CHAPTER 2
STUDY DESIGN

This chapter documents the methodology that EPA used to conduct this study of discharges incidental to normal operation of study vessels. It describes the steps EPA took to collect information on the nature and potential impacts of vessel discharges.

2.1 DATA SOURCES

EPA collected data from a variety of sources, including existing data from other EPA data collection efforts, meetings and telephone contacts with trade association representatives, vessel visits and sampling, literature reviews, and other governmental data sources. Each of these data sources is discussed below.

2.1.1 Existing EPA Data Sources

A significant source of existing data regarding vessel discharges is EPA's administrative record supporting EPA's 2008 Vessel General Permit (VGP). The administrative record is a collection of all materials EPA considered in developing the VGP, including supporting documents, references, and comments received on the proposed VGP. As a first step in conducting this study, EPA reviewed these existing data sources to determine whether and to what extent the data and information from these sources could be used to satisfy the study objectives. This review also identified data and information gaps for EPA to target for additional data collection efforts. In general, these existing data sources provided useful information regarding the types of vessel discharges generated by vessel class, as well as the shipboard processes that contribute to their generation; however, the existing data sources contained little or no information regarding the nature, composition, and volume of discharges.

Other existing data sources evaluated for this study included supporting documents and other materials from EPA's Uniform National Discharge Standards (UNDS) (USEPA, 1999) and cruise ship discharges (USEPA, 2008c) programs. These sources, which pertain to armed forces vessels and large cruise ships, respectively, have limited applicability to commercial fishing vessels and nonrecreational vessels less than 79 feet in length; however, these data sources did provide supplemental information regarding shipboard processes that result in wastewater generation, as well as information regarding the types and amounts of pollutants that may be found in selected vessel discharges such as graywater and bilgewater. One source directly applicable to this study, however, is the UNDS document, *Final Sampling Episode Report for Small Boat Engine Wet Exhaust Discharge from Compression Ignition Engines* (USEPA, 2008b), which provides pollutant data and other relevant information (e.g., vessel power levels) for wet exhaust discharges from two compression ignition engines. EPA used this report as a primary source of information and data for this vessel discharge.

2.1.2 Industry Participation

EPA was contacted by or contacted, met with, or otherwise collaborated with trade associations and individual companies. In the course of these meetings, EPA gathered the following types of information regarding vessel discharges:

- Vessel classes within and outside the scope of this study.
- Typical vessel lengths by vessel class.
- Vessel operating seasons and locations.
- Shipboard systems and operations that contribute to vessel discharges.
- Vessel discharges and locations by vessel class.
- Volume, frequency, and nature of discharges.
- Vessel tours to inspect and observe vessel systems and operations that contribute to vessel discharges.

Note that none of the trade associations or individual companies contacted were able to provide pollutant data for vessel discharges.

The trade associations that contacted EPA or that EPA contacted included:

- American Waterways Operators (represents over 250 members that operate carriers, tug boats, towboats, and barges).
- Passenger Vessel Association (represents approximately 600 members that operate vessels such as ferries, dinner cruises, whale watching expeditions, site seeing tours, and water taxis).
- National Association of Charterboat Operators (represents over 3,300 charterboat owner and operators who provide fishing, sailing, diving, eco-tours, and other excursion vessels that carry passengers for hire, as well as recreational for-hire vessels).
- Conference of Professional Operators for Response Towing (C-PORT) (represents over 170 members of the commercial marine assistance industry, providing services such as jump starts, fuel delivery, and towing to boaters).
- Pacific Seafood Processors Association (represents 10 seafood processing companies in Alaska, Washington, and Oregon).
- At-Sea Processors Association (represents five companies that own and operate 19 U.S.-flag catcher/processor vessels in the Alaskan pollock and West Coast Pacific whiting fisheries).
- Alaskan Longline Fishermen’s Association (represents about 60 members of longline fishing vessel companies and salmon fishing vessels that operate in southeast Alaska).
- United Fishermen of Alaska (represents about 37 commercial fishing organizations and associations concentrated in Alaska representing thousands of fishing companies operating as harvesters throughout Alaska waters and the adjoining Exclusive Economic Zone).
- Southeast Alaska Fishermen's Alliance (represents commercial fishermen and the commercial fishing industry in southeast Alaska).

- Northeast Seafood Coalition (represents commercial groundfish fishermen and shore-side businesses from mid-coast Maine to Long Island, New York).
- Southern Shrimp Alliance (alliance of shrimp fishermen and processors in Alabama, Florida, Georgia, Louisiana, Mississippi, North Carolina, South Carolina, and Texas).
- Petersburg Vessel Owners Association (represents fishermen in Petersburg, Alaska).
- Alaska Trollers Association (represents southeastern Alaska trollers).
- Cordova District Fisherman United (represents Cordova, Alaska, area fishermen).

Individual companies that provided additional information (generally after being contacted by their respective trade groups) included:

- Potomac Marine, Woodbridge, Virginia.
- Vane Brothers Company, Mid-Atlantic.
- Potomac Riverboat Company, Alexandria, Virginia.
- Northeast Seafood Processors, Gloucester, Massachusetts.
- Vulcan Materials Company, Havre de Grace, Maryland.
- Sea Tow, Pensacola, Florida.
- EPA Gulf Ecology Division Laboratory, Gulf Breeze, Florida.
- Sea Tow, Slidell, Louisiana.
- AEP River Operations, Convent, Louisiana.
- Shrimp Charters, Pass Christian, Louisiana.
- Baltimore Water Taxi, Baltimore, Maryland.
- Sitka Sound Seafoods, Sitka, Alaska.
- Seafood Producers Co-op, Sitka, Alaska.
- Silver Bay Seafoods, Sitka, Alaska.
- Argosy Cruises, Seattle, Washington.
- Tidewater Marine, LLC, Gulf Coast.
- E.N. Bisso & Son, Lower Mississippi River.
- Foss Maritime Company, California, Washington, Oregon, the Columbia River, and the Snake River.
- Taku Smokeries, Juneau, Alaska.
- Upper River Services, St. Paul, Minnesota.
- JB Marine Service, St. Louis, Missouri.
- Osage Marine Services, St. Louis, Missouri.
- AEP River Operations, New Orleans, Louisiana.
- Smith Shipyard, Baltimore, Maryland.
- Norfolk Tug Company, Norfolk, Virginia.
- Dann Marine, Baltimore, Maryland.
- Cape Fear Riverboats, Wilmington, North Carolina.

2.1.3 Vessel Sampling

EPA identified a critical need for pollutant data for vessel discharges following its review of existing data sources. To satisfy this requirement, EPA designed and implemented a vessel discharge sampling program, which is described in detail in Section 2.2 of this document. Through this sampling program, EPA collected wastewater pollutant characterization data for nine vessel discharges sampled from a total of 61 vessels (one to four discharges sampled per vessel). These samples were collected in 15 different towns/cities in nine separate states, representing several of the major regions of the United States. Another critical component of EPA's sampling program was the collection of information regarding the shipboard processes, equipment, materials, and operations that contribute to the discharges, as well as the discharge rates, duration, frequency, and location.

2.1.4 Literature Review

EPA was not able to sample and characterize all study vessel classes and discharges (discussed further in Section 2.3). To fill this data gap, EPA searched the literature (i.e., scientific and engineering journals or other academic publications) for relevant information. In general, these searches provided only general information regarding vessel classes and discharges and little or no specific information, such as discharge composition and volumes. EPA did, however, identify many relevant literature sources regarding vessel antifouling leachate. EPA used these literature sources as the primary sources of information and data for this vessel discharge.

