



Water Access Points in Boston Harbor: Encouraging Boating and a Clean Harbor

An Interactive Qualifying Project to be submitted to the faculty of Worcester Polytechnic Institute in partial fulfillment of the requirements for the Degree of Bachelor of Science

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ABSTRACT

The Harbor Water Access Project assisted its sponsor, the Boston Environment Department, in its goal of making the harbor safer and cleaner for boaters. Through surveys, interviews and data analysis, the project reviewed and developed mooring permit and pump-out facilities databases. These were then used in making recommendations about the permitting process and the ability of the harbor to meet pump-out requirements set by the EPA. Recommendations include a streamlined mooring permit process which allows more fluid integration between departments. This process will also limit input errors, making it easier for the Boston Police Harbormaster to verify permit information. The project also developed suggestions and supporting data for a potential 'No-Discharge Zone' application to the EPA. The project also developed Geographic Information Service maps to graphically display this data for concerned parties, and as a way providing this information to boaters.

ACKNOWLEDGEMENTS

The Boston Harbor Water Access Team would like to acknowledge the many groups and individuals that contributed to this project.

First, the team wishes to thank the many marinas and marine service facilities in and around Boston Harbor. Without their support, this project could not have succeeded. Many individuals, from dockhands to proprietors, took time out of their busy schedules to discuss all aspects of this study and provide a crucial perspective.

Expert advice on the state of the harbor was provided by the Boston Harbor Association, the Boston Waterways Board, and the Urban Harbors Institute. These groups volunteered their time to assist the group in every aspect of the project, from scope, to perspective of boaters, to ‘nuts and bolts’ help with Geographic Information Systems. In particular, the Urban Harbors Institute made its many data sets available to the team, and provided technical support to ensure that the information was useful to the project.

This project would not have been possible without the support of the two groups involved with the mooring permit process. The Treasury Department and the Boston Police Harbormaster took time out of busy schedules to provide us with very pertinent and crucial information relating to the core of this project.

The team also wishes to thank the staff of Boston City Hall, particularly the Property Management Department, for providing a positive and generous work environment. The Property Management staff was exceedingly helpful with the many administrative issues that arose during the project. In addition, the team would be remiss if it did not thank the Management Information Systems Department. MIS provided support on a host of issues, ranging from providing basic network services to providing the expertise and resources to place the project’s deliverables in the hands of those who will be using them.

Finally, the group wishes to thank the Boston Environment Department, who sponsored the project, and its director, Mr. Bryan Glascock. The friendly and helpful staff of the BED provided the team with invaluable advice and assistance. Additionally,

despite his very busy schedule, Mr. Glascock took the time to provide the team with key advice and support for the project. Every step of the way, Mr. Glascock offered advice and recommendations, networked the team with other departments, and made every effort to assist the team. Without his help, this project could never have even begun.

EXECUTIVE SUMMARY

Since the late 1980s, a significant effort has been made to clean up what was once the ‘filthiest harbor in the country’. Boston Harbor has come a long way due to the efforts of the Clean Water Act and recreational boating has also grown into a two billion dollar industry (Cox, Tom). In Boston, individual marinas attribute as much as six million dollars in spending to the many customers frequenting neighborhoods off of boats. Constitution marina supports 27 jobs alone, dedicated to serving marina customers (Cox, Tom). In an effort to make Boston friendlier to local boaters, as well as to increase safety, the city government has recently instituted a mooring permit. In addition, the Boston Environment Department (BED) is taking steps to ensure that the harbor never returns to its former state. One possible plan is to institute a no-discharge zone in the Boston Harbor area, which would prevent recreational and commercial boats from discharging sanitary waste within a set boundary.

With the new attractive state of Boston Harbor, recreational boating has become increasingly popular each year. There are several important amenities located throughout the harbor that are valuable to recreational boaters including marinas, mooring sites, and pump-out stations. Marinas provide stationary docks that allow boaters to tie up their boats safely and many of them also provide pump-out facilities. Pump-out stations are used to properly dispose of sanitary waste on boats so that it is not directly discharged into the waters. Many of these pump-out stations around the harbor were funded through the Clean Vessel Act, which contractually binds marina owners to provide free pump-outs to the public for varying amounts of time.

The BED is interested in promoting an increase in recreational boating in Boston Harbor while also continuing the environmental progress of the harbor. The BED aims to accomplish this by providing the public with a complete map of the amenities located throughout the harbor that is easily updated to remain accurate. Another feature of this map is that it allows the BED and other organizations to see a complete list of pump-out stations and the capabilities of these stations. This is helping them to decide if Boston

Harbor has the capability to support a no-discharge zone which would be a very effective way of protecting the cleanliness of the harbor.

The goal of this project was to help the BED to encourage recreational boating by verifying and mapping the location of access points throughout Boston Harbor and streamlining the mooring permit process. Simultaneously, the project was intended to provide information to the Environmental Protection Agency (EPA) about the harbor's capability to support a No-Discharge Zone (NDZ). The team developed a Geographic Information Systems (GIS) database showing the distribution of mooring sites, pump-out facilities, and marinas. This can be used to facilitate greater boater knowledge of these harbor amenities and help the EPA to determine the viability of a NDZ to protect the harbor.

The Boston Police Harbormaster and his staff play an important role in keeping the harbor safe by enforcing regulations. The Harbormaster also has the responsibility of maintaining all mooring locations and the mooring permit application process. These duties are important for several reasons including homeland security, verifying mooring placements, and boating safety.

In order to accomplish this project, the group used several methods which are broken down by each deliverable the group produced. The group interviewed many parties, including the Boston Police Harbormaster, the Treasury Department, marina operators, and boater interest groups. In addition, a survey was developed and completed which recorded a wealth of information on the pump-out facilities in the harbor. Finally, the group ran data analyses and combined information developed in the project with information already available to assemble useful and sustainable deliverables.

Findings

While conducting this project, the group found several problems in the current data and application process. The group quickly realized that there was a major problem with the mooring data that the team received from the Harbormaster. The applicants submitted their mooring location coordinates in many different formats and often did not report accurate data, so it was difficult to create a complete database. The group used different analysis techniques to correct the data on a case by case basis. After correcting the data, it became evident that the team had a complete data set of the mooring locations

throughout the harbor. The group also recognized that in order for the database to be sustainable in the future, it was important to restrict the types of data that people were using and hold people accountable for incorrect data.

Another problem that the group encountered was with the flow of information for the mooring application process. In order to move forward, a data input and editing method was used to develop project maps. When the project started, the system in place required information to be passed back and forth constantly between the Harbormaster and the Treasury Department. This system was inefficient for both parties because they had to spend extra time to get the exact information they were interested in. With this system, it was also difficult for the Treasury Department to check if Boston residents had paid the proper excise tax. The group realized that the process could be improved drastically by restructuring the flow of information and only providing each department with the information that pertained to them.

The last major constraint that the group faced was the large number of mooring permits using paper applications instead of electronic applications. This needed to be taken into consideration because the City of Boston cannot require that the public submit their applications electronically. Although the team could not require it, it was important to strongly encourage electronic submissions in the new application process to save time and effort.

Conclusions and Recommendations

With the development of the project deliverables, this project provided the city government with several key items to support the harbor; however, they will be useless if sustainability is not taken into account. With the mooring database, several steps will need to be taken to ensure that the changes made will take effect in the future. Through an internet-hosted database maintained by MIS, application information can move smoothly to interested parties. The database needs to be stored centrally so that it is accessible both by the Harbormaster and the Treasury Department. Fields in this database include the existing required data, but are also flexible to encompass future demands as they arise. Most importantly, this database must automatically update a GIS map so that both deliverables will be linked together. This updating process uses technology already in place on the city's MIS servers, so it is a relatively straightforward

process. These two deliverables are mutually dependant, so this link will be crucial for sustainability.

Through work with MIS the group has determined the best course of action for the permit process. The 2007 registration period is mostly over, so these recommendations will not take effect until February of 2008, when the new permitting period begins. When new applications come in, either through online forms or a paper form inputted by city employees, the information will enter the database and be flagged as a pending permit. The first step in the process will be for Treasury to approve the permit after verification of mooring fee payment, excise tax, and outstanding debt to the city. Once Treasury approves the permit, it will be flagged for the Harbormaster's review. The Harbormaster will determine whether or not the permit is in a safe location, and approve the permit if it is. He will do this by accessing a temporary map which will display the requested location for the new permit. If he approves the permit the flag will then be removed and the data will be available on the main map. At any point in this process, if the application is denied, the applicant will know exactly what caused the rejection and will be given instructions on how to rectify it.

The online map will be a representation of data that will reside in the databases developed during the project. The map will be accessible to the Treasury Department, the Harbormaster, and to the general public. MIS will be able to mask data such that these users will see only data pertinent to them. For example, the Treasury Department will see information relating to tax payments, while the public will only see the permit number, location and size of the boat. This map will draw on other information owned by the city government, so whenever more recent charts or aerial photographs become available, they will be updated on the map. In addition, the map can be set to include information on other amenities such as marinas or touch-and-go piers. Finally, this map will also include a layer of data on pump-out facilities. This will be useful to boaters looking for this resource, and to the city in its effort to develop a no-discharge zone application.

Based on the information collected, the team concludes that the pump-out facilities in the harbor are close to meeting the requirements for a no-discharge zone, but have yet met all of the harbor's needs. Many of the marina operators spend so much time

providing pump-out services that they have begun to feel as though they were the only outfit offering such a service. This is indicative of a lack of resources necessary in this area. The harbor is approaching the necessary amount of pump-out facilities for a no-discharge zone, but it will need at least two more pump-out services before it can be considered fully ready to support the demands of the boaters. For these new services, at least one of these needs to be a pump-out boat on the water. In addition, subsidies may need to be offered to pump-out stations in existence to encourage an increase in service offerings.

If these recommendations are adopted, a considerable effort must be made to keep the boaters satisfied. The Commonwealth of Massachusetts cannot afford to alienate the growing industry of recreational boating. Boaters will likely embrace these initiatives, so long as they are implemented with consideration to the resources and interests of the primary users of Boston Harbor.

AUTHORSHIP

This document was authored by an interdisciplinary team of students from Worcester Polytechnic Institute (WPI) as part of an Interdisciplinary Qualifying Project (IQP). The IQP is a large part of the WPI undergraduate curriculum, and contributes to WPI's goal of producing well-versed 'technological-humanists'. This report is a combined effort and was authored and reviewed by each member of the team equally. It is the culmination of an entire semester's worth of dedicated research and analysis. The team was made up of the following students:

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INTRODUCTION

Since the 1980's, America has experienced a number of movements to clean up its environment. One of the more significant movements has been promotion of cleaner waterways through legislation like the Clean Water Act. Harbors, lakes, and rivers across the country have been the focus of various government and non-government organizations that have the goal of cleaner, clearer water in mind. As major harbors begin to see the fruits of these efforts, opportunities for economic growth are rising. Areas that were formerly devoid of life have become sites of fishing, public beaches have sprung up, and recreational boating has grown enormously in popularity.

Figure 1 shows a recently populated mooring area in Boston Harbor. The waterfront areas associated with this new activity have an opportunity to become economic centers in their respective cities, so long as we are able to take advantage of the resources at hand.



Figure 1: Sailboats Moored in Boston Harbor

Boston Harbor, in particular, is a site with tremendous opportunity. Boston Harbor has gone from being “the filthiest harbor in the nation” in 1986 to a popular locality for swimming, recreational boating, island tourism, fishing, and a host of other activities (The Leading Edge, 2004). Sewage treatment plants combined with an increase in pump-out stations (boaters’ alternative to dumping waste into the harbor) have helped the harbor to become cleaner and more popular. The waterfront area of Boston Harbor is rich with public services ranging from hotels and restaurants to museums and concert venues. If Boston can take advantage of the increased boating activity of the harbor it has an opportunity to encourage an economic growth in areas of the city accessible by water while protecting and improving the marine environment.

Organizations like the Boston Environment Department (BED) and the Boston Waterways Board (BWB) are taking proactive measures to assess this opportunity and

take full advantage of it. The BED is concerned with the environmental well-being of the area, while the BWB is more concerned with the promotion of harbor use. Should the BED develop an interest in implementing a No-Discharge Zone (NDZ) it will require certain information for the application to the Environmental Protection Agency (EPA). A NDZ would prevent the flushing of sanitary tanks onboard vessels near the harbor or its islands. The BWB is interested in the opportunity to encourage economic growth in the waterfront area by facilitating use of harbor access points. Of particular interest to the BWB is the location of moorings throughout the harbor. A mooring is a float that boats can be secured to, which is held in place by a large weight on the ocean floor attached to the float by a rope and chain. As of now, the locations of these mooring sites are not mapped in any useful manner. The BED and the BWB are very interested in having this information, combined with other harbor amenities such as pump-out facilities and marinas, in the form of an electronic map that could be used to educate the public on what is available to boaters when visiting the harbor. This map and database information could also be used for projects such as encouraging pump-out facility use to aid in keeping the harbor clean.

Currently the Boston Harbormaster maintains the mooring sites throughout the harbor. He receives data on those mooring sites from the Boston Treasury Department. The data that he has is recorded each year, but it is not easily updated or in a form that is usable by the BED, BWB, or other organizations. In addition there are a number of pump-out facilities throughout the harbor that have not been accounted for on any map. If the mooring and pump-out information was catalogued, standardized, and presented in an organized fashion, it would be useful to the BWB and BED in that it could be used to analyze mooring placements, evaluate harbor pump-out resources and attract additional consumers to the harbor.

The goal of this project was to help the Boston Waterways Board to encourage an increase in recreational boating by verifying and mapping the location of access points throughout Boston Harbor. Simultaneously, the project provided information to the BED about the harbor's capability to support the pumping-out of all boats making port in Boston Harbor and streamlined the flow of mooring permit information to the harbormaster. The team inventoried and recorded the distribution of mooring sites,

pump-out facilities, and marinas, and used this information to develop a Geographic Information Systems database that could be made accessible over the internet. This can be used to facilitate greater boater knowledge of these harbor amenities, aid the Boston Waterways Board in furthering the economic development of Boston's waterfront areas, expedite the upkeep of the harbormaster's records, and to determine the viability of a "No-Discharge Zone" protecting the inner harbor and the harbor islands.

BACKGROUND

The background chapter begins with a discussion of the geography of Boston Harbor and its environmental history. The first section serves to highlight how Boston Harbor's geographic layout, cleansing, and continued improvement turned it into a burgeoning home to recreational boating. Also included in this section are the organizations that have an interest in protecting and cleaning the harbor. The second section is devoted to explaining the physical needs of boaters visiting a harbor. Also included in the section are the regulations in place that govern the activity of boaters.

Boston Harbor and Its Environmental History

Boston Harbor is an area with a long history of pollution and neglect. This section identifies some of the key historical sites and landmarks in the harbor. It also locates some of the more prominent geographic features and depicts the layout of the harbor. The problems that Boston Harbor faced with rampant pollution and the resulting cleanup process are explained next. In the final portion the organizations that are focused on protecting and improving the harbor are described.

Geography of the Harbor

Boston Harbor is the oldest continually open port in the United States and it boasts many attractions to recreational boaters (Massachusetts Port Authority 2007). The layout of the harbor facilitates a range of attractions from beaches to fishing. Boston Harbor is divided into two sections, the inner and outer harbors. The inner harbor is where the majority of the activity takes place. It starts at the mouths of the Charles and Mystic Rivers and leads all the way out to Logan International Airport. The inner harbor, which can be seen in Figure 2, features many harbor access points including five privately run marinas, boat launch ramps, mooring areas, and service docks (both for fuel and for repairs)(Harbor Guides and Travel Smart Media, Inc. 2007). Recreational boaters can even transit to several restaurants and hotels located right on the water. With its facilities, attractions and services the inner harbor is always a bustling place.



Figure 2: Map of Boston Harbor (<http://www.wreckhunter.net>)

Boston's outer harbor is a much larger geographic feature which starts at the inlet to the inner harbor and extends miles outward in all directions. The main feature of the outer harbor is the navigable channels that allow ships of all sizes to access the inner harbor. Travel in all directions offers access to the open ocean, but if vessels head north

or south they also have routes available to nearby cities of Hull, Winthrop and Quincy (Pike, John 2005).

Another major feature of the harbor is the cluster of islands located in the outer portion. There are large islands like Deer Island, depicted just above the center of Figure 2, which houses a waste treatment plant, and smaller islands like George's Island which feature tourist attractions like beaches and historic sites. There is even a landfill-turned-park in the form of Spectacle Island (Constitution Marina 2006). The layout of Boston Harbor allows easy access to a number of locations and provides the perfect backdrop for shipping, recreational boating and transportation (Massachusetts Port Authority 2007).

