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Impacts of EPA 2012 Commercial Pump-Out Regulations

FINAL REPORT

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Submitted by

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16. Abstract

. The US EPA issued the Vessel General Permit (VGP) for managing vessel discharges, under the Clean Water Act. As a result, commercial vessels operating in the New York/New Jersey Harbor and at Delaware River will be required to comply, including additional conditions imposed by the state. This will affect maritime commerce in terms of cost and operation to meet the VGP requirements. The objectives of this research are to (1) determine how this rule would affect maritime commerce in New Jersey, (2) perform an analysis of the US EPA standards and the VGP rules and determine their impacts on New Jersey maritime operations, and (3) determine what New Jersey needs to do to be prepared. To carry out the project tasks, information on vessels registered under the VGP Notice of Intent and vessels arrivals were solicited from the US EPA and US Coast Guard, respectively, and analyzed. A stakeholder committee was formed where key and urgent issues were discussed in several meetings. New Jersey ports and onshore storage and treatment facilities were investigated. A cost analysis of alternative methods and facilities for pump-out of the discharge, storage, transport to a treatment facility, and waste treatment was performed. A protocol was developed for the maritime industry for filing VGP compliance and reporting. With the 2008 VGP expiration date approaching, US EPA is proposing new, more stringent numeric technology-based effluent limitations for ballast water in the 2013 VGP. A draft sVGP for small vessels is also issued. Finally, the impact on New Jersey and recommendations to the maritime industry are presented.

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EXECUTIVE SUMMARY

The US EPA issued the Vessel General Permit (VGP) for Discharges Incidental to the Normal Operation of Vessels in 2008, under the Clean Water Act. This set forth requirements to be applied to most commercial vessel discharges within the US navigable waters. As a result, commercial vessels operating in the NY/NJ Harbor and at Delaware River facilities would be required to comply, including additional conditions imposed by the state. In addition, many vessels might need to pump-outa number of regulated discharges to operational facilities that currently do not exist. This would affect maritime commerce in terms of cost and operation to meet the VGP requirements. The VGP would impact the maritime industry as well as state governments since the requirements are rather new and some key issues remain to be resolved.

Therefore, the objectives of this research were to (1) determine how this rule would affect maritime commerce in New Jersey, (2) perform an analysis of the US EPA standards and the VGP rules and determine their impacts on New Jersey maritime operations, and (3) determine what New Jersey needs to do to be prepared.

To carry out the project tasks, data for vessel registered under the VGP Notice of Intent database was solicited from US EPA and vessel arrivals in NJ information was also collected from the US Coast Guard. These data were analyzed and presented. A stakeholder committee was formed and key and urgent issues were discussed in the meetings. New Jersey ports and onshore storage and treatment facilities were investigated. This study conducted a study on graywater and ballast water handling devices. A cost analysis of alternative methods and facilities for pump-out of the discharge, storage, transport to a treatment facility, and waste treatment was performed. The VGP will affect New Jersey in four areas: government's roles, discharges handling and on-shore facilities, compliance issues, and economic impact.

The study can be summarized:

- The VGP regulates discharges from vessels in terms of three effluent limits: general effluent; 26 specific discharge streams; and water-quality based limits.
- The VGP requirement generally expresses Best Management Practices (BMPs).
- Under the Clean Water Act, states can add additional requirements related to local water quality to the federal permit.
- New Jersey does not have additional state regulations for discharges under the VGP at the present time.
- New Jersey initially proposed to prohibit graywater and bilgewater discharges through the VGP 401 Certification. A revision was made later and the prohibition was removed since vessel operators would not be able to comply with the conditions by the deadline. Currently, New Jersey does not have additional state requirement.
- New York initially introduced 5 conditions to their 2008 VGP certification. However the NYDEC has issued a letter granting extensions for Conditions 2, 3, 4 and 5 for all vessels to the end of the 2008 VGP term (midnight Dec 19, 2013).

The extension applies to the compliance deadline for ballast water discharge standards for new and existing vessels, gray water discharge prohibition, and bilgewater discharge prohibition.

- US EPA and state agency are the enforcement agencies, but USCG would conduct vessel onboard inspection.
- 57,173 vessels filed NOI in 8 types of vessels. 16,950 vessels have some sort of onboard treatment facility.
- Approximately, 3000 to 4000 commercial vessels arrive in New Jersey annually.
- There are over 200 ports or waterway facilities in New Jersey that have a berth of 79 ft or greater. These facilities can be classified into 5 regions based on the waterway. The busiest region is Ports on NY-NJ Harbor and Kill Van Kull.
- Many vessels do not have room for on-board treatment facility or holding tank for graywater or other types of discharge.
- 170 pump-out facilities exist in New Jersey. But they are only for recreation vessel sewage only.
- Vessel sewage (blackwater) is regulated under the Clean Vessel Act (CVA) and enforced by the state.
- There are no onshore graywater or ballast water storage and treatment facilities in New Jersey.
- The US EPA economic assessment report, depending upon vessel type, could be just for activities regarding to the compliance of the VGP with respect to inspection, bookkeeping, and report filing. It would not cover other cost such as installation of an onboard holding tank or a treatment device.
- The draft 2013 VGP and 2013 sVGP have been made public and US EPA is in process of soliciting comments from states and maritime industry.
- US EPA has proposed to mandate numeric limits for exhaust gas scrubber effluent that are consistent with IMO guidelines in the draft 2013 VGP.
- US EPA also proposed numeric ballast water discharge standards applicable to vessels with ballast water tanks in the 2013 VGP. These discharge limitations are the same as IMO (International Maritime Organization) D-2 Regulations.

In terms of what New Jersey needs to do to be prepared, these are summarized and recommended below:

- Primarily, the 2008 VGP relies on self-monitoring, self-inspections, and self-reporting of violations so vessel owner/operators need to be aware of these requirements.
- The 2008 VGP sets forth various monitoring, inspection, and recording procedures. Vessels are required to conduct and log routine self-inspections and monitoring of all areas of the vessel that the permit encompasses every voyage, week, quarter, year or at dry dock. There are also several actions required in cases of non-compliance. These records must be kept on the vessel for a period of 3 years.
- The VGP also requires Annual Reporting to report instance of non-compliance and a One-time Report that must be completed by vessel owner/operators between 30 months and 36 months after obtaining permit coverage.

- A web site was developed to facilitate the maritime industry to file VGP compliance and prepare required reports. The URL is http:/transportation.njit.edu/vgp.
- Vessels will require ballast water treatment systems (starting in 2014 for certain vessels) or other methods of compliance in the proposed 2013 VGP.
- Vessels can also comply to ballast water discharge standards by using public drinking water as ballast, using onshore pump-out facilities, or not discharging at all. Therefore ports may need pump-out and/or treatment facilities to handle the discharge but onshore facilities are not the only solution.
- New York is still proposing to ban bilgewater discharges in 2013 VGP state certification, though graywater has been removed, which would require the storage of treated or untreated bilgewater while in New York waters. Maritime industry will need to prepare for this.
- Since there is no existing ballast water handling facility in New Jersey, a funded program for storage and treatment facilities should be planned, if onshore facilities are determined to be needed. It is recommended that further investigation be conducted to determine appropriate sources of funding for the infrastructure.
- Logistic issues are to be considered. There are limitations on space at many ports for the construction and operation of on-shore facilities. Additionally, various vessels do not have standard sized fittings or standards to follow so they may not be capable of delivering ballast water to land-based facilities. Even if onshore facilities are available certain issues need to be addressed such as: Will this facility be approved or certified by the US EPA, USCG, or a state agency? Where are the best locations for pump-out? Should mobile barges be used to pump-out? How will the service be charged?
- It would be optimal if state agencies could work to collaborate with the neighboring state agencies in their new 401 certifications in the future.

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 US Environmental Protection Agency (EPA) issued a regulation exempting discharges incidental to the normal operation of vessels. In December 2003, a coalition of environmental groups sued the US EPA to repeal the vessel exemption. The court ultimately held in March 2005 that the vessel exemption was beyond US EPA's authority to grant, and therefore ordered that the exemption be vacated. The US EPA's appeal was not successful, and the court ultimately ordered that the vessel exemption be annulled by December 19, 2008[45].

With the removal of the vessel exemption, any vessel discharge not specifically allowed by a permit would violate the Act, and subject the owner and operator to potential criminal liability, civil penalties, and the risk of lawsuits. Because discharges are a normal, and often unavoidable part of a ship operations, the US EPA had to create a general permit to cover normal vessel discharges for vessels that operate in U.S. waters. These discharges include ballast water, bilgewater, graywater and a number of others, which may cause pollution, in some cases, by contributing to the spread of aquatic invasive species. Instead of imposing numerical effluent limits, the US EPA decided to request a vessel to carry out certain "Best Management Practices" (BMPs) with regard to each of the discharges. Congress also reacted to the court's decision, passing two laws to mitigate the loss of the vessel discharge exemption, for recreational vessels and commercial fishing vessels and non-recreational vessels less than 79 feet in length [2, 45].

Due to the limited time provided in developing the VGP and the need to allow for public comments and input from the states, the US EPA requested an extension for the implementation of the VGP by noting that the maritime industry would need some time to prepare for the requirements of the Final VGP, including the various state conditions. The court agreed to extend the vessel exemption through February 6, 2009.

The regulation of the vessel discharges through the VGP can improve the water quality through the control a variety of materials, which include aquatic nuisance species (ANS), nutrients, pathogens, oil and grease, metals, conventional pollutants, and other toxic and non-conventional pollutants with toxic effects.

As a result, commercial vessels operating in the NY/NJ Harbor and at Delaware River facilities will be required to comply with the VGP, including those additional conditions imposed by the state. This will affect maritime commerce in terms of cost and operation to meet requirements in certain ways. The impact is expected since the requirements are rather new and some key issues remain to be resolved.

OBJECTIVES

The objectives of this research were to:

- Determine how this rule does/will affect maritime commerce in New Jersey,
- Perform an analysis of the US EPA standards and the VGP rules and determine their impacts on New Jersey maritime operations, and
- Determine what New Jersey needs to do to be prepared, including, if necessary, the conduct of a land-use survey of where "pump-out" facilities could be sited, what is required, how they might be operated, etc.

LITERATURE SEARCH

The Clean Water Act (CWA) generally prohibits “the discharge of any pollutant” unless the discharge is in compliance with certain sections of the Act. If there is a violation of the Act, US EPA may issue an order to impose a civil and criminal penalty plus any economic benefit of noncompliance and may also require correction of the violation [44]. One way a person may discharge a pollutant without violating the Act is by obtaining authorization to discharge under a National Pollutant Discharge Elimination System (NPDES) permit, which is issued by EPA or state government.

In late July 2008, Congress enacted two pieces of legislation to exempt discharges incidental to the normal operation of certain types of vessels from the need to obtain an NPDES permit. The first of these, the Clean Boating Act of 2008, excludes of recreational vessels incidental discharge from NPDES permitting, and instead requires US EPA to develop management practices to control. The second, PL 110-299, provides for a temporary moratorium, except for ballast water, on NPDES permitting for incidental discharges from (1) commercial fishing vessels and (2) non-recreational vessels less than 79 feet in length [42, 45, 50].

There are two basic types of NPDES permits, individual and general permits. An individual permit is a permit specifically tailored for an individual discharger. A general permit covers multiple facilities within a specific category for a specific period of time (not to exceed 5 years), after which the permit expires [42, 45].

The VGP consist of six parts and they are briefly described in the following paragraphs:

The general effluent limits of the VGP are designed to apply to all covered vessels for all covered discharge types present on a particular vessel. These effluent limits are generally preventative in nature, and are designed to minimize the discharge of pollutants from a vessel. The VGP effluent limits can be further classified in three types as follows:

- Five Technology-Based Effluent Limits are applicable to all vessels. This covers material storage, toxic and hazardous materials, fuel spills and overflow, discharges of oil and oily mixtures, and compliance with other regulations and statutes applicable to incidental discharges.

- Technology-Based Effluent Limits for specific discharge types. This effluent limit regulates the discharge of 26 kinds of specific discharges. These 26 types of discharge are illustrated in Table 1. Each type of discharge should have at least one BMP associated with the discharge [(2)].

- Water Quality-Based Effluent Limits (WQBELs). Under the WQBELs, each permittee must control its discharge as necessary to meet applicable water quality standards. Additional conditions are given via the State 401 Water Quality certification process.

Table 1 VGP 26 Specific Discharges [(42, 45)]

1. Deck Wash down and Runoff and Above Water Line Hull Cleaning 2. Bilgewater 3. Discharges of Ballast Water 4. Anti-Fouling Hull Coatings 5. Aqueous Film Forming Foam (AFFF) 6. Boiler/Economizer Blow down 7. Cathodic Protection 8. Chain Locker Effluent 9. Controllable Pitch Propeller Hydraulic Fluid and other Oil to Sea Interfaces 10. Distillation and Reverse Osmosis Brine 11. Elevator Pit Effluent 12. Firemain Systems 13. Freshwater Lay-up 14. Gas Turbine Wash Water 15. Graywater	16. Motor Gasoline and Compensating Discharge 17. Non-Oily Machinery Wastewater 18. Refrigeration and Air Condensate Discharge 19. Seawater Cooling Overboard Discharge 20. Seawater Piping Biofouling Prevention 21. Small Boat Engine Wet Exhaust 22. Sonar Dome Discharge 23. Underwater Ship Husbandry Discharges 24. Well deck Discharges 25. Gray water Mixed with Sewage from Vessels 26. Exhaust Gas Scrubber Washwater Discharge

To obtain VGP permit coverage, the vessel owner/operator would be required to submit a Notice of Intent (NOI). The NOI must be submitted between six and nine months after the VGP's issuance date. Vessels delivered after that date will receive permit coverage 30 days after US EPA receives the NOI. Vessels greater than or equal to 300 gross tons or with more than eight cubic meters of ballast water had to submit an NOI by September 19, 2009 [2, 10].

The VGP also sets forth various monitoring, inspection, and recording procedures. Vessels will be required to conduct and log routine self-inspections and monitoring of all areas of the vessel. Furthermore, there are several actions required in case of non-compliance and recordkeeping[42, 45].