2.1.5 Other Governmental Data Sources

EPA's primary data source for vessel information regarding population and other vessel characteristics is the U.S. Coast Guard's Marine Information for Safety and Law Enforcement (MISLE) database. The MISLE provides data for nearly 1 million vessels that operate in U.S. waters and is used to support the investigation and inspection activities of the U.S. Coast Guard throughout the United States and its territories. Of the 1 million vessels identified in the database, approximately 139,814 vessels comprise the study vessel population (see Chapter 1 for additional discussion). Relevant vessel characteristics tracked in this database are vessel type, length, geographical area of operation, age, hull material type, propulsion method and type, and horsepower ahead.

EPA used a screening-level analysis of a hypothetical estuarine harbor to evaluate the potential environmental impacts from multiple vessels discharging to large U.S. water bodies, specifically estuaries and brackish harbors (see Section 4.2). EPA used the characteristics of harbor salinity, volume, and freshwater inflow from a variety of U.S. estuaries that receive vessel discharges to develop the characteristics for the hypothetical estuary. EPA compiled these characteristics from the following online sources:

- National Oceanic and Atmospheric Administration BookletChart™ List
- National Oceanographic Data Center World Ocean Database 2005 (WOD05)
- Southeast Environmental Research Center, Biscayne Bay Water Quality Monitoring Network, Miami, Florida.
- Cronick, T., and A. McGuire. *Temperature and Salinity of the Yaquina Bay Estuary and the Potential Range of Carcinus maenas*, Corvallis, Oregon.
- Massachusetts Department of Environmental Protection, Total Maximum Daily Loads of Bacteria for Little Harbor, Worchester, Massachusetts.
- U.S. Geological Survey National Hydrography Dataset Plus.
- U.S. Geological Survey National Water Information System Surface Water Annual Statistics.

2.2 EPA VESSEL DISCHARGE SAMPLING PROGRAM

EPA conducted a sampling program of discharges from commercial fishing vessels and other nonrecreational vessels less than 79 feet in length. EPA's sampling program was designed to provide information to achieve the first two objectives of the study mandated by P.L. 110-299:

- A characterization of the nature, type, and composition of discharges for representative single vessels, and for each class of vessel.
- A determination of the volumes of those discharges, including the average volumes for representative single vessels, and for each class of vessel.

Accordingly, EPA's sampling program included the sampling of large numbers and varieties of vessel classes, vessels, and discharges, and the analysis of target analytes as discussed in the following subsections. In addition, EPA supplemented sample collection and analysis with the collection of information regarding the shipboard processes, equipment, materials, and operations that contribute to the discharges, as well as the discharge rates, duration, frequency, and location.

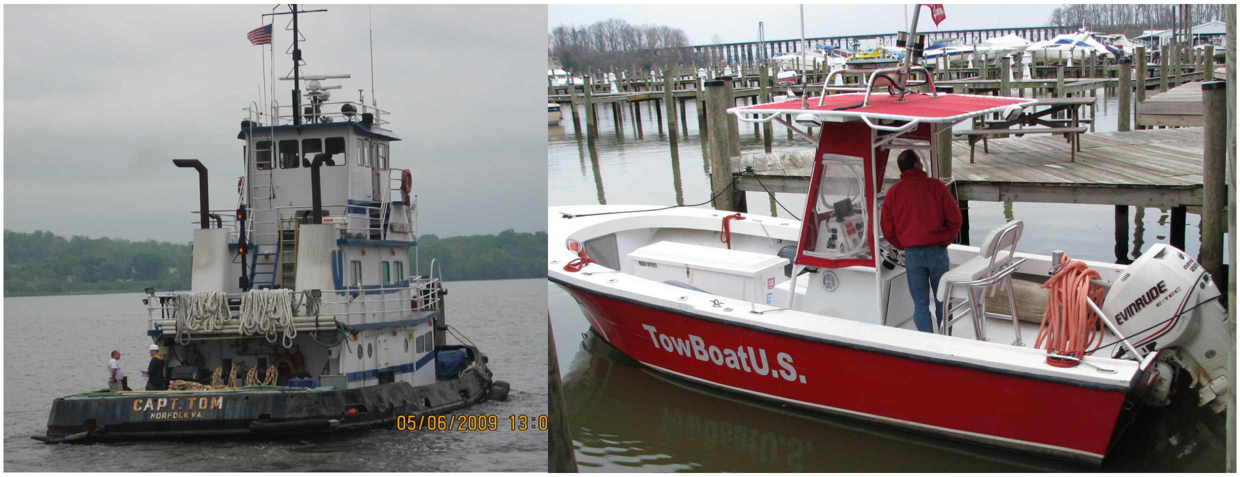
Though the Agency was still in the final stages of drafting the 2008 VGP, EPA began designing and planning the sampling program soon after enactment of P.L. 110-299. These activities included developing the size and scope of the program considering overall program schedule and resources; identifying priority locations, vessel classes, discharges, and analyte classes for sampling; developing a detailed Generic Sampling Analysis Plan and Quality Assurance Project Plan; procuring EPA regional laboratory and contract laboratory and sampling support; and soliciting industry input and volunteers for participation in the program. Sample collection was conducted from March through July 2009. The remainder of this section provides a further description of the sampling program, including the vessels sampled and their locations, sampled discharges, target analytes, sampling methods, and quality assurance/quality control.

2.2.1 Vessels Sampled and Locations

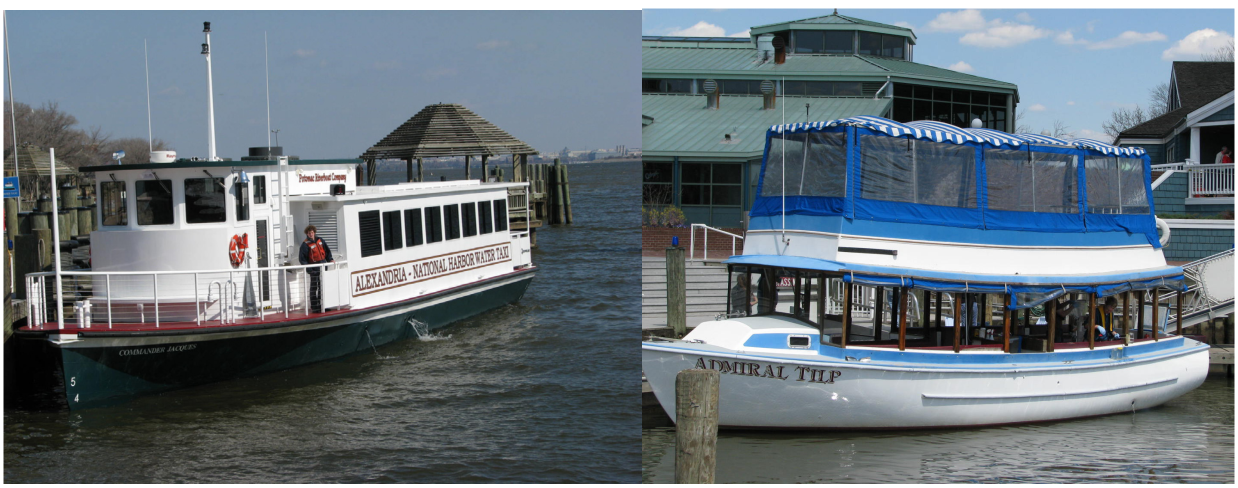
EPA sampled discharges from a total of 61 vessels in nine vessel classes (see Table 2.1). To select vessel classes for evaluation, EPA first developed a list of commercial vessel classes based on published information and the EPA team's existing understanding of vessels. Next, EPA narrowed the sampling scope to focus largely on those vessel classes believed to consist primarily of vessels less than 79 feet in length. Some examples of vessel classes on which EPA did not focus, due to their size, include cable laying ships, cruise ships, large ferries, oil and petroleum tankers, and freight ships/barges (most vessels in these classes are typically greater than 80 feet in length). Next, EPA eliminated vessel classes outside the scope of study vessels, including stationary seafood processing vessels and vessels that can be secured to the ocean floor for mineral or oil exploration, because the industrial discharges from these vessels were outside the scope of the previous 40 CFR Part 122.3(a) exclusion (USEPA, 2008d). After eliminating these vessels, the following common vessel classes were prioritized for evaluation:

- Commercial fishing vessels and tenders
- Tugs/towing vessels
- Water taxis/small ferries
- Tour boats

Purse Seiner in Alaska (left) and a Shrimp Trawler in Louisiana (right).



