Executive Summary

Commercial marine transportation on Narragansett Bay relies on an infrastructure that consists of two channels and three public ports. The two channels are the Providence River Channel and the Quonset/Davisville channel. Currently, the Port of Providence is more active than the ports of Fall River or Quonset/Davisville. This scenario may change in the future depending on the outcome of two proposed marine infrastructure projects, the maintenance dredging of the Providence River Channel and the development of a container port at Quonset/Davisville.

Like any terrestrial infrastructure, marine infrastructure needs to be maintained. In order to maintain the navigation depth of channels, which are the highways of the marine transportation sector, accumulated sediments must be removed by dredging. Dredged material can be disposed of in many ways. Very little dredging has been done in Rhode Island in the past 20 years due to the absence of any approved state or federal disposal sites.

Today, the majority of the commercial vessels that travel via the channels to the ports in Narragansett Bay are carrying petroleum products. In 1997 for example, 86% of the total cargo tonnage that moved through the bay consisted of petroleum products.

The oil that is delivered is carried mostly by non-self-propelled vessels (barges). This may be in part a result of the limited access of deep draft vessels (over 35 feet of draft) to the Port of Providence due to shoaling of the channel and associated traffic restrictions.

Not all of the vessels are carrying petroleum products. Some are transporting people, either on cruise ships or ferries. The number of cruise ships entering Rhode Island waters (almost exclusively with the port of Newport as a destination) has increased since 1994. There are several ferry services in operation on Narragansett Bay. Recently, there appears to be an increased interest in commuting by ferry as evidenced by the new Providence/Pawtucket and Newport/Providence routes.

The movement of commercial vessels on the Bay is managed by the Northeast Marine Pilots and the Coast Guard. In addition to the physical aids to navigation, technological improvements to the information handling infrastructure are changing the way vessel traffic is managed. New systems such as Universal Automatic Identification Systems are available. Pilots are using Global Positioning Systems (GPS) to navigate large ships through the Bay. A PORTS (Physical Oceanographic Real Time System) which provides real time tide, current and weather data is being installed. These and other technologies will enhance the safety of commercial and recreational vessel traffic.

The economic impact of the marine transportation industry on Narragansett Bay is driven by consumer demand for petroleum products for home and office heating and construction material for roads. Economic benefits include lower costs for oil and gas, employment for individuals and profits to businesses. The cruise ships that come to Narragansett Bay also bring economic benefit as part of the tourist industry.

As part of the analysis of maintenance and/or improvements to the marine transportation infrastructure in Rhode Island, the economic costs and benefits need to be considered. Two aspects of the economic impact of the maintenance dredging of the Providence River Channel are the cost due to losses in the fishing industry as a result of the disposal of the material and the benefit to consumers of cost savings on petroleum products derived from the elimination of the need for lightering.

Any analysis of a marine transportation project would also need to include the environmental costs and benefits. Environmental impacts include the impacts of any associated dredging and disposal of dredged material, port and terminal operations and the activities of ships. Oil spills which are accidental releases from petroleum carrying vessels, can cause significant environmental damage. There have been two major oil spills in Rhode Island waters, one in 1989 and the other in 1996. Another accidental release from ships which is initially imperceptible but is capable of causing lasting environmental damage is the introduction of nonindigenous invasive marine species.

At this time, the people of the state of Rhode Island are considering two large-scale marine transportation projects which should serve as a catalyst for decision makers to take a comprehensive look at the need for marine infrastructure. Existing regulations, plans and data sources should be integrated and in some cases supplemented to allow for a regional and watershed level management approach.

I. The Marine Infrastructure that Supports Commercial Marine Transportation

Secretary of Transportation Rodney E. Slater has made revitalization of the nation's Marine Transportation System (MTS) a matter of high priority. Recognizing the challenges of increasing use of our waterways, growing world population and demand for goods, and the increasing globalization of the world economy facing the marine portion of the nation's transportation system, Secretary Slater began the MTS initiative. The goal of this initiative is "to ensure that our Nation's waterways, ports and their intermodal connections will meet the needs of the 21st century by providing a safe and environmentally sound world-class system that improves the Nation's global competitiveness and security through improving coordination and cooperation among all stakeholders." (Proceedings of the National Conference on the Marine Transportation System: Waterways, Ports and their Intermodal Connections, Nov 1998)

The physical and information-handling infrastructure that supports our MTS must be maintained and upgraded to respond to changes in vessel design, technology, and trade patterns. (The information-handling infrastructure will be discussed below under vessel traffic management.) The MTS report projects a growth of world trade by at least 200% by the year 2020. In addition, the average vessel size is expected to increase. The U.S. system needs to be accessible to these vessels.

Most vessels travelling through Narragansett Bay are destined for one of the three principal public ports: (1) the Port of Providence; (2) the Port of Fall River; and (3) the Port of Quonset/Davisville. Several smaller, privately-operated facilities also exist in the harbors of the region, mainly for the receipt of refined petroleum products.

There are two channels in Narragansett Bay. One goes to the port of Providence and the second goes to Quonset/Davisville (Figure 1). The Providence River channel is 6.8 miles (27 kilometer) long. It begins near the head of Providence Harbor and follows the river on a southerly course to deep water near Prudence Island (Figure 1). The upper two and one-half miles comprise the Main Harbor. Providence River and Harbor together constitute the principal commercial waterway in Rhode Island.

The Providence River channel is authorized to be maintained at 40 feet below Mean Low Water. However, the shoaling that has occurred since 1976 has resulted in a controlling depth of 30 feet below Mean Low Water. The Coast Guard has also restricted the former two-way traffic to one-way traffic in the upper channel. The channel into Quonset is currently 32-35 feet deep, and into Davisville 28-30 feet deep.

II. Maintenance of Marine Infrastructure: Dredging

1. Introduction

An essential aspect of marine transportation in any enclosed waterway (such as Narragansett Bay) is the need for adequate water depth to permit safe passage of vessels. In most areas of the northeastern United States this requires periodic dredging of shipping channels to a federally-authorized depth. Narragansett Bay has a federal channel, commercial berths at piers and numerous marinas and harbors for small commercial and recreational vessels. If commercial ports are part of the future of the Bay, additional water depth may be required to permit passage of larger vessels.

