard growth.*
- *When available and feasible, use of vacuum control technologies to minimize the release or dispersion of antifouling hull coatings and fouling organisms into the water column.*

Cleaning of copper based antifoulant paints must not result in any visible cloud or plume of paint in the water: if a visible cloud or plume of paint develops, shift to a softer brush or less abrasive cleaning technique. Production of a visible cloud or plume of paint containing copper antifoulant paint is a permit violation.

Vessels that use copper based anti-fouling paint must not clean the hull in copper impaired waters within the first 365 days after paint application unless there is a significant visible indication of hull fouling.

Estimates of Cost

Since practices associated with underwater ship husbandry are contracted to diving companies, information gathered from diving companies is most useful. According to communication with a diving company based in

Florida (Seacor, 2008), it is standard to clean the hull using the appropriate Permit standards. It is also standard to use vacuum brushes to clean the hull. However, vacuum control technologies that completely avoid the release of hull coatings and organisms into the water column are not readily available to most diving companies because the cost of renting this advanced technology is near \$1 million per cleaning. Thus, this practice is only recommended, not required.

The additional BMPs within this discharge category are currently practiced by the contracted diving companies. Therefore, the costs incurred for the additional BMPs are currently negligible. In general, the BMPs associated with underwater hull husbandry are applicable to the diving companies contracted by the vessel company. The practices that they perform to clean the hull depend on the hull's condition. The diving company gave an average cost of \$25,000 to \$35,000 to perform underwater hull cleaning for a large cruise ship. This price is dependent on the dive depth as well as other technologies that are necessary for hull cleaning.

6.2.27 Welldeck Discharges

Affected Vessel Population

The costs incurred in this discharge category are assumed to be negligible and/or the industry is assumed to currently practice the Permit requirements. Thus, the vessel population that would apply to this Permit was not estimated since no vessels are expected to experience any cost.

Permit Requirements

Permit Text:

Welldeck discharges that contain graywater from smaller vessels should not be discharged within waters subject to this permit except in cases of emergency. Welldeck discharges from washdown of gas turbine engines may not be discharged within waters subject to this permit. Welldeck discharges from equipment and vehicle washdowns must be free from garbage and must not contain oil in quantities that may be harmful.

Estimates of Cost

No requirements within this discharge category require cost analysis because these practices are assumed to have negligible costs and/or the industry is assumed to currently practice the Permit requirements.

6.2.28 Graywater Mixed with Sewage from Vessels

Affected Vessel Population

The costs incurred in this discharge category are assumed to be negligible and/or the industry is assumed to currently practice the Permit requirements. Thus, the vessel population that would apply to this Permit was not estimated since no vessels are expected to experience any cost.

Permit Requirements

Permit Text:

The commingled discharge of graywater mixed with sewage from vessels must comply with the effluent limits for graywater discharge in Part 2 or Part 5 of this permit if applicable. Though not a requirement of this permit,

vessel owner/operators are advised that all discharges commingled with sewage must meet the requirements set forth in section 312 of the Clean Water Act and its implementing regulations.

Estimates of Cost

No requirements within this discharge category require cost analysis because these practices are assumed to have negligible costs and/or the industry is assumed to currently practice the Permit requirements.

6.2.29 Exhaust Gas Scrubber Washwater Discharge

Affected Vessel Population

The costs incurred in this discharge category are assumed to be negligible because of the limited number of vessels producing this discharge. Thus, the complete vessel population that would apply to this Permit was not estimated since a limited number of vessels, if any, are expected to experience any incremental cost.

Permit Requirements

Permit Text:

Exhaust gas scrubber washwater discharge must not contain oil, including oily mixtures, in quantities that may be harmful. Sludge generated from exhaust gas scrubber washwater discharge must not be discharged in waters subject to this permit.

Estimates of Cost

EPA believes that these limits and BMPs are reasonable for the proposed Commercial Vessel General Permit and do not require cost analysis because the current volume of exhaust gas scrubber washwater discharge is low due to the limited number of vessels utilizing exhaust gas cleaning systems. At this time, EPA is aware of only one vessel that sails in U.S. waters and uses this technology.

6.3 Per-Vessel Costs for Vessel-Specific Requirements

6.3.1 Large and Medium Cruise Ships

Affected Vessel Population

The population estimate shown in *Table 6-27* is provided by Cruise Lines International Association (CLIA). The large cruise ship count is based upon the 500+ passenger/crew capacity classification, and the medium cruise ship count is based upon the 250–499 passenger/crew capacity classification. However, since the medium cruise ship classification based upon the 100–499 passenger/crew capacity, the count of the medium cruise ships is an understatement.

Table 6-27: Cruise Ship Counts			
Vessel Class^a	Alaskan Certified Cruise Ships	Non- Alaskan Certified Cruise Ships	Total Count
Large Cruise Ships	30	113	143
Medium Cruise Ships ^c	0	32	32
TOTAL	30	145	175^b

a Cruise ships fall within the passenger vessels category.

b This count is based upon CLIA populations. There may be an additional 5% that are non-CLIA members.

c The medium cruise ship classification is based upon the 250-499 passenger/crew capacity classification. However, based on preliminary data provided by CLIA, there are not many cruise ships within the 100-249 passenger/crew capacity classification. Thus, this number is only a slight understatement.

Permit Requirements

Permit Sections Summary:

Sculleries and Galleys:

Cruise ship operators must use detergents that are phosphate free. Degreasers must be non-toxic if they will be discharged as part of any waste stream.

Hazardous Waste

Waste from mercury containing products, dry cleaners or dry cleaner condensate, photo processing labs, medical sinks or floor drains, salon and day spa sinks and floor drains, chemical storage areas, and print shops using traditional or non-soy based inks and chlorinated solvents must be prevented from entering the ship's graywater, blackwater, or bilgewater systems if water from these systems will ever be discharged into waters subject to this permit. Preventing these wastes from entering these systems can be accomplished by plugging all drains that flow to the graywater, blackwater, or bilge systems in areas where these wastes are produced and creating alternate waste receptacles or replumbing drains to appropriate holding tanks.

Discharge Standards:

Pierside Limits: While pierside, appropriate reception facilities for graywater must be used, if reasonably available.

Operational Limits: While operating within 1 nm of shore discharges of graywater are prohibited. If you operate within 3 nm of shore, discharges of graywater must either be released while the Cruise Ship is sailing at a speed of at least 6 knots and is not a water listed in Part 12.1 of the Permit (waters federally protected wholly or in part for conservation purposes).

Nutrient Impaired Water Limits: If large cruise ships are operating in nutrient impaired waters including the Chesapeake Bay, Puget Sound or the territorial Sea surrounding the mouth of the Mississippi River in the Gulf of Mexico, untreated graywater discharges must not occur. If the large cruise ship has sufficient holding capacity, they must not discharge any graywater in nutrient impaired, otherwise they must treat to standards listed in the permit. If medium cruise ships are operating in nutrient impaired waters, these ships must hold the graywater if they have sufficient capacity. Otherwise, untreated graywater discharges can only occur while sailing at a speed of at least 6 knots.

Monitoring Requirements: The owner/operator must maintain records estimating all discharges of untreated graywater into waters subject to this permit, including date, location and volume discharged in their recordkeeping documentation. These records can be maintained as part of the vessel's sewage and graywater discharge record book. If vessels will discharge treated graywater into waters within 1 nm of shore, or within 3 nm of shore and sailing less than 6 knots, they must conduct analytical monitoring.

Treatment Standards:

Treatment System Standard: The discharge of treated Graywater must meet the following standards:

1. *The discharge must satisfy the minimum level of effluent quality specified in 40 CFR 133.102;*
2. *The geometric mean of the samples from the discharge during any 30-day period may not exceed 20 fecal coliform/100 milliliters (ml) and not more than 10 percent of the samples exceed 40 fecal coliform/100 ml; and*
3. *Concentrations of total residual chlorine may not exceed 10.0 micrograms per liter ($\mu\text{g/l}$);*

Monitoring Requirements: Prior to entering waters of the U.S., vessel operators must demonstrate that they have an effective treatment system that complies with the graywater treatment standards if they will discharge graywater:

- *within 1 nm of shore, or*
- *within 3 nm of shore and sailing less than 6 knots*

In order to demonstrate the effectiveness of the treatment system, the vessel operator must take at least five samples taken from the vessel on different days over a 30-day period that are representative of the treated effluent to be discharged. Samples must be taken for BOD, suspended solids, pH, and total residual chlorine. Sampling and testing shall be conducted according to 40 CFR Part 136. After demonstrating the effectiveness of their system, vessel owner/operators must conduct the same sampling and analysis twice each year to demonstrate treatment equipment maintenance and compliance. Records of the sampling and testing results must be retained onboard for a period of 3 years in the vessels recordkeeping documentation.

Unless the Owner/operators meets the conditions in the following paragraph, they must submit data showing that the graywater standards are achieved by their treatment system to EPA, 1200 Pennsylvania Ave., MC 4203M, Washington, DC 20460. Initial sampling data must be submitted at least 7 days before entering waters subject to this permit. Maintenance monitoring data must be submitted at least once per year within 30 days of the second sample collection.

Educational and Training Requirements:

The crews of cruise ships play a key role in minimizing the discharge of pollutants from cruise ship operations and passengers. Therefore cruise ship operators are subject to the following requirements:

- *The ship's crew must receive training regarding shipboard environmental procedures and must be able to demonstrate proficiency in implementing these procedures.*
- *Advanced training in shipboard environmental management procedures must be provided for those directly involved in managing specific discharge types or areas of the ship and these crew must be able to demonstrate proficiency in implementing these procedures.*
- *Appropriate reprimand procedures must be developed for staff whose actions lead to violations of any effluent limit set forth in this permit or procedures established by the Cruise Ship operator to minimize the discharge of pollutants.*

Cruise ships must also educate passengers on their potential environmental impacts. The goals of these education efforts should include preventing trash from entering any waste stream, eliminating the addition of unused soaps, detergents, and pharmaceuticals to the graywater or blackwater systems and minimizing production of graywater. This can be accomplished in a variety of ways including, but not limited to posting signage and informational material in guestrooms and common areas, incorporating environmental information passenger orientation presentations or packages at the start of cruises, incorporating this information into additional lectures and seminars, or broadcasting information via loudspeakers.

Estimates of Cost

The majority of the BMPs associated with cruise ship graywater management are already practiced by the cruise ship industry. The cruise line members (including both large and medium cruise ships) of CLIA—approximately 95 percent of the entire cruise line industry—adhere to the CLIA industry standard for certain BMPs, including preventing hazardous waste from photo processing labs, dry cleaners or dry cleaner condensate, and print shops from entering the ship’s graywater system. Furthermore, according to a CLIA industry representative based on survey response, nearly all of the other practices associated with the Permit standards are already practiced by the cruise line industry:

Pierside and Operational Limits: These discharge standards associated with the Permit involve no incremental cost because the both large and medium cruise ships have sufficient holding capacity to avoid discharging within 1 nm from shore. Discharges within 3 nm from shore currently undergo graywater treatment or are discharged while the ship is sailing at a speed of at least 6 knots. Furthermore, regarding the Permit specifications, according to an industry representative, reception facilities for graywater are very rare and are not commonplace even at major ports.

Limits Applicable to Operation in Nutrient Impaired Waters: These limits are applicable to only a subset of large cruise ships: those that operate in these waters whose graywater holding capacity is exceeded due to the voyage length. These cruise ships will be required to treat the graywater prior to discharge. Thus, the incremental cost associated with this practice is the cost of installing a graywater treatment system for a subset of large cruise ships. This cost is based upon EPA information gathered as part of its evaluation of standards for discharges of sewage and graywater from cruise ships operating in Alaska. Based upon these data, an average cost per passenger (including crew), per season, for installing a graywater treatment system is \$7.09. This cost is applied to the preliminary average large cruise ship passenger/crew capacity of 3,211 to derive an average annual incremental cost per cruise ship of installing a graywater treatment system: \$22,765.99. According to preliminary estimates from an industry representative, the population of large cruise ships that will need to install a graywater treatment system due to discharge in nutrient impaired waters is 30. Thus, the total annual incremental cost for this requirement is \$683,022.24. The total cost associated with these large cruise ships is detailed in *Table 6-28*. These population estimates, as well as the average number of passengers and crew, is subject to change based on further communication with the CLIA representative.

Table 6-28: Cruise Ship Costs Associated with the Purchase of a Graywater Treatment System

Vessel Class	Total Number of Vessels	Incremental Number of Vessels that need to Purchase a Graywater Treatment System	Annual Cost per Passenger and Crew	Average Number of Passengers and Crew	Total Cost
Large Cruise Ships	113	30	\$7.09	3,211	\$683,022.24
Medium Cruise Ships	0	0	\$7.09	557	\$0.00
TOTAL	113	30			\$683,022.24

Medium cruise ships will incur no incremental cost associated with this practice since the Permit standards are currently practiced. These ships have the option to discharge graywater in nutrient impaired waters while sailing at a speed of at least 6 knots. Since this is already an industry standard, according to the CLIA representative, there is no incremental cost associated with this Permit requirement.

Sculleries and Galleys: Based upon industry communication as well as outside research with a vendor, EPA has found that there is no incremental cost of purchasing phosphate free soaps and non-toxic degreasers in lieu of standard soaps and degreasers. There are varied prices among high and low end products. However, there is enough variability among prices that a ship could opt for a standard phosphate free/non-toxic product in lieu of a

high end, non-phosphate free/toxic product. Also, the industry representative was not able to provide the percentage of large or medium ships that use these phosphate free/non-toxic products or the annual average number of gallons that are purchased by a ship. However, since there is no incremental cost associated with purchasing the phosphate free/non-toxic products, it is unnecessary to determine the population of ships to which this Permit requirement would apply.

Hazardous Waste: CLIA industry standards, as mentioned previously, already account for the Permit practices associated with some of the waste sources. Furthermore, based on communication with a CLIA representative, the other source drains (medical, salon, and chemical sources) are currently either replumbed to appropriate holding tanks, or are plugged and alternative waste receptacles are used. Thus, there is no incremental cost associated with this Permit standard for both large and medium cruise ships.

Untreated Graywater Documentation: Based on communication with a CLIA representative, documentation of these discharges is common practice. Thus, there is no incremental cost associated with this Permit standard for both large and medium cruise ships.

Monitoring: Sampling and analysis cost estimates of treated graywater are based upon communication with a CLIA representative and a field expert. The cost associated with one sampling event is approximately \$1,000 per ship. The actual cost of testing an individual sample, such as for biochemical oxygen demand (BOD), is low (approximately \$50–\$100); however, there is much more cost involved with the administration, setup, quality control, reporting, etc., of the actual sampling event. Furthermore, most non-Alaskan cruise ships would need to perform the samplings and have them sent to labs at foreign ports. Sampling costs at foreign ports are considerably higher than at domestic ports. Due to the varied itineraries of cruise ships, there can be wide variability among the cost of a sampling event—\$1,000 per sampling event is an average provided by the industry.

The sampling event accounts for the testing of each of the four chemicals (i.e., BOD, suspended solids, pH, and total residual chlorine). The Permit specifications call for five sampling events over a 30-day period, twice a year. Thus, ten sampling events per ship must occur on an annual basis. Based upon the \$1,000 average sampling cost, an annual incremental cost per ship of \$10,000 is estimated for both large and medium cruise ships that have a standard graywater treatment system and do not currently follow the Permit monitoring requirements. According to preliminary estimates from an industry representative, the population of large and medium cruise ships that will incur this incremental cost is 45. Thus, the total annual incremental cost for both large and medium cruise ships is \$450,000. *Table 6-29* details the cost estimates. These population estimates are subject to change based on further communication with the CLIA representative.

Table 6-29: Cruise Ship Costs Associated with Sampling

Vessel Class	Total Number of Vessels	Incremental Number of Vessels that need to Perform Sampling	Annual Cost per Vessel	Total Cost
Large Cruise Ships	113	40	\$10,000.00	\$400,000.00
Medium Cruise Ships	0	5	\$10,000.00	\$50,000.00
TOTAL	113	45		\$450,000.00

Educational and Training Requirements: The required training in environmental procedures and the additional requirement to educate passengers is already provided and performed by cruise ships as a CLIA standard. Thus, there is no incremental cost.

6.3.2 Large Ferries

Affected Vessel Population

The population of vessels associated with large ferries is currently unknown pending finalization of the large ferry definition.

Permit Requirements

Permit Text:

Large ferries may not discharge untreated below deck water from parking areas or other storage areas for motor vehicles or other motorized equipment into waters subject to this permit without first treating the effluent with an oily water separator or other appropriate device. Large ferry operators must use oil absorbent cloths to clean oily spills or substances from deck surfaces. Any effluent created by washing the decks may not be discharged into the waters subject to this permit listed in Part 12.1.

Pierside Limits – While pierside, appropriate reception facilities for Graywater must be used, if reasonably available. If such facilities are not reasonably available, you must hold the graywater if the vessel has the holding capacity and discharge the effluent while the vessel is underway. Appropriate reception facilities are those authorized for use by the port authority or municipality and that treat the discharge in accordance with its NPDES permit.

Operational Limits – If you operate within 3 nm from shore, discharges of graywater must be released while the ferry is sailing at a speed of at least 6 knots if feasible.

Educational and Training Requirements:

The crews of ferries play a key role in minimizing the discharge of pollutants from ferry operations and its passengers. Therefore ferry operators are subject to the following requirements:

- *The ship's crew must receive training regarding shipboard environmental procedures and must be able to demonstrate proficiency in implementing these procedures.*
- *Advanced training in shipboard environmental management procedures must be provided for those directly involved in managing specific discharge types or areas of the ship and these crew must be able to demonstrate proficiency in implementing these procedures.*
- *Appropriate reprimand procedures must be developed for crew whose actions lead to violations of any effluent limit set forth in this permit or procedures established by the Cruise Ship operator to minimize the discharge of pollutants.*

Ferry operators must also educate passengers on their potential environmental impacts. The goals of these education efforts should include eliminating the discharge of trash overboard, minimizing the production of trash from parking areas or other storage areas, eliminating the addition of unused soaps, detergents, and pharmaceuticals to the graywater or blackwater systems, minimizing production of graywater. This can be accomplished in a variety of ways including, but not limited to posting signage and informational material in common areas, incorporating environmental information into orientation presentations, or broadcasting information via loudspeakers.

Estimates of Cost

Based upon the above Permit requirements, costs were not further analyzed for these BMPs since the costs are expected to be negligible. Furthermore, if graywater requirements are introduced into the Permit, based upon an industry response from a ferry company, graywater is always disposed of onshore at appropriate facilities. Thus, costs regarding graywater BMPs were not further analyzed in this analysis since these costs are also expected to be negligible.

6.3.3 Barges

Affected Vessel Population

The population of vessels associated with river barges is shown in *Table 6-30*.

Vessel Class	Vessel Count
Commercial Fishing	0
Freight Barges	26,638
Freight Ships	0
Passenger Vessels	0
Recreational Ships ^a	0
Tank Barges	3,856
Tank Ships	0
Utility Vessels	0
TOTAL	30,494

a Includes only recreational ships ≥ 79 feet in length or ≥ 300 in gross tonnage.

Permit Requirements

Permit Text:

Additional Effluent Limits

Barges must minimize the contact of below deck condensation with oily or toxic materials, and any materials containing hydrocarbon. Whenever barges are pumping water from below deck, the discharge shall not contain oil in quantities that may be harmful. If a visible sheen is noted, vessel operators must initiate corrective action and meet recordkeeping requirements.

All tank barges must have spill rails and must plug their scuppers before any cargo operations. If any spills result during loading or unloading of cargo, vessel owner/operators must completely clean up spills or residue before scuppers are unplugged. Once all spills and residue have been cleaned, scuppers may be unplugged.

Vessel owner/operators must clean out cargo residues such that any remaining residue is minimized before washing the cargo compartment or tank and discharging wash water overboard.

Supplemental Inspection Requirements

After every instance of pumping water from areas below decks, or immediately following washing down the decks, you must conduct a visual sheen test. The visual sheen test is used to detect free oil by observing the surface of the receiving water for the presence of an oily sheen. The operator should focus the inspection on the area surrounding the vessel where discharges from below deck or deck washings are discharged into the receiving water. If a visible sheen is observed, you must initiate corrective actions and meet recordkeeping requirements.

Estimates of Cost

Costs were not analyzed in this analysis since the costs are expected to be negligible.

6.3.4 Oil Tankers or Petroleum Tankers

Affected Vessel Population

The population of vessels associated with oil or petroleum tankers is shown in *Table 6-31*.

Vessel Class	Vessel Count
Commercial Fishing	0
Freight Barges	0
Freight Ships	0
Passenger Vessels	0
Recreational Ships ^a	0
Tank Barges	0
Tank Ships	147
Utility Vessels	0
TOTAL	147

a Includes only recreational ships ≥ 79 feet in length or ≥ 300 in gross tonnage.

Permit Requirements

Permit Text:

The requirements for research vessels apply to vessel discharges from Oil Tankers or Petroleum tankers. Furthermore, oil tanker or petroleum tanker operators must comply with 33 CFR 157.10d (requiring a double hull) and 33 CFR 155.310.

Additional Authorized Discharges

For vessels which require an inert gas system, the effluent produced from inert gas scrubbers may be discharged into waters subject to this permit.

The discharges of water from deck seals are authorized when such seals are installed as an integral part of an IGS system.

Supplemental Authorized Discharges

Operators of oil tankers must plug scuppers during cargo loading and unloading operations to prevent the discharge of oil into waters subject to this permit. Any oil spilled must be cleaned with oil absorbent cloths or another appropriate approach.

Vessel operators must minimize the discharge of effluent produced from inert gas scrubbers if feasible for their vessel design.

Supplemental Inspection Requirements

After every instance of loading or unloading operations or immediately following washing down the decks, you must conduct a visual sheen test. The visual sheen test is used to detect free oil by observing the surface of the receiving water for the presence of an oily sheen. The owner/operator should focus the inspection on the area

surrounding the vessel where effluent from loading operations or deck washings discharge into the receiving water. If a visible sheen is observed, you must comply with all requirements contained in this permit and initiate corrective actions.

Educational and Training Requirements

The crews of oil tankers play a key role in minimizing the discharge of pollutants from vessel operations. Therefore oil tanker operators are subject to the following requirements:

- The ship’s crew must receive training regarding shipboard environmental procedures and must be able to demonstrate proficiency in implementing these procedures.
- Advanced training in shipboard environmental management procedures must be provided for those directly involved in managing specific discharge types or areas of the ship and these crew must be able to demonstrate proficiency in implementing these procedures.
- Appropriate reprimand procedures must be developed for staff actions that lead to violations of any effluent limit set forth in this permit or procedures established by the vessel operator to minimize the discharge of pollutants.

Estimates of Cost

Costs were not analyzed in this analysis since the costs are expected to be negligible.

6.3.5 Research Vessels

Affected Vessel Population

The population of vessels associated with research vessels is shown in *Table 6-32*.

Table 6-32: Vessel Counts for BMPs Associated with Research Vessels	
Vessel Class	Vessel Count
Commercial Fishing	0
Freight Barges	0
Freight Ships	0
Passenger Vessels	0
Recreational Ships ^a	0
Tank Barges	0
Tank Ships	0
Utility Vessels	233
TOTAL	233

a Includes only recreational ships ≥79 feet in length or ≥300 in gross tonnage.

Permit Requirements

Permit Text:

Supplemental authorized discharges

In addition to the discharges incidental to the normal operation of a vessel authorized elsewhere in this permit, owner/operators of research vessels are authorized to discharge tracers (dyes, fluorescent beads, SF6), drift cards, tracking devices and the like, and expendable bathythermograph (XBT) probes, into waters subject to this

permit, provided such discharges are for the sole purpose of conducting research on the aquatic environment or its natural resources in accordance with generally recognized scientific methods, principles, or techniques.

Additional Effluent Limits

Owner/operators of research vessels must discharge only the minimal amount of materials necessary to conduct research.

Estimates of Cost

Costs were not analyzed in this analysis since the costs are expected to be negligible.

6.3.6 Rescue Boats

Affected Vessel Population

The population of vessels associated with rescue boats is currently unknown.

Permit Requirements

Permit Text:

Supplemental authorized discharges

In addition to the discharges incidental to the normal operation of a vessel authorized elsewhere in this permit, vessel owner/operators of rescue boats are authorized to discharge waste streams in conjunction with training, testing, and maintenance operations, provided that they comply with all additional requirements of the Clean Water Act (e.g. section 311) and the National Contingency Plan (40 CFR 300). This section does not relieve vessel operators of any additional responsibilities under the CWA and the National Contingency Plan which prohibits the discharge of oil for research or demonstration purposes without Administrator approval. The use of foaming agents for oil or chemical fire response must be implemented in accordance with the National Contingency Plan (40 CFR 300).

Additional Effluent Limits

Owner/Operators are strongly encouraged to seek alternative formulations of AFFF that are less harmful to the aquatic environment, such as non-fluorinated foam, while maintaining their effectiveness in emergency operations. Furthermore, operators are encouraged to not use AFFF or discharge toxic substances in areas near active commercial or recreational fisheries, near swimmable waters, or in high traffic areas for maintenance or training purposes. Rescue vessel owner/operators are also encouraged to perform training, testing, and maintenance operations outside of port and as far from shore as possible. The use of foaming agents for oil or chemical fire response, and the control of their discharge from a vessel, must be implemented in accordance with the National Contingency Plan (40 CFR 300).

Estimates of Cost

Costs were not analyzed in this analysis since the costs are expected to be negligible.

6.3.7 Vessels Employing Experimental Ballast Water Treatment Systems

Affected Vessel Population

The population of vessels associated with this vessel class is currently unknown.

Permit Requirements

Permit Text:

Authorization of Residual Biocides Associated with Experimental Ballast Water Treatment Systems

Some experimental ballast water treatment systems produce or use biocides as an agent to reduce living organisms present in the ballast water tank. In order to be eligible for coverage under this permit, any ballast water technology must not use any biocide that is a "pesticide" within the meaning of the Federal Insecticide, Fungicide, Rodenticide Act (7 U.S.C § 136 et seq.) unless that biocide has been registered for use in ballast water treatment under such Act. The requirement in the preceding sentence does not apply if such biocide is generated solely by the use of a "device," as that term is defined in the Federal Insecticide, Fungicide, and Rodenticide Act, on board the same vessel as the ballast water to be treated by the biocide.. In addition, if the ballast water treatment system will discharge biocide residuals or derivatives into waters subject to this permit, you must meet the following condition:

- *The discharge of Total Residual Chlorine (TRC) as a biocide or derivative may not exceed 100 micrograms per liter (µg/l). Any other biocides or derivatives may not exceed applicable water quality criteria listed in EPA's 1986 Quality Criteria for Water [the Gold Book], and any subsequent revision, at the point of ballast water discharge. Discharges of biocide residuals or derivatives must also meet monitoring requirements, and reporting and recordkeeping requirements; or*

In lieu of complying with these conditions, a vessel owner/operator may apply for an individual NPDES permit for ballast water discharges that contain residual biocides or derivatives used as part of an experimental treatment system.

