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Impacts of EPA 2012 Pump-Out Regulations - Implementation

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Submitted by

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In cooperation with

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16. Abstract

. With the 2008 VGP expiration date approaching, US EPA issued the 2013 VGP. There are changes in the 2013 VGP, requiring compliance by vessel owners and operators. As a result, the new requirements will impact the commercial vessels operating in the NY/NJ Harbor and Delaware River. Another concern was an issue related to black water discharge. Therefore, the objectives of this study were to (1) perform an analysis of the 2013 VGPs and determine the impacts to New Jersey's maritime operations; (2) determine and recommend what New Jersey needs to do to be prepared to implement the 2013 VGP; and (3) study issues related to black water discharge and No Discharge Zones in New Jersey. To carry out the project tasks, information and data were collected from the US EPA, US Coast Guard, National Ballast Information Clearinghouse, Tugboat Enthusiasts Society of the American, and the Research and Innovative Technology Administration and analyzed. Meetings of the project stakeholders committee were held and key issues discussed. The findings related to the new requirements of the 2013 VGP, ballast water and non-ballast water discharge limitations, administrative report changes, as well as issues concerning black water discharges are discussed in detail and recommendations made for compliance.

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TABLE OF CONTENTS

LIST OF FIGURES

LIST OF TABLES

EXECUTIVE SUMMARY

The US Environmental Protection Agency (EPA) issued the Vessel General Permit (VGP) for Discharges Incidental to the Normal Operation of Vessels on December 19, 2008. With the 2008 VGP expiration date approaching, US EPA issued the 2013 VGP. Changes were made in the 2013 VGP which require the vessel owners and operators to comply. As a result, the new requirements will impact the commercial vessels operating in the NY/NJ Harbor and Delaware River.

Due to shared water bodies in the NY/NJ Harbor, the project's VGP Stakeholder Committee wanted to incorporate plans by New York City related to the installation of pump-out facilities for black water. Consensus determined that further investigation of this issue be conducted in this study.

Therefore, the objectives of this research were to (1) perform an analysis of the 2013 VGPs and determine the impacts to New Jersey's maritime operations; (2) determine and recommend what New Jersey needs to do to be prepared to implement the 2013 VGP; and (3) study issues related to black water discharge and No Discharge Zone in New Jersey.

To carry out the project tasks, literature review was conducted and data were collected from the US EPA, US Coast Guard, National Ballast Information Clearinghouse (NBIC), Tugboat Enthusiasts Society of the American (TESA), and the Research and Innovative Technology Administration (RITA) and analyzed. Stakeholder committee meetings were held and key issues discussed. The findings of this study can be summarized below:

- The 2013 VGP regulates discharges from vessels in terms of three effluent limits: general effluent; 27 specific discharge streams; and water-quality based limits.
- Three major changes in the 2013 VGP requirements from the 2008 VGP were made: (1) numeric effluent limitations for ballast water, (2) discharge effluent requirements for non-ballast water discharges such as oil to water interfaces, fish hold effluent, and exhaust gas scrubber effluent, and (3) administrative reports.
- There are four ways to handle ballast water as stated in the 2013 VGP with respect to ballast water management: onboard ballast water treatment, onshore ballast water treatment, use of water supply water or no ballast water discharge.
- EPA VGP database has 71,008 vessels filed Notice of Intent (NOI) in 2012, which had increased from 57,173 vessels for data collected in 2011 in 8 types of vessels. Only 23,707 vessels out of 71,008 have onboard treatment facility, such as marine sanitation device, oil water separator, or holding tank, for few selected discharges.
- USCG data indicates that over 4,300 commercial vessels arrived in New Jersey in 2012, which is similar to 2011 USCG data. The busiest ports/terminals are Newark, Elizabeth, Bayonne, and Paulsboro.

- NBIC 2012 data points out that over 3,000 vessels arrived in New Jersey, which had declined from the peak of 3,400 in 2010. The busiest ports/terminals are Newark, Elizabeth, and Bayway.
- Though, 491 tug boats operates in New York City (Total 663 in New York), only 16 tug boats runs in New Jersey waters according to TESA data.
- RITA provides information on the ferries. There are 44 ferries that use 15 marine terminals in New Jersey. About 8.8 million passengers made 5,846 trips in New Jersey in 2010. Over 88% of the passenger commuted between New Jersey and New York City, the rest traveled from central New Jersey to Pennsylvania or Delaware.
- Over 520 small vessels such as cargo barges, self-propellers vessels, and tug boats operated in New York City /New Jersey water according to US Army Corps of Engineers data.
- Clean Water Act (CWA) controls sewage or black water discharged from vessels by regulating the Marine Sanitation Device (MSDs) that treats or holds the sewage, and through the establishment of No Discharge Zones (NDZs).
- A NDZ is a designated body of water that prohibits the discharge of treated and untreated boat sewage. There are 5 NDZs in New Jersey: Manasquan River, Navesink River, Shark River, Shrewsbury River, and Barnegat Bay.
- The CWA requires a certified operable Marine Sanitation Devices (MSD) on every vessel with an installed toilet operating on U.S. navigable waters. Black water held in the MSDs can only be discharged onshore or 3 miles from shore.
- There are two existing pump-out facilities for commercial vessels in New York City and two additional are in the planning stage.
- There is no onshore ballast water storage and treatment facility in New Jersey.

The following is a summary of recommendations for the State of New Jersey for implementing the 2013 VGP:

- Vessel owners/operators should prepare for the changes made in the 2013 VGP, especially new requirements in ballast water and non-ballast water discharges, since numeric limitations and implementation schedule have been established.
- Based on the EPA NOI database, only 33.3% of the vessels have some onboard treatment or storage facility onboard and it is estimated 12% of the vessels were built before 1985, which might not have space for onboard treatment facility. Vessel owners with the need of discharging ballast water will need to find ways to install treatment or holding facility.
- Other than available space, other concerns related to onboard ballast water treatment equipment or holding tank include additional power requirement, safety issues, operation and maintenance of the equipment, and monitoring demand. In addition, naval architecture limits what can be done a ship. Retrofitting may not be possible.
- Currently, there is no onshore ballast water treatment or holding facilities exist in New Jersey. The demand for one may occur in the future once the 2013 VGP is fully implemented. The use of government bonds or private sources of funding may need to consider.

- Though numerical limits for exhaust gas scrubber effluent limits have been established in the 2013 VGP, efficient and cost-effective technologies and commercial products are not available at the present time. The marine industry will need help to receive up-to-date information in the near future.
- Black water discharges from vessels is controlled by the installation of Marine Sanitary Devices. Though all MSDs are certified by the USCG, a tracking record as how black water is being discharged was not found. The existing pump-out stations in New Jersey are mainly to serve recreation vessels. It is doubtful that large vessels such as tanker, cargo ship, and large ferries can use these facilities due to limited deck/pier length and water depth.
- Convenience will make it easier for the marine industry to comply with environmental regulations or guidelines if pump-out service is provided for commercial vessels.
- Black water pump-out services should be provided in the ports/terminals that have more marine traffic. This study found the busiest area is in the Newark Bay, and the second one is along the Delaware River. Also, municipal wastewater treatment plants are nearby in both locations. It is recommended black water pump-out station for commercial vessels be situated in these two areas first.
- Since New York City is looking into landsite infrastructure, it is recommendation a mobile pump-out service using barge be used. It has advantage of not being fixed in one location and can accommodate the need of vessels.
- There is a need to locate the funding for the purchase a barge since there is no government funding available. This again can be funded through government bonds or private sources.
- Black water generation is related to the number of person and type of plumbing system onboard. Information has been collected and presented in the report.
- To have a uniform design standard and provide service to all vessel owners/operators using pump-out facilities for vessels operating in the Newark Bay and Delaware River will need the cooperation from quite a number of state and interstate agencies. It is expected more discussion will be needed.

INTRODUCTION

Under the Clean Water Act (CWA), all discharges of pollutants into U.S. waters are prohibited, unless authorized by an issued permit or exempted. However, shortly after the Act went into effect, the EPA issued a regulation exempting discharges incidental to the normal operation of vessels. In December 2003, a coalition of environmental groups sued the EPA to repeal the vessel exemption. The court ultimately held in March 2005 that the vessel exemption was beyond EPA's authority to grant, and therefore ordered that the exemption be vacated. The EPA's appeal was not successful, and the court ultimately ordered that the vessel exemption be annulled by December 19, 2008 [51, 52].

The US EPA issued the Vessel General Permit (VGP) for Discharges Incidental to the Normal Operation of Vessels on December 19, 2008. Other than those exempted from the VGP, any vessel discharge not specifically allowed by a permit would violate the CWA, and subject the owner and operator to potential criminal liability, civil penalties, and the risk of lawsuits. Recreational vessels, commercial fishing vessels, Armed Forces vessels, and non-recreational vessels less than 79 feet in length are exempted from the 2008 VGP [51]. With the 2008 VGP expiration date of December 18th, 2013 approaching, US EPA issued the 2013 VGP. There are changes in the 2013 VGP from 2008 VGP which require the vessel owners and operators to comply.

As a result, commercial vessels operating in the NY/NJ Harbor and the Delaware River will be affected by the new requirements. This will affect maritime commerce in terms of cost and administration to meet such demands in certain ways. The impact is expected because of the new requirements and some issues that currently remain unresolved.

An issue related to the potential No Discharge Zone (NDZ) was raised in one of the project's stakeholders' meetings. US EPA is checking on the states willingness to pursue a NDZ in the New York harbor waters. New York City is also investigating the locations of pump-out facility for commercial vessels for black water. Since New Jersey shares the same harbor waters, discussions on whether New Jersey should follow suit were held in the stakeholders' meetings. It was agreed that further analysis of this issue be conducted in this study.

OBJECTIVES

The objectives of this research were to:

- Perform an analysis of the 2013 VGPs and determine the impacts to New Jersey's maritime operations;
- Determine and recommend what New Jersey needs to do to be prepared to implement the 2013 VGP; and
- Study issues related to black water discharge and No Discharge Zone in New Jersey, which would include refining the information and data, an assessment of

potential, likely or feasible locations for pump-out facilities and options, and assessment of marine traffic using map or graphics to decide where best to place pump out stations.

LITERATURE SEARCH

The 2008 VGP does not impose numerical effluent limits, as it normally does in connection with land-based discharges. Instead the requirement is for vessels to carry out certain "Best Management Practices" (BMPs) with regard to each of the discharges as set out in the VGP. The expiration date of the 2008 VGP was December 18th, 2013 and the 2013 VGP was made public in 2013. US EPA also issued a Small Vessel General Permit (sVGP) which covers the vessels less than 79 ft and commercial fishing vessels not carrying ballast. US EPA is still in process of soliciting comments from states and maritime industry [52].

The information of the 2008 VGP requirements has been discussed in detail in another report of the VGP study [17]. Many of the requirements imposed by the 2013 VGP duplicate existing 2008 VGP, but some changes have been made. The significant changes in the 2013 VGP from 2008 VGP are in three categories [51, 52]:

- Changes to ballast water requirements;
- Changes to other incidental discharge effluent requirements; and
- Changes to administrative requirements.

2013 VGP Ballast Water Requirements

The US EPA established stringent numeric technology-based effluent limitations applicable to vessels with ballast water tanks in the 2013 VGP. These limitations will achieve significant reductions in the spread of aquatic nuisance species (ANS). These discharge limitations are the same as IMO (International Maritime Organization) D-2 Regulations. Additional water quality based requirement are also proposed for certain vessels entering the Great Lakes.

Vessels that carry greater or equal to 8 m^3 of ballast water must meet numeric discharge limitations. Ballast water discharge limit is displayed in Table 1. The Vessels that are exempt from numeric discharge limitations include the following [51, 52]:

- Short distance voyage vessels;
- Unmanned, unpowered barges; and
- Existing bulk carrier vessels (''Lakers'') built before January 1, 2009 that operate exclusively in the Great Lakes upstream of the Welland Canal (existing ''confined Lakers'').

The 2013 VGP also lists the four measures that can be taken to manage the ballast water [51, 52]:

- Use a ballast water treatment system (BWTS) onboard; or
- Transfer ballast water to an NPDES permitted facility; or
- Use treated public water supply water; or
- No ballast water discharge.

Table 1- Ballast Water Discharge Limit [51, 52]

Organisms	2013 VGP/IMO
Number of organisms ≥50 μm	< 10 /m^3 ballast water
Number of organisms between 10 and 50 μm	< 10 /mL ballast water
Bacteria and Virus Counts (not to exceed)	Not Regulated
Toxicogenic *Vibrio cholerae*	< 1 CFU /100 mL
Escherichia coli	< 250 CFU /100 mL
Intestinal enterococci	< 1 CFU /100 mL

Additional requirements for managing the ballast water consist of the following [51, 52]:

- Ballast Water Treatment System will need to be approved according to US EPA-ETV (Environmental Technology Verification) Protocol.
- The monitoring is divided into three components
  - Equipment performance. Monitoring to assure the system is operating as designed;
  - Monitoring all ballast water systems for selected biological indicators; and
  - Monitoring of the ballast water discharge itself for biocides and residuals
- Reporting requirements.
- Compliance Schedule. The compliance schedules for ballast water treatment systems are shown in Table 2.

Table 2- Ballast Water Treatment System Compliance Schedule [51, 52]

	Vessel's Ballast Water Capacity (m^3)	Date Constructed	Vessel's Compliance Date
New Vessels		After 1/1/2012	On delivery
Existing Vessels	< 1500	Before 1/1/2011	First scheduled drydock after 1/1/2016
	1500 - 3000	Before 1/1/2011	First scheduled drydock after 1/1/2014
	> 5000	Before 1/1/2011	First scheduled drydock after 1/1/2016

2013 VGP Non-Ballast Water Requirements

For non-ballast water, the new requirements in the 2013 VGP are [51, 52]:

- 2013 VGP imposes more stringent technology-based effluent limits in BMPs for discharges of oil to sea interfaces (product substitution requirement).
- It requires that all powered new build vessels (constructed after December 19, 2013) must use ‘‘environmentally acceptable lubricants’’ in their oil-to-sea interfaces.
- It also authorizes the discharge of fish hold effluent and establishes appropriate Best Management Practices.
- New build vessels (after December 19, 2014) greater than 400 gross ton must sample and analyze bilge effluent once a year for oil and grease content.
- US EPA has also included numeric limits for exhaust gas scrubber effluent that are consistent with IMO guidelines.
- “Fish Hold Effluent” has been added to the list of Specific Discharges.
- US EPA *is* also specifically seeking input as to whether to include more stringent numeric limits for bilgewater for certain vessels, which would decrease oil (and potentially other pollutants) discharge.

2013 VGP Administrative Requirement Changes

The following administration changes were made in the 2013 VGP [51, 52]:

- Annual report
    - Eliminate One-Time Report and Annual Non-Compliance Report and consolidate into Annual Report.
    - Report all analytical monitoring as part of Annual Report.
    - Allow unmanned, unpowered barges meeting certain requirements to submit consolidated annual reports.
- Eliminating duplicative reporting
- Inspection
    - Eliminate quarterly visual monitoring.
    - Allow “Extended Unmanned Vessel” inspections in lieu of routine vessel inspections.

No Discharge Zone

Though the study of the black water pump-out facility and No Discharge Zone was not in the original proposal, it was decided that NJIT team will conduct this part of the study under Task 4 of the Contract and the scope of work is the third item listed under the Objectives of this report. Since the control of black water discharge from vessels is related to No Discharge Zone (NDZ) and Marine Sanitation Devices (MSDs). They are introduced below.

A No Discharge Zone or area is a designated body of water that prohibits the discharge of treated and untreated boat sewage. Federal Law prohibits the discharge of vessel sewage within most navigable waters of the U.S., which include territorial seas within three miles of shore [53].

States may establish an NDZ for some or all of their waters if US EPA determines that "adequate facilities for the safe and sanitary removal and treatment of the sewage from all vessels are reasonably available." States may also request that US EPA establish NDZs under certain conditions. Both New Jersey and New York have established certain water bodies as NDZs. Establishing an NDZ requires a determination that adequate facilities for the safe and sanitary removal and treatment of sewage from all vessels (both recreational and commercial) are reasonably available for proposed NDZ waters. In the past, pump-out facilities have been provided for recreation vessels and funded through the Clean Vessel Act (CVA).