2. Definition of Dredging

Dredging is the removal of sediments from waterways to maintain navigation depth. As rain washes soil from hillsides, farmland, backyards and city streets, it finds its way through streams and rivers into harbors and Narragansett Bay. Each year the sediment carried into the Bay settles into the channels, berth areas and marinas and decreases the water depth. Some parts of the Bay are naturally scoured or very deep, but many parts of the channel fill in until they reach the level of the surrounding sediment. In most cases the shipping channels have been artificially deepened to permit passage of sailboats and larger vessels (tankers, container ships, bulk cargo ships).

Dredging requires the physical removal of accumulated sediment through the use of dredging equipment. In most cases this involves sending a clamshell bucket to the Bay floor and lifting a mixture of sediment and water into a barge. The barge is towed to a location where the dredged material can be safely placed outside of the channel (another area of the seafloor, on land, or into a diked containment area). In some cases (e.g. breachways), the sediment may be removed with a hydraulic dredge and pumped onto a beach or into a barge.

3. Dredged Material

Dredged material is the mixture of water and sediments such as rock, gravel, sand and mud removed from the Bay floor. It can contain organic material (decomposing plant and animal remains), and material discarded by humans (bottles, shopping carts). Among the materials discarded by humans are contaminants carried in runoff and discharged directly into the Bay (oil, metal wastes, fertilizer.

A determination must be made of the risk to human and ecosystem health associated with the material proposed for dredging. In general dredged materials are classified as Suitable (for unconfined open ocean disposal) or Unsuitable. This determination is made by the U.S. Army Corps of Engineers in consultation with U.S. Environmental Protection Agency based on sediment chemistry and biological effects testing. Unsuitable sediments must be isolated from the marine ecosystem. If they are disposed on land, they must pass regulations for waste disposal and be isolated from groundwater discharge.

While some sediments may have contaminants, these sediments are not sludge, hazardous waste, or spoil. Sludge is an industrial product that collects in settlement tanks or ponds (e.g. sewage, metal processing). Hazardous waste is a classification of materials (liquids, soils, sediments) that are directly hazardous to human health and they are treated by a different set of procedures and laws. Spoil is an archaic term applied to the materials discarded from mines and dredging operations. It applies to the unregulated dumping of salt-laden sediments or acidic soils on agricultural or marshlands, rendering them "spoiled" for further use.

4. Disposal of dredged materials

The disposal of dredged materials is regulated by state and federal agencies under a number of laws and regulations. Determination of a disposal alternative is made on a project specific basis. There are five broad groupings of disposal options. The five categories and their potential use in Rhode Island are:

- Beneficial Use: If materials are coarse-grained (sand) they may be used for beach nourishment or construction fill. With treatment, remediation of contaminated land areas may be possible. Outside of the coastal ponds, very little of the materials from Narragansett Bay meet these criteria.
- Treatment Technologies: A wide variety of technologies can be used to remove or stabilize the contaminants, organic load, and salt content of the marine sediments. After treatment the by-products might be suitable for construction fill or landfill cover. While promising, these technologies are relatively expensive and most are designed for small-scale application to highly contaminated soils. An exception is if a large-scale process can be developed adjacent to a large-scale infrastructure project . For example, the contaminated sediments from New York Harbor are treated and used to create concrete for use in construction. All treatment technologies require large vacant land areas near the shore to dewater the sediment and process. To date, no available land areas have been identified in Rhode Island.
- Upland disposal: Where land is available (closed landfills, quarries, vacant lots), dewatered sediment can be contained on land behind berms with controls for groundwater contact. This approach requires dewatering sites near the water and truck transportation of materials to the site. Rhode Island has a small number of suitable sites but no identified dewatering capacity at present.
- Aquatic disposal: Dredged materials are barged directly to an aquatic disposal site and placed on the seafloor by opening the barge and letting the materials fall to the bottom. If unsuitable materials are permitted for disposal they are placed on the bottom and covered with a layer of clean material in a process known as capping. This process forms a low mound on the seafloor which can be monitored for impacts (SAIC 1995). Aquatic disposal of suitable sediments is currently being considered by the Army Corps of Engineers (ACOE) for disposal of material from the Providence River Channel.
- Aquatic CAD cells: A new approach involves opening a pit in the channel or harbor (the majority of the material removed from deep in the pit predates the production of contaminants), filling the pit with unsuitable sediments and capping the pit with clean sediments. This approach is called Confined Aquatic Disposal (CAD) in cells. This approach is under consideration for disposal of the unsuitable material from the Providence River Channel dredging project.

5. The need for dredging in Rhode Island

The primary dredging needs in Narragansett Bay and Rhode Island are: the federal navigation channel to Providence currently authorized to be maintained at a depth of 40 feet; harbors within the Bay, private marinas, and the breachways into coastal ponds. There remains the possibility that a deeper channel might be required leading to Quonset Point depending on details of development (container port, carrier museum, industrial park). The federal channel to Providence has not been dredged since 1976 and has shoaled (filled-in) significantly (between 3 and 10 feet of fill, ACOE 1998). Harbors with federal channels that may require dredging include: Block Island, Newport, Wickford, Sakonnet, Warwick Cove, Apponaug, Greenwich Bay, Bullocks Cove, Seekonk, Pawtuxet Cove, Potowomut River, Pt. Judith, Pawcatuck River, Little Narragansett Bay and Watch Hill Cove.

Table 1. Estimated requirements for dredging (as of Year 2000)

	Suitable for unconfined disposal	Unsuitable for unconfined disposal
Federal channel	4.7 million cubic yards*	1.2 million cubic yards
Harbors	2.7 million cubic yards	? unknown breakdown
Marinas and Ports	700,000 cubic yards	600,000 cubic yards
Breachways**	30,000 cubic yards per year	

* includes 1.6 million cyds removed from a confined aquatic disposal cell to permit isolation of unsuitable material

**Breachways and their associated flood tidal deltas will be part of a more extensive (and expensive) habitat restoration project in South County within the next few years. However the breachways need to be maintained on a regular basis and would form an essential part of a dredged material management plan. In most cases the breachway dredging should be able to provide beach nourishment material and serve as a beneficial use.