The Boston Harbor Cleanup

While Boston Harbor has always been a center of activity in the city, its environmental condition has often been neglected. From the time that the city was founded, its residents disposed of their garbage and raw sewage directly into the waters of the harbor and the rivers connected to it. The effects of all the waste were quantified in 1850 when a public health report “explained that high mortality rates were caused by poor sanitary conditions: only 30% of the newly-arrived immigrants from Ireland lived past the age of 10 in 1840” (The History of the Boston Harbor 1998). Twenty-eight years after the report, the city moved to a system of releasing millions of gallons of waste from storage vats, twice a day, over the course of several hours as the tide receded. However, the tidal flow did little to exchange the waters within the inner harbor and along the shoreline (MWRA, The State of Boston Harbor 2002). In the early 1900s, contact with water from the harbor would cause boils on exposed skin (The History of the Boston Harbor 1998).

It was not until 1952 that the first wastewater treatment facility was constructed to appropriately deal with the issue of raw sewage. The effluent from the treatment facility on Nut Island was directed down an outfall pipe that distributed it in deep water in the outer harbor. The nitrogen from the effluent caused huge plumes of algae growth during summer months. Ships transiting through the bay, to and from the harbor, threw bags of garbage overboard causing large amounts of trash to wash up on the shores of Cape Cod or along the bay (The Leading Edge 2004).

The Federal Water Pollution Control Act (FWPCA) Amendments were passed into law in 1972 in response to a public outcry concerning the rampant pollution of the rivers, lakes, and waterways of the nation. The amendments allowed for and helped to develop regulatory faculties controlling the release of any pollutants into the waters across the United States. In 1977, the FWPCA Amendments were altered to create the Clean Water Act (CWA). “The Clean Water Act made it unlawful for any person to discharge any pollutant from a point source into navigable waters, unless a permit was obtained under its provisions” (EPA Clean Water Act History). A point source is any single location that discharges effluent. Non-point sources of pollutants are generated by runoff from rainfall or snowmelt. The act also made it possible for the Environmental Protection Agency (EPA) to determine and establish wastewater standards for industry and municipalities, which were then supported through a construction grant program. The construction grant program provided funding for the erection of sewage treatment plants to help cleanse effluent waters. The five year period, between 1972 and 1977, allowed city and state governments to comply with the standards set by the FWPCA Amendments, prior to it being replaced by the more concrete Clean Water Act. However, many cities, such as Boston, failed to comply within that time frame.

Following a series of legal proceedings starting in 1982, the Metropolitan District Commission was charged with cleaning up the waters of Boston Harbor. They assembled the Massachusetts Water Resources Authority (MWRA) in 1985 to address the water quality issue in the harbor. The MWRA developed a plan to construct secondary treatment plants in accordance with the Clean Water Act of 1977 (The History of the Boston Harbor 1998). The outfall pipe from the treatment plant was moved farther out into the Bay of Massachusetts. The pipe now extends more than nine miles into the bay from Deer Island.

When the MWRA Boston Harbor Project completed the Deer Island outfall pipe on September 6, 2000, the water quality and clarity in the harbor improved substantially. Monitoring sites have seen a tremendous decrease in E. coli concentrations, ammonium, nitrogen, phosphorous, and biochemical oxygen demand. The drastic reduction in ammonium levels at Deer Island due to the outfall pipe can be seen by the monthly readings in Figure 3. The ammonium level drops from nearly forty micromoles per liter

to approximately zero at the end of the year 2000. Scum removal eliminated much of the oil and grease that had been issued into the waters of the harbor and bay (MWRA, The State of Boston Harbor 2002).

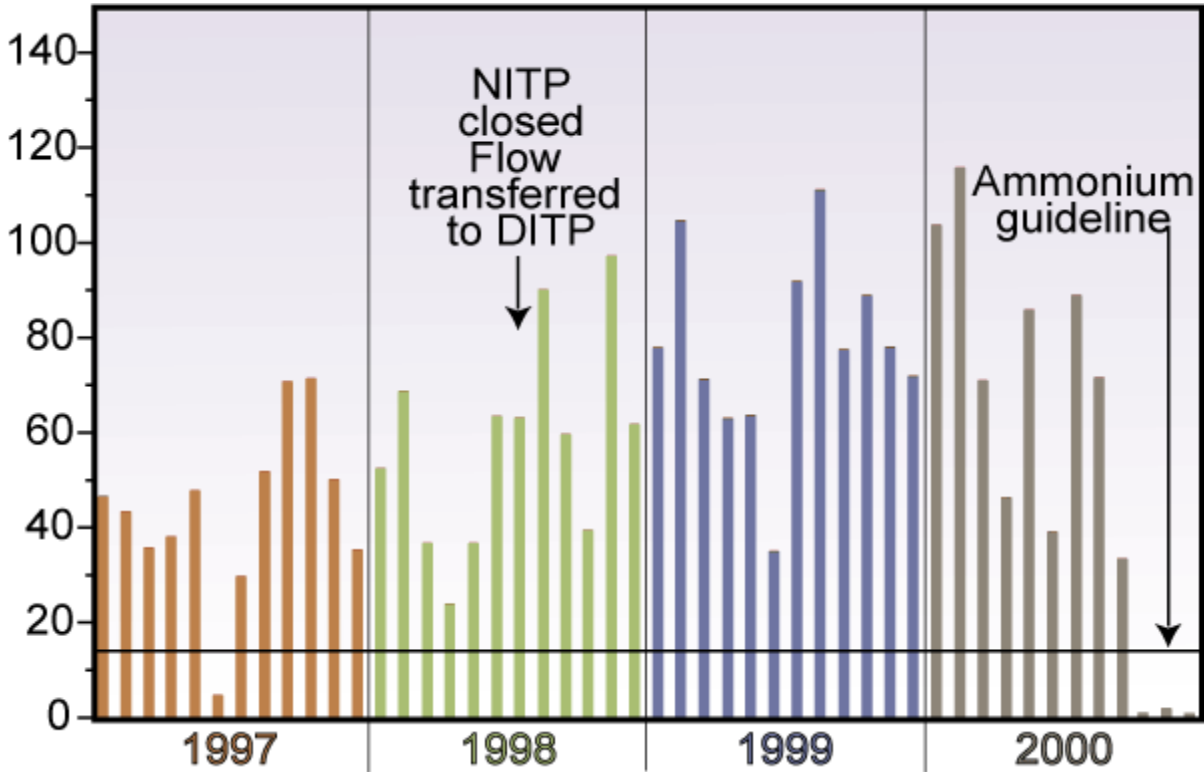


Figure 3: Ammonium at Deer Island: The graph displays ammonium levels in the water around the Deer Island Treatment Plant (DITP). The X-axis displays the year the measurements were taken in, divided into months, and the Y-axis displays the number of micromoles of ammonium per liter of water. The ammonium levels increased in the waters around DITP with the closing of the Nut Island Treatment Plant (NITP) in July of 1998. After September of 2000, the ammonium level drops off sharply with the opening of the nine mile long deep bay outfall pipe (MWRA, The State of Boston Harbor 2002).

The improvement in water quality in Boston Harbor and the Bay of Massachusetts is slowly allowing organisms within those waters to recover. Tumors and liver disease cases in flounder have been reduced dramatically. Shellfish and mollusks have also demonstrated reduced toxin levels in their flesh and shells (MWRA, The State of Boston Harbor 2002). The concentrations of toxins in the sediment beneath the harbor and bay, such as polycyclic aromatic hydrocarbons from fuel and oil, have seen and will continue to see reductions as they are consumed by microorganisms. The sediment beds have the capacity to cleanse themselves over the next ten to twenty years; barring future fuel or oil spills (Microorganisms are Cleaning Up Boston Harbor... 2002).

The improvements in water quality have drawn recreational fishermen back to the coastal waters of Massachusetts. Sunbathers and swimmers alike can once again enjoy the beaches of the commonwealth. Projects are being instituted by the city of Boston and non-government organizations to further clean the harbor, beautify the areas where the harbor meets the land, and to draw the citizens of Boston to one of their most valuable resources. One of these projects is the HarborWalk which is a public pedestrian path, extending from Chelsea Creek to the Neponset River following the shoreline. The pathway makes it easier for people from all walks of life to be able to make use of and enjoy the harbor. Boaters, swimmers, and sight-seers alike will be better able to share the harbor as these improvements continue.

Boston Harbor is one of the most vibrant and economically active spots in the northeast. It is appealing to tourists, recreational boaters and the commercial shipping industry alike. The cleanup of the harbor changed it from a supply of putrid smells, an embarrassment and a health risk to a point of pride and a source of increased income for the city.

Stewards of the Harbor

There are many types of organizations that have played key roles in cleaning, protecting, and promoting the usage of the harbor. There are several government organizations which include the Boston Waterways Board, the Boston Environment Department, and the Boston Redevelopment Authority. They all have different concerns but their efforts combine to protect the environment while trying to encourage economic growth in the area.

There are also numerous non-government organizations that are focused on the best interests of Boston Harbor. Trash-littered shorelines are no longer a problem thanks in large part to the efforts of non-profit organizations such as Save the Harbor/Save the Bay (SHSB) and The Boston Harbor Association (TBHA). Also, the Urban Harbors Institute proves to be a valuable resource by providing extensive information for the other organizations.

Boston Environment Department

The Boston Environment Department (BED) is a city government-run organization that consists of several different commissions. Protecting the Boston

environment and supplying information about the different concerns associated with it are some of the primary objectives of the BED. They also strive to preserve and improve the architectural, geographical, and historical aspects of the city of Boston. .

In an effort to support the most efficient management of environmentally friendly endeavors, in both the urban and the natural areas of Boston, the city's environment department has established a series of commissions. The commissions were designed to be able to evaluate and refine current practices and policies, while directing the administration of future projects. The following commissions were established: the Boston Conservation Commission, the Historic District Commissions, the Boston Landmarks Commission, and the Air Pollution Control Commission. Each of the commissions is made up of five to seven commissioners. The commissioners are appointed by the Mayor of Boston and serve under him. The boards of commissioners are responsible for conferring upon and deciding policies for their respective foci. The efforts of the various commissions and the environment department as a whole are led by the director, who is also appointed by the mayor.

Boston Redevelopment Authority

The Boston Redevelopment Authority (BRA) was established by the Boston City Council and the state legislature to fill a void left by the dissolution of the Boston City Planning Board. The responsibilities of that board were transferred to the BRA. They are primarily concerned with reviewing and overseeing projects dealing with urban renewal, areas receiving public subsidy, and "acquiring, selling and leasing real estate to achieve economic redevelopment and to promote public policy objectives, such as encouraging growth industries and appropriate land use policies" (About the BRA 2007) The BRA also takes on a number of other issues pertaining to economic growth and furthering business ventures within the greater Boston area.

Boston Waterways Board

The Boston Waterways Board was created in 2006 in the interest of protecting and promoting public access to Boston Harbor and its shoreline while expediting economic growth in the same area. Increased development around the harbor has begun to threaten the public's ability to view, visit, and enjoy the uses of the harbor. The Boston Waterways Board protects public access and promotes economic growth through

legislation and proposed ordinances as well as by financing projects through the Waterways Fund. This fund is compiled using a percentage of the money obtained from mooring permits and applications. Bryan Glascock, the Director of the BED, is the chair of the BWB and another prominent member of the board is Phillip Terenzi, the Harbormaster for the City of Boston.

The Boston Harbor Association

Since 1973, The Boston Harbor Association (TBHA) has worked toward the goal of a cleaner and more accessible Boston Harbor. It is a non-profit organization designed to serve the interests of the public. Among TBHA's volunteer members are waterfront businesses, harbor users, developers, environmentalists and other decision makers. These diverse groups of people work together to recognize the harbor's many uses and devise harbor solutions that balance everyone's needs.

One of TBHA's core beliefs is that Boston Harbor is one of Boston's most significant assets. They refer to the harbor as New England's maritime port and consider Boston Harbor to be an area of great recreational importance. They also recognize the harbor as an asset to Boston's tourism industry (The Boston Harbor Association 2007). By considering all of what makes Boston Harbor important to the city, TBHA helps the causes of the local maritime industry, the environment and harbor accessibility.

The Boston Harbor Association is involved in many projects that work to improve Boston Harbor and make it more accessible. To benefit Boston's maritime industry and continue the harbor's status as a working port, TBHA established its Working Port program. This initiative works to protect the needs of maritime users by increasing awareness of the harbor's industrial uses. Also, for the past seven years, TBHA has organized the Boston Harbor Marine Debris Cleanup Project. This project prevents and removes floatable debris from the harbor. "To date, more than 200 tons of marine debris has been removed during the past seven summers" (The Boston Harbor Association 2007).

Save the Harbor/ Save the Bay

Save the Harbor/ Save the Bay (SHSB) is an environmental advocacy group comprised of concerned citizens, scientists, community leaders and corporate representatives. The organization serves to protect the waters within the boundaries of

Massachusetts Bay, with special attention paid to Boston Harbor. SHSB has education programs designed to reestablish the link between the people of Massachusetts and the state's waters, as well as to educate children about what has been done to cleanse the harbor and the need for oversight in the future. SHSB has assembled groups of volunteers to sweep the state shoreline, picking up as much garbage as possible on an annual basis (Save the Harbor/Save the Bay 2007).

Urban Harbors Institute

Created in 1989, the Urban Harbors Institute (UHI) focuses on “utilizing policy, scientific, planning and management expertise to assist governments and communities in tackling the problems and issues associated with harbors and coastal areas.” Through the work that UHI has done to aid in the protection of the marine environment, it has developed an expertise in a number of areas. The institute has a great deal of experience with integrated coastal management, water transportation, natural resource protection, and partnership building. UHI has experienced significant growth over the past two decades and have completed projects around the world from Russia, and Bulgaria to Australia.

A decade ago, the UHI developed a set of databases and associated maps of resources within Boston Harbor. The information collected included city data, major roads, transportation paths, harbor access points, and a number of other data types. The data included in the databases simply includes site locations. Some layers are included with labels for the locations.

Recreational Boating and Its Regulation

While there are many different groups and organizations with interests in the harbor, one must not forget recreational boaters. Recreational boating has expanded over the last few decades and boaters can overcome the boundary between land and sea via several types of access points. These access points are described within this section. Boating and access points both require regulation, and so the discussion proceeds to the pertinent law and regulations, and governing bodies surrounding boating in Boston Harbor.

Boating Expansion

With such a large amount of money and time being spent on the clean-up of Boston Harbor, the harbor is becoming more attractive to boaters along the Eastern Seaboard. Massachusetts has seen continued growth in the number of recreational boaters between 1995 and 2005. In this time period, the number of registered boaters has increased 9.1% to just over 150,000 people (NMMA U.S. Recreational Boat Registration Statistics 2005). With increased recreational boating, many activities are becoming more popular on the water so there is a more of a demand placed on the boating facilities, access points, and law enforcement personnel in Boston Harbor.

Recreational boating and consumerism are directly tied together. There is a significant expense associated with harboring a boat at a marina. Further, the upkeep and maintenance of a boat is constantly ongoing and is costly in terms of labor and parts. Hundreds of gallons of fuel can be required to fill the tanks of motorboats, which can come at significant cost given current prices. Transient boaters must find food and they often choose to take shelter off of their boats while away from their homeport. This leads to the patronage of restaurants, supermarkets, and hotels. Boaters often take advantage of the shops and stores offered by a foreign locale, making numerous purchases and bolstering the economy through those purchases. With recreational boating becoming a more widespread activity it is important for the government to provide the necessary facilities for these boaters.

Boating Access Points

Boating access points are facilities that allow boaters to effectively “park” a boat, allowing for the loading/unloading of passengers, boat servicing, refueling, etc. The access points of interest to this section consist of bottom-anchored moorings, boat ramps, “touch and go” docks and pump-out stations. Moorings are fixtures that allow for the placement of boats when not in use. Touch and go docks allow for quick drop-off or pick-up of passengers. Finally, pump-out stations allow for the discharge of sewage from vessels. This section will discuss these access points in greater detail.

