Final Feasibility Report and Final Supplemental Environmental Impact Statement/ Massachusetts Final Environmental Impact Report for Deep Draft Navigation Improvement

Boston Harbor
Boston, Chelsea and Revere Massachusetts

MASSACHUSETTS
PORT AUTHORITY

US ARMY CORPS
OF ENGINEERS
New England District

April 2013

EXECUTIVE SUMMARY

STUDY INFORMATION

The U.S. Army Corps of Engineers (Corps) in partnership with the Massachusetts Port Authority (Massport), and in cooperation with other Federal and State agencies, has prepared this Feasibility Report (FR) and Supplemental Environmental Impact Statement (SEIS) for proposed channel and associated navigation feature maintenance and improvements to the Port of Boston. The SEIS has also been prepared as an Environmental Impact Report (EIR) in fulfillment of Commonwealth of Massachusetts requirements. The Federal authority for this study and a brief description of the scope, purpose, objectives, analysis, and recommendations contained in the Feasibility Report and SEIS/EIR is provided below.

Study Authority

The U.S. Army Corps of Engineers has been authorized to conduct a study to evaluate the feasibility of navigation improvements for the Boston Harbor Federal Navigation Project and to determine whether Federal participation in implementing such improvements is warranted. The Feasibility Study was called for by a Senate Subcommittee on Public Works Resolution dated September 11, 1969. The language of the resolution is provided below:

> "Resolved by the Committee on Public Works of the United States Senate, (September 11, 1969), that the Board of Engineers for Rivers and Harbors, created under Section 3 of the River and Harbor Act of June 13, 1902, be, and is hereby requested to review the report of the Chief of Engineers on Boston Harbor, Massachusetts, published as House Document Numbered 733, Seventy-ninth Congress, and other pertinent reports, with a view to determining whether any modifications of the recommendations contained therein are advisable at this time, with particular reference to modifying the project dimensions of the Main Ship Channel from deep water in Broad Sound to the upstream limit of the Federal project in the Mystic River."

The expedited reconnaissance investigation was initiated at the request of Massport, the study sponsor, in December 1999 using funds provided in the Energy and Water Development Appropriations Act for Fiscal Year 2000 with a $100,000 line item for Investigations in the tables appended to the Statement of the Committee on Conference. The House Bill, H.R. 2605, House Report 106-253, 106th Congress, 1st Session, 23 July 1999 included a provision on Page 31 as follows:

> "*Boston Harbor, Massachusetts*.–The Committee has provided funding for a reconnaissance study to evaluate the deepening of the Main Ship, Reserved and Entrance Channels to Boston Harbor, Massachusetts."

The 905(b) Reconnaissance Report was approved by the Corps North Atlantic Division (NAD) and Corps Headquarters (HQUSACE) in August 2000. The Corps and Massport executed the Feasibility Cost-Sharing Agreement (FCSA) for this project on 27 June 2002. Federal funding for the feasibility phase investigation was initially provided in the Energy and Water Development Appropriations Act for Fiscal Year 2002. The Conference Report accompanying that Act, House Report 107-258, 107th Congress, 1st Session, 30 October 2001, included a line item for $300,000 in the appended tables for *"Boston Harbor, MA (45-Foot Channel)"*.

The Draft Feasibility Report and SEIS/EIR were released for public and agency review on 11 April 2008, with Notice of Availability published in the Federal Register on 18 April 2008. The public review period under the NEPA and State processes closed on 2 June 2008. A Draft Final Feasibility Report and SEIS were submitted to Corps Headquarters in July 2008 and presented to the Civil Works Review Board at its 21 August 2008 meeting. At the Board's request, additional information was submitted and considered in September 2008. The Board directed that additional investigations of the project's economic justification be conducted with a view to determining the economically optimal depth of the main channel improvements for the benefits of container shipping.

A Framework for Additional Economic Analysis of the project was prepared in October 2008 and after extensive discussion a detailed scope for that analysis was approved by Corps Headquarters in August 2009. The Framework scope called principally for three tasks (1) a survey of shippers using container services to determine the source and destination of cargo and rationale and costs for land versus waterborne shipment of New England cargo, (2) interviews with containership carriers to develop further information on fleet forecasts, post-Panama Canal deepening shipping strategies, decisions on service and port rotation, and the potential for Boston Harbor to gain or lose services in both the with-project and without-project conditions, and (3) investigation of vessel loading practices with respect to current and projected practices, service schedules, and tidal assistance.

The surveys and interviews were carried out during 2010 and reports documenting these efforts were prepared in early 2011. The findings were presented to Corps reviewers and Headquarters in April 2011, after which additional information and model analysis was requested. That work was carried out through the remainder of 2011 and presented to Corps reviewers and Headquarters in February 2012. Additional economic shipping analysis was requested and that work completed in April 2012. The resulting revised Economic Evaluation for the project was reviewed and submitted to Corps Headquarters in May 2012 along with an updated Cost Engineering Appendix for review and reconsideration of the project. In September 2012 the Corps concluded that a supportable recommendation for an inner harbor project depth of 47 feet could proceed. Reanalysis of the additional depth required in the entrance channel using updated guidance was completed in December 2012 and recommended a 51-foot depth for that project feature. With Massport's agreement, a final feasibility report and Final SEIS/EIR was prepared and submitted for review in January 2013. Reconsideration of the project by the Civil Works Review Board is scheduled for April 2013. Following action by the Board the Final Feasibility Report and Final SEIS will accompany the Draft Chief of Engineers Report for State and Agency Review.

Study Sponsor

The Massachusetts Port Authority is the non-Federal Sponsor for the feasibility study, under the terms of a feasibility cost sharing agreement with the Corps executed June 27, 2002, and has indicated it willingness to sponsor project design and implementation. Massport is a public, legislatively-chartered, independent State authority with its own budgetary authority.

Massport has been the sponsor for several recent major Corps actions for Boston Harbor: the main tributary improvement and maintenance project constructed in 1998-2001, and the 2008 inner harbor maintenance dredging and confined disposal facility construction project. Massport views the proposed main channel deepening project to be crucial to the Port's continued growth and the region's economic health.

Study Purpose and Scope

The purpose of the Boston Harbor Navigation Improvement Study is to identify, formulate, evaluate and screen potential alternatives for channel deepening and related improvements at the Port of Boston, consistent with the goals of the study sponsor, Massport, and in response to direction from Congress in the authorizing resolution. Massport's goal is to provide deeper access to their Conley Container Terminal on the Reserved Channel in South Boston at a depth that would allow the port to retain and grow its container liner services and efficiently operate its bulk cargo facilities. Additional minor port improvements in the Mystic and Chelsea Rivers and in the Main Ship Channel above the Reserved Channel were also considered and are recommended.

This report and SEIS have also been prepared in fulfillment of Massachusetts regulatory review requirements under the Massachusetts Environmental Policy Act (MEPA) for an Environmental Impact Report – Executive Office of Energy and Environmental Affairs #12958.

Project Location and Congressional Districts

Boston Harbor is located in eastern Massachusetts on the western shore of Massachusetts Bay. Boston is the New England region's largest port. The Port and project area are partially located in the Massachusetts 5th, 7th, and 8th Congressional Districts. One of the sites under consideration for beneficial use of dredged materials lies offshore of the 6th District.

Prior Reports and Existing Water Projects

Boston Harbor and its improved tributaries have been the subject of numerous reports by the Corps of Engineers since 1825, from which time to 1866, the projects studied and adopted were focused primarily on works of preservation: projects designed and built to preserve navigable depths in the harbor by protecting the surrounding headlands and islands from erosion by constructing seawalls, jetties and aprons. The three entrance channels, Main Ship Channel, President Roads Anchorages, and the several tributary channels were authorized by subsequent Congressional actions. The basis for the existing project, as modified through the Water Resources Development Act of 1990, can be found in House Document number 733, 79th Congress, 2nd Session, 23 July 1946, and in House Document number 150, 105th Congress, 1st Session, 21 October 1997.

The main deep water harbor is comprised of the waterways of the Main Ship Channel, Reserved Channel, Mystic River and Chelsea River. These channels provide access at a depth of - 40 feet at Mean Lower Low Water (MLLW) to the Port's principal terminals, except for the Chelsea River which has an authorized depth of -38 feet MLLW. Deep water access to the harbor is provided by three entrance channels constructed and maintained by the Corps of

Engineers; the Broad Sound North Channel in two lanes at 35 and 40 feet, the Broad Sound South Channel at 30 feet, and the Narrows Channel at 27 feet.

Terminals located in the harbor complex ship and receive about 20 million tons of liquid and dry bulk, containerized, and general cargo annually. Bulk products, principally petroleum fuels, natural gas, cement, scrap metal, gypsum, and salt, are processed through more than twenty public and private terminals. Autos are landed at Massport's Boston Autoport on the Mystic River. Cruise ships call on Massport's Black Falcon Terminal on the Reserved Channel in South Boston. Containerized cargo, which makes up about seven percent of the Port's volume, is handled at Massport's Conley Terminal, also on the Reserved Channel in South Boston. In 2007 this containerized cargo had a value of more than $4.5 billion, more than 60 percent of the value of all cargo shipped through the port.

Federal Interest

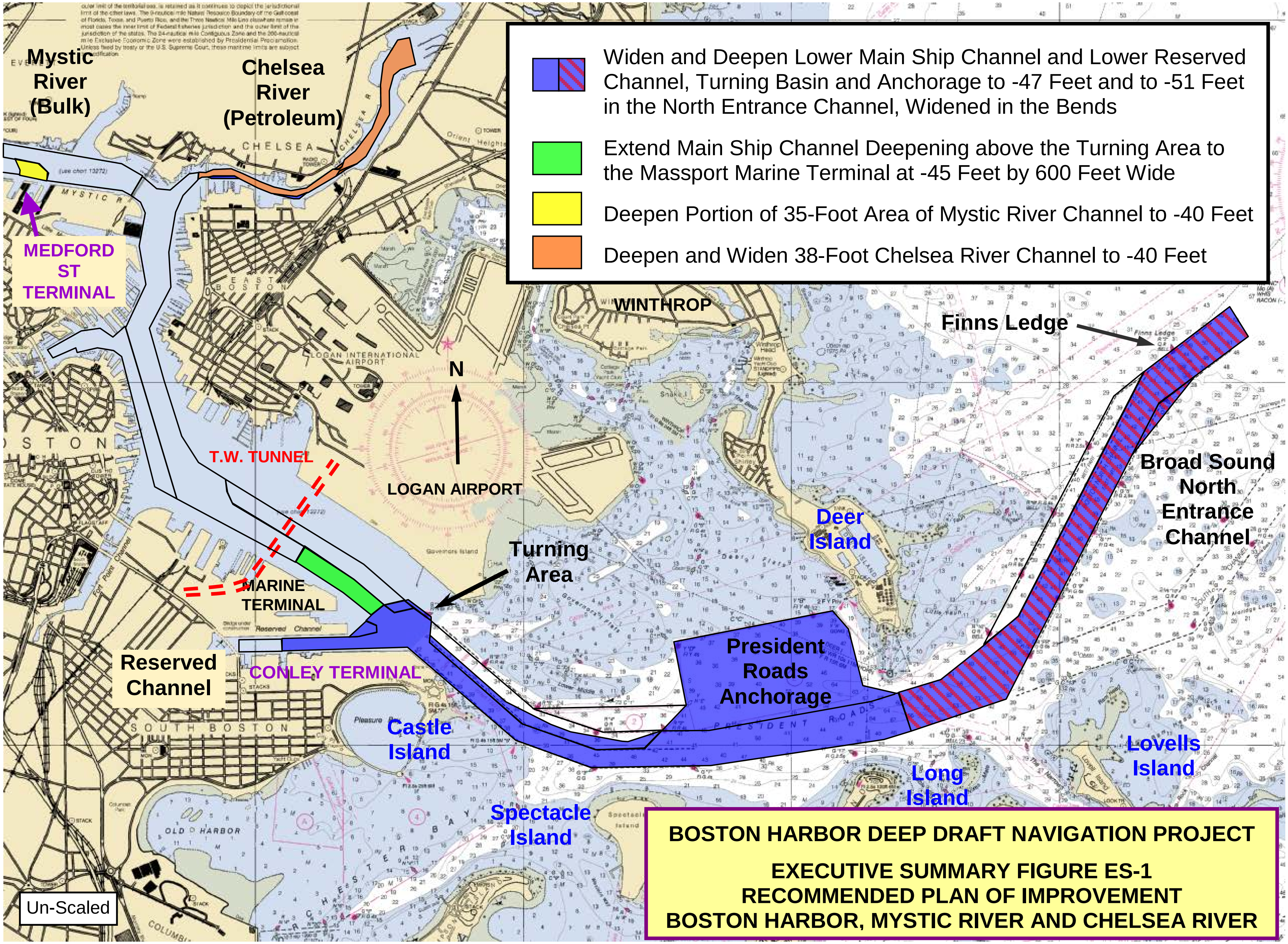
The City of Boston, Massachusetts is the hub of the nation's eleventh largest metropolitan area, with a population of nearly 4.6 million. The Federal Government, principally through the Corps of Engineers, has a long history of supporting waterborne commerce by contributing to the nation's water resources infrastructure in partnership with the States and local agencies. At Boston this partnership has provided the port with an extensive system of deep draft channels and other navigation features to serve the six-state region's 14.3 million residents with efficient transportation of domestic and international cargo.

As with all transportation infrastructure, improvements in capacity are periodically required to continue meeting the Nation's and region's needs. With the recent and continued growth in waterborne commerce, the number of services and sizes of vessels engaged in the transport of goods, particularly containerized cargo, has grown also. A large percentage of New England cargo is landed and loaded at terminals in the Port of New York and New Jersey (PONYNJ), and carried overland by truck through New England. Landing and loading a larger portion of that cargo at Boston would save time and cost, and significantly reduce highway truck miles and associated emissions over New England's roadways, but would require deepening Boston's channels to permit those larger and more heavily laden ships to call on the port.

Similarly, this study has also examined bulk cargo shipping at Boston Harbor, including liquid petroleum fuels and dry bulk cargo, to determine whether navigation improvements could provide transportation cost savings for those classes of goods.

STUDY OBJECTIVES

The goal of this report is to document the formulation and evaluation process followed for the Boston Harbor Deep Draft Navigation Improvement Study, to identify cost effective, implementable navigation improvement alternatives, and to recommend a preferred optimal alternative. The analysis and recommendation are consistent with the direction and language calling for the study, and conform to Federal statutes, regulations and Corps guidance governing the development of water resource projects and reports, and the Framework for additional economic reanalysis approved by HQUSACE. This study also included preparation of a Supplemental Environmental Impact Statement (SEIS).



BOSTON HARBOR DEEP DRAFT NAVIGATION PROJECT

EXECUTIVE SUMMARY FIGURE ES-1
RECOMMENDED PLAN OF IMPROVEMENT
BOSTON HARBOR, MYSTIC RIVER AND CHELSEA RIVER

Problems and Opportunities

This study focused on improving safe navigation access to Boston Harbor's deep draft cargo terminals. Growth in waterborne shipping of containers and bulk commodities is constrained by lack of adequate channel dimensions, particularly depth, to meet the needs of Massport, its customers, and other terminal operators. To meet the demand of increased container volumes, shippers are moving to larger vessels, and ports that wish to remain in the shipper's rotation must increase their access and berth depths to receive those vessels. For bulk commodities, transport in larger vessels results in unit-cost savings for the cargoes carried. Alternatives to deeper-draft waterborne transport, such as rail and truck, or smaller draft vessel carriage, are all more costly, leading to transportation cost-savings for port improvements undertaken.

Planning Objectives

The objective of the Boston Harbor Navigation Improvement Study is to develop an optimal plan for effectively and efficiently accommodating existing and prospective deep-draft vessel traffic in the Port of Boston. The optimal plan for Federal participation must be consistent with the Corps National Economic Development (NED) perspective as set forth in the Principles and Guidelines and must also account for the Regional Economic Development (RED) perspective. Plans must also account for Other Social Effects (OSE), be acceptable from the perspective of Environmental Quality (EQ), and be in concert with the Chief of Engineers' Environmental Operating Principles. Plans developed for analysis must be formulated to be complete, effective, efficient and acceptable, and to reasonably maximize net benefits over the 50-year period of analysis beginning with completion of construction projected for 2016-2017. The following are the principal planning objectives for this study:

- Contribute to National Economic Development by minimizing the cost of transporting existing cargo volumes and anticipated future increases in cargo volumes to and from New England in an environmentally acceptable and sustainable manner. Means of reducing tidal delays, including light-loading, lightering and increasing cargo capacity were examined for containerized, dry bulk and liquid bulk cargoes.
- Maximize the beneficial use of dredged material; particularly the large volume of rock that channel deepening would yield, for habitat creation and enhancement or other purposes during initial construction and future maintenance of the project.

Planning Constraints

Planning constraints are restrictions that limit the planning process and the available scope of solutions to the identified problems, or that limit consideration of opportunities. Planning constraints are either institutional (laws, policies and regulations governing Federal water resource project development), physical (sites available for port improvements), economic (limits on sponsor financing), environmental (habitat, endangered species) or sociological (cultural resources, strong local opposition). The following constraints were considered during this study:

- Highway and subway tunnels crossing beneath the harbor limit the deepening of the port's channels to areas of the waterfront seaward of the lower-most tunnel (I-90 – the Ted Williams Tunnel).

- There is only one container terminal at Boston - Massport's Conley Terminal on the Reserved Channel. No other land is available around the harbor sufficient in size for development of another terminal, especially down-harbor of the tunnels. This will constrain the scope of alternative terminal sites that can be considered.
- Massport's without-project upgrades to Conley Terminal efficiency, needed to handle significant increases in throughput, were largely completed in 2011.
- The presence of lobsters, anadromous fish, and other fisheries in the harbor will require development of a construction sequencing plan during the Design Phase, before the final regulatory reviews for the project, to enable construction to proceed without interruption while avoiding or minimizing impacts to different species found in the various areas of the harbor at environmentally critical times of year.
- Develop plans consistent with the US Coast Guard's stated needs for port security.
- The presence of the endangered right whale and other cetaceans at the disposal site will require use of whale observers to avoid impacts to these species.

ALTERNATIVES

Plan Formulation Rationale

Plans to address the problems and opportunities for navigation at Boston Harbor were developed consistent with the Planning Objectives and Constraints outlined above. The locations of existing channels and terminals, and absence of sites available for development of new terminals, limited the range of practicable alternatives. For each project segment various channel dimensions were examined relative to design vessel needs and projected cargo volumes. Measures to improve navigation and capacity were identified, screened and further developed into detailed plans. After extensive economic reanalysis in 2009 through 2012, plans were further evaluated and optimized to identify a recommended plan of improvement for each project segment.

Management Measures and Alternative Plans

Structural and non-structural measures were examined to address the navigation problems and opportunities of the port. These included:

- Entrance channels – which of the harbor's three entrance channels was most economic to provide a deeper depth than the current 40 feet in the North Entrance Channel.
- Regional ports – Investigation of alternatives to Boston Harbor for development of a regional containerport to replace the Conley Terminal in terms of regional growth. These were examined and dismissed due to lack of infrastructure and excessive cost.
- Tidal Navigation – use of tidal assistance in combination with channel depth to maximize port access by larger ships. Tidal assistance taking advantage of Boston's 9-foot average tidal range is currently practiced by larger carriers, with berths dredged deeper than the channels to facilitate this practice.
- Beneficial Use of Dredged Materials - Habitat creation using rock removed from the channel was examined. Use of other dredged materials for remediation purposes in the Bay was also examined with US EPA. Further analysis of these opportunities will be required in the Design Phase.

- Rail and Barge Transportation and greater use of smaller containerships – alternatives to deeper-draft containership carriage of cargo to Boston were examined and dismissed due to increased cost over both trucking and larger containerships. Use of barges, smaller and more lightly loaded containerships and continued use of trucking were also subjects of the economic reanalysis carried out in 2009-2012.
- Anchorage needs for port security and emergency purposes as compared to typical vessel operations were incorporated in consultation with the USCG and harbor pilots.

Final Array of Alternatives

The final array of alternatives, shown in Figure ES-1, was limited to the deepening of the existing channels serving existing terminals. Four improvement plans were developed.

- <u>Main Channels Improvements for Conley Terminal Access – Containers</u>: Plans ABC for improving access to the Conley Terminal for containerships included deepening of the Broad Sound North Entrance Channel, the Main Ship Channel through President Roads up to the Reserved Channel, the lower Reserved Channel at the Conley Terminal, the Reserved Channel Turning Area and the President Roads Anchorage. Channel depths with analysis presented in one-foot increments from -42 to -50 feet at mean lower low water (MLLW) were examined. In all plans the entrance channel would be dredged four feet deeper than the interior channels to account for increased seas and vessel motion. Berths at the Conley Terminal, now 45 feet, would be deepened to at least 3 feet greater than the inner harbor channel depth provided to facilitate continued use of tidal assistance by transiting vessels.
- <u>Extend Main Ship Channel Deepening to Massport Marine Terminal (MMT) – Dry Bulk</u>: A plan (Plan D) for improving access to the Massport Marine Terminal was developed for deeper draft dry bulk carriers, by extending the deepening of the Main Ship Channel above the Reserved Channel Turning Area to the Marine Terminal. Depths of from -42 to -45 feet MLLW were examined to deepen the existing 40-foot deep by 600-foot wide lane. The berth at the MMT would be deepened commensurate with that provided by the Improved channel.
- <u>Mystic River Channel Access to Medford Street Terminal (MST) – Dry Bulk</u>: A plan (Plan E) for improving access to Massport's Medford Street Terminal on the Mystic River for lesser draft dry bulk and break-bulk carriers was developed. Massport has already cleared the site and deepened the berth to 40 feet, leaving a small area of the 35-foot Federal channel between the berth and the 40-foot channel. Depths of from -37 to -40 feet MLLW were examined for this area to benefit smaller bulk operations than would be accommodated at the MMT.
- <u>Chelsea River Channel Deepening – Liquid Petroleum</u>: Plan F – would improve access to the Chelsea River primarily for its petroleum terminals. This would deepen the existing 38-foot channel to either 39 or 40 feet, with minor channel widening in two areas between the bridges.

Improvements to the Mystic and Chelsea Rivers were limited to -40 feet MLLW due to the downstream highway and subway tunnel restrictions.

Comparison of Alternatives

Screening analysis dismissed all alternatives other than channel modifications, with tidal assistance factored into the design and economic evaluations. Plans for each of the four project segments; main channels improvement from the sea to the Conley Terminal, Main Ship Channel extension to the Massport Marine Terminal, Mystic River and Chelsea River, were examined at one-foot increments to optimize the improvements. The plans that reasonably maximize net annual benefits for each segment were as follows:

- Main Channels Improvement – Plan ABC – 47 Feet with 51 Feet in the entrance channel
- MMT Extension of Main Ship Channel – Plan D – 45 Feet
- Mystic River Channel at Medford Street Terminal – Plan E – 40 Feet
- Chelsea River Channel – Plan F – 40 Feet

Hydrodynamic and ship simulation studies were conducted for the Chelsea River in 1993, and for the Main Channels Improvements in 2005-2007 to examine the handling characteristics of the evaluated design vessels in each these waterways. Minor modifications were made to the proposed channel layouts in each of these segments as a result of these studies.

Key Assumptions

Recommendations on channel improvements and depth optimization are predicated on levels of commerce identified through investigation and forecasts of future commerce. The without-project (no action) alternative assumes:

- Massport's efficiency upgrades to the Conley Terminal have been completed
- The Massport Marine Terminal begins operations before any Main Ship Channel deepening extension above the Reserved Channel improvements is undertaken
- Users of the Medford Street Terminal on the Mystic River are identified before any channel improvements are made at that location
- Growth in east coast container cargo volumes occur at least at the level predicted in the economic trade forecasts.
- The Panama Canal deepening project is completed in 2014-2015 as scheduled.
- The deepening of the Port of New York and New Jersey 50-foot project to the Port Elizabeth terminals is completed in 2015 as scheduled.
- Trans-oceanic container services now calling on Boston will shift to larger capacity vessels in response to the deepening of the Panama Canal and the Port of NYNJ.

Recommended Plan of Improvement

The recommended plan of improvement, as shown in Figure ES-1, consists of improvements accessing four segments of the port. The recommended plan for each project segment reasonably maximizes net national economic development and therefore is the NED Plan, while avoiding or minimizing significant adverse impacts. Some of the rock would be drilled and blasted. Rock and all other material would be removed by a heavy toothed bucket dredge, placed in scows and towed to the Massachusetts Bay Disposal Site about 18 miles east of the harbor. Beneficial use opportunities identified during the study, including creation of hard bottom habitat in Broad Sound and Massachusetts Bay using the rock, capping of the former Industrial Waste Site in Massachusetts Bay using the unconsolidated dredge materials, and use of rock by the State and others for shore protection projects, will be investigated further during project design and used if found feasible and approved through further review, and where any necessary cost-sharing partners are identified. The deepening is almost entirely confined to the very slow shoaling existing channel limits minimizing adverse impacts. Current maintenance cycles are between 16 and 40 years for the various project segments to be improved. Additional design phase investigations will develop plans for blasting and construction sequencing to further avoid and minimize impacts.

Main Channels Improvement to Access the Conley Terminal – Access from Massachusetts Bay to the port's sole container terminal would be improved (Plan ABC) as recommended in the ship simulation models as follows:

- The 40-foot deep lane of the Broad Sound North Entrance Channel would be deepened to -51 Feet MLLW from Massachusetts Bay to the harbor's Outer Confluence. The Channel would also be widened in the bend opposite Finns Ledge near its entrance to ease the turning of larger vessels.
- The 40-foot lane of the Main Ship Channel from the Outer Confluence, through President Roads and up to the Reserved Channel would be deepened to -47 feet MLLW. The 1200-foot width through the Roads would be retained, and the channel widened to 900 feet through the turns above the Roads, and to 800 feet above the turns to the Reserved Channel, with further widening in bend apexes. The widening would be accomplished by incorporating areas of the current 35-foot lane into the deepened lane to minimize improvement costs.
- The President Roads Anchorage would be deepened to -47 feet MLLW over its existing area, sufficient to accommodate two large vessels at anchor.
- The lower 40-foot reach of the Reserved Channel along the Conley Terminal would be deepened to 47 feet, and widened north of the channel entrance in its transition to the Turning Area.
- The 40-foot Reserved Channel Turning Area would be expanded from its current 1200-foot diameter to 1500 feet, deepened to -47 feet MLLW, and widened 100 feet further northeast.

These improvements would require the removal of about 900,000 cubic yards (CY) of rock and about 10.2 million CY of ordinary dredged material (unconsolidated – largely Boston blue clay, glacial till, sand, and cobble).

Main Ship Channel Deepening Extension to Massport Marine Terminal – The 40-foot lane of the Main Ship Channel would be deepened to -45 feet MLLW above the Reserved Channel Turning Area for a distance of about 2600 feet, at the existing width of the 600 feet, to accommodate large dry bulk carriers, principally cement, to access the redeveloped Massport Marine Terminal (Plan D). Massport and its redevelopment partners plan to complete work on the terminal in 2016 and will deepen the berths at the terminal to -45 feet MLLW. Benefits derive from use of larger vessels to transport bulk cargos including cement. This is the last deepwater terminal site below the harbor tunnels. This improvement would yield about 246,300 CY of ordinary dredged material and 78,400 CY of rock.

Mystic River Channel Access to Medford Street Terminal – A 9-acre area of the 35-foot channel lane would be deepened to -40 feet MLLW to connect the existing 40-foot channel lane with the 40-foot berth at the Medford Street Terminal (Plan E). Project benefits for this segment derive in general from dry-bulk cargo shipping efficiencies from use of larger vessels. This improvement would yield about 67,100 CY of ordinary dredged material. No rock removal is required for this channel. This recommendation is contingent on the identification of terminal users sufficient to support the economic justification before dredging.

Chelsea River Channel – The existing 38-foot channel and the turning basin at its upper end would be deepened to 40 feet MLLW (Plan F). The channel would be widened by 50 feet along the East Boston shore in two locations; just upstream of the McArdle Bridge near the river's mouth, and in the bend downstream of the Chelsea Street Bridge. This plan would yield about 342,600 CY of ordinary dredged material and 500 CY of rock. With the replacement of the Chelsea Street Bridge in 2012, the Corps and its partners undertook related improvements of the waterway to take advantage of the wider bridge opening in early 2012. Remains of prior highway and railway bridges, fenders, piers and pilings, and abandoned utilities were removed. Bulkheads were stabilized and retained utility crossings were protected with sheetpile. The channel passage through this area was widened to 175 feet, the same width as provided through the McArdle Bridge downstream. Deepening of the channel would permit passage of more heavily laden and larger tankships. Terminal operators would need to deepen their berths to the depth provided by the deepened channel.

Improvements for the Main Ship Channel Extension to the Massport Marine Terminal and the deepening of the Mystic River Channel at the Medford Street Terminal are both predicated on Massport's efforts to redevelop those facilities in partnership with third parties. In order for these improvement segments to move to construction, a Limited Re-Evaluation Report will need to be prepared during the design phase supporting the anticipated benefits and recommended improvements for those two segments.

Systems/Watershed Context

Improvements to the Port of Boston have been limited to deepening existing project features to serve existing terminals. There are no major rivers discharging into the harbor and all project features are in tidal waters. The two minor rivers discharging into the port area, the Charles and Mystic Rivers, are both controlled by dams at or a short distance above the existing improved deep-draft channels. Deepening the existing channels will have no negative impact on the watersheds of these rivers. From a coastal system perspective, the materials to be removed are parent material, mostly rock and clay. Little to none of the material would be suitable for beach nourishment. Other beneficial uses have been identified for all of the material.

Environmental Coordination, Impacts and Benefits

The project was designed and the study conducted in accord with the requirements of the National Environmental Policy Act. A Supplemental Environmental Impact Statement (SEIS) was prepared for this project, furthering the evaluation finalized in June 1995 for the 1990 authorized project, an SEIS prepared for the Inner Harbor maintenance dredging project finalized in May 2006, and environmental assessments prepared for the 2012 Chelsea River channel widening and lower inner harbor rock removal projects.

To understand and properly consider environmental impacts of the project and to solicit the views of other interests, this study continued involvement of a Technical Working Group (TWG) composed of representatives from Federal, State and Municipal agencies, universities, and non-governmental harbor interests. The TWG had been established during review of the EIS for the 1990 authorized project and was continued through the development of the four recent major maintenance actions. The TWG was used to solicit input on study scope, review of study findings, and dissemination of study information, materials, and recommendations.

By focusing on improvements to existing project features for the benefit of existing terminals the project minimizes the impacts of construction and port operations. The use of the existing channels also capitalizes on the harbor's sustainable low maintenance dredging frequency of 16 to 41 years for the various project segments.

The potential beneficial use opportunities identified in the study will require further evaluation and agency coordination during detailed design, but represent an opportunity for balance between port development and environment. The rock could be used to create offshore habitat, or potential use by the State or others for shore protection purposes on area projects. These uses will be examined further with the Sponsor, State and TWG participants during detailed design, as requested in responses to the Draft Feasibility Report.

The remaining dredged material has been suggested for use as cap material for the former EPA designated Industrial Waste Site (IWS) in Massachusetts Bay. The IWS was used until the early 1970s for disposal of chemical, low level radiological and medical waste in barrels and concrete containers still visible on the ocean floor. The IWS is located immediately north of the existing Massachusetts Bay Disposal Site (MBDS), the site used for the Federal base plan and the estimates included in this feasibility report. The potential for using the dredged material to cap this IWS has been investigated in deep-water capping demonstration projects at the existing ocean disposal site, and in studies of the IWS carried out jointly by the Corps and EPA. This proposal will be explored further with EPA and others during the detailed design phase. The cost for placement as cap at the IWS is estimated to be the same as for placement at the adjacent MBDS. The EPA, Corps and others view the deep draft navigation improvement project as a one-time opportunity to cap the IWS.

Air Quality mitigation may be required for construction and with-project emissions impacts. EPA anticipates revising the Boston area's attainment status in the summer of 2013, however at least one pollutant may still be of concern. Currently construction emissions are kept below the mitigation thresholds using a six-month construction shutdown every other winter to limit work to nine months annually. Alternative opportunities for emissions mitigation will be examined by the Corps and Massport during the design phase when EPA's revised standards and the extent of the rock removal efforts are better known.

Construction sequencing for rock removal, dredging and disposal from the various project segments will be developed and refined with the input of the TWG during the design phase once rock removal volumes and methods have been determined. Sequencing is anticipated to allow work to proceed in various areas of the harbor throughout the period of construction while avoiding work in ecologically sensitive times of year in each area. Benthic and fisheries resource studies are included in the design phase to support development of work sequencing plans. Monitoring studies are included in the construction phase to permit adaptive management of the sequencing. The design and construction phase studies will also provide a baseline to measure recolonization and inform future work efforts in the harbor.

Following completion of additional economic analyses and the identification of the recommended project depth of the main channels improvement re-coordination was initiated with the TWG agencies in October 2012. Endangered Species Act and Fish and Wildlife Coordination Act efforts were concluded in November 2012 and January 2013, respectively, with no adverse impacts identified. Coastal Zone Management Consistency Concurrence was issued by the Commonwealth November 29, 2012. Other than development of construction sequencing plans and a six-month emissions shutdown between years two and three of construction, no mitigation is required for the project.

Agency Technical Review (ATR) and Independent External Peer Review (IEPR)

ATR and IEPR for this study have been managed by the Deep Draft Navigation Planning Center of Expertise at the Corps South Atlantic Division, Mobile District (SAM). SAM tasked the New York District with technical review of the 2008 draft study documents, and a multi-District team from NAD and SAD for review of the final documents in January 2013. SAM has also managed an Independent External Peer Review of the draft study documents by experts outside of the Corps of Engineers. The Corps Center of Expertise for Cost Estimating at the Walla Walla District (NWW) was been tasked with technical review of the project cost estimates in both 2008 and 2012. The results of these reviews have been addressed and incorporated into the final project documents and recommendation.

EXPECTED PROJECT PERFORMANCE

Project Costs

Project costs are shown in Table ES-1. Updated project costs were developed at July-August 2011 price levels. Cost contingency risk analysis was conducted by the District in December 2011 through May 2012 with assistance from NWW. The estimates include costs for improvements to General Navigation Features (GNF - the channels, anchorage, and turning basins), costs for Local Service Facilities (LSF - berth deepening at terminals), costs for relocating aids to navigation (ATON - US Coast Guard), and real estate requirements during construction. GNF costs consist of drilling and blasting of rock, dredging and disposal of dredged material and rock, and costs for equipment mobilization, planning, engineering and design, construction management and inspection, and environmental monitoring. The design phase includes development of plans for construction sequencing, blasting practices, examination of alternative air quality compliance measures, optional beneficial uses for rock, post-maintenance resource baseline characterization, and biological recovery monitoring.

Equivalent Annual Costs and Benefits

To determine whether Federal interest in the proposed improvements is warranted, the project has been evaluated for its environmental impacts, social effects, and economic justification. Project benefits were developed based on July 2011 price levels using a project base year of 2016 for completion of construction. Economic justification is expressed in terms of Benefit-

TABLE ES-1 BOSTON HARBOR NAVIGATION IMPROVEMENT STUDY SUMMARY OF RECOMMENDED PLAN COSTS AND BENEFIT/COST ANALYSIS					
July 2011 Price Levels, Escalated to October 2012, with December 2012 Contingency Risk Analysis FY 2013 Interest Rates	**Main Channels Improvements (Containerships)**	**Main Ship Channel Extension to Marine Terminal**	**Mystic River Channel Deepening**	**Chelsea River Channel Deepening**	**Total All Recommended Improvements**
	PLAN ABC	**PLAN D**	**PLAN E**	**PLAN F**	**COMBINED**
GNF Dredging Quantities	**47/51 Feet**	**45 Feet**	**40 Feet**	**40 Feet**	
Ordinary Material	10,220,900	246,300	67,100	342,600	10,876,900
Rock Removal	992,950	78,400	0	540	1,071,900
GNF Construction					
Channel Improvements	$213,754,000	$12,648,000	$1,534,000	$8,498,000	$236,434,000
Contingencies	35,651,000	2,833,000	360,000	1,462,000	$40,306,000
Planning, Engineering & Design	5,361,000	367,000	170,000	394,000	$6,292,000
Construction Management	8,565,000	843,000	269,000	960,000	$10,637,000
Total GNF	$263,331,000	$16,691,000	$2,333,000	$11,314,000	$293,669,000
Non GNF Items					
LERRs (Real Estate - Massport)	$125,000	15,000	$4,000	$18,000	$162,000
Aids to Navigation (USCG)	192,000	24,000	0	48,000	$264,000
LSF - Berth Deepening	443,000	1,348,000	0	1,493,000	$3,284,000
Total Non-GNF	$760,000	$1,387,000	$4,000	$1,559,000	$3,710,000
Annual Costs and Benefit Cost Analysis - FY13 3-3/4% Interest Rate					
Total First Cost - July 2011 Price	$264,091,000	$18,078,000	$2,337,000	$12,873,000	$297,379,000
Investment Cost (+IDC)	$278,150,000	$18,157,000	$2,337,000	$12,944,000	$311,588,000
Total Annual Costs	$12,641,000	$831,000	$115,000	$718,000	$14,305,000
Total Annual Benefits	$100,176,000	$1,163,000	$221,000	$1,936,000	$103,496,000
Benefit/Cost Ratio	7.92	1.40	1.92	2.70	7.23
Net Annual Benefits	$87,535,000	$332,000	$106,000	$1,218,000	$89,191,000
Project First Cost - Constant Dollar Basis - 2013 Program/Budget Year					
Project Costs for Chief's Report	$273,853,000	$18,747,000	$2,423,000	$13,351,000	$308,374,000
GNF Consruction - Program Year	$258,612,000	$16,052,000	$1,964,000	$10,328,000	$286,956,000
GNF PED - Program Year Costs	$5,564,000	$381,000	$176,000	$409,000	$6,530,000
GNF CM - Program Year Costs	$8,889,000	$875,000	$279,000	$997,000	$11,040,000
LERRs Program Year Costs	$130,000	$16,000	$4,000	$19,000	$169,000
LSF Program Year Costs	$459,000	$1,398,000	$0	$1,548,000	$3,405,000
ATON Program Year Costs	$199,000	$25,000	$0	$50,000	$274,000
Fully Funded Project Cost (For PPA) - Escalated					
GNF Fully Funded Construction	$277,218,000	$17,973,000	$2,284,000	$11,526,000	$308,999,000
GNF Fully Funded PED Costs	$5,611,000	$384,000	$177,000	$412,000	$6,584,000
LERRs Fully Funded Constr.	$135,000	$17,000	$4,000	$19,000	$175,000
Total Fully-Funded GNF + LERRs	$282,964,000	$18,374,000	$2,465,000	$11,957,000	$315,758,000
LSF Fully Funded Constr.	$463,000	$1,472,000	$0	$1,518,000	$3,453,000
LSF Fully Funded PED	$10,000	$7,000	$0	$55,000	$72,000
Total Fully-Funded LSF	$473,000	$1,479,000	$0	$1,573,000	$3,525,000
ATON Fully Funded Costs	$206,000	$26,000	$0	$51,000	$283,000
Total Fully-Funded Project Costs	$283,643,000	$19,879,000	$2,465,000	$13,581,000	$319,566,000

Cost analysis. Project costs, amortized over the project economic life and annualized to present value are compared to average annual economic benefits that would be produced by the project. To be recommended a project must have a benefit-cost ratio of greater than one-to-one. In addition, alternatives are compared to determine and recommend the plan which reasonably maximizes net annual benefits.

At Boston Harbor, four separate improvements to different portions of the existing navigation features are recommended for improvement. As described above these are: (Plan ABC) the Main Channels Improvements accessing the Conley Terminal, (Plan D) the Main Ship Channel deepening extension to the Massport Marine Terminal, (Plan E) the Mystic River Channel deepening, and (Plan F) the Chelsea River Channel deepening. Each project segment was examined incrementally foot-by-foot to determine the net benefits yielded by each channel depth. The annual costs, annual benefits, and benefit cost analysis for the four project segments are summarized in Table ES-1.

The combined recommended project carries an annual cost of $14,305,000, and produces annual benefits of $103,496,000, yielding net annual benefits of $89,191,000 and a benefit-cost ratio of 7.2 using the fiscal year 2013 interest rate of 3.75 percent. Using an interest rate of 7 percent annual costs are $22,978,000, annual benefits are $103,475,000, yielding net annual benefits of $80,497,000 and a benefit-cost ratio of 4.5.

COST SHARING

Cost sharing for navigation improvement project varies with the recommended project depth. Where entrance channels have been increased in depth relative to interior channels to compensate for increased seas and vessel motion, the interior channel depth controls the cost-sharing for that feature. Project costs for depths of up to -45 feet MLLW require the non-Federal Sponsor to provide 25% of the design and implementation cost during those phases, with an additional 10% contribution due following construction, which may be paid over a period not to exceed 30 years. Project depths of greater than 45 feet increase the non-Federal up-front share to 50% for the additional cost for the greater depth, plus the 10% contribution. Where an improvement includes dredging above and below the 45-foot elevation, the costs must be split and the two share percentages applied to each increment. Also, 50% of the cost of future maintenance attributable to the increment beyond 45 feet must be borne by the non-Federal sponsor, while the maintenance attributed to the increment up to 45 feet is borne by the Federal government.

All costs for improvement and future operation and maintenance of local service facilities (LSF) required to achieve project benefits must be borne in full by non-Federal interests. For this project those LSF facility costs are limited to the cost of deepening terminal berths where necessary. Real Estate interests required for the project, including lands, easements, rights-of-way, and relocations (LERR), must also be provided at the expense of non-Federal Sponsor. The only real LERR acquisition activities anticipated for the project involve the temporary leasing of construction office space and construction staging and vessel access facilities during the period of construction of project and the associated rent payments. Real Estate costs may be credited against the Sponsor's 10% post-construction contribution. All other work is subtidal, so the Government will exercise its dominant rights under navigational servitude to implement the project. Cost sharing for the four project segments in shown in Table ES-2.

TABLE ES-2
BOSTON HARBOR NAVIGATION IMPROVEMENT STUDY
COST SHARING ($1000s) – FY2013 Program/Budget Year Cost for Four Segments of Combined Project - Escalated

Plan ABC - Main Channels - 47/51 Feet Plan D - MSC Extension - 45 Feet Plan E - Mystic River - 40 Feet Plan F - Chelsea River - 40 Feet	Total Cost	Federal Up-Front Cost Share 75%	Massport Up-Front GNF Cost Share 25%	Massport 10 Percent GNF Contribution (Post-Construction)	Non-Federal Funded Items LSF & LERRs	U.S. Coast Guard (ATON)
Sponsor's Reimbursed Share of Excess Feasibility Study Costs (50% of $850) Not Inlcuded in Total Cost	$425		$425			
PED (Design Phase for GNF)	$6,530	$4,898	$1,633	$653		
Non-GNF Design Phase	$68				$68	
Total Construction - GNF	$297,996	$223,497	$74,499	$29,800		
Incremental Cost of GNF Design and Construction of Main Channels from 45 Foot to 47 Foot Design	$65,241	($16,310)	$16,310			
Berth Deepening	$3,337				$3,337	
Real Estate (LERR)	$169			($169)	$169	
Aids to Navigation	$274					$274
TOTAL Fully Funded D&I	$308,374	$212,084	$92,442	$30,284	$3,574	$274

Note: All costs in this table are based on July 2011 price levels escalated to the program/budget year cost level (FY2013). Massport's up-front share of design costs is $1,633, plus a 50% share of excess feasibility study costs ($425). The Non-Federal up-front cost share for construction equals 25% of the cost for the General Navigation Features ($74,499) plus and additional 25% (50% total) of the cost of dredging beyond 45 feet to a 47-foot project ($16,310). The non-Federal post-construction contribution includes 10% of the total cost of design and construction of the General Navigation Features ($653 for design and $29,800 for construction). Massport's Real Estate (LERR) costs ($169) are creditable against its 10% post-construction contribution of GNF costs, for a net contribution of $30,284.

Project Implementation

Massport is the non-Federal Sponsor, and would supply all necessary items of local cooperation, including the non-Federal shares of design and construction costs, and the full cost for berth deepening at its facilities, temporary space for construction offices, and waterside access for the construction plant.

All construction, including disposal, would be subtidal. All the construction plant(s) would be waterborne. All dredging would be by a heavy toothed bucket dredge capable of removing the stiff clay, glacial till and rock. Some rock may require drilling and blasting, hammering or ripping before removal. Feasibility level cost estimates assume that all rock and hard material would require drilling and blasting. Dredging in various areas of the harbor may be sequenced to minimize impacts on fish and shellfish populations that exist in different areas of the harbor at different times of year. Under the Federal base plan approved by US EPA, all disposal of dredged materials would occur in Federal waters at the MBDS. Beneficial uses of rock for various purposes including habitat creation and shore protection, and use of unconsolidated materials for capping of the former Industrial Waste Site in Massachusetts Bay would be examined further during design with the assistance of the TWG.

Operation and Maintenance

Operation and maintenance of the completed project would be limited to continued periodic maintenance dredging of the existing channels and other dredged features of the project. The USACE would undertake this maintenance with financial participation from Massport for a portion of the cost of maintaining those channels deepened beyond 45 feet. The Sponsor and other terminals owners would be responsible for the periodic maintenance of their individual berths. Major maintenance dredging is currently required for the various segments of the existing project every 16 to 40 years, and the same is anticipated for the improved project.

OTHER CONSIDERATIONS

Key Social and Environmental Factors

The Boston is New England's largest city and largest seaport. More than 40 percent of Boston's 2011 loaded TEU volume was exports. Waterborne commerce is an important part of the region's economy and development.

The project benefits are primarily derived from reducing the truck hauling miles for containerized cargo with an origin or destination in New England, except the region's southwest which is closer by land to New York. Most New England cargo is landed in New Jersey and trucked through New England. Bringing more cargo to Boston by water would save several million truck-miles annually over New England roads. However, as more cargo would be shipped through the Port of Boston, roads in the immediate vicinity of the Conley Terminal would see an increase in truck traffic. This is offset by the proximity of the terminal to the Interstate 90 ramps at the seaport about one mile west of the terminal, mostly through the industrial seaport area. Overall, there is a significant savings in cost, time, fuel and air emissions from shipping New England cargo through Boston rather than the Port of New York-New Jersey.

In addition to being the region's largest commercial port, Boston Harbor is also a natural resource. The Boston Harbor Island National Recreation Area and Boston Harbor Islands State Park draw millions of visitors annually. Commercial lobstermen set their traps in the harbor, and a commercial fishing fleet operates out of South Boston. As the proposed improvements are largely confined to existing channel areas, the impact of port deepening is confined to areas already impacted by periodic maintenance dredging. However, close coordination of construction activities with other harbor interests will be necessary to minimize conflicts and impacts on those uses. Some impacts, though negligible against the background of a major urban industrial port, are unavoidable, including the noise and light of the several vessels comprising the floating construction plant, and submarine blasting operations.

Stakeholder Perspectives and Differences

The Boston Harbor Deep Draft Navigation Feasibility Study was conducted and the report prepared in partnership with Massport, the non-Federal Sponsor for the study. The Technical Working Group was engaged periodically throughout the study. There are several areas that will require continued coordination.

- The project will require removal of about one million cubic yards of rock. Agencies expressed concern with the impacts of any blasting on fisheries, shellfish, whales and the whale listening system of buoys in the Bay that are monitored to reduce ship strikes. The TWG members agreed to form a sub-group during the Design Phase to develop a blasting mitigation plan that would incorporate management practices and adaptive management processes to minimize the impacts of blasting on these resources. Project construction sequencing plans and other best management practices will be developed, using recent lessons learned, with assistance from the TWG during the Design Phase.
- The beneficial use proposal for the rock to create hard bottom habitat in the Bay will require additional investigation, coordination, and design. Several agencies expressed doubts on the acceptability or technical success of rock reef creation and the need to investigate siting, target species benefits, monitoring and measures of success. The TWG members will assist in the investigation and development of this potential opportunity.
- The State and some agencies requested more consideration of alternative beneficial uses for the rock removed, including use in shore protection projects or other construction purposes. Massachusetts Coastal Zone Management Office (MA CZM) has initiated discussions with some parties interested in receiving the rock from the project. The Corps, Massport and the State will investigate the potential for these opportunities further in the Design Phase.
- The beneficial use proposal to use the unconsolidated dredged material to cap the IWS will require further investigation, coordination, and design by the Corps, EPA and others. Some parties may object to any activity that would disturb this site, though all comments received on the Draft report was supportive of this plan. A field demonstration by the Corps at the Massachusetts Bay Disposal Site (MBDS) using clay dredged to form the inner harbor Confined Aquatic Disposal (CAD) cells for the recent maintenance dredging project was successful. Should it be determined that the site may not be capped with this material without additional significant impacts that outweigh any potential benefit from capping, then this dredged material would be placed at the MBDS as included in the

current base plan. EPA would also need to give permission to allow the capping of the IWS with dredged material.

- Lobstering occurs in many areas of the harbor, including some lobstermen who place their traps and gear in the navigation channels. This un-permitted and illegal activity, while a hazard to navigation, nevertheless occurs and a public notice will be issued at the beginning of the project construction so that lobstermen can remove their gear prior to drilling, blasting and dredging.
- Maintenance dredging of several areas of the project may occur concurrent with the improvement work. This includes maintenance of inner harbor areas requiring disposal in some of the harbor's confined disposal cells, or other materials permitted for disposal offshore. This work will need to be planned and budgeted (by the government and the Sponsor) concurrent with the improvement work that in some areas will be removing improvement material lying beneath the maintenance material.
- Resource characterization of the dredge areas would be reanalyzed during the design phase, as major maintenance of the harbor was ongoing through the feasibility study. Agency comments pointed to a need for updated post-maintenance characterization to serve as a basis for determining what resources are present in which areas of the harbor at what times of year, in order to develop construction sequencing.
- Agency comments also focused on development of construction sequencing plans to avoid and minimize impacts to harbor resources. These plans require the completion of Design Phase field investigations to permit mapping of harbor bottom types with and without the project, develop resource mapping and timelines, construction durations for blasting and dredging in various project reaches, and merge all the data together to find the best fit of construction sequencing with resource concerns.
- Air Quality compliance is currently achieved by avoiding emissions thresholds through construction shutdowns that limit work to nine months per year. Emissions credits and offsets were investigated but could not be identified at the feasibility phase. These will be re-examined during the design phase, and if identified, should reduce compliance costs.

Economic Risk and Uncertainty

Major port deepening projects such as the one recommended here represent significant public investments based on industry practices and trends, and assumptions about industry responses to future conditions, such as deepening of other ports, additional liner services, and larger global fleet, commodity and trade forecasts. Within this view optimization of the recommended project depth is required with analysis at one-foot increments for a project economic life of several decades. With this in mind, consideration must be given to other factors that address the risk of under-building versus the cost of over-building the project.

Major port deepening projects entail significant environmental impact to fisheries, marine life, other navigation uses of the port. The more frequently major dredging occurs, the more often these resources and uses are impacted. Dredging to a lesser project depth than what ultimately proves to be needed within a short term would require these impacts to be weathered twice. This is a particular concern with respect to the areas of rock to be drilled and blasted before dredging.

The beneficial use of dredged material for this project would require the eleven million cubic yards of unconsolidated material to cap the entire former industrial waste site. Dredging to lesser depths may mean leaving some of that area uncapped, or placing a reduced cap thickness and therefore less effective cap over the full IWS area. The less the volume of material available for beneficial use as cap for this site, the greater the risk that portions of the site would remain uncapped and exposed to the environment.

The deepening is intended to allow Boston to retain inter-oceanic container liner services as other ports, notably New York and the Panama Canal, are deepened, and to permit those larger vessels to load more cargo. Lesser dredging depths at Boston increase the risk that some carriers will drop the port from service as some carriers indicated in the Framework carrier interviews, fail to inaugurate new services, or carry lighter loads. Either more vessel traffic, or lesser reductions in landside truck miles would result from lesser channel depths.

Greater truck traffic carries impacts on regional air quality, highway maintenance, and highway safety. For example, under the base economic case for the recommended 47-foot project depth an average of 149 truck miles per TEU shifted to Boston means a savings of about 18 million truck miles, or about 2.6 million gallons of diesel fuel annually. This savings in mileage and fuel has significant benefits beyond the transportation cost savings realized, including highway maintenance, traffic congestion and safety, and air quality. While these benefits have not been quantified in economic terms they are significant. Lesser channel depths will yield lesser benefits.

Ship traffic carries risks to marine mammals and other resources. Greater channel depths within the range that would support the vessel classes and observed loading practices reduce these risks. Lesser channel depths mean relatively greater impacts if the harbor were to be dredged twice within a limited span of years.

Cost inefficiencies result from additional mobilization/demobilizations costs from having to deepen a project in multiple depth increments, rather than under one contract or continuous action. For larger volume projects such as Boston, mobilization costs can be several million dollars. Longer term construction costs will also likely be greater than near-term costs.

REVIEW OF THE DRAFT FEASIBILITY REPORT AND SEIS

The Draft Feasibility Report and Draft Supplemental Environmental Impact Statement (Massachusetts Draft Environmental Impact Report) was circulated for review and comment to interested Federal, State and Local agencies and officials, harbor interests and organizations, and the general public. A Notice of Availability was published in the Federal Register on 18 April 2008. The public review period was closed on 2 June 2008. A public meeting was held in South Boston on 20 May 2008 to provide interested parties with a detailed briefing on the project and an opportunity to address questions and concerns to the Corps and Massport. A total of 17 comment letters were received on the Draft documents; four from Federal agencies, seven from State agencies, the City of Boston, Town of Winthrop, and four local non-governmental organizations with interest in the harbor.

Concurrent with the public review process, the project documents underwent Agency Technical Review within the Corps of Engineers, Independent External Peer Review by experts outside the Corps of Engineers, and policy compliance review by Corps Headquarters. Following these reviews additional economic analysis of the project was conducted between 2009 and 2012 at which point a final recommendation on project depth was determined and coordination re-initiated with the TWG agencies. Agreements for design-phase investigations were reviewed and re-confirmed and updated coordination documents exchanged. Comments and concerns raised by the several reviews have been addressed and incorporated into this Final Feasibility Report and Final SEIS/EIR. Following higher level review and approval within the Corps, that document will also be published for comment before a Record of Decision is prepared and the project submitted to Congress.

FURTHER ACTION

Following completion of the Feasibility Phase, the project would proceed into detailed design (the Design Phase), followed by construction once authorized and funded. The Design Phase of the project is estimated to require about two years to complete and will cost about $6.6 million. The Sponsor would be required to share the cost of design during that phase through execution of an agreement prior to the initiation of design. The Design Phase would culminate in one or more design documents detailing the results of any additional engineering and environmental investigations, describing modifications to project design, any new mitigation requirements identified, and updating project benefit and cost estimates.

In additional to further investigation of the beneficial use of dredged materials as described above, the Design Phase is expected to focus on geologic and geotechnical investigations to better determine the distribution of rock and till within the area to be dredged, develop a detailed blasting mitigation plan to address impact concerns, develop an appropriate sequencing of construction activities to minimize environmental resource impacts, further investigate appropriate beneficial uses of rock material for habitat creation, shore protection or other purposes, determine appropriateness of beneficial use of non-rock material for capping the former Industrial Waste Site in Massachusetts Bay, investigate additional air quality compliance methods as alternatives to the construction shutdowns presently scoped, additional resource characterization investigations for the dredging and beneficial use areas, and continuation of the Technical Working Group for Boston Harbor. Technical Working Group members would be invited to participate in smaller sub-groups focusing on some of the specific topics listed above.

The NSTAR high voltage cable supplying the regional sewage treatment plant on Deer Island crosses the harbor beneath the Reserved and Main Ship Channels. The cable was installed subject to a 1989 River and Harbors Act Section 10 permit, but it was not fully embedded beneath the Reserved Channel to the depth required in the permit. The Corps referred this matter to the U.S. Attorney's office during the feasibility study, and discussions of means to resolve the issue were conducted with the cable owners to either protect the cable in place, determine a means to lower the cable, or replace the cable, to bring it into compliance, or otherwise allow the deepening project to be completed. The New England District will request that the U.S. Attorney engage in final discussions with NSTAR during the Design Phase so that a timely resolution that will mitigate any risk to the project and its schedule is made.

At the conclusion of Design Phase investigations, including preparation of any detailed implementation plans, any Federal or State regulatory processes requiring re-coordination would be completed. Additional public comment may be sought on new information developed in the Design Phase, minor changes to the project, construction sequencing plans or changes in air quality compliance measures.

Construction would commence upon appropriation of Federal funds for that purpose by Congress and provision of the Non-Federal up-front cost-share by the Sponsor.   Construction is estimated to take about three years.

DEPARTMENT OF THE ARMY
NEW ENGLAND DISTRICT
696 VIRGINIA ROAD
CONCORD, MASSACHUSETTS 01742-2751

REPLY TO
ATTENTION OF

BOSTON HARBOR, MASSACHUSETTS
NAVIGATION IMPROVEMENT PROJECT

FINAL FEASIBILITY REPORT
AND FINAL SUPPLEMENTAL
ENVIRONMENTAL IMPACT STATEMENT
AND MASSACHUSETTS FINAL
ENVIRONMENTAL IMPACT REPORT
(EOEA #12958)

APRIL 2013

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BOSTON HARBOR, MASSACHUSETTS
DEEP DRAFT NAVIGATION IMPROVEMENT STUDY
FEASIBILITY REPORT

INTRODUCTION

This study was conducted by the U.S. Army Corps of Engineers, New England District (Corps), in partnership with the Massachusetts Port Authority (Massport). The study examines whether maintenance and improvements to the Port of Boston's system of navigation channels and related access features are warranted and in the Federal interest.

The City of Boston, Massachusetts is the hub of the nation's tenth largest metropolitan area, with a population of nearly 4.6 million. The Port of Boston is the largest port in New England, serving a regional population of 14.3 million residents in the six states. The Port handles about 20 million tons of cargo, worth more than $9 billion annually.

The Port of Boston, Massachusetts, as shown in Figure 1, is the most northerly large deep-draft port on the U.S. eastern seaboard with a container terminal, and is the closest port on northern shipping routes to Europe. The port is located on the western shore of Massachusetts Bay, an arm of the Gulf of Maine, about 50 nautical miles northwesterly of the northern tip of Cape Cod. The harbor includes all the tidal waters bound by a line drawn roughly from Point Allerton in Hull northward to Point Shirley in Winthrop. The harbor comprises a water area of about 47 square miles.

The main deep water harbor is comprised of the waterways of the Main Ship Channel, Reserved Channel, Mystic River and Chelsea River. These channels provide access at a depth of 40 feet at mean lower low water (MLLW) to the Port's principal terminals, except for the Chelsea River which has an authorized depth of -38 feet MLLW. Deep water access to the harbor is provided by three entrance channels constructed and maintained by the Corps of Engineers; the Broad Sound North Channel in two lanes at 35 and 40 feet, the Broad Sound South Channel at 30 feet, and the Narrows Channel at 27 feet.

Terminals located in the harbor complex shipped and received about 19.1 million tons of liquid and dry bulk, containerized, and general cargo in 2010. Bulk products, principally petroleum fuels, natural gas, cement, scrap metal, gypsum, and salt, are processed through more than twenty public and private terminals. Autos are landed at the Boston Autoport on the Mystic River. Cruise ships call on the Black Falcon Terminal on the Reserved Channel in South Boston. Containerized cargo, which makes up about seven percent of the Port's volume, is handled at Massport's Conley Terminal, also on the Reserved Channel in South Boston. In 2007 this containerized cargo had a value of more than $5 billion, more than 60 percent of the value of all cargo shipped through the port.

The Port and project area are partially located in the Massachusetts 5th, 7th, and 8th Congressional Districts. One of the sites under consideration for beneficial use of dredged materials lies offshore of the 6th District.


BOSTON HARBOR, MASSACHUSETTS
FEASIBILITY REPORT FOR DEEP DRAFT
NAVIGATION IMPROVEMENT
FIGURE 1
LOCATION MAP WITH
EAST COAST CONTAINER PORTS
N
HALIFAX
BOSTON
Closest US
Containerport
to Europe
NEW YORK –
NEW JERSEY
PHILADELPHIA/
WILMINGTON, DE
BALTIMORE
NORFOLK/
HAMPTON
WILMINGTON, NC
CHARLESTON
SAVANNAH
JACKSONVILLE
PORT EVERGLADES
MIAMI
Un-Scaled

The goal of this report is to document the formulation and evaluation process followed for the Boston Harbor Deep Draft Navigation Improvement Study, to identify cost effective, implementable navigation improvement alternatives, and to recommend a preferred alternative. This study also included preparation of a Supplemental Environmental Impact Statement (SEIS).

The SEIS is also being written, and the report and appendices structured, to fulfill the Sponsor's requirements to prepare a Massachusetts Environmental Impact Report (EIR) in satisfaction of Massachusetts Environmental Policy Act (MEPA) reporting and review requirements. This will facilitate a joint Federal NEPA and State MEPA public review process and avoids duplication of notices and hearings.

Study Authority

The New England District, U.S. Army Corps of Engineers has been authorized to conduct a study to evaluate the feasibility of deep draft navigation improvements at Boston Harbor and to determine whether Federal participation in implementing such improvements is warranted. The Feasibility Study was authorized by a Senate Subcommittee on Public Works Resolution dated September 11, 1969. The language of the resolution is provided below:

> "Resolved by the Committee on Public Works of the United States Senate, (September 11, 1969), that the Board of Engineers for Rivers and Harbors, created under Section 3 of the River and Harbor Act of June 13, 1902, be, and is hereby requested to review the report of the Chief of Engineers on Boston Harbor, Massachusetts, published as House Document Numbered 733, Seventy-ninth Congress, and other pertinent reports, with a view to determining whether any modifications of the recommendations contained therein are advisable at this time, with particular reference to modifying the project dimensions of the Main Ship Channel from deep water in Broad Sound to the upstream limit of the Federal project in the Mystic River."

The expedited reconnaissance investigation was initiated at the request of the Massachusetts Port Authority (Massport), the study sponsor, in December 1999 using funds provided in the Energy and Water Development Appropriations Act for Fiscal Year 2000 with a $100,000 line item for Investigations in the tables appended to the Statement of the Committee on Conference. The House Bill, H.R. 2605, House Report 106-253, 106th Congress, 1st Session, 23 July 1999 included a provision on Page 31 as follows:

> "*Boston Harbor, Massachusetts*.–The Committee has provided funding for a reconnaissance study to evaluate the deepening of the Main Ship, Reserved and Entrance Channels to Boston Harbor, Massachusetts."

The 905(b) Reconnaissance Report was approved by NAD and HQUSACE in August 2000. The Corps and Massport executed the Feasibility Cost-Sharing Agreement (FCSA) for this project on 27 June 2002. The study was initiated in July 2002 upon receipt of Federal and Sponsor funds for the study. Federal funding for the feasibility phase investigation was initially provided in the Energy and Water Development Appropriations Act for Fiscal Year 2002. The Conference Report accompanying that Act, House Report 107-258, 107th Congress, 1st Session, 30 October 2001, included a line item for $300,000 in the appended tables for “Boston Harbor, MA (45-Foot Channel)”.

A Notice of Intent to prepare a Supplemental Environmental Impact Statement for the project was published in the Federal Register on 23 August 2002, and the first public involvement meeting on the proposed project was held on 5 September 2002. An Environmental Notification Form (ENF), which initiates the Massachusetts Environmental Policy Act (MEPA) review process was filed in January 2003.

A Draft Feasibility Report and SEIS/EIR were released for public and agency review on 11 April 2008, with Notice of Availability published in the Federal Register on 18 April 2008. The public review period under the NEPA and State processes closed on 2 June 2008. A Draft Final Feasibility Report and SEIS were submitted to Corps Headquarters in July 2008 and presented to the Civil Works Review Board at its 21 August 2008 meeting. At the Board’s request additional information was submitted and considered in September 2008. The Board directed that additional investigations of the project’s economic justification be conducted with a view to determining the economically optimal depth of the main channel improvements for the benefits of container shipping.

A Framework for Additional Economic Analysis of the project was prepared in October 2008 and after extensive discussion a detailed scope for that analysis was approved by Corps Headquarters in November 2009. The Framework scope called principally for three tasks (1) a survey of shippers using container services to determine the source and destination of cargo and rational and costs for land versus waterborne shipment, (2) interviews with container shippers to develop further information on fleet forecasts, post-Panama Canal deepening shipping strategies, decisions on service and port rotation, and the potential for Boston Harbor to gain or lose services in both the with-project and without-project conditions, and (3) investigation of vessel loading practices with respect to current and projected practices, service schedules, and tidal assistance. The surveys and interviews were carried out during 2010 and reports documenting these efforts were prepared in early 2011. The findings were presented to Corps reviewers and Headquarters in April 2011, after which additional information and model analysis was requested. That work was carried out through the remainder of 2011 and presented to Corps reviewers and Headquarters in February 2012. Additional economic shipping analysis was requested and that work completed in April 2012. The resulting revised Economic Evaluation for the project was reviewed and submitted to Corps Headquarters in May 2012 along with an updated Cost Engineering Appendix for review and reconsideration of the project.

After further discussion the Corps presented its recommendation for project improvements to Massport in September 2012. With the Sponsor’s concurrence preparation of a revised feasibility report began. This revised report will be presented to the Civil Works Review Board for action in the spring of 2013, after which final State and Agency review of the proposed Chief of Engineer’s Report as supported by the final Feasibility Report and FSEIS will occur. Preparation of a Record of Decision and submittal of these reports to Congress will follow.

Study Sponsor

The Massachusetts Port Authority (Massport) is the non-Federal Sponsor for the feasibility study, under the terms of a feasibility cost sharing agreement with the Corps executed June 27, 2002, and has indicated it willingness to sponsor project implementation. Massport is a public legislatively chartered independent State authority with its own budgetary authority. Massport owns and operates the commercial service airports in the eastern part of the State, including Logan International Airport in Boston, as well as the Tobin Bridge and public seaport facilities in Boston. Massport has been the sponsor for several recent major Corps actions for Boston Harbor: the main tributary improvement and maintenance project constructed in 1998-2001, the 2008 inner harbor maintenance dredging and confined disposal facility construction. Massport views the proposed main channel deepening project to be crucial to the Port's continued growth and the region's economic health.

Study Purpose and Scope

The purpose of the Boston Harbor Deep Draft Navigation Improvement Study is to identify, formulate, evaluate and screen potential alternatives for channel deepening and related improvements at the Port of Boston, consistent with the goals of the study sponsor, Massport, and in response to direction from Congress in the authorizing resolution. Massport's goal is to provide deeper access to their Conley Container Terminal on the Reserved Channel in South Boston at a depth at least equal to the 45 feet now available at that facility's berths. Additional minor port improvements in the Mystic and Chelsea Rivers and in the Main Ship Channel above the Reserved Channel are also under consideration.

Alternatives were selected for detailed study on the basis of estimated costs and benefits of the proposed channel and anchorage modifications. Project costs include the costs of channel deepening and widening through dredging and ledge removal, costs of disposal of dredged material, mitigation costs and project-induced improvements to land-side facilities and other improvements necessary to realize project benefits.

Civil works improvements must also be formulated and evaluated with an eye towards potential environmental enhancement that could reasonably be derived from the project, such as through the beneficial use of dredged materials, by leveraging other Federal and State project authorities. Environmental impacts of the project, including dredging and disposal impacts on fisheries, endangered species and other natural resources, construction and operation impacts on air quality, were defined and evaluated. Cultural resource impacts and other social effects of the project were also investigated.

The navigational and environmental problems and needs of the study area were identified through coordination with the Sponsor, harbor users, Federal, state and local agencies and the public. Baseline studies of the Port and all potential impact categories were performed. Management measures for improving the Port and addressing potential impacts were developed, and from these a range of alternative plans of improvement were formulated. Comparative evaluations were made of the alternative plans to screen impracticable alternatives and identify the best range of solutions. Criteria for evaluating the alternatives were based on engineering feasibility, economic impact and justification, social and environmental impact considerations, and environmental enhancement opportunities. Selection of a final recommended plan was accomplished by comparing the costs, benefits, and environmental impacts of the final alternative improvements. The recommended plan best optimized economic, environmental and social factors while meeting the planning objectives.

The feasibility report details the Corps of Engineers plan formulation and evaluation process and public participation followed for the Boston Harbor deep draft navigation improvement study in response to the study authority. Actual implementation of a plan of improvement for Boston Harbor will require approval of the recommendation by the Executive Branch, authorization of the Project by Congress, attaining the necessary Federal and State regulatory approvals, completion of final design for the project, construction, and receipt of Federal and Sponsor funds for each of these steps.

Study Participants and Coordination

Coordination with the Sponsor, other Federal, State and local agencies, harbor users and the public, was undertaken throughout the study through several ways. A Notice of Intent to prepare a Supplemental Environmental Impact Statement (SEIS) for the project was published in the Federal Register on 23 August 2002. The SEIS built upon and supplemented the information and analyses set forth in the 1995 EIS for the improvement project to deepen the major industrial tributary channels of the Port, the Environmental Assessment for major maintenance dredging operations for the outer harbor navigation features, and the 2006 SEIS for major maintenance dredging of the inner harbor navigation features. These prior documents prepared under the National Environmental Policy Act (NEPA) and similar State requirements under the MEPA dealt with dredging of the same channel areas proposed for deepening under this improvement project, the same dredged material disposal methods and areas, and the same resources and impacts associated with those actions.

As part of the 1990 authorized improvements which were the subject of the 1995 EIS and were constructed in 1998 to 2002, a Technical Working Group (TWG) was established consisting of representatives from interested Federal and State agencies, the two cities (Boston and Chelsea), Massport, harbor users, and other interested parties. This group has continued to function as an outreach group for Corps and Massport activities in the Port including the monitoring of construction impacts from the 1998-2002 improvement work and the 2004-2005 outer harbor maintenance, the 2008 inner harbor maintenance, and the scoping and evaluations conducted for this feasibility study. The TWG has met an average of three times a year throughout the course of the maintenance actions and improvement study, most recently in December 2007.

The first public involvement meeting on the proposed project was held on 5 September 2002. Updates to the general public have been made in conjunction with meetings held for the two major maintenance actions, most recently on 25 July 2006. Once settlement on a project recommendation was made the TWG was re-engaged in December 2012. Coordination was maintained with the following agencies and organizations during the feasibility study:

Federal Agencies

U.S. Environmental Protection Agency	National Marine Fisheries Service
U.S. Coast Guard – First District	U.S. Fish and Wildlife Service
National Park Service	Federal Aviation Administration

State Agencies and Authorities

MA Executive Office of Energy and Environmental Affairs

Massachusetts Port Authority (Massport)	MA Division of Marine Fisheries
MA Department of Environmental Protection	MA Historical Commission
MA Office of Coastal Zone Management	MA Water Resources Authority
MA Dept. of Conservation & Recreation	MA Turnpike Authority
MA Division of Fisheries and Wildlife	MA Seaport Advisory Council

Municipal Agencies

City of Boston – Environment Department	City of Chelsea – Conservation Commission
City of Revere – Conservation Commission	

Interested Organizations and Harbor Users

Save the Harbor Save the Bay	NSTAR Corporation
Boston Towing and Transportation	Boston Harbor Pilots Association
MIT Sea Grant Program	Keyspan Energy
Mediterranean Shipping Company	COSCO Container Shipping
CMA CGM Container Line	Distrigas LNG
Irving Oil Company	Conoco Phillips
Global Oil Company	Saint Lawrence Cement
Gulf Oil Company	LaFarge Cement
SMP Terminal Chelsea (Eastern Minerals)	University of Massachusetts at Boston

The New England District Engineer is responsible for conducting the overall study in cooperation with an executive committee comprised of representatives from Massport. Massport is contributing one-half the study cost in cash or in-kind services. Agreed-to in-kind services include providing engineering, cost and environmental information about planned land-side terminals and improvements (including berthing areas), hosting public involvement sessions, and preparing certain portions of the resource assessments, such as cumulative impacts.

Through its ongoing participation as part of the study team, Massport has demonstrated a strong commitment, both in financial resources and personnel to further improvement of the Port of Boston. Massport was the sponsor of the prior improvement project carried out under the WRDA 1990 authority, and has committed to act as sponsor for the second phase of the ongoing Main Channels maintenance dredging project, which will require construction of confined disposal facilities (CAD Cells) to handle unsuitable shoal material. Massport continues to actively market the port's cargo handling capabilities and make necessary investments to maintain and improve the Port's competitive regional importance.

Prior Studies, Reports and Authorizations

Boston Harbor and its improved tributaries have been the subject of numerous reports by the Corps of Engineers since 1825, from which time to 1866, the projects studied and adopted were focused primarily on works of preservation: projects designed and built to preserve navigable depths in the harbor by protecting the surrounding headlands and islands from erosion by constructing seawalls, jetties and aprons. The three entrance channels, Main Ship Channel, President Roads Anchorages, and the several tributary channels were authorized by subsequent Congressional actions. The basis for the existing project can be found in House Document number 733, 79th Congress, 2nd Session, 23 July 1946, and in House Document number 150, 105th Congress, 1st Session, 21 October 1997. The following Table 1 provides a brief timeline of the key civil works navigation improvements for the Port. Appendix B contains a complete history of the Boston Harbor Federal Navigation Project, including a list of all authorizations and deauthorizations, prior documents, and work history for improvement and maintenance. Several harbor tributaries, including the Chelsea and Mystic Rivers, were authorized independently and later merged in whole or in part into the overall project for Boston Harbor.

TABLE 1
BOSTON HARBOR, MASSACHUSETTS
Federal Navigation Project – Key Improvements

Improvements	Authorizing Documents and Acts	Construction
Harbor Seawalls – Works of Preservation	Act of 2 March 1825, 1843, & R&HA of 2 March 1867	1827 – 1874
23-Foot Narrows and Main Ship Channels	River & Harbor Acts of 1867, 1878 and 1879	1867 – 1883
23-Foot Fort Point Channel	River & Harbor Act of 5 August 1886 – House Ex. Doc. #206, 48th Cong., 2nd Sess.	1886 – 1907
15-Foot Nubble Channel	Annual Reports of 1883 and 1887	1883 – 1892
27-Foot Narrows and Main Ship Channels	River & Harbor Act 13 July 1892 – Annual Report for 1893, Page 766	1892 – 1906
18-Foot Chelsea River Channel	River & Harbor Act of 3 June 1896	1896 – 1907
30-Foot Broad Sound South Entrance Channel	River & Harbor Act of 3 March 1899 – House Doc. #133, 55th Cong., 2d Session	1900 – 1905
25-Foot Lower Mystic River Channel to Island End River	River & Harbor Act of 3 March 1899 – House Doc. #178, 55th Cong., 3d Session	1900 – 1907
35-Foot Broad Sound North Entrance Channel and Main Ship Channel	River & Harbor Act of 3 March 1902 House Doc. #119, 56th Cong., 2d Session	1903 – 1915

30-Foot Lower Mystic River Channel to Island End River	River & Harbor Act of 25 June 1910 – House Doc. #1086, 60th Cong., 2d Session	1910
25-Foot Chelsea River Channel	River & Harbor Act of 25 July 1912	1915 – 1916
40-Foot Broad Sound North Entrance Channel Lane	River & Harbor Act of 8 August 1917 – House Doc. #931, 63rd Cong., 2d Session	1926 – 1930
40-Foot President Roads Anchorage – Initial Area	River & Harbor Act of 30 August 1935 – House Doc. #244, 72nd Cong., 1st Session	1933 – 1937
40-Foot Main Ship Channel from President Roads up to East Boston Pier #1	River & Harbor Act of 30 August 1935 and Nat'l Industrial Recovery Act 6 Sept 1933 – House Doc. #244, 72nd Cong., 1st Session	1936 – 1941
30-Foot Lower Mystic River Channel Extension to Bridge	River & Harbor Act of 30 August 1935 – R&H Comm. Doc. #33, 74th Cong., 1st Sess.	1935 – 1938
40-Foot Dry Dock Channel	River & Harbor Act of 30 August 1935 – R&H Comm. Doc. #29, 74th Cong., 1st Sess.	1937 – 1939
30-Foot Chelsea River Channel	River & Harbor Act of 26 August 1937 – R&H Comm. Doc. #24, 75th Cong., 1st Sess.	1938 – 1940
20-Foot Mystic River Basin above Bridge	River & Harbor Act of 20 June 1938 – House Doc. #542, 75th Cong., 3d Session	1939 – 1940
30-Foot Reserved Channel	River & Harbor Act of 17 October 1940 – House Doc. #255, 76th Cong., 1st Session	1941
40-Foot Main Ship Channel Extended to Mystic Piers	River & Harbor Act of 2 March 1945 – House Doc. #733, 79th Cong., 2d Session	1951
Expand 40-Foot President Roads Anchorage and Add 35-Foot West Anchorage	River & Harbor Act of 24 July 1946 – House Doc. #244, 80th Cong., 1st Session	1956 – 1960
35-Foot Lower Mystic River Channel	River & Harbor Act of 17 May 1950 – House Doc. #645, 80th Cong., 2d Session	1956 – 1958
35-Foot Reserved Channel	River & Harbor Act of 3 July 1958 – House Doc. #349, 84th Cong., 2d Session	1960
35-Foot Chelsea River Channel and Turning Basin	River & Harbor Act of 23 October 1962 – House Doc. #350, 87th Cong., 2d Session	1965 – 1966
40-Foot Reserved Channel and Turning Area	Water Resources Development Act of 28 November 1990	1998 – 2000
40-Foot Inner Confluence and 40-Foot Lower Mystic River	Water Resources Development Act of 28 November 1990	1998 – 2000
38-Foot Chelsea River Channel	Water Resources Development Act of 1990	1999 – 2008

PROBLEM IDENTIFICATION

This section of the report describes the existing conditions in the study area and the project goals of the Government and non-Federal Sponsor, and evaluates these conditions together with probable future conditions likely to occur without Federal participation in navigation improvements to the Port (the Without Project Condition). From this evaluation, problems with navigation, commerce, the environment, and other conditions are identified. Planning objectives for the project are defined and constraints that may impact formulation are identified. Formulation of potential opportunities for solution of these problems, screening of alternatives for practicability, and detailed evaluation of the final alternatives occur in later steps in the planning process and are described in subsequent sections of this report.

EXISTING CONDITIONS

An understanding of the existing resources, development and economy of the study area is essential in identifying the problems and needs of the Port of Boston, in selecting management measures to address those problems and needs, and in formulating alternative plans. The following sections outline the physical, environmental, human and economic conditions and resources of the Boston Harbor area, with emphasis on existing and potential commercial navigation and environmental quality.

Boston Harbor is New England’s largest port serving as the principal distribution point for the commerce of Massachusetts, New Hampshire, Rhode Island and Vermont. The inner harbor has been extensively developed for water transportation and is comprised of the Main Ship, Reserved, Chelsea River and Mystic River Channels. Massport has been upgrading facilities at Conley Terminal, which is located along the southerly side of the Reserved Channel, to accommodate larger vessels, increase container handling capacity, and improve operational efficiency of the harbor.

Geographic and Institutional Setting

Boston Harbor is a large estuarine embayment off Massachusetts Bay. The City of Boston comprises the majority of Suffolk County and is the capital of the Commonwealth and the largest city in New England. Boston is located about 233 highway miles northeast of New York City and about 103 miles south of Portland, Maine. The location of Boston relative to New England’s other deep-draft ports, including their channel depths, is shown in Figure 2.

The harbor is located in a shallow lowland area surrounded by a ridge of bedrock known as the Boston Basin. The recession of glacial ice at the end of the last ice age left a number of drumlins (rounded hills) in and around the harbor, making up most of the harbor islands and many of the surrounding hills. The shoreline is irregular reflecting the effects of geological forces and human alteration. There are 30 harbor islands and about 180 miles of shoreline around the harbor. Continuous erosion by the sea and wind has reduced a number of harbor islands to shallow shoals, such as Nixes Mate and Bird Island. Other islands were leveled and incorporated into fill areas for the City and more recently Logan Airport. The creation of the airport alone reduced the water area of the harbor by more than three square miles. Much of the land fronting the Port was created by landfill, including dredged material from Port deepening projects through the 1960s.

The harbor is bordered by twelve municipalities. The immediate area of the Port and City of Boston is shown in Figure 3. Proceeding clockwise from the south, these are the City of Hull, Towns of Hingham, Weymouth and Braintree, the Cities of Quincy, Boston, Cambridge, Somerville, Everett, Chelsea and Revere, and the Town of Winthrop. The harbor is divided into inner and outer sections by a line between Castle Island in South Boston and the southern tip of Logan Airport in East Boston. The Outer Harbor is divided into four bays of Winthrop, Dorchester, Quincy and Hingham. The principal tributaries of the Inner Harbor are the Charles, Mystic and Chelsea Rivers and the Fort Point Channel. The Neponset River empties into Dorchester Bay, while the Town, Fore, Back and Weir Rivers empty into Hingham Bay.

Meteorological and Tidal Conditions

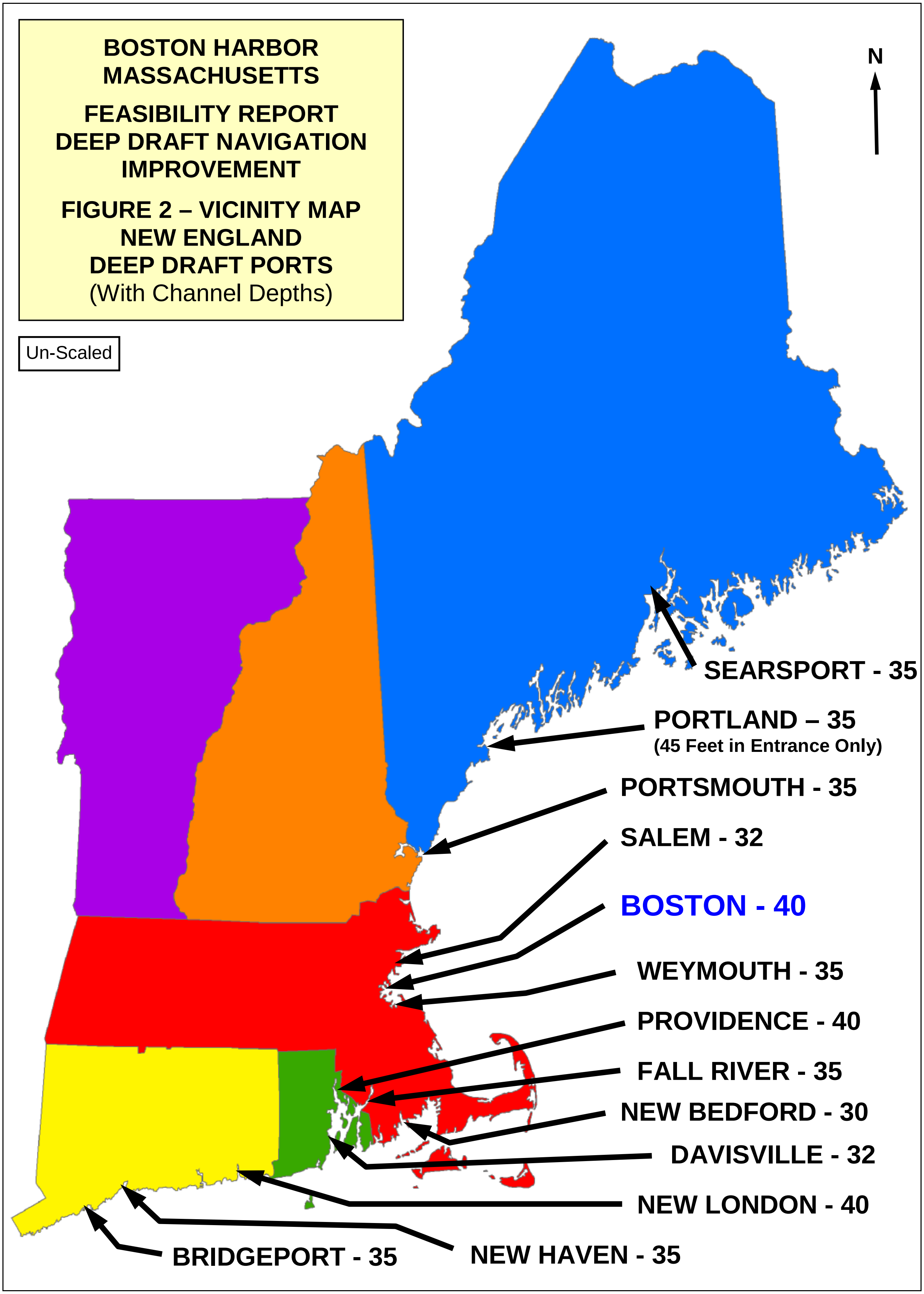
The climate of eastern New England is highly variable, and characterized by a wide range of temperatures and frequency but short periods of precipitation. Boston's latitude (42^{o}N) places it in a prevailing west to east air flow, with periodic intrusions of tropical and polar air masses, leading to rapid change. While the City's coastal location has a moderating effect on seasonal extremes (average 49^{o}F), it also assures a ready source of precipitation (annual average of 44 inches). Heavy fog occurs about two days per month. Prevailing winds from the northwest average about 13 miles per hour.

The Port is located in the Gulf of Maine tidal system, with semi-diurnal tidal conditions with a cycle of about 12.4 hours. The datum used for navigation and for recording all elevations for surveys and explorations is mean lower low water (MLLW). The mean tide range in the inner harbor is about 9.5 feet, and 9.0 feet in the outer harbor. Zero feet MLLW is approximately – 5.5 feet NAVD. Table 2 details tidal elevations and reference datum based on the 1983-2001 tidal epoch using the gage at the U.S. Coast Guard station in the Inner Harbor.

Sea Level Rise Impacts

With navigation projects sea level rise resulting from climate change and post-glacial continental margin subsidence is a consideration principally relative to port facility elevation and operations. At Boston Harbor Massport's three cargo terminals have deck elevations of between 10.5 and 12 feet above mean sea level (+5.2 feet MLLW). At mean high water freeboard at these facilities is between 5.9 and 7.4 feet. Low, medium and high projections of sea level rise at Boston are 0.87, 1.56 and 2.25 feet over the 50-year project life of 2016-2066. While terminal freeboard will be reduced under these scenarios the terminals will still be operational throughout the anticipated 50-year project life.

Other than facility operations, the effect of sea level rise is more of a benefit to navigation. Either the ships can load deeper in response to greater available navigable depth, or after adjusting the sea level and tidal datum project maintenance dredging can be deferred while that additional depth shoals.


BOSTON HARBOR
MASSACHUSETTS
FEASIBILITY REPORT
DEEP DRAFT NAVIGATION
IMPROVEMENT
FIGURE 2 – VICINITY MAP
NEW ENGLAND
DEEP DRAFT PORTS
(With Channel Depths)
Un-Scaled
N
SEARSPORT - 35
PORTLAND – 35
(45 Feet in Entrance Only)
PORTSMOUTH - 35
SALEM - 32
BOSTON - 40
WEYMOUTH - 35
PROVIDENCE - 40
FALL RIVER - 35
NEW BEDFORD - 30
DAVISVILLE - 32
NEW LONDON - 40
BRIDGEPORT - 35
NEW HAVEN - 35

BOSTON HARBOR, MASSACHUSETTS
FEASIBILITY REPORT FOR DEEP DRAFT NAVIGATION IMPROVEMENT

FIGURE 3 - BOSTON AREA MUNICIPALITIES

TABLE 2 TIDAL ELEVATIONS FOR BOSTON HARBOR	
Highest High Water (Extreme)	15.1
Mean Higher High Water	10.3
Mean High Water (mhw)	9.8
North American Vertical Datum – 1988	5.5
Mean Sea Level	5.2
Mean Tide Level	5.1
Mean Low Water (mlw)	0.3
Mean Lower Low Water (mllw)	0.0
Lowest Low Water (Extreme)	-3.7

Tidal range varies widely from day to day, and the two tides within any one day will also differ in range. Consecutive high or low tides may differ in range by more than two feet. The maximum range between high and low tide is about 18 feet, and the minimum is 5.5 feet. Tidal ranges generally cycle twice monthly with alternating high and low maximums and high and low minimums. High and low levels may vary by as much as four feet during a month. Ranges in the entrance channel, both high and low, will be 0.2 feet greater, than inside the harbor.

The dominant currents in the harbor are tidal in origin, although wind driven currents occur during storms. The harbor is relatively shallow and is well flushed by strong tides with complete replacement occurring at least every seven days. Freshwater flow discharges from the Mystic, Charles, Chelsea, Neponset and other rivers overlie the more dense seawater flows from the tides. Tidal flow input averages 320,000 cubic feet per second (cfs) per six-hour period, far exceeding the average freshwater flow of up to 500 cfs. The fastest tidal currents in the Outer Harbor, about 1.4 knots, occur in the 40-foot lane of the Main Ship Channel. While not severe, this occurs in the area of the series of channel bends between Castle and Spectacle Islands and was expressed as a design concern by harbor pilots. Currents and tides are discussed in greater detail in the design and modeling appendixes (Appendix D, F, G and H).

Population and Human Resources

The area surrounding the inner harbor and the northern shore of the outer harbor is the densely populated urban core of metropolitan Boston. The harbor islands that bound the southern limit of the lower and outer harbor area are unpopulated Federal and State parkland. Population of the region, state, metropolitan area and its cities and towns are shown below. The population of the metropolitan area and its constituent municipalities, as shown in Table 3 has been fairly stable over the past few decades.

TABLE 3 POPULATION STATISTICS FOR THE BOSTON HARBOR REGION			
	1990	**2000**	**2010**
New England – 6-State Region	13,206,943	13,922,517	14,345,184
Commonwealth of Massachusetts	6,016,425	6,349,097	6,477,096
Suffolk County	663,906	689,807	704,460
City of Boston	574,283	589,141	602609
City of Cambridge	95,802	101,355	103,506
City of Chelsea	28,710	35,080	34,532
City of Everett	35,701	38,037	40560
City of Revere	42,786	47,283	50008
City of Somerville	76,210	77,478	75,215
Town of Winthrop	18,127	18,303	17,311

Source: US Census Bureau – 1990 & 2000 Data and 2010 Estimates.

Environmental Setting and Natural Resources

The Supplemental Environmental Impact Statement (SEIS/EIR) included with this Feasibility Report contains a detailed discussion of the conditions and resources of the study area, the investigations carried out during this and other studies, and the probable impacts of the proposed project. The following sections summarize the information and analyses on the project's physical and ecological setting and impacts presented in the SEIS/EIR.

Boston Harbor is a large coastal estuary divided by many islands of glacial origin with several tributaries, including the Mystic, Chelsea, Neponset, Weymouth Fore & Back and Weir Rivers and other channels and marshes. Most tidelands surrounding the harbor were filled over the last three centuries for expansion of the cities surrounding the harbor and for port and airport development. In the developed harbor areas that are the focus of this investigation, the remaining habitat types are tidal rivers, shallow and deep subtidal areas, intertidal flats and rocky islands. There are isolated wetlands areas on some of the harbor islands, along the Chelsea River, upstream of the project areas on the Mystic River, and in the Back Channel and Winthrop Harbor areas north of the President Roads Anchorage.

Air Quality Conformity

Boston Harbor is located in the Metropolitan Boston Intrastate Air Quality Control Region (AQCR), which includes the City of Boston and its outlying suburbs. The contractor's dredging equipment, delivery and container trucks, and employee traffic associated with the project would generate emissions within this air quality region. Under the provisions of the

Clean Air Act U.S. EPA develops rules and regulations to preserve and improve air quality, and delegates specific responsibilities to state and local agencies. EPA has established the National Ambient Air Quality Standards (NAAQS) for criteria pollutants including carbon monoxide (CO), sulfur dioxide (SO_2), nitrogen dioxides (NO_2), ozone (O_3), particulate matter (PM), and lead (Pb). The Massachusetts Department of Environmental Protection (MADEP) has established Massachusetts Ambient Air Quality Standards (MAAQS), which are equal to current of former NAAQS. Areas that do not meet the NAAQS are called non-attainment areas. For non-attainment areas, the Clean Air Act requires states to develop and adopt State Implementation Plans (SIPs), showing how air quality standards will be attained. The Boston Metropolitan AQCR is a non attainment area for ozone (O_3) and a maintenance area for carbon monoxide (CO).

Section 176 (c) of the Clean Air Act requires that any Federal action to demonstrate that it conforms to the applicable SIP required under the Clean Air Act. In this context, conformity means that such Federal actions must be consistent with a SIP's purpose of eliminating or reducing the severity and number of violations of NAAQS and achieving attainment of those standards.

The Boston Harbor Deep Draft Navigation Improvement Project is subject to the General Conformity Rule. While maintenance dredging projects are presumed to conform and therefore exempt from analysis, improvement dredging projects must conform. The general conformity regulations apply to a Federal action if the total of direct and indirect emissions (but only for actions that the Federal government has control over) for a criteria pollutant from the action equals or exceeds the established de minimis thresholds.

In order for a Federally supported action to conform to the SIP, the total of direct and indirect emissions associated with the action must be in compliance or consistent with all applicable requirements in the SIP. Compliance requires that either the emissions must be specifically identified and accounted for in the SIP's attainment or maintenance demonstration; or the emissions must be fully offset through mitigation within the non-attainment or maintenance area, or a nearby non-attainment or maintenance area that impacts the area where the project is located; or, include the emissions with the SIP's emissions budget; or dispersion modeling analyses must be conducted that demonstrates the emissions do not cause or contribute to any new or increased violation of the NAAQS.