A Tugboat in Maryland (left) and a Tow/Salvage Vessel in Virginia (right).



A Water Taxi in Virginia (left) and a Tour Boat in Virginia (right).

Table 2.1. Number of Vessels Sampled by Vessel Class and Discharge

Vessel Class	Number of Vessels Sampled	Number of Vessels Sampled by Discharge								
		Bilge Water	Stern Tube Packing Gland	Deck Washdown	Fish Hold	Cleaning of Fish Hold	Graywater	Propulsion Engine Effluent	Generator Engine Effluent	Firemain
Fishing:										
Gillnetter	5			1	3			1		
Lobster [1]	1				1					
Longliner	3	1			3	1				
Purse Seiner	5				5	1		1	1	
Shrimp Trawler	6	1		6	2		1			
Tender	3				3	2				
Trawler	4			2	3	4				
Troller	6			2	6	1				
Tugboat	9		9	9			5			2
Water Taxi	4	2		1			1	4	1	
Tour Boat	3	1		2				3	2	3
Tow/Salvage	6	3		6				5		
Research	2							2		
Fire Boat	1			1				1	1	1
Supply Boat	1			1						
Recreational	2			1			1	2		
Total	61	8	9	32	26	9	8	19	5	6

(1) Sampled the lobster hold tank on a trawler.

Additionally, EPA sampled recreational vessels used for nonrecreational purposes as part of this study. This sampling was done for two purposes: 1) to provide a semiquantitative comparison of the discharges from these vessels and the other study vessels, and 2) to collect additional information for EPA's related work on the Clean Boating Act (P.L. 110-288). During the execution of the sampling program, EPA also conducted opportunistic sampling of additional non-priority vessel classes (e.g., fire boats, recreational boats, a supply boat) when EPA had access to these vessels and the resources to sample them. See Section 1.3 of this document for a short description of different vessel classes or types.

As discussed in Section 2.1.2, EPA was contacted by or otherwise developed contacts with trade associations and individual companies. Many of these entities relayed the purpose of the study to their constituents or peers, some of whom contacted EPA. Consequently, EPA obtained a pool of individual companies who were willing to volunteer their vessels for the sampling program. EPA then selected specific companies and vessels within the volunteer pool for sampling to obtain a variety of vessel classes, vessel platforms, companies, and geographic distribution. In general, EPA selected the entire volunteer pool within the following geographic areas to maximize the number and variety of sampled vessels based on available resources: New England (Gloucester/New Bedford, Massachusetts); Mid-Atlantic (Woodbridge, Virginia; Alexandria Virginia; Baltimore, Maryland; Havre de Grace, Maryland; and Philadelphia, Pennsylvania); Gulf Coast (Gulf Breeze, Florida; Pensacola, Florida; Bayou la Batre, Alabama; Pass Christian, Mississippi; Slidell, Louisiana; La Fitte, Louisiana; and Convent, Louisiana); and Sitka, Alaska.

EPA's vessel selection approach for commercial fishing vessels differed from that of other vessel classes due to the nature of this industry. During the fishing season, fishing trips typically last for multiple days with no preset schedule. The captain of each vessel determines the end of each fishing trip, returns to the seafood processor or tender to offload the catch, and then typically immediately returns to the fishing grounds. Therefore, EPA identified seafood processors, rather than specific fishing companies and vessels, as the means to obtain a pool of active fishing vessels for sampling. Sampling was conducted at the docks of the seafood processors during the offloading process, and EPA sampled all vessels that arrived while the EPA sampling crew was at the docks (with the permission of the captains). In this way, sampling of individual commercial fishing vessels was random. However, EPA did contact the seafood processing facilities prior to sampling to provide sampling details (e.g., nature of the study, discharges of interest, sampling dates). It was the facilities' discretion whether or not to share this information with the vessel fleets that use their offloading facilities.

Due to the assistance of trade groups and others, vessel owner/operators were generally very cooperative with EPA sampling teams. For example, the EPA vessel team found that most of the fishermen with whom they spoke in Sitka, Alaska, were aware of the study and that EPA would be sampling in the area during the summer. Other vessel owner/operators took EPA underway to sample engine effluent, waited to wash their dishes or take showers until EPA was able to collect the graywater discharge, and assisted EPA scientists in answering questions about their vessel operations.

During the public comment period for this report, EPA received comments noting that the types of vessels sampled for this study were not necessarily representative of the industry as a whole, specifically for commercial fishing vessels. Based on public comments, EPA evaluated the representativeness of the sampled commercial fishing vessels in terms of size, class, and geographic distribution. The commercial fishing industry is highly diverse (spanning a wide array of ocean and nearshore conditions, differing by both region and fishery). With respect to vessel size, EPA notes that the sampled commercial fishing vessel population does not represent discharges from vessels less than 26 feet in length, which comprise an estimated 10% of the overall commercial fishing vessel population. However, though EPA did not physically sample these vessels, we visually observed that these small vessels typically store their catch in coolers (which do not have a discharge) rather than in refrigerated seawater or ice holding tanks, which is a function of their relatively short fishing voyages. For larger fishing vessels, EPA believes the sampled vessel population is reasonably representative of the overall vessel population, albeit somewhat more heavily weighted toward the largest of commercial fishing vessels (i.e., 50 feet or more).

With respect to vessel class, EPA's sampled commercial fishing vessel population includes vessels in all of the fishing vessel classes. Furthermore, the percentage of sampled vessels by class is similar to or greater than the percentage of the overall vessel population by class for all vessel classes except for Pot/Trap vessels. Pot/Trap vessels include many of the smallest commercial vessels that are not represented by EPA's sampled vessel population. EPA also notes that it sampled a much higher percentage of Seiners than the overall vessel population (15% of vessels sampled versus only 2% of the overall vessel population). Sampling in Sitka, AK occurred at the start of the salmon fishing season, resulting in a preponderance of Seiners at the docks of seafood processers.

Finally, with respect to geographic distribution, EPA sampled commercial fishing vessels in the following regions: Alaska (21 vessels); Gulf Coast (6 vessels); and New England (6 vessels). According to the National Marine Fisheries Service, in 2008 these three areas combined represented approximately 77% of U.S. domestic commercial landings in 2008. Among the remaining geographic regions that EPA was unable to sample, the Pacific Coast (excluding Alaska) has the greatest landings in 2008 at 13% of U.S. domestic commercial landings; commercials fishing vessels in this region are expected to be similar to those in Alaska. Finally, many of other remaining geographic regions that EPA was unable to sample, such as the Chesapeake Bay, Middle Atlantic, and the Great Lakes, are likely dominated by small fishing vessels that most likely have low volumes of or no fish hold effluent discharges.