The permits contain self-inspections and monitoring as follows:

- Routine visual inspections are to be conducted once per voyage (maximum of once per day) or once per week.
- Annual vessel inspections are more comprehensive and must focus on areas likely to generate harmful pollution or violate effluent limits.
- Dry dock inspection, which is more comprehensive than the annual inspection and only required in coordination with drydocking (does not mandate additional dry docking).
- Analytical monitoring for select cruise ships and vessels with experimental ballast water treatment systems are required.

Corrective actions are follow-up actions a permittee must take to correct problems identified in an inspection; they are a requirement to review and revise control measures and vessel operations to ensure that any problems are eliminated and will not be repeated in the future. Furthermore, failure to take corrective action within specified time period is another permit violation.

Records must include owner and voyage information, additional maintenance & discharge information, certification, safety exemptions claimed, and any monitoring or inspection results.

Reporting should also include ballast water flushing or exchange, spills and other unauthorized discharge, and any noncompliance with the permit. The permit also requires owner/operators to submit a one-time report between 30 months and 36 months after obtaining permit coverage.

The US EPA determined that it was infeasible to calculate numeric effluent limits for most discharges, and therefore used technology-based BMPs in the VGP permit with respect to discharges, except for, graywater, pool and spa discharges from cruise ships, oil discharges, including oily mixtures, and residual biocides from vessels using experimental ballast water treatment systems [45].

The US EPA also performed an economic assessment of the VGP, including an economic impact this permit may have on small businesses. Based on this assessment, the US EPA concluded that this permit is not likely to have a significant economic impact on a substantial number of small businesses [45]. The US EPA has provided both flexibility in implementing the permit and did a study, which found that that the VGP has modest economic impacts on the water transportation, fishing, and mining industries[45].

The regulation of the vessel discharges through the VGP can improve the water quality through the control a variety of materials, which include aquatic nuisance species (ANS), nutrients, pathogens, oil and grease, metals, conventional pollutants, and other toxic and non-conventional pollutants with toxic effects[45].

Before the issuing of the VGP, in the past, some ship discharges, such as ballast water, bilgewater, blackwater, and graywater are regulated through other US laws and the International Maritime Organization's (IMO) *International Convention for the Prevention of Pollution from Ships (*MARPOL 73/78) and other IMO conventions [11].

From the review of the VGP regulations, it is observed that there are quite a number of challenges, both the government, EPA and state governments, and shipping industry will face. The VGP is rather new. It involves the regulation of mobile sources that may travel thousands of miles from one coast to another. It encompasses the control of 26 different types of discharges, which many of them with little information regarding their characteristics or quantity of generation. It engages diversified types of vessel. The time for maritime industry to comply is too short. The flexibility with respect to discharges can also be seen for not providing sufficient protection of the US Waters. Some of the issues have been discussed in length in the stakeholders' meetings.

SUMMARY OF THE WORK PERFORMED

Formation of a Stakeholders Committee

A stakeholders committee was formed and NJIT hosted 4 meetings at NJIT Newark campus to discuss the VGP challenges and issues on May 11, 2011, July 19, 2011, February 7, 2012, and April 24, 2012. Information has been exchanged in the meetings and through e-mails. Two field trips were arranged for committee members to visit vessels.

The committee consists of the following agencies and companies. The persons listed down below have attended at least one meeting.

- NJ Department of Transportation (NJDOT): Genevieve Boehm Clifton (OMR), Priscilla Ukpah (Research), Aly Meleis
- NJ Department of Environmental Protection (NJDEP): Stephen Seeberger

- New York City Economic Development Corporation (NYCEDC): Tamar Sandoze, Andrew Genn
- NY State Department of Environmental Conservation (NYSDEC): Larry Wilson, Don Tuxill, Dave Adams, Katharine Axt
- NYCDOT, Staten Island Ferry: John Garvey, Ed Brescia
- Maritime College, State University of New York: Eric Johansson
- US Coast Guard (USCG): Ralph Savercool, Tom Haug, Jack Walsh
- US Environmental Protection Agency: Sara Sorenson, Katherine Mann, Sieglinde Mueller
- Maritime Association of the Port of NY and NJ: Edward J. Kelly
- United NJ Sandy Hook Pilots Association: Ed Burns, John Oldmixon
- NYK Line (North America), Inc.: Matthew Martyn
- New Jersey Institute of Technology: Taha Marhaba, Hsin-Neng Hsieh, Paul Rodriguez

The committee members made two field trips for vessel visiting:

- The first vessel visits were conducted on September 19, 2011. The stakeholder committee members visited a tug boat and barges of Vane Bunkering Fleet, Brooklyn, New York, a freight ship of Horizon Discovery, and a Staten Island Ferry.
- The second was a cruise vessel visit which was carried out on November 15, 2011. Mr. Rich Pruitt and other environmental officers guided the tour. Discharges and waste handling facilities onboard of Celebrity Silhouette Cruise were introduced.

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. One of the objectives of this study is to find how the VGP would affect maritime commence, therefore, the number of vessels visiting New Jersey is important. However, NOI only requires vessel operator/owners to file what ports these vessels may visit. So it does not reflect the actual presence of the vessels in New Jersey ports and some vessel operator/owners even left this part blank since it is an optional item. In order to understand the actual condition in New Jersey, additional information was solicited from US Coast Guard. Input from stakeholders of the maritime industry and various government agencies in New York metropolitan area also helped understanding the concerns of the VGP.

Approximately 57,000 vessels have submitted NOIs to maintain coverage at the time the database was received in February, 2011. 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 2 shows the number and percentage of each type of vessel registered under the VGP [41].

It is seen from Table 2 that the largest group is barge (53.66%) and the second largest is “Other”. However, after checking the database, only 5,521 “Other” vessels provided information for their specific type of vessel. Out these “Other” vessels reporting additional vessel type information it was found that the majority of “Other” vessels are carrier/freight ships (81.47%), and the remaining are tug/tow vessels (5.54%), oil or gas tankers (3.43%), support/supply/utility vessels (3.23%), passenger vessels (0.95%), drilling/dredging (0.64%), and other (4.73%).

Table 2 Types of Vessels [41]

Vessel Primary Type	Number of Vessels	Percentage
Total	**57,132**	**100%**
Barge	30,658	53.66%
Other	20,638	36.12%
Oil or Gas Tanker	5,010	8.77%
Commercial Fishing Vessel with Ballast Water	233	0.41%
Large Ferry (250+ passengers or more than 100 tons of cargo.)	164	0.29%
Large Cruise Ship (500+ passengers)	189	0.33%
Medium Cruise Ship (100 to 499 passengers)	35	0.06%
Research Vessel	143	0.25%
Emergency Vessel	62	0.11%

As mentioned above, there are 3 types of effluent limits. The second type regulates the discharge of 26 potential pollutants. Out of the 57,132 vessels that have filed an NOI, 46,570 vessels provide information regarding to applicable discharges in the VGP as shown in Figure 1. Figure 1 also exhibits the percentage of vessels that may generate each of the 26 specific discharges. The discharges eligible for coverage under the VGP permit are those discharges incidental to the normal operation of a vessel. Some potential discharges are not incidental to the normal operation of a vessel, so discharges that are neither covered by the VGP permit nor exempt from Section 402 of the Clean Water Act must be covered under a separate individual or general permit.

It is observed from Figure 1, that the most common discharge of all vessels is deck washdown and runoff. The other three more common discharges, which are also in highest in volume and most subject to regulation, are ballast water, bilgewater, and graywater. Ballast water is water taken onboard into ballast water tanks, and assists with vessel draft, buoyancy, and stability. Ballast water is also regulated in the National Invasive Species Act (NISA) of 1996. 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 (blackwater). Graywater is of great concern in many places, and several states are imposing stricter graywater regulations. Cruise ships generally generate more graywater than other types of vessels [49].

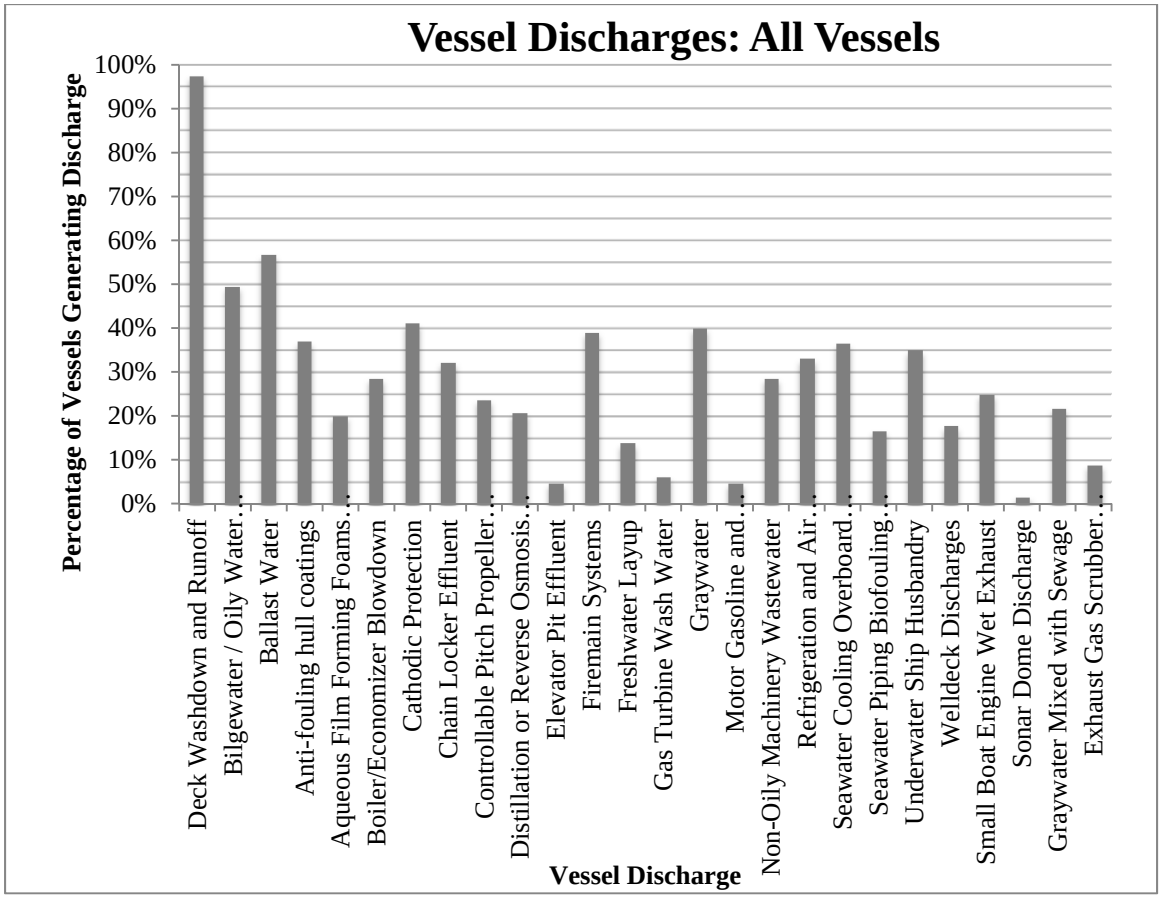

Figure 1 Vessel Discharge [41]

Other beneficial information is the onboard treatment facilities, shown in Table 3. Of the 57,132 vessels registered in NOI, only 45,394 (79.5%) responded to the question about onboard treatment facilities. Of these 45,394 vessels, a total of 16,950 (37.3%) stated that they have some sort of onboard treatment facility for graywater, oily water or

bilgewater. The types of waste streams treated onboard include wastewater, sewage/blackwater, graywater, graywater mixed with blackwater, oily water, and bilge water. The treatment systems mentioned in the database include sewage treatment devices, oil-water separators, incinerators, holding tanks, and Marine Sanitation Device (MSD) – Type I, II, or III. Oily water separators are more commonly found in commercial vessels due to MARPOL international regulations on oil and oily water discharges. Separate graywater treatment systems are rare in commercial vessels since there has not been much regulation requiring these systems. Advanced systems to treat graywater are only mainly used in cruise ships, but some vessels treat graywater through their existing sewage treatment such as an MSD. The database does not give information as to how many vessels have each of the above treatment systems, however, it does provide general information on how many vessels may have one or more of these onboard treatment systems.

Table 3 Onboard Treatment Facilities [41]

Vessel Primary Type	Number of Vessels	Onboard Treatment Facilities		
		YES	NO	No Info
Total	**57,132**	**16,950**	**28,444**	**11,738**
Barge	30,658	129	24,468	6,061
Other	20,638	12,653	3,437	4,548
Oil or Gas Tanker	5,010	3,730	222	1,058
Commercial Fishing Vessel with Ballast Water	233	104	108	21
Large Ferry (250+ passengers or more than 100 tons of cargo)	164	57	106	1
Large Cruise Ship (500+ passengers)	189	141	34	14
Medium Cruise Ship (100 to 499 passengers)	35	19	12	4
Research Vessel	143	90	23	30
Emergency Vessel	62	27	34	1

The VGP database also provides several pieces of information regarding vessel registration, which include country (of the company), registry port, homeport, and US visiting ports. These parts are optional, so some information is missing. Based on the database, shown in Figure 2, of all vessels registered in NOI, 33,565 (62.08%) are domestic owned vessels and foreign companies own 20,505 (37.92%). Foreign vessels come from up to 69 countries. If vessels are classified based on Registry port, then 20,660 vessels (50.80%) are domestic and 20,011 ships (49.20%) are from foreign countries. However, the database was not designed to give detailed information as to

which ports a vessel actually visits, and hence can only be used as an estimate. The visiting ports can be classified into five regions. The number of vessels that may visit the East Coast, West Coast, Alaska, Hawaii, and the fifth region is 9,937, 6,615, 485, 430, and 28,295, respectively. The fifth region includes the Gulf Coast, Mississippi River System, Gulf Intracoastal Waterway, and Great Lakes. Vessels included in this region visit more than one water body and hence the exact location is difficult to define. This information is not an actual record of visiting; it is simply an "anticipated visit" reported by vessel owner/operators. Some vessels may visit more than one region and some may or may not visit a region at all.