A conformity analysis must follow general procedures outlined in the regulations. For example, the Federal agency must employ the latest planning assumptions, based on projections of population, employment, travel, and congestion, approved by the local metropolitan planning organization (MPO). Also, the Federal agency must use the latest and most accurate emission estimation methods approved by EPA. Further, if the Federal agency performs any dispersion modeling, it must be consistent with EPA modeling guidance. In addition, the Federal agency must perform the analysis using the total of direct and indirect emissions from the action estimated for the mandated attainment year, the year of maximum emissions, and any year for which the SIP specifies an emissions budget. EPA's revised general conformity rule added provisions on how to address emissions occurring beyond the time period covered by the applicable SIP.

Because Eastern Massachusetts is still designated non-attainment under the 1997 eight-hour O_3 NAAQS, it would still be necessary to address general conformity for the Deep Draft Project with respect to O_3 precursor compounds (oxides of nitrogen and volatile organic compounds) absent a further change in status. However, EPA plans to promulgate a rule possibly by July 2013 to implement the 2008 eight-hour O_3 NAAQS, and it is anticipated that that rule would also revoke the 1997 eight-hour O_3 NAAQS[1]. This is a reasonable assumption because EPA has set precedent for revoking older standards when new standards are implemented. For example, EPA's rule to implement the 1997 eight-hour O_3 NAAQS revoked the one-hour O_3 NAAQS in most areas of the U.S. one year after area designations were promulgated under the 1997 eight-hour O_3 NAAQS. In addition, general conformity under the one-hour O_3 NAAQS no longer applied in former one-hour O_3 non-attainment areas one year after area designations were promulgated under the 1997 eight-hour O_3 NAAQS. Assuming EPA takes the same approach to implement the 2008 eight-hour O_3 NAAQS, then as long as the USACE does not take or start the Federal action[2] prior to revocation of the 1997 eight-hour O_3 NAAQS, it would not be necessary to address general conformity for the O_3 precursors. It should be noted that general conformity with respect to CO would continue to apply to the Deep Draft Project notwithstanding the method or timing of the implementation of the 2008 eight-hour O_3 NAAQS.

As air quality mitigation can be an expensive proposition for a large multi-year construction project, efforts should be made to plan the project in a manner that avoids exceeding air quality impacts and the SIP's thresholds.

Noise Conditions

In any large city, noise from traffic and ever-present construction and maintenance activities on public works and buildings is a constant fact of daily life. Dredging equipment working close to busy commercial and industrial areas is rarely of concern. Noise from marine construction plants can be an issue when the proposed dredging area is in close proximity to residential areas. In smaller harbors, dredging close to residential developments is often restricted to daylight hours. For the proposed Boston Harbor Deep Draft Navigation Improvement Project, the dredging and blasting areas are located far from any concentration of residential property. The entrance channel, anchorage, and Main Ship Channel areas to be dredged are more than a mile from the nearest residential areas. The Reserved Channel, Chelsea River and Mystic River are closer to residences (about half a mile – somewhat less for Chelsea River), but are already the scene of commercial terminal activities. Based on past experience in the harbor and absence of complaint, the temporary activities of dredging and sub-aqueous drilling and blasting will not result in any significant noticeable increase in noise in these residential areas, or in the Boston Harbor Islands National Recreation Area and State Park located south of the improved channels.

[1] Letter dated November 9, 2012, from Timothy L. Timmermann, EPA/Region 1 to John R. Kennelly, USACE.

[2] According to 40 CFR 93.152, "take or state the Federal action" means the date that the Federal agency signs or approves the permit, license, grant, or contract or otherwise physically begins the Federal action that requires a conformity evaluation.

Water Quality

As late as the mid-1990s, Boston Harbor was one of the most contaminated estuaries in the United States. Pollutants in runoff from rivers and urban areas in the harbor's watershed, coupled with inadequate sewage treatment facilities seriously degraded water quality.

A 1985 Federal court order led to the creation of the Massachusetts Water Resources Authority (MWRA) and construction of a new secondary sewage treatment plant and related facilities. From 1988 to 2000 the new plant and systems were brought on-line eliminating sludge and scum discharges into the harbor and decreasing pollutant discharges. A new ocean outfall 9.5 miles out in Massachusetts Bay was activated in 2000, ending direct effluent discharges into the harbor.

Since these improvements, the water quality classification in the inner harbor and President Roads area of Boston Harbor has improved. This has created favorable conditions for the return of flora and fauna more typical of a healthy estuary. The cleaner waters have also led to an increase in concern over issues such as turbidity, contaminant release, and sedimentation from dredging operations.

Sediment Characteristics and Quality

The sedimentary environment of Boston Harbor and Massachusetts Bay is highly variable. High energy erosional areas consist of exposed bedrock, cobble beds and exposed hard glacial deposits (tills and boulder fields) and predominate the outer harbor areas. Fine-grained depositional environments, particularly in the inner harbor areas are composed of predominantly silty materials and contain relatively high concentrations of organic matter. Less common are sediment reworking environments; areas where bottom currents fluctuate considerably in strength causing sediments to be intermittently eroded and deposited. Reworked areas are characterized by sandy-gravels to mud. A number of field investigations were conducted to determine the distribution of the surficial sedimentary environment of the Harbor and the nature of materials at depth, including sediment sampling, probes and borings, vibracores, and sub-bottom profiling.

Sediment contaminant concentration levels in general, and variability in contaminant concentrations, are higher in the Inner Harbor, where they are closest to point sources of pollution and where the sediments are fine-grained (compared to coarser grained samples in the Outer Harbor). Metals such as zinc, lead, chromium, copper, arsenic and silver, and organic contaminants such as polychlorinated biphenyls (PCBs), polyaromatic hydrocarbons (PAHs), and pesticides are found in elevated levels in fine-grained surface sediments deposited since industrialization of the area in the inner harbor.

To characterize the sediment in the channels of Boston Harbor proposed for deepening, sampling was conducted according to EPA and Corps national guidance. Sediment cores were taken from 49 locations within Boston Harbor between April 1999 and April 2004 to the proposed project depth, or to the elevation of refusal on hard materials. As these samples were intended to characterize both the maintenance shoal materials (since removed by maintenance dredging) and the underlying materials to be removed by improvement dredging, the samples were split at the horizon between the two elevations (maintenance v.

improvement). Only the material from elevations that was not being removed during maintenance dredging of the Outer and Inner Harbor areas will be discussed. Major maintenance dredging of all project areas proposed for deepening was completed by October 2012. The maintenance dredging actions were covered in the June 1995 EIS for the combined maintenance and improvement of the main tributaries channels, the June 2003 EA for the outer harbor operations, and the June 2006 SEIS for the inner harbor work, the September 2011 EA for Chelsea River maintenance and channel widening after completion of the new Chelsea Street Bridge, and in the July 2012 EA for lower Main Ship Channel rock removal. The samples from the improvement horizon were composited where appropriate and the composites were analyzed for grain size, and total organic carbon (TOC). Some composites were also subjected to bulk sediment chemistry. In all cases the material to be removed was determined to be parent material of glacial origin. In the Inner Harbor areas this material was mainly Boston blue clay. In portions of the Main Ship Channel, the upper end of Chelsea River, the Roads and Outer Harbor areas, substantial areas of hard till, gravel, cobble and ledge were also found.

The results of these tests were used to determine suitability of the dredged material for ocean and open water disposal. The nature of these materials indicated that they met U.S. EPA categorical exclusion from biological testing, as the material type, age of deposition, and chemical composition indicate that contaminants would be suitable for ocean disposal. A detailed discussion of the sampling locations and process, and test results is presented in the SEIS/EIR and in Appendix K (Sediment Test Results) and Appendix L (Suitability Determination for Dredged Material Disposal).

Submerged Aquatic Vegetation (SAV)

Eelgrass can successfully dominate shallow waters where light penetrates in depositional areas that have sediments ranging from soft mud to coarse sand. A century ago, seagrass meadows covered hundreds of acres of subtidal flats of Boston Harbor. Eelgrass meadows in Boston Harbor have largely vanished due to turbid water, viral diseases, and excessive nutrient concentrations. The Harbor now supports only small areas of seagrasses in Hingham Bay and near Logan Airport. With recent reduction in nutrients in the water and the increases in clarity, SAV restoration efforts by the U.S. Environmental Protection Agency (USEPA) and MA Division of Marine Fisheries (MADMF) are underway. Existing eelgrass beds east of Logan Airport, and the State eelgrass restoration site west of Long Island, are located outside the influence of dredging and disposal impacts from the harbor deepening project (more than 1000 feet from the dredging footprint). Turbidity monitoring has not shown any plumes migrating outside the navigation channels.

Benthic Resources

Benthic organisms link the primary producers, such as phytoplankton, with higher trophic level organisms, such as finfish, by consuming phytoplankton and then being consumed by larger organisms. Benthic invertebrate communities can be prime indicators of environmental health of an area because they have limited mobility and thus are unable to avoid adverse conditions; they live in sediments where they are exposed to environmental stressors, such as chemical contaminants and low dissolved oxygen levels; their life spans are long enough to reflect the effects of environmental stressors; and their communities are taxonomically diverse enough to respond to multiple types of stress. As a result the health of the benthic community is indicative of the health of marine resources as a whole.

The improvements to water quality in Boston Harbor brought on by the harbor cleanup effort, mainly the upgrade in sewage plant and discharge facilities, have led to significant improvements in benthic resources in areas of the harbor that were once considered heavily polluted by sludge discharges. Extensive investigations into the benthic community have been made by the Massachusetts Water Resources Authority (MWRA) and others to characterize infaunal diversity and abundance and the changes that have occurred since clean-up efforts began. In the northern harbor, where the navigation improvements are proposed, changes in benthos after cessation of discharges included dramatic increases in population, followed by fluctuations in infaunal abundance and an increase in species numbers and diversity. The southern part of the harbor, which was less influenced by the former treatment discharges, has not shown changes in benthos similar to the northern areas. Infaunal abundance can also vary tremendously from year-to-year.

Sections of the Mystic River, Chelsea River, Reserved Channel, Inner Confluence and the Reserved Channel Turning Basin were dredged between May 1998 and December 2001. Portions of the outer harbor including the lower Main Ship Channel, Presidents Roads Anchorage and the North Entrance Channel were dredged between August 2004 and June 2005. Blasting of ledge from the North Entrance Channel, President Roads Anchorage and lower Main Ship Channel was completed during the fall 2007 to spring of 2008. Maintenance dredging of the lower Inner Harbor portions of the Main Ship Channel below the I-90 Tunnel, the upper Reserved Channel, the Drydock Channel, and portions of the Chelsea River occurred in 2008. Maintenance of the remaining Main Ship Channel areas above the tunnel, and minor portions of the Mystic Rivers will occur after 2012. Further rock removal in the lower inner harbor and dredging to widen the Chelsea River Channel at the new Chelsea Street Bridge was accomplished in 2012. This dredging has and will remove the benthic resources within the dredging footprint of those areas and in some cases changed the bottom sediment type to clay or coarser material than the dredged shoal silts and sands. Resources in those areas are recovering and adapting to the new substrate.[3] Monitoring of the CAD cells 4-7 years after construction and capping indicates that the harbor is stressed by the predominance of pioneering Stage I organisms, both at the CAD cells and reference sites.

The Corps has conducted additional benthic resource studies in the navigation project areas for this investigation and in support of recent maintenance dredging actions. Two approaches were used to characterize the benthic community in the dredged areas: analysis of sediment profile images (SPI) collected by the MWRA; and the collection of grab samples by the Corps, from which infaunal animals were removed, identified, and counted. SPI data provide photographic documentation of the relationship between the infaunal organisms and their sedimentary habitat, whereas grab samples allow for the description of infaunal community structure.

<u>Mystic River</u> **–** The stations sampled in 2003 in the small 35-foot proposed project area off the Medford Street Terminal were in an area that was not dredged between 1998 and 2001. Surface sediments consist of silty materials. Therefore, no direct impact of the dredging on

[3] SEIS Section 3.3.2 and Appendix U. Also SAIC 2001 and ENSR 2005. See SEIS List of References

the benthos was found in 2003 and the faunal community is certainly representative of that portion of the Mystic River. Indirect dredging impacts, such as increased turbidity, would not be expected to have an impact on the community that would be detectable at least three years after dredging. The benthic community is characterized by low infaunal abundance and low species diversity.

Chelsea River **–** Chelsea River benthos were sampled by the Corps (upper channel) and Massport (terminal berths) in 2003 to determine the effect of the recently completed dredging. Sediments in the upper Chelsea River were mostly gravel and sand, and depths ranged from about 33 to 38 feet. As with the Mystic River, the benthic community is characterized by low infaunal abundance and low to moderate species diversity.

Lower Harbor – Information about the benthos in the Lower Harbor area is from the USACE 2003 study that sampled the Main Ship Channel and Presidents Roads Anchorage, and the MWRA SPI and infaunal studies that sampled in, and adjacent to both areas. The Main Ship Channel stations are separated into those northwest of Spectacle Island and those in Presidents Roads. The water depth in the Main Ship Channel is about 35 to 40 feet MLLW and was characterized by sand and sandy mud. The Main Ship Channel northwest of Spectacle Island showed moderately high infaunal abundance and moderately low species diversity while the Main Ship Channel near President Roads Anchorage area showed low infaunal abundance but moderately high species diversity.

The samples collected in 2003 within the President Roads Anchorage showed moderate to relatively high infaunal abundance. Species diversity was also relatively high. Water depth was about 40 feet MLLW with sand and sandy mud substrate. As this area was dredged in 2004 and 2005, the infaunal abundance and species diversity may be somewhat lower as the area recovers from disturbance.

Outer Harbor – The data set that best describes the Outer Harbor region is from the September 2003 field program conducted by the Corps. Waters in the outer harbor channel are generally about 35 to 42 feet deep and the sediments are poorly characterized. Benthos abundances among the stations were relatively low to moderate. Species diversity varied from low to moderately high. There was no noticeable pattern with increasing distance of the stations from the harbor.

All of the stations sampled in the Outer Harbor area in 2003 were in the area dredged from August 2004 to October 2004. Therefore, the communities that were described above represent those present about a year prior to a major disturbance to the harbor bottom and are not typical of the communities likely present there now.

Summary – Infaunal communities within the project study area of Boston Harbor are clearly separable into two geographic regions. The first extends from the innermost region, the Mystic and Chelsea Rivers, seaward to the vicinity of the Reserved Channel. Within this region, infaunal abundances and species diversity are generally low. The second region extends east from the Reserved Channel to the mouth of the harbor. In these areas, infaunal abundances and species diversity range from medium to high. These data indicate that the Inner Harbor is more stressed while the Lower and Outer Harbor is less stressed with lower organic levels.

Fishing and Shellfishing

Massachusetts coastal waters support extensive finfish resources including numerous demersal, pelagic, migratory, and anadromous species. These waters support substantial commercial and recreational fisheries. Many of the species found in these waters are managed at the Federal level by NOAA Fisheries (*i.e.*, National Marine Fisheries Service or NMFS) through the Magnuson-Stevens Fishery Conservation and Management Act. The Massachusetts Division of Marine Fisheries (MADMF) also regulates several key fisheries in the nearshore coastal waters. Lists of managed species and discussion of their commercial and recreational importance, and their life-history characteristics are included in the SEIS. An evaluation of the effect of the project on these species and other inshore species of ecological importance that may occur in the project area is also included. Keys to understanding the impacts the project may have on these species include bottom substrate type and times of year favored by the various life-stages of each species in the several areas of the project. Of particular concern for this project are the following:

<u>Winter Flounder</u> – Winter flounder is one of the most common commercially exploited species found in Massachusetts Bay. North of Cape Cod, this species spawns in estuaries or nearshore areas from February through May, generally over sandy bottoms in water from 6 to 20 feet in depth. Winter flounder eggs are demersal and adhesive and may be found on tidally submerged gravel bars and attached to fronds of macroalgae. In Boston Harbor, eggs are abundant between February and May. Winter flounder larvae stay near the bottom and are highly abundant in Boston Harbor in March through May. As winter flounder larvae mature and metamorphose into juveniles, they move to the lower portions of the estuary. Winter flounder larvae are negatively buoyant and appear to maintain their positions in estuaries by rising and sinking in the water column to take advantage of incoming and outgoing tides. In the fall, young-of-the-year (YOY) winter flounder will move out of estuaries and shallow-water areas to deeper water.

Juvenile and adult winter flounder are highly abundant in Boston Harbor year-round. During summer months when temperatures are high, juveniles and adults move to deeper channels and areas where water temperatures are cooler. In late fall and winter, when temperatures drop, juveniles and adults move into deeper waters or move out of the estuary. In the spring, winter flounder return to their natal estuary to spawn.

<u>Anadromous Fish</u> – Anadromous species are those which spend most of their juvenile and adult lives in coastal or estuarine regions, but will migrate into freshwater rivers to spawn. The rainbow smelt (*Osmerus mordax*), alewife (*Alosa pseudoharengus*), and blueback herring (*Alosa aestivalis*) use Boston Harbor, the Mystic River, and Chelsea River for passage to upstream spawning locations.

<u>Lobster</u> – With the decline of cod and other groundfish fisheries, the American lobster (*Homarus americanus*) has emerged as the most economically important fishery in Massachusetts State waters, where it has been found to occur from the intertidal zone offshore to water depths of 2,360 feet. However, lobsters captured from Massachusetts State waters, including Boston Harbor, have been showing a slight decline in numbers for the past decade. Populations of early benthic phase (EBP) lobsters less than 12 mm carapace length (CL) are known to exist in high densities just outside of the navigation channel and along island coastlines. Here, they utilize cracks within the bedrock, boulders/cobble, and rocks within

glacial drift for their shelter-providing habitat. The depth of the navigation channel and the substrate in the Inner Harbor and Mystic and Chelsea Rivers may restrict habitat exploitation by EBPs, which prefer shallower, non-depositional habitats outside of the footprint. Other size classes of lobsters, such as larger juveniles (>12 mm CL), sub-legal sized lobsters (> 30 mm CL), and adults capable of utilizing all of the described habitats in the navigation channel, are found in all of these environments in Boston Harbor. Both non-depositional and depositional environments exist within the navigation channel; therefore, lobsters of these larger class sizes are likely to take advantage of the habitats in the same manner as they make use of the habitats outside of the planned dredge footprint.

Marine Mammals

Only transient marine mammals are found in the Boston Harbor area during seasonal migrations. The likelihood of finding one of these species increases in Massachusetts Bay. Most of the marine mammals that may be possible visitors to Boston Harbor or Massachusetts Bay are listed as Federally threatened or endangered. This includes the humpback whale, fin whale, North Atlantic right whale, sei whale, and the sperm whale. Other marine mammal species that may travel within the project areas but are not Federally threatened or endangered are the harbor seal, white-side dolphin, harbor porpoise, gray seal, and minke whale.

The North Atlantic right whale, humpback whale, fin whale, sei whale, sperm whale, and minke whale may all be found seasonally in Massachusetts' waters. The North Atlantic right whales have been documented in the nearshore waters of this regions including Massachusetts Bay from January through September. Humpback whales feed during the spring, summer, and fall over a range that encompasses the eastern coast of the United States. Minke whales are distributed south from Canada to the Gulf of Mexico, but distribution is primarily concentrated in New England waters, with most sightings occurring in the spring and summer months. Fin, sei, and sperm whales are common in deeper offshore waters. While these whale species are not considered residents of Boston Harbor or Massachusetts Bay, it is possible that transients may enter the area during seasonal migrations.

Harbor seals move to southern New England waters in fall and early winter. The population consists mostly of juveniles and sub-adults. After over-wintering in southern New England, the vast majority of the population migrates to the northern waters of New Hampshire, Maine, and Canada in the spring for the pupping season (mid-May through June). No pupping areas have been identified in the project area.

Gray seals inhabit temperate and sub-arctic waters and are found from Maine to Long Island Sound. Gray seals are the second most common pinniped along the Atlantic coast, living on remote, exposed islands, shoals, and unstable sandbars. Pupping occurs from late December through mid-February. A small number of animals and pupping have been observed on several isolated islands along the Maine coast and in Nantucket and Vineyard Sounds, Massachusetts. There are no regular seasonal migrations, but young individuals wander extensively during their first two years of life.

White-sided dolphins are potential, but rare visitors to the outer project areas in Massachusetts Bay. The habitat range of the white-sided dolphin is generally in deeper waters of the continental shelf and they would rarely be found in the inner Boston Harbor, but have been sighted around the Boston Harbor islands. The harbor porpoise, on the other hand, is primarily an inshore species. During the summer the harbor porpoise is concentrated in the northern Gulf of Maine and the southern Bay of Fundy region. This stock of harbor porpoises migrates south into the mid-Atlantic region during the fall and spring months. They are widely distributed from Maine to New Jersey. The preferred nearshore habitat of the harbor porpoise makes it a potential species to be found in the Boston Harbor area. The harbor porpoise has been recorded as far into the harbor area as the Chelsea River.

Threatened and Endangered Species

There are ten Federally listed threatened and endangered marine mammal and reptile species that may occur in the project area. They are the Federally endangered North Atlantic right whales, humpback whales, fin whales, sei whales, sperm whales, Kemp's ridley sea turtle, and the leatherback sea turtle. Federally threatened species include the loggerhead and green sea turtles and the Atlantic sturgeon. Distribution of the whale species has been described in the preceding section.

All four sea turtle species may be found in New England during the warmer months, in particular the summer. In New England coastal waters, these sea turtles may be found feeding on their preferred prey. In general, these turtles are considered rare visitors to the project area.

Any native species listed as endangered or threatened by the U.S. Fish and Wildlife Service is also included on the Massachusetts State list as threatened or endangered (MA Natural Heritage and Endangered Species Program, 2004). However, no solely State-protected rare species have been identified in the project area (letter dated May 31, 2005).

Cultural Resources

Boston Harbor has a rich colonial and pre-contact history and cultural resources are a concern with any large public project. Several investigations were conducted on behalf of the Corps during planning for this project.

- The proposed channel improvement areas were surveyed using remote sensing gear (sidescan sonar, magnetometer, sub-bottom profiler). See Appendix M-1 – *Remote Sensing Archaeological Survey and Geologic Interpretation, Boston Harbor Navigation Improvement Study, Boston Harbor, Boston, Massachusetts* prepared by the University of Massachusetts Archaeological Service (UMAS).
- Inspection of magnetic anomalies targeted by remote sensing using ROVs to locate, identify and inspect potential cultural resources. See Appendix M-2 – *Inspection of Magnetic Anomalies, Remote Sensing Archaeological Survey, Boston Harbor Deep Draft Navigation Improvement Study* prepared by the Public Archaeology Laboratory Inc. (PAL). No resources of significance were discovered.

- Vibracores were taken at depth in channel areas with a potential for submerged shore features that may hold archaeological artifacts, but none were encountered. See Appendix M-3 – *Archaeological Subsurface Testing for the Boston Harbor Navigation Improvement Study, Boston Harbor, Boston, Massachusetts* prepared by UMAS.

The majority of the work was within existing navigation channels subject to prior deepening. Additional areas of channel widening were also included. Of the 1205 acres of bottom area to be impacted by the improvement dredging, about 20 acres lies in areas outside of and adjacent to the existing channels in areas where the channel bends or turning basin would be widened. In the lower and outer harbor these areas were covered by the cultural resources investigations. In Chelsea River these areas will be the subject of further investigation during the design phase, and some additional examination of the Mystic River results will be made also. Construction-related blasting is not expected to impact on-shore and near-shore structures.

Pre-Contact Context: The Mystic, Neponset, and Charles Rivers of southeastern Massachusetts, which feed into the Massachusetts Bay Basin, were focal points for Native American occupation for more than 9,000 years. The Boston Harbor islands contain a concentration of Native American archaeological sites. Currently, 60 documented sites spanning the Early Archaic to the Late Woodland Periods are distributed among 21 islands.

Historic Period Shipwreck Context: All of the potentially significant historic period sites that might be found in the study area would likely be water vessels and their contents. Since Boston Harbor has attracted almost all types of ships, boats, and barges throughout the centuries, the remains of any type of vessel used in the Atlantic during the last four centuries could conceivably be found.

Results of Cultural Resource Investigations

The University of Massachusetts conducted a remote sensing archaeological survey of the project area in 2003. Utilizing site location characteristics, sea level curves, and reconstructed past landforms, the study found that there was a potential for inundated Native American sites to be located within portions of the project area. Subsurface testing through the use of vibratory cores was recommended. The historic period background research indicated that at least 93 vessels were lost in the general area of the harbor channel, but none were known to be specifically within the study area. Analysis of the remote sensing data produced 187 targets that required further consideration; however, only 3 appeared to be potentially significant historic shipwrecks. Dive investigations were recommended for these 3 targets.

In September 2003, the Public Archaeology Laboratory, Inc. (PAL) conducted an inspection to determine the nature of the three magnetic anomalies identified in the initial remote sensing survey. The survey was conducted with the use of a remotely operated vehicle (ROV), with the collection of visual and magnetic data. Limited excavation using the ROV thruster-wash deflector was also conducted at the three locations. No cultural materials or archaeological features were identified during the ROV survey. The only targets noted were lobster pots and modern debris. Lobster pots and/or magnetic rock outcrops or boulders likely caused the magnetic anomalies.

Additionally, archaeological subsurface testing through the use of nine vibratory cores was completed in September 2003 by UMAS. Testing was concentrated within three separate areas: the North Channel; western portions of the project area including the Reserved Channel and Mystic River confluence; and the Mystic River. Cores were collected and then analyzed for stratigraphic integrity and evidence of inundated archaeological resources. Both visual means and magnetic susceptibility techniques were used to attempt to detect buried soil horizons. Potentially sensitive sediments were also screened for artifacts. Profiles of visible stratigraphy were recorded and the magnetic susceptibility was plotted and graphically reproduced. No artifacts or stratigraphic potential for resources were identified and no further survey was recommended.

As a result of the preceding investigations, no significant resources are expected to be encountered during dredging operations conducted for the Boston Harbor Deep Draft Navigation Improvement Project. Coordination with the Massachusetts State Historic Preservation Officer (MA SHPO), and the MA Board of Underwater Archaeological Resources (MA BUAR) resulted in their concurrence with this determination. The Draft report included the coordination letters to the BUAR (20 August 2002 and 22 June 2004 and 4 October 2007), and letters from the BUAR to NAE (26 August 2002). Recently, letters from the BUAR (2 June 2008) and the SHPO (5 May 2008) were received concurring with these recommendations and looking forward to further coordination as the project proceeds. These letters are included in Appendix A, Part 4.

Specifically, the agencies concur with the Corps findings of no impact for the lower and outer harbor improvements and the plan for additional surveys on the Chelsea River and further examination of the Mystic River data.

The Massachusetts Bay Disposal Site has been disturbed from the disposal of dredged material over many decades. The site has been the subject of extensive investigations over this period including the EIS leading to its designation by EPA as an ocean disposal site. No shipwrecks or other cultural resources are located in the MBDS, and no further investigations are recommended for that site.

Further investigations may be required for any of the five potential hard-bottom habitat enhancement sites under consideration for beneficial use of the rock and other hard material to be removed for the Boston Harbor Deep Draft Navigation Improvement Project. Sidescan sonar surveys of these areas have already been conducted, however additional surveys may be undertaken. These potential additional efforts would be conducted during final design of the project and are discussed in the SEIS and Appendix M.

Existing Navigation Conditions

Existing Federal Navigation Project

The system of general navigation features (GNF) in the Port of Boston; its entrance and access channels, general anchorage areas and tributary channels; are described below, and shown in Figure 4A. These improvements represent a significant investment of public resources over the past 180 years by the Federal government, the Commonwealth, and the affected municipalities. During the colonial period and for the first seven decades after independence, Boston was the country's largest port. It remains the closest major deep-water general cargo port to the European market. As the size and propulsion characteristics of commercial vessels has changed, improvement of the Port's GNF and cargo facilities has sought to keep up these trends to facilitate commerce and the steady growth in domestic and international trade. The glaciated geography and ever-changing growth of a major metropolitan area in the middle of what is the Commonwealth's largest estuarine system have and will continue to present challenges to development of the Port.

Entrance Channels: There are three improved entrance channels to Boston Harbor; the Narrows Channel at –27 feet mean lower low water (MLLW), the Broad Sound South Channel at –30 feet MLLW and the Broad Sound North Channel with a spit depth of -35 and -40 feet MLLW. The Narrows Channel was the original natural entrance to Boston Harbor and was first improved in the latter half of the 1800s by ledge removal and dredging first to 23 feet and later to 27 feet. During planning for a 30-foot channel in the late 1890s, improvement of the Narrows Channel was abandoned in favor of dredging the South Channel when it was determined that further deepening of the Narrows would have required removal of adjacent harbor islands. Further deepening of the South Channel was abandoned in the early 1900s in favor of dredging the North Channel when it was determined that extensive ledge removal would be required for a 35-foot channel depth. The North Channel's present dimensions with the southern lane deepened to -40 feet (-45 feet in rock) were authorized in 1917 and completed in 1930. Adjacent to and north of the 900 wide by 40-foot deep shipping lane is a -600 wide and 35-foot deep shipping lane.

There are no other existing or potential alternative routes for entrance into Boston Harbor. The existing navigation features of the outer and lower harbor areas are shown in Figure 4A. Further deepening of the entrance to Boston Harbor must focus on the Broad Sound North Entrance Channel (BSNEC) as the only practicable route open to further deepening.

President Roads Anchorage: There are six anchorage grounds in Boston Harbor designated by the U.S. Coast Guard (33 CFR §110.138), of which three have been improved by dredging. The 35 and 40-foot anchorages at President Roads are part of the Federal navigation project, while the 30-foot anchorage at Bird Island was improved by the Commonwealth. The anchorages east of Long Island, south of Castle Island, and in Nantasket Roads have not been improved by dredging. The harbor islands divide the harbor into northern and southern areas. The only deep draft connection between the northern and southern parts of the harbor is the 27-foot deep Narrows Channel.

The anchorage ground at Nantasket Roads is located in the southern part of the harbor between Rainsford and Peddocks Islands. The deeper parts of this area have natural depths of between 30 to 40 feet with a rocky bottom. This area has never been improved due to extensive ledge but is used occasionally by vessels bound for the Weymouth Fore River channel. The U.S. Coast Guard designates this as an explosives anchorage, although that use is also permitted for President Roads by the Captain of the Port on limited occasions. This anchorage is also crossed by a buried high pressure natural gas pipeline connecting Weymouth and Beverly.

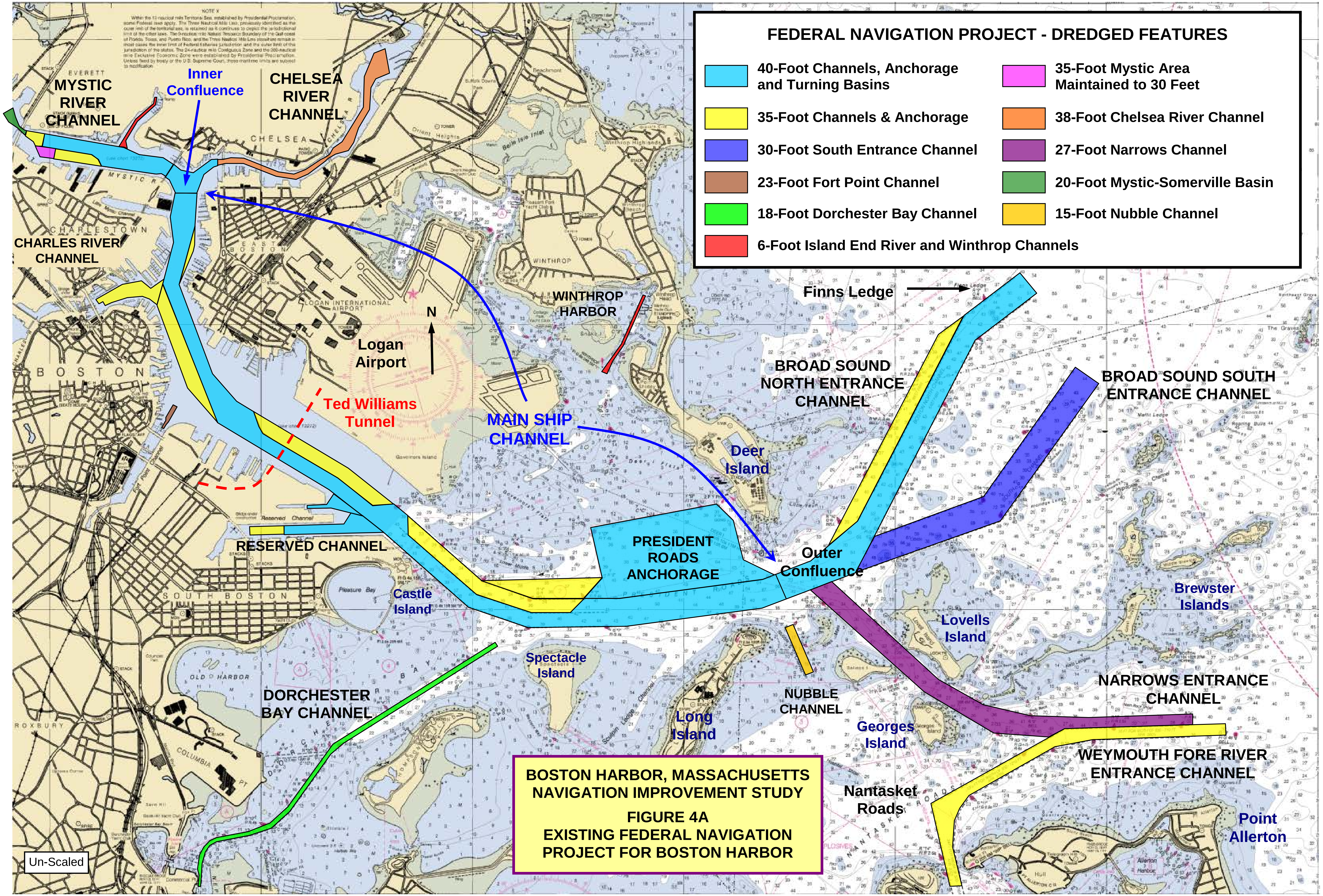
The Long Island anchorage ground is located in the area bounded roughly by Long, Gallops, Georges, and Rainsford Islands. The deeper parts of this area have natural depths of between 18 to 30 feet with a rocky bottom. This area has never been improved due to extensive ledge and is rarely used by large vessels.

The Castle Island anchorage ground is located in Dorchester Bay between Castle Island and the 18-foot Dorchester Bay Channel. This area has never been improved by dredging, has depths of between 6 and 20 feet and is used only by small craft.

The only deep-draft anchorage serving Boston Harbor proper is located on the north side of President Roads along the north limit of the Main Ship Channel. The 40-foot by 5,500-foot long President Roads anchorage was authorized in 1935, and expanded in 1956 and 1990 and now provides a total area of about 420 acres. The 1990 authorized improvements included expanding the anchorage through a non-structural realignment of the 1200-foot wide 40-foot channel lane south of the anchorage further south, increasing the width of the anchorage from 2,650 feet to 3,150 feet, adding about 67 acres to accommodate larger vessels using the harbor. The present 40-foot anchorage dimensions are 5,500 by 3,150 feet, with flares for ease of access at the junctions with the Main Ship Channel.

The smaller 67-acre, 35-foot deep President Roads Anchorage is located immediately to the west of the 40-foot anchorage and is used principally by barges and other small vessels. The 30-foot Bird Island Anchorage, dredged by the Commonwealth, is located between the Main Ship Channel and Logan Airport above the Reserved Channel, on either side of the Ted Williams Tunnel. There are no other large areas in the harbor unencumbered by channels or shallow ledge that would provide a practicable location for a general deep-draft anchorage. Any improvements to anchorage capacity or depth for Boston Harbor would be limited to President Roads.

Main Ship Channel: As adopted in 1867 and modified by subsequent Acts through the River and Harbor Act of 1945 and WRDA 1990, the Main Ship Channel in generally 1200 feet wide from the outer confluence of the entrance channels south of Deer Island, through the southern area of President Roads, and up through the lower and inner harbor to the Inner Confluence (of the Chelsea and Mystic Rivers). As authorized in 1902 the entire channel was originally constructed with a 35-foot depth. Within the 1200-foot width, a 40-foot channel, authorized in 1935 and 1945, with varying widths is provided: 1200 feet wide through the roads along the anchorage, 600 feet wide along the southern limit from the Roads to the Fort Point Channel, 1200 feet wide through the bend between Commonwealth Pier and the North End waterfront, 600 to 900 feet wide from the waterfront up to the inner confluence.



BOSTON HARBOR, MASSACHUSETTS
NAVIGATION IMPROVEMENT STUDY

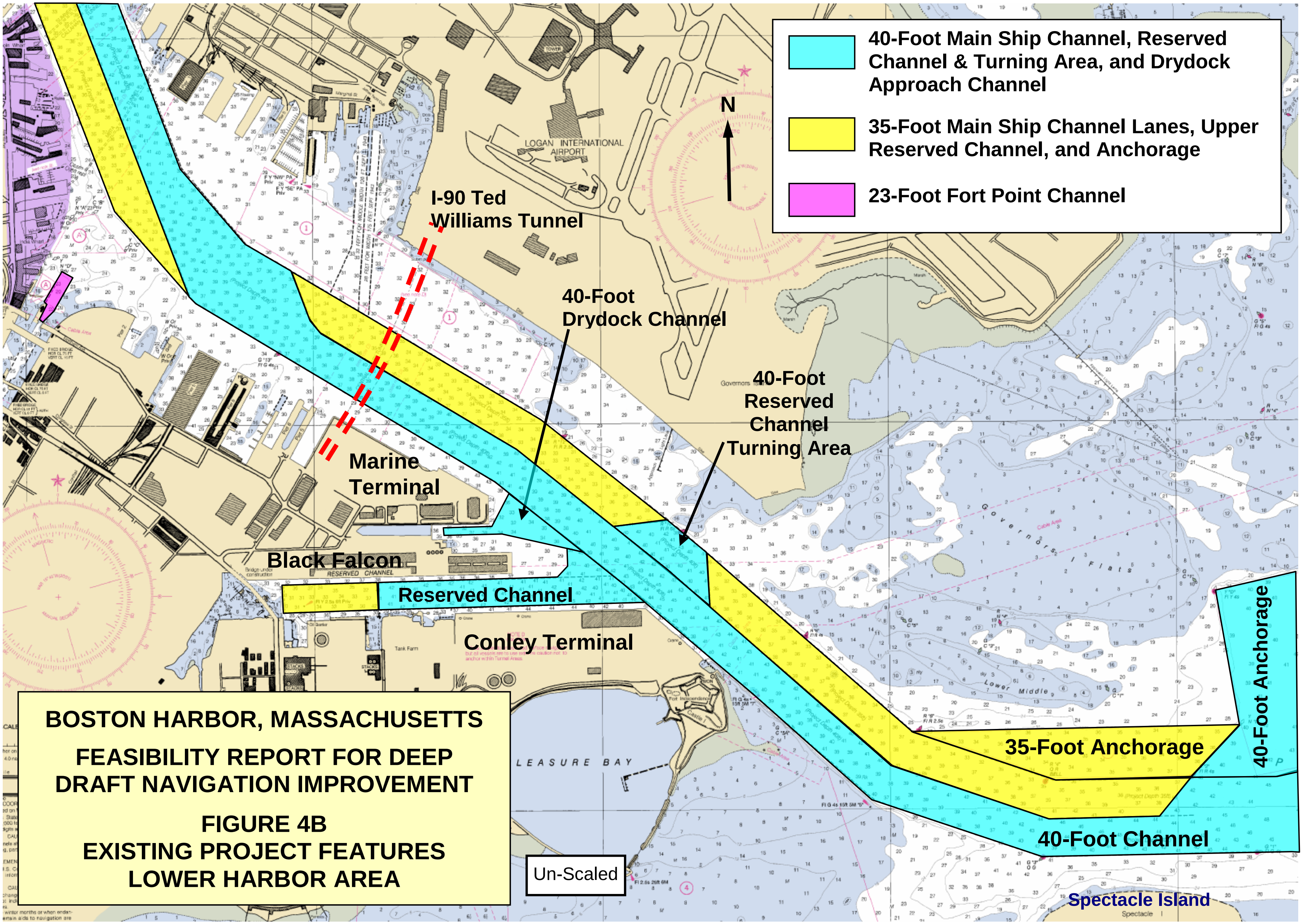
FIGURE 4A
EXISTING FEDERAL NAVIGATION
PROJECT FOR BOSTON HARBOR

The 40-foot Main Ship Channel cut shifted sides of the wider 35-foot cut in order to access the three former US Navy facilities located on different sides of the harbor. Deep-draft traffic today follows the 40-foot channel with shallower-draft traffic using the adjacent 35-foot lanes in passing situations. The widened area of the Inner Confluence was originally included as part of the 35-foot project to permit access to the lower Mystic River Channel and Chelsea River Channel. The Inner Confluence was deepened to 40 feet as part of the 1990 authorization. The Main Ship Channel provides access to the three deep-draft industrial tributaries, the Reserved Channel, Mystic River and Chelsea River.

Reserved Channel and Turning Area – see Figure 4B: As adopted in 1940 at 30 feet, modified in 1958 to 35 feet, and to 40-feet in its lower reaches by WRDA 1990, the Reserved Channel extends about 1¼ miles upstream from the Main Ship Channel to below the L Street Bridge. In its lower reach, about one mile long, the channel provides a depth of 40-feet, 430 feet wide along the Conley Terminal's containership berths and the former petroleum terminal immediately upstream. The lower reach of the channel was deepened to 40 feet under the 1990 project and completed in 2001. The upper 1,340 feet of the channel remains at –35 feet to access the upper berths at the Black Falcon cruise ship terminal. A 40-foot turning area for large vessels entering and exiting the Reserved Channel was dredged at the Channel's mouth and across the 1200-foot width of the Main Ship Channel and adjacent areas in 2001 as part of the 1990 improvement.

Lower Mystic River Channel – see Figure 4C: The lower Mystic River provides a channel with depths of 30, 35 and 40 feet. The channel extends from the Inner Confluence, where it is crossed by the Mystic Tobin Bridge, about 6,570 feet upstream to the Malden Bridge. The 30-foot area is at the far upstream end of the project along the south shore in an area that no longer fronts facilities requiring deep-draft access. While this area was included in the 1950 authorization for the 35-foot lower Mystic River Channel, it was never deepened due to a lack of navigation need at the time of construction. The far upper reaches along the northern side of the channel above the Prolerized scrap terminal and the mid-channel area along the south shore between the Boston Autoport and the 30-foot area are authorized and maintained to -35 feet. The lower half of the channel for its full 740 to 960-foot width and a northern lane 440 feet wide along the mid-channel from the Exxon Terminal upriver to the Prolerized Terminal were all deepened to 40 feet in 1998-2000 as part of the 1990 authorized project. The 40-foot deepening project for the lower Mystic River Channel improved access to Massport's Boston Autoport, the US Gypsum Terminal, Exxon, Blue Circle Cement, Distrigas (LNG), Prolerized (Scrap Exports) and KeySpan's Mystic Station (power plant). This work was completed in 2000, and was the first part of the 1990 project to be completed. Immediately upstream of the Moran Terminal is the former Revere Sugar Terminal, now Massport's Medford Street Terminal. The authorized project areas of the lower Mystic River are shown in Figure 4C.

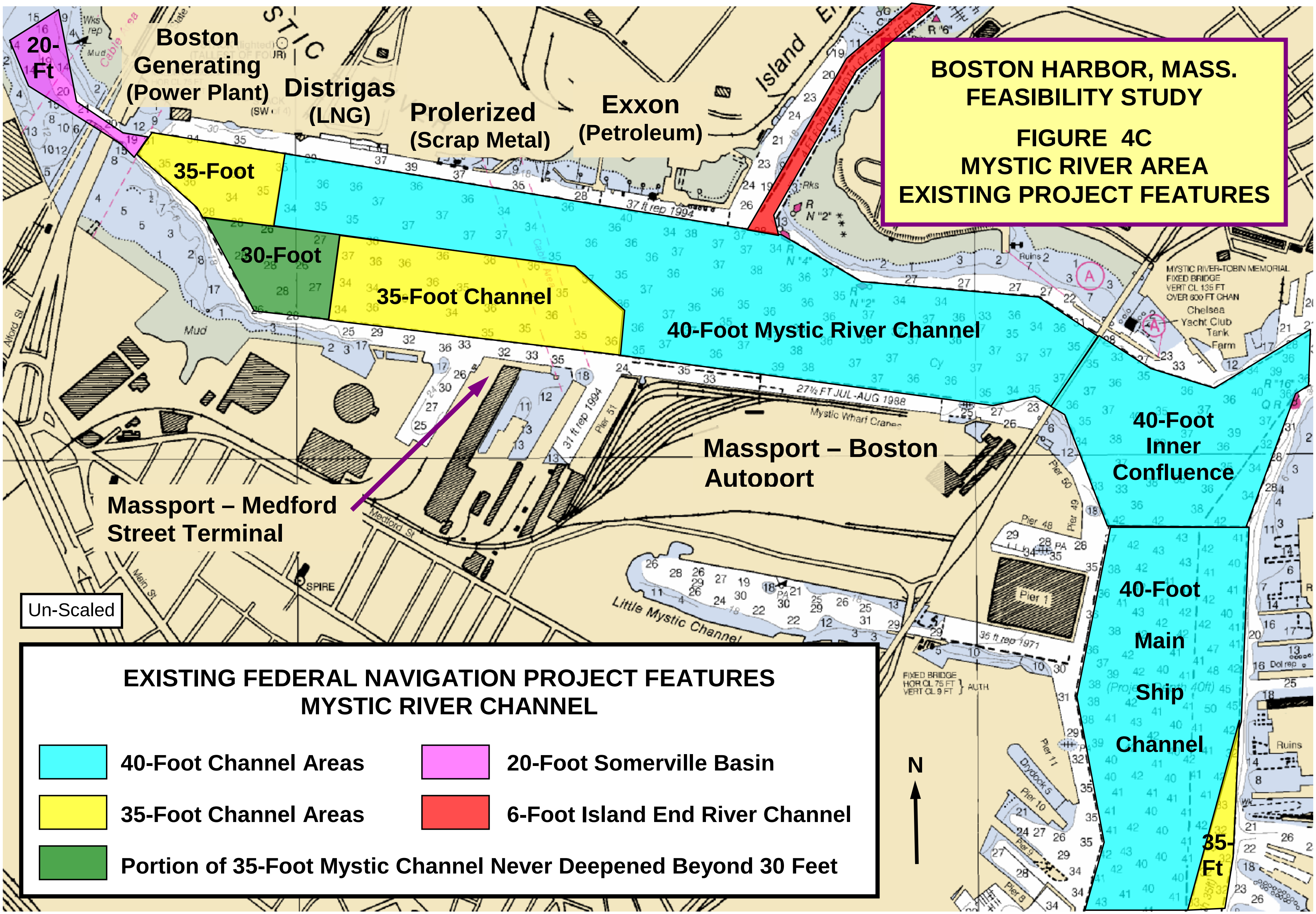
Massport is in the process of redeveloping the Medford Street Terminal along the southern mid-reach of the Mystic River Channel. Massport included deepening the berth at this terminal to 40 feet as part of the 1998-2000 deepening of the Mystic River Channel, and would like the 40-foot channel depth along the south shore extended above the Autoport to access this property.



BOSTON HARBOR, MASSACHUSETTS

FEASIBILITY REPORT FOR DEEP DRAFT NAVIGATION IMPROVEMENT

FIGURE 4B
EXISTING PROJECT FEATURES
LOWER HARBOR AREA


BOSTON HARBOR, MASS.
FEASIBILITY STUDY
FIGURE 4C
MYSTIC RIVER AREA
EXISTING PROJECT FEATURES
20-Ft
Boston Generating (Power Plant)
Distrigas (LNG)
Prolerized (Scrap Metal)
Exxon (Petroleum)
Island End
35-Foot
30-Foot
35-Foot Channel
40-Foot Mystic River Channel
40-Foot Inner Confluence
Massport – Boston Autoport
Massport – Medford Street Terminal
40-Foot Main Ship Channel
35-Ft
Little Mystic Channel
Medford St
Mystic Wharf Cranes
27½ FT JUL-AUG 1988
37 ft rep 1994
31 ft rep 1994
35 ft rep 1971
MYSTIC RIVER-TOBIN MEMORIAL FIXED BRIDGE VERT CL 135 FT OVER 600 FT CHAN
Chelsea Yacht Club
Tank Farm
Pier 1
Un-Scaled
N
EXISTING FEDERAL NAVIGATION PROJECT FEATURES
MYSTIC RIVER CHANNEL
40-Foot Channel Areas
20-Foot Somerville Basin
35-Foot Channel Areas
6-Foot Island End River Channel
Portion of 35-Foot Mystic Channel Never Deepened Beyond 30 Feet

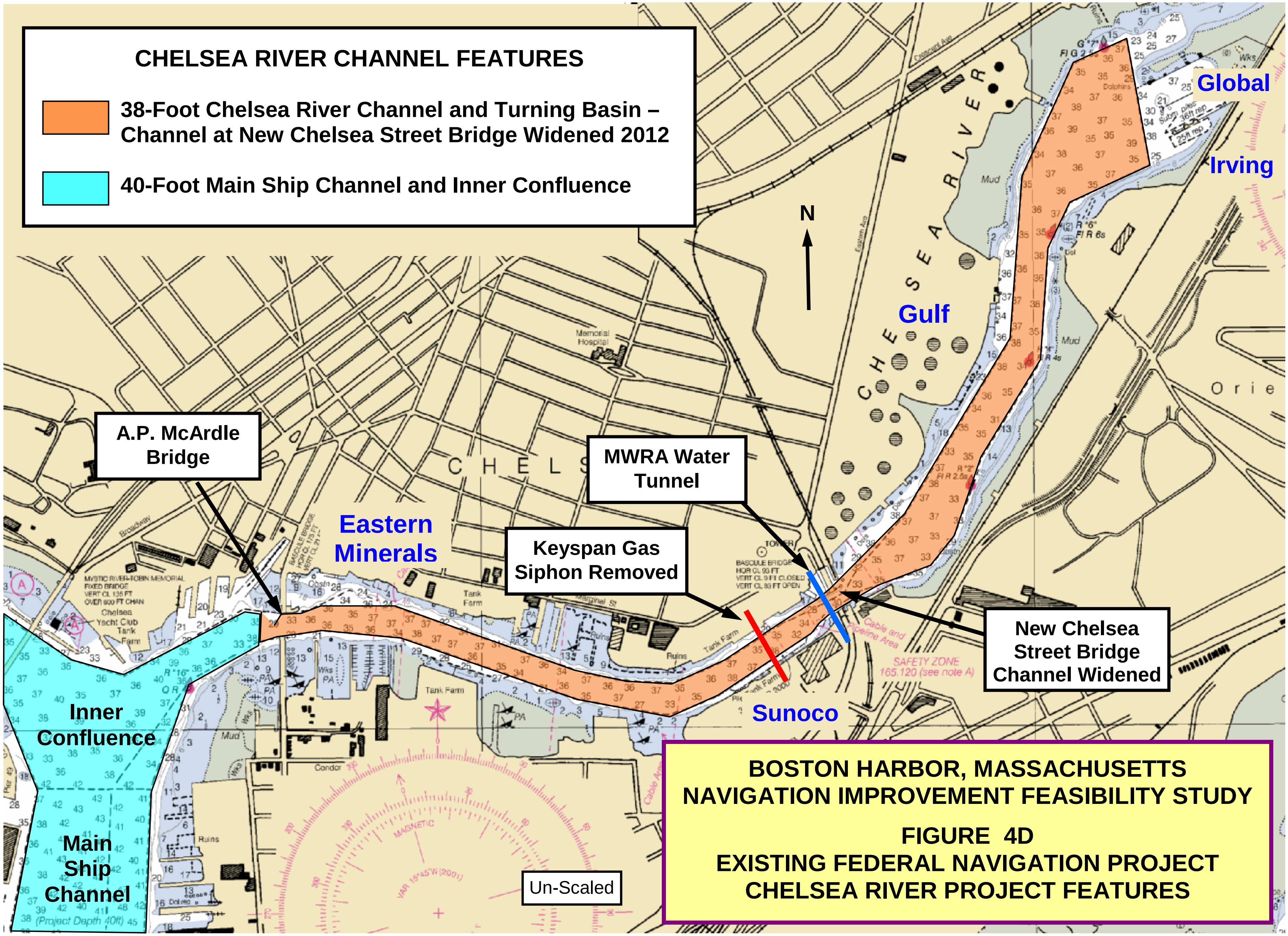
Chelsea River – see Figure 4D: Chelsea River is New England's largest petroleum port for products intended for domestic use. Portland, Maine imports more petroleum products due to crude offloaded into pipelines discharging in Canada. Five major fuel terminals are located along the Chelsea River, mainly at its upper end. The McArdle Bridge crosses the channel at the River's mouth, while the Chelsea Street Bridge crosses about mid-way upriver. The channel is 225 to 250 feet between the bridges and about 250 to 430 feet wide above Chelsea Street. A turning basin generally 800 feet wide and 1,000 feet long is located at its upper limit. The channel was deepened to -38 feet MLLW as part of the 1990 project in 2001. Minor work remains to be done in association with utility relocations to complete that project.

As part of the 2008 inner harbor maintenance operation, Massport requested the Corps remove an old KeySpan gas siphon that crosses the channel to enable dredging of the material around that area to complete the 1990 authorized 38-foot deepening of the Federal channel. The Chelsea Street Bridge, which formerly limited vessel sizes on the waterway and precluded further channel improvements beyond the 38-foot depth now provided, was replaced in 2011-2012 with a vertical lift bridge spanning the entire waterway. The Corps widened the Chelsea Channel through the new bridge opening in 2012. At the beginning of this Feasibility Study Massport has requested that feasibility efforts examine deepening the Chelsea River to 40 feet.

Other Boston Project Channels: The project for Boston Harbor includes several other tributary channels including: the 40-foot South Boston Drydock Approach Channel located off the Main Ship Channel adjacent to the Reserved Channel, the 15-foot Nubble Channel that provides a small craft passage between President Roads and Nantasket Roads, the 23-foot Fort Point Channel that provides access to shallow draft recreational facilities seaward of the Northern Avenue Bridge (upstream reaches have been deauthorized), the 12-foot Nantasket or Weir River Channel that provides access to the State Pier in Hull, and the 35-foot lower Charles River Channel located off the Main Ship Channel between Boston's North End and Charlestown that provides access to the US Coast Guard and National Park Service facilities.

Other Tributary Channels: There are a number of other separately authorized Federal navigation projects located around or tributary to Boston Harbor. These include:

- the 6-foot Island End River Channel northerly off the lower Mystic River Channel between Everett and Chelsea,
- the 6-foot Winthrop Harbor Channel located north of the President Roads Anchorage,
- the 18-foot Dorchester Bay Channel which branches off the Main Ship Channel between Spectacle and Castle Islands and connects to the 15-foot Neponset River Channel,
- the 35-foot Weymouth Fore River Channel that branches off the Narrows Channel and extends south through Hingham Bay to the Fore and Town Rivers and their petroleum terminals and power plant, with 35-foot turning basins in each river, and with upstream channel extensions at 15 feet in the Town River, and 6 feet in the Fore River to Braintree, and a 27-foot channel across the bar between Quincy and Hingham Bays,
- the 15-foot Weymouth Back River Channel southerly from Hingham Bay,
- the 10-foot Hingham Harbor Channel which provides access from Hingham Bay,
- the upper Mystic River project to Somerville and Medford with its 20, 6 and 4-foot channels, and
- the 6-foot Malden River Channel extending northerly to Wellington.


CHELSEA RIVER CHANNEL FEATURES
38-Foot Chelsea River Channel and Turning Basin – Channel at New Chelsea Street Bridge Widened 2012
40-Foot Main Ship Channel and Inner Confluence
N
A.P. McArdle Bridge
MWRA Water Tunnel
Keyspan Gas Siphon Removed
New Chelsea Street Bridge Channel Widened
Eastern Minerals
Gulf
Global
Irving
Sunoco
Inner Confluence
Main Ship Channel
CHELSEA RIVER
Un-Scaled
BOSTON HARBOR, MASSACHUSETTS
NAVIGATION IMPROVEMENT FEASIBILITY STUDY
FIGURE 4D
EXISTING FEDERAL NAVIGATION PROJECT
CHELSEA RIVER PROJECT FEATURES

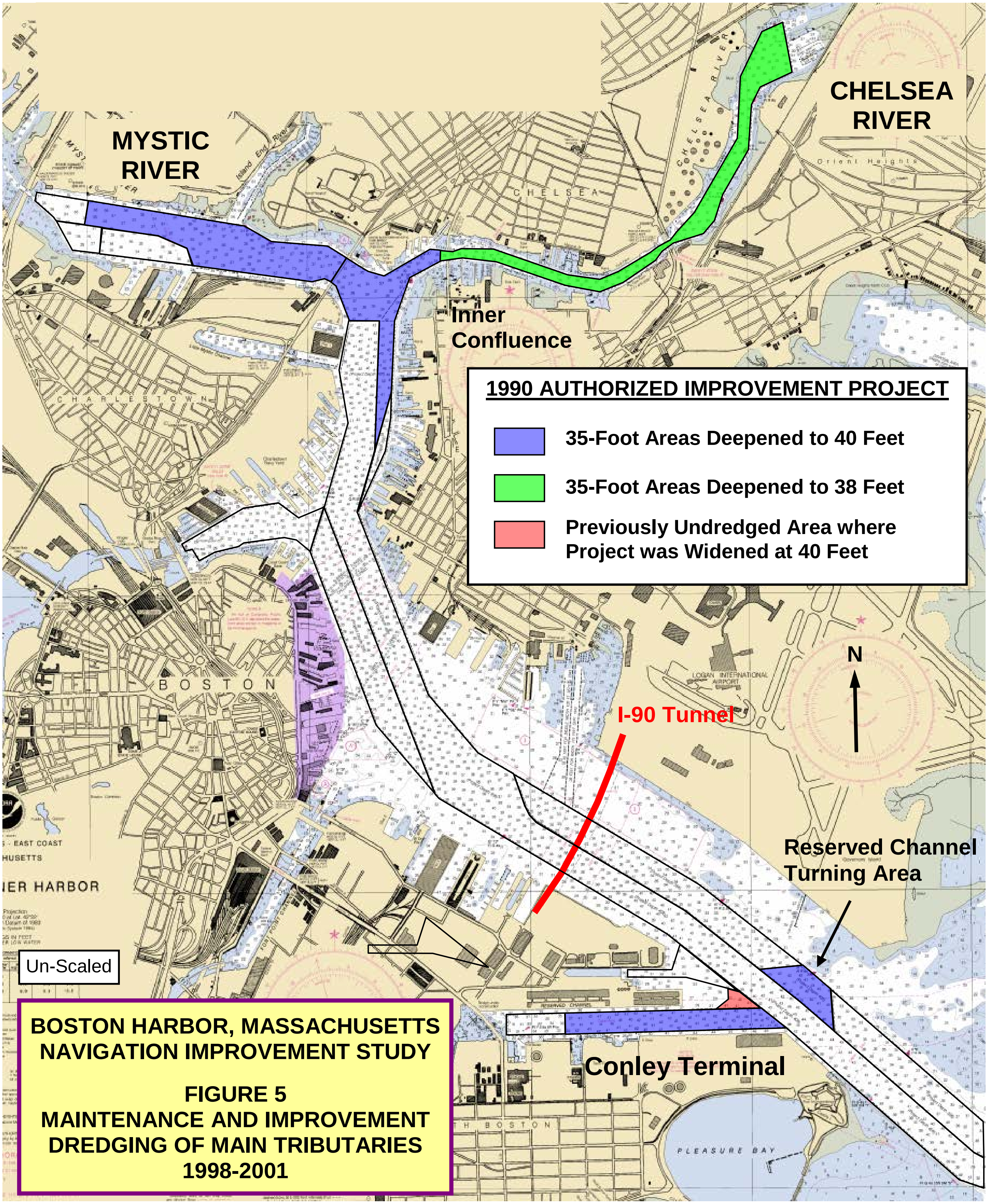
The authorized dimensions of these channels are all adequate for their existing and prospective navigation needs and no improvements are contemplated.

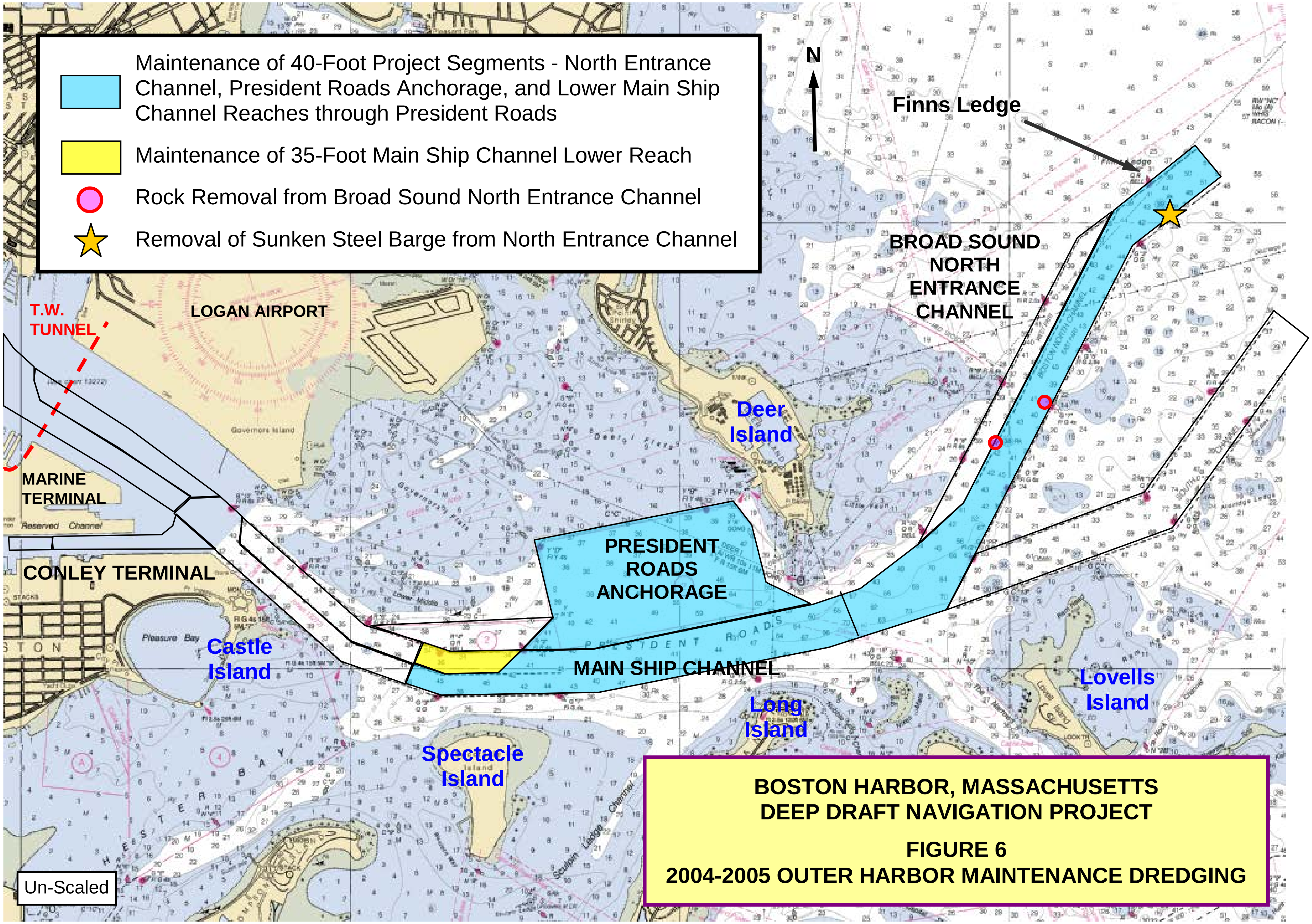
Harbor Seawalls: Stone shore protection works were constructed on several of the harbor islands and headlands between 1827 and 1874 to curtail deposition of shoal material in the harbor channels from erosion of these shorelines. These works of preservation were constructed on Deer Island, Castle Island, Georges Island and Rainsford Island between 1827 and 1838; on Lovells Island and Great Brewster Island between 1849 and 1869, and on Long Island Head, Gallops Island and Point Allerton in Hull between 1868 and 1874. Over the years these structures have been strengthened and maintained, most recently at Point Allerton in 1982. Several, including the protection at Deer and Castle Islands have been extensively modified by the State. No work for maintenance or modification is planned for these structures at this time.

Recent Federal Navigation Project Improvement and Maintenance Activities

The WRDA of 1990 authorized deepening of the harbor's three main industrial tributary channels. The lower two-thirds of the Reserved Channel and a new turning basin at its confluence with the Main Ship Channel, and portions of the lower Mystic River Channel together with the Inner Confluence Area at its mouth, were all deepened from 35 feet to a depth of 40 feet. The Chelsea River Channel was deepened to 38 feet. A depth of 40 feet in the Chelsea River was precluded by limitations on vessels size due to the narrow waterway. A non-structural realignment of the Main Ship Channel and President Roads Anchorage was also authorized that shifted the channel southerly to increase the size of the anchorage. Maintenance dredging limited to the areas to be deepened was accomplished concurrently. Since the maintenance material was unsuitable for ocean placement, a series of confined aquatic disposal cells (CAD cells) were constructed beneath the upper project limits in the Mystic and Chelsea Rivers. All of the improvement material was placed at the Massachusetts Bay Disposal Site, including the material removed to develop the CAD cells. Construction of the project began in 1998 and was substantially completed in 2001. Dredging of a small portion of the 38-foot Chelsea River Channel to complete that project was accomplished in 2008 concurrent with the completion of maintenance dredging of the inner harbor project features. The dredged features of the 1990 project are shown in Figure 5. The locations of the CAD cells constructed are described in a later section. The sequence of this work and quantities removed are provided in Appendix B.

During 2004 to 2005, maintenance dredging of the outer and lower harbor project features was accomplished. This work restored the authorized depths in the 40-foot lane of the Broad Sound North Entrance Channel, the 40-foot President Roads Anchorage, the 35 and 40-foot Main Ship Channel lanes from the Outer Confluence to Spectacle Island. Several large boulders were removed from the North Entrance Channel, and a sunken steel barge that had migrated down the slope of the Entrance Channel opposite Finns Ledge was broken up and removed. All the dredged material from this work was placed at the Massachusetts Bay Disposal Site. The 2004-2005 outer harbor maintenance work is shown in Figure 6.


MYSTIC RIVER
CHELSEA RIVER
Inner Confluence
1990 AUTHORIZED IMPROVEMENT PROJECT
35-Foot Areas Deepened to 40 Feet
35-Foot Areas Deepened to 38 Feet
Previously Undredged Area where Project was Widened at 40 Feet
N
I-90 Tunnel
Reserved Channel Turning Area
Conley Terminal
Un-Scaled
BOSTON HARBOR, MASSACHUSETTS
NAVIGATION IMPROVEMENT STUDY
FIGURE 5
MAINTENANCE AND IMPROVEMENT
DREDGING OF MAIN TRIBUTARIES
1998-2001



BOSTON HARBOR, MASSACHUSETTS
DEEP DRAFT NAVIGATION PROJECT

FIGURE 6
2004-2005 OUTER HARBOR MAINTENANCE DREDGING

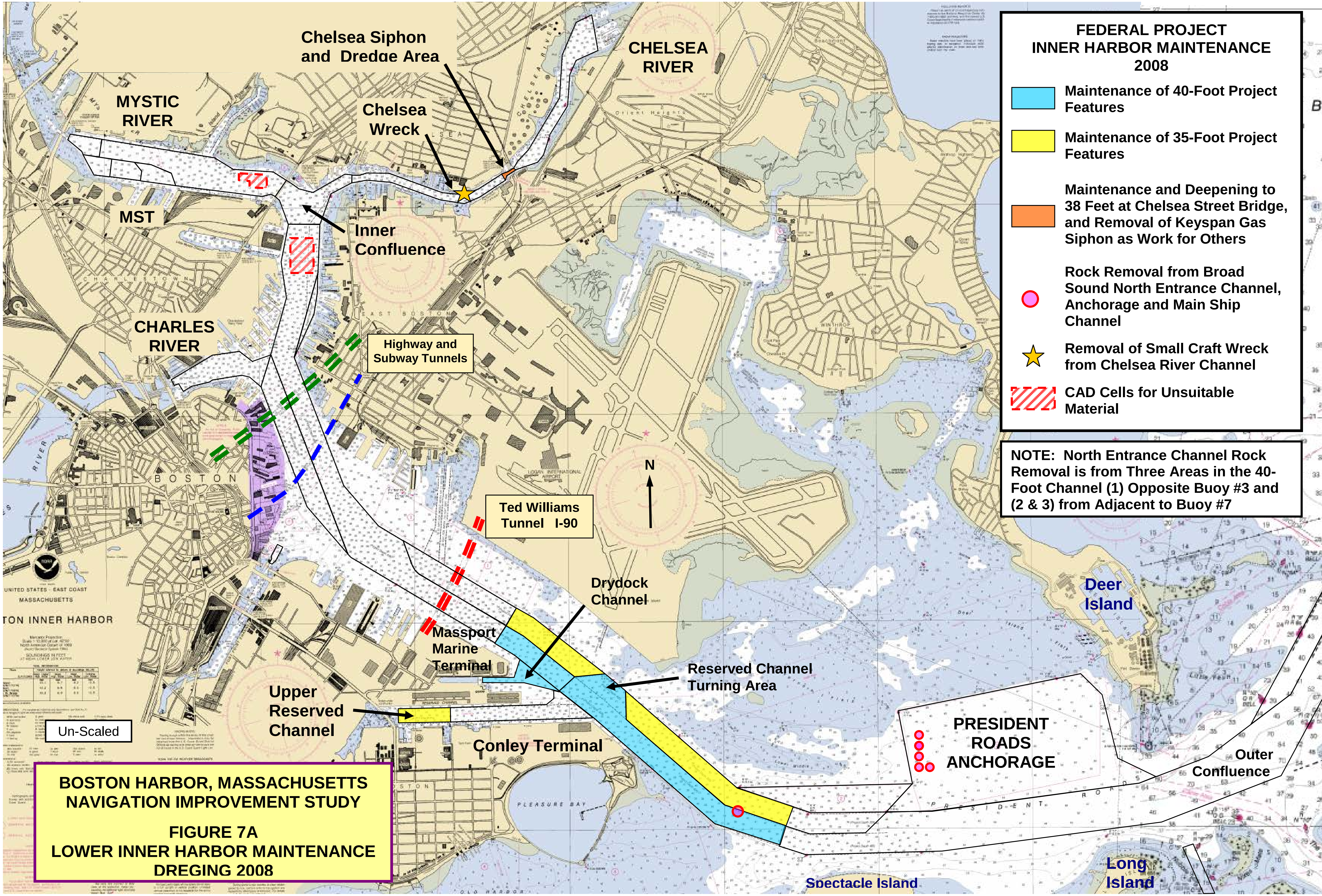
Additional rock areas lying above the project depth were discovered during the outer harbor maintenance in the North Entrance Channel and President Roads Anchorage. Another known area of ledge located in the side-slope transition between the 35 and 40-foot lanes of the Main Ship Channel just upstream of Spectacle Island was also determined to be a hazard to navigation. Removal of these rock areas was included in a separate contract, together with removal of similar ledge areas discovered during the 2004 maintenance dredging of Providence River and Harbor, Rhode Island. This ledge removal commenced in October 2007 and was completed in August 2008.

Construction began on a maintenance dredging contract for the deep draft portions of the Boston Harbor project in the lower inner harbor above Spectacle Island up to the Commonwealth Pier crossover (the Boston Inner Harbor maintenance dredging project) in April 2008. This work includes dredging the 35 and 40-foot lanes of Main Ship Channel areas above Spectacle Island to the channel crossover , the 35-foot upper third of the Reserved Channel, and the 40-foot South Boston Drydock Channel. As described above completion of the 38-foot Chelsea River Channel is included in this contract. Also included was removal of the abandoned KeySpan natural gas siphon beneath the Chelsea River, at the request of Massport and to be paid for by KeySpan, and removal of a recent sunken wreck of a small recreational craft from the channel opposite the lower end of the Sunoco Logistics (former Conoco-Phillips) terminal. Most of the maintenance material from the inner harbor project has been determined unsuitable for ocean disposal and will require construction of two additional CAD cells, one in the lower Mystic River Channel and the other in the Main Ship Channel just downstream of the Inner Confluence. The rest of the material, including most material downstream of the Ted Williams Tunnel was found suitable for ocean placement at the Massachusetts Bay Disposal Site. The 2008 inner harbor maintenance work was completed in December 2008 and is shown in Figure 7A.

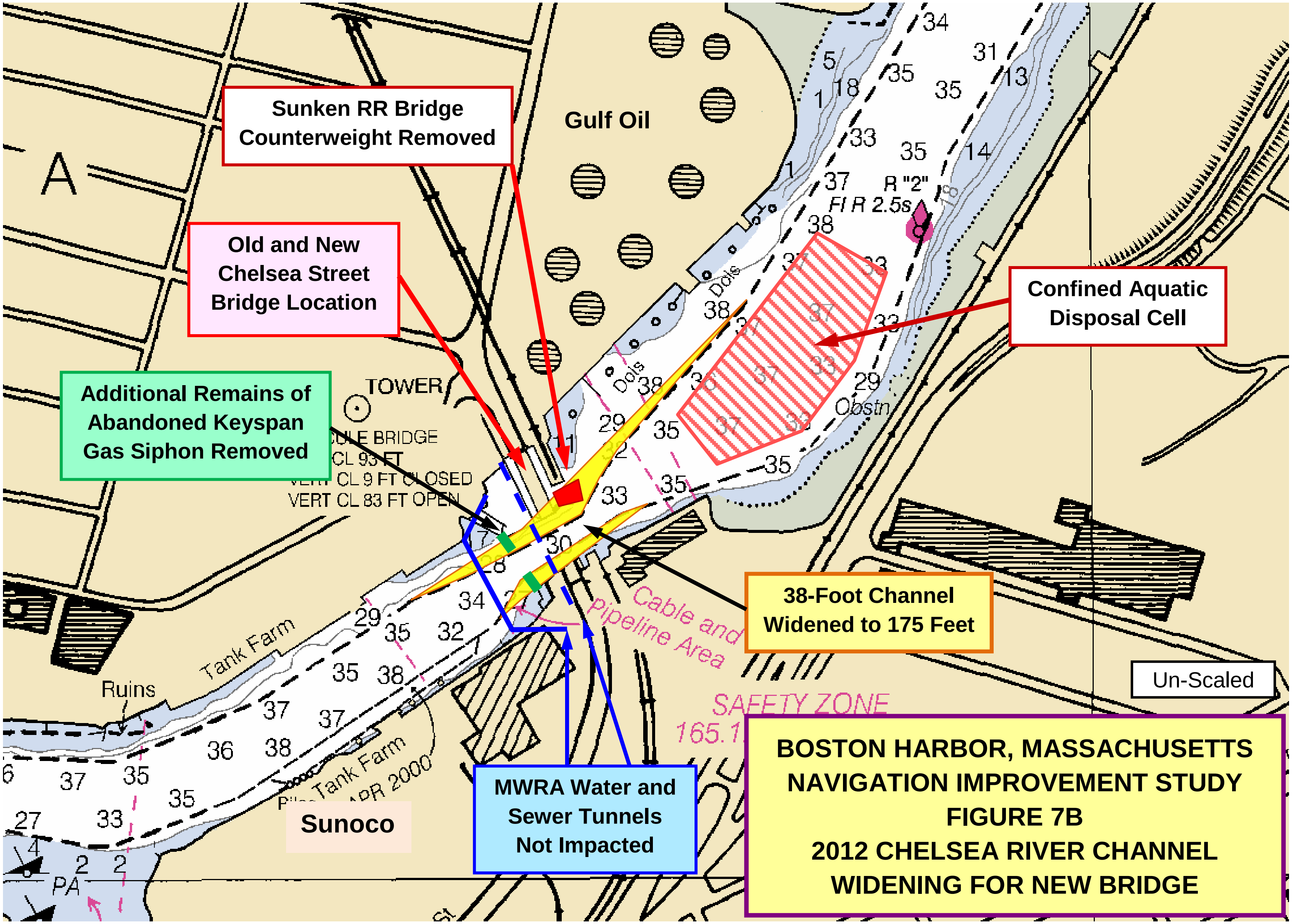
In March to April 2012 additional work was carried out on the 38-foot Chelsea River Channel after completion of the new Chelsea Street Bridge and removal of the old span by the State and others. This work was done to widen the Federal channel to 175 feet through the area of the former highway bridge. The work included removal of the large concrete counterweight from the former Grand Trunk Railroad Bridge that had been left in the river north of the old bridge, removal of additional portions of the abandoned MWRA water tunnel, removal of derelict pilings and other debris from the former highway and railway bridges that was buried beneath the channel bottom, and dredging to establish the widened channel limits, Suitable dredged material was placed at the Massachusetts Bay Disposal Site while a minor amount of unsuitable material was placed in the open Chelsea River CAD Cell. The extent of this work is shown in Figure 7B.

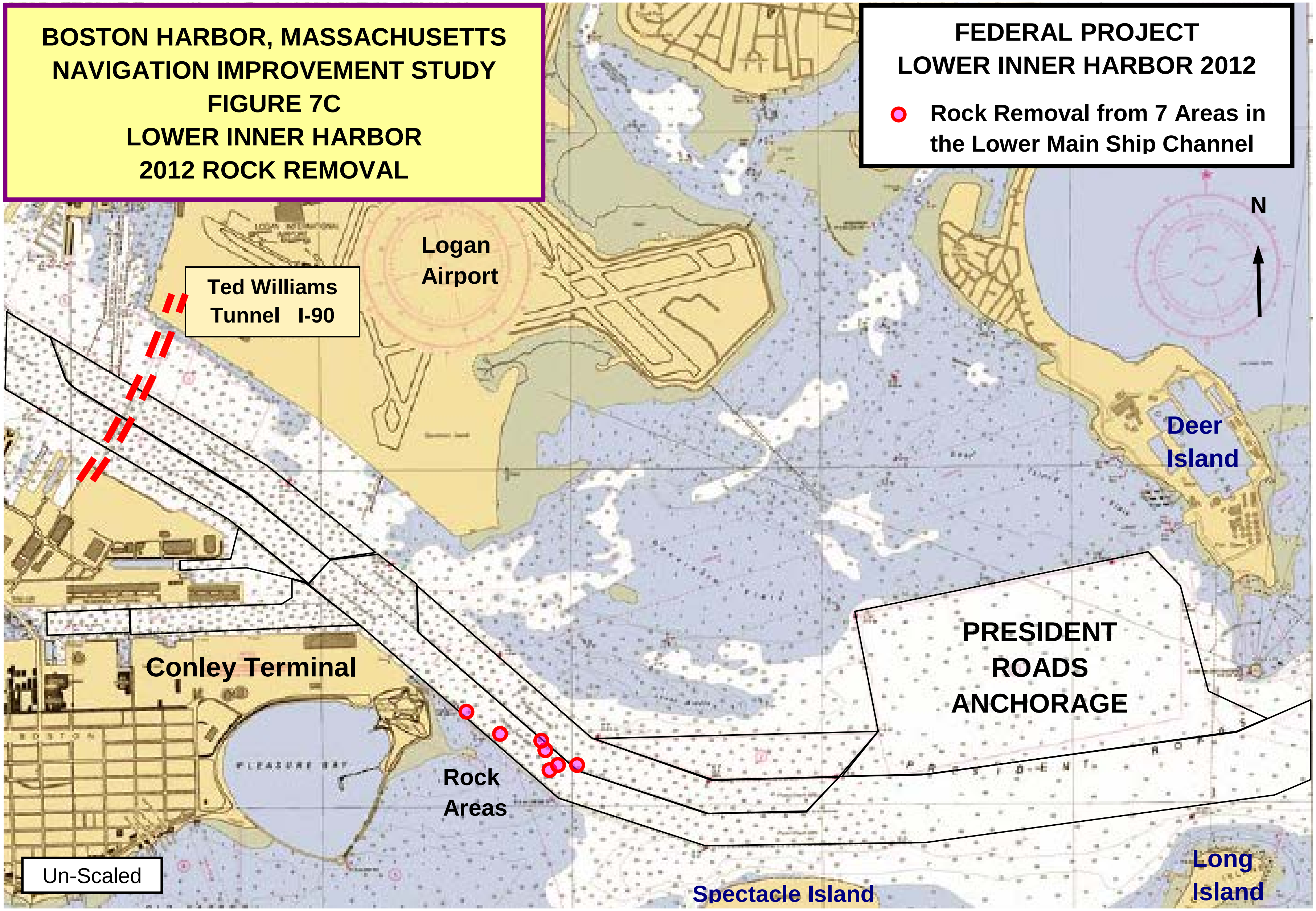
Additional ledge pinnacles uncovered during the 2008 lower inner harbor maintenance dredging were removed under contract in August to mid-September 2012. Seven ledge areas were blasted and removed from the lower Main Ship Channel between Spectacle Island and Castle Island. The rock was placed at the Massachusetts Bay Disposal Site. The extent of this work is shown in Figure 7C.

As of the end of 2012 the remaining areas of the existing project requiring maintenance include the 35 and 40-foot reaches of the Main Ship Channel in the upper inner harbor above the Commonwealth Pier crossover to the Inner Confluence, the 35-foot lower Charles River



Chelsea Siphon and Dredge Area
CHELSEA RIVER
MYSTIC RIVER
Chelsea Wreck
MST
Inner Confluence
CHARLES RIVER
Highway and Subway Tunnels
Ted Williams Tunnel I-90
N
Drydock Channel
Massport Marine Terminal
Reserved Channel Turning Area
Upper Reserved Channel
Conley Terminal
PRESIDENT ROADS ANCHORAGE
Deer Island
Outer Confluence
Long Island
Spectacle Island
Un-Scaled
FEDERAL PROJECT
INNER HARBOR MAINTENANCE
2008
Maintenance of 40-Foot Project Features
Maintenance of 35-Foot Project Features
Maintenance and Deepening to 38 Feet at Chelsea Street Bridge, and Removal of Keyspan Gas Siphon as Work for Others
Rock Removal from Broad Sound North Entrance Channel, Anchorage and Main Ship Channel
Removal of Small Craft Wreck from Chelsea River Channel
CAD Cells for Unsuitable Material
NOTE: North Entrance Channel Rock Removal is from Three Areas in the 40-Foot Channel (1) Opposite Buoy #3 and (2 & 3) from Adjacent to Buoy #7
BOSTON HARBOR, MASSACHUSETTS
NAVIGATION IMPROVEMENT STUDY
FIGURE 7A
LOWER INNER HARBOR MAINTENANCE DREGING 2008


Sunken RR Bridge Counterweight Removed
Old and New Chelsea Street Bridge Location
Additional Remains of Abandoned Keyspan Gas Siphon Removed
Confined Aquatic Disposal Cell
38-Foot Channel Widened to 175 Feet
MWRA Water and Sewer Tunnels Not Impacted
Gulf Oil
Sunoco
Tank Farm
Ruins
TOWER
Cable and Pipeline Area
SAFETY ZONE
Un-Scaled
BOSTON HARBOR, MASSACHUSETTS
NAVIGATION IMPROVEMENT STUDY
FIGURE 7B
2012 CHELSEA RIVER CHANNEL
WIDENING FOR NEW BRIDGE

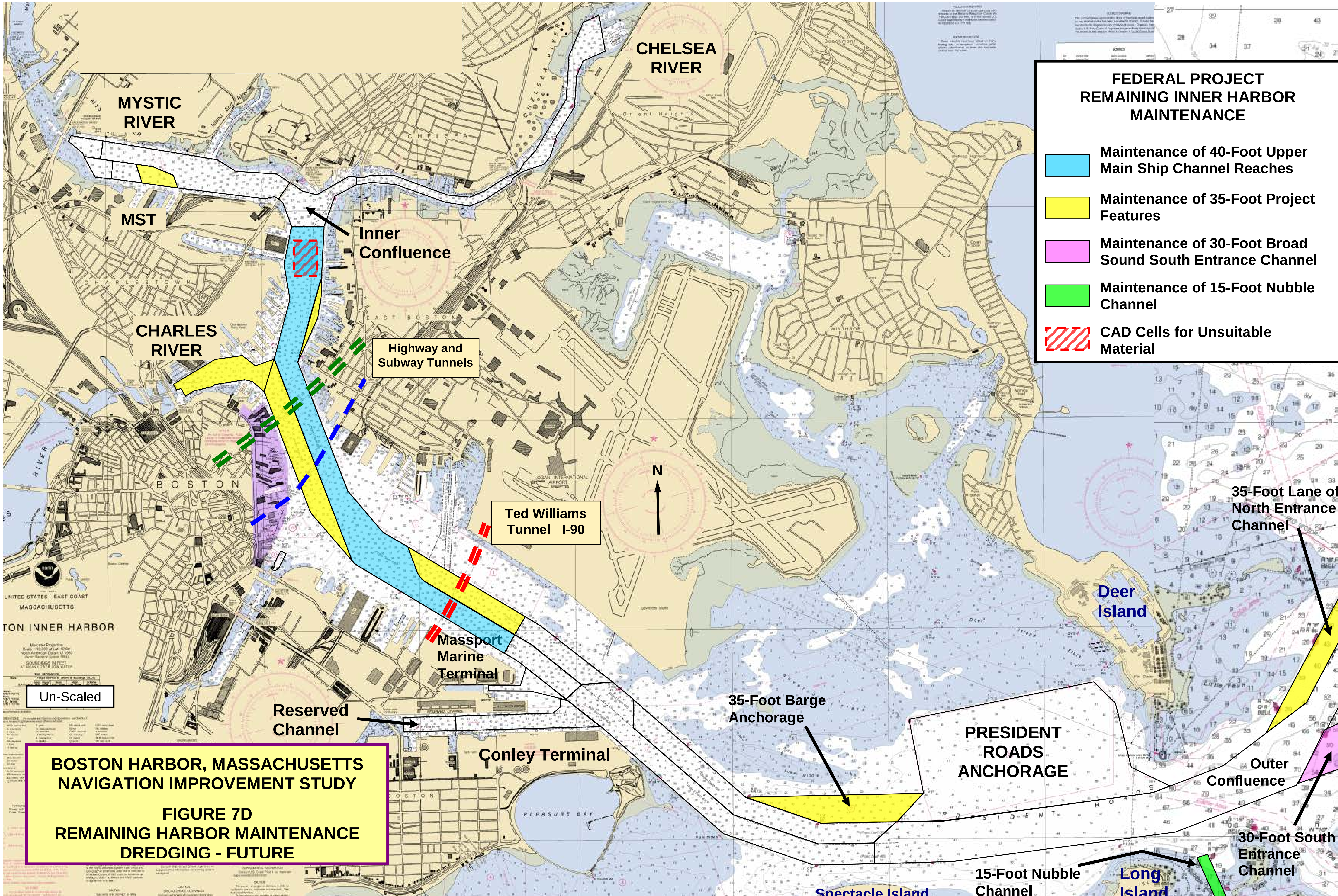

BOSTON HARBOR, MASSACHUSETTS
NAVIGATION IMPROVEMENT STUDY
FIGURE 7C
LOWER INNER HARBOR
2012 ROCK REMOVAL
FEDERAL PROJECT
LOWER INNER HARBOR 2012
Rock Removal from 7 Areas in the Lower Main Ship Channel
Ted Williams Tunnel I-90
Logan Airport
N
Deer Island
PRESIDENT ROADS ANCHORAGE
Conley Terminal
Rock Areas
Un-Scaled
Spectacle Island
Long Island

Channel reach at the USCG Base, and the 35-foot sections of the Mystic River Channel at the Medford Street Terminal. Additional project features such as the 30-foot South Entrance Channel, 15-foot Nubble Channel and 35-Foot Barge Anchorage may also require maintenance dredging to facilitate their full use as alternative vessel traffic transit and anchoring areas during construction of the deep draft improvement project. The specifics of these will be discussed later in the report.

Current Dredged Material Management and Disposal Sites

Disposal of dredged material from Boston Harbor has involved several methods and a number of sites in the past. Most dredging of the harbor through the 1950s used material for reclamation of tidelands to create new land for port development. Most of the present waterfront of the City was created in this fashion. In the 1940s to 1970s, filling of tidelands for construction and expansion of Logan Airport consumed additional dredged materials. Two ocean disposal sites in Massachusetts Bay have been used for dredged materials from Boston Harbor: the Boston Lightship Site and the Massachusetts Bay Disposal Site. Use of the Boston Lightship Disposal Site located about 11 miles east of the South Channel entrance has been discontinued. The Massachusetts Bay Disposal Site, a U.S. Environmental Protection Agency designated ocean disposal site, remains in use, most recently for the suitable materials from the BHNIP and the Outer and Inner Harbor maintenance dredging and rock removal projects and the Chelsea River Channel widening.

Beginning with the 1998-2001 BHNIP construction for the main tributaries maintenance and deepening project, disposal of unsuitable overlying maintenance material was accomplished through the creation of Confined Aquatic Disposal (CAD) cells beneath the Mystic and Chelsea River channels and the Inner Confluence that were under improvement. The Chelsea River C-12 CAD cell was not completely filled at that time or by its more recent use and remains available for use. Other CAD cell sites in the Chelsea and Mystic Rivers and the upper harbor were permitted for use but not yet constructed. The presently available disposal options are discussed below and screening of disposal alternatives and final selection is discussed in detail in the SEIS/EIR.



BOSTON HARBOR, MASSACHUSETTS
NAVIGATION IMPROVEMENT STUDY

FIGURE 7D
REMAINING HARBOR MAINTENANCE
DREDGING - FUTURE

Massachusetts Bay Disposal Site

Massachusetts Bay is a semi-enclosed embayment surrounded by the Boston metropolitan region in the north and west, and Cape Cod in the south and southeast while it is open to the Gulf of Maine in the northeast. It is about 60 miles long and 30 miles wide, and has an average depth of 115 feet. Stellwagen Basin is the only deep basin in Massachusetts Bay with a depth up to 300 feet.

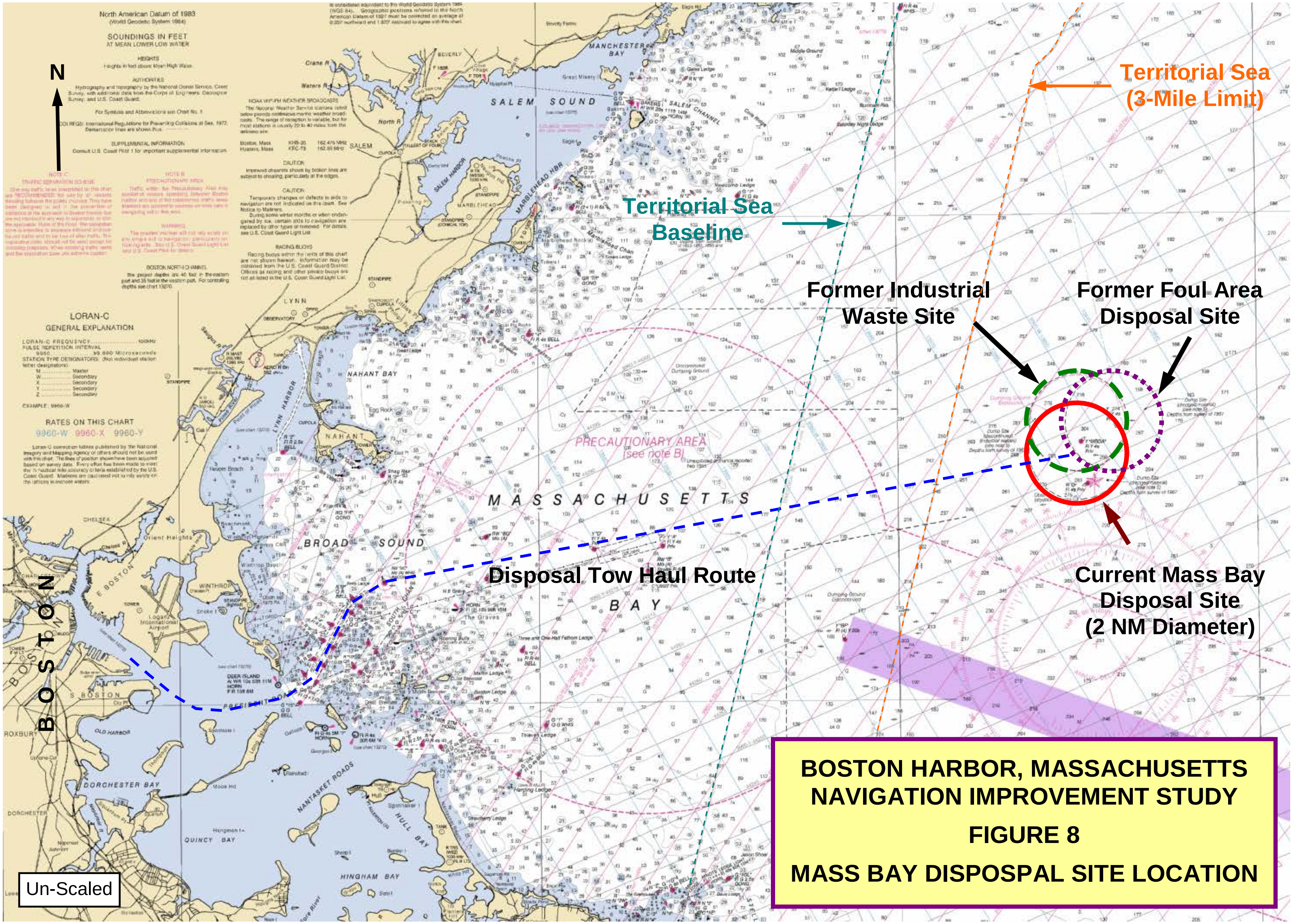
The Massachusetts Bay Disposal Site (MBDS – see Figure 8) has been the principal disposal site used for Boston Harbor dredged materials and for the other harbors of northeastern Massachusetts for the past half century. The MBDS is located in Stellwagen Basin off the western edge of Stellwagen Bank in Massachusetts Bay, about 16.4 miles east of East Point in Nahant and 12 miles south-southeast of Eastern Point in Gloucester. The MBDS is about 17.2 miles from the entrance to the North Entrance Channel or about 24 miles from the Conley Terminal. The site is a 2-nautical mile circle and receives on average about 300,000 cubic yards annually. The MBDS has been shifted slightly from the historic disposal site, first about one mile to the west for its interim selection in 1977, and then about one-half mile south when it was designated as an ocean dredged material disposal site by the U.S. Environmental Protection Agency in 1993.