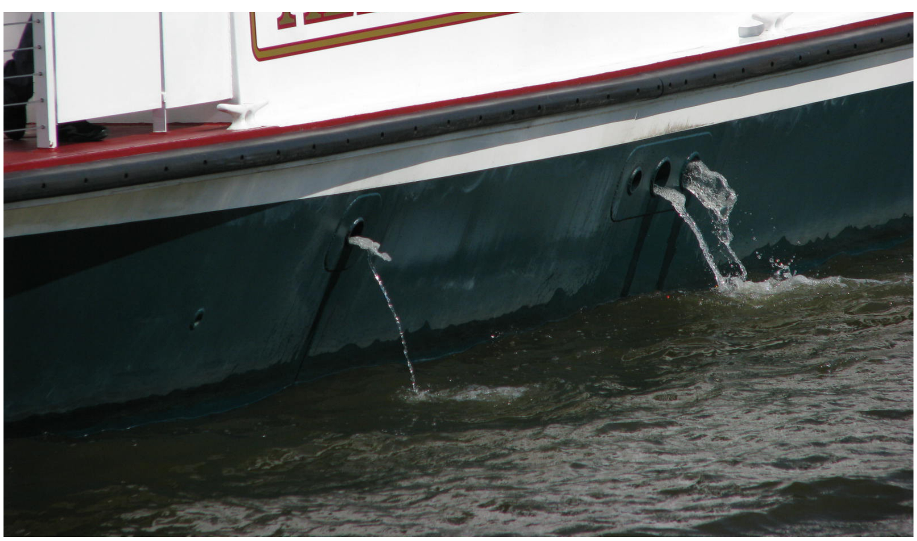
Hence, with the exception of the smallest commercial fishing vessels, EPA believes that the sampled vessel population is a representative cross-section of vessels and is adequate to evaluate the vessel population for the purpose of this study.

2.2.2 Sampled Discharges

EPA sampled a total of nine discharge types during the sampling program (see Table 2.1). To identify priority discharges for sampling, EPA first developed a list of vessel discharges based on information collected from discussions with industry representatives (see Section 2.1.2), as well as EPA's understanding of vessel discharges. Next, EPA prioritized the list to focus on the following discharges that are commonly generated by the vessel classes of interest and that are amenable to sampling (see Chapter 1 for descriptions and locations of these discharges):

- Bilgewater
- Stern tube packing gland effluent
- Deck runoff and/or washdown
- Fish hold effluent (including both refrigerated seawater effluent and ice slurry)
- Effluent from the cleaning of fish holds
- Graywater
- Propulsion engine effluent
- Generator engine effluent
- Firemain discharges

Vessels routinely use ambient waters to conduct normal operational and cleaning activities that lead to the generation of above discharges. EPA collected samples of ambient water where the vessels were operating. EPA also collected potable water used onboard the vessels (service water) to characterize any background concentrations of pollutants that might be detected in discharges from vessel operations that use service water.



Various Discharges Through Hull Discharge Ports.

EPA did not select non-oily machinery wastewater as a priority discharge for sampling because it was not expected to be discharged separately from bilgewater. The vessels that EPA sampled during this program use the bilge system to manage non-oily machinery wastewater (if there is any), such as fresh- and saltwater pump drains, chilled water condensate drains, and potable water tank overflows, rather than installing dedicated drip pans, funnels, and deck drains to provide for segregated discharge. Note, however, that EPA has not performed a comprehensive investigation of whether or not certain non-oily machinery wastewaters may have segregated discharges on other study vessels.

EPA did not select the discharges listed below as priority discharges for sampling because they were not reasonable or practical to sample within the overall program schedule and available resources.

- Anti-fouling hull coatings.
- Cathodic protection.
- Controllable pitch propeller and thruster hydraulic fluid and other oil-to-sea interfaces.
- Underwater ship husbandry.

EPA did not select the discharges listed below as priority discharges for sampling because they were not expected to be commonly generated on commercial fishing vessels or nonrecreational vessels less than 79 feet in length.

- Aqueous film-forming foam
- Boiler/economizer blowdown
- Distillation and reverse osmosis brine
- Elevator pit effluent
- Exhaust gas scrubber wash water
- Freshwater layup
- Gas turbine wash water
- Motor gasoline and compensating discharge
- Sonar dome discharge
- Welldeck discharges
- Graywater mixed with sewage

None of these discharges were sampled during the sampling program because none of the 61 vessels that EPA selected for sampling generated these discharges. Note, however, that EPA has not performed a comprehensive investigation of whether or not these discharges are applicable to other study vessels.

2.2.3 Target Analytes

EPA's vessel discharge sampling and analysis program included 301 target analytes in the following eight analyte groups:[1]

- Microbiologicals (pathogen indicators)
- Volatile and semivolatile organic compounds
- Total and dissolved metals
- Oil and grease
- Sulfide
- Long and short chain nonylphenol and octylphenol ethoxylates (i.e., alkylphenol ethoxylates) and total nonylphenol (NP)
- Nutrients
- Other physical/chemical parameters

Appendix D lists the target analytes included in each group, along with the analytical methods. EPA selected this comprehensive list of analytes to perform a screening-level analysis of the presence or absence of almost all priority pollutants (listed at 40 CFR Part 423, Appendix A), conventional pollutants defined at Section 304(a)(4) of the Clean Water Act, and toxic pollutants from EPA's 2006 National Recommended Water Quality Criteria for freshwater and saltwater aquatic life and human health, as well as many other nonconventional pollutants. Nearly half of these analytes (147) were never detected in any vessel discharge sample (see Chapter 3).

EPA did not analyze all vessel discharges for all selected analyte groups (see Table 2.2). Analyte groups were selected for analysis based on their possible presence in discharges, as determined from existing data sources and EPA's understanding of what constituents are possibly present in the different vessel discharges. For example, long-chain nonylphenol and octylphenol ethoxylates were only analyzed for in those discharges with the potential to contain detergents (i.e., bilgewater, packing gland, deck washdown, fish hold cleaning effluent, and graywater). Furthermore, short-chain nonylphenol and octylphenol ethoxylates and NP were only analyzed for in those discharges for which the long-chain structural isomers of these two subsets of alkylphenol ethoxylates were analyzed, and that also had a holding time onboard the vessel that would allow for the possible degradation of the long-chain isomers to the short-chain isomers and NP (e.g., bilgewater held in the bilge, graywater stored in a holding tank).

[1] Due to overall program resource constraints and other factors, not all analyte groups of possible concern were selected for this study (see Section 2.3.3).

Table 2.2. Analyte Groups by Discharge

Vessel Class and Priority Discharge	Microbiologicals	Volatile and Semi-volatile Organic Compounds	Metals (Total and Dissolved)	Oil and Grease	Sulfide	Short-Chain Alkylphenol Ethoxylates and NP	Long-Chain Alkylphenol Ethoxylates	Nutrients	BOD_5, COD, TOC (a)	Total Suspended Solids	Other Physical/Chemical Parameters (b)
Bilgewater	√ (c)	√	√	√	√	√	√	√	√	√	√
Stern tube packing gland effluent		√	√	√	√	√	√	√	√	√	√
Deck runoff and/or washdown	√ (d)		√	√			√	√	√	√	√
Fish hold effluent (including both refrigerated seawater effluent and ice slurry)	√		√	√	√			√	√	√	√
Effluent from the cleaning of fish holds	√		√	√	√		√	√	√	√	√
Graywater	√		√	√	√	√ (e)	√	√	√	√	√
Propulsion engine effluent		√	√	√	√					√	√
Generator engine effluent		√	√	√	√					√	√
Firemain systems		√	√								√

(a) Biochemical oxygen demand (BOD_5), chemical oxygen demand (COD), and total organic carbon (TOC).
(b) Other physical/chemical parameters include: conductivity; dissolved oxygen; pH; salinity; temperature; total residual chlorine; turbidity; and observations of odor, color, and floating and settleable material.
(c) Microbiologicals analyzed for only those vessels with potential for a source of these pollutants to enter the bilge (e.g., graywater piping, fish hold effluent).
(d) Microbiologicals analyzed for only commercial fishing vessels.
(e) Short-chain alkylphenol ethoxylates (i.e., nonylphenol and octylphenol ethoxylates) and NP analyzed only for graywater that has been stored in a holding tank prior to discharge.