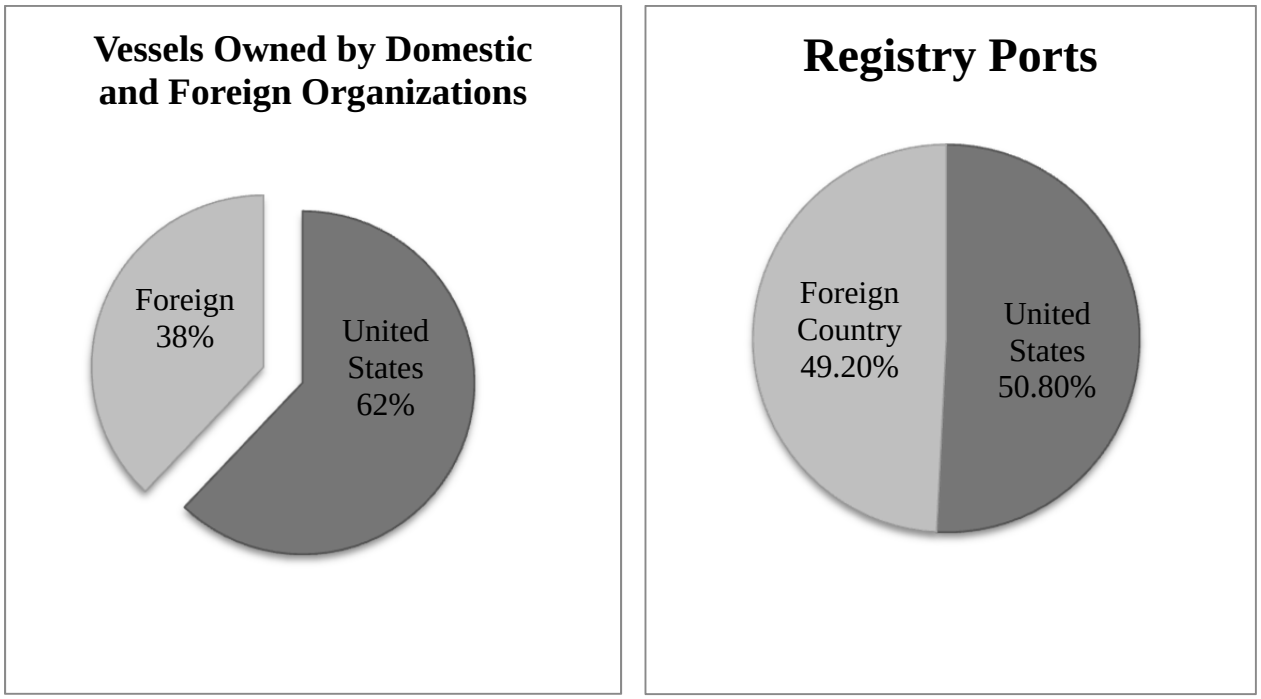

Figure 2 Vessel Registrations [41]

New Jersey Ports

In 1999, the U.S. Army Corps of Engineers (USACE) collected data on all commercial ports or waterway facilities in New Jersey. The USACE identified a total of 249 ports or waterway facilities that have a berth of 79 ft or greater. These facilities can be classified into 5 regions based on the waterway [31]:

(1) NY-NJ Harbor and Kill Van Kull,
(2) Arthur Kill & Raritan River,
(3) Delaware River,
(4) Hackensack-Hudson-Passaic River
(5) Sandy Hook Bay

Table 4 shows the number of operational and nonoperational ports as of 1999. Since the data is over 10 year old, there could be several changes in the operational and nonoperational facilities as well as port or waterway facilities constructed or removed.

Table 4 New Jersey Terminals and Waterway Facilities [31]

Regions		Number of Facilities		
		Total	(In Operation)	(Not in Operation)
1)	Ports on NY-NJ Harbor and Kill Van Kull	68	61	7
2)	Ports on Arthur Kill & Raritan River	57	41	16
3)	Ports on the Delaware River	61	49	12
4)	Ports on the Hackensack/Hudson/Passaic River	55	26	29
5)	Ports on or near Sandy Hook Bay	8	8	0
Total for All New Jersey		249	185	64

Ports on NY-NJ Harbor are mainly cargo ports of the New York – New Jersey Port Authority and some ports serving the Staten Island Ferry and a cruise port managed by Cape Liberty Cruises. The Port Authority of New York and New Jersey (PANYNJ) operates the following terminals and their locations are illustrated in Figure 3:

- Port Jersey Marine Terminal in Bayonne and Jersey City.
- Brooklyn Port Authority Marine Terminal (a combined terminal of Brooklyn Piers and Red Hook Container Terminal) in Red Hook, Brooklyn, NY.
- Howland Hook Marine Terminal on Staten Island.
- Port Newark-Elizabeth Marine Terminal in Elizabeth.

Figure 3 New York – New Jersey Terminals [22]

The terminals along the Arthur Kill are mainly petroleum and chemical terminals. Major terminals along Arthur Kill are presented in Figure 4.

1. Locro Petroleum Services, Bayway/Elizabeth, NJ
2. Conoco Phillips – Bayway Refinery, Linden/Bayway, NJ
3. NuStar and Citgo Linden Terminal, Linden, NJ
4. KMI Terminal – Carteret, Carteret, NJ
5. Hess Corporation, Port Reading/Perth Amboy, NJ
6. Chevron – Perth Amboy Refinery (Closed Down)
7. KMI Terminal – Perth Amboy, Perth Amboy, NJ
8. Perth Amboy Municipal Marina, Perth Amboy, NJ

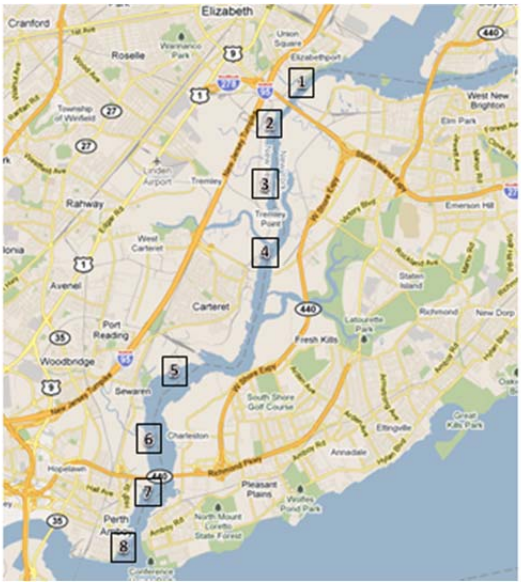

Figure 4 Major Terminals along Arthur Kill (Google Map 2011)

Major terminals along Delaware River are shown in Figure 5.The Delaware River terminals consist of cargo, petroleum and chemical, and ferry terminals. The South Jersey Port Corporation manages cargo terminals in Camden. Delaware River Port Authority of Pennsylvania and New Jersey (DRPA) and Port Authority Transit Corp. (PATCO) operate the RiverLink Ferry, which crosses of the Delaware River, connecting the Camden, New Jersey with Philadelphia, PA. The Philadelphia Cruise Terminal operation was closed on Dec. 31, 2010.

1. Unknown Ports, Burlington, NJ
2. Hess, Pennsauken, NJ
3. Citgo, Petty's Island, Pennsauken, NJ
4. Unknown Port, Camden, NJ
5. Beckett St Terminal, Camden, NJ
6. Broadway Terminal, Camden, NJ
7. Gloucester City Marina and Unknown Port, Gloucester City, NJ
8. Sunoco – Eagle Point Refinery, Westville, Gloucester, NJ (Closed Down)
9. NuStar Energy Paulsboro Asphalt Refinery, Paulsboro, NJ
10. Paulsboro Refinery, Paulsboro, NJ
11. DuPont Chambers Work Facility, Pennsville, Salem County, NJ
12. Barber's Basin, Marina, Salem, NJ

Figure 5 Major Terminals along Delaware River (Google Map 2011)

The majority of terminals in New Jersey are private facilities that receive or transport petroleum or petroleum products, chemicals, construction products, food products, fish, automobiles, and other general cargo. Petroleum and petroleum products are the most common handled commodities by these New Jersey facilities. However general cargo is handled in much larger quantities (number of vessels & tonnage) then all other commodities.

Regarding the amount of shipping tonnage, New Jersey ranked the 6th largest among all states in the U.S. in 2004 [30]. Considering the ranking of port facilities in shipping tonnage in the U.S., the Port Authority of NY-NJ ports ranked 3rd, Paulsboro, ranked 24th, and Camden-Gloucester ranked 65th in 2009 [31]. Therefore the most shipping is handled in cargo terminals on the NY-NJ Harbor, managed by the Port Authority, and on the Delaware River, managed by the South Jersey Port Corporation.

At the present time, the PANYNJ still handles the largest amount of shipping in New Jersey, it also has a majority of commercial vessel traffic at the NY-NJ Harbor. Vessels that only operate in the NY-NJ Harbor area normally do not go out of state waters to

discharge sewage or graywater 3nm (Nautical miles) from shore. Therefore the prohibition of graywater discharge will greatly impact vessels traveling, idling or docking at these terminals if onshore pump-out terminals are not available. Vessels traveling along the Delaware River and Hudson River would face similar problems. If a prohibition of treated and untreated graywater discharge is instated then these vessels will need to install graywater storage tanks and onshore pump-out facilities will have to be made available. If only untreated graywater discharges are banned then vessels may need to install onboard graywater treatment systems or treat graywater with sewage through type II MSD (Marine Sanitation Device).

Vessels Arriving at New Jersey Ports

EPA's NOI database does not have very specific information regarding vessel arrival information. One part in NOI form requests vessel owner/operator to input "US Ports Visiting". However, many left that part blank. So it is difficult to estimate the number of vessels that are using New Jersey terminal service. Information has to be obtained from other sources. NJIT research team has solicited records from two other sources. The first one is from the USCG[34], and the second was from National Ballast Information Clearinghouse (NBIC) database[13].

US Coast Guard Data

When vessels greater than 300 gross tons enters a U.S. port they are required to report to the U.S. Coast Guard (USCG) their arrival and departure data. Table 5 shows the vessel arrival information in year 2010. This table indicates approximately 4000 vessels arriving in New Jersey. The busiest port is Newark, next is Port of Elizabeth, and Bayonne ranks the third. The number of vessels arrives in each season is about the same, with the lowest in the 1st quarter. This table confirms Table 4 data based on the USCG classification. The busiest region is terminals on NY-NJ Harbor and Kill Van Kull since Newark, Port of Elizabeth, Bayonne, Bayway, and Carteret are all in this region.

Table 5 Vessels Arrival in New Jersey Ports [33]

Vessel Arrivals	Quarter 1	Quarter2	Quarter3	Quarter4	Total
Atlantic City	0	7	7	2	**16**
Barneget	5	4	0	0	**9**
Bayonne	106	123	144	106	**479**
Bayway	37	41	39	22	**139**
Burlington	4	3	3	3	**13**
Camden	56	43	36	26	**161**
Cape May	3	2	7	1	**13**
Carteret	34	30	31	42	**137**
Eagle Point	0	0	0	0	**0**
Earle	0	1	0	0	**1**

Gloucester	18	7	7	25	**57**
Gloucester City	8	11	6	9	**34**
Grasselli	0	0	0	0	**0**
Hoboken	0	0	0	0	**0**
Jersey City	25	28	35	36	**124**
Kearny	3	1	1	1	**6**
Leonardo	0	0	0	0	**0**
Linden	10	13	9	5	**37**
Newark	264	321	304	298	**1,187**
Paulsboro	32	35	39	44	**150**
Paulsboro Pilot Station	3	2	4	1	**10**
Penns Grove	0	0	0	0	**0**
Pennsauken	23	23	23	25	**94**
Perth Amboy	14	11	15	15	**55**
Petty Island	0	0	0	0	**0**
Port Newark	53	59	64	67	**243**
Port Of Elizabeth	214	229	260	234	**937**
Port Reading	13	5	20	14	**52**
Port Socony	0	0	0	0	**0**
Salem	12	14	13	14	**53**
Sandy Hook	5	0	3	2	**10**
Sandy Point	0	0	0	0	**0**
Sewaren	13	10	11	9	**43**
Sewell Point	0	0	0	0	**0**
South Amboy	0	0	0	0	**0**
Tremley Point	0	0	0	0	**0**
Trenton	0	0	0	0	**0**
Trumbell Asphalt	0	0	0	2	**2**
Weehawken	0	1	1	4	**6**
Westville	0	0	0	0	**0**
New Jersey	**955**	**1,024**	**1,082**	**1,007**	**4,068**

National Ballast Information Clearinghouse Data

Federal law mandates that all ships with ballast tanks arriving at U.S. ports submit a ballast water information report to the National Ballast Information Clearinghouse (NBIC). Since the majority of commercial vessels require ballast tanks for stability, this data may closely estimate the amount of vessels arriving in New Jersey that are affected by the VGP. The data shows that there have been 3,364 vessel arrivals to New Jersey ports in a year from January 1st to December 31st 2010 [13]. Of these visits 39.63% are from overseas (>200nm from shore) and 60.34% are coastwise (<200nm from shore). Table 6 shows the regions of vessel arrivals. The most frequented area of vessel arrivals is the NY-NJ Harbor and Kill Van Kull Area with 60% of all arrivals, which

is again consistent with USCG data. The difference of number of vessels arrival illustrated in Tables 5 and 6 are due to the different criteria of data collection.

Table 6: New Jersey Vessel Arrivals by Port Region in 2010[13]

Port Region	Vessel Arrivals	
NY-NJ Harbor and Kill Van Kull	2035	60.5%
Arthur Kill & Raritan River	625	18.6%
Delaware River	625	18.6%
Other	79	2.3%
Total	**3364**	

Table 7 shows the type of vessels arriving in New Jersey, based on NBIC data. The largest group is Container, followed by Tanker and "Other" group.

Table 7: New Jersey Vessel Arrivals by Ship Type in 2010 [13]

Vessel Type	Vessel Arrivals	
Bulker	124	3.69%
Combo	2	0.06%
Container	1187	35.29%
General Cargo	67	1.99%
Other	731	21.73%
Passenger	63	1.87%
Reefer	107	3.18%
RoRo	263	7.82%
Tanker	820	24.38%
Total	**3364**	

State's Additional Requirements

Though, the VGP is national in scope, it does not guarantee uniformity because CWA requires compliance with state water quality standards and other possible more stringent state requirements. The VGP is subjected to the state's certification. Table 8 displays the states that have conditioned their certifications on additional discharge restrictions. This state 401 certification only applies to waters within the state's jurisdiction. The additional requirements are specific to certain discharge(s) such as ballast water and/or graywater. Challenges to these state 401 certificate conditions are

normally dealt within the state, and not federal court [2, 8, 46]. New Jersey does not have additional state 401 certificate.