6. Managing dredging in Rhode

The Coastal Resources Management Council (CRMC) is the lead agency for with the responsibility for managing dredging and disposal in Rhode Island. They are charged with developing a dredged material management plan for the state and designating sites for disposal of clean sediments from marinas and yacht clubs. The Department of Environmental Management conducts Clean Water Act review of permits and ensures that water quality standards are not violated during dredging or disposal. The U.S. Army Corps of Engineers New England District issues permits for dredging and disposal in the Bay and is responsible for maintaining federal navigation channels. The U.S. Environmental Protection Agency (USEPA) reviews permits for dredging and disposal in the Bay and would be the lead agency for designating any offshore disposal sites in Rhode Island Sound. The U.S. Fish and Wildlife Service and the National Marine Fisheries Service reviews permits for dredging and disposal in the in relation to endangered species and fish and wildlife resources.

III. Waterborne Transport: A Description of What Moves on Narragansett Bay

1. Introduction

In this section, our focus is on commercial marine transportation. Hence, fishing boats, pleasure craft, and military vessels will not be discussed. The most readily available shipping data is for the Providence River and Harbor, and our discussion emphasizes this area. We note, however, that vessels periodically visit Quonset Point/Davisville to deliver automobiles and for fish loading, and vessels also pass through the Bay to service Brayton Point and Fall River in Massachusetts. We believe that the information described herein reasonably captures Rhode Island marine transportation activity on Narragansett Bay. Nevertheless, we recognize that our omission of data for Fall River, Brayton Point, and Quonset/Davisville understates total vessel activity on the Bay.

2. Cargo Traffic

An analysis of cargo movements on Narragansett Bay was done. It relies on data supplied by the U.S. Army Corps of Engineers' Waterborne Cargo Statistics. Data for harbor areas provided by the Corps includes the combined traffic at both public and private terminals, and are reported in thousands of short tons (2,000 lbs.)

Review of the data for the Providence River and Harbor suggests several trends:

A. Marine transportation on Narragansett Bay primarily involves delivery of petroleum products, especially gasoline and distillate fuel.

Of the 8,780 thousand metric tons of cargo delivered in 1997, fully 86 % by volume was petroleum or petroleum products (Figure 2). Of these cargoes, 60 % was gasoline and 28 % distillate fuel. Crude materials and primary manufactured products (e.g., cement, chemicals, preformed steel, lumber, asphalt, and bulk salt) made up 13 % of the volume

B. Vessel traffic on the Bay has steadily declined over the past two decades, although cargo tonnage has increased.

The number of inbound and outbound trips in the Providence River and Harbor fell from 5,614 in 1980 to 2,893 in 1997 (Figure 3). With the exception of 1991 – 1993, the decline in vessel traffic has been continuous, with a smoothed rate of decline of about 3 percent from 1980 to 1997. Over the same period, however, cargo movement through the Bay has increased from 7.5 million tons in 1980 to 8.8 million tons in 1997, a smoothed annual increase of about 1 % (Figure 4).

C. Most of the vessels using the Bay are domestic, non-self propelled tankers

In 1997, most of the vessels inbound to Providence River and Harbor were tankers (39 %) and tug and tow vessels (42 %). Most tankers (77 %) were non-self-propelled (i.e., they were barges). Only 5 % were non-self propelled dry cargo vessels. Most inbound vessels are domestic, reflecting the fact that the vast share of petroleum and petroleum product comes from domestic sources, and by law, coastwise shipments must be carried on domestic vessels.

D. Access by deep-draft vessels to the Providence River and Harbor is limited and has diminished with the decrease in depth and width of the federal channel.

Sediment buildup since the last major dredging project in 1976 generally limits access to vessels with a draft of less than 35 feet. In 1988, for example, some 80 vessels with a draft of over 35 feet visited the Providence River and Harbor; in 1997 that number was about 25.

Due to depth limits, deep-draft tankers (up to about 50 feet) must lighter onto smaller vessels before entering the Bay, light load (i.e., carry less than full loads), or await a high tide in order to meet bottom draft limits. Deliveries on deep-draft vessels (>35 feet) have diminished over time, and most vessels now using the Providence River and Harbor have shallow drafts (73 % < 18 feet in 1997).

3. Passenger/Cruise Ship Traffic

Two ports, Newport and Providence, have historically served as ports-of-call to large cruise ships entering Narragansett Bay. Newport is the primary port for cruise ships, since it is a destination site well known for the mansions and other historical sites. In the recent past few ships have visited Providence.

Twenty three different cruise ships greater than 100 dwt (deadweight tons) came to Narragansett Bay from 1992 to 1999. Overall, cruise ship activity has been growing since 1994. In the period under study there were a total of 230 port visits. The depths of water in the channel of lower Narragansett Bay are sufficiently deep to allow all cruise ships in service to enter the Bay, and anchor at Newport. However, if in the future it becomes necessary to accommodate cruise ships at berths constructed at other sites (for example at Providence), then minor dredging might have to be undertaken.

4. Passenger/Ferry Traffic

There are several year-round several ferry services in Rhode Island waters. Such services are provided to Block Island and Connecticut, with several vessels departing from Point Judith. Another service connects Bristol with Hog and Prudence Islands. A ferry service will begin in the summer of 2000 between Providence and Newport. Last year a ferry/ commuter service was inaugurated between Pawtucket and Providence with two 49-passenger ferries, which also provide tour cruises daily in off-peak hours and on weekends.

There are currently three existing water taxi operations on the Bay. A service is provided in the northern reaches of Narragansett Bay, with two boats. Within Newport Harbor, one firm has several water taxis available. And small ferry/water taxi service connects Jamestown with Newport. In addition, next summer, a nonprofit organization hopes to offer service in the Newport Harbor Area.