Moorings

A popular type of access points used by recreational boaters is mooring sites. A mooring site consists of a buoy that is attached to an anchor using a chain that is dropped

to the bottom of the ocean, as can be seen in Figure 4. There are many different factors

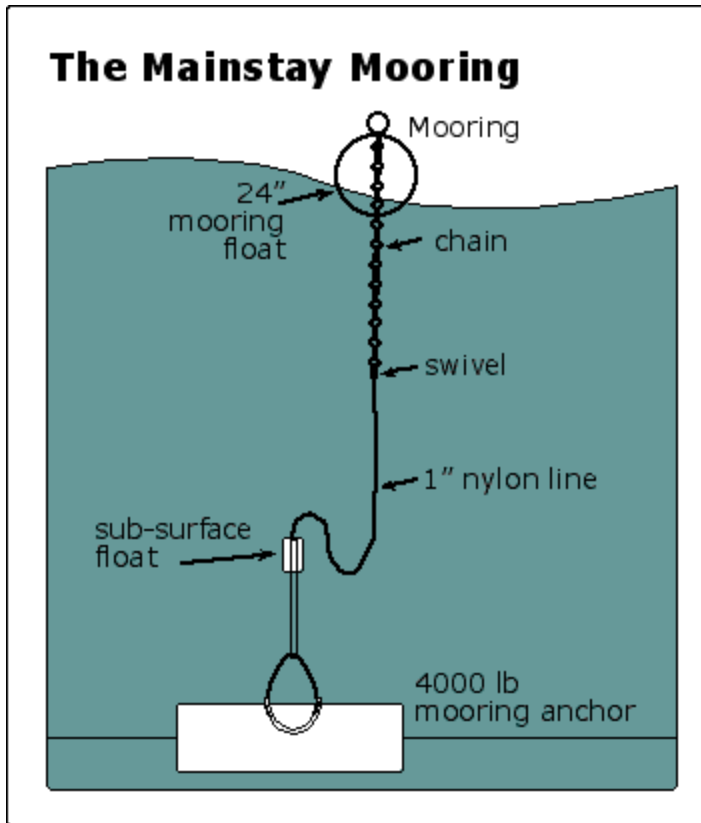


Figure 4: Sample Mooring Tackle Diagram: The mainstay mooring extends through the water column, with the float on the water surface and the mooring anchor resting on the bottom. The float is attached to the anchor by combination of chain and line. A swivel connection allows the metal chain to be securely attached to the nylon line. The mooring anchors can be poured concrete blocks, expired engine blocks, or any other object weighing enough to counter the forces of tide, wind, and waves acting on a moored boat (The Mainstay Mooring 2002)

that go into the design of mooring sites such as the type of anchor used, chain length, and location (Quinn, Alonzo DeF 1961). Mooring sites provide boaters with a location to secure their boats to when they are not using them. After tying up their boat, a launch or dinghy is used to shuttle the boaters ashore.

These mooring sites are valuable because there is not enough shoreline to have everyone dock their boat in a marina. Mooring sites can be taken up during winter months or moved to a new location, making them a flexible and simple means of securing a boat. Moorings are located throughout Boston Harbor and significantly expand the holding capacity of

marinas where it is not possible or practical to build piers.

Moorings sites within Boston Harbor are not laid by a government agency. Generally, private parties hire contractors to install moorings. Different types of mooring tackle are used to accommodate various bottom compositions, currents, and wave action. The terrestrial coordinates of mooring sites are taken by the boaters or by the contracting agency hired to install the moorings. The Harbormaster is in possession of a spreadsheet that logs the locations of all of the mooring sites within Boston Harbor, as well as the permit information for the moorings.

Boat Ramps

Boat ramps allow for the launching of boats transported on trailers. Because of these ramps, people can launch a boat for an afternoon or weekend and retrieve it at the end of their boating excursion or remove them at the end of the boating season. The ramps are constructed using concrete, timbers, or both. Boat ramps slope down to meet the edge of a body of water, so that a towing vehicle and trailer can be backed up into the water until the boat can float off of the trailer. In bodies of water with soft bottom composition, the ramps extend under the water to support the trailer and the rear end of the towing vehicle.

Touch and Go Piers

There are a number of piers in Boston Harbor that have been restricted to “touch and go” access. These piers allow boats to tie up for a period of several minutes to drop off or pick up people or supplies. The piers are not intended to dock boats while the owners are not onboard.

Pump-out Stations

A concern of boating that is often overlooked is the development of human waste. Many boats in Boston Harbor have a ‘head’ system aboard which is used as a toilet. Waste generated by boaters is stored in a tank which has a finite volume, generally no more than several dozen gallons. When the tanks are full, their contents must be pumped out by a marina or ground up and pumped into the ocean by a device known as a macerator. Many marinas, as well as independent facilities, are equipped with pumps that can evacuate the holding tanks onboard a boat and then pump the waste into the local sewer line. The pumps used must be primed with water and therefore cannot be operated when temperatures fall below freezing (Boston Waterboat Marina 2007). Many of these facilities received funding for the pump-out equipment through grants stemming from the Clean Vessel Act (CVA) and therefore are required to provide free pump-out services for a few years.

Established in 1992, the Clean Vessel Act (CVA) addresses the environmental concerns related to boat sewage. By informing boaters of proper discharging practices and encouraging the use of pump-out stations, the CVA has increased the environmental awareness of the boating public. An example of this was observed on Nantucket Island

where a local marina manager "found a huge change in the boater's attitude towards pump-outs." Through CVA grants, 2,200 pump-out stations have been installed, providing boaters nationwide with access to pump-out services (U.S. Fish and Wildlife Service 2007). While a maximum fee of \$5.00 can be charged for these CVA-sponsored services, facilities in Boston Harbor can be used free of charge.

Environmental Regulations

Many recognize the benefits of a cleaner environment and more importantly the consequences of pollution. It behooves governments to enact and enforce regulations that maintain their natural resources. Several organizations, from Boston City Hall to the EPA, are working to protect Boston's ever-improving harbor by enforcing legislation such as the Clean Water Act while considering new regulations such as "No-Discharge Zones".

No-Discharge Zones

"No-Discharge Zones" (NDZs) exist at several locations along the coastline of Massachusetts, as shown by the red areas in Figure 5.

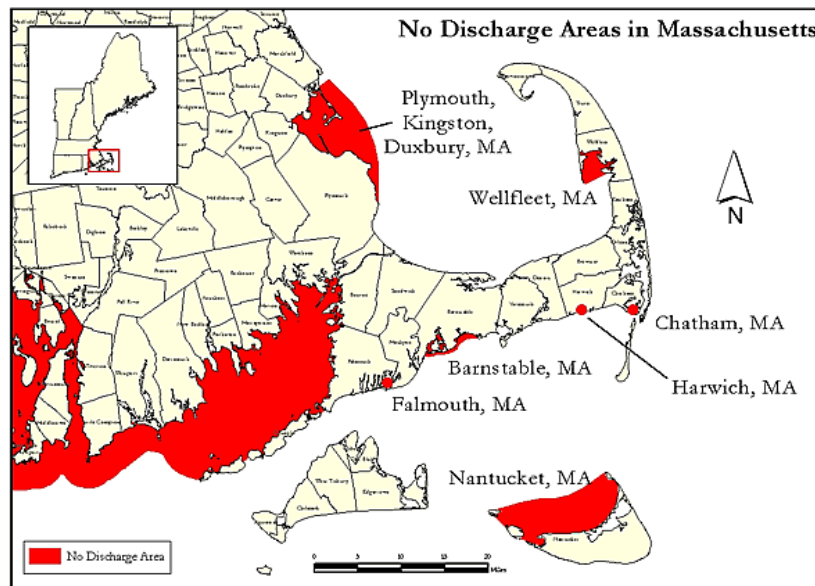


Figure 5: No-Discharge Zones in Massachusetts: The map above displays the waterways within the Commonwealth of Massachusetts that have already been designated as No-Discharge Zones. Buzzards Bay, Plymouth Bay, Wellfleet Harbor, and several other portions of Massachusetts.

As it would help to improve the marine environment, the BED may consider evaluating the possibility of establishing a NDZ in Boston Harbor. To apply for the designation of a

NDZ, the following information must be collected (Code of Federal Regulations, Title 40, Volume 19)

- (1) A certification that the protection and enhancement of the waters described in the petition requires greater environmental protection than the applicable Federal standard;
- (2) A map showing the location of commercial and recreational pump-out facilities;
- (3) A description of the location of pump-out facilities within waters designated for no discharge;
- (4) The general schedule of operating hours of the pump-out facilities;
- (5) The draught requirements on vessels that may be excluded because of insufficient water depth adjacent to the facility;
- (6) Information indicating that treatment of wastes from such pump-out facilities is in conformance with Federal law; and
- (7) Information on vessel population and vessel usage of the subject waters.

As listed in the Section 140.4, the EPA must have a map of pump-out facilities as well as several other pieces of information before the application will be approved. All of this information can be organized into a single GIS database and then displayed in coordination with the map of the facilities. NDZs exist to provide extra environmental protection where conventional regulations are insufficient.

Government regulations, namely the CWA, impose a distance restriction on how close to the shore sewage can be discharged. No untreated sewage can be dumped within the nation's navigable waters or within its coastal waters, which extend three nautical miles from the coastline. Sewage that has been treated by a Type-I or Type II marine sanitation device (MSD) can be released anywhere that has not been designated as a "No-Discharge Zone" (NDZ) (Pollution Problems...). A MSD is a rudimentary sewage treatment system that can be installed onboard boats. Only a Type-III MSD, which is equipped with a storage tank, can be operated in a NDZ because the treated waste enters a storage tank instead of the ocean waters. Due to the contours of the shoreline, there are areas of the outer harbor which are not protected from this activity. Because of this, raw

sewage is being dumped into the harbor, despite the efforts of the harbor cleanup. This sewage contains high levels of nutrients, such as nitrogen and ammonia, as well as other chemicals and bacteria. As a boat transits through the harbor's shipping channels it comes, at times, within several hundred yards of island beaches and so the chemicals and bacteria could be released in close proximity to those same beaches. While it is not known how prevalent such dumping is currently, a No-Discharge Zone would make any dumping illegal in and around the harbor islands.

Chapter 91

The Boston Environment Department and the Boston Redevelopment Authority are both responsible for aiding in the application of Chapter 91 within the limits of Boston. Chapter 91 of Massachusetts General Law is a piece of legislation designed to protect public's right to access the Commonwealth's waterways. The spirit of the law harkens back to when citizens drew subsistence from the inter-tidal zone, be it through hunting fowl, fishing, clam digging, or harvesting other resources. Over time, land development has erected both physical and perceived barriers to activities requiring access to tidal waters to occur, despite the fact that the public maintains the same rights to that territory.

Under Section 10 of Chapter 91: Powers and duties relative to harbors, etc. the Department of Conservation and Recreation (DCR) is tasked with the supervising the general care of harbors and tide waters within the commonwealth. To meet this requirement the DCR must coordinate with city level government to prevent the interference of harbor navigation and remove unauthorized encroachments within the commonwealth's harbors.

Section 10A of Chapter 91: Temporary moorings of floats or rafts; permits, issuance or refusal; review; public nuisances states that the Harbormaster may authorize the temporary mooring of floats or rafts within Boston. These authorizations are to be given based on the application for and issuance of mooring permits.

Mooring Permit Process

The permitting process enables to city government to ensure that required taxes and fees are collected while also monitoring the owners and locations of moorings, thereby improving security (Boston Assessing Dept. 2007;). Tankers filled with liquefied

natural gas regularly transit through the harbor. There is a threat that terrorists could moor boats in the harbor in the interest of launching an attack against one of these tankers. Information about permitted, moored boats allows the authorities to recognize unauthorized boats, limiting the risk of such a terrorist attack.

A mooring permit will not be processed until the Boston Treasury Department has taken receipt of boat excise tax payment. The excise tax needs to be paid in the city of residence for the applicant. The mooring permit request can be submitted electronically over the internet or a paper copy can be submitted to the Treasury Department. A permit fee must be paid at the time of application and is a variable charge dependent upon boat length and the boater's town of residence. Residents of Boston are charged one dollar per foot and non-residents are charged five dollars per foot.

According to chapter 16, section 48 of the city of Boston municipal code, there are several important pieces of information that must be recorded on a mooring permit. First and foremost is the personal information of the applicant: full name, address of primary residence and phone number (residential, office or emergency). Other pieces of required information relate to the applicant's boat, such as name and descriptive feature to include make, model, year, color, draft, length and use. Also, the applicant must provide the boat's registration number. The latitude and longitude of the proposed mooring site must be included with failure to specify a correct or appropriate mooring location resulting in denial of the permit.

Once issued, the permit must be displayed on the port side of the boat, in close proximity to the transom, or stern, of the boat, and is valid until February 15 of the next calendar year. Any vessel moored in Boston Harbor without a permit will be moved to an area assigned by the Harbormaster at the owner's expense. Mooring sites are not to be rented to third parties and are only to be used by the boat that is associated with the permit. As the permit number displayed on the boat is also displayed on the mooring ball, this can be checked by members of the Harbormaster's staff as they patrol the harbor.

The entire mooring permit process, from application to approval, can be very time consuming for the Harbormaster and the Treasury Department. While electronic submission is available, a great deal of applications are submitted via a more tangible

paper form. After processing, a spreadsheet of the latest applications is sent to the Harbormaster. The Harbormaster then prints this spreadsheet and takes it on his boat to verify proposed mooring placements. This process will be repeated as applications are filed. Therefore, as the number of applications increases, so will the need for a more streamlined and efficient permitting process. Such a process would provide both offices with automatic updates of the information they require. This improved access would then allow for quicker application processing with fewer human resources.

METHODOLOGY

The goal of this project was to encourage an increase in recreational boating by providing a user friendly map that showed mooring sites, marinas, and pump-out stations. This map was intended to provide useful features for the Boston Harbormaster, recreational boaters, and many other organizations. The team accomplished this goal by gathering new and existing information, applying the information to create a new updated database, and devising a plan to make the database sustainable. This is particularly important, as this allows the database to be updated easily and frequently so that it is usable for a long period of time.

Three main objectives were identified for the success of this project. The first objective was to gather information with respect to the locations of moorings, pump-out facilities, and marinas in and around Boston Harbor. The second objective was to evaluate existing databases available through the Urban Harbors Institute and the Massachusetts Office of Geographic and Environmental Information (MassGIS). These databases were evaluated to ensure that they were applicable to the project and in a useful format. The last objective was to study the final data that the team compiled and arrive at several conclusions as to how this data should be organized. From these conclusions several recommendations were made to ensure the future sustainability and utility of the final product.

Objective 1: Collection of Mooring and Pump-Out Facility Data

In this objective, the team collected the existing information on mooring sites and pump-out stations located at local marinas. After receiving the mooring data from the Harbormaster, the team interviewed him to assess the data's quality. This was done in order to get a better understanding of how the Harbormaster recorded the information. Meanwhile, surveying the pump-out facilities at local marinas helped the team to evaluate the accuracy and availability of pump-out information.

Mooring Data

Gathering mooring site data was performed in three major steps. The first was to determine exactly what information was available from the Harbormaster. The second

step was to assess the quality of the data. The third step was to analyze the data and assemble a complete database. This work took place during the first two weeks of the project and was headquartered out of the Boston Environment Department office located in Boston City Hall. Interviewing was among the data gathering methods performed by the team.

One of the earliest field interviews was with the Boston Harbormaster. While the database he e-mailed the team was quite large and detailed (containing at least 450 moorings), there were additional features and data entries that raised several questions. This interview sought to clarify these items and identify what methods and equipment were used to obtain the data, as well as how recently it was collected. Prior to interviewing the Harbormaster, the group developed an interview plan that intended to get his perspective on the whole process. Questions focused mainly on the permitting process, but also referred to the overall use of the permits. The team hoped to explore every aspect of the Harbormaster's involvement in order to find out what could be done to make his job easier. In addition, the team needed a detailed explanation of the database he was using, as it was in an unusual format and was somewhat difficult to decipher due to a proprietary system of color-coordination. The actual protocol used to interview the Harbormaster is located in Appendix E.

After interviewing the Harbormaster, the team went back to work evaluating the database he provided. First, raw data from the Harbormaster needed to be converted into a usable format. In order to do this, the group first evaluated the format of that data that the Harbormaster had. This format, a Microsoft Excel spreadsheet, was not easily usable by the Boston Waterways Board, so standardizing the data by converting it to a Microsoft Access database was paramount. Standardizing these data made it useful to the group and the Boston Waterways Board in future objectives. In addition, once the data was in a format that was widely used and easily accessible, sustainability of this database was possible.

Verifying the quality of the mooring site data was very important to the success of this project for several reasons. It was essential for the group to have accurate data to work with in order to make this analysis. To do this, the team evaluated the quality of this information based on the interview and decided what additional measures needed to

be taken. While some researchers feel that quality refers to validity or reliability of data, others consider it to be a measure of evaluating the trustworthiness and transparency of the information {Knight, P. T., 2002}. This project required the group to evaluate the Harbormaster's data in a way that combined elements of each of these schools of thought.

The Boston Harbormaster provided the group with a spreadsheet that included all the mooring permit information he had on file for the floating, bottom-anchored moorings in Boston Harbor. This spreadsheet had fields of information for specifics on the applicant, including address and contact information, information on the boat such as size, make, model and year, and additional information used for taxation purposes. The most important data in this stage of the project was the positional data providing the location of applicants' mooring sites. This information was provided in latitude and longitude, and gave the group a way of plotting these positions on the Geographic Information Systems map as part of a major deliverable. Plotting locations on this map also served to help the group determine if locations were even reasonable, before checking finer location details.