Table 8 States with Additional Discharging Restrictions [8, 46]

California	Illinois	Minnesota	Pennsylvania
Connecticut	Indiana	Missouri	Rhode Island
Florida	Iowa	Nebraska	Utah
Georgia	Kansas	Nevada	Vermont
Guam	Maine	New Hampshire	Wyoming
Hawaii	Massachusetts	New York	
Idaho	Michigan	Ohio	

Some states have placed Conditions on Key Effluent Category Discharges in addition to the Federal VGP. Table 9 shows the effluents most frequently restricted by the states. For example, New York proposed to not allow any vessel to discharge treated or untreated graywater in state waters starting January 1, 2012, though the date has been extended. Some states, such as New Jersey and New York, share some water together (e.g. Hudson River). The additional or lack of restrictions in one state may affect the shipping industry, vessel operations or water quality in the neighboring state. It is even possible that vessel owners may move their maritime operations and shipping business from one port or terminal to another so that the vessel may deal with less demanding state regulations.

Table 9 State 401 Requirements [8, 9, 20, 44, 46]

State	Additional State Requirements to VGP
California	**Ballast Water:** Ballast water discharges must comply with California Public Resources Code (PRC Section 71200 et. seq.) and California State Lands Commission (CSLC) Ballast Water Performance Standards (California Code of Regulation (CCR) Title 2: Sections 2270-2291). **Hull Husbandry:** Hull fouling control must comply with PRC 71200 et. seq. and CSLC (CCR Title 2: Sections 2270-2291). Propeller cleaning is allowed until Jan 1, 2012, after this cleaning shall be in accordance with CSLC regulations. All other in-water hull cleaning is prohibited unless conducted using Best Available Technologies as determined by the CSLC and State Water Board. **Discharge/Effluent Limits:** Discharges must be in accordance with PRC Section 72400et.seq requirements. None of the 26 discharges covered by the VGP may contain hazardous waste as defined in the PRC. The following may not be discharged: sewage sludge, used or spent oil, garbage or trash, photo-developing wastes, dry cleaning wastes, noxious liquid substance residue, and medical waste. There must not be any sheen created from any discharge. Oil and grease must not exceed 15 mg/L from any discharge. Detergents must not be used to disperse any hydrocarbon sheens in any

	waste stream. Methylene blue active substances (MBAS) should not exceed 0.5 mg/L. **Reporting:** The following additional California specific reports must be submitted to US EPA: 1) CSLC Marine Invasive Species Program Hull Husbandry Reporting Form (annually within 60 days of receiving a request from CSLC); and 2) Ballast Water Reporting Form (upon departure from each port or place in state waters) **Other:** Vessels must submit certification stating that discharges are not hazardous
Connecticut	**Graywater:** Graywater discharge is prohibited unless vessel cannot hold graywater. After Jan 1 2012, no graywater shall be discharged into state waters. **Ballast Water:** Vessels with ballast water treatment system must treat ballast water to highest level afforded by that system prior to discharge in state waters.
Florida	**Discharge/Effluent Limits:** Vessels must comply with State Rule 62-302-.530(5) for emulsified oils and greases, which must not exceed 5.0 mg/L.
Georgia	**Graywater:** Vessels less than 20 GRT must process through a Marine Sanitation Device (MSD) that is in compliance with federal standards, otherwise VGP applies.
Guam	**Discharge:** Avoid discharges to coral spawning areas during coral mass spawning (Jan-July)
Hawaii	**Ballast Water:** Ballast water discharges must also comply with Hawaii Administrative Rules (HAR), Chapter 13-76. Concentration of Total Residual Chlorine (TRC) in effluent discharges shall not exceed an acute concentration of 13.0 μg/l in salt water or an acute concentration of 19.0 μg/l in fresh water. **Discharges:** Receiving waters of the state must be free of substances attributable to the discharges, including high or low temperatures; biocides, pathogenic organisms, toxic, radioactive, corrosive or other deleterious substances at harmful levels. Receiving waters must be free of substances attributable to the discharges, including floating debris, oil, grease, scum or other floating materials. An incidental discharge may not interfere with or become injurious to any assigned uses of state waters.
Illinois	**Ballast Water:** Vessels must meet International Maritime Organization (IMO) Treatment Standards no later than 1/1/2016. Vessels built 1/1/2012 or later shall meet IMO Standard beginning 1/1/2012. Also TRC shall not exceed 50 μg/L from ballast water treatment system. Biocides may not cause violations of applicable water quality standards. **Discharges:** Discharges of Bioaccumulative Chemicals of Concern (BCCs) must be in accordance with state requirements (35 Ill. Adm. Code 302.520, 302,521, and 302.530). All discharges may not violate Illinois Water Quality Standards (35 Ill. Adm. Code Part 302 and 304). Effluent may not contain settleable solids, floating debris, visible oil, grease, scum or sludge solids. Color, odor and turbidity must be reduced to below obvious levels (35 Ill. Adm. Code 304.106). Discharges must be free from substances in concentrations toxic/harmful to human health, or to animal, plant or aquatic life.

Indiana	**Ballast Water:** Vessels must meet IMO Treatment Standards no later than 1/1/2016. Vessels built 1/1/2012 or later shall meet IMO Standard beginning 1/1/2012. Also TRC shall not exceed 20 μg/L from ballast water treatment system. Biocides may not be discharged in harmful or toxic concentrations. **Discharges:** Activities authorized under VGP may not violate State Water Quality Standards. **Monitoring and Inspection:** Vessels are required to allow state, upon presentation of credentials to enter and inspect, sample or monitor pollutant discharges and have access to and copy records**.**
Iowa	**Ballast Water:** USCG Additional mandatory practice must be followed.
Maine	**Graywater:** Large Passenger vessels (LPV's) >250 passengers prohibited from discharging graywater/sewage or mixtures unless authorized through Maine DEP General Permit. LPV's prohibited from discharging graywater into No Discharge Areas. LPV's must report to the state discharges of blackwater/greywater not authorized through the Permit or discharges to No Discharge Areas. **Hull Husbandry:** Prohibited except as required for emergency hull repairs. **Discharges:** No discharge of pollutants to Class GPA or class SA waters.
Massachusetts	**Ballast Water:** Vessels engaged in coastwide trade on Atlantic or Gulf Coasts must meet Pacific Near-shore ballast water exchange requirements (exchange required at least 50 miles from shore). Discharges from experimental ballast treatment systems must not exceed 10 μg/L TRC. **Graywater:** Vessels that have the capacity to store graywater may not discharge into Boston Harbor Islands National Recreation Area, the Cape Cod National Seashore and the Essex National Heritage Area. Also the discharge of untreated graywater for vessels > 400 gt is prohibited within 3nm, regardless of speed. Also Graywater commingled with sewage is prohibited from discharge in No Discharge Areas. Further regulations are set for large and medium cruise ships and large ferries (VGP Sect 6.15) **Graywater/Sewage Mixtures:** Not allowed to be discharged in "No Discharge" areas. **Hull Husbandry:** Prohibited within 3 nm of shore unless emergency hull repair. All hull cleaning shall occur at drydock or at other landside facility. Seawater piping biofouling prevention discharges must meet chlorine discharge limit of 10 μg/L. **Discharge:** Discharge of tetrachloroethylene (TCE) from all activities (not just dry cleaning) is prohibited.
Michigan	**Ballast Water:** Oceangoing vessels are prohibited from discharging ballast water unless the vessel obtains a Certificate of Coverage under the Ballast Water Control General Permit or individual state permit. Non-oceangoing vessels that operate experimental ballast water treatment systems are prohibited from discharging with a TRC above 38ug/L when discharge is over 160minutes or above 200ug/L when discharge is less than 160minutes. These vessels are also prohibited from discharging ballast water with a chlorite concentration above 13μg/L. **Graywater:** Discharges of graywater and blackwater are prohibited in Michigan waters. **Discharges:** All vessels are prohibited from lowering the water quality of the

	state's Outstanding State Resource Waters (specified in VGP Sect6.16) or from causing or contributing to exceedances of the Marine Water Quality Standards **Monitoring and Inspection:** Vessels required to operate a ballast water treatment system are required to allow the state reasonable entry onto the vessel for inspection, access to records and collection of ballast water discharge.
Minnesota	**Ballast Water:** Must obtain permit from state for vessel discharges. Vessels must meet Ballast Water Treatment Standards, specified in VGP Certification, no later than 1/1/2016 for existing vessels and 1/1/2012 for vessels built on 1/1/2012 or later. TRC shall not exceed 0.038 mg/L.
New Hampshire	**Discharges:** All boat sewage whether treated or untreated is prohibited in a No Discharge Area.
New Jersey	Former Conditions on Graywater discharge withdrawn before VGP became effective.
New York	**Ballast Water:** NY feels that More stringent concentration-based standards, than standards proposed by IMO, are needed to protect New York's waters and are specified as conditions in the 401 certification. 1) Vessels whose voyage originating in the Exclusive Economic Zone (EEZ) and entering NY Waters with ballast onboard, must conduct ballast water exchange >50 nm from shore and in waters >200 m deep. If such vessels only carry residual amounts of ballast water and/or sediments must conduct saltwater flushing >50 nm from shore and in waters >200 m deep. All vessels entering NY Waters must maintain the ability to measure salinity levels in each tank onboard to ensure salinities of 30ppt. (This requirement does not apply to vessels operating exclusively on the Great Lakes, NY Harbor or Long Island Sound. Also does not apply to vessels entering NY Harbor from ports of call in New Jersey and Connecticut waters provided that the vessel has met the requirements of this condition prior to entering the waters of the NY Harbor or Long Island Sound. Also does not apply to vessels that carry permanent ballast water, in sealed tanks.) 2) NY state has set specific discharge standards for ballast water treatment systems in existing vessels to be in effect no later August 1, 2013 (see VGP Sect 6.22) Note: NY has extended this condition from 1/1/2012 to 8/1/2013. 3) NY state has set specific discharge standards for ballast water treatment systems in vessels built on or after 1/1/2013. **Graywater:** Effective 1/1/2012 no vessel may discharge treated or untreated graywater in state waters **Bilgewater:** Effective 1/1/2012 no vessel may discharge treated or untreated bilgewater except for safety reasons. **NOTE UPDATE**: NY has removed the Condition number 2 and 3 for ballast water and all conditions for graywater and bilgewater.
Ohio	**Ballast Water:** Prohibited from discharge within breakwaters of Lake Erie Ports. Vessels must meet IMO Treatment Standards no later than 1/1/2016. Vessels built 1/1/2012 or later shall meet IMO Standard beginning 1/1/2012. Also TRC shall not exceed 38ug/L from ballast water treatment system. Also ballast treatment systems using other biocides must meet Ohio's narrative toxicity water quality standards.

	Discharges: Discharge of organic quaternary ammonium compounds is prohibited. Discharge of any biocide or toxic chemical shall not be toxic to organisms in ambient waters, or rapidly lethal within mixing zone.
Pennsylvania	**Ballast Water:** PA has withdrawn their former conditions on ballast water. **Discharges:** Discharges of floating materials, oil grease, scum foam, sheen and substances which produce color, taste turbidity or settle to form deposits in concentrations or amounts sufficient to be, or creating a danger of being, inimical to the water uses to protected or to human, animal, plant or aquatic life are prohibited.
Rhode Island	No additional discharge requirements **Misc:** The state reserves the right to revoke the VGP for a specific vessel for cause and reserves the right to amend their certification at any time. Nutrient Impaired waters are those referenced in the state's most current 303D list. A map identifying all state nutrient and biodiversity impaired waters must be included in all VGP

Other states such as Washington and Oregon do not have 401 certification, but these states do regulate ballast waters through separate state regulations, i.e. Washington State Ballast Water Management Rules and Oregon Ballast Water Program. The vessel owner/operator should identify existing state regulations for discharges in additional to the VGP to avoid confusion.

It can be seem from Table 9 that 401 state certifications are not identical in every state. Since vessel discharges are a mobile source, vessel owners face several challenges in complying with both federal and state regulations. As previously stated the greatest number of vessels anticipated visits to inland waters of the Gulf Coast, Mississippi River System, Gulf Intracoastal Waterway, and Great Lakes. The Great Lakes, includes 8 states, 6 of which have different additional 401 certifications and entrance through the St. Lawrence Seaway requires all vessels entering the Great Lakes to comply with the strict New York additional state requirements. Maritime organizations, such as the American Waterways Operators(AWO), have long-held the position that the NPDES permitting system is poorly suited for regulating discharges from mobile sources and that Congress needs to fix this system and establish a uniform regulatory regime for vessel discharges.

New Jersey 401 Requirements

Currently there are no regulations that restrict the discharge of graywater into New Jersey State waters. New Jersey initially proposed to prohibit graywater and bilgewater discharges through the VGP 401 Water Quality Certification on September 24, 2008. This condition was to take effect on February 6, 2009. However, in January 26, 2009, New Jersey made a revision, removing this condition from their certification since vessel operators would not be able to comply with the conditions by the February deadline. From the nature of the actions, at the time, it seems that New Jersey still planned to instate a prohibition on graywater and bilgewater discharges similar to those proposed by New York but preferred to extend the deadline. In the issuance of the next VGP, New Jersey and New York will be collaborating in their new 401 certifications [(44)]. However

from the stakeholders meeting an NJDEP representative made aware that NJ will not establish any additional requirements in the next issuance of the VGP, so there will be no prohibition of graywater or bilgewater.

New York 401 Requirements

New York state additional requirement are of a concern to New Jersey since some water, such as NY-NJ Harbor, Arthur Kill, and Hudson River, are shared by both states. As shown in Table 9, New York actually did prohibit treated or untreated graywater and bilgewater by 1/1/2012. This is where lack of pump-out facilities affected New Jersey waters. If New York or New Jersey did not make shoreside pump-out facilities available or vessels did not have holding tanks, vessels would have trouble complying. This regulation could have also caused New Jersey water quality problems, since New Jersey did not have the same regulation banning graywater or bilgewater discharge and vessels bordering both states would discharge more in the New Jersey side. New York initially granted extensions for vessels that could not meet regulations by the 2012 deadline but ultimately removed the additional requirements for graywater and bilgewater in February 16, 2012.