Monitoring Requirements

If you meet or expect to meet the conditions described above, you must conduct monitoring of the vessel ballast water discharge for any residual biocides or derivatives used in the treatment process to demonstrate compliance with the conditions in Part 5.8.1.1. For instance, if chlorine is the biocide used in the ballast water treatment, you must test for chlorine in the vessel ballast water discharge to see if it complies with the standards. If there are no Part 136 test methods for the residual biocide or derivatives of the residual biocide, you must seek coverage under an individual NPDES permit. In order to demonstrate that residual biocides or derivatives are in compliance with this permit, the vessel operator initially must take at least five (5) samples on different days over a 90-day period that are representative of the treated ballast water discharge. Each sample must be tested independently and the individual results must be reported and not averaged. Samples must be tested as soon as possible after sampling, and may not be held longer than recommended for each tested constituent as given in 40 CFR Part 136. Sampling and testing shall be conducted according to 40 CFR Part 136.

Records of monitoring information shall include:

- *The date, exact place, and time of sampling or measurements;*
- *The individual(s) who performed the sampling or measurements;*
- *The date(s) analyses were performed;*
- *The individual(s) who performed the analyses;*
- *The analytical techniques or methods used; and*
- *The results of such analyses.*

Thereafter, you must conduct maintenance sampling and analysis at least quarterly (4 times per year) of the vessel ballast water discharge in order to demonstrate continued compliance with the standards. If any of the initial or maintenance samples exceed the standards, then the owner/operator must immediately undertake steps necessary to achieve compliance and take and submit samples demonstrating such compliance or cease discharging and seek coverage under an individual permit, then the operator must seek coverage under an individual permit under a different part of this permit.

Additional Recordkeeping and reporting requirements

Records of the sampling and testing results must be retained onboard for a period of 3 years in the vessel's recordkeeping documentation.

You must submit your monitoring data to EPA HQ, Attn: Experimental Ballast Water Treatment System Test Results -Mail Code 4203M, 1200 Pennsylvania Ave., Washington DC 20460 at least once per year. For systems already in use as of the effective date of this permit, initial sampling data must be submitted within 6 months of this permit's effective date. For systems which are not already in use as of the effective date of this permit, initial sampling data must be submitted within 6 months of the system's first use. Maintenance monitoring data must be submitted at least once per year within 30 days of the final sample collection. Data must be submitted on Discharge Monitoring Reports available in Appendix I of this permit or submitted to EPA's e-reporting system available at [website will be listed upon permit finalization], which will be available within two years of finalization of this permit.

Estimates of Cost

Costs were not analyzed in this analysis since EPA is uncertain how many vessels may seek permit coverage under this provision. Due to the very low number of vessels using experimental ballast water treatment systems, the number of vessels affected will be quite small.

6.3.8 Uncertainties and Limitations

This analysis relies heavily on data provided by industry representatives in estimating the percentage of vessels that are practicing the BMPs required by the Permit under the baseline scenario and in estimating costs of individual BMPs. Although EPA believes that the industry representatives provided good faith estimates, their responses are based on either expert judgment or communication with selected firms within the industry and thus are subject to uncertainty. In addition, there is some incentive for representatives of industry to overstate costs.

Additional information was obtained from personal communications with the industry experts (e.g., David Peters), manufacturers (e.g., Dawg, Inc.) and a diving company (Seacor International). Because EPA made a limited number of contacts, the relevant estimates are likely to be subject to uncertainty.

In estimating the annual cost of ballast water exchange, this analysis assumes that the unit cost of ballast water exchange for the vessels with empty ballast tanks and the practices associated with developing a Ballast Water Management Plan are no different for the vessels for which it was applied within the USCG analysis. However, there may be considerable uncertainty associated with each cost component due to some differences in vessel characteristics to which these estimates applied (e.g., oceangoing vessels vs Pacific nearshore vessels or vessels in ballast vs vessels with empty tanks).

6.4 Permit Paperwork Burden

The permit paperwork burden is comprised of five potential cost inputs. Recordkeeping, routine inspections, and annual inspections are already required for these vessels. However, based on the introduction of the Permit best management practices, additional time for these tasks may be required. Therefore, for the high end estimates, EPA has estimated an additional amount of time required for these vessels for recordkeeping, routine inspections, and

annual inspections. The low end estimates assume that no additional time is required for these three practices. The two other components of the permit paperwork burden are the Notice of Intent filing (for a subset of vessels) and the one-time report requirement for all vessels. The time required for these practices is the same for both the high end and low end estimate since they are new requirements and will introduce costs to applicable vessels.

The additional time required for recordkeeping, routine inspections, and annual inspections varies according to vessel class. EPA is assuming that certain vessel classes are more likely to have a higher number of applicable discharge categories, and thus, a potentially higher number of Permit BMPs to perform. Thus, in *Table 6-33* EPA has assumed that the following are “large” and “small” vessels. For these three practices, large vessels have a greater time requirement than do small vessels. Furthermore, to calculate the total annual cost per vessel, EPA used the average labor rate provided by the industry survey responses of \$31.61.

Table 6-33: Vessel Class Breakdown	
Large Vessels	Small Vessels
Cruise Ships	Commercial Fishing
Freight Ships	Freight Barges
Tank Ships	Passenger Vessels
	Recreational Ships
	Utility Vessels
	Tank Barges

- **Recordkeeping:** Vessels are already required to keep extensive records. Since there are very few additional requirements that vessels must record, EPA is assuming a small incremental number of hours required for this practice. For the high end estimate, EPA assumes that 0.5 additional hours is annually required of small vessels, and 1 additional hour is annually required of large vessels. This practice is performed for five years. The detailed high end cost estimates are shown in *Table 6-34*. The low end total cost estimates are null.

Table 6-34: Recordkeeping Burden			
Vessel Class	Vessel Count	Total Burden Hours	Total Annual Cost ^a
Large Vessels - 1 Burden Hour			
Cruise Ships	175	175	\$5,532
Freight Ships	697	697	\$22,032
Tank Ships	147	147	\$4,647
Large Vessels TOTAL	1,019	1,019	\$32,211
Small Vessels - 0.5 Burden Hours			
Commercial Fishing	28,875	14,438	\$456,369
Freight Barges	32,842	16,421	\$519,068
Passenger Vessels ^b	11,346	5,673	\$179,324
Recreational Ships	926	463	\$14,635
Utility Vessels	10,761	5,381	\$170,078
Tank Barges	4,944	2,472	\$78,140
Small Vessels TOTAL	89,694	44,847	\$1,417,614
TOTAL	90,713	45,866	\$1,449,824

a Incurred every year for the first five years.

b Cruise ships are in the passenger vessels category. Thus, the 175 cruise ship count was subtracted from the normal passenger vessel count of 11,521.

- **NOI:** The NOI filing requirement is only applicable to vessels that are greater than or equal to 300 gross tons. Based on the Information Collection Request for NPDES Permits and the Sewage Sludge Management Permits (US EPA, 2006), EPA has found that 1 hour is required to file an NOI for a general

permit. This is a one-time requirement and does not carry through over multiple years. This cost is annualized over five years at a 7 percent discount rate. The detailed low and high end cost estimates are shown in *Table 6-35*.

Table 6-35: NOI Burden				
Vessel Class	Vessel Count^a	Total Burden Hours	Total Cost	Total Annual Cost^b
All Vessels - 1 Burden Hour				
Cruise Ships	175	175	\$5,532	\$1,349.14
Freight Ships	469	469	\$14,825	\$3,615.70
Tank Ships	117	117	\$3,698	\$902.00
Commercial Fishing	1,688	1,688	\$53,358	\$13,013.44
Freight Barges	30,961	30,961	\$978,677	\$238,690.26
Passenger Vessels ^c	1,095	1,095	\$34,613	\$8,441.78
Recreational Ships	926	926	\$29,271	\$7,138.89
Utility Vessels	4,124	4,124	\$130,360	\$31,793.50
Tank Barges	4,808	4,808	\$151,981	\$37,066.72
TOTAL	44,363	44,363	\$1,402,314.43	\$342,011.44

a The count of vessels required to submit an NOI is a conservative estimate since data on gross tonnage are not complete. Thus, this count is based on the number of vessels that are either ≥79' in length or ≥300 gross tons.

b Total cost annualized over five years at a 7% discount rate.

c Cruise Ships are within the Passenger Vessels category. Thus, the 175 cruise ship count was subtracted from the normal Passenger Vessel count of 1,270.

- **Routine Inspections:** Vessels are already performing these routine inspections. However, additional time may be required based on the introduction of the Permit BMPs. For the high end estimate, EPA assumes that 0.5 additional hours are annually required of small vessels and 2 additional hours are annually required of large vessels. This practice is performed for five years. The detailed high end cost estimates are shown in *Table 6-36*. The low end total cost estimates are null.

Table 6-36: Routine Inspection Burden			
Vessel Class	Vessel Count	Total Burden Hours	Total Annual Cost^a
Large Vessels - 2 Burden Hours			
Cruise Ships	175	350	\$11,064
Freight Ships	697	1,394	\$44,064
Tank Ships	147	294	\$9,293
Large Vessels TOTAL	1,019	2,038	\$64,421
Small Vessels - 0.5 Burden Hours			
Commercial Fishing	28,875	14,438	\$456,369
Freight Barges	32,842	16,421	\$519,068
Passenger Vessels ^b	11,346	5,673	\$179,324
Recreational Ships	926	463	\$14,635
Utility Vessels	10,761	5,381	\$170,078
Tank Barges	4,944	2,472	\$78,140
Small Vessels TOTAL	89,694	44,847	\$1,417,614
TOTAL	90,713	46,885	\$1,482,035

a Incurred every year for the first five years.

b Cruise ships are in the passenger vessels category. Thus, the 175 cruise ship count was subtracted from the normal passenger vessel count of 11,521.

- **Annual Inspection:** Vessels are already performing annual inspections. However, additional time may be required based on the introduction of the Permit BMPs. For the high end estimate, EPA is assuming that 0.5 additional hours is annually required of small vessels and 2 additional hours are annually required of large vessels. This practice is performed for five years. The detailed high end cost estimates are shown in *Table 6-37*. The low end total cost estimates are null.

Table 6-37: Annual Inspection Burden			
Vessel Class	Vessel Count	Total Burden Hours	Total Annual Cost ^a
Large Vessels - 2 Burden Hours			
Cruise Ships	175	350	\$11,064
Freight Ships	697	1,394	\$44,064
Tank Ships	147	294	\$9,293
Large Vessels TOTAL	1,019	2,038	\$64,421
Small Vessels - 0.5 Burden Hours			
Commercial Fishing	28,875	14,438	\$456,369
Freight Barges	32,842	16,421	\$519,068
Passenger Vessels ^b	11,346	5,673	\$179,324
Recreational Ships	926	463	\$14,635
Utility Vessels	10,761	5,381	\$170,078
Tank Barges	4,944	2,472	\$78,140
Small Vessels TOTAL	89,694	44,847	\$1,417,614
TOTAL	90,713	46,885	\$1,482,035

a Incurred every year for the first five years.

b Cruise ships are in the passenger vessels category. Thus, the 175 cruise ship count was subtracted from the normal passenger vessel count of 11,521.

- **One-time Report:** Since this is a new Permit requirement, EPA has assumed that, for both the low and high end estimate, 0.5 hours is required for small and large vessels. This is a one-time requirement and does not carry through over multiple years. This cost is annualized over five years at a 7 percent discount rate. The detailed low and high end cost estimates are shown in *Table 6-38*.

Table 6-38: One-Time Report Burden				
Vessel Class	Vessel Count	Total Burden Hours	Total Cost	Total Annual Cost ^a
All Vessels - 0.5 Burden Hours				
Cruise Ships	175	88	\$2,766	\$675
Freight Ships	697	349	\$11,016	\$2,687
Tank Ships	147	74	\$2,323	\$567
Commercial Fishing	28,875	14,438	\$456,369	\$111,304
Freight Barges	32,842	16,421	\$519,068	\$126,596
Passenger Vessels ^b	11,346	5,673	\$179,324	\$43,735
Recreational Ships	926	463	\$14,635	\$3,569
Utility Vessels	10,761	5,381	\$170,078	\$41,480
Tank Barges	4,944	2,472	\$78,140	\$19,058
TOTAL	90,713	45,357	\$1,433,719	\$349,670.71

a Total cost annualized over five years at a 7% discount rate.

b Cruise ships are in the passenger vessels category. Thus, the 175 cruise ship count was subtracted from the normal passenger vessel count of 11,521.

6.5 Analysis of Total National Costs

The estimated total compliance costs for all BMPs are provided in *Table 6-39*. The estimated VGP compliance costs, including the \$468,248 and \$1,139,417 annual incremental costs for ballast water practices for domestic and foreign vessels, respectively, vary because of the different assumptions made regarding the populations and the number of instances for which incremental costs will be incurred. The total low end estimate is approximately \$6.7 million, whereas the total high end estimate is approximately \$20.2 million.

Table 6-39: Total Annual Compliance Costs for All BMPs by Vessel Type			
Vessel Type	Total Cost		
	Domestic	Foreign ^a	Total
Low End Estimates			
Commercial Fishing	\$148,916.48	\$0.00	\$148,916.48
Freight Barges	\$3,179,040.67	\$367.28	\$3,179,407.94
Freight Ships	\$160,678.91	\$711,188.58	\$871,867.49
Passenger Vessels	\$78,386.81	\$69,617.49	\$148,004.30
Recreational Ships ^a	\$72,346.25	\$549.57	\$72,895.82
Tank Barges	\$562,408.23	\$729.88	\$563,138.11
Tank Ships	\$233,688.51	\$352,661.77	\$586,350.27
Utility Vessels	\$1,170,286.60	\$4,302.10	\$1,174,588.70
Low End TOTAL	\$5,605,752.45	\$1,139,416.67	\$6,745,169.12
High End Estimates			
Commercial Fishing	\$3,316,313.62	\$0.00	\$3,316,313.62
Freight Barges	\$9,714,226.01	\$367.28	\$9,714,593.29
Freight Ships	\$308,314.77	\$711,188.58	\$1,019,503.36
Passenger Vessels	\$156,535.47	\$69,617.49	\$226,152.96
Recreational Ships ^a	\$246,770.64	\$549.57	\$247,320.21
Tank Barges	\$1,606,030.05	\$729.88	\$1,606,759.94
Tank Ships	\$268,554.43	\$352,661.77	\$621,216.19
Utility Vessels	\$3,467,406.29	\$4,302.10	\$3,471,708.39
High End TOTAL	\$19,084,151.29	\$1,139,416.67	\$20,223,567.96

^a Only includes ballast water exchange/flushing costs.

The total costs to cruise ships are provided in *Table 6-40*. These ships are in the passenger vessel category. Thus, this cost is allocated within the totals for the passenger vessel class. These costs are currently based on assumptions made regarding the population of ships that would need to purchase a graywater treatment system and those that would need to undergo sampling practices. EPA is currently waiting for the exact population from the CLIA representative.

Table 6-40: Total Annual Incremental Cost for Cruise Ships	
Vessel Type ^a	Total Domestic Cost
Large Cruise Ships	\$1,083,022.24
Medium Cruise Ships	\$50,000.00
TOTAL	\$1,133,022.24

^a Cruise ships are in the passenger vessels category.

Total paperwork costs are provided within *Table 6-41*. The low end estimate total is nearly \$700,000, whereas the high end estimate is approximately \$5.1 million.

Table 6-41: Total Permit Recordkeeping Burden Cost	
Vessel Type	Total Cost to Domestic Vessels
Low End Estimate	
Cruise Ships	\$2,023.71
Commercial Fishing	\$124,317.69
Freight Barges	\$365,286.07
Freight Ships	\$6,302.42
Passenger Vessels	\$52,177.12
Recreational Ships ^a	\$10,708.34
Tank Barges	\$56,124.32
Tank Ships	\$1,468.64
Utility Vessels	\$73,273.85
Low End TOTAL	\$691,682.15
High End Estimate	
Cruise Ships	\$29,682.46
Commercial Fishing	\$1,493,425.81
Freight Barges	\$1,922,489.50
Freight Ships	\$116,463.27
Passenger Vessels	\$590,147.71
Recreational Ships ^a	\$54,614.63
Tank Barges	\$290,544.08
Tank Ships	\$24,701.99
Utility Vessels	\$583,506.66
High End TOTAL	\$5,105,576.11

The total annual incremental costs are provided in *Table 6-42*. This includes the paperwork cost estimates from *Table 6-41*, the sum of the ballast water cost analysis and the sensitivity analysis costs for all other individual BMPs (*Table 6-39*), and the costs to cruise ships (*Table 6-40*). The total low end estimate is approximately \$8.2 million, including a \$7.1 million cost to domestic flagged vessels and a \$1.1 million cost for ballast water requirements to foreign flagged vessels. The total high end estimate is approximately \$26.1 million, including a \$25.0 million cost to domestic flagged vessels and a \$1.1 million cost for ballast water requirements to foreign flagged vessels.

Table 6-42: Total Annual Incremental Cost

Vessel Type	Total Cost		
	Domestic	Foreign ^a	Total
Low End Estimates			
Commercial Fishing	\$260,220.72	\$0.00	\$260,220.72
Freight Barges	\$3,305,636.47	\$367.28	\$3,306,003.75
Freight Ships	\$163,365.63	\$711,188.58	\$874,554.21
Passenger Vessels	\$1,255,818.96	\$69,617.49	\$1,325,436.45
Recreational Ships ^a	\$75,915.70	\$549.57	\$76,465.27
Tank Barges	\$581,465.83	\$729.88	\$582,195.71
Tank Ships	\$234,255.15	\$352,661.77	\$586,916.91
Utility Vessels	\$1,211,766.95	\$4,302.10	\$1,216,069.05
Low End TOTAL	\$7,088,445.40	\$1,139,416.67	\$8,227,862.07
High End Estimates			
Commercial Fishing	\$4,796,725.99	\$0.00	\$4,796,725.99
Freight Barges	\$11,398,025.25	\$367.28	\$11,398,392.53
Freight Ships	\$421,162.34	\$711,188.58	\$1,132,350.93
Passenger Vessels	\$1,899,596.96	\$69,617.49	\$1,969,214.46
Recreational Ships ^a	\$294,246.38	\$549.57	\$294,795.94
Tank Barges	\$1,859,507.41	\$729.88	\$1,860,237.30
Tank Ships	\$292,354.42	\$352,661.77	\$645,016.18
Utility Vessels	\$4,019,119.45	\$4,302.10	\$4,023,421.55
High End TOTAL	\$24,980,738.21	\$1,139,416.67	\$26,120,154.88

^a Only includes ballast water exchange/flushing costs.

7 Analysis of Impacts on Firm Revenues and Financial Performance

The previous chapters assessed total compliance costs to the water transportation and fishing industries. The firm-level analysis examines the impact of the introduced BMP costs per vessel on model firms that represent the financial conditions of “typical” businesses in each of the 10 examined NAICS codes. Since approximately 95 percent of the firms in the water transportation and fishing industries are small (see *Section 5.4.2: Small Businesses*), it is unlikely that firm-level impacts would be material among large firms in this industry. Therefore, a firm-level analysis focuses on assessment of impacts on small businesses, as required by the Regulatory Flexibility Act (RFA) and the Small Business Regulatory Enforcement and Fairness Act (SBREFA).

7.1 Methodology

The analysis establishes baseline financial conditions of the model firms, which are used in combination with the introduced BMP costs to examine the firm financial impact. Model-firm impacts provide the basis for estimating the number of firms expected to experience financial stress at the national/total industry level. After identifying the post-compliance cost-to-revenue ratio, the analysis will estimate the total number of firms expected to experience potential financial stress. Financial stress may be seen from a lack of profitability, cash deficiencies, or even bankruptcy. Firms expected to experience financial stress may need to change their business operations, including potentially downsizing or closing operations.

The steps involved in this process include: (1) assigning each vessel in the vessel database to a North American Industry Classification System (NAICS) code, (2) estimating the number of vessels per firm, (3) estimating the distribution of costs per vessel, and (4) comparing the costs to the revenues.

7.1.1 Assign Each Vessel to a NAICS Code

The framework for the model firms reflects the range of firm types across the major industry groups. Since the Economic Census does not have the same vessel categories as compared to other data sources (VESDOC/WTLUS, which contain more complete numbers of all potentially regulated vessels and firms), each of the vessels and firms from the vessel database was assigned to a NAICS code to establish financial data that are available from the Economic Census.

The number of firms likely to incur costs as a result of the Permit was identified using the VESDOC and WTLUS databases. Firms identified in this vessel database were assigned a NAICS code in order to determine the number of firms for each NAICS code. Industry classification information for individual firms was obtained primarily from ReferenceUSA’s Business Database (ReferenceUSA, 2006) and Dun & Bradstreet’s Million Dollar Database (Dun & Bradstreet, 2006), supplemented by company Web sites and industry publications. Both ReferenceUSA and Dun & Bradstreet link subsidiaries and branch offices to company headquarters, allowing for an identification of domestic parent entities. Dun & Bradstreet’s Million Dollar Database classifies businesses based on eight-digit Standard Industrial Classification (SIC) codes. Since both the Census and the Small Business Administration base their data on NAICS codes, EPA matched the first four digits of the SIC codes to corresponding six-digit NAICS codes using the U.S. Census Bureau’s bridge between 1987 SIC and 2002 NAICS codes (U.S. Census Bureau, 2002b). These company names were matched to the names in the VESDOC/WTLUS database to provide a NAICS code classification for most vessels in the vessel database.

Once the number of firms was determined for each NAICS code, EPA distributed these firms over revenue size categories based on Economic Census data. This calculation determines the more complete firm numbers as compared to the Economic Census firm numbers in each revenue bracket for each NAICS code. These totals were used to determine the number and percentage of firms experiencing economic impacts.

7.1.2 Estimate the Number of Vessels per Firm

To establish the baseline and post-cost financials for each model firm, the vessel BMP costs developed from *Chapter 6* are applied to the firm level. To determine the total BMP costs that a firm could incur, EPA first estimated the average number of vessels owned and operated by firms in each NAICS sector using the VESDOC/WTLUS database. For each NAICS code, EPA determined the number of vessels that were listed with a firm name as well as the number of firms within this subset. Based upon the total number of firms and vessels within the subset in each NAICS code, the average number of vessels per firm per NAICS code was determined. However, since this value is expected to vary among the different firm sizes, this average value was used in proportion with the revenue values to determine an average number of vessels per firm for firms across the revenue size categories derived from the Economic Census data.

Data were available from the Economic Census and from the Small Business Administration's Statistics of U.S. Businesses on the total number of firms by revenue size. No data were available on the number of vessels by revenue size; however, data on the average number of vessels per firm per NAICS sector across all revenue sizes were available from the VESDOC/WTLUS database. Multiplying the number of firms in each NAICS sector by the average number of vessels per firm yields an estimate of the number of vessels in the NAICS sector. The number of vessels in each NAICS sector was then distributed over revenue size categories in such a way that the average number of vessels in each revenue size range is proportional to the midpoint of revenue in a revenue size category. This calculation maintains the overall estimated average and total number of vessels in each NAICS sector but recognizes that the number of vessels owned by firms is likely to be approximately proportional to the revenue size of the firm. For example, for an industry with two revenue brackets, \$0–\$100,000 and \$100,000–\$200,000, two firms in each bracket, and six vessels per firm on average across all brackets, EPA would assume that there were three vessels per firm in the first bracket and nine vessels per firm in the second bracket. Thus, since the midpoint revenue is three times as high in the second revenue bracket as the midpoint revenue in the first bracket, the number of vessels per firm is also three times as high in the second revenue bracket. Note that EPA did not allow the average number of vessels per firm to be less than one for any revenue bracket.

7.1.3 Estimate the Distribution of Costs per Vessel

For each vessel type and BMP, EPA has already estimated in *Sections 6.2 and 0*: (1) the total number of vessels, (2) the probability of a vessel incurring incremental costs, and (3) the incremental cost of each BMP. By assuming that the probability of incurring an incremental cost for a given BMP is independent of incurring costs for any of the other BMPs, EPA can estimate the probabilities of incurring costs for all possible combinations of BMPs.

In the analysis, the low end cost estimate includes 15 possible BMPs, and the high end cost estimate includes 19 possible BMPs. Treating each BMP cost as an independent, binary “on/off” cost event, this means that there are 2^{15} and 2^{19} possible combinations of BMP cost events for the low end and high end cost estimate, respectively. Each combination BMP cost event is defined on the basis of whether or not each of the specific BMPs is “on” or “off” together with the probability of each specific BMP being “on” or “off.” As described earlier, each BMP is assigned a probability of occurrence, and this is the probability of the individual BMP event when the BMP is “on.” When the individual BMP is “off,” the probability is one *minus* the probability of the BMP's occurrence. The overall probability of occurrence for a given BMP combination is the product of these individual probabilities. As a result, most of the BMP cost combinations are not meaningful for the impact analysis because one or more of the BMP “on/off” instances in the combination event have a zero probability of occurrence, and thus the overall probability of that particular event, which is calculated as the product of the individual “on” or “off” BMP probabilities, is zero. The high occurrence of zero probability *combination* BMP events results from the presence of BMPs that are assigned a one hundred percent probability of occurrence—when these events are turned “off,” the probability of the inverse event is, by definition, therefore zero. For example, only 17 BMP combinations are observed under the low end cost estimate for passenger ships. The maximum number of

observed BMP combinations for a vessel type is only 1,025, which is substantially smaller than the 524,288 possibilities ($524,288 = 2^{19}$).

For each of these observed combinations EPA multiplied the total number of vessels by vessel class by the calculated probability of the combination BMP event to estimate the number of vessels incurring costs for a given combination of BMPs. Finally, EPA calculated the per-vessel cost by vessel class associated with each combination of BMPs by summing the costs of the individual BMPs where costs are incurred. This calculation provided the distribution of per-vessel costs. The distribution shows a high probability of occurrence for very low cost combination BMP events. The probability of occurrence declines rapidly as the cost of the combination BMP events increases. The higher cost combination BMP events—which require a combination of all or nearly all of the individual BMPs—have a very low probability of occurrence.

EPA estimated the distribution of per-firm costs from the distribution of per-vessel costs using the following approach. For firms in industries with more than one vessel class, EPA estimated the percentiles from 0 to 100 in intervals of 10 percentiles for each distribution of vessel costs—this gave us 11 possible vessel costs, which are all equally likely. For firms in industries with two vessel types, EPA evaluated their costs for 11^2 possible combinations of costs. For firms in industries with N vessel types, EPA evaluated their costs for 11^N possible combinations of costs—11 possible costs for each vessel class. Each possibility includes a per-vessel cost for each vessel class. EPA calculated an average per-vessel cost from the vessel class-specific costs for all 11^N possible combinations based on the relative number of vessels in each class for each industry. This average cost per vessel is multiplied by the number of vessels per firm in each industry, which is derived as described in *Section 7.1.2*. Thus, for industries with more than one vessel class, EPA estimated a distribution of costs per firm with 11^N equally likely possibilities, where N is the number of vessel classes observed for the industry.

For firms in industries with only one vessel class, EPA estimated the total vessel costs for all possible combinations of the individual practice costs. There were 128 and 1,024 possible practice cost combinations in the commercial fishing and port and harbor operations industries, respectively. The likelihood of each possible combination is estimated from the likelihoods of incurring each individual practice cost, which are assumed to be independent. The costs per vessel are multiplied by the number of vessels per firm in each industry to estimate all the possible firm costs. Thus, for industries with only one vessel class, EPA estimated a distribution of costs per firm with 128 and 1,024 possibilities for the commercial fishing and port and harbor operations industries, respectively.