The Stellwagen Bank National Marine Sanctuary is located east of the Mass Bay Disposal Site and is administered by NOAA. The 639 square nautical mile Marine Sanctuary was designated in November 1992. Fishing, including bottom trawling, is allowed in the Sanctuary, while mineral extraction is prohibited.

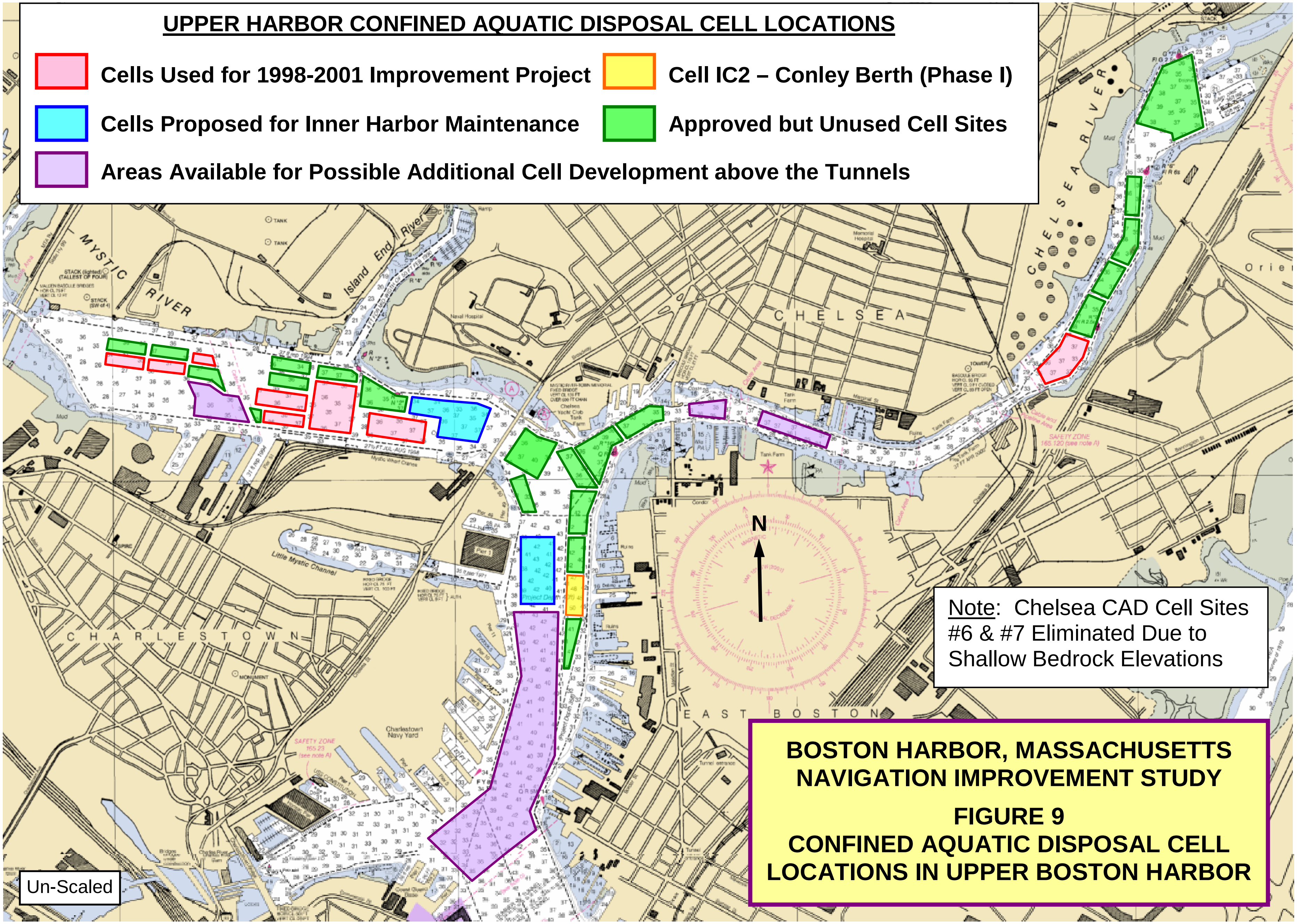
Confined Aquatic Disposal Cells

Figure 9 shows the location of the CAD cells that were constructed for the 1998-2001 Boston Harbor navigation improvement and maintenance project (BHNIP) and associated terminal berth dredging: those proposed and permitted for the 2008-2009 Inner Harbor maintenance dredging project; those cell sites previously permitted for the 1998-2001 improvement work but not yet constructed; and additional areas above the tunnels that may be available for future CAD cell development. These cells were mostly located in areas where deposits of stiff Boston blue clay extend from the channel bottom to the bedrock surface at an elevation of some 60 to 100 feet below MLLW. The stiffness of the clay permitted construction of the cells with virtually no side slope, maximizing the created cell capacity. Most of the 1998-2001 cells were capped with sandy maintenance material dredged from the Cape Cod Canal, a CAD cell in Chelsea Creek was left uncapped due to only partial filling and has served as an experiment to test the ability of natural siltation to form an adequate cap.

It is unlikely that any of the material to be removed for the proposed channel deepening would prove unsuitable for unconfined ocean disposal at the MBDS. However, some maintenance material may be dredged in association with the improvement project. Any maintenance material from the inner harbor areas could be unsuitable for ocean disposal and may require confined disposal. Use of a portion of the remaining CAD cell capacity, either through further filling of existing cells or construction at some of the remaining approved cell sites would likely be the least cost means of disposing of unsuitable dredged materials. CAD cells, their use and impacts are discussed in greater detail in the SEIS/EIR.



BOSTON HARBOR, MASSACHUSETTS
NAVIGATION IMPROVEMENT STUDY
FIGURE 8
MASS BAY DISPOSPAL SITE LOCATION


UPPER HARBOR CONFINED AQUATIC DISPOSAL CELL LOCATIONS
Cells Used for 1998-2001 Improvement Project
Cell IC2 – Conley Berth (Phase I)
Cells Proposed for Inner Harbor Maintenance
Approved but Unused Cell Sites
Areas Available for Possible Additional Cell Development above the Tunnels
MYSTIC RIVER
Island End River
CHELSEA
CHELSEA RIVER
CHARLESTOWN
EAST BOSTON
Little Mystic Channel
Charlestown Navy Yard
N
Note: Chelsea CAD Cell Sites #6 & #7 Eliminated Due to Shallow Bedrock Elevations
BOSTON HARBOR, MASSACHUSETTS
NAVIGATION IMPROVEMENT STUDY
FIGURE 9
CONFINED AQUATIC DISPOSAL CELL LOCATIONS IN UPPER BOSTON HARBOR
Un-Scaled

Tunnel and Bridge Restrictions on Navigation

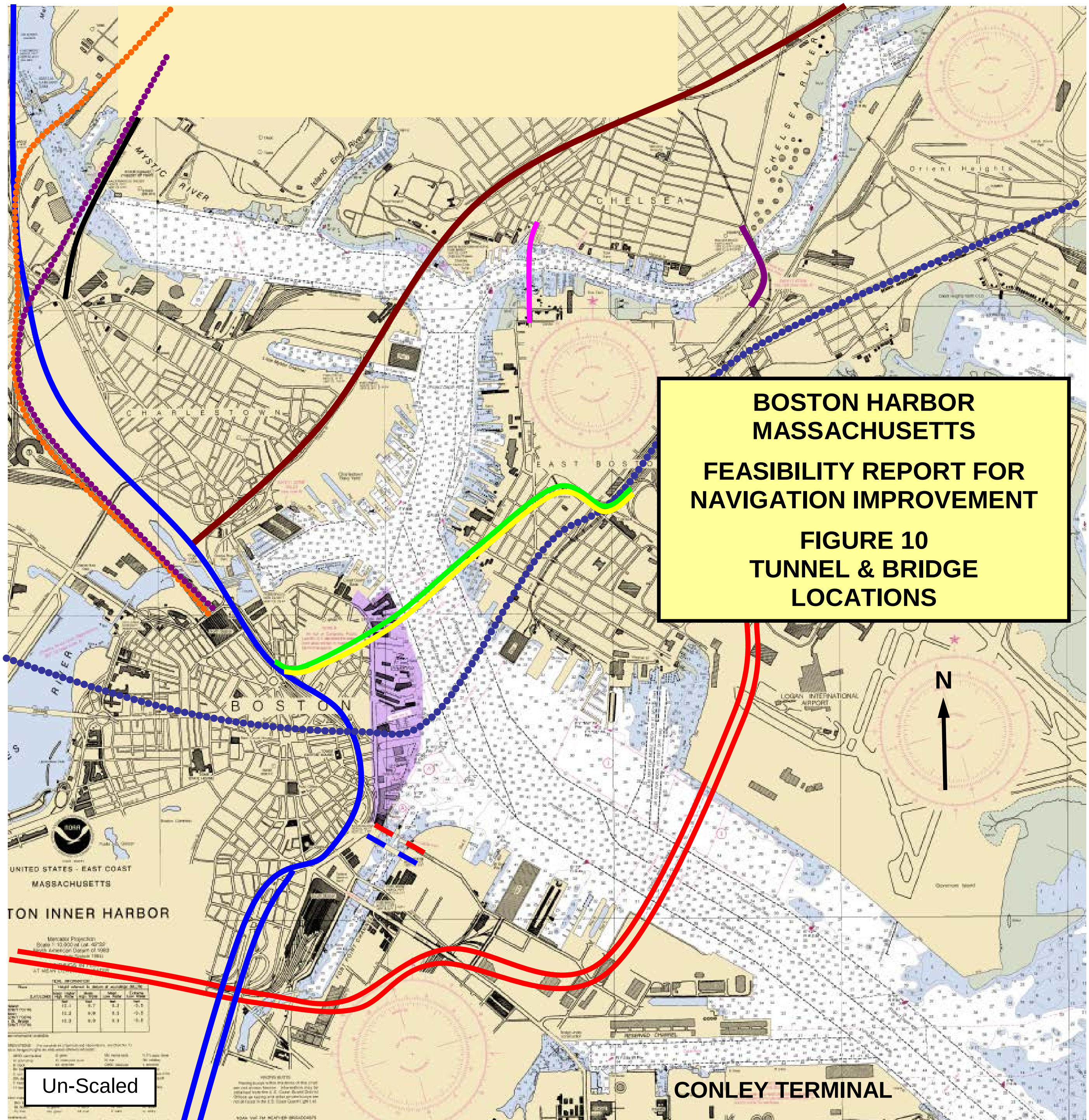
Locations of the several highway and railway tunnels and bridges crossing the harbor are shown in Figure 10.

Harbor Tunnel Crossings: There are four tunnels crossing beneath the Main Ship Channel, one subway and three highway crossings. The downstream-most crossing, the Ted Williams Tunnel (I-90 – TWT) is located just upstream of the Massport Marine Terminal in South Boston. The elevation of armor protection atop the TWT may permit deepening of the Main Ship Channel up to a depth of 45 feet, as stated by the Mass Turnpike Authority (MTA) in their letter of 27 February 2003. However, as the MTA suggests, this assumption would need to be tested by additional analyses if deepening over the tunnel was proposed, and overdepth and other dredging clearance factors may substantially reduce or eliminate this clearance.

The three remaining tunnels above the TWT are the Massachusetts Bay Transportation Authority's Blue Line subway tunnel, which connects the City core with Logan Airport, East Boston and the City of Revere. Above the Blue Line are the paired Callahan and Sumner Tunnels connecting the city core with East Boston, carrying US Route 1A beneath the harbor. The elevation of the three upper tunnels, particularly the Blue Line, will not permit any deepening of the Main Ship Channel beyond the 40 feet now provided. There are no facilities located above the TWT and below the Blue Line that would benefit from any increased depth in the Main Ship Channel at this time. The 40 foot access already provided to the shipyard, the Fish Pier, the World Trade Center and Massport's East Boston Piers is sufficient for all existing and expected future traffic to these facilities. Future deep-draft port improvements at Boston, except for minor modifications limited to 40 feet, are only practicable in areas downstream of the TWT.

Bridges: Three bridges cross the channels under study. The clearances for these spans are shown below in Table 4. The Tobin Bridge, constructed between 1948 and 1950, is a fixed cantilevered truss in three spans that crosses the mouth of the Mystic River at its junction with the Inner Confluence. The 800-foot center span has a navigation opening of 600 feet between the fenders, with a vertical clearance of 135 feet at MHW.

The Chelsea Street Bridge crosses the Chelsea River about midway along that channel. The former restricted clearance single-leaf bascule bridge was replaced in 2011-2012 with a new vertical lift bridge that spans the entire width of the waterway. The vertical lift center span of the new Chelsea Street Bridge has a length of about 450 feet and the bridge design contemplates a channel width of at least 220 feet. Once the bridge was completed the Corps widened the 38-foot Federal channel through the area of the old and new bridges under the Corps operation and maintenance authority for the existing project to a minimum of 175 feet, the same restriction posed by the McArdle Bridge at the entrance to Chelsea River. Any additional channel widening to the 220-foot authorized width or any greater width would require reconstruction of adjacent bulkheads and armored slopes.



BRIDGES & TUNNELS

I-90 Ted Williams Tunnel	Callahan & Sumner Tunnels
I-93 Central Artery – Charles River Br.	Chelsea Street Bridge
Old & New Northern Avenue Bridges	Mystic Tobin Bridge & US 1
MBTA Blue Line Subway Tunnel	State Route 90 Malden Br
MBTA Commuter Rail Line	MBTA Orange Line
A. P. McArdle Bridge	

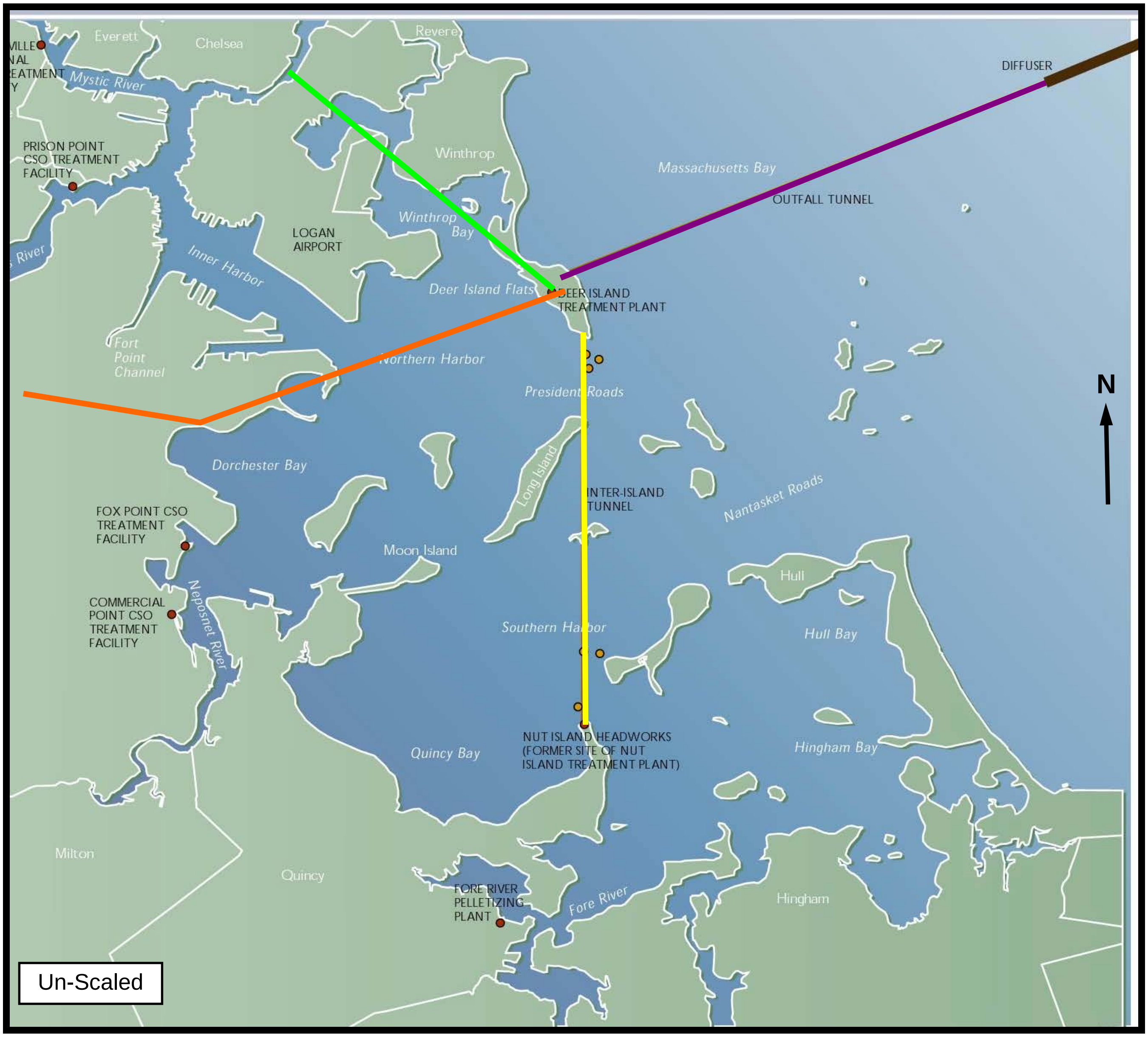
TABLE 4
BOSTON HARBOR, MASSACHUSETTS
BRIDGE CLEARANCES

Bridge	Type of Span	Horizontal Clearance Between Fenders	Vertical Clearance at Mean High Water
Tobin – Mystic River	Fixed	600 Feet	135 Feet
McArdle – Chelsea River	Dual Bascule	175 Feet	21 Feet Closed
Old Chelsea Street – Removed	Single Bascule	Removed Was 93 Feet	Removed Was 83 Feet Open
New Chelsea Street – Chelsea	Vertical Lift	220 Feet	175 Feet Raised

The McArdle Bridge is a dual leaf bascule span that crosses the mouth of the Chelsea River just above its junction with the Inner Confluence. The bridge has a 175-foot horizontal clearance between the fenders. There are no other bridges crossing the harbor's deep-draft waterways.

Sewer Tunnels: The Massachusetts Water Resources Authority (MWRA) operates the metropolitan area's water and sewer facilities. The MWRA has four sewer lines that cross beneath the harbor channels. The location of these tunnels is shown in Figure 11. All four tunnels were bored through bedrock. A large sewer force main crosses the harbor connecting MWRA facilities on Nut Island and Deer Island. The line crosses beneath the President Roads reach of the Main Ship Channel just west of the Outer Confluence. This tunnel was bored through bedrock, and where it crosses beneath navigation channel, it does so beneath the deep depression of the outer confluence, where no dredging or rock removal would be required, even with a 52-foot entrance channel design depth. There is also a sewer line that crosses the Chelsea River immediately downstream of the new Chelsea Street Bridge. This sewer line is located at -60 feet MLLW and would not be impacted by dredging of the Chelsea River to -40 feet MLLW.

The main outfall for MWRA's new Deer Island sewage treatment passes beneath the Broad Sound North Entrance Channel on its route seaward to the diffuser array located in about 105 feet of water about 8.8 miles east of Deer Island. This outfall tunnel was a deep bore cut through the bedrock and would not be impacted by the proposed channel deepening.



SEWER TUNNELS CROSSING HARBOR

- **Inter-Island Tunnel from Nut Island Headworks to Deer Island Plant** (yellow)
- **Outfall Tunnel from Deer Island to Massachusetts Bay** (purple)
- **Main Drainage Tunnel from South Boston to Deer Island (1959)** (orange)
- **Chelsea Drainage Tunnel from Chelsea to Deer Island** (green)

Adapted from MWRA Website Map of Sewer Tunnels

BOSTON HARBOR, MASSACHUSETTS

FEASIBILITY REPORT FOR DEEP DRAFT NAVIGATION IMPROVEMENT

FIGURE 11
MWRA SEWER TUNNEL LOCATIONS

The Main Drainage Tunnel for the City of Boston, completed in 1959, is a deep bore cut in bedrock, about 300 feet below MLW, crossing from approximately beneath Fort Independence in South Boston north-northeasterly under the Main Ship Channel and north of the Anchorage to Deer Island. This tunnel would not be impacted by the proposed deepening of the Main Ship Channel. The Chelsea Drainage Tunnel is also a deep bore cut in bedrock, from Chelsea southeasterly beneath the Chelsea River Channel, East Boston and Logan Airport, to Deer Island. This tunnel would not be impacted by the proposed deepening of the Chelsea River.

The MWRA also operates a water tunnel beneath the Chelsea River downstream of the Chelsea Street Bridge. In their November 2012 letter MWRA stated it does not believe that this tunnel would need to be removed and replaced to accommodate the deepening of the Chelsea River Channel by up to an additional two feet to 40 feet.

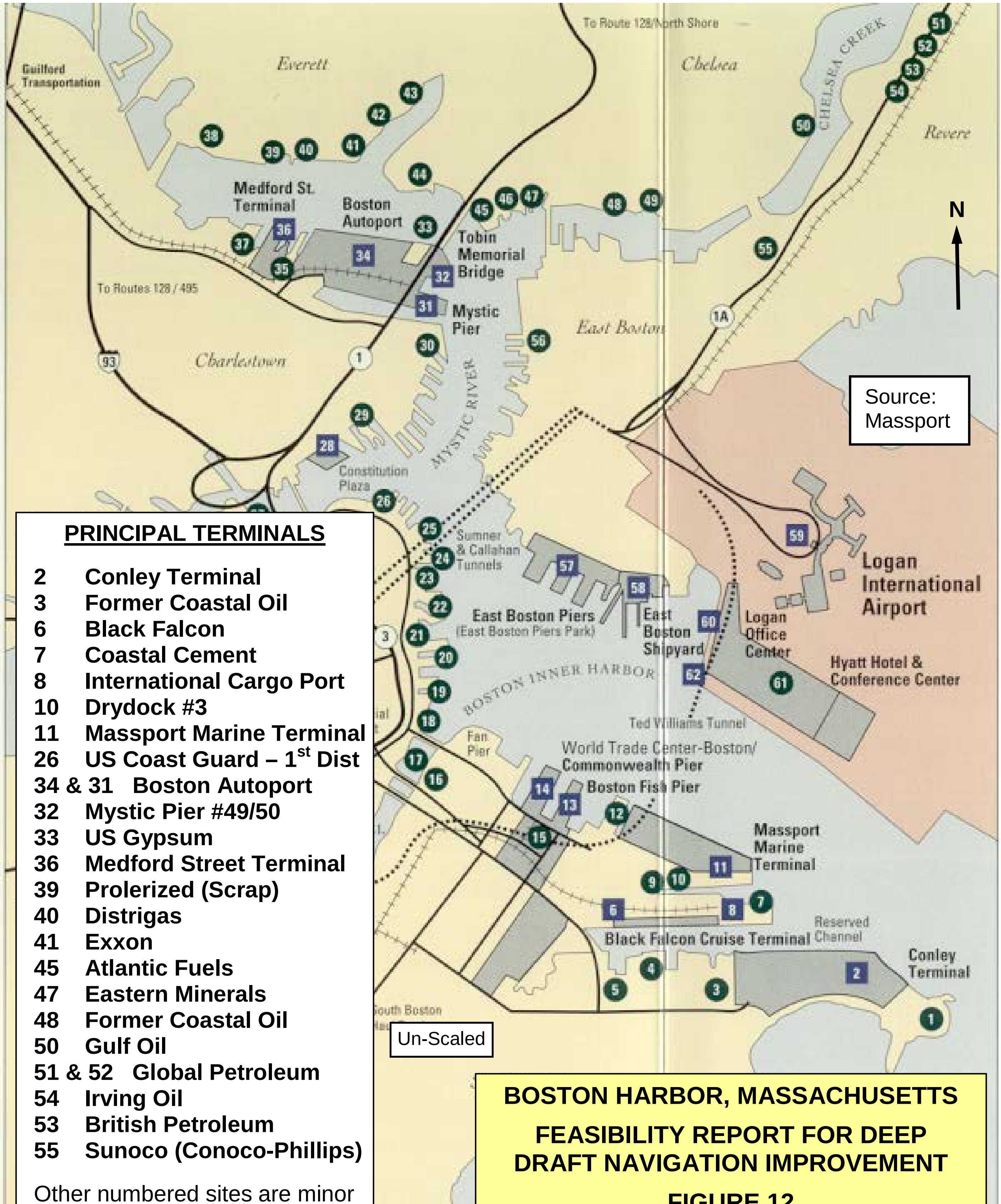
Existing Terminal Facilities

This section will describe the existing terminals located along each of the Port's deep draft channels now under consideration for improvement. Massport's map of the many public and private terminals and other waterfront facilities is shown in Figure 12. The terminals' ownership, existing conditions, use, and plans for improvement are described.

Reserved Channel – See the map in Figure 4B and the photo in Figure 13: The Reserved Channel accesses the Massport's Conley Terminal, the harbor's sole container terminal located on its south shore. The former Coastal Oil Terminal, upstream of the Conley Terminal, has been decommissioned and Massport is actively negotiating to purchase the property for expansion of the Conley Terminal and plans to complete this acquisition over the next year. The northern shore of the Reserved Channel is the former Boston Army Base, also owned by Massport. The Black Falcon Cruise Terminal, also owned by Massport, is located at the inner end, while Massport leases property and berths at the outer end to a cement importer and warehouse operator.

Black Falcon Terminal – North Side of Reserved Channel

Massport's Black Falcon Terminal opened in 1986 to re-establish passenger carriage through the Port. Since that first year when the terminal saw 13 ship calls and about 18,000 passengers, service has grown to over 100 cruise ships from 15 cruise lines annually, most recently handling more than 220,000 passengers. Cruises of the New England and Canadian Maritime Provinces, Boston to Bermuda service and some trans-Atlantic services are regularly handled. Berths at the Black Falcon Terminal are generally 35 feet adjacent to the both the 35-foot upper channel reach and the 40-foot channel. The cement berths at the outer end of the Pier are also maintained to 35 feet. A USCG Safety Zone restricts access around berthed cruise ships at the terminal. The existing 35-foot berth depths are sufficient for the existing and prospective needs of the Black Falcon Terminal. Cruise ship activity at the terminal for the past few years is shown below in Table 5.



PRINCIPAL TERMINALS

2 Conley Terminal
3 Former Coastal Oil
6 Black Falcon
7 Coastal Cement
8 International Cargo Port
10 Drydock #3
11 Massport Marine Terminal
26 US Coast Guard – 1st Dist
34 & 31 Boston Autoport
32 Mystic Pier #49/50
33 US Gypsum
36 Medford Street Terminal
39 Prolerized (Scrap)
40 Distrigas
41 Exxon
45 Atlantic Fuels
47 Eastern Minerals
48 Former Coastal Oil
50 Gulf Oil
51 & 52 Global Petroleum
54 Irving Oil
53 British Petroleum
55 Sunoco (Conoco-Phillips)

Other numbered sites are minor facilities not factoring into deep draft improvements

BOSTON HARBOR, MASSACHUSETTS

FEASIBILITY REPORT FOR DEEP DRAFT NAVIGATION IMPROVEMENT

FIGURE 12
PRINCIPAL TERMINAL LOCATIONS

Figure 13 – Aerial Photo of Reserved Channel with Black Falcon Terminal at Right

TABLE 5 BOSTON HARBOR, MASSACHUSETTS BLACK FALCON TERMINAL CRUISE SHIP ACTIVITY		
Year	**Number of Cruise Ship Calls**	**Number of Passengers**
2004	95	199,453
2005	102	233,702
2006	81	208,883
2007	101	223,884
2008	113	269,911
2009	104	299,736
2010	111	322,238
2011	107	310,238

Conley Terminal – South Side of Reserved Channel (Figure 14)

Massport deepened berths at the Conley Terminal on the Reserved Channel to 45 feet in 1998 prior to the recently completed Federal channel 40-foot deepening. The Conley Terminal's location and available areas for expansion of capacity make it the focus of the Port's future for container growth. Massport plans to relocate container-related operations from a nearby property onto the adjacent Coastal Oil Terminal property, and eventually to add an additional container berth to the property.

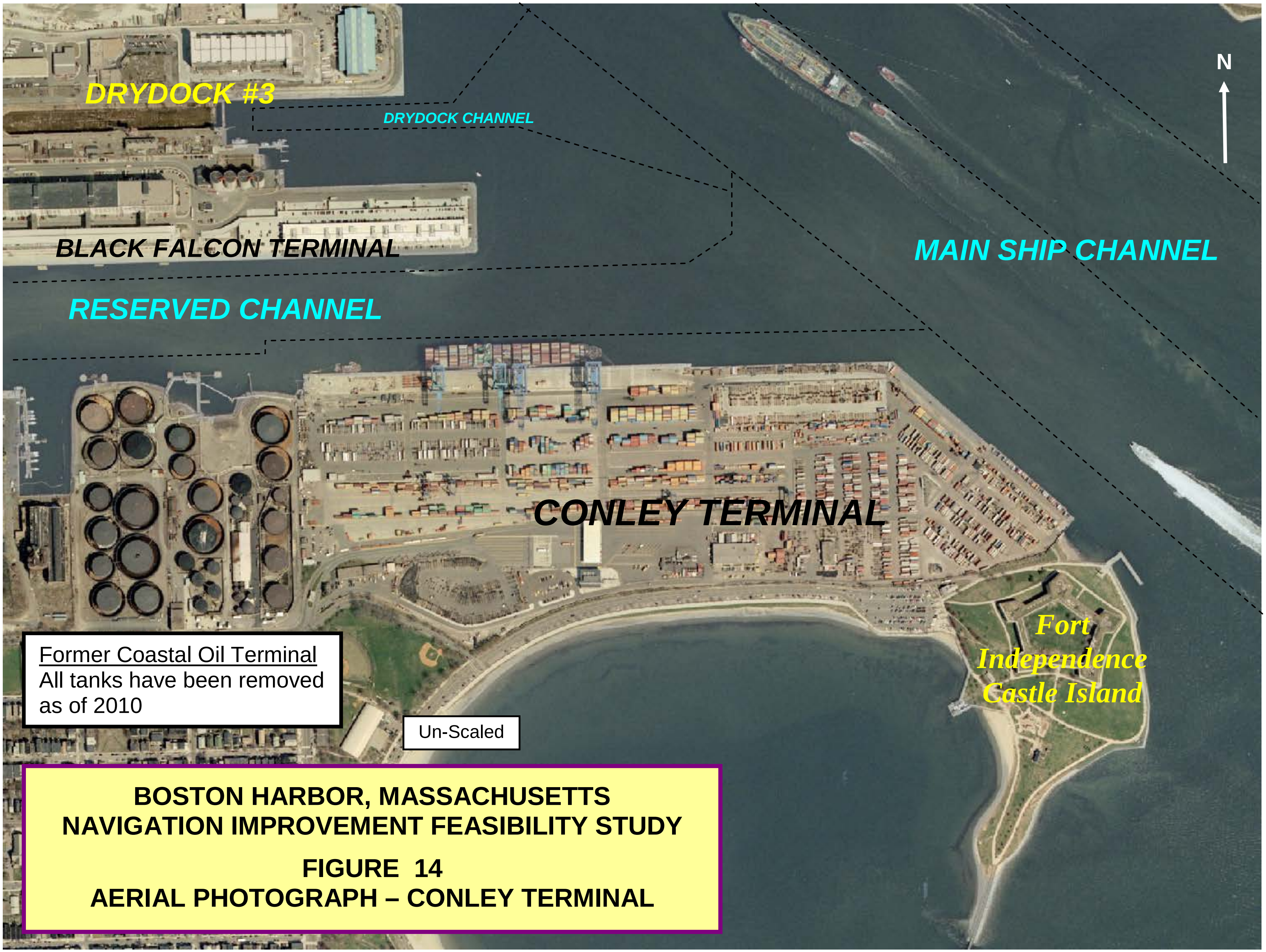
The Port of Boston Competitiveness Task Force Report, dated December 1998, concluded that the channels accessing Conley Terminal must be dredged to at least 45 feet for New England companies to remain competitive by receiving containerized cargo by direct ocean going service. This becomes increasingly important as the next generation of container ships, drawing 45 feet or more, come into service. The terminal has 2,000 LF of 45-foot deep berth and 2,500 LF of 35-foot berth. The deep berths have four post-Panamax gantry cranes with an outboard reach of up to 150 feet. The Conley Terminal is shown in Figure 14.

Containers transiting Boston Harbor in 2006 to 2011 were moved via one of six services:

- MSC's northern Europe – US east coast weekly liner service;
- MSC's Mediterranean- US east coast weekly liner service;
- COSCO's (CHKY Alliance) China – US-east coast weekly liner service;
- CMA-CGM Liberty Bridge Service – Biweekly liner service from Northern Europe – Ceased service in July 2008;
- Columbia Coastal Transport's short sea Port of New York and New Jersey (PONYNJ) to Boston weekly barge service (Abandoned Service in December 2009);
- Eimskip's weekly service from Halifax (Abandoned Service in December 2007).
- A southern Asia via Suez service operated as an alliance by COSCO, Hanjin and other carriers briefly serviced the US East Coast including Boston Harbor in 2011 with a small post-Panamax (6000 TEU) vessel but has been discontinued due to lack of East Coast market demand.

Table 6 presents the total container volumes for Boston Harbor's container-port at Conley Terminal for 2005 through 2007. Containers and containership capacity are measured in TEUs: Twenty-Foot Equivalent Units, as containers come in different sizes. Conley Terminal is owned and operated by Massport, and is currently operating well below its expected 2016 capacity of 550,000 TEUs per year.

MSC (the Mediterranean Shipping Company) is currently operating two liner services with weekly calls at Boston Harbor. Boston Harbor is the first US port of call for MSC vessels arriving from the Mediterranean (Valencia, Spain, Sines, Portugal, LaSpezia and Naples, Italy), followed by New York, Savannah and Charleston. Boston is also the first US port of call for the Northern Europe service (LeHarve, France, Boston, New York, Philadelphia, Baltimore, Norfolk, to Bremerhaven, Antwerp, Rotterdam, Felixstowe and other N. European ports).



BOSTON HARBOR, MASSACHUSETTS
NAVIGATION IMPROVEMENT FEASIBILITY STUDY

FIGURE 14
AERIAL PHOTOGRAPH – CONLEY TERMINAL

TABLE 6 BOSTON HARBOR, MASSACHUSETTS CONLEY TERMINAL TEU VOLUMES					
Service	**Loaded TEUs**			**Empty**	**Grand**
	Imports	**Exports**	**Total**	**TEUs**	**Total**
Conley Terminal – 2005 Total Container TEU Volumes					
MSC Euro	17,311	13,208	30,519	5,559	36,078
MSC Med	12,465	8,942	21,407	4,785	26,192
CHKY Asia	35,391	29,318	64,709	9,600	74,309
Barge/Feeder**	21,408	10,509	31,917	18,214	50,131
Total	86,575	61,977	148,552	38,158	186,710
Conley Terminal – 2006 Total Container TEU Volumes					
MSC Euro	19,574	17,970	37,544	11,149	48,693
MSC Med	13,464	5,962	19,426	918	20,344
CHKY Asia	42,205	32,903	75,108	13,858	88,966
CMA-CGM*	65	21	86	116	202
Barge/Feeder**	17,627	9,176	26,803	15,143	41,946
Total	92,935	66,032	158,967	41,184	200,151
Conley Terminal – 2007 Total Container TEU Volumes					
MSC Euro	18,444	16,931	35,375	4,592	39,976
MSC Med	13,581	7,348	20,929	3,186	24,115
CHKY Asia	56,407	35,511	91,918	24,200	116,118
CMA-CGM*	5,085	2,606	7,691	3,346	11,037
Barge/Feeder**	12,251	6,682	18,933	10,170	29,103
Total	108,768	69,078	174,846	45,494	220,340
Conley Terminal – 2008 Total Container TEU Volumes					
MSC Euro	22,743	13,479	36,222	7,142	43,364
MSC Med	12,360	10,077	22,437	6,197	28,634
CHKY Asia	56,386	32,104	88,490	28,427	116,917
CMA-CGM*	1,364	21794	2,158	624	2,782
Barge/Feeder**	9,023	4,501	13,524	3,405	16,929
Total	101,876	60,955	162,831	45,795	208,626

TABLE 6 (Continued) BOSTON HARBOR, MASSACHUSETTS CONLEY TERMINAL TEU VOLUMES					
Service	**Loaded TEUs**			**Empty**	**Grand**
	Imports	**Exports**	**Total**	**TEUs**	**Total**
Conley Terminal – 2009 Total Container TEU Volumes					
MSC Euro	19,664	11,817	31,481	3,253	34,734
MSC Med	11,548	13,305	24,853	3,813	28,666
CHKY Asia	50,720	37,458	88,178	16,241	104,419
CMA-CGM*	782	2,971	3,753	1,818	5,571
Barge/Feeder**	6,147	2,993	9,140	4,915	14,055
Total	88,861	68,544	157,405	30,040	187,445
Conley Terminal – 2010 Total Container TEU Volumes					
MSC Euro	18,878	16,255	35,133	3,518	28,651
MSC Med	12,848	4,899	17,747	6,399	24,146
CHKY Asia	50,145	31,113	81,258	16,402	97,660
CMA-CGM*	101	76	177	70	247
Barge/Feeder**	2,905	950	3,855	3,726	7,581
Total	84,877	53,293	138,170	30,115	168,285
Conley Terminal – 2011 Total Container TEU Volumes					
MSC Euro	20,987	18,228	39,215	3,993	43,208
MSC Med	13,347	8,840	21,827	4,403	26,230
CHKY Asia	35,937	24,004	59,941	14,493	74,434
Hanjin Suez	26,124	11,880	38,004	10,444	48,448
Barge/Feeder**	210	173	383	0	383
Total	96,605	62,765	159,370	33,333	192,703

Source: Massport

* CMA-CGM ceased service to Boston in July 2008

** Includes weekly service from the PONYNJ. Weekly feeder from Halifax, Nova Scotia (Eimskip) ceased operation in 2007.

*** South Asia via Suez Service called on Boston with Post-Panamax vessels in May thru Nov 2011

COSCO (Cosco Container Lines Ltd.) currently operates a weekly liner service (AWE-2) from China to the US east coast from Qingdao, Shanghai, Ningbo and Yokohama via Lazaro Cardenas, Mexico, the Panama Canal, and Cristobal, which calls at Boston Harbor as the last US east coast port-of-call prior to returning to China. This service started in March 2002 and was operated by the CHKY Alliance (COSCO, Hanjin, K-Line, and Yang Ming). From 2002 through 2004, the AWE-2 service fleet included six COSCO ships, one K-Line vessel (Delaware Bridge), and one Yang Ming vessel (YM South). In January 2005, the service shifted to an all COSCO fleet. Additionally in January 2005, Norfolk was dropped from the port rotation and a bi-weekly call at Cristobal, Panama was added.

CMA-CGM began operating the Liberty Bridge Service biweekly to Boston from Northern Europe beginning in late 2006. Vessels used on this service averaged 2,680 TEUs. Rotation for this service consisted of Le Harve-Antwerp-Rotterdam-Bremerhaven-Liverpool-Boston-New York-Baltimore-Norfolk. CMA-CGM ceased service to Boston in July 2008.

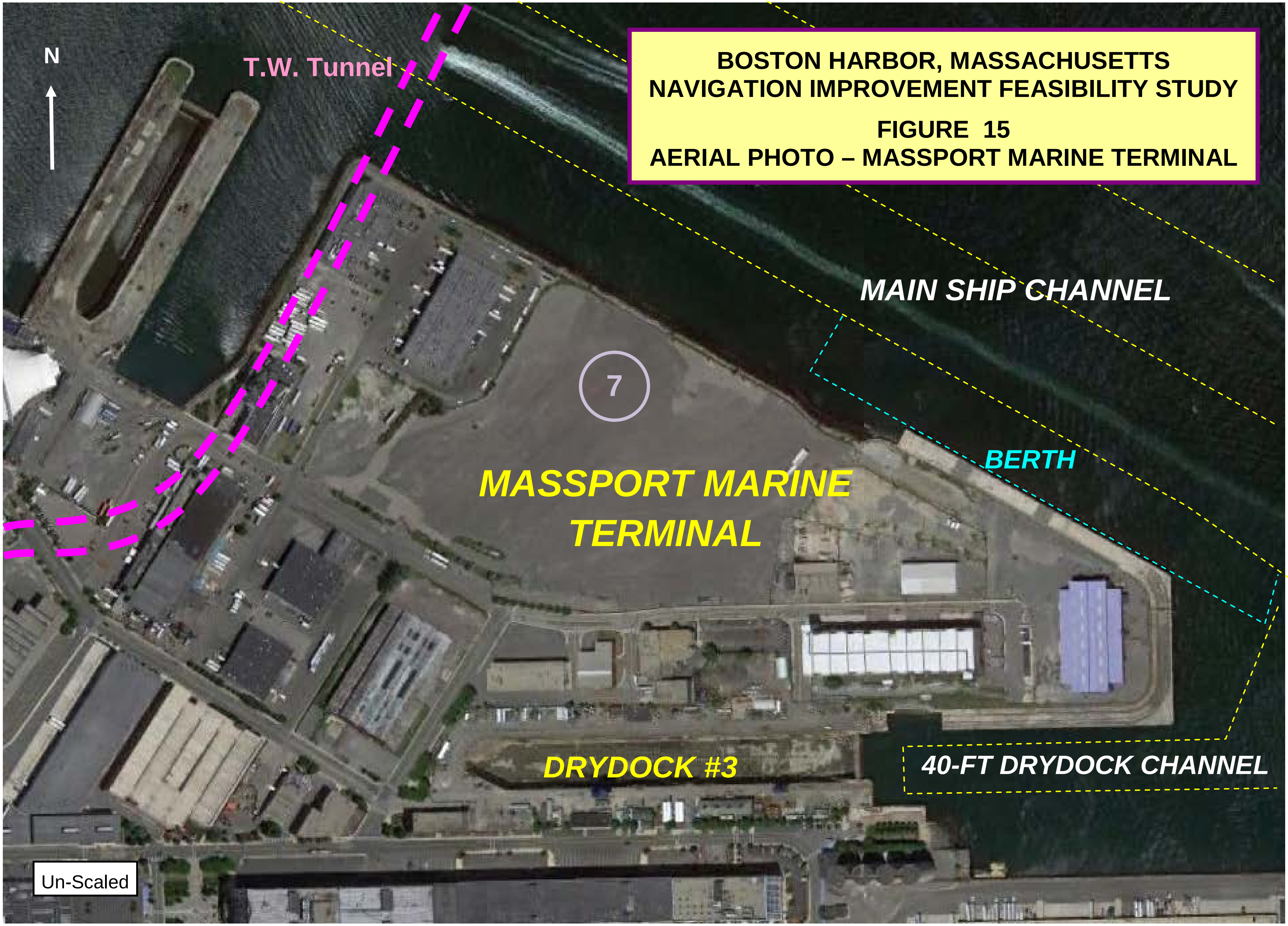
Between May and November 2011 Hanjin, in alliance with COSCO and others, operated a weekly service from southern Asia via the Suez Canal to the US East Coast, with Boston as its first port of call. That service included the ports of Boston, New York, Norfolk, Kaohsiung, Hong Kong, Yantian, Vuna Tao, and Singapore in its rotation.

Lower Main Ship Channel – Massport Marine Terminal: Between the Reserved Channel and the TWT, a portion of the South Boston shore along the MSC known as the Massport Marine Terminal is being developed by Massport and its partners to handle bulk cargo and intermodal cargo warehousing. This property had been used for the I-90/I-93 highway/tunnel project (the Big Dig) for more than a decade as a construction staging area and for excavated material storage and transfer. The property has reverted to Massport control and a developer for the site has been selected to redevelop the site for port uses – see the map in Figure 4B and the photo in Figure 15.

About 10 acres of the Massport Marine Terminal, one-quarter of its area, has been leased and redeveloped for operation of seafood processing plants. The berth at lower end of the property, known as the North Jetty, totals about 1000 LF and is located along the 40-foot lane of the MSC above the Drydock Approach Channel. Massport dredged the berth along the bulkhead to 40 feet during the 1998-2001 improvement project.

Massport has leased about 500,000 square feet of the site to Cargo Ventures, LLC which has plans to develop maritime industrial warehouse facilities in support of bulk cargo operations at the North Jetty berth. Permits have been issued for the first building and construction is expected to begin shortly. The schedule for additional development phases is not definite and depends on channel deepening to attract additional customers. Massport indicates that a 45-foot channel and berth would enable more efficient operations in the long term. Should the 45-foot Main Ship Channel deepening extension be recommended, then commensurate deepening of the berth to 45 feet would be included in the improvement plan.

As previously stated, no improvements or channel deepening is needed or considered for terminals located along the Main Ship Channel above the TWT.


BOSTON HARBOR, MASSACHUSETTS
NAVIGATION IMPROVEMENT FEASIBILITY STUDY
FIGURE 15
AERIAL PHOTO – MASSPORT MARINE TERMINAL
N
T.W. Tunnel
MAIN SHIP CHANNEL
7
BERTH
MASSPORT MARINE TERMINAL
DRYDOCK #3
40-FT DRYDOCK CHANNEL
Un-Scaled

Lower Mystic River Channel – See the map in Figure 4C and photo in Figure 16: The 40-foot deepening project authorized in 1990 for the lower Mystic River Channel improved access to Massport's Boston Autoport, the US Gypsum Terminal, Exxon, Holcim (St. Lawrence) Cement, Suez/Distrigas (LNG), Prolerized (Scrap Exports) and Boston Generating's Mystic Station (power plant). This work was completed in 2000, and was the first part of the 1990-authorized project to be completed.

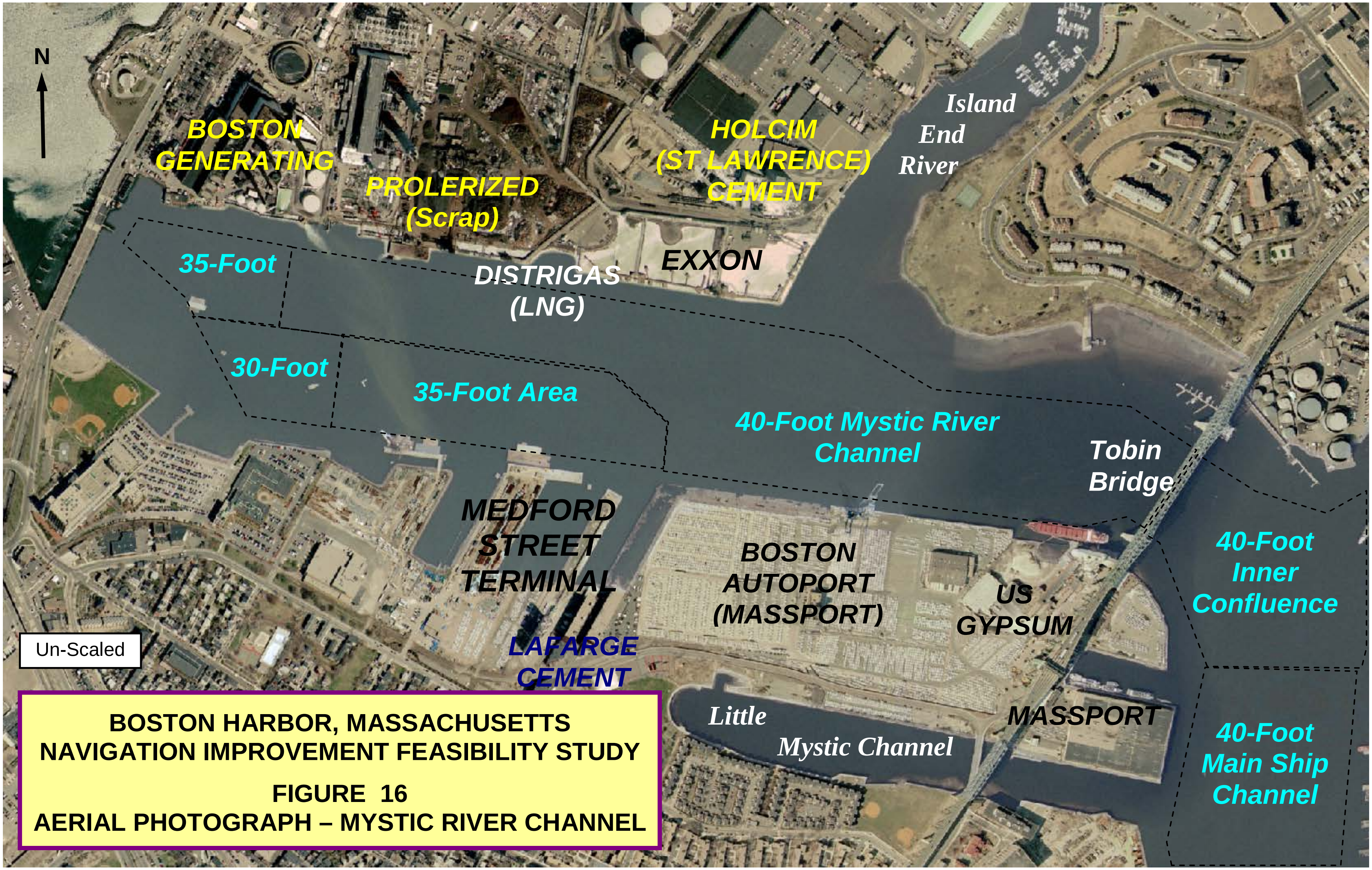
Massport redeveloped the former Moran container terminal as an auto receiving facility in the 1990s. The 65-acre Boston Autoport terminal is accessed by the 40-foot Mystic River Channel. The terminal has on-dock rail and has the capacity to import and process up to 100,000 cars a year. The existing 40-foot channel accessing this terminal is sufficient for its existing and projected use.

Immediately upstream of the Moran Terminal is the former Revere Sugar Terminal, now Massport's Medford Street Terminal. Massport purchased this 14-acre property in 1986 to preserve it for future maritime use and has redeveloped the facility for bulk cargo operations. Massport deepened the berths at this terminal to 40 feet as part of the 2000 project, but the adjacent channel area accessing the site remained at 35 feet, as terminal benefits were deemed speculative for inclusion in the 40-foot 1990 Federal project justification. Massport has requested that this proposal be revisited as part of this feasibility study.

Massport has improved the site and access and had negotiated a lease with LaFarge Cement for use of this public facility as a bulk operation of lesser scale than that planned for the MMT. LaFarge already operates a cement terminal on the adjacent property on the Mystic River but only receives shipment by barge due to that facilities dock and berth limitations. LaFarge planned to make improvements to Massport's dock and construct new terminal facilities including storage domes or silos. With the existing 40-foot berth LaFarge would have received cement by ship instead of barge. With deepening of the channel access to 40 feet those ships would be deeper loaded and have reduced tidal delay. Massport requested that its proposal for deeper channel access to this terminal be revisited as part of this feasibility study. However, during internal review of this draft report Massport was notified that LaFarge had changed its plans and would expand their operations elsewhere. Massport is now exploring other bulk opportunities for the site including cement, auto import/export, wind mill assembly and import/export, and passenger vessel operations. The most likely use of this terminal is for dry and break-bulk, and its future will be evaluated as such.

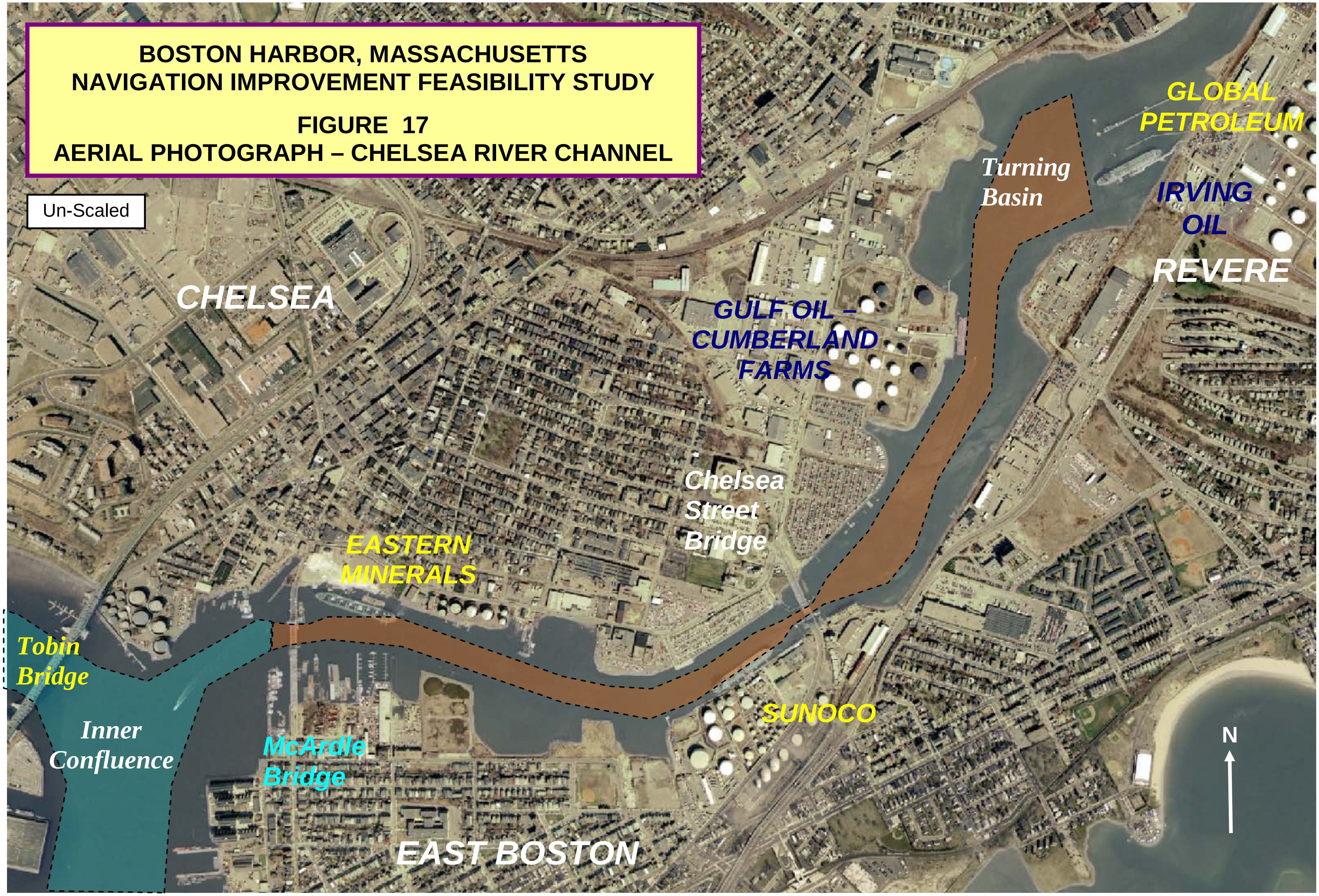
Deepening of the Mystic River beyond 40 feet, as with all inner harbor areas, is constrained by the clearances over the harbor tunnels located to seaward.

Chelsea River Channel – See the map in Figure 4D and photo in Figure 17: The Chelsea River is obstructed by two highway bridges; the Andrew P. McArdle Bridge at its mouth, and the Chelsea Street Bridge at its mid-point. All deep-draft terminals on the Chelsea River are private petroleum terminals with the exception of the SMP Terminal (formerly Eastern Minerals), which receives salt. The SMP, Conoco-Phillips Petroleum terminal, and the inactive Coastal Oil and Northeast Petroleum terminals are located between the bridges. The Gulf Oil, Irving Oil and Global Petroleum terminals are located above the Chelsea Street Bridge around the turning basin at the head of navigation.



BOSTON HARBOR, MASSACHUSETTS
NAVIGATION IMPROVEMENT FEASIBILITY STUDY

FIGURE 16
AERIAL PHOTOGRAPH – MYSTIC RIVER CHANNEL



BOSTON HARBOR, MASSACHUSETTS
NAVIGATION IMPROVEMENT FEASIBILITY STUDY

FIGURE 17
AERIAL PHOTOGRAPH – CHELSEA RIVER CHANNEL

KeySpan has replaced their natural gas siphon located just downstream of the Chelsea Street Bridge by a deep directional bore in 2008. As part of the 2008-2009 inner harbor maintenance dredging project, Massport (with funds provided by Keyspan) paid the Corps to remove the sections of the old gas siphon to enable dredging of the material around that area to complete the 1990-authorized 38-foot deepening of the Federal channel. In 2012 following replacement of the Chelsea Street Bridge and removal of the old bridge span, the Corps widened the Chelsea River Federal Channel limits through the new bridge opening to a minimum of 175 feet, and removed additional sections of the abandoned gas siphon.

Utilities

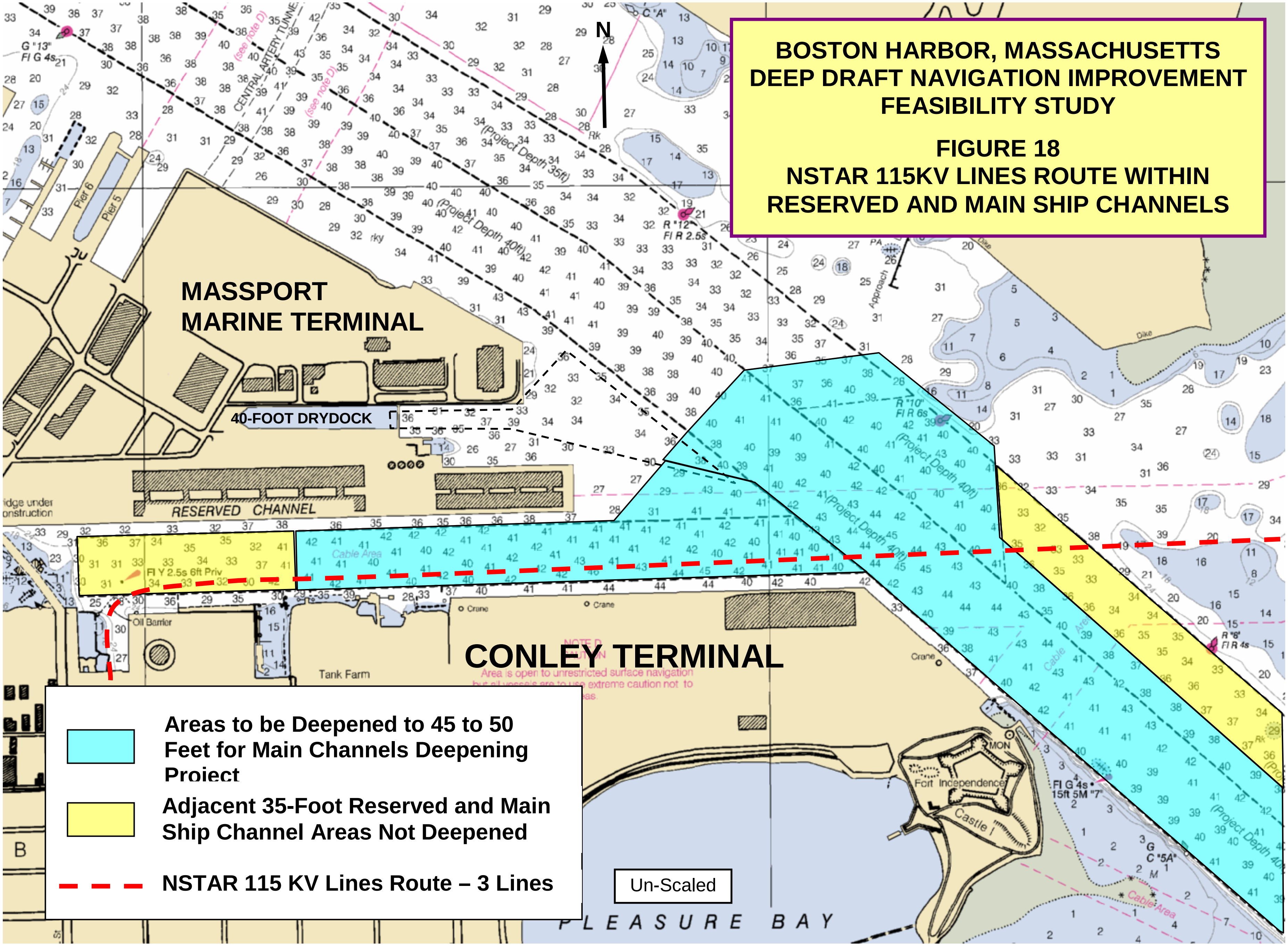
There are a number of utilities crossing the harbor, particularly in its upper reaches. Within the areas proposed for deepening under this improvement project utilities are located beneath the Reserved Channel and the Chelsea River.

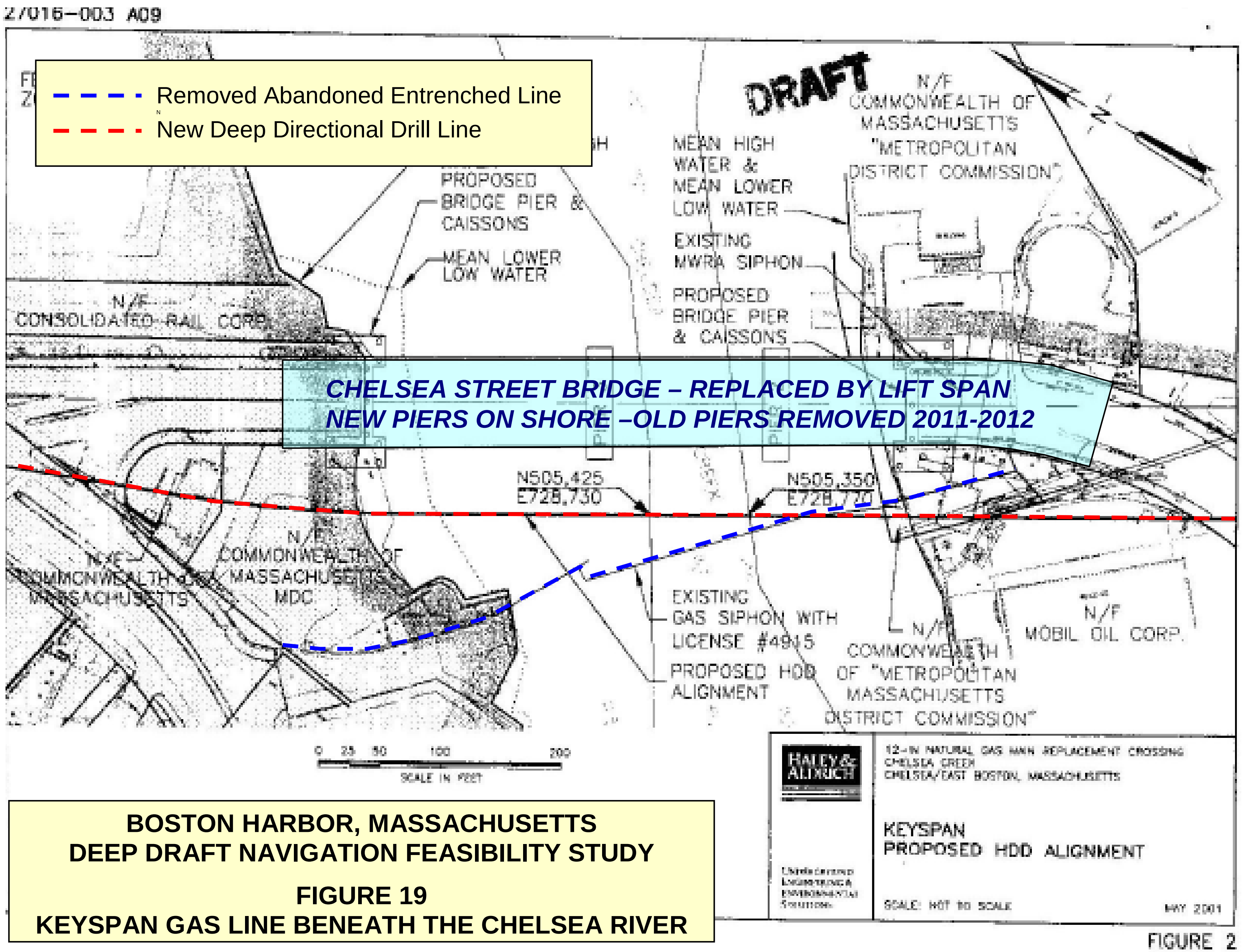
The MWRA's main power supply line to its Deer Island Treatment Plant runs from the South Boston generating plant on the Reserved Channel, beneath the Reserved Channel and Main Ship Channel, and across the flats southeast of Logan Airport, to Deer Island. These 115KV hydraulically cooled power lines were placed in a trench dredged beneath the channels and jetted into the harbor bottom in areas outside the channels. The U.S. Army Corps of Engineers issued a Section 10 permit for the cable in 1989, and the permitted depth of the line was designed to accommodate future port deepening of the Main Ship and Reserved Channels. However, the cable was placed shallower than the minimum depths specified in the Corps permit in several locations beneath the Reserved Channel. The Corps has referred the matter to U.S. Attorney's office as an enforcement action. The U.S. Attorney's office is currently in negotiations with MWRA and NSTAR to ensure that the cable will not impact the deepening project. The location of the NSTAR – Deer Island cable is shown in Figure 18.

As mentioned previously, a natural gas siphon owned by KeySpan crosses beneath the Chelsea River immediately downstream of the Chelsea Street Bridge. This line is a deep directional drill with a minimum elevation of -80 feet MLLW beneath the channel. Portions of the former shallow gas line were removed from the channel and slopes during the 1998-2001 38-foot improvement dredging and the 2012 channel widening projects. This would be sufficient to allow further deepening of the Chelsea River Channel beyond 38 feet. The location of the KeySpan gas line is shown in Figure 19.

Security and Safety Zones

Port security and maritime safety are the primary responsibility of the US Coast Guard's Captain of the Port. Additionally Massport, the Harbor Patrol Unit of the Boston Police Department, the Massachusetts State Police Maritime Unit, and the Massachusetts Environmental Police patrol the harbor and its waterfront.


BOSTON HARBOR, MASSACHUSETTS
DEEP DRAFT NAVIGATION IMPROVEMENT
FEASIBILITY STUDY
FIGURE 18
NSTAR 115KV LINES ROUTE WITHIN
RESERVED AND MAIN SHIP CHANNELS
N
MASSPORT
MARINE TERMINAL
40-FOOT DRYDOCK
RESERVED CHANNEL
CONLEY TERMINAL
Tank Farm
Oil Barrier
Fort Independence
Castle I
PLEASURE BAY
(Project Depth 35ft)
(Project Depth 40ft)
CENTRAL ARTERY TUNNEL
Un-Scaled
Areas to be Deepened to 45 to 50 Feet for Main Channels Deepening Project
Adjacent 35-Foot Reserved and Main Ship Channel Areas Not Deepened
NSTAR 115 KV Lines Route – 3 Lines



BOSTON HARBOR, MASSACHUSETTS
DEEP DRAFT NAVIGATION FEASIBILITY STUDY

FIGURE 19
KEYSPAN GAS LINE BENEATH THE CHELSEA RIVER

The U.S. Coast Guard operates a Security Broadcast System for Boston Harbor to supplement vessel bridge-to-bridge communications and provide advanced notice of vessel movements in the harbor and its approaches. Security notification is required of large vessels inbound and outbound at the Precautionary Area buoy, at the entrance to the Broad Sound North Channel, at the entrance to President Roads, at the vicinity of Commonwealth Pier and at the Inner Confluence, and when reaching or departing the berth.

In addition, all vessels in excess of 300 tons are required to report to the U.S. Coast Guard, Marine Safety Office Boston, when entering the Mandatory Ship Reporting System – Northeastern Area encompassing Massachusetts and Cape Cod bays and offshore areas (33 CFR §169.100 to 140). While this system was developed to reduce the potential for ship strikes on whales, it provides additional information to the Port Captain on vessel movements in the approaches to Boston Harbor.

33 CFR §160.201 to 215 sets forth the requirements for Notifications of Arrival for vessels transporting hazardous cargo or providing notice of a hazardous condition aboard or caused by the vessel.

Safety and Security Zones for Boston Harbor are established and regulated by the U.S. Coast Guard under 33 CFR §165.114 to 120, covering zones around escorted vessels (§§114), zones around the Black Falcon Terminal and Coast Guard base (§§116) and at the Chelsea Street Bridge (§§120). For escorted vessels, including LNG tank ships in transit, a security zone extends 1000 yards ahead and astern and 100 yards abeam when the vessel is inshore of Deer Island Light. This zone prohibits unauthorized vessel movements and effectively shuts the port to other traffic during LNG vessel passage. Other "escorted vessels" can come under this regulation at the discretion of the Captain of the Port.

In the Reserved Channel, a safety and security zone is established extending 150 yards off the bow and stern and 100 yards abeam of any vessel moored at the Black Falcon Terminal. This restriction is primarily to protect cruise ships transferring passengers in port.

In the Chelsea River, a safety and security zone is established extending 100 yards upstream and downstream of the Chelsea Street Bridge (33 CFR 165.120). This zone restricts the size, draft, speed, use of tugs, and hours of operation of tank ships passing the bridge, with restrictions varying according to vessel length and beam. This zone also requires all tank ships greater than 1000 tons to be under the direction of a licensed Federal pilot. This zone places additional restrictions limiting the size of transiting vessels when other vessels are moored at terminals immediately adjacent to the bridge, and limits all transits of vessels greater than 630 feet to daylight hours. The specifics of this zone would be reviewed should the Chelsea Street Bridge be replaced and removed, and the channel widened through the new opening, as completed in 2012. On January 31, 2013, the USCG published a notice of intent to review the Chelsea River security zone to determine whether changes should be made given the replacement of the Chelsea Street Bridge, removal of debris and obstructions, and the widening of the channel through that passage (Federal Register Volume 78, #21, pages 6782-83).

Recreational Uses of the Harbor

Boston Harbor supports a large recreational fleet based at the many marinas along the downtown waterfront and in neighboring municipalities. No recreational facilities are located on the industrial waterways of the Reserved Channel, lower Main Ship Channel, or the Mystic River. A small marina is located on the Chelsea River near its mouth well removed from the deep draft channel. The limited number of existing and projected deep-draft vessels transiting the harbor is of minimal concern to recreational traffic. No recreational facilities would be included in the proposed project and the Sponsor has no interest in recreational use.

Existing Commerce

Over the period of 2001 to 2010, the Port of Boston handled an average of about 22,000,000 tons of cargo annually, or which about 16,500,000 was petroleum products. Waterborne Commerce Statistics (WCS) report aggregate numbers for the port, and breakdowns for selected major tributaries and the main waterfront, however which tributaries are separately reported has not always been consistent. Ton-miles and trips are reported for some of these selected tributaries, but not for the harbor as a whole.

The most recent year for which WCS data are available, 2010, shows a typically diverse mix of cargo types for a large port. Table 7 shows the 2010 WCS data detail on tonnage inbound and outbound for both foreign, Canadian and domestic US sources and internal intra-port movements within the Port of Boston. Table 8 shows summary data for the Port by commodity classification for 1998 to 2010. The decline of about 3 million tons between 2004 and 2005 and beyond is due almost entirely to a reduction in LNG receipts at the Distrigas terminal. Petroleum receipts, including LNG, vary according to the severity of the New England winter. The detailed data on major the tributaries reflects the location of the harbor's many terminals, including the location of most of the liquid bulk petroleum terminals on the Chelsea River (Table 9), and the terminals on the Mystic River (Table 10). Mystic River terminals include Distrigas (LNG), Exxon-Mobil, Boston Autoport, US Gypsum, LaFarge Cement, and Saint Lawrence Cement terminals. The two Mystic River cement terminals represent more than half the port's cement terminal capacity.

The Boston Harbor Pilots keep detailed records of vessel transits for which pilotage is required, generally vessels drawing 35 feet or more during passage inbound or outbound. The pilots data for the 12-month period of 1 July 2005 to 30 June 2006 is shown in Table 11.

The 2005 Waterborne Commerce Statistics harbor transit tables for Boston Harbor are provided in the Engineering Appendix I. That data shows that Boston Harbor had 794 transits of vessels with drafts of 30 feet or more in 2005. Of these, 310 transits were to/from the Reserved Channel, about 6 weekly, leaving about 9 weekly transits for terminals above the Reserved Channel. This traffic volume does not require two-way traffic for deep draft vessels. However the port also saw about 40,000 transits of vessels less than 30 feet in draft, making passing situations involving large craft and small craft a certainty for each large ship transit. The only exception would be for LNG vessel transits, for which the USCG prohibits all other traffic within a certain distance fore and aft of the transiting cryo-tank ships.

TABLE 7
PORT OF BOSTON - 2010 WATERBORNE COMMERCE STATISTICS – COMMODITY CLASS DETAIL

Commodity	2010 Total	Foreign		Canadian		Domestic		Intraport
		Inbound	Outbound	Inbound	Outbound	Inbound	Outbound	
Total All Commodities	19,091	6,312	1,231	5,410	0	5,847	152	135
Gasoline	5,575	890		3,833		822		30
Kerosene	634			12		616	6	
Fuel Oils	4,796	121		1471		3,026	73	105
Other Liquid Petroleum	218	25		67		125		1
LNG	3,644	3,644						
Chemicals	984	78	40			862		4
Forest Products & Waste Paper	185	9	176					
Gypsum & Stone	11	11						
Scrap Metal	734	1	719				14	
Clay	1	1						
Minerals (Salt)	782	781	1					
Paper Products	63	23	40					
Cement	369			25		344		
Glass & Mineral Products	54	50	4					
Iron & Steel Products	7	5	2					
Non-Ferris Metal Products	136	46	90					
Wood Products	3	3						
Fish & Shellfish	122	108	14					
Grain, Seeds, Vegetables	104	101	3					
Alcoholic Beverages	116	115	1					
Other Agricultural Products	79	34	45					
Vehicles	97	49	48					
Other Machinery & Equipment	352	201	41			52	58	
Unknown or Unclassified	23	15	8					

TABLE 8
PORT OF BOSTON - 1998 TO 2010 WATERBORNE COMMERCE STATISTICS SUMMARY

Commodities (x1000)	1998	1999	2000	2001	2002	2003	2004	2005	2006	2007	2008	2009	2010
Total All Commodities	21,222	22,171	20,751	20,581	20,354	24,832	25,797	22,378	21,853	22,370	21,035	20456	19,091
Coal	0	100	0	0	46	0	67	0	0	0	0	0	0
Gasoline	6,217	6,752	6,562	6,220	6,452	7,199	7,827	7,618	6,178	5,520	5,000	5,846	5,575
Kerosene	475	467	1,169	1,151	823	1,090	747	948	1,125	1,188	1,112	700	634
Fuel Oils	8,411	7,111	4,343	4,916	3,044	4,916	4,847	4,601	5,633	6,205	5,741	4,790	4,801
Other Liquid Petroleum	206	259	2,334	1,180	1,384	1,681	420	559	299	423	296	203	219
LNG	1,196	2,790	1,988	1,398	3,102	3,876	6,109	3,268	3,783	3,898	3,634	3,825	3,644
Chemicals & Fertilizer	235	249	148	160	230	151	236	225	711	951	843	877	980
Forest Products & Waste Paper	83	100	91	62	148	190	246	287	311	311	217	299	185
Gypsum, Stone, S&G	389	239	383	356	476	626	243	231	188	189	57	11	11
Scrap Metal	547	410	417	570	351	425	369	388	699	617	713	941	734
Clay & Shell	2	3	0	0	17	0	35	170	0	1	1	1	1
Minerals (Salt)	387	552	634	916	565	1,085	844	1,531	595	797	1293	1,260	782
Paper Products	51	68	45	25	26	23	31	40	35	42	41	90	63
Cement	833	1,038	1,158	1,115	987	846	899	985	850	731	601	503	369
Glass & Mineral Products	60	73	55	106	115	60	164	67	58	65	64	46	53
Iron & Steel Products	32	9	19	33	46	22	43	64	11	21	126	10	8
Non-Ferris Metal Products	28	34	198	83	96	119	342	284	242	320	237	90	137
Wood Products	2	4	2	5	2	1	25	4	4	5	6	3	3
Fish & Shellfish	65	64	52	45	88	114	142	154	144	121	110	121	122
Grain, Seeds, Vegetables	91	130	37	62	102	36	37	74	65	104	88	79	103
Alcoholic Beverages	271	301	140	159	167	153	155	86	101	129	124	132	117
Other Food Products	83	114	58	33	77	72	88	105	114	117	94	98	78
Vehicles	110	140	146	163	135	30	36	39	44	51	81	66	96
Other Machinery & Equipment	647	490	130	621	538	392	486	482	626	534	450	430	353
Waste and Scrap	798	668	625	1,181	1,150	1,352	1,327	146	0	0	0	0	0
Unknown or Unclassified	3	8	16	22	183	373	30	27	38	32	106	24	23

TABLE 9
CHELSEA RIVER - 1998 TO 2010 WATERBORNE COMMERCE STATISTICS SUMMARY

Commodities (x1000)	1998	1999	2000	2001	2002	2003	2004	2005	2006	2007	2008	2009	2010
Ton-Miles (x1000)	20,120	19,837	18,784	18,597	15,835	19,051	16,730	13,591	13,410	16,049	14,422	15,004	14,985
Total All Commodities	7,559	7,397	6,869	6,586	5,652	6,768	5,943	6,241	5,890	6,753	6,377	6,863	6,668
Gasoline	3,223	3,630	3,237	2,287	2,783	2,756	2,842	2,867	2,934	3,102	2,634	3,736	3,581
Kerosene	117	173	463	271	214	269	69	62	68	114	56	3	18
Fuel Oils	3,570	2,961	1,952	2,362	1,558	2,419	2,166	1,996	1,933	2,542	2,170	1,722	1,998
Other Liquid Petroleum	169	303	502	653	441	334	34	69	15	75	37	7	10
LNG	153	0	0	92	0	0	0	0	0	0			
Chemicals	67	78	24	25	16	15	21	54	302	386	420	368	521
Forest Products & Waste Paper	1	0	0		2								
Gypsum & Stone			30		0		5						
Minerals (Salt)	258	215	632	817	456	959	624	1,164	492	526	1,024	1,004	539
Paper Products		2	0		2								
Cement		28	23	14									
Glass & Mineral Products				58	60		101						
Iron & Steel Products			4	3	0		9	7					
Non-Ferris Metal Products							35				1		
Wood Products							23			6			
Other Food Products	1	5	0		15			7			1		
Other Machinery & Equipment		1	1	2	66		14	13	147		1	22	0
Unknown or Unclassified		0	0		39	17					33		

TABLE 10
MYSTIC RIVER - 1998 TO 2010 WATERBORNE COMMERCE STATISTICS SUMMARY

Commodities (x1000)	1998	1999	2000	2001	2002	2003	2004	2005	2006	2007	2008	2009	2010
Ton-Miles (x1000)	3,856	6,043	6,423	7,093	8,404	9,441	12,471	8,947	9,160	9,244	8,672	8,401	7,580
Total All Commodities	3,856	6,043	6,391	7,082	8,400	9,404	12,267	8,883	9,160	9,244	8,672	8,401	7,574
Coal							27						
Gasoline	285	366	244	1,654	1,693	1,739	2,796	2,273	2,437	2,092	2,023	2,005	1,693
Kerosene	5	1	34	51	19	44	19	24		12	4		
Fuel Oils	776	538	507	554	531	679	927	847	624	587	734	599	625
Other Liquid Petroleum	2	0	0	327	766	1,240	222	277	262	346	249	193	190
LNG	691	2,186	1,988	1,246	3,102	3,634	6,060	3,268	3,719	3,898	3,549	3,618	3,350
Chemicals	0			6	67	7	35		137	228	129	219	217
Waste Paper & Lumber	6				29								
Gypsum	97	186	201	155	175	213	222	213	168	175	45		
Scrap Metal	452	288	416	558	349	398	366	353	639	605	705	934	722
Minerals (Salt)	0			98	108	64	219	317	94	268	266	254	240
Cement	734	729	755	726	594	501	554	532	410	420	308	276	243
Iron & Steel Products	8			6	33	8	17	41		5	115		
Non-Ferris Metal Products	0		162	16	69	83	245	169	153	208	133	12	76
Paper & Wood Products	1			2									
Fish & Shellfish	18												
Agricultural Products	3			0	4		9						
Vehicles	46	87	132	152	119	16	18	17	19	14	40	37	64
Other Machinery & Equipm	482	288	1	531	357	254	286	258	261	254	176	141	112
Unknown or Unclassified	0			1	114	260		3	12	1	37		
Thru Traffic	250	1,373	1,952	999	271	263	243	290	226	129	159	113	41

TABLE 11 BOSTON HARBOR, MASSACHUSETTS BOSTON HARBOR PILOTS VESSEL TRANSIT DATA 1 JULY 2005 TO 30 JUNE 2006						
Type	**Number of Transits**	**Percent of Total**	**Average Draft**	**Average LOA**	**Average Beam**	**Average DWT**
Containerships	280	43.1%	37.5	826	106	42,038
Bulk Carriers	48	7.4%	36.4	624	100	26,599
LNG Cryotankers	82	12.6%	35.5	927	139	91,548
Tank Ships	239	36.8%	35.2	600	93	24,518
TOTAL	649	100.0%				
Note: Bulk carriers are generally loaded inbound with salt and cement or outbound with scrap metal and waste paper						

Economic Profile

The geographic scope of the socio-economic profile of the Port extends to all of New England and includes the domestic economic hinterlands of the Port. The economic condition in these hinterlands impacts the future of cargo moving through the Port of Boston. Detailed information is provided in the draft economic analysis of container benefits (see Appendix C).

In addition to the analysis of the Boston Harbor hinterland PIERS data, an analysis of the PONYNJ hinterland conducted for the 2004 economic re-evaluation of the New York-New Jersey Harbor deepening project was also used to gain additional understanding of trade origins, destinations, and port selection.

Boston Harbor's hinterland is primarily comprised of the New England states (CT, MA, ME, NH, VT, and RI). Table 12, based on 2011 PIERS data provided by Massport, displays the regional distribution of US origins and destinations for all containerized cargo that transits Boston Harbor. Because PIERS data represents a sample of TEUs (the data was not corrected for missing data, incomplete entries, or misleading entries), raw PIERS data is best presented in percentage terms, which identifies relative volumes of TEUs. Table 12 indicates that the US east coast is the dominant origin and destination for TEUs transiting Boston Harbor. Table 13 presents the individual states that, as a group, are the origin or destination for more than 90% of the TEUs moving through Boston Harbor.

TABLE 12 BOSTON HARBOR, MASSACHUSETTS	
Boston Harbor TEU Distribution by Region of Origin or Destination (2011)	
Region	**Percentage**
US East Coast	74%
US West Coast	19%
US Central	4%
US Gulf States	2%
Canada	1%
Other/Unidentified	1%
Total	100%
Source: 2011 PIERS data provided by Massport	

TABLE 13 BOSTON HARBOR, MASSACHUSETTS			
Boston Harbor TEU Distribution by State (2011)			
State	**Percentage**	**State**	**Percentage**
Massachusetts	38.3%	California	17.1%
North Carolina	2.3%	New York	6.3%
Rhode Island	3.8%	New Jersey	7.9%
New Hampshire	5.9%	Florida	1.4%
Maine	3.1%	Missouri	1.4%
		Others	12.5%
New England	89.6%	Total All	100%
Source: 2011 PIERS data provided by Massport			

The two tables presented above somewhat understate the proportion of Boston Harbor's TEUs destined for or originating in New England. This understatement is due to the nature of the PIERS data, which identifies the location (state) of the controlling interest, and not the ultimate final destination. Two major examples explain the apparently high proportions of TEUs for New York and California. In the case of New York, Heineken Breweries, which has its US offices in White Plains, NY, accounts for most of the imports identified as destined for New York. These goods, however, are mostly distributed throughout New England and are attributed to New York by the PIERS data because of the location of the company office listed on the manifest. Similarly, Chinese seafood products imported by a California based company, which are distributed locally from Boston Harbor, appear in the data as having a California destination. Similar examples are found in the New Jersey and Washington import data. If these factors are taken into account, the hinterland of the Port of Boston consists primarily of the six New England states.

Table 14, also developed from the 2003 to 2011 PIERS data, shows the distribution of imported containerized cargo among the US ports that compete for Boston Harbor's New England hinterland. Boston Harbor shares this hinterland with the Port of New York and New Jersey, which is the dominant port for trade with the New England states. West coast ports, especially Los Angeles and Long Beach, also service a large proportion of TEUs to New England via the land-bridge (double stack rail from the west coast). Boston Harbor is the 4th major port landing TEUs bound for the New England region, after PONYNJ, Los Angeles, and Long Beach.

TABLE 14
BOSTON HARBOR, MASSACHUSETTS

Imports to New England States by Port of Entry (2003 to 2011)

Port	2003	2004	2005	2006	2007	2008	2009	2010	2011
PONYNJ	42%	34%	35%	39%	40%	43%	42%	41%	34%
LA/LB	30%	28%	27%	28%	26%	20%	19%	20%	10%
Boston	7%	17%	15%	10%	12%	14%	15%	12%	10%
Others	21%	21%	23%	23%	22%	23%	24%	27%	45%
Total	100%	100%	100%	100%	100%	100%	100%	100%	100%

Source: 2003-2011 PIERS data provided by Massport

Table 14 shows that, between 2003 and 2011, Boston Harbor has gained proportionally as a port of entry for New England imports while PONYNJ and LA/LB have declined. This increase has been facilitated by two liner services adding Boston Harbor to their schedules in mid-2003. The proportional increase in Boston Harbor imports is indicative of New England shippers taking advantage of the lower cost of shipping through Boston Harbor. However, further increases are constrained by existing channel conditions, as will be discussed in following sections of this report. The peak in Boston Harbor's proportion of New England TEUs shown in 2004 – 2005 and 2009 occurred as the new services attracted cargo away from PONYNJ. By 2006 and again in 2011, these services were operating near their TEU capacity, which explains the drop in Boston's share of New England cargo to 10%.

Because the PONYNJ is the major port servicing Boston Harbor's hinterland, a detailed analysis of PIERS data for the PONYNJ was referenced for additional insight. The analysis of PIERS data for the PONYNJ was conducted in 2003 and 2004 for the USACE New York District as a part of the economic re-evaluation of the New York-New Jersey Harbor deepening project. The PONYNJ hinterland analysis conducted for the re-evaluation augmented PONYNJ raw PIERS data with phone interviews that increased the accuracy of the PIERS data concerning origins and destinations. Table 15 below presents the 2002 PONYNJ TEU volume for the five states with the greatest volumes and for the remaining New England states, based on the adjusted PIERS data.

TABLE 15
BOSTON HARBOR, MASSACHUSETTS

2002 PONYNJ TEU Volumes: Top Five and New England States

State	Exports	Imports	Total
Illinois	51,289	341,496	392,786
New Jersey	196,172	156,867	353,039
Massachusetts	50,794	280,193	330,987
New York	175,881	134,741	310,622
Pennsylvania	39,592	265,520	305,112
Connecticut	7,320	15,706	23,026
Rhode Island	2,141	12,190	14,331
Maine	1,626	1,88	2,814
New Hampshire	798	520	1,318
Vermont	888	191	1,079
New England Total	63,567	309,988	373,555

Source: New York District

Regional Transportation

Commercial trucking is the dominant means of transporting cargo in the region, including that passing through the Port. The Port's main terminals are all within three miles of the either I-90 or I-93 which both connect to I-95 within 10 miles of the harbor. The State and the US Department of Transportation recently completed the $15 billion reconstruction and extension of I-90 and I-93 through the city. This included extending I-90 to the seaport and airport. Part of this work included construction of a truck haul road (South Boston Bypass Road) connecting I-90 to the marine industrial area west of the Reserved Channel. This puts the Conley Terminal less than one mile from the haul road and its interstate highway access. Trucks follow one of two routes between Conley Terminal and the haul road over the Summer Street Bridge that avoid residential areas. These new road improvements provide sufficient highway capacity to handle the anticipated increase in container truck traffic from the terminal.

Logan Airport (also operated by Massport) is located across the Main Ship Channel (MSC) from the Conley Terminal, one mile by truck through the Ted Williams Tunnel (TWT – I-90). While some transshipment by air does occur, it is insignificant compared to truck traffic.

The Beacon Park rail transfer yard is located adjacent to I-90 about 4 miles from the Conley Terminal via a dedicated truck haul road. This facility has direct rail access to Conrail. However, transshipment via rail is not a major vector for containers, as only about eight percent of Boston landed containers are transported out of New England.

An experiment was made in 2002-2003 to carry containers by rail between Halifax, Nova Scotia and Ayer, Massachusetts, about 31 miles northwest of Boston. This service failed due to the lengthy transit times experienced carrying cargo over multiple systems. Transshipment took a week or more, and automated container tracking over the Guilford system was a problem.

Current Cargo Movements

The capacity of a terminal to handle container cargo is a function of its available land area and its rate of movements for those containers. The terminal's available land is occupied by full containers awaiting export, newly arrived imported containers awaiting transport inland, and empty containers awaiting transport. Rates of movement are affected by such things as crane capacity, ease of truck access, terminal gate efficiency, connection to road systems, etc. Efficiency of movements and labor relations also play into productivity measured in annual lifts per acre (L/A/Y). Because containers come in different sizes, container cargo is measured in twenty-foot equivalent units (TEUs). The average box (container) shipped through Boston equals 1.75 TEUs.

Port Operations

Vessel operations for the Port are outlined below. Different descriptions are provided for containerships/terminals, tankships/terminals and the bulk carriers expected to use the MMT. Ship and terminal operations for barge traffic and auto carriers are not discussed as these vessels are not currently depth-constrained and their fleet mix is not expected to change significantly with or without channel improvements.

The Boston Harbor Pilots detailed vessel transit data for the latest reported year was shown earlier in Table 11. The pilots data indicates that 649 transits of vessels drawing 35 feet or more were made in the 2005-2006 reporting period. That equals an average of about seven vessel transits weekly, of which about five were containerships.

The 2005 Waterborne Commerce Statistics harbor transit tables for Boston Harbor are provided in the Engineering Design (D-1). That data shows that Boston Harbor had 794 transits of vessels with drafts of 30 feet or more in 2005. Of these, 310 transits were to/from the Reserved Channel, about 6 weekly, leaving about 9 weekly transits for terminals above the Reserved Channel. This traffic volume does not require two-way traffic for deep draft vessels. However the port also saw about 40,000 transits of vessels less than 30 feet in draft, making passing situations involving large craft and small craft a certainty for each large ship transit. The only exception would be for LNG vessel transits, for which the USCG prohibits all other traffic within a certain distance fore and aft of the transiting cryo-tank ships.

Containership Operations: Containership benefits are the largest projected benefit category for any deepening at the Port of Boston. Many containerships arrive and depart the Port of Boston light-loaded. This is generally undesirable from a shipper's point of view because average costs per box are increased if the ship is light loaded. Vessel draft and tidal assistance with respect to channel limitations, routing between ports-of-call and scheduling of arrivals and departures all play a role in limiting containership operations. Some vessels have greater drafts than the Port's channels can accommodate, even with assistance from the tides and with berths deepened beyond the channel depth. Some vessels may choose to offload cargo (light-load) at a prior port-of-call to avoid delays at Boston. Vessels carry cargo destined for multiple ports and only shift part of their cargo at Boston. Shippers also require strict scheduling to maintain predictable service for their customers and light-load vessels to avoid delays. Some shippers require minimum underkeel clearances for safety and insurance purposes.

Based on the analysis of PIERS data that was performed for this study, the Port of New York/New Jersey moves 4 to 5 times as many New England-bound TEUs as Boston does. These containers were then trucked or carried by barge into New England from New Jersey increasing total transportation and handling costs for that cargo. Shippers with vessels calling on Boston indicate that arrivals are at or greater than the channel's controlling depth about 87% of the time, requiring most vessels to make frequent use of tidal assistance to access the berths. The port has a 9.5-foot mean tidal range at South Boston, with a 13.5-foot spring range and a 5.5-foot minimum range. The variance in range adds additional difficulty to tidal navigation of the harbor.

A draft of the Economic Evaluation of Containership Benefits for this study is included in the Economics Appendix (Appendix C-1) to this Feasibility Report. That evaluation, prepared by David Miller Associates, provides a detailed view of existing containership operations, vessels, cargos, routing, destinations, market hinterland, and other factors affecting container cargo volumes and movements. The evaluation also describes the modeling and methods used to project containership practices that would occur in the without-project condition, and with any deepening of the Port of Boston to the Conley Terminal. Containership benefits are the largest projected benefit category for any deepening at the Port of Boston.