Many metropolitan areas throughout the United States are experiencing a resurgence in interest in passenger water transportation. Two factors that have accelerated the implementation of ferry plans are the increase in waterfront real estate development in urban areas and the inclusion of obsolete or underutilized maritime transport facilities in development plans. Additionally, highways have become increasingly crowded. The potential for the provision of new ferry services on Narragansett Bay into the 21st century will be dependent on future studies identifying passenger transport demand.

IV. Vessel Traffic Management

All large vessels are required to have a pilot aboard while transiting inland waters such as Narragansett Bay. Vessels that are US flag and are trading between US ports may hire either a federally licensed pilot, or a state licensed pilot. Foreign flag vessels are required to take a RI State licensed pilot in RI waters. Tugs and barges carrying over 1000 gross tons of petroleum are required to take a pilot until the tug operator has completed 12 round trips to the port and back.

When a vessel is scheduled for a port call, the owner (or operator) calls their nearest preferred ship agent, who arranges for the pilot. The Northeast Marine Pilot office in Newport provides the pilots for vessels using Narragansett Bay. As a result of this process, the pilot office is a clearing house for information regarding the arrival & sailing times of vessels in RI waters. (The exception is tug and barges who no longer need a pilot). Due to a limited number of tugs, one way traffic in the Providence River, and other factors (tides, weather, daylight, etc.), the pilot office and the pilots assigned to the vessels, coordinate vessel traffic.

During the five year period from January 1, 1995 through December 31, 1999 there were 4094 vessel movements within Rhode Island waters with a Northeast Pilot aboard. Most of these vessels were ships and a small percentage were barges. Of these, 3057 vessel movements were destined for a Rhode Island port and 1037 for a Massachusetts port.

The state of Rhode Island has recently advanced technological safety by purchasing several Global Positioning System (GPS) capable lap top computers for use by the Northeast Marine Pilots who navigate large ships through the Bay. With these portable computers, the pilots have a highly accurate and reliable indication of their vessel's position in the Bay which reduces the risk of grounding or collision.

The in-water aids to navigation used by the pilots and others to move vessels safely in Narragansett Bay are established and serviced by the Coast Guard Aids to Navigation Team (ANT) which is based in Bristol, Rhode Island, and is a subordinate unit of Coast Guard Group Woods Hole, Massachusetts. ANT Bristol services 282 floating aids and 48 structures, including 13 lighthouses within an area from the Sakonnet River to Watch Hill. The ANT also has secondary responsibility for 140 floating aids to navigation.

Presently there are several new systems being developed under the general term of Universal Automatic Identification Systems (AIS) that could revolutionize the efficient and safe flow of vessel traffic. AIS is a shipborne transponder-based navigation safety system that enables the efficient exchange of data such as name, type, position, course, speed, navigation status, dimensions, or type of cargo among ships and between shore stations and ships. If fully implemented, the AIS could provide detailed, real-time information from any large vessel in the Bay for use by other vessels, port authorities, waterfront terminals, ship agents, government authorities, and ship suppliers.

This year, the state of Rhode Island paid for the installation of a PORTS system (Physical Oceanographic Real Time System) for Narragansett Bay that could provide real-time tide, current, and weather information to all the users of the Bay. At the time of this writing, the system was nearly completely installed, but federal funding for the support of the project had been eliminated from the budget. This funding is needed for the system to be activated.

Despite the recent technological advances in vessel traffic management, there are often conflicts over the use of the Bay that are brought to the attention of the Coast Guard. Several examples are:

- Recreational boats were reported violating the Nautical Rules of the Road by impeding the safe navigation of deep draft vessels that are constrained to the limits of the navigable channel.
- The new Seekonk River commuter passenger ferry created a wake that interfered with the use of the waterway by recreational rowing skulls.
- A request was received by the Coast Guard to permit the establishment of an aquaculture farm in a designated vessel anchorage area that would negate its use as an anchorage.
- Recreational boats anchoring near Jamestown Island were reported to be impinging on the adjacent deep-draft vessel anchorage.

Who has the responsibility to manage and resolve these conflicts? Presently, the Coast Guard and the state have jurisdiction to enforce many safety and environmental regulations for users of the Bay. However, as illustrated in the examples above, many of the conflicts that arise do not involve a violation of law or regulation, thereby placing the issue beyond the scope of state or federal intervention. In many ports, federal, state, or privately supported Harbor Safety Committees have been meeting for many years to address port safety. Rhode Island law, passed in the wake of the North Cape oil spill, called for the creation of the Rhode Island Port and Waterways Safety Committee which would annually "review all aspects of navigation and marine operation in Rhode Island waters and make recommendations for safety improvements." The Committee has yet to be formed and would be a valuable forum for resolving user conflicts.

V. Economic Impact of Marine Transportation

1.Economic benefits of the marine transportation industry

Commercial marine transportation activity on Narragansett Bay rests on the demand by individuals and businesses for gasoline to fuel cars, heating oil for homes and offices, construction materials for roads and buildings, etc. Those who receive petroleum or petroleum products, or who send or receive bulk cargo or finished products on tankers, barges, or cargo ships, use vessels because they are a less costly mode of transport than the next-best alternative, truck or rail.

Many thousands of tons of cargo move on the Bay each year, and marine transportation provides economic benefits to different users. These benefits include:

- lower costs for gasoline, heating oil, and other products used directly or indirectly by Rhode Island residents and businesses
- profits from transportation cost savings received by owners and operators of terminals, wholesalers, local gas stations, and heating oil companies
- payments to the many hundreds of individuals who are employed in the marine transport sector and earn more than they could in their next-best alternative

Currently, private terminals, including Mobil Oil, Sprague Energy Corp., Getty, Northeast Petroleum, Hudson Petroleum, as well as PROVPORT, operate in and around Providence River and Harbor. Several marinas also operate in this area. Overall, in 1995 in Rhode Island some 716 individuals were employed in water transportation activities and earned $18.66 million in compensation. Businesses in this sector had output valued at $131.83 million and value added (wages, profits, interest, etc.) of some $26.72 million. These figures include marinas, which are not considered as commercial marine transportation in this report, and, therefore, somewhat overstate economic activity in the water transportation sector.