Pump-out Facilities and Other Data

While work progressed on obtaining and verifying mooring data, the same was carried out with regard to pump-out facilities and marinas. A number of facilities, both commercial and public, exist within the Boston Harbor area. A list of pump-out facilities with their respective phone numbers are published every year by the Massachusetts Office of Coastal Zone Management. However, it only lists facilities intended for use by recreational boaters. Facilities for commercial boaters had to be identified through the assistance of the BED, BRA and the Massachusetts Port Authority. Exact coordinates of all facilities were identified using utilities such as Google Maps and Google Earth. Each location was then surveyed for information that would aid the BED in the development of a No-Discharge Zone. The survey was conducted by e-mail, interview or telephone (depending on the availability of pump-out operators) and requested the following information such as hours and seasons of operation, capacity, methods and equipment used, and where funding came from. A more complete survey protocol can be found in Appendix F.

After all data was recorded and found to be of satisfactory quality, work could begin on converting the data into a format suitable for GIS mapping. In addition to gathering data on the locations of moorings and pump-out facilities, the team gathered different perspectives from which this project might be viewed.

The team sought advice from potential stakeholders in harbor recreational use such as marina owners, boaters, the Boston Waterways Board and The Boston Harbor Association. These discussions helped to determine how the project will be of most use and to identify important topical fields for the team's databases. These measures helped to make the final output more useful in an inter-agency setting.

Objective 2: Examine Existing Databases and GIS Layers

The focus of the second project objective was gathering existing data that complemented the information gathered in the first objective. There were several sources of data available to the team. MassGIS was one resource that provided dozens of data layers that allowed the team to pick and choose information that help to further project goals. Another resource was the Urban Harbors Institute. Because of prior work done for the BED by the Urban Harbors Institute, there existed several layers of base-data that provided a solid foundation for the project's map. An interview with UHI was scheduled to facilitate greater understanding of these available resources.

UHI has been involved in mapping Boston Harbor for some time now. The result of their work has produced databases that can produce GIS data layers. The depth, detail and completion of these layers was unknown until the group met with a mapping expert at UHI. Prior to this interview, the group developed an interview plan that included the following key questions:

- 1) What GIS layers are available from the Urban Harbors Institute? Do these layers identify important boater access points such as moorings, pump-out facilities, marinas, etc.?
- 2) In what format are these databases and layers created?
- 3) What software is used to develop these databases and layers?
- 4) Can you identify layers where data is either incomplete or obsolete?
- 5) Are there any regulations pertaining to use and representation of UHI proprietary data?

There have been significant efforts to electronically map Boston Harbor in the past; accessing the products of these efforts was crucial to completing this project properly and in the time allotted.

Because the variety of GIS layers the Urban Harbors Institute and MassGIS was provided in differing formats, the team spent significant time going through archival data from these sources. Ultimately, the layers that were of most use to the project were those that outlined the waterfront areas of the harbor and pinpointed boating amenities, such as marinas or service stations, within the harbor. This method was used to determine which databases were useful to the project, and what needed to be done to adapt them to the team's standard formatting {Knight, P. T., 2002}. Once this was done, the data from UHI and MassGIS was integrated with data collected in other objectives. Finally, when all data had been thoroughly organized, analyzed and made complete, the group utilized it in working toward the completion of project deliverables. In order to have confidence in the project's findings and deliverables, it was prudent to check all data and their respective sources for reliability.

The accuracy of information collected on behalf of the state of Massachusetts or the city of Boston was not considered to be suspect because it was gathered by professional research analysts who were hired by either of those entities. Some of the information, however, was collected up to a decade ago and there was a distinct possibility that changes have occurred. Businesses may have closed or organizations may have dissolved and so their continued operation had to be verified. In most cases, the businesses and organizations simply needed to be contacted.

Objective 3: Ensure Database Sustainability

After the gathering and restructuring of data from the Urban Harbors Institute and the Boston Harbormaster several Geographic Information System (GIS) layers were constructed to display all findings. These layers were assembled into a graphic representation in the form of a map, which displayed all of the data obtained throughout the project. The map was a crucial part of the final deliverables of the project. Based on the graphical information displayed by this map, the group made recommendations to the Boston Environment Department on sustainability and action-items. The next phase of

the project focused on organizing the data and making the final products more useful to potential stakeholders.

The group took each of the databases developed in earlier objectives and input them into GIS software. This allowed the construction of layers based on the information contained within these databases. An example of GIS layers is shown in Figure 6. One layer was constructed to depict the precise location of all of the mooring sites within Boston Harbor. Embedded within each point indicating a mooring was the depth of the water at that location and the

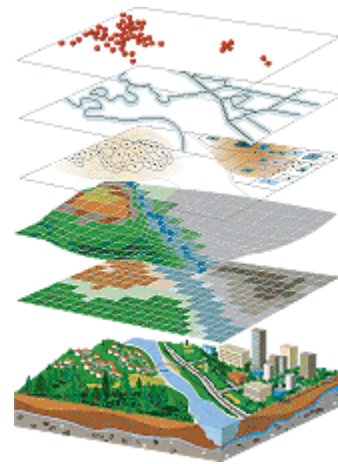


Figure 6: Layers of a GIS Map

maximum boat length that the mooring could accommodate.

In addition, registration information such as boat make, model and year, permit holder's address and contact information, and whether or not the person had held a permit previously. Additional layers depicted pump-outs and marinas. The series of GIS layers that were ultimately produced constituted a user-friendly and efficient means of displaying the facilities available to boaters within Boston. However, GIS layers alone will not solve all of the problems that this project addresses. Complementary tools needed to be created to keep the map easily updated and referenced.

The team used the information represented in the map to make recommendations to the Boston Environment Department. In order to facilitate sustainability, the group needed to determine the best way of keeping the mooring and pump-out databases updated, accurate and accessible to a variety of agencies. To do this, the mooring permit application process had to be evaluated. The team developed a form to be placed online that will automatically update the database when the application is submitted.

Microsoft Access is an efficient database program that is easily imported into MapInfo. Microsoft Access has the ability to create forms that will automatically update the database. However, after investigating various options, the group selected a new program called Microsoft InfoPath which is intended exclusively for designing and implementing forms. The group decided to use this program instead of Microsoft Access

because of its more advanced capabilities; it also made the form easier to export to the internet.

The group used Microsoft InfoPath to create a form to be linked to the Microsoft Access Database. By combining the strengths of each of these programs, a more effective form could be created that can not only collect data, but also transfer it to a database. The database takes the process one step further by importing the data directly to the GIS map. The programs work together to create a modular, easy to use information system that provides a quick, convenient means of data distribution. Similar systems were developed to log information on pump-out services located in the harbor.

Other recommendations were made based on the data included in the pump-out layer. The Boston Environment Department had a variety of needs for this information, the foremost being an application for a No-Discharge Zone status in Boston Harbor. The information the group assembled regarding pump-out facilities was used to make recommendations on the feasibility of such a status.

As it was the final objective in a sequence of three, the construction of GIS mapping layers could only begin after the other two objectives were complete. This objective required the data gathered and verified during work on Objectives I and II as well as a familiarity with how to manipulate GIS software. Completion of the objective allowed analysis of data pertaining to recreational boating in Boston Harbor. It also filled a void in the records of the Boston Conservation Commission and the Boston Waterways Board and allowed for improved management of Boston Harbor resources by overlaying information in a visual form, for simplified correlation.

RESULTS AND ANALYSIS

Team research yielded a significant amount of data. Through interviews, surveys, and archival research the team has identified processes for rectifying the problems with the current mooring application process, a means of accurately displaying access points throughout the harbor, and key data that needs to be displayed alongside those sites to satisfy the informational needs of the parties that will be using the deliverables that have been developed.

Mooring Permit Database and Permit Application

Today, mooring permit information resides in a Microsoft Excel spreadsheet residing in the Treasury Department of Boston City Hall. Through interviews with the Harbormaster and the Treasury Department the team was able to acquire a copy of this spreadsheet. This database contains a variety of information on hundreds of permits, but is difficult to access and cumbersome to those charged with its upkeep. The

Harbormaster and the Treasury Department require specific information from different portions of the mooring permit application. That information has to be requested from boaters in a manner that the average citizen can understand and comply with. Not only is this information not necessary to all viewers; some of it may in fact be privileged information protected by the Privacy Act, and therefore it is very important to ensure that the correct people get the proper pieces of information. Interviews with Vivian Leo from the Treasury Department and the Boston Harbormaster, Sgt. Phillip Terenzi, revealed that this database (shown, in part, in Table 1) is currently cumbersome and problematic for those who have to use it. It also became clear that it causes tension between the Boston

Permit No	Latitude	Longitude	Last Name	First Name
382	042.19.55	071.01.30	Holden	Lawrence
5	042.19.47	071.01.31	Carthas	Paul
539	042.19.55	071.01.45	Moran	Steven
707	042.19.47	071.01.13	CAVANAUGH	Scott
83	042.19.76	071.01.47	Gilson	Peter
955	042.19.93	071.01.49	So Bos Yacht Clu	Sbyc
956	042.19.91	071.01.55	So. Bos Yc	So. Bos Yc
979	042.19.80	071.01.36	Barry	Kevin
1899	042.19.85	071.01.54	Mcman	Philip
1501	042.19.54	071.01.44	Moran	Steven
917	042.17.30	071.02.30	Huminik	John
937	042.17.40	071.02.30	Mong	Sally
1941	042.18.71	071.02.45	Sweeney	Christopher

Table 1: Sample shot of the initial Mooring Database

Police Harbormaster and the Boston Treasury Department due to the extra work and communication required to update it. The current path of an application, which is incredibly complex, is shown in Figure 7. The process requires an intense amount of manual manipulation of data and is thus highly inefficient.

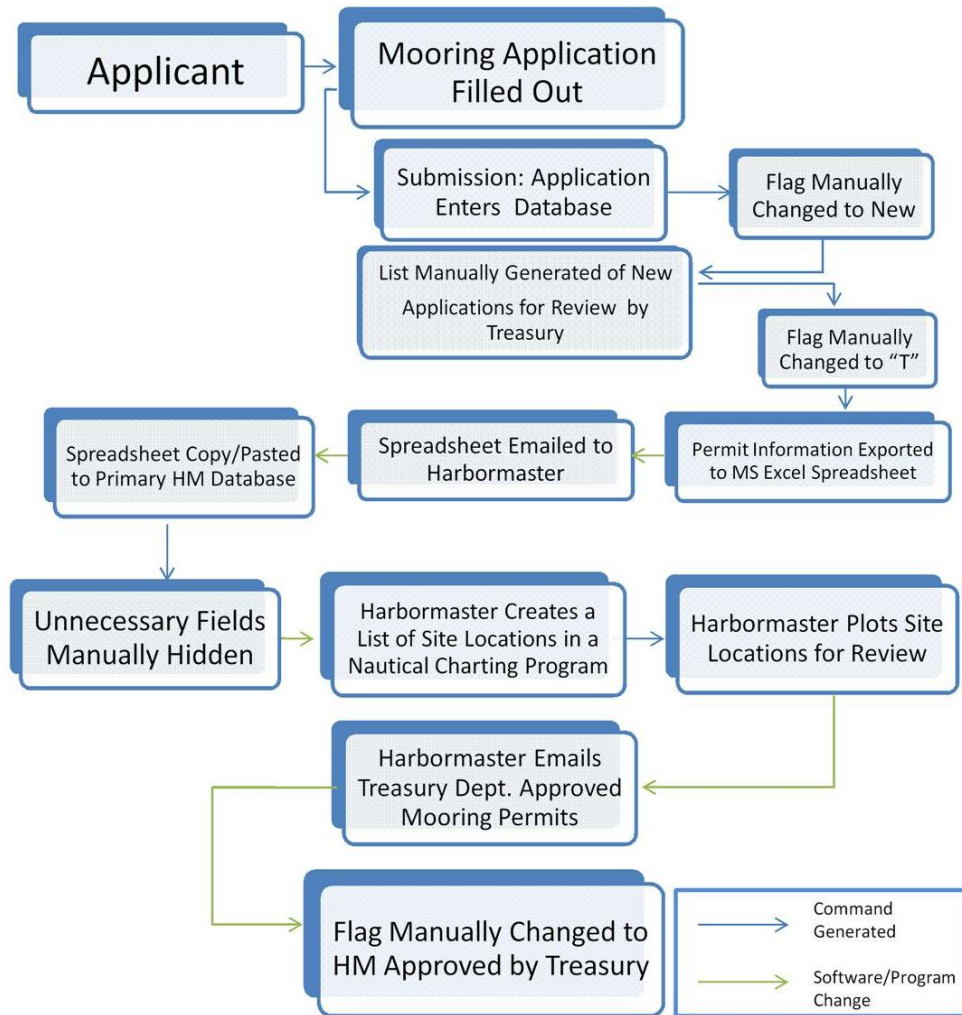


Figure 7: Current Mooring Permit Process

Issues with the Permit Application Process

Though he has the responsibility of approving or disapproving mooring permit applications, the Boston Harbormaster’s primary concern is not with the process. The job of the Harbormaster is to enforce laws and promote safety on the water. The time his

office devotes to processing permit applications is time out of the group's primary responsibilities. Because the permitting duties are secondary, the Harbormaster has no special training in computer applications or database work. This hampers his ability to organize the influx of data, and limits what he can do with the data. Without the ability to critically analyze data in real-time as it comes in, it is virtually impossible for the Harbormaster to get the level of detail he needs.

There are some key problems with the existing system that prevent the Harbormaster from improving the procedure for examining permit data. The biggest problem currently is that the existing permit application does not necessarily address all the information needed to properly execute the Harbormaster's duties. Furthermore, the positional data he gets from this database is not always accurate or precise, and is frequently formatted incorrectly. Initially, mapping the information caused problems due to confusion on how the information had been procured. Standard coordinates are provided in Degrees, Minutes, Seconds (DMS) form, but the Harbormaster's information was provided in Degrees, Minutes, and thousandths of minutes.

Once this problem was overcome, several more presented themselves. Specifically, of the approximately 470 mooring sites in the existing database, only about 400 were in the uniform format of degrees, minutes, and thousandths of minutes, each separated by decimal points. Of those that were formatted properly, nearly 100 coordinate sets produced positions that were clearly inaccurate. Many of these anomalies were as minor as sites listed on piers or shorelines, but some projected thousands of miles away from Boston in all directions, as indicated in Figure 8.

Yet another problem with the current process came from applications that would have been better served through simpler renewals. Renewal forms require less information to be filled-out by the applicant and less data entry by the Treasury Department, as the database from the previous year can call-up the permit information from the previous year. Some applicants mistakenly request a new permit. This generates a new permit number and the need for new permit stickers to be distributed adding to the work that must be done to in conjunction with paperwork coordinated with permit issuance.

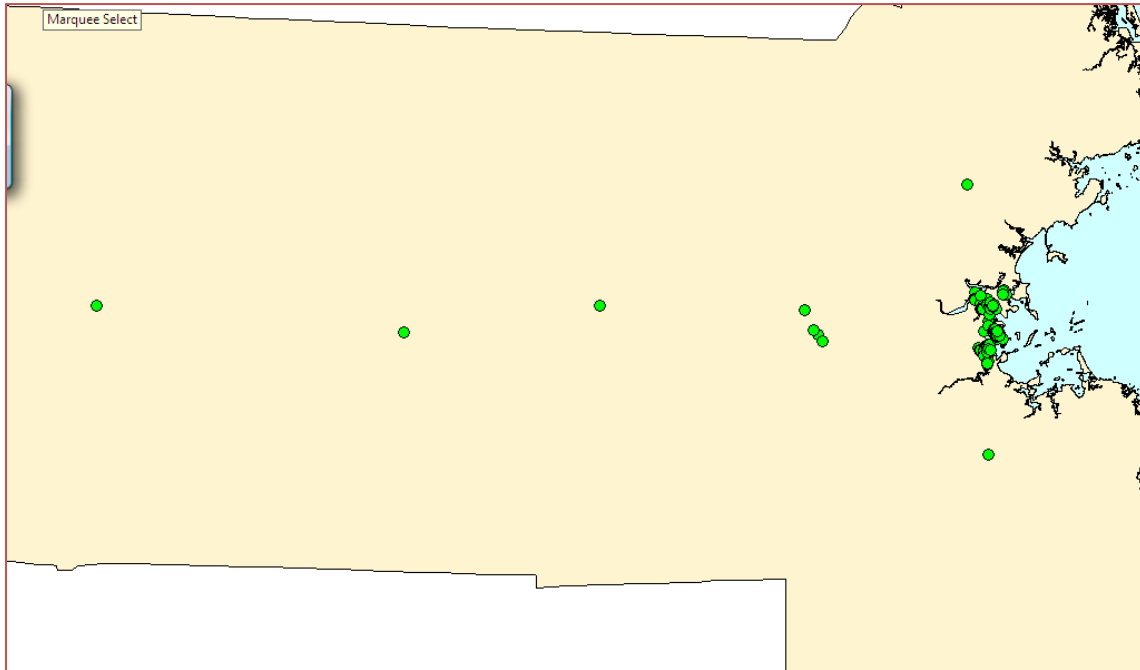


Figure 8: A screenshot of the map displaying erroneous permit locations

Issues with Permit Application Data

One major problem identified by the Harbormaster is the fact that information provided by applicants is not always provided honestly. There are a variety of motivations behind falsifying information on the mooring permit application. According to accounts from employees of the Treasury Department, many people simply wish to avoid paying excise taxes, or hope to receive the special ‘Boston Resident’ application fee, which is \$1 per foot versus the standard \$5 per foot. Other intentions, as explained by marina operator John Sinagra, range from providing inaccurate or estimated latitude and longitude coordinates to avoid having to input data for many sites in a small area (organizations like sailing clubs with many small boats), and individuals registering private permits with the intention to market them for financial gain. According to the Harbormaster, it is illegal for a private citizen to profit from the sale of a mooring, as the waterways are publicly owned and therefore cannot be the property of any one individual. In the past there have been instances of marina operators registering for groups of permits, and in turn renting these mooring sites out to transient and resident customers for varying lengths of time. Currently, the permitting process does not catch attempts to do

this, and the Harbormaster does not have the resources to enforce these laws after the permits have been issued.