Barge Feeder Services for Containers: Transshipment of containers between northeastern ports including Boston occurs on a limited scale compared to liner services. Three barge feeder services called on Boston in 2007. The most significant service, Columbia Coastal Transport operates one weekly call on Boston from the PONYNJ. Columbia calls weekly on three locations in New Jersey (Port Newark Container Terminal, and the Maher and APM Terminals at Port Elizabeth). The service also calls on the Global Terminal in Bayonne, NJ and the New York Container Terminal on Staten Island, NY intermittently on inducement of sufficient cargo to justify the cost of the call. Every other week the service also calls on Portland, Maine. Boston accounts for the majority of cargo carried by this service.

Much of Boston's barge deliveries are legal road-weight Boston Bill of Lading cargo that is required to land at Boston. Other barge container cargo includes overweight containers that cannot be carried over the road, and refrigerated containers that require a generator to operate the refrigeration unit. The barge offers a 440V power pack to power the refrigerated containers while in transit. None of the refrigerated cargo could move by rail as CSX (railroad) does not offer protective service for refrigerated containers. The overweight containers could not move by truck from the railheads in Worcester as they would be over the legal weight limit.

Columbia Coastal Transport's annual volumes, in number of boxes for 2003 to August 2010 when that service ceased calling on Boston are shown below in Table 16. The 18,486 boxes carried by this service in 2005 equals about 32,350 TEUs, or about 64 percent of the total barge volume for Boston that year (17 percent of overall container volume for the port. For 2006 the service carried 77 percent of Boston's barge volume, or 16 percent of the port's total container volume.

TABLE 16
BOSTON HARBOR, MASSACHUSETTS
Columbia Coastal Barge Service Volumes for PONYNJ to Boston Weekly Service

Year	Total Full Containers	Inbound Full Containers	Outbound Full Containers	Empties	Total All Containers
2003	12,778	8,349	4,429	4,519	17,297
2004	14,201	9,355	4,846	4,463	18,664
2005	11,843	8,652	3,191	6,643	18,486
2006	11,498	8,173	3,325	7,050	18,548
2007	10,172	6,861	3,311	5,435	15,607
2008	7,648	5,287	2,361	1,948	9,596
2009	5,099	3,537	1,562	2,641	7,740
2010	2,113	1,611	502	1,917	4,030
Source: Massport					

The Port of Halifax, Nova Scotia, Canada plays a minimal role in northern New England exports. While liner services continue to call at Halifax, they ship cargo discharging from the Canadian Maritimes, internal Canada sources such as Montreal and Toronto, and some U.S. Midwest cargoes. A barge feeder service between Halifax and Boston was operated by Halship, but ceased service in July 2005. The demise of Halship resulted in the rerouting of northern New England cargoes through the PONYNJ. The deepening of the PONYNJ channels to 45 feet and the ongoing 50-foot project deepening have reduced the incentive for large carriers to call at Halifax and offload New England cargo to reduce draft in preparation for the call on PONYNJ.

The Icelandic company Eimskip has recently tried to rekindle the Halifax-New England barge feeder route. In July 2007 Eimskip resumed a service with calls on Halifax, Portland, Maine, Portsmouth, New Hampshire and Boston weekly. The number of boxes landed and loaded at Boston, including empties, was about 45 weekly, compared to the 200 boxes weekly through Boston by Halship. In December 2007, Eimskip ceased operating this service, leaving the weekly Columbia Coastal as the only barge carrier servicing Boston Harbor.

Another attempt to establish a Halifax-based feeder service calling on Boston and Portland, Maine operated briefly in 2011 and 2012 but was also discontinued due to lack of demand.

<u>Tankship Operations</u>: The Distrigas (LNG) and Exxon-Mobil terminals are located on the Mystic River's 40-foot channel. Conoco-Phillips Petroleum, Gulf Oil, Irving Oil and Global Petroleum are located on the Chelsea River 38-foot channel. Seventy percent (70%) of the harbor's fuel shipments, including all aviation fuel for Logan Airport, come through the Chelsea River.

No crude oil is imported to Boston. Due to tidal conditions and draft restrictions, tank vessels often wait on the tide in the President Roads Anchorage and occasionally lighter there onto smaller ships or barges before completing transit to the berth, particularly Chelsea River bound vessels. Chelsea bound vessels were formerly restricted in size by the old Chelsea Street Bridge and its 96-foot horizontal clearance between the fenders and air draft restrictions due to the leaf span. Transiting the Chelsea River Channel through the bridge was also restricted to daylight hours. The current 38-foot Federal channel depth was the maximum that could be justified without those bridge and utility replacements. With the replacement of that bridge in 2011-2012 and the replacement of the KeySpan gas line in 2008 further deepening of the Chelsea channel is now possible.

During LNG tankship transits to and from the Mystic River, all other harbor traffic is halted by the USCG. Other large carriers wait at their berths or in the anchorage during LNG transits. However LNG carriers made only 41 calls on Boston in the 2005-2006 season (82 channel transits – source Boston Harbor Pilots logs). So these occurrences are only an occasional and minor inconvenience for other shipping.

<u>Bulk Carrier Operations</u>: Non-tank bulk carriers currently import cement, salt, gypsum, frozen seafood, some manufactured goods, and other products, and export scrap metal and scrap newspaper, among other goods. All of these operations are currently afforded at least a 40-foot depth by the existing project. Exceptions are Eastern Minerals on the Chelsea River which has 38-foot access, and the proposed bulk operation at the Massport Medford Street Pier on the Mystic River, an area under consideration in this study for deepening to 40 feet.

Massport's planned use of the Massport Marine Terminal in South Boston involves shippers using larger craft than would transit further up-harbor above the tunnels. The MMT currently has 40 foot access and berthing, having been deepened by Massport during the last improvement project. This terminal is now being examined in this study for deepening to 45 feet (main ship channel deepening extension above the Reserved Turning Area).

<u>Tidal Advantage</u>: Tidal advantage involves using the additional channel depth available at higher tidal stages to transit to and from the terminal berths with the vessels loaded to a deeper draft than the channel depth would permit at lower tides. The transit from deep water

in Massachusetts Bay to the terminals takes several hours and requires vessels taking advantage of the tide to track their effective draft and time their transits with care to avoid grounding.

Boston has a 9.5-foot mean tide range and a spring tide range of about 11.0 feet. The highest and lowest astronomical ranges are 13.5 and 5.5 feet respectively. These tides give vessels an advantage at higher tides. Most large commercial ships operate with a minimum of three feet under keel for safety purposes in response to operating policy of the vessel owner and insurance requirements of the pilots. The wide variance in tidal range, coupled with underkeel requirements, requires close attention to vessel loading at origin, sea conditions in the entrance, and transit commencement times and durations.

Tidal delays are missed transit opportunities when a vessel's arrival outside the port or at the anchorage is not timed to take advantage of the tide and the vessel must wait for the next tide cycle to complete its transit. These delays are severe constraints on containership operations and most carriers will either light load to avoid any delay, or change port routing if vessel loads non-coincident with tidal advantage become more than a rare occurrence. Boston has lost shipping lines to other ports in recent years primarily due to tidal delay issues with shippers who did not want to incur delay costs at one or more ports on their east coast routes.

<u>Light-Loading</u>: Light-loading is the practice of not loading a vessel to its full capacity in order to lessen the draft to enable a call at a port with a channel depth incapable of accommodating the vessel at full load. Light-loading occurs at the port of origin or a port along the vessel's route prior to the port in question. Light-loading is different from lightering, a practice described below. Some vessels routed through Boston are light-loaded at New York or other ports to eliminate tidal delay frequency at Boston. A deeper Boston channel could permit shippers to benefit from less need to rely on this practice, thereby landing more goods directly at Boston.

<u>Lightering</u>: Lightering is the practice of offloading cargo at the port before moving to the berth in order to reduce vessel draft to depth capable of reaching the berth. Lightering at Boston most often occurs with liquid bulk carriers (petroleum) in the President Roads Anchorage offloading by pump onto barges. Most vessels engaged in this practice are Chelsea river bound fuel carriers. Lightering carries an increased risk of fuel spillage into the waterway as the vessels involved are tied alongside at anchor subject to movement by the wind and currents. Deepening of the channels at Boston has the potential for reducing lightering for some vessels. Deepening of the anchorage area would increase the size of vessels that could call at the port with lightering. Whether the channel is deepened alone, or both the channel and anchorage are deepened together, or a deeper entrance depth is provided, will determine the with-project mix between these two effects. Other factors including terminal storage capacity and FAA restrictions on air draft in the anchorage (parts of which are within the flight path/envelope to Logan Airport's runways), are considerations in estimating the future of this practice with navigation improvements.

<u>Air Draft</u>: There are no bridges seaward of the Inner Confluence at the junction of the Mystic and Chelsea Rivers. While the two bridges on the Chelsea River are leaf spans, neither lifts fully vertical and both therefore raise some air-draft concerns for the larger tank vessels. The Tobin Bridge (US Route 1) across the mouth of the Mystic River is a fixed span that also

raises air draft concerns, but only for the largest of the LNG tank vessels calling on the Distrigas Everett Terminal upstream of the bridge. The large LNG ships must balance air draft restrictions with tidal assistance draft requirements when judging loading and their transit commencement. The tank vessels (Exxon), scrap ships (Prolerized) and auto carriers (Boston Autoport), the largest vessels using the 40-foot Mystic River Channel do not have air draft restrictions with the Tobin Bridge and its 135-foot vertical clearance at mean high water. The deepening of the entrance and main ship channel in the lower reaches may provide the LNG carriers with some tidal delay reduction benefits, although currently those vessels are limited to a 37-foot draft.

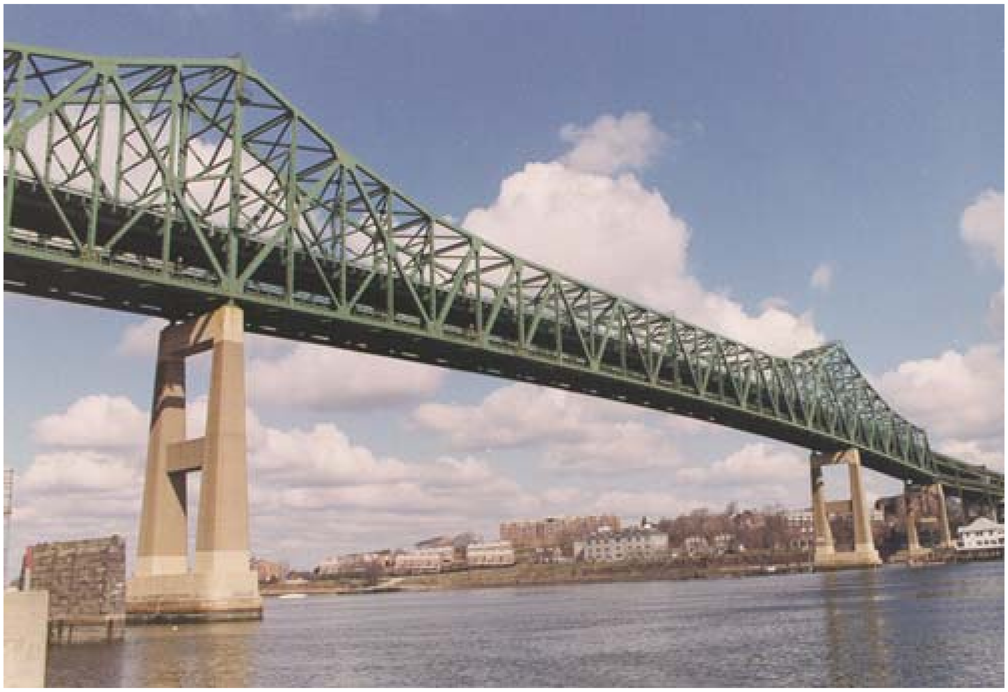


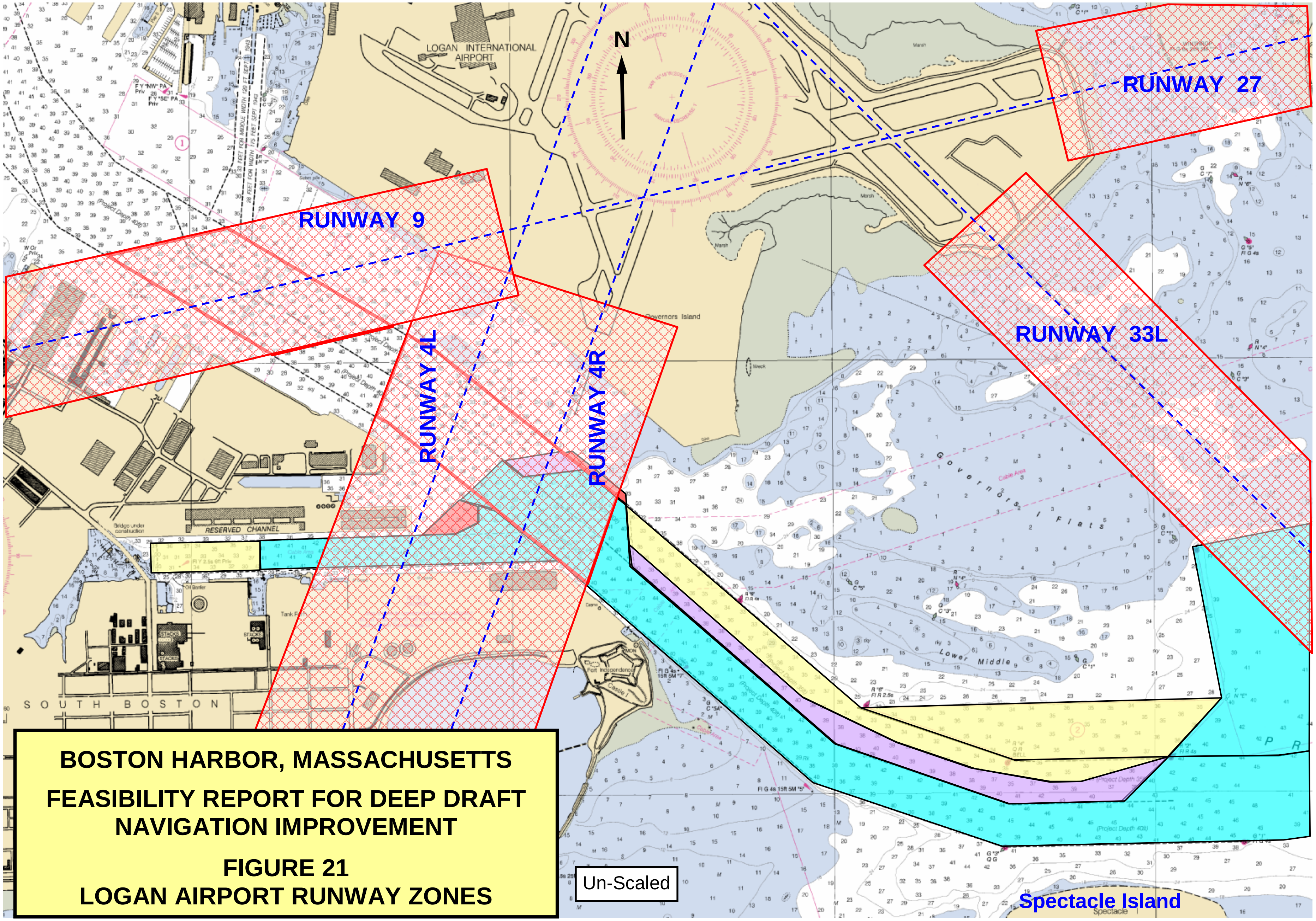
Figure 20 - Mystic-Tobin Bridge – Northwest through Navigation Opening

The harbor channels and President Roads anchorages are located in proximity to Logan International Airport, also owned and operated by Massport. The runway flight envelopes pass over portions of the anchorage, part of the Conley Terminal and other waterfront facilities. The FAA reviews and rules on any air draft issues within the runway approaches. During the recently completed maintenance dredging of the anchorage, and the last improvement dredging at the Reserved Channel, FAA issued approvals for the dredging equipment after review of the equipment's air draft. Any port improvements or development that would result in vessels of greater air draft, or facilities and equipment of greater heights (such as larger gantry cranes for handling containers at Conley Terminal) would likely require FAA review and approval. While this is a concern to be addressed, it is not anticipated to impact plan formulation or recommendation, as flight operations typically are shifted to another of the airports runways during vessel turning or construction activities in the approach zone. A representation of the runway flight zones are shown in Figure 21. Design of the turning basin improvements have incorporated considerations to expedite vessel movements to minimize activities directly below the active aircraft approach and departure paths.

Routing: All of the factors cited above – tidal advantage and delays, light-loading, lightering, etc., influence shippers decisions as to which ports a service will call on, and how vessels in that service will be routed between ports, including what harbors are first and last on any trans-oceanic route. Routing is accomplished with both transportation cost per cargo unit, and cargo time-in-transit in mind. Both cost and time are important elements in shipping. Whether any particular port provides a deeper channel does not necessarily mean that any shipping line or alliance of lines engaged in a service would choose to take advantage of deeper channel by altering their vessel size, vessel loading, ports of call, or vessel routing. However, if one port in a service has shallower water than the rest of the ports, a line may opt to bring on larger vessels and drop the shallow port from the service unless other economic considerations outweigh the benefit of the larger vessels.

Transportation Costs

Transportation cost savings for goods in carriage, whether containers, liquid or dry bulk or other cargo, is the measure of impact, and source of benefit, for any proposed navigation improvements or port development. Transportation cost-savings are calculated from vessel operating costs, vessel time in-port and at-sea, differential cost of alternate transportation methods (truck, rail), transit time to other ports, cost and time for lightering, etc. Transportation costs are calculated in accordance with ER 1105-2-100, dated 22 April 2000, and IWR Report 91-R-13, National Economic Development (NED) Procedures Manual for Deep Draft Navigation. Current vessel operating costs are taken from Economic Guidance Memorandum #11-04 (11 Feb 2011). While the cost for operating a larger vessel is greater than for a smaller one, the per-unit cost for cargo is typically less due to the larger volume carried.



BOSTON HARBOR, MASSACHUSETTS

FEASIBILITY REPORT FOR DEEP DRAFT NAVIGATION IMPROVEMENT

FIGURE 21
LOGAN AIRPORT RUNWAY ZONES

WITHOUT PROJECT (FUTURE) CONDITION

The existing conditions described previously are those at the time the study is conducted. A forecast of the future "without-project" condition must be made to provide a basis to formulate alternative plans and evaluate their anticipated impacts. This future without-project condition reflects the conditions and trends expected during the period of analysis for the proposed project. For navigation improvement projects under the Corps civil works authority, the period of analysis is fifty years. The without project condition should address all aspects of the physical, economic, social, environmental and institutional conditions that may have a bearing on the implementation and performance of the project or any potential alternative.

General Conditions

Even without channel depth improvements, the Port of Boston would likely remain New England's largest port in terms of tonnage (discounting the crude input to the Montreal pipeline at Portland, Maine) and value. The tonnage of the New England region's ports for 2000 to 2010 from the Waterborne Commerce Statistics is shown in Table 17 below. Boston has been and will remain the region's largest port for containerized cargo, general cargo and domestically consumed petroleum products. Feasibility studies are underway for deepening Searsport, Maine and for expanding turning basins at Portsmouth, New Hampshire. However improvements proposed for both of those Ports are keyed to shipping that would not compete with Boston: for niche cargos, such as forest products and aggregates at Searsport, and safety improvements for existing traffic at Portsmouth.

Study resolutions are outstanding for deepening Fall River, Massachusetts, the Fore River Channel at Portland, Maine, and New Haven Harbor, Connecticut, all generally to 40 feet, primarily for petroleum product imports to those areas of New England. Improvements at these ports would benefit sub-regional markets and would not compete with Boston for cargo.

Boston's place in the eastern seaboard multi-port movement of ships and cargo is less secure without port improvements. Table 18 below shows Boston's ranking by total tonnage among the several other large deep-draft container ports on the eastern seaboard.

Most of the principal ports on the eastern seaboard are undergoing, or have under study, major port deepening projects. A brief summary of the status of each is provided below.

The principal cargo channels for the Port of New York and New Jersey are currently under further improvement. The 45-foot Newark Bay and Kill Van Kull Channels project has been completed, along with the 41-foot Arthur Kill deepening has been completed to the Howland Hook Marine Terminal. Work on the authorized 50-foot deepening project began in 2004 with work advancing under multiple contracts, with some channel reaches already completed and completion of the entire improvement expected for 2015.

The Port of Norfolk, Hampton Roads and Newport News recently completed deepening that Port's inbound channel lane to 50 feet. The outbound lane had been deepened some years back.

TABLE 17
BOSTON HARBOR, MASSACHUSETTS

(all cargo volumes in thousand short tons)
Cargo Volumes for New England Ports – 2000-2010 – WCS

Harbor	State	Depth	2000	2001	2002	2003	2004	2005	2006	2007	2008	2009	2010	11-Year Average
Portland	ME	45/35	28,795	28,492	27,132	29,161	29,709	29,286	25,242	24,254	22,124	21,002	18,158	25,760
Boston	MA	40	20,751	20,581	20,354	24,832	25,797	22,378	21,853	22,370	21,035	20,456	19,091	21,773
New Haven	CT	35	10,604	9,876	10,142	10,385	10,856	10,931	10,897	9,574	9,663	10,135	9,987	10,277
Providence	RI	40	8,870	9,030	8,244	9,214	9,559	10,045	9,267	9,225	8,518	6,928	7,115	8,729
Bridgeport	CT	35	4,255	4,581	4,607	4,756	5,671	5,486	5,389	7,628	5,841	4,577	4,535	5,211
Portsmouth	NH	35	4,462	4,447	4,108	4,971	4,795	5,254	4,823	4,026	3,833	3,583	2,964	4,297
Fall River	MA	35	3,402	3,382	3,392	2,977	3,161	3,157	3,364	3,648	3,655	3,423	2,517	3,280
Searsport	ME	35	1,441	1,196	1,040	1,264	1,832	1.965	2,040	1,782	1,856	1,490	1,987	1,448
New London	CT	40	1,771	1,590	1,328	1,475	1,535	1,520	1,418	1,890	2,140	1,772	1,666	1,646
Salem	MA	32	1,205	1,058	867	963	933	1,313	1,064	847	586	629	658	920
New Bedford	MA	30	813	818	953	648	628	785	599	425	345	286	320	602

TABLE 18
BOSTON HARBOR, MASSACHUSETTS

Project Depths and Cargo Volumes for Eastern Seaboard Ports – 2000-2010 WCS

Harbor	State	Current Depth	Proposed Depth	Cargo Volumes – 1000s of Short Tons – All Cargo Types											11- Year Average
				2000	2001	2002	2003	2004	2005	2006	2007	2008	2009	2010	
New York/ New Jersey	NY/	45	50	137,171	144,225	134,505	145,889	152,378	152,132	157,630	157,202	153,480	144,690	139,198	147,136
Norfolk/Hampton	VA	50	Same	56,940	51,994	39,756	42,089	49,198	49,549	45,483	40,167	45,115	40,592	41,958	45,713
Baltimore	MD	50	Same	40,832	42,072	38,823	40,183	47,399	44,113	42,439	41,251	43,413	30,136	39,629	40,935
Philadelphia	PA	40	45	40,824	46,372	34,101	33,249	35,220	39,365	38,597	35,149	32,283	31,751	34,036	36,450
Charleston	SC	45	50	21,082	23,250	24,993	25,199	24,739	25,439	26,425	22,616	20,936	15,834	17,986	22,591
Savannah	GA	42	47	19,517	19,392	20,664	23,369	28,177	30,114	33,971	36,486	35,394	32,339	34,682	28,555
Port Everglades	FL	42	Same	22,500	21,915	21,280	23,040	24,900	24,684	24,824	24,216	21,652	20,059	20,233	22,664
Boston	MA	40	47	20,751	20,581	20,354	24,832	25,797	22,378	21,853	22,370	21,035	20,456	19,091	21,773
Jacksonville	FL	40	45	19,701	17,809	17,906	21,731	21,451	21,777	22,210	21,207	21,050	17,691	19,122	20,150
Miami	FL	44/42	50/52	8,610	8,514	8,927	9,165	9,755	9,048	8,130	7,479	6,826	6,772	6,960	8,199
Wilmington	NC	42	Same	7,788	7,287	7,460	7,784	9,478	9,328	9,456	8,785	7,653	7,115	8,043	8,198

The Port of Baltimore, Maryland has an entrance and main channel depth of 50 feet, with tributary channels to various terminal areas at 49, 42 and 40 feet. WRDA 1999 authorized the deepening of anchorage areas based on a 1997 feasibility report at an estimated cost of $28 million, based on a BCR of 4.3 and annual benefits of $9.8 million. Dredging began in 2002 and was completed in 2003.

A proposal to deepen the Delaware River up to the Port of Philadelphia to 45 feet was authorized by WRDA 1992 and WRDA 1999. The 103 mile-long channel through the Bay up to Philadelphia is currently maintained at 40 feet, with channel widths of 1200 to 400 feet. A reanalysis of project benefits requested by the GAO was completed in 2002 and again updated and approved in 2004, with a BCR of 1.15. Construction of this project was ongoing in 2012.

Deepening of the Port of Savannah to 48 feet was authorized by WRDA 1999 and preparation of a General Re-evaluation Report (GRR) was completed in 2007 with additional analysis conducted through 2011. The final recommendation for that Port's improvement was for a 46-foot channel with the Georgia Port Authority paying for an additional foot of depth to -47 feet.

Port Everglades, Broward County, Florida has an authorized depth of 42 feet (44 feet in the entrance), as completed in 1984. A study examining channel deepening is underway.

The Port of Charleston, South Carolina has a depth of 47 feet over the entrance bars and 45 feet in the main and interior access channels. A study was recently initiated to examine a project for further channel deepening with the port authority requesting a depth of 50 feet.

The Port of Jacksonville, Florida has a river channel depth of 40 feet, with 42 feet over the entrance bars. A feasibility study is underway to examine deepening the river channel to 45 feet.

The Port of Wilmington, North Carolina was authorized by WRDA 1996 to deepen its channels by 4 feet to 42 feet (44 feet in the entrance) over 37 miles of channel. The work was estimated to cost $440 million, with a BCR of 1.4 based on $39 million in annual benefits. Work began in the fall of 2000 and was substantially completed in January 2004. A study of further deepening and realignment of the harbor entrance and expansion of deepened upstream areas is underway.

The Port of Miami, Florida, is currently maintained at 44 feet, with 42 feet in some inner sections. This depth was authorized by WRDA 1990 and was constructed by the Port under Section 404 authority. A General Re-evaluation Report, revised October 2004, recommended deepening the port to 50 feet (52 feet in the entrance) at a cost of $143 million for the Federal channels, based on a BCR of 1.21 and annual benefits of $15 million. A ROD for the project was signed by the ASA in May 2006. The project was authorized by the Water Resources Development Act of 2007 and construction is underway.

Each of the principal east coast ports that share shipping line routing with the Port of Boston has projects or plans for deepening underway. The favorable actions on these proposals are primarily due to the increase in global shipping and the resulting increase in vessel size. For a port to remain on the rotation for line service and vessel calls, it must keep up with the trend for deeper access. Without channel deepening, the number of vessels in service able to access the port would decline, and Boston would lose its ability to attract and keep shipping line service. Over time an increasing percentage of New England cargos would be diverted to other ports and carried to or from New England destinations by truck or feeder barge at a higher transportation cost.

International Development Considerations

In a national referendum held on October 21, 2006 the people of Panama voted in favor of a proposal to modernize the Panama Canal for passage of larger vessels. The proposed improvements estimated to cost between $5 and $10 billion would consist of new locks and channels capable of handling the increased drafts and beams of the larger trans-oceanic vessels now coming into service. The canal expansion project is scheduled for completion in late 2014. When completed, the increased capacity of the Panama Canal may significantly change the nature of the world fleet and economics of shipping between Atlantic ports and east Asia. Completion of the canal project by 2015 is included in the without project condition.

Table 19 shows ports depths and TEU volumes for oversees harbors included in the routes of services calling on Boston Harbor. Only limited data was available for some ports.

Containerized Cargo Future Conditions

Currently, there are three container liner services calling on Boston Harbor. The Mediterranean Shipping Company (MSC) operates two weekly liner services, the first operating between Northern Europe and the US East Coast, and the second between the Mediterranean and the US East Coast. Cosco Container Lines Ltd. (COSCO) operates one weekly liner service which calls on Boston, the US East Coast, Mexico, Panama, and Asian ports, and runs through the Panama Canal. CMA-CGM had operated a biweekly service between northern Europe and the US east coast that called on Boston but discontinued that service as part of its alliance with Maersk. Barge services from Boston to New York, Halifax and Iceland have carried container cargo through the port in recent years, but none is currently in operation. A new south Asia via Suez service (Hanjin) called on Boston and other east coast ports for six months in 2011 using small post-Panamax vessels (5,500 to 6,100 TEU ships) but was cancelled due to lack of east coast market demand, despite significantly increasing Boston landed container volumes.

In 2011, these services carried a total of 192,705 TEUs in imports and exports through the Port of Boston (AAPA Data). In the recent past, total TEUs through the Port of Boston have been growing at a rate higher than the growth rate of US East Coast container ports as a whole, with only Savannah, Wilmington and Port Everglades showing a higher average 10-year growth rate. The MSC and COSCO vessels are currently operating at and beyond the controlling depths, and require extensive and regular use of the tides in order to access and exit the harbor. Light loading and tidal delays are common, and greatly decrease the efficiency of transport.

TABLE 19
BOSTON HARBOR, MASSACHUSETTS

Port Depths and Cargo Volumes for Overseas Ports on Boston Service Routes – 2002-2011

Harbor	Current Depth	Proposed Depth	Year	Containers in TEUs 2002	2003	2004	2005	2006	2007	2008	2009	2010	2011
Panama Canal, Panama	40	55	2015										6,600,000
Suez Canal, Egypt	78	Same	Current										
AMERICAS													
Cristobal, Panama	48	Same	Current		39,773	48,369				249,244	354,956	689,058	980,738
Colon/Manzanillo, Panama	46	52	2014							2,219,276	1,855,756	2,121,605	2,390,976
Halifax, Canada	55	Same	Current	524,336	541,650	525,553	550,462	529,890	490,072	387,347	344,811	435,461	410,649
Lazaro Cardenas, Mexico	52.5	54	2015	134	1,646	43,445	132,479	160,696	270,240	524,791	591,467	796,023	953,497
EUROPE													
Antwerp, Belgium	51	Same	Current	4,777,151	5,445,437	6,063,746	6,482,029	7,018,799	8,176,614	8,663,736	7,309,639	8,468,475	8,664,243
Bremerhaven, Germany	49	Same	Current	3,004,432	3,158,020	3,441,919	3,698,681	4,420,134	4,900,000	5,448,000	4,579,000	4,888,655	5,920,000
Felixstowe, England	49	Same	Current	2,750,000	2,500,000	2,717,000	2,700,000	3,000,000	3,300,000	3,251,077	3,100,000	3,400,000	3,740,000
Gioia Tauro, Italy	59	Same	Current		3,094,000	3,170,000	3,123,000	2,835,000	3,464,000	3,481,403	2,857,438	2,851,261	
Hamburg, Germany	55	Varies	Current	5,373,999	6,137,926	7,003,479	8,087,545	8,861,804	9,889,792	9,737,110	7,007,704	7,895,736	9,014,165
LaSpezia, Italy	46	49	2013	975,000	1,007,000	1,040,000	1,024,000	1,137,000	1,187,000	1,246,000	1,046,063	1,285,455	
Le Havre, France	55	Same	Current	1,720,459	1,984,542	2,131,833	2,118,509	2,137,828	2,656,171	2,488,654	2,240,714	2,358,077	2,215,262
Liverpool, England	42	54	2015	535,000	578,000	616,000	626,000	630,000	676,000	674,000	589,000	662,000	
Naples, Italy	49	NA	NA	446,163	433,303	347,537	373,706	444,982	460,812	481,521	515,868	534,432	526,768
Rotterdam, Netherlands	55	65.5	2013	6,506,311	7,143,918	8,291,994	9,288,399	9,612,526	10,812,701	10,664,912	9,607,942	11,051,325	11,876,921
Sines, Portugal	52	Same	Current	NA	40	19,211	50,994	121,957	150,038	233,118	253,495	382,089	447,495
Valencia, Spain	52	Same	Current	1,821,005	1,992,903	2,145,236	2,409,821	2,612,049	3,042,665	3,602,112	3,653,000	4,206,937	4,327,371
ASIA													
Hong Kong, China	51	Same	Current	19,144,000	20,449,000	21,984,000	22,602,000	23,539,000	23,998,000	24,494,229	21,040,096	23,699,242	24,384,000
Kaohsiung, Tiawan	49	Same	Current				9,470,000	9,800,000	10,300,000	9,676,554	8,581,273	9,121,211	9,640,000
Ningbo, China	49	Same	Current	1,860,000	2,772,000	4,006,000	5,208,000	7,068,000	9,349,000	11,226,000	10,502,000	13,144,000	14,720,000
Qingdao, China	57	Same	Current	3,410,000	4,239,000	5,140,000	6,307,000	7,702,000	9,462,000	10,320,000	10,260,000	12,012,000	13,020,000
Shanghai, China	52.5	Same	Current	8,620,000	11,280,000	14,557,000	18,084,000	21,710,000	26,150,000	27,980,000	25,002,000	29,069,000	31,740,000
Singapore	53	Same	Current				23,200,000	24,800,000	27,100,000	29,918,200	25,866,600	28,431,100	29,940,000
Yokohama, Japan	52.5	Same	Current	2,301,248	2,504,627	2,717,630	2,873,276	3,199,882	3,428,112	3,481,492	2,797,994	3,281,051	3,083,474

In 2007 (the last year of detailed origin/destination data), 62 percent (255,000 TEU) of New England containerized cargo was handled through the PONYNJ. Boston Harbor handled only 38 percent of New England cargo, and only 46 percent of New England cargo that was closer to Boston than the PONYNJ. In 2010 approximately 181,000 loaded TEUs originating in or destined for New England locations closer to Boston Harbor that the PONYNJ were shipped through the PONYNJ.

Boston Harbor is the 12th largest US east coast container-port (Appendix C-1, Table 1-2). Although similar in Twenty-foot equivalent unit (TEU) volume to the Port of Philadelphia, Boston Harbor is not a niche port, as compared to Philadelphia which relies heavily on refrigerated cargo. Conley Terminal handles a wide variety of containerized cargo, much of which originates in or is destined for the New England region. Boston Harbor's average annual 7.5% growth in TEUs handled from 2001 – 2007 (prior to the current recession) was similar to growth experienced in Norfolk (7.25%) and the PONYNJ (6.92%), but less than the growth experienced at Savannah (13.44%). Boston Harbor's number of TEUs handled grew at a greater rate than Baltimore (3.10%), Charleston (1.99%), Miami (-1.09%), Palm Beach (3.42%), Philadelphia (5.11%), and Wilmington (4.30%). Table 20 shows the 2002 to 2011 TEU growth for 13 east coast container ports.

The large growth in liner service TEU volumes at Boston Harbor is largely due to a shift from the PONYNJ to Boston Harbor. The economic rationale for shifting from PONYNJ to Boston Harbor for New England TEUs is the transportation cost savings (minimum $470 per box) afforded by using Boston Harbor. Continuance of this shift and increases in transportation cost savings are currently limited by the controlling depth (38 feet) at Boston Harbor. With maintenance of the Main Ship Channel, including rock pinnacle removal completed in 2012 the controlling depth will increase to the 40-foot authorized depth. However, even with the maintenance dredging, which primarily will reduce the significant tidal delays that the current containerships incur, Boston Harbor TEU volumes will still be constrained by the authorized channel depth (i.e., vessel sailing drafts are maximized given depth constraints but the vessels are capable of deeper drafts and additional cargo is available for loading).

Significant changes to the world's containership fleet are currently occurring and are expected to continue into the near future. Large post-Panamax vessels, some in excess of 8,000 to 18,000 TEUs, have recently entered the world fleet and more than 250 post-Panamax new-builds entered the fleet between 2005 and 2008. The world fleet will also see the addition of 225 Panamax vessels during the same time period. These new Panamax vessels carry as many as 5,100 TEUs.

MSC and COSCO, the largest container shippers using Boston, will likely shift to larger vessels under the without-project condition, to 4000 and 5100 TEU ships, respectively. The ongoing maintenance dredging to 40-feet would provide the additional depth needed to accommodate such a shift. However, full loading of these larger vessels would be limited by the 40-foot controlling depth.

TABLE 20 BOSTON HARBOR, MASSACHUSETTS														
Project Depths and TEU Volumes for US Eastern Seaboard Ports – 2002-2011														
Port/Harbor	Current Depth	Proposed Depth	TEU VOLUMES (LOADED AND EMPTY) – AAPA DATA										10-Year Average	Average Annual Growth
			2002	2003	2004	2005	2006	2007	2008	2009	2010	2011		
Port of NY/NJ	40/45	50	3,749,014	4,067,812	4,478,480	4,785,318	5,092,806	5,299,105	5,265,058	4,561,528	5,292,036	5,503,485	4,809,464	2.93%
Savannah, GA	42	47	1,327,939	1,521,206	1,662,021	1,901,520	2,160,168	2,604,312	2,616,126	2,356,512	2,825,179	2,944,678	2,191,966	6.15%
Norfolk VA	50	Same	1,437,779	1,646,279	1,808,933	1,981,955	2,046,285	2,128,366	2,083,278	1,745,228	1,895,017	1,918,029	1,869,115	3.01%
Charleston, SC	45	50	1,592,834	1,690,847	1,863,917	1,986,586	1,968,474	1,754,376	1,635,534	1,181,353	1,364,502	1,381,349	1,641,977	1.22%
Jacksonville, FL	40	45	683,836	692,422	727,660	777,318	768,239	710,073	697,494	754,352	826,580	899,258	753,723	1.30%
Miami, FL	44	50	980,743	1,041,483	1,009,500	1,054,462	976,514	884,945	828,349	807,069	847,249	906,607	933,692	-0.32%
Port Everglades, FL	42	Same	554,041	569,697	653,628	797,238	864,030	948,680	985,095	796,160	793,227	880,999	784,280	4.21%
Baltimore, MD	50	Same	508,068	528,899	557,877	602,475	627,947	610,466	612,877	525,296	610,922	631,802	581,663	1.69%
Wilmington, NC	42	Same	100,170	96,453	104,122	148,784	177,634	191,070	196,040	225,176	265,074	287,469	179,199	8.01%
Philadelphia, PA	40	45	215,061	147,413	178,046	204,912	247,211	253,492	255,994	222,900	272,824	291,091	228,894	2.34%
Wilmington, DE	40	45	244,564	254,191	253,925	250,507	262,856	284,352	267,684	259,964	263,040	272,996	261,408	0.76%
Boston, MA	40	47	142,102	158,041	175,679	188,869	200,113	220,139	208,626	187,094	168,285	192,705	184,165	3.03%
Palm Beach, FL	33	Study	221,132	217,558	226,002	248,206	244,004	249,931	244,638	199,393	213,000	212,008	227,587	0.59%

Existing Project Maintained Depths

Table 21 presents the existing authorized and maintained depths of the various deep-draft channels and anchorage areas in the Port of Boston. With few exceptions the authorized depths are the maintained depths. Without improvements to the Port, it is anticipated that these project dimensions will be maintained throughout the period of analysis.

TABLE 21
BOSTON HARBOR, MASSACHUSETTS

WITHOUT-PROJECT CONDITION
DEEP-DRAFT NAVIGATION PROJECT FEATURE DEPTHS

Project Segment	Authorized Depth	Authorized Width	Maintained Dimensions
Broad Sound North Entrance Channel			
South Lane	40	1100 – 900	Same
North Lane	35	600	Same
Broad Sound South Entrance Channel	30	1200	Same
Narrows Entrance Channel	27	1000	Same
President Roads Anchorage	40	420 acres	Same
Lower Middle Anchorage	35	600	Same
Main Ship Channel – President Roads	40	1200	Same
Main Ship Channel – Primary Lane	40	1200 - 600	Same
Secondary lane	35	600	Same
Reserved Channel – Lower Reach	40	400	Same
Turning Area	40	1200	Same
Upper Reach	35	430	Same
Drydock Channel	40	NA	Same
Lower Charles River Channel	35	Varies	Same
Inner Confluence	40	NA	Same
Lower Mystic River Channel			
Main Portion	40	1100 – 600	Same
Southwest Area	35	Varies	30 to 35
Chelsea River Channel	38	175-430	38 at same width
Fort Point Channel	23	175	Not Maintained
Nubble (Nixes Mate) Channel	15	300	Same

Future Dredged Material Disposal Without the Project

The Massachusetts Bay Disposal Site has an essentially unlimited capacity over the foreseeable future. With a depth of about 300 feet and an area of more than 3 square miles, the site could receive suitable dredged material for at least the next century. Disposal of Boston Harbor dredged materials deemed unsuitable for unconfined ocean disposal has been cost-effectively managed in recent years by creating a series of CAD cells beneath the harbor. There is ample capacity in the harbor for creating more such cells as the need arises. However, maintenance and improvement dredging operations since 1998 have removed nearly all of the less suitable material from the harbor's shipping channels. Any proposed future improvement projects would remove ledge and material consisting of underlying glacial deposits which will be suitable for ocean disposal or potentially a variety of beneficial uses. Future harbor maintenance dredging would presumably yield cleaner shoal materials, as sources of contaminants are removed from the harbor and its watershed. Future dredged material disposal in Boston Harbor and Massachusetts Bay is not expected to involve any particularly difficult challenges over the 50-year period of analysis. No change is thus expected in the current dredged material management practices for the harbor without the proposed improvement project.

Productivity Increases

The Conley Terminal is currently operating below its 2016 expected future capacity of 550,000 TEUs per year. Reaching that capacity will require the completion by Massport of its next program of shoreside terminal upgrades. Massport recently completed a $25 million program of efficiency improvements including realignment of the yard and gate to optimize efficiency, the purchase of eight new rubber tire gantry cranes, repaving to allow for greater container stacking, and relocation of the chassis pool and maintenance and repair functions to a nearby site to increase available yard space. In addition, Massport has acquired the former Coastal Oil Terminal property located immediately west of Conley to further expand container-related operations, and will do so with or without channel improvements. Massport has also acquired (from the Port of Oakland) two new post-Panamax cranes capable of servicing the larger TEU vessels coming into service with their greater beams. While Boston (Conley Terminal) has sufficient landside capacity to accommodate future growth, deepening of the Port's channels is necessary to accommodate larger ships which can carry more cargo.

Changes in Fleet Characteristics

Global trade in containerized cargo has increased significantly once trade recovers from the recent economic downturn and is expected to continue to increase over the 50-year period of analysis for the project. For example, MSC moved 2.5 million TEUs globally in 2000 using about 140 ships. By 2005 MSC's numbers had increased to 6.5 million TEUs and 278 ships. For this one line a doubling of the number of vessels enabled it to carry about 2.6 times the number of TEUs in five years with the average annual carriage capacity of its ships increasing from 17,900 in 2000 to 23,400 in 2005. Other lines experienced similar growth and vessel capacity increases.

Non-Federal Sponsor's Port Development Plans

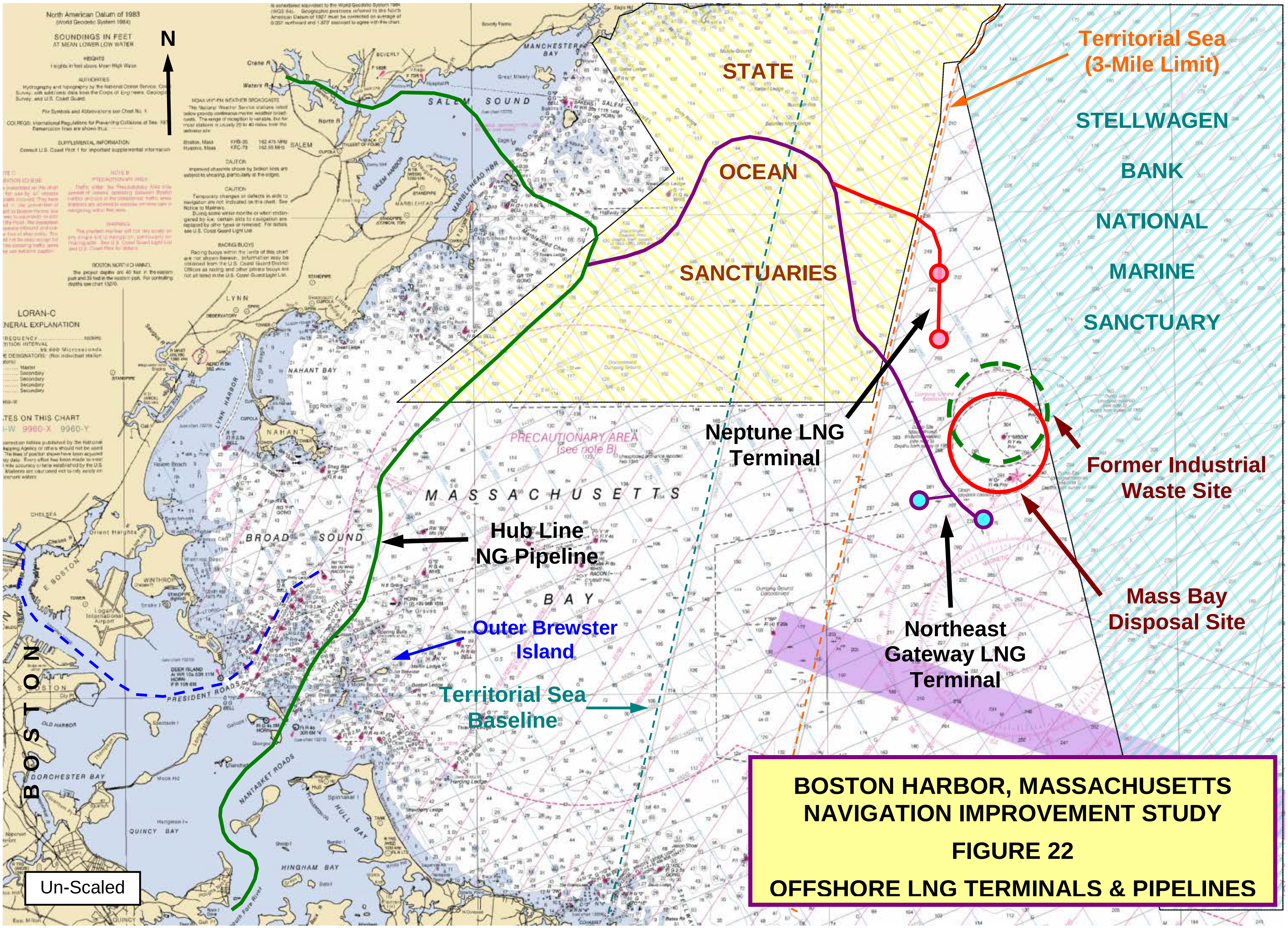
As described briefly earlier, Massport port development plans consist of five actions. These actions will all proceed under the without project condition.

- First, the expansion of Conley Terminal through redevelopment of the former Coastal Oil Terminal adjacent to the container terminal will increase available acreage for container lay-down and chassis storage or related operations and ultimately enable development of an expanded container storage yard and a third deep draft berth if found necessary.
- Massport has completed a $25 million upgrade program for the Conley Terminal that focused on shoreside efficiencies with container movement and storage.
- Massport has also installed two new post-Panamax cranes with a 17 box-row reach
- Massport's Conley upgrades completed by 2010 included stack layout, gate relocation and other landside modernizations expected to increase the efficiency and throughput capacity of the terminal (even without the Coastal Oil property) to 550,000 TEUs annually.
- Massport's planned redevelopment of the Massport Marine Terminal property upstream of the Reserved Channel along the Main Ship Channel is proceeding with formal designation of a developer and negotiation of the development agreement and sublease for bulk cargo operations. Development plans have been completed and the first regulatory approvals issued. The shoreside facilities will be completed and in operation by 2013 and beyond for new warehouses and cement and other bulk imports. The berths would be deepened beyond 40 feet if this reach of the Main Ship Channel is deepened, and would enable calls by larger and more deeply laden vessels.
- The development of the Medford Street Terminal as a bulk operation, is also planned. The terminal area is presently used for expanded auto-port operations. Massport is now exploring other bulk cargo operations for this site including cement. The berth at this terminal has already been deepened to 40 feet by Massport

Other Port Development Plans

At the time of the 2008 draft report there were two proposals under state and Federal regulatory review for construction and operation of deepwater offshore LNG terminals in Massachusetts Bay. These terminals, as shown in Figure 22, are located in Federal waters north and southwest of the Mass Bay Disposal Site. Both operations use submerged loading buoys that LNG tankers would retrieve and tie-up to, and re-gasify, odorize and pump-off their cargos. Both terminals consist of two such buoys, and be tied by 24 inch diameter lateral pipelines on the Bay floor to Spectra Energy's 30-inch diameter nearshore Hubline gas line that crosses the Bay from Beverly in the north to Weymouth in the South. Each buoy is anchored to eight embedded bottom moorings and rest at a depth of about 100 feet below the surface when not in use.

The terminal operated by Northeast Gateway Energy Bridge, a subsidiary of Excelerate Energy, is located southwest of the disposal site. This terminal was completed in 2008 The terminal will receive ship calls by re-gasification vessels carrying about 4.9 million cubic feet (MCF) of LNG that would re-gasify to about 2.9 billion cubic feet. The facility has a capacity of transmitting 400 to 800 MCF/day.



BOSTON HARBOR, MASSACHUSETTS
NAVIGATION IMPROVEMENT STUDY

FIGURE 22

OFFSHORE LNG TERMINALS & PIPELINES

Neptune LNG LLC, a subsidiary of GDF Suez Gas NA, completed its terminal, located about four miles north of the Mass Bay Disposal Site, in 2010. This facility receives shipment from re-gasification vessels of similar size, with a throughput capacity of about 500 to 750 MCF/day.

These facilities are intended to meet the region's growing demand for natural gas. These sources supplement, but do not replace the Distrigas terminal on the Mystic River in Everett. USCG mandated safety and security zones, no anchor areas, and avoidance areas will surround each buoy location concentrically, with diameters of 0.54, 1.1 and 1.4 nautical miles, respectively. The Northeast Gateway buoys, which are located closest to the MBDS boundary, were sited using a 200 meter offset from the disposal site for the outermost of these restriction zones. Except when LNG vessels are in transit to the buoys, there will be no restrictions on disposal tow travel to or use of the MBDS due to the placement and operation of the two LNG facilities.

A third LNG terminal proposal, this one by AES Battery Rock LLC, for an onshore facility to be constructed on Outer Brewster Island near Boston Harbor's southeastern entrance was proposed in 2007, but met with significant opposition from the State and interest groups.

Bridge and Utility Replacements & Modifications without the Project

Replacement of the Chelsea Street Bridge was completed in 2012. Replacement of the KeySpan gas line under the Chelsea River was completed in 2008. This leaves only two utility issues with respect to the further deepening of Boston Harbor as considered in this feasibility study. Both of these involve the MWRA and were discussed in their November 9, 2012 letter.

The MWRA has a second water supply tunnel beneath the Chelsea River serving East Boston. One tunnel was abandoned and removed as part of the 38-foot 1998-2001 deepening of the Chelsea River Channel. The second line is a 36-inch diameter water with a minimum elevation of -45 feet MLLW beneath the channel. As demonstrated by past controlled elevation dredging in the Chelsea River this line should not require replacement for a deepening of up to -40 feet with a two-foot overdepth allowance.

The NSTAR high voltage cable from South Boston to Deer Island crosses beneath the Reserved Channel and Main Ship Channel. The required permitted embedment depth was not achieved in all reaches during original installation of this cable. The Corps has referred the matter to U.S. Attorney's office as an enforcement action. The U.S. Attorney's office is currently in negotiations with MWRA and NSTAR to ensure that the cable will not interfere with dredging operations of the proposed project. Compliance with terms of the existing permit is therefore part of the without project condition.

District's Without-Project Condition

<u>Container Shipping</u>: Under the without-project condition, the relatively shallow controlling depth at Boston Harbor makes it unlikely that any of the liner services currently calling at Boston Harbor would upgrade their existing fleet to larger vessels. In addition, it is unlikely

that any new services with larger vessels would call at Boston Harbor. Growth in Boston Harbor TEU volumes for the two MSC liner services would be limited to the additional sailing draft for some of the MSC vessels afforded by the scheduled maintenance dredging. Completion of the major maintenance dredging cycle in 2012 will allow this growth to continue, but vessel sizes and further growth may be constrained by channel depth and Panama Canal constraints. TEU growth will end when the vessels achieve their maximum sailing drafts that are not constrained by without-project conditions.

TEU volume growth for the COSCO service is expected to continue as empty boxes continue to be displaced by cargo shifted from the Port of New York/New Jersey (PONYNJ) until that port completes its 50-foot deepening project. COSCO has stated that its shift to even larger vessels once the PONYNJ is deepened will preclude continuing its service to Boston as those ships would not be able to economically call on a 40-foot port.

It is projected that, by 2016, there will be more than 370,000 New England TEUs moving through PONYNJ (based on a 3.5 percent annual growth rate from the 255,000 TEUs in 2007), which is 5 percent of the projected 2016 cargo volume for PONYNJ, based on the North Atlantic trade model forecast. An analysis of New England container box origin/destination data was conducted and is presented in detail in later sections and in the Economic Assessment – Appendix I. This data demonstrates that each New England box moving through the PONYNJ presently incurs a transportation cost that is on average a minimum of $470 greater than the cost of moving through Boston Harbor.

Massport's program of shoreside upgrades and efficiency improvements to the Conley Terminal, including acquisition and incorporation of the adjacent former oil terminal property into the container terminal, and acquisition of additional post-Panamax cranes has been completed. Only the grading and paving of the new yard area remains, which will be completed regardless of whether any channel improvements are implemented.

<u>Dry Bulk Cargo</u>: Growth in bulk cargo trade and shipment, as with growth in container shipping, is in response to increased demand for goods that comes from overall income growth. This growth will seek reduced transportation costs, of which increased efficiencies in shipping are a part. Boston has seen substantial growth in several cargo categories over the past decade before the recent economic downturn. Table 8 presents data from the Waterborne Commerce Statistics from 1998 to 2010 for Boston Harbor. Dry bulk commodities such as salt, clay, metal products, fish and forest and paper products have increased steadily through 2007. This trend is expected to resume as income and demand for goods recovers and continues to grow in New England. Cement imports declined in 2002 with completion of the major components of the "Big Dig" highways projects..

To ensure the port continues to meet expected demand, Massport and its partners are redeveloping its two dry bulk terminals, the Massport Marine Terminal in South Boston, and the Medford Street Terminal on the Mystic River, as described above. These terminal projects are ongoing and will be completed by 2016, whether or not any Federal channel deepening is accomplished.

<u>Liquid Petroleum Cargo</u>: Liquid petroleum cargos include LNG and other liquid fuels. As described earlier, one petroleum terminal (Exxon-Mobil) and the harbor's sole LNG terminal (Distrigas) are located on the Mystic River and are already afforded a 40-foot channel depth.

The harbor's remaining petroleum terminals are located on the Chelsea River Channel with a 38-foot depth. In 2010, LNG shipments totaled 3,644 thousand tons, while all other liquid petroleum products totaled 6,421 thousand tons. Gasoline and fuel oil are the largest components of the non-LNG figures. Demand for both fuel oil and LNG fluctuates with the severity of the winter season in the region. Demand for these products is expected to continue.

For petroleum products, this study focused on Chelsea Creek and its non-LNG terminals. Four of the five active terminals are expected to be beneficiaries of deepening the Chelsea River Channel. Under the without project condition, each of these terminals is expected to remain in operation, with receipts at their current levels, varying with the severity of the seasons. These terminals would deepen their berths to 40 feet concurrent with channel deepening. The combination of bridge replacement and channel deepening would permit these terminals to receive calls from tank ships up to 50,000 DWT instead of the current maximum of 41,000 DWT. Further increases in vessel size are constrained by the limited width of the waterway.

PROBLEMS AND OPPORTUNITIES

The objective of Federal water resources planning is to contribute to national economic development consistent with protecting the Nation's environment pursuant to national environmental statutes, executive orders and other Federal regulations and requirements. The benefits and impacts of any proposed alternative improvements, or lack of action, on national economic development, environmental quality and other social effects must be evaluated through a process that begins with an analysis of the problems and opportunities presented.

Problems and opportunities are expressed in relation to the Federal objectives stated above, and the specific planning objectives for the project under consideration. Problems and opportunities should be defined in a manner that does not preclude the consideration of all potential alternatives to solve the problems and needs and achieve the opportunities.[4] Specific statements of problems and opportunities are provided below for each class of objectives and apply to the 2016 to 2066 period of analysis for this project.

Navigation and National Economic Development

The existing 40-foot channel depth at Boston Harbor (and 38-foot depth in Chelsea River) restricts navigation for larger carriers. This limited depth, relative to other eastern seaboard ports, forces some carriers not to call at Boston, and requires those that do to adapt their routing and loading practices or incur tidal delays and adopt lightering or light-loading requirements to access the Port.

Without channel improvements in the form of deepening, widening and expanded turning areas inefficiencies will persist and worsen, including tidal delays, light loading, lightering, and increased diversion of cargo to other ports. These problems will increase as cargo tonnages and vessel sizes increase. The replacement of older vessels in the fleet with larger

[4] Planning Guidance Notebook, Paragraph 2-3.a.

more efficient ships will force shippers to adapt in a manner likely to increase the overall cost of transporting goods into and out of New England.

For containerized cargo, only a minor amount of New England originating or destined cargo arrives in the region by ship. Most New England cargo is carried overland by truck at a relatively higher cost. In the longer term, the continued growth in trade expected between New England and other markets will increase the amount of containerized and other cargo carried through the region. The ability of larger vessels that would carry this cargo to access the Conley Terminal will be compromised by inadequate channel depth and width between the open Bay and the Reserved Channel and inadequate turning basin diameter as average vessel sizes continue to increase.

The problems of high cost for cargo transport to and from the New England region, and the growth in cargo carriage needs, will need to be addressed by identifying and implementing means of cargo transport with lesser cost. Whether by increased channel dimensions, or carriage by other means such as increased rail or barge service, methods for shipping and handling the anticipated cargo volume over the period of analysis need to be identified.

Environmental Quality

Consideration should be given to the widest array of beneficial uses for the large volume of clay, rock and other materials that would be generated improvement dredging. Consideration should be given to using rock and other hard materials to create or enhance hard-bottom habitat areas favored by many species. Consideration should be given to using clayey dredged materials to cap older disposal mounds or remediate other sites in Massachusetts Bay.

Consideration should be given in plan development, implementation sequencing, and time-of-year restrictions on dredging and blasting in various areas of the harbor to:

(a) addressing the air quality impacts of construction operations
(b) addressing impact avoidance for critical marine species including lobster, winter flounder and anadromous fish, all of which rely on harbor waters and bottom areas spawning, development and forage at various times of the year
(c) addressing any endangered species impacts of construction operations

Disposal operations at the Massachusetts Bay Disposal Site, and transport of materials to the site, must consider potential impacts to the Right Whale and other cetaceans which frequent Stellwagen Bank to the east.

Evaluation of all alternatives, including no-action, should consider the impact of increased or decreased truck traffic on air quality due to cargo diversion either to or from Boston.

An opportunity exists to use this large-scale improvement dredging project to ground-truth and improve environmental monitoring of such potential impacts as:

(a) water quality and sedimentation from turbidity due to dredging
(b) fish egg and juvenile mortality due to sedimentation
(c) predictions of turbidity in the water column in the vicinity of dredging operations
(d) colonization of habitat areas created through beneficial use of dredged materials

Other Social Effects

A project the scale of deepening the Port of Boston will have impacts on other competing uses of the harbor and its waters. Lobstermen who currently set their traps within the channel areas, albeit without approval or the required Federal permits, will have to shift the areas harvested as dredging operations progress through the harbor. Recent major maintenance dredging operations have established a process for providing timely notice to lobstermen so that they may relocate their gear from dredging areas. These procedures should be continued and where practical improved.

There may be some minor disruption of other waterborne activities, such as boating and recreational fishing during construction as work progresses. Procedures for adequate public notice will need to be developed, and traffic management coordinated with the US Coast Guard as practiced during the ongoing major maintenance dredging activities.

Evaluation of the no-action alternative should consider the impact of reduced marine cargo operations at Boston on the labor market for longshoremen and other harbor and inland transportation workers.

Evaluation of all alternatives, including no-action, should consider the impact of increased or decreased truck traffic on highway congestion and other landside infrastructure maintenance costs due to cargo diversion.

Planning Objectives

The objective of the Boston Harbor Navigation Improvement Study is to develop an optimal plan for effectively and efficiently accommodating existing and prospective deep-draft vessel traffic in the Port of Boston. The optimal plan for Federal participation must be consistent with the Corps National Economic Development (NED) perspective as set forth in the Principles and Guidelines and must also account for the Regional Economic Development (RED) perspective. Plans must also account for Other Social Effects (OSE), be acceptable from the perspective of Environmental Quality (EQ), and be in concert with the Chief of Engineers' Environmental Operating Principles. Plans developed for analysis must be formulated to be complete, effective, efficient and acceptable, and to reasonably maximize net benefits.

Planning objectives are statements that describe the desired results of the planning process by solving the problems and taking advantage of the opportunities identified.[5] Alternative plans will be evaluated based on the extent to which they meet one or more of the planning objectives. The period of analysis stated below is for the main channels improvements and assumes a three-year construction period with work beginning in 2011.

(1) Contribute to National Economic Development by minimizing the cost of transporting existing cargo volumes and anticipated future increases in cargo volumes to and from

[5] Planning Guidance Notebook, Paragraph 2-3.a(4)

New England in an environmentally acceptable and sustainable manner during the 2016 to 2066 period of analysis.

(2) Reduce current and expected future tidal delays for the existing and anticipated future fleet of container and bulk cargo vessels calling at Boston Harbor during the 2016 to 2066 period of analysis by examining improvements to channel, anchorage and turning basin dimensions and local berths and facilities.

(3) Reduced current and expected future light loading requirements for vessels calling at Boston Harbor during the 2016 to 2066 period of analysis by examining improvements to the harbors general navigation features and local service facilities.

(4) Reduce current lightering requirements and potential future increases in lightering for petroleum tank ships calling at Boston Harbor during the 2016 to 2066 period of analysis by examining improvements to channel dimensions in the Chelsea River.

(5) Maximize the beneficial use of dredged material for habitat creation and other purposes during the 2016 to 2066 period of analysis covering initial construction and future maintenance of the project.

(6) Consider all the previously identified opportunities in the formulation and evaluation of alternative plans, and recommend the preferred means of achieving the above-listed objectives, consistent with the Federal interest as set forth in the Principles and Guidelines, during the 2016 to 2066 period of analysis.

Planning Constraints

Planning constraints are restrictions that limit the planning process and the available scope of solutions to the identified problems, or that limit consideration of opportunities. Alternative plans should be formulated in a manner that meets the planning objectives while avoiding the planning constraints. Planning constraints may be physical (bridges, landmasses, utilities), institutional (legal or legislative), economic, environmental (essential fish habitat, endangered species), sociological (cultural resources or strong local opposition). The following constraints were considered during the plan formulation and evaluation process.

Alternative Port/Terminal Analysis: There is only one container terminal at Boston - Massport's Conley Terminal on the Reserved Channel. No other land is available around the harbor sufficient in size for development of another terminal. This will constrain the scope of alternative terminal sites that can be considered.

Tunnels: The four existing tunnels constrain channel depth above the TWT (I-90) to no greater than the current 40 feet. Deepening proposals for the Mystic and Chelsea Rivers are therefore limited to 40 feet.

Bridges: The Tobin Bridge poses no constraint to deepening portions of the lower Mystic River to depths of up to 40 feet, the same as provided in adjacent areas. Replacement of the Chelsea Street Bridge by the City and US Coast Guard will make the McArdle (lower) bridge the limiting factor for that waterway. The new Chelsea Street Bridge will not pose any restraint of the larger classes of tank ships expected to call on the upstream terminals. The 175-foot horizontal clearance at the McArdle Bridge and the passage through the Chelsea Street Bridge area will, like the tunnels, limit the size of vessels using the Chelsea River to those not requiring more than 40 feet in channel depth.

Utilities: No with-project utility constraints were identified for Boston Harbor. The enforcement referral to the U.S. Attorney's office regarding the NSTAR cables and the ongoing negotiations on this matter would ensure that, consistent with the terms of the original permit conditions, there will be no constraint to deepening the Reserved Channel and adjacent areas of the Main Ship Channel to at least the 50-foot MLLW maximum improvement depth being considered in this study.

Local Service Facility Constraints: Existing shore facilities may constrain channel deepening unless berths are deepened commensurate with the recommended channel depths. Massport has already deepened its two deep berths at the Conley Terminal to 45 feet and could deepen them further. In order for shippers to retain the same tidal advantage as currently experienced at Boston, berths at the container terminal will need to be deepened to at least three feet greater than any improved channel depth. As Boston's tidal advantage is an attractive feature for shippers; project design, cost estimates and benefit analysis need to include the deeper berths in the local service facilities for the project.

The project segment for the Massport Marine Terminal with its proposed bulk cargo operations, will need to deepen its berth to the same depth as that recommended for the main ship channel deepening extension to this facility. As Massport has already deepened the berth at the Medford Street Terminal on the Mystic River, no further Local Service Facility improvements are needed for that project segment. The proposed deepening on the Chelsea River would also require the deepening of the berths at the beneficiary terminals to the same depth as that recommended for the channel.

Lobster Populations: In the winter months, from mid-November to early March, those lobsters which don't migrate offshore may burrow in the sediments, including the channel slopes. Blasting operations could have significant impacts in the immediate area of the work. It may not be possible to limit all blasting operations to a particular time of year given the extent of the project; however consideration should be given to sequencing the work to avoid the most critical impact areas at sensitive times, by shifting work among the several areas of the harbor to be deepened.

Fisheries Impacts: Similar to minimizing lobster impacts, project sequencing will be considered where practicable to avoid critical areas and times for the benefit of species of concern. Sufficient variability exists in the resources present in the several different areas of the harbor to avoid total shut-down of the project by sequencing work to minimize significant impact to critical resources. Construction sequencing plans should be developed once sufficient detailed design data on subsurface conditions, blasting requirements, and post-maintenance resource characterization have been collected and evaluated.

Port Operations: Underkeel requirements for large carriers in Boston Harbor are the result of cooperation between the shippers, harbor pilots, insurers and the Coast Guard. Given the hard-bottom nature of Boston channels, an underkeel clearance of 10 percent of a vessel's draft is used by most shippers and prescribed by the pilots for most vessels. This allowance must be considered in developing the design depths for the improved channels, and the forecasting models from which the economic analysis is drawn.

Port Security: Adequate maneuverability and safety is critical to safe operations in modern deep-draft ports and any plan for improvements to Boston Harbor's navigation system must include features necessary to ensure adequate security. Corps policy on incorporation of port security features into harbor design may be found in the policy letter titled: National Security Considerations in the Planning, Design, Construction, and Operation and Maintenance of Harbor and Inland Harbor Projects. This policy letter states "the planning, formulation, engineering, design, funding and construction of security features and facilities for new and modified navigation projects will be accomplished as an integral part of the navigation project development process. Navigation projects and project modifications formulated in feasibility studies and recommended in feasibility reports will include appropriate cost effective security features and facilities."

US Coast Guard Regulation of Vessel Movement: The US Coast Guard restricts all vessel movement on the Harbor during the transit of LNG carriers. Movements happen on a twice a week schedule (one transit inbound and one outbound) during the mid-September to mid-May period and will require a shut-down of about two-hours per transit for any operations in the North Entrance and Main Ship Channels. Project cost estimates have taken these restrictions into account.

Endangered Species – Whales at the Mass Bay Disposal Site, Atlantic Sturgeon and Sea Turtles: Under interagency agreement, transit to and disposal at the MBDS requires the use of a whale observer and limitations on tow speed and disposal operations during a portion of the year and day when whales are more likely to be present. While this has only been a minor constraint on recent disposal operations, some inefficiency must be built into the cost contingencies for improvements involving ocean disposal. Sea turtles would be considered a rare visitor to Boston Harbor. Dredging would not be expected to impact them since a mechanical, not a hopper dredge, will be used. During blasting, marine mammal and sea turtle observers will be on site to monitor for the presence of these species.

The recent listing of the Atlantic Sturgeon may require employment of fish startle systems and other observers during construction, particularly during blasting operations. Analyses conducted during the 2012 lower main ship channel rock removal project yielded data on appropriate distances for exclusion zones. These lessons, together with results of design phase construction sequencing plans that will be developed with resource agency input will help minimize impacts on listed species.

Container Throughput Capacity: The Conley Terminal, with acquisition of the adjacent global terminal property and reconfiguration of the terminal's laydown areas and gate, will have an annual throughput capacity of about 550,000 TEUs before 2016. Some further improvements to on-site stacking/picking equipment and practices and more efficient distribution offsite, could boost that capacity further in the future. However the limitations of available lay-down space represent a limitation on throughput that will constrain the ultimate maximum size of container vessels calling at the Port. These constraints were taken into consideration in the study's economic evaluation, but were determined not to limit the range of throughput projected for project benefits.

PLAN FORMULATION

This section of the report describes the planning process involved in the formulation of alternative plans for deep draft navigation improvements to the Port of Boston. Alternative plans are formulated to achieve the planning objectives defined earlier, subject to the identified planning constraints. Later sections of the report will screen and evaluate these plans and select a recommended plan of improvement.

PLAN FORMULATION RATIONALE

The plan formulation rationale describes the sequence and methodology used in developing alternative plans, identifying management measures available to pursue those plans, screening plans for practicability, evaluating effects and impacts of the surviving plans in detail, and ultimate selection of a recommended plan of improvement. Initial screening of the formulated alternatives was performed in order to determine whether an alternative would be carried forward for more detailed evaluation. This screening process yielded the final array of alternatives to be assessed and evaluated. In sequence, the process involves:

(1) The plans of other Port interests to modify their facilities and operations, discussed earlier under the existing and without-project conditions, are addressed and evaluated with respect to the range of with-project conditions.
(2) Consideration is given to the national goals of Economic Development, Environmental Quality and Other Social Effects.
(3) Identification and evaluation of management measures, both structural and non-structural, which address the planning objectives to varying degrees, consistent with the identified planning constraints.
(4) Management measures deemed applicable to the study objectives are combined to form alternative plans and are then screened for practicability.
(5) The alternatives that survive preliminary screening are further refined, evaluated in detail, and optimized to determine the selected plan.

Plans of Others and Port Operations

The Port of Boston with its mix of public and private terminals and operations serves the Boston area and its hinterland; primarily the six-state New England region. Massport operates the port's public terminal facilities and bridges, and eastern Massachusetts' commercial airports. Massport has consolidated public container cargo operations at a single terminal (Conley), closest to the sea. Bulk cargo operations are located throughout the harbor and will be expanded at the redeveloped Massport Marine Terminal in South Boston. The Boston Autoport operations with its lesser draft requirements are located on the Mystic River. Private terminals for oil, bulk cargo, and LNG are located throughout the harbor, primarily in the upper harbor areas of the lower Mystic River and Chelsea River.

International container shipping is a constantly changing global environment. The shift in the world fleet towards ever larger containerships (post-Panamax and larger vessels), and the growth and constant change in vessel shipping alliances make this transport sector highly competitive and fluid. Any evaluation of the cost of transporting goods from origin to destination must consider vessel operations and land-side factors. The mechanics and efficiency of terminal operations (capacity and equipment limitations, labor issues, etc.), land side transport practices (truck and rail), intermodal capabilities and logistical limitations associated with each segment of transport must all be considered in examining existing, without-project and with-project conditions.

Petroleum products terminals in the Port are concentrated in the Chelsea River (Conoco-Phillips, Gulf, Global, and Irving), the Inner Confluence (Atlantic Fuels), and the Mystic River (Exxon-Mobil and Distrigas). No other petroleum terminals exist in Boston Harbor. Smaller terminals are located on the Weymouth Fore River (35 feet) to the south and Salem Harbor (32 feet) to the north, but neither of these waterways has the channel depths already afforded the Chelsea (38 feet) and Mystic (40 feet) Rivers terminals. No available land exists to expand the Salem or Weymouth terminals. There are no plans to expand storage capacity at the Chelsea and Mystic terminals, as inventories are kept low to minimize costs. The former Coastal Oil (White Fuel) terminal on the Reserved Channel has been closed and the fuel tanks removed. The former Coastal Oil and Northeast Petroleum terminals on the Chelsea River have been closed and converted to other uses.

Replacement and lowering of utility lines and bridge replacement have been discussed in previous sections. Other than the 40-foot up-harbor depth limitation imposed by the elevation of the harbor tunnels, there are no restrictions posed by utilities, bridges, or pipelines under the without-project condition for the channel depth ranges under consideration for the several project areas.

Changes in the world fleets for both containerships and oil tankers are discussed under the without project condition (no Federal action) and presented in detail in the economic assessment (Appendix C). The continued phase-in of double-hulled tank ships and the shift to ever more larger containerships will make the impacts of shallow waterways increasingly restrictive, and waterway deepening ever-more critical to sustaining port operations and competitiveness.

Corps of Engineers Environmental Operating Principles

The Corps civil works mission has traditionally focused on its principal areas of responsibility: navigation, flood control, storm damage protection, and most recently environmental restoration. Water resources projects look to address society’s need to encourage economic growth consistent with a healthy environment and national security. Key to integrating these goals, which in the past were often viewed as conflicting, is development of projects and systems that are sustainable in the long term from each perspective. Integrated water resources management requires an examination of proposed projects in a manner that comprehensively examines outputs and potential to integrate other purposes to achieve overall sustainability. The Corps has reaffirmed its commitment to the environment in a set of "Environmental Operating Principles". These principles foster unity of purpose on environmental issues and reflect a positive tone and direction for dialogue on environmental matters. By implementing these principles within the framework of Corps regulations, the Corps continues its efforts to evaluate the effects of its projects on the environment and to seek better ways of achieving environmentally sustainable solutions in partnership with stakeholders. The seven “Environmental Operating Principles” are as follows:

1. Foster sustainability as a way of life throughout the organization. The improvements involve the use of the existing channels and so capitalize on the harbor's low sustainable maintenance dredging frequency of 16 to 41 years.
2. Proactively consider environmental consequences of all Corps activities and act accordingly. By focusing on improvements to existing project features for the benefit of existing terminals the project minimizes the impacts of construction and port operations.
3. Create mutually supporting economic and environmentally sustainable solutions. The potential beneficial use opportunities identified in the study represent an opportunity for balance between port development and the environment.
4. Continue to meet our corporate responsibility and accountability under the law for activities undertaken by the Corps, which may impact human and natural environments. The project will comply with all Federal and State laws and regulations, notably in the areas of economic justification, environmental impacts, and review and comment.
5. Consider the environment in employing a risk management and systems approach throughout the life cycles of projects and programs. Beneficial use of the dredged material and rock has been suggested as cap material for the former EPA designated Industrial Waste Site (IWS) in Massachusetts Bay, or for habitat enhancement or shore protection use.
6. Leverage scientific, economic and social knowledge to understand the environmental context and effects of Corps actions in a collaborative manner. An interagency Technical Working Group established during review of the EIS for the 1990 authorized project has been continued through the development of two major maintenance actions, and was used for this feasibility study to solicit input on study scope, review of findings, and dissemination of study information, materials, and recommendations. This will be continued through design and construction of the project.
7. Employ an open, transparent process that respects views of individuals and groups interested in Corps activities. This study was fully coordinated in a collaborative manner with the sponsor (Massport) and the Technical Working Group (TWG) which is comprised of Federal, state, and municipal agencies, local universities, and local non-governmental organizations (NGO's) with an interest in Boston Harbor.

For large-scale navigation improvements, the EOP require a view that doesn't end with merely minimizing and mitigating the impacts of dredging and dredged material disposal, but look further to examine how a project might incorporate features, methods and procedures that synergistically incorporate these mission goals. Towards that end, management measures are developed to address such opportunities, and where appropriate these are incorporated into project plans. Other procedures are evaluated and incorporated into project design at later stages when project recommendations are more defined.

Corps of Engineers Campaign Plan

The USACE Campaign Plan guides Corps policy decisions on how we organize, train, and equip our personnel; how we plan, prioritize, and allocate resources; and how we respond to emerging requirements and challenges. Implementation of the goals and objectives from this Campaign Plan will lead to actual change in the Corps organization moving the Corps from "good to great." The Corps strategic plan effort towards improvement began in August 2006 with the "12 Actions for Change" and has evolved to four goals and associated objectives. Although the effort originally developed with a focus on missions that seek to manage risk associated with flooding and storm damage, the Campaign Plan Goals and Objectives are applied to all aspects of the Corps including the navigation mission.

USACE Campaign Plan Goals and Objectives are derived, in part, from the Commander's Intent, the Army Campaign Plan, and Office of Management and Budget guidance. The four goals with associated objectives applicable to this civil works navigation improvement are:

- Goal 1: Deliver USACE support to combat, stability and disaster operations through forward deployed and reach back capabilities.
- Goal 2: Deliver enduring and essential water resource solutions through collaboration with partners and stakeholders.
    - Objective 2a: Deliver integrated, sustainable, water resources solutions.
    - Objective 2b: Implement collaborative approaches to effectively solve water resource problems.
- Goal 3: Deliver innovative, resilient, sustainable solutions to the Armed Forces and the Nation.
- Goal 4: Build and cultivate a competent, disciplined, and resilient team equipped to deliver high quality solutions.
    - Objective 4b: Communicate strategically and transparently.

The applicable objectives are incorporated in the navigation improvement feasibility study in various ways including:

Objective 2a and 2b. Considering the harbor as a physical and economic system with general navigation features, local service facilities, carriers and shippers and consideration of the environmental system associated with the area potentially impacted by the project. The recommended plan will be based on risk informed decision making by considering the likelihood and potential for gain in economic benefits related to the project improvements. The public is involved through the NEPA review process.

Objective 4b. The study provides opportunities for agency technical review and involvement of the Corps established Centers of Expertise, and technical and policy expertise available though the vertical chain of command at the New England District, North Atlantic Division, and Corps Headquarters, Office of Water Policy Review, Washington D.C.

MANAGEMENT MEASURES

Management measures are actions used to address the planning objectives and combined to create alternative plans. Management measures can be structural, such as channel dredging or new terminal development, or non-structural, such as reducing underkeel safety clearances or landing cargo at alternative ports. Non-structural measures for one port under study can have secondary structural requirements and impacts elsewhere, so all effects must be considered. At Boston Harbor, the planning objectives deal with the problems and needs relative to three types of cargo; containerized, general and dry bulk, and liquid bulk (petroleum fuels). While some management measures will relate to navigation impacts common to all three, some will relate solely to a specific cargo type. Management Measures should address overall cargo transportation costs, tidal delays, light-loading and lightering inefficiencies, port security requirements, and the risk of vessel damage/cargo loss. A list of the management measures being considered is provided below.

1. Non-Structural Management Measures for Port Operations in General
    A. Reduced Underkeel Clearance Requirements
    B. Improving Traffic Management Practices
    C. Changes in System of Aids to Navigation
    D. Optimizing Facility Operations
2. Structural Management Measures for Port Operations in General
    A. Development of New Terminals in the Port of Boston
    B. Development of Offshore Terminals
    C. Development or Expansion of Terminals in Other New England Ports
    D. Two-Way Traffic & Passing Measures (President Roads & Fort Point)
    E. Minor Bend Widening Improvements
3. Non-Structural Management Measures for Container Cargo Shipping
    A. Scheduling Modifications for Containership Port Calls
    B. Increasing Container Terminal Shoreside Operational Efficiency
    C. Expanded Feeder Operations
4. Structural Management Measures for Container Cargo Shipping
    A. Channel Deepening for Increased Containership Drafts
    B. Turning Basin Modifications for Larger Container Ships
5. Non-Structural Management Measures for Dry Bulk Cargo Shipping
    A. Increasing Bulk Terminal Shoreside Operational Efficiency
    B. Terminal Capacity Expansion at other New England Ports
6. Structural Management Measures for Dry Bulk Cargo Shipping
    A. Channel Deepening for Larger Dry Bulk Carriers
7. Non-Structural Management Measures for Liquid Bulk Shipping
    A. Offshore Liquid Petroleum Terminal & Pipeline Development
    B. Terminal Capacity Expansion at other New England Ports
8. Structural Management Measures for Liquid Bulk Shipping
    A. Chelsea River Deepening for Larger Tank Ships
9. Management Measures for Dredged Material Disposal
    A. Ocean Disposal
    B. Beneficial Use of Hard Bottom Materials
    C. Beneficial Use of Clay and Silty Materials
    D. Other Non-In-Water Options for Dredged Material Use
10. Management Measures for Impact Minimization and Avoidance
    A. Use Existing Project Limits to Maximum Extent
    B. Sequence Construction to Avoid and Minimize Impacts
    C. Use Best Management Practices for Blasting, Dredging and Disposal
    D. Maximize Beneficial Use of Dredged Materials

Non-Structural Management Measures for Port Operations in General

<u>Reduced Underkeel Clearance Requirements</u>: Underkeel clearance requirements for large cargo vessels at Boston, as practiced by the harbor pilots and shippers, is generally ten percent of vessel draft and no less than three feet, after accounting for vessel trim and other factors. With much of the harbor bottom ledge, till, cobble and other hard material, the pilots consider this a minimum for safe operation.

Attention must also be paid to the tides with their large variation in range, as shown in Table 22 below. The annual extreme minimum and maximum tidal ranges for the inner harbor are 5.5 and 10.3 feet, respectively, with an extreme greatest range of up to 18.8 feet. At an average of about 9.5 feet, rates of rise and fall in the inner harbor average about 1.6 feet per hour. Annual extremes relative to MLW range from a highest high water of about 14.7 feet and a lowest low water level of about -4.1 feet. These variations make scheduling around the tides difficult and place greater reliance on pilots.

TABLE 22
BOSTON HARBOR TIDAL DATUM DETAILS

Inner Harbor Tide Levels (at Castle Island)	Elevation (Feet)		
	NAVD88	MLW	MLLW
Highest Observed Water Level	+9.59	+14.76	+15.10
Mean Higher High Water	+4.76	+9.93	+10.27
Mean High Water	+4.32	+9.49	+9.83
Lowest High Water	+2.42	+7.56	+7.90
North American Vertical Datum 88	0.00	+5.17	+5.51
Mean Sea Level	-0.31	+4.86	+5.20
Mean Tide Level	-0.42	+4.75	+5.09
Highest Low Water	-2.12	+2.06	+2.40
Mean Low Water	-5.17	0.00	+0.34
Mean Lower Low Water	-5.51	-0.34	0.00
Lowest Observed Water Level	-9.23	-4.06	-3.72
TIDAL RANGES AT BOSTON HARBOR			
Extreme Least Range	LHW	HLW	5.50
Mean Range	MHW	MLW	9.49
Mean Greatest Range	MHHW	MLLW	10.27
Extreme Greatest Range	HOW	LOW	18.82

The greater exposure to seas in the entrance is also considered when planning vessel passage. Seas are commonly at least two feet higher outside of the protected headlands and islands that separate the Roads from Broad Sound and Massachusetts Bay, even in relatively calm conditions. With the authorized channel depths currently the same for the deeper lanes of the entrance and inner channels (40 feet), these sea conditions negate to some degree the ability of larger vessels to ride the tides to the berths. These conditions also lead to greater reliance on underkeel clearance than for inner harbor areas.

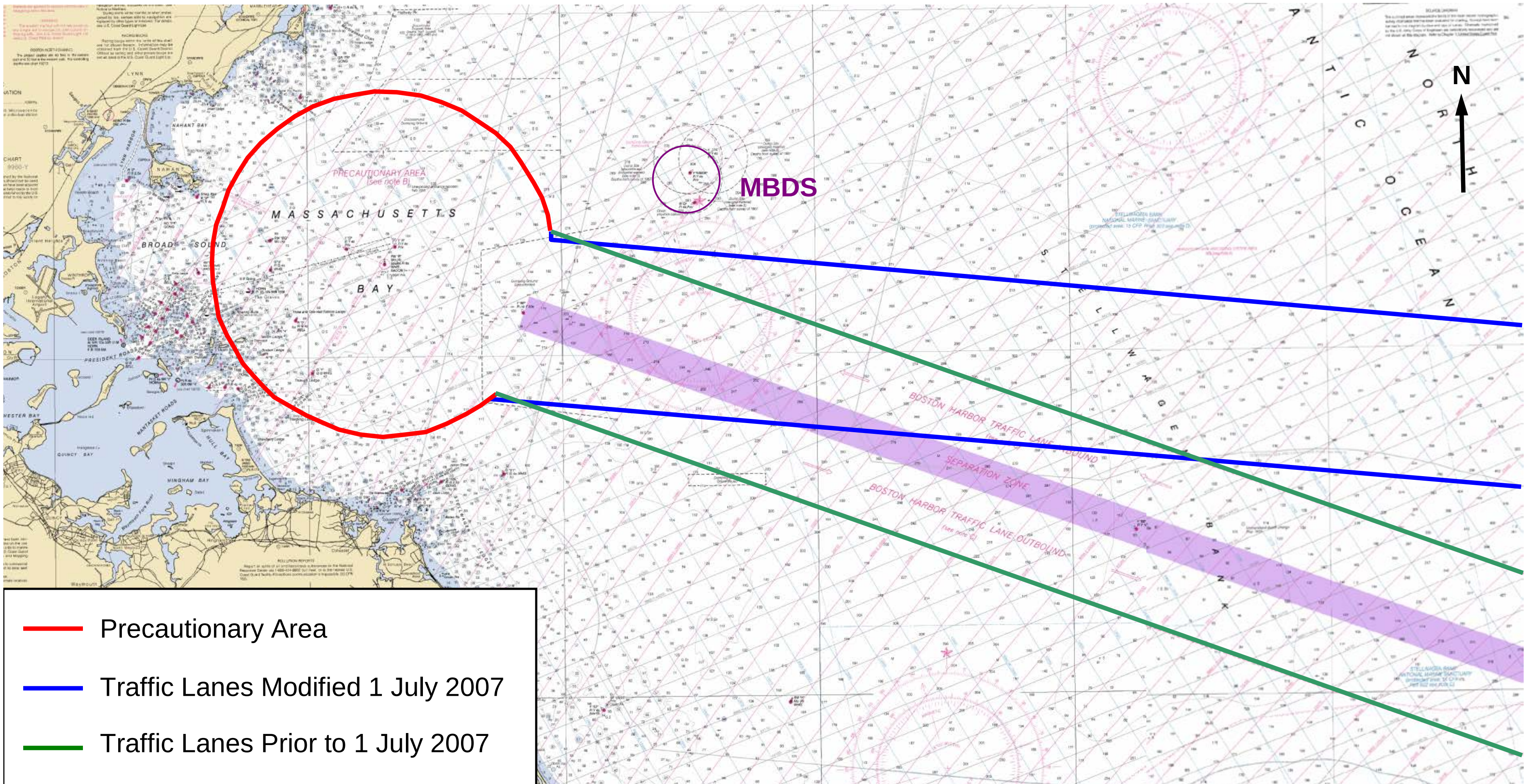
Normally, deeper-drawing vessels enter the harbor as the tide is rising so that they may make their berth and begin offloading as the tide turns and begins to fall. With this attentive management of vessel movement, groundings are rare, but still occasionally occur in the narrow (600 foot) and turning Main Ship Channel, and in the turning basins. The pilots and US Coast Guard believe that existing practices make maximum safe use of the available depth given the tides and current conditions, and that any reduction in the current underkeel clearance practices for large carriers would be imprudent. However, with the rate of rise and fall over each approximately 6-hour turn of the tide, and the distance traveled between the open Bay and the terminals, this assistance only adds about two to three feet of clearance.

<u>Improved Traffic Management Practices</u>: Traffic management practices, including vessel routing, vessel location and tracking, better timing of transits to tidal stages, can potentially improve harbor efficiency by reducing transit times for individual ships or for the fleet as a whole. Traffic management also has an important safety component to reduce the risk of vessel collisions and groundings. Communication between vessels in transit with each other, pilots, tugs, terminal management, enforcement authorities and port operators is key. A number of systems exist to facilitate harbor communications and traffic management including the US Coast Guard managed differential global positioning system, the traffic lane system in the Port's approaches, the Port's aids to navigation, weather forecasts and notices, and marine radio communications.

The U.S. Coast Guard provides differential global positioning service (DGPS) to the public in all U.S. harbors and approach areas. The system provides radio-navigational accuracy of 10 meters or less. All commercial vessels operating in U.S. waters are required to have and use onboard GPS receivers to plot their location and course.

The approach to Boston Harbor for large commercial vessels is one of 13 traffic lane systems in the United States prescribed by the International Maritime Organization. The approach system provides for 2 mile wide inbound and outbound traffic lanes with a 1 mile wide ship separation zone between them. Navigation according to such traffic separation schemes is intended to comply with Rule 10 of the International Regulations for Preventing Collisions at Sea (COLREGS). For the Boston approaches, these lanes are marked on NOAA's coast charts (#13267 – Massachusetts Bay, and #13270 – Boston Harbor) and terminate at the precautionary buoy (Lighted Whistle Buoy "B") in Massachusetts Bay, about six nautical miles easterly of the entrances to the two Broad Sound entrance channels. The turn through the 10-mile diameter Precautionary Area into the North Channel entrance is gated by a pair of buoys north of the Graves Light (RW "BG" and Fl G "5"). The Precautionary Area and harbor approaches are shown in Figure 23.

The traffic lanes were recently shifted as a result of action by the Government in response to concern over ship strikes with the endangered North Atlantic Right Whale, a seasonal inhabitant of Massachusetts Bay. The former route crossed close to Race Point off the northern end of Cape Cod and over the southern areas of Stellwagen Bank, a shallow sand bank favored by whales and other animals for feeding. The new route that went into effect on 1 July 2007 approaches the precautionary area from a more easterly direction to avoid the Bank and the Cape Cod shore. There are also established limits on vessel speeds in these areas as further protection.



BOSTON HARBOR, MASSACHUSETTS
DEEP DRAFT NAVIGATION FEASIBILITY STUDY

FIGURE 23
PRECAUTIONARY AREA AND CHANGES IN TRAFFIC LANES

Pilots generally board inbound vessels near the precautionary area buoy to direct passage of large vessels into and through the harbor. The US Coast Guard's Security Broadcast System for Boston Harbor, intended as a voluntary supplement to bridge-to-bridge radiotelephone regulations (33 CFR 26, VHF-MF Channel 13), requires security notification at the Precautionary Area buoy, at the entrance to the Broad Sound North Channel (Lighted Gong Buoy "NC"), at the entrance to President Roads, at the vicinity of Commonwealth Pier and at the Inner Confluence. Outbound vessels also give notice when departing the berth.

Marine traffic at Boston is currently managed in an efficient manner within the constraint imposed by the natural conditions of tides, weather and ecological impact. No traffic management options were identified that would improve on the existing condition and address the problems and opportunities for improved navigation and commerce.

<u>Changes in System of Aids to Navigation</u>: Aids to navigation (ATON) in use at Boston consist of lighthouses, buoys, ranges and radar. Lighthouses mark the northernmost (The Graves Light) and southernmost (Boston Light on Little Brewster Island) of the outer harbor islands. These serve to bracket the island and shoal-studded area between the Narrows Entrance and the two Broad Sound entrances to the harbor. Long Island Head Light and the light tower on the ledge south of Deer Island gate the main channel in the short reach between the outer confluence of the three entrance channels and President Roads. These aids are described in Table 23.

Lighted buoys mark the main channels from the Precautionary Area in the open Bay into the harbor and throughout its deep draft channels to the terminals. Seaward of the entrance channel these also include fog signals (horns and whistles). In the entrance and main ship channels these buoys mark the turns and "gate" the straight channel reaches in pairs every half-mile. Single lighted buoys mark specific obstructions outside the channels, such as Finn's Ledge north of the entrance to the North Channel, and the Great Faun Shoal east of Deer Island (RN "6A"). The perimeters of the two anchorage areas in President Roads are also marked by lighted buoys. At a few critical turns (Castle Island and Charles River) buoys have been replaced with smaller lighted towers.

TABLE 23
BOSTON HARBOR AIDS TO NAVIGATION

Light	Elevation Above MHW	Tower Type	Other Signals
Boston Light	102 Feet	White Conical Tower	Fog
The Graves Light	98 Feet	Grey Conical Tower	Fog
Deer Island Light	53 Feet	Red Cylinder Tower	Fog
Long Island Head Light	120 Feet	White Tower	- -

Boston Harbor is well provisioned with aids to navigation. The locations of the harbor islands and headlands with respect to channel alignment do not lend themselves to the establishment of fixed ranges in the outer harbor. In the inner harbor areas, the many channel turns (every half-mile below Castle Island and about every mile above) make ranges impractical. The extensive system of lighted gated buoys adequately marks the existing channels and is deployed and maintained in a manner that effectively promotes navigational safety and efficiency.

Channel modifications, particularly channel widening, would require relocation of buoys to match the revised channel limits. Incorporation of bend wideners in the channel may require additional buoys to mark the increased number of turn apexes. However, no non-structural alternatives incorporating modifications to the Port's ATON system were identified.