7.1.4 Compare Costs to Revenues

Data from the Economic Census as well as from the SBA's Statistics of U.S. Businesses were used to determine the firm-level financial data. These sources provided the distribution of firms across several revenue brackets as well as the average revenue value in each revenue bracket.

To evaluate the potential impact of the Commercial Vessel General Permit on small entities, EPA used a cost-to-revenue test to evaluate the potential severity of economic impact on vessels and facilities owned by small entities. The test calculates annualized pre-tax compliance cost as a percentage of total revenues and uses a threshold of 1 and 3 percent to identify facilities that would be significantly impacted as a result of this Permit.

The cost values equivalent to the 1 and 3 percent thresholds were estimated from the average revenue in each revenue bracket, or the midpoint of the revenue bracket when average revenue was not reported. Each possibility from the distribution of firm costs, described in *Section 7.1.3*, was compared to the 1 and 3 percent thresholds. EPA estimated the percentage of firms that would be significantly impacted as a result of this Permit as the percentage of cost possibilities where the firm costs exceeded the revenue thresholds.

7.2 Small Entity Analysis

Consistent with the framework and requirements of the Regulatory Flexibility Act, EPA prepared a screening analysis that examines the impacts of this Permit on small entities. A small entity may be:

- A small business according to SBA size standards
- A small governmental jurisdiction that is a government of a city, county, town, school district, or special district with a population of less than 50,000
- A small organization that is a not-for-profit enterprise that is independently owned and operated and is not dominant in its field.

The SBA defines small businesses based on NAICS codes and size standards expressed by the number of employees or annual receipts (13 CFR §121.20). For the water transportation and fishing industry sectors, SBA's business size standards are based on annual revenues as well as employee size. If the revenues or employment were smaller than the corresponding thresholds, EPA classified the entities as small. *Section 5.4.2: Small Businesses* presents the small business thresholds used in this analysis and the number of small businesses in each sector of the water transportation and fishing industries. On the whole, both industries contain more than 90 percent small businesses. Based on data from the U.S. Census Bureau and the SBA, of the 5,037 firms in the water transportation industries, 4,717 (93.7 percent) are small. In the fishing industry, 1,843 (96.2 percent) of the 1,916 firms are small.

After calculating the distribution of per-firm costs, the number and percentage of firms where costs exceed 1 percent and 3 percent of revenue was estimated (by NAICS sector and revenue bracket).

The costs used in the RFA analysis are annualized costs, which reflect the annual equivalent value of first-year (one-time) costs and recurring costs. The resulting 2007 annualized costs range from \$0 to \$34,700 per vessel in the water transportation industry and from \$0 to \$2,509 per vessel in the fishing industry. *Table 7-1* lists the median, 5th and 95th percentile firm-level costs across all NAICS codes.

Table 7-1: Estimated Median and 5th and 95th Percentile Firm Costs by NAICS Code

		5 th Percentile	Median	95 th Percentile
Low End Cost Estimate				
11411	Finfishing, shellfishing, and other commercial fishing	\$4	\$4	\$2,354
483111/483113	Deep sea/coastal and Great Lakes freight	\$80	\$146	\$3,662
483112/483114	Deep sea/coastal and Great Lakes passenger	\$4	\$4	\$1,906
483211	Inland waterways freight transportation and towing transportation	\$82	\$392	\$13,048
483212	Inland waterways passenger transportation and other water transportation	\$4	\$4	\$1,934
487210	Scenic and sightseeing transportation, water	\$10	\$23	\$1,955
488310	Port and harbor operations	\$78	\$78	\$3,125
488320	Marine cargo handling	\$82	\$795	\$20,354
488330	Navigational services to shipping and salvage	\$77	\$81	\$3,006
488390	Other support activities for water transportation	\$80	\$80	\$944
High End Cost Estimate				
11411	Finfishing, shellfishing, and other commercial fishing	\$153	\$153	\$2,670
483111/483113	Deep sea/coastal and Great Lakes freight	\$315	\$535	\$5,506
483112/483114	Deep sea/coastal and Great Lakes passenger	\$53	\$53	\$1,956
483211	Inland waterways freight transportation and towing transportation	\$307	\$1,448	\$18,352
483212	Inland waterways passenger transportation and other water transportation	\$53	\$53	\$1,982
487210	Scenic and sightseeing transportation, water	\$74	\$102	\$2,102
488310	Port and harbor operations	\$307	\$311	\$4,604
488320	Marine cargo handling	\$307	\$1,598	\$32,612
488330	Navigational services to shipping and salvage	\$301	\$308	\$5,039
488390	Other support activities for water transportation	\$294	\$294	\$1,324

Figure 7-1 through *Figure 7-3* depicts the percentage of firms exceeding specified cost thresholds for three industries: commercial fishing, deep sea/coastal and great lakes passenger transportation, and marine cargo handling. Different cost ranges are used for low and high cost estimates since different BMP practices are required. *Figure 7-1* depicts the percentage of firms exceeding specified cost thresholds for the commercial fishing industry. As shown in *Figure 7-1*, the majority of commercial fishing firms are expected not exceed the 500-dollar threshold, both for the low and high end estimate.

Figure 7-1: Percentage of Firms Exceeding Low End and High End Cost Thresholds, NAICS 11411 - Finfishing, shellfishing, and other commercial fishing

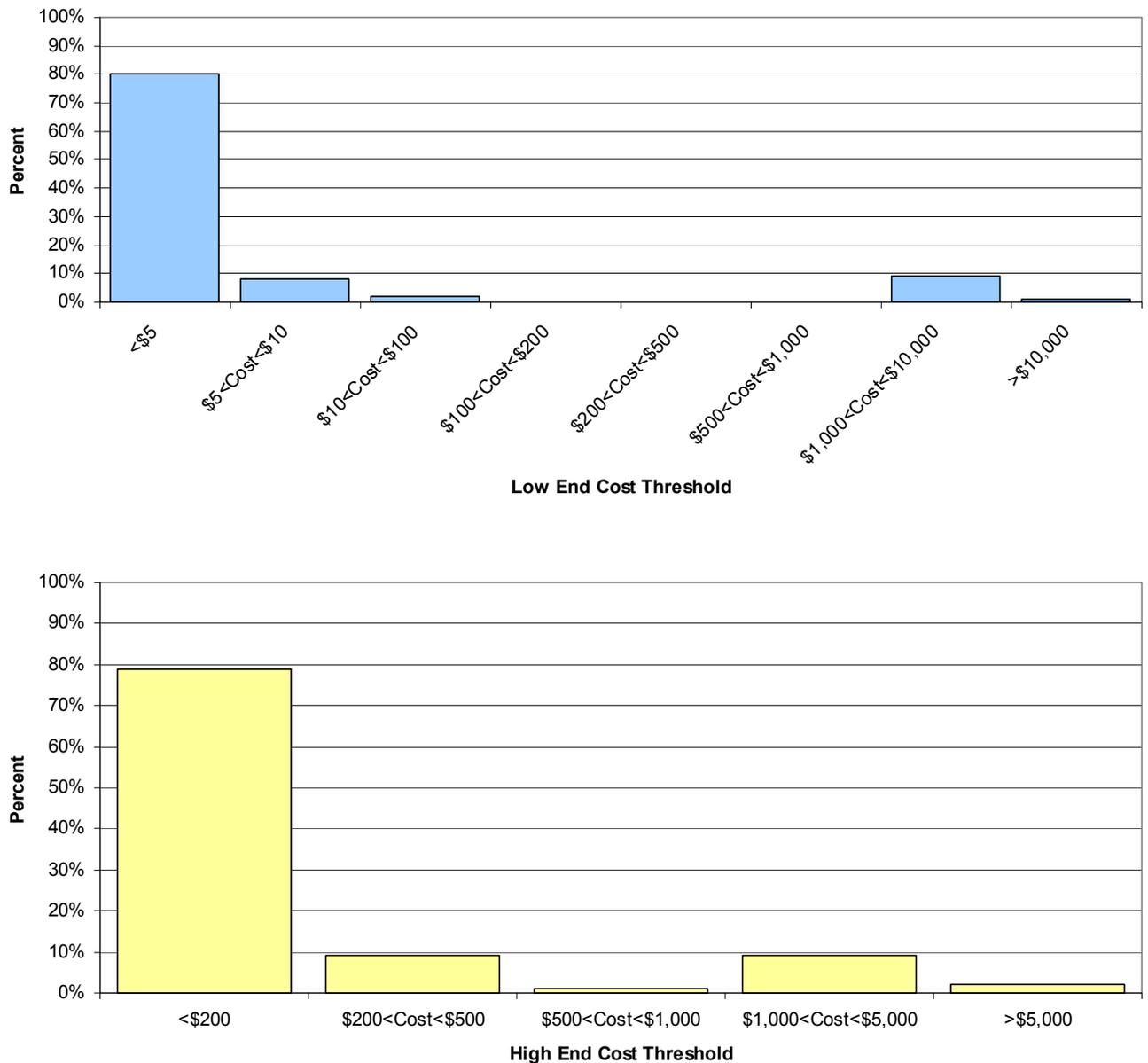


Figure 7-2 depicts the percentage of firms exceeding specified cost thresholds for the deep sea/coastal and great lakes passenger category. As shown in Figure 7-2, the majority of these firms are also expected not exceed the 500-dollar threshold, both for the low and high end cost estimate.

Figure 7-2: Percentage of Firms Exceeding Low End and High End Cost Thresholds, NAICS 483112/483114 - Deep sea/coastal and Great Lakes passenger

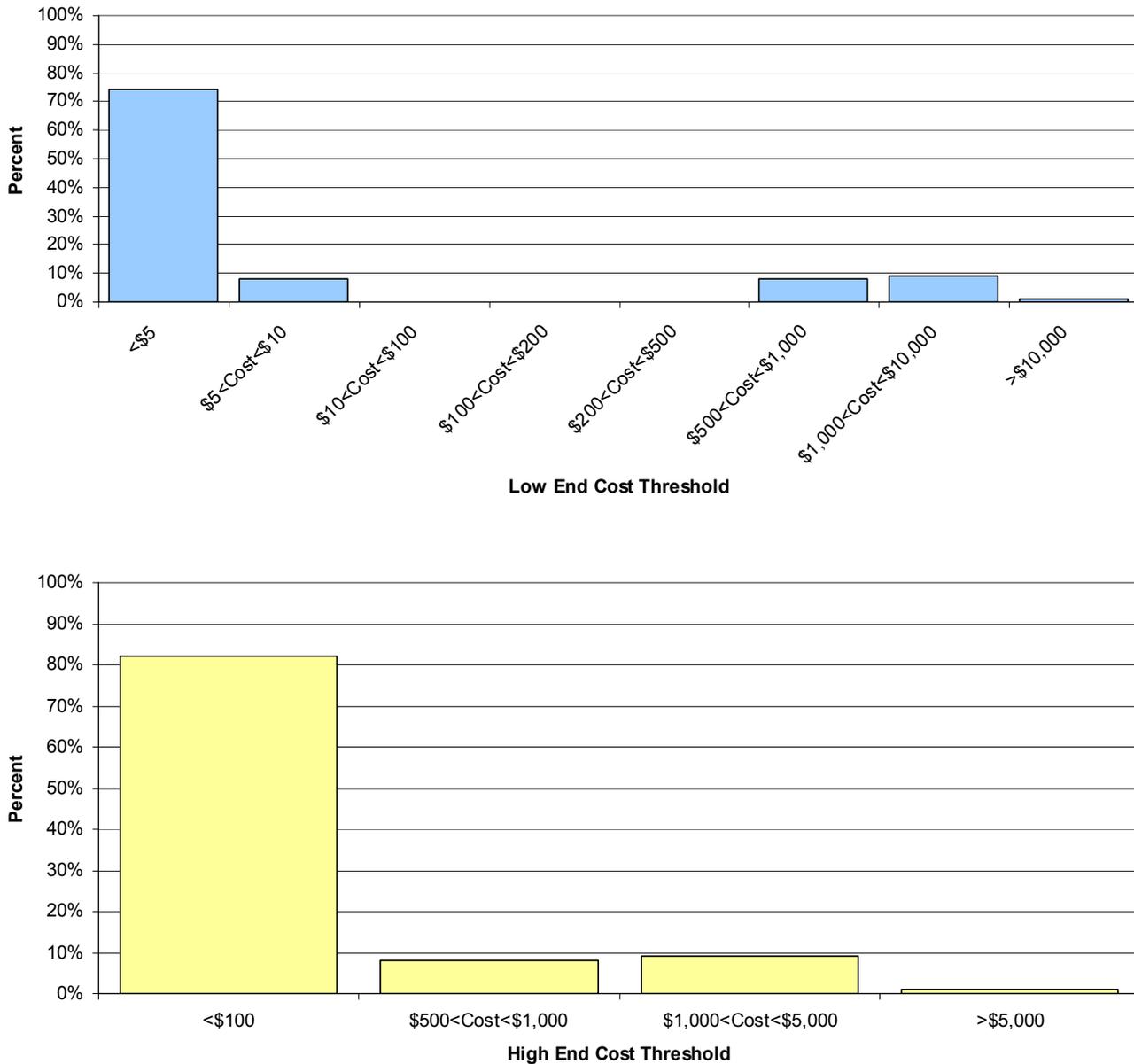


Figure 7-3 depicts the percentage of firms exceeding specified cost thresholds for the marine cargo handling category. As shown in Figure 7-3, the majority of these firms are expected not exceed the 5,000-dollar threshold, both for the low and high end cost estimate. This category experiences higher firm level costs since the overall average number of vessels per firm is much higher.

Figure 7-3: Percentage of Firms Exceeding Low End and High End Cost Thresholds, NAICS 488320- Marine Cargo Handling

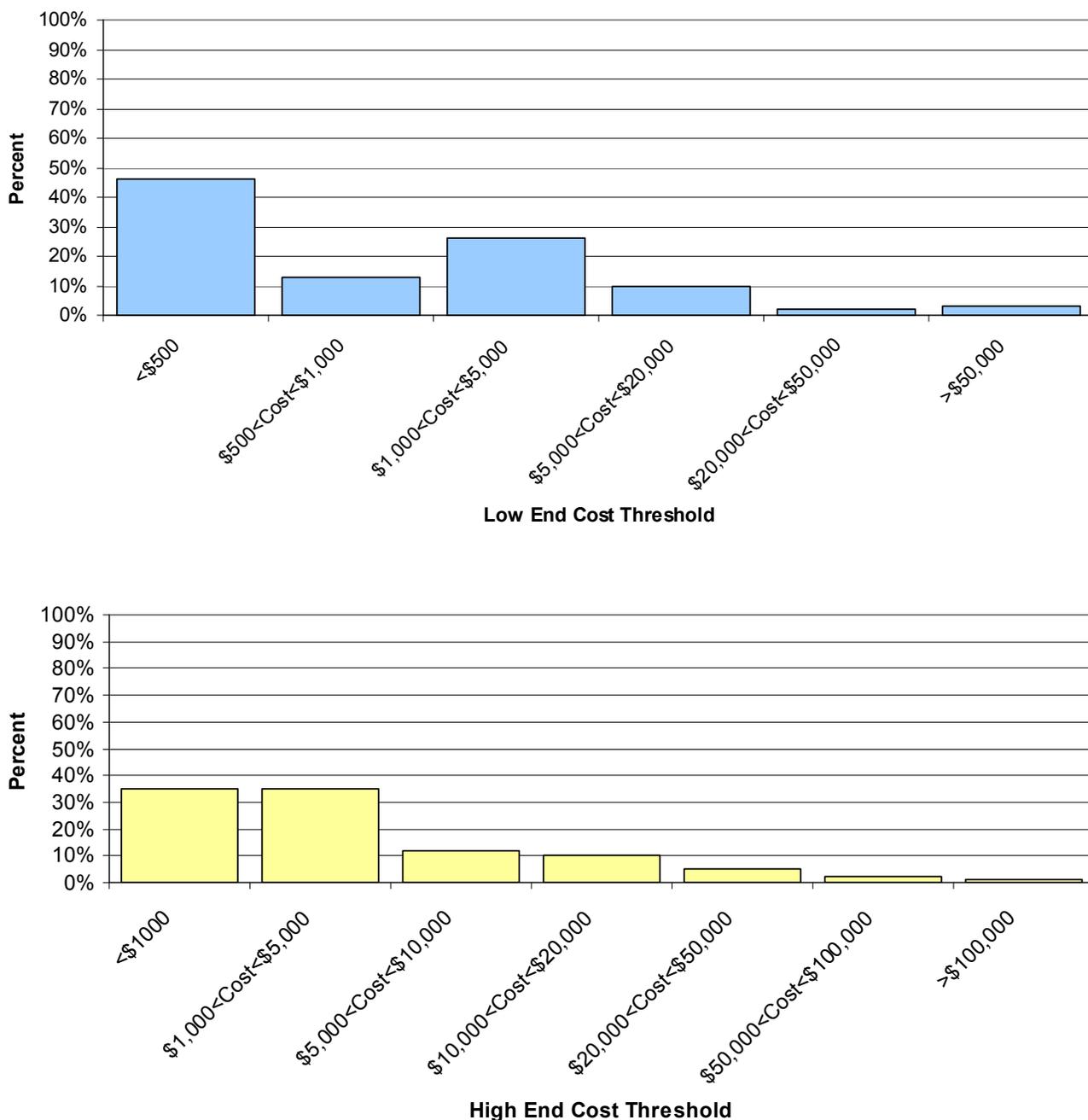


Table 7-2 presents the distribution of the entities' cost-to-revenue ratios. As shown in Table 7-2, the total number of small entities in the *fishing industry* that are expected to exceed the 1 percent cost-to-revenue threshold is 36 for the low end cost assumptions and 72 for the high end cost assumptions. The total number of small entities in the *water transportation industry* that are expected to exceed the 1 percent cost-to-revenue threshold ranges from 249 to 326 under the low and high end cost assumptions, respectively. The two industries combined constitute 285 and 398 entities that are expected to exceed the 1 percent cost-to-revenue threshold under the low and high end cost assumptions, respectively. This represents less than 1 percent of the total number of firms in the water transportation and fishing industries under both analytic scenarios.

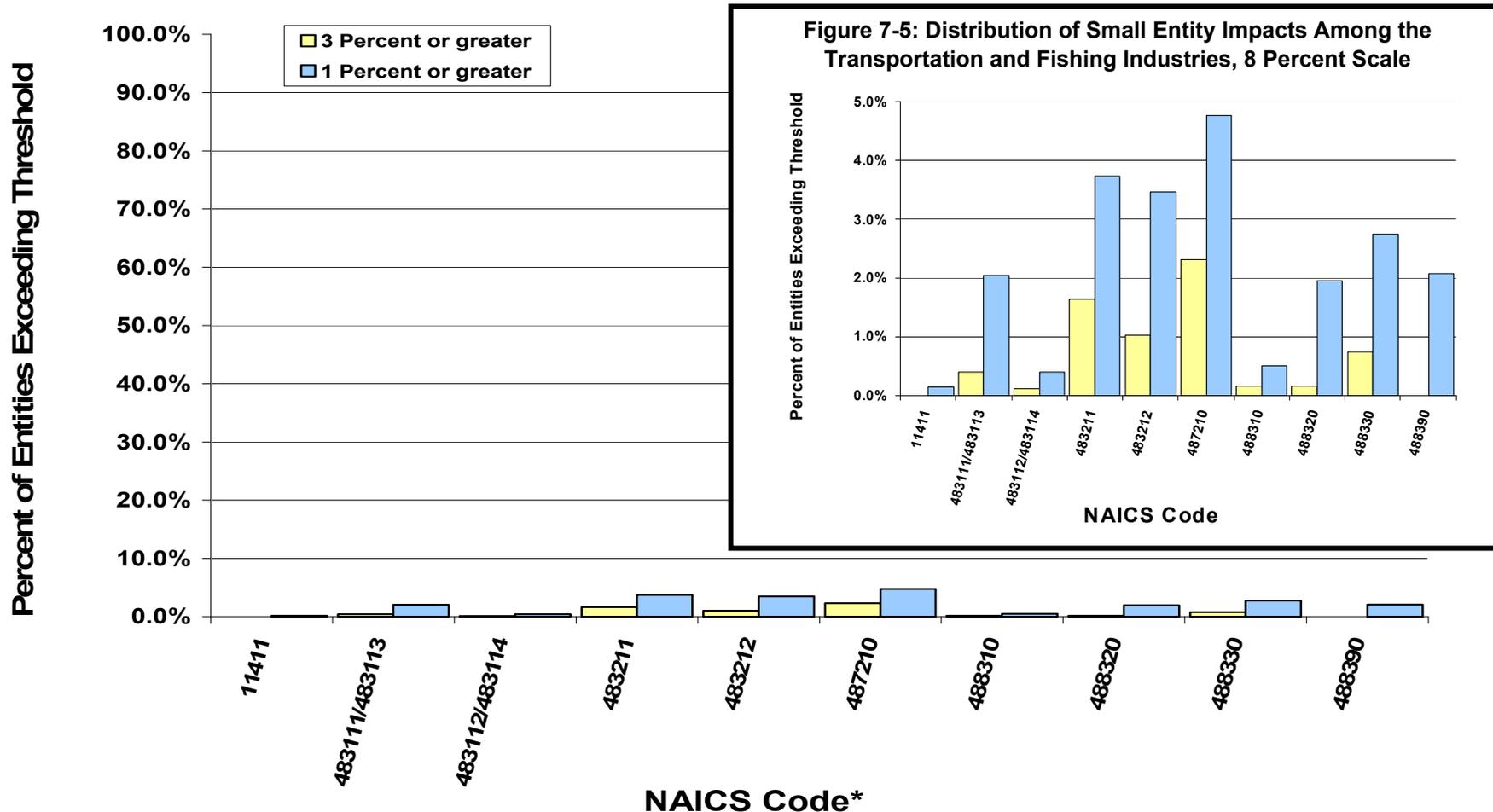
The critical cost thresholds range depending on revenue range and NAICS code. For example, a fishing firm within the revenue range of \$0-\$100,000 (with an average revenue of \$54,610) would have a 1 percent critical cost threshold of \$546. On the other hand, a firm within the marine cargo handling industry, within the revenue range of \$100 million or more (with an average revenue of over \$235 million) would have a 1 percent critical cost threshold of nearly \$2.4 million. The majority of firms in the fishing industry fall within the revenue range from \$100,000 to \$499,999. The majority of firms in the water transportation industry fall within the revenue range from \$100,000 to \$249,999. As shown in *Table 7-2*, the percentage of firms expected to exceed the 1 percent threshold under both the low and high end cost assumptions ranges from 0.14 to 4.82 percent depending on the NAICS code. In examining the percentage of entities affected, the most impacted entities fall within the inland waterways freight transportation and towing transportation, inland waterways passenger transportation and other water transportation, and scenic and sightseeing transportation sectors. These three sectors all have approximately 3.5 percent or more entities that exceed the 1 percent threshold under both the low and high end cost assumptions.

Table 7-2: Results of the Small Entity Impact Analysis

NAICS Code	NAICS Description	1 Percent or greater		Between 1 Percent and 3 Percent		3 Percent or greater	
Low End Cost Estimate							
11411	Finfishing, shellfishing, and other commercial fishing	36	0.14%	36	0.14%	0	0.00%
483111/483113	Deep sea/coastal and Great Lakes freight	29	2.04%	23	1.64%	6	0.41%
483112/483114	Deep sea/coastal and Great Lakes passenger	30	0.41%	21	0.29%	9	0.12%
483211	Inland waterways freight transportation and towing transportation	43	3.74%	24	2.10%	19	1.64%
483212	Inland waterways passenger transportation and other water transportation	42	3.46%	29	2.44%	12	1.03%
487210	Scenic and sightseeing transportation, water	9	4.76%	5	2.45%	4	2.31%
488310	Port and harbor operations	6	0.50%	4	0.34%	2	0.17%
488320	Marine cargo handling	0	1.96%	0	1.80%	0	0.16%
488330	Navigational services to shipping and salvage	70	2.74%	51	1.99%	19	0.75%
488390	Other support activities for water transportation	19	2.07%	19	2.07%	0	0.00%
TOTAL		285	0.69%	213	0.52%	71	0.17%
High End Cost Estimate							
11411	Finfishing, shellfishing, and other commercial fishing	72	0.29%	72	0.29%	0	0.00%
483111/483113	Deep sea/coastal and Great Lakes freight	37	2.60%	31	2.20%	6	0.41%
483112/483114	Deep sea/coastal and Great Lakes passenger	30	0.41%	21	0.29%	9	0.12%
483211	Inland waterways freight transportation and towing transportation	53	4.63%	34	2.94%	19	1.69%
483212	Inland waterways passenger transportation and other water transportation	42	3.46%	29	2.44%	12	1.03%
487210	Scenic and sightseeing transportation, water	9	4.76%	5	2.45%	4	2.31%
488310	Port and harbor operations	12	1.01%	6	0.50%	6	0.50%
488320	Marine cargo handling	0	2.94%	0	1.78%	0	1.16%
488330	Navigational services to shipping and salvage	123	4.82%	104	4.07%	19	0.75%
488390	Other support activities for water transportation	19	2.07%	19	2.07%	0	0.00%
TOTAL		398	0.97%	322	0.78%	76	0.18%

The following graphs, *Figure 7-4* and *Figure 7-5*, demonstrate the percentage of entities exceeding the 1 percent and 3 percent cost-to-revenue threshold for the low end cost estimate. The number and percentage of entities exceeding the thresholds for the high end estimate are in line with the below figures. *Figure 7-4* presents the percentage of entities at the 100 percent scale, demonstrating the overall low percentage of entities affected. *Figure 7-5* is a small scaled version of *Figure 7-4*, detailing the percentage of entities affected across each NAICS code.

Figure 7-4: Distribution of Small Entity Impacts Among the Transportation and Fishing Industries, 100 Percent Scale



* The industries that are attributed to each NAICS code are as follows: 11411 – Fin fishing, shell fishing, and other commercial fishing; 483111/483113 – Deep sea/coastal and Great Lakes freight; 483112/483114 – Deep sea/coastal and Great Lakes passenger; 483211 – Inland waterways freight transportation and towing transportation; 483212 – Inland waterways passenger transportation and other water transportation; 487210 – Scenic and sightseeing transportation, water; 488310 – Port and harbor operations; 488320 – Marine cargo handling; 488330 – Navigational services to shipping and salvage; 488390 – Other support activities for water transportation

7.3 Issues and Uncertainties

The number and percentage of firms estimated to incur economic impacts is based upon the scaled firm number from the VESDOC/WTLUS database. EPA assumes that the Economic Census distribution of firms by revenue size is the same as the VESDOC/WTLUS distribution of firms by revenue size. However, this could place more or fewer firms in the lower revenue brackets than there should be.