The No Discharged Zones in US EPA region 2 waters, which includes New York and New Jersey, are displayed in Figure 1. The following New Jersey water bodies have been designated No Discharge Zone and have been approved by both NJDEP and US EPA [(54)].

- Manasquan River is NJ's first NDZ. The 23-mile long Manasquan River drains over 80 square miles in Monmouth County. Heavily used public bathing beaches are located immediately north and south of the Manasquan Inlet which is one of the busiest inlets on the eastern seaboard. Boating, fishing and clamming are common activities along the river, with more than 1,500 acres of shellfish waters and over 2,500 boats within the estuary.
- The Navesink River, part of the New York-New Jersey Harbor Estuary Program, has been identified as a water body of national significance. It is an important coastal area for swimming, recreation and fishing. The river contains nearly 2,300 acres of shellfish growing waters that support substantial populations of soft and hard shell clams.
- The Shark River No Discharge Zone, located in central New Jersey, has its headwaters in Tinton Falls and flows into its estuary of approximately 810 acres.
- The Shrewsbury River No Discharge Zone is located in Monmouth County, New Jersey, and is part of the Atlantic Coastal Drainage Basin.
- Barnegat Bay is a shallow lagoon-type estuary bordered by two barrier islands - Island Beach and Long Beach Island. It provides an important recreational outlet for the people of New Jersey, and supports hard clam and blue crab populations for harvest.

New York State has designated the following water bodies as NDZs: Hempstead Harbor, Hudson River (water intake zones), Hudson River Estuary, Huntington-Northport Bay Complex, Jamaica Bay, Lake Champlain, Lake George,, Lake Ontario, Long Island Sound, Mamaroneck Harbor, New York State Canal System, Oyster Bay/Cold Spring Harbor, Peconic Estuary, Peconic Waters, East Hampton, Port Jefferson Complex, and South Shore Estuary Reserve [(54)].

A statement made earlier is particularly important to this study. In 2010, New York State and the US EPA Region 2 announced a joint initiative to establish NDZs in the remaining coastal waters and navigable connecting waterways of the State. New York

is seeking the approval of petitions for Lake Erie, Saint Lawrence River, New York Harbor waters, and easternmost Long Island South Shore [54].

Figure 1. US EPA Region 2 No Discharge Zone [54]

Marine Sanitation Devices

Under section 312 of the Clean Water Act (CWA), vessel sewage (black water) is generally controlled by regulating the equipment that treats or holds the sewage (Marine Sanitation Devices), and through the establishment No Discharge Zones. Section 312 of the CWA also requires a certified operable Marine Sanitation Device (MSD) on every vessel with an installed toilet operating on U.S. navigable waters. Vessel with installed toilets that are not equipped with an MSD, and discharges raw sewage directly over the side, are illegal. Section 312(g)(2) of the CWA directs the Coast Guard to certify MSDs. A vessel with no installed toilet is not subject to the provisions of section 312 [49].

There are three MSD equipment classes [49]:

- Type I: A flow through discharges device that produces effluent having a fecal coliform count no greater than 1000/1000 milliliters and no visible floating solids. Type I MSD is commonly a physical/chemical type. May be installed only on vessels less than or equal to 65 feet in length.
- Type II: A flow through discharges device that produces effluent having a fecal coliform count no greater than 200/1000 milliliters and no visible floating solids.

Type II MSD is commonly a biological plant, but several physical/chemical type plants have been certified. May be installed on vessels of any length.
- Type III: Typically a holding tank where sewage is stored until it can be disposed of shore-side or at sea (beyond three miles from shore). May be installed on vessels of any length.

SUMMARY OF THE WORK PERFORMED

Stakeholders Committee

A stakeholders committee was formed in the previous study and NJIT hosted meetings at NJIT Newark campus[16]. This committee has provided valuable input to the study; and the 2013 VGP and other key issues such as black water discharge were discussed in the meetings. Meetings were arranged again on April 12, 2013 and May 11, 2013 during this study. Additional Information exchanged was conducted through e-mails and phone calls.

The committee consists of the following persons and their associated agencies and companies. The persons listed below have attended at least one meeting. The US EPA representatives attended meetings and field trips in the previous study, but not in this part of the work.

- NJ Department of Transportation (NJDOT): Genevieve Boehm Clifton (OMR), Priscilla Ukpah (Research)
- NJ Department of Environmental Protection (NJDEP): Stephen Seeberger
- New York City Economic Development Corporation (NYCEDC): Andrew Genn
- NY State Department of Environmental Conservation (NYSDEC): Larry Wilson
- NYCDOT, Staten Island Ferry: John Garvey
- NY Shipping Association: James Crozz
- US Coast Guard (USCG): Ralph Savercool, Daniel R. Cruce
- Maritime Association of the Port of NY and NJ: Edward J. Kelly
- Port Authority of NY & NJ: Joseph Monaco, Sharon Heller
- NYK Line (North America), Inc.: Matthew Martyn
- New Jersey Institute of Technology: Taha Marhaba, Hsin-Neng Hsieh, Aliasghar Ghadimkhani, Kunzang Kazi

Data Collection and Analysis

To understand the challenges of the VGP, information about vessels and their discharges covered by the VGP is needed. According to the VGP, new vessels or vessels newly entering US water must submit a Notice of Intent (NOI) to US EPA 30 days prior to discharging. NOI Database was solicited from US EPA and analyzed. NJIT research team first obtained the database from the US EPA in February, 2011 and the results of the data analysis and findings were presented in the first phase of the study [(16)]. In order to understand the present condition for this phase of the study, the

updated VGP database was acquired in August 2012 from the US EPA [55]. The analysis of the 2nd set of data is presented in this report.

US EPA's NOI database does not have very specific information regarding vessel arrival data. As such, it is difficult to estimate the number of vessels that are using New Jersey's terminal services. This information has to be obtained from other sources. NJIT research team has solicited vessel records from the US Coast Guard (CG), National Ballast Information Clearinghouse (NBIC), and several other sources. USCG provided vessel information to NJIT twice. The 2011 data and their analysis were presented in the first phase report [17, 47] and 2012 data analysis is presented in this report [48].

The second set of data was downloaded from National Ballast Information Clearinghouse [26]. Federal law mandates that all ships with ballast tanks arriving at US ports submit a ballast water information report to the NBIC. Since the majority of commercial vessels require ballast tanks for stability, this data provide another source of information regarding vessel arrivals in New Jersey.

Edward Kelly, of the Maritime Association of the Port of NY and NJ, stated at the May 2013 stakeholders' meeting that small vessels operating locally in New Jersey may not be in the USCG and NBIC databases. NJIT team tried to seek his assistance gathering small vessel information. A survey form was designed and sent it to him on September 19, 2013. The survey form is shown in the Appendix A. An online survey form was also designed for such use and the URL is provided in the survey form. Unfortunately, no response was received. So NJIT research team looked somewhere else for small vessels information. Tug boats, ferries, and barges statistics in New Jersey and its neighborhood were found from the following sources:

- Tugboat Enthusiasts Society of the American (TESA). This association web site contains information about tug boat companies and some of them are in the NY/NJ area [44]. A database file was downloaded from the web site.
- RITA Database. The Research and Innovative Technology Administration (RITA) coordinates the U.S. Department of Transportation's (DOT) research programs and brings together important data in various areas of transportation. Bureau of Transportation Statistics has information on ferries. RITA has a web site which ferry Information data files can be downloaded [40]. Ferries in NY/NJ region can be searched by setting up search criteria in the National Census of Ferry Operators (NCFO) database. This database provides information on ferries operating in NY/NJ area and number of passengers.
- New York City Economic Development Corporation (NYCEDC). A report prepared for NYCEDC by Maritime College also provides some information for barges, tug boats and self-propelled vessels operating in New York City [23]. The data used in the report was from U.S. Waterway Data, National Data Center, US Army Corps of Engineers [28]. This data is also presented here.

VGP Data Analysis

As mentioned earlier, the VGP NOI database was acquired from the US EPA twice. The database is in spreadsheet format. Since Excel is not able to handle such large quantities of data, MS Access was used to analyze the data. The data was first obtained in February 2011; and the content was scrutinized and results presented in the first phase report [17]. At that time approximately 57,000 vessels submitted NOIs to maintain coverage. In the present stage of this study, more up-to-date data was obtained in August 2012 and it was discovered over 71,008 vessels filed for the VGP. According to the VGP, vessels are classified into eight classes or types: Medium Cruise Ships, Large Cruise Ships, Large Ferries, Oil or Gas Tankers, Barges, Research Vessels, Emergency Vessels, Commercial Fishing Vessel with Ballast Water, and "Other." Table 3 shows the number and percentage of each type of vessel registered under the VGP. Data obtained in these two years, 2011 and 2012, are both presented for comparison [55, 57].

It is seen from Table 3 that the largest group is barge. It has 53.66% in 2011 and 51.34% in 2012. The second largest group is "Other," it has 36.12% in 2011 and 38.07% in 2012. The top three groups under "Other" category are carrier, freight ships, and bulker. For the 20,638 and 36,459 vessels in the "Other" group, only 5,521 in 2011 data and 11,538 in 2012 data, provided information for their specific type of vessel and others are unknown. This information is presented in Table 4.

Table 3- Types of Vessel Covered in VGP [55, 57]

Vessel Primary Type	**Number of Vessels**		**Percentage**	
	2011	2012	2011	2012
Total	57,132	71008	100%	100%
Barge	30,658	36459	53.66%	51.34%
Other	20,638	27030	36.12%	38.07%
Oil or Gas Tanker	5,010	6473	8.77%	9.12%
Commercial Fishing Vessel with Ballast Water	233	337	0.41%	0.47%
Large Ferry (250+ passengers or more than 100 tons of cargo.)	164	180	0.29%	0.25%
Large Cruise Ship (500+ passengers)	189	228	0.33%	0.32%
Medium Cruise Ship (100 to 499 passengers)	35	55	0.06%	0.08%
Research Vessel	143	180	0.25%	0.25%
Emergency Vessel	62	66	0.11%	0.09%

Table 4- Type of Vessels Listed under "Other" Category [55, 56]

Type of Vessel	2011 Data	2012 Data
Carrier/freight ships/bulker	81.47%	72.2%
Tug/tow vessels	5.54%	3.41%
Oil or gas tankers	3.43%	1.44%
Support/supply/utility vessels	3.23%	0.28%
Passenger vessels	0.95%	0.31%
Drilling/dredging	0.64%	0.03%
Other	4.73%	22.32%
Number of vessels	5,521	11,538

There are 3 types of effluent limits stated in the VGP. The second type regulates the discharge of 27 potential pollutants in the 2013 VGP. The fish hold effluent is a newly regulated discharge in the 2013 VGP and thus discharge information is not in the database. The other 26 types of discharge in the up-to-date VGP database are illustrated in Figure 2. Out of the 71,008 vessels that have filed an NOI, 59,468 vessels provide information regarding applicable discharges in the VGP. Figure 2 also exhibits the percentage of vessels that may generate each of the 26 specific discharges.

For the new addition, fish hold effluent is composed of seawater, ice-melt, or ice slurry collected inside fish hold tanks. Fish hold effluent contains pollutants which result from seafood catch and other on-board vessel sources. These pollutants can include biological wastes, metals, nutrients, and wastewater from fish hold cleaning activities. For vessels with refrigerated seawater tanks, fish are typically extracted using a vacuum system that removes both the fish and refrigerated seawater simultaneously [52].

The 2013 VGP requirement for this effluent is to physically separate excess fish waste from fish hold effluent prior to discharge. Discharging fish hold effluent to a shore-based discharge facility if it is available. Otherwise, use physical separation techniques such as coarse filters, or equipment such as a De-Watering Box (DWB) or Wetpump Separator to remove solids. These techniques and equipment are consistent with existing fishing vessel practices and will meet the VGP requirements. The VGP also prohibits discarding unused live bait overboard, unless the bait was caught in that water body or watershed [52].

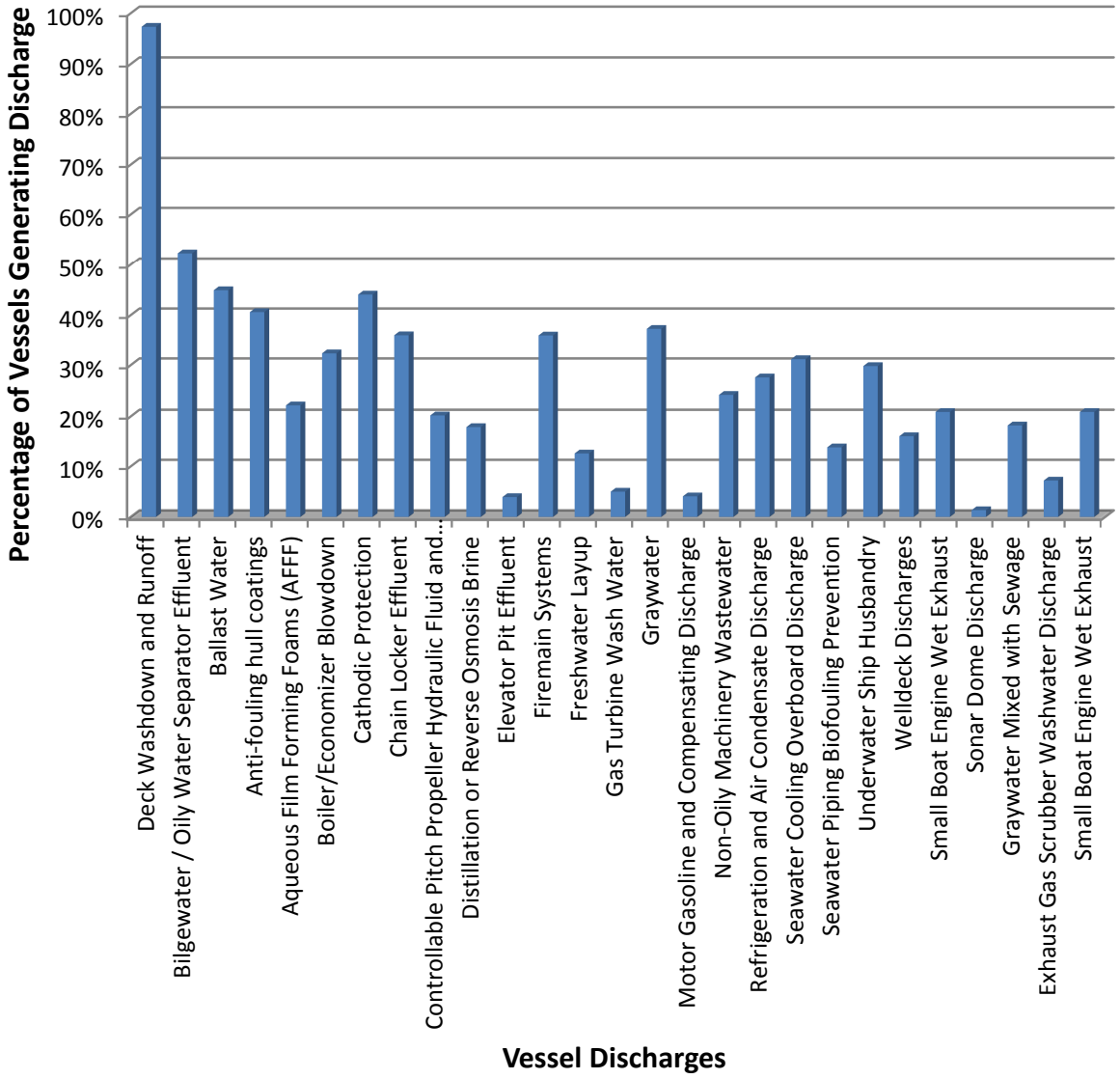

Figure 2. Types of Vessel Discharges under VGP (55)

It is evident from Figure 2, that the most common discharge of all vessels is deck washdown and runoff. The other three more common discharges, which are also highest in volume and most subject to regulation, are ballast water, bilgewater, and graywater. Ballast water is also regulated in the National Invasive Species Act (NISA) of 1996 and more will be explained later. Bilgewater is the water collected from various vessel operations that drain to the lowest inner part of the hull, known as the bilge. Graywater is water collected from shower, kitchen, and laundry, except sewage.