No Discharge Zones & Nutrient Impaired Waters

States are allowed to submit requests to US EPA for “No Discharge Zones (NDZ)” within state waters. A NDZ is a designated body of water that prohibits the discharge of treated and untreated boat sewage. These NDZ do not apply to graywater discharges, however they indicate bodies of water that should be protected from discharges. New Jersey’s NDZ include Barnegat Bay, Manasquan River, Navesink River, Shark River, and Shrewsbury River [(36)]. US EPA also requires states to indicate any “Nutrient Impaired Waters”, which are bodies of water that cannot meet their designated use due to pollutants from point and nonpoint sources. Many of the nutrient impaired waters are caused primarily by nonpoint sources and regulated stormwater sources [(15)]. However excessive untreated point source discharges from vessels in nutrient impaired waters can worsen impaired water conditions.

New Jersey Water Quality Standards

The New Jersey Surface Water Quality Standards (SWQS) establish the designated uses and anti- degradation categories of the state's surface waters and classify surface waters based on those uses, and specify the water quality criteria and other policies and provisions necessary to attain those designated uses. Designated uses include drinking water supply, fish consumption, shellfish resources, propagation of fish and wildlife, recreation, and agricultural and industrial water supplies. In addition, the SWQS specify general, technical, and interstate policies, and policies pertaining to the establishment of water quality-based effluent limitations [(14)].

Surface waters are classified based on the type of water body and the designated use of the water body. New Jersey has both fresh and saline waters. Freshwaters are

classified as FW1 (not subject to any man-made wastewater discharges) and FW2 waters (all other freshwaters except Pinelands waters). Freshwaters are further classified based on trout status, trout production (FW2-TP), trout maintenance (FW2-TM), and non-trout (FW2-NT). Saline waters are classified as saline estuarine (SE) and saline coastal (SC). SE waters are further classified into SE1, SE2, and SE3 based on their designated uses. Waters within Pinelands Protection and Preservation areas (which may be either freshwater or saline) are classified as Pinelands waters (PL). Some water quality criteria were established under the jurisdiction of the Delaware River Basin Commission (DRBC).

Water Quality-Based Effluent Limitations (WQBELs) are established for all discharges based on surface waters classification. For example, Delaware River main stem (with all zones) and tributaries with classification FW2, SE1, and SE1 have the maximum monthly and weekly BOD_5 effluent limitations 25 and 37.5 mg/l, respectively. These requirements have been implemented for land-based discharges such as municipal wastewater treatment and industrial wastewater treatment.

Graywater Discharge

One of the topics discussed in the stakeholder meetings is the discharge of graywater since it is one of the major wastes generated in the vessel and many states set additional requirements for its treatment and discharge.

Graywater defined by US EPA VGP and USCG in the CFR (Code of Federal Regulation): Navigation and Navigable Waters (33 CFR 151), are very close. US EPA VGP defines graywater as galley, bath, and shower water, as well as wastewater from lavatory sinks, laundry, and water fountains (Modified from 40 CFR 1700.4 without shop sinks). 33 CFR 151 defines graywater as drainage from dishwasher, shower, laundry, bath, and washbasin drains and does not include drainage from toilets, urinals, hospitals, and cargo spaces.

To understand how the VGP may affect the shipping industry one must first know how many vessels would be affected. The VGP NOI asks vessels owners if their vessel has an Onboard Treatment Facility (e.g. Advanced Wastewater Treatment System for Graywater, Oily Water Separator), what waste streams are treated and also Applicable Discharges relating to the 26 Discharge Specific Effluents. A total of 46,570 vessels responded, 81.45% of the total number of 57,173 vessels registered in the NOI for their applicable discharges in the VGP. Table 10 shows types of effluent being discharged and numbers vessels that state they discharge each effluent. It is seen that 18,665, or 40%, of vessels discharge graywater and 10,195 or 22%, of vessels discharge greywater mixed with sewage. Since some vessels may discharge both graywater separately or together with sewage, the total of vessels that discharge graywater (either method) is 19,340 or 41.5%. These numbers seem insignificant. But the small percentage is due to the fact that 53.66% of the vessels registered are barges and many of them have no man onboard during operation.

Table 10 Percentage of Waste Discharged from Vessels [41]

	Discharges	Number of Vessels	Percent out of 46,570 vessels
1	Deck Washdown and Runoff	45,378	97%
2	Bilgewater / Oily Water Separator Effluent	23,086	50%
3	Ballast Water	26,404	57%
4	Anti-fouling hull coatings	17,234	37%
5	Aqueous Film Forming Foams (AFFF)	9,366	20%
6	Boiler/Economizer Blowdown	13,368	29%
7	Cathodic Protection	19,151	41%
8	Chain Locker Effluent	15,028	32%
9	Controllable Pitch Propeller Hydraulic Fluid and other Oil-to-Sea Interfaces	11,101	24%
10	Distillation or Reverse Osmosis Brine	9,710	21%
11	Elevator Pit Effluent	2,257	5%
12	Firemain Systems	18,235	39%
13	Freshwater Layup	6,482	14%
14	Gas Turbine Wash Water	2,955	6%
15	**Graywater**	18,665	40%
16	Motor Gasoline and Compensating Discharge	2,241	5%
17	Non-Oily Machinery Wastewater	13,364	29%
18	Refrigeration and Air Condensate Discharge	15,415	33%
19	Seawater Cooling Overboard Discharge	17,024	37%
20	Seawater Piping Biofouling Prevention	7,819	17%
21	Underwater Ship Husbandry	16,323	35%
22	Welldeck Discharges	8,309	18%
23	Small Boat Engine Wet Exhaust	11,663	25%
24	Sonar Dome Discharge	757	2%
25	**Graywater Mixed with Sewage**	**10,195**	**22%**
26	Exhaust Gas Scrubber Washwater Discharge	4,161	9%
	Graywater or Graywater Mixed with Sewage	19,340	41.5%

The VGP requirement for graywater mainly expresses Best Management Practices (BMPs). The regulation requires vessel to store graywater within 1nm and dispose of onshore only if appropriate facilities are available and such disposal is economically practicable and achievable. If a vessel cannot store or treat graywater its production should be minimized. This includes the minimization of graywater discharge while the vessel is not underway, within 1 nm from shore or while in port. Lastly vessel operators

are required to minimize kitchen oils, food and use only phosphate free and non-toxic detergents. (45)

The VGP does not require the implementation of onshore facilities, onboard treatment systems or storage tanks unless the vessel has the capacity to do so or it is economically practicable and achievable. Vessels owners without these systems may simply adhere to the BMPs without installing any new systems.

However, some state 401 regulations are prohibiting the discharge of treated or untreated discharge of graywater in state waters. Table 11 shows these states with additional graywater requirements. Connecticut and New York have added requirements of no discharge of treated or untreated graywater in state waters after January 1st 2012, initially. New York has postponed the date. Georgia requires vessels less than 20 gross registered tons to process graywater through a Marine Sanitation Device. Other states, such as Maine, Massachusetts and Michigan also have additional regulations(8, 9, 46).

Table 11 States with 401 Graywater Requirements (8, 9, 46)

State	Additional Graywater Requirements
Connecticut	Prior to 1/1/2012 graywater discharge is prohibited unless vessel cannot hold graywater. After 1/1/2012, no graywater shall be discharged into state waters.
Georgia	Vessels less than 20 gross registered tons must process graywater through a Marine Sanitation Device (MSD) that is in compliance with federal standards.
Maine	- Large Passenger vessels (LPV's), >250 passengers, are prohibited from discharging graywater, sewage or mixtures unless authorized by Maine DEP General Permit. - LPV's prohibited from discharging graywater into No Discharge Areas. - LPV's must report to the state discharges of blackwater/greywater not authorized through the Permit or discharges to No Discharge Areas.
Massachusetts	- Vessels that have the capacity to store graywater may not discharge into Boston Harbor Islands National Recreation Area, the Cape Cod National Seashore and the Essex National Heritage Area. - The discharge of untreated graywater for vessels > 400 gross tons is prohibited within 3nm, regardless of speed. - Graywater commingled with sewage is prohibited from discharge in No Discharge Areas. (¾ of state waters). - Further regulations are set for large and medium cruise ships and large ferries (see VGP Section 6.15)
Michigan	Discharge of blackwater and graywater are prohibited in Michigan waters.
New York	After 1/1/2012 no vessel may discharge treated or untreated graywater in state waters - Date has been extended.

Graywater Discharge with Onboard Storage

One way, to comply within states that will not allow treated or untreated graywater discharge is to install graywater holding tanks onboard vessels. The contents (treated or untreated) could then be discharged outside of state waters or at onshore pump-out facilities. Figure 6 shows a schematic diagram of the graywater discharge process if onboard storage is available. If a vessel is within no-graywater-discharge areas, the graywater can be stored in the onboard storage tank and disposed of at an onshore pump-out facility or a barge with handling facility. If the vessel is not in a no discharge area it may redirect the graywater directly overboard.

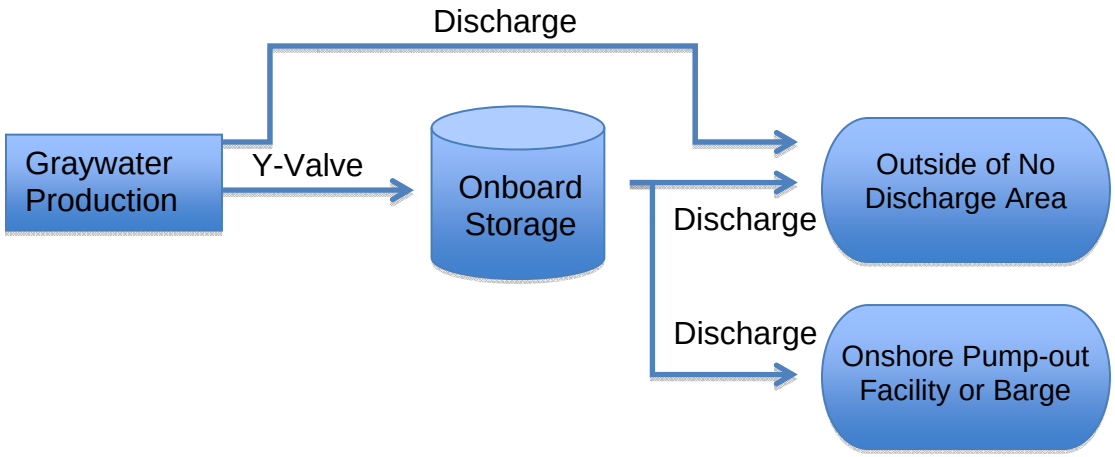

Figure 6 Schematic Diagram of Graywater Discharge

A number of commercially available storage tanks for vessels are available in the commercial market. These storage tanks are made of polyethylene to prevent corrosion and are used for storing sewage as a Type III MSD. They are rather simple systems, which consist of a tank with an inlet and outlet pipe as well as a vent pipe. The inlet pipe can be installed with a Y valve, allowing the graywater to be directed overboard. When the vessel is in a no discharge area the Y valve can be put in a closed position so the graywater is sent to the storage tank. Y valves are inexpensive ranging from $30 for ½-inch pipes to $140 for 2-inch pipes [(6)].

Holding tanks volumes range from 5 gallons to 260-gallons. As can be seen from Table 17, the 100-gallon tanks are approximately $500 - $1,000 and the 200-gallon tanks are roughly $700 - $1,300. A 200-gallon tank may have a size of 5'x3'x2' or 4'x3'x3'. If more then 200-gallons of storage is required or space constraints do not allow for a big holding tank, more than one storage tank can be used to meet graywater storage needs. The Tank Depot provides an online category of pre-fabricated holding tanks for vessels based on the required capacity, length, width or height of the tank. Raritan Engineering Company, a local company in Raritan, New Jersey, sells semi-custom holding tanks including fittings. Raritan Engineering also offers a variety of geometric

shapes of tanks to optimize space use onboard. Prices for tanks from both companies are shown in Table 17. Raritan Engineering's pricing is based on their custom models while the Tank Depot pricing is based on standard pre-fabricated tanks. Both companies ship the tank from California [23, 28]. There are a variety of other companies that provide these services and this report does not intend to endorse or promote any particular company.

Table 12 Pricing Comparison for Onboard Storage Tanks [23, 28]

Capacity (gal)	Tank Depot	Raritan Engineering
30	$260	$445
60	$410	$728
100*	$430	$954
125*	$530	$1,036
150*	$575	$1,182
200*	$690	$1,258
260*	-	$1,346

* Shipping is not included, which is additional $200 - $250.

Additional costs of installing storage tanks include pipes or hoses from each fixture to the tank, connection to the discharge outlets, valves, pipe-fittings and pumps.

Onboard Treatment of Graywater

The VGP and state additional regulations do not require vessels to treat graywater. Some Cruise and Navy vessels are the only vessels that have graywater treatment. For other vessels wishing to install onboard graywater treatment facilities, there are few but emerging technologies.

Since few regulations exist on the treatment of graywater in the U.S., there has not been a demand for these systems. However, the South Australian Environmental Protection Authority (SA-EPA) established graywater regulations in the Standard AS-4995-2009 "Greywater Treatment Systems for Vessels Operated on Inland Waters". This standard requires graywater treatment or containment for certain types of boats in inland water of South Australia from January 2011 and mainly applies to houseboats but is relevant to cruisers, yachts, pontoons or remote residences. Treatment systems are required to treat based on BOD, E. coli, Enterococci, Oil and Grease, Total Phosphorous, Suspended Solids and Total Nitrogen [27, 45]. Due to these new standards, two companies manufacture graywater treatment systems in South Australia.

1) Aerofloat is a graywater treatment company that has worked with SA-EPA to meet graywater treatment standards. Aerofloat's systems utilize an adaptation of

Dissolved Air Flotation (DAF) technology. These systems currently have treatment rates of 200 – 750 liters per hour (50 - 200 gallons per hour). The systems are priced at $7,975 and higher [1].

2) Newtreat is also a South Australian company that meets SA-EPA's graywater treatment standards. The "Newtreat Super System" contains an Electrolytic Treatment Module, which treats graywater by controlled electro-chemical reactions. These systems have treatment rates of 140 liters per hour (37 gallons per hour) and are priced at $9,850 and higher [17].

Both of these systems have not been used in the U.S. yet and it is still not certain if they are applicable to all vessels.