2.2.4 Sampling Methods

EPA used a variety of sample collection methods depending on the nature of the discharge. This section describes the most commonly used sampling methods.

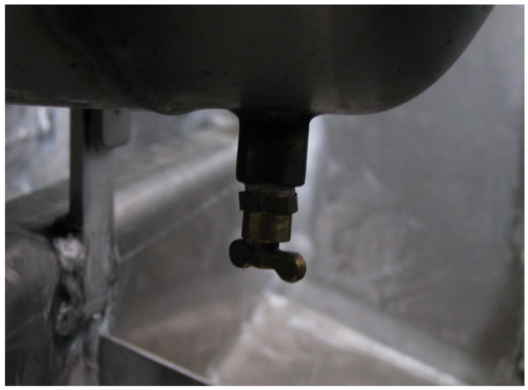
Discharge from a discharge port well above the water line.

Samples of these types of discharges were typically collected directly into a 5-gallon utility bucket lined with a new pail liner. For some samples, the bucket could be lowered by hand, while for other samples, the bucket was lowered by rope. The sample in the pail liner was then poured into the individual sample bottles. Whenever possible, samples for analysis of oil and grease were collected directly into the sample bottles (either held by hand or attached to a pole) to avoid the possible loss of oils to the sides of the sample transfer jar and pail liner. However, when oil and grease sample bottles were filled directly by attaching to a pole, it was typically necessary to "top off" the sample bottles with sample from the pail liner to ensure adequate sample volume for analysis.

Sample Collection Well Above the Water Line.

Discharge from a discharge port at or below the water line.

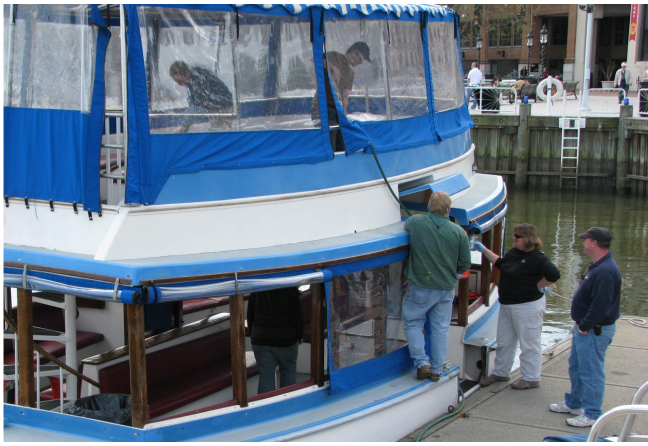
Typically, samples of these types of discharges were impossible or too unsafe to collect. In a few cases, however, EPA was able to collect samples upstream of the discharge port via a sampling port. For example, on one vessel, engine effluent could be accessed from a petcock valve on the muffler. Samples of these types of discharges were preferentially collected directly into sample bottles. In some cases, the clearance between the sampling port and the vessel hull was insufficient to accommodate the sample bottles and instead, required sample collection directly into a new pail liner; the sample in the pail liner was then poured into the individual sample bottles.



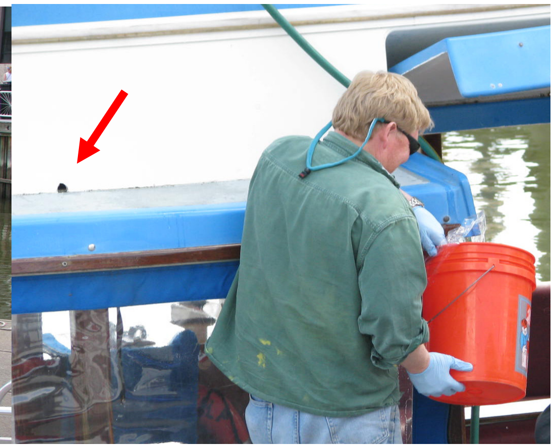
Close-up of Petcock Valve.

<u>Deck washdown and runoff.</u>

Deck washdown and runoff wastewater is discharged through scuppers located along the perimeter of the deck. To collect samples of this discharge, EPA generally directed the discharge to one or more (up to four) select scuppers using a variety of methods. On some vessels, deck washdown water naturally flowed by gravity to one or more scuppers at the lowest end of the deck. On other vessels, EPA used either the spray from the hose used to wash the deck or the broom used to wash the deck to direct the deck washwater to one or more selected scuppers. Finally, on some vessels, EPA arranged the deck washing hose on the vessel deck such that it directed and pooled deck washdown water to one or more selected scuppers. To collect the discharge from a selected scupper, EPA held a new pail liner against the hull of the vessel to capture the deck washdown water as it drained through the scupper. If deck washdown water was discharged through multiple scuppers, EPA filled the pail liners proportionally from each scupper (e.g., half from each of two scuppers, one-third from each of three scuppers). The sample in the pail liner was then poured into the individual sample bottles.



Deck Cleaning and Collecting Deck Washdown Sample.



Collecting Deck Washdown Sample with Close-up of Scupper (Indicated with Red Arrow).

For select fishing vessels, EPA attempted to collect samples of runoff during actual fishing operations. EPA arranged to travel with an overnight shrimping vessel on the Gulf Coast; however, due to a temporary seasonal shrimp fishery closing, EPA obtained a research permit to collect runoff from "demonstration" operations. Because these were demonstration operations and the shrimp fishermen would be unable to keep the catch, the vessel operator used a smaller net for shorter durations and did not handle the catch as he normally would. As a result, these samples only partially resemble normal operations. While in Alaska, the U.S. Coast Guard assisted EPA in attempting to sample deck washdown from fishing vessels immediately after they pulled in their catch. EPA and the Coast Guard attempted to sample three to five vessels during this operation. Due to weather conditions, however, they were only able to sample one vessel successfully.

<u>Fish hold tanks.</u>

Three types of fish hold tanks were sampled during the program: tanks containing refrigerated seawater, tanks containing ice slurry, and tanks containing chipped ice. Refrigerated seawater tanks were common to tenders, purse seiners, and trawlers, while slurry and chipped ice tanks were common to trollers, long-liners, gillnetters, and some trawlers. For vessels with refrigerated seawater tanks, fish are typically extracted using a vacuum system that removes both the fish and refrigerated seawater simultaneously. Both fish and refrigerated seawater are transferred to the seafood processing plant. The refrigerated seawater is generally recycled back to the fish hold tank to provide the liquid needed to operate the vacuum system. Any excess refrigerated seawater that is not required to assist in fish extraction is pumped overboard pier side. EPA collected samples of the refrigerated seawater directly into a 5-gallon utility bucket lined with a new pail liner as the water was pumped overboard. The sample in the pail liner was then poured into the individual sample bottles. Because removal of fish and refrigerated seawater can take several hours depending on the vessel size, EPA collected the sample approximately mid-way through the fish removal process. For vessels such as trollers and long-liners, which use chipped or slurry ice, EPA collected a sample of the ice or slurry once the fish had been removed from the fish hold tank. Ice/slurry was collected into a new pail liner and allowed to melt. Once melted, the sample was poured from the pail liner into the individual sample bottles.

Collecting Fish Hold Sample with a Lined Bucket.

Fish hold cleaning.