The VGP database also has information regarding the onboard treatment facility. The 2012 data is presented in Table 5. Of the 71,008 vessels registered in NOI, only 58,408 (82.25%) responded to the question about onboard treatment facilities. Of these 58,408

vessels, a total of 23,707 (40.58%) stated that they have some sort of onboard treatment facility. The treatment systems mentioned in the database include sewage treatment devices, oil-water separators, incinerators, holding tanks, and Marine Sanitation Devices. Advanced systems to treat graywater and black water are mainly used in cruise ships. The database does not give information as to how many vessels have each of the above treatment systems.

Table 5- Onboard Treatment Facilities in 2012 VGP Data [55]

Vessel Primary Type	No of Vessels	Onboard Treatment Facilities		
		YES	NO	No Info
Total	71008	23707	34701	12600
Barge	36459	138	29372	12600
Other	27030	17848	4627	6949
Oil or Gas Tanker	6473	5158	296	4555
Commercial Fishing Vessel with Ballast Water	337	149	164	1019
Large Ferry (250+ passengers or more than 100	180	62	117	24
Large Cruise Ship (500+ passengers)	228	174	38	1
Medium Cruise Ship (100 to 499 passengers)	55	37	14	16
Research Vessel	180	113	36	4
Emergency Vessel	66	28	37	31

US Coast Guard (CG) Data

A data file for vessels arriving in New Jersey ports/terminals was obtained from USCG. The file shows that about 4,348 vessels arrived in New Jersey in 2012, which is close to the number 4,068 obtained in 2011 [16]. Figure 3 shows the vessel type and numbers of each type of the vessel. It shows that the largest group is container ship and it roughly close to 50%. Other categories include general, oil tank ship, chemical tank ship and unspecified (owner/operator did not provide information). "General" vessels include bulk cargo that carry gravel, cocoa beans, brown sugar; and heavy cargo which carry trucks, railroad track, or even be bananas.

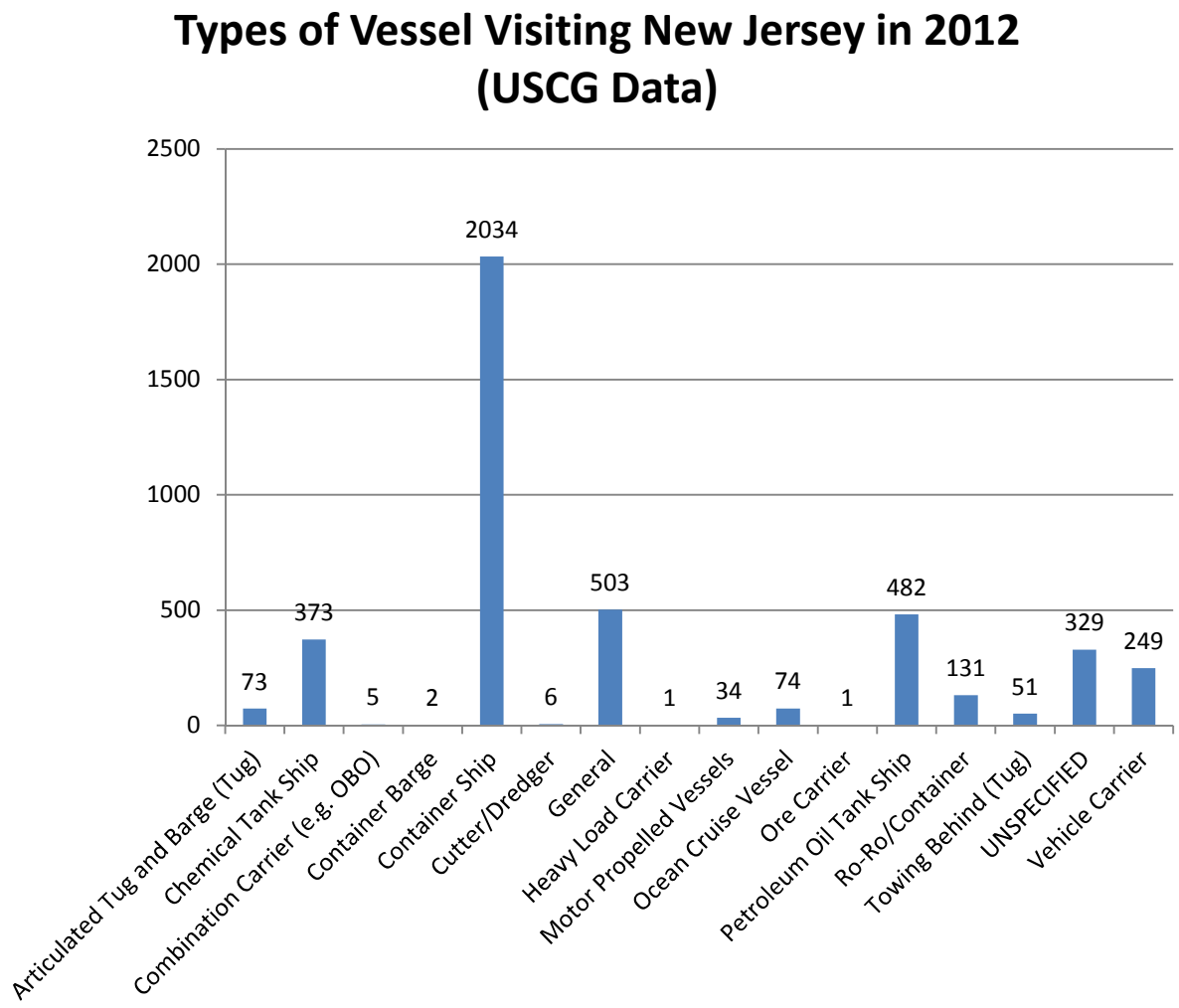

Figure 3. Vessel Arrivals in New Jersey (USCG Data) [48]

Figure 4 illustrates the distribution of the length of the vessels visiting New Jersey. This Figure shows that majority of the vessels (71%) have a length between 500 ft and 1,000 ft. Only 1% of vessels have length less than 79 ft. It is mentioned earlier that vessels with 79 ft length or larger is covered in the VGP, while length less than 79 ft and have less than 8 m^3 of ballast water is covered in the 2013 Small Vessel General Permit (sVGP). Under the sVGP, the vessel owners or operators do not need to submit an NOI to receive permit coverage. But the vessel owners still need to read and implement the sVGP requirements, sign and maintain the Permit Authorization and Record of Inspection (PARI) form onboard, and conduct quarterly visual inspections.

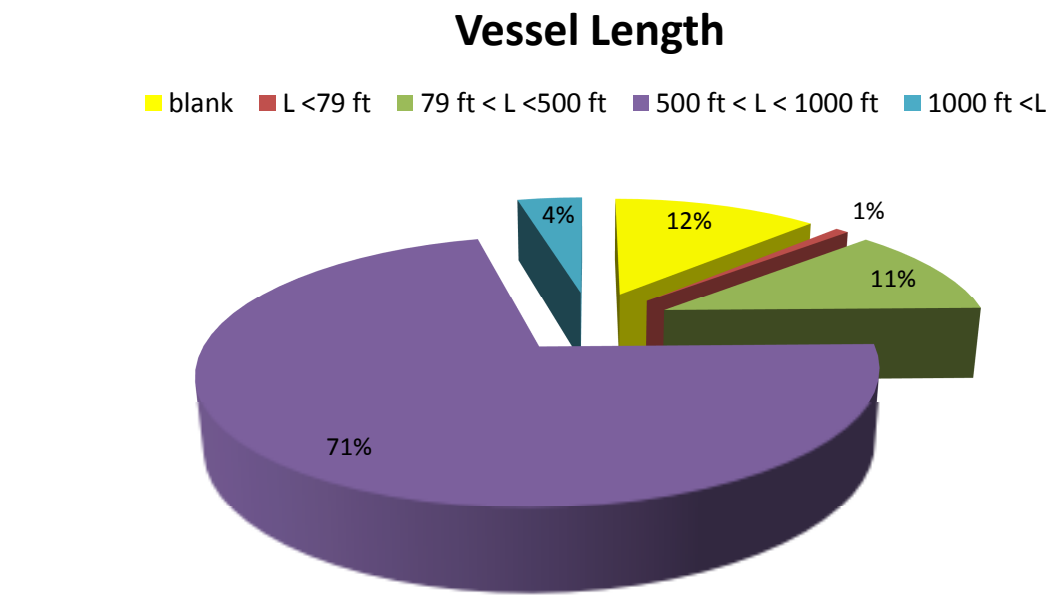

Figure 4. Vessel Length [48]

The number of vessel arrival in New Jersey at various locations based on 2012 USCG data is shown in the Figure 5. This Figure shows that the top four ports/terminals vessels visited are Newark, Elizabeth, Bayonne, and Paulsboro.

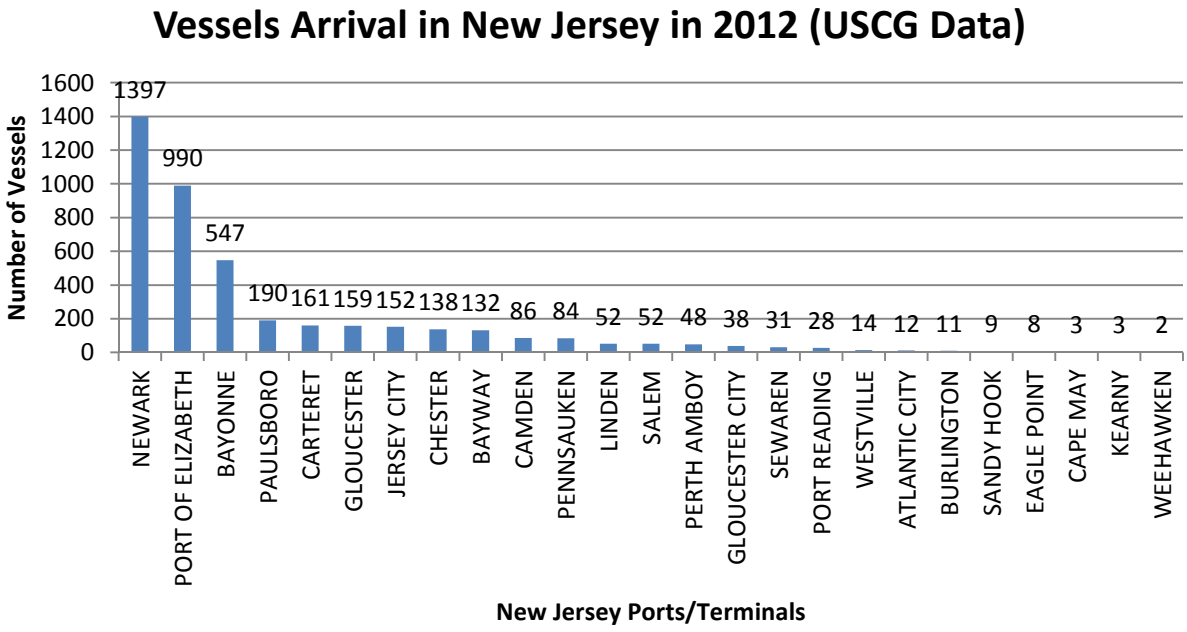

Figure 5. Vessel Arrivals in New Jersey (USCG Data) [48]

NBIC Database

The trend of vessels visiting in New Jersey is plotted in Figure 6. The number of vessel arrivals increased from 2004 to 2010, and then slightly dropped in the next two years. The highest number of vessel arrivals occurred in 2010 (3,401 vessels). Types of vessel visiting New Jersey and numbers of each type in 2012 NBIC data is shown in Figure 7. It also displays the number of vessels from overseas. This figure also points out that majority of the vessels were containers and tankers.

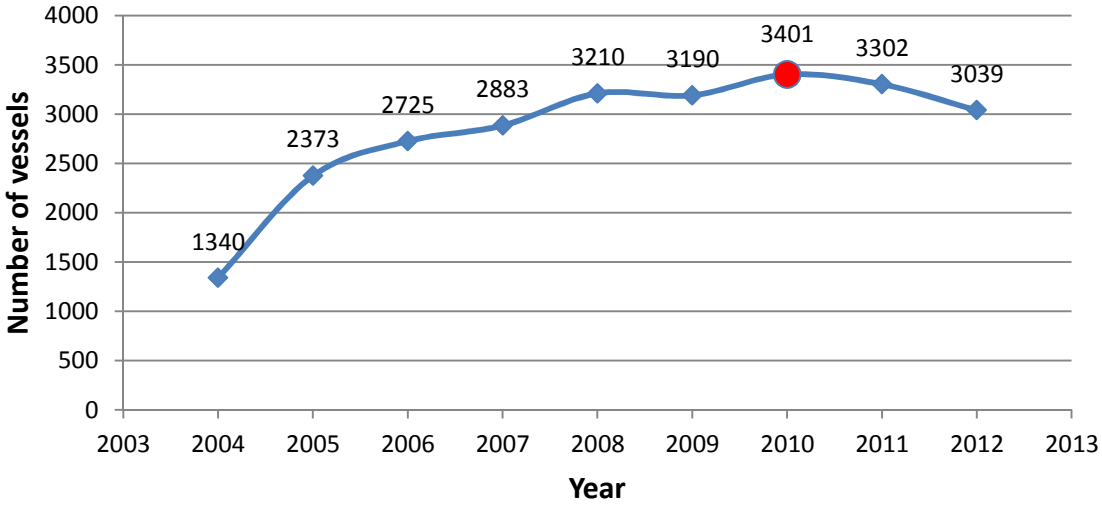

Figure 6. Trend of Vessels Arrival in New Jersey [25]

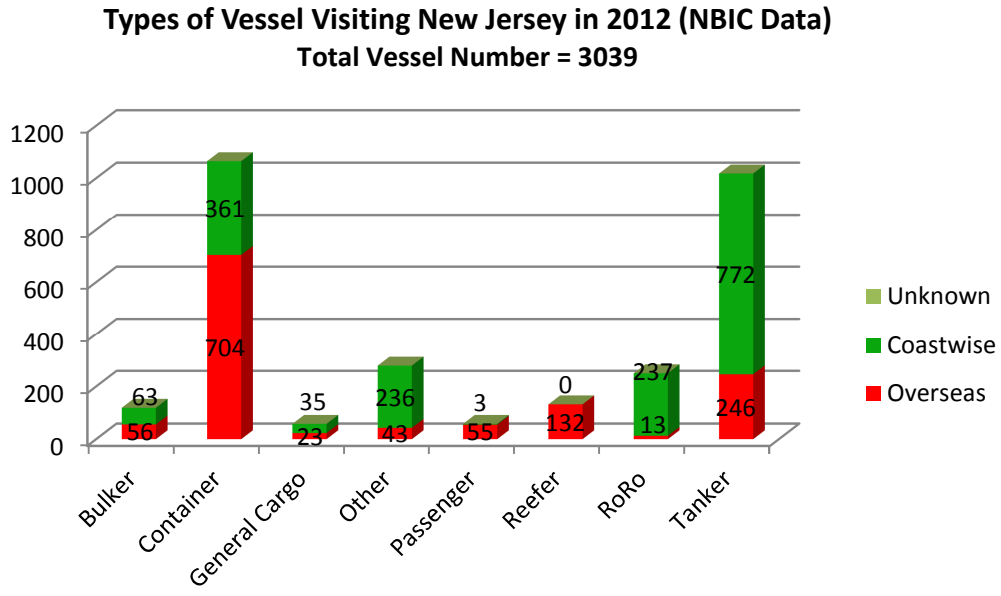

Figure 7. Types of Vessel Visiting in New Jersey in 2012 [26]

The ports/terminals that vessels visited in New Jersey are illustrated in Figure 8. NBIC data verifies that Newark, Elizabeth, and Bayonne had more vessels in 2012. Paulsboro and Bayway were the next two.