There is uncertainty surrounding EPA's assumption that the average number of vessels for firms is proportional to the revenue midpoint of their revenue bracket. In addition, the constraint that there must be at least one vessel per firm was binding for the lower revenue brackets. These assumptions may result in underestimation or overestimation of the number of vessels per firm, and the underestimation or overestimation may vary by revenue size category. In instances—in the aggregate or by revenue size category—where EPA underestimates the number of vessels per firm, market impacts may be underestimated. In instances where EPA overestimates the number of vessels per firm, market impacts may be overestimated. There is uncertainty surrounding the choice of estimating 11 possible costs for each vessel class. Increasing the number of vessel cost possibilities increases the precision of the estimates. However, since industries can have up to seven vessel types, the number of sampled vessel costs is limited by computational feasibility - with 11 possible vessel-class costs and 7 vessel types there are 11^7 possible firm costs. Because industries with fewer vessel classes are more likely to be sensitive to the sample size, EPA evaluated all possible costs for industries with only one vessel class (i.e., all possible combinations of the estimated individual practice costs). Future analysis can test the sensitivity of the results to the choice of the number of possibilities for industries with more than one vessel class.

After simulating a sample of vessel class costs, EPA calculated an average cost per vessel across all vessel classes. For example, for NAICS 483212, the vessel types include passenger vessels and utility vessels, and the average number of vessels per firm is one for the lowest revenue bracket. Since 99.5 percent of the firms' vessels are passenger vessels, the firm cost is estimated as $(99.5\% * [\text{Passenger Vessel Cost}] + 0.5\% * [\text{Utility Vessel Cost}]) * 1$, where the Passenger Vessel Cost and Utility Vessel Cost are sampled as described in *Section 7.1.3*. There is uncertainty associated with this simplifying assumption, because calculating a weighted average vessel cost results in less cost variation compared to an alternative approach that simulates a distribution of vessel classes for firms.

For each revenue bracket EPA assumed that firm revenues were equal to the average revenue in the bracket (or the midpoint when the average was not available). There is uncertainty associated with this simplifying assumption, because calculating an average firm cost results in less variation compared to an alternative approach that simulates a distribution of firm revenues within revenue size ranges.

8 Benefits Analysis

EPA expects that reductions in vessel discharges will benefit society in two broad categories: (1) reduced risk of invasive species introduction and (2) enhanced environmental quality from reduced pollutant discharges. *Section 8.1.2: Benefits Analysis* provides a qualitative assessment of the ecological and economic impacts of invasive species introductions and the benefits of reducing the occurrence of invasive species. *Section 8.2* discusses pollutants of concern (POCs) found in vessel discharges, their environmental effects, and the benefits likely to be achieved by the requirements of the Commercial Vessel General Permit.

8.1 Ballast Water Exchange and Invasive Species Impacts

8.1.1 Introduction and Background

Introductions of non-indigenous species have occurred in the United States for centuries, with more than 50,000 total non-native species thought to be successfully established with reproducing populations in U.S. territory (Pimentel et al., 2005). Scientists and governments have long recognized the economic and ecological damages associated with land-based invaders, but attention has only turned toward aquatic non-indigenous species (ANS) since the 1980s, when the extent of the zebra mussel invasions in the Great Lakes region first became a serious problem (Ruiz and Reid, 2007). ANS invasions have caused tremendous economic and ecological damages to critical coastal and inland waters throughout the United States.

ANS may be introduced through a variety of vectors, including intentional introductions, escape from a confined environment, or ballast water and sediment from ballast tanks. One of the major known vectors for ANS introduction is through the ballast water tanks of commercial vessels. Ballast water is taken on in or near port to provide stability to ships that are not fully loaded. Often, aquatic invertebrates, plants, or microorganisms, as well as suspended sediments that may contain invasive species, are unintentionally taken in along with the ballast water.

Two recent studies conducted by NOAA's Great Lakes Environmental Research Laboratory (GLERL) found that a majority of ships and a near-majority of tanks surveyed contained non-indigenous strains of pathogens known to cause human health impacts (Johengen et al., 2005; Reid et al., 2007). The Johengen et al. (2005) study also found that viable populations of non-native dinoflagellate and invertebrate species were present in a large majority of tanks sampled. Glassner-Shwayder refers to ships with ballast water as "biological islands" because they carry such a wide variety of organisms in their ballasts (1999). According to some studies, as many as 4,000 species can be found in a typical ship's ballast water at one time.

When this ballast water is discharged in another port, or when sediments in the ballast tank are mixed with new ballast water, these species can be introduced into an exotic environment, and may become established under some conditions (Ruiz and Reid, 2007). Several of the most harmful invasive species currently known to exist in the United States, including the zebra mussel, the green crab, and the Asian clam, are all thought to have been introduced via ballast water. Researchers hypothesize that as international trade, and therefore shipping traffic, increases, so does the threat of more ANS introductions (Glassner-Shwayder, 1999).

The U.S. Coast Guard's 2004 Rulemaking for Mandatory Ballast Water Management (codified in 33 CFR 151) mandated open ocean ballast water exchange for ships traveling outside the 200-nautical mile exclusive economic zone (EEZ) of the United States. While promulgation of this Permit is reducing the probability of new introductions, it covers neither vessels traveling within the U.S. EEZ nor vessels with empty ballast tanks, both of which are potential sources of ANS introductions.

The ballast water provisions of EPA’s new Commercial Vessel General Permit will help to address these gaps, further reducing the possibility of ANS introductions. Specifically, the Permit requires ballast water exchanges at least 50 nm from shore for vessels engaged in Pacific nearshore voyages, which were previously exempted from mandatory exchange procedures. It also requires saltwater flushing for vessels declaring no ballast on board (NoBOB) or for vessels with some proportion of their ballast tanks empty.

8.1.2 ANS Impacts

ANS invasions are a persistent problem in U.S. coastal and inland waters. ANS invade U.S. waters through a number of dispersal mechanisms including releases from fisheries; research and education facilities; restoration efforts; public aquaria and the aquarium pet industry; and by being attached to or within ships, drydocks, amphibious planes, floating marine debris, drilling platforms, navigation buoys and marine floats, canals, and recreational equipment (Carlton et al., 2003). Each vector has been associated with introductions of highly damaging species in the past, although this analysis will focus primarily on the ballast vector described in the previous section.

Though no reliable and comprehensive estimates of total ANS introductions nationwide exist, case studies of several major bodies of water across the country, as summarized in *Table 8-1*, provide a sense of the extent of the problem.

Table 8-1: Estimates of Invasive Species in Several Major Water Systems

Region	Estimated Rate of Invasion ^a	Estimated Total Invasions to Date ^b
Great Lakes	Once every 28 weeks ^c	162
Mississippi River System	Unknown	100
San Francisco Bay	Once every 24 weeks ^d	212
Lower Columbia River Basin	Once every 5 months ^e	81
Gulf of Mexico	Unknown	579

a Ruiz and Reid (2007) suggest that these figures may not reliably represent the true rate of introduction, as they are based on discovery data, which may not always track with the underlying rate of introduction.
 b All figures in this column are taken from USCG (2004b).
 c NOAA (2007).
 d Cohen and Carlton (1995).
 e Sytsma et al. (2004).

The total costs associated with ANS in the United States are staggering. A recent study suggests that expenditures on control alone for ANS in the United States total approximately \$9 billion annually (Pimentel et al., 2005). A broad range of damages are associated with any introduction of a given type of species, summarized in *Table 8-2*. Although some species cause no economic damage, others may cause hundreds of millions of dollars in damages. The majority of these damages may be broken down into six broad categories of impacts, which are described in the subsequent subsections.⁹

⁹ Portions of a previous analysis of benefits associated with ANS introduction reductions are incorporated into this analysis (Abt Associates Inc., 2005).

Table 8-2: Estimates of Invasive Species Damages by Type of Species

Type of Species	Range of Potential Damages per Invasion per Year (Million 2007\$)
Fish	0 – 153 ^a
Mollusks	0 – 6,100 ^b
Non-Mollusk Invertebrates	0 – 22.6 ^c
Plants	0 – 35.1 ^d
Pathogens	0 – 0.726 ^e

a Based on Ruffe (Leigh, 1998), adjusted to 2007\$ using CPI.

b Based on Zebra Mussel (Pimentel et al., 1999), adjusted to 2007\$ using CPI.

c Based on European Green Crab (EPA, 2008a).

d Based on hydrilla (OTA, 1993), adjusted to 2007\$ using CPI.

e Based on an outbreak of epidemic cholera (Lovell and Drake, 2007), adjusted to 2007\$ using CPI.

Commercial and Recreational Fisheries

As noted above, the introduction of ANS can cause the imbalance of native ecosystems. ANS pose an especially serious risk to commercial and recreational fisheries, which like other aquatic resources could be devastated by ANS (IDNR, 2003). Several examples of ANS impacts on fisheries are provided below.

- **Sea Lamprey:** The sea lamprey, which is native to the Atlantic Ocean, was not initially introduced to the Great Lakes by ballast water, but has been introduced elsewhere through contaminated ballast water (Toledo, 2001). Upon its initial introduction, the sea lamprey caused a massive collapse of the trout fisheries in the Great Lakes. If sea lamprey control measures were eliminated, the resulting lost value to fisheries would be approximately \$500 million annually, according to one estimate (OTA, 1993). Control measures that have been introduced to counteract the impacts of sea lampreys cost more than \$12 million annually (ANSTF, 2007).
- **European Green Crab:** The most likely mode of the initial European green crab introduction on the East Coast of North America was ship fouling (Cohen et al., 1995). Other possible pathways of introduction include ballast water and solid ballast. Grosholz (2006) and Cohen (1997) believe that incidental transport with commercial fishery products is the most likely vector for the initial introduction of *C. maenas* to the West Coast. The annual estimated economic damages from European green crab predation to commercial and recreational shellfisheries and eelgrass restoration efforts range from \$18.6 to \$22.6 million per year in the United States (EPA, 2008a).
- **Round Goby:** The round goby, native to Eurasia and likely introduced via ballast water, is thought to have adverse impacts on fisheries, due to its lack of value as a sport or commercial catch and its aggressive tendencies toward baited lines. Fishermen report that they are sometimes able to catch only gobies when fishing for the more desirable walleye (Marsden and Jude, 1995). No attempts to quantify the value of these impacts have been made to date.
- **Zebra Mussel:** An invasion of zebra mussels, which are native to the Caspian Sea and were introduced to U.S. waters in ballast water, has led to a halt in the \$3 billion dollar Mississippi River shelling industry (Randall, 2001).
- **Pathogens:** Pathogens transported in ballast water can also have significant adverse impacts on fisheries. infectious salmon anemia (ISA) has been a persistent problem in U.S. Atlantic fisheries' stocks since 2001. The original source and vector of this pathogen is unknown. Though there has been no attempt to quantify damages to the U.S. economy specifically from ISA, it is estimated that the annual cost in 1999 was \$11 million in Norway, \$14 million in Canada and \$32 million in Scotland (Cipriano and Miller, 2002).

Another recent fish pathogen of concern has been viral hemorrhagic septicemia (VHS). VHS has been known to exist in the coastal regions since the late 1980s, but only recently migrated into the Great Lakes through an unknown vector (USDA, 2006). An unpublished study found that VHS has impacted 6 of 23 fish species caught commercially in the Great Lakes, including two that account for 76 percent of the entire \$13.5 million dollar harvest (Lovell and Drake, 2007). In 1991, an exotic strain of *Vibrio cholerae* (epidemic cholera) was identified in oysters in Mobile Bay on the Gulf Coast. The estimated economic losses due to the closure of oyster harvesting in Mobile Bay for five months in 1991 as a response to concerns about epidemic cholera contamination were \$726,000 (2007\$) (Lovell and Drake, 2007).

Two non-native pathogens, MSX (*Haplosporidium nelsoni*) and Dermo (*Perkinsus marinus*) have caused substantial damages to native oyster populations in several U.S. coastal regions. Though the original vector of introduction is unknown for both pathogens, ballast water is considered to be one potential source of MSX, and Dermo is known to transmit relatively easily between infected and uninfected oysters (McKnight, 2007; Ewart and Ford, 1993).

Other Water-Based Recreation and Tourism

ANS have also had adverse impacts on recreation and tourism nationwide by damaging water quality and flow. Two invasive plants, hydrilla and water lettuce, have caused significant damages in U.S. waters. Both clog the water's surface, blocking boating and swimming, impeding water flow, and disrupting plant and animal communities. Florida spends an estimated \$1 million or more annually to control water lettuce, and the rest of the Eastern U.S. states spend approximately \$100,000 annually (Van Driesche et al., 2002). Studies of two lakes in Florida affected by hydrilla found that degradation caused by the hydrilla cost the state \$11 million in lost recreation expenditures (Pimentel et al., 1999).¹⁰

Invasive mollusks such as zebra mussels can also adversely affect a number of recreational activities, including boating and swimming. Zebra mussels often cover shorelines with sharp-edged shells and rotting mussel flesh, which can diminish interest in visiting infested beaches. Biofouling can also be a deterrent to recreational boaters who would rather avoid zebra mussel fouling and the resulting necessity of extensive vessel cleaning (USACE, 2002). A study by Vilaplana and Hushak (1994) estimated that incremental annual costs to boat owners in the Great Lakes related to the mussel included \$94 for protective anti-fouling paints, \$171 for additional maintenance, and \$207 for insurance.

Biodiversity and Ecosystems

Introductions of ANS can drastically alter virtually every characteristic of an aquatic ecosystem. ANS can affect the "composition, density, and interactions of native species" that can then cause "significant changes to the ecosystem, such as alterations to the food webs, nutrient dynamics and biodiversity" (IDNR, 2003). Ecosystems provide a variety of services, including water quality maintenance, detoxification and decomposition of waste, climate stabilization, mitigation of natural disaster impacts, and a source of income. Several significant instances of adverse ecosystem impact include:

- **Zebra Mussel:** Zebra mussels have had some of the most dramatic impacts observed to date on ecosystems, particularly in the Great Lakes region. The mussels achieved densities as high as 700,000 per square meter, which led to a much greater filtration rate of particulate matter, resulting in much lower turbidity (Griffiths et al., 1991; MacIsaac et al., 1995). This in turn led to much greater filtration of light through the water column, which affected plant viability and substantially increased competition for food for indigenous mollusks.

¹⁰ This cost may have an adverse impact locally, but because the money is still available to be spent elsewhere, this adverse impact does not represent a true net welfare loss.

- **Round Goby:** The round goby was first introduced into the Great Lakes region via ballast water. The goby preys on benthic fauna competing with species native to the Great Lakes and takes over prime spawning sites of native species, which is changing the balance of the ecosystem. Introduction of the round goby adversely affected a number of native species, including mottled sculpin, logperch, and darters. Because of this threat, the U.S. Army Corps of Engineers and U.S. EPA have spent \$1.2 million to erect a dispersal barrier to prevent its further spread down the Chicago Sanitary and Ship Canal to the Mississippi River (Glassner-Shwayder, 1999).
- **European Ruffe:** The European ruffe preys on native fish and competes with them for habitat. It was introduced into the Great Lakes via ballast water and poses a serious threat to species like the walleye, yellow perch, and whitefish (Leigh, 1998). Populations of spawning European ruffe in the St. Louis River went from 200,000 in 1989 to 1.8 million in 1991. At the same time, populations of yellow perch, troutperch, emerald shiners, and spottail shiners decreased by 75 percent (RTF, 1992). The expected reduction in value of sport and commercial fisheries in the Great Lakes region due to the ruffe invasion is \$119 million (ANSTF, 2007).
- **Snowflake Coral:** *Carijoa riisei*, or snowflake coral, an invasive coral species, is threatening the ecosystem stability of the ecologically sensitive Northwestern Hawaiian Islands Coral Reef Ecosystem Reserve (NOAA, 2004a; Toonen, 2005). It is also a threat to the native black coral, which a local industry valued at \$30 million harvests and uses to make jewelry.

Threatened and Endangered Species

Invasions have had especially adverse impacts on threatened and endangered species by predation, alteration of habitat, or further competition for limited resources. It is estimated that non-indigenous species are a contributing factor to the endangered status of 70 percent of listed fish species, and more than half of combined endangered and threatened listings (OTA, 1993). They are also estimated to have contributed to 68 percent of fish extinctions in the last 100 years (Larson and Sytsma, 2006).

Damage to Infrastructure

Industrial facilities, such as those that purify water, generate electricity, and manufacture goods, depend on water intake structures to perform their services. These structures can often be adversely affected by ANS.

So far, zebra mussels have been the most damaging ANS introduced into U.S. fresh waters, causing particularly severe problems with water intake structures (USACE, 2002). Zebra mussels attach to surfaces of water intake structures, navigation dams, pumping stations, and gears, often making them inoperable, which inconveniences the public and costs industry significant financial losses and damages (USACE, 2002).

Hushak (1996) reports on the results of 398 surveys of Great Lakes users with lake water intake structures from 1989 to 1994 for private and public utilities, municipal water facilities, and industrial users. Extrapolating the results of this survey to all facilities in the Great Lakes yielded total monitoring and control costs of \$120 million from 1989 to 1994 with an average cost of \$30 million annually (Park and Hushak, 1998). Another study done in 1995 of the economic impact of zebra mussels (O'Neill, 1997) found that the total costs of zebra mussels control and monitoring were \$69 million, with a mean cost of \$205,570 per facility. The study results also showed that total annual expenses rose from \$234,140 in 1989 to \$17,751,000 in 1995 as the range of mussels increased (O'Neill, 1997).

Another invasive bivalve species, the Asian clam, is estimated to have caused fouling damage that cost the nuclear industry about \$1 billion per year in the early 1980s (OTA, 1993). Two other invasive bivalves, the brown mussel and the green mussel, have also caused fouling damages in the Gulf Coast region and Tampa Bay,

respectively, where each has become established, although the total economic value of the damages is not known (Benson et al., 2002; GSMFC, 2003).

Finally, invasive plant species such as hydrilla and water hyacinth can disrupt water flow in irrigation canals and in utility cooling reservoirs. Annual expenditures on aquatic weed control in the United States, much of which is spent on ANS weeds specifically, are estimated at \$110 million (Pimentel et al., 2005).

Human Health Impacts

Most new human pathogens arise by the introduction of organisms from outside the country. Although a comprehensive estimate of the monetary cost of exotic pathogens to Americans is not available, but it is certain to be considerable. Examples of exotic pathogens that pose a threat to human health in the United States include West Nile virus, avian influenza, and human immunodeficiency virus (USDA, 2007). The expansion of trade and globalization and human mobility are significant factors in the spread of human pathogens.

Though the exact nature of the link between human health impacts and ANS invasions through ballast water is poorly understood, studies have established that pathogenic invasive species can be transported in ballast water (Ruiz and Reid, 2007). Moreover, in the case of epidemic cholera, a serious human pathogen, the presence of non-native strains has already been confirmed in U.S. waters (CDC, 1993). The potential human health impacts associated with ballast water transport are an object of increasing concern. Some pathogenic bacteria identified in ballast water known to be associated with adverse human health impacts include *E. coli*, enterococci, *Vibrio cholerae*, *Clostridium perfringens*, *Salmonella spp.*, *Cryptosporidium spp.*, and *Giardia spp.*, as well as a variety of viruses (Knight et al., 1999; Reynolds et al., 1999; Zo et al., 1999).

In July 1991, a strain of *Vibrio cholerae* was identified in oysters in Mobile Bay on the Gulf Coast that was indistinguishable from a Latin American strain not endemic to the United States. An investigation indicated that the pathogen was most probably introduced from the discharge of contaminated ballast water (CDC, 1993). Because oysters are often eaten raw, this is a potential human health threat. Of the 61 cases of cholera in the United States between 1995 and 2000, 14 were caused by the consumption of undercooked seafood (Steinberg, 2001). Though it is unclear whether any of these cases were caused by exotic strains of *Vibrio cholerae*, this evidence clearly indicates that the potential exists for the transport of harmful non-native pathogens in ballast water.

As mentioned in the introduction to this section, a study by NOAA also showed the potential for pathogens to be transported in ballast water tanks, even when they are not filled. The study found that virus-like particle concentrations in sampled ballast tanks ranged from 10^7 to 10^9 per ml in residual unpumpable ballast water and from 10^7 to 10^{11} per ml in sediment porewater. Bacteria concentrations under the same conditions were 10^5 to 10^9 per ml and 10^4 to 10^8 per ml, respectively (Johengen et al., 2005). Since a critical component of the new Permit is its provisions for saltwater flushing in vessels with empty ballast tanks, removing sediments may reduce the potential for pathogen contamination.

Ballast water is also a vector for the microorganisms associated with the “red tide” or harmful algal bloom phenomenon. This phenomenon occurs when certain species of algae release toxins into an aquatic environment, which adversely impacts aquatic life and can also impact human health if fish contaminated with the toxin are consumed (WHOI, 2007). Although current USCG mandatory BMPs for all vessels with ballast tanks, codified in 33 CFR 151, require vessels not to take up ballast water in areas known to be contaminated with such organisms, the new Permit’s requirements governing ballast exchange may further reduce the spread and impact of these organisms.

8.1.3 Efficacy of Ballast Water Exchange and Saltwater Flushing

Studies have found that ballast water exchange and saltwater flushing generally reduce the quantity of ANS discharged into U.S. waters and therefore the risk of potential invasions (Johengen et al., 2005; Reid et al., 2007).

Dye tests found that 300 percent flow through exchange and empty tank refill exchange successfully displaced 80–99 percent of initial water in ballast tanks (Reid et al., 2007).

A NOAA study of saltwater exchange efficacy found that saltwater flushing results in the resuspension of 30–80 percent of sediment deposits in a given vessel (Reid et al., 2007). As sediments are one potential vector for introductions, reducing sediments in tanks can in turn reduce ANS discharges. One piece of the study found that salinity alone reduces populations of several types of potential invaders, including most phytoplankton species, rotifers, cladocerans, and some copepods and flatworms. Results were less conclusive for several other important types of potential invasive species, including pathogens, bivalves, crabs, barnacles and shrimp (Reid et al., 2007).

All available studies conclude that mandatory ballast water management practices are a valuable tool in combating invasions, and should be extended to vessels with empty tanks and vessels not departing the EEZ, as the new EPA Permit will do in some cases.

8.1.4 Benefits of Reducing ANS Introductions

The evidence presented in *Section 8.1.2: ANS Impacts* demonstrates that introductions of ANS through ballast water are associated with significant detrimental impacts throughout the United States. The ballast water provisions of EPA's proposed Commercial Vessel General Permit, to the degree that they fill a gap in the existing ballast water management practices, can therefore be expected to generate benefits by reducing the risk of such damages in the future. Benefits would include the prevention of damages to fisheries, tourism, and recreation, of damages to infrastructure, and of adverse human health impacts, as well as prevention of further stresses on native biodiversity and ecosystems.

The issue of ANS invasions and their impacts presents unique challenges for the estimation of the benefits associated with this Permit. Although ballast water is one of the major pathways of invasive species introduction, estimating changes in risk of introduction of invasive species from the Permit requirements is not feasible due to the lack of data on rates of invasive species introduction associated with ballast water releases. Moreover, because the type of species introduced in the future is unknown and the range of potential economic impacts associated with each species type is very large, estimating the monetary value of benefits from preventing future invasions with a reasonable degree of certainty would not be possible.

Commercial and Recreational Fisheries

A reduction in the number of ANS introductions due to the proposed ballast management requirements and other Permit requirements may prevent significant future damages to commercial and recreational fisheries that play a critical role in the U.S. economy. In 2006, 9.5 billion pounds of commercial landings were made by U.S. fishermen at U.S. ports, and were valued at \$4 billion (NMFS, 2007). An additional 29.9 million anglers aged 16 and older spent an average of 17 days fishing in 2006, spending more than \$40 billion dollars on trips, equipment, licenses, and other costs (USDOJ, 2007). Leigh (1998) estimated the annual reduction in value of yellow perch, walleye, and whitefish fisheries due to ruffe invasion under moderate scenario assumptions to be \$119 million (in 1998 dollars; \$153 million (2007\$) inflated using the Consumer Price Index (CPI)).

Other Water-Based Recreation and Tourism

Another source of potential benefits from the reduction of ANS introductions under the Permit will be the prevention of damages to valuable recreation and tourism sites. A report by NOAA (2004b) estimated the annual revenue associated with coastal tourism in the United States to be \$54 billion, and found that beaches are the most popular tourist destinations in the United States. One invasive plant species alone, hydrilla, is associated with \$14.5 million annually in control costs, and reduces lake recreation on two Florida lakes alone by \$11 million in years when hydrilla covers the lakes (Pimentel et al., 1999). Since data are limited on the impacts of invasive species on recreation and tourism in ecosystems for which estimated rates of invasion exist, it is not possible to

calculate the level of expected benefits for other water-based recreation and tourism. However, EPA projects that there will be some incremental benefits.

Biodiversity and Ecosystems

Additional significant benefits from the Permit will accrue to biodiversity and ecosystems. As detailed in *Section 8.1.2: ANS Impacts*, ANS are associated with substantial adverse impacts on the composition of ecosystems and the biodiversity therein. The quantification of biodiversity benefits will not be attempted in this analysis due to the great deal of uncertainty surrounding the impact of a single ANS introduction on a given ecosystem relative to other factors, as well as the difficulty. However, potential benefits in the form of preservation of habitat and species are likely.

Threatened and Endangered Species

The Permit requirements for ballast water management, by reducing the impacts of invasive species introductions on threatened and endangered species, will have benefits in terms of prevention of reduction in species population and species extinction. Total federal spending nationwide on programs related to the Endangered Species Act for 2004, the most recent year for which data are available, was more than \$1.2 billion, and state spending was more than \$200 million (USFWS, 2005).

As mentioned above, ANS are considered likely contributors to the threatened or endangered status of 70 percent of listed fish species (Larson and Sytsma, 2006). Combined federal and state expenditures per listed species of fish in 2004 ranged from \$25,000 to \$1.09 million (USFWS, 2005). It is not possible to calculate a range of benefits to threatened and endangered species associated with EPA's Permit requirements, due to the lack of research linking specific invasions with quantifiable impacts on particular species. However, it is likely that some proportion of potential future expenditures on endangered and threatened fish, as well as expenditures on other aquatic endangered species, would be averted by reduced ANS introductions under the Permit requirements.

Damage to Infrastructure

Another benefit of the Permit requirements for ballast management will result from averting damages to infrastructure by invasive species of plants and mollusks. Fouling by species such as the Asian clam, zebra mussel, and hydrilla has caused substantial economic damage to a variety of municipal and industrial entities in the past. Most of this damage takes the form of clogging water intake structures and disrupting the flow of water. One study estimated fouling damage to water intake infrastructure by zebra mussels for the year 2000 to be \$5 billion (Khalanski (1997), and cited in Pimentel et al. (1999); \$6.1 billion in 2007\$ using CPI).

Human Health

Estimating expected human health benefits of EPA's Permit is not feasible due to very limited data on the rates of non-endemic pathogen invasions and the human health effects of these pathogens. Nevertheless, the Permit provisions are likely to reduce the probability of introduction of harmful exotic pathogens and thus are expected to benefit human health.

Summary of Benefits

The ballast water management practices established in this Commercial Vessel General Permit are designed to directly address the likelihood of future ANS invasions. The categories of potential damages from such ANS invasions have been discussed above, and studies referenced as to the potential magnitude of these damages for each. To the degree that these damage estimates provide an indicator of the likely payback that can be anticipated from reducing ANS invasions, EPA believes the benefits of this Permit can be expected to be very significant. However, the complexity of the ANS issue, the wide range and varied nature of impacts these invasions can

cause, and the great breadth of the scope of this Permit prohibit EPA from developing a quantified estimate of these benefits.