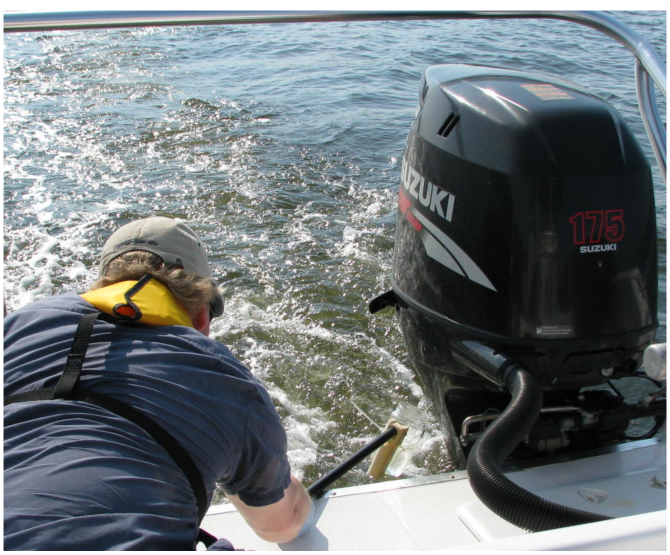
After the fish hold has been evacuated, the vessel crew cleans the fish hold as described in Section 1.3. For vessels with refrigerated seawater tanks or chipped ice tanks, the fish hold cleaning wastewater is pumped overboard. EPA collected samples of the fish hold cleaning wastewater directly into a 5-gallon utility bucket lined with a new pail liner as the cleaning water was pumped overboard.

Firemain.

EPA used valving on the firemain system to throttle the flow rate to allow firemain samples to be collected from the fire hose directly into sample containers. None of the vessels visited by EPA for this study tests its firemain system more frequently than once every two weeks, and none operates its system for secondary purposes such as deck washing. Of the six firemain systems sampled, five were wet systems (the firemain piping is normally filled with water) and one was a dry system (the firemain piping is normally filled with air). The resulting sampling data are applicable to firemain systems that are operated infrequently with intake provided by surrounding water and without additions to the discharge (e.g., no addition of foam-forming agents).

<u>Composite samples of multiple wastewaters.</u>

To better characterize some discharges, EPA decided to combine multiple samples of wastewaters into a single sample for analysis. The most common example is a vessel that operates its engines at multiple power levels—idle at the pier, half-speed when motoring through the no wake zone, and three-quarter speed when performing harbor tours. Another example is a vessel that generates two types of graywater—wastewater from a galley sink and wastewater from a shower. In these cases, EPA filled a new pail liner proportionally based on the number of wastewater sources (e.g., one-third from each of three power levels, half from each of sink and shower water) using one or more of the sample collection methods described above. The sample in the pail liner was then poured into the individual sample bottles. Whenever possible, EPA collected and analyzed separate samples for each discharge for oil and grease and for volatile organics, rather than using the composite sample; this minimized the possible loss of these target analytes from volatilization during sample transfer among multiple sampling equipment or due to adherence of oils to the sides of multiple sampling equipment.



Collecting Engine Effluent with a Transfer Jar.

Compositing the Sample in a Lined Bucket.

2.2.5 QA/QC

Quality assurance/quality control (QA/QC) procedures applicable to EPA's vessel sampling program are outlined in the *Quality Assurance Project Plan for Discharges from Commercial Fishing Vessels and Other Non-Recreational Vessels Less Than 79 Feet* (QAPP), which is included in the docket of the Federal Register notice announcing this study. This section describes the QC practices used to assess the precision and accuracy of the analytical data.

2.2.5.1 Analytical Quality Control

Analytical chemistry support for this program was provided by EPA's own laboratories in Regions 2, 3, and 5, as well as several subcontract laboratories. The EPA Regions were responsible for the quality of the work generated by their laboratories and for verifying that laboratory performance was acceptable by conducting QC checks of the analytical data as specified by the QAPP. Subcontract laboratories functioned within the quality system of EPA's sampling contractor, who verified the acceptability of subcontract laboratory performance by conducting QC checks of the analytical data as specified by the QAPP. Based on the data quality review and evaluation of the analytical data under this sampling program, all analytical data were deemed within or sufficiently close to the target analytical QC limits established for the study to assure the data could be used for the specified intentions. QC failures were generally attributed to matrix interference; these results are not uncommon for complex wastewater samples. Furthermore, the sample collection, handling, preparation, and analysis process utilized in this sampling program was deemed acceptable for the matrices and conditions sampled.

2.2.5.2 Field Quality Control

Field QA/QC measures and results for the bottle blanks, equipment blanks, trip blanks, field blanks, and field duplicates are discussed in this subsection.

Bottle blank.

A representative bottle and cap from the first lot of bottles purchased for collection of samples for analysis of pathogen indicators were analyzed for wide-spectrum contamination prior to their use in the sampling program. Bottles were filled with sterile deionized water, and 100–milliliter (mL) aliquots were filtered by membrane filtration. The filters were placed on water agar, nutrient agar, modified mTEC agar (for *E. coli* cultures), and mEL agar (for enterococci cultures). No pathogen indicators or other organisms (water or nutrient agar) were detected in the bottle blank, indicating that the bottles were sterile.

Equipment blanks.

Two equipment blanks were prepared and analyzed for volatile and semivolatile organic compounds (SVOC), total and dissolved metals, nutrients, soaps and detergents, and other physical/chemical parameters to assess the potential introduction of contaminants by sample collection equipment. The sample collection equipment used to collect the equipment blanks was the same as that used at the sampling points: 1) a new, factory-cleaned, Teflon® PFA pail liner from the first lot of bags purchased from the vendor, and 2) a 3-foot segment of silicone tubing connected to a 25-foot segment of Teflon tubing used in the peristaltic pump (only used on three samples throughout the entire project). The pail liner equipment blank was prepared by rinsing the bag with high performance liquid chromatography (HPLC) water and then pouring it into sample bottles. The pump tubing equipment blank was prepared by pumping HPLC water through this equipment and collecting directly into sample bottles. Of the 459 equipment blank sample results, 29 (6.3 percent) were above the method reporting limit (RL). Of the cases where the equipment blank exceeded the RL, 15 were for SVOC analytes and seven were for VOC analytes. In all 22 of these cases, however, the analytes were tentatively identified compounds (TICs), which are appropriately labeled in the analytical database as such. The remaining cases where the equipment blank exceeded the RL were as follows: biochemical oxygen demand (BOD) (two instances), chemical oxygen demand (COD) (two instances), total Kjeldahl nitrogen (TKN) (one instance), nitrate/nitrite nitrogen (one instance), and zinc (one instance). In each instance, the vast majority (greater than 90 percent) of the associated discharge sample amounts were significantly higher than the equipment blank levels.

Trip blanks.

Trip blanks were prepared and analyzed for volatile organics to evaluate possible contamination during shipment and handling of samples. These samples consisted of HPLC water poured into the sample bottles and transported unopened to the field and finally to the laboratory. One trip blank was prepared for each location-specific sampling event (e.g., Gulf Coast, New England). Evaluation of the trip blanks indicated that of the 612 VOC results for these samples, only two analytes were detected (tetramethylsilanol and tetrahydrofuran), and these were at levels below the RL. Neither of these analytes was detected in any vessel discharge samples, indicating that there was no sample contamination during transport, field handling, and storage.

Field blanks.

Field blanks were prepared and analyzed for all target analytes to monitor for the contamination of samples during sample collection and handling. These samples were prepared aboard selected vessels at the location of greatest potential for contamination (e.g., the vessel bilge space). The samples were prepared by pouring HPLC water into the sample bottles. One field blank was prepared for each location-specific sampling event (e.g., Gulf Coast, New

England). Only six target analytes (conductivity, dissolved organic carbon, nitrate/nitrite, TKN, turbidity, and total zinc) were detected in any of the 670 field blank results (0.3 percent) at levels above the RL. In each instance, the associated discharge sample amounts were significantly higher than the field blank levels.

Field duplicates.