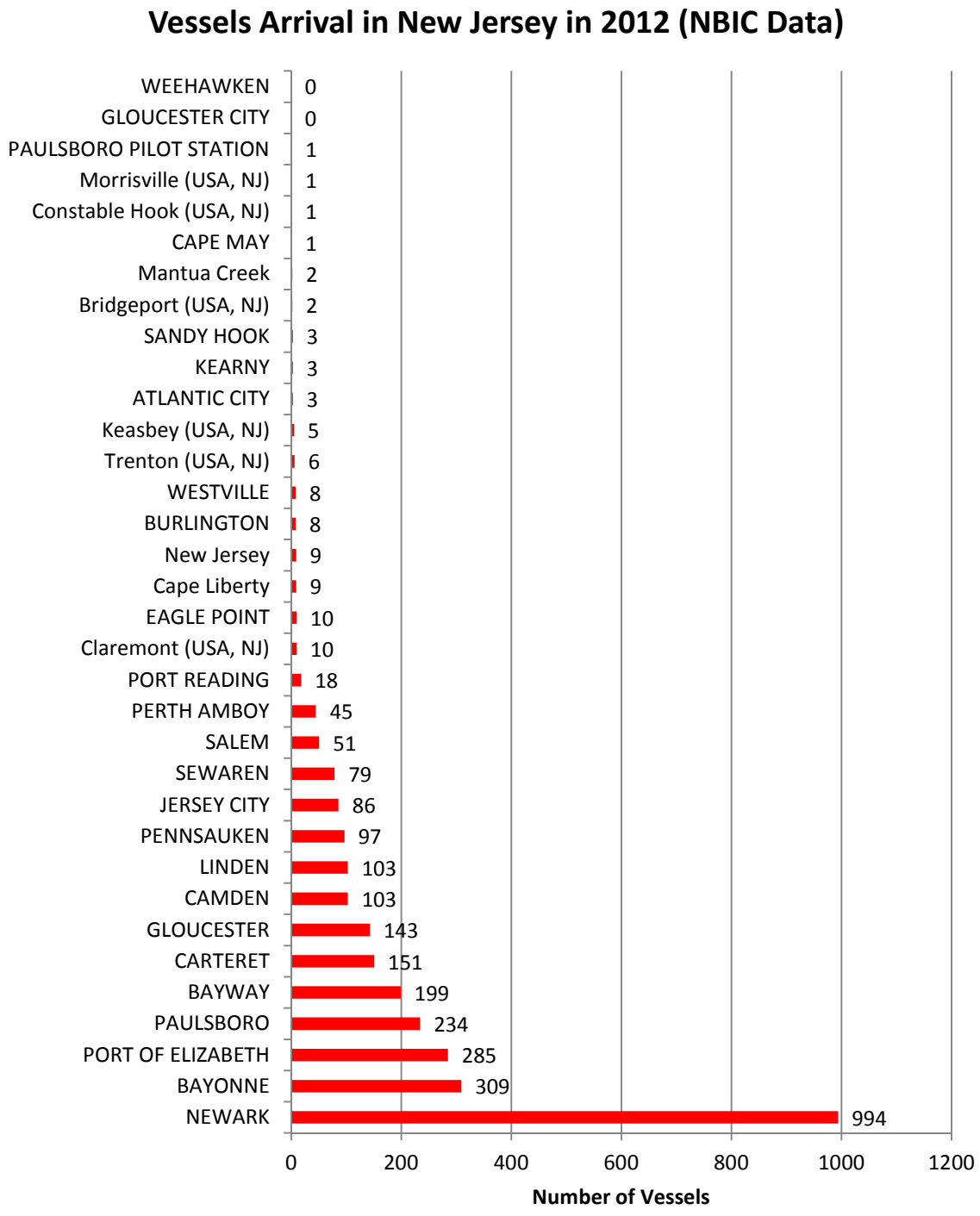

Figure 8. Vessel Arrivals in New Jersey in 2012 [26]

US Coast Guard data shows that 4,347 vessels arrived in New Jersey while NBIC data shows that a little over 3,000 in 2012. The discrepancy of these two numbers is due to the difference in reporting criteria. USCG promotes safety of life and property in US waters, and is responsible for a number of tasks, while NBIS only requires ships with ballast water tanks to report. It is expected USCG has more ships in its database.

Tugboat Enthusiasts Society of the American (TESA) Data

This association web site contains information about tug boat companies and some of them are in the NY/NJ area [44]. A database file was downloaded and studied.

There are 8,168 tugboats listed in the database. After data filtering, it was found 16 tug boats are operating in New Jersey (3 in Atlantic city, 1 in Cranford, 1 in Stone Harbor, 2 in Camden, 1 in Coinjock, 1 in Secaucus, 1 in Salem, 3 in Perth Amboy, 1 in Kearny, 1 in Edgewater, 1 in Mays landing). The name, horsepower (HP) and home port of these boats are shown in Table 6. The same database indicates 663 tug boats are in New York State and 491 in New York City [44]. It is seen from Table 6 that New Jersey tugboats are rather old, except one, all were built before 1970.

Table 6- Tug Boats Registered in New Jersey [44]

Name	HP	Built Year	Home Port
Akela	400	1956	Atlantic City, NJ
Christopher	350	1975	Cranford, NJ
Dynamic	210	1958	Stone Harbor, NJ
Emma R.	750	1941	Camden, NJ
Express Explorer	3000	1977	Camden, NJ
Flat Top	450	1945	Coinjock, NC
Grand Island	300	1962	Secaucus, NJ
High Roller	2250	1969	Salem, NJ
Huntress	325	1955	Perth Amboy, NJ
Lisa		1959	Kearny, NJ
M. L. Wescoat	500	1943	Atlantic City, NJ
Matthew C.	1000	1965	Atlantic City, NJ
New Jersey Responder	2560	1993	Perth Amboy, NJ
Viola F.	165	1949	Edgewater, NJ
Voyager	450	1937	Mays Landing, NJ
Vulcan III	450	1958	Perth Amboy, NJ

RITA Database

The Research and Innovative Technology Administration (RITA) coordinates the U.S. Department of Transportation's (DOT) research programs and brings together important data in various areas of transportation. Bureau of Transportation Statistics has information on ferries. RITA has a web site that contains ferry Information [40]. Ferries

in NY/NJ region can be searched by setting up search criteria in the National Census of Ferry Operators (NCFO) database. The ferry information has ferry routes in New York/New Jersey area, trips made, and number of passengers.

The data was downloaded and examined. It was found that there are 44 ferries that use 15 marine terminals in New Jersey. Total number of passengers served was close to 8.8 million and total number of trips made was 5,846 in 2010. The names of the ferries, passenger capacity, and year built are shown in Table 7. The ferry routes, the passengers, and average trip time in each route in 2010 are shown in Table 8. Table 8 indicates that the average trip time for most routes is rather short. The same table also shows that four routes with terminals are not in New Jersey, i.e. segment number 1464, 1485, 1502, and 1503; but in New York City, Beacon, NY, and Ossining, NY. Beacon is located south of Poughkeepsie, NY and opposites to Newburgh, NJ. Ossining is north of White Plain, NY and opposites to New City, NJ. Both Beacon and Ossining are along the Hudson River. We assume that these four routes listed under New Jersey are probably that these ferries stop in New Jersey terminals to pick up or drop passengers. Figure 9 shows the ferry routes, which seems to confirm this assumption since the top right insert shows that commuter peak service is provided at Newburgh – Beacon ferry and Haverstraw-Ossining ferry, where Haverstraw, NJ is north of New City, NJ.

Table 7- Ferries Operating in New Jersey [40]

Ferry Name	Passenger capacity	Built Year	In service
Abraham Lincoln	399	1989	Yes
Alexander Hamilton	399	1989	Yes
Cape Henlopen	598	1981	Yes
Cape May	895	1985	Yes
Delaware	898	1974	Yes
Empire State	399	1993	Yes
Garden State	399	1994	Yes
George Washington	399	1989	Yes
Henry Hudson	399	1992	Yes
New Jersey	598	1974	Yes
Port Imperial Manhattan	399	1987	Yes
Port Imperial New Jersey	399	1988	Yes
Robert Fulton	399	1993	Yes
Thomas Jefferson	399	1989	Yes
Twin Capes	895	1975	Yes
American River	101	1980	No
Delafort	89	1990	Yes
SeaStreak Highlands	396	2004	Yes
SeaStreak Wall Street	396	2003	Yes
SeaStreak New Jersey	396	2001	Yes
SeaStreak New York	396	2001	Yes

Freedom	599	1981	Yes
Yogi Berra	149	1999	Yes
Fiorella LaGuardia	149	1999	Yes
Christopher Columbus	149	2000	Yes
Frank Sinatra	149	1999	Yes
Peter Weiss	149	2001	Yes
Brooklyn	149	2002	Yes
Hoboken	149	2002	Yes
Sen. Frank Lautenberg	149	2002	Yes
Jersey City	149	2003	Yes
Bayonne	149	2003	Yes
Robert Roe	149	2003	Yes
Governor Kean	149	2002	Yes
Admiral Bennis	149	2003	Yes
Douglas B Garian	97	2001	Yes
Austin Tobin	97	2001	Yes
Moira Smith	97	2001	Yes
Father M. Judge	97	2001	Yes
Enduring Freedom	97	2002	Yes
Fred V Morrone	97	1986	Yes
Bravest	370	1996	Yes
Finest	370	1996	Yes
John Stevens	399	-	Yes

Table 8- Ferry Routes in New Jersey and Passengers in 2010 [40]

NJ Terminal (Segment ID)	Route	Type	Passengers	Ave. Trip Time
Atlantic Highlands (429)	Atlantic Highlands (NJ) - Wall Street Ferry Terminal; Pier 11 (NY)	Interstate	380,000	0:35
Cape May (482)	Lewes (DE) - Cape May (NJ)	Interstate	419,754	1:20 1:20
Highlands (572)	Highlands (NJ) - Wall Street Ferry Terminal; Pier 11 (NY)	Interstate	455,000	0:35
Camden (682)	Camden (NJ) - Penns Landing; Philadelphia (PA)	Interstate	82,755	0:12
Fort Mott, (906)	Delaware City (DE) - Fort Mott (NJ)	Interstate	22,519	0:30
Hoboken, 14th St. (959)	Hoboken; 14th St. (NJ) - Midtown/W. 39th St. (NY)	Interstate	533,615	0:08
Camden, (1154)	Penns Landing; Philadelphia	Interstate	82,755	0:12

	(PA) - Camden (NJ)			
Cape May, (1440)	Cape May (NJ) - Lewes (DE)	Interstate	388,794	1:20
Hoboken, Hoboken Rail Terminal (1441)	Hoboken; Hoboken Rail Terminal (NJ) - Midtown/W. 39th St. (NY)	Interstate	1,855,130	0:10
Hoboken, Hoboken Rail Terminal, (1451)	Hoboken; Hoboken Rail Terminal (NJ) - Ossining (NY)	Interstate	241,144	0:18
Edgewater, (1455)	Edgewater (NJ) - Midtown/W. 39th St. (NY)	Interstate	119,174	0:15
(1464)	W 38th Street Ferry Terminal; Manhattan (NY) - Midtown/W. 39th St. (NY)	Intrastate	490,377	0:10
Hoboken, Hoboken Rail Terminal, (1466)	Hoboken; Hoboken Rail Terminal (NJ) - Lincoln Harbor; Weehawken (NJ)	Intrastate	139,135	0:16
(1485)	World Financial Center; Battery Park City (NY) - Ossining (NY)	Intrastate	415,791	0:40
Belford (1499)	Belford (NJ) - Ossining (NY)	Interstate	949,534	0:15
Belford, Lincoln Harbor, (1500)	Belford (NJ) - Lincoln Harbor; Weehawken (NJ)	Intrastate	548,093	0:10
Lincoln Harbor, Weehawken, (1501)	Beacon (NY) - Lincoln Harbor; Weehawken (NJ)	Interstate	341,392	0:07
(1502)	Beacon (NY) - Midtown/W. 39th St. (NY)	Intrastate	166,403	0:15
(1503)	Beacon (NY) - Ossining (NY)	Intrastate	629,320	1:08
Port Liberte, Jersey City, (1505)	Port Liberte; Jersey City (NJ) - Ossining (NY)	Interstate	199,031	0:20
Liberty Harbor-Marin Blvd. (1507)	Liberty Harbor-Marin Blvd. (NJ) - Ossining (NY)	Interstate	125,934	0:12
Colgate Palmolive, Exchange Place, Jersey City, (1512)	Haverstraw (NY) - Colgate Palmolive; Exchange Place; Jersey City (NJ)	Interstate	119,790	0:15
Port Imperial, Weehawken, (1513)	Newburgh (NY) - Port Imperial; Weehawken (NJ)	Interstate	92,217	0:09

Figure 9. Commuter Ferry Routes on Hudson River and East River [37]

Table 9 shows the terminals in New Jersey and New York, and some are not in Figure 9. The ferry routes in Figure 9 are operated by private companies such as New York Waterway, Liberty Park Water Taxi, Seastreak. They are in public-private partnership with agencies such as the Port Authority of New York and New Jersey, New Jersey Transit, New York City Department of Transportation, and Metropolitan Transportation Authority, and provide service and maintain docking facilities [27]. In addition, there are sightseeing and tour boat operators such as Circle Line Downtown, Circle Line Sightseeing Cruise, Liberty Landing Ferry, the Trust for Governors Island, Seaport Liberty Cruise, and Statue Cruises.

New York Waterway is a private company that runs ferry in New York and New Jersey. In 2009, New York Waterway fleet included 33 boats, 15 of which are operated by its associate company, Billybey Ferry [25, 33]. New York Waterway also provides commuter

peak service on the Haverstraw–Ossining Ferry, Newburgh–Beacon Ferry, and to the Raritan Bayshore. Liberty Water Taxi based in Jersey City and offers services between Jersey City, Liberty State Park, and Manhattan and operates a fleet of 2 catamarans. Seastreak provides commuter service between Monmouth County, New Jersey and Manhattan and operates a fleet of 4 ferries. .

Table 9- Harbor Commuter Ferry Terminals [29, 33, 39]

New Jersey Terminals		New York Terminals	
Bedford/Harbor Way	Lincoln Harbor, Weehawken	Beacon, NY	Red Hook-IKEA, Brooklyn
Edgewater Ferry Landing	New Port (closed, post Sandy Hurricane)	Haverstraw, NY	Red Hook-Van Brunt, Brooklyn
Hoboken/NJ Transit Terminal	Paulus Hook	Pier 79, Midtown/W. 39th St., Manhattan	Fulton Ferry Landing, Brooklyn
Hoboken 14th St.	Port Imperial/ Weehawken	Newburgh, NY	Schaefer Landing/ South Williamsburg, Brooklyn
Liberty Harbor/Martin Blvd.	Port Liberte, Jersey City	Ossining, NY	N. 6th St./ North Williamsburg, Brooklyn
Warren St., Jersey City	Liberty State Park	East 34th-35th Street, Manhattan	India St./Greenpoint, Brooklyn
Atlantic Highlands, Highlands	Camden	World Finance Center Landing/Battery Park City, Manhattan	Hunters Point South/ Long Island City, Queens
Fort Mott	Cape May	Pier 11/Wall St., Manhattan	Rockaway Landing, Queens
Highlands		Battery maritime Bldg., Manhattan	St. George, Staten Island
		Whitehall, Manhattan	Hart Island, Bronx
			City island, Bronx

New York City Economic Development Corporation (NYCEDC) Information

A report prepared for NYCEDC by maritime College also provides some information for small vessels such as barges, tug boats and self-propelled vessels operating in New York City [23]. The report took 2004 data from U.S. Waterway Data, National Data Center, US Army Corps of Engineers [28]. The information is summarized in in Table 10.

Table 10- Number of Small Vessels Operating in New York City [22]

Vessel Type	2010	2011
Covered Dry Cargo Barges	13	12
Open Dry Cargo Barges	49	48
Self-Propelled Vessels	58	59
Tank Barges	23	21
Towboats	27	23
Deck Barges	68	76
Total	522	525
Vessel Company	46	49

Considerations for Black Water Pump-Out Facilities

In general, there are three ways to transport black water from the vessel to an onshore treatment facility. These are the use of (1) existing sanitary sewer system, (2) trucks, or (3) a barge. If ports have sewer systems nearby, the black water can be pumped directly to them. If no sewer system is available then a storage tank would be required and black water is held at the tank until it is filled, and then transported to a treatment facility.