Once the data was plotted, it became clear that there were many issues with the accuracy of the data. The map made it possible to visualize just how wrong some of the information was. For example, while most of the points were plotted in the harbor's general location, many of them appeared other places, including western Massachusetts, Europe, and the middle of the ocean. In addition, using the orthographic photographs layered over the map, it was possible to reconcile projected mooring fields with their actual locations. It was very easy to determine if something was in the wrong place based on this.

Another major issue was that the data was not all in the same format. After plotting the points, a query determined that around 40 data points were not being displayed on the map. An individual check on each of these points showed that they were in various formats, using hyphens, decimal points, dashes and colons to separate values. Because this information differed from the standard, it was not being accepted into the software and therefore not being plotted on the map with the rest of the mooring sites.

Along with formatting, there were major issues in determining the way the data was provided. Standard latitude and longitude coordinates are provided using a system of D (degrees), M (minutes), and S (seconds). Minutes and seconds are based on a time-scale, so each must be a number out of 60, for example 42 Degrees, 30 minutes, 15 seconds (read, 042°30'15"). In many cases, seconds were provided as three-digit numbers or as two-digit numbers over 60. This would be impossible, as anything over 60 seconds would be read as an additional minute (i.e. 90 seconds = 1 minute, 30 seconds). After considerable confusion, it was determined that these positions were using different conventions; providing degrees, minutes, and a decimal number referring to a fraction of minutes. This decimal number varied in how many places it was carried out to. To further confound matters, the same symbol to denote a decimal was being used to separate degrees and minutes, which led to the confusion with this data.

A final issue encountered in plotting this data was the fact that boaters don't always know their coordinates to provide for the application. In some cases, marinas

were providing general coordinates for their areas of operation, and allowing boaters to enter the same coordinates for multiple boats. This led to data points being plotted right on top of one another, and these data points were useless as they did not provide specific enough information on the map. In other cases, boaters simply guessed at their positions, or made information up. This data was the most difficult for the group to interpret as it was nearly impossible to determine the location intended in the applications. Identifying these areas of inconsistency was a major step in understanding the way the data is collected. Analyzing the way these errors occurred allowed the group to figure out how best to correct them.

Analyzing Mooring Data

Mooring fields are installed based on a number of criteria such as geographical features, shipping channels, bottom contours, composition and preferences of the installer. Some fields are installed with sites falling in rows and columns, with others expanding out in a radial fashion and other placed haphazardly. Mooring fields do not change a great deal from one year to the next. Only a limited number of pieces of tackle, perhaps one or two per field, are lifted or moved during or at the end of the boating season. Because of this, the fields maintain a unique characteristic shape. By overlaying mooring site data above the orthographic maps produced from aerial photography, the actual location of mooring fields can be compared to the location of fields generated from mooring permit applications. Mooring sites, plotted according to mooring data, were appropriately placed relative to one another. Therefore, the plotted fields took on the appropriate characteristic shapes. The vast majority of the plotted fields fell perfectly upon the fields depicted in the orthographic maps. For those fields that were translated north, south, east or west of their true location, the latitudes and longitudes were adjusted until the sites fell in the correct locations.

Formatting issues were corrected by running a “replacement search”, available through the excel tools menu, which finds a selection within an application and offers the opportunity to replace that selection with an alternate character or word. All separators were replaced by colons. At the end of the formatting process, all of the latitudes and longitudes had been standardized to the form DD:MM:SS.

The area of the harbor in which mooring sites are located falls within 70-77 degrees longitude and 40-44 degrees latitude. Any degree values outside of those ranges were incorrect, as they are not bound by the harbor. In some cases, degree measurements were recorded as 420 or 710 degrees. Such entries were identified by sorting the database in order of increasing value. They were then deemed to be typographical errors made by applicants that intended to enter 042 degrees latitude and 071 degrees longitude. In those cases where the minute values exceeded sixty, the values were compared to those recorded for other boats in the same mooring fields. None of the mooring fields are more than one minute or one nautical mile across; therefore the minute values were altered to reflect the values for the remainder of the field. To ensure proper placement, these alterations were then compared to the previously mentioned orthographic maps.

There were also cases where marinas were providing either one location for their entire mooring field or simply altering an initial location by a single thousandth of a minute for each new site, nothing was done to change the locations. The number of such cases was limited, with only a small percentage of mooring site locations being entered in that manner. Any changes to the locations would have been done without any degree of certainty, doing nothing to improve the team's data. The only measure that can be taken to rectify this problem is to prevent such entries in future rounds of permit application.

A new database has been developed for the mooring permit data to reside in. This new database was created in MS Access and will serve as a template for the City of Boston MIS Department to follow during the creation of a SQL- based database. The SQL database will be maintained on a server in Boston City Hall. The new database template addresses the limitations of the current application form, database, and approval pathway by allowing the addition of new fields, and recommending adjustments to the flow of information. A properly formatted mooring field is shown in Figure 9.

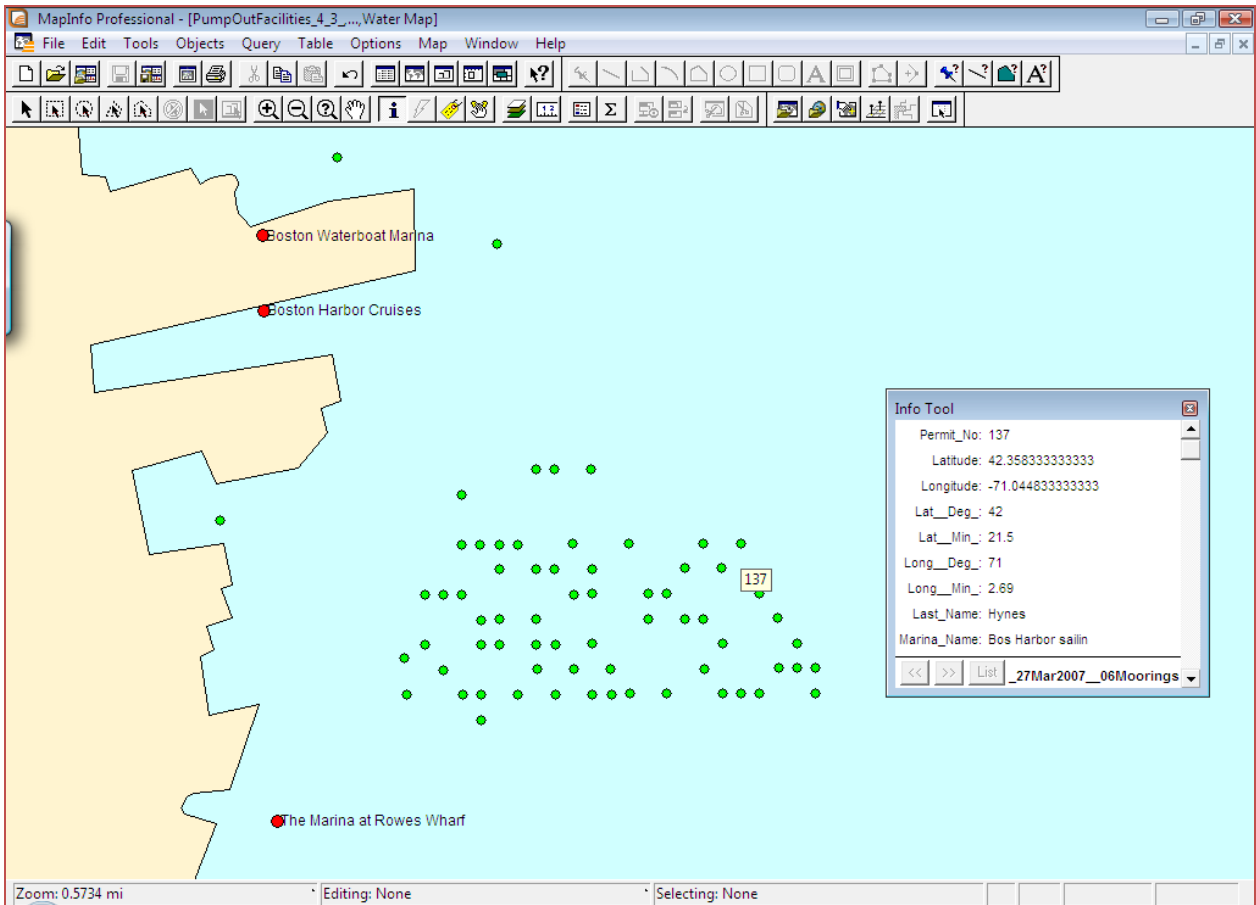


Figure 9: A screenshot of the properly formatted Mooring Database Map

Permit Payments

There are additional problems with the current process relating to permit payments. The Boston Treasury Department is the primary location of the current mooring database. Because the Treasury is mainly concerned with receipt of payment of excise taxes and mooring permit fees and does not require the other, boating specific, information included in the permit, most of the other information in the database is essentially ignored. Despite the fact that this information is largely meaningless to the Treasury Department, people in this area have been given the task of adding new entries, maintaining the database, and providing the Harbormaster with updated lists.

One of the main issues with this situation is that the Treasury Department puts time and effort into this task but does not always gain anything back from it. An example provided by the Treasury Department is a list of over sixty applications from a non-profit organization (NPO). These permits are exempt from fees and taxes because of the NPO

status, so the Treasury does not receive any compensation; however, the amount of work that goes into processing these permits is staggering.

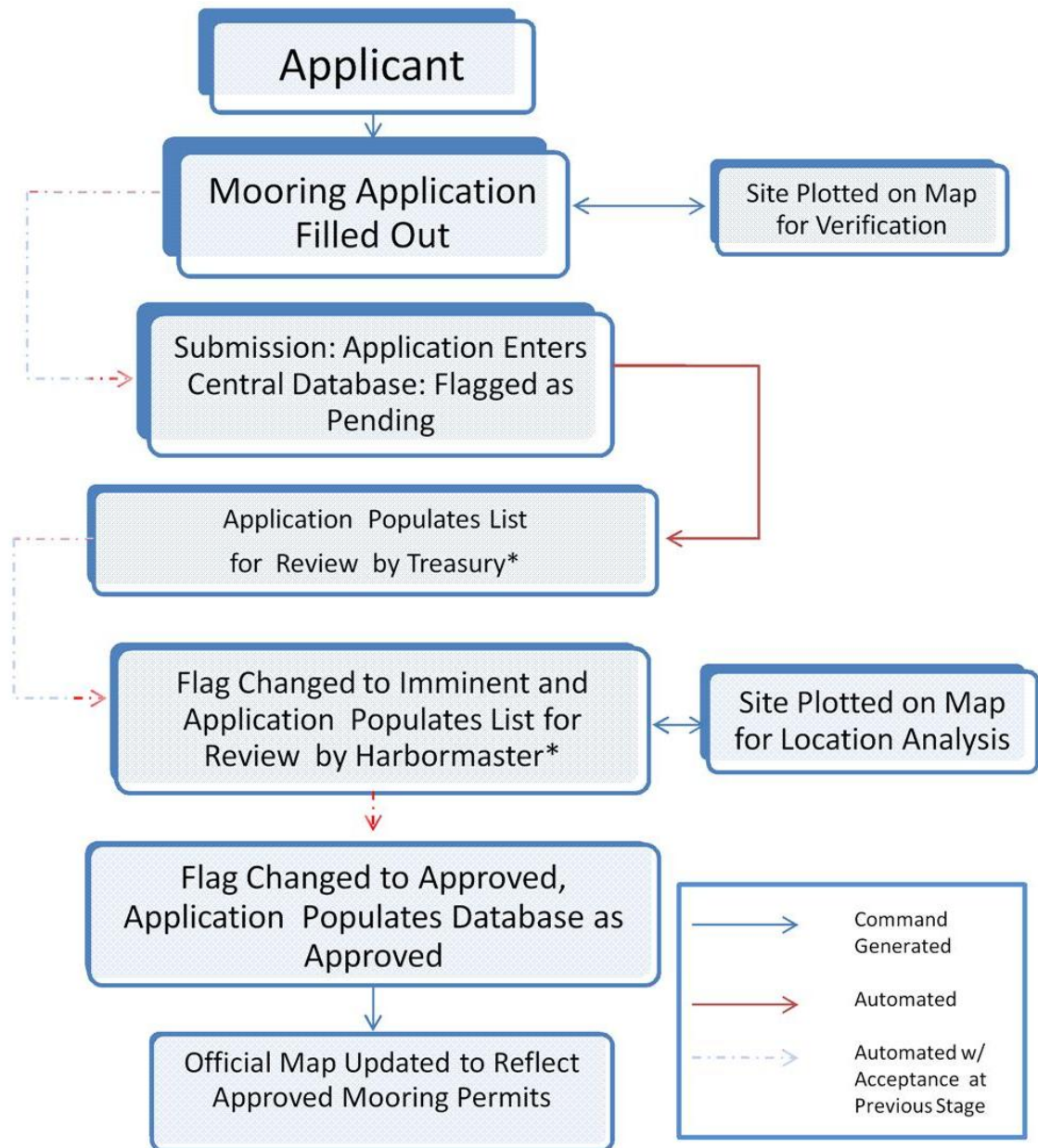
Another issue depicted by the Treasury Department involves money owed to the city by applicants. Excise tax payment verification is a key step in this process. In some instances people have attempted to escape paying excise tax through a variety of tactics surrounding residence statements. Another problem, as mentioned before, is payment of the application fee. Non-residents have been known to attempt to declare marinas as a residence in order to get the one dollar per foot rate, which is reserved for Boston residents (as opposed to the five dollar per foot rate for non-residents). The current database does not have the ability to detect this, even though it would be simple to do so. The easiest way to spot this situation is right on the application. If a person declares residence in Boston, but states their mailing address in a different city, they are clearly attempting to get the lower rate.

Simplifying the Process

After experiencing many difficulties using the harbormaster's mooring site coordinates, it was important to create a form that limited the way boaters could input their information. To that end, a limit was placed on the number of digits that could specify coordinates. An example entry was placed next to the field so that the applicant understands the required format. Since the database is linked to the GIS layers, the map will also be updated. The team referenced the pre-existing online application so that the new form remains consistent with respect to presentation and required fields. The team then had a discussion with the Treasury Department to gain insight on the information flow of the application process. This was not a formal interview, but rather an informal discussion with both sides sharing information. They, along with other organizations, voiced their concerns and stated their needs for the new form. For example, the Harbormaster and the BWB showed an interest in knowing exactly what kind of tackle was used for the mooring sites. They recommended that it would be best to place a text box in the form to allow for a brief description of tackle.

User-friendliness was also addresses in the development of the form. The level of experience that boaters have varies widely as does the level of familiarity with computers. Because of this, one of the most important aspects of input to this database

will be that it will be simple to understand, and easy to use. The online application form, developed by the team in conjunction with Management Information Services (MIS) includes help windows which will appear when a cursor is rolled over fields of input. Particularly complex fields, such as the latitude and longitude coordinates, include detailed instruction on formatting, and additional help, should a person lack the familiarity to determine his or her coordinates. This will prevent the application from having basic errors in formatting, and discourage applicants from falsifying information. The same map that is available to the Harbormaster to aid in approving applications can also be made available online to boaters in order to help select a mooring site, and to locate other amenities nearby. The proposed mooring permit process is shown in Figure 10.



* In those cases where an application does not receive approval from a reviewing party, the applicant will be sent a notification that describes the problem and a means to resolve the problem. Such messages can be developed by the Harbormaster or the Treasury Department.