Simple graywater treatment systems mainly use disinfection methods to treat the water. Some systems include grease traps that pre-treat graywater by removing oil and fat. These are more commonly used to for kitchen sink graywater. Grease traps range in capacities of 4 gpm to 100 gpm and cost between $130 and $1,400 [21].

For cruise vessels, more than 1 million gallons of graywater are typically produced on a 7-10 day cruise [7]. Studies by US EPA, International Council of Cruise Lines and the Science Advisory Panel of the State of Alaska concluded that current major cruise line graywater practices resulted in minimal negative impacts on the environment due to the high dispersion rates. Generally cruise lines only discharge graywater and treated blackwater while the ship is underway at a speed of not less than 6 knots. Also when graywater is held in tanks near warm engine components, higher bacteria counts are found due to the accelerated bacterial growth [7]. In addition to standard MSD's, many cruise ships are also using advanced wastewater treatment technologies for graywater and blackwater. These systems include reverse osmosis and membrane bioreactors. Prices for these systems are based on specific vessel characteristics and capacity, and therefore, the cost can only be provided by the manufacturer.

Graywater Generation Estimate

The NJIT team did a literature search and found that little information is available for estimating graywater generated onboard. However, graywater is no different from wastewater generated in household. There are well established methods to estimate different types of wastewater generated in a household. Methods used for graywater generation estimate can be classified into 3 categories:

- Fixture Units
- Daily generation/person
- USCG Guideline

Fixture Units Method

Fixture Units method is to consider graywater production facilities on a vessel such as hand basins, kitchen sinks, showers, laundry machines and dishwashers. The volume of graywater estimate can be expressed by the following equation:

$$V_{Graywater} = V_{\text{Hand Basin}} + V_{\text{Kitchen Sink}} + V_{\text{Shower}} + V_{Laundry} + V_{Dishwasher}$$

where:
$V_{\text{Hand Basin}}$= (Volume per use of Hand Basin)(Uses per day)
$V_{\text{Kitchen Sink}}$= (Volume per use of Kitchen Sink)(Uses per day)
V_{Shower}= (Flowrate of Shower Head)(Time of Shower)(Uses per day)
V_{Laundry}=(Volume per cycle)(Uses per week)(1week/7days)
$V_{\text{Dishwasher}}$=(Volume per cycle)(Uses per week)(1week/7days)

It is seen from the calculations, the volume of graywater depends how many times a day each facility is used and the amount of water is used during each use. Tables 12 and 13 show typical water use in a household from two most used references [3, 13].

Table 13 Typical Water Use in a Household [3, 12]

	U.S. Customary		SI Unit	
Device or Appliance	Range	Unit	Range	Unit
Automatic home-type washing machine:				
Top Loading	34-57	gal/load	130-216	L/load
Front Loading	12-15	gal/load	45-60	L/load
Automatic home-type dishwasher	9.5 - 15.5	gal/load	36-60	L/load
Shower	2.5 - 3	gal/min-use	9-11	L/min-use
Washbasin	2 - 3	gal/min-use	8-11	L/min-use

Table 14 Daily Generation – Household [3, 12]

	Flow, gal/cap-day	
Use	Without Water conservation	Water Conservation
Faucets	10.9	10.8
Showers	11.6	8.8
Dishwashing	1.0	0.7
Clothes washing	15.0	10.0

Another information is taken from the River Murray Boat Owners Association and shown in Table 14. It also provides an online graywater calculator for use [4].

Table 15 Rate of Water Use [4]

Device	SI Unit	U.S. Customary
Hand basin	1 liter/use	0.264 gal/use
Kitchen sink	8 liters/use	2.113 gal/use
Shower	9 liters/min	2.377 gal/min
Washing machine	30 liters/cycle	7.926 gal/cycle
Dishwasher	30 liters/wash cycle	7.926 gal/wash cycle

Daily Generation/Person

If graywater generation/person/day is known, then multiplication of that amount by the number of person and days onboard can be used for design a facility.

The National Defense Authorization Act of 1996 amended Section 312 of the CWA to require DoD(Department of Defense) and US EPA develop uniform national discharge standards (UNDS) for vessels of the Armed Forces discharges. Based on the data collected, the U.S. Navy uses a design figure of 30 gallons per capita per day (gal/cap/day) when designing graywater collections systems**.**

Another technical report, interestingly, provides a very close number. Today's military are highly mobile and often deployed in remote places with limited resources and power supply. The Department of Defense's Forward Operating Bases (FOBs) are bases used to support tactical operations without establishing full support facilities. A base may be used for an extended time period. Support by a main operating base will be required to provide backup support for a forward operating base.

A report, prepared for SERDP Sustainable Forward Operating Bases, provides information, for Force Provider (FP), for a 600 man base regarding wastewater generation [18]. This base generates 17,575 gal graywater per day (29.3 gal/day/person) and 3,465 gallons of blackwater per day (5.8 gal/day/person). This information provides a basis for facility design.

US Coast Guard Guideline

Graywater production depends on three factors: the number of passengers and crew onboard, duration of trip, and amount of graywater produced per person per trip or day. In particular we are interested in the graywater production while in no discharge areas.

Since some vessels do not have showers or galleys, the graywater production varies depending on the vessel type. The USCG provides estimates on the volume of graywater produced per day, based on the way the vessel operates. The USCG has separated the daily graywater generation into 3 categories based on trip duration. The graywater information adapted from the USCG is shown in Table 15 [32].

Table 16Graywater Generation/Person/Day [32]

Trip Duration	**User**	**Graywater**	
		Liters/cap/day	**Gallons/cap/day**
Long	Crew	113.6	30.01
	Passengers	113.6	30.01
Medium	Crew	113.6	30.01
	Passengers	56.8	15.00
Short	Crew	11.4	3.01
	Passengers	5.7	1.51

Different vessel types experience different trip durations. For example, Barge, Tankers and Freight Ships operate for long periods of time with a crew that is onboard 24-hours/day but carry little to no passengers, therefore it can be considered under the Long duration category. The higher graywater production for a Long trip accounts for showers, clothes washing and other graywater production. However, Passenger Ferry Vessels operate for short durations, making several trips a day between two nearby ports so it can be considered under the Short duration category.

Table 16displaysestimated total graywater production by different vessels per day using the USCG estimates from Table 15. If the vessel spends less than 24 hours in a no discharge area then the graywater storage requirements will be less than these shown in Table 16.

Table 17 – Estimated Daily Graywater Production by Different Vessels

Vessel Type	Trip Duration Category	Graywater per crew member per day (Gal/cap/day)	Graywater per passenger per day (Gal/cap/day)	Number of Crew	Number of Passengers	Total Daily Graywater Production (Gallons/day)
Barge, Tug, Freight or Tanker	Long	30.01	30.01	2	-	**60**
				5	-	**150**
				10	-	**300**
				20	-	**600**
Ferry	Short	3.01	1.51	10	840	**1,299**
					1,500	**2,295**
					3,000	**4,560**
					5,000	**7,580**
					10,000	**15,130**

The analysis of graywater produced on vessels is a lot more complicated than these illustrated in Table 16. For example, the USCG graywater estimates allows us to consider a ferry that travels 6 trips in one day for 2 hours each trip. However, when analyzing a specific ferry, the amount of trips per day and voyage time may be different. Furthermore, the water may not need to be contained for an entire day but only for a few hours in between pump-outs. Vessel owners will need to analyze their vessel graywater productions through their naval architect/planner or the storage/treatment system company. A more accurate method of estimating graywater production would be to measure the flow through each fixture unit for several days.

Onshore Pump-out and Treatment Facilities

Existing Condition for Recreation Vessels

If the controlled discharges are stored onboard, then they can be treated at the ports or hauled to another location, such as a Publically-Owned Treatment Works (POTWs) for graywater and black water treatment, or publically owned oil water separators for wastewater containing hydrocarbons. The concept of land based treatment facilities would seem to be attractive, as it treats water at the source and standards of treatment could be guaranteed. However, before the VGP, only ballast water and vessel sewage are regulated. The former is under the legislation of National Invasive Species Act (NISA) 1996 and USCG enforces the regulation. The latter is regulated under the Clean Vessel Act (CVA) and is enforced by the states. Because of these two Acts, existing pump-out station and treatment facilities are only for these two types of discharge. There is no existing pump-out or treatment facility for graywater or any other types of discharges. In addition, there is no federal funded program available for handling or treating such discharges at the present time.

In actual practice, many ships discharge ballast water before entering ports, which makes land based treatment an unattractive single option. Also because of the high capital and operation costs, very few onshore treatment facilities exist. So far only one on-shore facility, the Port Valdez facility in Alaska, is in use for ballast water treatment. Others are in the study or planning stage [(5)].

Congress passed the Clean Vessel Act (CVA) of 1992 to help reduce pollution from vessel sewage discharges. The Act established a five-year federal grant program ($40 million) and it was reauthorized in 1998 with additional $50 million for disposal of recreational boater sewage.

However, the primary goal of the CVA is to reduce overboard sewage discharge from recreational boats. These pump-out facilities are for recreation boats only, and may not have the capacity to handle the VGP discharges.

The CVA provides funds to states for the construction, renovation, operation, and maintenance of pump-out stations for holding tanks and dump stations for portable

toilets. New Jersey has also established a New Jersey Clean Vessel Act. Locations of some New Jersey and New York Harbor Pump-out stations are shown in Figure 7 and the general practice in New Jersey and New York are described below [16].

- There are currently 170 operating pump-out stations in New Jersey, 630 dump stations and 8 pump-out boats [16].
- Waste from pump-out stations and pump boats are discharged into local sewage treatment facilities.
- Each pump-out boat can carry up to 300 gallons of sewage.
- Locations of the recreational vessels pump-out stations in New Jersey can be found at two online maps:
    - ❖ North and South NJ Maps: http://www.state.nj.us/dep/fgw/cvadir.htm
    - ❖ Delaware, NJ, PA Area Map: http://www.state.nj.us/drbc/pump.pdf
- Pump-out boats in New Jersey are operated by the Borough of Seaside Park, Monmouth County, and Ocean County.
- There are approximately 300 pump-out stations in New York funded through the Clean Vessel Assistance Program (CVAP), which is a federally funded Program. NYS Environmental Facilities Corporation is in charge of CVAP.
- There may be more pump-out stations available through private funding.
- There are approximately 20-30 pump-out boats in NY funded through the CVAP.
- Under CVAP, these boats only allowed to pump sewage.
- NY pump-out boats are usually 23 ft fiberglass boats with an average capacity of 250 gallons.
- Most of these boats are built by Marine Boatbuilders Co. (http://www.pumpoutboats.com)
- This company claims size of the holding tanks onboard ranges from 300 – 950 gallons depending on the length of the boat.

Figure 7 Locations of New Jersey and New York Harbor Sewage Pump-Out Stations (16)

Cost Analysis for Onshore Facilities

To move discharges from vessel to port handling facilities, a number of alternatives are available and this is illustrated in Figure 8. For the present time, the most important and most probable discharge required to handle is graywater, so graywater is used as an example in the following description.

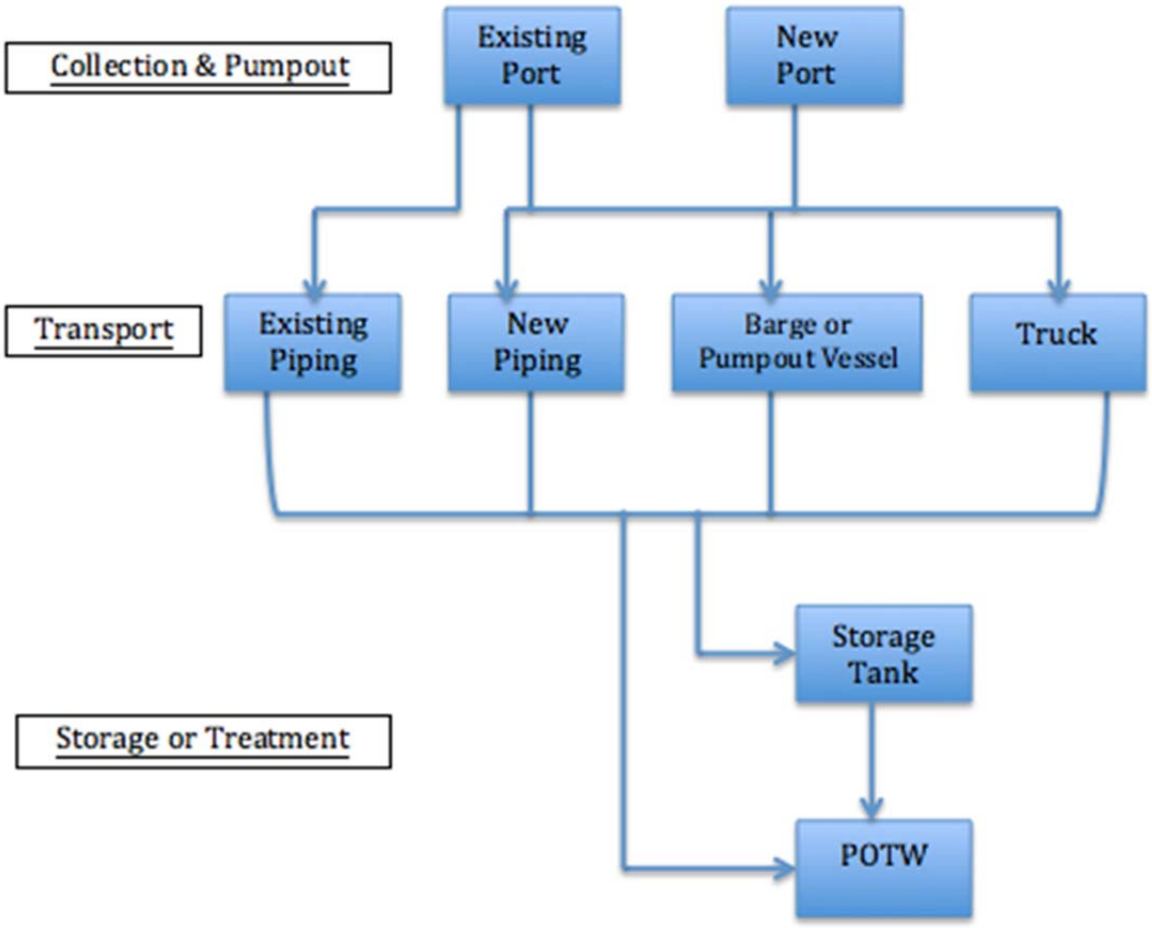

Figure 8 Flow Diagram of Alternatives in Onshore Treatment of Graywater

The collection of graywater can either be conducted at an existing port or at a new port facility. If a new port or dock is to be used solely for the collection of vessel discharges, costs of this new facility will include the purchase of land, engineering design and construction.