Since New York City is considering the use of landside pump-out facilities, New Jersey probably should take into account of using mobile facility, such as a barge. Barge has the advantage of being flexible as far as the location is concerned. A landsite facility can only serve at one location, while a barge can accommodate at different places. The use of a landside facility also has more demanding requirements [45].

Most barges are purpose-built and designed for a specific trade, although ships have been converted throughout the ages. Tank barges have been used for carriage of liquid cargoes such as petroleum and chemicals. Passaic Valley Sewerage Commission treatment plant has a deck and is accepting liquid sludge using a barge from New York. Barges can be designed as self-propelled or non-self-propelled. The cost to purchase a barge will require an initial investment of $200,000 - $500,000 depending on the features and age of the barge, plus an additional $10,000 per tugboat movement [8].

Truck has been used for cruises for handling sewage. A typical waste hauling truck has a capacity of 5,000 gallons [5]. With this capacity, the truck would be able to make several collections before having to transport black water to a nearby treatment plant. The individual capacity of a common size barge is about 1.7 million gallons so one barge would be sufficient [7].

Pump-out facilities, no matter the use of a barge, truck, or a landside facility, for commercial vessels should be located where there is more marine traffic and greater demand for such services. Data collection and analysis will provide information with

respect to most visited ports/terminals. Other than marine traffic, other considerations are discussed below.

Commercial vessels tend to be larger, have deeper drafts, are less maneuverable, hold larger volumes of sewage and are more pressed for time than recreational boats [45]. Therefore, a barge should cater to the need of commercial vessels. The considerations are briefly summarized here.

1. Gravity feed or pump – Black water can be fed from a vessel to a barge then a sewer line by gravity. Is there a need for using the pump to speed up the transport rate?
2. Tie to municipal sewer – A deck proximity to municipal sewer lines is required; otherwise additional sewer line is needed. If sewer lines are already in place this reduces the costs of installing a pump-out system.
3. Existing infrastructure – Is a deck available and in good operation condition?
4. Other amenities – Does the deck site offer a service other than pump-out, such as fueling?
5. Staff – Would staff be available to connect to the sewer line, or would it be self-serve?
6. Security – Are there security concerns under the new Homeland Security regulations?
7. O&M organization – Who would assume responsibility for operating and maintaining the system?

Ports/Terminals for Commercial Vessels in New Jersey

The 6 most vessel visiting commercial ports/terminals in New Jersey are listed in Table 11 using NBIC and USCG data. In both data sources, the top 3 ports/terminals are Newark, Elizabeth, and Bayonne, and more than 67% of all vessels reached these locations based on USCG data. All three ports/terminals are in Newark Bay. Port Newark, which operates as one fully integrated marine terminal with the adjacent Elizabeth-Port Authority Marine Terminal, is the largest seaport on the East Coast of North America. It is a gateway to the most concentrated and affluent consumer market in the world, the port also ranks as the third largest port in the nation in terms of volume and the second largest in terms of value. Bayonne is the major cruise terminal in New Jersey. Bayway and Carteret are both in Middlesex County and located along Arthur Kill, which separates Staten Island, NYC and New Jersey; and connects Newark Bay on the north and Raritan Bay on its south.

Locations of the ports/terminals in Newark Bay are shown in Figure 10, except Bayway. Bayway is located between Elizabeth and Carteret terminals. Other than Bayway and Carteret, there are other 6 terminals along the Arthur Kill. Paulsboro on the other hand, is in Gloucester County and along Delaware River. Other than Paulsboro, there are other 10 ports/terminals along Delaware River as shown in Figure 11 and Table 12.

Table 11- Top 6 Visiting Commercial Ports/Terminals in New Jersey [25, 48]

Commercial Port/Terminal	No. of Vessels, USCG Data	USCG Rank	No. of Vessels, NBIC Data	NBIC Rank
Newark	1397	1	994	1
Elizabeth	990	2	285	3
Bayonne	547	3	309	2
Paulsboro	190	4	234	4
Bayway		9	199	5
Carteret	161	5	151	6
Total	4347		2979	

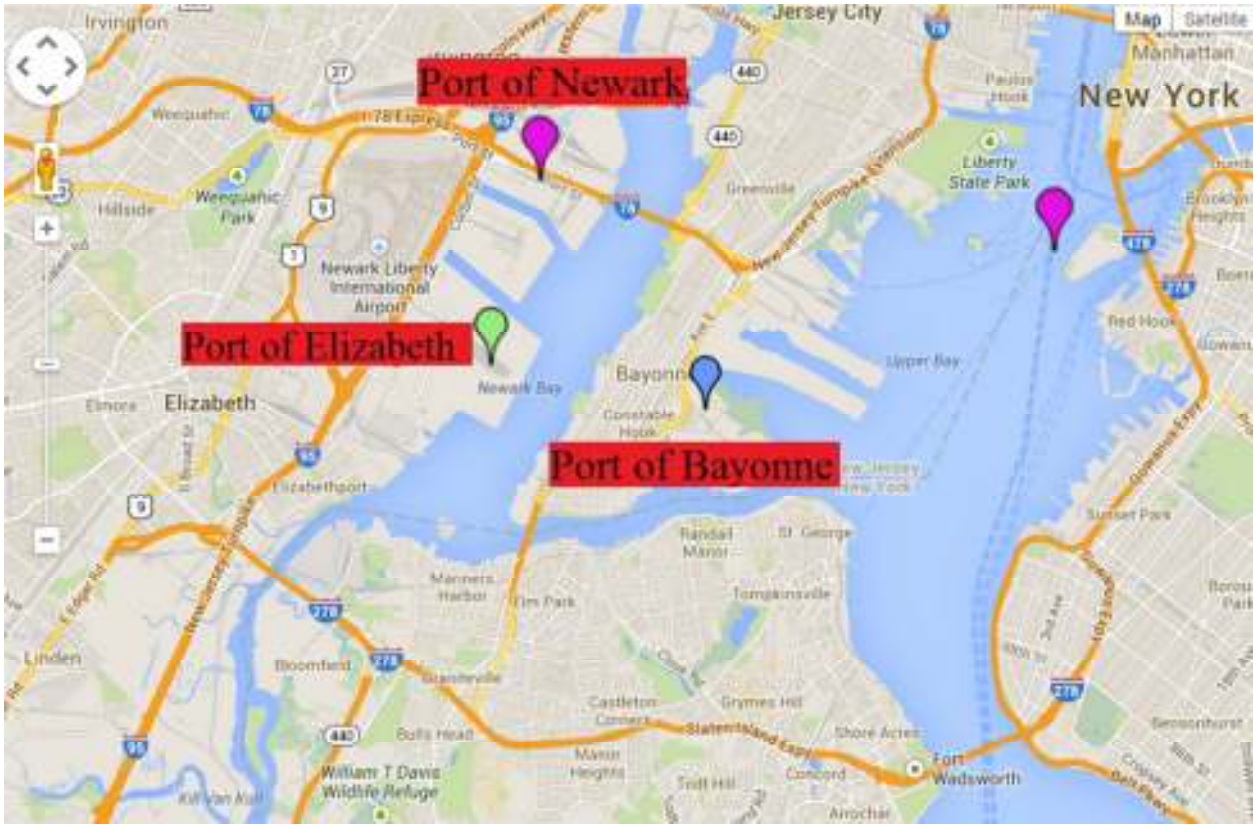

Figure 10. Locations of Ports/Terminals in Newark Bay

Figure 11. Ports/Terminals along Delaware River

Table 12- Ports/Terminals along Delaware River [25, 48]

No.	Port/terminal name	No. of vessels (NBIC)	No. of vessels (USCG)
1	Port of Pennsauken	101	84
2	Port of Camden	103	86
3	Port of Philadelphia	1107	936
4	Gloucester Marine Terminal	143	164
5	Port of Paulsboro	241	190
6	Penn terminals (private owned)		
7	Port of Chester	105	138
8	Port of Marcus Hook	1	91
9	The Port of Wilmington		425
10	Deepwater point		
11	Port of Delaware City		89

Major Ports/Terminals Information

World Port Source (WPS) provides major ports/terminals information online [61]. Some of the more important information is summarized in Table 13. Carteret is not on the list, but the length, width, and depth of waterways of Carteret can be found on a US Army Corps of Engineers web site [46]. This web site points out that Carteret is along the Arthur Kill and on the Fresh Kills Reach. The width and depth of the channel is approximately 500 ft and 35 ft, respectively; and the minimum channel depth entering from seaward is about 30 ft. Kinder Morgan Inc. (KMI) terminal in Carteret is mainly for liquid petroleum and chemical distribution [20]. Bayway is also not on the list, but port information can be found at FleetMon web site [134]. The site indicates Bayway is located in Linden/Elizabeth and at the entrance of Arthur Kill. Bayway terminal is owned by Phillips 66 and mainly used for oil transportation. There are another 6 terminals along the Arthur Kill, 5 of the 6 terminals are also mainly for petroleum services and only the 6th one, Perth Amboy is a municipal marina. Because Bayway and Carteret are mainly for private use, they are excluded from pump-out location consideration.

Table 13- New Jersey Major Ports/Terminal information [14, 61]

Port Name	Newark	Elizabeth	Bayonne	Paulsboro	Bayway
Harbor size	Medium	Small	Medium	Very small	Very small
Harbor type	River basin	Coast natural	River basin	River natural	River
Turning area	Yes	Yes	Yes		
Max. vessel size	> 500 ft	> 500 ft	> 500 ft	> 500ft	> 500 ft
Water depth					
Channel	26 – 30 ft	36 – 40 ft	31 – 35 ft	31 - 35 ft	31 – 35 ft
Anchorage	36 – 40 ft	36 – 40 ft	41 – 45 ft	31 - 35 ft	31 – 35 ft
Cargo pier	36 – 40 ft	31 – 35 ft	41 – 45 ft	31 – 35 ft	30 ft
Mean tide	5 ft	5 ft	5 ft	6 ft	

Table 13 shows that Newark, Elizabeth, Bayonne, and Paulsboro are all good to serve as the locations for pump-out station.

Ferries

After examining Table 8 for ferry routes and the number of passengers carefully, it is obviously that majority (88.63%) of passengers commute between Manhattan and various locations in New Jersey. Only 11.37% of passengers commute from central New Jersey to Pennsylvania or Delaware.

Ports/Terminals to be Considered for Pump-out Service

Based on the number of commercial vessel arrivals and the number of the passengers on ferries, the first pump-out service to be considered should be along the Hudson River and located in Newark Bay/Upper New York Bay. Over 4,100 commercial vessels passed through this area and arrived at Newark, Elizabeth, and Bayonne ports/terminals based on USCG 2012 data and approximately 7.7 million passengers traveled through this water based on the ferry information. In additional, over 500 small vessels, such as cargo barges, tanks barges, towboats, deck boats, supported the port/terminal activities and transport merchandise and goods to New York City and New Jersey, shown in Table 10.

The site information shown in Table 13 indicates the channel depth in this area ranges 26 – 40 ft, anchorage depth 36 – 45 ft, and cargo pier depth 31 – 45 ft. It means all the three major ports/terminals i.e. Newark, Elizabeth, and Bayonne, can accommodate for vessels longer than 500 ft and with enough turning area. If a wastewater treatment facility or a sanitary sewer system is nearby, cost can be saved with respect to sewer connection. It was found that sanitary sewer system exists and four wastewater treatments are within a short distance, as shown in Table 14. These four treatment plants are all secondary treatment facilities. Passaic Valley Sewerage Commission also has a deck for sewage/sludge barge.

Table 14- Wastewater Treatments close to Hudson River and Delaware River [31]

Name	Location	Annual Ave. Flow Rate (MGD)	Permit Flow rate (MGD)
Newark Bay Treatment Plant operated by Passaic Valley Sewerage Commission [35]	Newark, NJ (22 miles sewer lines)	234	330
Joint Meeting of Essex & Union Counties [18]	Elizabeth, NJ (65 sewer square mile area)	60	85
Bergan County Utility Authority [7]	Little Ferry, NJ (serves 46 municipalities)	83	109
Edward J. Patten Water Reclamation Center operated by Middlesex County Utility Authority [24]	Sayreville, NJ (140 miles of sewer lines)	212	147
Gloucester County Utility Authority [15]	West Deptford, NJ	17.26	24.1

The second pump-out service to be considered should be along the Delaware River. The reason is that Paulsboro is one of the top five busiest ports/terminals in New Jersey and there are other 10 ports/terminals nearby, as shown in Table 12. A pump-out barge provided here can serve over 2,000 vessels. For site information, Table 13 reveals that the channel depth in this area ranges 31 to 35 ft, anchorage depth 31 – 35 ft, and cargo pier length 31 – 55 ft. Paulsboro can accommodate for vessels longer than 500 ft. There is one wastewater treatment plant located near Paulsboro, which is Gloucester County Utility Authority [15].

Publicly owned treatment works (POTWs) collect wastewater from homes, commercial buildings, and industrial facilities and transport it via sanitary sewer systems. Generally, POTWs are designed to treat domestic sewage only. However, POTWs also receive wastewater from industrial (non-domestic) users. The General Pretreatment Regulations, under the Clean Water Act, establish responsibilities of federal, state, and local government, industry and the public to implement Pretreatment Standards to control pollutants from the industrial users which may pass through or interfere with POTW treatment processes or which may contaminate sewage sludge. As long as black water does not interfere with POTW operation, it can be treated in a POTW. Pre-treatment Permits are required before discharging to POTWs. POTW may also charge a fee for black water treatment. When a barge discharges black water to a sewer system, a permit and fee agreement will be required in advance.

Black Water Generation Estimate

In this study, estimate of black water generation was conducted. This information can be used for sizing a holding tank onboard a vessel and sizing a barge used for pump-out service. Black water generation is related to the number of crews and passengers. The safety and security at sea depends on the professionalism and competence of seafarers. IMO (International Maritime Organization) set an International Safety Management (ISM) Code regarding the required manpower at sea. In response to this, a manual, Marine Safety Manual, was developed in the US to interpret international convention and US regulatory issues relating to marine industry personnel. This manual gives guidance and sample vessel manning scales for various tasks performed in a ship for both general and specific classes of vessels [49]. This manual was used for estimating the number of crews in a specific type of a vessel.

Vessel crew requirement depends on types of vessel and job performed. These include master (sea captain), mates, seaman, engineers, fireman, radio officers, etc. The actual required manpower will depend on quite a number of factors, which include size of the vessel; route; hull and equipment maintenance needs (protective coatings, cargo gear, equipment sophistication, etc.); type and horsepower of propulsion machinery; maintenance of machinery and equipment; degree of automation of deck and engine room equipment; type of cargo; cargo transfer system; fire protection systems (crew operational requirements); general arrangement of vessel equipment as it relates to crew operational requirements; lifesaving equipment; level of qualification of each crew position to perform tasks demanded by the vessel's mission; number of passengers carried; hazards peculiar to route and service; hours of operation within a 24-hour

period; and many others. Samples of minimum manpower for various vessels is summarized and presented in Appendix B

Two methods can be used for black water generation estimate, namely daily generation/person and fixture (toilet) units.

Information was collected from various sources and the estimate of black water generation for every person onboard every day is summarized in Table 15. Total amount of black water required for treatment or holding is then equal to the generation rate multiplied by the number of people on board and the days for vessel traveling. Information collected with respect to the fixture unit is shown in Table 16. Based on the fixture unit, the black water generation rate will equal to the average flush rate multiplied by the number of person and days of travelling.

The estimate of black water generation for various vessels in the major ports/terminals and on each ferry routes are displayed in Appendix C. This is an estimate and field information to confirm it has not been located.

Table 15- Black Water Generation per Person

Black Water Generation Rate	Source	Comment
1.1 to 27 gallons/person/day	US EPA [58]	Survey of 29 cruise ships operating in Alaska in 2004
17 gallons/person/day	US EPA [58]	Sampling of four ships with Advanced Wastewater Treatment systems
5.8 gal/ person/day	Noblis [31]	Estimate for Army Forward Operating base

Table 16- Black Water Generation Estimate Based on Fixture Units

Black Water Generation	Source	Comments
0.3 gal/flush	US EPA [58, 59]	Survey of 29 cruise ships operating in Alaska in 2004
1.3 gal/flush	US EPA [58,59]	Land based water-saving, high-efficiency domestic toilet
1.85 – 3.7 gal/person	S. Australia EPA [42]	Conventional toilet (dual-flush cistern)
8.5 gal/person	S. Australia EPA [42]	Marine toilet, subject to model and type, vacuum toilets require 0.106 gal (0.4 L) per flush

Considerations of Pump-out Facilities

Existing Pump-Out Facilities

There are two existing pump-out stations for commercial vessels in New York City:

1. Homeport, Stapleton, Staten Island. Contact is Donald Lillinoa, New York Waterway.
2. Pier 83 Hudson River. The contact is Costas N. Markou, New York Cruise Lines, Inc.