Optimizing Facility Operations: Existing facilities are operated in a manner that meets each terminal owner's needs to service their vessels and customers. Massport's public terminals are segregated to concentrate differing operations at different locations around the port, with its deepest draft needs (containers and the new deeper draft bulk terminal) located closest to the sea. Massport is currently implementing upgrades to the Conley Terminal's shoreside operations to maximize landside capacity and throughput times by improving vehicle access, tracking of containers, reconfiguring laydown and gate areas, installing additional (and larger) cranes, and better management and export of empty containers. Massport has already deepened two berths at Conley to handle larger post-Panamax containerships expected with channel deepening to 45 feet, and has plans for additional deepening to accompany any greater recommended channel depths. Massport is also acquiring adjacent land to expand the container terminal. All of these improvements, except for berth deepening beyond 45 feet, will occur whether the channels are deepened or not, and will serve to make maximum use of terminal capacity and operation.

Massport's redevelopment of the Medford Street Terminal, and the planned redevelopment of the Marine Terminal in South Boston have attracted importers interested in using these facilities. These companies, will work with Massport to bring these new services and terminals on line, including new bulkheads and berths at the Marine Terminal, whether or not the Federal channels are deepened beyond 40 feet. While these new terminals and services will be designed to optimize shoreside operations, actual experience will likely lead to improved efficiencies over time. The companies planning to operate out of each of the two terminals want to bring in deeper-draft dry bulk vessels and are planning their operations accordingly.

The Port's liquid bulk petroleum terminals, with the exception of Exxon, are all located on the Chelsea River. Replacement of the Chelsea Street Bridge will give each the ability to receive tankers with greater beams than the current Chelsea-max vessels which are generally 25,000 DWT. With bridge replaced and the channel at the 38-foot currently authorized depth, the fleet mix of tankers using the waterway will shift up to 35,000 DWT with some above that (16% under 35,000 and 15% over 35,000). With the channel deepened to 40 feet the tanker fleet mix will again change to where the majority are now greater than 35,000 DWT (8% under 35,000 and 23% over 35,000). Berth deepening will be required to accommodate these larger tankers, however no shoreside improvements are required as storage capacity is sufficient to accommodate the slightly larger cargos that would be discharged.

Other than the improvements already planned by Massport and its customers for the container and dry bulk terminals, no shoreside improvements were identified that would, without further channel deepening, result in additional cargo shipments.

Structural Management Measures for Port Operations in General

Development of New Terminals in the Port of Boston: Nearly all waterfront land in the City of Boston seaward of the tunnels is currently developed or under development. Massport is working with a developer to redevelop the Massport Marine Terminal in South Boston for a dry bulk cargo terminal, cargo transshipment, and warehousing operations. Massport has also acquired the former Coastal Oil terminal on the Reserved Channel for expansion of the Conley Terminal. The Fan Pier area located at the mouth of the Fort Point Channel had until recently been the last large undeveloped parcel on the waterfront, but is now the site of the new Federal courthouse and a proposed hotel-residential-office-retail mixed use development. Elsewhere around the harbor outside the City there are no remaining undeveloped or underdeveloped properties of sufficient area and access to develop new container or other cargo terminals. Those harbor islands not included in the Boston Harbor Islands National Recreation Area are included in the Harbor Islands State Park, are used by the Massachusetts Water Resources Authority for sewage treatment facilities, are City parkland, or used for other purposes (hospital and private nature preserve).

Above the tunnels, channel depth is limited to the 40 feet that is currently carried over them. There are a number of underutilized properties along the East Boston shore along the upper Main Ship Channel. However these are all constrained by a lack of shoreside area needed to support cargo operations. Most are slowly being converted into residential and recreational use, though some commercial activities, including the harbor’s tug fleet operations, and small ship yards are located in these areas. Similarly, there is underutilized land along both sides of the Chelsea River, some of which was once petroleum tank farms. All of these properties are constrained by the tunnel depth and would not be usable for new deeper-draft container or bulk operations requiring more than 40 feet.

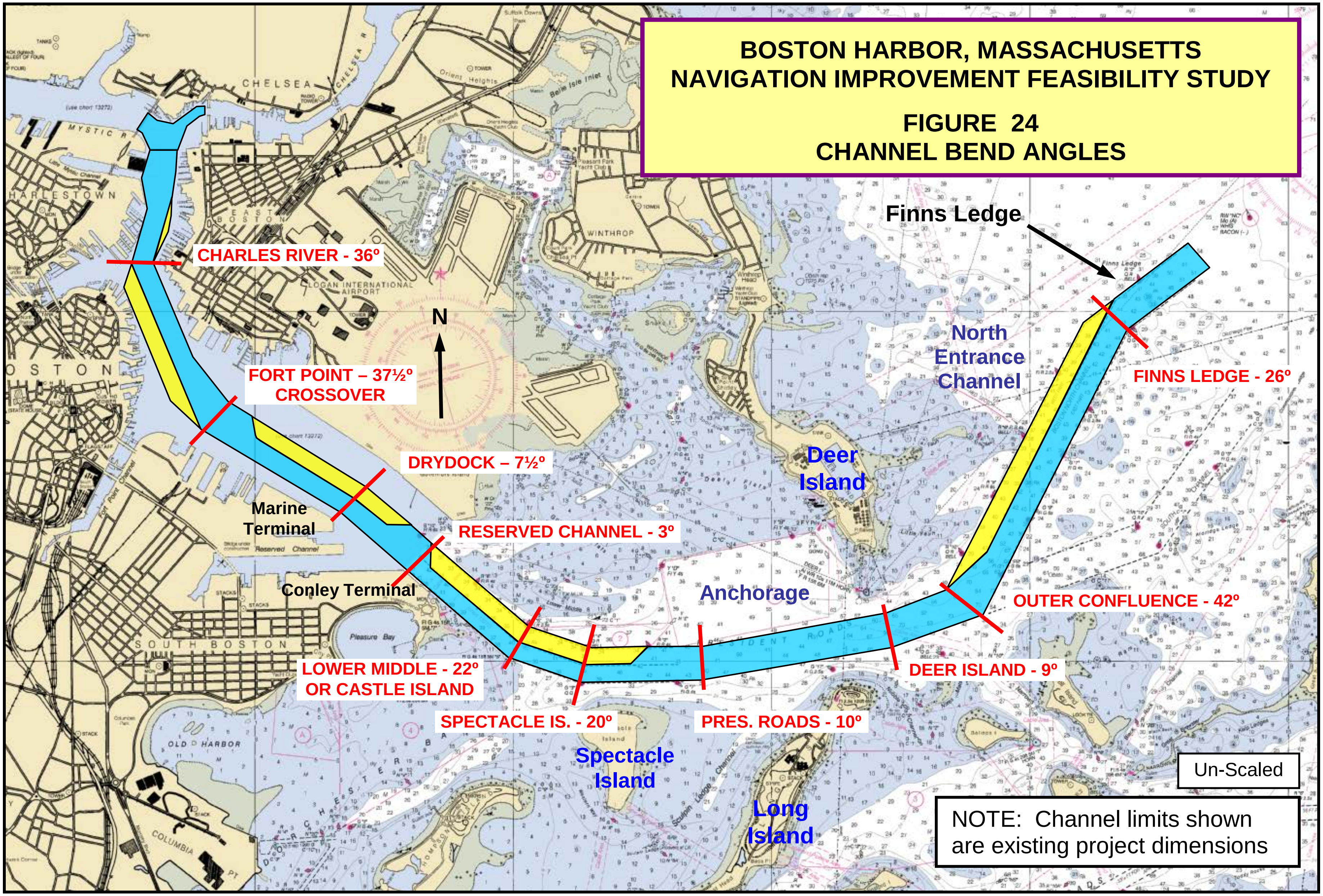
Development of Offshore Terminals: As stated previously, there are presently two proposals to construct offshore LNG offloading terminals in Federal waters northeast of the harbor entrance, one of which became operational in late December 2007 and the other in 2010. Operating such facilities in the open waters of Massachusetts Bay and the Gulf of Maine will present engineering and logistical/operational challenges. These facilities involve mooring submergible loading buoys to offload degasified LNG from tankships and feed gas into pipelines connecting to existing pipelines under the Bay leading to the existing pipelines and terminals ashore.

Offshore terminal development for liquid petroleum products is more problematic. The EIS studies for the gas terminals narrowed the areas available to offshore terminal placement to discrete areas inshore of Stellwagen Bank and seaward of ecologically sensitive and protected state waters, after considering conflicting uses and critical resource areas in the Bay. After construction of the two gas terminals, siting of an additional ocean terminal in the Federal waters of the Bay may be possible, but would be limited to an exposed section of the Bay east of Marblehead and south of Gloucester. Offloading liquid petroleum products into offshore pipelines in the exposed seas of the North Atlantic carries a significant potential for accidental release of oil and other products into the ecologically sensitive waters of Massachusetts Bay. Proposals for liquid bulk terminals in the Bay have been considered in the past and are unlikely to meet approval in the future.

Minor Bend Widening Improvements: Bend wideners are presently provided only at four locations in Boston's 40-foot channel system. Table 24 below, and Figure 24 show the angles for each turn or bend in the North Entrance and Main Ship Channel. At the seaward end of President Roads the three entrance channels join the Main Ship Channel in the Outer Confluence. A flare (or bend apex cut-off) in the northern limit of the 40-foot channel is provided east of Deer Island Light to ease the bend between the MSC and the North Entrance Channel. A second flare is provided where the Main Ship Channel narrows from 1200 to 600 feet as it exits President Roads to ease the inbound transition, and smaller flares are provided at either side of the anchorage to ease access to and from channel. A third widened area provided at the Main Ship Channel crossover off the mouth of the Fort Point Channel (between the tunnels) where the 40-foot lane changes sides in the MSC. The Inner Confluence of the Main Ship, Mystic and Chelsea channels at the head of the harbor is also widened through its approaches to ease turning to and from the two tributaries.

TABLE 24
BOSTON HARBOR CHANNEL BEND/TURN ANGLES

Channel Bend or Turn	Buoys Marking Turn	Angle or Turn Measured at Apex
Broad Sound North Entrance Channel – Finns Ledge Turn	FR-2 & FG-3	26º
Turn from Entrance through Outer Confluence	RB-10, GB-15 & FG/R PR	42º
Deer Island Bend	FG-17 & DI Lt.	9º
President Roads Bend	FG-1 & FR-2	10º
Spectacle Island Turn	FG-3 & FRB-4	20º
Lower Middle Ground Turn	FR-6	22º
Reserved Channel Bend	FR-10	3º
Drydock Bend	FR-12	7½º
Fort Point Crossover Turn	FG-13	37½º
Charles River Turn	Light R-14	36º


BOSTON HARBOR, MASSACHUSETTS
NAVIGATION IMPROVEMENT FEASIBILITY STUDY
FIGURE 24
CHANNEL BEND ANGLES
Finns Ledge
CHARLES RIVER - 36º
FORT POINT – 37½º CROSSOVER
DRYDOCK – 7½º
RESERVED CHANNEL - 3º
LOWER MIDDLE - 22º OR CASTLE ISLAND
SPECTACLE IS. - 20º
PRES. ROADS - 10º
DEER ISLAND - 9º
OUTER CONFLUENCE - 42º
FINNS LEDGE - 26º
N
Marine Terminal
Conley Terminal
North Entrance Channel
Deer Island
Anchorage
Spectacle Island
Long Island
CHELSEA
CHARLESTOWN
EAST BOSTON
WINTHROP
LOGAN INTERNATIONAL AIRPORT
SOUTH BOSTON
Un-Scaled
NOTE: Channel limits shown are existing project dimensions

The Boston Harbor Pilots requested that any improvements examine providing additional bend wideners in the outer North Entrance Channel and lower Main Ship Channel. At the bend between the 1100 and 900-foot wide reaches of the 40-foot lane in the entrance channel, a widening at the bend apex opposite Finns Ledge was requested to assist large vessels in avoiding this obstruction. In the lower Main Ship Channel additional width was requested in the channel itself with further widening in transition between the Roads and the MSC and in the two bends between the Roads and the Reserved Turning Area. These requests were included in the Ship Simulation Study conducted by ERDC that will be discussed in detail later.

Two-Way Traffic & Passing (President Roads & Fort Point): The deeper-draft lanes of the existing project (40-foot) provide 1,100 feet in the outer reach of the entrance channel, 900 feet in the remaining reaches of the entrance channel, 1200 feet through President Roads and 600 feet in the Main Ship Channel. These widths provide ample room under most circumstances for large carriers and their attendant tugs to pass smaller craft, such as the many commuter ferries, barges, fishing and tour boats that travel the same channels.

Increasing the size of the large carriers calling on the Port will require a review of the channel width requirements for passing situations involving larger and smaller craft. This is complicated by the location of the deeper-draft channel lanes at Boston largely located on the port-side inbound, forcing starboard to starboard passing, contrary to the rules of the road in inshore waters. The passing of two large carriers in the narrower channel reaches is rare and the location of President Roads and the channel lane cross-over area, where the deeper depth spans both lanes, helps limit conflicts. Any deepening of the deeper-draft lane that includes the full width through President Roads will maintain the current system and avoid the need to provide two-way deeper-draft traffic throughout the entire Main Ship Channel. Providing additional channel width for the passing of two large modern carriers is not necessary given the existing or projected traffic for Boston Harbor.

Non-Structural Management Measures for Container Cargo Shipping

Scheduling Modifications for Containership Port Calls: Container lines place varying degrees of emphasis on port rotation, scheduling, loading and delay avoidance in accordance with each line's business model and practices. Where one line may adjust arrivals and load to avoid any potential delay in schedule, another may prefer to accept some delay in exchange for loading more boxes. The shippers adjust their practices as their needs and markets change, adding or dropping ports, changing rotation or adjusting loading and tidal navigation practices. One or more of these methods are already practiced by the lines calling at Boston as they balance minimizing transportation cost and meeting schedules. If all shipping lines were to adopt similar practices, other inefficiencies, such as lack of open berth space at particular ports, could result as multiple vessels applying the same weight to the various factors seek the same operating conditions.

While there are likely small efficiencies to be found in any complex system like global container shipping, it must be remembered that the various shipping lines and agents are private enterprises in competition for cargo and customers. These companies will make operational decisions based on their own strategy for meeting customer needs and maintaining and growing their business according to their own capabilities. Not all will see any particular practice, like riding the tide, changing their fleet mix, or changing rotation as desirable, and most may not care to publicly speculate how they might respond to changes in port depth or capacity, let alone how they might change in the absence or occurrence of any improvements.

Shippers are unlikely to add or retain smaller vessels for a particular service just to meet the needs of lesser depth ports as using multiple ships would add substantially to their cost for that service. The increased landside transportation cost for New England cargo landed and loaded in New Jersey represents less of a burden than the cost of additional vessels to a portion of that same cargo. It is the ever increasing gross volume of trade requiring carriage, the economies of scale of larger ships, and the competitive nature of the carriers that has driven recent increases in vessel sizes and influences carriers' decisions on port rotations.

Increased Landside Operational Efficiencies at Conley Terminal: Under the without project condition, Massport has and will continue to undertake operational improvements and expansion at Conley Terminal that would increase its annual container throughput capacity. Conley currently handles about 220,000 TEUs annually (2007 - Massport). The proposed terminal upgrades and improvements, expected to be completed by 2010, would increase annual throughput capacity to about 550,000 TEUs. These improvements in the facility, process and movement of boxes will enable the port to absorb a significant increase in boxes shipped. This increase in capacity would be filled by the additional cargo landed by the larger vessels that would be accommodated by deeper channels. Additional increases in efficiency and capacity are not planned at this time.

Expanded Barge Feeder Operations at Boston Harbor: In the past, Boston has received container shipment by barge feeder operations from the PONYNJ and Halifax. The last three barge services from Halifax have failed, most recently EIMSKIP in December 2007.

The Columbia Coastal Transport barge operation was a weekly service from the PONYNJ. It carried mainly overweight and refrigerated containers that were more difficult to ship overland by truck. In 2007 only 15,607 containers were carried by this service and Eimskip for the few months it was in operation, a decline of nearly 20 percent from 2006. Barge service accounted for only about seven percent of containers shipped through Boston in 2007. Columbia Coastal ceased service to Boston in 2009 due to a lack of demand.

American Feeder Lines ran a barge container service between Halifax, Portland, Maine and Boston for nine months in 2011-2012, but suspended service in April 2012, also due to a lack of cargo, and despite a subsidy from the Province of Nova Scotia.

Should the channels at Boston not be deepened, with the result that direct container service calls decrease, then more heavy reliance on truck and barge carriage may result. The barge services operate at shallow drafts (28 feet or less) and access Boston on all tides without regard to any proposed changes in channel depth. As discussed in later sections of this report, and in detail in the Economic appendix (C-1), barge transport requires additional rehandling costs which make it more expensive than trucking, and use of barges also entails more delay time over trucking.

Structural Management Measures for Container Cargo Shipping

Channel Deepening for Containership Operations: Given the importance in scheduling to container shippers and the use of tidal assistance already practiced at Boston, increasing the volume of containers shipped into the port in any substantial amount would require deepening of the main channels accessing the Conley Terminal. Increased barge transportation, as discussed above and later in this report, has not proven viable at Boston, as high costs have forced cessation of all but one service. Use of additional small containerships in international trade has been discounted by shippers, and use of these ships in east coast trans-shipment services would, as with barges, not compare favorably with trucking due to increased rehandling and storage costs, or with direct calls by larger ships.

Development or Expansion of Terminals at Other New England Ports: Development of additional port capacity for containerized cargo outside the Port of Boston to serve the New England demand was considered. New England harbors with navigation depths of 30 feet or greater include the following ports shown in Table 25. (see Figure 3)

TABLE 25
ALTERNATIVE NEW ENGLAND CONTAINER PORTS

Harbor	Channel Depth in Feet MLLW	Interstate Highway Miles from Boston	Container Terminal	Barge Feeder Service
Searsport Harbor, ME	35	230	No	No
Portland Harbor, ME	35	107	No	No[3]
Portsmouth Harbor, NH	35	57	No	No[1]
Salem Harbor, MA	32	22	No	No
Boston Harbor, MA	40	- -	Yes	No[3]
Weymouth Fore River, MA	35	12	No	No
New Bedford Harbor, MA	30	58	No	No
Fall River Harbor, MA	35	50	No	No
Providence Harbor, RI	40	52	No	No
Quonset-Davisville, RI	35	75	No	No
New London Harbor, CT	40	110	No	No
New Haven Harbor, CT	35	147	No	No
Bridgeport Harbor, CT	35	167	No	No[2]

1 - Service resumed in July 2007 and then dropped in December 2007 (Eimskip)
2 – Service proposed but not developed
3 – AFL barge service from Halifax ceased April 2012

Searsport Harbor, Maine has an existing Federal channel with an authorized depth of 35 feet. The project serves two petroleum products terminals (Irving Oil and Spraque Energy) and the State Pier owned by Maine DOT which receives and exports dry bulk cargos including aggregates, wood products, tapioca, and manufactured goods. A feasibility study cost-shared between the Corps and Maine DOT is currently underway to look at deepening the channel to 40 feet to permit deeper draft vessels to access the terminals to improve the efficiency of handling existing cargo types. No container handling capacity or equipment exists at Searsport. A proposal to develop a containerport on adjacent Sears Island in the 1980s was abandoned by the State after intense NGO and political opposition. The limited nature of this port's operations and its distance from Boston make it impractical as an alternative port to Boston for any classes of cargo.

Portland Harbor, Maine is that state's largest Port. The Portland Pipeline Company has deepened the harbor's entrance channel as far as its berths to 48 feet. This facility receives crude oil and pumps it overland to refineries in Quebec. There are no areas available for new terminal development seaward of the pipeline company. All other terminals are located along the 35-foot Fore River Channel. Portland Harbor, Maine was the subject of an unfavorable April 1987 report that examined deepening the existing 35-foot Fore River channel to depths of between 38 and 45 feet. The improvement was intended to primarily benefit petroleum products deliveries for the northern New England market. The extremely narrow clearance of the State Route 77 bridge, since replaced with a larger span and opening, made use of larger tankships impossible. Little interest has been shown by terminal operators in re-visiting the channel deepening proposal since the bridge replacement, and Maine DOT indicates the State is not interested in further study at this time. There is but one dry bulk cargo terminal that handles a limited number of containers landed by barge, but no scheduled service since the American Feeder Lines ceased service in April 2012. There are no plans for development of a larger container terminal at Portland and its distance from the more heavily populated areas of southern New England make it an impractical substitute for Boston.

The Port of Quonset-Davisville was studied by the Corps and the State of Rhode Island in the 1990s and early 2000s in connection with plans for re-use of the former US Naval base at Quonset-Davisville, for redevelopment as a containerport. A Section 905(b) Reconnaissance Report for the Port of Quonset-Davisville called for by §452 of WRDA 2000 was published in July 2001 and favorably considered development of a new regional deep-draft container port. Dredging a 45 to 50-foot MLLW channel to the port would have required removal of between 7 and 11 million CY at a cost of $120 to $180 million (2000 costs), plus more than $250 million for State development of the new Port's shore facilities. Additional non-Federal costs for highway improvements, takings, and mitigation and ancillary improvements were not estimated at the 905(b) level. The cost for new port development at Quonset-Davisville would be far in excess of the proposed deepening costs for Boston Harbor.

No feasibility study was ever conducted for Quonset-Davisville, as intense public opposition to development of this port led the proposal to become a major issue in the 2004 Rhode Island gubernatorial campaign. The new governor terminated planning efforts for development of the port and the proposal is not expected to be resurrected in the future. The northern area of that port was developed by Rhode Island for auto imports and frozen seafood shipments, but no other improvements are planned. The southern area of the port is being redeveloped for light industrial uses including a small shipyard fabricating submarine hull sections, ferry service to Martha's Vineyard and a number of non-navigation dependent uses. As of 2011 the State had expressed an interest in attracting a container barge feeder service, but none has been initiated.

No other New England ports have the facilities and depths sufficient to provide a viable alternative to the Port of Boston for containerized cargo. Alternative means of cargo transport consist mainly of the trucking into the region of cargo landed at more distant ports. Under the existing and without-project conditions, large volumes of New England destined cargo are landed at the Port of New York and New Jersey. This cargo is then trucked into the region or loaded onto barges for transport to Boston or other smaller New England ports such as Portsmouth NH or Portland ME (both 35 feet), and Providence RI (40 feet). A barge feeder operation from New York Harbor to Bridgeport, Connecticut (also 35 feet) has been examined in an effort by the State to reduce truck traffic on the Connecticut turnpike, but no such service has begun.

Development of Alternative Container Terminal Sites within the Port of Boston: Development of additional port capacity for containerized cargo within the Port of Boston has severe limitations. As stated previously in outlining the existing conditions, container operations at Boston are segregated in a single terminal (Conley), the terminal located closest to the sea and downstream of the tunnel restrictions on channel depth. In the heavily developed metropolitan area of eastern Massachusetts, no other sites exist at which a new terminal could be constructed that has both highway and deep water access in close proximity. In any event, the cost of developing a new container terminal would far exceed the cost of improving the channel depths to the existing Conley Terminal.

Turning Basin Modifications for Larger Container Ships: With all containerships calling on Boston using the narrow Reserved Channel, the ships must be turned either inbound or outbound. Present practice is to use tugs to turn the ships inbound and back them into the Reserved Channel a short distance to the deep berths at the Conley Terminal. The Confluence of the Reserved Channel, Main Ship Channel and the Drydock Approach Channel, all dredged to 40 feet since 2000, allows for the efficient location of the Reserved Channel Turning Area off the seaward end of the terminal. The existing 1200-foot effective diameter of the turning basin was established by the design effort for the 40-foot project authorized in 1990. Any increase in the size (length) of the containerships calling on the Conley Terminal will require an increase in the effective diameter of the Reserved Channel Turning Area.

The needs of the pilots and tug masters to work with the currents and turn the vessels so that they align properly to reverse into the channel to the berth is one consideration. The approach and safety zone for one of the principal runways to Logan Airport crosses over the area of the turning basin. The need of the airport to have the turning vessels in the area for the minimum amount of time needed must also be considered. The presence of large areas of shallow ledge located both up and down-channel from the existing basin site is also of concern. Alternative turning basin configurations were developed to examine these potentially competing factors and are shown in Figure 20.

Non-Structural Management Measures for Dry Bulk Cargo Shipping

Increasing Bulk Terminal Shoreside Operational Efficiency: As stated previously, Boston's several private bulk cargo terminals are primarily small specialized operations handling one specific commodity, like salt or gypsum. There are no large general bulk cargo terminals; a situation Massport intends to address through the redevelopment of the Marine Terminal and Medford Street Terminal. Massport's analysis of demand for terminal capacity has focused their efforts on cement and refrigerated cargos requiring additional space. There are several small cement import operations around Boston Harbor, one on the seaward end of the former Army base pier on the north side of the Reserved Channel, and the others on the Mystic River. These operations have limited space both dockside and landside and would be unlikely to expand at their current locations. Of the potential partners with Massport in the new terminal developments, most are cement importers, indicating the continued demand for this product in New England. If an increase in these cargoes is to be accommodated, new terminal capacity needs to be developed.

Expansion of Existing or New Boston Terminals for Dry Bulk Cargo: There are a number of dry bulk facilities located around Boston Harbor as discussed earlier. Most of these are specialty terminals handling salt, gypsum, scrap metal, cement and refrigerated foods. Massport's discussions with potential lessees and users of its facilities point to a shortage in capacity for cement and refrigerated cargo. Existing terminals have insufficient storage and throughput capacity to meet this demand, and so Massport has been re-developing its facilities at South Boston and at Medford Street in Charlestown (Mystic River) to meet this demand. Both these sites have the existing landside access, storage area, and easy connection to the highway system to enable increased cargo handling and shipment.

There are few other unused sites on the harbor's waterfront with sufficient size to support development of new dry bulk facilities of more than very limited capacity. Downstream of the tunnels, and therefore available for channel access greater than 40 feet, only the Massport Marine Terminal site remains available for development.

Upstream of the tunnels most waterfront use has been converted to non-marine industrial uses. In recent years a new Federal courthouse, hotels, marinas, State and Federal parks, residences, airport expansion, museums, and convention centers have been constructed along the harbor's waterfront. The entire City core waterfront on the Main Ship and Charles River channels, with the exception of the Coast Guard base is now residential, hotel and retail space, with some small marinas, ferry terminals and the New England Aquarium. On the Charlestown side of the Main Ship Channel, only Massport's Mystic Piers (small bulk operations) remain in use for shipping. The remaining Charlestown waterfront is used for residential, marina and National Park Service use. On the Chelsea River, two former oil terminals have been converted to parking facilities for Logan Airport. On the Mystic River, the former Chelsea Naval Hospital was redeveloped for residential use and properties along the 30-foot channel area were converted to retail and residential uses. The former Naval Fuel Depot adjacent to the airport was converted to marina and small ship repair uses. Massport's East Boston Piers along the main ship channel are leased for small commercial operations and small craft access.

Massport has begun redevelopment of its Medford Street Terminal on the Mystic River by clearing the site and deepening the berth to 40 feet. With the berth already deepened Massport is seeking a developer to modernize and operate the terminal for bulk cargo. In the meantime the terminal is being used to handle overflow storage from the adjacent Autoport. No other unused or underutilized sites have been suggested for additional bulk operations in any of the upper harbor areas. However, as the eastern New England region's demand for bulk commodities continues to grow, some means of expanding delivery capacity to the region for these goods will need to be developed.

Bulk Terminal Capacity Expansion at other New England Ports: Expansion of terminal capacity at other New England ports is occurring. Improvements have been made and are planned for Searsport and Portsmouth; however those ports serve limited market areas. Although Searsport is proposed for deepening to 40 feet, its distance from Boston makes it unlikely to compete with Boston for bulk cargo bound for southern New England. Maine has its own in-state producer of cement and is an exporter of refrigerated produce. Providence has some additional capacity for bulk cargo shipment, however that port is constrained to a 40-foot depth by the CAD cells located under the harbor basin. New London's 40-foot channel dredged by the US Navy only accesses the Pfizer terminal and General Dynamics shipyard. All other New England deep draft ports have depths of 35 feet or less. No expansion of terminal capacity would occur in these ports without corresponding channel deepening. At Boston the new terminals are already or will shortly be under development and only channel improvements are needed to increase their handling capacity.

Structural Management Measures for Dry Bulk Cargo Shipping

Channel Deepening above the Reserved Channel: With no land seaward of the Reserved Channel available for a dry bulk or general cargo facility, areas up-harbor must be considered. Accessing any of these at a depth greater than the 40 feet already provided by the Main Ship Channel would require channel deepening and potentially facility and berth improvements as well. Both of the sites available for development of such facilities and operations are owned by Massport; the Marine Terminal in South Boston and the Medford Street Terminal in Charlestown.

Of those two facilities, only the Massport Marine Terminal is located seaward of the tunnels and could have access improved to depths greater than 40 feet. The redevelopment of this facility is being negotiated by Massport and its designated developers for the property. Terminal redevelopment would occur with or without deepening of the Main Ship Channel beyond the existing 40 feet and would consist of new bulkheads, a maintained berth depth of at least 40 feet, and development of shoreside facilities for each cargo type (cement, reefer, and others).

The Medford Street Terminal on the Mystic River already has a 40-foot berth and 35-foot channel access. As previously noted, Massport until recently expected to lease the terminal to a bulk cement terminal operator but learned in 2008 that the lease would not be executed. Massport is currently exploring other bulk cargo operations for the site including cement, automobile imports/exports, wind mill component assembly and export, and passenger vessel operations. With the expected resumption in the increase in dry bulk and break bulk cargo through the Port of Boston, and resumed economic growth demand for such commodities in eastern New England, there is a need for additional terminals dedicated to handling these types of cargo. Its is anticipated that Massport will have little difficulty in finding other prospective tenants and operators in the near term. While channel deepening may or may not be needed to attract such operations, depending on the commodities to be shipped, a deeper channel may be needed to allow arrival of more heavily laden ships.

Non-Structural Management Measures for Liquid Bulk Cargo Shipping

Using Smaller Capacity Tank Vessels: Chelsea River, with its extreme width limitation at the old Chelsea Street Bridge, had acquired its own class of narrow beam tankships. These Chelsea class ships were also required at other northeast ports such as Portland ME and New Jersey where similar bridge restrictions existed until the last decade. Chelsea River was the last waterway with that restriction, which was eliminated by completion of construction of the new Chelsea Street Bridge in 2012 and removal of the old span. The conversion of the world fleet to double hulls also made bridge replacement imperative for this waterway. These aging smaller tank ships will soon be excessed and no longer available for use in US waters. Without channel deepening the ships replacing them will have to come into Chelsea light, either by light loading at origin, offloading at other ports first, or lightering in the anchorage as do larger vessels already. The U.S. Coast Guard does not allow lightering of tank ships carrying gasoline inside the harbor, including the anchorage.

Increased Use of Lightering: As stated above, with the bridge replaced and without any channel deepening, light loading and lightering will become increasingly necessary for carriers supplying the region's fuel terminals on the Chelsea River. With an increase in the average vessel size in the tanker fleet serving the northeast, use of the deep-draft anchorage is expected to increase.

Structural Management Measures for Liquid Bulk Cargo Shipping

Chelsea River Channel Deepening for Larger Tank Ships: With replacement of the Chelsea Street Bridge, and in the absence of other improvements, deepening of the Chelsea channel would be required to allow receipt of liquid petroleum cargos by larger or less-lightered tank ships, which would increase the cost-effectiveness of oil shipments into Boston. With an additional two feet of channel depth to -40 feet MLLW, the maximum practical channel depth upstream of the tunnels, tank ships of up to 50,000 DWT would be able to transit the waterway with tug assistance. Minor bend widening in the bridge approaches as recommended in the 1992-93 simulation study would be required, along with deepening the berths at the principal terminals. Given the lack of sediment sources, maintenance dredging at 40 feet is not expected to be greater than maintenance needs for the existing 38-foot channel; about once every 20 years or so. Table 26 provides the WCS data for Boston Harbor's petroleum products shipments.

Pipeline Terminal Outside the Chelsea River: In the 1970s and 1980s development of pipeline terminals in the outer harbor with connection to the tank farms along the Chelsea River was considered and dismissed. Concerns over the potential for spills in the ecologically sensitive outer harbor were the main reason for dismissing the concept. The outer harbor's use for lobster harvesting, finfish spawning and recreation were all greater considerations. The presence of the airport also contributed to the unfavorable view on such development, as conflicts with runway approaches would exist at most any location accessed by the Main Ship Channel. The cost for developing a joint pipeline system to carry multiple products (gasoline, fuel oils, aviation fuel, kerosene, etc.) to multiple competing terminals and storage areas would also likely exceed the cost of channel improvements, given the infrequent maintenance dredging needs for this waterway.

TABLE 26
BOSTON HARBOR PETROLEUM PRODUCTS SHIPMENTS
(2010 Waterborne Commerce Statistics)

Commodity (x 1000 Tons)	2010 Total	Foreign		Domestic	
		Tons	% Liquid	Tons	% Liquid
Total Petroleum Products	14,867	10,063		4,804	
Total All Liquid Petroleum	11,223	6,419	57 %	4,804	43 %
Gasoline	5,575	,4723	42 %	852	8 %
Kerosene	634	12	0 %	622	6 %
Fuel Oils	4,796	1,592	14 %	3,204	29 %
Other Liquid Petroleum	218	92	1 %	126	1 %
LNG	3,644	3,644		0	

<u>Offshore Petroleum Terminal Development</u>: Offshore terminal development for liquid petroleum products was discussed above under general structural port improvements. Given the resource concerns and other existing uses, very limited areas exist in Massachusetts Bay where such terminals could be constructed. Regardless of location in the Bay, the frequent storms and heavy seas of the North Atlantic would make operation of an offshore terminal for liquid petroleum products risky. Peak demand for these cargoes occurs during the winter period of the worst weather, so that any extended storm event could delay receipt of fuel to the point of causing shortages in stored volume ashore. The risk of accidental spills and the risk of shortfall in fuel supplies, make offshore terminal development impractical for the port and region.

<u>Regional Pipeline</u>: Regional pipelines exist for transmission of natural gas into and through New England. However, due to high demand these lines have not met the region's total need and existing and proposed deliveries by cryo-tank ships will continue. Delivering petroleum fuels to New England by pipelines overland from sources outside the region was considered in the 1980s and dismissed due to the high cost relative to waterborne transport of these cargoes. The 1988 feasibility report for Boston Harbor cited a cost of at least one million dollars per mile for a gasoline pipeline running the 225 miles from the Port Elizabeth NJ area to Boston. That cost would be considerably more at today's price levels. In addition, as shown in the table below, about 60 percent of all liquid petroleum shipped through Boston is from foreign vessels and would need to be carried by ship to any US pipeline terminal. No private sector interest has been expressed in developing such a pipeline.

SCREENING OF PRELIMINARY PLANS

Assessment of plans was measured in terms of contributions to the primary objective of National Economic Development, with consideration of Regional Economic Development, Environmental Quality and Other Social Effects. The assessment results in identification of plan(s) that best serve the project's planning objectives. The study consisted of three categories of alternative plans:

A No-Action Plan – This plan considers the most likely future condition without improvements to the Port's system of General Navigation Features (GNF - channels, anchorage areas and turning basins). How will shipping in the Port, and the cost of transporting cargo to and from New England, change if no further improvement is made to the deep draft segments of the Boston Harbor Federal Navigation Project, including impacts to the environment, and the economic and social impacts to the maritime industry, its labor force, and the region.

Non Structural Plans – Plans that would provide for more efficient use of the existing waterways and shipping facilities through modification or adoption of new maritime management practices for shipping through the Port of Boston.

Structural Plans – Improvements to the Port's GNFs (deepening and widening of channels, anchorage areas and turning basins) and/or terminal improvements within the Port of Boston or outside the port.

Projected commerce levels were derived from accepted models of worldwide macroeconomic trends and cargo shipping projections. These were compared to the capacities of the terminals and waterway (channels) to determine whether terminal and channel throughput capacity is expected to continue to meet or constrain the volume of commerce anticipated to enter the harbor and its hinterland. Terminal capacity is typically constrained by available land area, number of berths available and their depth, cargo handling equipment, and carrier practices with respect to alliances, vessels in service, cargo allocations, and leases.

Project costs for improvements to the waterway's GNFs and terminals were developed. These include dredging costs, operating and maintenance costs, mitigation costs, and project-dependent terminal expansion costs, other equipment costs of improving terminal capacity such as larger cranes if necessary to handle larger vessels, berthing deepening, and costs for bulkhead modifications and other improvements to accommodate deeper berths, if necessary.

The primary benefit from deepening the navigation channels is the reduced transportation cost savings associated with the operation of deeper draft vessels in the Port of Boston. With cargoes segregated by terminal (a single container terminal in an optimal location) a comparison of the incremental costs of multiple terminals was unnecessary. Optimization of design channel depth on a foot-by-foot basis was performed.

Bulk cargo operations, terminals and waterway needs were considered separately. Tank vessel operations were considered separately from other bulk cargo needs. However, channel improvements formulated for container shipping would also benefit other carriers to some degree. For example: as many container, dry bulk and tanks vessels all rely on tidal assist to reach their berths, a deeper entrance, anchorage and lower main ship channel would provide cost savings from reduction in delays or ability to load deeper for all these types of cargoes and carriers. All reasonably anticipated benefits were considered in depth optimization and in identifying the NED plan.

No Action Plan

The no action plan represents the most likely future condition without improvements to the Port's navigation features. In the event that no proposed alternative meets the Federal criteria of having a benefit-cost ratio (BCR) greater than or equal to 1.0 (i.e., positive net excess benefits), the No Action Plan would become the recommended plan.

Future conditions under such a plan are detailed in the Without-Project Condition section presented earlier in this document. In brief, if no further improvement is made to the deep draft segments of the Boston Harbor Federal Navigation Project, transportation costs for cargo shipped into New England will increase, as a greater proportion of the region's exports and imports will be landed at other ports and shipped overland at higher cost. Boston's ability to attract and retain waterborne cargo shipping services will decline. This will have wide ranging impacts on the regional environment, and have economic and social impacts to the region's maritime industry and its labor force. Massport and regional business interests also believe that, in the long-term, failure to deepen the port, and the increased transportation costs that result, would drive business and industry out of the region, as companies seek to remain competitive in the cost of their products delivered to their customers.

Non-Structural Plans

Non-structural measures for achieving the planning objectives, in whole or in part, were examined and considered. These measures do not involve improving the Port's existing GNFs and fall into three broad categories:

1. Measures that allow for greater unit-loading of vessels without deepening (tidal advantage, light loading and lightering)
2. Continue use of one-way navigation for large carriers with passing at President Roads and Fort Point
3. Greater use of smaller containerships and barges to trans-ship cargo

Shippers already use several measures that allow for increased vessel loading and shipping economy at Boston. These were discussed earlier under Port Operations, and include transit using tidal advantage, light-loading of vessels, and occasional lightering of tank vessels. Each of these methods is generally practiced in concert with routing of ships between multiple ports. Shippers must balance the economies of each of these methods, measured together with the importance of scheduling, alliances, cargo allocation, land-side factors, and other competitive arrangements in determining what practices to employ and what ports to use.

Tidal Navigation: At Boston, the largest carriers for all cargo categories already have maximum navigation drafts in excess of the channel depths. These vessels take advantage of Boston's 9.5-foot average tidal range to transit the channel at drafts that would be impassable at lower tide stages. Continued port operations using these loading and routing measures will only continue the problems encountered under the without-project condition, and future growth in cargo volumes will be limited.

As discussed earlier in relation to underkeel clearance requirements (see Table 22) the range of the tide varies greatly at Boston; 9.5-foot mean, 5.5-foot minimum and 10.3-foot maximum. Extremes over the period of record range from +14.7 to -4.1 feet MLW (18.8-foot extreme range). While this large variation makes scheduling tidal assist on any particular passage difficult, the elevations are generally predictable. With the expertise of the harbor pilots, many shippers make frequent use of this method to load ships deeper. Shippers and pilots carefully account for the expected tidal advantage at the time of arrival at or departure from Boston. On average, the tidal advantage, with consideration of safe underkeel clearance and the transit time between open water and the berth, confers a two to three foot advantage for vessel loading. Use of this advantage is expected to continue with or without channel deepening.

Making use of this method requires timing the channel transit, with an eye to sea states as well. Seas vary between the outer and inner harbor areas, with pitch, roll and yaw of the vessel increasing its effective draft, particularly in the entrance channel seaward of Deer Island Light. Vessel draft must be measured against the channel controlling depth, the tidal range and elevations on the day in question, effects of seas, winds and currents on vessel motion (increases in effective draft), the desired underkeel clearance and the time of transit to the berth relative to the rise and fall of the tide.

The typical speed of large vessels transiting Boston varies greatly according to sea conditions and other factors. In October 2012 the Boston Harbor Pilots estimate that transit speeds for larger container ships for the North Entrance Channel inbound would be about 10 knots, 6 to 8 knots through the Roads, and 6 knots in the Main Ship Channel[1]. Transit times from the harbor entrance to the anchorage and terminals are as follows: President Roads Anchorage – 4.2 miles – 44 minutes, Reserved Channel – 6.3 miles – 79 minutes, MMT – 6.9 miles 89 minutes, Medford Street Terminal – 10.2 miles – 88 minutes, Chelsea River Turning Basin – 11.3 miles – 133 minutes. Table 27 shows the distance from the North Channel entrance buoy to several of the key harbor terminals.

Table 28 shows a typical computation of tidal transit using a 42-foot draft containership requiring a 4-foot underkeel clearance inbound to the Conley Terminal. This is currently the maximum draft that can be safely brought into Boston Harbor taking full advantage of the mean tidal range of 9.5 feet, and leaving only an hour before high water to begin the run through the entrance channel.

[1] Email from Captain Hammond, Boston Harbor Pilots, 31 October 2012

TABLE 27 - CHANNEL TRANSIT DISTANCES AND TIMES		
Nautical Miles From North Channel Entrance Buoy RW “NC” to Various Terminals, Bridges and Turning Basins		Transit Time (Hours)
Precautionary Buoy RW "B" to Buoy RW “NC”	5.4	0.39
Buoy RW “NC” to Deer Is Light (End of North Channel)	3.4	0.34
President Roads Anchorage	4.2	0.44
Reserved Turning Area	6.3	0.79
Conley Container Terminal - Reserved Channel	6.7	1.22
Black Falcon Cruise Ship Terminal - Reserved Channel	7.2	1.39
Massport Marine Terminal - Main Ship Channel	6.9	1.19
US Coast Guard Station - Charles River	8.7	1.19
Inner Confluence Turning Basin	9.4	1.31
Tobin Bridge - Mystic River	9.5	1.63
US Gypsum - Mystic River	9.6	1.65
Boston Autoport - Mystic River	9.8	1.69
Medford Street Terminal – Mystic River	10.2	1.77
Exxon Terminal - Mystic River	10.0	1.73
Distrigas LNG Terminal - Mystic River	10.3	1.79
Prolerized Scrap Terminal - Mystic River	10.4	1.81
McArdle Bridge - Chelsea River	9.6	1.37
Conoco-Phillips Terminal - Chelsea River	10.3	1.72
Chelsea Street Bridge - Old - Chelsea River	10.4	1.77
Gulf Oil – Cumberland Farms Terminal – Chelsea River	10.9	2.02
Chelsea Upper Turning Basin Terminals	11.3	2.22
1 Nautical Mile = 1.15 Statute Miles or 6076.115 Feet (US)		
Vessel speeds used: 14 knots in outer approach, 10 knots in entrance channel, 8 knots through Roads, 6 knots in MSC to ICA, 5 knots in Mystic River, and 3 knots in Reserved Channel. Transit from ICA up Chelsea River are 0.5 hours to Conoco and one hour to upper basin terminals (about 2 knots).		
Turning times included: 0.3 hours for RTA (Reserved Channel and MMT) and 0.3 hours for ICA (Mystic River terminals). Chelsea vessels are turned outbound in Chelsea River Turning Basin.		

<table>
<tr><th colspan="3">TABLE 28 - TYPICAL NAVIGATION TRANSIT USING TIDAL ASSIST</th></tr>
<tr><th colspan="3">Channel Transit Depth Minimums Under Calm Conditions</th></tr>
<tr><td>Existing Loaded Max Draft - Inbound - 4300 TEU Ship</td><td rowspan="4">Feet</td><td>42.0</td></tr>
<tr><td>Underkeel Clearance - Minimum</td><td>4.0</td></tr>
<tr><td>Water Needed - Inner Channels</td><td>46.0</td></tr>
<tr><td>Water Needed - In Entrance Channel (+2 Feet Minimum)</td><td>48.0</td></tr>
<tr><th colspan="3">Channel Transit Times</th></tr>
<tr><td>Entrance Channel Transit Time</td><td rowspan="6">Time (Hours)</td><td>0.24</td></tr>
<tr><td>Main Channel Transit Time</td><td>0.43</td></tr>
<tr><td>Turning Vessel in Basin</td><td>0.40</td></tr>
<tr><td>Tug Assist to Conley Berth</td><td>0.13</td></tr>
<tr><td>Secure and Begin Offloading (after 1.20 hour transit)</td><td><u>0.50</u></td></tr>
<tr><td>Total</td><td>1.70</td></tr>
<tr><th colspan="3">Tidal Elevation Change Corrections</th></tr>
<tr><td>Mean Tidal Range</td><td rowspan="4">Feet</td><td>9.5</td></tr>
<tr><td>Controlling Depth of Channel</td><td>40.0</td></tr>
<tr><td>Total Depth</td><td>49.5</td></tr>
<tr><td>Rate of Rise/Fall (Feet per Hour)</td><td>1.6</td></tr>
<tr><th colspan="3">Entrance Channel Transit</th></tr>
<tr><td>Channel Depth Needed – Entrance</td><td rowspan="3">Feet</td><td>48.0</td></tr>
<tr><td>Transit Time X Rate of Change/Hour (0.24 X 1.6)</td><td>0.4</td></tr>
<tr><td>Depth in Entrance 1 Hour Either Side of HW</td><td>47.9</td></tr>
<tr><td colspan="3">Vessel may Enter Channel in window between one hour before HW and 45 minutes after HW, in order to complete the 0.24 hour transit of entrance by 1 hour after HW</td></tr>
<tr><th colspan="3">Inner Channels Transit</th></tr>
<tr><td>Water Depth Needed - Inner Channels</td><td rowspan="4">Feet</td><td>46.0</td></tr>
<tr><td>Depth at 1 Hour After High Water (40.0 + 9.5 – 1.6)</td><td>47.9</td></tr>
<tr><td>Fall During Transit to Conley Terminal ((1.20 - 0.24) X 1.6)</td><td>1.5</td></tr>
<tr><td>Depth before Offloading</td><td>46.4</td></tr>
<tr><td colspan="3">Under this formula, vessels has a 1:45 window for entering the harbor, making its transit to the Conley Terminal berths, and begin offloading, before the fall in tide encroaches on its underkeel clearance, with an 0.4-hour cushion on the inner channels leg.</td></tr>
</table>

- A 42-foot draft vessel needing 4 feet under keel in normal conditions, and an additional 2+ feet for higher seas in the entrance will require 48 feet of depth to safely navigate the channel in typical conditions.
- With a mean tide range of 9.5 feet, a semi-diurnal rate of rise and fall of 1.6 feet per hour, and a 40-foot MLLW controlling depth, depths of 48 feet or greater occur during a period of about 1 hour before high water to 1 hour after high water
- At an average speed of 10 knots, the 3.4 miles of the entrance channel can be transited in about 0.34 hours. This leaves about a 1.65 hour window in which a large vessel can begin its transit.

Tidal navigation for the deepest draft vessels now servicing Boston Harbor is a common practice for some lines, provided the tidal elevations during the time of transit are average or greater. Regardless of the depth to which the channel may be deepened, it is expected that one or more services may load deeper to take advantage of the tidal range. These factors will be incorporated into the economic analysis of the various improvement plans and depth optimization and will not be carried forward on their own as separate plans.

Continue One-Way Navigation Practices: For large carriers the asymmetrical channel configuration at Boston Harbor, with its 35 and 40-foot lanes, does not allow for passing situations, except for smaller vessels using the shallower lane to pass larger ships. Passing of two large vessels only occurs at President Roads and more rarely in the channel lane cross-over off Fort Point. Deepening the entire 1500 to 1200-foot wide entrance and main ship channels would be economically impractical. Any widening of the deeper lane for increased vessel size would be accomplished by incorporating a portion of the shallower lane. This means that the existing passing situation would be incorporated into any plans for channel improvement and would therefore be both a without-project and with-project condition. Given the short main channel transit times to South Boston of about 1.25 hours, passing situations for two large vessels would continue to be rare and confined to President Roads, even in the with-project condition base case, or with the expected increase in container shipping in the higher end economic scenarios that add an additional liner service at Boston. Total transits of the Main Ship Channel under the with-project condition would still be only about 15 to 16 large vessels weekly, an insufficient level to warrant additional provisions for two-way traffic for passing of large vessels. One-way traffic of large vessels will remain a component of any improvement plans, with the existing widened cut through President Roads south of the anchorage used for passing and turning to and from the anchorage.

Use of Smaller Containerships: Use of smaller containerships to trans-ship cargo to Boston, as an alternative to deepening the channels for larger containerships was considered. About two-thirds of New England's container cargo is now landed in New Jersey. Most of that is then trucked into or out of New England. A portion is transshipped by barge into Boston. This practice is already captured in the cargo routing and volume analysis for the without project condition and the several improvement alternatives for Boston. Should those shippers now using Boston continue their conversion to larger capacity vessels for their trans-Atlantic or Asian services, those vessels would at some point no longer call at Boston if channel improvements are not made, as tidal delays and light loading requirements would make retention of Boston in those services' port rotation un-economic. Should that occur the question then becomes how to get those boxes into and out of New England. Alternatives could include greater reliance on overland trucking, increased use of barges or other smaller ships to transship the cargo.

Containerships have been carrying an increasing percentage of Boston-shipped cargo. Between 2005 and 2011 barge and feeder service percentage of TEUs carried though Boston Harbor declined from about 27 percent (50,131 TEUs) to 0.2 percent (383 TEUs) The four major liner carriers (CMA-CGM only had Boston services in operation intermittently between 2006 and 2010, and the Hanjin Asian-Suez service was only in operation for about half of 2011), representing alliances of a total of seven shippers, shipped a total of about 4,237 TEUs weekly at Boston in 2007 (about 1,210 boxes per ship), and about 3,698 TEUs weekly in 2011 (about 1,057 boxes per ship).

Dedicated smaller containership services to Boston are unlikely. Boston boxes are now slotted on three containership services to the Port and even more to NY/NJ. But Boston slots represent only a small percentage of any ship's volume. On a weekly basis shippers would not dedicate a smaller ship to trans-Atlantic runs into Boston, and customers would be unlikely to accept delays in shipment from a less-than weekly service, with the alternative to truck the cargo. So an East Coast inter-port transshipping arrangement would be the only way to sustain volume by ship on a regular frequent schedule into Boston if the major lines were to drop the port from their direct services. The Conley Terminal is projected to be able to handle about 550,000 TEUs annually with the shoreside upgrades now substantially completed, for a throughput capacity of about 10,580 TEUs weekly. Under the base case economic scenario in the analysis prepared for this report, the port would ship about 280,000 TEUs with a 48-foot channel (5,400 TEUs weekly). Under the larger of the higher-end economic scenarios, with an Asian-Suez service added, the port would ship a total of about 431,500 TEUs (about 8,300 TEUs weekly. Both cases fall within the Conley Terminal's expected capacity. However, an analysis of smaller containership use cost compared to the cost of trucking from the PONYNJ into New England (See Appendix C-1) shows that trucking is the less expensive and faster alternative to small containership transport, a spoke and hub system, or barge transshipment.

Greater Use of Barges: Greater use of barges to trans-ship cargo to Boston, similar to the New Jersey barge feeder operation which ceased in 2009, has been suggested as an alternative to deepening the channels for larger containerships. From a planning perspective, these services eliminate the need for deeper channels and berths, and larger cranes associated with the deeper draft vessels, but they are less reliable and involve additional transshipment costs compared to direct call services.

The vessels on the barge, feeder, and bi-weekly services that have called at Boston in the past several years are relatively shallow draft vessels that would not operate any differently under with-project (deeper channels) conditions. One discontinued barge service was a weekly service running from the PONYNJ to Boston and back, with a bi-weekly call at Portland Maine, that typically sailed at one-half to two-thirds of its TEU capacity.

Barge service to eastern New England has been shown to be largely uneconomic. The last three barge services operating between Halifax and Boston have failed, including the EIMSKIP service which was resumed in July 2007 and terminated in December 2007, and the

American Feeder Service which only operated for a several month period in 2011-2012, both ceased due to continued low volumes. Volumes on the weekly PONYNJ-Boston barge service operated by Columbia Coastal declined after 2006 and the service ceased in 2009. Other attempted barge services out of NY have repeatedly failed as well. Barge shipment data for the past several years is shown below.

Year	All TEUs	Barge TEUs	Percent
2005	186,710	50,131	26.9 %
2006	200,151	41,946	21.0 %
2007	220,340	29,103	13.2 %
2008	208,626	16,929	8.1%
2009	187,445	14,055	7.5%
2010	168,285	7,581	4.5%
2011	192,703	383	0.2%

New England cargo offloaded at PONYNJ is typically loaded onto trucks and carried to its destination. The relative inefficiency of barge service from PONYNJ to Boston Harbor is largely due to the double handling of cargo. Cargo landed at the PONYNJ and shipped by barge must offloaded, transported to the barge, wait for the barge to be loaded once weekly, and then landed and handled a second time at Boston, before delivery by truck to the customer. Rehandling, storage and reloading adds cost and time to the shipment. In addition to transshipment inefficiencies barges offer less frequent service than ships. Customers want lesser cost and more timely delivery.

The capacity of the system is also a disincentive to expanded barge service. In 2007, the Columbia Coastal barge service between PONYNJ and Boston and the Eimskip service from Halifax shipped a total of 29,103 TEUs (15,607 boxes – See Table 16), with Eimskip operating for only one-half of the year. These were distributed as 44 percent imports, 21 percent exports and 35 percent empties. These were carried on about 78 barge calls that year, or an average of about 373 TEUs (200 boxes) per barge. At that capacity converting Conley's entire 2007 TEU volume of 220,340 TEUs to barge landings would have required about 590 barge calls, or about 11 to 12 calls weekly. To carry the entire base economic case projection (with-project) of 431,550 TEUs (at a 48-foot channel depth) would require about 22 weekly barge calls. While the terminal could handle those movements, it is unlikely that many new barge services would develop to handle Boston trans-shipments by barge. Even before 2009, with such a large volume of New England boxes transported through the PONYNJ by truck, only one weekly barge service (Columbia Coastal Transport) provided transshipping, and that service failed from lack of demand. As of late 2012 there are no barge services calling on Boston Harbor. A comparison of barge transshipment costs versus trucking costs provided in Appendix C-1 shows trucking to be the less expensive of the two means of moving New England boxes from the PONYNJ.

Substitution of expanded barge service for carriage of Boston's current or projected future container volume in lieu of larger containership is not considered a practical alternative.

Summary of Non-Structural Alternatives: Tidal navigation, one-way traffic, and continued use of barge feeder services at the present rates are all expected to continue under the with-project condition. Also, some New York landed cargo destined for eastern New England would be diverted to landing at the Port of Boston with the project. These conditions are each included in the development and analysis of the recommended plans and are therefore not carried as separate alternatives.

Use of smaller containerships on more services instead of increasing containership size in the existing services was examined and discussed with Massport and shippers and determined to be impractical from a shipper's standpoint due to scheduling, routing and time in transit concerns. Greater reliance on barge trans-shipment was also determined unlikely given the low barge volume now carried in spite of the proportion of New England boxes landed at PONYNJ presently. The lack of reliable commercial rail capacity in New England makes increasing reliance on that mode of transportation impractical. Reduction in underkeel clearance requirements was discussed with shippers and pilots and determined impractical given the tides, bottom conditions and trends towards larger vessels with even greater underkeel safety requirements.

Structural Plans

Structural plans proposed consist of improvements to channel depths and associated general navigation feature improvements at Boston Harbor. Channel deepening to accommodate larger container and bulk vessels must also take into account channel width, bend, turning area and anchorage improvements commensurate with the increased depth and design vessel characteristics, consistent with safe navigation practices, port security, and environmental acceptability.

Channel Deepening: In the absence of other practicable means of meeting the goals and objectives of the project to reduce transportation costs for cargo originating or destined for the New England market, channel deepening to improve vessel access is the likely solution. Channel deepening would reduce or eliminate tidal restraints on those classes of vessels currently calling on the port to access the terminals under consideration in this analysis. Depending on the channel improvement depth recommended, larger vessels may also be able to call on the port with or without tidal assistance depending on draft.

Any plan to deepen the system of main channels to improve access to the Conley Terminal from the sea would require deepening the entrance channel, the President Roads Anchorage, the Main Ship Channel from the Roads to the Reserved Channel, the lower Reserved Channel, and the Reserved Channel Turning Area. Improvements to access the Massport Marine Terminal would extend the Main Ship Channel deepening above the Reserved Channel Turning Area to the upper end of the berths at the Marine Terminal below the Ted Williams Tunnel. Improvements to access to the Medford Street Terminal are minor in nature with only a small area requiring deepening in a portion of the lower Mystic River Channel. Improvements to the Chelsea River are dependent on replacement of the Chelsea Street Bridge.

Channel design depths are developed from the design vessels as outlined below and must take into account a number of factors relating to vessel operation and movement. These factors are discussed in detail for each of the alternatives.

<u>Entrance Channel Alternatives</u>: As described under Existing Conditions, Boston Harbor has three entrance channels, as shown in Figure 25. As the harbor's navigation features evolved over time, deepening projects examined different routes for cost-effectiveness.

Narrows Channel: The Narrows was the original natural entrance to Boston Harbor, and was improved initially by a 23-foot channel, later deepened to 27 feet with a width of 1,000 feet. The R&HA of 1867 authorized a 23-foot channel which was constructed through the Narrows at a width of 685 feet. Work was begun in 1867 and continued intermittently through 1891 when a least width of 625 feet had been obtained. The R&HA of 1892 authorized deepening the main channels at Boston Harbor to 27 feet, with a width of 1000 feet through the Narrows. Work on this improvement began in late 1892 and continued through 1906 after authorization of the 30-foot project.

Broad Sound South Entrance Channel: The R&H Act of 1899 authorized dredging a new more direct entrance channel for Boston Harbor through the shoals and ledges from Broad Sound to President Roads at 30 feet by 1200 feet wide. The authorizing document for this improvement (House Doc. #133, 55th Congress, 2d Session, 9 December 1897) estimated that further deepening of the Narrows to 30 feet would require removal of 2 million CY more material than the new South Channel route, including cutting back the shoreline of the adjacent Lovells and Gallops Islands. Ledge removal for the South Channel was also determined to be less than one-fifth that required for deepening the Narrows Channel. The new South Channel route was recommended over further improvement of the Narrows. Work on the South Entrance Channel was begun in 1900 and completed in 1905.

35-Foot Broad Sound North Entrance Channel: The R&HA of 1902 authorized a 35-foot depth for the entrance and main ship channels of Boston Harbor, with a width of 1500 feet in the entrance and 1200 feet in the Main Ship Channel. The authorizing document (House Doc. #119, 56th Congress, 2d Session, 6 December 1900) for this improvement compared providing a 2000-foot wide channel through both the North and South Channel routes. It was determined that the north route would require removal of 6.8 million CY ordinary material and 5,000 CY rock, while the south route would require removal of 5.7 million CY ordinary material and 189,000 CY rock. The route selected for the 35-foot entrance was the more northerly alignment to Broad Sound due the overall lesser cost associated with the less ledge removal required on that alignment. Authorization limited the channel width to 1500 feet in the entrance. Work on the 35-foot North Entrance Channel began in 1903 and was completed in 1915 to the 1500-foot width.

40-Foot Broad Sound North Entrance Channel: The R&HA of 1917 authorized a 40-foot depth for the North Entrance Channel (45 feet in rock) with a width of 900 feet along the southerly channel limit and 1100 feet in the entrance seaward of Finns Ledge. The authorizing document for this improvement is House Doc. #931, 63rd Congress, 2d Session, 28 April 1914. Work on this improvement did not begin until 1926 and was completed in 1930.

Other Routes: River & Harbor Act of 2 March 1919 directed an examination of providing a new 40-foot entrance to Boston Harbor, via a more than two-mile-long land cut beginning at Short Beach between Winthrop and Revere, across the Belle Isle marshes and down the Chelsea River into the upper harbor. The report on this proposal, a Preliminary Examination dated 1 December 1919 estimated that such a project would require removal of 21 million CY of material for a 40-foot channel at a width of 400 feet. That report was considered unfavorable to further study.

Discussion: Provision of a new entrance to Boston Harbor at a depth greater than the 40 feet now provided would be most economic along the existing North Entrance Channel alignment. Deepening of the Narrows Channel beyond 27 feet was considered and abandoned in 1897 when considering the 30-foot project due to the extensive amount of ledge along that route and the need to remove portions of the adjacent islands for the channel side slopes. Removal of some 13 feet of material would be required merely to reach the 40-foot depth along this alignment.

Similarly, the South Entrance Channel route at its present 30 feet would require removal of 10 feet of material to reach the existing 40-foot project depth provided by the North Channel. Deepening the North Entrance Channel to 45 feet is estimated to require removal of some 1,260,000 CY of ordinary material and 180,000 CY of rock. The estimate from the 1900 report indicates that a greater amount of material would be required merely to deepen the South Channel to 35 feet (5.7 million CY plus 190,000 CY rock). Deepening of the South Channel would require far more work than further improvement of the North Channel.

Deepening of the North Entrance Channel was determined to be the most cost-effective means of providing a greater entrance depth to Boston Harbor. Other entrance routes were not considered further.

Turning Basins: The use of larger ships calling on the Conley Terminal would require modification to the Reserved Channel Turning Area to accommodate the ships larger length and beam. The existing 1200 foot diameter basin was modeled as part of the ship simulation study in 1992. The design guidance consulted for this study recommended an enlarged diameter of 1500 feet, and the simulation recommended additional widening to ease the bends into the turning basin and along its outer limit. These improvements should accommodate vessels up to 7500 TEU class.

The turning basin located in the Inner Confluence at the junction of the Mystic and Chelsea Rivers with the head of the Main Ship Channel was redesigned, expanded and deepened as part of the 1990 improvement project completed in 2001. The final expansion plan was based on the recommendations of the 1993 ship simulation study and included widening the basin approach along the East Boston shore. This area adequately serves the existing vessels calling on the terminals of the Mystic and Chelsea Rivers. The largest of these are the tank ships calling on the Exxon-Mobil and Distrigas terminals in the Mystic River and the car carriers calling on the Boston Autoport. These ships are larger than the vessels projected to call on the re-developed Medford Street Terminal and the deepened Chelsea River. No further improvements to the Inner Confluence turning basin are considered in this project.

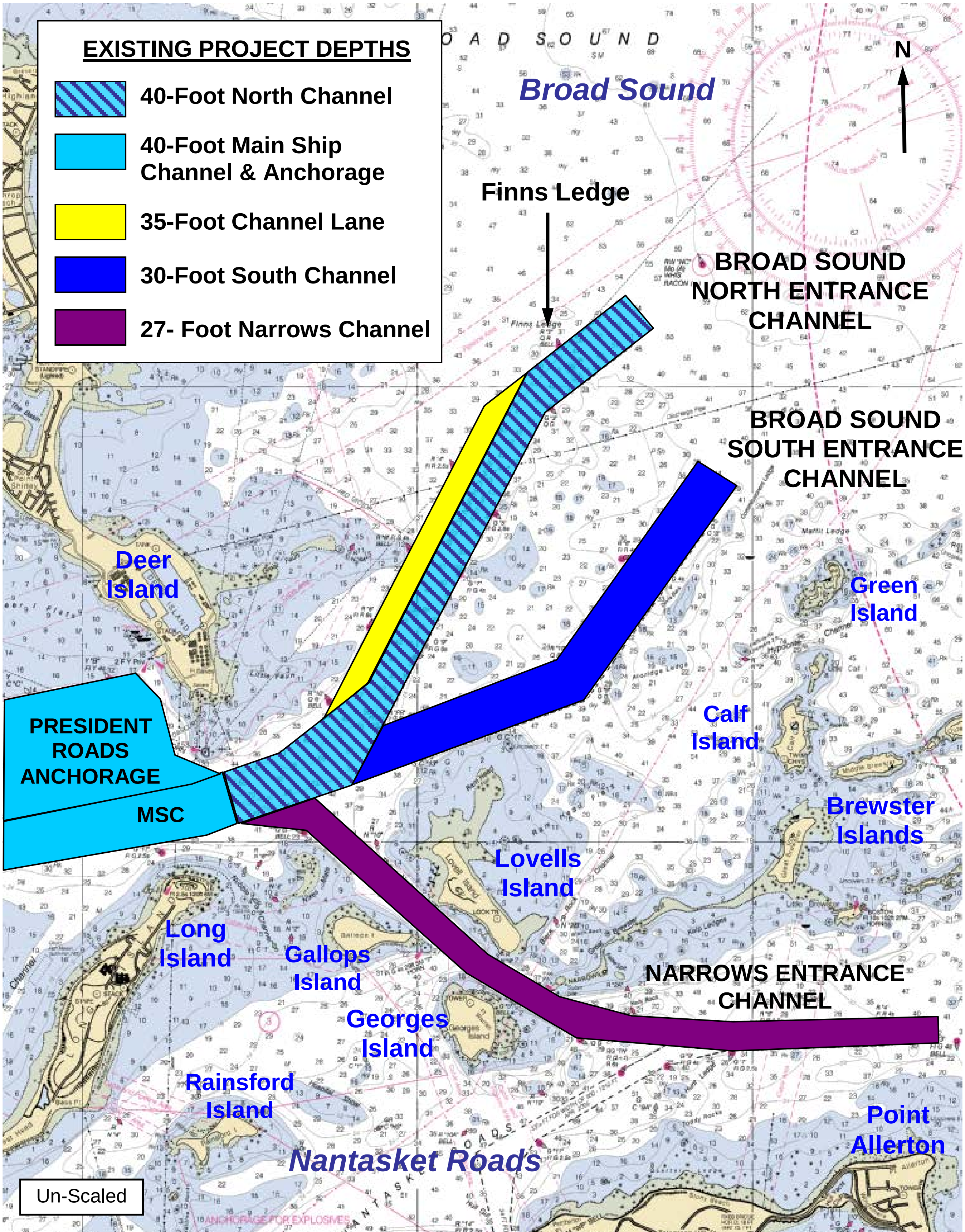


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FIGURE 25 – EXISTING ENTRANCE CHANNELS

Bend Wideners: Incorporation of bend wideners (widening the channel at the apex of the principal bends and turns) will be incorporated into any plans for channel improvements. Larger vessels will require wider channels to provide for safe maneuverability. Easing transit of the channel bends requires further widening through these bends, as called for in design guidance, recommended by the pilots and confirmed by the ship simulation study. The areas being considered for such features include the entrance bend at Finns Ledge, the bends at either end of the Roads, and the bends in the Main Ship Channel between the Roads and the Reserved Channel Turning Area. Bends in the approaches to the bridges in the Chelsea River would also incorporate widening, as recommended in the 1992 ship simulation study for that waterway.

Anchorage Deepening: Deepening of the President Roads Anchorage to a depth equal to that of any channel improvements was recommended by both the US Coast Guard and the Boston Harbor Pilots, as discussed more fully in following sections.

Berth Improvements at Terminals: Berth improvements by non-Federal interests would be necessary to support and take full advantage of improvements made to the channel depths. Construction and or maintenance of berths to depths commensurate with the depth provided by the improved channels is necessary to generate project benefits. At the Conley terminal Massport has already deepened the two main berths to 45 feet at a width of 143 feet, and would deepen the berths further if channel deepening is provided to maintain a berth depth of at least three feet greater than the channel depth. This would enable vessels to continue making full use of the tidal advantage provided by the harbor's tidal range and short distance between the terminal and deep water. Beyond deepening the two berths, no further non-Federal work is required as the bulkhead for these berths was recently replaced.

For the Marine Terminal along the Main Ship Channel below the tunnels, new bulkheads will be constructed for the new bulk terminal operations regardless of any channel deepening. Massport deepened the berth here to 40 feet and would deepen it further to match the channel depth provided.

For the Mystic River – Medford Street Terminal, Massport has already deepened the berth to 40 feet and no further improvements are required.

For the Chelsea River, the four principal petroleum terminals that are expected to benefit from the channel deepening would each deepen their berth to the depth provided by the new channel. This would enable these terminals to take full advantage of the new widened bridge opening at Chelsea Street and the channel passage that was widened to a minimum of 175 feet, both completed in 2012.

Design Vessel Criteria

The proposed improvements would be designed for the primary benefit of increased container shipping. Separable incremental improvements for the benefit of bulk cargo operations were also examined. Improvements for these purposes, principally those for container shipping, would also be of some benefit to other port operations, primarily LNG and petroleum products tanker shipping. For example, deepening the harbor entrance, anchorage and lower main ship channel would allow tank ships bound for terminals on the Chelsea and Mystic

Rivers a larger window for tidal assist navigation of the harbor, reducing tidal delays for these vessels. A channel deepened for container traffic might also allow tank vessels to load deeper at their port of origin. Since all of these vessels would be using the improved channel, their requirements for channel dimensions and safe navigation must be taken into account, even though they may not need the increased depth.

The increase in all types of shipping in the Port of Boston over the past two decades has made passing situations for large vessels more common than at the time of the last feasibility report in 1988. The only situation in which passing is prohibited in the port is when an LNG tank ship is transiting areas inshore of Deer Island. Inside of Deer Island, a security zone established by the USCG extends fore and aft of the LNH ship as it moves through the harbor. Aside from the LNG security zone, containerships, petroleum tank ships, cruise ships, auto carriers and bulk cargo ships do pass each other in the channel reach through President Roads, where the 40-foot deep lane covers the full 1200-foot channel width south of the anchorage.

Design Vessel Underkeel Clearance

Design of safe and efficient general navigation features must include underkeel clearance allowances for the design vessels to accommodate such factors as vessel squat (the tendency of vessels underway to settle at the stern), trim (the variation in draft along the keel due to cargo loading practices, done in part to improve maneuverability), and pitch (vertical movement along the fore-aft axis in response to seas. Reduced salinity in up-harbor areas due to fresh water inflow from rivers also causes a slight increase in effective draft as the vessel's mass settles deeper in less dense water, but is not a factor at Boston due to the predominance of tidal flow. Roll involves vertical movement to port and starboard around the keel axis in response to wind, seas or turning of the vessel. The wider a vessel's beam, the more draft is increased by roll. Factors to compensate for movement due to seas and wind are typically critical in more seaward areas, leading to a requirement for additional depth in entrance channels. The vessels considered in the design of channel improvements to Boston Harbor and their design factors are shown in Table 29. Vessel dimensions are those published by the ship's owners.

Pilots and shippers use different underkeel clearance requirements depending on the level of risk they are willing to assume relative to factors such as insurance requirements, company policy, type of vessel and cargo, nature of the channel bottom, and hull configuration. Vessels with a wider beam will have a greater increase in draft than a smaller ship on a constant list. This had led shippers, pilots and insurers to adopt a percentage of draft requirement for underkeel allowance. Pilots still adhere to minimum underkeel allowances, with minimums specified by the US Coast Guard for specific ports. The standard for safe underkeel allowance adopted by most large Boston shippers and the Boston Pilots for large carriers is ten percent of the vessel draft. As vessel size and draft increase with channel and berth depth, safe underkeel allowances will also increase and must be accounted for in any depth optimization analysis. In the protected up-harbor areas, where seas are not a problem and soft bottom predominates, such as the Mystic and Chelsea Rivers, underkeel clearance is generally three feet.

TABLE 29 BOSTON HARBOR DESIGN VESSELS						
Vessel Class	Capacity	Year Built	DWT	Draft	Beam	LOA
CONTAINERSHIPS						
MSC Delaware Bay Class - Panamax	4713 TEU	2002	56,700	43.3	106	872
COSCO Hamburg Class – Post Panamax	5618 TEU	2001	69,193	45.9	131	919
MSC Alessia Class – Post Panamax	6732 TEU		85,891	47.6	131	984
COSCO Yokohama Class – Post Panamax	7455 TEU	2004	92,900	46	141	1050
COSCO or Hanjin Post Panamax - Asian Service	8500 TEU		Varies	48	140	1099
LIQUID BULK TANK SHIPS						
LNG Cryotanker - Distrigas	125,000 CM			42	140	940
Chelsea-Max			41,000	35	90	585
Chelsea – With-Project			50,000	42	106	692
Mystic - Exxon			87,000	45	138	840
DRY BULK CARRIERS						
Marine Terminal – Cement			60,000	42	105	715
Mystic River - Cement			40,000	37	93	632
TUGS						
Typical Harbor Tug			160	12.5	29	100
Note: Vessel drafts are typical fully loaded static (at rest), summer (warm water), salt water (high salinity) drafts						

Additional underkeel safety clearance needs to be provided in areas of hard bottom. The consequences of grounding on hard bottom are more severe than in soft bottom. Extensive ledge and hard glacial till deposits are found throughout Boston Harbor and have been identified through geologic and geotechnical investigations conducted for this study and prior improvement efforts. In these areas, an additional required dredging increment of two feet would be included in project design, quantity and cost estimates. This additional safety clearance will then be permitted to shoal over time, creating a softer bottom that would permit future maintenance to occur only to the standard two-foot overdepth elevation without the additional two feet of required dredging.

Bottom materials in Boston Harbor outside of the identified ledge and glacial till areas are predominantly Boston blue clay. This clay is a marine deposit that while stiff exhibits low probe blow counts after significant weight-of-rod penetration. Other than the clay, some shallow sandy deposits are found in the outer harbor areas, and more silty glacial era deposits are found in some up-harbor areas. All unconsolidated materials (clay, silt, sand) have proven readily removable by toothed bucket dredge. Glacial tills will require removal by a large excavator. Ledge will need to be blasted and also removed by a large excavator.

In March and April 2007 the Corps and Massport conducted a series of interviews with the three largest container shipping lines that serve Boston Harbor. As part of those discussions the companies' practices with respect to underkeel clearance requirements for movement of the vessels were discussed. COSCO wants at least 10 percent of draft underkeel in the inner channel reaches for its current ship sizes. Since COSCO operates an Asian service, it would rather minimize tidal delays through light loading than risk missing a return slot through the Panama Canal. Even so missed passages occur several times a year at a penalty of $50,000 plus a day's demurrage and lost service.

MSC wants at least three to four feet underkeel at Boston for its two current services. Using this requirement, MSC vessels already arrive at maximum draft of 42 feet riding the tide to the berths. MSC estimated its cost for losing a tidal cycle due to draft restrictions is about $28,000 per day in demurrage plus the cost of fuel at $10,000 per day required to make up time. With channel deepening, MSC would bring in larger vessels of 5,600 TEU (base economic case) to 6,700 TEU (higher-end economic scenario for at least one service). MSC wants to have at least 10 percent of draft underkeel for these larger ships. With the 6,700 TEU vessel typically operating at a 45-foot draft, that ship would require 50 feet in the channel, or with some degree of tidal assistance at lesser channel depths.

WITH-PROJECT CONDITION

Under the with-project condition improvements to Boston Harbor are projected to be authorized and designed by 2014, with construction ending in 2017. The entrance channel at Boston Harbor would be deepened to a depth greater than the currently authorized 40 feet by 2015, with all main channels improvements to access Conley Terminal completed by 2016. Deeper channel depth would put Boston Harbor more in-line with channel depths at other US east coast and foreign container-ports, which are typically 45 to 50 feet in depth, and even greater in Europe. Additional channel depth would reduce depth constraints for vessels with sailing drafts greater than 40 feet. It is anticipated that even with a deeper channel, vessels that could benefit from using Boston Harbor's tidal advantage (9.5–foot average tide cycle) would do so in the same way that vessels use the tide under existing conditions.

With improvements to the Port's GNFs, some cargo destined for the Port's hinterland that now arrives overland after offloading in the Port of New York and New Jersey would be landed directly in Boston. The evaluation of with-project shipping practices and consultation with shippers indicates that some diversion of New England-bound cargo from New York to Boston would occur once Boston is capable of accommodating deeper drafts. No land-side terminal improvements are necessary at Boston to achieve this increase in landings, as Massport's Conley Terminal already has deepened its main berths to 45 feet and will add new lay-down area and larger cranes under the without-project condition.

For channel depths greater than 43 feet, berth deepening at the Conley Terminal would be required in order for shippers to continue to take full advantage of Boston's tides. Massport has indicated its intent to deepen its berths to at least 50 feet should the channels be deepened. The cost of berth deepening to a depth of three feet greater than the proposed channel depth has been included in the first costs of the improvement depths over 43 feet.

Development of Alternatives

Channel Design Guidance

Channel design was developed using the guidance contained in the joint report of the Permanent International Association of Navigation Congresses (PIANC) and the International Association of Ports and Harbors (IAPH) in cooperation with the International Maritime Pilots Association (IMPA) and the International Association of Lighthouse Authorities (IALA) published the final report of the Working Group II-30 titled "Approach Channels – A Guide for Design", June 1997. These analyses were adjusted based on the results of the ship simulation investigation. Quantity and cost estimates provided in this document and the draft feasibility report were derived from the adjusted design. The Corps revised May 2006 deep draft design manual, EM 1110-2-1613, was unavailable when the design for Boston Harbor improvements was developed in 2005. However a re-examination of entrance channel depth increases was conducted in 2012 using EM-1613 with consideration also given to the views of the Boston Harbor Pilots and the analysis conducted by ERDC for its September 2011 report on the New York Harbor Ambrose Channel and sea approaches.

Ship Simulation Studies

ERDC and the New England District collected additional hydraulic data from the harbor in the fall of 2004 to augment data collection efforts from the 1992-93 ship simulation study. The data was used to develop a hydrodynamic model of the harbor completed in June 2005, including its channels, currents, winds and other factors important to vessel motion. Models of the design vessels were also developed under contract to ERDC. A ship simulation was conducted with these ERDC models in August to September of 2005 with the participation of the Boston Harbor Pilots. The final ERDC reports were completed in 2007. The data collection and hydrodynamic modeling reports are included as Appendix F and G, respectively, to this document. The ERDC ship simulation report is included as Appendix H. As with the 1990 project's simulation study in 1992-1993, these efforts were used to test and refine the proposed channel and turning basin alignments under consideration.

The ERDC reports found the channel layout and dimensions adequate for the design vessels with minor modifications consisting of: additional widening of the Reserved Channel Turning Area along its northeast side and westerly in the confluence with the Reserved Channel off the former Army Base Pier. The results also confirmed the need for a wider channel in the reaches and bends between Spectacle and Castle Islands and in the entrance turn at Finns Ledge. The model and simulation also discussed and confirmed the designs relative to the Main Ship Channel deepening extension to the Massport Marine Terminal and the Mystic River. These recommendations were incorporated into the project design, and are discussed under the sections dealing with design of the individual project segments.

The results of the 1992-93 ship simulation were applied to the design for the Chelsea River improvements. That simulation had included analysis of the current design tank vessel in a scenario involving replacement of the Chelsea Street Bridge as an alternative considered for the detailed design phase of the 1990 project, though that level of improvement was not recommended at that time. The 1992-93 simulation recommended widening of the Chelsea Channel through a new bridge opening, widening in the upstream approaches to the McArdle Bridge at the River's mouth, and widening along the easterly channel limit in the bend between the two bridges. These modifications were incorporated in the recommended plan of improvement for this project's proposal to deepen the Chelsea River Channel to 40 feet.

Depending on the status of any re-evaluation of containership economic studies during the design phase, it may be necessary to make additional simulation runs using larger vessels than the 5630 TEU vessel modeled in 2005. To be conservative, the cost of this simulation update has been included in the PED estimate.

Entrance and Main Ship Channel Deepening Needs for Containerships

Containerships will be the deepest draft vessels calling on the Port of Boston under the with-project condition. Two classes of containership were modeled, a large 4,700 TEU Panamax ship that shippers believe is very likely to call on the port if deepened, and a larger 5,600 TEU ship expected to be used on the existing services if the channel was deepened. Shippers have stated that even larger vessels (6700 to 8500 TEUs) could also call as part of trans-Suez route services to North America that may stop at Boston if an even deeper channel were provided. The dimensions of these ships are provided above. These vessels require an underkeel clearance of about 10 percent of their transit draft in the lower harbor, and an additional two feet in the entrance channel to compensate for increased vessel motion from heavier seas and winds. The anticipated transit drafts for these vessels at Boston are provided in the economic analysis of containership benefits appended to this report. With a ten percent underkeel clearance, a fully-loaded Panamax vessel would require 48 feet of water depth in the harbor channels and at least 50 feet of water depth in the entrance channel. The larger vessels that would likely be placed into use by the existing services, and any Suez route vessels would require greater depth if fully loaded, up to 51 feet of water depth in the harbor and a 55 feet of water depth in the entrance channel. The tidal advantage at Boston, if used as is current practice, would make the harbor accessible for these larger ships and increase the transit window for these vessels. A two-foot overdepth allowance would be added to the channel design elevations for quantity estimating purposes, with a further two feet additional required removal increment in areas of ledge or other hard bottom material.

Channel widths would also need to be adjusted for these ships, with their beams of 131 to 141 feet. Additional width would be required in the main channel and in the channel bends to compensate for vessel motion relative to maneuvering lane requirements, passing vessel clearances, bank clearances and use of tugs. Channel design calculations for each principal channel segment are presented in the design report appended to this document. In general, these larger classes of container ships will require a channel design width of (1) at least 900 feet in the entrance channel, (with 1100 feet in the seaward entrance bend at Finn's Ledge, widened further in that bend itself), (2) retaining the present width of 1,200 feet in the President Roads channel reach where the channel abuts the anchorage and where vessels transition between the entrance, anchorage and main ship channel, (3) 900 feet from President Roads to Castle Island (widened further in the bends themselves), and (4) 800 feet in the Main Ship Channel from Castle Island to the Reserved Channel Turning Area.

Increased Depth in the Entrance Channel

The entrances to Boston Harbor are directly from the open waters of Massachusetts Bay, an embayment between Cape Ann and Cape Cod open to the North Atlantic to the east. Depths over the offshore banks (Stellwagen and Jeffries Ledge) are about 100 feet, while depths inshore of the banks range from 100 to 300 feet. The outer harbor is defined by the collection of glacial islands and headlands extending in an arc from offshore of Deer Island south to Point Allerton. The ridges of ledge and glacial till are the "bars" through which the entrance channels cross. Sea states in the Bay and its northern arm; Broad Sound; typically result in an additional two feet of effective draft on large vessels transiting the entrance. Provision of an additional two feet in channel depth in the entrance is necessary to provide the same underkeel allowance as in the shallower Main Ship Channel inside the islands and headlands. Corps planning guidance (ER 1105-2-100, 22 April 2000, Appendix E, page 23) provides that when entrance channels require additional depth to compensate for increased seas, they will be cost-shared according to the rates for the depth provided in the interior channels. Plans for channel deepening for larger containerships at Boston will incorporate additional depth over that for the interior channel plans and increments under consideration. Examining an 1100-foot-long containership transiting with a 43-foot draft without tidal assistance or a 48-foot draft with tidal assistance yielded an entrance channel depth up to four feet greater than the design depth of the inner harbor channels.

Inside the headlands and harbor islands, wave climate decreases. Additional depth beyond the typical ten percent underkeel allowance for vessel motion and safety is not required inshore of the outer confluence and Deer Island Light.

Channel Bend Modifications

The Boston Harbor Pilots have been advocating for many years for widening of the critical bends in the entrance and main ship channels. Channel design to accommodate even larger ships than those now calling on the port required this issue be addressed in design. The

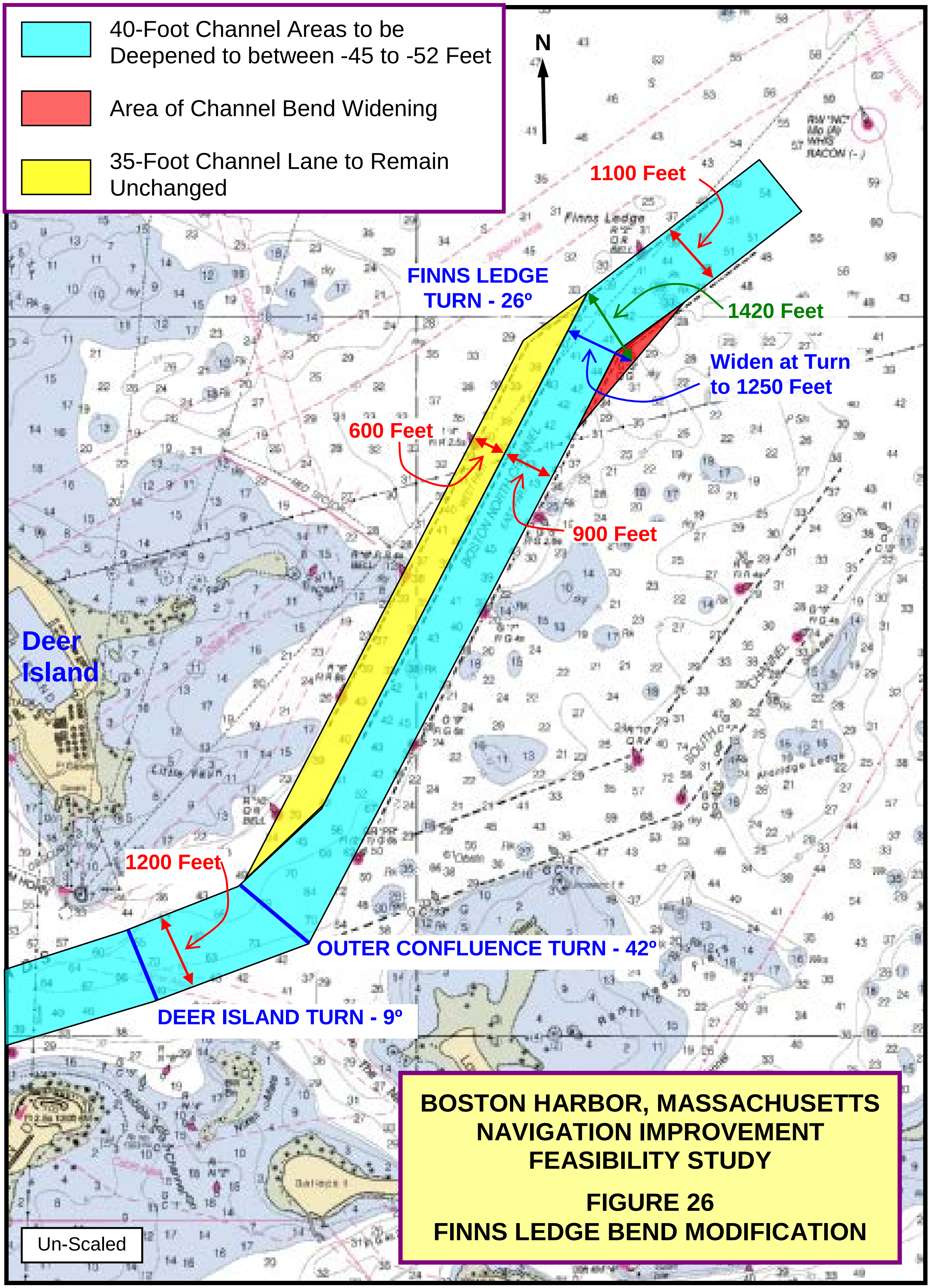
District's initial design, beyond calling for widening the lower Main Ship Channel to 800 feet between the Roads and the Reserved Channel, also included further widening in four areas: (1) the 26 degree bend at the entrance to the Broad Sound North Entrance Channel opposite Finns Ledge, (2) the transition in the Main Ship Channel between the President Roads Reach and the narrower lanes upstream, (3) the 20 degree turn in the Main Ship Channel at Spectacle Island, and (4) the 22 degree turn in the Main Ship Channel opposite the Lower Middle Shoal. The turn at the outer confluence where the entrance channels meet the Roads, at 1200 feet wide, was considered sufficient for all present and prospective traffic. The other turns at Deer Island (9 degrees), President Roads (10 degrees), and the Drydock (7½ degrees), were determined minor enough not to require additional width. The 3 degree turn at the Reserved Channel is incorporated within the limits of the turning basin and does not in itself require modification. The widening of the Reserved Channel Turning Basin is discussed separately.

Broad Sound North Entrance Channel at Finns Ledge: The bend in the North Entrance Channel at Finns Ledge is the first obstruction to navigation when entering the harbor. Proposals to straighten the entrance channel by cutting through the southeastern portion of Finns Ledge have been considered a number of times since 1892 when the north channel route was first designed. The 1988 feasibility report was the latest to consider such an improvement and estimated that 220,000 cubic yards of rock and 40,000 cubic yards of other material would need to be removed to widen the channel at the existing depth of 40 feet. This proposal was not considered further as the designers and pilots agreed that a lesser modification consisting of widening the channel bend at the apex opposite the ledge would provide an effective solution to the problem.

The District's design resulted in widening the channel across the bend at the inside apex by about 330 feet. This results in a total channel width at the apex of about 1240 feet or 1420 feet as measured off the 900 or 1100 foot adjoining channel reaches, respectively. The proposed design for the channel bend widening at the Finns Ledge turn of the Broad Sound North Entrance Channel in shown in Figure 26. The ship simulation study conducted by ERDC confirmed this design widening requirement from the design vessel track lines.

Lower Main Ship Channel Bends: Vessels transiting the Main Ship Channel must align their approach through the President Roads Reach to transition between the 1200-foot channel width in the outer confluence and up-channel along the anchorage boundary to the narrower width of the lower main ship channel where it splits into separate deep and shallow lanes upstream of the anchorage. This transition occurs over the course of about 3000 channel feet, or about three vessel lengths for the larger carriers, before the apex of the 20 degree turn at Spectacle Island. The Spectacle Island and Lower Middle Shoal turns are about 2500 feet apart as measured along the channel center line.

The District's design analysis, based on vessel turn radii and judgment of maneuverability yielded a channel design of 900 feet from the reaches between the Roads and the 800-foot recommended straight reach between the Lower Middle turn and the Reserved Channel Turning Area. The pilots requested that additional width be provided in the transition and the two turns. The ERDC ship simulation runs confirmed the pilots request as ebb tide currents appear to force inbound vessels to the north against the inside of these turns, while flood tide currents force the track lines south towards the outside of the turns.



BOSTON HARBOR, MASSACHUSETTS NAVIGATION IMPROVEMENT FEASIBILITY STUDY

FIGURE 26
FINNS LEDGE BEND MODIFICATION

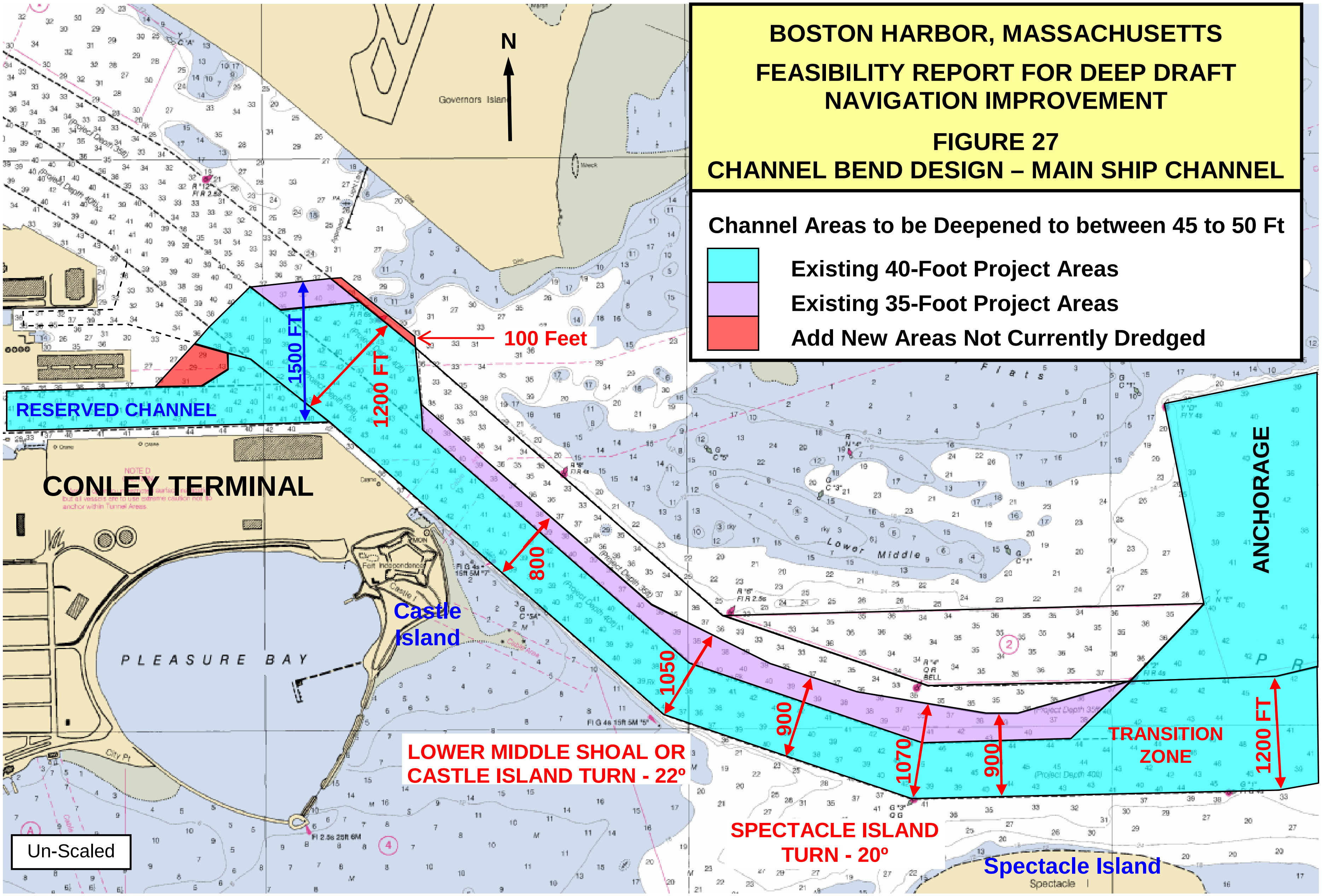
Widening the inside of the deepened bends further north into the existing 35-foot channel lane would permit the pilots to adjust their turn angle and keep a safe distance from the channel limits in both directions. Accordingly the modified design for these turns provides an apex cutoff of 1070 feet (as measured across the channel at the apex) at Spectacle Island, and 1050 feet at the Castle Island/Lower Middle Shoal turn. The bend design for widening the Main Ship Channel at the Spectacle Island and Lower Middle Shoal turns is shown in Figure 27.