Field duplicate samples were collected and analyzed for all target analytes to assess the precision of the entire sample collection, handling, preparation, and analysis process. Field duplicate samples were collected simultaneously from the same location as the original samples (i.e., poured from the pail liner as a split sample or sampled sequentially when collecting samples directly into sample bottles from discharge ports). The relative percent difference (RPD) between the two duplicate sample results was calculated and compared to the data quality objective. The occurrence of field duplicate samples (number of samples exceeding out of total number of duplicate samples) where one or more analytes within an analyte type (VOCs, SVOCs, dissolved metals) exceeded the target RPD was 89 of 356 pairs of field duplicate samples, or 25 percent. The higher RPDs were calculated in samples where the concentrations of the analytes were detected at levels at or near the detection level for the respective methods, mainly for VOCs, Silica Gel Treated N-Hexane (SGT-HEM), and residual chlorine. For these methods, the analytical variability increases as analyte concentrations approach their detection limits. These results are not uncommon in complex wastewater samples.

2.2.5.3 Database Development

An Access database was created in which to collect and organize all analytical results. This database contained data and associated qualifier information. Although a number of EPA and contractor staff were involved in reviewing the results, only one person had the authority to make any changes to the database during its development. This one-person control system eliminated the possibility of someone accidentally creating more than one current version of the database and minimized the risk of errors. Each time the database was updated, the current date and time stamp were used to name the new version, which was uploaded to a secure FTP server.

After each sampling event, the chains of custody (COC) and field data sheets were used to manually enter information into the "COC Information" table. This table contained identifiers given to samples in the field (FieldIDs) associated with vessel name, location, and discharge information, as well as the sample date and time. A second person performed a 100-percent check of the data entered to ensure there were no transcription errors or mistakes made during data entry.

Four analytical chemistry and subcontract laboratories —EPA Region 2 (Edison, New Jersey), EPA Region 3 (EPA Environmental Science Center, Fort Meade, Maryland), TriMatrix (Grand Rapids, Michigan), and Admiralty (Juneau, Alaska)—provided EPA's contractor with electronic data deliverables (EDDs) in either Excel or delimited text format. EDDs were first imported into the database as new tables that remained unaltered while the fields of interest, contained therein, were appended to a table called "Vessel Results." The remaining fields were populated using queries. Ten percent of the data in the Vessel Results table from three of the four laboratories were compared to the original hard copy reports, if provided. This ensured consistency between the EDD and hard copy report, as well as validated the importing procedure. As a further quality assurance measure, a 100-percent check was done comparing these PDF reports to database entries derived from the fourth lab's EDD reports.

Data that were not received in EDD format (i.e., hard copies, PDFs, and field data sheets) were manually entered directly into the Vessel Results table. These data were provided by six additional analytical chemistry and subcontract laboratories: EPA Region 5 (Chicago, Illinois), Biomarine (Gloucester, Massachusetts), EnviroChem (Mobile, Alabama), QC Laboratories (Southampton, Pennsylvania), Northeast Environmental Laboratory (Danvers, Massachusetts), and Sitka Water Treatment Plant (Sitka, Alaska). As with the COC information, a second person did a 100-percent check of the accuracy of data entry.

In addition to checking for reporting accuracy, a check of laboratory QC procedures was performed. EPA examined laboratory QC parameters, including method type, hold times, laboratory blanks and duplicates, laboratory control samples, and surrogate recovery, where applicable, for all subcontract laboratories.

2.3 DATA CONSIDERATIONS AND STUDY LIMITATIONS

2.3.1 Voluntary Nature of the Sampling Program

All vessel sampling performed for this study was conducted on a voluntary basis (i.e., vessel owners/operators voluntarily allowed EPA to sample their vessels). As such, the selection process was not completely random from within the universe of study vessels, nor were the vessels sampled unannounced, with the possible exception of fishing vessels (see Section 2.2.1). These issues raise potential concerns regarding the representativeness of the sampling and the statistical uncertainty of the resulting data analyses. To minimize these concerns, EPA provided study volunteers with guidance for participation in the sampling program. This guidance stressed EPA's desire to sample normal discharge cycles/events and requested that volunteers not alter vessel operations from normal (typical) operation. The guidance specifically instructed that volunteers should not perform any special cleaning in preparation for sampling, add or eliminate or alter any typical discharges, or increase or decrease the volume or other characteristics of discharges, etc. Also, as EPA preferred to collect samples pierside rather than underway, EPA instructed volunteers to inform the Agency if conducting sampling pierside compromised, in any way, the characteristics of discharges (sources, volumes, composition).

As a further consideration, EPA assumed that most of the volunteers were generally 'good actors' who would have the best maintained vessels and be in compliance with all existing applicable regulations, which could also affect the representativeness of the data collected for the vessel class as a whole.

2.3.2 Vessels/Discharges Not Sampled

While this study included the sampling of a large number of discharges from a large number of vessels, certain vessel classes and discharges were either not sampled at all or received only limited sampling due to overall program schedule and resource constraints or other factors (see Sections 2.2.1 and 2.2.2). EPA supplemented its sampling program with information and data collected from other data sources to the extent possible; however, the Agency acknowledges remaining gaps in achieving the study objectives for certain segments of the industry. In particular, EPA has little or no information or data regarding freight barges, freight ships, tank barges, and tank ships less than 79 feet in length (estimated to represent 7 percent of study vessels). In addition, EPA has little information or data regarding the applicability of several discharges listed in Section 2.2.2 to study vessels.

EPA's ability to fully characterize certain discharges was limited by some practical considerations. For example, on many vessels, discharges were too close to the waterline, or even under the waterline, precluding the ability to collect an uncontaminated sample. Installation of sample taps upstream of these discharge ports was either impossible (i.e., would compromise system integrity) or impractical within time constraints for the sampling events. On other vessels, collection of vessel discharges under normal operations was either impossible or unsafe. These conditions included:

- Vessel configurations blocking access to discharge ports
- Discharge volumes insufficient for sampling
- Discharges not generated during the sampling event
- Systems such as generators not operational during the sampling event
- Systems operated only during emergency
- Discharges requiring underway sampling
- Fishing vessel platforms inactive during the sampling schedule
- Fishing seasons closed or outside the sampling schedule
- Inability to sample all U.S. fisheries

As an example, EPA was able to sample bilgewater on only eight of the 61 sampled vessels (13 percent). Bilgewater sampling was infeasible for approximately three quarters of the remaining vessels for three reasons. First, automatic bilge pumps operating while the vessel was underway resulted in an empty bilge when the vessel returned to pier. Manual activation of the bilge pump on these vessels did not result in any discharge or only a small volume of discharge. Second, as a matter of policy, many vessels restrict bilgewater discharges to only while underway or when outside U.S. waters due to possible concerns of exceeding existing Clean Water Act § 311 requirements. Third, some bilgewater discharges were too close to the waterline for sampling. For the remaining one quarter of vessels, sampling was not performed because the vessels never discharge bilgewater. On these vessels, a contractor steam cleans the bilges once per month, and the resulting cleaning waste is removed from the vessels for shoreside disposal.

2.3.3 Pollutants Not Sampled

A few candidate analyte groups (pesticides, polychlorinated biphenyls, dioxins/furans, flame retardants, uranium, and asbestos) were not selected for analysis, as they are not anticipated to be present in the vessel discharges due to the lack of a readily apparent source for these pollutants.

While EPA's list of target analytes includes many persistent, bioaccumulative, and toxic chemicals (PBTs), many other PBTs were not analyzed for due to the lack of test methods or resources. In general, these unanalyzed compounds either have no known use or source onboard vessels or have no readily available means to enter the vessel discharges. Mercury was not selected for analysis because it requires specialized sampling techniques inapplicable to vessel sampling to minimize the potential for sample contamination (e.g., vessel sampling cannot be conducted away from sources of metals or sources of airborne contamination such as engines or generators).