The number of cruise passengers visiting the Bay also has an economic impact. Passengers are tourists who spend money on the local economy. This is especially important for the City of Newport, which is highly reliant on tourism dollars.

If the assumption is made that ships were fully occupied, then in the past eight years, approximately 250,000 people (passengers and crew) toured Newport due to cruise ship calls. Based on a conservative estimate, if each person landing at Newport spent $10.00 (on tours and incidentals), then their spending would have contributed $2.5 million to the local economy.

Other, less tangible benefits are captured by residents and visitors who annually take many thousands of trips on ferries. The benefit to these passengers the means to reach a destination.

2. Current Marine transportation Issues

Current marine transportation issues include the maintenance dredging for the federal channel and in and around the Providence River and Harbor and disposal of the dredged materials, and the potential development of a new port at Quonset/Davisville.

A. Maintenance Dredging of the Providence River Channel

Maintenance dredging is a recurring issue in the federal channel, at commercial berths, and at local marinas in and around Providence River and Harbor (See Part II).

Key concerns with dredging are the disturbance of contaminated sediments at dredging sites and the consequences of disposal of clean sediments for Bay fisheries. There will be an economic cost of disposal of clean marine sediments from the Providence River Channel.

The US Army Corps of Engineers (ACOE) currently is weighing which of several sites in Narragansett Bay or Rhode Island Sound to use as a marine disposal site for clean sediments (ACOE, Draft Environmental Impact Statement, 1998). Rapid disposal of sediment will suffocate mollusks, lobster, and benthic species (e.g. flounder and scup), and perhaps other species, and will cause short-term and long-run losses both on site and offsite due to loss of adults, young-of-year, and juveniles. Additional losses may occur due to food web effects. Fishery losses will affect commercial and recreational catch and will continue until species recover.

Grigalunas, Opaluch and Luo (1999) (GOL) have estimated the cost to commercial and recreational fisheries of disposal of some 5.1 million cubic yards of clean sediments from dredging the federal channel and berths in and around the Port of Providence. They used a bio-economic framework to estimate losses to fisheries at seven potential disposal sites, three in the Bay and four in Rhode Island Sound. Only losses to fisheries were considered; transportation costs to different disposal sites, and other factors that might influence site selection were not considered.

The fishery losses estimated by GOL include short-term effects, long-term effects, and indirect (food web) effects. To provide conservative (i.e., high) estimates, they use an overstated-cost approach by adopting assumptions that lead to higher estimates whenever judgments had to be made. For example, they assume 100 % mortality to all biota in the affected area during the entire 18-month disposal period.

GOL estimate base-case losses to fisheries of from $0.39 million to $2.43 million with costs consistently much higher at potential disposal sites in Narragansett Bay as compared with potential sites in Rhode Island Sound. Recreational losses were found to be substantial, particularly for Bay sites, and indeed at one Bay site, recreational losses exceed commercial losses. Losses to species such as tautog that are heavily harvested by recreational users can be large because they have a higher marginal value for catch than most commercial prices. Losses in Rhode Island Sound would primarily affect commercial fisheries, notably flounder and lobster.

A series of sensitivity analyses considered how several factors would affect estimated costs. Factors considered include: mortality impacts over a larger area, greater food web effects, and a longer recovery period. These (and other) assumptions result in “worst-case” estimates of costs, ranging from $0.70 million to $4.44 million. Again, potential disposal sites in the Bay have larger estimated fishery losses than those in the Sound.

There are also potential economic benefits from dredging the Providence River Channel. Currently, some 150 million gallons of gasoline are lightered each year, according to the ACOE. Lightering is the transfer of oil from a deep-draft tank ship into barges. The lightering site in Rhode Island is North of the Newport Bridge. Lightering involves an extra cost

Considering the costs associated with lightering, if dredging in and around Providence River and Harbor allowed deeper draft vessels to use the Bay and by that, reduced costs by, say, $0.025 per gallon of oil lightered, then the annual benefit would be on the order of $3.75 million (=.025 * 150,000,000).

Dredging creates savings by decreasing the price to consumers. If consumers do not receive all of these benefits, then some share of the savings becomes a gain to Rhode Island terminal operators and distributors. Benefit from dredging may go to RI consumers, petroleum dealers, or businesses--or be shared among these groups, depending upon the degree of competition in the petroleum market. Benefits continue on into future years until gradual sediment buildup in the channel and at berths once again requires light loading, lightering, and delays due to tides or one-way traffic restrictions.

A more realistic assessment of potential savings to Rhode Island from dredging would take into account the fact that (1) not all of the lightered product is delivered to Rhode Island, (2) dredging of the federal channel may not allow all facilities to accept immediately deeper draft vessels, and (3) the benefits from dredging will erode over time since sediment build up in the channel is a continuous process and sedimentation will start again as soon as the channel is dredged. On the other hand, the $3.75 million figure mentioned above is an understatement since demand for petroleum products is generally increasing over time. Without dredging, costs to Rhode Island individuals and businesses might grow.

To gain some idea of the potential benefits from dredging, we use a series of simplifying (but not entirely implausible) assumptions. First, we presume that sediment buildup in the federal channel starts as soon as dredging is completed and over time eliminates the benefit from dredging. The time it will take for sediment buildup to reach current levels is not clear (the last maintenance dredging was done in 1976), so we use alternative scenarios that sediment buildup to current levels will take either 15 or 20 years. We further assume that the annual benefits from using deeper draft vessels decline linearly over time as sediment buildup proceeds. For example, for the 20-year case, in year 1 all of the benefits are captured, in year two 95% are realized, year three, 90%, etc, until in year 20 the benefits from maintenance dredging today cease.