Other Considerations in Design: Boston Harbor is a wide embayment with a mouth several miles across. Only three minor rivers discharge into the harbor; the Charles, Neponset and Mystic Rivers. The harbor is entirely tidal, and low riverine inflow has no effect on salinity in the channels with respect to navigable depth or displacement of vessels. There are also no littoral concerns with respect to sediment transport and the dredged channels. Shoaling rates for the project are very long, 16 to 40 years depending on channel reach, including 36 years for the Broad Sound North Entrance Channel. Any significant impact on littoral process would result in more rapid shoaling of the channels, however this is not expected to be an issue with Boston Harbor. Surrounding bottom types in the outer harbor and adjacent areas of the Bay are largely coarse materials; boulder, cobble and exposed bedrock and glacial till, not materials available for littoral transport.

Reserved Channel and Turning Area

The Reserved Channel provides access between the Main Ship Channel and the several terminals on the Reserved Channel itself, including the Conley Container Terminal. This study is only concerned with the Conley Terminal, as the existing 40-foot and 35-foot channel reaches provide adequate depth for the classes of cruise ships calling on the Black Falcon Terminal. Massport has already deepened its two principal berths (#11 and #12) at the Conley Terminal to 45 feet, to enable ships with a draft of up to 43 feet to reach the berths on the tide and still transfer cargo. Design vessels under the base-case and high-end economic future scenarios are described above, requiring either a 45-foot channel or a 48-foot channel, the same as provided in the Main Ship Channel, would call on the Conley Terminal under the with-project condition. A two-foot overdepth allowance would be added to these elevations, with a further two feet additional required removal increment in areas of ledge or other hard bottom material.

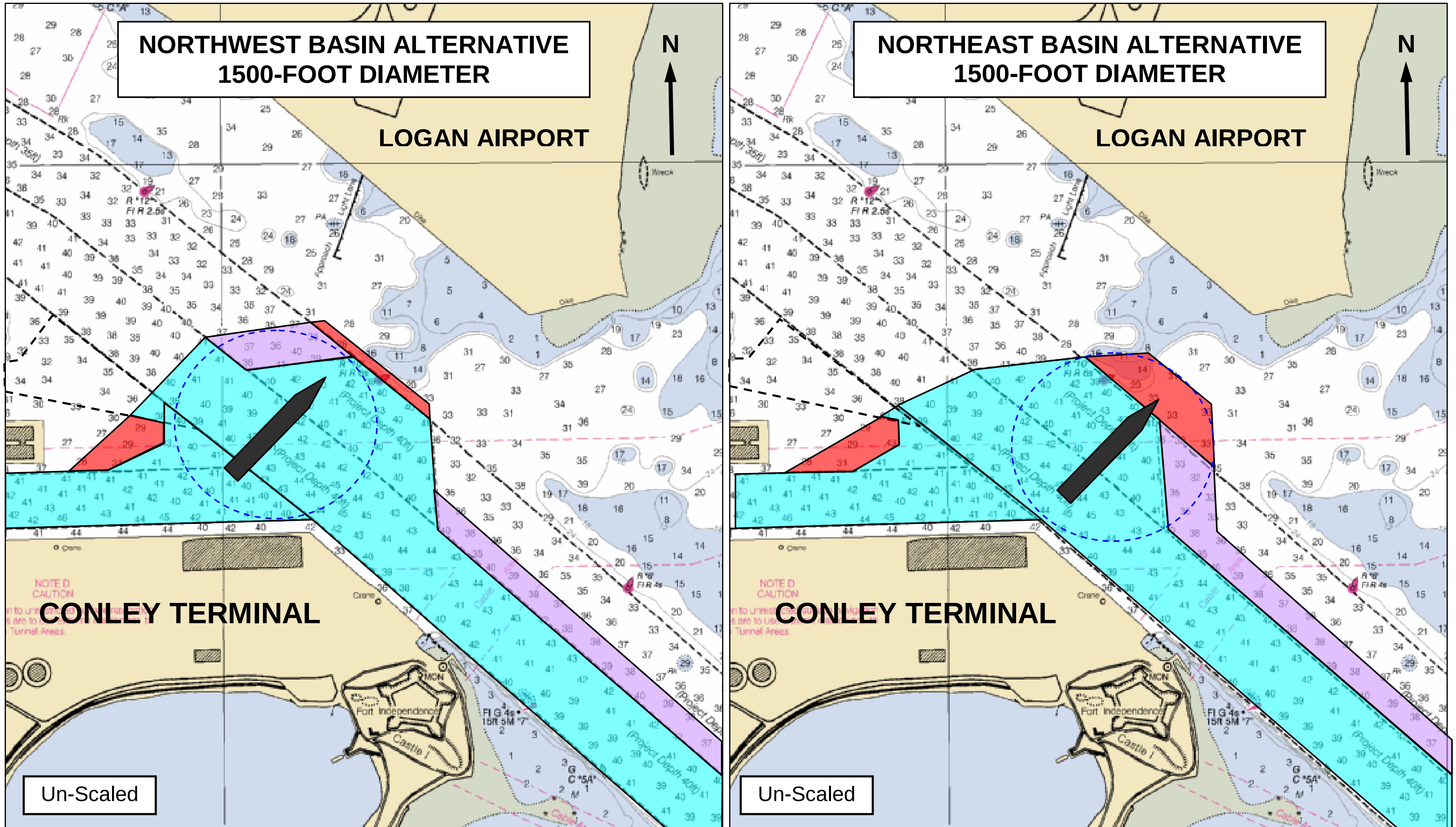
Except for the smaller cruise ships calling on the Black Falcon Terminal, all ships enter and depart the Reserved Channel with tug assist. One-way traffic is required by the channel's 400-foot width, and the Federal channel limits were reduced to allow for wider berths (143 feet wide in berths #11 and #12) under the 1990 project. This berth width is sufficient to accommodate containerships as large as the 7500 TEU ships projected in the high-end economic scenario. No further adjustments in channel or berth widths are included in this project design and the upper reach of the channel lying beyond the Conley Terminal would remain at its authorized depth of 35 feet for access to the upper berths at the Black Falcon Terminal.


BOSTON HARBOR, MASSACHUSETTS
FEASIBILITY REPORT FOR DEEP DRAFT NAVIGATION IMPROVEMENT
FIGURE 27
CHANNEL BEND DESIGN – MAIN SHIP CHANNEL
Channel Areas to be Deepened to between 45 to 50 Ft
Existing 40-Foot Project Areas
Existing 35-Foot Project Areas
Add New Areas Not Currently Dredged
N
Governors Island
100 Feet
1500 FT
1200 FT
RESERVED CHANNEL
CONLEY TERMINAL
800
Castle Island
PLEASURE BAY
1050
900
1070
900
LOWER MIDDLE SHOAL OR
CASTLE ISLAND TURN - 22º
SPECTACLE ISLAND
TURN - 20º
TRANSITION
ZONE
1200 FT
ANCHORAGE
Spectacle Island
Un-Scaled

The Reserved Channel Turning Area, located at the confluence of the channel with the Main Ship Channel, is currently configured with a diameter of 1200 feet spanning the two lanes of the Main Ship Channel at a depth of 40 feet with some widening of the confluence of the channels for transition. The two new design container vessels would require a slightly larger turning radius of 1500 feet. Figure 9-1 of the EM 1110-2-1613 (2006) calls for a turning basin radius of 1.2 to 1.5 times the vessel length for situations where current velocities range from 0 to 1.5 knots, with designs subject to simulation above those velocities. When the tide is running at its strongest the velocities in the area of the Reserved Channel Turning Area exceed 1.5 knots. The initial design for this turning area prior to ship simulation studies used the 1.5 time length factor rounded up to 1500 feet, with the approaches flared out at 45 degrees to the Main Ship Channel and even further to the Reserved Channel. ERDC's ship simulation recommended additional easing of the flares to the Reserved Channel and an additional 100 feet in basin diameter to the northeast (total 1,600 foot diameter). These changes were incorporated into the project design and are shown in the revised figures.

The Boston Harbor Pilots were consulted in the design of the expanded turning area and participated in the Ship Simulation Study conducted by ERDC. The two considerations in the Pilots view with the turning area are the action of easterly winds in conjunction with the large shallow (27-foot) ledge area off the Army Base pier (north side of the Reserved Channel entrance), and tidal currents that force a turning vessel either towards that ledge (flood) or towards the outer berth at the Conley Terminal (ebb). The pilots requested that (1) any turning basin radius be enlarged slightly to take these forces and hazards into consideration, and (2) that any expansion of the basin be upstream in the main ship channel to avoid the ledge and berths. The redesigned turning basin with a radius of 1500 feet, expanded an additional 100 feet northeasterly, and with additional flared transition to the Main Ship and Reserved Channels makes these adjustments, as confirmed by the simulation results.

Two turning basin layouts were developed for the new larger basin, taking into account the harbor pilots' and containerships' needs for adequate and efficient turning area, and the airport's needs for runway safety zones and minimized disruptions in airport operations. The airport runway restriction zones were discussed and described earlier under the existing conditions and shown in Figure 21. The two turning basin configurations are shown in Figure 28. A northwest basin alternative orientation was preferred by harbor pilots due to easier turning, less impact from currents and faster time to the berth. The second alternative shifted the new enlarged basin to the northeast, further way from the Runway 4R restriction zone. However turning times in this second orientation as developed from ship simulation studies described below were greater than with the northwest orientation. The northeast alignment also extends the basin 300 to 400 feet outside and north of the existing channel limits and closer to the airport shore, as the area off the Army Base Pier is not available for a portion of the basin in this location. The northeast orientation also requires extensive ledge removal relative to the northwest basin alignment. Locating the basin any further down the main ship channel would require vessels to be backed up-harbor against the current before turning into the Reserved Channel, an impractical maneuver given the currents.



Legend
40-Foot Main Ship Channel Areas Deepened to 45 to 50 Feet for Main Channels Containership Access
Presently Undredged Areas – Deepen to 45 to 50 Ft
35-Foot Main Ship Channel Lane Areas Deepened to 45 to 50 Feet to Widen Deep Channel Lane

BOSTON HARBOR, MASSACHUSETTS
DEEP DRAFT NAVIGATION IMPROVEMENT
FEASIBILITY STUDY

FIGURE 28
RESERVED CHANNEL TURNING AREA EXPANSION
ALTERNATIVE BASIN ALIGNMENTS

Overall, the northwest basin alignment was determined to pose the least problems for airport operations due to the faster turning time and time to the berth. At present use of Runway 4R is typically suspended when large air-draft ships are turning in the basin, and operations temporarily delayed for several minutes or shifted to another of the airport's four major runways. A fifth runway is too short for jet aircraft use. When dredges are working in the turning basin close coordination is maintained between the Corps, its contractor, Massport's maritime and airport staff, and FAA airport operations, to minimize disruptions to both dredging and air operations. Prior to construction activities for the last improvement and major maintenance dredging, the Corps and Massport requested clearance from the FAA for dredging activities and worked out the system of notices and schedules to be followed. This process will be continued for any improvement dredging project. No quantifiable costs to the airport and its users for adjusting airport operations to the presence of turning ships or construction equipment working in the turning basin have been identified due to the system of coordination between the agencies and the availability of other runways.

Anchorage Deepening Plans

The President Roads Anchorage is the Port's only improved deep-draft commercial vessel anchorage. The 40-foot anchorage was initially constructed in 1933-35 and enlarged by dredging in 1960. The 1990 authorized project provided for further enlargement of the anchorage for modern ships through a non-structural shifting of the entrance channel along the south side of the Roads. The existing anchorage is about 3,110 by 5,890 feet with flares in its transition to the Main Ship Channel limits.

The Boston Harbor Pilots and US Coast Guard believe that deepening of the entrance and main ship channels must be accompanied by a commensurate deepening of the President Roads Anchorage. Pilots point to use of the anchorage for lightering of petroleum tank ships, vessels waiting for favorable tide conditions, berth access, or clearance for bridge passage on the Chelsea River, or for inspections. The anchorage lies in relatively sheltered waters inside Deer Island and Long Island and will not require any additional project design depth for the increased sea states found in the outer harbor entrance or bay. In a series of discussions over the fall and winter of 2007 the harbor pilots provided the following information and made the following points considering the use of the anchorage and need for anchorage deepening.

- Pilots use the 40-foot anchorage for vessels drafting up to 37 feet. Vessels drafting more than 37 feet are not brought into the harbor unless there is an open berth waiting for their arrival.
- Over the two year period of 2006-2007 the pilots placed 326 large ships in the anchorage, about one every other day.
- Most ships using the anchorage are petroleum/petrochemical tankers that use the anchorage for:
  - Lightering liquid cargos and coal
  - Waiting for an open berth at the terminals
  - Waiting for daylight hours for transit up-harbor
  - Testing cargo to meet fuel specs of buyers

- Both tankers and bulk carriers use the anchorage for:
  - Waiting for favorable tides for up-harbor passage
  - Waiting for transit of LNG vessels
  - For Mystic-bound vessels – waiting for LNG tankers to finish offloading
  - Shifting cargo to adjust vessel trim
  - Bunkering vessels – taking on fuel
  - Some lightering of dry bulk cargos
- The anchorage is the last emergency turn-out for inbound vessels

The Boston Harbor Pilots further stressed that anchorage depth able to accommodate the draft of vessels using the harbor's channels is critical to safe operation of the harbor. While the majority of ships using the anchorage would continue to be tank ships and other carriers bound for the upper harbor, where channel depths are limited to 40 feet, some of those are transiting with tidal advantage and therefore require anchorage greater than 40 feet in depth. With the majority of the ships using the anchorage being tankers, and Chelsea River being deepened to 40 feet, additional anchorage depths for those boats will be required.

Also, for all vessels, including those larger design vessels using the deeper channels to access the Conley Terminal and Marine Terminal, a deeper anchorage is required for mechanical and other emergencies, berth clearance, and waiting for clear channel passage. While those instances are and would be infrequent, they do occur and should be accommodated in the interest of safe navigation and public safety.

In discussions held with the USCG First District and Massport on 7 July 2005, and in the fall and winter of 2007, the need for the President Roads Anchorage as an integral part of the harbor's navigation infrastructure was discussed. President Roads is the last opportunity for inbound vessels to be stopped for safety or security reasons before entering the developed and populated areas of the City of Boston. The Coast Guard considers the President Roads Anchorage to be a Port Security Feature, and outlined the importance of the anchorage as in integral part of the port for operations, safe navigation and security as follows. Some of these echo the reasons stated by the Boston Harbor Pilots:

(1) The President Roads Anchorage is the Port's only improved deep-draft commercial vessel anchorage.

(2) It is the only large area of the port near the deep draft channels where vessels can anchor in sheltered waters. Seas in the anchorage are commonly 1 to 2 feet in calm conditions, while they are 2 to 5 feet outside the harbor in calm conditions.

(3) In rare conditions of exceptionally heavy weather it is the only safe place for pilots and USCG inspectors to board vessels. Typically vessels are boarded and inspected outside the Captain of the Port Safety Zone which extends outside the harbor entrance into Broad Sound. However about two to three times a year heavy weather forces the Captain of the Port to direct a ship to the anchorage for inspection.

(4) The anchorage is used occasionally by large tank vessels for lightering and more often by vessels while waiting for favorable tides to transit to the berth and while awaiting clear passage conditions. The anchorage is used particularly for ships bound for the Chelsea River waiting for other vessels to depart the berths or upper channel reaches, or waiting for daylight transit conditions.

(5) President Roads is also the last opportunity for inbound vessels to be stopped for safety or security reasons before entering the highly developed and densely populated areas of the City of Boston.

(6) In vessel emergencies, ships are directed to the anchorage. During vessel fires or mechanical problems with steerage or otherwise, ships are directed to stop in the anchorage, or ordered off the berth and to the anchorage. As with inspection boardings in the anchorage these situations are rare. However, as the anchorage is already in use one out of every two days by vessels of any size for other purposes, the chance of needing two vessel spaces in the deep anchorage for emergencies is 50/50.

The USCG believes that any main channel deepening would need to include anchorage deepening to retain these purposes for the larger classes of vessels that would be attracted to the port due to the deeper channels.

Corps policy on incorporation of port security features into harbor design may be found in the policy memorandum from the Director of Civil Works titled: National Security Considerations in the Planning, Design, Construction, and Operation and Maintenance of Harbor and Inland Harbor Projects, dated 21 December 2004. This policy letter states “the planning, formulation, engineering, design, funding and construction of security features and facilities for new and modified navigation projects will be accomplished as an integral part of the navigation project development process. Navigation projects and project modifications formulated in feasibility studies and recommended in feasibility reports will include appropriate cost effective security features and facilities.” That guidance states “features and facilities for security will be shared as General Navigation Features (GNF) under Section 101 of the Water Resources Development Act (WRDA) 86, as amended. The operation and maintenance costs of security features and facilities will be shared as GNF operation and maintenance costs.” The guidance also states, “While benefits will be identified and quantified to the extent possible, security will be considered an absolute criterion and appropriate cost effective measures will be included in navigation project without regard to any incremental economic justification.”

The area of anchorage required to be deepened for these purposes is a separate question. Corps design guidance contained in EM 1110-2-1613 provides a framework for examining anchorage design. General anchorages used for the open-mooring of large vessels on their own anchors for refuge, lightering and bunkering, in emergencies, or while waiting for passage (the principal uses for the President Roads Anchorage) are typically sized based on single point anchoring of the ships. In this case the ship is provided a 360 degree swing around a single anchor. Two alternate methodologies are discussed in the EM. In the first, an anchor scope equal to at least five times the high water depth is added to the ship’s overall length (LOA) to give the radius of the mooring circle. For example at a design depth of 48 feet with a MHW elevation of about 10 feet a 1040-foot long ship would require a diameter of about 2,660 feet (((58 X 2) + 1040) X 2). Alternatively the guidance suggests a mooring circle of about three times the LOA of the vessel (1040 X 3 = 3,120 feet in this example). In sheltered conditions a minor degree of overlap in adjacent mooring circles may be allowed if like vessels are determined to swing in the same direction in response to current, swells and wind. At higher tides the anchor scopes would shorten and any would overlap would decrease.

**BOSTON HARBOR, MASSACHUSETTS
DEEP DRAFT NAVIGATION IMPROVEMENT
FEASIBILITY REPORT**

**FIGURE 29
PRESIDENT ROADS ANCHORAGE LAYOUT
FOR TWO LARGER CONTAINERSHIPS
AND/OR TANK SHIPS**

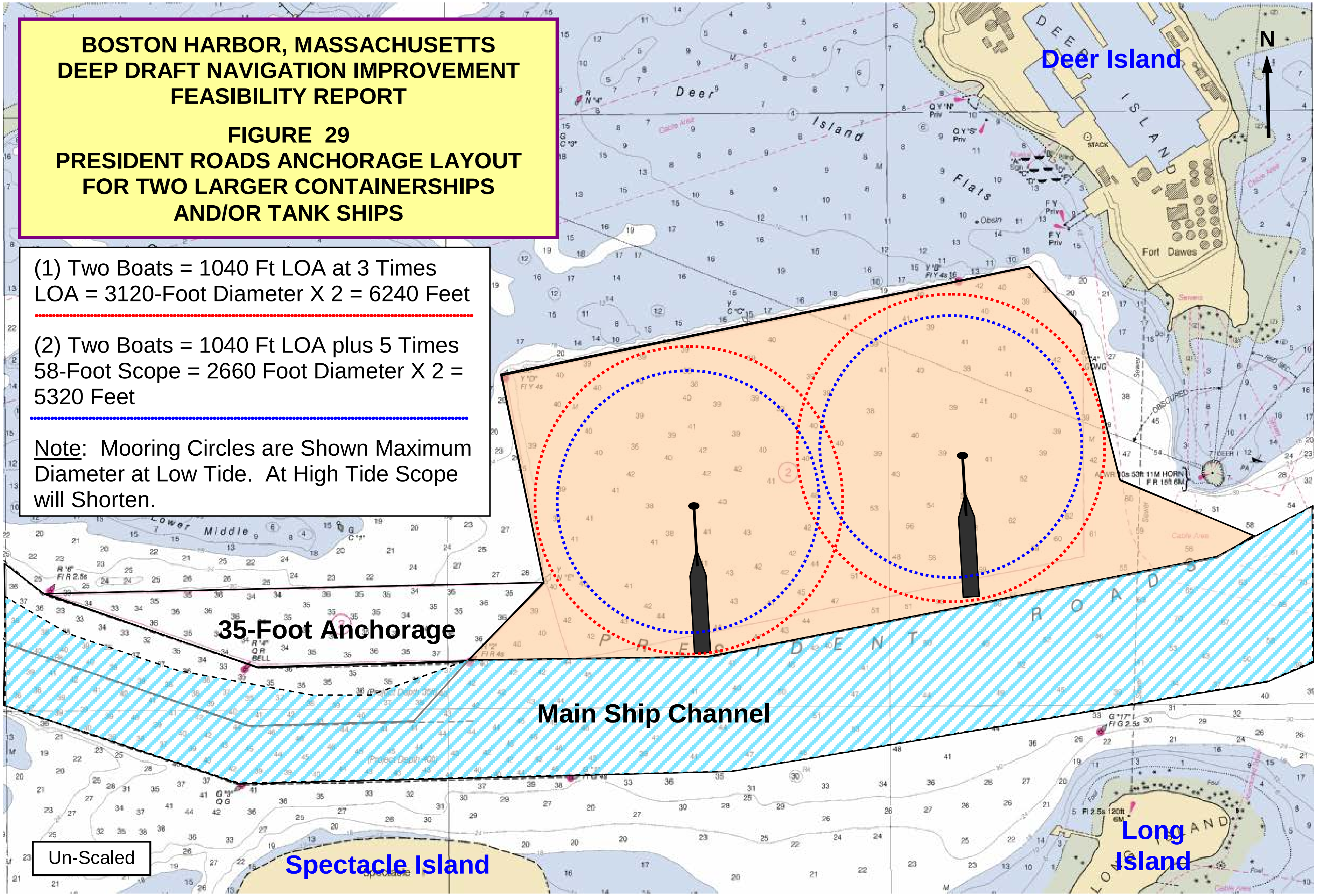


Figure 29 shows how the President Roads Anchorage could accommodate two large vessels in the 900 to 1040-foot LOA range on single-point anchoring. In the five-times anchor scope example, the 5,320-foot need for two vessels would fit well within the 5660-foot wide anchorage without overlap of the mooring circles. In the three-times LOA method, the 6,240 feet required for two vessels would require a 280-foot overlap in the mooring circles (maximum at low tide), a nine percent overlap acceptable in the sheltered conditions of President Roads. Therefore two of these vessels would be safely accommodated in the President Roads Anchorage. These are the largest tank and container vessels projected for Boston under the with-project conditions.

In accordance with this guidance, and after consultation with the US Coast Guard (First District), Massport and the Boston Harbor Pilots, deepening of the President Roads Anchorage to a depth equal to the design depth for the Main Ship Channel would be included in the project plan as necessary to provide space for two deep-draft vessels to anchor. Anchorage design would also include a two-foot overdepth allowance and plus an additional two feet in ledge or hard bottom areas will be included. This decision was made on the following determination:

(1) That one deep-draft anchorage space must always be available for port safety and security inspections in inclement weather and other conditions as the Captain of the Port may direct.
(2) That an additional anchorage space must be available, separate from that needed for safety and security purposes, for vessel emergencies and normal port operations as outlined above, capable of accommodating up to the largest classes of vessels calling on the port's terminals.
(3) That current and projected vessel traffic and port use would not require more than two vessels be accommodated in the anchorage for any purpose
(4) That additional anchorage depth to accommodate vessels larger than those calling on the port's terminals is not necessary.
(5) That design and construction of the anchorage will be cost-shared as GNF.

Marine Terminal Main Channel Deepening Extension

An incremental extension of the deepened Main Ship Channel upstream of the Reserved Channel Turning Area was considered to access the Massport Marine Terminal in South Boston, the last terminal located below the tunnels. Berths for this terminal front on the Main Ship Channel and are currently at a depth of 40 feet. There is a distance of 240 to 280 feet between the Federal channel limit and the terminal bulkhead, more than necessary for the berths. As described earlier, Massport is in the process of redeveloping this terminal for bulk cargo shipping, has entered an agreement with a developer to redevelop the site for marine transportation uses, and identified the first tenant for future bulk cargo operations (cement). The new terminal will begin operations in 2010, and shippers have indicated a need for channel and berth depths of 45 feet to support increased operations. The assumed design vessel for this project segment is the 60,000 DWT 42-foot draft dry bulk carrier described above. Massport and its development partners would need to deepen the berths at this terminal to a depth commensurate with that of any improved Federal channel. The costs of berth deepening are included in the cost estimates for this project segment as a non-Federal cost. Extension of Main Ship Channel deepening above this area is restricted by the clearances for the Ted Williams Tunnel, which limits the upper harbor areas to no greater than 40 feet (the top of the tunnel's rock cover layer is generally -45 feet MLW). Depths of 42 to 45 feet would be analyzed for this channel deepening extension to the MMT. A two-foot overdepth allowance would be added to these elevations, with a further two feet additional required removal increment in areas of ledge or other hard bottom material.

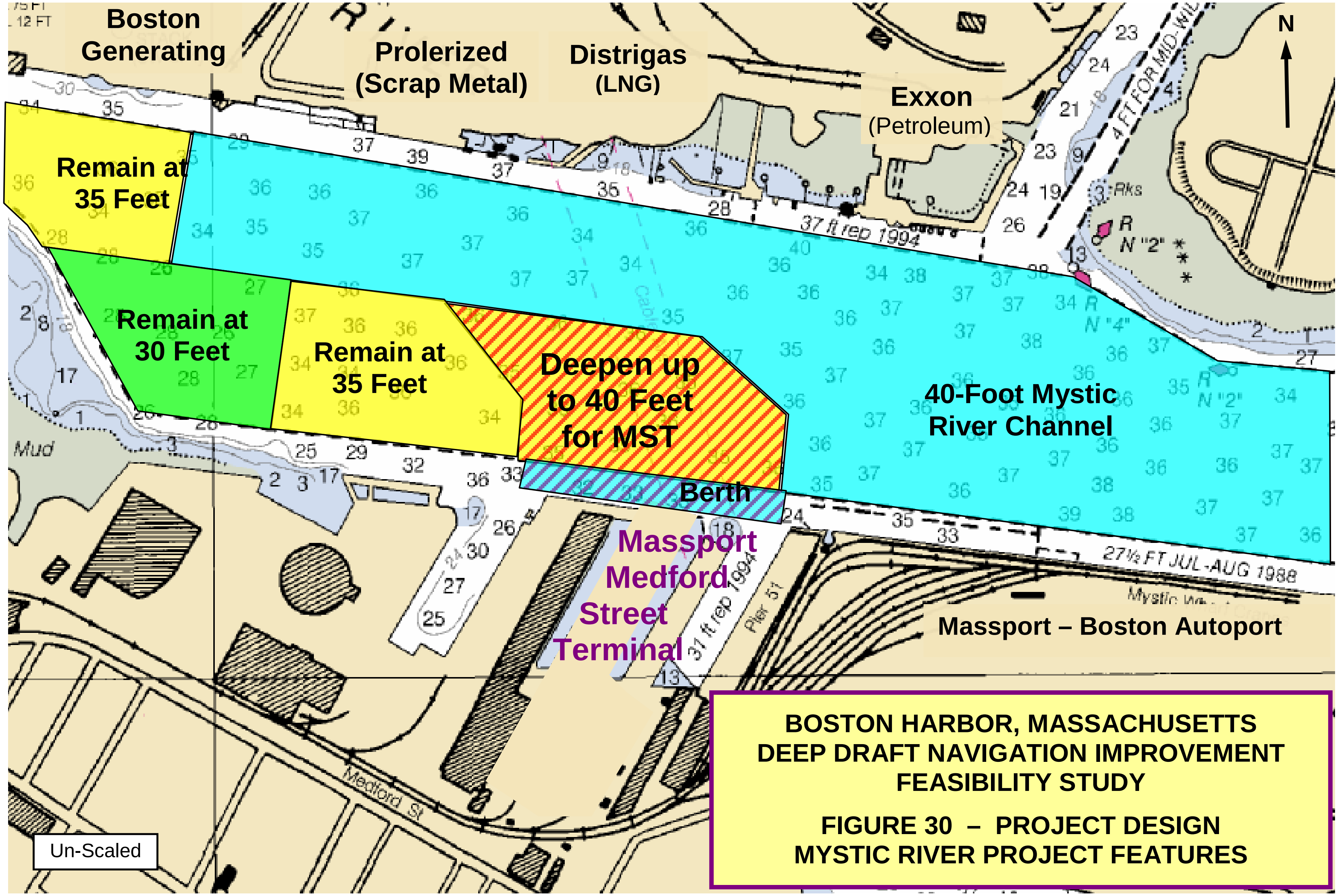
As with the seaward reaches of the main ship channel, two-way traffic of large commercial cargo ships is not a consideration for this reach of the channel. Channel transit information by vessel draft is provided in Appendix D-1 (Engineering Design). Nearly all of the inner harbor's small craft traffic, commuter ferries, US Naval and USCG vessels, and the tanker and bulk carrier traffic to and from the Mystic and Chelsea Rivers pass this terminal. However, transits of larger vessels requiring the deep channel lane are limited, especially above the Reserved Channel (the destination for all containerships and large cruise ships). Smaller vessels will travel in the 35-foot northern channel lane when larger ships are in the 40-foot lane, but two-way traffic with larger bulk carriers and smaller vessels does occasionally occur similar to that discussed for the lower reaches of the Main Ship Channel. A typical dry bulk vessel that would require a 45-foot channel would have a 105-foot beam as described above. Two-way traffic in the deep channel lane between such a ship and a large barge, commuter ferry or excursion boat, the most likely passing situations, would not require more than the current 600-foot channel width.

Mystic River Channel Modification

The only modification under consideration for the Mystic River Channel at this time, as shown in Figure 30, is an extension of the 40-foot channel cut along the southern, Charlestown, shoreline, upstream above Massport's Boston Autoport (Moran Terminal) to the Medford Street Terminal. Massport plans to redevelop this terminal for bulk cargo operations, most likely cement or automobile import/export. This area of the Federal project is authorized and maintained to a depth of 35 feet and was not deepened under the 1990 project as the future of this terminal was too speculative at that time. Massport has cleared the site and deepened the berth at the Medford Street Terminal to 40 feet during the improvement dredging of the 40-foot Mystic River Channel. As the Ted Williams Tunnel clearances limit access to the upper harbor areas to 40 feet, deepening additional portions of the Mystic River Channel will only be considered up to a depth of 40 feet. The design vessel for this section of the Mystic River is the 40,000 DWT 37-foot draft vessel described above.

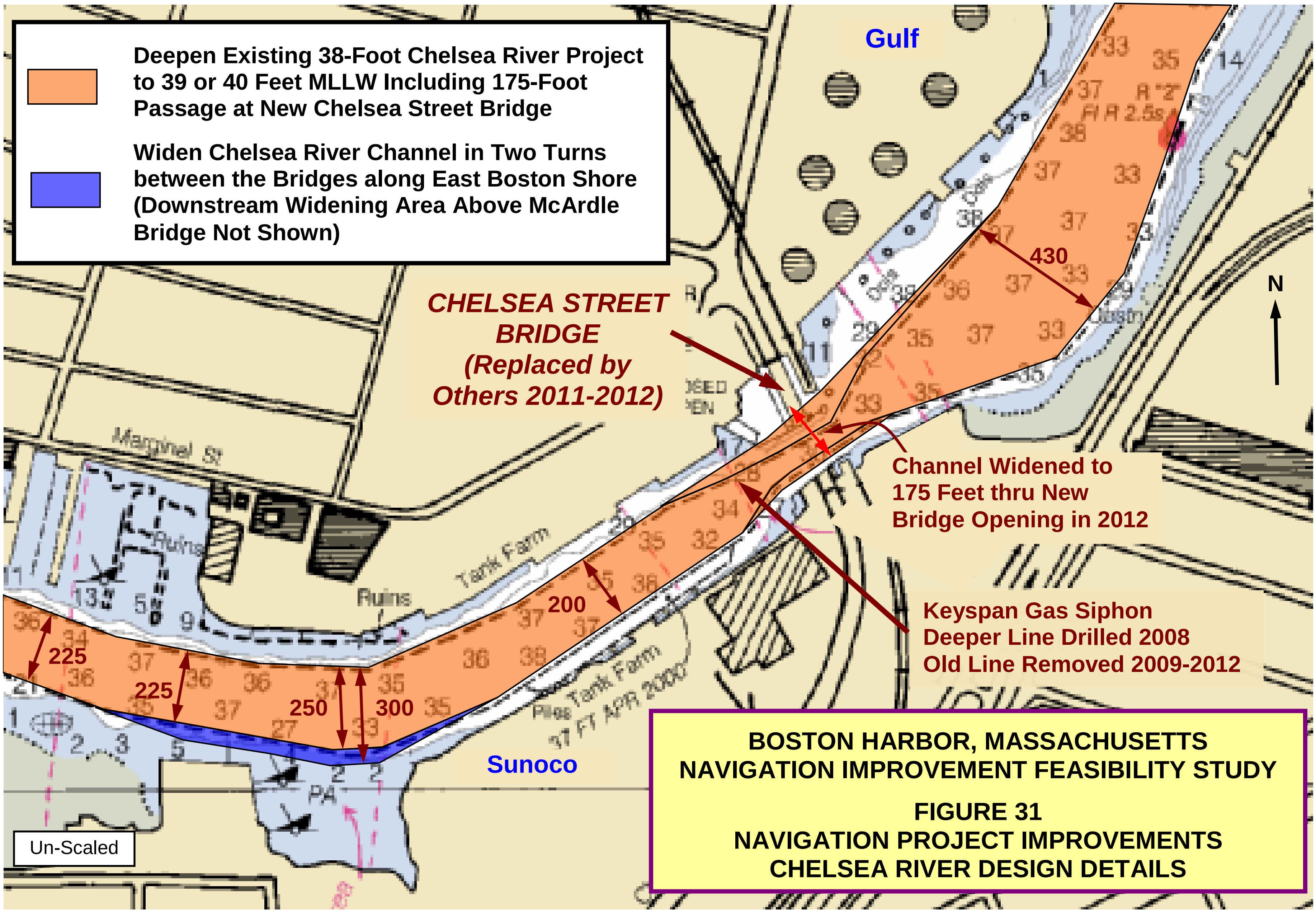
Subsurface investigations revealed no ledge or other hard material present in the proposed dredging horizon for this area of the Mystic River. Subsurface explorations show the material to be removed is predominantly Boston blue clay. Accordingly, only a 2-foot allowable overdepth increment for soft bottom materials need be added to the feature design and quantity estimates.

The minor nature of this improvement, less than 90,000 cubic yards of clean clay suitable for ocean disposal, would have made it a candidate for study and authorization under Section 107 authority. However with the deep draft improvement study ongoing, Massport requested that this improvement be examined under this study.



BOSTON HARBOR, MASSACHUSETTS
DEEP DRAFT NAVIGATION IMPROVEMENT
FEASIBILITY STUDY

FIGURE 30 – PROJECT DESIGN
MYSTIC RIVER PROJECT FEATURES


Deepen Existing 38-Foot Chelsea River Project to 39 or 40 Feet MLLW Including 175-Foot Passage at New Chelsea Street Bridge
Widen Chelsea River Channel in Two Turns between the Bridges along East Boston Shore (Downstream Widening Area Above McArdle Bridge Not Shown)
Gulf
CHELSEA STREET BRIDGE (Replaced by Others 2011-2012)
430
N
Marginal St
Ruins
Tank Farm
200
Channel Widened to 175 Feet thru New Bridge Opening in 2012
Keyspan Gas Siphon Deeper Line Drilled 2008 Old Line Removed 2009-2012
225
225
250
300
Sunoco
Un-Scaled
BOSTON HARBOR, MASSACHUSETTS
NAVIGATION IMPROVEMENT FEASIBILITY STUDY
FIGURE 31
NAVIGATION PROJECT IMPROVEMENTS
CHELSEA RIVER DESIGN DETAILS

Chelsea River Channel Deepening

Consideration of deepening the Chelsea River beyond the current 38-foot project depth, as shown in Figure 31, is based on the assumption that the Chelsea Street Bridge would be replaced by others under the without project condition. Ship simulation studies prepared for the last improvement project in 1992, and design studies prepared in 1996 concluded that the maximum channel depth needed by vessels capable of passing through the existing bridge was 38 feet, and that vessels needing any greater depth would also require removal of the bridge.

As the Ted Williams Tunnel clearances limit access to the upper harbor areas to 40 feet, deepening the Chelsea River Channel to 40 feet was the only increment considered. The design vessel for a 40-foot Chelsea channel, as described above, is a 50,000 DWT tanker, loaded to a draft of 37 feet.

Subsurface investigations revealed no ledge or other hard material present in the majority of the proposed dredging limits and depth horizon for the Chelsea River. The exceptions are an area of ledge near the confluence of the channel and the turning basin at the head of navigation along the East Boston shore, and an area of hard till material in the vicinity of the Chelsea Street Bridge, also along the East Boston Shore. In all areas an additional two feet of required dredging will be incorporated into the dredging feature's design and quantity estimates.

The 1992-93 ship simulation study examined the current design vessel for transits of Chelsea Creek under a scenario that considered replacement of the Chelsea Street Bridge, so additional simulation studies for this waterway segment were not repeated for this study. The 1995 simulation recommended slight modifications to the Chelsea Channel by minor widening in the two bridge approaches and in the wide bend between the two bridges. An increase in channel width of 50 feet has been incorporated in the design along the East Boston shore immediately upstream of the McArdle Bridge and in the bend between the bridges.

Construction of the new vertical lift span Chelsea Street Bridge, including removal of the old span, was completed in 2012. At that time the Corps widened the channel cut through the bridge to a minimum of 175 feet at the authorized 38-foot depth. Detail of the project design limits, existing and proposed, in the vicinity of the Chelsea Street Bridge are shown in Figure 31.

Project Feature Summary

Table 30 shows the project dredge depth calculations for the several channel reaches and deepening plans under consideration. Containership improvement features are presented first, with all other improvements presented separately below. Dredge depth calculations are shown for the Post-Panamax classes of 5100 and 8000 TEU container ships, the most likely larger future vessels to be placed in use by existing services calling on the Port of Boston under the economic analysis base case.

TABLE 30
BOSTON HARBOR DEEP DRAFT IMPROVEMENT PROJECT – CHANNEL DESIGN DEPTH REQUIREMENTS

Project Feature	Existing Depth	Proposed Design Depth	Additional Design Requirement for Seas & Vessel Motion	Overdepth Allowance in All Materials	Additional Requirement in Hard Material	Maximum Dredge Depth in Soft Material	Maximum Dredge Depth in Hard Material
CONTAINERSHIP PROJECT FEATURES							
Broad Sound North Entrance Channel	35 & 40	47	4	2	2	53	55
President Roads Channel Reach	40	47	0	2	2	49	51
Main Ship Channel below RTA	35 & 40	47	0	2	2	49	51
Reserved Channel Turning Area	40	47	0	2	2	49	51
Reserved Channel – Lower Reach	40	47	0	2	2	49	51
President Roads Anchorage	40	47	0	2	2	49	51
OTHER PROJECT FEATURES							
Main Ship Channel above RTA	35 & 40	45	0	2	2	47	49
Mystic River – Medford St. Area	35	40	0	2	NA	42	NA
Chelsea River Channel	38	40	0	2	NA	42	44

EVALUATION OF ALTERNATIVES

The identified channel improvements are the only features that could meet the planning objectives in a reasonable cost and timeframe. Channel deepening would provide improved access to the Port's various container, liquid and dry bulk terminals and allow for the passage of fully loaded or near fully loaded deep draft vessels. Channel deepening would also permit shippers to retain or include Boston in their liner services as they upgrade to larger capacity (deeper draft) vessels on their service routes or add new services. Widening and realignment of channel segments and expansion of the turning area would improve the flow of large vessel traffic and reduce the potential for maritime accidents. Project depths would be selected to maximize net benefits from the project. All project depths are referenced to mean lower low water (MLLW).

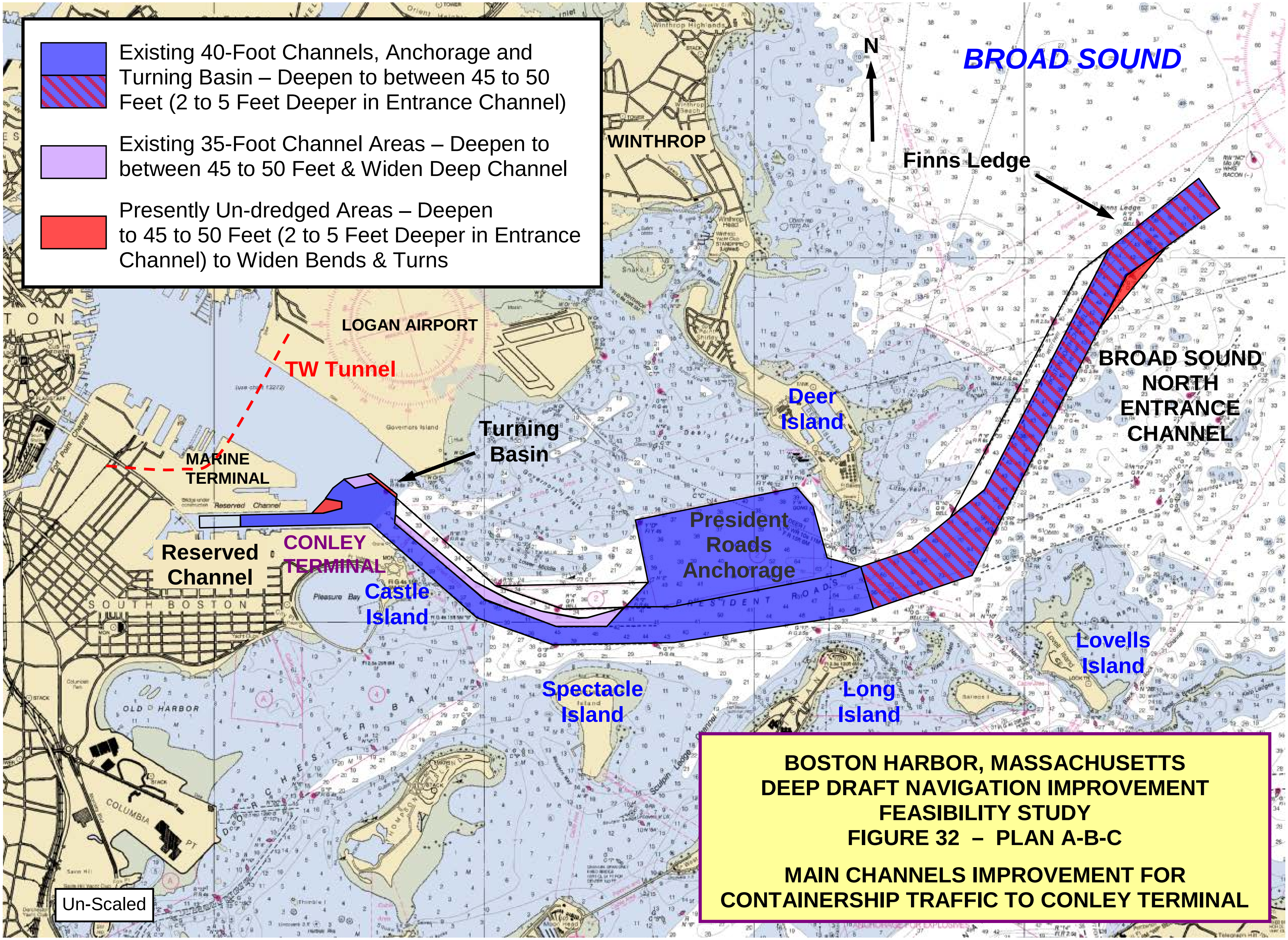
NAVIGATION IMPROVEMENT ALTERNATIVES

After detailed discussions with various cargo carriers that currently call on Boston Harbor, on most likely future shipping vessels and routes, the needs for the various design vessels in each channel reach were combined to form preliminary plans of improvement for the design container vessels and for the other additional bulk cargo improvements under consideration. The container-focused plans for the main channels into Conley Terminal were evaluated at one-foot increments from -42 to -50 feet MLLW. The Main Ship Channel Deepening Extension to the Marine Terminal (Plan D) was evaluated at this stage as incremental to the post-Panamax container ship improvement plan (Plan ABC), as deepening downstream of the Reserved Channel would be necessary before deepening upstream to the Marine Terminal. The plans for deepening in the Mystic and Chelsea Rivers are limited to the 40 foot MLLW depth that can be carried over the subway and highway tunnels, and therefore are independent of any deepening beyond 40 feet in the downstream areas of the harbor.

Containership Improvement Alternatives for Conley Terminal Access

The plans for main channel improvements, as shown in Figure 32, were developed for the primary benefit of containership traffic to the Conley Terminal. These plans consist of dredging and rock removal to deepen the Broad Sound North Entrance Channel, President Roads Anchorage, the Main Ship Channel between the anchorage and the Reserved Channel, the Reserved Channel Turning Area and the lower reach of the Reserved Channel, for the benefit of the larger Panamax and Post-Panamax containerships that would call on the Conley Terminal. In all plans, the entrance channel would be deepened an additional two to four feet to compensate for increased sea states in the bay and outer harbor. Other vessels and cargos may also benefit from these improvements, particularly the entrance channel and anchorage deepening, but those benefits have not been quantified.

The main channel plans differ only with respect to depth optimization. Economic optimization evaluated the range of channel depths from -42 to -50 feet MLLW in one-foot increments. In the 2008 draft report three of these depth increments were selected for presentation of costs and impacts, namely the 45, 48 and 50-foot depth increments for the inner channels design depth. Subsequent to 2009 all analyses looked at the entire range of depth and referred to these collectively as Plan ABC, with presentation of all evaluated depth increments.


Existing 40-Foot Channels, Anchorage and Turning Basin – Deepen to between 45 to 50 Feet (2 to 5 Feet Deeper in Entrance Channel)
Existing 35-Foot Channel Areas – Deepen to between 45 to 50 Feet & Widen Deep Channel
Presently Un-dredged Areas – Deepen to 45 to 50 Feet (2 to 5 Feet Deeper in Entrance Channel) to Widen Bends & Turns
N
BROAD SOUND
WINTHROP
Finns Ledge
LOGAN AIRPORT
TW Tunnel
Deer Island
Turning Basin
MARINE TERMINAL
BROAD SOUND NORTH ENTRANCE CHANNEL
President Roads Anchorage
CONLEY TERMINAL
Reserved Channel
Castle Island
Lovells Island
Spectacle Island
Long Island
Un-Scaled
BOSTON HARBOR, MASSACHUSETTS
DEEP DRAFT NAVIGATION IMPROVEMENT
FEASIBILITY STUDY
FIGURE 32 – PLAN A-B-C
MAIN CHANNELS IMPROVEMENT FOR
CONTAINERSHIP TRAFFIC TO CONLEY TERMINAL

Plan ABC includes expansion of the Reserved Channel Turning Area to a 1500-Foot diameter, widened at its junctions with the Main Ship and Reserved Channels and further widened to the northeast by 100 feet, as recommended by the ship simulation study. These plan increments also include widening the channels at three critical bends at Finns Ledge in the entrance channel, and at Spectacle Island and the Lower Middle Shoal below Castle Island in the lower Main Ship Channel. The details of the main channels improvements in the Reserved Channel, its turning basin, and vicinity are shown in Figure 33.

Plan ABC also includes deepening the Broad Sound North Entrance Channel by an additional increment below the design depth for the inner harbor channels. The additional depth would compensate for the higher sea states (wind, waves, swells) and the resulting vessel motion in the exposed entrance, allowing the channel to function as a system. The Boston Harbor Pilots would, as at present, time their ship transits with respect to the changing tide and sea conditions to maintain adequate safe underkeel clearance through their entire transit, while maximizing use of the tide. At the time of the 2008 draft report, engineering guidance pointed to a two foot increase in channel depth in the entrance, for a fifty percent increase in underkeel clearance. In the 2008 draft report all main channel plan increments from -42 to -50 feet included two additional feet of depth in the entrance channel. New engineering guidance developed for other east coast ports since 2008 required a re-examination of additional entrance channel depth and yielded a requirement for a four foot difference in underkeel clearance. In the 2012 final report main channel plan increments from -45 to -48 feet were developed including the four foot increase in entrance channel depth.

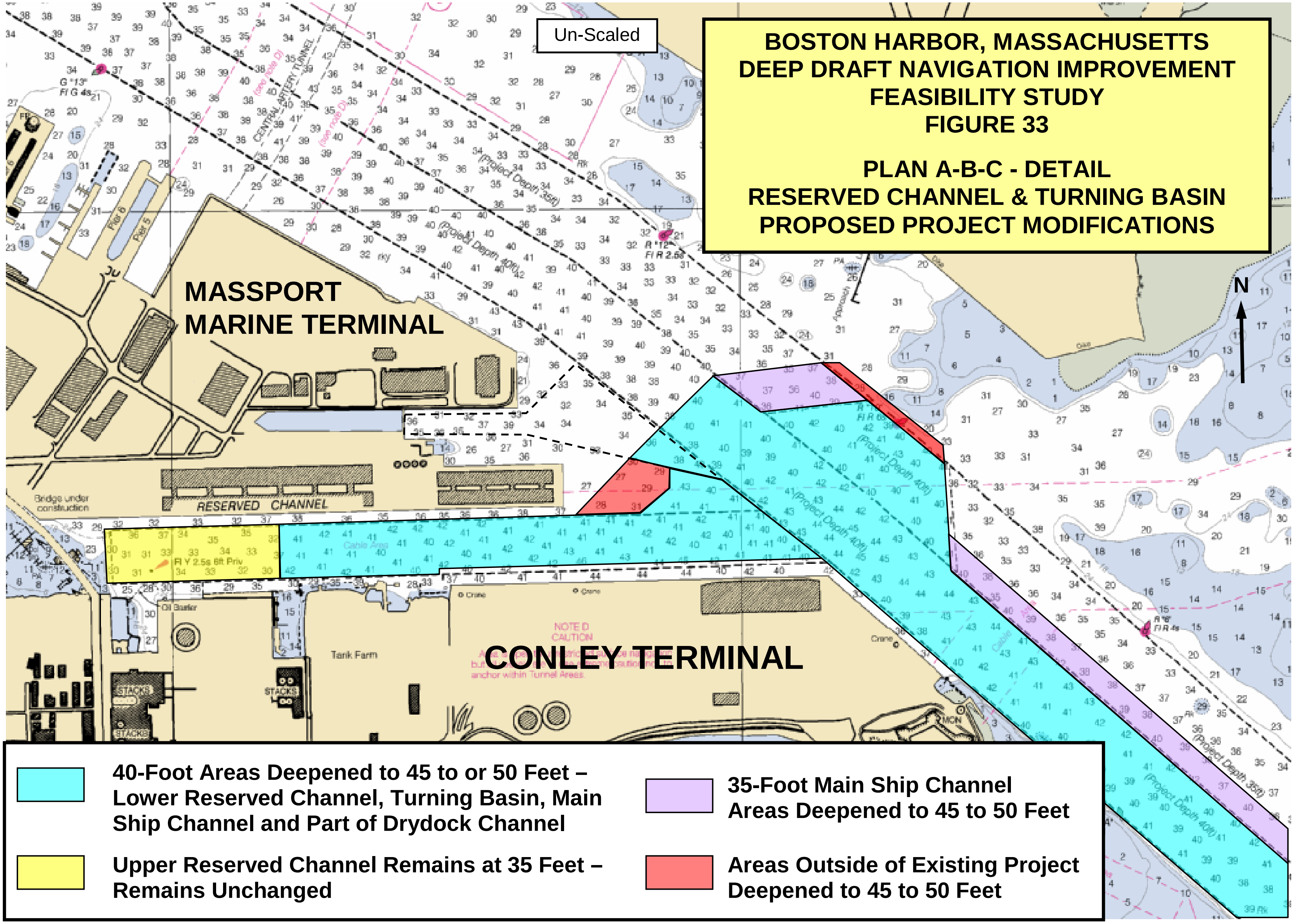
Bulk Cargo Terminals Access Plans

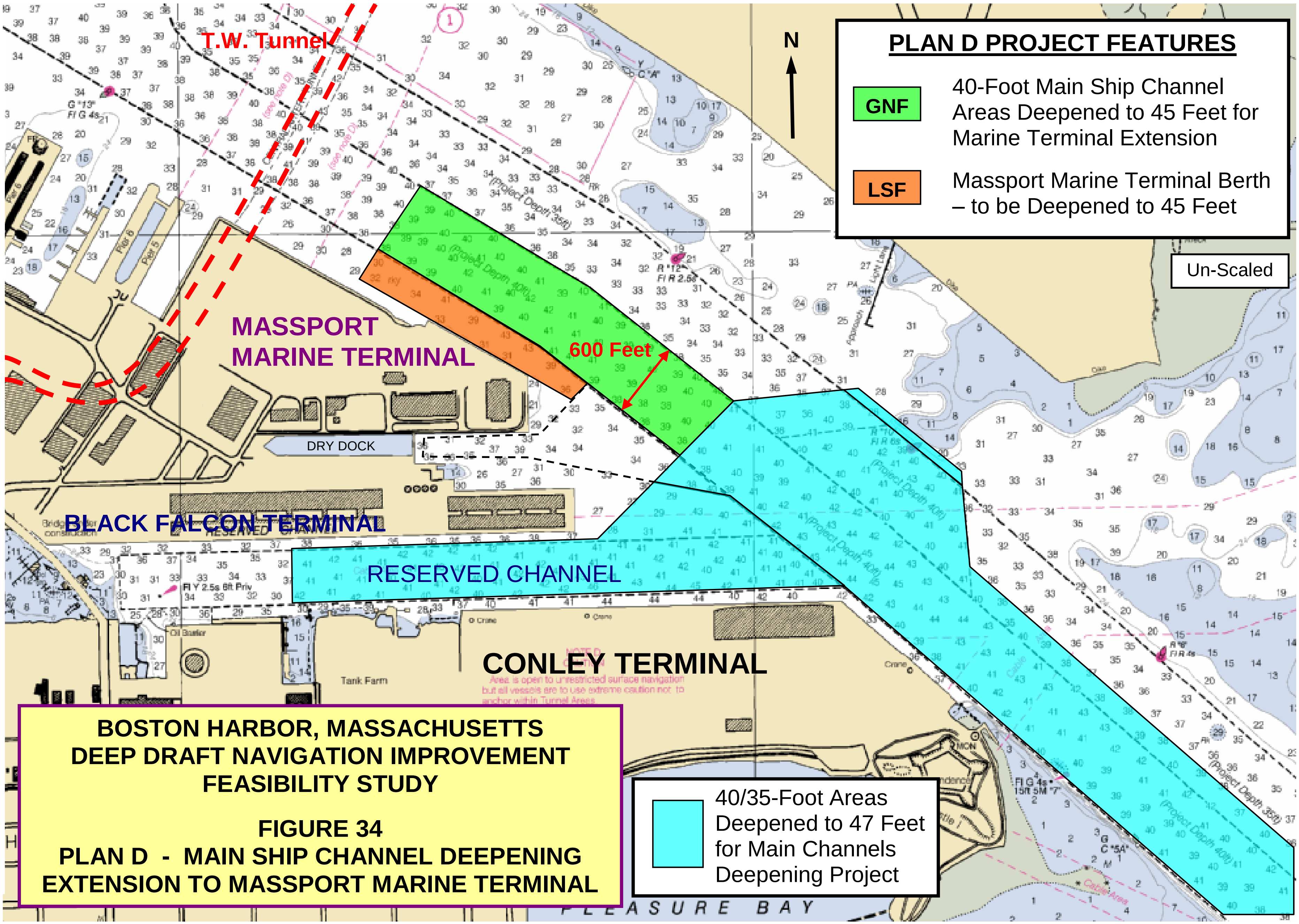
PLAN D – Main Ship Channel Deepening Extension: Plan D, shown in Figure 34, consists of extending the deepened lane of the Main Ship Channel up-harbor along the Massport Marine Terminal above the Reserved Channel in South Boston to a depth of up to –45 feet MLLW. This plan's costs would be incremental to the main channels plans, and would benefit Massport's redevelopment of the MMT as a bulk cargo facility with a 45-foot berth.

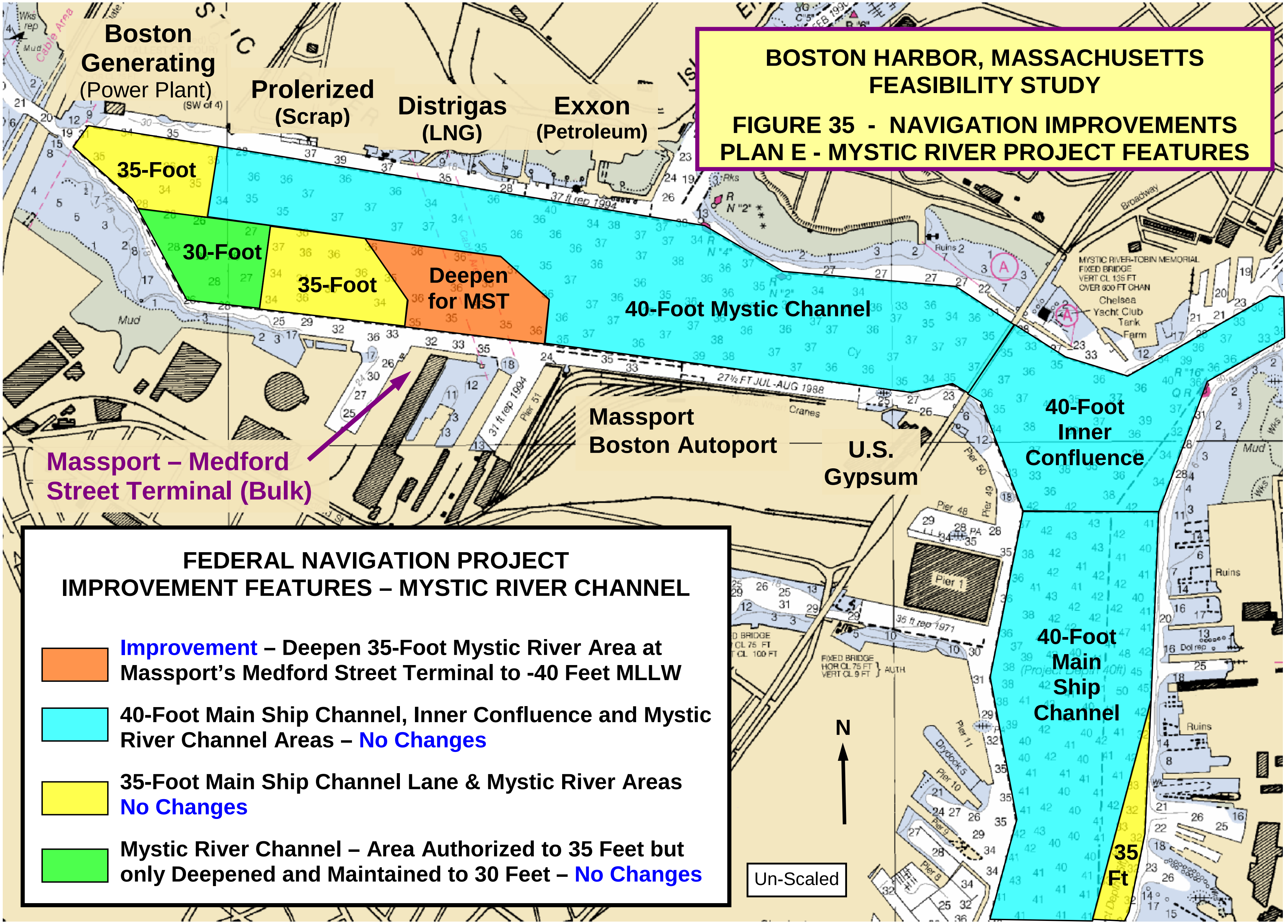
PLAN E – Mystic River Channel Deepening: Plan E, shown in Figure 35, consists of deepening a small area of the Mystic River Channel from 35 to 40 feet to access Massport's Medford Street Terminal in Charlestown. This area was not deepened as part of the 1990 authorized improvement as the benefits of improving access to an undefined planned bulk cargo facility were not yet developed. Massport has now redeveloped this terminal and deepened its berth to 40 feet to accommodate smaller bulk cargo operations for which space is not available at the Marine Terminal in South Boston.

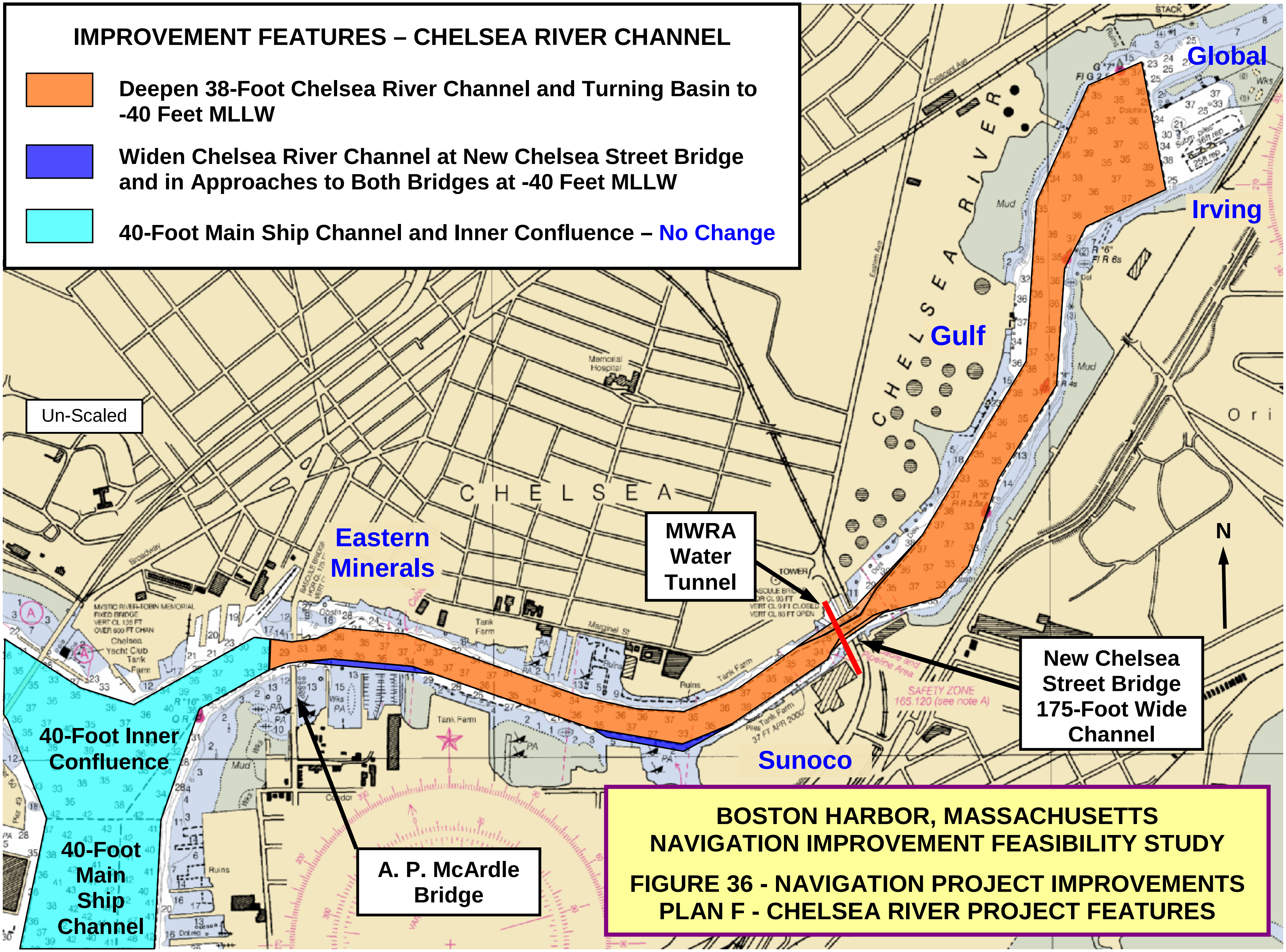
Petroleum Terminal Access Plan

PLAN F – Chelsea River Channel Deepening: Plan F, shown in Figure 36, consists of deepening the entire Chelsea River Channel, including its upstream turning basin from its current depth of –38 feet to –40 feet MLLW. This plan was developed assuming that the Chelsea Street Bridge would be replaced and that the Corps would then increase the channel


BOSTON HARBOR, MASSACHUSETTS
DEEP DRAFT NAVIGATION IMPROVEMENT
FEASIBILITY STUDY
FIGURE 33
PLAN A-B-C - DETAIL
RESERVED CHANNEL & TURNING BASIN
PROPOSED PROJECT MODIFICATIONS
Un-Scaled
N
MASSPORT
MARINE TERMINAL
CONLEY TERMINAL
RESERVED CHANNEL
Tank Farm
Bridge under construction
40-Foot Areas Deepened to 45 to or 50 Feet – Lower Reserved Channel, Turning Basin, Main Ship Channel and Part of Drydock Channel
Upper Reserved Channel Remains at 35 Feet – Remains Unchanged
35-Foot Main Ship Channel Areas Deepened to 45 to 50 Feet
Areas Outside of Existing Project Deepened to 45 to 50 Feet


PLAN D PROJECT FEATURES
GNF
40-Foot Main Ship Channel Areas Deepened to 45 Feet for Marine Terminal Extension
LSF
Massport Marine Terminal Berth – to be Deepened to 45 Feet
Un-Scaled
N
T.W. Tunnel
MASSPORT MARINE TERMINAL
600 Feet
DRY DOCK
BLACK FALCON TERMINAL
RESERVED CHANNEL
CONLEY TERMINAL
Tank Farm
40/35-Foot Areas Deepened to 47 Feet for Main Channels Deepening Project
BOSTON HARBOR, MASSACHUSETTS
DEEP DRAFT NAVIGATION IMPROVEMENT
FEASIBILITY STUDY
FIGURE 34
PLAN D - MAIN SHIP CHANNEL DEEPENING
EXTENSION TO MASSPORT MARINE TERMINAL
PLEASURE BAY


BOSTON HARBOR, MASSACHUSETTS
FEASIBILITY STUDY
FIGURE 35 - NAVIGATION IMPROVEMENTS
PLAN E - MYSTIC RIVER PROJECT FEATURES
Boston Generating (Power Plant)
Prolerized (Scrap)
Distrigas (LNG)
Exxon (Petroleum)
35-Foot
30-Foot
35-Foot
Deepen for MST
40-Foot Mystic Channel
40-Foot Inner Confluence
40-Foot Main Ship Channel
35 Ft
Massport Boston Autoport
U.S. Gypsum
Massport – Medford Street Terminal (Bulk)
Chelsea Yacht Club Tank Farm
MYSTIC RIVER-TOBIN MEMORIAL FIXED BRIDGE VERT CL 135 FT OVER 600 FT CHAN
27½ FT JUL-AUG 1988
37 ft rep 1994
31 ft rep 1994
35 ft rep 1971
Mud
Ruins
Pier 1
N
Un-Scaled
FEDERAL NAVIGATION PROJECT
IMPROVEMENT FEATURES – MYSTIC RIVER CHANNEL
Improvement – Deepen 35-Foot Mystic River Area at Massport's Medford Street Terminal to -40 Feet MLLW
40-Foot Main Ship Channel, Inner Confluence and Mystic River Channel Areas – No Changes
35-Foot Main Ship Channel Lane & Mystic River Areas No Changes
Mystic River Channel – Area Authorized to 35 Feet but only Deepened and Maintained to 30 Feet – No Changes


IMPROVEMENT FEATURES – CHELSEA RIVER CHANNEL
Deepen 38-Foot Chelsea River Channel and Turning Basin to -40 Feet MLLW
Widen Chelsea River Channel at New Chelsea Street Bridge and in Approaches to Both Bridges at -40 Feet MLLW
40-Foot Main Ship Channel and Inner Confluence – No Change
Un-Scaled
Global
Irving
Gulf
CHELSEA RIVER
CHELSEA
Eastern Minerals
MWRA Water Tunnel
New Chelsea Street Bridge 175-Foot Wide Channel
N
Sunoco
40-Foot Inner Confluence
40-Foot Main Ship Channel
A. P. McArdle Bridge
BOSTON HARBOR, MASSACHUSETTS
NAVIGATION IMPROVEMENT FEASIBILITY STUDY
FIGURE 36 - NAVIGATION PROJECT IMPROVEMENTS
PLAN F - CHELSEA RIVER PROJECT FEATURES

width through the new wider bridge opening under its O&M authority. The plan also assumed that the Keyspan gas siphon located under the channel immediately downstream of the Chelsea Street Bridge is being replaced by a deep directional bore and the old siphon will be removed. Each of these assumed actions has already occurred. This improvement would benefit the Eastern Minerals terminal and the four active petroleum terminals along this waterway.

ENGINEERING INVESTIGATIONS

The several engineering investigations conducted for this study are provided in the technical appendices accompanying this Feasibility Report as follows:

Appendix D-1	Engineering Design
Appendix D-2	Cost Estimates
Appendix F	Field Data Collection Report for Hydrodynamic Model
Appendix G	Hydrodynamic Modeling Report
Appendix H	Ship Simulation Study – ERDC
Appendix I	Geology and Geotechnical Studies
Appendix J	Geophysical Investigations
Appendix K	Sediment Sampling and Testing

These appendices provide the technical documentation and estimates supporting the summary analyses presented in this Feasibility Report. The principal analyses are described below.

Surveys and Subsurface Investigations and Nature of Material

The nature of the material to be removed under the various plans and depth increments was determined by a combination of surveys and sampling. Bottom surface conditions were determined through sidescan sonar and multibeam hydrographic condition and after-dredge surveys. The quantity estimates are based on the most recent surveys of the various project segments under study.

The nature of material at depth was determined by sub-bottom profile surveys ground-truthed by a limited program of borings and probings, and referenced to visible surface features from the side-scan surveys and to the large volume historical boring data collected for these channels since the 1940s. This information was used to define the elevation of the acoustic basement, assumed as the surface of bedrock or glacial till, and all material below that basement elevation was assumed to require drilling and blasting, which is considered a worst case condition. Current and historic boring data, and vibracores performed for this study for environmental sediment characterization and cultural resource surveys were used together with records from recent channel and CAD cell construction activities to characterize the unconsolidated material.

Ledge quantities are based on the sub-bottom profiling conducted in 2003, as corrected through borings and probes also completed that year. All ledge removal is currently estimated as requiring blasting; a conservative assumption given that all ledge removal required for the 1990 improvement project, except for the Chelsea River, was accomplished without blasting.

During the design phase for the project an extensive subsurface exploration program, relying more heavily on borings and probings, is planned to more accurately define the extent and nature of the various materials present at depth. The costs of this program will vary slightly by project depth (and thus footprint) up to $1.2 million and are included in the Engineering and Design estimates. New hydrographic surveys would also be conducted during design. The costs for these efforts are included in the Planning, Engineering and Design (PED) estimates. This information will be used to determine the extent of ledge to be removed and whether or not blasting would be required in various areas. The results will be used to refine the project cost estimates. For the feasibility phase estimates a conservative approach was adopted that considered all hard material (below the acoustic basement) as requiring blasting and removal by excavator, and all unconsolidated material as clay requiring removal by a toothed bucket dredge.

Main Channels Improvement Plans

Areas of ledge and till occur in several areas of the project features included in the plan to deepen access in the lower harbor up to the Conley Terminal. In the Broad Sound North Entrance channel there are two large areas of argillite ledge, one at Finns Ledge and the other an easterly extension of the Great Faun and Little Faun shoals (see Figure 4A). The remainder of the North Channel is characterized by sandy and gravelly surface sediments overlying clay. There are several small areas of ledge located in the western areas of the President Roads Anchorage and in the Main Ship Channel reach south of the anchorage. The remainder of the material in the anchorage is predominantly clay, while coarser materials are found in the channel reach to the south.

The Main Ship Channel reaches between the anchorage and the Reserved Channel, including the Reserved Channel Turning Area are the most variable. Ledge and other hard materials are found in the northeastern half of the Turning Basin, off the Army Base Pier in the transition between the north side of the Reserved Channel and the turning basin, across both lanes of the Main Ship Channel between Castle Island and the Lower Middle Shoal, and in a few limited areas of the middle of the Reserved Channel. Most materials to be removed from these areas are unconsolidated sands, gravels, and clays. Ledge removed from the anchorage and Main Ship Channel areas in the past has been argillite.

Main Ship Channel Deepening Extension to Marine Terminal

This area involves the greatest percentage of rock and hard materials relative to the total volume to be dredged in that area. Ledge and till is found throughout this area in both Main Ship Channel lanes, except in the mid-point of the area under improvement and the terminal berth. Past work and the tunnel excavation has shown the rock in this area to be argillite.

Mystic River Channel Deepening at Medford Street Terminal

Core samples taken for this study show the material in the area of the Mystic River to be deepened to 40 feet to be silty shoal material overlying Boston Blue Clay and other softer materials. Ledge was found in the northern portion of the area to be deepened in mid-channel at an elevation above -55 feet MLLW but not near the maximum overdepth elevation of -42 feet being considered for this improvement.

Chelsea River Channel Deepening

The Chelsea River Channel was deepened from 35 to 38 feet as part of the 1990 authorized project constructed in 1998-2001 with final widening of the channel accomplished in 2012 after completion of the new Chelsea Street Bridge. That improvement dredging removed material into the Boston Blue Clay throughout the channel and turning basin except at two locations. In the vicinity of the Chelsea Street Bridge a small area of till was encountered along the East Boston shore, but that proved removable by the same heavy toothed bucket that was used to dredge the clay. At the entrance to the turning basin along the East Boston shore a small area of pink granite ledge was uncovered by dredging that required drilling and blasting, followed by removal by bucket. For this proposed improvement to deepen the channel to 40 feet the same materials will be encountered – marine clay throughout the channel and basin, except for the small areas of till at the Chelsea Street Bridge and the granite ledge at the turning basin entrance.

Channel Design

Channel design was developed using the guidance contained in the joint report of the Permanent International Association of Navigation Congresses (PIANC) and the International Association of Ports and Harbors (IAPH) in cooperation with the International Maritime Pilots Association (IMPA) and the International Association of Lighthouse Authorities (IALA) published the final report of the Working Group II-30 titled “Approach Channels – A Guide for Design”, June 1997. These analyses were adjusted based on modeling and the results of the ship simulation investigation as part of this study. The adjustments consisted of increases in channel bend widths at critical turns and an increase in the dimensions of the Reserved Channel Turning Basin. Quantity and cost estimates provided in this draft Feasibility Report and Appendix D-2 were derived from the adjusted design.

Following final identification of the recommended plan for main channels improvement in 2012 for a 47-foot design depth in the inner channel reaches, the subject of the appropriate safe depth of the entrance channel was re-examined. The design depth for the Broad Sound North Entrance Channel was re-examined in 2012 using the guidance in the 2006 update of EM 1110-2-1613 Hydraulic Design of Deep Draft Navigation Projects, published in 2006.

At the time of the 2008 report the design process for determining the additional depth needed to compensate for increased vessel motion in entrance channels exposed to ocean waves, swell and winds focused on the guidance standards included in the PIANC guidance. Analysis using that guidance resulted in a recommendation to increase the inner harbor channels underkeel clearance requirement by 50 percent in the entrance channel. The 4-foot underkeel allowance in the harbor (10 percent of the typical large vessel draft) became 6 feet in the entrance channel. All plan increments for inner main channel depths of -42 through -50 feet MLLW were developed using two feet greater depth in the entrance channel. These plans are referred to in the following text and tables using the inner/entrance depths: i.e. 42/44 feet through 50/52 feet.

Since the design included in the 2008 report was finalized an updated version of the Corps own guidance entitled EM 1110-2-1613, Hydraulic Design of Deep Draft Navigation Projects, dated May 31, 2006, was published. Additional analysis of this subject was also performed by the Corps Engineering Research and Development Center (ERDC) for the New York Harbor Ambrose Channel in 2011. Applying this guidance and methodology to the specific situation of the Boston Harbor entrance channel yielded a recommendation for an additional four feet in that channel segment. The plan increment for the recommended 47-foot inner channels depth was then re-run using a -51-foot MLLW entrance channel, and is referred to as the 47/51 plan. Similarly the inner channel design depth increments for -45 through -48 feet were also re-run using the four-foot entrance channel depth increase.

Ship Simulation Studies

Ship simulation studies were completed by ERDC and NAE in 2007. Data collection and model development were initiated in the fall of 2004 and completed in June 2005. Vessel models were prepared in July 2005. The simulation model was developed in May to July 2005 and the Boston Harbor Pilots conducted the simulations with ERDC staff in August to September 2005. As with the 1990 project's simulation study in 1993, these efforts were used to test and refine the proposed channel and turning basin alignments under consideration. The simulation report recommended minor changes to the Reserved Channel Turning Basin layout and the alignments of the transition between the basin and the two channels. The simulation report also concurred in the incorporation of bend widening in the entrance and main ship channels.

The results of the 1993 ship simulation were applied to the design for the Chelsea River improvements. That simulation had included analysis of the current design tank vessel in a scenario involving replacement of the Chelsea Street Bridge as an alternative considered for the detailed design phase of the 1990 project, though that level of improvement was not recommended at that time. The 1993 simulation recommended widening of the Chelsea Channel through a new bridge opening, widening in the upstream approaches to the McArdle Bridge at the River's mouth, and widening along the easterly channel limit in the bend between the two bridges. These modifications were incorporated in the recommended plan of improvement for this project's proposal to deepen the Chelsea River Channel to 40 feet. Depending on the status of any re-evaluation of containership economic studies during the design phase, it may be necessary to make additional simulation runs using larger vessels than the 5630 TEU vessel modeled in 2005. That ship had a length of 918 feet and beam of 131 feet. The larger ships 8500 TEU ships projected as of 2012 are about 180 feet longer but only 9 feet greater in beam. This should have a negligible impact on channel width design in straight reaches, but may require additional width in the channel bend apex cut-offs. To be conservative, the cost of this simulation update has been included in the PED estimate.

QUANTITY ESTIMATES

Quantity estimates for the various channel features were developed using a 1:3 side slope in ordinary material and 1:1 side slopes in rock. As stated above, an additional two feet of required dredging was estimated in areas of rock or other hard bottom materials like cobble and glacial till (ER 1130-2-520, Nov 1996, Chapter 6). Overdepth allowance for dredging tolerance was two feet in all areas. Quantities for both ordinary material and ledge were calculated at one-foot increments beginning at the overdepth elevation for the existing project depth in each respective channel segment. Quantities for each of the evaluated plans and dredging increments are shown in Table 31 for the main channels improvements, and Table 32 for the additional improvements.

This incremental quantity calculation is presented in the Cost Engineering Appendix (Appendix D-2, Table D2-10). Quantities for the several project segments were combined to form plans of improvement for the design container vessels and for the other additional improvements under consideration. All channel segments considered for improvement in this study are maintained at their authorized depths and most have been either dredged within the past five years or will be dredged within the next two years. Maintenance material quantities that will remain after these operations are complete are assumed to be negligible for this analysis in this very slow-shoaling harbor. Project features at Boston typically require maintenance on only a 16 to 40 year dredging frequency. Only improvement dredging quantities are included in the following tables.

Improvement dredging quantities are calculated beginning at the base of the overdepth limit for the existing project. A representative cross-section showing the basis for this calculation is shown in Figure 37, as adapted from Figure 1, Page G-3 of ER 1165-2-131, and modified for the split depth of the Main Ship Channel at Boston Harbor.

The most recent hydrographic condition and after-dredge surveys of the various project segments under study were used to determine the harbor bottom elevations, and quantities of material to be removed were developed in one-foot increments. Surveys from most areas seaward of Spectacle Island are from 2008 at the latest, while those from above Spectacle Island are from 2009, except Chelsea River which was surveyed after the 2012 widening work. .

The location, extent and elevations of rock and other hard materials was determined first by use of hydrographic surveys, sub-bottom profiling and side scan sonar surveys to define the acoustic basement of the harbor within and near the proposed improvements. This work was conducted in 2003. A limited program of borings and probings was then conducted to "ground-truth" the survey results and referenced to the large volume historical boring data collected for these channels since the 1940s. This information was used to define the elevation of the acoustic basement assumed as the surface of bedrock or glacial till, and all material below that basement elevation was assumed to require drilling and blasting.

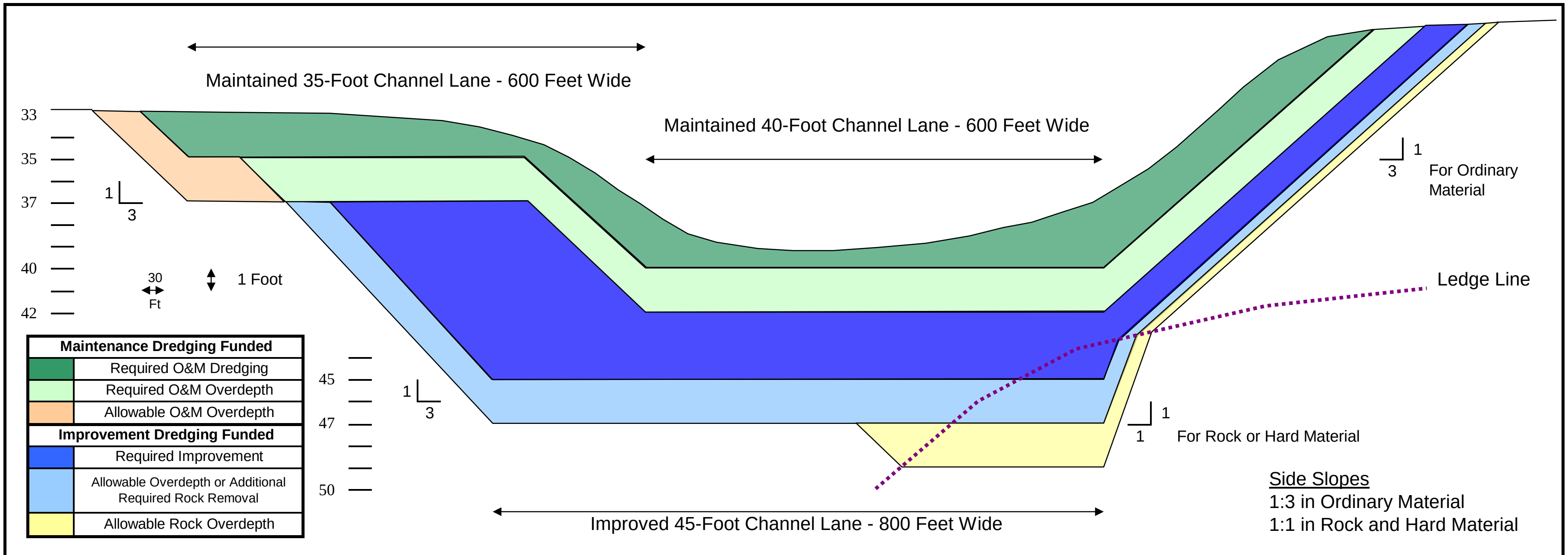
Current and historic boring and probing data, and vibracores performed for this study for environmental sediment characterization and cultural resource surveys, were used together with records from recent channel and CAD cell construction activities to characterize the unconsolidated material. Quantity estimates at one-foot increments for hard materials were determined from this adjusted basement. The hard material quantities were subtracted from the total volumes to yield the volume of unconsolidated materials for each depth increment. A more extensive subsurface exploration program would be conducted during the project's final design phase relying principally on borings and probings of the several ledge areas identified during the feasibility study.

TABLE 31
BOSTON HARBOR DEEP DRAFT IMPROVEMENT PROJECT – DREDGING QUANTITIES (CUBIC YARDS)
MAIN CHANNELS DEEPENING PLAN FOR CONTAINERSHIP ACCESS

Detailed Plans	Ordinary Material			Ledge Blasting and Removal				Total Quantity - All Material		
	Cut to Design Depth	2-Foot Pay Overdepth Allowance	Total Ordinary Material	Cut to Design Depth	2-Foot Additional Required	2-Foot Overdepth	Total All Rock Removal	Cut to Design Depth	All Overdepth	Total All Material
Plan ABC Includes Deepening of the Broad Sound North Entrance Channel, President Roads Anchorage, Widened Lower Main Ship Channel, Lower Reserved Channel & Expanded Reserved Channel Turning Area – All Plans Include an Additional 2 to 4 Feet in Entrance Channel										
42/44-Foot Depth	595,900	1,679,700	2,275,600	13,500	27,300	68,000	108,800	636,700	1,747,800	2,384,500
43/45-Foot Depth	1,249,900	2,288,600	3,538,500	22,800	60,500	130,100	213,400	1,333,200	2,418,700	3,751,900
44/46-Foot Depth	2,275,900	2,648,600	4,924,500	40,800	113,500	173,100	327,400	2,430,200	2,821,700	5,251,900
45/47-Foot Depth	3,538,500	2,855,000	6,393,500	83,400	158,600	204,700	446,700	3,780,500	3,059,700	6,840,200
45/49-Foot Depth	4,211,700	2,882,000	7,093,700	206,200	203,200	245,000	654,400	4,621,100	3,127,000	7,748,100
46/48-Foot Depth	4,924,500	2,992,900	7,917,400	154,300	195,900	246,800	597,000	5,274,700	3,239,700	8,514,400
46/50-Foot Depth	5,615,300	3,017,100	8,632,400	299,900	236,600	279,700	816,200	6,151,800	3,296,800	9,448,600
47/49-Foot Depth	6,393,600	3,091,300	9,484,900	241,900	237,100	285,600	764,700	6,872,600	3,376,900	10,249,600
47/50-Foot Depth	6,740,800	3,106,100	9,846,900	320,400	256,000	300,600	877,100	7,317,200	3,406,700	10,724,000
47/51-Foot Depth	7,093,800	3,127,100	10,220,900	409,300	271,600	312,000	993,000	7,774,700	3,439,100	11,213,900
47/52-Foot Depth	7,455,700	3,154,200	10,609,900	576,510	329,200	371,800	1,277,500	8,361,410	3,526,000	11,887,400
48/50-Foot Depth	7,917,400	3,179,000	11,096,400	350,100	277,500	325,700	953,300	8,545,000	3,504,700	12,049,700
49/51-Foot Depth	9,484,900	3,258,400	12,743,300	479,000	316,700	362,400	1,158,100	10,280,600	3,620,800	13,901,400
50/52-Foot Depth	11,096,200	3,330,000	14,426,200	627,900	353,900	399,100	1,380,900	12,078,000	3,729,100	15,807,100

TABLE 32
BOSTON HARBOR DEEP DRAFT IMPROVEMENT PROJECT – DREDGING QUANTITIES (CUBIC YARDS)

Detailed Plans	Ordinary Material			Ledge Blasting and Removal				Total Quantity - All Material		
	Cut to Design Depth	2-Foot Pay Overdepth Allowance	Total Ordinary Material	Cut to Design Depth	2-Foot Additional Required	2-Foot Pay Overdepth	Total All Rock Removal	All Required Material	All Overdepth	Total All Material
PLAN D - MAIN SHIP CHANNEL DEEPENING EXTENSION TO MASSPORT MARINE TERMINAL AT 600-FOOT WIDTH										
42-Foot Depth	0	100,000	100,000	300	4,100	13,700	18,100	4,400	113,700	118,100
43-Foot Depth	46,200	105,600	151,800	900	11,700	23,700	36,300	58,800	129,300	188,100
44-Foot Depth	99,800	100,400	220,200	4,300	21,400	31,200	56,900	125,500	131,600	257,100
45-Foot Depth	151,800	94,500	246,300	12,600	29,500	36,300	78,400	193,900	130,800	324,700
PLAN E - MYSTIC RIVER CHANNEL DEEPENING PLANS FOR MASSPORT MEDFORD STREET TERMINAL ACCESS										
37-Foot Depth	0	25,100	25,100	0	0	0	0	0	25,100	25,100
38-Foot Depth	12,200	26,300	38,500	0	0	0	0	12,200	26,300	38,500
39-Foot Depth	25,100	27,400	52,500	0	0	0	0	25,100	27,400	52,500
40-Foot Depth	38,500	28,600	67,100	0	0	0	0	38,500	28,600	67,100
PLAN F - CHELSEA RIVER CHANNEL DEEPENING PLANS										
39-Foot Depth	74,100	119,800	193,900	0	10	60	70	74,100	119,900	194,000
40-Foot Depth	80,200	262,400	342,600	0	50	490	540	80,200	262,900	343,100
TOTAL OF ALL RECOMMENDED IMPROVEMENT INCREMENTS - PLANS ABC, D, E & F										
ABC-D-E-F	7,364,300	3,512,600	10,876,900	421,900	301,150	348,790	1,071,940	8,087,300	3,861,400	11,948,800



Representative Figure illustrating maintenance of 40 and 35-foot channel lanes with a 45-foot channel improvement. Adapted from ER 1165-2-131, Figure 1, Page G-3

For greater improvement project depths increase all removal depths accordingly

FIGURE 37
REQUIRED DREDGING AND DREDGING TOLERANCE (OVERDEPTH) DIAGRAM FOR ALLOCATION OF MAINTENANCE AND IMPROVEMENT COSTS

Boston Harbor dredged material for this improvement project is all parent glacial deposits or bedrock located beneath and along the existing channel cuts and their side slopes, and in the adjacent areas where the channel turns would be widened. For this estimate materials were classified as ordinary materials removal by a heavy toothed bucket dredge, and hard materials requiring blasting and removal by a large excavator. Ordinary materials consist largely of Boston blue clay, a typically stiff outwash deposit that underlies much of the area. Other ordinary materials of lesser extent, and often intermixed with the clay include sands and non-organic silts. Hard materials consist of glacial tills, often gravelly or cobblely, and rock. Bedrock underlying northern area of the harbor is predominantly Cambridge argillite, with occasional areas of granite (upper Chelsea River). In general, the upper harbor areas are nearly all blue clay, while the lower and outer harbor areas are a mix of clay, sands, till and rock.

All ledge removal is currently estimated as requiring blasting. As stated above this is a conservative assumption given that most ledge removal required for the 1990 improvement project, and for some of the 2007-2008 lower and outer harbor ledge removal, was accomplished without blasting. The argillite found in the Reserved Channel Turning Area, Main Ship Channel, and Inner Confluence, was ripped by heavy excavator. The small area of ledge found in the Chelsea River turning basin was granite and was blasted before removal. A more detailed program of subsurface investigations, relying more heavily on borings and probes, would be conducted during the design phase of this project to more accurately determine the extent of ledge to be removed and whether or not blasting would be required in various areas. New hydrographic surveys would also be conducted during design. The costs for these efforts are included in the PED estimates.

Table 31 shows the quantity estimates for the main channels deepening plans increments (Plan ABC) for the containership improvements from the bay into the Conley Terminal including the Broad Sound North Entrance Channel, the Main Ship Channel through President Roads and the lower harbor up to the Reserved Channel, the President Roads Anchorage, the Reserved Channel Turning Area and the lower Reserved Channel along the terminal. Quantity estimates for these plans are provided in one-foot increments from -42 feet MLLW to 50 feet MLLW. Each estimate include an additional two feet in the entrance channel to account for the effects on increased seas in this exposed channel as developed in the original plans presented in the 2008 draft report. The recommended 47-foot design depth for the inner main channels reaches was also evaluated with the 4-foot entrance channel depth increase resulting from the 2012 re-analysis. Quantities in rock and other hard material include an additional two feet of required dredging. All quantities also include a two-foot overdepth allowance.

Table 32 shows the quantity estimates for the three additional improvement plans. Plan D estimates for the extension of the Main Ship Channel deepening above the Reserved Turning Area to the Massport Marine Terminal are provided in one-foot increments from -42 feet to -45 feet with same allowances for overdepth and hard material stated for the main channels plans. Plan E estimates cover dredging to deepen the small 35-foot area of the Mystic River Channel in one-foot increments from -37 feet to -40 feet. Plan F estimates cover dredging to deepen the Chelsea River Channel to a depth of either -39 feet or -40 feet.