Test methods for pharmaceuticals and personal care products (PPCPs) have recently been developed; however, EPA did not select this analyte group for analysis due to a lack of resources. These compounds are most likely to be found in sewage, which is outside the scope of this study; however, they can also be expected to be found in graywater sources, such as sink and shower wastewater, albeit at very low concentrations.

Although ballast water, and its assessment as a vector for aquatic invasive species, was specifically excluded from this study by the statutory language in P.L. 110-299 (see Appendix C), EPA recognizes that other vessel discharges, such as bilgewater; stern tube packing gland effluent; fish hold effluent; and discharges from vessel hulls, propellers, and other exposed surfaces are also potential vectors for the spread of aquatic invasive species. EPA excluded any aquatic invasive species characterization as part of this study in consideration of overall program schedule and resources.

2.3.4 Application to Other Vessels, Including Larger Vessels Not Sampled for this Study

EPA's primary objective in conducting the vessel sampling program was to characterize discharges specific to commercial fishing vessels and nonrecreational vessels less than 79 feet (i.e., study vessels). Some data are applicable to other vessels, however, including larger vessels not sampled for this study. This subsection discusses EPA's consideration of the applicability of these sample data to other vessels, as well as factors that data users should consider in determining the broader applicability of the data.

Bilgewater.

The composition and volume of bilgewater is highly dependent on the specific sources of wastewater that accumulate in bilge, as well as vessel size, hull design and construction, vessel operation, and a variety of additional factors (see Section 1.3). Any researcher, regulator, or other stakeholder who subsequently uses the data collected in this study should evaluate and compare the characteristics of the vessels sampled for this study to those of other vessels to determine the applicability of EPA's sampling data. In general, EPA believes that the design, construction, and operation of vessels not sampled for this study (e.g., cruise ships, ferries, barges, tankers) differ considerably from those of the sampled vessels, which would result in significantly different bilgewater characteristics. Hence, EPA cautions against applying the limited bilgewater results from this study to all vessels.

Stern tube packing gland effluent.

This discharge applies to vessels that collect the ambient water that leaks through the stuffing box and packing gland that surround the propeller shaft in a segregated area from the general bilge. During this study, EPA observed this segregated discharge onboard tugboats but not on any other vessel classes. On tugboats, the stuffing box is packed with greased flax rings. EPA's stern tube packing gland effluent data should be applicable to other vessel classes (if any) that use this same type of stern tube packing gland and that collect the resulting wastewater for segregated discharge.

Deck runoff and/or washdown.

Factors contributing to the volume and composition of deck runoff and/or washdown include deck equipment and operations, deck surface material, and method of washing the deck (see Section 1.3). Data users should evaluate and compare the characteristics of the vessels sampled for this study to those of other vessels to determine the applicability of EPA's sampling data. In general, EPA believes that deck operations performed on vessels outside the scope of this study differ significantly from those of the sampled vessels. For example, deck washdown generated by fishing vessels might be applicable only to this industry, particularly in cases where these vessels are washing significant organic material from fishing operations overboard. As another example, only one sampled vessel, a supply boat, is used to support the transfer and handling of non-fish cargo. On the other hand, deck washdown from sampled passenger vessels might apply to other vessels, such as larger tour boats, water taxis, and possibly cruise ships.

Fish hold effluent (including both refrigerated seawater effluent and ice slurry) and effluent from the cleaning of fish holds.

Since only commercial fishing vessels or tenders use fish holds for storing seafood products or fish, EPA believes that fish hold effluent discharges are unique to commercial fishing operations and are not applicable to other vessels.

Graywater.

The graywater sources sampled by EPA for this study are "domestic" in nature, such as sink water from washing hands and dishes, wastewater from shower stalls, and laundry water from domestic washing machines. EPA cautions the data user against applying these sampling data to non-domestic graywater operations, such as large-scale industrial dishwashing and laundry equipment. In addition, the graywater sources sampled by EPA were discharged immediately upon generation; therefore, these data do not represent graywater that has been retained in collection or storage tanks or graywater mixed with sewage. Finally, EPA's graywater data do not apply to wastewater discharges from food waste processing operations, such as food grinders or food pulping systems.

Propulsion and generator engine effluent.

For this study, EPA sampled propulsion and generator effluent from a large number and variety of engines. These include:

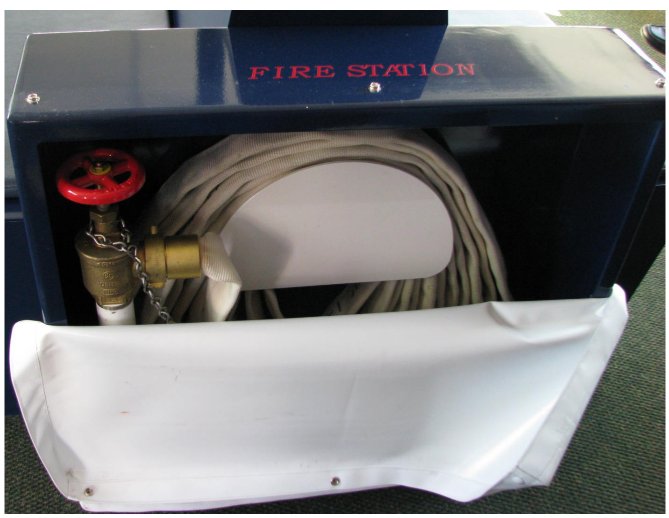
- Inboard and outboard.
- Two-stroke and four-stroke.
- Spark ignition and compression ignition.
- Diesel- and gasoline-fueled.
- New and existing.
- Direct cooling systems (raw water directly cools the engine) and indirect cooling systems (raw water cools antifreeze, which cools the engine).
- With and without wet engine exhausts (some raw water is injected into the exhaust to cool and quiet the exhaust).
- Variety of manufacturers, sizes, and engine horsepower.
- Operation at varying engine power levels (i.e., idle, slow troll, half throttle, three-quarters throttle, and full throttle) depending on vessel use.

EPA also observed a number of vessels, such as tug boats and larger commercial fishing vessels, that use keel-cooled propulsion engines and generators. The closed-loop cooling systems used on these engines do not discharge any wastewater.

Based on an evaluation of the engine effluent sampling results, EPA observed significant differences in the nature and composition of discharges from inboard and outboard propulsion engines and from generators. EPA may also have observed differences between diesel- and gasoline-fueled inboard propulsion engines; however, the data set was too small to be conclusive. Based on these findings, EPA believes the engine effluent data are applicable only to engines of similar types, specifically inboard propulsion versus outboard propulsion versus generators and diesel- versus gasoline-fueled engines.

Firemain systems.

EPA sampled relatively few firemain systems for this study. Firefighting equipment requirements are specified by the U.S. Coast Guard and differ by vessel type, size, construction (e.g., open decks versus enclosed spaces with potential to entrap explosives, flammable gases, or vapors), whether or not the vessel carries passengers for hire, and many other factors. Not all vessels within the scope of this study are required to carry firefighting equipment. For those vessels that require firefighting equipment, these requirements are often satisfied by carrying hand-portable fire extinguishers rather than firemain systems. For vessels outfitted with firemain systems, the systems are used during emergency and testing. None of the vessels visited by EPA for this study tests its firemain system more frequently than once every two weeks, and none operates its system for secondary purposes such as deck washing. Operating personnel from three tour boats and two tugboats that EPA visited agreed to engage their firemain systems for EPA sampling. Most operated wet rather than dry systems. The resulting sampling data apply primarily to wet-type firemain systems that are operated infrequently, with intake provided by surrounding water and without additions to the discharge (e.g., no addition of foam-forming agents).



Firemain System on a Passenger Vessel.

EPA also sampled the firefighting system onboard a fire boat; however, these sampling data may only apply to fire boats or other vessels equipped with high-pressure/high-volume fire pumps.