Finally, we use two assumptions about growth of oil through the Bay. Our high assumption assumes that petroleum product demand increases annually by 2.6%, the average of the annual growth rates for deliveries to the Port of Providence over the ten year period from 1988-1997.

So, if 150 million gallons are lightered now, in year 1, 153.9 million gallons are lightered, in year 2, 157.9 million gallons are lightered, etc. Our low assumption uses a lower growth rate of 2 % to reflect possible increased substitution of natural gas for oil in the market area.

Table 2 shows the estimated benefits from dredging under the assumptions used.

Table 2: Net Present Value of Cost Savings From Dredging in Providence River and Harbor Under Alternative Assumptions

A: Average annual growth rate 2.6%

Incremental cost per gallon ($)		$0.02	$0.05	$0.08
Period (Years): 15 (Million $)	100%	$52	$130	$208
RI share (Million $)	50%	$26	$65	$104
	70%	$36	$91	$145
Period (Years): 20 (Million $)	100%	$62	$154	$247
RI share (Million $)	50%	$31	$77	$123
	70%	$43	$108	$173

B: Average annual growth rate 2%

Incremental cost per gallon ($)		$0.02	$0.05	$0.08
Period (Years): 15 (Million $)	100%	$50	$124	$199
RI share (Million $)	50%	$25	$62	$99
	70%	$35	$87	$139
Period (Years): 20 (Million $)	100%	$58	$145	$233
RI share (Million $)	50%	$29	$73	$116
	70%	$41	$102	$163

The results show different assumptions about the amount saved per gallon by avoiding lightering (ranging from $0.02 to $0.08 per gallon). To estimate how Rhode Island individuals and businesses would benefit, the results present cases where Rhode Islanders are assumed to get either (1) 50% or (2) 75 % of the lightered oil.

For example, if benefits from dredging last for 15 years (declining each year due to sediment buildup, as noted), if the savings per gallon is $0.02, and if Rhode Island receives only 50 % of the lightered oil, then the estimated present value of benefits amount to $23 million. Benefits are higher in the other cases. These dollar values are the present value of the annual savings estimated using the above assumptions and a discount rate of 6.87%, the rate used by the ACOE for this project. Clearly, this area warrants much more careful research to pin down these benefits than is possible in this modest document. An assessment of the *net* benefits to Rhode Island, of course, would have to include any incremental costs borne by the State and any incremental environmental costs that result (for example, any damages if lightering leads to an increase in oil spill).

At present there are also costs associated with the delay of some vessels due to waiting for high tides, restriction of traffic to one way at a time and light loading. Clearly, there needs to be a careful study of the economic costs and benefits of dredging the Providence River Channel and nearby berths.

B. Potential Port at Quonset/Davisville

A second important potential development concerns possible construction of a port at Quonset Point/Davisville. Such a port could be designed to handle the growing number of containers expected to arrive on the East Coast in the near future and/or complement current activity at the Port of Providence.

Rapid growth in use of containers, the expansion of port activity in Southeast Asia and South Central Asia (India and Bangladesh), and technological advances favoring the use of larger container ships, are changing the structure of the container shipping industry. One result is an increase in demand for container port services along the US Atlantic Coast to accommodate more and larger container ships to serve regional and Mid-West markets.

A recent proposal for a large-scale, privately financed container hub port, advanced by the Quonset Point Partners, was rejected by the Economic Development Corporation due to the inability of the proposed developers to secure firm commitments from shipping companies to use the port. Nevertheless, the presence of land, rail, and road access to facilities in relatively close proximity to open water makes the area potentially attractive as a port.

Development of any new port at Quonset-Davisville will depend upon what type of port is envisioned, the products to be handled, and site-specific factors. Key concerns raised during a recent stakeholder process included: financial feasibility, net benefits to the state (who gains, who pays and how much), marine and terrestrial environmental issues and social issues. All of these concerns have an associated economic cost.

VI Environmental Impacts of Marine Transportation and Dredging

1. Marine Transportation

When considering the impacts of shipping on the Bay, one must take into account both the impacts of port and terminal operations and the activities of the ships themselves. Projecting the future environmental risks associated with increased shipping requires an analysis of historical marine pollution and vessel accident data. Using this information, it is possible to attempt to forecast future shipping-related risks based on the expected increase in vessel traffic. By identifying these issues early and taking a precautionary approach, we can manage marine pollution risks more effectively.

Vessel-related marine environmental impacts can be divided into three areas: port operations, accidental releases from vessels, and operational releases from vessels. The following table summarizes the vessel activities, pollutants, environmental impacts, and identifies the responsible regulatory authority:

Table 3: Vessel-related Marine Environmental Problems

Activity	Pollutant(s)	Environmental Impac	Regulatory Authority
I. <u>Port Operation</u>			EPA, USCG,

1) Shoreline & channel modification	Physical alteration of coastal and marine environment	Habitat loss; degraded water quality; disruption of coastal and benthic ecosystems	USFWS ACOE, CRMC, DEM
2) Ship repair and maintenance; surface preparation and painting	Heavy metals, particulates and VOCs,	Acute and chronic water, sediment and air contamination	EPA, DEM, OSHA
II. <u>Operational</u>			
1) Transfer of cargo; bunkering; discharge of ballast water, bilge water, tank cleaning residues, cooling system water, solid waste disposal	Petroleum hydrocarbons, solid waste, toxic chemicals and wastewater	Chronic water and sediment pollution; contamination of marine organisms Impairment of commercial and recreational use of marine waters	IMO, USCG, EPA, DEM
2) Receiving and discharging ballast water	Introduction of Nonindegious Species	Ecological degradation from invasive species colonization	IMO, USCG, EPA, DOI RIDEM
3) Treatment of hulls, submerged parts and pier structures with antifouling coatings	Antifoulant Paints containing TBT (tributyltin)	Mutagenesis in non-target species; toxic accumulation in marine sediments and surrounding water	IMO, EPA, RIDEM
4) Burning of fossil fuels	Contribution of SO_x and NO_x to the atmosphere	Air Pollution	IMO, EPA, RIDEM
5) Transferring bulk petroleum products (tank vessels)	Contribution of volatile organic compounds (VOCs) to the atmosphere	Air Pollution	EPA, RIDEM USCG
6) Burning of solid waste and hazardous substances	Release of toxic compounds into the atmosphere	Air Pollution	IMO, USCG, EPA, RIDEM
	Cargo spills	Hyper-toxicity of water and sediments; fish and wildlife kill	IMO, USCG, EPA, DOI, NOAA, DEM

substances III. <u>Accidental</u> 1) Physical accidents involving vessel(s)		kill Impairment of commercial and recreational use of marine waters	DOI, NOAA, DEM EPA, RIDEM