Three most practical alternatives to transport graywater from the vessel to an onshore treatment or storage facility are through existing piping, new piping or a barge/pump-out vessel. Piping is a very common device used in engineering for transport, but barge is not. The individual capacity of a common size barge is about 1.7 MG so one barge would be sufficient [(5)]. The biggest disadvantage to this alternative is that the port will need to purchase a barge which requires 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 [(5)]. Truck has been used for cruises for handling sewage. A typical waste hauling truck has an individual capacity of 5,000 gallons [(5)]. With the high capacity, the truck would be able to make several collections before having to transport graywater to a nearby location for treatment.

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 graywater does not interfere with POTW operation, it can be treated in a POTW. Onshore treatment of graywater would be achievable through an existing POTW. In some cases, Pre-treatment Permits are required before discharging to POTWs. POTW may also charge a fee for graywater treatment.

If ports have sewer systems, they can pump directly to the POTW. If no sewer system is available then a storage tank would be required to collect graywater and transport from storage tank to the POTW. Prefabricated storage tanks have been used for different usage, such as water storage. Table A3 in Appendix A shows the cost for above ground steel water storage tanks.

NJIT team has performed cost analysis on discharge collection, transport, storage and treatment. The cost is very site specific and is related to the type of discharge. A unit cost analysis is provided and listed in Appendix A.

Draft 2013 VGP and sVGP

With the 2008 VGP expiration date of December 18th, 2013 approaching, there are several actions being taken to regulate commercial vessel discharges. Under current CWA regulations, the US EPA must issue a new VGP on December 19th, 2013. The draft 2013 VGP and 2013 sVGP have been made public and US EPA is in process of soliciting comments from states and maritime industry. Some states are still proposing more stringent regulations through 401 state certification. It is expected some of these new regulations will further affect the maritime industry. The USCG is also proposing a new legislation to amend the CWA and modify regulations for a uniform standard for discharges of all commercial vessels.

US EPA recently released a draft 2013 VGP and sVGP (Small Vessel General Permit) for review. The 2013 VGP regulates commercial vessels greater then 79ft and includes numerical ballast water discharge standards as well as other additional requirements. The sVGP addresses commercial vessels less than 79ft and commercial fishing vessels not carrying ballast [36, 37, 38, 39, 40].

On the other hand, the U.S. Coast Guard is proposing a new legislation to amend the Clean Water Act. This legislation is referred to as the Commercial Vessel Discharge Reform Act of 2011 (H.R. 2840). If passed, the legislation will modify regulations for discharges of all commercial vessels. The legislation includes ballast water performance standards similar to the 2013 VGP and leaves the VGP responsible for regulating other

discharges incidental to normal operations of commercial vessels. The greatest change is that the legislation will remove states authority to impose vessel discharge requirements through 401 state certifications. Even though the USCG is proposing this bill, distinct roles are set for the US EPA and USCG to work together. The content of this bill has been incorporated into the Coast Guard and Maritime Operations Act of 2011 (H.R. 2838) and was passed in the House of Representatives on November 15th, 2011. It is still waiting to be voted on in the Senate [(35)].

The significant changes of 2013 VGP include the following:

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

Of these changes, the most important is related to the ballast water.US EPA is proposing new, more stringent numeric technology-based effluent limitations applicable to vessels with ballast water tanks [(36)]. These limitations will achieve significant reductions in the spread of aquatic nuisance species (ANS). The discharge limitations are the same as IMO (International Maritime Organization) D-2 Regulations. In addition, water quality based requirement for certain vessels entering the Great Lakes are also proposed.

For non-ballast water, 2013 VGP imposes more stringent technology-based effluent limits in Best Management Practices (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 use of appropriate BMPs. US EPA has also included mandatory numeric limits for exhaust gas scrubber effluent that are consistent with IMO guidelines. US EPA is similarly 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.

The draft 2013 sVGP covers non-recreational, non-military, fishing and commercial vessels less than 79 ft and have less than 8 m^3 of ballast water. There is no need for vessel owner or operator to submit an NOI to receive permit coverage. However, the vessel owners must read and implement the sVGP requirements; sign and maintain the Permit Authorization and Record of Inspection (PARI) form onboard; and conduct quarterly visual inspections. The discharges covered in the sVGP are categorized into several broad categories. It includes non-numeric effluent limits in BMPs. States are allowed to add 401 certification requirements to the sVGP as well.

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 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 flow diagram illustrated in Figure 9 shows the outline of the protocol.

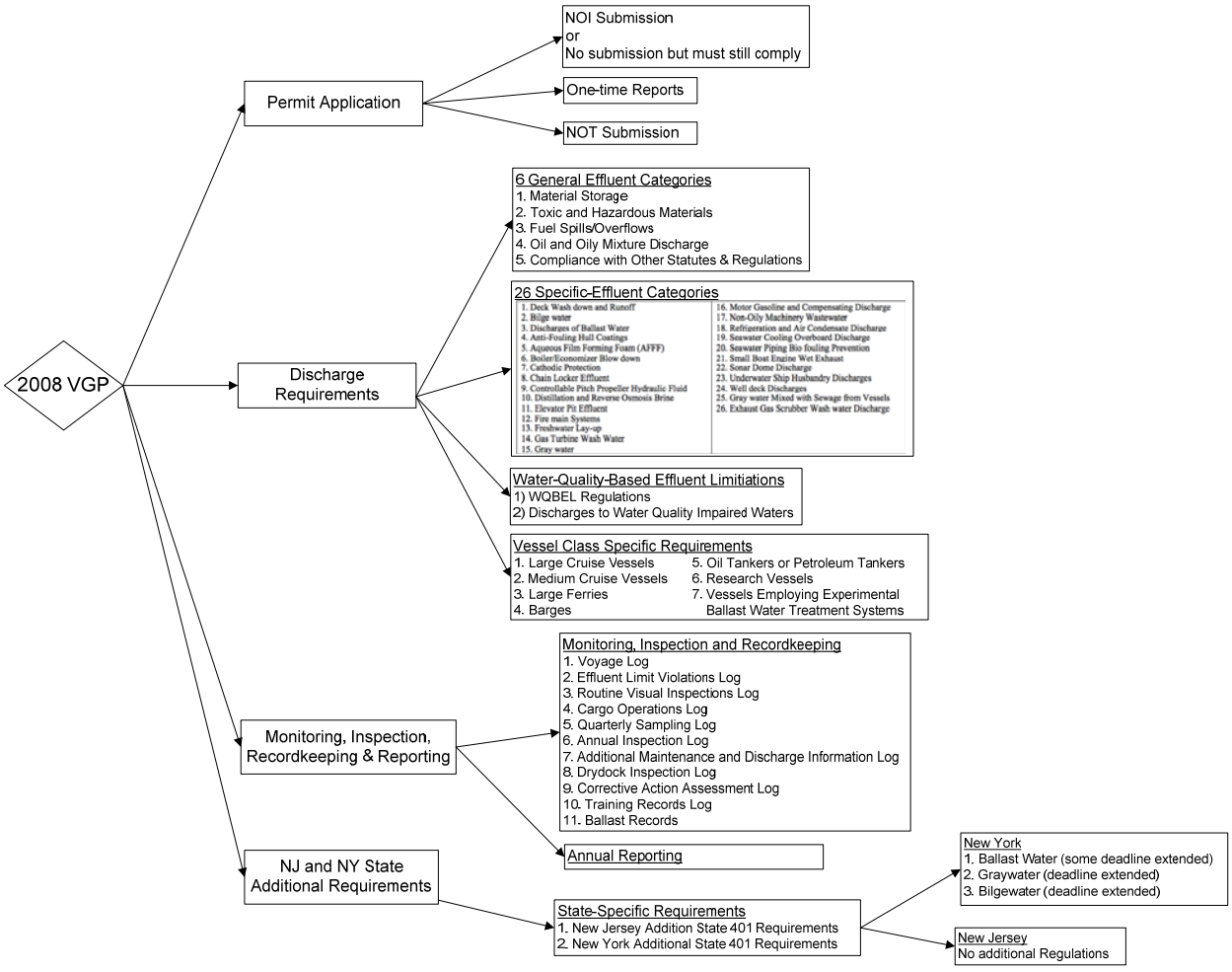

Figure 9 Flow Diagram of the 2008 VGP Protocol

A web site which contains all the VGP requirements and documents listed in the flow diagram is prepared. The home page can link to 2008 VGP, 2013 VGP and sVGP. Since 2013 VGP and sVGP have not been finalized, the content is still to be developed. To view the information or download the forms, select 2008 VGP first. Then, simply by 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 US EPA determined that it was infeasible to calculate numeric effluent limits for most discharges, and therefore used technology-based BMPs in the VGP permit with respect to discharges, except for, graywater, pool and spa discharges from cruise ships, oil discharges, including oily mixtures, and residual biocides from vessels using experimental ballast water treatment systems [(45)].

The US EPA also performed an economic assessment of the VGP, including an economic impact this permit may have on small businesses. Based on this assessment, the US EPA concluded that this permit is not likely to have a significant economic impact on a substantial number of small businesses [(45)]. The US EPA has provided both flexibility in implementing the permit and did a study, which found that the VGP has modest economic impacts on the water transportation, fishing, and mining industries [(47)].

However, the VGP is rather new. It involves the regulation of mobile sources that may travel thousands of miles from one coast to another. It encompasses the control of 26 different types of discharges, which many of them with little information regarding their characteristics or quantity of generation. It engages diversified types of vessels. The time for maritime industry to comply is too short. The flexibility with respect to discharges can also be seen for not providing sufficient protection of the US Waters. So the impact of the VGP is expected. This section will discuss the impact in four areas: government's roles, discharges handling and on-shore facilities, compliance issues, and economic impact.

Government's Role

Since the VGP is under the Clean Water Act and the CWA allows states to "certify" the federal VGP because of the specific requirements in state water quality criteria. In so doing, states can add additional requirements to the federal permit under the State 401 Rule. Because of this, the enforcement agencies are US EPA and state agencies. In concept, the enforcement can be performed through Port State Control boarding which began on March 13, 2011, or state agencies, for example California Land Commissions agent, or general public reporting pollution incidents. However, in reality, neither US EPA nor the state governments have the manpower or budget to perform the task. On February 11, 2011, the USCG and US EPA signed a Memorandum of Understanding (MOU) to better coordinate efforts to implement and enforce VGP requirements for vessels. However, the US EPA is the agency primarily charged with making the determination of whether a permit condition has been violated. The USCG can only

board and inspect the vessel, but does not the authority to take action if a violation is found. The results of the inspection are submitted to US EPA to take action.

On the other side, many states share waters between 2 or more states. When one state poses more stringent 401 state requirements, neighboring state(s) will be affected. For example, eight states have shoreline along the Great Lakes and 6 of which have different additional 401 certifications. New York is one of them and is proposing all vessels entering the Great Lakes through the St. Lawrence Seaway to comply with the strict New York additional state requirements. These additional requirements in New York would also affect New Jersey. State agencies, such as NJ DOT and NJ DEP (Department of Environmental Protection) should collaborate with the neighboring states such as New York in new 401 certifications.

Discharges Handling and Onshore Facilities

If the controlled water cannot be discharged directly, it will need an onboard storage or treatment facility. If a vessel has an onboard holding tank but no treatment facility, then shore-based facilities for transport, storage, and treatment of the discharge will be required.

Installation of onboard holding tanks may itself be a challenge. Many vessels have very little room or no room at all for such holding tanks. Furthermore, problems arise with the design and installation of onboard holding tanks because the volumes and pollutant concentrations for many of the 26 discharges are not well-studied. Also, due to the different characteristics of the discharges, it may not be a good idea to store or treat different types of water in one tank.

On-shore transport facilities consist of pipes, pipe fittings, and pumps. Currently, the existing pump-out facilities are for sewage generated from recreational vessels only and it is discussed in detail in section “Existing Condition for Recreation Vessels”.

Other than sewage pump-out facilities, very few land based treatment facility exist. One of the very few, the Valdez Marine Terminal in Alaska is for ballast water treatment. Prior to concerns of invasive species, the major concern with ballast water was the discharge of hydrocarbons and other chemicals in ballast water from the petroleum and chemical industry. That facility is designed for hydrocarbon removal and not for the removal of living organisms. Some existing ports are actively considering building ballast water treatment facilities [(5)]. However, it will be costly to build these facilities and it will take some time before they will be available for use. In addition, some facilities for the land-based treatment of bilgewater exist, such as that of the Staten Island Ferry (SIF). The SIF has removed oily water separators from their ferry vessels and instead collects the bilge and oily water for discharge and treatment while docked.

In addition, logistic issues are to be considered. There are limitations on space at many ports for the construction and operation of on-shore facilities. Additionally, various

vessels do not have standard sized fittings or standards to follow so they may not be capable of delivering ballast water or other discharges to land-based facilities. Also, even if onshore facility is available, will this facility be able to accept all kinds of discharges or only certain types of discharge? Will this facility be approved or certified by the US EPA or USCG? How will the service be charged?

Even the US EPA noted that land-based treatment alone cannot be the only answer, as there are several instances where vessels must discharge ballast water while underway, such as discharging ballast water taken up while underway to clear low bridges or discharging ballast water to clear sand bars or while operating in shallow draft channels [44].

Compliance Issues

It is mentioned earlier that one of the VGP effluent limits is a Water Quality-Based effluent limit. Since states set the state water quality standards, the standards will also apply within state waters. Water quality standards are based on the water usage, i.e. navigation, recreation, fishing, and drinking, which means Water Quality standards may be different in different sections of the river or a coast. However, the permit is not clear about these distinctions. When a vessel travels from one section of the river to another or from one coast to another, would the VGP allow a ship discharge to be different? How does a vessel adapt to different effluent limits?