8.2 Benefits of Reduced Pollutant Discharges from Vessels

8.2.1 Introduction and Background

The Clean Water Act and its associated regulations have greatly improved the quality of the nation's waters over the past 35 years. Nevertheless, large portions of the United States' fresh and saline waters remain degraded by elevated concentrations of harmful pollutants. EPA's 2007 National Water Quality Inventory Report to Congress found that 45 percent of assessed rivers and streams; 47 percent of assessed lakes, ponds, and reservoirs; and 32 percent of assessed bays and estuaries were classified as impaired for at least one of their designated uses (EPA, 2007c).¹¹ These impairments are associated with a variety of economic and ecological damages throughout the country.

Many of the discharges regulated by EPA's Commercial Vessel General Permit (2008b) were previously regulated under select circumstances. Several discharges are associated with a wide variety of harmful pollutants in substantial concentrations. For example, untreated graywater may contain pathogenic bacteria, toxic and carcinogenic organic and inorganic compounds, nutrients, and metals (EPA, 2007a).

The Permit covers many discharges and contains special provisions for numerous vessel types (see EPA (2008b) for information on the affected discharges and provisions by vessel type). Because of the breadth of coverage and provisions in the Permit, the following discussion does not address all of these provisions individually, but focuses on the more important changes in Permit coverage for certain types of vessel discharges. Previous sections of this analysis address its most critical provisions, which will close a number of gaps in existing coverage of pollutant discharges and will generate significant potential benefits for aquatic ecosystems. These benefits will be likely to occur mostly in waterways receiving the greatest amount of vessel traffic.

8.2.2 Pollutants Commonly Found in Vessel Discharges

The numerous individual harmful constituents of vessel discharges may be grouped into six broad categories: nutrients, pathogens, oil and grease, metals, other pollutants with toxic effects, and other non-toxic pollutants. Many of the 26 types of discharges covered by EPA's Permit are associated with one of these six types of pollution. *Table 8-3* summarizes pollutant types potentially reduced by Permit requirements.¹²

¹¹ States are responsible for assessing impairment of water bodies. States assessed 19 percent of rivers and streams; 37 percent of lakes, ponds, and reservoirs; and 35 percent of bays and estuaries in the reporting cycle summarized in this report.

¹² The effect of ballast water provisions on risk of introduction of ANS is discussed in the preceding section.

Table 8-3: Pollutants Found in Vessel Discharges^a

Type of Discharge	Nutrients	Pathogens	Oil & Grease	Metals	Other Toxics	Other Non-Toxics
Deck Runoff	x		x	x	x	x
Bilgewater	x		x	x	x	
Anti-fouling Hull Coating				x	x	
AFFF					x	
Boiler Blowdown					x	x
Cathodic Protection				x		
Chain Locker Effluent			x	x		
Controllable Pitch Propeller Hydraulic Fluid			x	x		
Elevator Pit Effluent	x			x	x	
Firemain Systems	x			x	x	x
Freshwater Layup					x	
Gas Turbine Wash Water			x		x	
Graywater	x	x	x	x	x	x
Motor Gasoline and Compensating Discharge				x	x	
Non-Oily Machinery Wastewater			x	x	x	
Refrigeration and Air Condensate Discharge			x		x	
Rudder Bearing Lubrication Discharge			x			
Seawater Cooling Overboard Discharge				x		x
Seawater Piping Biofouling Prevention					x	
Small Boat Engine Wet Exhaust			x		x	
Sonar Dome Discharge				x	x	
Underwater Ship Husbandry				x		
Welldeck Discharges	x	x	x	x	x	x

Source: Battelle (2007)

a: Other Permit requirements that could not be firmly linked to one of these six categories of pollutants are excluded from the table.

Several types of discharges covered by EPA's Permit have particularly significant pollutant constituents and therefore also may be associated with substantial incremental benefits. They are described in more detail below.

Graywater

Untreated graywater, as defined in *Section 4.2: Graywater*, contains multiple constituents of concern, including pathogenic bacteria, toxic and carcinogenic organic and inorganic compounds, nutrients, and metals (EPA, 2007a). *Table 8-4* summarizes the rates of discharge for major pollutants found in graywater in an EPA survey of cruise ships. The same survey found that total graywater discharge volumes ranged from 36 to 119 gallons/day/person, with a mean value of 67 gallons/day/person.

Type of Discharge	Average Concentration of Pollutants ^a	EPA NRWQC Standard ^b
Ammonia – Nitrogen	2130-2210 µg N/L	2140-15,600 µg N/L CMC, 321-2960 µg N/L CCC
Nitrate	0.009-0.0872 mg/L	-----
Total Kjeldahl Nitrogen	11.1-26.2 mg/L	-----
Total Phosphorus	3.34-10.1 mg/L	-----
Fecal Coliform	2,950,000 MPN/100 mL	43 MPN/100 mL
Enterococci	8920 MPN/100 mL	35 MPN/100 mL
Hexane Extractable Material ^c	78-149 mg/L	-----
Arsenic	1.22-2.25 µg/L	0.14 µg/L
Copper ^d	483-510 µg/L total, 195 µg/L dissolved	74 µg/L CMC, 8.2 µg/L CCC
Nickel	29.7-48.7 µg/L total, 18.2 µg/L dissolved	4.8 µg/L CMC, 3.1 µg/L CCC
Thallium	0.93 µg/L total, 0.403 µg/L dissolved	0.47 µg/L (in shellfish)
Zinc	790-2540 µg/L total, 1610 µg/L dissolved	90 µg/L CMC, 81 µg/L CCC
Bis(2-ethylhexyl) phthalate	22.4-71.9 µg/L	2.2 µg/L
Tetrachloroethylene	10.7-11.4 µg/L	3.3 µg/L
Phenol	1.16-52.5 µg/L	-----
Total Residual Chlorine ^e	372 µg/L	13 µg/L CMC, 7.5 µg/L CCC
Chlorides	125 mg/L	-----

Source: EPA (2007a)

Note: Because of the quantity of metals and toxics detected, only pollutants exceeding EPA's national recommended water quality criteria (NRWQC) or pollutants discussed elsewhere in this analysis are listed here.

a Ranges presented in this table represent differences in reported concentrations between data from the Alaska Cruise Ship Initiative of the Alaska Department of Environmental Conservation (ACSI/ADEC), and EPA's own data, both presented in EPA (2007a).

b EPA has not set NRWQC for all pollutants of interest. CCC is an abbreviation for Criterion Continuous Concentration, a long-term measure of pollutant loading. CMC is Criterion Maximum Concentration, a short-term measure.

c Hexane extractable material is considered an indicator of level of oil and grease contamination.

d ACSI/ADEC did not conduct separate sampling for dissolved metals, so a range is not listed for dissolved metals.

e EPA did not sample total residual chlorine; ACSI/ADEC did not sample chloride.

Previously, discharges of graywater have been largely unregulated at the federal level in the territorial waters of the United States, with two exceptions: the Great Lakes, where graywater discharges must be treated similarly to sewage discharges under the Clean Water Act; and the territorial waters of Alaska, where graywater discharges by cruise ships within the territorial waters are subject to discharge standards. Maine, Washington, Hawaii, and Florida also have state-level programs to reduce the impacts of graywater discharges from cruise ships. (See *Chapter 4: Permit Overlap with Existing Regulations* for a detailed breakdown of these requirements.)

Under the new Permit, all vessels must minimize discharges of graywater in port, and large oceangoing vessels must not discharge graywater within 1 nm of shore if they have the capacity to store it. Vessel operators should also use biodegradable detergents, and must use non-toxic and phosphate-free soaps and detergents, which will reduce harmful constituents of discharges. Phosphate-based soaps and detergents are a source of phosphorus, which is a limiting nutrient in freshwater systems. Finally, medium- and large-sized cruise ships, as well as large ferries, will be subject to stricter requirements, including effluent standards for discharges within 1 nm of shore and requirements to discharge while underway at a speed of 6 knots or greater between 1 and 3 nm from shore. Because cruise ships and ferries have the largest numbers of passengers and crew, these requirements will have a particularly significant positive impact on receiving waters.

Bilgewater

Bilgewater is water from a variety of sources, including wastewater and leakage, that drains into a compartment in a vessel's inner hull. Known pollutant constituents of bilgewater include nutrients, pathogens, oil and grease,

metals, and toxic and/or carcinogenic compounds (EPA and DOD, 1999). It is difficult to assess an average rate of bilgewater production, as rates of generation vary widely by vessel size and type.

The constituents of bilgewater that are of greatest concern from an environmental perspective are oil and grease. Current regulations require the use of oily-water separators prior to discharging bilgewater for all vessels weighing more than 400 tons. However, this practice does not eliminate all oil and grease from discharges, but merely reduces it to a level below 15 ppm (EPA and DOD, 1999). Furthermore, the use of oily-water separators does not have any significant impact on concentrations of other pollutants found in bilgewater.

EPA's Permit addresses this problem by retaining existing requirements governing untreated bilgewater, and adds requirements that "MARPOL" vessels weighing more than 400 tons not discharge any bilgewater within 1 nm of shore, and only discharge treated bilgewater between 1 and 3 nm from shore if underway at a speed of at least 6 knots. It also requires that all vessels reduce bilgewater discharges to the minimum levels required to operate the vessel safely (EPA, 2008b). Though these requirements will not eliminate all discharges of harmful pollutants via bilgewater, they will reduce the loads in areas with heavy vessel traffic that are in nearshore environments.

Aqueous Film-Forming Foam

Aqueous film-forming foam (AFFF) is a relatively rare type of discharge compared to many of the discharges covered by EPA's Permit, but it is associated with potentially substantial adverse impacts to human health and ecosystems due to the toxic and carcinogenic constituents of some formulations. The primary constituents of concern are perfluorooctane sulfonate (PFOS) and perfluorooctanoic acid (PFOA), although AFFF discharges may be mixed with firemain water, which can contain bis(2-ethylhexyl) phthalate, nutrients, and metals (EPA and DOD, 1999; Scheffey and Hanauska, 2002).¹³

3M Inc., the largest U.S. manufacturer of PFOS-based AFFF, voluntarily began to phase out production in 2000 due to suspicion of toxicity and carcinogenicity, and had ceased production altogether by fall 2001 (Scheffey and Hanauska, 2002). EPA then published a rule that requires companies to file notice if they intend to manufacture or import any of the PFOS-based substances that 3M phased out, effectively ending all manufacture. However, remaining stocks of PFOS-based AFFF may still be in use.

There is still a lack of understanding as to the extent to which PFOA and its telomers enter the environment through various discharges, so these chemicals remain legal to manufacture and distribute in the United States, including in AFFF. EPA has nonetheless encouraged participation of U.S. businesses in its voluntary 2010/15 PFOA Stewardship Program, in which businesses agree to eliminate 95 percent of PFOA use by 2010 and 100 percent by 2015 (EPA, 2007d).

AFFF discharges were previously not regulated, but under EPA's Permit, they are heavily restricted. Vessels that regularly sail outside the U.S. EEZ may not discharge AFFF within the EEZ except in emergencies, and vessels that do not sail outside the EEZ must collect all discharged AFFF and dispose of it onshore. Additionally, non-fluorinated firefighting foams are recommended for use in all vessels.

8.2.3 Pollutant Impacts

Vessel discharges contain a wide variety of pollutants with the potential to cause ecological and economic harm to aquatic species and their habitat. The relationship between types of pollutants and associated discharges is summarized in *Table 8-4: Types of Pollutants Found in Graywater Discharges*, above.

¹³ Scheffey and Hanauska's report discusses AFFF with respect to the aviation industry; however, similar formulations are used onboard vessels.

Nutrients

Nutrient pollution, including nitrogen and phosphorus, is a component of vessel discharges and a major source of water quality degradation throughout the United States (USGS, 1999). Though traditionally associated with agricultural runoff from fertilizer, sewage treatment facilities, and urban stormwater, a variety of other sources do exist, including graywater and bilgewater discharges from ships.

Nutrient pollution is associated with a variety of negative environmental impacts, the most notable of which is eutrophication, which can lead to reduced levels of dissolved oxygen due to increased demand (sometimes to the extremes of hypoxia), reduced levels of light penetration and turbidity, and changes in the composition of aquatic flora and fauna (National Research Council, 2000). It also helps to fuel the harmful algal blooms described in *Section 8.1.2: ANS Impacts*, which can have devastating impacts on both aquatic life and human health, if affected organisms are consumed (WHOI, 2007). The impacts of these water quality reductions on recreation and fishing can be significant, particularly in estuaries. For example, a 1989 study found that a hypothetical 20 percent reduction in nitrogen and phosphorus loading in the Chesapeake Bay would result in an increase in recreation worth \$34.6 million (in 1984 dollars) from increased public beach usage (National Research Council, 2000). Nutrient pollution has also contributed to the decline of the Chesapeake crab fishery, due to its role in degrading underwater vegetation, which serves as an important habitat for post-larval crabs (Maryland DLS, 2005).

Pathogens

Pathogens are another important constituent of discharges from vessels, particularly in graywater. EPA's study of graywater discharges from cruise ships found that levels of pathogen indicator bacteria exceeded enterococci standards for marine water bathing and fecal coliform standards for harvesting shellfish 66 percent and over 80 percent of the time, respectively (EPA, 2007a). Specific pathogens of concern found in graywater include *Salmonella*, *E. coli*, enteroviruses, hepatitis, and pathogenic protists (National Research Council, 1993). Elevated levels of these pathogens have increasingly resulted in beach closures in recent years, which in turn have reduced the recreational value of impacted beaches (NRDC, 2005).

Though it is difficult to determine the precise contribution of vessel discharges to infections by these organisms, epidemiologists have attempted to quantify the proportion of total infections that are waterborne. For example, waterborne infection may account for as many as 60 percent of *Giardia* infections and 75 percent of pathogenic *E. coli* infections (National Research Council, 1993). Graywater discharges are a significant source of pathogenic microorganisms within the regulated waters, and reducing them would likely be associated with non-negligible human health benefits.

Oil and Grease

Oil and grease are another known component of vessel discharges with potentially harmful impacts to humans and to aquatic life. Oil in vessel discharges is required to be discharged in concentrations that may not be harmful, consistent with existing regulation. The Group of Experts on the Scientific Aspects of Marine Environmental Protection (GESAMP), a United Nations body, found that voluntary vessel discharges account for less than 1 percent of vessel oil discharges into the marine environment (GESAMP, 2007). However, vessel discharges may still contain enough oil to do ecological damage, even if they meet existing concentration requirements and account for a small percentage of total oil discharges worldwide. Oils are highly toxic and carcinogenic, and may inhibit reproduction and cause organ damage or even mortality (AMSA, 2003). Additionally, oil can taint organisms that are consumed by humans, which is a potential source of adverse health impacts.

Metals

Metals are a diverse group of pollutants, many of which are toxic to aquatic life and humans. Vessel discharges can contain a variety of metal constituents. For example, EPA's study of cruise ship graywater found a total of 13

different metals in at least 10 percent of samples, with copper, nickel, and zinc detected in 100 percent of samples (EPA, 2007a). Bilgewater also contains these constituents and likely others (Battelle, 2007).

While some metals, including copper, nickel, and zinc, are known to be essential to organism function, many others, including thallium and arsenic, are non-essential or are known to have only adverse impacts. Even essential metals can do serious damage to organism function in sufficiently elevated concentrations. Adverse impacts can include impaired organ function; impaired reproduction and birth defects; and, at extreme concentrations, acute mortality. Additionally, through a process known as bioaccumulation, metals may not be fully eliminated removed from blood and tissues by natural processes, and may accumulate in predator organisms further up the food chain (EPA, 2007b). This process can result in adverse health impacts for humans, who may consume contaminated fish and mollusks.

However, the impacts of metals on any given ecosystem are difficult to predict, due to the relatively complicated circumstances by which they are available to organisms. Bioavailability of metals, and therefore impacts, varies by species of organism, as well as by climate and chemistry of a water body (John and Leventhal, 1996). Moreover, background levels of metals can vary substantially by location (EPA, 2007b).

Other Pollutants with Toxic Effects

The term “other pollutants with toxic effects,” as it applies to constituents of vessel discharges, encompasses a variety of chemical compounds known to have a broad array of adverse impacts on aquatic species and human health. For example, EPA’s study of cruise ship graywater found a total of 16 different volatile and semi-volatile organic compounds in at least 10 percent of samples, for which the most significant rates and levels of detection were phthalates, phenol, and tetrachloroethylene. Other notable pollutants with toxic effects detected included free residual chlorine and chlorides.

These compounds can cause a variety of adverse impacts on ecosystems, including fisheries, as well as on human health. Phthalates are known to interfere with reproductive health and liver and kidney function in both animals and humans (Sekizawa et al., 2003; DiGangi et al., 2002). Chlorine, though toxic to humans at high concentrations, is of much greater concern to aquatic species, which can experience respiratory problems, hemorrhaging, and acute mortality even at relatively low concentrations (EPA, 2007a).

PFOS and PFOA, potentially found in AFFF discharges, are persistent, bioaccumulative chemical compounds. A United Kingdom study found that PFOS is toxic to humans and wildlife, and carcinogenic in humans (Footitt et al., 2004). 3M, the only U.S. manufacturer of PFOS-based AFFF, voluntarily ceased production in 2002, and EPA enacted an effective ban on the substance due to concerns about its impacts on human health and wildlife. However, existing stocks may still be in use (EPA, 2007d). The health impacts of PFOA and its telomers are not as well understood, particularly in aquatic environments, but EPA’s Science Advisory Board has concluded that PFOA “is likely to be carcinogenic in humans” (SAB, 2006).

Other Non-Toxic Pollutants

The category “other non-toxic pollutants” includes all non-conventional pollutants except fecal coliform (discussed in pathogens) as applied to vessel discharges also consists of multiple pollutants with disparate impacts. The most important types are pH pollution and thermal pollution, which can be found in several of the covered discharges, including graywater and bilgewater.

Some vessel discharges are more acidic or basic than the receiving waters, which can have a localized effect on pH (ADEC, 2007). Though no research has been done linking vessel pollution specifically to pH impacts on aquatic ecosystems, extensive literature on the impacts of pH changes in the contexts of aquaculture and acid rain does exist. For nearly all fish populations, pH more acidic than 5 or more basic than 10 will cause rapid mortality,

and many individual species are sensitive to more moderate changes in pH (EPA, 2007e; Wurts and Durborrow, 1992).

Some vessel discharges may also be warmer or colder than the ambient temperature of the receiving water, which can affect temperature locally (Battelle, 2007). Thermal impacts of vessel discharges are generally much smaller than those from better-known sources such as dams, power plant cooling water, and runoff, due to scale. However, even small temperature changes can impact some sensitive organisms' growth, reproduction, and even survival, which implies that some vessel discharges may have adverse impacts on aquatic ecosystems, and also fisheries (Abbaspour et al., 2005; Cairns, 1972; Govorushko, 2007).

8.2.4 Benefits of Reducing Pollutant Discharges

Many of the nation's busiest ports are considered to be impaired by a variety of pollutants found in vessel discharges, as is summarized in *Table 8-5*. The Permit is expected to reduce discharges of nutrients, metals, oil, grease, toxics, and other pollutants in waters with high levels of vessel traffic.

Port	Impairments by Pollutants Found in Vessel Discharges
Houston, TX	Bacteria, Nutrients ^a
New York City, NY	Nitrogen, Oxygen Demand, ^b Cadmium, Mercury
Port Everglades, FL	Fecal Coliform, Dissolved Oxygen, Nutrients
Miami, FL	None listed
Los Angeles/Long Beach, CA	Polycyclic Aromatic Hydrocarbons (PAHs), ^c Zinc, Copper, Chromium, Lead, Mercury, Cadmium, Nickel
San Juan, PR	Ammonia, Fecal Coliform, Dissolved Oxygen
Savannah, GA	Mercury, Dissolved Oxygen
St. Thomas, Virgin Islands	Dissolved Oxygen, Fecal Coliform, Oil and Grease, pH
Seattle, WA	PAHs, Fecal Coliform, pH
New Orleans, LA	Fecal Coliform
Charleston, SC	None listed
Baltimore, MD	Zinc, Chromium
Elizabeth River, VA	Phosphorus, Fecal Coliform
Oakland, CA	Mercury, Selenium
Bayou Lafourche, LA	Dissolved Oxygen, Nutrients, Total and Fecal Coliform
Galveston, TX	Bacteria
Tacoma, WA	Bis(2-ethylhexyl) phthalate, PAHs
Jacksonville, FL	Coliform, Nutrients, Turbidity
South Louisiana, LA	Fecal Coliform

Source: Battelle (2007)

a Two of the listed pollutants are found in the areas surrounding the shipping route through the Bay of Galveston to Houston, rather than in the Port of Houston itself.

b Oxygen demand is associated with eutrophication (see the subsection on Nutrient pollution).

c PAHs are a subset of volatile and semi-volatile organic compounds and are associated with petroleum products.

These impacts will be particularly significant in those nutrient-impaired areas frequented by cruise ships (e.g., San Francisco Bay and Chesapeake Bay), which can discharge large volumes of graywater and are subject to stringent discharge requirements under the Permit. For example, phosphorus loading could be reduced by 6 lbs to 18.1 lbs, and zinc loading could be reduced by 1.42 lbs to 4.56 lbs per day. *Table 8-6* summarizes the daily pollutant loadings likely to be prevented for an average large cruise ship, as the term is defined in the Permit language.^{14,15}

¹⁴ Daily loadings are calculated by taking average passenger capacity for a large cruise ship and multiplying by the average per-person discharge rate found in EPA (2007b). This assumes that some vessels currently remain in waters subject to the Permit requirements for

Table 8-6: Potential Daily Reduction in Loadings of Pollutants from Graywater Discharges by a Large Cruise Ship in U.S. Territorial Waters

Pollutant	Average Graywater Generated per Day (L) ^a	Average Pollutant Concentration in Untreated Graywater	Reduction in Pollutant Loading per Day (g)
Ammonia - Nitrogen	814,382	2,130-2,210 µg N/L	1,734-1,800
Nitrate	814,382	0.009-0.0872 mg/L	7.33-71.01
Total Kjeldahl Nitrogen	814,382	11.1-26.2 mg/L	9,040-21,337
Total Phosphorus	814,382	3.34-10.1 mg/L	2,720-8,225
Hexane Extractable Material	814,382	78-149 mg/L	63,522-121,343
Arsenic	814,382	1.22-2.25 µg/L	0.994-1.83
Copper	814,382	483-510 µg/L	393-415
Nickel	814,382	29.7-48.7 µg/L	24.2-39.7
Thallium	814,382	0.93 µg/L	0.757
Zinc	814,382	790-2540 µg/L	643-2,069
Bis(2-ethylhexyl) phthalate	814,382	22.4-71.9 µg/L	18.2-58.6
Tetrachloroethylene	814,382	10.7-11.4 µg/L	8.71-9.28
Phenol	814,382	1.16-52.5 µg/L	0.945-42.8
Total Residual Chlorine	814,382	372 µg/L	303
Chlorides	814,382	125 mg/L	102

Sources: EPA (2007a)

a EPA (2007a) estimates average graywater generated per person per day onboard cruise ships to be 67 gallons, which was multiplied by 3,211 (the average passenger capacity for the "large cruise ship" Permit category) and converted to liters for compatibility with pollutant concentration data. Since crews also generate graywater, this number may underestimate actual graywater generation rates.

The evidence presented in the pollutant impacts section demonstrates that vessel discharges, particularly ANS spread by ballast water, are associated with significant detrimental impacts throughout the United States. Controls on specific discharges, as well as general housekeeping requirements of the Permit, can be expected to generate benefits through reducing the risk of damages in the future and making water quality improvements in already-impaired waters. Monetized benefits will include the prevention of fishery closures and of adverse human health impacts, as well as increased opportunities for recreation. Non-monetized benefits will include prevention of further stresses on biodiversity and ecosystems. Though the magnitude of benefits is not calculable, *Table 8-7* presents a summary of potential benefits resulting from the Permit requirements.

multiple days, and thus discharge graywater equivalent to the generation rate on each subsequent day after maximum storage capacity is reached.

¹⁵ *E. Coli* and enterococci, which are found in *Table 8-4*, were excluded from *Table 8-6* because concentration, rather than total loading, is the primary metric of interest for pathogens.

Table 8-7: Benefits of Reducing Pollutants Found in Vessel Discharges						
Type of Benefit	Nutrients	Pathogens	Oil & Grease	Metals	Other Toxics	Other Non-Toxics
Human Health	x	x	x	x	x	
Biodiversity	x		x	x	x	x
Ecosystem Function	x		x	x	x	x
Improved Fishery Conditions	x	x		x	x	x
Increased Opportunities for Recreation	x	x			x	

References

- 33 CFR 121.201. Small Business Size Regulations. Available at <http://frwebgate.access.gpo.gov/cgi-bin/get-cfr.cgi>. Accessed February 21, 2008.
- 33 CFR 151. Vessels Carrying Oil, Noxious Liquid Substances, Garbage, Municipal or Commercial Waste, and Ballast Water. Available at: http://www.access.gpo.gov/nara/cfr/waisidx_07/33cfr151_07.html. Accessed December 4, 2007.
- 33 CFR 155. Oil or Hazardous Material Pollution Prevention Regulations for Vessels. Available at: http://www.access.gpo.gov/nara/cfr/waisidx_07/33cfr155_07.html. Accessed December 4, 2007.
- 33 CFR 159.309. Marine Sanitation Devices: Limitations on Discharge of Treated Sewage or Graywater. Available at: http://a257.g.akamaitech.net/7/257/2422/11sep20071500/edocket.access.gpo.gov/cfr_2007/julqtr/33cfr159.309.htm. Accessed December 4, 2007.
- 40 CFR 122. EPA Administered Permit Programs: The National Pollutant Discharge Elimination System. Available at: http://www.access.gpo.gov/nara/cfr/waisidx_07/40cfr122_07.html. Accessed December 4, 2007.
- 40 CFR 302. Designation, Reportable Quantities, and Notification. Available at: http://www.access.gpo.gov/nara/cfr/waisidx_07/40cfr302_07.html. Accessed December 4, 2007.
- 70 CFR 168. Ballast Water Management for Vessels Entering the Great Lakes That Declare No Ballast Onboard. Available at: http://www.uscg.mil/hq/g-m/mso/docs/nobob_policy_fr.pdf. Accessed February 14, 2008.
- 5 USC § 605(b). Regulatory Flexibility Act: Avoidance of Duplicative or Unnecessary Analyses. Accessed Available at <http://www.archives.gov/federal-register/laws/regulatory-flexibility/605.html>. Accessed February 21, 2008.
- 33 USC § 1251 et seq. Federal Water Pollution Control Act. Available at <http://epa.gov/region5/water/pdf/ecwa.pdf>. Accessed December 4, 2007.
- 33 USC § 1901 et seq. Act to Prevent Pollution from Ships. Available at http://www.access.gpo.gov/uscode/title33/chapter33_.html. Accessed December 4, 2007.
- 33 USC § 2401 et seq. Organotin Anti-fouling Paint Control Act. Available at http://www.access.gpo.gov/uscode/title33/chapter37_.html. Accessed December 4, 2007.
- 42 USC § 9601 et seq. Comprehensive Environmental Response, Compensation and Liability Act. Available http://www.access.gpo.gov/uscode/title42/chapter103_.html. Accessed December 4, 2007.
- Abbaspour, M., A.H. Javid, P. Moghimi, and K. Kayhan. 2005. Modeling of Thermal Pollution in Coastal Area and its Economical and Environmental Assessment. *International Journal of Environmental Science and Technology*. 2(1): 13-26.
- Abt Associates Inc., 2005. Qualitative Benefits Assessment for Proposed Ballast Water Discharge Standards. Memo to U.S. Environmental Protection Agency.
- Alaska Department of Environmental Conservation (ADEC). 2007. Large Commercial Passenger Vessel Wastewater Discharge: General Permit Information Sheet. Available at: http://www.dec.state.ak.us/water/cruise_ships/pdfs/GP%20Information%20Sheet.pdf.
- Aquatic Nuisance Species Task Force (ANSTF). 2007. ANS Impacts. Available at: <http://www.anstaskforce.gov/impacts.php>. Accessed December 27, 2007.