NYCDEC intends to develop two additional pump-out stations at Brooklyn Army Terminal (BAT) and Skyport (E 23rd Street and East River). Both are in design and permit stage. This will give a good coverage of Upper Bay West (Homeport), Upper Bay East (BAT), Hudson (Pier 83), and East River (Skyport) [14].

Table 17 shows how the ferries handle their greywater and black water.

Table 17- Ferry Grey/Black Water Management

Ferry Co.	Ferry Grey/Black Water Management	Contact
Sea Streak	Both greywater and black water are pumped out to a holding tank, pumped onto a barge, and then pumped into city sewer connection	Jack Bevins 732-693-5900
Statue Cruises	Sewer connection directly to boat	Mike Burke 551-655-0405
NYWW	Greywater: Pumps out to a truck for disposal Black water: Pumps out to a tank, then trucked out	Alan Warren 201-660-2289
Cape May	Both greywater and black water are pumped out to a truck for disposal	Steve Melniczuk 856-297-3222
SIF	Water treatment on board and then pumps out to the waterway	Barry Torrey 718-876-2653
NYWT - Taxi	Greywater - Pump out directly to waterway Black water - Pumped out to a facility, then pumped through a pipeline to sewer	Bill Buckley 646-208-9535
NYWT - Zephyr	Pumps out to a truck for disposal	Bill Buckley

The existing pump-out facilities in New Jersey are mainly for recreation vessels. These facilities were funded and built through the Clean Vessel Act (CVA) of 1992 and the primary goal of the CVA is to reduce overboard sewage discharge from recreational boats. Some facilities are merely a simple pump installed at a deck. Locations of some New Jersey and New York Harbor Pump-out stations have been presented in the previous study [17, 29, 30]. Since these pump-out facilities are only for recreation boats,

many of them may not have enough capacity or pier/deck length or water depth for large commercial vessels or ferries to use.

Marine Traffic Map

It was discussed in a Stakeholder meeting if it is feasible to use a map or a graphic method to present marine traffic conditions in New Jersey. NJIT team checked and found that several web sites already present such information online for anyone to check marine traffic in any ports/terminals in the US at any given time. Some are free to use. The findings are discussed below.

AIS (Automatic Identification System) is an international Maritime Organization standard requiring all vessel 300 tons and over, and all passenger vessels, to carry an AIS transponder. The transponder broadcasts information such as vessel name, position, speed and course plus information such as dimensions and the details of the current voyage. The AIS transmitter includes GPS capability for very accurate positioning. The range of AIS reception between vessels is typically 15-20 nautical miles. Land stations with well-placed antennas can get data from over 100 nautical miles away. Data can even be monitored via satellite for true global coverage. AIS was originally intended for collision avoidance.

So far, several companies that store AIS information and provide graphic presentation of vessel movement have been located. They are AIS Live, Shipfinder, Vessel Finder, Marine Traffic, and ShipSpotting.

AIS Live, owned by IHS Maritime, is a web site which tracks and monitors live and historic coverage of ship positions and movements along the world's critical maritime trade routes for any vessel 65-feet or longer [(1)]. The drawback is there is a subscription fee for using this web site.

Shipfinder is a marine traffic app designed to track live vessel activity from across the world [(41)]. Shipfinder works by picking up AIS ship feeds used by commercial vessels and recreation craft to transmit their name, position, MMSI, status and others. It also provides information such as route history and photos for presentation in its apps.

Vessel Finder, Marine Traffic, and ShipSpotting also provide similar online live monitoring of vessel movement.

It was decided that Shipfinder was used for analysis. This web site provides some very useful information. It can show the movement of the exact number of vessels at a specific time and dates at a specific location by using the “Playback” button. A sample is shown in the following Figure and the pathway of each vessel is highlighted. It also indicates various types of vessel displayed such as Cargo, Dredger (including Fishing), Drive vessel (did not find), high speed, Passenger, Pleasure craft, SAR search craft (Search and Rescue), SAR aircraft, military, Pilot (tug), tanker. When a vessel is

clicked, the vessel information (name, MMSI number, size, flag, location, etc.) and its pathway will show.

Figure 12. Sample Marine Traffic Conditions in Newark Bay

Though the web site provides all vessels movement at a specific location, it does not provide the destination of the vessels. Some vessels may simply pass by. In addition, the map only shows the movement at a specific time in animation movement. It is good for study at one point of time, but it does not give a whole picture. It is good to view online, but it does not provide numeric numbers in a technical analysis.

Ballast Water

Traditionally, ballast water management can be performed through two means, exchange and treatment. Ballast water exchange (BWE) is the current approach used by ships to reduce invasive species. IMO (International Maritime Organization) Regulation D-1 requires ships to discharge ballast water and re-ballast in the deep ocean during BWE operation. The basis is that marine organisms transported from coastal environments are unlikely to become established when discharged in deep water; conversely those marine organisms taken onboard from the deep ocean are far fewer in number and unlikely to survive due to the change in water's chemistry, temperature, and salinity. Ballast water exchange is seen as an interim and not a long term solution because scientific studies have proven its limited effectiveness [16]. As an intermediate solution, ships can implement either ballast water exchange or ballast water treatment (BWT). Eventually most ships will need to install an onboard ballast water treatment system to meet discharge limit.

The 2013 VGP has adopted ballast water treatment concept and set ballast water discharge limit, shown in Table 1, and also compliance schedule, shown in Table 2. The 2013 VGP also requires that Ballast Water Treatment System be approved according to US EPA-ETV (Environmental Technology Verification) Protocol [60].

The US EPA's ETV Program has cooperated with the USCG National Ballast Water Management Program to develop performance verification protocols for new ballast water treatment technology designed for installation onboard commercial ships. A draft protocol has been developed and used as basis of IMO recommendations. A test facility at Naval Research Laboratory in Key West, Florida was built per the protocol specifications [52].

Regarding ballast water discharge, the VGP NOI database points out that out of the 71,008 vessels that have filed an NOI, 49,468 vessels, 44.9% of the vessels (26,704) requested ballast water discharge permit and 23,707 (40.58%) had some onboard some treatment facilities. These facilities related to ballast water are mainly holding tanks.

Information on ballast water treatment devices approved by the US EPA is not available, but these approved by IMO can be found. Currently, 24 out of 64 proposed treatment systems have been approved to meet IMO-D2 standards and they are displayed in Figure 13. This figure illustrates that although many systems have been proposed in the USA, only 3 are approved. China, Germany, Japan and Korea have more approved systems than the US. The technologies employed include physical separation such as filtration and hydro cyclones; physical disinfection such as ultraviolet radiation (UV), thermal, ultrasound (US), de-oxygenation; and chemical disinfection using biocides, chlorine, ozone, hydrogen peroxide, chlorine dioxide and others [21].

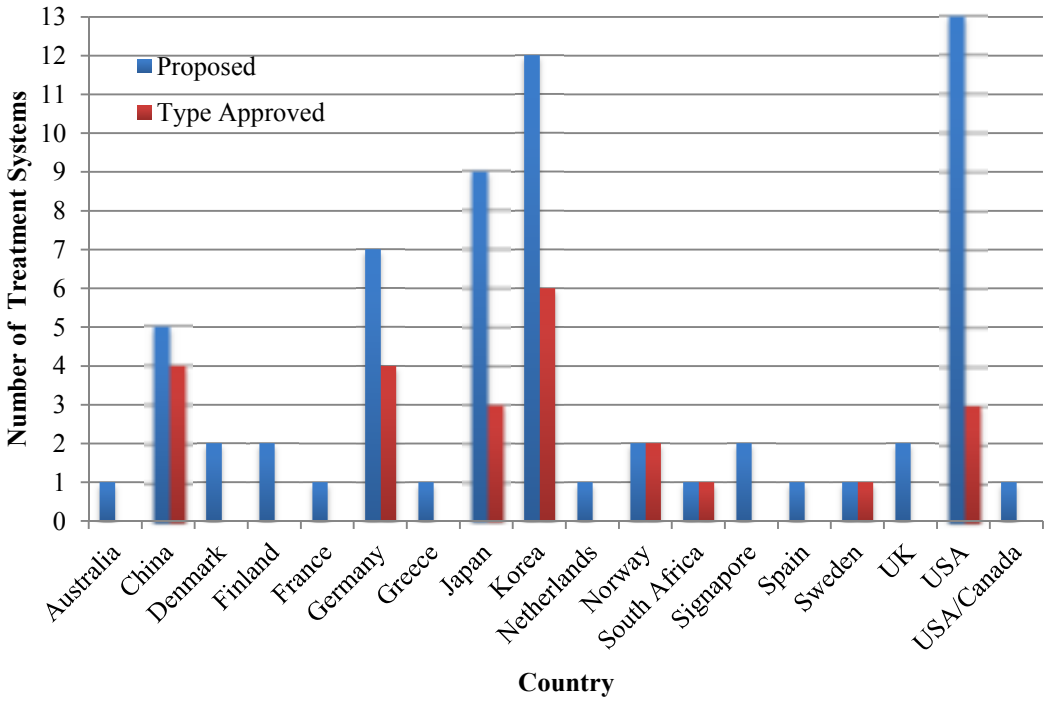

Figure 13. Proposed and Approved Ballast Water Treatment Systems by IMO [21]

There are several concerns regarding to the installation of ballast water treatment systems onboard. A report indicates that most systems require a foot print in a range of 3 to 13 m^2 but some system can require as much as 100 m^2 [21]. Though many vessels were built more recently, many are older than 25 years, which would have problems of installing a treatment system with limited space. Installation of an onboard treatment system generally calls for situating them within the ship's engine room, where ballast pumps are usually located [27]. It was reported that ships design tend to reduce machinery space to maximize cargo capacity and because of this, engine rooms tend to have very limited room for extra equipment [2, 4, 5, 6, 9, 12, 26, 36].

Other than limited space, other major constraints for onboard treatment systems are power need for the equipment [9, 12, 19, 27], limited time for operation and maintenance during voyage [27, 34], and an unstable platform [4, 12, 39]. Another drawback for onboard treatment is safety. Shipboard treatment involves restricted working spaces and potentially hazardous working conditions at sea, which increases the risk of accidents related to treatment processes or storage and use of biocides or other hazardous chemicals [4, 10, 38, 11, 12]. There is also risk of accidental discharge of biocides or hazardous chemicals to the environment [4, 10, 35].

The cost of equipment is also a factor to consider. An US EPA's report estimates that capital costs range from less than $300,000 to more than $2.5 million depending on the type of vessel, ballast water capacity, and type of treatment system. The operation and maintenance costs were assessed to be comparatively low, at $1,708 per vessel per year on average [56]. Operational costs can be much higher for systems with active substances, or chemicals or power consuming equipment, such as electro-chlorination or ozonation.

An alternative to onboard ballast water treatment is to treat ballast water onshore [4]. The onshore facilities will need pumping-out, piping, storage, and treatment systems. Since there is no space limitation, the onshore treatment has the advantage of using any of the treatment processes used onboard a vessel, plus a greater variety of other common and relatively inexpensive treatment methods, such as settling, floating, and filtration [4, 11, 12, 27, 37]. So far, the Valdez Marine Terminal in Alaska is one of the very few existing ballast water treatment facilities which was designed to treat 33 million gallons of oil mixed ballast water and the treatment system does not eliminate invasive species [43]. Onshore treatment system tends to be expensive and there are operational issues which may restrict its use. Some vessels will need to discharge ballast water to cross over a shallow bar or to enter a shallow channel [9, 11, 34]. It takes time to discharge ballast water, some vessels such as bulk carries may not be able to complete discharge at berth by the time the cargo is loaded [4, 11, 34].

Protocol

The purpose of developing a protocol is to provide vessel operators and owners with the necessary information to meet the requirements of the US EPA 2013 Vessel General Permit for vessels. This protocol provides information and guidance on how to comply with the requirements with some taken from the VGP. This protocol will be helpful to file VGP compliance, check on discharge requirements, examine monitoring and inspection requirements, prepare required documentations, submit reports and other useful information. A web site which contains the VGP requirements and information is prepared. By simply clicking on the four main topics, which are shown on the left column of that web page and down below, one can select and go to the desired information page.

- Permit Application,
- Discharge Requirements,
- Monitoring, Inspection, Recordkeeping, & Reporting, and
- NY & NJ State Additional Requirements

The URL (Uniform Resource Locator) of this web site is http:/transportation.njit.edu/vgp.

Impact in New Jersey

The impact study conducted is mainly concentrated in two areas, the implementation of the 2013 VGP and if a new NO Discharge Zone is created in New York harbor waters.

Impact of 2013 VGP

It is mentioned earlier that the major changes from 2008 VGP are three: ballast water requirements, other non-ballast water requirements, and administrative requirements. This will affect vessel owners as well as vessel operators.

The most significant impact is the ballast water requirements. Both stringent numeric technology-based effluent limitations and compliance schedule have been established. The discharge standards apply to all vessels covered under the VGP with a ballast water capacity of 8 m^3 or more. These vessels have the option of four ballast water management measures to meet these numerical discharge standards: approved ballast water treatment system; onshore treatment of ballast water; use of treated public water as ballast water; or no discharge of ballast water. 44.9% of the vessels registered with VGP requested ballast water discharge permit and NBIC data shows over 3,000 vessels arrived in New Jersey have ballast water.

So far, there is no onshore ballast water treatment facility in New Jersey. New Jersey does need to consider building one. When the 2013 VGP is fully implemented, some vessels may need the service someday. Before that happens, vessels with ballast water arriving in New Jersey will have to use one of the other three alternatives. Table 4 shows that 29,372 out of 36,459 barges (80.56%), and more than 50% of ferry and commercial fishing vessels with ballast water, have no onboard treatment facility or

holding tank. These vessels will need such equipment unless they do not discharge ballast water or use public water as ballast. The need is especially true for small locally operating vessels, since many of them only operate in harbors or rivers.

The compliance date depends on the date of the vessel construction (Table 2). Installation of onboard ballast water treatment system may itself be a challenge. The treatment technology has to be approved by the US EPA Environmental Technology Verification protocol. Which and how many have been approved by the US EPA at the present time is uncertain, though 13 have been proposed and only 3 received IMO Type approval. Related concerns have been discussed in detail earlier under the "Ballast Water" section include available equipment space, required power, space for chemical storage, safety issues, and equipment capital and operation and maintenance cost.

Monitoring requirements for equipment performance, selected biological indicators, and biocides and residuals in the discharge; and filing report on time are also needed. Crew engaged in the active management of ballast water must understand how to operate and maintain ballast water equipment. Additionally, if the vessel crew will engage in sampling of any ballast water discharge streams, those crew must understand how to engage in proper sample collection, handling, and packaging. Thus, the US EPA is requiring that owner/operators maintain a written training plan, which describes the training provided to the vessel crew, as well as a record of the date on which that training was provided to each member of the crew.

All vessels equipped with ballast water tanks must have a ballast water management plan. Other than VGP, USCG regulations also establish mandatory ballast water reporting and recordkeeping requirements (33 CFR 151.2041 and 151.2043), and require vessels to have a ballast water management plan that is specific for that vessel and assigns responsibility to the master or appropriate official to understand and execute the ballast water management strategy for that vessel (33 CFR 151.2035(a)(7)).