(Source/Data: Thesis of Jeffrey Nield, Brown University Department of Environmental Studies, 1999)

Of all these types of pollution, oil spills have received the most attention. The 1989 World Prodigy oil spill released 392,724 gallons into Rhode Island Sound off Newport; in 1996, the barge North Cape ran aground on Moonstone Beach in South Kingstown, releasing 828,469 gallons. Between 1985 and 1996, the US Coast Guard reported 616 marine pollution incidents in Narragansett Bay overall. Of these, 406 reports included oil spill data. They are shown in Table 4. The total reported volume of cargo spilled during that time period was approximately 1,229,617 gallons. It is clear when looking at this total that the 2 major oil spills account for the vast majority of total reported spills. While the environmental damage from the 2 major spills are well-documented, the cumulative impacts of operational spills on the Narragansett Bay ecosystem are poorly understood.

Table 4 Yearly Summary of Actual Reported Oil Spills involving Marine Vessels, Narragansett Bay, 1985-1996

Year	**Number of Spills (All Vessels)**	**Number of Spills(Commercial Vessels)**	**Reported Number of Gallons Spilled**	**Reported Number of Gallons Recovered**
1985	5	1	58	-
1986	56	13	4,508	984
1987	32	5	575	75
1988	27	7	318	48
1989	41	9	392,724	109,093
1990	54	6	491	148
1991	21	3	166	38
1992	44	7	410	126
1993	42	11	757	350
1994	27	4	386	27
1995	27	4	755	355
1996	30	8	828,469	65
TOTAL	406	78	1,229,617	111,309
Source: USCG. 1985-1996. MSMS.				

To explore this issue further, a preliminary statistical analysis was done using USCG oil spill data for the period 1980 to 1997. The objective was to get some idea of factors that explain the number of annual spills.

The preliminary statistical results suggest that the number of spills increases with as the number of trips by vessels of any type increases. However, self-propelled tankers are more likely to spill oil than other vessels.

Specifically, the preliminary statistical results suggest that on average, *one minor oil spill* would be expected in the Bay:

- for every 227 self-propelled tanker trips
- for every 256 non-self propelled dry cargo vessel trips, and
- for every 666 barge trips.

These results are suggestive—not conclusive—as this was a very simplified and preliminary analysis using only readily available data. Clearly, oil spills are complicated issues, involving several factors beyond the scope of this modest effort (e.g. age and condition of vessel, weather, depth, domestic versus foreign flag, etc.) and a careful analysis requires a much more substantial research effort. It should also be noted that spills from vessels each year contribute far less hydrocarbons to the Bay than does runoff from urban areas.

Also, it should be noted that road and rail alternatives to movement of petroleum products by barge and ship impose environmental costs in the form of road congestion, safety, air pollution and noise.

Another accidental release from vessels is the accidental introduction of non-indigenous, invasive species of plants and animals. This has been the subject of international regulation and concern in recent years. While a number of non-native species are known to have proliferated in Narragansett Bay in the 20th century, it is extremely difficult to trace their origins, much less eradicate them. If Rhode Island experiences a major increase in commercial vessel traffic, the introduction of exotic species may be accelerated. An example of a recently introduced species to the Bay is the Japanese Shore Crab. As with many introduced species which often lack predators or compeditors in their new environment, this species may outcompete native species for food and habitat. Other ecosystems have experienced major changes due to introduced species. One example is the well documented invasion of the Great Lakes by the zebra mussel. Again, more stringent regulations and a comprehensive management strategy on state, national and international levels will be key to reducing these risks, though they cannot be eliminated.

Other operational impacts of ports and shipping include toxic releases, such as paints, and chemicals, that can accumulate in marine sediments surrounding the port facilities and ship channel. Sediment analyses reveal that historical commercial port areas and dredged channels typically have higher levels of toxic pollutants than other areas of the Bay. Suspension of these sediments from ship operations contributes to the degradation of marine habitat in and around port facilities and dredged channels. However, only in a few limited areas of the Bay is toxic sediment contamination considered limiting to the types of marine animals living there.

There are also environmental risks associated with lightering. To date, there have been no major oil spills attributed to lightering in Narragansett Bay, and very few minor spills. While there is certainly a risk of oil spills each time cargo is transferred, lightering is considered to be a relatively safe practice.

The environmental risks of lightering activities verses the risks associated with large tank and cargo vessels should be carefully analyzed as part of any plan to develop marine infrastructure.

2. Environmental Impacts of Dredging

The dredging activities that may be required in Narragansett Bay in the future have the potential to cause environmental impacts both from the dredging itself and the disposal of dredged material.

Dredging generally has a short-term impact on Bay habitats and resources. The areas that are dredged lie at the bottom of channels and harbors and tend to collect finer-grained sediments (except for coastal ponds). These habitats tend to experience high sedimentation rates and some level of disturbance from passing vessels. However, the disturbance of these sediments can cause a localized increase in suspended sediment (turbidity), the redistribution of fine sediments to other habitats and disturbance of spawning populations (winter flounder, tautog, shellfish). The extent of turbidity is determined by the method of dredging, the ambient currents and the grain size of the sediments. Monitoring studies in Boston Harbor around dredging activities have shown that turbidity increases are about the scale of disturbance caused by ship traffic or coastal storms (2-3 times ambient in a 300m diameter area) and return to ambient conditions within hours after cessation of dredging.