DREDGED MATERIAL DISPOSAL ALTERNATIVES

Ocean Disposal at the Massachusetts Bay Disposal Site

Sediments to be removed under the proposed improvement plans and increments were sampled extensively. Sampling and testing for the maintenance dredging increment for the outer harbor completed in 2005 and for the inner harbor areas completed in 2008-2009 were conducted at the same time. Most of the maintenance materials from the Reserved Channel area outbound were determined suitable for unconfined ocean disposal at the Massachusetts Bay Disposal Site (MBDS). The MBDS is a US EPA designated ocean disposal site about 18 miles east of the harbor entrance in Massachusetts Bay beyond the territorial sea in Federally-regulated waters (see Figure 8). The MBDS is located in an approximate 300-foot deep basin located inshore of Stellwagen Bank. The MBDS and its immediate area have been used for ocean disposal of dredged and other materials since at least the early 1900s.

Maintenance material to be removed from some inner harbor reaches of the Main Ship Channel and upper Reserved Channel was found unsuitable for ocean disposal and required placement in CAD cells dredged beneath the Mystic River and upper harbor areas as part of the 2008-2009 inner harbor maintenance operation (see Figure 9). Massport was the cost-sharing partner for the construction of these aquatic Confined Disposal Facilities. Less than half of the CAD Cell locations permitted for the 1998-2001 construction were used and the remaining locations will provide a long-term low cost method of disposal for unsuitable dredged materials through at least the next major maintenance cycle in the 2040 or later timeframe. Should it be found that any overlying maintenance shoal material remained after completion of the maintenance operations, that material would be removed in conjunction with any improvement dredging to deepen the channels recommended in this report, and anticipated to begin in about 2014-2015. This remaining maintenance shoal material would also be placed in CAD cells as part of continued maintenance at that time and those costs would not be borne by this deep draft improvement project.

Improvement material from the Broad Sound North Entrance Channel and the Main Ship Channel through President Roads and the lower Main Ship Channel reaches was found to be ledge, sand, gravel and other hard material that was excluded from the chemical and biological testing requirements under the Corps/EPA Regional Implementation Manual for testing of dredged material for ocean disposal. Similarly, improvement materials beneath the lower Reserved Channel, its Turning Area, the Main Ship Channel reaches above and below the Reserved Channel, the President Roads Anchorage, the lower Mystic River at the Medford Street Terminal, and the Chelsea River, were all found to be either ledge, gravel or Boston Blue Clay, all materials excluded from further chemical and biological testing as course or non-organic native and glacial (non-shoal) materials.

All improvement dredging materials for this investigation were determined suitable for unconfined ocean disposal at the MBDS by the Corps and EPA. Disposal at the MBDS was determined to be the least cost environmentally acceptable disposal alternative and is the Federal Base Plan for disposal. However, during the feasibility study alternative means of disposal were identified that bear further examination during the detailed design phase of the project. The opportunities involve beneficial use of the two principal types of dredged material generated by the improvement project; rock and other hard materials, and the blue clay and other unconsolidated materials.

Beneficial Use Opportunities

The improvement project would generate two types of materials that may lend themselves to beneficial use or some other use besides ocean disposal. Blasted ledge, gravel, cobble and other stony materials may be suitable for development of hard bottom habitat in the harbor or nearby in Massachusetts Bay. The Boston Blue Clay and other unconsolidated materials that will be found throughout the anchorage and upper channel areas could be used to cap portions of a former disposal site in Massachusetts Bay where concern exists with long term potential for disturbance of contaminants released from past chemical and radiological waste disposal.

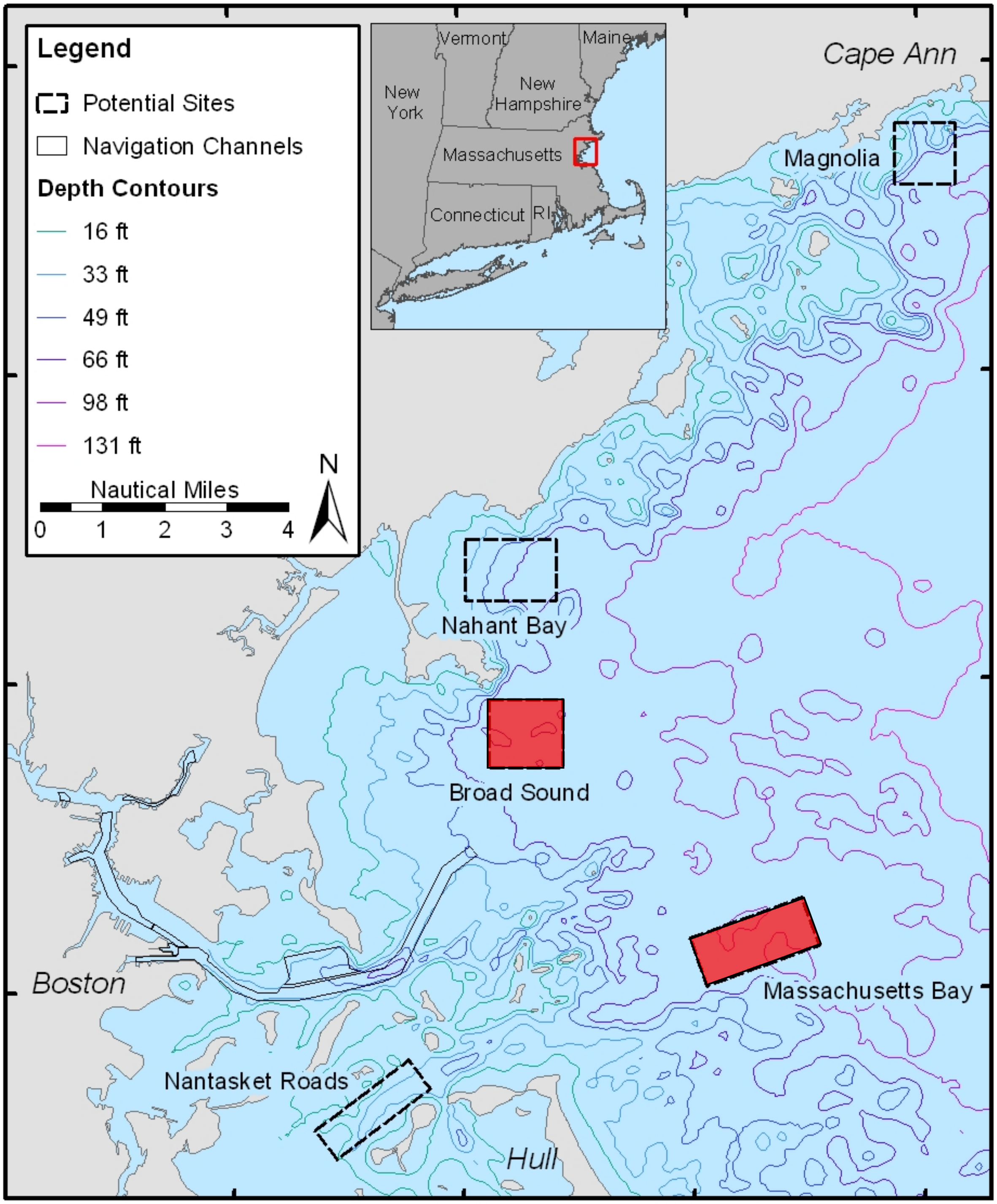
Beneficial Use Opportunity - Hard-Bottom Habitat Creation

Hard-Bottom Habitat Creation: The Main Channels Improvement project would generate between an estimated 108,800 and 1,380,900 cy of rock (range from the -42/44-foot to -50/52-foot inner/outer harbor project design depths), and an additional amount of gravelly and cobble material that could be used to create the hard bottom habitat favored by many species including lobster. The rock from the other minor improvement plans for the Main Ship Channel deepening extension (Plan D) and the Chelsea River deepening (Plan E) would generate up to an additional 78,900 cubic yards of rock. No rock would be generated by the Mystic River deepening (Plan E). The removed rock could be used beneficially for habitat creation in the harbor or bay, or provided to State, municipalities or others for use upland or shore protection projects in the region.

Proposed sites for hard-bottom habitat development have been extensively examined as part of the feasibility study. State fisheries officials and lobstermen were questioned to determine likely sites to investigate (See Figure 38). Smaller scale hard-bottom habitat creation has been conducted in the harbor and the bay as part of mitigation for recent pipeline projects. Bottom areas with surface deposits of lower-productivity soft sediments can be covered with harder materials and left to vegetate and be colonized by hard-bottom species. The higher cost associated with controlled placement to distribute the dredged materials in a relatively thin layer over a wide area would likely be offset by the savings from a shorter haul distance than that required to bring these materials to the more distant MBDS. Monitoring of these habitat creation sites for several years after disposal would be necessary to determine rates of colonization important for future consideration of this beneficial use option for other projects. Additional design-phase investigations and post-construction monitoring of these areas are included in the project costs.

Avoiding existing hard bottom areas and shipwrecks in the two sites, along with a placement method that would facilitate post-construction monitoring will be the initial goals for this alternative. A depiction of the placement concept under discussion, with the rock placed along track lines with open-bottom left between the lines, is shown in Figure 39. The area potentially covered by rock disposal under the several channel improvements under consideration is shown in Table 33.

In its January 2006 report Battelle had recommended the Broad Sound and Nahant Bay sites for further consideration for rock reef development. On further review it was noted that the Nahant Bay site contained a significant amount of sandy substrate in comparison to the Massachusetts Bay Site. The Corps determined that of the two sites, the Massachusetts Bay Site was the more appropriate location for development of new hard bottom habitat due to the higher perceived value of sandy bottom in Massachusetts Bay.

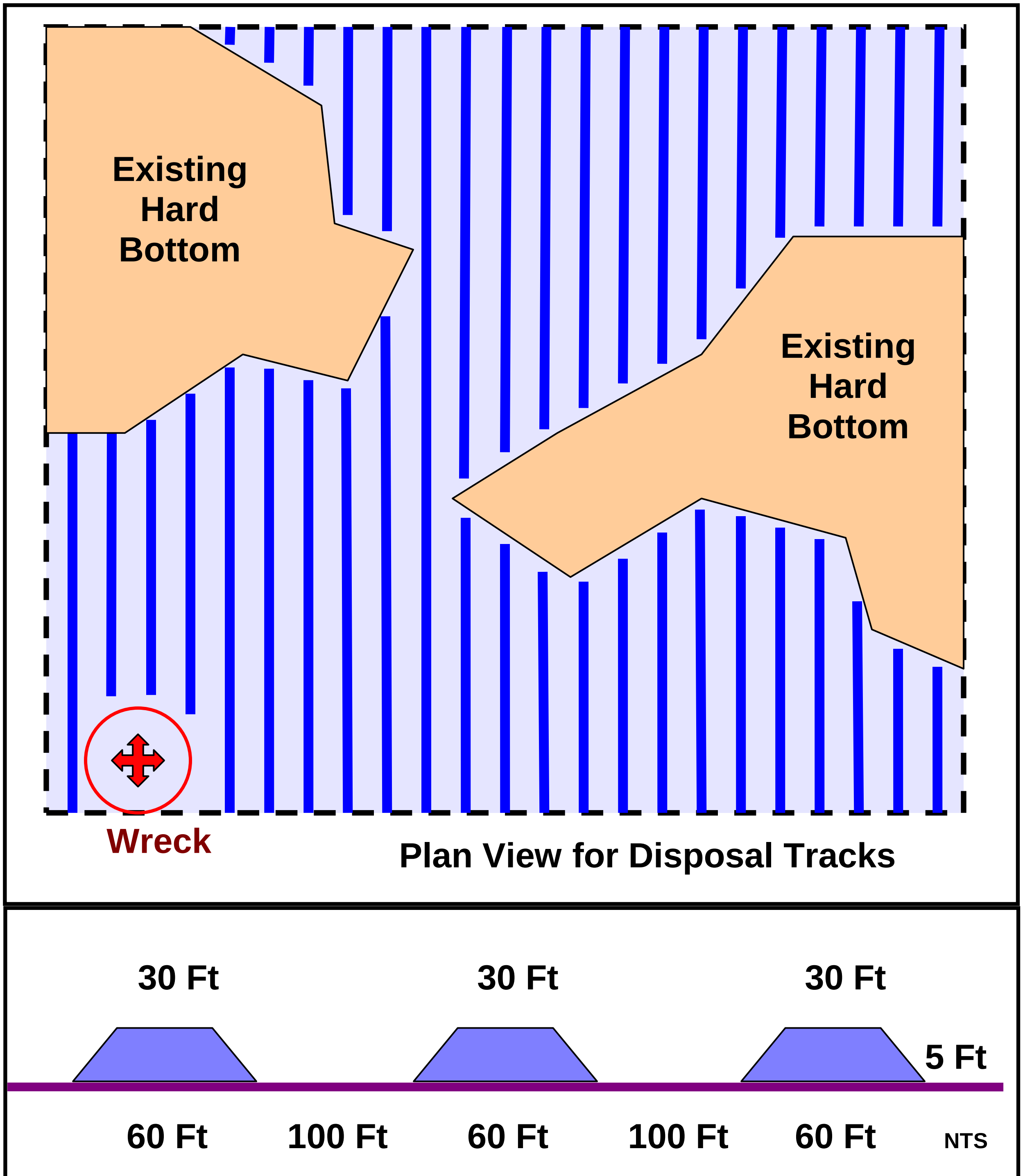


Most Suitable Sites for Creating Hard Bottom Habitat

From January 2006 Battelle Final Report as Modified by Corps

BOSTON HARBOR, MASSACHUSETTS NAVIGATION IMPROVEMENT FEASIBILITY STUDY

FIGURE 38
HARD BOTTOM HABITAT REEF CREATION SITES INVESTIGATED



BOSTON HARBOR, MASSACHUSETTS
DEEP DRAFT NAVIGATION IMPROVEMENT FEASIBILITY STUDY

FIGURE 39
ROCK REEF HABITAT CREATION – CONCEPTUAL SITE LAYOUT

TABLE 33
BOSTON HARBOR DEEP DRAFT NAVIGATION IMPROVEMENT STUDY
HARD BOTTOM HABITAT CREATION BENEFICIAL USE ALTERNATIVE FOR ROCK
SITE AREA NEEDS BY PROJECT DEPTH

Main Channels Improvements - Plans A-B-C Depths	42/44 Feet	43/45 Feet	44/46 Feet	45/47 Feet	45/49 Feet	46/48 Feet	46/50 Feet	47/49 Feet	47/50 Feet	47/51 Feet	47/52 Feet	48/50 Feet	48/52 Feet	49/51 Feet	50/52 Feet
VOLUME OF ROCK GENERATED BY THE PROJECT															
Main Channels Improvements - A-B-C	108,760	213,400	327,400	446,700	654,400	597,000	816,200	764,700	877,100	899,800	1,277,500	953,300	1,188,600	1,158,100	1,380,900
Main Ship Channel Extension to MMT	18,100	36,300	56,900	78,400	78,400	78,400	78,400	78,400	78,400	78,400	78,400	78,400	78,400	78,400	78,400
Chelsea River Channel (40 Feet)	500	500	500	500	500	500	500	500	500	500	500	500	500	500	500
Total Rock (Cubic Yards)	127,360	250,200	384,800	525,600	733,300	675,900	895,100	843,600	956,000	978,700	1,356,400	1,032,200	1,267,500	1,237,000	1,459,800
Total Rock (Cubic Feet)	3,438,720	6,755,400	10,389,600	14,191,200	19,799,100	18,249,300	24,167,700	22,777,200	25,812,000	26,424,900	36,622,800	27,869,400	34,222,500	33,399,000	39,414,600
AREA OF BAY BOTTOM NEEDED FOR HABITAT CREATION SITE															
Cross-Sectional Area (SF) of 5-Foot High Trapezoidal Rock Mound with 50-Foot Wide Base and 1:3 Slopes	175	175	175	175	175	175	175	175	175	175	175	175	175	175	175
Linear Feet of Mound Formed	19,650	38,602	59,369	81,093	113,138	104,282	138,101	130,155	147,497	150,999	209,273	159,254	195,557	190,851	225,226
Square Miles Covered at 100-Foot on Center Spacing for Mounds	0.07	0.14	0.21	0.29	0.41	0.37	0.50	0.47	0.53	0.54	0.75	0.57	0.70	0.68	0.81
VOLUME OF ORDINARY MATERIAL GENERATED BY THE PROJECT															
Main Channels Improvements - A-B-C	2,275,700	3,538,500	4,924,500	6,393,500	7,093,700	7,917,400	8,632,400	9,484,900	9,846,900	10,220,900	13,132,300	11,096,400	11,859,400	12,743,300	14,426,200
Main Ship Channel Extension to MMT	100,000	151,800	200,200	246,300	246,300	246,300	246,300	246,300	246,300	246,300	246,300	246,300	246,300	246,300	246,300
Mystic River Channel (40 Feet)	67,100	67,100	67,100	67,100	67,100	67,100	67,100	67,100	67,100	67,100	67,100	67,100	67,100	67,100	67,100
Chelsea River Channel (40 Feet)	343,600	343,600	343,600	343,600	343,600	343,600	343,600	343,600	343,600	343,600	343,600	343,600	343,600	343,600	343,600
Total Ordinary Material	2,786,400	4,101,000	5,535,400	7,050,500	7,750,700	8,574,400	9,289,400	10,141,900	10,503,900	10,877,900	13,789,300	11,753,400	12,516,400	13,400,300	15,083,200
AREA OF INDUSTRIAL WASTE SITE COVERED AT VARIOUS CAP THICKNESSES IN SQUARE STATUTE MILES															
Square Miles of Site that would be Covered at 4-Foot Cap Thickness	0.67	0.99	1.34	1.71	1.88	2.08	2.25	2.46	2.54	2.63	3.34	2.85	3.03	3.24	3.65
With 5-Foot Cap Thickness	0.54	0.79	1.07	1.37	1.50	1.66	1.80	1.96	2.03	2.11	2.67	2.28	2.42	2.60	2.92
With 6-Foot Cap Thickness	0.45	0.66	0.89	1.14	1.25	1.38	1.50	1.64	1.70	1.76	2.23	1.90	2.02	2.16	2.43
With 7-Foot Cap Thickness	0.39	0.57	0.77	0.98	1.07	1.19	1.29	1.40	1.45	1.51	1.91	1.63	1.73	1.85	2.09
With 8-Foot Cap Thickness	0.34	0.50	0.67	0.85	0.94	1.04	1.12	1.23	1.27	1.32	1.67	1.42	1.52	1.62	1.83
Area of IWS in Square Statute Miles IWS is 2 NM Diameter	4.16														
One-Half of Area of IWS in Sq SM	2.08														

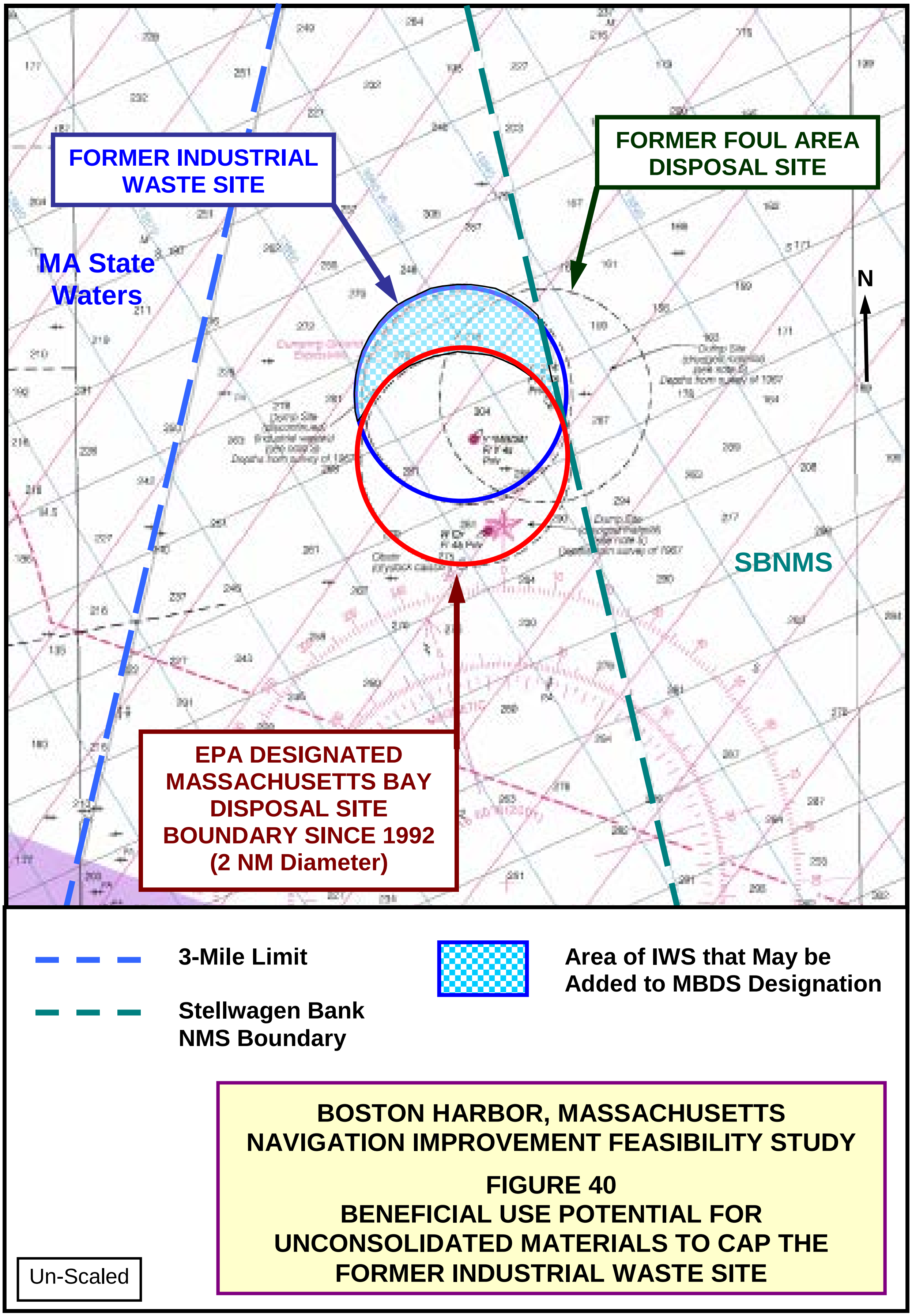
The Commonwealth, in its letter of 28 June 2007, wrote in support of this proposed beneficial use. In its more recent letter of October 24, 2012 the Massachusetts Office of Coastal Zone Management expressed its preference for finding beneficial uses for the rock other than habitat creation, including shore protection and upland use. During the design phase of this project additional subsurface explorations and analysis will better determine the extent and nature of rock and other hard materials to be removed. The Corps will work with the interagency Technical Working Group members, including the Commonwealth and the NMFS to further evaluate potential beneficial uses for the rock removed.

Beneficial Use Opportunity - Industrial Waste Site Capping

Boston Blue Clay that would be removed in large quantities from the President Roads Anchorage and upper channel reaches is stiff impervious clay. Creation of CAD cells dredged in this clay under the last improvement project formed a nearly vertical slope from the 40-foot channel bottom to a cell depth of about 90 feet. For this feasibility analysis, costs for this material assume it will be disposed at the MBDS. The Corps and EPA are considering using the Boston Blue Clay and other unconsolidated materials that would be removed in large quantities from the improvement dredging to cap the former Industrial Waste Site (IWS) in Massachusetts Bay.

The IWS overlaps and extends north of the existing MBDS in the Stellwagen Basin. The IWS was used for disposal of chemical, medical and radiological wastes from the 1940s to the 1970s. Additionally, during and prior to this time the site and adjacent waters were used for disposal of a wide range of wastes including construction and demolition debris, and scuttling of derelict vessels. The chemical and radiological wastes were disposed in steel barrels and concrete containers, many of which are still visible in side scan images collected as recently as 2006 by EPA. Many if not most of the steel barrels have deteriorated and spilled their contents on the sea floor.

Although EPA has determined that the health risk is low from the past disposal of these wastes at the IWS, the Corps and EPA discussed the potential use of dredged material from the deep draft project to cap portions of the IWS. One of the reasons is that this area is still trawled by fishermen and occasionally these trawls have resulted in barrels being brought to the surface. Figure 40 shows the area of the IWS for which EPA approval must be granted to facilitate this use of the dredged material. EPA modification of the MBDS boundary to include this area is one potential method to provide such approval. EPA is presently working to determine the most appropriate method for site modification. Capping the IWS would reduce the potential risk of fishermen pulling the debris up in their nets. EPA is in the process of developing an inventory and map of barrel concentrations and priorities for capping based on their surveys and prior work by NOAA, the Commonwealth and others in the early 1990s. A report and memoranda from EPA Region I describing their efforts to date is included as Appendix R. The principal barrel concentrations are located over a wide area within a mile north of the MBDS boundary covering about one-half of the site’s two nautical mile diameter area (about 2.08 square statue miles).



BOSTON HARBOR, MASSACHUSETTS
NAVIGATION IMPROVEMENT FEASIBILITY STUDY

FIGURE 40
BENEFICIAL USE POTENTIAL FOR UNCONSOLIDATED MATERIALS TO CAP THE FORMER INDUSTRIAL WASTE SITE

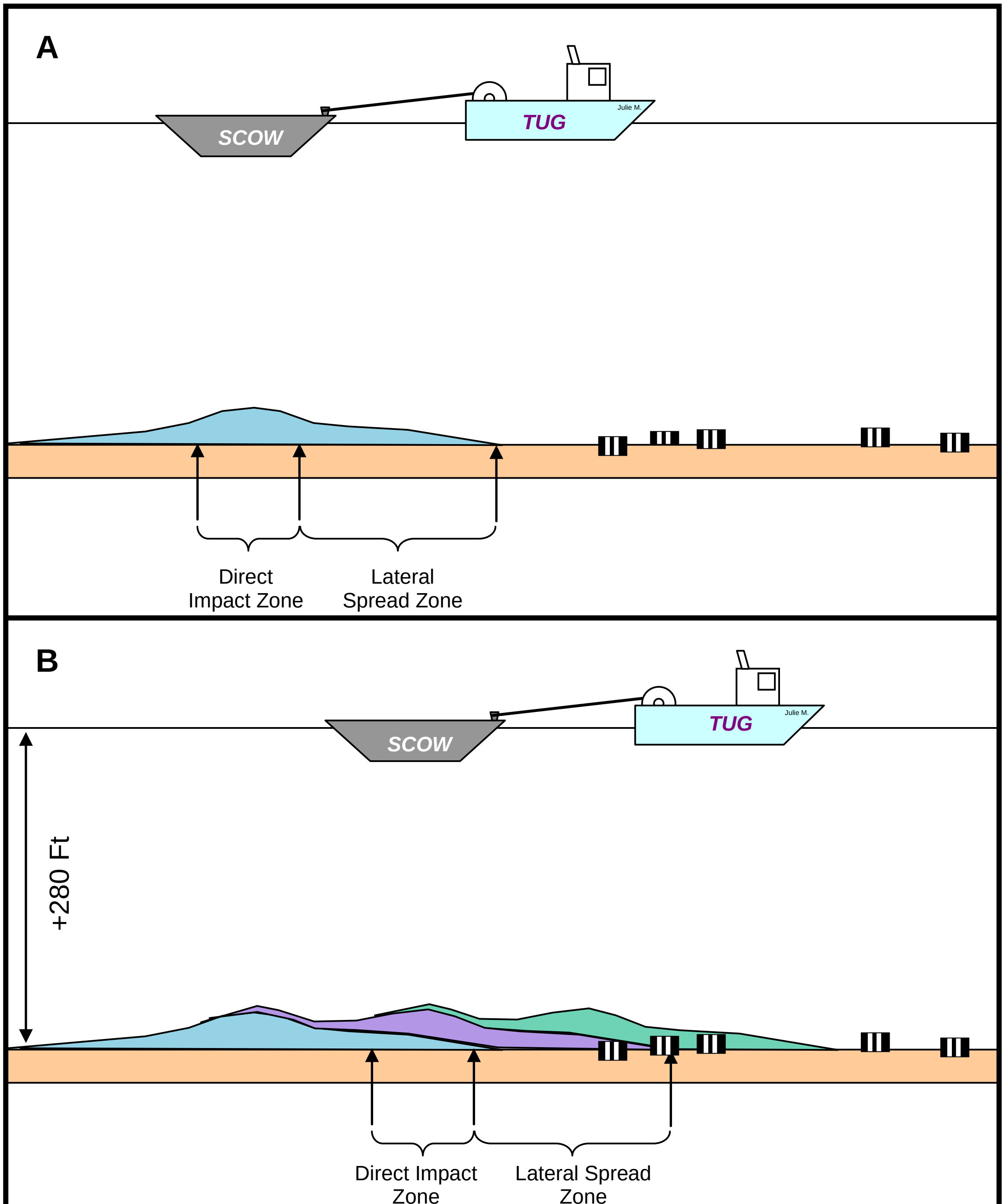
Table 33 shows the amount of improvement material that could be used to cap the IWS under the several improvement increments being considered and the depth to which that material would cap either the entire site or the one-half of the area containing barrel concentrations. Additionally any material dredged to form the upper Main Ship Channel CAD cell for the remaining inner harbor maintenance operation, a volume of about one million cubic yards, could also be used for the IWS cap.

The Corps as part of the 2008-2009 inner harbor maintenance dredging operation conducted a demonstration of controlled capping at the MBDS using the clay material dredged from construction of the two CAD cells in the lower Mystic River and upper harbor. The demonstration determined that a cap of adequate thickness can be formed with these materials at that depth without displacing the existing bottom materials. Should the EPA ultimately not designate or modify the site to permit capping with dredged material, the Federal base plan for disposal of this material at the MBDS would be followed.

A schematic showing in basic terms the approach that was followed in the demonstration, and deemed a successful placement method for the IWS capping is shown in Figure 41. Dredged material would be placed at the site in a manner that would minimize the potential for ambient sediment to become resuspended from disposal. Initial placement of dredged material would occur on the edge of the barrel field. Subsequent drops of dredged material would be placed on top of the flanks of the initial sediment mound to help absorb energy from the drop and to create an apron that would build to cover the barrel field. The use of the improvement project materials to cap areas of the IWS will be refined during the design phase of this project with the assistance of EPA and other agencies if it is decided to pursue this use. The availability of a large volume of material as would be generated by the port deepening project is viewed by many as a one-time opportunity to cap the IWS.

Both the MBDS and the IWS are located a short distance inshore of the western boundary of the Stellwagen Bank National Marine Sanctuary (SBNMS), a Federal refuge administered by NOAA. The location of the SBNMS relative to the disposal sites and the harbor is shown in Figure 42. While continued use of the MBDS for disposal of dredged material determined suitable for ocean disposal has been determined to entail no significant impact on the refuge and the marine resources it protects, any proposal for activity at the IWS, including a plan intended to cap that site, will face significant scrutiny by the Federal and State government and interest groups. If this proposal is pursued further, investigations during the design phase will need to engage these agencies and groups in the evaluation of its likelihood of success, and development of an appropriate monitoring plan.

As the IWS and MBDS are adjacent sites, the haul distance from Boston Harbor would be the same. With modern controlled dumping techniques and automated disposal tracking systems, disposal on a controlled grid at the IWS should not entail a greater effort than would have been required for MBDS disposal. Additional costs for placement of the dredged material at the IWS are expected to be negligible compared to MBDS disposal and largely limited to post-construction surveys. No post-capping monitoring has been determined necessary at this time for the IWS. The Corps and EPA presently routinely monitor these sites under other programs, activities which led to the proposal to cap the IWS with this project. The areas potentially covered by a cap of the IWS under the quantities generated by the various channel depth plans under consideration are shown in Table 33 above for caps of various thicknesses.

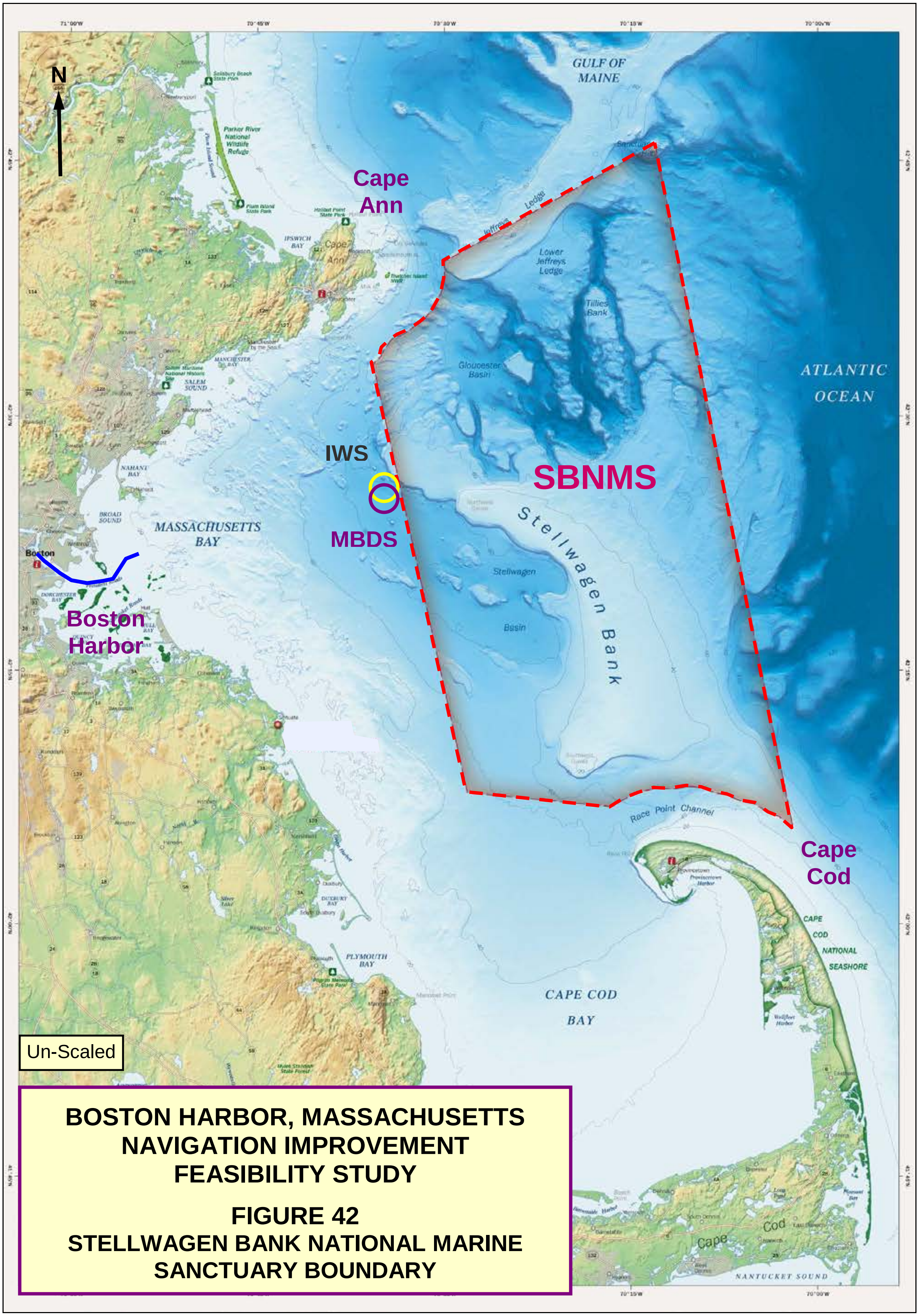


A. Initial cap placement events to occur outside barrel field creating zones of direct bottom impact and zones where sediment spreads laterally.

B. Later cap placement events to occur over lateral spread zone which helps protect original seafloor and minimizes resuspension.

FIGURE 41
BOSTON HARBOR NAVIGATION IMPROVEMENT PROJECT

SCHEMATIC OF REMEDIATION CAPPING DEMO APPROACH FOR INDUSTRIAL WASTE SITE BENEFICIAL USE



BOSTON HARBOR, MASSACHUSETTS NAVIGATION IMPROVEMENT FEASIBILITY STUDY

FIGURE 42
STELLWAGEN BANK NATIONAL MARINE SANCTUARY BOUNDARY

Confined Disposal Facility Needs for Maintenance Increment

Since all improvement materials were found suitable for ocean disposal, no containment sites are needed for the project. The following paragraphs discuss the potential for future maintenance needs for CAD cell disposal.

The 2004-2005 outer harbor maintenance operation and the 2008 lower inner harbor maintenance operation have nearly completed the 16-40 year major maintenance cycle for the harbor. The areas of maintenance remaining include the upper inner harbor optional work that was not exercised under the 2008 contract due to funding issues. Sampling and testing for the maintenance dredging determined that all outer harbor areas and those reaches of the Main Ship Channel downstream of the Navy Dry Dock were suitable for unconfined ocean disposal at the MBDS. Areas upstream of the Navy Dry Dock were determined to be largely unsuitable for ocean placement and CAD cell development in the Mystic and the upper Main Ship Channel was proposed and carried-out. A small amount of Chelsea River material removed at this time was placed in the open Chelsea River CAD cell. Massport was the cost-sharing partner for the construction of these CAD Cells. Following completion of the 2008 maintenance work, and the additional work carried-out following the Chelsea Street Bridge replacement and channel widening only the following unsuitable maintenance material remains and requires CAD Cell placement: the 35 and 40-foot lanes of the Main Ship Channel from the Massport Marine Terminal up-harbor to the Inner Confluence Area, the portion of the 35-foot lane of the Mystic River Channel at the Medford Street Terminal, the 35-foot Charles River Channel branch of the Main Ship Channel which accesses the USCG Station. These areas total about 1.4 million cubic yards and would require completion of the upper Main Ship Channel CAD Cell described in the 2007 SEIS. Since the 2008 work removed the unsuitable silty material lying atop the area of the entire cell, the only material remaining to be removed to complete excavation of the cell is blue clay that is suitable for placement at the MBDS.

Any remaining maintenance material that would be removed in conjunction with the deep draft improvement dredging would be from channel reaches determined suitable for ocean disposal. Material from any maintenance determined necessary by further surveys prior to improvement construction from reaches deemed unsuitable by present test results would either need to be placed in a Confined Aquatic Disposal Cells dredged beneath the channels or some other adjacent area of the harbor, or may be retested and disposed accordingly.

The EIS prepared in 1995 for the 1990 improvement project, the EA prepared for the 2004-2005 outer harbor maintenance dredging, the SEIS prepared in 2007 for the 2008 inner harbor maintenance dredging, and the 2012 EA prepared for that year's Chelsea River work all examined alternative disposal options for both suitable and unsuitable dredged material. Extensive consideration was given to regional upland disposal options, treatment and reuse of the material, and even transport of the material out of the region. All such options proved infeasible or otherwise prohibitively expensive, and were dropped from consideration. Given the recentness of the latest of these analyses it was determined unnecessary to repeat those evaluations for this study. With the exception of the potential beneficial use alternatives for rock and hard materials, and for unconsolidated materials, ocean disposal remained the only practicable disposal option for suitable dredged materials, and CAD Cell placement for disposal of unsuitable maintenance materials.

Additional CAD Cell sites and capacity exist in upper Boston Harbor (upstream of the tunnels) to handle any potential unsuitable maintenance materials that could be encountered (See Figure 9). Post-disposal consolidation of sediments in the existing CAD cells would likely yield additional capacity for additional maintenance materials removed in conjunction with the improvement project. The PPA for the 2008 maintenance dredging and CAD cell construction provides a mechanism for partnering in the development of additional cells from among the population of already permitted but unconstructed cell sites should additional capacity be found necessary.

Until final design phase surveys in conjunction with the proposed improvement dredging, it will remain unknown exactly how much maintenance material may remain to be removed in order to deepen the channels. The majority of this material would be suitable for ocean disposal and would be placed at the MBDS with the improvement material, including maintenance material from the outer harbor features that would be maintained to enable navigation traffic management during construction. If any maintenance material is determined unsuitable for ocean disposal, it would be placed in CAD cells as part of continued maintenance at that time. However, this volume is expected to be insignificant compared to the projected improvement volume, even for lesser incremental improvement depths, and will therefore have an insignificant impact on lowering improvement costs when a final allocation projection is made between the maintenance and improvement increments.

Future Dredged Material Management

The MBDS has sufficient capacity to accommodate disposal of suitable dredged materials from Boston and the other harbors around Massachusetts Bay for a century or more. The site's two nautical mile diameter and 300 foot depth provide ample long-term disposal capacity for the region. Disposal of Boston Harbor dredged materials determined unsuitable for ocean disposal has been managed by constructing CAD cells beneath the harbor in areas upstream of the tunnels that are limited to the 40-foot existing channel depth. This has proven a feasible low-cost means of disposal for these materials. The unconsolidated materials, mainly Boston blue clay, dredged to form the CAD cells is placed at the MBDS.

Additional CAD cell sites and capacity exist in the upper harbor to meet unsuitable maintenance material disposal needs for the next several maintenance cycles. Less than half of the CAD cell locations permitted for the 1998-2001 construction were constructed. Two other sites were constructed and used for the 2008 lower inner harbor maintenance operation. Some of the unused locations in the Mystic and Chelsea Rivers have since been removed from consideration due to the discovery of ledge. However, the remaining cell locations, and other areas located between the Inner Confluence and the tunnels that may prove suitable for cell siting, will provide a long-term low cost method of disposal for unsuitable dredged materials through at least the next major maintenance cycle in the 2040 timeframe. With maintenance at Boston ranging from 16 to 40 years for individual project segments, that capacity is sufficient to accommodate that need for the 20-year maintenance horizon and potentially the entire 50-year improvement project economic life or beyond.

OTHER PROJECT IMPROVEMENTS INVESTIGATED

Utility Relocation Requirements

There are no utility relocation costs included in the proposed improvement project. However, there are several utility considerations associated with deepening the various channels at Boston Harbor. Mainly these are confined to the completion of the earlier BHNIP deepening of the Chelsea River Channel to its currently authorized depth and the proposed improvement work in the Reserved Channel.

NSTAR, the regional electrical utility, maintains three 115KV hydraulic-cooled lines that run from their South Boston generating station, under the Reserved Channel and across the Main Ship Channel to the Massachusetts Water Resources Authority (MWRA) sewage treatment plant at Deer Island. A 1989 Corps permit for these lines required that they be buried to at least 25 feet below the mud line (or to a minimum -60 feet MLW). At that elevation the lines could be left in place, without modification, under a 45-foot to 50-foot channel improvement. The Corps issued a Section 10 permit to MWRA, Boston Edison (NSTAR's predecessor in interest), and Harbor Energy Electric Company ("HEEC," a wholly-owned subsidiary of Boston Edison). The Corps learned in 2003, however, that the permittees did not comply with the permit requirements for minimum embedded depth for these lines during installation.

The Corps engaged in extensive discussions with NSTAR and the MWRA in an attempt to resolve the permit noncompliance issues. These discussions did not lead to resolution of the issues, and in late 2004 the Corps referred the matter to the U.S. Attorney's office as an enforcement action. The Corps asked the U.S. Attorney's office to resolve the noncompliance issues irrespective of whether the current improvement project proceeded or not. The U.S. Attorney's office has engaged in negotiations with NSTAR and MWRA to resolve the issues in a manner that will ensure that the NSTAR cable will not impact the proposed improvement project. The negotiations have produced methods of protecting or lowering the cable to permit deepening to proceed. However the U.S. Attorney and parties have been waiting for the Corps decision on proceeding with a project at a recommended depth before concluding any agreement. Publication of a Chief of Engineers Report would re-engage a timely resolution. Should the matter fail to be resolved through a negotiated settlement, the Corps would recommend that a permit enforcement action be filed in Federal District Court, since, as noted above, if the relevant conditions had been satisfied at the time of installation, the cable would be located well below the proposed depths of the current improvement project.

Several utilities run under the Chelsea River Channel. A number were abandoned and removed as part of the last improvement for the 38-foot deepening completed in 2001 and the channel widening effort at Chelsea Street Bridge completed in 2012. KeySpan, now known as National Grid, executed an Administrative Consent Order (ACO) with the Commonwealth that required replacement and removal of their natural gas siphon beneath the Chelsea Channel immediately downstream of the Chelsea Street Bridge. The line was replaced with a deep directional drill line at an elevation of least –90 feet MSL and the abandoned line was removed in 2008.

The electrical cable supplying power to the Andrew P. McArdle Bridge, a double-leaf span at the entrance to the Chelsea River, is embedded in the trench at a depth of at least –46 feet MLLW, and would not require further modification as part of any deepening of the Chelsea

Channel to 40 feet. The need to take care in dredging in the trench area, including limiting overdepth, prohibiting non-pay overdepth dredging, instituting no-spud – no-anchor zones, and maintaining vertical control on dredging equipment, will be noted in the project plans.

The MWRA also has a water tunnel under the Chelsea River which supplies East Boston, including Logan Airport. The tunnel is located immediately downstream of the Chelsea Street Bridge. In their letter of November 9, 2012 the Authority stated that dredging to -40 feet MLLW with a 2-foot overdepth would not impact the water line provided the channel was not widened beyond the 175-foot with currently provided through that area.

During the design phase additional investigations will be made to confirm the locations and elevations of the several utility crossings that may require special construction techniques, actions or limitations to avoid damage. Plans will be developed in coordination with the utility owners and in consultation with other Corps Districts with more recent experience in these techniques as part of final design.

Bridge Replacement – Chelsea River Channel

At the time of the 2008 report the Chelsea Street Bridge had not yet been replaced, but its replacement was considered part of the without-project condition. Construction of the new vertical lift bridge was completed in 2012, including removal of the old span and other debris following which the Corps widened the channel through the area of the bridge to a minimum of 175 feet. This is the same width provided through the fenders of the McArdle Bridge at the river's mouth and is adequate for traffic that would use any improved 39-foot or 40-foot deep channel. There are no other bridges crossing the sections of the project proposed for improvement that would limit the traffic projected to use the improved waterways.

Terminal and Land-Side Infrastructure Costs

Conley Terminal: Land-side infrastructure costs would be limited for the main channels deepening plans. Massport has already deepened its two principal berths (#11 and #12) at the Conley Terminal to -45 feet MLLW at a width of 143, sufficient to accommodate post-Panamax vessels up to about 8500 TEUs. Massport has completed a program of terminal efficiency improvements independent of the deepening project, as described below. The existing terminal lands (lay-down area and access), without project crane capacity, terminal configuration, and security features are sufficient to handle the increases in container volume projected in each of the alternative economic scenarios of container cargo benefits included in Appendix C-1. All other benefits from this plan are incidental tidal delay savings for other vessels and non-containerized cargos that would have increased transit windows due to the deeper channels and greater use of the anchorage under this plan. These other benefits are minor and were not quantified for the main channels improvement plans.

For main channel improvement depths of 43 feet and beyond, deepening of the Conley berths would be required to continue the tidal navigation practices of shippers. Massport intends to deepen its two 45 foot berths (Conley berths 11 and 12) to a depth of at least three feet greater than any improved channel depth to enable current tidal navigation practices of the shippers to continue. The several alternative depth increment plans include berth deepening of both deep berths to a depth of three feet greater than the channel depth in each plan. These are the only project related non-Federal facility costs. Quantity estimates for non-Federal berth deepening are provided in Table 34.

Massport's analysis of its efficiency improvements at Conley, including new stack layouts, new cranes and reconfigured gate and expanded lay-down area, will increase Conley's throughput capacity to at least 550,000 TEUs annually. These improvements are intended to accommodate the larger vessels and their greater cargo volume that Massport's own market analysis projects for the port. These shoreside improvements were part of the without project condition in the 2008 draft report as they were to be (and were) made regardless of the ultimate authorization of channel deepening. Berth deepening however would be dependant on channel deepening and so is included in the project costs.

<u>Massport Marine Terminal (Plan D)</u>: For the 45-foot Main Ship Channel extension to the Massport Marine Terminal (MMT) above the Reserved Channel, berth deepening would be required. As the berth was deepened to 40 feet during the last improvement project in 1998, it is assumed that the material would be the same parent marine clay and other glacial deposits found along the south side of the adjacent channel, and would be suitable for ocean disposal. Further improvements such as bulkhead repairs, paving, bollards, and other terminal facilities to support dry bulk operations would also be required. However, Massport and its developer intend to construct these facilities, regardless of whether or not the Main Ship Channel is deepened to 45 feet up to this facility to facilitate the proposed cement transshipment facility for this site even if it is limited to the current 40-foot access.

As with present operation of the Conley Terminal, vessels would be expected to transit to and from the berths here with tidal assistance. The developer would deepen the berth at this terminal to at least the same depth provided as the deepened Main Ship Channel. The facility redevelopment costs except for the berth deepening are therefore considered part of the without-project condition. Non-Federally funded berth deepening costs are included in the project first and annual costs. No other non-Federal costs beyond the berth dredging are necessary for realization of any benefits that may come from extending the channel deepening up-harbor to this terminal.

<u>Mystic River – Medford Street Terminal (Plan E)</u>: For the 40-foot deepening of the portion of the Mystic River Channel adjacent to Massport's Medford Street Terminal, no non-Federal facility costs would be necessary. Similar to the situation at the MMT, the Medford Street Terminal will be developed regardless of whether the adjacent channel area is deepened in the approach to the berth. The berth at Medford Street was already deepened by Massport to 40 feet during the 40-foot channel improvement dredging completed in 2000. Only a small area of the Federal Channel left at 35 feet needs to be crossed to reach the berth. Vessels use tidal assist for transit of this area and would continue to do so if the channel were not deepened.

<u>Chelsea River – Petroleum Terminals (Plan F)</u>: For the Chelsea River Channel, the main petroleum terminals would need to deepen their berths to 40 feet to generate project benefits from a 40-foot Federal channel deepening. The four largest petroleum terminals on the Chelsea River are Sunoco Logistics, Gulf Oil, Irving Oil and Global Petroleum. Sunoco is located immediately downstream of the Chelsea Street Bridge, while the other three are located around the turning basin at the head of navigation. Vessels offloading at Sunoco pass through the bridge in order to turn in the basin and transit back downstream through the bridge again and to the berth. All four beneficiary petroleum terminals therefore require

deepening of the entire channel. These four terminals are all potential beneficiaries and would need to deepen their berths to generate sufficient benefits to justify channel deepening.

TABLE 34 NON-FEDERAL BERTH DEEPENING QUANTITIES		
	Berth Design Depth	Quantity (cy) (Including 2-Foot OD)
CONLEY TERMINAL BERTHS #11 & #12 QUANTITIES		
42-Foot Channel	45 Feet	0
43-Foot Channel	46 Feet	6,200
44-Foot Channel	47 Feet	12,400
45-Foot Channel	48 Feet	18,700
46-Foot Channel	49 Feet	24,900
47-Foot Channel	50 Feet	31,100
48-Foot Channel	51 Feet	37,300
49-Foot Channel	52 Feet	43,600
50-Foot Channel	53 Feet	49,800
MASSPORT MARINE TERMINAL BERTH QUANTITY		
42-Foot Channel	42 Feet	29,400
43-Foot Channel	43 Feet	44,100
44-Foot Channel	44 Feet	58,800
45-Foot Channel	45 Feet	73,500
CHELSEA RIVER CHANNEL – FIVE TERMINALS QUANTITY		
39-Foot Channel	39 Feet	20,500
40-Foot Channel	40 Feet	41,000

Eastern Minerals operates a terminal on the Chelsea shore just upstream of the McArdle Bridge. This facility, which primarily handles road salt, would also benefit from Chelsea River Channel deepening and would also need to deepen its berth to the same depth as the Federal channel. The first and annual costs of berth deepening for these five facilities will be included for purposes of determining channel deepening project costs and justification.

Project Implementation Costs

Project cost estimates involve several assumptions. Those involving quantities and material types, dredged material disposal options, utilities, bridges and associated non-Federal facilities and berth improvements are discussed above. Cost estimates are broken down into line items for the various stages in the construction process, the types of work being accomplished (e.g. the types of material being removed), or whether efforts are accomplished under contract or through direct agency resources (e.g. labor). Contingencies were developed using risk analysis for the contract cost and are included in the construction estimates. Contingencies are also worked into non-contract costs separately. Items estimated in prior fiscal years are escalated to the current period for cost-benefit comparison purposes, and are further escalated to the anticipated construction period for budgeting purposes.

Mobilization and Demobilization Costs (Mob-Demob): Mob-Demob costs include the contractor's costs for preparing his plant and transporting it to and from the project site. Mob-Demob costs for this project assume a large contractor mobilizing from an east coast port to and from Boston Harbor. Major mobilization and demobilization are included with only one feature or segment of the project and lesser costs were associated with moving within the project from one segment to the next. Due to Air Quality concerns discussed elsewhere the current base plan includes shut-down periods built into the schedules for the larger volume and longer duration plans that will require demobilizations and remobilizations every other winter to reduce air emissions. Costs for these additional activities are reflected in the estimates. If during the project's design phase, lesser cost means of meeting the air quality regulations, such as purchase of credits, or implementation of offset methods are identified that would result in a cost savings to the project, then use of construction period shut-downs with their increase Mob-Demob costs would be reconsidered.

Unit Costs for Dredging and Disposal: Costs for removal of material to construct the deepened and widened channels are provided per cubic yard of material in-place based on hydrographic surveys performed by New England District survey crews. Separate costs are given for (1) dredging and disposal of ordinary material, (2) drilling and blasting of rock and other hard materials (consolidated tills), and (3) removal and disposal of rock and hard materials. Ordinary material dredging unit costs include dredging, transport and disposal. Rock removal costs include drilling and blasting, dredging, transport and disposal. The details of each type of work are discussed below.

Construction Sequencing for Marine Resource Impacts: It is assumed that due to the wide range of resource issues in the harbor and the larger areas covered by the several proposed improvements, that dredging could occur year-round with proper sequencing of work to avoid environmentally sensitive areas at different times of year, and avoid any need for total shut-down of project activities and resulting additional mobilization-demobilization costs. This has been the experience with the last two large-scale dredging operations in the harbor; the 1998-2001 maintenance and improvement dredging of the main tributary channels, and the 2004-2005 major maintenance dredging of the outer harbor features. A construction sequence was also developed for the 2008 inner harbor major maintenance operation to minimize lobster impacts in the lower harbor. Winter flounder are found in various areas of the lower harbor at different times of year, while anadromous fish transit the harbor to and from the Mystic and Charles Rivers in the spring and late fall. Maintenance construction in 2008 occurred without time of year restrictions, but shifted between different areas of the harbor seasonally to minimize impacts. A similar sequencing will be developed for this deep draft improvement project, which provides more flexibility for these adaptations given its larger scope. Sequencing will be developed in consultation with the State and Federal resource agencies during the design phase, and will incorporate the air quality shutdown periods as discussed below should that aspect of the sequencing be retained.

Dredging Plant and Process: It was originally anticipated that two to three large mechanical dredges (bucket or clamshell) would be employed on the job round the clock and year-round for the period of construction. At the conclusion of the air quality analysis it was determined that use of a third dredge would increase annual emissions beyond the level that could be reasonably addressed through biannual construction shutdowns. The final plan for removal of ordinary material is based on two dredges working 24/7 except during the air quality shutdown periods which will occur every other winter as described in the air quality mitigation section below. Both dredges are anticipated to be large barge-mounted cable arm dredges using heavy toothed buckets of 21 cubic yards or greater in size, except in the Mystic and Chelsea River where use of smaller equipment was estimated. During the 1998-2001 construction and for the 2008 work the contractor used the same larger-sized equipment for all project areas, including the Mystic and Chelsea Rivers. The nature of the improvement material, stiff clays, till, cobble and other not-soft materials requires use of a heavy toothed bucket. The lack of non-stiff fines also makes use of a closed environmental bucket impractical and unnecessary.

The dredges would remove the material from the channel bottom and place the material in large split-hull scows for transport to the disposal site. Each dredge would require at least three scows of 5000 cubic yards capacity and two or more ocean-going tugs, so that one scow may be filled while the others are in transit to and from the disposal site, to minimize dredge idle time. Scows of 3000 cubic yards capacity would be used in the Mystic and Chelsea Rivers with the smaller dredge. The contractor is also expected to employ smaller harbor tugs to help position the equipment, work boats for crew and supply transfer, a fuel barge, and a survey boat.

Blasting Plant and Process: Rock removal during the 1998-2001 improvement dredging of the Reserved Channel, Turning Basin, Inner Confluence and Mystic River was accomplished by ripping the bedrock with a large toothed bucket mounted on a heavy excavator. Only the granite ledge in the upper Chelsea River required blasting for removal under that project. However, until the conclusion of the subsurface exploration program included in the design phase of this project, it cannot be determined whether the large volumes of rock required to be removed will lend itself to ripping or removal by other means such as a rock hammer. It may be that the rock cuts from the last improvement project were from zones that were more heavily weathered and fractured thus lent themselves to removal by ripping, and that the rock encountered in this improvement will be different in character. Rock cuts of more than five feet were made in all areas of the 1998-2001 work by heavy toothed bucket ripping without difficulty. For the feasibility level estimates it was assumed that drilling and blasting would be required for removal of all rock under this project.

Blasting and removal of rock ledge is a two-stage operation: drilling and blasting followed by dredging and disposal. It is assumed that one or two large drill barges (depending on the project segment) would be employed for fracturing the ledge areas or any very large boulders identified for removal from the several project segments. Whether one or two drilling rigs will be required is based largely on the depth increment and total volume of rock requiring removal. The drill barges would each mount three drill frame set for an average 9-foot spacing (7-foot spacing at Chelsea River). An explosives barge would be used to transfer charges from shore to the blasting sites and to store charges.

The area to be drilled and blasted for rock removal includes side slope areas (one on one slope) outside the channel limits, additional holes around the perimeter of the target area to ensure sufficient fracturing, and an additional required removal horizon of two feet and the two-foot allowable overdepth horizon. Over-drilling of the charge holes by four to five feet below the allowable overdepth is included to ensure that the cones of rock fractured by each charge will overlap below the overdepth elevation, ensuring the ability to remove of all rock to at least the allowable grade. This requires drilling and blasting over a slightly larger area than that within the contour of the target removal elevation.

Rock removal estimates also include costs for test blasts, seismic monitoring, safety inspection, fish monitors, fish startle systems, and daylight-only operations for blasting. In developing the estimates for Boston Harbor the New England District relied on the New York District's generic drilling and blasting program developed from their extensive experience with the New York – New Jersey Harbor Kill Van Kull blasting and rock removal operation. The District also consulted with the Corps Walla Walla District (the Corps Center of Expertise for Cost Estimating) in development of the drilling and blasting estimates. Drilling costs are dependent on the square-footage of the area to be drilled, hole spacing, the depth of cut required, and the drilling efficiency (linear feet of hole drilled per day). Side slope areas (one-on-one in rock) were included in these estimates. To be conservative at this phase of project cost estimating, the area used to calculate the drilling and blasting plan and for rock removal area included all areas of required material, plus an area outside the required footprint equal to 20 percent of the additional footprint to the allowable overdepth elevation. This will ensure that the estimate includes sufficient area to permit fracturing of all required and allowable material within the required dredging footprint, and attainment of the required elevation by dredging all rock within the required elevation.

The estimates assume that a large heavy toothed bucket of 14 cubic yards or greater on a large barge-mounted excavator or cable arm dredge would be used for removal of rock and other hard materials. As with the unconsolidated materials, the rock and hard material would be placed in split-hull scows for transport to the disposal or beneficial use site(s). The additional equipment supporting the excavator operations, including tugs, scows, work boats, survey boats, and fuel barge were also included in the rock estimates.

After completion of the Design Phase subsurface investigations, the Corps and Massport will develop a detailed rock removal approach with the technical assistance of the TWG. The approach will detail mitigation and management practices, including those mentioned above, aimed at minimizing impacts to fisheries, and procedures for adaptive management during construction. The rock removal approach, including and blasting impact mitigation, will be integrated into the larger construction sequencing plan after the post-maintenance baseline biological resource surveys are completed. At this time it is assumed that blasting would be able to occur without interruption due to resource concerns by sequencing work throughout the several diverse areas of the harbor by shifting work to avoid significant impact to critical resources at different times of year in different areas of the harbor.

Once the subsurface design effort is completed the Corps will determine whether or not blasting is still required for all or part of the rock to be removed from this project segment, and work with the affected agencies to develop a blasting plan. The blasting plan will address environmental concerns as well as structural concerns. Funds are included in the design phase estimate for these analyses. For the Main Ship Channel Extension segment that extends up-harbor to about 1,000 feet downstream of the tunnel, the Corps and Massport will coordinate development of the blasting plan with the Massachusetts Turnpike Authority, the owners of the I-90 tunnel. If necessary, blasting operations will be adjusted to ensure no impact to the tunnel, including the monitoring of test blasts and adapting the final plan to those results.

Disposal of Dredged Material: All disposal costs are included in the unit costs for each of the two classes of material to be removed. All improvement dredging material has been found suitable for unconfined open-water disposal at the MPRSA designated Massachusetts Bay Disposal Site, based on a Suitability Determination with US EPA concurrence dated 8 December 2006. Under the Federal Base Plan for this improvement project all dredged material would be loaded into scows and towed to the MBDS for discharge. The MBDS is located about 18 miles easterly of the harbor entrance, and about 30 miles from the Chelsea and Mystic Rivers. The actual haul distance from each dredge area to the Massachusetts Bay Disposal Site was used to compute cycle times and transit costs. Multiple scow and tug units would be assigned to each dredge or excavator to allow for uninterrupted dredging operations. Depending on which project area was being worked, any overlying maintenance material would either be dredged and disposed along with the improvement material at the MBDS, or would be removed separately and placed in scows for deposit in one or more of the existing CAD cells dredged beneath the channel in the upper harbor above the tunnels, as called for in the NEPA documents covering harbor maintenance.

Haul Costs: Hauling costs are included in the unit costs for each of the two classes of material to be removed. Haul times to the disposal site are based on the actual haul distance to the Massachusetts Bay Disposal Site from each plan under consideration. For the several channel improvement plans the actual distance varied from 21 to 31 miles. The haul times were used to determine the cycle times for the scows and the number of scows and tugs needed to maintain a continuous dredging operation.

Air Quality Impacts on Project Cost: Air quality concerns with potential threshold exceedence for non-attainment pollutants during construction required stretching out the construction period. Investigations did not identify any emissions credits available in the work area for the anticipated construction period, but will need to be re-visited during design. Shut-downs were accomplished by adding no-work periods to limit construction to nine months per year, thus lowering the annual emissions totals for the construction plant. During design the potential to avoid shut-downs through air quality mitigation or the purchase of air quality credits will be examined. However at this time opportunities for mitigation and availability of credits for sale within the non-attainment area were considered speculative. Mitigation, including the purchase of emissions credits must reduce emissions of those target pollutants to zero, not merely back to the threshold level. Contingent on further investigation, construction shut-down periods, even with the additional mobilization/demobilization and escalation costs, are considered the least-cost means of compliance with the Clean Air Act. The shut-down periods were sequenced to bridge calendar years, thereby minimizing additional mobilization/ demobilization costs. The impact of air quality emission threshold shutdowns on the construction period is shown below in Table 35. A graphic representation of the construction sequencing timeline is included in Appendix D2. These shutdowns increased the mobilization/ demobilization costs and cost escalation factors for the affected plans.

TABLE 35 CONSTRUCTION SEQUENCE MODIFICATIONS FOR AIR QUALITY IMPACTS & MOBILIZATION/DEMOBILIZATION COSTS						
Plan and Depth Increment	**Construction Duration (Months)**	**Modified Duration for AQ Impact (Months)**	**Mob-Demob Costs (Initial & Completion)**	**Number of AQ Shutdowns**	**Cost of Additional AQ Mobilizations**	**Total Mob-Demob Costs**
Main Channels 42/44	16	16	$4,837,000	0	0	$4,837,000
Main Channels 43/45	18	18	$4,952,000	0	0	$4,952,000
Main Channels 44/46	20	26	$5,058,000	1	$4,360,000	$9,418,000
Main Channels 45/47	21	27	$5,179,000	1	$4,467,000	$9,646,000
Main Channels 45/49	22	28	$5,273,000	1	$4,561,000	$9,834,000
Main Channels 46/48	22	28	$5,292,000	1	$4,573,000	$9,865,000
Main Channels 46/50	23	29	$5,283,000	1	$4,564,000	$9,847,000
Main Channels 47/49	23	29	$5,400,000	1	$4,669,000	$10,069,000
Main Channels 47/50	24	30	$5,403,000	1	$4,672,000	$10,075,000
Main Channels 47/51	28	34	$5,416,000	1	$4,685,000	$10,101,000
Main Channels 47/52	29	35	$5,507,000	1	$4,776,000	$10,283,000
Main Channels 48/50	25	31	$5,410,000	1	$4,672,000	$10,082,000
Main Channels 48/52	31	37	$5,514,000	1	$4,776,000	$10,290,000
Main Channels 49/51	34	40	$5,529,000	1	$4,791,000	$10,320,000
Main Channels 50/52	39	51	$5,727,000	2	$9,978,000	$15,705,000
MSC Extension to MMT – 42 & 43	3	3	$363,000	0	0	$363,000
MSC Extension to MMT – 44 & 45	4	4	$370,000	0	0	$370,000
Mystic River - MST – 37 to 40	1	1	$90,000	0	0	$90,000
Chelsea River – 39 & 40	4 to 5	4 to 5	$331,000	0	0	$331,000
See Appendix D2 – Cost Estimates – For Construction Schedule and Sequencing						

Contract Costs: Mob-Demob costs and unit costs for material removal and disposal include contractor's plant, labor, insurance and materials costs, as well as overhead, bond and profit. The sum of these costs represents the anticipated contract cost, subject to contingencies and escalation.

Contingencies: Contingencies are applied to the construction contract estimates to account for actual variations in the nature and quantities of dredged materials, potential weather impacts, types and sizes of equipment available to potential bidders, bid competition, changes in market rates for equipment rental and operation, costs of bonds, and other factors affecting dredging production and costs. Contingency levels may be adjusted during final design based on changes in the level of certainty and risk associated with these variables.

As of August 2007, the Corps requires that all project cost estimates for large construction projects undergo a risk analysis to determine the appropriate contingency to use for each aspect of project construction. The Corps has elected to use a commercial risk analysis program known as Crystal Ball. In consultation with the Walla Walla District and the software vendor, models were developed for each segment of the project including drilling and blasting, dredging, and rock removal efforts. Contingency estimates were adjusted based on the results of this analysis. Samples of the risk evaluation, the resulting contingency determinations, and detailed cost estimates for the several improvement plans are provided in Appendix D-2.

Environmental Monitoring: Environmental monitoring (EM) costs are included as a separate line item in the Construction Management costs. These costs would be incurred during the period of construction and for a period of five years post-construction. Monitoring costs as part of the recommended plan would be covered by any Project Partnership Agreement and so are cost-shared with the project sponsor. These costs include field monitoring investigations and analysis, and preparation of monitoring reports for the dredging areas and the MBDS. Monitoring of CAD Cells used for maintenance material is an operations and maintenance cost and is not included in these estimates. Monitoring for any beneficial use alternatives and sites would be developed further during the design phase if it is decided to include such opportunities in the implemented project. The feasibility level estimate has drawn on the District's experience with the recent projects in Boston Harbor and requests by City, State and Federal agencies for monitoring at the dredge site, and the Corps ongoing efforts for monitoring activity at the MBDS in concert with US EPA's site management and monitoring plan. It was assumed for the purpose of developing EM costs that monitoring of turbidity at the dredge site and surveys of mound formation at the MBDS would be the focus of monitoring efforts. A plume tracking study is being conducted for the Inner Harbor maintenance dredging effort to verify SSFATE modeling of the harbor. Depending on the results of this study, further turbidity plume monitoring may be found unnecessary.

Environmental monitoring will also be required during the design phase to update biological resource characterization and substrate mapping, after harbor maintenance actions have been concluded. This update is necessary to provide a baseline for post-construction monitoring studies to track benthic recolonization of the substrate and successive recolonization, as the feasibility phase characterization efforts were largely conducted prior to the maintenance dredging operations.

Environmental monitoring costs are largely a function of the construction duration of any particular plan (the length of time of dredging and disposal activities) and therefore relative to the construction contract cost. For this level of analysis a series of monitoring events were forecast during the construction period for each of the improvement plans. Pre and immediate post-construction monitoring events were also included in the total of events and a cost per event was assumed. These calculations are shown in the Cost Estimate Appendix (D-2) to this report.

<u>Planning, Engineering and Design Costs (PED)</u>: PED costs consist of costs for the design phase including development of any required design phase document and preparation of Plans and Specifications, Design phase costs for this project include final development of beneficial use plans, preparation of a final Design Document, conducting a Value Engineering review, any required final regulatory permitting for the project, specifications surveys, preparation of Plans and Specifications, and related costs for management and pre-construction contracting and other pre-construction phase activities. The cost estimate Appendix D-2 contains a detailed table of itemized PED estimates for the several plans and increments under consideration. PED estimates for this project include the below listed tasks.

- Project management and advanced planning activities during design
- Hydrographic surveys of the dredging and disposal areas for refinement of quantity estimates and design of disposal activities
- Subsurface explorations (borings and probings) to define the nature and quantities of various material classes at depth, particularly rock and other hard materials
- Seismic surveys of areas of the project not surveyed during feasibility also to be used to help refine the nature and extent of various materials at depth
- Additional ship simulator runs using larger container ships if necessary
- Geotechnical investigations to establish set-backs for dredging alongside various facilities and to assist in developing the blasting plans
- Structural engineering investigations of waterfront structures to assist in set back development and to assist in developing the rock removal plans
- Cultural resource investigations in areas not already covered during feasibility, specifically the channel widening areas along Chelsea River and the beneficial use sites
- Additional environmental analysis may be done if there are any significant design changes and any rock reef or other beneficial use alternatives in accordance with applicable NEPA requirements
- Continued public involvement and participation of the Technical Working Group during the Design Phase
- Preparation of a design document and reviews
- Conduct a Value Engineering review
- Updates to the economic evaluation
- Updates to the project design and cost estimates if found necessary from the results of other design phase investigations
- Environmental investigations of the rock reef beneficial use sites, should the State, EPA and the Sponsor support including these sites and plans in the project
- Preparation of Plans and Specifications for soliciting bids for construction

Value Engineering Review: Value Engineering review will be conducted during the design phase in accordance with ER 1110-2-1150 (see par 13.14). Design Phase investigations, particularly the subsurface exploration program, are expected to provide more refined information on the division between glacial till, rock requiring blasting and rock removable by means other than blasting. Feasibility estimates are conservatively based on all this material being rock requiring blasting. Once the final quantities and distribution of these materials is know, rock removal plans, construction sequencing and equipment needs can be better defined. Value Engineering would then be initiated. This information will be added to the cost Appendix (D-2) and Feasibility Report text.

Construction Management Costs (CM): CM costs include costs for contract administration; supervision and inspection of the construction contract activities, including silent inspector services; pre-dredge, progress and after-dredge surveys; and management during the construction phase. These costs are also largely relative to the construction duration and some are estimated in part as a percentage of the contract cost. Costs for Engineering During Construction (EDC) dealing with any needed construction phase engineering investigations and design modifications are traditionally included with PED costs, but have been included in the Construction Management discussion, as they would be budgeted in this phase, not in PED. The cost estimate Appendix D-2 contains a detailed table of itemized S&A estimates for the several plans and increments under consideration. S&A estimates for this project include the following tasks:

- Project management and advanced planning activities during construction
- Hydrographic surveys of the dredging area prior to, during and after construction of each major project segment to determine pre-dredge, progress and post-dredge quantities for purposes of assuring project acceptance and completion, and for measurement and payment
- Contracting division, safety office and other support during contract award, construction and contract close-out
- Construction contract administration costs
- Construction supervision and inspection costs, including inspectors, construction management, travel and other inspection costs
- Any needed diving inspection and supervision costs during rock removal operations
- Continued public involvement and participation of the Technical Working Group during the Construction Phase
- Fisheries, Marine Mammal and Turtle Observers as Required during blasting and disposal operations
- Use of the Silent Inspector System (Primarily a Contract Cost)
- Preparation of a construction summary document
- Engineering during construction (EDC)

Aids to Navigation: The United States Coast Guard is responsible for managing and maintaining the systems of aids to navigation in the nation's ports and harbors. As the proposed improvement plans involve deepening of existing marked Federal channels, no new aids to navigation would be required for any of the improvement plans. Relocation and resetting of some buoys may be required during construction to facilitate dredging operations, and at the conclusion of construction of each channel area to mark the new deep lane width and turns. The relocation of navigation aids is a Federal expense to be paid by the United

States Coast Guard, and is included in the project cost. The number of aids that require resetting is shown below. Costs for these relocations are included in the estimates for each plan as required.

AIDS TO NAVIGATION REQURING RESETTING BY CHANNEL REACH			
Broad Sound North Entrance Channel	6	Reserved Channel	0
President Roads Anchorage	2	Main Ship Channel Extension to MMT	2
President Roads Reach of MSC	2	Mystic River	0
Lower Main Ship Channel	6	Chelsea River	4

Real Estate Costs: All real estate interests required for construction and future maintenance of the project, including lands, easements, rights-of-way, and relocations (LERRs), must be provided at the expense of non-Federal interests. As all lands required for the Boston Harbor improvement, including areas needed for disposal of dredged material and beneficial use of dredged material, are subtidal, the Government can exercise its dominant rights under navigational servitude to implement the project, so no real estate is required to be acquired by the non-Federal sponsor. There are therefore no real estate costs other than rental costs for temporary lands needed during construction and future maintenance dredging operations for construction office space, construction crew parking, and shore access and berths for vessels.

For the 1998-2002 improvement and maintenance project Massport made land at its waterfront facilities available for these uses. The Sponsor's costs for temporarily providing this access for this project have been included in the project costs, and described in a Real Estate Plan dated 17 September 2007, included with this Feasibility Report as Appendix E. For purposes of the Feasibility analysis, these costs were considered creditable against the Sponsor's reimbursable share of project costs. Whether these real estate costs are in fact reimbursable will depend on whether the areas made available are upland or are subject to navigation servitude. This determination will be made during negotiation of the Project Partnership Agreement with the Sponsor when actual temporary space to be used is identified.

As the berths and piers are also subject to the Government's navigation servitude rights no credit would be due the Sponsor for this use. However, during the 1998-2002 improvement project the temporary office space and a parking area were located on an upland site adjacent to a Massport pier in East Boston. Massport as project sponsor for that work was given a credit against the reimbursement amount for the project. For purposes of the feasibility level estimate, real estate costs were estimated based on the square footage of land and reimbursement rates used for the 1998-2001 work, escalated to 2011. This cost is also largely a function of the construction duration, which was used to compute the term the temporary facilities would be needed. These calculations are shown in the Cost Estimate Appendix D-2.

Cost Escalation: Costs were estimated at July 2011 price levels. The July 2011 cost is the first cost for purposes of the benefit-cost analysis which also uses benefits calculated at 2011 levels. For budget purposes, costs must also be escalated to the period of construction, so that project authorization amounts will more closely reflect the actual costs that will be incurred at the time of construction. This escalated cost is referred to as the fully funded cost. Typically the mid-point of the construction period for each plan and increment is used to compute the escalation factor to be applied to construction phase costs. The mid-point of the design phase is used to escalate the costs of that phase. A cost escalation table developed for use with each project segment and increment from factors from the current Civil Works Construction Cost Index System (CWCCIS) document is provided in the Cost Estimate Appendix (Appendix D2, Table D2-8) and shows the derivation of the factors used for each plan and increment. A factor of 1.04077 was used to escalate design phase costs to the design mid-point of December 2013. The factors used for the construction phase range from a low of 1.01584 for the Mystic River Channel, which will only take one month to construct, up to 1.05810 for the deepening of the main ship channel extension to 45 feet, which would be completed in November 2016, after completion of the main channels deepening to the Conley Terminal. The fully funded cost is used solely for budget purposes and is not used for benefit-cost analysis.

Cost Estimate Summary: Project cost estimates are presented in detail in the Cost Estimate Appendix (Appendix D-2). Estimates were developed using the Corps of Engineers Dredge Estimating Program (CEDEP), and are based in part on recent bids for similar work in the New England District (in particular at Boston Harbor) and elsewhere. Rock removal estimates also relied on the experience of the New York District in the New York – New Jersey Harbor deepening project, and on assistance from the Walla Walla District, as discussed above. The tables below summarize the cost estimates for the principal plans of improvement. In order to support an economic depth optimization analysis, project costs were estimated for one-foot depth increments for the principal channels under consideration. The estimates include costs for mobilization and demobilization (including shut-downs every other winter to avoid exceeding air emissions thresholds that would otherwise trigger more costly mitigation measures), dredging, rock blasting and removal, and disposal of materials, contingencies, environmental monitoring during and after construction, supervision and administration, planning, engineering and design, and real estate costs.

A summary of the construction costs for the several improvement plans and incremental depths are shown below in Table 36 (Main Channels), Table 37 (MSC Extension), Table 38 (Mystic River), and Table 39 (Chelsea River). Total project cost summary forms for the recommended plan of improvement for each project segment are provided in the Cost Estimate Appendix (Appendix D-2).

Local Service Facility (LSF) costs are also included where required, and are shown at the bottom of each table. LSF costs for the project are limited to berth deepening at the beneficiary terminals on each project segment, except for the Mystic River (Plan E) where there are no non-Federal improvements required as Massport has already deepened that berth to the maximum elevation under consideration for the channel.

TABLE 36
BOSTON HARBOR DEEP DRAFT NAVIGATION IMPROVEMENT STUDY
COST ESTIMATES FOR ALTERNATIVE PLANS AND DEPTHS
PLAN ABC - MAIN CHANNELS DEEPENING TO CONLEY TERMINAL

DEEPEN THE NORTH ENTRANCE CHANNEL, LOWER MAIN SHIP CHANNEL, PRESIDENT ROADS ANCHORAGE, LOWER RESERVED CHANNEL & RESERVED CHANNEL TURNING AREA TO A DEPTH OF UP TO -50 FEET MLLW WITH TWO FEET GREATER DEPTH IN THE ENTRANCE CHANNEL

PLAN			
Inner Channels Depth	42 Feet	43 Feet	44 Feet
North Entrance Channel Depth	44 Feet	45 Feet	46 Feet
Conley Terminal Berths Depth	45 Feet	46 Feet	47 Feet
Federal Project GNF Implementation Costs			
Mobilization/Demobilization	$4,837,000	$4,952,000	$9,418,000
Dredging and Ocean Disposal	$48,683,000	$61,304,000	$69,318,000
Ledge Drilling and Blasting	$13,312,000	$25,208,000	$35,272,000
Ledge Blasting, Removal & Disposal	$2,043,000	$3,888,000	$5,750,000
Miscellaneous Costs	$284,000	$284,000	$284,000
Contract Subtotal	$69,159,000	$95,636,000	$120,042,000
Construction Contingency	$11,712,000	$16,196,000	$20,329,000
Subtotal - Construction	$80,871,000	$111,832,000	$140,371,000
Planning, Engineering & Design	$4,044,000	$4,273,000	$4,522,000
Supervision & Administration	$4,432,000	$5,044,000	$6,473,000
Resetting of Aids to Navigation	$192,000	$192,000	$192,000
Real Estate	$59,000	$66,000	95,000
Total First Cost - July 2011 Prices	$89,598,000	$121,407,000	$151,653,000
Costs Escalated to Design & Construction	$94,730,000	$129,008,000	$161,965,000
Construction Period (Months)	16	18	26
Non-Federal Feature Costs - Conley Terminal Berths			
Mobilization/Demobilization	NA	$53,000	$53,000
Dredging and Ocean Disposal	NA	$89,218	$174,468
Construction Contingency		$15,100	$29,500
Subtotal - Construction	NA	$157,300	$257,000
E&D and S&A		$13,100	$20,200
Total First Cost	NA	$170,000	$277,000
Costs Escalated to Design & Construction	NA	$181,000	$296,000

Table 36 Revised December 2012

TABLE 36 (Continued) BOSTON HARBOR DEEP DRAFT NAVIGATION IMPROVEMENT STUDY COST ESTIMATES FOR ALTERNATIVE PLANS AND DEPTHS PLAN ABC - MAIN CHANNELS DEEPENING TO CONLEY TERMINAL			
DEEPEN THE NORTH ENTRANCE CHANNEL, LOWER MAIN SHIP CHANNEL, PRESIDENT ROADS ANCHORAGE, LOWER RESERVED CHANNEL & RESERVED CHANNEL TURNING AREA TO A DEPTH OF UP TO -50 FEET MLLW WITH TWO FEET GREATER DEPTH IN THE ENTRANCE CHANNEL			
PLAN			
Inner Channels Depth	45 Feet	45 Feet	46 Feet
North Entrance Channel Depth	47 Feet	49 Feet	48 Feet
Conley Terminal Berths Depth	48 Feet	48 Feet	49 Feet
Federal Project GNF Implementation Costs			
Mobilization/Demobilization	$9,646,000	$9,834,000	$9,865,000
Dredging and Ocean Disposal	$78,377,000	$82,526,000	$87,528,000
Ledge Drilling and Blasting	$44,607,000	$58,406,000	$56,124,000
Ledge Blasting, Removal & Disposal	$7,663,000	$10,788,000	$10,163,000
Miscellaneous Costs	$284,000	$284,000	$284,000
Contract Subtotal	$140,577,000	$161,838,000	$163,964,000
Construction Contingency	$23,807,000	$26,790,000	$27,767,000
Subtotal - Construction	$164,384,000	$188,628,000	$191,731,000
Planning, Engineering & Design	$4,710,000	$4,830,000	$4,916,000
Supervision & Administration	$6,672,000	$6,957,000	$7,103,000
Resetting of Aids to Navigation	$192,000	$192,000	$192,000
Real Estate	99,000	103,000	103,000
Total First Cost - July 2011 Prices	$176,057,000	$200,710,000	$204,045,000
Costs Escalated to Design & Construction	$188,038,000	$214,384,000	$217,950,000
Construction Period (Months)	27	28	28
Non-Federal Feature Costs - Conley Terminal Berths			
Mobilization/Demobilization	$53,000	$53,000	$53,000
Dredging and Ocean Disposal	$225,335	$225,335	$273,402
Construction Contingency	$38,200	$38,200	$46,300
Subtotal - Construction	$316,500	$316,500	$372,700
E&D and S&A	$21,900	$21,900	$23,400
Total First Cost	$338,000	$338,000	$396,000
Costs Escalated to Design & Construction	$361,000	$361,000	$423,000
Table 36 Revised December 2012			

TABLE 36 (Continued)
BOSTON HARBOR DEEP DRAFT NAVIGATION IMPROVEMENT STUDY
COST ESTIMATES FOR ALTERNATIVE PLANS AND DEPTHS
PLAN ABC - MAIN CHANNELS DEEPENING TO CONLEY TERMINAL

DEEPEN THE NORTH ENTRANCE CHANNEL, LOWER MAIN SHIP CHANNEL, PRESIDENT ROADS ANCHORAGE, LOWER RESERVED CHANNEL & RESERVED CHANNEL TURNING AREA TO A DEPTH OF UP TO -50 FEET MLLW WITH TWO FEET GREATER DEPTH IN THE ENTRANCE CHANNEL

PLAN			
Inner Channels Depth	46 Feet	47 Feet	47 Feet
North Entrance Channel Depth	50 Feet	49 Feet	50 Feet
Conley Terminal Berths Depth	49 Feet	50 Feet	50 Feet
Federal Project GNF Implementation Costs			
Mobilization/Demobilization	$9,847,000	$10,069,000	$10,075,000
Dredging and Ocean Disposal	$91,522,000	$96,834,000	$97,343,000
Ledge Drilling and Blasting	$82,285,000	$69,228,000	$78,494,000
Ledge Blasting, Removal & Disposal	15,274,000	12,859,000	14,557,000
Miscellaneous Costs	284,000	284,000	284,000
Contract Subtotal	199,212,000	189,274,000	200,753,000
Construction Contingency	32,786,000	32,164,000	34,115,000
Subtotal - Construction	$231,998,000	$221,438,000	$234,868,000
Planning, Engineering & Design	$5,039,000	$5,130,000	$5,267,000
Supervision & Administration	$7,680,000	$7,561,000	$7,844,000
Resetting of Aids to Navigation	$192,000	$192,000	$192,000
Real Estate	106,000	106,000	110,000
Total First Cost - July 2011 Prices	$245,015,000	$234,427,000	$248,281,000
Costs Escalated to Design & Construction	$261,737,000	$250,420,000	$265,228,000
Construction Period (Months)	29	29	30
Non-Federal Feature Costs - Conley Terminal Berths			
Mobilization/Demobilization	$53,000	$53,000	$53,000
Dredging and Ocean Disposal	$273,402	$312,866	$312,866
Construction Contingency	$46,300	$53,200	$53,200
Subtotal - Construction	$372,700	$419,100	$419,100
E&D and S&A	$23,400	$24,000	$24,000
Total First Cost	$396,000	$443,000	$443,000
Costs Escalated to Design & Construction	$423,000	$473,000	$473,000
Table 36 Revised December 2012			

TABLE 36 (Continued) BOSTON HARBOR DEEP DRAFT NAVIGATION IMPROVEMENT STUDY COST ESTIMATES FOR ALTERNATIVE PLANS AND DEPTHS PLAN ABC - MAIN CHANNELS DEEPENING TO CONLEY TERMINAL			
DEEPEN THE NORTH ENTRANCE CHANNEL, LOWER MAIN SHIP CHANNEL, PRESIDENT ROADS ANCHORAGE, LOWER RESERVED CHANNEL & RESERVED CHANNEL TURNING AREA TO A DEPTH OF UP TO -50 FEET MLLW WITH TWO FEET GREATER DEPTH IN THE ENTRANCE CHANNEL			
PLAN			
Inner Channels Depth	47 Feet	47 Feet	48 Feet
North Entrance Channel Depth	51 Feet	52 Feet	50 Feet
Conley Terminal Berths Depth	50 Feet	50 Feet	51 Feet
Federal Project GNF Implementation Costs			
Mobilization/Demobilization	$10,101,000	$10,305,000	$10,082,000
Dredging and Ocean Disposal	$98,984,000	$104,497,000	$104,373,000
Ledge Drilling and Blasting	$87,993,000	$93,526,000	$85,518,000
Ledge Blasting, Removal & Disposal	16,392,000	17,988,000	15,950,000
Miscellaneous Costs	284,000	284,000	284,000
Contract Subtotal	213,754,000	226,600,000	216,207,000
Construction Contingency	35,651,000	38,684,000	36,815,000
Subtotal - Construction	$249,405,000	$265,284,000	$253,022,000
Planning, Engineering & Design	$5,361,000	$5,442,000	$5,362,000
Supervision & Administration	$8,565,000	$8,874,000	$8,180,000
Resetting of Aids to Navigation	$192,000	$192,000	$192,000
Real Estate	125,000	128,000	114,000
Total First Cost - July 2011 Prices	$263,648,000	$279,920,000	$266,870,000
Costs Escalated to Design & Construction	$282,964,000	$301,764,000	$286,401,000
Construction Period (Months)	34	35	31
Non-Federal Feature Costs - Conley Terminal Berths			
Mobilization/Demobilization	$53,000	$53,000	$53,000
Dredging and Ocean Disposal	$312,866	$312,866	$361,810
Construction Contingency	$53,200	$53,200	$61,600
Subtotal - Construction	$419,100	$419,100	$476,400
E&D and S&A	$24,000	$24,000	$25,500
Total First Cost	$443,000	$443,000	$502,000
Costs Escalated to Design & Construction	$473,000	$473,000	$539,000
Table 36 Revised December 2012			

TABLE 36 (Continued) BOSTON HARBOR DEEP DRAFT NAVIGATION IMPROVEMENT STUDY COST ESTIMATES FOR ALTERNATIVE PLANS AND DEPTHS PLAN ABC - MAIN CHANNELS DEEPENING TO CONLEY TERMINAL			
DEEPEN THE NORTH ENTRANCE CHANNEL, LOWER MAIN SHIP CHANNEL, PRESIDENT ROADS ANCHORAGE, LOWER RESERVED CHANNEL & RESERVED CHANNEL TURNING AREA TO A DEPTH OF UP TO -50 FEET MLLW WITH TWO FEET GREATER DEPTH IN THE ENTRANCE CHANNEL			
PLAN			
Inner Channels Depth	48 Feet	49 Feet	50 Feet
North Entrance Channel Depth	52 Feet	51 Feet	52 Feet
Conley Terminal Berths Depth	51 Feet	52 Feet	53 Feet
Federal Project GNF Implementation Costs			
Mobilization/Demobilization	$10,290,000	$10,320,000	$15,705,000
Dredging and Ocean Disposal	$111,527,000	$112,935,000	$129,013,000
Ledge Drilling and Blasting	$100,550,000	$102,511,000	$116,106,000
Ledge Blasting, Removal & Disposal	19,381,000	19,346,000	22,817,000
Miscellaneous Costs	284,000	284,000	284,000
Contract Subtotal	242,032,000	245,396,000	283,925,000
Construction Contingency	40,497,000	41,893,000	48,470,000
Subtotal - Construction	$282,529,000	$287,289,000	$332,395,000
Planning, Engineering & Design	$5,533,000	$5,802,000	$6,146,000
Supervision & Administration	$9,327,000	$9,712,000	$11,643,000
Resetting of Aids to Navigation	$192,000	$192,000	$192,000
Real Estate	136,000	147,000	187,000
Total First Cost - July 2011 Prices	$297,717,000	$303,142,000	$350,563,000
Costs Escalated to Design & Construction	$319,011,000	$326,822,000	$381,519,000
Construction Period (Months)	37	40	51
Non-Federal Feature Costs - Conley Terminal Berths			
Mobilization/Demobilization	$53,000	$53,000	$53,000
Dredging and Ocean Disposal	$361,810	$406,788	$451,686
Construction Contingency	$61,600	$69,400	$77,100
Subtotal - Construction	$476,400	$529,200	$581,800
E&D and S&A	$25,500	$28,600	$31,200
Total First Cost	$502,000	$558,000	$613,000
Costs Escalated to Design & Construction	$539,000	$602,000	$667,000
Table 36 Revised December 2012			

TABLE 37
BOSTON HARBOR DEEP DRAFT NAVIGATION IMPROVEMENT STUDY
COST ESTIMATES FOR ALTERNATIVE PLANS AND DEPTHS
PLAN D - MAIN SHIP CHANNEL EXTENSION
TO MASSPORT MARINE TERMINAL

DEEPEN THE 600-FOOT WIDE -40-FOOT CHANNEL LANE OF THE MAIN SHIP CHANNEL ABOVE THE RESERVED CHANNEL TURNING AREA AND BELOW THE TED WILLIAMS TUNNEL TO DEPTHS UP TO -45 FEET MLLW – JULY 2011 PRICE LEVELS

First Cost of GNF Construction	PLAN D-42	PLAN D-43	PLAN D-44	PLAN D-45
Mobilization/Demobilization	$363,000	$363,000	$370,000	370,000
Dredging and Ocean Disposal	$2,439,000	$2,913,000	$3,275,000	3,502,000
Ledge Drilling and Blasting	$2,338,000	$4,222,000	$5,867,000	7,197,000
Ledge Removal & Disposal	$413,000	$757,000	$1,151,000	1,508,000
Miscellaneous Costs	$71,000	$71,000	$71,000	71,000
Construction Contingency	$1,260,000	$1,865,000	$2,404,000	2,833,000
Subtotal - Construction	$6,884,000	$10,191,000	$13,138,000	15,481,000
Planning, Engineering & Design	$313,000	$332,000	$353,000	367,000
Supervision & Administration	$626,000	$659,000	$819,000	843,000
Resetting of Aids to Navigation	$24,000	$24,000	$24,000	24,000
Real Estate	$11,000	$11,000	$15,000	15,000
Total First Cost - July 2011 Prices	$7,858,000	$11,217,000	$14,349,000	16,730,000
Escalated Cost (to Design & Const.)	$8,627,000	$12,313,000	$15,761,000	18,374,000
First Cost of Berth Deepening	**PLAN D-42**	**PLAN D-43**	**PLAN D-44**	**PLAN D-45**
Mobilization/Demobilization	$37,000	$37,000	$41,000	$41,000
Dredging and Ocean Disposal	$717,000	$846,000	$962,000	$1,045,000
Construction Contingency	$169,000	$198,000	$225,000	$243,000
Subtotal – Construction	$923,000	$1,081,000	$1,228,000	$1,329,000
Non-Contract Costs (PED, CM)	$23,000	$19,000	$20,000	$19,000
Total First Cost - July 2011	$946,000	$1,100,000	$1,248,000	$1,348,000
Cost Escalated to Construction	$1,038,000	$1,207,000	$1,369,000	$1,479,000

TABLE 38
BOSTON HARBOR DEEP DRAFT NAVIGATION IMPROVEMENT STUDY
COST ESTIMATES FOR ALTERNATIVE PLANS AND DEPTHS
PLAN E - MYSTIC RIVER CHANNEL

IMPROVEMENT DREDGING COSTS FOR 37, 38, 39 AND 40 FOOT DEPTHS DEEPEN THE AREA OF THE MYSTIC RIVER ALONG THE SOUTHERN CHANNEL LANE ADJACENT TO MASSPORT'S MEDFORD STREET TERMINAL TO DEPTHS GREATER THAN THE 35-FOOT EXISTING PROJECT DEPTH UP TO -40 FEET – JULY 2011 PRICE LEVELS

First Cost of GNF Construction	PLAN E-37	PLAN E-38	PLAN E-39	PLAN E-40
Mobilization/Demobilization	$86,000	$86,000	$90,000	90,000
Dredging and Ocean Disposal	$865,000	$1,050,000	$1,198,000	1,418,000
Miscellaneous Costs	$26,000	$26,000	$26,000	26,000
Construction Contingency	$230,000	$273,000	$309,000	360,000
Subtotal - Construction	$1,207,000	$1,435,000	$1,623,000	1,894,000
Planning, Engineering & Design	$168,000	$168,000	$168,000	170,000
Supervision & Administration	$262,000	$264,000	$265,000	269,000
Resetting of Aids to Navigation	$0	$0	$0	0
Real Estate	$4,000	$4,000	$4,000	4,000
Total First Cost - July 2011 Prices	$1,641,000	$1,871,000	$2,060,000	2,337,000
Escalated Cost (to Design & Const.)	$1,733,000	$1,975,000	$2,174,000	2,465,000
First Cost of Berth Deepening	**PLAN E-37**	**PLAN E-38**	**PLAN E-39**	**PLAN E-40**
Berth Already at 40 Feet MLLW	None	None	None	None

TABLE 39
BOSTON HARBOR DEEP DRAFT NAVIGATION IMPROVEMENT STUDY
COST ESTIMATES FOR ALTERNATIVE PLANS AND DEPTHS
PLAN F - CHELSEA RIVER CHANNEL

IMPROVEMENT DREDGING COSTS FOR 39 AND 40 FOOT DEPTHS
IMPROVEMENT INCLUDES DEEPENING ENTIRE CHANNEL AND TURNING BASIN AND CHANNEL WIDENING AT KEY TURNS AND BRIDGE APPROACHES
ALSO ASSUMES WITHOUT-PROJECT REPLACEMENT OF THE CHELSEA STREET BRIDGE BY OTHERS AND WIDENING THE CHANNEL THROUGH THE NEW CHELSEA STREET BRIDGE OPENING ACCOMPLISHED UNDER O&M AUTHORITY
JULY 2011 PRICE LEVELS

First Cost of GNF Construction	PLAN F-39	PLAN F-40
Mobilization/Demobilization	$311,000	$331,000
Dredging and Ocean Disposal	$5,773,000	$7,825,000
Ledge Drilling and Blasting	$107,000	$247,000
Ledge Removal & Disposal	$12,000	$24,000
Miscellaneous Costs	$71,000	$71,000
Construction Contingency	$1,079,000	$1,462,000
Subtotal - Construction	$7,353,000	$9,960,000
Planning, Engineering & Design	$384,000	$394,000
Supervision & Administration	$801,000	$960,000
Resetting of Aids to Navigation	$48,000	$48,000
Real Estate	$15,000	$18,000
Total First Cost – July 2011 Prices	$8,601,000	$11,380,000
Escalated Cost (to Design & Construction)	$8,986,000	$11,957,000
CHELSEA RIVER - ASSOCIATED NON-FEDERAL BERTH DEEPENING		
First Cost of Non-Federal Berths	**PLAN F-39**	**PLAN F-40**
Mobilization/Demobilization	$41,000	$50,000
Dredging and Ocean Disposal - 5 Berths	$734,000	$1,093,000
Construction Contingency	$116,000	$171,000
Plus E&D, S&A, Etc.	$144,000	$179,000
Total First Cost – July 2011 Prices	$1,035,000	$1,493,000
Cost Escalated to Construction	$1,086,000	$1,573,000

Annual Costs

The costs of dredging and disposal for the Federal project improvements must be annualized to place them on an equal footing to enable comparison to evaluated project benefits. First the total improvement cost of the Federal project is increased for interest during construction, to account for the cost of construction funds over the period of construction, yielding the total investment cost. The project construction period is expected to be about four to seven years for the large 42 to 50 foot containership channel deepening plan increments. Lesser periods of three to four months would be required for the Main Ship Channel Deepening Extension to the MMT, one month for the Mystic River Channel, and two months for the Chelsea River Channel improvement. Project implementation costs are annualized using factors developed from interest rates adjusted in accordance with Federal statutes and regulations covering evaluation of civil works water resources projects. The period of economic analysis for navigation improvements is 50 years, and the capital recovery factor for the current fiscal year (2013) is 3-3/4 percent amortized over that period. This factor (0.04457) is applied to the investment costs for each plan to determine the annual cost for interest and amortization of the investment cost. Regulations also require that annual costs be displayed for the recommended plan using a 7 percent interest rate for the 50-year period of analysis for the purpose of budget prioritization. Annual costs using this factor (0.07245) are also provided in the tables.