For the non-ballast water requirements, the major concern will be the numerical limits set for exhaust gas scrubber effluent limits and monitoring requirements which are consistent with IMO guidelines. The purpose is to reduce vessel air emissions of sulfur. IMO guideline includes limits for pH, one PAHs compound, turbidity, nitrates and nitrites. Exhaust gas scrubbers can be classified as dry scrubbers, wet scrubbers, and hybrid scrubbers. The limits applicable in the 2013 VGP apply to wet scrubbers and hybrid scrubbers. The wash water generated from the scrubber is acidic (sulfate and nitrate) and contains particular matter (PM). Neutralization of wash water and PM removed by multi-cylones (alone or in combination with filtration), or an advanced treatment system incorporating coagulation and filtration, floatation and adsorption have been proposed. The US EPA has also included several monitoring requirements for those vessels which use exhaust gas scrubber systems. However, the marine gas exhaust systems are in the early stages of development. Though, the US EPA found that use of these technologies may be economically achievable, the effectiveness of these gas scrubbers and their cost are not available at the present time. In a similar

way crews will need training for sampling inlet water (for background), water after the scrubber (before any treatment system) and discharge water and analyzing these samples for the following parameters: pH, PAH and oil, nitrate and nitrite, and metals (Cd, Cu, Ni, Pb, Zn, As, Cr and V).

For the changes to administrative requirements, the main part is a modification of ways to report which should not be a problem for vessel owners/operators to comply.

Impact of New No Discharge Zone in Harbor Waters

It is mentioned earlier that the US EPA is checking the States willingness to pursue No Discharge Zone in New York Harbor waters and New York State also announced an initiative to establish NDZ in the same places. In addition, New York City is investigating the locations of black water pump-out facilities for commercial vessels. The future of a Harbor-wide NDZ is unclear. Nonetheless, New Jersey may want to consider whether permanent infrastructure, barge systems, landside sewer connections or other options are feasible given Harbor logistics and the public-private nature of the operations.

An understanding the existing condition and regulation may help. First, the CWA clear states that as long as a toilet is installed onboard, a Marine Sanitation Device must be provided. If the MSD is a holding tank, the content must be discharged onshore or 3 miles from shore. Second, there is no discharge treated or untreated sewage in No Discharge Zones. It was reported in the previous study that 249 ports or water facilities that has a berth of 79 feet exist in New Jersey and they are in five 5 regions: NY-NJ harbor and Kill Kull, Arthur Kill and Raritan River, Delaware River, Hackensack-Hudson-Passaic River, and Sandy Hook Bay [(16)]. All these five regions are not in New Jersey NDZs. The concern becomes if all the vessels follow the regulation by not discharging illegally.

At the present time, the pump-out stations installed are under the Clean Vessel Act and mainly serve recreation vessels and many of them are on a deck with short berth length with shallow water depth. Majority of them may not be able to serve large commercial vessels. The alternative is to discharge 3 miles from shore. The installation of pump-out stations to serve large vessels will provide convenience for vessel owners/ operators to comply with the regulation.

To establish an NDZ, States may request that US EPA establish NDZs. Since New York Harbor waters are shared by both New York and New Jersey. It is a reasonable assumption that both States will agree on the terms and locations before a new NDZ is founded. Before that, a vessel can manage the black water using a MSD or discharging it three miles from shore.

For the time being, the provision of pump-out service, such as the use a barge recommended in this study is a voluntary action. However, a number of logistical concerns should be determined in advance. A standardized pipe and fittings should be discussed and set so that all vessels can use. This could involve a number of parties,

such as a state agency, city agency, inter-state agency, or a private for-profit company. The funding source and the way to pay back the loan and interest through service charge should also be agreed in advance. Since quite a number of the vessels pass through Newark Bay and Delaware River and they are owned or operated by different companies and agencies. Coordination among all these agencies, name a few such as New Jersey, New York, Pennsylvania, and Delaware state agencies, New York City government agencies, Port Authority of New York/New Jersey, will be required.

CONCLUSIONS AND RECOMMENDATIONS

Conclusions

Based on the information collected and data analyzed, the conclusions of this study are recapped below.

The major changes of the 2013 VGP are three: ballast water discharge, non-ballast water discharge and administration reporting. The most significant is the new requirements for ballast water discharge. Stringent numeric-based effluent limits and deadline to meet the requirements are the same as these in the IMO ballast water discharge requirements. The 2013 VGP also imposes a variety of changes for non-ballast water discharges. It requires new vessels to use technically feasible "environmentally acceptable lubricant" in their oil-to-sea interfaces. Exhaust gas scrubber wash water discharge standards are listed as well. The permit also require operator to monitor their ballast water, exhaust gas scrubber effluent, bilge water, and grey water if they discharge under the VGP.

The 2013 VGP clarifies the permittees may use electronic recordkeeping, eliminate certain duplicate reporting requirements, and allows for consolidated reporting for certain vessels. There is one significant recording change. Those owner/operators who are not required to submit an NOI to obtain coverage must now complete and keep a Permit Authority and record of Inspection (PARI) form onboard their vessel at all time.

Ballast water discharge requirement will affect many vessels. The US EPA NOI database shows that approximately 45% of the vessels registered discharge ballast water. Though 23,707 out of 71,008 vessels registered claimed they have some type of treatment facility onboard, few of them actually have ballast water treatment facility. In addition, very few onshore ballast water treatment facilities exist in the US and none is in New Jersey. The US EPA NOI database also points out that 10.3% of vessels registered with ballast capacity between 1,500 and 5000 m^3, will need to meet the initial January 1, 2014 deadline, and the rest of the vessels, 34% with ballast water capacity less than 1,500 m^3 and 55.5% with ballast capacity greater than 5,000 m^3 ballast, will have the target date on January 1, 2016.

Due the lack of onshore facilities in the U.S., many vessel owners and operators will need to install an onboard ballast water treatment system. A number of challenges are expected. Other than the newly built vessels with IMO ballast water discharge requirement in mind, older vessels may find the space available for onboard treatment

or holding facility is limited. The availability of additional power requirement, safety consideration of chemical handling, and costs are few of other concerns. Routine monitoring and sampling of ballast water discharges are other obligations to follow.

Another factor unclear is the ballast water treatment systems that have been approved. The 2013 VGP requires that ballast water treatment systems be approved according to US EPA Environmental Technology Verification Protocol. So far, what technologies have been approved has not been made public. Since the 2013 VGP follows the IMO requirements, the devices approved by the IMO, presumably, will also be approved by the US EPA. Currently, only 3 technologies out of 13 proposed in the USA have been approved to meet IMO-D2 standards. It is expected more will be approved due to the demand of the market, but what devices, when they will be available in the market, and at what cost are uncertain at the present time.

On the other hand, the new requirements for non-ballast water will affect only small number of vessel owners/operators. Though, numerical limits for exhaust gas scrubber effluent limits have also been set, only approximately 7% vessels discharge exhaust gas scrubber effluent. The efficient and cost-effective technologies and commercial available products for this charge are also lacking. The leakage of oil from mechanical or equipment seal can probably be controlled through proper design and maintenance, and product substitution.

Regarding the concern of the No Discharge Zone, currently, New York Harbor waters are not on the list NDZs in both New York and New Jersey. However, New York and the US EPA did announce a joint initiative to establish NDZs in New York Harbor waters in 2010, and US EPA is checking on the States willingness again recently. New York is also planning to have up to 4 pump-out stations for commercial vessels in the near future. Before the new NDZs are created, a vessel can handle black water using an onboard Marine Sanitation Devise or discharge it three miles from shore based on section 312 of the federal Clean Water Act. In the meantime New Jersey may voluntarily set up pump-out facilities to serve the maritime industry. If this is to be performed, this study proposes to use a mobile facility such as a barge, so that it can accommodate the need of the vessels at different locations in a more flexible way. The mobile pump-out barge is recommended to be place in locations that have more marine traffic. Based on the data collected from a number of sources, which include the data from US Coast Guard, National Ballast Information Clearinghouse, Tugboat Enthusiasts Society of the American, and US Department of transportation, and others, it is recommend to provide the service in the New York Harbor/Newark Bay area first, and the second area to be considered is in the Delaware river area. Both locations have easy access to the sanitary sewer connections.

Recommendations

Based on the findings in this study, the following recommendations can be made.

The 2013 VGP replaced the 2008 VGP when it expired on December 19, 2013. It is important that vessel owners/operator be familiar with the new requirements and understands and prepare for the changes. For example, the 2013 VGP states that environmentally acceptable lubricant (EAL) must be used in all oil-to-sea interface on any vessel greater than 79 feet. Because of this requirement, seal and equipment need to be maintained to regulation standards. The equipment or devices to be checked will include stern tubes, controllable pitch propellers, rudders, thrusters, wire ropes, etc. If there is a risk of leakage running overboard, the deck equipment will need the use of EAL oil. Another example is the extensive monitoring requirements in 2013 VGP for bilgewater, ballast water, graywater, and exhaust gas scrubber wash water. Therefore, adequate general training of the master, operator, person-in-charge, and crew members with respect to implementing the terms of the permit and responding to fuel spills and overflows are in need. In the same way, special training for the crews responsible for the sampling and monitoring should also be arranged. If samples are not to be analyzed onboard, a contract with a certified laboratory is required.

As for the new numerical requirements for ballast water discharge, many vessels will need either to install an onboard treatment facility or onshore treatment service since only 33.3% of the vessels have some onboard treatment or storage facility onboard, and the facility may not even be used to handle ballast water. The US EPA data indicates roughly 12% of the vessels were built before 1985, which might not have space for onboard treatment facility. Also because the ballast water treatment devises that have been approved by the US EPA is unclear at the present time and only three in the US have been approved by the IMO, the vessel owners will need to check with equipment manufactures and the US EPA for up-to-date information. In the meantime, vessel owners with the need of discharging ballast water will need to find ways to manage the ballast water before the deadline, and to train the crews to operate and maintain the equipment. Since there is no onshore ballast water treatment or holding faculties exist in New Jersey. The demand for one may occur in the future once the VGP is fully implemented. A way to finding the sources of funding either through government bond or private companies should be considered. Other related issues related to onshore facility to be considered will be the siting and treatment processes to be used.

It is explained in this report, before the establishment of a new No Discharge Zone in New Jersey, the use of a mobile pump-out barge or the use of truck for black water is a voluntary action. The provision of such service will certainly make it convenient and easier for the marine industry to comply with environmental regulations or guidelines, and preserve the New Jersey waters clean. Similar to the construction of an onshore ballast water treatment facility, the sources of funding can be through government bonds or private companies. Other than the capital cost, operation and maintenance of the barge, service charge, and time to recover the investment will need to be investigated in advance.

Before purchasing a barge and having sewer line connection, a uniform pipe connection to all vessels, having a discharge permit and contract with a municipal wastewater

treatment plant, cooperation from State and interstate agencies, and logistic consideration should be planned and discussed in advance.

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APPENDIX A - SMALL VESSEL SURVEY FORM

Date: _ _ - _ _ - _ _

Small Vessel Survey

You are invited to participate in a research study entitled "Review of Maritime Industry Needs and NJ Siting of Commercial Pump-Out Options". This study is being conducted by New Jersey Institute of Technology (NJIT). The purpose of this study is to collect small vessel information operated in New Jersey waters. You can either fill this form or do it online at (http://tiny.cc/u0et1w).

A. Vessel Owner/Operator Information (Optional)
1. Name: …….
2. Company Name: ……..……...….
3. Mailing Address: **a**. Street: ……..……..……..….
b. City……: **c**. State: _ _ **d**. Zip code: _ _ _ _ _ - _ _ _ _
e. Phone: _ _ _ - _ _ _ - _ _ _ _
f. Fax: _ _ _ - _ _ _ - _ _ _ _
g. E-mail: ……

B. Vessel Information
1. Vessel Name: ……..
2. Vessel ID/Registered Number: ……
3. Port of Registry/Home Port ……..
4. Type of Vessel (select one)
   - ☐ Ferry ☐ Barge
   - ☐ Tugboat ☐ Other:
5. Vessel Dimensions: a. Weight: …….. Gross tons b. length……feet c. Width……feet
6. Required water depth in port (ft): ……..
7. Vessel ballast water capacity (gallon) …….……
8. Ballast water tank clean frequency: …….
9. Year vessel built: **……..**

C. Vessel Voyage Information
1. Most Frequented Visited Port/Terminal: ……..……
2. Maximum Number of: a. Passengers …….. b. Crew…….. in a trip.
3. Does vessel travel beyond the US EEZ (i.e. more than 200 nm from any shore)? Yes…… No …….
4. Number of trips per day……..
5. Number of trips per month……..
6. Number of trips per tear……..…….
7. Trip length (distance or time) ……..……....

D. Discharge (Circle all that apply)
- ☐ Graywater ☐ Black water ☐ Mixture of black water and graywater
- ☐ Ballast water ☐ Other:

1. Marine Sanitation Device (MSD) Installed? Yes….. No…...
2. Do you have any plan to install MSD? Yes….. No…...
3. Does the vessel have other onboard waste treatment system? (Circle all that apply)
   - ☐ Graywater ☐ Mixture of graywater and black water
   - ☐ Oil/water separator ☐ No treatment system
4. If there is no MSD or holding tank onboard, will it be a financial burden to install one? Yes….. No…...
5. Does vessel has enough room to install a MSD or holding tank? Yes….. No…...

Please send the form to the following address, or scan it and e-mail it to hsieh@njit.edu.

Mailing Address:
H. Hsieh, Department of Civil and Environmental Engineering, New Jersey Institute of Technology
University Heights, Newark, New Jersey 07102-1982

APPENDIX B SAMPLE VESSEL MANNING SCALE

Base on the US Department of Transportation and US Coast Guard "Marine Safety Manual", Chapter 21 [(50)], the sample of minimum required manpower for various vessels is summarized in the following table.

Tank vessel manning standards are required by 46 U.S.C. 9102 to take into account a number of factors relating to the duties, qualifications, and training of officers and crew. These factors include standards related to vessel navigation, cargo handling, size and type of vessel, qualification by virtue of simulator training, maintenance functions, physical fitness criteria, as well as retraining and special training requirements. Section 20.C also addresses specific factors to be considered in manning determinations.

Table B1- Sample Vessel Manning Scales [(50)]

	Vessel Type	Max. No. of Crew	Sample Scales
A	Mechanically -Propelled Passenger Vessels of 100 and more Gross Tons (GT).	28	a. Ocean or Coastwise. 1-Master 1-Chief Engineer *1-Chief Mate *1-1st Assistant Engineer *1-2nd Mate *1-2nd Assistant Engineer *1-3rd Mate *1-3rd Assistant Engineer *6-Able Seamen *3-Firemen/Watertenders *3-Ordinary Seamen *3-Oilers *3-Radio Officers *-Tankermen * -Certificated Lifeboatmen
		27	b. Great Lakes. 1-Master/1st Class Pilot *1-Chief Engineer 3-Mates/1st Class Pilots *1-1st Assistant Engineer *6-Able Seamen *1-2nd Assistant Engineer *3-Ordinary Seamen *1-3rd Assistant Engineer *3-Tankermen *3-Firemen/Watertenders * -Certificated Lifeboatmen *3-Oilers
		16	c. Lakes, Bays, and Sounds (Except Great Lakes). (1) Crew (General Operations). 1-Master/1st Class Pilot *1-Patrolman or Watchman *1-Mate/1st Class Pilot *1-Chief Engineer *4-Able Seamen *1-1st Assistant Engineer *2-Ordinary Seamen *2-Fireman/Watertenders
		10	* -Certificated Lifeboatmen *2-Oilers (2) Crew (12-Hour Operation). 1-Master/1st Class Pilot *1-Patrolman or Watchman *1-Inland Mate *1-Chief Engineer *2-Able Seamen *1-Fireman/Watertender
		18	*1-Ordinary Seaman *1-Oiler * -Certificated Lifeboatmen
			d. Rivers.