Figure 10: Proposed Mooring Application Information Path

Pump-out Facilities and Readiness Level for NDZ Designation

Data on the pump-out facilities throughout Boston Harbor was gathered through interviews and phone-based surveys. The information was catalogued within a pump-out facility MS Access database. The database along with other information accrued during the interviews and surveys has elicited some insight into the harbors readiness to institute a No-Discharge Zone.

On paper, it would appear that Boston Harbor has adequate resources to maintain a NDZ. With 1800 registered recreational boats and 17 pump-out facilities available to those boats, Boston Harbor easily meets EPA recommendations for one facility for every 450 MSD-equipped vessels. However, numbers alone cannot adequately describe the practicality of a NDZ. When approved, a NDZ will have immediate impact on all boating activities both commercial and recreational and so the operating schedules for the existing facilities and their capabilities need to be evaluated.

The sanitary pumps used by many of the pump-out facilities within the harbor are charged by freshwater. Because of this, they cannot operate during those months in which the temperature falls below freezing; generally, November to March. The only recreational pump-out facilities that maintain operations year-round are Constitution Marina and Boston Harbor Shipyard and Marina. Those pump-outs are equipped with specially designed pumps that do not freeze-up. The commercial pump-out facilities in the harbor operate year-round, except in cases of extreme cold. These facilities are Black Falcon Cruise Terminal, Boston Harbor Cruises Pier, Boston Towing and Transportation, Constellation Tug Corporation, and Charlestown Pier 4. Improvement could also be made with respect to commercial boating by developing at least one more large-scale stationary facility.

Previous work at the BED concluded that there are a prohibitively small number of pump-out facilities available for commercial vessels. A discussion with Boston Harbor Cruises supported this position when they explained that BHC facilities were being used only by BHC boats and were still over-capacity. The impression is that the amount of installations in existence currently will not be sufficient to support the commercial boating industry. However, the establishment of a NDZ may motivate local boating industries to install more pump-out facilities. For example, Boston Towing and

Transportation has expressed interest in activating additional facilities if an NDZ were established.

Four pump-out boats are operated in the harbor, in addition to the land-based installations. Constitution and Boston Waterboat Marinas provide both land-based and boat-based pump-outs. Charles River Yacht Club and Quincy Bay Marina are only equipped with pump-out boats, with the Quincy Bay Marina pump-out boat servicing Marina Bay on Boston Harbor at regular intervals.

Many of the twenty-two commercial and recreational facilities within Boston Harbor were constructed with funding provided by the Clean Vessel Act (CVA). When provided with CVA funding, the facilities entered into contractual obligations to provide free pump-out services to those boats that they were equipped to aid. Twelve of the facilities in operation are still under contract and so, they offer free pump-outs.

The vast majority of the facilities are located along waters of the harbor that are deep enough, on average, to service boats at low tide. However, Bay Pointe Marina is not. At low tide, the water depth in the marina drops low enough that boats cannot maneuver to access the pump-out station. As the low tide portion of the tidal cycle lasts for six hours and twelve minutes, the facility could be rendered inoperable for a large portion of the business day.

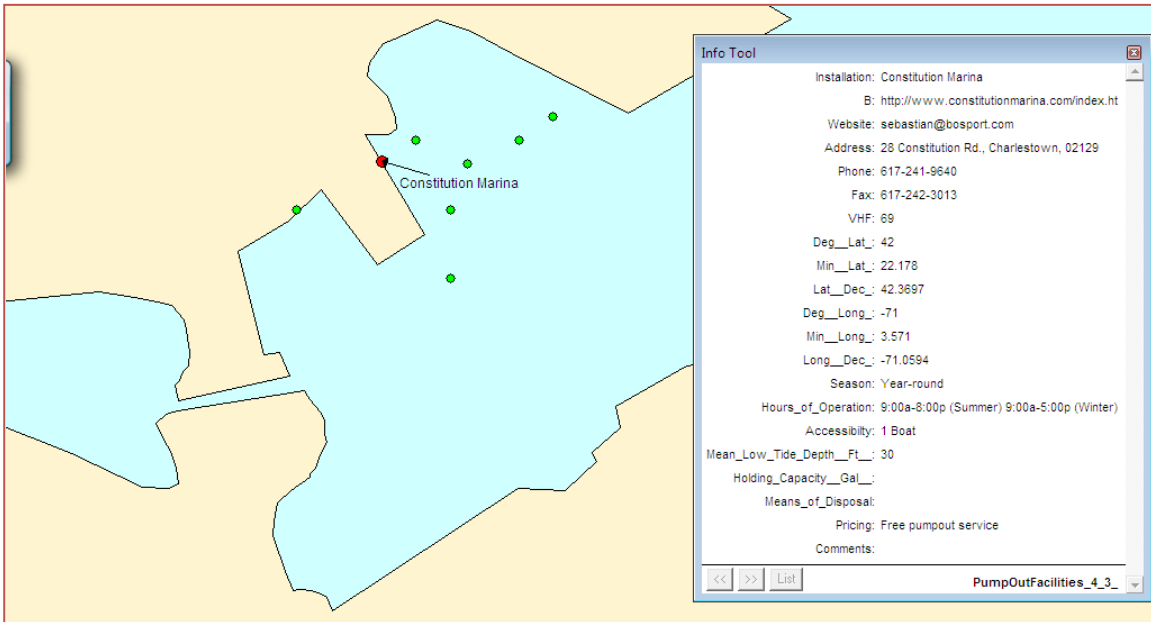


Figure 11: Map Entry for Constitution Marina Pump-Out Facility

All of the information included in the pump-out database was organized and used by the group to create a GIS mapping display output. The map displays the information captured by the database tied to the facilities' physical locations. In Figure 11, the location of a particular pump-out station, the Constitution Marina pump-out, is demarcated on a map, generated from the database, by a red circle on a map of Boston Harbor. Alongside the red pump-out marker, a window displays a portion of the catalogue of information required by the EPA. The window includes hours of operation for the facility, whether or not the site received CVA funding, if the site is attached to a sewer line, as well as a few other items. The database of all pump-out stations will serve as a template for a SQL database that will be created by the City of Boston MIS Department and then adopted by the city. It has been included in Appendix D, and the form used to update this database can be seen in Figure 12. Appendix D shows that a number of pump-out stations are not operable during the winter months. Only Constitution Marina and Boston Harbor Shipyard and Marina run pump-out operations year-round. Others are not funded by the Clean Vessel Act, and so, the general public is not necessarily guaranteed access.

As stated, the harbor currently meets the EPA's requirement for one pump-out facility for every four hundred and fifty MSD-equipped vessels. With less than two thousand recreational boats registered to moor within the harbor and 17 pump-out facilities available to recreational boaters, the harbor is operating at roughly one fourth of its EPA-defined pump-out carrying capacity. This can be misleading as over the course of the boating season, a large number of transient boaters visit the harbor, many of whom bring with them sanitary tanks that were filled over the course of their journey. While the number of transient boaters visiting the harbor is not recorded, and therefore cannot be tracked, the flow of visitors is consistent throughout the summer months. Additionally, as the boating season progresses, facilities experience mechanical failures, disabling the facilities. Other problems arise while boating is in full swing, inhibiting the use of pump-out facilities and drastically reducing the harbor's ability to pump-out the recreational vessels operating within it.

Boston Harbor Pump-Out Facilities

Register here to provide pump-out services

General Information

Name of Installation

Street 1

Street 2

City State Select... Zip Code

Contact Information

Phone Fax Primary VHF Secondary VHF

Website URL

Email Address

Accessibility Information

Season (approx.) Select... to Select...

Hours of Operation to
Field 44

Latitude Deg. Min.

Longitude Deg. Min.

Pump-Out Dock Pump-Out Boat Both

Maximum Draft Feet

Pricing

Notes

Additional Information

Clean Vessel Act Funded

Number of Boats Serviceable at one time Select...

Mean Low-Water Depth Feet

Means of Disposal

Holding Capacity Gallons

Figure 12 - A Screen Shot of the Pump- Out Form

Obstacles to Pumping out Vessels in Marinas

As it is the focal point of their business ventures, marina owners benefit from improvements to the marine environment. A sewage free harbor provides a healthier and more inviting atmosphere to recreational boaters. That being said, there are a number of factors that limit the use of pump-out sites.

All of the pump-out stations available to recreational boaters within Boston Harbor are located as close to a localized sewer line as possible, for simplified transfer of waste. Such placement often does not promote the greatest accessibility to boats as the sewer lines are as close to shore as possible, deep within the marina. It can be difficult for large boats to navigate around the docking slips and the boats moored within them to gain access to the station. This problem is exacerbated if a large boat blocks access to the pump altogether. To deal with this issue, several marinas have constructed and put into service boats outfitted with pumping systems and holding tanks. Constitution Marina, Boston Waterboat Marina and several other marinas within the harbor have made such boats available. The marinas that do not have pump-out boats available call upon their better equipped neighbors to pump-out their clients. This has created a disparity between marinas capable of pumping-out boats. Tom Cox of Constitution Marina and Paul Bramsen of Boston Waterboat Marina both remarked during interviews that they felt as though they were the only companies in the area that were routinely pumping-out boats. They both mentioned that they were being called on to pump-out boats in marinas equipped with the appropriate facilities.

The marinas that received CVA funding cannot charge for pump-out services, as mentioned above. That is not to say that they do not incur expenses when they provide pump-outs to boaters. Electricity is used to drive the pumps and gas is used to propel the pump-out boats. Both of these energy sources cost money and as of late, the prices for them have been on the rise. Additionally, the staff members who operate the pump-out facilities are paid an hourly wage. With pump-outs taking up to a half an hour, marinas can pay their staff members up to half of their hourly wage for each pump-out.

It is not uncommon for the sanitary pumps used by pump-out facilities to be taken out of commission. The pumps installed throughout the harbor and like any other machinery, they are prone to malfunction. Clogs in the tubing, seal failure, or other

issues arise after disuse over the summer and during periods of intense use in the warmer months. While the failures are not always catastrophic, disassembly of a sanitary pump is an undesirable task and so, is often neglected, leaving the pump in a state of disrepair. According to Bruce Evans of Boston Yacht Haven, dockhands avoid the repair of pumps so that they do not have to be bothered with the task of pumping out boats. In some cases, Mr. Evans said that dockhands break the system intentionally to meet the same end.

When a pump-out breaks down, the number of boats within the harbor in need of pump-out services does not decrease in conjunction. The boats pump-out responsibilities of marinas with malfunctioning equipment are forced to direct boaters to other facilities that are still functional. This redistribution of boaters causes some pump-out facilities to be overwhelmed with boats, while others go for days or weeks without providing any services.

One example of an overworked pump-out facility was Boston Waterboat Marina. The staff of this popular marina has made great efforts to provide pump-out service to not only their own boaters, but also boaters from neighboring marinas. It is easy to see why; as their service is free to the public and their pump-out boat can travel throughout the harbor. The trouble with this situation develops when neighboring marinas and yacht clubs that should be able to accommodate their own boats are not able to because of maintenance issues. The body of vessels looking for pump-outs increases sharply, causing the staff at Boston Waterboat to be quite overworked.

Marinas hire on additional staff members to deal with the influx of activity during the boating season. The pumping out of boats is also undertaken by dockhands. From an interview of Tom Cox of Constitution Marina, it was discovered that time devoted to pumping-out boats takes away from the time that dockhands should be devoting to other tasks. Additional pump-out responsibilities would further increase the demands placed on the staff members of marinas.

Perceived Limitations to Use of Pump-outs

As the obligations of CVA funding contracts, which are between three to five years depending on the level of funding by the CVA, begin to expire, installations will start requiring payment for discharging waste from shipboard holding tanks. This will

place a small fiscal burden on boaters. However, it is not uncommon for boaters to spend up to several hundred dollars to fill their fuel tanks. It would not be unreasonable to require boaters to pay a nominal fee for pump-out services. Boston Waterboat Marina completed their obligation to the CVA two years ago, but they have continued to offer free pump-outs. They are considering charging for the service this upcoming season

Boston Harbor covers dozens of square miles of territory. Identifying and locating pump-out stations without some type of aid can be a daunting task for a transient boater entering the area for the first time. The members of the Boston Waterways Board explained to the group that boaters entering the harbor must be notified of the locations of appropriate facilities, so that they can navigate to them for a pump-out. Providing contact information for these facilities in addition to operating hours allows the facilities to be contacted to schedule a pump-out. Contact information includes marine radio frequencies and telephone numbers. Furthermore, boaters must be notified of their rights as consumers and boaters. Signs posted around facilities can give boaters the impression that they are not authorized to make use of said facility. It needs to be made clear if a marina is required to pump-out any boat in need of such services free of charge.

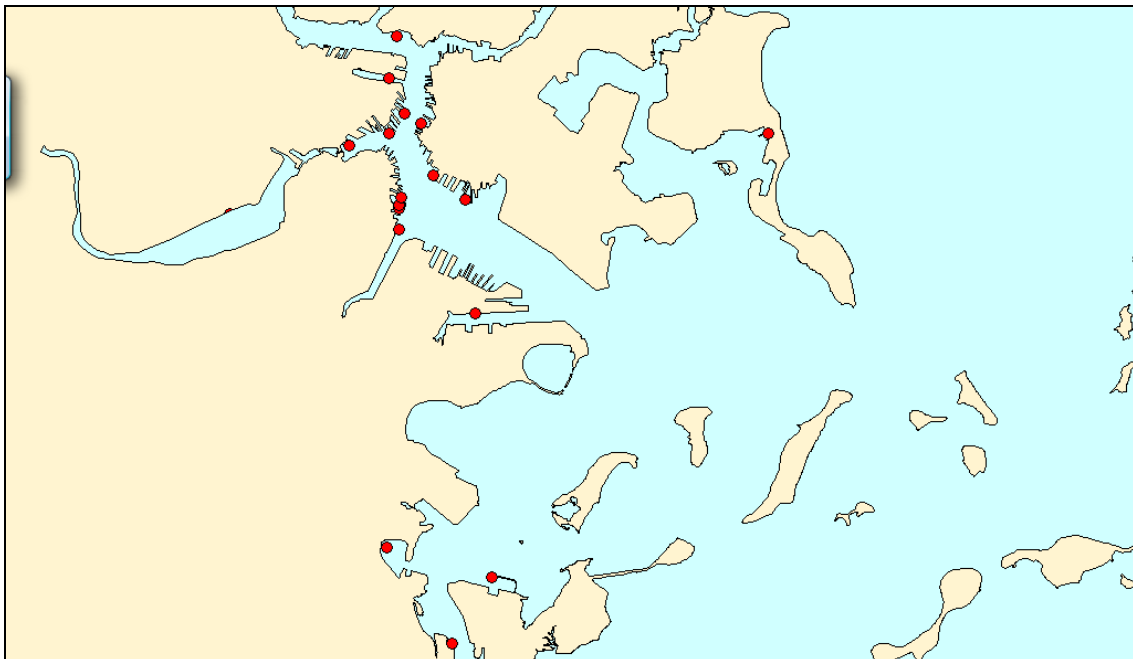


Figure 13: A screenshot of the completed map layer with the location of various pump-outs facilities

Boston Harbor is close to being adequately prepared to support a NDZ. The facilities to support the pump-out of boats within the harbor are available. In order for these facilities to be used at full capacity, limitations to their use, both concrete and perceived, must be eliminated. Maintenance, accessibility, and economic issues must be rectified while use and awareness need to be promoted. Such improvements will educate boaters where they can receive a pump-out and ensure that they can find pump-out services when in need.

Legal Considerations of Providing a Map to the Boating Public

In the interest of increasing awareness amongst boaters about information pertaining to harbor amenities, such as the locations, operating schedules, and pricing for pump-out facilities, the group has investigated making a visual output of the databases that the team generated, in the form of a GIS map that can be placed on the internet. Some concern developed with regard to what information could be included in the map so as to satisfy the Public Information Act as well as the Privacy Act. Because the databases and the map are being maintained by the City of Boston, the information within them is technically considered to be public information, and therefore the public has a right to access it. That being said, a map displaying complete permitting data would include the home phone numbers and addresses for boaters mooring in the harbor, and would invade the privacy of those boaters. According to Karen Roach of the City of Boston Legal Department, the amount of information released to the public can be restricted based on the provision for exceptions to public information designations due to security measures within Massachusetts General Law, Chapter 4, Section 7. Due to this provision, the personal information of boaters can be withheld from any and all of the maps produced from the mooring permit or pump-out facility databases.

CONCLUSIONS AND RECOMMENDATIONS

This chapter includes conclusions and recommendations on how to improve the City of Boston's mooring permit application process, conclusions about the harbor's capability to support a No-Discharge Zone (NDZ), recommendations on how the city can further prepare for a NDZ and how to provide an informational resource depicting what is available to boaters visiting the harbor. Please note that this chapter presents *italicized* conclusions with corresponding recommendations. The recommendations were developed based on the conclusions drawn from the team's findings. Adopting the recommended changes will help to alleviate the current limitations in data, processes, and city knowledge.