- Australian Maritime Safety Authority (AMSA). 2003. Effects of Oil on Wildlife. Available at: http://www.amsa.gov.au/Marine_Environment_Protection/Educational_resources_and_information/Teachers/The_Effects_of_Oil_on_Wildlife.asp.
- Battelle. 2007. Technical Support for EPA Development of a Permitting Framework to Address the Vacatur of the NPDES Vessel Exclusion. Revised Draft, September 2007.
- Benson, A.J., D.C. Marelli, M. E. Frischer, J.M. Danforth, and J.D. Williams. 2002. Establishment of the green mussel, *Perna viridis* (Linnaeus 1758), (Mollusca: Mytilidae) on the west coast of Florida. Available at: <http://cars.er.usgs.gov/posters/index.html>. Accessed February 14, 2008.
- Boniface, D.E., LCDR. 2004. A Decision Analysis Framework for Evaluating Ballast Water Management Strategies. U.S. Coast Guard.
- Bourdeau, P. and M. Treshow. 1978. Ecosystem Response to Pollution. In Butler, G.C. (ed). *Principles of Ecotoxicology*. John Wiley & Sons, Chichester. Available at <http://globalecology.stanford.edu/DGE/SCOPE/SCOPE%2012/SCOPE%2012.html>. Accessed December 21, 2007.
- Cairns, John Jr. 1972. Environmental Quality and the Thermal Pollution Problem. In Farvar, M.G. and J.P. Milton. (eds.) *The Careless Technology: Ecology and International Development*. The World Conservation Union. Garden City, NY: Natural History Press. Available at: <http://www.iucn.org/themes/ceesp/Publications/SL/CT.htm>. Accessed February 14, 2008.
- Cal. Pub. Res. Code. 71200-71271. Ballast Water Management for the Control of Nonindigenous Species. Available at: <http://www.leginfo.ca.gov/cgi-bin/calawquery?codesection=prc&codebody=&hits=20>. Accessed February 14, 2008.
- Cal. Pub. Res. Code. 72420-72425. California Clean Coast Act. Available at: <http://www.leginfo.ca.gov/cgi-bin/calawquery?codesection=prc&codebody=&hits=20>. Accessed February 14, 2008.
- Centers for Disease Control (CDC). 1993. *Isolation of Vibrio Cholera 01 from Oysters – Mobile Bay, 1991, 1992*. Morbidity and Mortality Weekly Report, Feb. 12, 1993, Vol. 42(05); 91-93.
- Cipriano, R.C., and O. Miller. 2002. Infectious Salmon Anemia: The Current State of Our Knowledge, proceedings of the symposium ‘International Response to Infectious Salmon Anemia: Prevention, Control, and Eradication,’ USDA/USDI/USDC, New Orleans, September 3-4, 2002.
- Cohen, A.N., and J.T. Carlton, 1995. Nonindigenous Aquatic Species in a United States Estuary: A Case Study of the Biological Invasions of the San Francisco Bay and Delta, University of California at Berkeley, Williams College-Mystic Seaport.
- Cohen, Andrew N., J.T. Carlton, and M.C. Fountain. 1995. Introduction, dispersal and potential impacts of the green crab *Carcinus maenas* in San Francisco Bay, California. *Marine Biology* 122: 225-237.
- Cohen, Andrew N. 1997. Have Claw, Will Travel. *Aquatic Nuisance Species Digest*, Volume 2, No. 2, August 1997.
- Cummins, Tim CDR. U.S. Coast Guard. Personal Communication. December 20, 2007.
- Cruise Lines International Association (CLIA). “Cruise Industry Overview.” 2006. Accessed January 23, 2008. Available at http://www.cruising.org/press/overview%202006/ind_overview.cfm.
- Dawg, Inc. Personal Communication with a sales representative. January 14, 2008.

- DiGangi, J., T. Schettler, M. Cobbing, and M. Rossi. 2002. Aggregate Exposures to Phthalate in Humans. Health Care Without Harm. Available at: http://www.ecocenter.org/dust/Phthalate_hcwh.pdf. Accessed February 14, 2008.
- Dun & Bradstreet. 2006. D&B's Million Dollar Databases. Available at: <http://mddi.dnb.com/mddi/>. Accessed January 2006.
- Dun & Bradstreet. 2007. Industry Norms and Key Business Ratios.
- Eaton, J.G., J.H. McCormick, B.E. Goodno, D.G. O'Brien, H.G. Stefany, M. Hondzo, and R.M. Scheller. 1995. A field information-based system for estimating fish temperature tolerances. *Fisheries* 20:10-18.
- Enujiugha, V.N. and L.C. Nwanna. 2004. Aquatic Oil Pollution Impact Indicators. *Journal of Applied Science and Environmental Management*. 8(2): 71-75.
- Ewart, J.W., and S.E. Ford. 1993. History and Impact of MSX and Dermo diseases on Oyster Stocks in the Northeast Region. Northeast Regional Aquaculture Center: Fact Sheet No. 200.
- Footitt, A., T.A. Nwaogu, and D. Brooke. 2004. Risk Reduction Strategy and Analysis of Advantages and Drawbacks for Perfluorooctane Sulphonate (PFOS). Prepared for UK Department of Environment, Food and Rural Affairs and the Environment Agency for England and Wales by RPA and BRE Environment.
- Ghosh, Sujit. Personal Communication. 16 January 2008.
- Glassner-Shwayder, K. 1999. Great Lakes Nonindigenous Invasive Species. Briefing Paper presented at the Great Lakes Nonindigenous Invasive Species Workshop. Chicago, IL. October 20-21, 1999.
- Govorushko, S.M. 2007. Effect of Human Activity on Rivers. International Conference on River Basin Management. Organized by the General Directorate of State Hydraulic Works (DSI), Turkey. Available at: <http://www.dsi.gov.tr/english/congress2007/>.
- Griffiths, R.W., D.W. Schloesser, J.H. Leach, W.P. Kovalak. 1991. "Distribution and Dispersal of the Zebra Mussel in the Great Lakes Region." *Canadian Journal of Fishery and Aquatic Science*. 48:1381.
- Grosholz, Edwin D. 2006. Personal Communication. Department of Environmental Science and Policy, University of California, Davis.
- Group of Experts on the Scientific Aspects of Marine Environmental Pollution (GESAMP). 2007. Estimates of Oil Entering the Marine Environment from Sea-Based Activities. International Maritime Organization. GESAMP No. 75.
- Gulf States Marine Fisheries Commission (GSMFC). 2003. Fact sheet for *Perna perna*. Available at: http://nis.gsmfc.org/nis_factsheet.php?toc_id=149.
- Hushak, Leroy. 1996. "Zebra mussels cost Great Lakes water users an estimated \$120 million." ANS Update. Available at: <http://www.glc.org/ans/ansupdate/pdf/ansv2n1.html>.
- Indiana Department of Natural Resources (IDNR). 2003. Indiana Aquatic Nuisance Species (ANS) Management Plan. Phil Seng and Gwen White, Editors. Available at: <http://www.in.gov/dnr/invasivespecies/inansmanagementplan.html>.
- International Council of Cruise Lines (ICCL). 2001. Memorandum of Understanding. Available at: http://www.iccl.org/resources/fdep_mou.cfm. Accessed January 21, 2008.
- Jenkins, Phil. Personal Communication. 20 December 2007.

- Johengen, T., D. Reid, G. Fahnenstiel, H. MacIsaac, F. Dobbs, M. Doblin, G. Ruiz and P. Jenkins. 2005. Assessment of Transoceanic NOBOB Vessels and Low-Salinity Ballast Water as Vectors for Non-indigenous Species Introductions to the Great Lakes. NOAA Great Lakes Environmental Research Laboratory.
- John, D.A. and J.S. Leventhal. 1996. Bioavailability of Metals. In du Bray, E.A. (ed.) *Preliminary Compilation of Geoenvironmental Mineral Deposit Models*. United States Geological Survey.
- Khalanski M. 1997. Industrial and ecological consequences of the introduction of new species in continental aquatic ecosystems: the zebra mussel and other invasive species. *Bulletin Francais de la Peche et de la Pisciculture* 0 (344-345): 385-404.
- Knight, I.T., C.S. Wells, B. Wiggins, H. Russell, K.A. Reynolds, and A. Huq. 1999. Detection and Enumeration of Fecal Indicators and Pathogens in the Ballast Water of Transoceanic Cargo Vessels Entering the Great Lakes. Presented at the General Meeting of the American Society for Microbiology, Chicago, IL, 1999 Abstract Q-71, p. 546.
- Larson, I., and M. Sytsma. 2006. Ballast Water Management on the Columbia River. Prepared for the Puget Sound Action Team, Office of the Governor, State of Washington. Available at: <http://www.psat.wa.gov/Programs/ANS/ColumbiaRiverBWReportFinal.pdf>.
- Leigh, Peter. 1998. Benefits and Costs of the Ruffe Control Program for the Great Lakes Fishery. *Journal of Great Lakes Resources*. 24(2): 351-360.
- Licking, Ellen. 1999. "They're Here and They're Taking Over." *Business Week*, May 24, 1999.
- Lloyd's Register. "Ballast Water Management Services, Definition of Acceptable Sea State."
- Lovell, S.J., and L.A. Drake. 2007. Tiny Stowaways: What are the Potential Economic Consequences of Invasive Aquatic Microorganisms Transported by Ships? Unpublished.
- MacIsaac, H.J., C.J. Lonnee, and J.H. Leach. 1995. "Suppression of microzooplankton by zebra mussels: Importance of mussel size," *Freshwater Biology* 34(2) 379-387.
- Maehara, E. 2004. Water Monitoring: Protecting the Aquatic Environment. Hawaii Legislative Reference Bureau. Available at: <http://hawaii.gov/lrb/rpts04/watermon.pdf>. Accessed February 14, 2008.
- Marsden, J.E. and D.J. Jude. 1995. Round gobies invade North America. Great Lakes Sea Grant Network.
- McKnight, J.A. 2007. Invasive Species of Concern in Maryland: MSX. Maryland Department of Natural Resources. Available at: http://www.mdinvasivesp.org/archived_invasders/archived_invasders_2007_03.html
- Me. Rev. Stat. Ann. tit. 38, 423D. Graywater and Blackwater Discharges from Commercial Vessels. Available at: <http://janus.state.me.us/legis/statutes/38/title38sec423-D.html>. Accessed February 14, 2008.
- Michigan Department of Environmental Quality. 2006. Ballast Water Control General Permit. Available at: <http://www.deq.state.mi.us/documents/deq-water-npdes-generalpermit-MIG140000.pdf>. Accessed December 4, 2007.
- Munn, M.D., and P.A. Hamilton. 2003. "New Studies Initiated by US Geological Survey: Effects of Nutrient Enrichment on Stream Ecosystems." U.S. Geological Survey Fact Sheet 118-03. Available at: <http://pubs.usgs.gov/fs/fs11803/pdf/fs-118-03.pdf>. Accessed December 31, 2007.
- National Ballast Information Clearinghouse (NBIC). 2005. NBIC database.
- National Marine Fisheries Service (NMFS). 2007. *Fisheries of the United States, 2006*. Silver Spring, MD: National Oceanic and Atmospheric Administration.

- National Marine Manufacturers Association (NMMA). 2005. 2005 U.S. Recreational Boat Registration Statistics. National Marine Manufacturers Association.
- National Oceanic and Atmospheric Administration. September 2003. Accessed January 22, 2008. Available at <http://www.st.nmfs.noaa.gov/st1/fus/current/2002-fus.pdf>.
- National Oceanic and Atmospheric Administration (NOAA). 2004a. Snowflakes Unwelcome in the Tropics! Scientists Fight to Eradicate Invasive Coral. Coral Reef News. 1(4).
- National Oceanic and Atmospheric Administration (NOAA). 2004b. *International Year of the Ocean Fact Sheets: Coastal Tourism*. U.S. Department of Commerce. National Oceanic and Atmospheric Administration.
- National Oceanic and Atmospheric Administration (NOAA). 2005. Assessing Environmental Harm: How Toxic is Oil? Available at: [http://response.restoration.noaa.gov/topic_subtopic_entry.php?RECORD_KEY%28entry_subtopic_topic%29=entry_id,subtopic_id,topic_id&entry_id\(entry_subtopic_topic\)=243&subtopic_id\(entry_subtopic_topic\)=13&topic_id\(entry_subtopic_topic\)=1](http://response.restoration.noaa.gov/topic_subtopic_entry.php?RECORD_KEY%28entry_subtopic_topic%29=entry_id,subtopic_id,topic_id&entry_id(entry_subtopic_topic)=243&subtopic_id(entry_subtopic_topic)=13&topic_id(entry_subtopic_topic)=1). Accessed December 31, 2007.
- National Oceanic and Atmospheric Administration (NOAA). 2007. Aquatic Invasive Species Research Program. Great Lakes Environmental Research Laboratory. Available at: <http://www.glerl.noaa.gov/res/Programs/ais/>. Accessed December 27, 2007.
- National Research Council. 1993. Managing Wastewater in Coastal Urban Areas. Water Science and Technology Board.
- National Research Council. 2000. Clean Coastal Waters: Understanding and Reducing the Effects of Nutrient Pollution. Ocean Studies Board and Water Science and Technology Board.
- Natural Resources Defense Council (NRDC). 2005. Contamination Forces More Beach Closings Nationwide. Press Release. Available at: <http://www.nrdc.org/media/pressreleases/050728.asp>.
- Office of Technology Assessment (OTA) (U.S. Congress). 1993. *Harmful Non-Indigenous Species in the United States*. OTA Publication OTA-F-565. U.S. Government Printing Office, Washington DC.
- O'Neill, Jr., C.R., 1997. Economic Impact of Zebra Mussels – Results of the 1995 National Zebra Mussel Information Clearinghouse Study, New York Sea Grant Institute.
- Or. Admin. R. 340-143-0010. Ballast Water Management. Available at http://arcweb.sos.state.or.us/rules/OARs_300/OAR_340/340_143.html. Accessed February 14, 2008.
- Park, J. and L.J. Hushak. 1998. *Zebra Mussel Control Costs in Surface Water Using Facilities, Technical Summary OHSU-TS-028*. Ohio Sea Grant College Program, Ohio State University.
- Peters, David. Personal Communication. January 14, 2008.
- Pimentel, D., L. Lach, R. Zuniga, and D. Morrison. 1999. *Environmental and Economic Costs Associated with Non-indigenous Species in the United States*. The College of Agriculture and Life Sciences, Cornell University, Ithaca, NY.
- Pimentel, D., L. Lach, R. Zuniga, and D. Morrison. 2000. "Environmental and Economic Costs of Nonindigenous Species in the United States." *Bioscience*, 50(1): 53-56.
- Pimentel, D., R. Zuniga, and D. Morrison. 2005. Update on the environmental and economic costs associated with alien-invasive species in the United States. *Ecological Economics*. 52: 273-288.
- Rahel, F.J., C.J. Keleher and J.L. Anderson. 1996. Potential habitat loss and population fragmentation for cold water fish in the North Platte River drainage of the Rocky Mountains: response to climate warming. *Limnol. Oceanogr.* 41:1116-1123.

- Randall, Alan. 2001. "Dealing with the Analytical Challenges of Valuation: Aquatic Nuisance Species Control." In *Revealing the Economic Value of Protecting the Great Lakes*. The Northeast-Midwest Institute and The National Oceanic and Atmospheric Administration.
- Reference for Business. 2007a. "SIC 0912-Finfish." *Encyclopedia of American Industries*. Accessed January 24, 2008. Available at <http://www.referenceforbusiness.com/industries/Agriculture-Forestry-Fishing/Finfish.html>.
- Reference for Business. 2007b. "SIC 0913-Shellfish." *Encyclopedia of American Industries*. Accessed January 24, 2008. Available at <http://www.referenceforbusiness.com/industries/Agriculture-Forestry-Fishing/Shellfish.html>.
- Reference for Business. 2007c. "SIC 4482-Ferries." *Encyclopedia of American Industries*. Accessed January 23, 2008. Available at <http://www.referenceforbusiness.com/industries/Transportation-Communications-Utilities/Ferries.html>.
- Reference for Business. 2007d. "SIC 4489-Water Transportation of Passengers, not Elsewhere Classified." *Encyclopedia of American Industries*. Accessed January 23, 2008. Available at <http://www.referenceforbusiness.com/industries/Transportation-Communications-Utilities/Water-Transportation-Passengers-Elsewhere-Classified.html>.
- Reference for Business. 2007e. "SIC 4491-Marine Cargo Handling." *Encyclopedia of American Industries*. Accessed January 23, 2008. Available at <http://www.referenceforbusiness.com/industries/Transportation-Communications-Utilities/Marine-Cargo-Handling.html>.
- Reference for Business. 2007f. "SIC 4499-Water Transportation Services, not Elsewhere Classified." *Encyclopedia of American Industries*. Accessed January 23, 2008. Available at <http://www.referenceforbusiness.com/industries/Transportation-Communications-Utilities/Water-Transportation-Services-Elsewhere-Classified.html>.
- ReferenceUSA. 2006. Business Database. Available at: www.referenceusa.com. Accessed Jan./Feb. 2006.
- Reid, D.F., T.H. Johengen, H. MacIsaac, F. Dobbs, M. Doblin, L. Drake, G. Ruiz and P. Jenkins. 2007. *Identifying and Establishing Options for Best Management Practices for NOBOB Vessels*. NOAA Great Lakes Environmental Research Laboratory.
- Reynolds, K.A., I.T. Knight, C.S. Wells, I.L. Pepper, and C.P. Gerba. 1999. Detection of Human Pathogenic Protozoa and Viruses in Ballast Water Using Conventional and Molecular Methods. Presented at the General Meeting of the American Society for Microbiology, Chicago, IL, Abstract Q-318, p. 594.
- Risk Management Association (RMA) eStatement Studies: Annual Statement Studies, Financial Ratios and Benchmarks. 2007.
- Rockwell, Jr., H.W. 2003. "Summary of a Survey of the Literature on the Economic Impact of Aquatic Weeds." Report for the Aquatic Ecosystem Restoration Foundation. August. <http://www.aquatics.org/pubs/economics.htm>.
- Ruffe Task Force (RTF). 1992. *Ruffe in the Great Lakes: A Threat to North American Fisheries*. Great Lakes Fishery Commission. Ann Arbor, MI.
- Ruiz, G.M., A.W. Miller, K. Lion, B. Steves, A. Arnwine, E. Collinetti, and E. Wells. 2001. *First Biennial Report of the National Ballast Information Clearinghouse*. Smithsonian Environmental Research Center. Edgewater, Maryland.
- Ruiz, G.M., and D.F. Reid. 2007. Current State of Understanding about the Effectiveness of Ballast Water Exchange (BWE) in Reducing Aquatic Nonindigenous Species (ANS) Introductions to the Great Lakes Basin

and Chesapeake Bay, USA: Synthesis and Analysis of Existing Information. National Oceanic and Atmospheric Administration.

St. Lawrence Seaway Management Corporation and St. Lawrence Seaway Development Corporation. 2007. *The St. Lawrence Seaway 2006 Traffic Report*. Available at http://www.greatlakes-seaway.com/en/pdf/traffic_report_2006.pdf. Accessed December 17, 2007.

Seacor International. Personal Communication. January 7, 2008.

Scheffey, J.L., and C.P. Hanauska. 2002. Status Report on Environmental Concerns Relating to Aqueous Film Forming Foam (AFFF). Report to the Federal Aviation Administration Technology Transfer Conference. Available at: <http://www.airporttech.tc.faa.gov/naptf/att07/2002%20TRACK%20S.pdf/S15.pdf>.

Sekizawa, J., S. Dobson, and R.J. Touch III. 2003. Diethyl Phthalate. World Health Organization, Concise International Chemical Assessment Document 52.

Steinberg, E.B., et al. 2001. Cholera in the United States, 1995-2000: Trends at the End of the Twentieth Century. *Journal of Infectious Diseases*, 2001, Vol. 184, pp.799-802.

Sytma, M.D., J.R. Cordell, J.W. Chapman, and R.C. Draheim. 2004. Lower Columbia River Aquatic Nonindigenous Species Survey 2001-2004: Final Technical Report. Prepared for the U.S. Coast Guard and U.S. Fish and Wildlife Service. Available at: <http://www.clr.pdx.edu/docs/LCRANSFinalReport.pdf>. Accessed December 31, 2007.

Toledo, D.P. 2001. Sea Lamprey (*Petromyzon marinus*). Introduced Species Summary Project, Columbia University. Available at: http://www.columbia.edu/itc/cerc/danoff-burg/invasion_bio/inv_spp_summ/petromyzon_marinus.html.

Toonen, R. 2005. Reproduction and developmental characteristics of an alien soft coral (*Carijoa riisei*) in Hawaii. Available at: http://www.hawaii.edu/ssri/hcri/research/projects/threats/inv_spec-invert-bio-01.shtml.

Transportation Institute. "Industry Profile." Accessed January 23, 2008. Available at <http://www.transinst.org/1.html>.

United States Army Corps of Engineers (USACE). 2001. Waterborne Transportation Lines of the United States. Volume 3: Vessel Characteristics. United States Army Corps of Engineers, Institute for Water Resources. Alexandria, Virginia.

United States Army Corps of Engineers (USACE). 2002. Zebra Mussel Information System. Available at: <http://el.erdc.usace.army.mil/zebra/zmis/>. Accessed February 14, 2008.

U.S. Army Corps of Engineers (USACE). 2005a. Waterborne Commerce of the United States, 2005. Institute for Water Resources. 2005. Available at <http://www.iwr.usace.army.mil/ndc/wcsc/pdf/wcusnatl05.pdf>.

U.S. Army Corps of Engineers (USACE). 2005b. Waterborne Transportation Lines of the United States. Volume 1: National Summaries. United States Army Corps of Engineers, Institute for Water Resources. Alexandria, Virginia.

U.S. Army Corps of Engineers (USACE). 2005c. Waterborne Transportation Lines of the United States. Volume 2: Vessel Company Summary. United States Army Corps of Engineers, Institute for Water Resources. Alexandria, Virginia.

U.S. Army Corps of Engineers (USACE). 2005d. Waterborne Transportation Lines of the United States. Volume 3: Vessel Characteristics. United States Army Corps of Engineers, Institute for Water Resources. Alexandria, Virginia.

- U.S. Army Corps of Engineers (USACE), Navigation Data Center (NDC), 2007. Available at: <http://www.iwr.usace.army.mil/ndc/data/datavess.htm>. Accessed 12/5/07.
- U.S. Army Corps of Engineers (USACE), Navigation Data Center (NDC), 2008. Available at: <http://www.iwr.usace.army.mil/ndc/veslchar/veslchar.htm>. Accessed 1/18/08.
- U.S. Bureau of Economic Analysis. 2007. "Current-dollar and 'real' GDP." National Economic Accounts. Updated December 20, 2007. Available at <http://www.bea.gov/national/index.htm>.
- U.S. Census Bureau. 1997. 1997 Economic Census. Available at <http://www.census.gov/epcd/ec97/us/US000.HTM>.
- U.S. Census Bureau. 1998. 1998 County Business Patterns for the United States. Available at <http://www.census.gov/epcd/cbp/view/us98.txt>.
- U.S. Census Bureau. 2002a. 2002 County Business Patterns for the United States. Available at <http://www.census.gov/epcd/cbp/view/us02.txt>.
- U.S. Census Bureau. 2002b. 2002 Economic Census. Available at <http://www.census.gov/econ/census02/>.
- U.S. Census Bureau. 2005. 2002 Economic Census: Transportation and Warehousing. Various Reports. Available online at: <http://www.census.gov/econ/census02/guide/INDRPT23.HTM>.
- U.S. Coast Guard (USCG), 2004a. Regulatory Evaluation for the Final Rule: Mandatory Ballast Water Management Program for U.S. Waters. U.S. Coast Guard, Standards Evaluation and Analysis Division.
- U.S. Coast Guard (USCG). 2004b. Programmatic Environmental Assessment for Mandatory Ballast Water Management Program for U.S. Waters. Prepared by Battelle for U.S. Coast Guard.
- U.S. Coast Guard (USCG), 2005. Environmental Assessment for Voluntary Best Management Practices for Vessels Declaring No Ballast Onboard That Enter the Great Lakes.
- U.S. Coast Guard (USCG). 2007a. Merchant Vessels of the United States (VESDOC). National Vessel Documentation Center. Revised May 5, 2007. Available at: http://www.bts.gov/programs/maritime_data_working_group/uscg/merchant_vessels_of_the_united_states/index.html. Accessed December 4, 2007.
- U.S. Coast Guard (USCG). 2007b. Marine Casualty and Pollution Database (MPCD). Marine Safety Information and Law Enforcement System. United States Coast Guard. Available at: http://transtats.bts.gov/Tables.asp?DB_ID=610&DB_Name=Marine%20Casualty%20And%20Pollution%20Database&DB_Short_Name=Marine%20Casualty/Pollution. Accessed December 4, 2007.
- U.S. Coast Guard (USCG). 2007c. National Vessel Movement Center (NVMC). Available at: <http://www.nvmc.uscg.gov/download.aspx>.
- U.S. Customs and Border Protection. 2007. 2005 U.S. Customs Vessels Entrances and Clearances. USACE, Navigation Data Center. Available at: <http://www.ndc.iwr.usace.army.mil/data/dataclen.htm>. Accessed December 4, 2007.
- U.S. Department of Agriculture (USDA). 2006. Viral Hemorrhagic Septicemia in the Great Lakes Region. Industry Alert, October 2006.
- U.S. Department of the Interior, Fish and Wildlife Service and U.S. Department of Commerce, U.S. Census Bureau (USDOI). 2007. *2006 National Survey of Fishing, Hunting, and Wildlife-Associated Recreation*.
- U.S. Department of Transportation, Research and Innovative Technology Administration, Bureau of Transportation Statistics. 2008. *Maritime Data Working Group, Merchant Vessels of the United States*. Available at:

- http://www.bts.gov/programs/maritime_data_working_group/uscg/merchant_vessels_of_the_united_states/html/front_matter.html. Accessed January 18, 2008.
- U.S. Environmental Protection Agency and U.S. Department of Defense (EPA and DOD). 1999. Phase I Uniform National Discharge Standards for Vessels of the Armed Forces: Technical Development Document. Available at: <http://www.epa.gov/waterscience/rules/UNDS/vessels.pdf>.
- U.S. Environmental Protection Agency and United States Department of Defense (EPA and DOD). 2007. Uniform National Discharge Standards Batch Rulemaking Process. Available at: <http://www.epa.gov/owow/oceans/regulatory/unds/batchruleprocess.html>. Accessed December 20, 2007.
- U.S. Environmental Protection Agency (EPA). 1999. Revised Interim Guidance for EPA Rulewriters: Regulatory Flexibility Act as amended by the Small Business Regulatory Enforcement Fairness Act. 29 March 1999.
- U.S. Environmental Protection Agency (EPA). 2006. Information Collection Request: Applications for National Pollutant Discharge Elimination System Discharge Permits and the Sewage Sludge Management Permits. June 2006.
- U.S. Environmental Protection Agency (EPA). 2007a. Draft Cruise Ship Discharge Assessment Report. Available at: http://www.epa.gov/owow/oceans/cruise_ships/disch_assess_draft.html. Accessed December 21, 2007.
- U.S. Environmental Protection Agency (EPA). 2007b. Framework for Metals Risk Assessment. Available at: <http://www.epa.gov/osa/metalsframework/>. Accessed December 21, 2007.
- U.S. Environmental Protection Agency (EPA). 2007c. National Water Quality Inventory: Report to Congress, 2002 Reporting Cycle. Available at: <http://www.epa.gov/305b/>. Accessed December 21, 2007.
- U.S. Environmental Protection Agency (EPA). 2007d. Basic Information on PFOA. Available at: <http://www.epa.gov/oppt/pfoa/pubs/pfoainfo.htm>.
- U.S. Environmental Protection Agency (EPA). 2007e. Effects of Acid Rain – Surface Waters and Aquatic Animals. Available at: http://www.epa.gov/acidrain/effects/surface_water.html.
- U.S. Environmental Protection Agency (EPA). 2008a. Ecological and Economic Impacts, and Invasion Management Strategies for the European Green Crab. Draft Report prepared for U.S. EPA’s National Center for Environmental Economics. Washington DC. March 14, 2008.
- U.S. Environmental Protection Agency (EPA). 2008b. Vessel General Permit for Discharges Incidental to the Normal Operation of Non-Recreational Vessels and Select Recreational Vessels (VGP). Draft, March 19, 2008. U.S. Environmental Protection Agency.
- U.S. Environmental Protection Agency, Science Advisory Board (SAB). 2006. SAB Review of EPA’s Draft Risk Assessment of Potential Human Health Effects Associated with PFOA and Its Salts. Available at: [http://yosemite.epa.gov/sab/SABPRODUCT.NSF/A3C83648E77252828525717F004B9099/\\$File/sab_06_006.pdf](http://yosemite.epa.gov/sab/SABPRODUCT.NSF/A3C83648E77252828525717F004B9099/$File/sab_06_006.pdf).
- U.S. Fish and Wildlife Service (USFWS). 2005. Federal and State Endangered and Threatened Species Expenditures: Fiscal Year 2004.
- U.S. Geological Survey (USGS). 1999. The Quality of Our Nation’s Waters: Nutrients and Pesticides. USGS Circular 1225. Available at: <http://pubs.usgs.gov/circ/circ1225/>. Accessed December 21, 2007.
- U.S. Maritime Administration (MARAD). 2006. U.S. Domestic Ocean Trades 2004. Available at http://www.marad.dot.gov/marad_statistics. Accessed December 17, 2007.
- U.S. Small Business Administration. 1997. U.S. all industries data by receipt size, 1997. *Firm Size Data*. Available at http://www.sba.gov/advo/research/us_rec97.txt.