			1-Master/1st Class Pilot *1-Chief Engineer *1-1st Class Pilot *1-1st Assistant Engineer *1-Mate *2-Firemen/Watertenders (NC) *1-Patrolman or Watchman *2-Oilers (NC) *8-Deckhands
B	Small Passenger Vessels (SPVs) (under 100 GT)	4	a. Crew (General Operations). 1 Master 1 crewmember for each passenger deck *1 Mate *Additional deckhands based on number of passengers on board
C	Passenger Barges under Tow	3	Barge. 1 Master *1 Deckhand for each passenger deck *1 Mate *Additional deckhands based on number of passengers on board
D	Mechanically -Propelled Cargo/Tank Vessels of 100 and more GT.	28	a. Ocean and Coastwise. 1-Master 1-Chief Engineer *1-Chief Mate *1-1st Assistant Engineer *1-2nd Mate *1-2nd Assistant Engineer *1-3rd Mate *1-3rd Assistant Engineer *6-Able Seamen *3-Firemen/Watertenders *3-Ordinary Seamen *3-Oilers *1-Radio Officer *3-Tankermen * -Certificated Lifeboatmen
		27	b. Great Lakes. 1-Master/1st Class Pilot 1-Chief Engineer 1-Chief Mate/1st Class Pilot *1-1st Assistant Engineer *1-2nd Assistant Engineer 2-Mates/1st Class Pilots *1-3rd Assistant Engineer *6-Able Seamen *3-Firemen/Watertenders *3-Ordinary Seamen *3-Oilers * - Certificated Lifeboatmen *3-Tankermen
		17	c. Lakes, Bays, and Sounds (1) Crew (General Operations). 1-Master/1st Class Pilot *1-Chief Engineer *1-Mate/1st Class Pilot *1-1st Assistant Engineer *4-Able Seamen *2-Fireman/Watertenders *2-Ordinary Seamen *2-Oilers * -Certificated Lifeboatmen *2-Tankerman
		9	(2) Crew (12-Hour Operation). 1-Master/1st Class Pilot *1-Chief Engineer *2-Able Seamen *1-Fireman/Watertender *1-Ordinary Seaman *1-Oiler * -Certificated Lifeboatmen *1-Tankerman
E	Mechanically -Propelled Cargo/Tank Vessels under 100 GT	6	a. General Operations. 1 Master, 1 Mate, *2 Deckhands, *2 Tankermen.
		3	b. With 12-hour Operation Limit. 1 Master, *1 Deckhand, *1 Tankerman.
F	Integrated		1. Inspected Tugs and Dual-Mode Integrated Tug-Barges (ITBs).

	Tug-Barges (ITBs) [Refer to NVIC 2-81].	15	1-Master 1-Chief Engineer *2-Licensed Mates *2-Assistant Engineer 4-Able Seamen *3-Oilers 2-Ordinary Seamen 2. Push-Mode ITBs. 1-Master 1-Chief Engineer 1-Chief Mate *2-Assistant Engineers 2-Mates *3-Oilers *6-Able Seamen *3-Tankermen (if subject to 46 U.S.C. 3702) *1-Radio Officer (as req.by FCC)
		20	
G	Cargo And Miscellaneous Barges.	2+	(1) Voyages of less than 600 NM (nautical miles) *2 Able seamen, **other persons;
		3+	(2) Voyages of 600 NM or Greater. *2 Able seamen, 1 ordinary seaman, **other persons. * One of the crew must hold an appropriate tankerman certificate (aboard tank barges only). ** Other persons may be permitted, depending on the berthing accommodations and lifesaving devices available aboard the barge.
H	Public Vessels		1. Army Corps of Engineers (USACE) vessels a. Lakes, Bays, Sounds, and Rivers
		8	1-Master 1-Chief Engineer 1-Mate *1-Assistant Engineer 2-Able Seamen *1-Fireman/Watertender 1-Ordinary Seaman 1-Oiler
			b. Great Lakes
		8	1-Master and First Class Pilot 1-Chief Engineer *1-Assistant Engineer 1-Mate/First Class *1-Oiler 1-Ordinary Seaman 2-Able Seamen
			2. School Ship Operated by the US Merchant Marine/State Maritime Academies
		19	Licensed officers (one master, three licensed mates, one chief engineer, three assistant engineers, and one radio officer) Unlicensed Deck Crew (3 Able seamen, one per watch) Unlicensed Engine Room Personnel: Three firemen/watertenders or oilers (one per watch) Lookouts Lifeboatmen
I	Sailing School Vessels	2+	In determining the manning needed to safely operate the vessel, the OCMI shall take into consideration the vessel's route and specific characteristics, including the number of masts, type of sails, and number of persons needed for evolutions. Vessels equipped with more than one mast must carry a seaman (Able seaman or deckhand, as appropriate) for each mast, and an additional Able seaman for each square-rigged mast.
J	Offshore Supply Vessels (OSVs)		1. Vessels of 600 NM and more
		13	1-Master *3-Designated Duty Engineers 2-Mates *3-Oilers 2-Able Seamen *1-Tankerman 1-Ordinary Seaman 2. Vessels of less than 600 NM

		9	1-Master *2-Designated Duty Engineers 1-Mates *2-Oilers 1-Able Seamen *1-Tankerman 1-Ordinary Seaman
K	Oil Spill Response Vessels (OSRVs).	See items D & E 12 8	a. Oil Spill Recovery Vessels of More Than 500 Gross Tons These vessels should be manned similarly to a tank vessel. b. Oil Spill Recovery Vessels between 100 and 500 Gross Tons 1-Master *1-Chief Engineer *2-Mates *2-Assistant Engineers *3-Able Seamen *3-Oilers *2-Tankermen c. Oil Spill Recovery Vessels of 100 Gross Tons and Less 1-Master, *1-Mate, 2-Deckhands, *2-Tankermen
L	Oil Spill Response Barges (OSRBs).	4	a. Able seamen and Ordinary Seaman. b. Watchmen. c. Certificated Lifeboatmen d. Tankermen/Persons-In-Charge.
M	Mobile Offshore Drilling Units (MODUs).	10 21 16 12 21	a. Drillships on Location 1-Master (With OIM Endorsement) 1-Chief Engineer *1-Assistant Engineer 1-Mate *2-Oilers 2-Able Seamen 1-Ordinary Seaman 1-Radio Officer (If required by the FCC) b. Drillships Underway-Voyage of More Than 72 Hours 1-Master 1-Chief Engineer 1-Chief Mate *3-Assistant Engineers 1-Second Mate *3-Oilers 1-Third Mate *6-Able Seamen *3-Ordinary Seamen 1-Radio Officer (If required by the FCC) c. Drillships Underway-Voyage Of More Than 16 But Not More Than 72 Hours 1-Master 1-Chief Engineer 2-Mates *2-Assistant Engineers 4-Able Seamen * 3-Oilers *2-Ordinary Seamen 1-Radio Officer (If required by the FCC) d. Drillships Underway-Voyage of Not More Than 16 Hours 1-Master 1-Chief Engineer 1-Mate *1-Assistant Engineer 4-Able Seamen *2-Oilers *2-Ordinary Seamen 1-Radio Officer (If required by the FCC) e. Self-Propelled Surface Units (Other Than Drillships) Underway-Voyage of More Than 72 Hours. 1-Master (With OIM Endorsement) 1-Chief Engineer *3-Assistant Engineers 1-Chief Mate (With BS or BCO Endorsement) *3-Oilers *6-Able Seamen

			2-Mates (With BCO Endorsement) 3-Ordinary Seamen 1-Radio Officer (If required by the FCC) f. Self-Propelled Surface Units (Other Than Drillships) Underway-Voyage of More Than 16 Hours But Not More Than 72 Hours. 1-Master (With OIM Endorsement) 15 *1-Chief Engineer *2-Assistant Engineers 2-Mates (With BCO Endorsement) *2-Oilers 4-Able Seamen *2-Ordinary Seamen 1-Radio Officer (If required by the FCC) g. Self-Propelled Surface Units (Other Than Drillships) Underway-Voyage of Not 14 More Than 16 Hours. 1-Master (With OIM Endorsement) *1-Chief Engineer 2-Mates (With BCO Endorsement) *2-Oilers *2-Ordinary Seamen *1-Assistant Engineer 4-Able Seamen 1-Radio Officer (If required by the FCC) 11 h. Self-Propelled Surface Units (Other Than Drillships) on Location or Under Tow. 1-Master (With OIM Endorsement) 1-Chief Engineer *1-Assistant Engineer 1-Mate (With BCO Endorsement) *2-Oilers 1-Ballast Control Operator 2-Able Seamen 7 1-Ordinary Seamen 1-Radio Officer (If required by the FCC) i. Non-Self-Propelled MODUs (Excluding Bottom Bearing Units) On Location Or Under Tow. 1-Offshore Installation Manager 1-Barge Supervisor 2-Ballast Control Operators 4 2-Able Seamen 1-Ordinary Seaman j. Non-Self-Propelled Bottom Bearing Units on Location or Under Tow. 1-Offshore Installation Manager 2-Able Seamen 1-Ordinary Seaman
N	Dredges	11	1-Master 1-Chief Engineer 1-Mate 1-Assistant Engineer 2-Able Seamen 2-Firemen/Watertenders 1-Ordinary Seaman 2-Oilers
O	Nuclear-Powered Vessels	7	Any request for a manning scale for a nuclear-powered vessel shall be forwarded to Commandant (G-MOC).
P	Motor-Propelled Oceangoing Yachts (300 or more GT)	7	1-Master, *1-Chief Engineer *1-Licensed Mates, *1-Assistant Engineers * -Able Seamen , * -Oilers, * -Deckhands
Q	Hydrofoils and Air Cushion	6	A hydrofoil or ACV shall carry two licensed individuals having radar observer endorsements on their licenses; this arrangement will allow one operator to monitor the radar while the other "cons" the vessel. The number of required deckhands shall be

	Vehicles (ACVs) under 100 GT		determined by the OCMI according to the size and arrangement of the vessel, its route(s), and its operation; a minimum of four deckhands is envisioned.
R	Hydrofoils and ACVs Over 100 GT		Requests relative to personnel qualifications and manning scales for large hydrofoils and ACVs, other than those subject to inspection under 46 U.S.C. 3301, shall be forwarded with full background information to the Commandant (G-MOC), via the district commander.
S	Submersible Vessels	2	1-Master, *1-Mate, Additional Deckhands based on the number of passengers aboard or service requirements

* denotes variables
NVIC: Navigation and Vessel Inspection Circular No. 2-81.
OCMI, Officer in Charge, marine Inspection
OIM: Offshore Installation manager
FCC: Federal Communication Commission
BS or BCO: Barge supervisor or ballast control operator

APPENDIX C BLACK WATER GENERATION ESTIMATE

Table C1- Black Water Generation Estimate for Major Ports in Newark Bay

	Newark		**Elizabeth**		**Bayonne**		**Carteret**	
	No. of Vessels	Crew/ Passenger	No. of Vessels	Crew/ Passenger	No. of Vessels	Crew/ Passenger	No. of Vessels	Crew/ Passenger
Bulker	43	30	0	0	2	30	0	0
Container	706	6	282	6	3	6	0	0
General Cargo	7	6	2	6	7	6	0	0
Other	4	6	1	6	22	6	19	6
RoRo	208	6	0	0	41	6	0	0
Tanker	48	27	0	27	179	27	0	0
Passenger	0	0	0	0	59	750 (1)	129	150 (2)
Total	***1016***	***81***	***285***	***45***	***313***	***831***	***148***	***156***
BW (gal/day)		**3833**		**597**		**12114**		**1075**
Note (1): Passengers = 500, Crew = 50% of Passengers= 250, Total Crew and Passengers = 500 + 250 = 750								BW (gal/day)
Note (2): Passengers = 100, Crew = 50% of Passengers = 50, Total Crew and Passengers = 100 + 50 = 150								

Table C2- Black Water Generation Estimate for Ferries Operating in New Jersey

NJ Terminal (Segment ID)	Route	Passengers	Ave Trip Time	Factor (%)	BW Generation (gal/day)
Atlantic Highlands (429)	Atlantic Highlands (NJ) - Wall Street Ferry Terminal; Pier 11 (NY)	380,000	0:35	0.1	625
Cape May (482)	Lewes (DE) - Cape May (NJ)	419,754	1:20	0.5	3450
Highlands (572)	Highlands (NJ) - Wall Street Ferry Terminal; Pier 11 (NY)		1:20	0.5	0
Camden (682)	Camden (NJ) - Penns Landing; Philadelphia (PA)	455,000	0:35	0.1	748
Fort Mott, (906)	Delaware City (DE) - Fort Mott (NJ)	82,755	0:12	0.05	68
Hoboken, 14th St. (959)	Hoboken; 14th St. (NJ) - Midtown/W. 39th St. (NY)	22,519	0:30	0.1	37
Camden, (1154)	Penns Landing; Philadelphia (PA) - Camden (NJ)	533,615	0:08	0.1	877
Cape May, (1440)	Cape May (NJ) - Lewes (DE)	82,755	0:12	0.1	136
Hoboken, Hoboken Rail Terminal (1441)	Hoboken; Hoboken Rail Terminal (NJ) - Midtown/W. 39th St. (NY)	388,794	1:20	1	6391
Hoboken, Hoboken Rail Terminal, (1451)	Hoboken; Hoboken Rail Terminal (NJ) - Ossining (NY)	1,855,130	0:10	0.1	3050
Edgewater, (1455)	Edgewater (NJ) - Midtown/W. 39th St. (NY)	241,144	0:18	0.08	317
(1464)	W 38th Street Ferry Terminal; Manhattan (NY) - Midtown/W. 39th St. (NY)	119,174	0:15	0.05	98
Hoboken, Hoboken Rail Terminal, (1466)	Hoboken; Hoboken Rail Terminal (NJ) - Lincoln Harbor; Weehawken (NJ)	490,377	0:10	0.1	806
-1485	World Financial Center; Battery Park City (NY) - Ossining (NY)	139,135	0:16	0.16	366
Belford (1499)	Belford (NJ) - Ossining (NY)	415,791	0:40		0
Belford, Lincoln Harbor, (1500)	Belford (NJ) - Lincoln Harbor; Weehawken (NJ)	949,534	0:15	0.15	2341
Lincoln Harbor, Weehawken, (1501)	Beacon (NY) - Lincoln Harbor; Weehawken (NJ)	548,093	0:10	0.05	450
(1502)	Beacon (NY) - Midtown/W. 39th St. (NY)	341,392	0:07	0.01	56
(1503)	Beacon (NY) - Ossining (NY)	166,403	0:15	0.05	137
Port Liberte, Jersey City, (1505)	Port Liberte; Jersey City (NJ) - Ossining (NY)	629,320	1:08	0.5	5172
Liberty Harbor-Marin Blvd. (1507)	Liberty Harbor-Marin Blvd. (NJ) - Ossining (NY)	199,031	0:20	0.1	327
Colgate Palmolive, Exchange Place, Jersey City, (1512)	Haverstraw (NY) - Colgate Palmolive; Exchange Place; Jersey City (NJ)	125,934	0:12	0.1	207
Port Imperial, Weehawken, (1513)	Newburgh (NY) - Port Imperial; Weehawken (NJ)	119,790	0:15	0.05	98
				Total BW Generation (gallon/day) =	**25,758**

Table C3- Black Water Generation Estimate for Ports/Terminals along Delaware River

			Bulker	Container	General Cargo	Other	Passenger	RoRo	Tanker	Reefer	Total	Total Crews	Total Passengers
New Jersey	**Paulsboro**	*No. of vessels*	0	0	0	43	0	0	198		241		0
		Crew	30	6	6	6	6	6	27	6	93	22413	0
	Pennsauken	*No. of vessels*	0	0	0	77	0	0	24	0	101		0
		Crew	30	6	6	6	6	6	27	6	93	9393	0
	Gloucester	*No. of vessels*	2	0	7	2	0	0	0	102	113		0
		Crew	30	6	6	6	6	6	27	6	93	10509	0
	Camden	*No. of vessels*	43		35	21	0	4			103		0
		Crew	30	6	6	6	6	6	27	6	93	9579	0
Pennsylvania	**Philadelphia**	*No. of vessels*	69	254	107	185	1	114	283	94	1107		0
		Crew	30	6	6	6	750	6	27	6	837	926559	463280
	Marcus Hook	*No. of vessels*				7			30		37		0
		Crew	30	6	6	6	6	6	27	6	93	3441	0
	Chester	*No. of vessels*	0	52	0	1	0	0	0	52	105		0
		Crew	30	6	6	6	6	6	27	6	93	9765	0
Delaware	**Delaware City**	*No. of vessels*	0	0	0	33	0	0	129	0	162		0
		Crew	30	6	6	6	6	6	27	6	93	15066	0
	Wilmington	*No. of vessels*	37	106	26	37	1	96	27	44	374		0
		Crew	30	6	6	6	750	6	27	6	837	313038	0
								Total (year)				1309998	463279.5
								Total Crew/Passenger =				**1773278**	
								BW (gal/day) =				**82,591**	