Mooring Permit Application Process: Conclusions and Recommendations

The mooring permit application process currently used by the city of Boston serves the majority of its purpose. It fulfills most of the informational needs of the Boston Harbormaster and the Boston Treasury Department; however, the process is cumbersome, creating more work for the involved parties. Those gaps in information that arise from the process cost the city of Boston money and introduce security risks. To produce a more streamlined and fruitful application process, it is necessary to identify the weaknesses in the existing permit application process. These weaknesses are:

- Application does not specify a format for entering mooring coordinates
- Online Application does not detect whether or not a boater has submitted previous applications
- Claims of marinas as residences are difficult to verify
- Treasury Dept. and Harbormaster are given extraneous information
- Application data are not automatically updated to databases

This section is devoted to outlining recommendations for processing future mooring applications. The path was developed as a part of this project and it eliminates a large number of the problems with which the current pathway is troubled. The Management of Information Systems Department (MIS), within the City of Boston

government, has the capability to create a database and permit pathway. If this new database is adopted, it will allow the Treasury Department and the Office of the Harbormaster to minimize the resources required for the permitting process.

Permit Application

The team's recommendations for the mooring permit application process begin with the application itself. This form should be made available as a printable or electronically submitted online document, with a paper copy available as well. The form developed during the course of the project contains the same fields as the application that is currently in use: name, address, contact information, boat details, site coordinates, and renewal or new status, but it has also been expanded to include additional fields. This new form will also address the team's recommendations:

- *Boaters should renew permits instead of requesting new permits and permit numbers.* The majority of the boaters in the harbor maintain their mooring sites from year to year. In most cases, none of the information included in the application and database changes. By retrieving data from previous mooring permit applications, the city can avoid generating new permit numbers and producing new stickers for boats that are continuing to moor from one year to the next.
- *Any boater claiming their boat as a residence needs to attach documentation.* Some boaters falsely list their home address as their marina to avoid paying non-resident mooring permit fees. To prevent this, boaters need to be held accountable for their claims by producing proof from their marina. This attachment parameter has been included in our application page and can be made functional by the MIS Webpage team.
- *The new form will include additional functionality to prevent common data entry errors.* To rectify the issues stemming from latitude and longitude data being entered in varying forms, the entry fields will limit the range of values that can be entered. The number of spaces available and the characters separating the numerical values will be restricted as

well. These measures will ensure a consistent format of latitude and longitude entries. As the applicant is inputting the data, questions may arise about the fields because of the different data-output options available with geographical positioning systems. To answer these questions, a textbox will be located next to the fields, explaining how to properly fulfill the information request.

- *In the case of the paper applications, Treasury Department employees need to transfer the data.* It must be recognized that not all permit applicants will be ready to embrace a paperless application process. To accommodate these individuals, paper applications will be made available. The Treasury Department can accept these forms, verify their completion and transfer the information to the database. If necessary the Treasury Department can also indicate a gross error in mooring position by detecting locations that fall on land or outside of Boston Harbor.
- *When applicants have successfully entered the required data, they should check their entries.* The City Hall MIS department is capable of creating a utility that can generate a map of proposed coordinates. Therefore when the applicant submits the form they should be prompted to accept the location. If the location is false, they can be directed back to the latitude and longitude entry fields.

Once all of the fields are completed, the applicant can submit the form directing the information into a central database, supported by a city server. A successfully submitted application should be flagged as “pending”, for review. An application will not be processed without payment of all money owed to the Treasury Department

Treasury Department

The Treasury Department should only view permit information relevant to their task. The Treasury’s database of pending mooring applications should only display the information that is pertinent to their interests (such as name and address) so that the other information does not need to be sifted through. Using this information, a background check will be conducted to ensure that the boaters’ excise tax and mooring permit fees

have been paid. The Treasury Department will then cross reference the application with the applicant's tax records, denying the permit if any additional money is owed to the city. If the applicant needs to pay a fee or tax, the system will generate a message that will notify the applicant of the situation. Once all dues are paid, the application can be passed to the Harbormaster for further review.

Harbormaster

The Harbormaster should view a map layer of pending mooring locations. These locations are specified by permit applications that meet the requirements of the Treasury Department but await evaluation by the Harbormaster. This layer should be superimposed over navigational charts and approved mooring sites. Using this GIS map, the Harbormaster can see the mooring location relative to shipping channels, other mooring sites and other features of interest. If the location is acceptable, it can advance to a finalized database. Otherwise, the system allows for a message to be sent to the applicant describing the issue and a means of rectifying it. Once an application is approved by both the Treasury Department and the Harbormaster, the application data can be added to the finalized database and GIS map.

No-Discharge Zone Application: Conclusions and Recommendations

Conversations with area pump-out operators have provided the team with a number of perspectives on the practicality of a NDZ. Every conversation reached the same conclusion; there are pump-out facilities that see overuse while others go under-utilized. This is troublesome because if boaters find the availability of pump-outs inadequate, it could mean a drastic decrease in local boating activity. Therefore, it is recommended that Boston Harbor's NDZ be established only with great attention to the needs of the local boating community. By taking the following steps to promote the accessibility of pump-out facilities, Boston can minimize the NDZ's disruption to local boaters.

Pump-Out Economics

Further analysis will need to be done to investigate the marketability and profitability of pump-out services. Grants funded by the Clean Vessel Act (CVA) are

encouraging pump-out prevalence in Boston Harbor by making them more economically appealing to pump-out operators, but not all facilities apply for or receive such funding. It remains to be answered how fiscal influences affect pump-out use. A broader analysis can shed light on this by answering questions such as:

- What expenses do pump-out facilities incur during operation?
- What level of profit margin would make pumping-out appealing and advantageous to operators?
- What are boaters willing to pay to have their boats pumped out?
- Are marinas with pump-out facilities more appealing to boaters than those without them?
- What are the difficulties in maintaining a facility?
- How does CVA funding affect the level of use a pump-out facility sees over the course of a year?

The analysis of the economic issues relating to pump-out facilities should strive to evaluate a means of establishing a free-market system for pump-out facilities, in which pump-out operators can charge boaters for their services but are also competing with other companies. Such a system would provide operators with a source of profit and it would also ensure that boaters were benefitting from equitable prices and suitable service derived from a competitive market. Both of these goals are achieved with limited government regulation, creating a close to ideal situation.

Offer compensation for facilities that proactively seek to serve their fellow boaters. Should a free-market system fail to even out the distribution of use, government subsidies can be an effective means of promoting environmentally sound policies. A ubiquitous example of this would be deposits on recyclable beverage containers. By offering a reward of 5 cents for every returned container, significant amounts of landfill waste has been reduced. This can easily translate to Boston Harbor's pump-out facilities. Pump-out operators will be more inclined to offer their services if they know that their work will return a profit. These encouraged operators will then seek to improve the accessibility and convenience of pump-out services to the boating community. Therefore

it is recommended that the city of Boston encourage environmentally-conscious discharge practices by supporting operators who, in exchange, help to maintain the NDZ.

Pump-out Boats

It is recommended that Boston supply the harbor with at least one more CVA funded pump-out boat. It is important to note that a pump-out boat was specified, as opposed to stationary dockside facilities. Such boats can make a NDZ much less disruptive to boating activities as they eliminate the boat size restrictions usually accompanied by dockside facilities. Pump-out boats also make the process more transparent, as the service can be performed without the boat operator's assistance. A dockside facility requires the boat operator to carefully maneuver the vessel to a designated section of the marina. This process can be very inconvenient, especially during an outing with friends and family. Pump-out boats can solve this problem by arriving to the vessel at the operator's convenience. The service can even be performed while the boat is not in use. Based on this information, an additional pump-out boat will help to decrease the workload of existing facilities significantly.

It should also be noted that other marinas have expressed interest in additional pump-out boats. Bay Pointe Marina in Quincy, for example, has told the team a great deal about the local pump-out boat's constant activity in that area. Again, another pump-out would lessen the workload of their existing pump-out infrastructure. It is not hard to imagine similar situations not only around Boston Harbor, but elsewhere in the Commonwealth. By adding additional pump-out boats, Boston can effectively advertise their versatility and effectiveness to neighboring communities.

Recommendations from Environmental Agencies

The Massachusetts Office of Coastal Zone Management (CZM) offers several recommendations to ensure a favorable response from the EPA. These recommendations are outlined in a template for the application of a NDZ. According to this template, the EPA strongly recommends that the city identify measures to reduce water pollution from other sources such as storm drains and runoff. In addition, the template suggests that the city initiate a pump-out awareness program with pamphlets, press materials and other

forms of public outreach. Lastly, CZM recommends that Boston outline its strategies in enforcing a NDZ should one be established. If Boston can sufficiently follow these recommendations, then they will be very successful in establishing a NDZ.

Future Integration of Land Access with Water Access

This project is but one half of a greater initiative to promote awareness of Boston's ever-improving waterfront. The team has managed to create an interactive, geographical representation of moorings, pump-out facilities and marinas with all data relevant to each location. This work will be combined with a parallel effort to catalogue waterfront amenities outlined by Chapter 91 licenses. Using information gathered in past efforts by organizations such as UHI, both teams constructed organized databases. These databases will work together to form a GIS map that will be used by various people from the general public to government agencies, the former being especially important to the future development of the harbor.

Future Development

To further improve the accessibility of Boston Harbor, efforts to identify public boat access need to continue. The mapping of Boston Harbor's resources is by no means complete. For example, harbor features such as public "Touch and Go" docks, fueling stations and public restrooms, have not yet been mapped alongside pump-out facilities, marinas, and mooring fields in an aggregate form. Boston should identify all that the harbor can offer to boaters. This information should then be added to the existing databases. By taking these steps, Boston can realize a grander vision of harbor accessibility where Boston can be reached, explored, and enjoyed by boat as easily as by car or train.

Harbor Awareness

It is recommended that this information be placed on the internet. It is the public that can benefit most from this work. Citizens and tourists alike have a right to enjoy the results of years of development effort. Therefore, all GIS harbor layers should be made publicly available so that people will finally be fully aware of the properties available to them. This should be done while taking the proper precautions with respect to privacy.

Given the detailed information provided by mooring permit applications alone, a great deal of personal information can be gathered. Therefore only a portion of that data should be available to the public (*coordinates and boat length are the only pieces of mooring data recommended for public viewing*). This map can also be shared with other relevant boating websites and publications such as Coast Pilot to further spread awareness. By following these recommendations, the two projects will achieve a greater goal of public awareness of harbor resources. It will be through this greater awareness that further improvement to Boston Harbor can continue.

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APPENDIX A: BOSTON ENVIRONMENT DEPARTMENT

Background and Mission of the Boston Environment Department

The Boston Environment Department (referred to as BED) is a city government-run organization that consists of several different subdivisions. They strive to preserve and improve the architectural, geographical, and historical aspects of the city of Boston. Protecting the Boston environment and supplying information about the different concerns associated with it are some of the primary objectives of the BED.

Another key goal of the BED is to monitor the various pollution levels throughout the city. They distribute licenses accordingly and enforce regulations to try to maintain the health of the environment in the city of Boston. The BED and all of the departments that comprise it work together with other agencies and organizations to achieve these common goals.

The Boston Waterways Board

The Boston Waterways Board was created in 2006 in the interest of protecting and promoting public access to Boston Harbor and its shoreline. Increased development around the harbor has begun to threaten the public's ability to view, visit, and make use of the harbor. The Boston Waterways Board protects public access indefinitely through extensive legislation and proposed ordinances. The Boston HarborWalk would, which is an endeavor seeking to promote access to the harbor, would be protected through the aforementioned legislation. The chair of the board is Mr. Brian Glascock.

Influence Through Commissions

In an effort to support the most efficient management of environmentally friendly endeavors, in both the urban and the natural areas of Boston, the city's environment department has been divided into a series of commissions. The commissions were designed to be able to evaluate and refine current practices and policies, while directing the administration of future projects. The following commissions were established: the Boston Conservation Commission, the Historic District Commissions, the Boston Landmarks Commission, and the Air Pollution Control Commission. Each of the commissions is made up of five to seven commissioners. The commissioners are

appointed by the Mayor of Boston and they serve at his leisure. The boards of commissioners are responsible for conferring upon and deciding policies for their respective focuses. The efforts of the various commissions and the environment department as a whole is led by the environment department head, the director, who is also appointed by the mayor.

The Conservation Commission

The Boston Conservation Commission is responsible for, among other things, the preservation of the wetlands within the city limits. That tasking makes the commission accountable for any development, including public access, within the wetland region. The Boston Harbor Water Access project looks to find a sustainable method of measuring water usage and use of water access points. It will lead to a recommendation for attenuating excessive use while promoting increased use in other areas. The projects deliverable should allow the Boston Conservation Commission to protect the environment of the harbor's littoral by limiting water usage to reasonable levels throughout.

What Kind of Resources Can be Focused on the Problem?

The Boston Environment Department (BED) is willing to offer information, funding and expertise toward the goal of a more accessible and organized harbor in Boston. Their motivations toward this goal are obvious with efforts such as their ongoing seaport study. Since 1996, the BED has worked closely with the Mass Port Authority and the Boston Redevelopment Authority to develop Boston's seaport economically by expanding maritime industries, including the promotion of tourism and transportation.

Collaboration with Other Agencies

Many organizations play a role in the operation and management of Boston Harbor. These organizations range from small city-level initiatives such as the Urban Harbors Institute, to state authorities like the Mass Port Authority and all the way to federal agencies such as the U.S. Coast Guard. However, very few of them will be collaborating directly with the BED on the project, given its narrow scope.

APPENDIX B: EFFECTS OF BOATING ON BOSTON HARBOR

Introduction

This section provides basic background information on the environmental effects of boating in Boston Harbor and worldwide.

Effects of Boating

Hull Scraping

Each time that the hull of a boat brushes against the ground or is put into the water after sanding, particles of paint are released into the water. The paints used to protect hulls contain toxic metals, pesticides, and other hazardous chemicals. When introduced to the ecosystem, these particles have a detrimental effect on the growth of plankton in and around marinas. The plankton communities play an integral role in attracting fish to the coves and protected areas where marinas are constructed.

Boat Cleaning

The solvents, chemicals, and detergents that are used to clean float on water. This means that they accumulate on the surface and, like the hull scrapings, destroy colonies of plankton. The layer of chemicals also inhibits exchange of oxygen with the atmosphere, reducing dissolved oxygen levels in the water column.

Fuels and Oil

Fuel and oil are deposited into the marine environment in a number of ways. Gasoline drips into the water at fueling stations in small but steady amounts. The oil and fuel that are collected in the bilge of boats are routinely purged into the water. Due to inefficiencies in some engines, up to 30% of the fuel that enters into the combustion chamber can be ejected directly into the environment.

Waste

Human waste is flushed from holding tanks while boats are underway, but they are also pumped into sanitary tanks at marinas. Spills during the pumping process build up in the marinas. Solid waste, if not properly disposed of can choke marine mammals, fish, or birds.

APPENDIX C: LAW ENFORCEMENT

As with any large area, Boston Harbor must be patrolled by law enforcement to keep it safe. Hazards of water travel make it necessary to have agents available not just to prevent violations of the law, but also to ensure safety and lend assistance to those in need. Because of its size and importance, the harbor is patrolled by agencies at the local, state and federal level.

The United States Coast Guard maintains a strong presence in Boston Harbor. Headquartered in North Boston, the Coast Guard station is a strong presence in the harbor. It boasts three large, medium-endurance cutters as well as multiple mid-sized vessels, and many smaller fast-response boats. The service men and women stationed there are highly trained in emergency services and water rescue, and come to the aid of everyone from stranded boaters in the inner harbor to large ships foundering on the open ocean. The Coast Guard is also heavily involved in keeping the harbor protected from terrorist attacks. In addition, the Coast Guard also maintains all the aids to navigation, which keep the harbor safe and orderly. Recreational boaters can count on the Coast Guard keeping them safe whether it be through random safety checks, routine traffic enforcement or rescues at sea (Pike, John 2005;).

As a major hub for the Commonwealth of Massachusetts, as well as being the capitol city, Boston's waterways are also protected by the Massachusetts State Police. The State Police Marine Division is a specialized unit that is based in North Boston near the mouth of the Charles River. Like the Coast Guard, the State Police maintain order by enforcing laws such as speed limits and boating safety (OUI, inspections, etc.) but they



also have the responsibility of operating the system of locks which allows traffic to flow up and down the Charles River while maintaining the desired water levels in the Charles River Basin. The State Police Marine Division is heavily involved with recreational boating through their certification process. This

allows them to provide boaters with the instruction necessary for licensing purposes (Massachusetts State Police 2007;).