The VGP requires vessels to carry out a number of actions, including weekly, annual, and dry-dock inspections, quarterly testing of waste streams, extensive record-keeping, training, and disciplinary actions. However, the "effluent limits" imposed by the VGP can only be applicable to discharges made within the three-mile territorial sea. Because most foreign-flag ships (37.92% are foreign-own in NOI database), and those U.S. flag ships engaged in foreign trade, are only in U.S. waters a limited number of days each year, the VGP, and by extension the BMP's required by the VGP, will not be applicable for most of their operations. However, as some commenters' noted, BMP's onboard ships can be difficult to turn "on" and "off." Moreover, whether the inspection requirements, the record keeping, and report provisions should only be performed and maintained with respect to vessel operations within the navigable waters of the United States is not clear [50].

Economic Impact

The US EPA performed an economic assessment of the VGP. Based on this assessment, US EPA concludes that this permit is not likely to have a significant economic impact on a small business [47]. The US EPA reports, depending upon vessel type, median costs per firm range from $1 to $795 in the low-end assumptions and from $5 to $1,967 in the high-end assumptions [45]. However, with such low figures, these numbers could be just for activities that relate to compliance of the VGP with respect to inspection, bookkeeping, and report filing. It would not cover other cost such as installation of an onboard holding tank or a treatment device.

Table 3 shows that 24,468 out of 30,658 barges (80%), in addition to more than 50% of ferry and commercial fishing vessels with ballast water, have no onboard treatment facilities. These vessels will need to modify their existing systems or install onboard holding tanks or treatment devices, since most of them only operate in harbors or rivers. Even if it is feasible to do so, a small company may need to seek outside help for technical support and finance due to costs that may be beyond the range discussed above.

The maritime industry is generally unfamiliar with compliance and documentation requirements established by the US EPA for CWA general permits. Accordingly, vessel managers/operators will need to review and understand the various types of discharges covered under the VGP. It will also be necessary to train staff who will have responsibility for managing these regulated discharges and maintaining the required paperwork to document compliance. Training is very critical. Within the maritime industry it is common to structure employee work periods on a rotational basis. Those that are working are, in most cases, dispersed over a broad area on various vessels. Employee training in the maritime industry is logistically difficult at best; to train all affected employees in permit requirements is often difficult to accomplish in a short period of time [45].

When the Clean Water Act was promulgated in 1972, it also provided a construction grants program. This program funded the construction of sewage treatment plants. Many of the POTWs in use today were built during that period. However, even with the shortage of on-shore VGP supporting facilities, there is no such construction grant available. With the present state financial conditions, it is unlikely that any state will provide financial support to build these facilities. In a planning study, the capital costs of the feasible on-shore collection and treatment alternatives ranged from $1.3 million to $6.6 million [5]. If an on-shore facility is needed, who will foot the bill?

The current VGP expires on December 19, 2013. The US EPA already proposed 2013 new VGP which includes numeric concentration-based effluent limits for ballast water discharges. This means funding will be needed for onboard treatment devices or on-shore treatment facilities. It also means more studies will be required regarding the efficacy of the treatment devises and ballast water management.

CONCLUSIONS AND RECOMMENDATIONS

Conclusions

Based on the work conducted, conclusions can be made in support of the study objectives in four general parts of concern; VGP requirements, data analyses, pump-out facilities, and 2013 VGPs and sVGP.

VGP Requirements:

- The VGP regulates discharges from vessels in terms of three effluent limits: general effluent; 26 specific discharge streams; and water-quality based limits.
- The VGP requirement generally expresses Best Management Practices (BMPs).
- Under the Clean Water Act, states can add additional requirements related to local water quality to the federal permit.
- New Jersey does not have additional state regulations for discharges under the VGP at the present time.
- New York initially introduced 5 conditions to their 2008 VGP certification. However the NYDEC has issued a letter granting extensions for Conditions 2, 3, 4 and 5 for all vessels to the end of the 2008 VGP term (midnight Dec 19, 2013). The extension applies to the compliance deadline for ballast water discharge standards for new and existing vessels, graywater discharge prohibition, and bilgewater discharge prohibition.
- US EPA and state agency are the enforcement agencies, but USCG would conduct vessel onboard inspection.

Data Analyses:

- 57,173 vessels filed NOI in 8 types of vessels. 16,950 vessels have some sort of onboard treatment facility.
- Approximately, 3000 to 4000 commercial vessels arrive in New Jersey annually.
- There are over 200 ports or waterway facilities in New Jersey that have a berth of 79 ft or greater. These facilities can be classified into 5 regions based on the waterway. The busiest region is Ports on NY-NJ Harbor and Kill Van Kull.

Pump-out Facilities:

- Many vessels do not have room for on-board treatment facility or holding tank for graywater or other types of discharge.
- Methods for estimating graywater generation vessels are proposed in this report.
- Only 170 pump-out facilities for recreation vessel sewage exist in New Jersey. The capacity would not be enough for other types of discharges such as graywater. Operations and logistics will also be problems.
- There are no onshore graywater or ballast water storage and treatment facilities in New Jersey.
- No federal funded programs are available at the present time for the VGP regulation.

- Cost analysis on discharge land handling facilities such as discharge collection, transport, storage and treatment was performed in this report. The cost is very site specific and is related to the type of discharge. A unit cost analysis was conducted based on handling graywater.
- The US EPA economic assessment report, depending upon vessel type, could be just for activities regarding to the compliance of the VGP with respect to inspection, bookkeeping, and report filing. It would not cover other cost such as installation of an onboard holding tank or a treatment device.

New 2013 VGP and 2013 sVGP Regulations:

- The draft 2013 VGP and 2013 sVGP have been made public and US EPA is in process of soliciting comments from states and maritime industry. The 2013 VGP covers non-recreational, non-military commercial vessels greater than 79 ft within 3 nm limits. Vessels less than 79ft can seek coverage under the permit or sVGP.
- The proposed 2013 VGP New York state certifications indicate that there will be no graywater discharge prohibition, but the bilgewater discharge prohibition is still being proposed.
- US EPA is proposing new, more stringent numeric technology-based effluent limitations applicable to vessels with ballast water tanks.
- The VGP will affect New Jersey in four areas: government's roles, discharges handling and on-shore facilities, compliance issues, and economic impact.

Recommendations

In terms of what New Jersey needs to do to be prepared, these can be summarized and recommended below:

- Under the 2008 VGP, non-recreational, non-military, commercial vessels greater than 79 ft operating in US Waters and within 3 nautical miles of the shoreline, will need to have an NPDES permits for discharges
- Primarily, the 2008 VGP relies on self-monitoring, self-inspections, and self-reporting of violations so vessel owner/operators need to be aware of these requirements.
- The 2008 VGP sets forth various monitoring, inspection, and recording procedures. Vessels are required to conduct and log routine self-inspections and monitoring of all areas of the vessel that the permit encompasses every voyage, week, quarter, year or at dry dock. There are also several actions required in cases of non-compliance. These records must be kept on the vessel for a period of 3 years.
- The VGP also requires Annual Reporting to report instance of non-compliance and a One-time Report that must be completed by vessel owner/operators between 30 months and 36 months after obtaining permit coverage.
- Since New Jersey and New York have removed their 2008 VGP additional state regulations on banning graywater discharge and their 2013 VGP proposed state certifications indicate no additional requirements on graywater, vessels will not

have to install holding tanks for graywater and onshore graywater pump-out facilities will not be required.

- New York is still proposing to ban bilgewater discharges, which would require the storage of treated or untreated bilgewater while in New York waters.
- US EPA has proposed to mandate numeric limits for exhaust gas scrubber effluent that are consistent with IMO guidelines.
- US EPA also proposed numeric ballast water discharge standards applicable to vessels with ballast water tanks in the 2013 VGP. These discharge limitations are the same as IMO (International Maritime Organization) D-2 Regulations. Vessels will require ballast water treatment systems (starting in 2014 for certain vessels) or other methods of compliance.
- Vessels can also comply to ballast water discharge standards by using public drinking water as ballast, using onshore pump-out facilities, or not discharging at all. Therefore ports may need pump-out and/or treatment facilities to handle the discharge but onshore facilities are not the only solution.
- Since there is no existing ballast water handling facility in New Jersey, a funded program for storage and treatment facilities should be planned, if onshore facilities are determined to be needed. It is recommended that further investigation be conducted to determine appropriate sources of funding for the infrastructure.
- Logistic issues are to be considered. There are limitations on space at many ports for the construction and operation of on-shore facilities. Additionally, various vessels do not have standard sized fittings or standards to follow so they may not be capable of delivering ballast water to land-based facilities. Even if onshore facilities are available certain issues need to be addressed such as: Will this facility be approved or certified by the US EPA, USCG, or a state agency? Where are the best locations for pump-out? Should mobile barges be used to pump-out? How will the service be charged? What should be considered in the areas of safety, security, and staff?
- State agencies should collaborate with the neighboring state agencies in their new 401 certifications in the future.
- A VGP Stakeholder committee formed during this study consists of members from NJDOT, NJDEP, USCG, NJDEP, NYSDEC, and representatives from the maritime industry. Meetings were held to discuss the VGP challenge issues, exchange information, and resolve problems encountered. Such a committee and its function should be maintained to facilitate the communication among various government agencies and the shipping industry.

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APPENDIX A - COST ANALYSIS

It is mentioned in the manuscript, cost analysis is site specific and related to the type of discharge. Unit cost analysis is provided and graywater is used as an example. The cost estimate should also include the cost of land, which is related to the location of the infrastructure and the real-estate market at the time of purchase. The design and construction of an infrastructure should consider future expansion.

Pump-Out Cost

As discussed previously, graywater generation varies depending on the type of vessel, trip duration and passengers. The discharge and capture of graywater must be completed within the shortest possible time so as to not interfere with vessel operations. Ideally the pumpout would take place during loading or unloading of passengers or cargo. Washington State governs recreational pump-out stations to lift sewage at a rate not less than 15 gallons per minute[49]. Table A1 shows that a storage tank of 200 gallons can be emptied in about 13 minutes at a flow rate of 15 gpm. The time to empty the tank is proportional to the volume of graywater and the design flow rate. Actual discharge times will be larger then shown in Table A1, due the time needed to make connections from the tank to the pumpout. If more than one storage tank needs to be emptied, then it will take more time to empty as well as additional time to make connections.

Table A1 Comparison of Time to Empty Different Volumes of Graywater at Different Design Flows

Flow Rate (gpm)	Graywater Volume (gal)	Time to Empty (min.)
15	200	13.33
15	400	26.67
15	800	53.33
30	200	6.67
30	400	13.33
30	800	26.67

Collection

Pumping

Graywater collection from the holding tank to pump-out station will be similar to sewage pump-out since the holding tanks are made to conform to Type III MSD's industry standards. The graywater can be pumped from a portable pump or fixed pump. The cost of a 15 – 30 gpm pump is $500-$600 [24].

Piping

The unit construction cost of 4" diameter PVC piping is $110 per lineal foot (Brown and Caldwell, 2007). The total cost of piping includes costs of pipe racks, pier connections, 25% contingency on construction costs and 30% of those costs for technical services.

Barge or Pump-out Vessel

A barge costs about $200,000 - $500,000 depending on the features and age of the barge, plus an additional $10,000 per tugboat movement (Brown and Caldwell, 2007).

Some ports may only receive small quantities of graywater, such that a small barge or a pumpout vessel may be more economical. Pump-out vessels are available from Marine Boatbuilder Company. The company offers 5 different sizes of boats: 19', 20', 23', 26' and 31' in length. Table A2 shows the prices and storage capacity of these boats.

Table A2 Pump-out Boats Prices

Length of Boat	Storage Capacity	Price
19 feet	240 gallons	$60,000
23 feet	420 gallons	$85,000
31 feet	1,000 gallons	$150,000

Truck

If a piping system to pumpout sewage or graywater is not available at the port or it is economically or technically infeasible, then an alternative would be to use a truck to transport graywater to a treatment facility. A typical waste hauling truck has an individual capacity of 5,000 gallons (Brown and Caldwell, 2007). With the high capacity, the truck would be able to make several collections before having to transport graywater to a nearby location for treatment.

Storage Facility

If ports have sewer systems, they can pump directly to a POTW. If no sewer system is available then a storage tank is required to collect graywater and transport from storage tank to POTW. Prefabricated storage tanks have been used for different usage, such as water storage. Table A3 shows the cost for above ground steel water storage tanks.

Table A3 Steel Water Storage Tank Prices [24]

Capacity	Price
100,000 gallons	$137,000
250,000 gallons	$145,373
500,000 gallons	$221,777
1,000,000 gallons	$403,964

Pump-Out Station

Table A4 Costs of Constructing Pump-out Station [5, 24]

Items	Cost per Unit	Description
Pumping Equipment	$500 - $600	15 – 30 gpm pump
Holding Tank	$137,000 – $403,000	Steal water tank (onshore) 100,000 gallons to 1,000,000 gallons
Lift Station	$185,600	200,000 gpd sewage lift station
Grinder Pump	$1,725	18 gpm at 60psi, 150 gal tank grinder pump
Back Flow Prevention Device	$1,871	Flanged domestic water backflow preventer: 4” pipe size and gated valves.
Construction Work	(see description)	Will vary based on the amount of construction work required. Charged on a case by case basis or percent of total cost of project.
PVC Piping from Holding Tank to Pumpout Station	$110 per lineal foot	4” PVC Pipe includes costs of pipe racks, pier connections, 25% contingency on construction costs and 30% of those costs for technical services.
PVC Piping from Pumpout Station to Sewer Hook Up	$110 per lineal foot	4” PVC Pipe includes costs of pipe racks, pier connections, 25% contingency on construction costs and 30% of those costs for technical services.
Electrical Wiring and Supplies for Power	(see description)	Prices for electrical wiring vary depending on the type and length of wiring, outlet fittings, and specific facility conditions.
Labor	(see description)	Labor varies depending on the specific facility conditions and type of work such as installation of equipment, plumbing, construction or electrical work
Cost to allow Municipal Sewage Treatment Plant to accept Graywater	(see description)	Depends on the location of treatment facility, the degree of treatment required, extra piping required to connect to treatment facility, and local regulations.

Permitting	(see description)	Fees depend on states
Engineering Work	(see description)	Will vary based on the engineering work required. Charged on a case by case basis or percent of total cost of project.
Barge	$200,000 - $500,000	1.7 MG Barge, plus $10,000 per tug movement
Pumpout Vessel	$60,000 - $150,000	240 – 1,000 gallon capacity