- U.S. Small Business Administration. 2002a. U.S. data, Classified by Employment size of firm-All Industries, 1998-2002. *Firm Size Data*. Available at http://www.sba.gov/advo/research/us98_02n97.txt.
- U.S. Small Business Administration. 2002b. U.S. all industries data by receipt size, 2002. *Firm Size Data*. Available at http://www.sba.gov/advo/research/us_rec02.txt.
- U.S. Small Business Administration. 2004. U.S. Dynamic data, by births, deaths, growth, and decline, 1998-2004. *Firm Size Data*. Available at http://www.sba.gov/advo/research/dyn_us_98_04n4.txt.
- U.S. Small Business Administration (SBA). 2006. Table of Small Business Size Standards Matched to the North American Industry Classification System (NAICS 2002), Effective July 1, 2007. Available online at: http://www.sba.gov/idc/groups/public/documents/sba_homepage/serv_sstd_tablepdf.pdf.
- U.S. Small Business Administration. Firm Size Data. Available at <http://www.sba.gov/advo/research/data.html>.
- Van Driesche, R., et al., 2002, Biological Control of Invasive Plants in the Eastern United States, USDA Forest Service Publication FHTET-2002-04, p. 413. Available at: <http://www.invasive.org/eastern/biocontrol/>. Accessed February 14, 2008.
- Vilaplana, Jorge V., and Leroy J. Hushak. 1994. "Recreation and the Zebra Mussel in Lake Erie, Ohio." Technical Summary. Ohio Sea Grant College Program, The Ohio State University.
- Wash. Admin. Code 77-120-030. Authorized Ballast Water Discharge – Adoption of Standards by Rule. Available at: <http://apps.leg.wa.gov/RCW/default.aspx?cite=77.120.030>. Accessed February 14, 2008.
- Washington Department of Ecology, 2007. Amendment Number 3 of the Memorandum of Understanding: Cruise Ship Operations in Washington State. Available at: http://www.ecy.wa.gov/programs/wq/wastewater/cruise_mou/MOU%203rd%20Amendment%205-25-07%20final.pdf. Accessed February 14, 2008.
- Woods Hole Oceanographic Institute (WHOI). 2007. Harmful Algae: What are Harmful Algal Blooms (HABs)? Available at <http://www.whoi.edu/redtide/page.do?pid=9257>.
- Wurts, W.A. and R.M. Durborrow. 1992. Interactions of pH, Carbon Dioxide, Alkalinity and Hardness in Fish Ponds. Southern Regional Aquaculture Center Publication No. 464.
- Zo, Y., C. Grimm, M. Matte, G. Matte, I.T. Knight, A. Huq, and R.R. Colwell. 1999. Detection and Enumeration of Pathogenic Bacteria in Ballast Water of Transoceanic Vessels Entering the Great Lakes and Resistance to Common Antibiotics. General Meeting of the American Society for Microbiology, Chicago, IL, 1999, Abstract Q317.

Appendix A: Survey Questionnaires

Individual BMP Survey

Why Does EPA need this information?

The Agency is evaluating the impacts of instituting a General Permit for practices associated with discharges incidental to normal operation of cruise ships as part of developing a permitting framework for commercial vessels. The Agency will use your responses to estimate any incremental costs that would result from implementing best management practices required under this Permit. The discharges that are applicable, unless noted otherwise, are those that take place within U.S. waters, i.e. within 12 nm.

Survey Instructions:

Please fill out all pieces of information that are relevant and obtainable. Include any comments if any of the requested information is not available and/or not relevant. If you are unable to estimate the cost for a piece of information in the manner requested but are **able** to estimate the cost in a separate manner, please do so and mark accordingly.

If any of these discharge categories do not apply to your vessel types, please mark "N/A" within the specific section and list which vessel types to which the discharge category **does not** apply. If a straightforward response is not possible, please explain the variances in responses as best as possible.

Primary contact person:

Last Name _____ First Name _____ Title _____
Company _____
Telephone Number _____
Email _____
Date _____

1. Please provide a general, average labor rate that would be applicable to practices associated with the 9 discharge categories listed above _____ \$ per hour.¹⁶
2. Please list the total number of vessels that your company has within each vessel category and, if possible, how many vessels sail outside of the territorial sea (outside 12 nm) more than once per month (herein referred to as “ocean going vessels”) and how many vessels **do not** sail outside of the territorial sea (outside 12 nm) more than once per month (herein referred to as “non-ocean going vessels”).

Vessel ID	Vessel Category	Total Number of Vessels	Ocean Going Vessels	Non-Ocean Going Vessels
<i>Example</i>	<i>Example Vessel Category</i>	<i>10</i>	<i>7</i>	<i>3</i>
1	General Cargo Freighter (Includes (a) freight ships, and (b) public freight ships)			
2	Break Bulk/RO-RO Carrier			
3	RO-RO Vessel			
4	Bulk Carrier			
5	Containership			
6	Partial Containership			
7	Container/Vehicle/Trailer (RO-RO)			
8	Vehicle Carrier			
9	Passenger Vessel ¹⁷			
10	Commercial Fishing			
11	Petroleum/Chemical Carrier			
12	Chemical Carrier			
13	Liquid Bulk Tanker			
14	Other Tanker			
15	Push Boat			
16	Tugboat/Towing Vessel			
17	Open Hopper Barge			
18	Covered Hopper Barge			
19	Car Float (Railroad Car Barge)			
20	Flat/Deck Barge			
21	Pontoon Barge			
22	Open Dry Cargo Barge			
23	Covered Dry Cargo Barge			
24	RO-RO Barge			
25	Container Barge			
26	Lash/Seabee Barge			
27	Liquid Cargo Barge			
28	Other Liquid Cargo Barge, Not Elsewhere Included (Includes tank barge)			
29	Convertible Barge			
30	Passenger Barge			
31	Other Dry Cargo Barge (Includes freight)			

(Proceed to the relevant sections.)

¹⁶ The average labor cost includes the base rate, fringe benefits such as vacation, sick leave, insurance, and allowance for overhead and other agency indirect burden.

¹⁷ Includes excursion/sightseeing vessels, ferries, and combined passenger and cargo vessels.

1) DECK RUNOFF

4. Indicate how many times per month a vessel performs deck cleanup (i.e. removing debris, garbage, and other loose materials) prior to conducting **deck washdowns or prior to departing from port**: ____ times per month

a. Estimate the cost involved with performing deck cleanup prior to conducting **deck washdowns or prior to departing from port**:

▫ *Labor Hours* typically required to perform deck cleanup: _____ hours

OR

▫ *Total Cost*: \$____ per cleanup.

OR

▫ Check this box if this cost is negligible

b. Indicate how many deck washdowns a vessel performs per month: _____ times per month

c. Indicate how many times a vessel departs from port per month: _____ times per month

Question d. is specific to Commercial Fishing vessels:

d. How often do you perform deck cleanup after moving fish to the fish hold?

Always _____ *Most of the time* _____ *Sometimes* _____ *Rarely* _____ *Never* _____

5. Indicate the percentage of vessels that have coamings or drip pans to collect any oily water from machinery and to prevent spills for all machinery on deck: _____ % of vessels

e. Estimate a cost of installing these coamings or drip pans for every piece of machinery on deck:

▫ *Total Cost*: \$____ per installation.

f. Estimate how many times per year you need to install these coamings or drip pans for every piece of machinery on deck: _____ times per year

6. Estimate the number of times a vessel's drip pans/coamings become full, per month: ____ times per month

When drip pans become full from runoff, estimate how often a vessel drains or wipes and cleans the drip pans: *Always* _____ *Most of the time* _____ *Sometimes* _____ *Rarely* _____ *Never* _____

g. Estimate the cost involved with performing this task:

▫ *Labor Hours* typically required to drain/wipe and clean drip pans: _____ hours

▫ *Additional Cost and Fees*: \$____ per instance of draining/wiping and cleaning drip pans.

OR

▫ *Total Cost*: \$____ per instance of draining/wiping and cleaning drip pans.

OR

▫ Check this box if this cost is negligible

7. Indicate the percentage of vessels that use non-toxic or other environmentally preferable cleaners (i.e. low or no phosphorus content or biodegradable) for the washdown: _____ % of vessels

h. Estimate how many gallons of cleaner are used per month:

_____ per vessel, gallons per month **OR** _____ per company, gallons per month

2) AQUEOUS FILM FORMING FOAM (AFFF)

OCEAN GOING VESSELS

8. Indicate the number of times per year a vessel discharges AFFF for maintenance and/or training purposes:...for certification purposes:

(Maintenance/Training) _____ times per year

(Certification) _____ times per year

9. Indicate the percentage of your vessels that use a non-fluorinated foaming agent: _____ % of vessels

i. Estimate the number of gallons of foam a vessel purchases a year: _____ gallons of foam purchased per year

NON-OCEAN GOING VESSELS

10. Indicate the number of times per year a vessel discharges AFFF for maintenance and/or training purposes: _____ times per year

11. Indicate how often a vessel collects and stores this discharge of AFFF for onshore disposal:

Always _____ *Most of the time* _____ *Sometimes* _____ *Rarely* _____ *Never* _____

j. Estimate the cost involved with collecting and storing the AFFF discharge for onshore disposal:

▫ *Labor Hours* typically required to collect and store AFFF for onshore disposal: _____ hours

▫ *Additional Cost and Fees*: \$ _____ per instance of collecting and storing AFFF for onshore disposal.

OR

▫ *Total Cost*: \$ _____ per instance of collecting and storing AFFF for onshore disposal.

OR

▫ Check this box if this cost is negligible

12. Indicate the percentage of your vessels use a non-fluorinated foaming agent: _____ % of vessels

k. Estimate the number of gallons of foam a vessel purchases a year: _____ gallons of foam purchased per year

ALL VESSELS

13. Unless 1) for emergency purposes, 2) for discharge by rescue vessels (such as fireboats for firefighting purposes), or 3) for vessels owned or under contract to do business exclusively in or within 1 nm of those protected areas by the US government or state or local governments, estimate how many of your vessels discharge AFFF in or within 1 nm of waters of exceptional value: _____ vessels

1. Indicate the number of times per year AFFF discharges occur within those waters for **emergency purposes**: ____ times per year.
 - i. Indicate how often, on average, a vessel documents the discharge:
Always ____ *Most of the time* ____ *Sometimes* ____ *Rarely* ____ *Never* ____
 - ii. Estimate the typical cost of documenting this discharge:
 1. *Labor Hours* typically required to document this discharge: _____ hours

OR

 2. *Total Cost*: \$ ____ per instance of documenting this discharge.
- m. Not including the above mentioned exceptions, indicate the number of times per year a vessel operating within 1 nm of water of exceptional value performs this discharge: ____ times per year

3) GRAYWATER

OCEAN GOING VESSELS

14. Indicate what percentage of your ocean going vessels are able to store graywater in order to reach a distance greater than 1 nm to discharge: _____% of vessels
 - a. For those vessels that are underway and are able to store graywater by these specifications, estimate how often a vessel discharges graywater greater than 1 nm from shore:
Always ____ *Most of the time* ____ *Sometimes* ____ *Rarely* ____ *Never* ____
 - n. Estimate the cost involved (for those ocean going vessels able to store graywater) with needing to discharge graywater greater than 1 nm from shore:
 - *Labor Hours* typically required to discharge greater than 1 nm from shore: _____ hours

OR

 - Check this box if this cost is negligible
 - o. Indicate how often a vessel (for those ocean going vessels able to store graywater) that is underway needs to discharge graywater: ____ times per month.

NON-OCEAN GOING VESSELS

15. Estimate how many times per month a vessel needs to dispose of graywater: _____ times per month
 - p. Estimate how many times per year, on average, a vessel disposes of graywater on shore at the appropriate facilities: _____ times per year
 - a. Estimate the cost involved with disposing of graywater on shore:
 - *Labor Hours* typically required to dispose of graywater on shore: _____ hours
 - *Additional Cost and Fees*: \$ ____ per instance of disposing graywater onshore.

OR

 - *Total Cost*: \$ ____ per instance of disposing graywater onshore.
 - q. Estimate the number of times per year appropriate facilities are **not** available and the vessel needs to dispose of graywater: _____ times per year

16. If appropriate facilities are not available, estimate how often a vessel discharges graywater into waters with an ability to dilute concentrations of detergents, soaps, and pathogens:... discharges graywater while the vessel is underway:

(Certain Waters) Always ____ Most of the time ____ Sometimes ____ Rarely ____ Never ____

(Underway) Always ____ Most of the time ____ Sometimes ____ Rarely ____ Never ____

a. Estimate the additional cost of needing to discharge graywater into waters with an ability to dilute concentrations of detergents, soaps, and pathogens:...of needing to discharge graywater while the vessel is underway:

Certain Waters

▫ Total Cost: \$ ____ per instance of discharging graywater into waters with an ability to dilute concentrations of detergents, soaps, and pathogens.

OR

▫ Check this box if this cost is negligible

Vessel Underway

▫ Total Cost: \$ ____ per instance of discharging graywater while the vessel is underway.

OR

▫ Check this box if this cost is negligible

ALL VESSELS

17. Estimate the percentage of your vessels that are able to store graywater: _____ % of vessels

a. For those vessels **able** to store graywater, while a vessel is underway, how often does a vessel avoid discharging graywater in “waters of exceptional value”:

Always ____ Most of the time ____ Sometimes ____ Rarely ____ Never ____

18. Estimate the percentage of vessels that use non-toxic soaps:...non-toxic detergents:

(Soaps) _____ % of vessels

(Detergents) _____ % of vessels

a. Estimate the number of gallons of soap/detergent used per year, per vessel:

(Soaps) _____ gallons per year

(Detergents) _____ gallons per year

4) UNDERWATER SHIP HUSBANDRY

19. Indicate the number of times per year a vessel cleans the hull **underwater**: _____ times per year

a. Estimate how often a vessel cleans the hull by methods that minimize the discharge of fouling organisms and antifouling hull coatings:

Always ____ Most of the time ____ Sometimes ____ Rarely ____ Never ____

b. Estimate the cost involved with cleaning the hull:

- *Labor Hours* typically required to clean the hull: _____ hours
- *Additional Cost and Fees:* \$ _____ per instance of cleaning the hull.

OR

- *Total Cost:* \$ _____ per instance of cleaning the hull.

20. Estimate how often a vessel disposes of removed substances in accordance with local, State, and Federal regulations: *Always* _____ *Most of the time* _____ *Sometimes* _____ *Rarely* _____ *Never* _____

a. Estimate the cost involved, if any, with disposal of any removed substances from the hull:

- *Labor Hours* typically required to dispose of removed substances: _____ hours
- *Additional Cost and Fees:* \$ _____ per instance of disposing of the removed substances.

OR

- *Total Cost:* \$ _____ per instance of disposing of removed substances.

OR

- Check this box if this cost is negligible

21. When performing mechanical underwater scrubbing, indicate the percentage of vessels that use vacuum control technologies to remove the addition of biocide paints and detached living organisms from the waters: _____ % of vessels

a. Estimate the cost of purchasing vacuum control technologies: \$ _____

b. Indicate how many times per year a vessel performs mechanical underwater scrubbing: _____ times per year

5) CATHODIC PROTECTION

22. Indicate the percentage of your vessels that use ICCP (Impressed Current Cathodic Protection) as the method of Cathodic Protection:...sacrificial electrodes as the method of Cathodic Protection:

(ICCP) _____ % of vessels

(Sacrificial Electrodes) _____ % of vessels

(If **all** vessels use ICCP, skip question 3)

23. Indicate how many times per year a vessel performs maintenance _____ times per year

r. Indicate how often cleaning the anodes, including minimizing the flaking of the large, corroded portions of the anodes is done during maintenance periods:

Always _____ *Most of the time* _____ *Sometimes* _____ *Rarely* _____ *Never* _____

s. Estimate the cost of performing maintenance (i.e. cleaning) to the anodes:

- *Labor Hours* typically required to perform maintenance to the anodes: _____ hours
- *Additional Cost and Fees:* \$ _____ per instance of performing maintenance to the anodes.

OR

- *Total Cost:* \$ _____ per instance of performing maintenance to the anodes.

24. (With awareness that magnesium is less toxic than aluminum which is less toxic than zinc), when economically and physically feasible, estimate the percent of vessels that use the metals that are less toxic for sacrificial electrodes: _____ % of vessels
- a. Estimate the additional cost per vessel of purchasing these specific types of less toxic metals: \$ _____
25. Estimate the cost per vessel of installing sacrificial electrodes as the method of Cathodic Protection:
- *Total Cost:* \$ ____ per instance of installing sacrificial electrodes as the method of Cathodic Protection.
26. Estimate the cost per vessel of installing ICCP as the method of Cathodic Protection:
- *Total Cost:* \$ ____ per instance of installing ICCP as the method of Cathodic Protection.

6) CHAIN LOCKER EFFLUENT

27. Estimate how often a vessel carefully and thoroughly washes down the anchor chain as it is being hauled out of the water to remove sediment and marine organisms:
- Always* _____ *Most of the time* _____ *Sometimes* _____ *Rarely* _____ *Never* _____
- t. Estimate the cost involved with this task:
- *Labor Hours* typically required to wash down the anchor chain: ____ hours
 - *Additional Cost and Fees:* \$ ____ per instance of washing down the anchor chain.
- OR**
- *Total Cost:* \$ ____ per instance of washing down the anchor chain.
- OR**
- Check this box if this cost is negligible
- u. Indicate how many times per year a vessel hauls the anchor chain out of the water: _____ times per year
28. During dry docks, how often does a vessel thoroughly clean chain lockers to eliminate accumulated sediments and any potential accompanying pollutants:
- Always* _____ *Most of the time* _____ *Sometimes* _____ *Rarely* _____ *Never* _____
- a. Estimate the cost involved with this task:
- *Labor Hours* typically required to clean chain lockers: ____ hours
 - *Additional Cost and Fees:* \$ ____ per instance of cleaning chain lockers.
- OR**
- *Total Cost:* \$ ____ per instance of cleaning the chain lockers.
- OR**
- Check this box if this cost is negligible
- b. Indicate how many times per year a vessel dry docks: _____ times per year
29. Estimate how often a vessel inspects, cleans, and pumps out the space beneath the chain locker prior to entering nearshore waters:

Always ___ *Most of the time* ___ *Sometimes* ___ *Rarely* ___ *Never* ___

a. Estimate the cost involved with this task:

- *Labor Hours* typically required to inspect, clean, and pump out the space beneath the chain locker: ___ hours
- *Additional Cost and Fees*: \$ ___ per instance of inspecting, cleaning, and pumping out the space beneath the chain locker.

OR

- *Total Cost*: \$ ___ per instance to inspect, clean, and pump out this space.

OR

- Check this box if this cost is negligible

b. Estimate the number of times per year a vessel enters nearshore waters: _____ times per year

30. Unless rinsing/pumping within 3 nm from shore is necessary for safety purposes, how often does a vessel rinse or pump this space greater than 3 nm from shore:

Always ___ *Most of the time* ___ *Sometimes* ___ *Rarely* ___ *Never* ___

v. If rinsing/pumping within 3 nm from shore is necessary, how often is the safety claim is documented: *Always* ___ *Most of the time* ___ *Sometimes* ___ *Rarely* ___ *Never* ___

i. Estimate the cost involved with the documentation:

- *Labor Hours* typically required to document the safety claim: ___ hours

OR

- *Total Cost*: \$ ___ per instance to document the safety claim.

ii. Estimate how many times per year a vessel rinses/pumps within 3 nm from shore if necessary for safety purposes: _____ times per year

7) CONTROLLABLE PITCH PROPELLER HYDRAULIC FLUID

31. During dry docks, how often does a vessel perform maintenance activities on controllable pitch propellers: *Always* ___ *Most of the time* ___ *Sometimes* ___ *Rarely* ___ *Never* ___

a. Estimate the cost involved with this task:

- *Labor Hours* typically required to perform maintenance activities on controllable pitch propellers: ___ hours
- *Additional Cost and Fees*: \$ ___ per instance of performing maintenance activities on controllable pitch propellers.

OR

- *Total Cost*: \$ ___ per instance to perform maintenance on controllable pitch propellers.

OR

- Check this box if this cost is negligible

b. Indicate how many times per year a vessel dry docks: _____ times per year

32. During instances of maintenance when the vessel is in the water, how often does a vessel use an oil boom to contain any hydraulic oil leakage:

Always _____ Most of the time _____ Sometimes _____ Rarely _____ Never _____

- a. Estimate the cost involved with using an oil boom to contain any hydraulic oil leakage:
 - *Labor Hours* typically required to use an oil boom to contain any hydraulic oil leakage: _____ hours
 - *Additional Cost and Fees*: \$ _____ per instance of using an oil boom to contain any hydraulic oil leakage.

OR

 - *Total Cost*: \$ _____ per instance to use an oil boom.

OR

 - Check this box if this cost is negligible
- b. Estimate how many times per year a vessel performs this type of maintenance while the vessel is in the water: _____ times per year
- c. Estimate the percentage of vessel operators that have appropriate equipment such as oil absorbent pads to clean any potential oil spills: _____ % of vessel operators
 - i. Estimate the additional cost per individual vessel of purchasing the appropriate equipment to clean any potential oil spills: \$ _____

8) ELEVATOR PIT EFFLUENT

33. In cases of **non-emergency**, estimate how many times per year a vessel discharges elevator pit effluent: _____ times per year

- a. Estimate the cost involved, if any, to dispose of this effluent onshore:
 - *Labor Hours* typically required to dispose this effluent onshore: _____ hours
 - *Additional Cost and Fees*: \$ _____ per instance of disposing this effluent onshore.

OR

 - *Total Cost*: \$ _____ per instance to dispose of effluent onshore.

OR

 - Check this box if this cost is negligible

34. In cases of **emergency**, how often does a vessel discharge elevator pit effluent with an oil content below 15 ppm: Always _____ Most of the time _____ Sometimes _____ Rarely _____ Never _____

- a. Estimate the cost involved, if any, to ensure that the elevator pit effluent has an oil content below 15 ppm:
 - *Labor Hours* typically required to ensure that the elevator pit effluent has an oil content below 15 ppm: _____ hours
 - *Additional Cost and Fees*: \$ _____ per instance of ensuring that the elevator pit effluent has an oil content below 15 ppm.

OR

 - *Total Cost*: \$ _____ per instance to ensure the oil level.

OR

 - Check this box if this cost is negligible

- b. In cases of emergency, estimate how many times per year a vessel discharges elevator pit effluent: _____ times per year

9) FIREMAIN SYSTEMS

35. Except in emergency situations or when washing down the anchor chain to comply with anchor wash down when pulling the anchor and anchor chain from waters, estimate how many times per year a vessel discharges from firemain systems into “waters of exceptional value”: _____ times per year

w. Estimate the cost involved, if any, to dispose of the firemain system discharge onshore:

- *Labor Hours* typically required to dispose of the firemain system discharge onshore: _____ hours
- *Additional Cost and Fees:* \$ _____ per instance of disposing of the firemain system discharge onshore.

OR

- *Total Cost:* \$ _____ per instance to dispose of the discharge onshore.