The Boston Harbor Master is responsible for overseeing and policing the activity that takes place within the harbor. The Harbor Master, along with the Harbor Patrol, falls under the jurisdiction of the local city police department and are an important element in the protection of safe harbor use. The Harbor Patrol joins the Coast Guard and State Police in enforcing laws and also provides services such as underwater search-and-rescue, and navigation assistance. In addition, the Harbormaster is often the first point of contact for new vessels entering Boston from other ports. Because he is responsible for the placement and maintenance of mooring balls, the Harbormaster can also provide recommendations on where boaters may secure vessels and helps regulate the rental of mooring sites in the outer harbor (Glascock, Brian 2007;).

APPENDIX D: PUMP-OUT DATABASE

Boston Harbor Water Access 2007	
Boston Harbor Pump-Out Facilities	
Installation	Website
Marina at Admiral's Hill	http://admiralshillmarina.com/index.html
Bay Pointe Marina	
Black Falcon Pier	
Boston Harbor Cruises	http://www.bostonharborcruises.com/
Boston Harbor Shipyard & Marina	http://www.bhsmarina.com/maine-fuel.html
Boston Towing & Transportation	http://www.reinauer.com/boston.html
The Marina at Rowes Wharf	http://www.sail-the-net.com/marinas/north_america/usa/massachusetts/boston/the-marina-at-rows-wharf.html
Boston Waterboat Marina	http://www.bostonwaterboatmarina.com/index.htm
Boston Yacht Haven	
Captain's Cove Marina	http://www.captainscovemarina.com/
Charles River Yacht Club	http://www.charlesriveryachtclub.com/
Charlestown Pier 4	
Constellation Tug Corporation	http://www.constellationtug.com/
Constitution Marina	http://www.constitutionmarina.com/index.html
Dorchester Yacht Club	
Manna Bay on Boston Harbor	http://www.flagshipmarinas.com/marinas/marinabay/Default.htm
Mystic Marine	http://www.seatowboston.com/mystic/
Port Norfolk Yacht Club	
Quincy Bay	
Shipyard Quarters Marina	http://www.shipyardquartersmarina.com/
Town River Yacht Club	http://www.townriveryachtclub.com/main/index.asp
Wessagussett Yacht Club	http://wyc-online.org/

E-Mail Address	Street Address	Phone	Fax	VHF Channel	Degrees Latitude	Minutes Lat
mgt@AdmiralHillMarina.com	1000 Justin Dr., Chelsea, 02150	617-889-4002	617-884-4765	9, 10	42	23.530
	64 Washington Ct., Quincy, 02168	617-471-1777	617-471-9099	9	42	15.019
	1 Black Falcon Ave., Boston, 02210	617-946-4417		N/A	42	20.603
contact@bostonharborcruises.com	1 Long Wharf, Boston, 02110	617-227-4321	617-723-2011	N/A	42	21.591
pgately@bhsmarina.com	256 Marginal St., E. Boston, 02128	617-561-1400	617-561-9539	9	42	21.667
	36 New St., E. Boston, 02128	617-567-9100		N/A	42	22.384
	70 Rows Wharf, Boston, 02110	617-439-3131	617-204-1145	9	42	21.385
info@bostonwaterboatmarina.com	66 Long Wharf, Boston, 02110	617-523-1027	617-523-1215	9	42	21.625
	87 Commercial Wharf, Boston, 02110	617-367-5050	617-367-1583	9	42	21.697
Steve@CaptainsCoveMarina.com	100 Cove Way, Quincy, 02169	617-328-3331	617-773-3840	69	42	15.156
info@charlestownyachtclub.com	99 Memorial Dr., Cambridge, 02142	617-354-8681	617-868-3023	9	42	21.547
	8th St., Charlestown, 02129	617-918-6201		N/A	42	22.291
http://www.constellationtug.com/contact.php	1 S. Bremen St., E. Boston, 02128	617-561-0223		N/A	42	21.893
sebastian@bosport.com	28 Constitution Rd., Charlestown, 02129	617-241-9640	617-242-3013	69	42	22.178
	100 Playstead Rd., Dorchester, 02125	617-436-1002		9	42	18.373
mainabay@flagshipmarinas.com	333 Victory Rd., N. Quincy, 02171	617-847-1800	617-847-1840	10	42	18.112
mystickfuel@seatownboston.com	100 Terminal St., Charlestown, 02129	617-293-6247	617-241-0217	72	42	22.823
	179 Walnut St., Dorchester, 02122	617-822-3333		9, 11	42	17.491
	N/A	617-908-9757		9	42	14.989
Dockmaster@ShipyardQuartersMarina.com	1 13th St. #8, Charlestown, 02129	617-242-2020	617-242-5296	9, 7, 16	42	22.574
webguy@townriveryachtclub.com	60 Mound St., Quincy, 02169	617-471-2716	617-479-4183	71	42	15.226
webmaster@wvc-online.org	212 Wessagussett Rd., Weymouth, 02191	781-335-0247		71	42	15.012

Decimal	Degrees Longitude	Minutes Longitude	Decimal	Season	Hours of Operation	Accessibility
42.3867	-71	3.009	-71.0494	Year-round	7:00a-6:00p	1 Boat
42.2503	-70	58.425	-70.9738	Memorial Day-Columbus Day	Call Ahead	1 Boat
42.3434	-71	1.982	-71.0330	Year-round	9:00a-5:00p	1 Boat
42.3599	-71	2.944	-71.0491	Year-round	6:30a-8:30p (Weekday) 10:00a-6:30p (Weekend)	1 Boat
42.3611	-71	2.106	-71.0351	Year-round	6:00a-8:00p (Summer) 7:00a-3:00p (Winter)	2 Boats
42.3731	-71	2.660	-71.0443	Year-round	24/7	2 Boats
42.3565	-71	2.933	-71.0490	May-Oct	7:00a-10:00p	1 Boat
42.3604	-71	2.948	-71.0491	May-Oct	Call Ahead	2 Boats
42.3616	-71	2.910	-71.0485	May-Oct	8:00a-7:00p	1 Boat
42.2526	-70	58.896	-70.9816	May-Oct	24/7	1 Boat
42.3591	-71	5.090	-71.0848	May-Nov	8:00a-8:00p	1 Boat
42.3715	-71	3.060	-71.0510	Year-round	Appointment Only	3 Boats
42.3649	-71	2.507	-71.0418	Year-round	24/7	1 Boat
42.3697	-71	3.571	-71.0594	Year-round	9:00a-8:00p (Summer) 9:00a-5:00p (Winter)	1 Boat
42.3067	-71	3.122	-71.0519	Memorial Day-Labor Day	8:00a-6:00p	1 Boat
42.3020	-71	1.786	-71.0300	May-Nov	7:30a-8:00p	2 Boats
42.3803	-71	3.068	-71.0511	April-Oct	Mon-Fri 7:00a-7:00p	3 Boats
42.2917	-71	2.299	-71.0383	May-Oct	Call Ahead	1 Boat
42.2494	-70	58.438	-70.9721	Jun-Oct	High-Tide (Weekday) 8:00a-4:00p (Weekend)	1 Boat
42.3747	-71	2.972	-71.0478	Summer	8:00a-8:00p	2 Boats
42.2538	-70	58.710	-70.9785	Apr-Nov	Call Ahead	1 Boat
42.2503	-70	56.854	-70.9472	Jun-Oct	Mon-Fri 6:00a-8:00p Sat-Sun 9:00a-9:00p	1 Boat

Mean Low-Tide Depth (Ft.)	Holding Capacity (Gal.)	Means of Disposal	Pricing	Comments
6	N/A	City Sewer	Free pumpout service	Dockside pumpout only
8	N/A	City Sewer	\$15 for non-members	Dockside pumpout only; Shut down at low tide
35	N/A	City Sewer	\$165 + \$1.30 / ton	Commercial use; Closed during extreme cold
22	100	City Sewer	N/A	BHC vessels only; Difficult to use during the
25	150 (Boat)	City Sewer	Free pumpout service	Pump-out emptied on a weekly basis
N/A	90,000 & 280,000	Black Falcon and Charlestown Pier 4	\$900 / day	2 Barges; Used for commercial and naval ves
30	N/A	City Sewer	Members only	Dockside pumpout only
4.5	150 (Boat)	City Sewer	Free pumpout service	Boat is pumped out every few days
10	N/A	City Sewer	\$20 for non-members	Dockside pumpout only; Pump-outs take app
6	N/A	City Sewer	Free pumpout service	
N/A	~200	City Sewer	Free pumpout service	Pump-out by boat only
30	N/A	City Sewer	\$1.00 / linear ft.	Commercial use; License w/ BRA Required
N/A	80,000	Black Falcon and Charlestown Pier 4	Call for pricing	Commercial Use; Appt. only
30	N/A	City Sewer	Free pumpout service	Both dockside and boat-side services availabl
7	N/A	City Sewer	Call for pricing	Dockside pumpout only
N/A	300(Boat)	City Sewer	Free pumpout service	Served by Quincy's pump-out boat
40	125	Moran Terminal Catch Basin	Free with fuel purchase	Cannot accept sewage from large-capacity ve
7.5	N/A	City Sewer	Free pumpout service	
N/A	300	Bay Pointe Pump-out	Free pumpout service	Pump-out by boat only; Boat is pumped out r
25	N/A	City Sewer	Free pumpout service	Pump-out dock needs repairs; Pump-out by fl
35	N/A	City Sewer	Free pumpout service	Dockside pumpout only
8	N/A	City Sewer	Free pumpout service	Dockside pumpout only

Table 2: Pump-Out Database

APPENDIX E: BOSTON POLICE HARBORMASTER INTERVIEW

This list of questions was used to interview Sgt. Phillip Terenzi, Boston Police Harbormaster, with regard to the mooring permit database, and the process used to maintain said database.

- 1) On the database that you e-mailed us earlier, what do fields 2 and 3 mean?
 - a) How should we place moorings that are indicated to be correct in field 3 but invalid in field 2?
- 2) How complete is the spreadsheet that was e-mailed to us?
 - a) Where might one find other moorings?
- 3) How do you install a mooring?
 - a) When and where in this process do you take the coordinates of the mooring location? How is this performed?
 - b) To what degree of precision are your coordinates measured?
 - c) Is there a particular type of tackle that is being used?
- 4) Please describe your role in the mooring application process.
 - a) Do you receive permit application data from the assessing dept.? If so, how?
 - b) Does this process consume a significant amount of resources that could be directed elsewhere?
 - c) What changes, if any, would you like to see in this process?
- 5) Who is installing the moorings? Are you checking the coordinates of these moorings?
 - a) Are marinas fabricating the data?
 - b) Are the moorings being pulled up at any point and being reinstalled in slightly different locations?
- 6) Can you explain why some mooring sites have unusual coordinates? (61-834 seconds) What is the third digit supposed to represent?
- 7) Are there any fields that you would like to see represented in our database?

APPENDIX F: PUMP-OUT FACILITY SURVEY PROTOCOL

This survey protocol was used in a series of telephone conversations with the pump-out facilities located in and around Boston Harbor. In some cases, information was updated from existing data; in other cases, entirely new entries were created.

- 1) At what time during the year does your facility operate? What time of day?
- 2) How many boats can your facility service at one time?
- 3) Is your facility directly connected to the city's sewer system?
 - a. If not, what is the holding capacity of your facility before it must be discharged?
 - b. What arrangements have you made to dispose of the waste?
- 4) What is the mean low-tide water depth where boats are pumped out?
- 5) Is this facility funded under the Clean Vessel Act?
 - a. If not, how much do you charge for pump-out service?

APPENDIX G: MARINA DATABASE

Boston Harbor Water Access 2007			
Boston-Area Marinas (Pump-outs Excluded)			
Name	Website	E-Mail	Address
Anchor Marina			666 Southern Artery, Quincy, 02169
Atlantis Marina	http://www.atlantismarina.net/	sales@atlantismarina.net	550 Pleasant St., Winthrop, 02152
Boston Harbor Sailing Club	http://www.bostonharborsailing.com/	info@bostonharborsailing.com	65 East India Row, Boston, 02110
Boston Harbor Yacht Club			1805 William J. Day Blvd., Boston, 02127
Charlesgate Yacht Club	http://www.charlesgateyc.org/	http://www.charlesgateyc.org/cyc_feedback.htm	20 Cambridge Pkwy., Cambridge, 02142
Chelsea Yacht Club			1 Broadway, Chelsea, 02150
Clipper Marina			75 Palmer St., Quincy, 02169
Columbia Yacht Club	http://www.cpyc.org/	commandore@cpyc.org	1825 Day Blvd., S Boston, 02127
Cottage Park Yacht Club	http://www.sail-the-net.com/marinas/no	curtinassociates@aol.com	76 Orlando Ave., Winthrop, 02152
Crystal Cove Marina			529 Shirley St., Winthrop, 02152
East Boston Yacht Club			Rice St., E Boston, 02128
Harveys Wharf			8 Harveys Ln., Quincy, 02169
India Wharf Marina	http://www.indiawharfmarina.com/	info@indiawharfmarina.com	Commercial Wharf, Boston, 02210
Jeffries Yacht Club			565 Summer St., E Boston, 02128
Lewis Wharf Marina			54 Lewis Wharf, Boston, 02110
Mullins Marine Service			554 Pleasant St., Winthrop, 02152
Old Colony Yacht Club			235 Victory Rd., Dorchester, 02122
Orient Heights Yacht Club			61 Baywater St., E Boston, 02128
Pleasant Park Yacht Club			562 Pleasant St., Winthrop, 02152
Quartermark Marine Corporation			84 Condor St., E Boston, 02128
Quincy Yacht Club	http://www.quincy yachtclub.com/	webmaster@quincy yachtclub.com	1310 Sea St., Quincy, 02169
Savin Hill Yacht Club	http://www.savinhillyc.org/	http://www.savinhillyc.org/feedback.html	400 Morrissey Blvd., Dorchester, 02125
South Boston Yacht Club	http://www.southbostonyc.com/	sbyc@verizon.net	1849 Columbia Rd., S Boston, 02127
Squantum Yacht Club	http://www.squantumyc.org/	webmaster@squantumyc.org	646 Quincy Shore Dr., Quincy, 02170
Thomas Marine			24 Ericsson St., Dorchester, 02122
Venezia Restaurant & Marina			20 Ericsson St., Dorchester, 02122
Winthrop Yacht Club	http://www.win-ytc.org/	webmaster@win-ytc.org	649 Shirley St., Winthrop, 02152
Wollaston Yacht Club	http://www.wollastonyc-tribod.com/	wollastonyc@hotmail.com	592 Quincy Shore Dr., Quincy, 02170

Phone	Fax	VHF Channel	Latitude	Degrees Latitude	Minutes Latitude	Longitude	Degress Longitude	Minutes Longitude
617-471-2666			42.2534	42	15.201	-70.9866	-70	59.198
617-846-5262			42.3807	42	22.840	-70.9927	-70	59.563
617-720-0049		9	42.3574	42	21.444	-71.0487	-71	2.919
617-269-9420			42.3292	42	19.753	-71.0361	-71	2.166
617-354-8215			42.3666	42	21.993	-71.0739	-71	4.434
617-884-9864			42.3857	42	23.142	-71.0462	-71	2.771
617-479-1449			42.2574	42	15.443	-70.9783	-70	58.696
617-269-9831			42.3314	42	19.884	-71.0273	-71	1.637
617-846-9801			42.3675	42	22.049	-70.9866	-70	59.195
617-846-7245	617-846-4301	6,9,16	42.3712	42	22.272	-70.9711	-70	58.267
617-567-9698			42.3805	42	22.831	-71.0122	-71	0.731
617-773-3020			42.2704	42	16.223	-70.9503	-70	57.019
617-737-9222			42.3585	42	21.511	-71.0483	-71	2.897
617-567-9656			42.3635	42	21.809	-71.0281	-71	1.685
617-523-2313			42.3635	42	21.813	-71.0491	-71	2.948
617-846-1551			42.3809	42	22.855	-70.9926	-70	59.557
617-436-0513			42.2993	42	17.959	-71.0442	-71	2.653
617-567-9439			42.3837	42	23.020	-71.0047	-71	0.280
617-846-7124			42.3813	42	22.878	-70.9924	-70	59.545
617-569-5212			42.3843	42	23.055	-71.0372	-71	2.230
617-471-6136			42.2721	42	16.326	-70.9495	-70	56.972
617-825-1108		68	42.3099	42	18.593	-71.0424	-71	2.544
617-268-6132	617-268-6104		42.3317	42	19.904	-71.0266	-71	1.595
617-770-4811			42.2794	42	16.763	-71.0140	-71	0.838
617-288-1000			42.2929	42	17.577	-71.0410	-71	2.459
617-436-3120			42.2927	42	17.561	-71.0395	-71	2.372
617-846-9774			42.3686	42	22.113	-70.9722	-70	58.334
617-472-9196			42.2787	42	16.722	-71.0125	-71	0.751

Table 3: Boston Harbor Marina Database