The regulation of dredging requires that state water quality criteria (for contaminants in the water) are not violated during dredging and operations can be suspended if water quality conditions are exceeded. Seasonal restrictions limit dredging periods to avoid known conflicts with spawning populations. On the positive side, dredging in harbors often removes significant amounts of contaminated sediments from high population centers. While the channel often comprises a small fraction of the harbor floor, it tends to act as a sink for fine sediments washed into the harbor. Repeated dredging of the channel could serve to remove a sizeable portion of the most contaminated sediments from urban areas. There is some concern that deepening channels that are presently relatively shallow (e.g. Quonset Point) could change tidal circulation patterns and affect either water quality (low dissolved oxygen) or spawning activities. At present there is no evidence to support this concern, but it will require more extensive investigation.

Disturbance of Bay sediments necessarily disrupts habitats (most sediment types have distinctive communities of animals and in some cases plants). While the channel floors are generally considered a disturbed habitat (due to sedimentation and resuspension from ship traffic) the dredging will remove any existing shellfish (quahogs and lobsters) and alter the habitat for several years. After dredging has ended, the recolonization of the disturbed seafloor (by small worms, lobsters and shellfish) can occur quickly, but is not likely to return to ambient conditions for six months to two years.

The disposal of dredged materials has quite different effects than the removal by dredging, primarily because the dredging requires removing a small thickness of sediment over a large area, whereas disposal is usually confined to a relatively small area.

Aquatic disposal results in short term disturbance of the aquatic site (burial of all slow-moving animals); potential long term change in habitat (if the material significantly changes depth or sediment type; temporary loss of use by wildlife (feeding may be disrupted), disturbance of spawning populations (if disposal occurs during spawning season). Studies of disposal of dredged material at Connimicut Point from Bullocks Cove concluded that there were no long-term irreversible impacts. The habitat recovered within 2 years and appeared stable (ACOE 1997). Similar conclusions were made in monitoring studies of disposal of dredged material at the Brenton Reef disposal site and at Long Island Sound disposal sites (SAIC 1995). Upland disposal can also result in a change in habitat, potential groundwater discharge impacts (these must be controlled to obtain a permit) and temporary loss of use by wildlife. Treatment alternatives require location of facilities for the treatment (dewatering, processing) and disposal of sidestreams (contaminants, bulk treated sediments, wastewater and/or gas).

3. Current issues

Presently, the State of Rhode Island is considering two major marine infrastructure projects: The Providence River and Harbor Maintenance Dredging Project, and the proposed dredging and filling associated with development of deep-water port facilities at Quonset Point/Davisville in North Kingstown. Each of these projects are expected to significantly increase commercial vessel traffic in Narragansett Bay. If implemented together, a restored Providence River channel and a major port facility at Quonset would result in an increase in tanker and container vessel traffic over roughly a 25-year period.

If commercial vessel traffic grows as projected, it will increase the risk of environmental impacts due to accidental and operational spills, introduction of non-native species to the Bay, and other associated impacts. The process of dredging, dredged material disposal, and filling of tidal waters may have the most significant impacts to the Bay of all the marine transportation-related activities discussed above. Comprehensive marine infrastructure planning and improved vessel traffic management systems are essential to reducing these risks.

VII. Management Strategies

As discussed above, there are currently two large marine infrastructure projects under consideration in Rhode Island.

One project is the maintenance dredging of the Providence River Channel to return it to the authorized configuration of 40 feet below Mean Low Water and a two-way traffic pattern. The regulatory process to permit this project has been underway since 1996 and is expected to be completed by 2001. A draft Environmental Impact Statement has been prepared by the ACOE with input from other federal, state and local groups including the general public.

The other project is the possible construction of a container port at Quonset Point/Davisville. To date, a stakeholder process has been undertaken from which certain development principles were agreed to by the majority of the participants. No applications for the development of the project have been submitted to any state or federal agencies

These projects highlight the importance of carefully considering and planning for any marine infrastructure project.

A process should be put in place to integrate existing regulations and plans that pertain to the Bay. A regional and watershed level management approach should be taken to assess the economic, environmental and social impacts of any project. The need for maintenance and/or creation of deep water channels and development of cargo and petroleum port facilities should be considered.

As a part of a comprehensive planning process, several areas have been identified in this paper that need to be addressed.

In terms of the cruise ship and ferry traffic on Narragansett Bay, in order to fully take advantage of passenger movement through the ports, there will need to be efficient people/luggage transportation linking the airport and rail terminals to the marine port. For example, future travelers could purchase one ticket that will include air, ground, and ferry transportation to a destination such as Block Island.

A dredged material management plan should be developed which would include both existing and future dredged material disposal needs. Maintenance dredging projects such as the Providence River Channel need to be analyzed to determine whether there is a need for the project. Any future shipping and port development plans and the associated dredging need to consider resource allocation and environmental management strategies.

Such a plan should include a Bay-wide plan for managing sediment influx into the Bay, identification of dredging needs, long-term disposal alternatives and a monitoring plan. The plan would need to make beneficial use of dredged materials a high priority and examine historical disposal sites and potential future disposal sites. The current regulatory process needs to be examined to insure that it works in conjunction with a dredged material management plan.

For the State of Rhode Island to effectively manage vessel traffic and pollution risks from commercial shipping and ports, we must have a comprehensive marine infrastructure planning and management strategy in place. Simple technological approaches such as the various Vessel Traffic Control Systems (VTS) used by other commercial waterways would offer some added margin of safety. These systems, similar in some ways to air traffic control, keep track of vessel movements in the Bay at a central facility using real-time information

Rhode Island law, passed in the wake of the North Cape oil spill, called for the creation of the Rhode Island Port and Waterways Safety Committee which would annually "review all aspects of navigation and marine operation in Rhode Island waters and make recommendations for safety improvements." The Committee has yet to be formed and would be a valuable forum for resolving use conflicts.

In order to develop a plan to deal with the invasion of non-indigenous species, a scientific survey needs to be conducted to analyze the current presence and distribution of any invasive species.

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