OR

- Check this box if this cost is negligible

DEFINITIONS OF DISCHARGE CATEGORIES

36. **Deck Runoff:** the precipitation, washdowns, and seawater falling on the weather deck of a vessel and discharged overboard through deck openings. Primarily, we are referring to the runoff caused by deck washdowns (unless the question specifies otherwise).
37. **Aqueous Film-Forming Foam:** the firefighting foam and seawater mixture discharged during training, testing, or maintenance operations.
38. **Graywater:** galley, bath, and shower water, as well as wastewater from lavatory sinks, laundry, interior deck drains, water fountains, and shop sinks where vapors could accumulate.
39. **Underwater Ship Husbandry:** the materials discharged during the inspection, maintenance, cleaning, and repair of hulls performed while the vessel is waterborne.
40. **Cathodic Protection:** the constituents released into surrounding water from sacrificial anode or impressed current cathodic hull corrosion protection systems.
41. **Chain Locker Effluent:** the accumulated precipitation and seawater that is emptied from the compartment used to store the vessel's anchor chain.
42. **Controllable Pitch Propeller Hydraulic Fluid:** the hydraulic fluid that discharges into the surrounding seawater from propeller seals as part of normal operation, and the hydraulic fluid released during routine maintenance of the propellers.
43. **Elevator Pit Effluent:** the liquid that accumulates in, and is discharged from, the sumps of elevator wells on vessels.
44. **Firemain Systems:** the seawater pumped through the firemain system for firemain testing, maintenance, and training, and to supply water for the operation of certain vessel systems.

Cruise Ship Survey

WHY DOES EPA NEED THIS INFORMATION?

The Agency is evaluating the impacts of instituting a General Permit for practices associated with discharges incidental to normal operation of cruise ships as part of developing a permitting framework for commercial vessels. The Agency will use your responses to estimate any incremental costs that would result from implementing best management practices required under this Permit.

SURVEY INSTRUCTIONS

Please fill out all pieces of information that are relevant and obtainable. Include any comments if any of the requested information is not available and/or not relevant. If you are unable to estimate the cost for a piece of information in the manner requested but are **able** to estimate the cost in a separate manner, please do so and mark accordingly.

Please either fill out the survey and email the electronic version to Steve Collins at scollins@crusing.org or print out the survey and scan/email and/or fax the hard copy survey to Steve at (fax) 754-224-2250.

PRIMARY CONTACT PERSON:

Last Name _____ First Name _____ Title _____
Company _____

QUESTIONS:

1. HOW MANY VESSELS ARE IN YOUR COMPANY?

2. HOW MANY VESSELS ARE:

- a. Large cruise ships authorized to carry 500 or more passengers? _____
- b. Medium cruise ships authorized to carry 250 to 499 passengers? _____
- c. Medium cruise ships authorized to carry 100 to 249 passengers? _____

Unless otherwise noted, when asking for information regarding medium cruise ships, please include information for both medium cruise ship classifications, i.e. those authorized to carry 250-499 passengers and those authorized to carry 100-249 passengers.

3. INDICATE THE NUMBER OF YOUR CRUISE SHIPS THAT HAVE AN ADVANCED WASTEWATER PURIFICATION (OR TREATMENT) SYSTEM FOR TREATING BLACKWATER THAT ARE ALSO CONFIGURED TO TREAT GRAYWATER THAT MEET THE FOLLOWING DISCHARGE STANDARDS:

(1) The discharge must satisfy the minimum level of effluent quality specified in 40 CFR 133.102;

(2) The geometric mean of the samples from the discharge during any 30-day period may not exceed 20 fecal coliform/100 milliliters (ml) and not more than 10 percent of the samples exceed 40 fecal coliform/100 ml; and/or

(3) Concentrations of total residual chlorine may not exceed 10.0 micrograms per liter ($\mu\text{g/l}$);

____ large cruise ships ____ medium cruise ships

4. DESCRIBE DISCHARGE SAMPLING ACTIVITIES

a. How many of your cruise ships are certified for use in Alaska?

____ large cruise ships ____ medium cruise ships

b. Indicate the number of samples all other cruise ships take (not including those cruise ships authorized to operate in Alaska) take over a 30 day period:

____ samples from large cruise ships

____ samples from medium cruise ships

c. Please indicate if test samples are typically taken:

1. Biological oxygen demand (BOD): ____yes ____ no

2. Suspended solids: ____yes ____ no

3. pH: ____yes ____ no

4. Total residual chlorine: ____yes ____ no

d. Estimate typical **total** cost of analyzing water samples: \$ ____

*(If **all** cruise ships have graywater treatment systems to meet the standards within question 1 (Alaskan standards), skip questions 5, 6, and 7).*

5. INDICATE THE NUMBER OF CRUISE SHIPS THAT DO NOT HAVE A STANDARD GRAYWATER TREATMENT SYSTEM AND DO NOT HAVE HOLDING CAPACITY TO DISCHARGE IN WATERS GREATER THAN 1 NM FROM SHORE:

____ large cruise ships ____ medium cruise ships

*(If **all** cruise ships have sufficient holding capacity, skip questions 6 and 7)*

6. INDICATE THE NUMBER OF CRUISE SHIPS THAT DO NOT HAVE SUFFICIENT HOLDING CAPACITY AND THUS NEED TO DISCHARGE WHILE PIERSIDE:

____ large cruise ships ____ medium cruise ships

(If 0, skip all of question 6.)

a. Estimate the average number of days per year that a cruise ship is pierside:

____ days for large cruise ships ____ day for medium cruise ships

b. Estimate what percentage of time discharge is necessary while pierside and appropriate reception facilities for graywater are **available**?

____ % for large cruise ships ____ % for medium cruise ships

- c. Estimate what percentage of time discharge is necessary while pierside and appropriate reception facilities for graywater are **used**?
____ % for large cruise ships ____ % for medium cruise ships
- d. Estimate the average amount of labor hours required of discharging graywater at appropriate reception facilities, **per instance**:
____ labor hours per large cruise ships ____ labor hours per medium cruise ships

7. UNTREATED GRAYWATER DISCHARGES

- a. On average, how many times per year do untreated graywater discharges occur?
____ times per year per large cruise ship
____ times per year per medium cruise ship
- b. How often do vessel operators thoroughly document untreated graywater discharges within their recordkeeping books?
Large Cruise Ships: *Always* ____ *Most of the time* ____ *Sometimes* ____ *Rarely* ____
Medium Cruise Ships: *Always* ____ *Most of the time* ____ *Sometimes* ____ *Rarely* ____
- c. Estimate the average amount of labor hours required for documenting untreated graywater discharges **per instance**:
____ labor hours per large cruise ships ____ labor hours per medium cruise ships

Number of not documented discharges per year:

____ large cruise ships ____ medium cruise ships

8. CRUISE SHIPS OPERATING IN UNITED STATES NUTRIENT IMPAIRED WATERS

- a. How many of your cruise ships operate in nutrient impaired waters (including, but not limited to, Chesapeake Bay, San Francisco Bay, Puget Sound, and the territorial sea surrounding the mouth of the Mississippi River in the Gulf of Mexico)?
____ large cruise ships ____ medium cruise ships
____ *unsure if cruise ships operate in nutrient impaired waters*
- (If 0 or unsure, skip all of question 8)*
- b. How many of these cruise ships have a standard graywater treatment system as noted within question 3 (same as Alaskan standards)?
____ large cruise ships ____ medium cruise ships
 - c. How many of the cruise ships with no standard graywater treatment system have sufficient holding capacity for graywater in order to not discharge within these waters? ____ large cruise ships ____ medium cruise ships

9. DUE TO THE PENDING PERMIT REQUIREMENT, HOW MANY OF YOUR CRUISE SHIPS ARE LIKELY TO CONTINUE TO HOLD AND DISCHARGE GRAYWATER ACCORDING TO THE PERMIT STANDARDS VERSUS PURCHASING/UPGRADING THE GRAYWATER TREATMENT SYSTEM ACCORDING TO THE STANDARDS WITHIN QUESTION 3 (SAME AS ALASKAN STANDARDS) (SEE ATTACHMENT FOR A SUMMARY OF DISCHARGE AND TREATMENT STANDARDS)?

___ large cruise ships ___ medium cruise ships

10. USE OF SOAPS AND DETERGENTS

- a. Please indicate the number of gallons of soap/degreaser or number of cruise ships that are associated with each section:

	Number of Gallons purchased of <i>all</i> types of soaps/degreasers, per fleet per year			Number of Cruise Ships Using <i>Phosphate Free</i> Soaps or <i>Non-Toxic</i> Degreasers		
	Large Cruise Ships	Medium Cruise Ships	Total	Large Cruise Ships	Medium Cruise Ships	Total
Soaps ¹⁸						
Degreasers						

- b. Estimate the incremental cost of purchasing phosphate free soaps and non-toxic degreasers:

	Incremental Cost per Gallon	Incremental Cost per Fleet
Soaps ¹⁹		
Degreasers		

11. DESCRIBE MANAGEMENT PRACTICES TO PREVENT WASTEWATER DISCHARGES

- a. What practices does a cruise ship typically perform to prevent unintended waste discharge from these sources? Check all that apply. *Please note if there are any significant differences among large and medium cruise ships.*

¹⁸ I.E. shower and hand soaps, laundry detergents, and dishwashing soaps.

¹⁹ I.E. shower and hand soaps, laundry detergents, and dishwashing soaps.

Waste discharge	Practice		
	Plug area drains that flow to graywater, blackwater, or bilge systems	Create alternative waste receptacles	Replumbing drains to appropriate holding tanks and then disposing of these wastes
Medical sinks or floor drains			
Salon/ day spa sinks and floor drains			
Chemical storage areas			

b. Please estimate *incremental* installation, maintenance, and labor hours that are associated with each of these practices:

Cost	Practice		
	Plug drains	Waste receptacles	Replumbing
Installation Cost			
Maintenance Cost			
Total Labor Hours:			

ATTACHMENT:

PERMIT SPECIFICATIONS REGARDING DISCHARGE STANDARDS AND GRAYWATER TREATMENT STANDARDS

DISCHARGE STANDARDS:

Pierside Limits:

- 1) While pierside, appropriate reception facilities for Graywater must be used, if reasonably available.

Operational Limits:

- 1) While operating within 1 nm of shore for *large cruise ships* or 1000 feet of shore for *medium cruise ships*, discharges of graywater are prohibited.
- 3) If you operate within 3 nm of shore, discharges of graywater must either be released while the Cruise Ship is sailing at a speed of at least 6 knots and is not in a water of exceptional value.

Nutrient Impaired Water Limits:

- 1) *Large Cruise Ships*: If you are operating in nutrient impaired waters including, but not limited to, such as the Chesapeake Bay or the territorial Sea surrounding the mouth of the Mississippi River in the Gulf of Mexico, you must not discharge graywater.
- 2) *Medium Cruise Ships*: If you are operating in nutrient impaired waters including, but not limited to, such as the Chesapeake Bay or the territorial Sea surrounding the mouth of the Mississippi River in the Gulf of Mexico, you must discharge the Graywater while the Cruise Ship is sailing at a speed of at least 6 knots or dispose of graywater properly on shore.

Monitoring Requirements:

- 1) The owner/operator must maintain records estimating all discharges of untreated graywater into waters subject to this permit, including date, location and volume discharged in their recordkeeping documentation. These records can be maintained as part of the vessel's sewage and graywater discharge record book

TREATMENT STANDARDS:

Treatment System Standard:

The discharge of treated Graywater must meet the following standards:

- (1) The discharge must satisfy the minimum level of effluent quality specified in 40 CFR 133.102;
- (2) The geometric mean of the samples from the discharge during any 30-day period may not exceed 20 fecal coliform/100 milliliters (ml) and not more than 10 percent of the samples exceed 40 fecal coliform/100 ml; and
- (3) Concentrations of total residual chlorine may not exceed 10.0 micrograms per liter ($\mu\text{g/l}$);

(Based on 33 CFR 159.309 – Alaskan Cruise Ship Regulation)

Monitoring Requirements:

- 1) In order to demonstrate the effectiveness of the treatment system, the vessel operator must take at least five samples taken from the vessel on different days over a 30-day period that are representative of the treated effluent to be discharged. Samples must be taken for BOD, suspended solids, pH, and total residual chlorine. Sampling and testing shall be conducted according to 40 CFR Part 136.

2) After demonstrating the effectiveness of their system, vessel owner/operators must conduct the same sampling and analysis twice each year to demonstrate treatment equipment maintenance and compliance. Records of the sampling and testing results must be retained onboard for a period of 3 years in the vessels recordkeeping documentation.

Appendix B: Summary of Survey Responses

Individual BMP Survey

The following tables summarize the industry responses to the questionnaires in Appendix A. The Individual BMP Questionnaire regarding typical practices and cost estimates was sent to four different industry representatives who represent: (1) commercial fishing vessels, (2) passenger vessels, (3) towing vessels and barges, and (4) freight and tank ships. Except for the representative of the commercial fishing vessel industry, who sent the questionnaire to a commercial fishing association, the industry representatives sent this questionnaire to their member companies to obtain information. So far, the passenger vessel industry has received one response from its member companies, which was sent directly to Abt Associates for review. The towing vessels and barges industry received nine responses from five different companies. One company among these nine respondents provided information on behalf of four different operational areas. These surveys were also sent directly to Abt Associates for review. Member companies in the freight and tank ships industry have not yet responded to the full questionnaire. However, the industry representative has provided information on more general questions that were answered by the member companies.

The Cruise Ship Questionnaire was sent to one industry representative, who sent the survey to member cruise lines. The industry representative provided a summary of the responses and has provided further information on request as a supplement to these responses.

Survey Responses Regarding Labor Rates^a

Passenger Vessel Company	Provided an average labor rate of \$35.
Commercial Fishing Association	Provided an average labor rate of \$50.
Towing Vessel and Barge Companies	Five companies with a very small number of vessels provided an average labor rate of \$75. Two other companies with a slightly larger number of vessels provided rates of \$32 and \$60 per hour. Two other companies with the largest number of vessels provided rates of \$14 and \$15 per hour.
Freight and Tank Ship Industry	Has not yet provided labor rate information.

^a Based upon these average labor rates and the corresponding number of vessels associated with each industry response, an average labor rate of \$31.61 was calculated among all these industries. The weighted average labor rate used for deck runoff practice cost estimates is \$16.53. This labor rate remains lower than the overall average since this calculation does not include the responses from the passenger vessel company and the commercial fishing association.

Survey Responses Regarding Deck Runoff				
	Deck Cleanup	Drip Pan Installation	Drip Pan Cleaning	Deck Washdown Cleaners
Passenger Vessel Company	Deck cleanup is regularly performed prior to washdown/departing from port.			
Commercial Fishing Association	Performs 6 deck cleanups per month, estimates 2 hours per cleanup. Departs from port 6 times per month. Performs a deck washdown every day because of moving fish to the fish hold. "Always" performs deck cleanup after moving fish to the fish hold.	100% of vessels have drip pans for all machinery on deck. Estimates total one-time cost of \$500 per installation for all pieces of machinery.	Always drains or wipes and cleans drip pans when full. Estimates 2 hours to perform this practice per instance.	
Towing Vessel and Barge Companies	Three of the nine respondents stated that their vessels do not perform deck washdowns or deck cleanups. The other six respondents provided a range of the number of times that a vessel performs deck cleanup and deck washdown and the number of times a vessel departs from port, per month. The number of times a vessel performs deck cleanup ranges from one to 15 times per month, the number of times a vessel performs deck washdown ranges from one to 20 times per month, and the number of times a vessel departs from port ranges from four to 30 times per month. The respondents provided a range of 1 to 6 hours required per cleanup.	Eight of the nine respondents stated their vessels had drip pans installed. One of the nine respondents stated that drip pans were not installed. The respondents estimated a cost ranging from \$2,000 to \$8,000 for the one-time installation.	Seven of the nine respondents stated that they regularly clean drip pans when necessary. The respondents provided a range of the frequency that the drip pans need to be cleaned/drained of once per month to four times per month. They also provided a range of the cost of disposal of \$200 to \$1,200 per cleaning. The other two respondents did not respond to this question.	Eight of the nine respondents stated that their vessels use environmentally friendly cleaners for the deck washdown. Five of the eight respondents provided the number of gallons of cleaner purchased per vessel, per month: ranging from 10 to 833 gallons. The other respondent did not respond to this question.
Freight and Tank Ship Industry	Deck cleanup is an ongoing activity on all ship types. Ships do not generally perform deck washdowns. The exception is that inland vessels and dry bulk cargo vessels collect cargo residues and may perform a washdown.			

Survey Responses Regarding AFFF	
Passenger Vessel Company	AFFF is not an applicable discharge to passenger vessels.
Commercial Fishing Association	AFFF is not an applicable discharge to commercial fishing vessels.
Towing Vessel and Barge Companies	AFFF is not an applicable discharge to these vessels.
Freight and Tank Ship Industry	Foams are typically not changed out of ships more frequently than every 5 years. Respondents provided a range of 5 to 25 years in which foams may need to be replaced. AFFF is by far the most frequent foam used by vessels, while some vessels also use protein and polar solvent foams. The type of foam that is carried onboard is dependent on the type of cargo. The amount of foam in the tanks ranges from 300 to 6,000 gallons, dependent on ship type. It is not standard to have the technology to collect and store maintenance/training discharges of foams. It is common practice to wash the foam over the side of the ship. It is uncommon to perform these maintenance/training discharges while in inland waters. Most vessels perform these discharges while at sea.

Survey Responses Regarding Graywater		
	Graywater Discharge	Soaps and Detergents
Passenger Vessel Company	Graywater is always disposed of onshore at appropriate facilities. The respondent cited a cost of \$0.18 per gallon to dispose onshore. 100% of vessels can store graywater in holding tanks.	The respondent uses non-toxic detergents; purchases approximately 5 gallons per year.
Commercial Fishing Association	No vessels are able to store graywater. It is constantly being discharged while underway and sometimes in waters able to dilute graywater concentrations. Estimates a cost of \$15,000 to \$20,000 per vessel to install a graywater storage system. Notes that most vessels are too small to accommodate storage and would incur stability problems.	100% of vessels use environmentally friendly soaps and detergents. 24 gallons of soap are purchased per year; 2 gallons of detergent are purchased per year.
Towing Vessel and Barge Companies	Six of the nine respondents stated that 0% of their vessels are able to store graywater. One of the other respondents stated that 100% of oceangoing vessels are able to store graywater in order to reach a distance of greater than 1 nm to discharge and, most of the time, they discharge in waters greater than 1 nm from shore. Another of the other respondents stated that 50% of oceangoing vessels are able to store graywater in order to reach a distance of greater than 1 nm to discharge, and they always discharge in waters greater than 1 nm from shore. These vessels need to discharge approximately 10 times per month. Both of these respondents stated that all vessels that are able to store graywater avoid discharging in waters of exceptional value and that there is no additional cost of discharging in waters greater than 1 nm from shore. The remaining respondent did not respond to this question.	Five of the nine respondents stated that 100% of their vessels use environmentally friendly soaps and detergents. The number of gallons purchased per vessel ranges from 24 to 125 gallons of soap and 12 to 200 gallons of detergent per year. The other four respondents did not respond to this question.
Freight and Tank Ship Industry	Some vessels are able to retain graywater and some are not.	

Survey Responses Regarding Underwater Hull Husbandry	
Passenger Vessel Company	Does not clean hull underwater.
Commercial Fishing Association	Underwater hull husbandry is not applicable to commercial fishing vessels.
Towing Vessel and Barge Companies	Eight of the nine respondents stated that the hull is always cleaned during drydocks, not while underwater. The other respondent stated that the hull is cleaned during drydock or while underwater every 30 months. If cleaning is performed underwater, the hull is always cleaned by methods that minimize the discharge of fouling organisms and anti-fouling hull coatings. Estimates a cost of \$70,000 per cleaning. Always disposes of removed substances in accordance with local, state, and federal regulations.
Freight and Tank Ship Industry	Hull cleaning is performed based on need.

Survey Responses Regarding Cathodic Protection			
	Cathodic Protection System	Metals Used	Maintenance/Replacement
Passenger Vessel Company	Use sacrificial electrodes (magnesium) as the method of cathodic protection.		
Commercial Fishing Association	100% of vessels use sacrificial electrodes as the method of cathodic protection.		Always performs maintenance to the anodes when performing regular vessel maintenance. Estimates cost of \$12,000 to \$25,000 to perform maintenance and cites the same cost to install a cathodic protection system.
Towing Vessel and Barge Companies	Seven of the nine respondents stated that 100% of their vessels use sacrificial electrodes as the method of cathodic protection. One of the other respondents stated that 100% of its vessels use an impressed current system as the method of cathodic protection. The other respondent stated that 30% of its vessels use sacrificial electrodes as the method of cathodic protection. Estimates a cost ranging from \$4,500 to \$30,000 to install a cathodic protection system.	Two of the nine respondents stated that none of their vessels have magnesium or aluminum anodes. Four of the nine respondents stated that 100% of their vessels use the less toxic metals. The other three respondents did not respond to this question.	Four of the nine respondents stated that maintenance to the cathodic protection system is performed during regular periods of maintenance. The respondents provided a range of the maintenance timeline: maintenance is performed every 30 months to once in five years. One of the four respondents stated that anodes are simply replaced, not cleaned. The other five respondents did not respond to this question.
Freight and Tank Ship Industry	The majority of ships have impressed current systems installed, and some have sacrificial anodes added for increased protection.		

Survey Responses Regarding Chain Locker Effluent				
	Wash Anchor Chain as Hauled Out of Water	Clean Chain Lockers in Drydock	Clean Space Beneath Chain Locker Prior to Entering Nearshore Water	Document Safety Claim if Space Rinsed within 3nm from Shore
Passenger Vessel Company	Chain locker effluent does not apply to these vessels.			
Commercial Fishing Association	Chain locker effluent does not apply to these vessels.			
Towing Vessel and Barge Companies	Three of the nine respondents stated that this practice is not applicable to their vessels. Four of the other six respondents stated that the anchor chain is always washed down as it is being hauled out of the water. Two of the other six respondents stated that the anchor chain is rarely washed down as it is being hauled out of the water. These six respondents stated that the number of times that an anchor is hauled out of the water varies depending on the type of vessels. Most provided an average between 12 and 50 times per year and an estimate of 0.5 to 1 hour to perform this cleaning. The other two respondents did not respond to this question.	Two of the nine respondents stated that this practice is not applicable to their vessels. Six of the other seven respondents stated that, during drydocks, a vessel always thoroughly cleans chain lockers. One of the seven respondents stated that this was done most of the time. These seven respondents estimated a cost ranging from \$2,000 to \$15,000 per cleaning and that a vessel is drydocked from twice every five years to twice every three years.	Two of the nine respondents stated that this practice is not applicable to their vessels. The other seven respondents stated that the space beneath the chain locker is rarely inspected, cleaned, and pumped out prior to entering nearshore waters. These seven respondents provided a range of the number of times that a vessel enters nearshore waters ranging from 50 times per year to daily. One of the seven respondents estimated a cost of \$2,000 per instance, and another estimated that 40 labor hours are required per instance.	Two of the nine respondents stated that this practice is not applicable to their vessels. The other seven respondents stated that this discharge does not take place within 3 nm from shore.
Freight and Tank Ship Industry	It is normal practice to rig a fire hose and wash down the anchor as it is being heaved. Additionally, most new ships have several high-pressure freshwater spray nozzles installed in the hawsepipes that spray the chain and anchor as it is being heaved and thus wash seafloor sediment back into the water.	Chain lockers are typically cleaned during normal shipyard periods and <i>not</i> during normal underway operations (since the lockers are full of anchor chain) whether on the deep sea or in nearshore waters.		

Survey Responses Regarding Controllable Pitch Propeller Hydraulic Fluid			
	Maintenance During Dry Dock	Use of Oil Boom for Underwater Maintenance	Oil Spill Equipment Onboard
Passenger Vessel Company	Controllable pitch propeller hydraulic fluid is not applicable to these vessels.		
Commercial Fishing Association	Controllable pitch propeller hydraulic fluid is not applicable to these vessels.		
Towing Vessel and Barge Companies	Seven out of the nine respondents stated that controllable pitch propeller hydraulic fluid is not applicable to these vessels. The other two respondents stated that, during drydocks, a vessel always performs maintenance on controllable pitch propellers. One of the respondents estimated a \$15,000 cost per instance and stated that a vessel drydocks 0.67 times per year.	The two respondents to whom this question was applicable stated that these vessels never perform this maintenance in the water. One respondent stated that if the maintenance was done in the water, an oil boom would be rigged. The other respondent stated that an oil boom would not be rigged.	The two respondents to whom this question was applicable stated that 100% of vessel operators have oil spill equipment on hand. Estimates a cost of \$1,000 to \$2,000 to purchase the equipment.
Freight and Tank Ship Industry	Routine maintenance of the controllable pitch propeller occurs during drydocks.	It is not common to rig an oil boom because the vessel is drydocked. If any maintenance is to be done with the vessel in the water it would be boomed.	All ships have some supply of absorbent pads and other equipment aboard ship.

Survey Responses Regarding Elevator Pit Effluent	
Passenger Vessel Company	Elevator pit effluent is not applicable to these vessels.
Commercial Fishing Association	Elevator pit effluent is not applicable to these vessels.
Towing Vessel and Barge Companies	Eight respondents stated that this discharge is not applicable to these vessels. Another respondent stated that vessels never discharge elevator pit effluent. Estimates a cost of \$2,000 per instance to dispose of the effluent onshore. In cases of emergency, a vessel never discharges this effluent with an oil content >15 ppm. However, this emergency discharge never occurs.
Freight and Tank Ship Industry	Elevator pit effluent would be pumped to an oily waste tank and either transferred to a slop tank for disposal ashore, or burned in the incinerator.

Survey Responses Regarding Firemain Discharges

Passenger Vessel Company	Firemain discharge is not applicable to these vessels.
Commercial Fishing Association	Firemain discharge is not applicable to these vessels.
Towing Vessel and Barge Companies	Three out of the nine respondents stated that firemain discharge is not applicable to these vessels. Another four respondents stated that a vessel never discharges from firemain systems into waters of exceptional value. The last two respondents stated that a vessel may discharge from firemain systems into waters of exceptional value from 12 to 52 times per year.
Freight and Tank Ship Industry	Unless in emergency situations, legally required drills and system activation are conducted out of port. Firemain discharges are charged with freshwater, operated with the effluent going over the side through normal deck drainage ports.

Cruise Ship Survey

Survey Responses Regarding Cruise Ships

Pierside and Operational Limits	Both large and medium cruise ships have sufficient holding capacity to avoid discharging within 1 nm from shore. Discharges within 3 nm from shore currently undergo graywater treatment or are discharged while the ship is sailing at a speed of at least 6 knots. Furthermore, regarding the Permit specifications, according to an industry representative, reception facilities for graywater are very rare and are not commonplace even at major ports.
Limits Applicable to Operation in Nutrient Impaired Waters	If necessary to discharge, medium cruise ships discharge graywater in these waters while sailing at a speed of at least 6 knots. There is a subset of large cruise ships that operate in these waters whose graywater holding capacity is exceeded due to the voyage length.
Sculleries and Galleys	The industry representative was not able to provide the percentage of large or medium ships that use these phosphate free/non-toxic products or the annual average number of gallons that are purchased by a ship.
Hazardous Waste	Source drains are currently either replumbed to appropriate holding tanks or are plugged and alternative waste receptacles are used.
Untreated Graywater Documentation	Documentation of these discharges is common practice.
Monitoring	The cost associated with one sampling event is approximately \$1,000 per ship. Sampling is not a current practice for the majority of cruise ships.