Annual costs also include an annualized estimate of the cost of maintaining the project over the period of analysis. Since the General Navigation Features of the proposed project are limited to dredging to deepen existing Federal channels, the only annual maintenance cost applicable to this improvement project is the increase in periodic maintenance dredging of the improved areas to their new recommended depth. This requires an analysis of current maintenance dredging frequency and volume for each channel segment and an estimate of any increase in shoaling rate and volume that would result from a deeper channel.

Maintenance dredging of the main channels and anchorage at Boston is typically required every 16 to 40 years, depending on the project segment. The last two maintenance cycles and volumes for each channel segment were examined to determine a representative annual shoaling rate. Channel deepening would not change the sediment discharge loads of the harbor tributaries (all of which are controlled by dams), longshore sediment transport (not a large factor at Boston), or the resulting channel shoaling rates. It is therefore not expected that channel deepening would increase the frequency or volume of maintenance required for the project. However, for purposes of this analysis it was decided to allocate an increase to the current maintenance requirements for the various plans relative to the increase in depth.

The Engineering Design and Cost Estimate Appendix (Appendix D-2) provides a table that displays the calculation used to compute increased maintenance volume expected to result from channel deepening over and above that currently occurring with the existing channels. The total volume removed from each channel segment during its last maintenance dredging was divided by the years between the last two maintenance operations to yield an annual shoaling volume for each channel or segment. For the main channels improvements (A-B-C and other increments) the resulting annual volumes were aggregated into a single number. For Plan D, the MSC extension, the annual volume for the lower main ship channel was divided by 4, representing that segments length relative to the total length of the lower Main

Ship Channel, as a separate volume for that segment could not be calculated from the historical record. For the Mystic River the area under consideration in Plan E for deepening was compared to the total area of that channel last dredged and a factor was used (13 percent) to calculate the annual volume solely for that area's footprint. For the Chelsea River a single number for the entire channel and basin area was used.

To arrive at a volume representing the increase in maintenance requirements attributable to the channel deepening, a percentage was selected based on the magnitude of the depth increase. For all areas a base increase of 10 percent was used for the first depth increment. That percentage was increased two percent for each additional depth increment. As examples, for the main channels improvement (Plan ABC) 10 percent was used for the 42-foot improvement, 12 percent for 43 feet, up to 26 percent for 50 feet. Plan D, the MSC extension, used 10 percent at 42 feet, up to 16 percent at 45 feet. The Mystic River calculation used 10 percent at 37 feet, up to 16 percent at 40 feet. The Chelsea River calculation used 10 percent at 39 feet and 12 percent at 40 feet. The resulting annual increase in shoaling volume was multiplied by the unit cost for each plan and increment's first cost for dredging ordinary material, as adjusted to the total first cost of that plan (i.e. increased to account for mobilization-demobilization, contingencies, and non-contract costs) to arrive at an annual increased maintenance cost. Table 40 shows a sample computation for the 47/51-foot main channels (Conley) improvement plan, and the greatest depth increments of the other three plans. Annual increases in maintenance costs were also calculated for the non-Federal berth deepening for the Conley Terminal (Plan ABC increments), the Massport Marine Terminal (MMT), and the five terminals on the Chelsea River.

The annual costs for the alternative plans and incremental depths, including Federal GNF and non-Federal improvements, are shown the following Tables. Table 41 shows the annual costs for the Plan ABC incremental depths for the main channels plan for access to the Conley Terminal. Tables 42, 43 and 44, show the annual costs for the Main Ship Channel Deepening Extension to the MMT, the Mystic River Channel at the MST, and the Chelsea River Channel, respectively.

TABLE 40
BOSTON HARBOR DEEP DRAFT NAVIGATION IMPROVEMENT STUDY
Typical Annual Maintenance Increase Calculation for Improvements

Channel Segment/Depth	Maintenance Actions		O&M Interval (Years)	CY Dredged in Last Operation	Annual CY	Percent Increase	Annual CY Increase	Cost per CY	Annual O&M Cost Increase
BSN Entrance Channel – 51	1969	2005	36	72,192	2,005	22	17,948	$12.36	$222,000
President Roads Anchorage – 47	1982	2004	22	1,166,447	53,020	22			
Lower Main Ship Channel – 47	1967	2008	41	849,936	21,071	22			
Lower Reserved Channel – 47	1960	1999	39	214,000	5,487	22			
Main Ship Channel Extend to MMT – 45 ÷ 4	One-Quarter Area of Lower MSC				5,268	16	843	$18.15	$15,000
Mystic River at MST- 40 ÷ 13	1982	1998	16	270,000	2,194	16	351	$30.00	$11,000
Chelsea River – 40 Feet	1983	1999	16	218,000	13,625	12	1,635	$31.32	$51,000

Note: The calculations shown are for the 47/51-foot main channels depth, and for the greatest increments for the other channel improvements. Similar calculations were made for each incremental channel depth and those costs were included in the annual with-project maintenance increase figures for annual costs. See Appendix D-1 and D-2.

TABLE 41
BOSTON HARBOR DEEP DRAFT NAVIGATION IMPROVEMENT STUDY
ANNUAL COSTS FOR ALTERNATIVE PLANS AND DEPTHS
PLAN ABC - MAIN CHANNELS DEEPENING TO CONLEY TERMINAL

DEEPEN THE NORTH ENTRANCE, LOWER MAIN SHIP CHANNEL, PRESIDENT ROADS ANCHORAGE, LOWER RESERVED CHANNEL & RESERVED CHANNEL TURNING AREA TO A DEPTH OF UP TO -50 FEET MLLW WITH 2 TO 4 FEET GREATER DEPTH IN THE ENTRANCE

PLAN					
Inner Federal Channels Depth		42 Feet	43 Feet	44 Feet	45 Feet
North Entrance Channel Depth		44 Feet	45 Feet	46 Feet	47 Feet
Conley Terminal Berths Depth		45 Feet	46 Feet	47 Feet	48 Feet
Federal Project GNF Annual Cost - 3-3/4%					
First Cost - July/Aug 2011		$89,598,000	$121,407,000	$151,653,000	$176,057,000
Construction Duration (Months)		16	18	26	27
IDC Rate		1.02378	1.02701	1.04006	1.04170
Implementation Cost (+ IDC)		$91,729,000	$124,686,000	$157,728,000	$183,399,000
Interest & Amortization - 3-3/4%	0.04457	$4,088,000	$5,557,000	$7,030,000	$8,174,000
Increased Annual Maintenance		$223,000	$217,000	$205,000	$204,000
Total Federal GNF Annual Cost		$4,311,000	$5,774,000	$7,235,000	$8,378,000
Non-Federal Annual Cost - 3-3/4%					
First Cost - July/Aug 2011		NA	$170,000	$277,000	$338,000
Implementation Cost (+ IDC)		NA	$170,000	$277,000	$338,000
Interest & Amortization - 3-3/4%	0.04457	NA	$8,000	$12,000	$15,000
Increased Annual Maintenance		NA	$9,000	$14,000	$17,000
Total Federal GNF Annual Cost		NA	$17,000	$26,000	$32,000
Federal Project GNF Annual Cost - 7%					
Interest & Amortization - 7%	0.07245	$6,646,000	$9,034,000	$11,427,000	$13,287,000
Increased Annual Maintenance		$223,000	$217,000	$205,000	$204,000
Total Federal GNF Annual Cost		$6,869,000	$9,251,000	$11,632,000	$13,491,000
Non-Federal Annual Cost - 7%					
Interest & Amortization - 7%	0.07245	$1	$12,000	$20,000	$24,000
Increased Annual Maintenance		NA	$9,000	$14,000	$17,000
Total Non-Federal Annual Cost		NA	$21,000	$34,000	$41,000
Total Federal and Non-Federal Annual Costs					
Total Project Annual Costs	3-3/4%	$4,311,000	$5,791,000	$7,261,000	$8,410,000
Total Project Annual Costs	7%	$6,869,000	$9,272,000	$11,666,000	$13,532,000

TABLE 41 (Continued) BOSTON HARBOR DEEP DRAFT NAVIGATION IMPROVEMENT STUDY ANNUAL COSTS FOR ALTERNATIVE PLANS AND DEPTHS PLAN ABC - MAIN CHANNELS DEEPENING TO CONLEY TERMINAL					
DEEPEN THE NORTH ENTRANCE, LOWER MAIN SHIP CHANNEL, PRESIDENT ROADS ANCHORAGE, LOWER RESERVED CHANNEL & RESERVED CHANNEL TURNING AREA TO A DEPTH OF UP TO -50 FEET MLLW WITH 2 TO 4 FEET GREATER DEPTH IN THE ENTRANCE					
PLAN					
Inner Federal Channels Depth		46 Feet	47 Feet	48 Feet	49 Feet
North Entrance Channel Depth		48 Feet	49 Feet	50 Feet	51 Feet
Conley Terminal Berths Depth		49 Feet	50 Feet	51 Feet	52 Feet
Federal Project GNF Annual Cost - 3-3/4%					
First Cost - July/Aug 2011		$204,045,000	$234,427,000	$266,870,000	$303,142,000
Construction Duration (Months)		28	29	31	40
IDC Rate		1.04335	1.04501	1.04832	1.06342
Implementation Cost (+ IDC)		$212,891,000	$244,978,000	$279,766,000	$322,368,000
Interest & Amortization - 3-3/4%	0.04457	$9,489,000	$10,919,000	$12,469,000	$14,368,000
Increased Annual Maintenance		$207,000	$213,000	$216,000	$222,000
Total Federal GNF Annual Cost		$9,696,000	$11,132,000	$12,685,000	$14,590,000
Non-Federal Annual Cost - 3-3/4%					
First Cost - July/Aug 2011		$396,000	$443,000	$502,000	$558,000
Implementation Cost (+ IDC)		$396,000	$443,000	$502,000	$558,000
Interest & Amortization - 3-3/4%	0.04457	$18,000	$20,000	$22,000	$25,000
Increased Annual Maintenance		$20,000	$22,000	$25,000	$28,000
Total Federal GNF Annual Cost		$38,000	$42,000	$47,000	$53,000
Federal Project GNF Annual Cost - 7%					
Interest & Amortization - 7%	0.07245	$15,424,000	$17,749,000	$20,269,000	$23,356,000
Increased Annual Maintenance		$207,000	$213,000	$216,000	$222,000
Total Federal GNF Annual Cost		$15,631,000	$17,962,000	$20,485,000	$23,578,000
Non-Federal Annual Cost - 7%					
Interest & Amortization - 7%	0.07245	$29,000	$32,000	$36,000	$40,000
Increased Annual Maintenance		$20,000	$22,000	$25,000	$28,000
Total Non-Federal Annual Cost		$49,000	$54,000	$61,000	$68,000
Total Federal and Non-Federal Annual Costs					
Total Project Annual Costs	3-3/4%	$9,734,000	$11,174,000	$12,732,000	$14,643,000
Total Project Annual Costs	7%	$15,680,000	$18,016,000	$20,546,000	$23,646,000

TABLE 41 (Continued)
BOSTON HARBOR DEEP DRAFT NAVIGATION IMPROVEMENT STUDY
ANNUAL COSTS FOR ALTERNATIVE PLANS AND DEPTHS
PLAN ABC - MAIN CHANNELS DEEPENING TO CONLEY TERMINAL

DEEPEN THE NORTH ENTRANCE, LOWER MAIN SHIP CHANNEL, PRESIDENT ROADS ANCHORAGE, LOWER RESERVED CHANNEL & RESERVED CHANNEL TURNING AREA TO A DEPTH OF UP TO -50 FEET MLLW WITH 2 TO 4 FEET GREATER DEPTH IN THE ENTRANCE

PLAN					
Inner Federal Channels Depth		50 Feet	47 Feet	47 Feet	47 Feet
North Entrance Channel Depth		52 Feet	50 Feet	51 Feet	52 Feet
Conley Terminal Berths Depth		53 Feet	50 Feet	50 Feet	50 Feet
Federal Project GNF Annual Cost - 3-3/4%					
First Cost - July/Aug 2011		$350,563,000	$248,281,000	$263,648,000	$279,920,000
Construction Duration (Months)		51	30	34	35
IDC Rate		1.08227	1.04666	1.05332	1.05500
Implementation Cost (+ IDC)		$379,403,000	$259,866,000	$277,707,000	$295,315,000
Interest & Amortization - 3-3/4%	0.04457	$16,910,000	$11,582,000	$12,377,000	$13,162,000
Increased Annual Maintenance		$242,000	$216,000	$222,000	$236,000
Total Federal GNF Annual Cost		$17,152,000	$11,798,000	$12,599,000	$13,398,000
Non-Federal Annual Cost - 3-3/4%					
First Cost - July/Aug 2011		$613,000	$443,000	$459,000	$443,000
Implementation Cost (+ IDC)		$613,000	$443,000	$443,000	$443,000
Interest & Amortization - 3-3/4%	0.04457	$27,000	$20,000	$20,000	$20,000
Increased Annual Maintenance		$31,000	$22,000	$22,000	$22,000
Total Federal GNF Annual Cost		$58,000	$42,000	$42,000	$42,000
Federal Project GNF Annual Cost - 7%					
Interest & Amortization - 7%	0.07245	$27,488,000	$18,827,000	$20,120,000	$21,396,000
Increased Annual Maintenance		$242,000	$216,000	$222,000	$236,000
Total Federal GNF Annual Cost		$27,730,000	$19,043,000	$20,342,000	$21,632,000
Non-Federal Annual Cost - 7%					
Interest & Amortization - 7%	0.07245	$44,000	$32,000	$32,000	$32,000
Increased Annual Maintenance		$31,000	$22,000	$22,000	$22,000
Total Non-Federal Annual Cost		$75,000	$54,000	$54,000	$54,000
Total Federal and Non-Federal Annual Costs					
Total Project Annual Costs	3-3/4%	$17,210,000	$11,840,000	$12,641,000	$13,440,000
Total Project Annual Costs	7%	$27,805,000	$19,097,000	$20,396,000	$21,686,000

TABLE 41 (Continued) BOSTON HARBOR DEEP DRAFT NAVIGATION IMPROVEMENT STUDY ANNUAL COSTS FOR ALTERNATIVE PLANS AND DEPTHS PLAN ABC - MAIN CHANNELS DEEPENING TO CONLEY TERMINAL					
DEEPEN THE NORTH ENTRANCE, LOWER MAIN SHIP CHANNEL, PRESIDENT ROADS ANCHORAGE, LOWER RESERVED CHANNEL & RESERVED CHANNEL TURNING AREA TO A DEPTH OF UP TO -50 FEET MLLW WITH 2 TO 4 FEET GREATER DEPTH IN THE ENTRANCE					
PLAN					
Inner Federal Channels Depth		45 Feet	46 Feet	48 Feet	
North Entrance Channel Depth		49 Feet	50 Feet	52 Feet	
Conley Terminal Berths Depth		48 Feet	49 Feet	51 Feet	
Federal Project GNF Annual Cost - 3-3/4%					
First Cost - July/Aug 2011		$200,710,000	$245,015,000	$297,717,000	
Construction Duration (Months)		28	29	37	
IDC Rate		1.04335	1.04501	1.05836	
Implementation Cost (+ IDC)		$209,411,000	$256,042,000	$315,091,000	
Interest & Amortization - 3-3/4%	0	$9,333,000	$11,412,000	$14,044,000	
Increased Annual Maintenance		$206,000	$201,000	$225,000	
Total Federal GNF Annual Cost		$9,539,000	$11,613,000	$14,269,000	
Non-Federal Annual Cost - 3-3/4%					
First Cost - July/Aug 2011		$338,000	$396,000	$502,000	
Implementation Cost (+ IDC)		$338,000	$396,000	$502,000	
Interest & Amortization - 3-3/4%	0.04457	$15,000	$18,000	$22,000	
Increased Annual Maintenance		$17,000	$20,000	$25,000	
Total Federal GNF Annual Cost		$32,000	$38,000	$47,000	
Federal Project GNF Annual Cost - 7%					
Interest & Amortization - 7%	0.07245	$15,172,000	$18,550,000	$22,828,000	
Increased Annual Maintenance		$206,000	$201,000	$225,000	
Total Federal GNF Annual Cost		$15,378,000	$18,751,000	$23,053,000	
Non-Federal Annual Cost - 7%					
Interest & Amortization - 7%	0.07245	$24,000	$29,000	$36,000	
Increased Annual Maintenance		$17,000	$29,000	$25,000	
Total Non-Federal Annual Cost		$41,000	$49,000	$61,000	
Total Federal and Non-Federal Annual Costs					
Total Project Annual Costs	3-3/4%	$9,571,000	$11,651,000	$14,316,000	
Total Project Annual Costs	7%	$15,419,000	$18,800,000	$23,114,000	

TABLE 42
PLAN D - MAIN SHIP CHANNEL DEEPENING EXTENSION – ANNUAL COSTS

**EXTEND THE DEEPENING OF THE LOWER MAIN SHIP CHANNEL
FROM ABOVE THE RESERVED CHANNEL TO BELOW THE TED WILLIAMS TUNNEL
TO ACCESS THE MASSPORT MARINE TERMINAL IN SOUTH BOSTON**

Federal Project GNF Annual Cost			**42 Feet**	**43 Feet**	**44 Feet**	**45 Feet**
First Cost July 2011 (without Escalation)			$7,858,000	$11,217,000	$14,349,000	$16,730,000
Implementation Cost (+ IDC)			$7,883,000	$11,252,000	$14,416,000	$16,809,000
Interest & Amortization	3-3/4%	0.04457	$351,000	$502,000	$643,000	$749,000
Increased Annual Maintenance			$16,000	$15,000	$15,000	$15,000
Total Federal GNF Annual Cost			$367,000	$517,000	$658,000	$764,000
Interest & Amortization	7%	0.07245	$571,000	$815,000	$1,044,000	$1,218,000
Increased Annual Maintenance			$16,000	$15,000	$15,000	$15,000
Total Federal GNF Annual Cost			$587,000	$830,000	$1,059,000	$1,233,000
Non-Federal Annual Cost			**42 Feet**	**43 Feet**	**44 Feet**	**45 Feet**
First Cost July 2011 (without Escalation)			$946,000	$1,100,000	$1,248,000	$1,348,000
Interest & Amortization	3-3/4%	0.04457	$42,000	$49,000	$56,000	$60,000
Increased Annual Maintenance			$5,000	$6,000	$6,000	$7,000
Total Non-Federal Annual Cost			$47,000	$55,000	$62,000	$67,000
Interest & Amortization	7%	0.07245	$69,000	$80,000	$90,000	$98,000
Increased Annual Maintenance			$5,000	$6,000	$6,000	$7,000
Total Non-Federal Annual Cost			$74,000	$86,000	$96,000	$105,000
Total Federal and Non-Federal Annual Costs			**42 Feet**	**43 Feet**	**44 Feet**	**45 Feet**
Total Project Annual Costs	3-3/4%	0.04457	$414,000	$572,000	$720,000	$831,000
Total Project Annual Costs	7%	0.07245	$661,000	$916,000	$1,155,000	$1,338,000

TABLE 43
BOSTON HARBOR DEEP DRAFT NAVIGATION IMPROVEMENT STUDY
PLAN E - MYSTIC RIVER CHANNEL
ANNUAL COSTS

DEEPEN THE AREA OF THE MYSTIC RIVER ALONG THE SOUTHERN CHANNEL LANE ADJACENT TO MASSPORT'S MEDFORD STREET TERMINAL TO DEPTHS GREATER THAN THE 35-FOOT EXISTING PROJECT DEPTH UP TO -40 FEET

PLAN E - FEDERAL GNF - MYSTIC RIVER			37 Feet	38 Feet	39 Feet	40 Feet
First Cost (without Escalation)			$1,641,000	$1,871,000	$2,060,000	$2,337,000
Construction Period (Months)			1	1	1	1
Implementation Cost (+ IDC)			$1,641,000	$1,871,000	$2,060,000	$2,337,000
Interest & Amortization	3-3/4%	0.04457	$73,000	$83,000	$92,000	$104,000
Increased Annual Maintenance	10% or 16%		$12,000	$11,000	$10,000	$11,000
Total Federal GNF Annual Cost			$85,000	$94,000	$102,000	$115,000
Interest & Amortization	7%	0.07245	$119,000	$136,000	$149,000	$169,000
Increased Annual Maintenance	10% or 16%		$12,000	$11,000	$10,000	$11,000
Total Federal GNF Annual Cost			$131,000	$147,000	$159,000	$180,000

TABLE 44 BOSTON HARBOR DEEP DRAFT NAVIGATION IMPROVEMENT STUDY PLAN F - CHELSEA RIVER CHANNEL – ANNUAL COSTS				
DEEPEN THE EXISTING 38-FOOT CHELSEA RIVER CHANNEL AND TURNING BASIN TO UP TO 40 FEET WITH MINOR WIDENING IN CRITICAL BENDS AND BRIDGE APPROACHES				
PLAN F - FEDERAL GNF			**39 Feet**	**40 Feet**
First Cost (without Escalation)			$8,601,000	$11,380,000
Implementation Cost (+ IDC)			$8,641,000	$11,451,000
Interest & Amortization	3-3/4%	0.04457	$385,000	$510,000
Increased Annual Maintenance			$57,000	$51,000
Total Federal GNF Annual Cost			$442,000	$561,000
Interest & Amortization	7%	0.07245	$626,000	$830,000
Increased Annual Maintenance			$57,000	$51,000
Total Federal GNF Annual Cost			$683,000	$881,000
PLAN F - TERMINAL BERTHS			**39 Feet**	**40 Feet**
First Cost (without Escalation)			$1,035,000	$1,493,000
Interest & Amortization	3-3/4%	0.04457	$46,000	$67,000
Increased Annual Maintenance	5% or 6%		$52,000	$90,000
Total Non-Federal Annual Cost			$98,000	$157,000
Interest & Amortization	7%	0.07245	$75,000	$108,000
Increased Annual Maintenance			$52,000	$75,000
Total Non-Federal Annual Cost			$127,000	$183,000
TOTAL FEDERAL & NON-FEDERAL ANNUAL COSTS			**39 Feet**	**40 Feet**
Total Project Annual Costs	3-3/4%	0.04457	$540,000	$718,000
Total Project Annual Costs	7%	0.07245	$1,897,000	$1,064,000

ECONOMIC BENEFIT ANALYSIS

The primary focus of the economic analyses conducted for this study has been the analysis of container shipping benefits, since it is container shipping that would be the primary beneficiary of channel deepening. Additional economic analyses conducted include (1) an examination of bulk cargo benefits for the extension of the Main Ship Channel to the Massport Marine Terminal, and the deepening of a small portion of the Mystic River Channel, and (2) an analysis of petroleum carrier benefits for deepening of the Chelsea River Channel. These analyses are included within the Economics Appendix to this report.

Containership Improvements: The Containership Economic Analysis was conducted under contract by David Miller & Associates of Vienna, Virginia during FY 2005, and updated in 2006, 2007, 2010, 2011 and 2012. These analyses were reviewed by the study team, including New England District team members, Massport team members, and an Economist at the University of Massachusetts at Boston who is a member of the project's Technical Working Group. The 2005 analysis was also reviewed by deep-draft experts at New York District for an Independent Technical Review. The August 2007 update, underwent Agency Technical Review by a team from the New York District, and was further refined and updated in response to that review and comments raised during the Alternative Formulation Briefing in December 2007. The April 2008 revised report was reviewed again through Agency Technical Review, Public Review, Independent External Peer Review and the Corps Vertical Team and edited prior to submission to the Civil Works Review Board. A Draft Final Feasibility Report and SEIS were submitted to Corps Headquarters in July 2008 and presented to the Civil Works Review Board at its 21 August 2008 meeting. At the Board's request additional information was submitted and considered in September 2008. The Board directed that additional investigations of the project's economic justification be conducted with a view to determining the economically optimal depth of the main channel improvements for the benefits of container shipping.

A Framework for Additional Economic Analysis of the project was prepared in October 2008 and after extensive discussion a detailed scope for that analysis was approved by Corps Headquarters in November 2009. The Framework scope called principally for three tasks (1) a survey of shippers using container services to determine the source and destination of cargo and rational and costs for land versus waterborne shipment, (2) interviews with container shippers to develop further information on fleet forecasts, post-Panama Canal deepening shipping strategies, decisions on service and port rotation, and the potential for Boston Harbor to gain or lose services in both the with-project and without-project conditions, and (3) investigation of vessel loading practices with respect to current and projected practices, service schedules, and tidal assistance. The surveys and interviews were carried out during 2010 and reports documenting these efforts were prepared in early 2011. The findings were presented to Corps reviewers and Headquarters in April 2011, after which additional information and model analysis was requested. That work was carried out through the remainder of 2011 and presented to Corps reviewers and Headquarters in February 2012. Additional economic shipping analysis was again requested and that work completed in April 2012. The resulting revised Economic Evaluation for the project was reviewed and submitted to Corps Headquarters in May 2012 along with an updated Cost Engineering Appendix for review and reconsideration of the project.

After further discussion the Corps presented its recommendation for project improvements to Massport in August 2012. With the Sponsor's concurrence preparation of a revised feasibility report began.

Bulk Cargo Improvements: The additional economic analyses for the channel deepening to the Massport Marine Terminal off the Main Ship Channel, to the Medford Street Terminal in the Mystic River, and to oil terminals in the Chelsea River, are also included in the Economics Appendix (C). The commerce forecast for the two dry bulk terminals is detailed in Economics Appendix C2. The forecasts are based on cargo volumes expected at the two terminals, which are based on market analyses conducted by the future tenants and Massport, and based on expected general population and economic trends for the region. The commerce forecast for the Chelsea River analysis is also contained in Economics Appendix C2. The economic analysis for the Chelsea River is based on the assumption that future oil volumes delivered to terminals on the river will be at least equal to current volumes.

WITHOUT PROJECT CONDITION

Without channel deepening, the containerships currently using Boston Harbor will continue to experience tidal delays, many vessels will continue to be light loaded, and a large part of New England cargo will continue to be shipped in or out of the PONYNJ, increasing total transportation costs. Recent trends of cargo shifting from PONYNJ to Boston Harbor, due to the lower landside transportation costs of shipping New England cargo through Boston, will continue only to the extent provided by the 40-foot maintenance dredging. As the lower and outer harbor re-shoal over their demonstrated 36 to 41 year O&M cycle reduced controlling depths will result in reduced vessel loading and or increased delays until the next maintenance dredging operation restores the controlling depth to at least the authorized project depth.

As liner services to Boston Harbor have become more available over recent years, New England importers and exporters have been shifting from the PONYNJ to Boston Harbor to take advantage of the lower transportation costs via Boston Harbor. Table 45 below presents the trucking cost differential for New England goods transiting Boston Harbor as compared to PONYNJ. The potential mileage savings that would result from shifting from the PONYNJ to Boston Harbor were calculated as the difference between the distance from the New England location to Port Elizabeth in Newark, New Jersey, and the distance from the same New England location to Conley Terminal in Boston Harbor. The weighted average distance for each state was weighted by the TEU volume for each city or town as identified in 2007 PIERS data adjusted for the results of a shipper survey conducted in 2009-2010. This resulted in a weighted average distance saved of 148.5 miles per TEU.

TABLE 45 BOSTON HARBOR DEEP DRAFT NAVIGATION IMPROVEMENT STUDY Total Per Box Transportation Cost Differential 47-Foot Example	
Port Fees	$41.78
Trucking Costs (Table C1-7-6)	$477.61
Minus Increased Waterborne Costs (Table C1-7-7)	- $6.55
Total	$471.06
Rounded	$471
Notes: Based on weighted average mileage differential of 148.5 miles per box and 1.85 TEUs per box	

TEU Volumes – Without Project

A world trade forecast was conducted for this analysis by Global Insight, Inc., which focused on containerized trade to and from ports in the North Atlantic region of the US. More recent Global Insight projections for all North American ports were published in the July 2007 issue of Containerization International (pages 5-7). The growth rates in the recently published trade forecasts are used to project trade volumes for 2007-2009, based on observed 2006 volumes. Trade volumes for 2010-2060 are based on the growth rates exhibited in the original 2006 forecast. Table 46 presents short-term (2007 – 2009) annual TEU volume growth rates (imports and exports) for US North Atlantic ports for European trade (including the Mediterranean), Asian trade, and total trade. Table 46 also presents longer-term (2010 – 2025) annual TEU volume growth rates.

TABLE 46 BOSTON HARBOR DEEP DRAFT NAVIGATION IMPROVEMENT STUDY FORECASTED TEU VOLUME GROWTH RATES Forecasted Short-Term TEU Volume Growth Rates for US North Atlantic Ports					
	2007	**2008**	**2009**		
Europe	4.52%	3.98%	5.08%		
SE Asia	6.01%	5.84%	4.45%		
NE Asia	9.03%	10.16%	7.78%		

Forecasted Longer-Term TEU Volume Growth Rates for US North Atlantic Ports			
	2010-2015	**2015-2020**	**2020-2025**
Europe	2.5%	2.7%	2.8%
Asia	4.8%	4.0%	2.9%
All	3.9%	3.6%	3.4%

Growth in liner service TEU volumes at Boston Harbor is constrained by characteristics of the fleet calling at Boston Harbor and by the without-project controlling depth (40 feet MLLW). Without-project liner service TEU volumes are based on the assumptions that the existing liner services continue to call at Boston Harbor and that no new liner service adds Boston Harbor to its port rotation. The future continuance of cargo shifting from PONYNJ to Boston Harbor is based on the assumption that the cost differential ($471) identified under existing conditions will continue into the future.

The TEU volume growth expected at Boston Harbor for the two MSC liner services in the without project condition would be due to increased channel depth provided by the maintenance dredging, which would allow slightly more TEUs to be shifted from the PONYNJ. Once these vessels achieve their maximum operating draft however, no additional growth for these liner services is expected. The COSCO service, which will shift to larger vessels once PONYNJ deepening is completed in 2015, is projected to drop Boston from its rotation if Boston is not deepened. Non-liner service carriers (barge and feeder) had all dropped Boston as of 2012.

The TEU volumes for the three liner services, and the short-lived Hanjin-Suez and AFS services for 2011 presented in Table 47, show the current 2011 PIERS data and estimated maximum upper limit for liner service TEU volumes at Boston Harbor under without-project conditions, after maintenance dredging to 40 feet.

TABLE 47
BOSTON HARBOR DEEP DRAFT NAVIGATION IMPROVEMENT STUDY
2011 and Projected Without-Project Condition
Boston Harbor TEU Volumes

	MSC Euro	MSC Med	COSCO CHKY	Hanjin Suez	All Others	Total
2011	43,208	26,230	74,434	48,448	383	192,703
W/out Project	42,526	20,072	0 (Dropped)	0 (Dropped)	0	62,598

Expected Fleet – Without Project

Significant changes to the world's containership fleet are currently occurring and are expected to continue into the near future. Large post-Panamax vessels, some in excess of 13,000 TEUs, have recently entered the world fleet and more than 250 post-Panamax new-builds were scheduled to enter the fleet between 2005 and 2008. The world fleet also saw the addition of 225 Panamax vessels during the same time period. These new Panamax vessels are typically designed with drafts greater than the current Panama Canal limit (39.4 feet) and carry as many as 5,100 TEUs. Some of the older Panamax vessels, such as those built in the 1970's, carry fewer than 3,000 TEUs.

The most likely without-project fleet for the MSC liner services is the existing fleet for the MSC Euro Service (4000 TEU vessels), and a shift for the MSC Med Service from its current 2700 TEU vessels to 4000 TEU vessels. This is based upon the observation that the vessels are currently operating as full as they can, and based upon the expectation that they will be able to operate with maximum loads once the maintenance dredging is completed. Any larger, new vessels entering the MSC fleet would be deployed elsewhere because they would be depth constrained at Boston Harbor.

COSCO liner has shifted to 5100 TEU vessels, the largest Panamax vessel, for its Boston service. The maintenance dredging to 40-feet as completed in 2012 provides the additional depth needed to accommodate such a shift. However, full loading of these larger vessels would be limited by the current 40-foot controlling depth, and also by the existing dimensions of the Panama Canal.

WITH-PROJECT CONDITION

With the Project TEU Volumes and Fleet

The with-project condition is based on the assumption that a large portion of New England cargo will continue to be handled by the PONYNJ, and that the shift from the PONYNJ to Boston Harbor observed in 2003 – 2006 will continue, if vessel space is available. Several different with-project scenarios are examined in the containership analysis. The scenarios project that the same two carriers (MSC and COSCO) will continue to draw New England cargo from the PONYNJ to Boston Harbor in the same manner exhibited in 2003 – 2006. By 2010 it is predicted that there will be approximately 900,000 import and export New England TEUs. Since PONYNJ currently handles about 37 percent of Boston Harbor cargo, it is projected that approximately 330,000 of those New England TEUs will be handled at the PONYNJ in 2010 and 240,000 at Boston Harbor under the without-project condition. The largest volume Boston Harbor with-project scenario adds about 138,000 TEUs to Boston Harbor's without-project condition TEU volume. Although many of these additional with-project Boston Harbor TEUs are expected to shift from the PONYNJ, it is also possible that some of these TEUs may shift from US west coast and other US east coast ports.

In the with-project conditions analysis, incremental increases in channel depth allow deeper vessels to call and for those vessels to carry more loaded TEUs. The proportion of additional cargo on each ship which would be off-loaded or on-loaded at Boston Harbor is based on observed 2006 proportions.

Under the base case scenario, Boston Harbor remains a port of call for the same three major liner services which call under existing conditions. Vessels on the MSC Euro and MSC Med services are assumed to have characteristics similar to vessels such as the MSC Ornella, which is a Panamax vessel with a 5,050 TEU capacity and a maximum operating draft of 44 feet. MSC currently has 13 of these vessels, some of which are deployed on a liner service calling at Port Everglades, Savannah, and PONYNJ. These vessels would be depth constrained under with-project conditions at controlling depths up to 44 feet.

At controlling depths greater than 44 feet both MSC services are assumed to switch to vessels with characteristics similar to the MSC Malta, which has a TEU capacity of approximately 5,600 and a maximum operating draft of 46 feet. MSC will have at least 10 vessels of this size by 2012. Vessels with these characteristics currently in MSC's fleet call at ports in the Mediterranean, the Mid-East, and Asia. The route of the MSC Euro and MSC Med services routes are shown in Figure 43.

COSCO's AWE-2 (CHKY) service is projected to continue under the base case with-project condition. This service would continue to use the 5,100 TEU vessels as in the without-project condition. COSCO has 15 such vessels scheduled for delivery through 2010. These vessels have a maximum operating draft of 44 feet and would be depth constrained under with-project conditions at controlling depths up to 44 feet. At controlling depths greater than 44 feet the AWE-2 (CHKY) service is projected to switch to vessels with characteristics similar to the COSCO Rotterdam, which has a TEU capacity of 5,618 TEUs and a maximum operating draft of 46 feet. COSCO currently has 10 vessels with these characteristics. Some of these vessels currently call at Long Beach and Oakland, CA. Table 48 presents the with-project condition TEU volumes projected for the base case in this analysis.

TABLE 48
BOSTON HARBOR DEEP DRAFT NAVIGATION IMPROVEMENT STUDY
Base Case: With-Project Condition TEU Volumes

Depth (Feet)	MSC Euro	MSC Med	AWE-2 CHKY	Total	Increment
40 (w/o project)	42,526	20,072	0	62,598	
41	46,837	21,127	0	67,965	5,367
42	49,967	26,608	0	76,574	8,610
43	52,825	27,853	0	80,678	4,104
44	54,636	28,962	0	83,598	2,920
45	56,112	29,907	170,927	256,946	173,348
46	57,321	30,647	179,525	267,492	10,546
47	58,097	31,102	186,062	275,261	7,769
48	58,509	31,307	190,034	279,850	4,589
49	58,725	31,485	191,074	281,284	1,435
50	58,784	31,568	191,074	281,427	143
51	58,784	31,568	191,074	281,427	0
		Total Additional With-Project TEUs			218,829

Other scenarios are examined in the containership analysis (Appendix C-1), and variations on the degree of shift to larger vessels, as well as the addition of a Suez line to Boston services. Key assumptions are identified in the containership analysis, and are tested in several sensitivity analyses. The existing COSCO service's route and the recent Suez service route are shown in Figure 44.

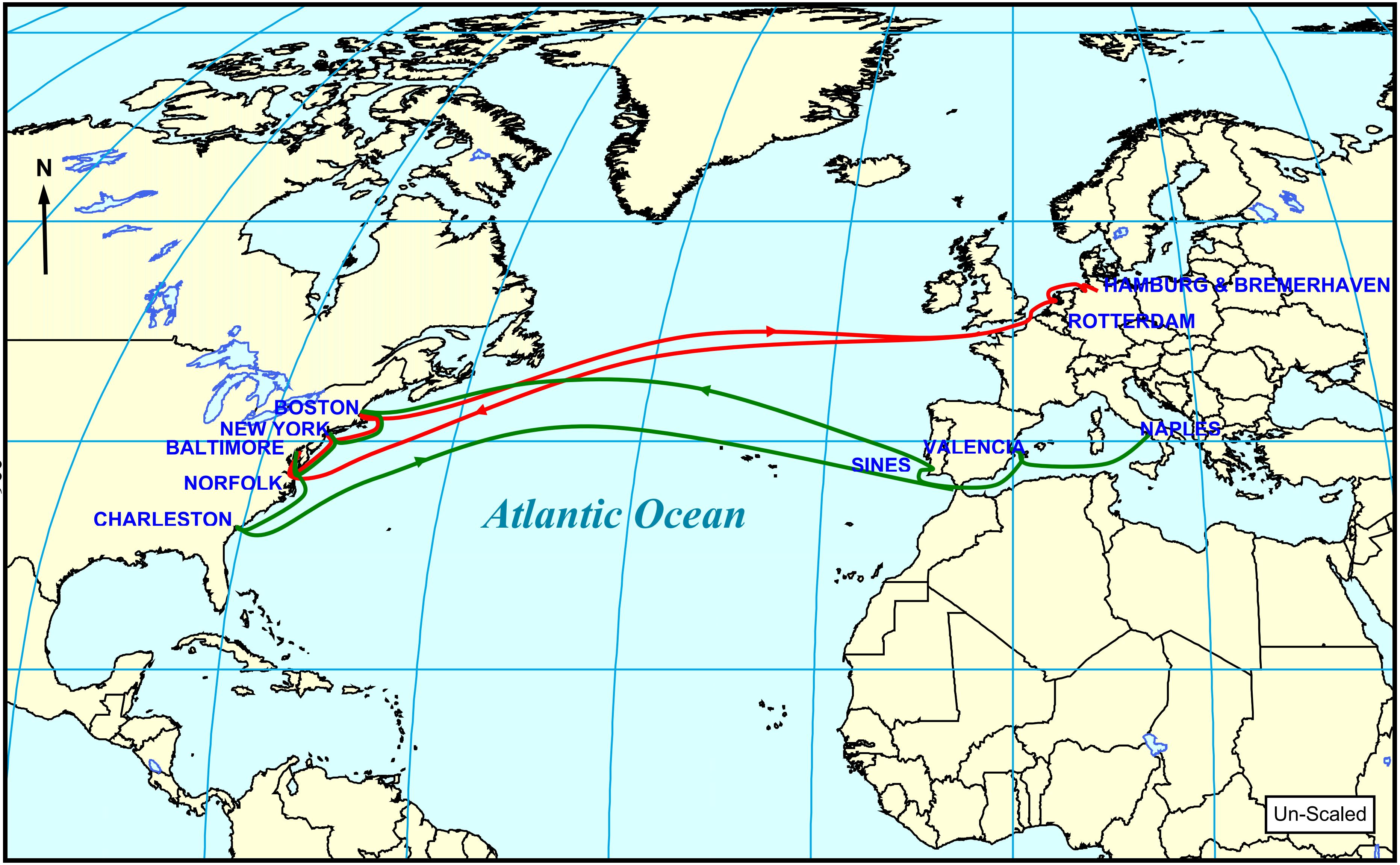


FIGURE 43 – CONTAINER LINE SERVICE ROUTES – MSC

MSC Northern European Service **MSC Mediterranean North Atlantic Service**

FIGURE 44 – CONTAINER LINE SERVICE ROUTES – COSCO

Existing Asian Service via Panama Canal — Proposed Asian-Mediterranean Service via Suez Canal

Landside Transportation Cost Savings

With a deeper channel at Boston Harbor, MSC and COSCO are expected to upgrade their liner services fleet to larger vessels that would provide the opportunity for more New England TEUs to shift from using the relatively more expensive PONYNJ to using the relatively less expensive Boston Harbor. Table 45, above, Landside Transportation Cost Differential, presents the landside transportation costs associated with the PONYNJ and Boston Harbor. The $479/box cost savings is understood to be the economic rationale behind the shift from the PONYNJ to Boston Harbor that has been observed in 2003 and 2006.

Table 49 presents the annual landside transportation cost savings. The TEU to box conversion ratios used in the analysis are based on 2006 TEU and box size data provided by Massport. The TEU to box conversion ratio for MSC's European service is 1.78 TEUs per box. The conversion ratio for MSC's Mediterranean service is 1.70 TEUs per box. At the incremental increase from 44 to 45 feet, it is assumed that the fleet would shift to slightly larger vessels as described in the Base Case With-Project TEU Volumes. At channel depths greater than 48 feet no additional benefits are created because the maximum sailing draft for the base case with-project fleet is 46 feet. Vessels are assumed to use tidal advantage in order to maintain appropriate underkeel clearance as observed in the 2006 data and as explained in section on With-Project Conditions. Benefits for the AWE-2 service are constrained by controlling depth at the Panama Canal until 2015, at which time the new locks are projected to be operational.

TABLE 49
BOSTON HARBOR DEEP DRAFT
NAVIGATION IMPROVEMENT STUDY
Base Case Average Annual Transportation Cost Savings ($1000s)

Channel Depth	Total TEUs	Incremental TEU Increase	Total Cost Savings	Incremental Cost Savings
40	62,598	-	-	-
41	67,965	5,367	$2,578	$2,578
42	76,574	8,610	$6,627	$4,048
43	80,678	4,104	$8,611	$1,985
44	83,598	2,920	$10,049	$1,438
45	256,946	173,348	$91,222	$81,174
46	267,492	10,546	$96,306	$5,083
47	275,261	7,769	$100,176	$3,871
48	279,850	4,589	$102,555	$2,378
49	281,284	1,435	$103,426	$871
50	281,427	143	$103,720	$294
51	281,427	0	$103,859	$139

Three alternatives with-project scenarios to the base case were also examined, along with upper and lower confidence limit analyses to the base case, and 17 alternative benefits scenarios. The transportation cost savings with the three base case alternatives and the first of the alternative scenarios are shown below in Table 50. The remaining scenarios, confidence limit alternatives, and details regarding all these analyses are contained in the containership benefits analysis report (Appendix C-1).

Benefit Cost Analysis

The various alternative main channel plan depth increments and the three additional minor improvement plans were each evaluated to compare estimated project costs with anticipated project benefits. Costs and benefits were developed at 2011 price levels, and are expressed in annual terms using the FY2013 interest and amortization rate of 3-3/4 percent.

The sum of annual costs for Federal General Navigation Features and non-Federal Local Service Facilities is the total annual cost for each project segment and increment evaluated. The total annual benefits as described above in the economic analysis are compared to the total annual costs by dividing benefits by costs to yield a benefit-cost ratio, and by subtracting costs from benefits to yield the net annual benefit. In order for Federal interest in a project, plan or project segment to be found warranted, a benefit cost ratio of one or greater must be demonstrated. In comparing those plans with a favorable BCR, the plan or increment with the highest net annual benefit will be recommended as the National Economic Development (NED) plan.

The Federal budget prioritization process also requires that the benefit cost analysis be computed using a 7 percent interest rate. Projects with a BCR of 3.0 or greater using the 7 percent rate are typically considered high priority projects eligible for inclusion in the President's budget.

Table 51 shows the benefit cost analysis for the main channels improvement plans in one-foot increments to determine the optimal project depth, including the three depths . This analysis determined that the 48-foot inner channels depth to be the optimal increment for deeper containership access to the Conley Terminal based on the highest net annual benefit of the depth increments evaluated. These were examined using the economic base case, its alternatives and the 17 various scenarios. Most alternatives and scenarios yielded the 48-foot depth as optimal.

Based on costs, benefits and environmental screening conducted to date, a plan that provides harbor deepening improvements to the Port of Boston consisting of a 48-foot MLLW depth in the lower Main Ship Channel, the Reserved Channel and its Turning Area, and the President Roads Channel Reach and Anchorage, further deepening in the harbor's North Entrance Channel from Broad Sound, would appear to be the NED Plan. This plan meets the NED criteria and the intent of the Environmental Operating Principals in that it maximizes annual net benefits, does not result in insurmountable environmental impacts and incorporates environmental benefits through the potential beneficial use of dredged material.

TABLE 50
BOSTON HARBOR DEEP DRAFT NAVIGATION IMPROVEMENT STUDY

Alternative With-Project Scenarios
Average Annual Transportation Cost Savings ($1000s – May 2012)

	Base Alternative A No Asian Post-Panamax Vessels		Base Alternative B Asian-Suez Service Returns at 45-Foot Depth		Base Alternative C No Unit Assessment Fees		Sensitivity Analysis #1 5-Year Delay in Asian Service Return	
Depth	Total	Incremental	Total	Incremental	Total	Incremental	Total	Incremental
41	$5,914	$5,914	$2,578	$2,578	$2,354	$2,354	$2,629	$2,629
42	$13,194	$7,280	$6,627	$4,048	$6,043	$3,689	$6,758	$4,128
43	$17,920	$4,725	$8,611	$1,985	$7,856	$1,813	$8,782	$2,024
44	$21,411	$3,491	$10,049	$1,438	$9,171	$1,316	$10,248	$1,466
45	$23,793	$2,382	$146,450	$136,401	$83,102	$73,931	$76,128	$65,881
46	$25,046	$1,253	$154,337	$7,888	$87,744	$4,643	$80,449	$4,320
47	$25,767	$721	$160,349	$6,012	$91,291	$3,546	$83,721	$3,272
48	$26,407	$640	$164,087	$3,738	$93,477	$2,186	$85,742	$2,021
49	$26,783	$377	$165,336	$1,249	$94,289	$812	$86,517	$775
50	$27,077	$294	$165,659	$323	$94,576	$288	$86,810	$293
51	$27,216	$139	$165,915	$256	$94,715	$139	$86,923	$112

TABLE 51
BOSTON HARBOR DEEP DRAFT NAVIGATION IMPROVEMENT STUDY
BENEFIT-COST ANALYSIS FOR ALTERNATIVE PLANS AND DEPTHS - PLANS A, B & C - MAIN CHANNELS DEEPENING TO CONLEY TERMINAL

DEEPEN THE BROAD SOUND NORTH ENTRANCE, PRESIDENT ROADS ANCHORAGE, LOWER MAIN SHIP CHANNEL FROM PRESIDENT ROADS TO THE RESERVED CHANNEL, LOWER RESERVED CHANNEL AND RESERVED CHANNEL TURNING AREA TO A DEPTH OF UP TO -50 FEET MLLW WITH TWO OR FOUR FEET GREATER DEPTH IN THE ENTRANCE CHANNEL

PLAN A-B-C - FEDERAL GNF			42/44 Feet	43/45 Feet	44/46 Feet	45/47 Feet	46/48 Feet	47/49 Feet	48/50 Feet	49/51 Feet	50/52 Feet	45/49 Feet	46/50 Feet	47/51 Feet	48/52 Feet
First Cost - July/August 2011			$89,598,000	$121,407,000	$151,653,000	$176,057,000	$204,045,000	$234,427,000	$266,870,000	$303,142,000	$350,563,000	$200,710,000	$245,015,000	$263,648,000	$297,717,000
Implementation Cost (+ IDC)			$91,729,000	$124,686,000	$157,728,000	$183,399,000	$212,891,000	$244,978,000	$279,766,000	$322,368,000	$379,403,000	$209,411,000	$256,042,000	$277,707,000	$315,091,000
Interest & Amortization	3-3/4%	0.04457	$4,088,000	$5,557,000	$7,030,000	$8,174,000	$9,489,000	$10,919,000	$12,469,000	$14,368,000	$16,910,000	$9,333,000	$11,412,000	$12,377,000	$14,044,000
Increased Annual Maintenance	10% or 26%		$223,000	$217,000	$205,000	$204,000	$207,000	$213,000	$216,000	$222,000	$242,000	$206,000	$201,000	$222,000	$225,000
Total Federal GNF Annual Cost			$4,311,000	$5,774,000	$7,235,000	$8,378,000	$9,696,000	$11,132,000	$12,685,000	$14,590,000	$17,152,000	$9,539,000	$11,613,000	$12,599,000	$14,269,000
PLAN A-B-C - NON-FEDERAL LSF-LERRDs															
First Cost - July/August 2011 + IDC			NA	$170,000	$277,000	$338,000	$396,000	$443,000	$502,000	$558,000	$613,000	$338,000	$396,000	$443,000	$502,000
Interest & Amortization	3-3/4%	0.04457	NA	$8,000	$12,000	$15,000	$18,000	$20,000	$22,000	$25,000	$27,000	$15,000	$18,000	$20,000	$22,000
Increased Annual Maintenance	5%		NA	$9,000	$14,000	$17,000	$20,000	$22,000	$25,000	$28,000	$31,000	$17,000	$20,000	$22,000	$25,000
Total Non-GNF Annual Cost			$0	$17,000	$26,000	$32,000	$38,000	$42,000	$47,000	$53,000	$58,000	$32,000	$38,000	$42,000	$47,000
TOTAL ANNUAL COST - BASE COST CASE															
Total Annual Cost - GNF & Non-GNF	3-3/4%	0.04457	$4,311,000	$5,791,000	$7,261,000	$8,410,000	$9,734,000	$11,174,000	$12,732,000	$14,643,000	$17,210,000	$9,571,000	$11,651,000	$12,641,000	$14,316,000
Incremental Percentage				134.3%	125.4%	115.8%	115.7%	114.8%	113.9%	115.0%	117.5%		121.7%	108.5%	113.3%
Incremental Increase				$1,480,000	$1,470,000	$1,149,000	$1,324,000	$1,440,000	$1,558,000	$1,911,000	$2,567,000		$2,080,000	$990,000	$1,675,000
BENEFIT-COST ANALYSIS - APRIL 2012 BASE CASE															
Base Case															
CCBA Table 7-8		***Feet***	***42/44***	***43/45***	***44/46***	***45/47***	***46/48***	***47/49***	***48/50***	***49/51***	***50/52***	***45/49***	***46/50***	***47/51***	***48/52***
Annual Benefits - April 2012			$6,627,000	$8,611,000	$10,049,000	$91,222,000	$96,306,000	$100,176,000	$102,555,000	$103,426,000	$103,720,000	$91,222,000	$96,306,000	$100,176,000	$102,555,000
B/C Ratio	3-3/4%	0.04457	1.54	1.49	1.38	10.85	9.89	8.97	8.05	7.06	6.03	9.53	8.27	7.92	7.16
Net Benefits			$2,316,000	$2,820,000	$2,788,000	$82,812,000	$86,572,000	$89,002,000	$89,823,000	$88,783,000	$86,510,000	$81,651,000	$84,655,000	$87,535,000	$88,239,000
BENEFIT-COST ANALYSIS - APRIL 2012 BASE CASE WITH 95% CONFIDENCE INTERVALS															
Base Case with 95% Confidence Intervals - Lower Limit															
CCBA Table 7-9		***Feet***	***42/44***	***43/45***	***44/46***	***45/47***	***46/48***	***47/49***	***48/50***	***49/51***	***50/52***	***45/49***	***46/50***	***47/51***	***48/52***
Annual Benefits - April 2012			$5,719,000	$7,431,000	$8,672,000	$78,725,000	$83,112,000	$86,452,000	$88,505,000	$89,257,000	$89,510,000	$78,725,000	$83,112,000	$86,452,000	$88,505,000
B/C Ratio	3-3/4%	0.04457	1.33	1.28	1.19	9.36	8.54	7.74	6.95	6.10	5.20	8.23	7.13	6.84	6.18
Net Benefits			$1,408,000	$1,640,000	$1,411,000	$70,315,000	$73,378,000	$75,278,000	$75,773,000	$74,614,000	$72,300,000	$69,154,000	$71,461,000	$73,811,000	$74,189,000
Base Case with 95% Confidence Intervals - Upper Limit															
CCBA Table 7-9		***Feet***	***42/44***	***43/45***	***44/46***	***45/47***	***46/48***	***47/49***	***48/50***	***49/51***	***50/52***	***45/49***	***46/50***	***47/51***	***48/52***
Annual Benefits - April 2012			$7,283,000	$9,464,000	$11,044,000	$100,253,000	$105,840,000	$110,094,000	$112,708,000	$113,665,000	$113,988,000	$100,253,000	$105,840,000	$110,094,000	$112,708,000
B/C Ratio	3-3/4%	0.04457	1.69	1.63	1.52	11.92	10.87	9.85	8.85	7.76	6.62	10.47	9.08	8.71	7.87
Net Benefits			$2,972,000	$3,673,000	$3,783,000	$91,843,000	$96,106,000	$98,920,000	$99,976,000	$99,022,000	$96,778,000	$90,682,000	$94,189,000	$97,453,000	$98,392,000
BENEFIT-COST ANALYSIS - BASE CASE WITH NO POST-PANAMAX VESSELS ON ASIA THRU PANAMA SERVICE WITH-PROJECT															
Base Case without Post-Panamax Asian Vesssles: Base case transportation cost savings with no Post-Panamax vessels on the Asia via Panama Services in the With-Project Condition.															
CCBA Table 7-10		***Feet***	***42/44***	***43/45***	***44/46***	***45/47***	***46/48***	***47/49***	***48/50***	***49/51***	***50/52***	***45/49***	***46/50***	***47/51***	***48/52***
Annual Benefits - April 2012			$13,194,000	$17,920,000	$21,411,000	$23,793,000	$25,046,000	$25,767,000	$26,407,000	$26,783,000	$27,077,000	$23,793,000	$25,046,000	$25,767,000	$26,407,000
B/C Ratio	3-3/4%	0.04457	3.06	3.09	2.95	2.83	2.57	2.31	2.07	1.83	1.57	2.49	2.15	2.04	1.84
Net Benefits			$8,883,000	$12,129,000	$14,150,000	$15,383,000	$15,312,000	$14,593,000	$13,675,000	$12,140,000	$9,867,000	$14,222,000	$13,395,000	$13,126,000	$12,091,000
BENEFIT-COST ANALYSIS - BASE CASE WITH ASIAN SUEZ SERVICE RETURNING AT 45-FOOT DEPTH															
Base Case with Asian Suez Service having deprated in the without project cndition and not returning to Boston until at least 45-foot depth provided															
CCBA Table 7-11		***Feet***	***42/44***	***43/45***	***44/46***	***45/47***	***46/48***	***47/49***	***48/50***	***49/51***	***50/52***	***45/49***	***46/50***	***47/51***	***48/52***
Annual Benefits - May 2012			$6,627,000	$8,611,000	$10,049,000	$146,450,000	$154,337,000	$160,349,000	$164,087,000	$165,336,000	$165,659,000	$146,450,000	$154,337,000	$160,349,000	$164,087,000
B/C Ratio	3-3/4%	0.04457	1.54	1.49	1.38	17.41	15.86	14.35	12.89	11.29	9.63	15.30	13.25	12.68	11.46
Net Benefits			$2,316,000	$2,820,000	$2,788,000	$138,040,000	$144,603,000	$149,175,000	$151,355,000	$150,693,000	$148,449,000	$136,879,000	$142,686,000	$147,708,000	$149,771,000

TABLE 51 - BENEFIT COST ANALYSIS - PLAN ABC - CONTINUED

BENEFIT-COST ANALYSIS - BASE CASE WITHOUT ILA FEE SAVINGS AS BENEFIT															
Base Case without ILA Fee Savings as Benefit: Base case transportation cost savings with the Container Unit Assessment fee excluded. The exclusion of the Container Unit Assessment fee as a component of transportation costs reduces the transportation cost savings afforded by shifting from the PONYNJ to Boston Harbor.															
CCBA Table 7-12		*Feet*	*42/44*	*43/45*	*44/46*	*45/47*	*46/48*	*47/49*	*48/50*	*49/51*	*50/52*	*45/49*	*46/50*	*47/51*	*48/52*
Annual Benefits - April 2012			$6,043,000	$7,856,000	$9,171,000	$83,102,000	$87,744,000	$91,291,000	$93,477,000	$94,289,000	$94,576,000	$83,102,000	$87,744,000	$91,291,000	$93,477,000
B/C Ratio	3-3/4%	0.04457	1.40	1.36	1.26	9.88	9.01	8.17	7.34	6.44	5.50	8.68	7.53	7.22	6.53
Net Benefits			$1,732,000	$2,065,000	$1,910,000	$74,692,000	$78,010,000	$80,117,000	$80,745,000	$79,646,000	$77,366,000	$73,531,000	$76,093,000	$78,650,000	$79,161,000
BENEFIT-COST ANALYSIS - SENSITIVITY ANALYSIS #1 - FIVE-YEAR POST-IMPLEMENTATION GAP IN VESSEL CHANGE-OVER FOR ASIAN SERVICES															
Sensitivity Analysis 1: Same with and without-project conditions as the base case with the exceptions that the Asia Panama service waits for five years after the base-year before calling at Boston Harbor and the larger Post-Panamax vessel on the Asia Suez service also waits for five years after the base-year before calling at Boston Harbor.															
CCBA Page 74		*Feet*	*42/44*	*43/45*	*44/46*	*45/47*	*46/48*	*47/49*	*48/50*	*49/51*	*50/52*	*45/49*	*46/50*	*47/51*	*48/52*
Annual Benefits - April 2012			$6,758,000	$8,782,000	$10,248,000	$76,128,000	$80,449,000	$83,721,000	$85,742,000	$86,517,000	$86,810,000	$76,128,000	$80,449,000	$83,721,000	$85,742,000
B/C Ratio	3-3/4%	0.04457	1.57	1.52	1.41	9.05	8.26	7.49	6.73	5.91	5.04	7.95	6.90	6.62	5.99
Net Benefits			$2,447,000	$2,991,000	$2,987,000	$67,718,000	$70,715,000	$72,547,000	$73,010,000	$71,874,000	$69,600,000	$66,557,000	$68,798,000	$71,080,000	$71,426,000
BENEFIT-COST ANALYSIS - SENSITIVITY ANALYSIS #2 - MEDITERRANEAN POST-PANAMAX VESSEL IS 8,400 TEU															
Sensitivity Analysis 2: Same with and without-project conditions as the base case with the exception that the Post-Panamax vessel entering the Mediterranean service is an 8,400 TEU vessel.															
CCBA Page 75		*Feet*	*42/44*	*43/45*	*44/46*	*45/47*	*46/48*	*47/49*	*48/50*	*49/51*	*50/52*	*45/49*	*46/50*	*47/51*	*48/52*
Annual Benefits - April 2012			$9,855,000	$11,964,000	$13,503,000	$94,769,000	$99,928,000	$103,848,000	$106,271,000	$107,163,000	$107,485,000	$94,769,000	$99,928,000	$103,848,000	$106,271,000
B/C Ratio	3-3/4%	0.04457	2.29	2.07	1.86	11.27	10.27	9.29	8.35	7.32	6.25	9.90	8.58	8.22	7.42
Net Benefits			$5,544,000	$6,173,000	$6,242,000	$86,359,000	$90,194,000	$92,674,000	$93,539,000	$92,520,000	$90,275,000	$85,198,000	$88,277,000	$91,207,000	$91,955,000
BENEFIT-COST ANALYSIS - SENSITIVITY ANALYSIS #3 - NO POST-PANAMAX VESSELS ON MEDITERRANEAN SERVICES															
Sensitivity Analysis 3: Same with and without-project conditions as the base case with the exception that no Post-Panamax vessels enter the Mediterranean service.															
CCBA Page 76		*Feet*	*42/44*	*43/45*	*44/46*	*45/47*	*46/48*	*47/49*	*48/50*	*49/51*	*50/52*	*45/49*	*46/50*	*47/51*	*48/52*
Annual Benefits - April 2012			$4,618,000	$6,309,000	$7,404,000	$88,338,000	$93,123,000	$96,839,000	$99,002,000	$99,771,000	$99,933,000	$88,338,000	$93,123,000	$96,839,000	$99,002,000
B/C Ratio	3-3/4%	0.04457	1.07	1.09	1.02	10.50	9.57	8.67	7.78	6.81	5.81	9.23	7.99	7.66	6.92
Net Benefits			$307,000	$518,000	$143,000	$79,928,000	$83,389,000	$85,665,000	$86,270,000	$85,128,000	$82,723,000	$78,767,000	$81,472,000	$84,198,000	$84,686,000
BENEFIT-COST ANALYSIS - SENSITIVITY ANALYSIS #4 - NEW MEDITERRANEAN (5th) SERVICE CALLS WITH 8,400 TEU VESSEL BEGINNING AT 42 FEET															
Sensitivity Analysis 4: Same with and without-project conditions as the base case with the exception that a new fifth service (Mediterranean) calls at Boston Harbor using 8,400 TEU vessels beginning at a controlling depth of 42 feet.															
CCBA Page 77		*Feet*	*42/44*	*43/45*	*44/46*	*45/47*	*46/48*	*47/49*	*48/50*	*49/51*	*50/52*	*45/49*	*46/50*	*47/51*	*48/52*
Annual Benefits - April 2012			$22,301,000	$25,003,000	$27,079,000	$108,807,000	$114,344,000	$118,510,000	$121,147,000	$122,142,000	$122,595,000	$108,807,000	$114,344,000	$118,510,000	$121,147,000
B/C Ratio	3-3/4%	0.04457	5.17	4.32	3.73	12.94	11.75	10.61	9.52	8.34	7.12	11.37	9.81	9.38	8.46
Net Benefits			$17,990,000	$19,212,000	$19,818,000	$100,397,000	$104,610,000	$107,336,000	$108,415,000	$107,499,000	$105,385,000	$99,236,000	$102,693,000	$105,869,000	$106,831,000
BENEFIT-COST ANALYSIS - SENSITIVITY ANALYSIS #5 - NEW MEDITERRANEAN (4th) SERVICE CALLS WITH 8,400 TEU VESSEL BEGINNING AT 45 FEET															
Sensitivity Analysis 5: Same with and without-project conditions as the base case with the exception that a new fifth service (Mediterranean) calls at Boston Harbor using 8,400 TEU vessels beginning at a controlling depth of 45 feet.															
CCBA Page 78		*Feet*	*42/44*	*43/45*	*44/46*	*45/47*	*46/48*	*47/49*	*48/50*	*49/51*	*50/52*	*45/49*	*46/50*	*47/51*	*48/52*
Annual Benefits - April 2012			$6,627,000	$8,611,000	$10,049,000	$108,807,000	$114,344,000	$118,510,000	$121,147,000	$122,142,000	$122,595,000	$108,807,000	$114,344,000	$118,510,000	$121,147,000
B/C Ratio	3-3/4%	0.04457	1.54	1.49	1.38	12.94	11.75	10.61	9.52	8.34	7.12	11.37	9.81	9.38	8.46
Net Benefits			$2,316,000	$2,820,000	$2,788,000	$100,397,000	$104,610,000	$107,336,000	$108,415,000	$107,499,000	$105,385,000	$99,236,000	$102,693,000	$105,869,000	$106,831,000
BENEFIT-COST ANALYSIS - SENSITIVITY ANALYSIS #6 - SOUTH ASIA SUEZ SERVICE LIMITED TO 5800 TEU															
Sensitivity Analysis 6: Same with and without-project conditions as the base case with the exception that the Asia Suez service vessel size is constrained to the existing (5,800 TEU) fleet size.															
CCBA Page 79		*Feet*	*42/44*	*43/45*	*44/46*	*45/47*	*46/48*	*47/49*	*48/50*	*49/51*	*50/52*	*45/49*	*46/50*	*47/51*	*48/52*
Annual Benefits - April 2012			$6,627,000	$8,611,000	$10,049,000	$69,556,000	$72,552,000	$73,824,000	$74,319,000	$74,671,000	$75,026,000	$69,556,000	$72,552,000	$73,824,000	$74,319,000
B/C Ratio	3-3/4%	0.04457	1.54	1.49	1.38	8.27	7.45	6.61	5.84	5.10	4.36	7.27	6.23	5.84	5.19
Net Benefits			$2,316,000	$2,820,000	$2,788,000	$61,146,000	$62,818,000	$62,650,000	$61,587,000	$60,028,000	$57,816,000	$59,985,000	$60,901,000	$61,183,000	$60,003,000
BENEFIT-COST ANALYSIS - SENSITIVITY ANALYSIS #7 - NO ASIA THRU PANAMA POST-PANAMAX, SOUTH ASIA SUEZ LIMITED TO 5800 TEU															
Sensitivity Analysis #7: Same with and without-project conditions as the base case with the exception that there are no Post-Panamax vessels on the Asia Panama service and the Asia Suez service vessel size is constrained to the existing (5,800 TEU) fleet size.															
CCBA Page 80		*Feet*	*42/44*	*43/45*	*44/46*	*45/47*	*46/48*	*47/49*	*48/50*	*49/51*	*50/52*	*45/49*	*46/50*	*47/51*	*48/52*
Annual Benefits - April 2012			$13,103,000	$17,799,000	$21,263,000	$23,522,000	$24,751,000	$25,444,000	$25,996,000	$26,328,000	$26,593,000	$23,522,000	$24,751,000	$25,444,000	$25,996,000
B/C Ratio	3-3/4%	0.04457	3.04	3.07	2.93	2.80	2.54	2.28	2.04	1.80	1.55	2.46	2.12	2.01	1.82
Net Benefits			$8,792,000	$12,008,000	$14,002,000	$15,112,000	$15,017,000	$14,270,000	$13,264,000	$11,685,000	$9,383,000	$13,951,000	$13,100,000	$12,803,000	$11,680,000

TABLE 51 - BENEFIT COST ANALYSIS - PLAN ABC - CONTINUED

BENEFIT-COST ANALYSIS - SENSITIVITY ANALYSIS #8 - BOSTON LIMITED TO 7500 TEU VESSELS															
Sensitivity Analysis #8: Sensitivity Analysis 8: Same with and without-project conditions as the base case with the exception that the largest vessel to call at Boston Harbor is a 7,500 TEU vessel															
CCBA Page 81		***Feet***	***42/44***	***43/45***	***44/46***	***45/47***	***46/48***	***47/49***	***48/50***	***49/51***	***50/52***	***45/49***	***46/50***	***47/51***	***48/52***
Annual Benefits - April 2012			$6,627,000	$8,611,000	$10,049,000	$81,349,000	$85,955,000	$89,439,000	$91,521,000	$92,294,000	$92,584,000	$81,349,000	$85,955,000	$89,439,000	$91,521,000
B/C Ratio	3-3/4%	0.04457	1.54	1.49	1.38	9.67	8.83	8.00	7.19	6.30	5.38	8.50	7.38	7.08	6.39
Net Benefits			$2,316,000	$2,820,000	$2,788,000	$72,939,000	$76,221,000	$78,265,000	$78,789,000	$77,651,000	$75,374,000	$71,778,000	$74,304,000	$76,798,000	$77,205,000
BENEFIT-COST ANALYSIS - SENSITIVITY ANALYSIS #9 - ASIAN POST-PANAMAX SERVICES USE OAKLAND 2010 OBSERVED DRAFTS															
Sensitivity Analysis #9: Same with and without-project conditions as the base case with the exception that the largest Post-Panamax vessels on the two Asia services arrive and depart at drafts similar to operating drafts observed at Oakland Harbor in 2010 for services with similar vessel size, ports of call, and placement in the port rotation.															
CCBA Page 82		***Feet***	***42/44***	***43/45***	***44/46***	***45/47***	***46/48***	***47/49***	***48/50***	***49/51***	***50/52***	***45/49***	***46/50***	***47/51***	***48/52***
Annual Benefits - April 2012			$6,627,000	$8,611,000	$10,049,000	$50,794,000	$56,049,000	$60,983,000	$61,455,000	$61,788,000	$62,053,000	$50,794,000	$56,049,000	$60,983,000	$61,455,000
B/C Ratio	3-3/4%	0.04457	1.54	1.49	1.38	6.04	5.76	5.46	4.83	4.22	3.61	5.31	4.81	4.82	4.29
Net Benefits			$2,316,000	$2,820,000	$2,788,000	$42,384,000	$46,315,000	$49,809,000	$48,723,000	$47,145,000	$44,843,000	$41,223,000	$44,398,000	$48,342,000	$47,139,000
BENEFIT-COST ANALYSIS - SENSITIVITY ANALYSIS #10 - WATER SIDE - ALL TEUs ON SHIP COUNTED															
Sensitivity Analysis #10: Same with and without-project conditions as the base case. Post May 2011 IPR Waterside Benefits Analysis counting waterside transportation cost savings for all TEUs carried, Boston and Non-Boston cargo.															
CCBA Page 83		***Feet***	***42/44***	***43/45***	***44/46***	***45/47***	***46/48***	***47/49***	***48/50***	***49/51***	***50/52***	***45/49***	***46/50***	***47/51***	***48/52***
Annual Benefits - April 2012			$65,563,000	$90,527,000	$107,469,000	$141,804,000	$157,485,000	$168,151,000	$174,099,000	$175,993,000	$176,225,000	$141,804,000	$157,485,000	$168,151,000	$174,099,000
B/C Ratio	3-3/4%	0.04457	15.21	15.63	14.80	16.86	16.18	15.05	13.67	12.02	10.24	14.82	13.52	13.30	12.16
Net Benefits			$61,252,000	$84,736,000	$100,208,000	$133,394,000	$147,751,000	$156,977,000	$161,367,000	$161,350,000	$159,015,000	$132,233,000	$145,834,000	$155,510,000	$159,783,000
BENEFIT-COST ANALYSIS - SENSITIVITY ANALYSIS #11 - WATER SIDE - ONLY BOSTON TEUs ABOARD COUNTED															
Sensitivity Analysis #11: Same with and without-project conditions as the base case. Post May 2011 IPR Waterside Benefits Analysis. Only counting waterside benefits from Boston O/D TEUs.															
CCBA Page 83		***Feet***	***42/44***	***43/45***	***44/46***	***45/47***	***46/48***	***47/49***	***48/50***	***49/51***	***50/52***	***45/49***	***46/50***	***47/51***	***48/52***
Annual Benefits - April 2012			$15,727,000	$21,266,000	$25,007,000	$33,836,000	$37,632,000	$40,260,000	$41,754,000	$42,166,000	$42,185,000	$33,836,000	$37,632,000	$40,260,000	$41,754,000
B/C Ratio	3-3/4%	0.04457	3.65	3.67	3.44	4.02	3.87	3.60	3.28	2.88	2.45	3.54	3.23	3.18	2.92
Net Benefits			$11,416,000	$15,475,000	$17,746,000	$25,426,000	$27,898,000	$29,086,000	$29,022,000	$27,523,000	$24,975,000	$24,265,000	$25,981,000	$27,619,000	$27,438,000
BENEFIT-COST ANALYSIS - SENSITIVITY ANALYSIS #12 - VESSEL CLASSES UNCHANGED FROM EXISTING BUT MORE SHIPS ADDED															
Sensitivity Analysis #12: The Base Case number of shifted TEUs is hauled by to Boston by increasing the number of calls by existing vessel classes.															
CCBA Page 85		***Feet***	***42/44***	***43/45***	***44/46***	***45/47***	***46/48***	***47/49***	***48/50***	***49/51***	***50/52***	***45/49***	***46/50***	***47/51***	***48/52***
Annual Benefits - April 2012			$5,819,000	$7,541,000	$8,762,000	$69,576,000	$72,261,000	$74,197,000	$75,320,000	NA	NA	$69,576,000	$72,261,000	$74,197,000	$75,320,000
B/C Ratio	3-3/4%	0.04457	1.35	1.30	1.21	8.27	7.42	6.64	5.92			7.27	6.20	5.87	5.26
Net Benefits			$1,508,000	$1,750,000	$1,501,000	$61,166,000	$62,527,000	$63,023,000	$62,588,000			$60,005,000	$60,610,000	$61,556,000	$61,004,000
BENEFIT-COST ANALYSIS - SENSITIVITY ANALYSIS #13A - STRICT OBSERVED LOADED DRAFT DISTRIBUTION WITH NO ADVANCEMENT															
Sensitivity Analysis #13A: Observed operating draft distribution strictly adhered to - vessels do not load more deeply.															
CCBA Page 86		***Feet***	***42/44***	***43/45***	***44/46***	***45/47***	***46/48***	***47/49***	***48/50***	***49/51***	***50/52***	***45/49***	***46/50***	***47/51***	***48/52***
Annual Benefits - April 2012			$6,627,000	$6,627,000	$6,627,000	$86,596,000	$90,682,000	$90,682,000	$90,682,000	$90,682,000	$90,682,000	$86,596,000	$90,682,000	$90,682,000	$90,682,000
B/C Ratio	3-3/4%	0.04457	1.54	1.14	0.91	10.30	9.32	8.12	7.12	6.19	5.27	9.05	7.78	7.17	6.33
Net Benefits			$2,316,000	$836,000	($634,000)	$78,186,000	$80,948,000	$79,508,000	$77,950,000	$76,039,000	$73,472,000	$77,025,000	$79,031,000	$78,041,000	$76,366,000
BENEFIT-COST ANALYSIS - SENSITIVITY ANALYSIS #13B - ALL VESSELS FULLY LOADED															
Sensitivity Analysis #13B: All vessels fully loaded and agressively using the tide more than observed															
CCBA Page 87		***Feet***	***42/44***	***43/45***	***44/46***	***45/47***	***46/48***	***47/49***	***48/50***	***49/51***	***50/52***	***45/49***	***46/50***	***47/51***	***48/52***
Annual Benefits - April 2012			$12,916,000	$13,023,000	$13,119,000	$102,604,000	$102,768,000	$103,044,000	$103,277,000	$103,480,000	$103,720,000	$102,604,000	$102,768,000	$103,044,000	$103,277,000
B/C Ratio	3-3/4%	0.04457	3.00	2.25	1.81	12.20	10.56	9.22	8.11	7.07	6.03	10.72	8.82	8.15	7.21
Net Benefits			$8,605,000	$7,232,000	$5,858,000	$94,194,000	$93,034,000	$91,870,000	$90,545,000	$88,837,000	$86,510,000	$93,033,000	$91,117,000	$90,403,000	$88,961,000
BENEFIT-COST ANALYSIS - SENSITIVITY ANALYSIS #13C - USE SAVANNAH HARBOR DEEPENING STUDY DRAFT DISTRIBUTION															
Sensitivity Analysis #13C: Operating drafts constrained to Savannah Harbor deepening study drafts and extrapolated															
CCBA Page 88		***Feet***	***42/44***	***43/45***	***44/46***	***45/47***	***46/48***	***47/49***	***48/50***	***49/51***	***50/52***	***45/49***	***46/50***	***47/51***	***48/52***
Annual Benefits - April 2012			$2,074,000	$2,460,000	$2,776,000	$69,865,000	$72,414,000	$76,710,000	$76,768,000	$76,799,000	$76,821,000	$69,865,000	$72,414,000	$76,710,000	$76,768,000
B/C Ratio	3-3/4%	0.04457	0.48	0.42	0.38	8.31	7.44	6.87	6.03	5.24	4.46	7.30	6.22	6.07	5.36
Net Benefits			($2,237,000)	($3,331,000)	($4,485,000)	$61,455,000	$62,680,000	$65,536,000	$64,036,000	$62,156,000	$59,611,000	$60,294,000	$60,763,000	$64,069,000	$62,452,000

TABLE 51 - BENEFIT COST ANALYSIS - PLAN ABC - CONTINUED

BENEFIT-COST ANALYSIS - SENSITIVITY ANALYSIS #13D - MAXIMUM OPERATING DRAFT CONSTRAINED BY 2.5 FEET

Sensitivity Analysis #13D: Maximum operating drafts of all vessels constrained to 2.5 feet less than vessel design draft

CCBA Page 89		*Feet*	*42/44*	*43/45*	*44/46*	*45/47*	*46/48*	*47/49*	*48/50*	*49/51*	*50/52*	*45/49*	*46/50*	*47/51*	*48/52*
Annual Benefits - April 2012			$5,542,000	$6,821,000	$7,895,000	$87,391,000	$90,397,000	$91,519,000	$91,909,000	$91,938,000	$92,077,000	$87,391,000	$90,397,000	$91,519,000	$91,909,000
B/C Ratio	3-3/4%	0.04457	1.29	1.18	1.09	10.39	9.29	8.19	7.22	6.28	5.35	9.13	7.76	7.24	6.42
Net Benefits			$1,231,000	$1,030,000	$634,000	$78,981,000	$80,663,000	$80,345,000	$79,177,000	$77,295,000	$74,867,000	$77,820,000	$78,746,000	$78,878,000	$77,593,000

BENEFIT-COST ANALYSIS - SENSITIVITY ANALYSIS #13E - REDUCED TIDAL ADVANTAGE

Sensitivity Analysis #13E: Tidal advantage at Boston reduced to one-half of observed use

CCBA Page 90		*Feet*	*42/44*	*43/45*	*44/46*	*45/47*	*46/48*	*47/49*	*48/50*	*49/51*	*50/52*	*45/49*	*46/50*	*47/51*	*48/52*
Annual Benefits - April 2012			$4,481,000	$5,450,000	$6,787,000	$72,531,000	$75,307,000	$78,571,000	$81,883,000	$85,024,000	$88,235,000	$72,531,000	$75,307,000	$78,571,000	$81,883,000
B/C Ratio	3-3/4%	0.04457	1.04	0.94	0.93	8.62	7.74	7.03	6.43	5.81	5.13	7.58	6.46	6.22	5.72
Net Benefits			$170,000	($341,000)	($474,000)	$64,121,000	$65,573,000	$67,397,000	$69,151,000	$70,381,000	$71,025,000	$62,960,000	$63,656,000	$65,930,000	$67,567,000

However, Corps guidance contained in Appendix G of ER 1105-2-100 requires another level of examination for optimization. Appendix G, Exhibit G-1. General Evaluation Guidelines indicates identification of the NED plan is to be based on consideration of the most effective plans for providing different levels of output or service. Where two cost-effective plans produce no significantly different levels of net benefits, the less costly plan is to be the NED plan, even though the level of outputs may be less. In the Boston Harbor analysis the maximum net benefits are attributed to the 48 foot plan as stated above. However, since the increase of net benefits between the 47 foot plan and the 48 foot plan was only $500,000 per year, resulting in a flattening of the net benefits curve between those depth increments, then based on the guidelines the 47 foot plan becomes the recommended plan.

Table 52 shows the benefit cost analysis for the three minor improvement plans for the Main Ship Channel deepening extension to the Massport Marine Terminal (Plan D), the Mystic River Channel deepening for access to Massport's Medford Street Terminal (Plan E), and the Chelsea River Channel deepening (Plan F). Analysis of various depth increments for each channel segment is provided to determine the optimal channel depth.

TABLE 52
BENEFIT-COST ANALYSIS - ADDITIONAL CHANNEL IMPROVEMENTS
PLAN D - MAIN SHIP CHANNEL DEEPENING EXTENSION
PLAN E - MYSTIC RIVER CHANNEL DEEPENING AT MEDFORD ST TERMINAL
PLAN F - CHELSEA RIVER CHANNEL DEEPENING

PLAN D - MAIN SHIP CHANNEL DEEPENING EXTENSION TO MASSPORT MARINE TERMINAL			42 Feet	43 Feet	44 Feet	45 Feet
Total Federal GNF Annual Cost			$367,000	$517,000	$658,000	$764,000
Non-Federal Annual Cost			$47,000	$55,000	$62,000	$67,000
Total Annual Cost	3-3/4%	0.04457	$414,000	$572,000	$720,000	$831,000
Annual Benefit			$444,000	$800,000	$967,000	$1,163,000
Benefit Cost Ratio			1.07	1.40	1.34	1.40
Net Benefit			$30,000	$228,000	$247,000	$332,000
PLAN E - MYSTIC RIVER CHANNEL AT MEDFORD STREET TERMINAL			**37 Feet**	**38 Feet**	**39 Feet**	**40 Feet**
Total Federal GNF Annual Cost			$85,000	$94,000	$102,000	$115,000
Non-Federal Annual Cost			$0	$0	$0	$0
Total Annual Cost	3-3/4%	0.04457	$85,000	$94,000	$102,000	$115,000
Annual Benefit			$98,000	$140,000	$168,000	$221,000
Benefit Cost Ratio			1.15	1.49	1.65	1.92
Net Benefit			$13,000	$46,000	$66,000	$106,000
PLAN F - CHELSEA RIVER CHANNEL			**39 Feet**	**40 Feet**		
Total Federal GNF Annual Cost			$442,000	$561,000		
Non-Federal Annual Cost			$98,000	$157,000		
Total Annual Cost	3-3/4%	0.04457	$540,000	$718,000		
Annual Benefit			$1,243,000	$1,936,000		
Benefit Cost Ratio			2.30	2.70		
Net Benefit			$703,000	$1,218,000		

ASSOCIATED MAINTENANCE DREDGING

Maintenance dredging of existing Federal navigation features would be carried out concurrent with the deep draft improvement project in two ways, and may also be pursued in a third. First, while major maintenance dredging of the outer and lower inner harbor areas was accomplished in the 2004-2005, 2008, and 2012 work, minor amounts of maintenance material may remain at the time of the improvement dredging. Second, additional channel areas not maintained in the past two operations may be maintained at the time of the improvement dredging for the purposes of assisting in traffic management during construction. Third, maintenance dredging of the upper inner harbor reaches of the Main Ship Channel, as covered in the 2006 operations and maintenance SEIS may be completed in the same time period as the improvement.

Maintenance of Project Features Deepened by the Improvement Project

Removal of any remaining maintenance material from the project areas being deepened under the deep draft improvement project would be accomplished concurrent with removal of the improvement materials. Given the recentness of the two major maintenance operations and the low shoaling rate in Boston Harbor these amounts are expected to be minimal.

In project areas where the maintenance material was tested and determined suitable for ocean disposal under the 2004 and 2008 projects, any remaining maintenance materials would be removed, transported, and disposed along with the improvement materials, in accordance with existing suitability determinations, at the Massachusetts Bay Disposal Site, or used in conjunction with the capping of the Industrial Waste Site if that beneficial use is pursued. These areas include the Broad Sound North Entrance Channel (deep lane), the President Roads Anchorage, the lower Reserved Channel and its Turning Area, and the Main Ship Channel from President Roads to Spectacle Island, the majority of the reach from Spectacle to Castle Island, and from Castle Island to the Massport Marine Terminal.

In channel areas where the maintenance material was determined unsuitable for ocean disposal, the Corps will either place that material in CAD Cells constructed or to be constructed at previously identified locations in the upper harbor, or the Corps will re-test those materials and dispose of them in accordance with any revised suitability determination. Any re-testing and any new suitability determinations will be fully coordinated with Federal, State and local agencies. These areas include a portion of the reach of the Main Ship Channel upstream of the Massport Marine Terminal, the Mystic River, and the Chelsea River

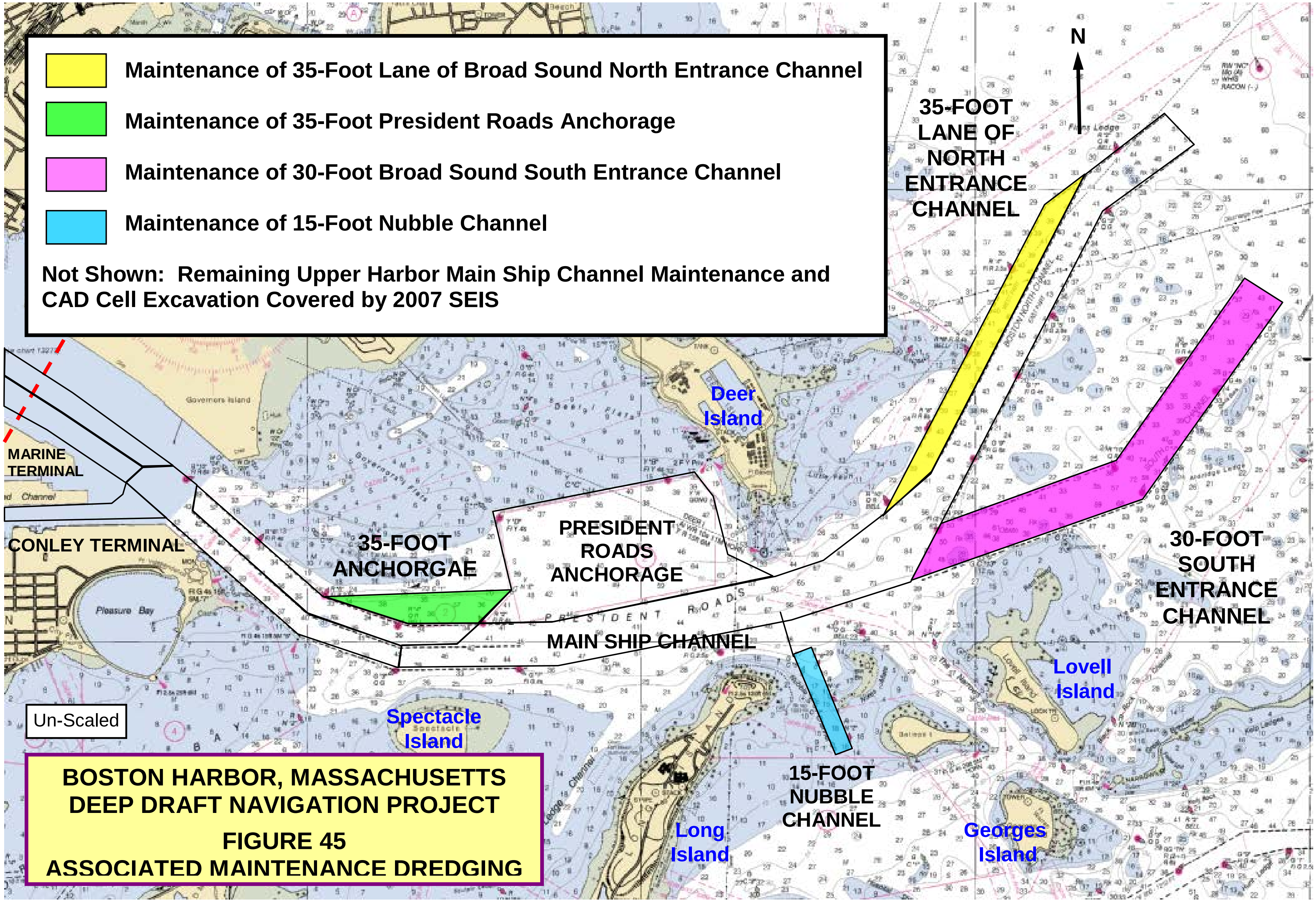
Maintenance of Other Federal Project Features

Maintenance of the Boston Harbor Federal Navigation Project in existing channel areas outside of those proposed for deepening may also be carried out concurrent with the deep draft improvement project. This would occur because some areas not dredged in the 2004 to 2012 maintenance operations would require maintenance by the 2012-2016 improvement project timeframe, or because maintenance to improve the controlling depths of those project features was needed to assist in harbor traffic management during the construction of the improvement project. These areas include the 30-foot Broad Sound South Entrance Channel, the 35-foot northern lane of the Broad Sound North Entrance Channel, the 15-foot Nubble Channel, and the 35-foot West Anchorage at President Roads (the barge anchorage). Minimizing navigation traffic disruptions of the drilling, blasting and dredging operations for the deep draft improvement project can be accomplished by providing alternative routes for shallow-draft traffic not needing the 40-foot channels that would be deepened. Routing of shallower-draft vessels, consistent with tidal navigation, through the South Entrance Channel with its 30-foot authorized depth, and later also through the 35-foot north lane of the North Entrance Channel, would allow deepening of the deep lane of the North Entrance Channel to progress with minimal shut-downs for large vessel passage, thereby shortening the construction duration for deepening that project feature. Similarly, encouraging a greater volume of smaller ferry and small craft traffic to use the Nubble Channel rather than transiting the Outer Confluence would aid in deepening that area of the project with minimal navigation disruption. Maintenance of the 35-foot anchorage would enable more barge and smaller cargo vessels to use that area instead of the 40-foot President Roads Anchorage while the latter area is being deepened.

Maintenance materials from these project areas would need to be tested during the design phase of the improvement project, and suitability determinations made for their disposal. At this time, given the suitable determinations issued for maintenance of adjacent areas, and the location of these project features in the Outer Harbor, it is assumed that the materials would be found suitable for ocean disposal and would be disposed at the Massachusetts Bay Disposal Site or used to supplement the capping volumes at the Industrial Waste Site. An estimate of the dredging volumes and dredging footprints for these areas is provided in Table 53 below. The locations of these areas are shown in Figure 45.

Maintenance dredging of the remaining project areas included in the 2006 SEIS but not undertaken at that time due to local funding constraints with respect to CAD cell construction may also be carried-out in the same timeframe as the improvement work. This work includes maintenance dredging of the Main Ship Channel lanes above the Massport Marine Terminal to the inner confluence area, and may also include maintenance of all or a portion of the 35-foot Charles River segment of the upper Main Ship Channel which access the USCG Station. Maintenance of the portion of the 35-foot lane of the Mystic River Channel proposed for improvement as part of this project was also included for maintenance in the 2006 SEIS but not accomplished in the 2008 maintenance work. The volumes for all associated and remaining additional maintenance work for the deep draft project features at Boston Harbor are shown in Table 53.

TABLE 53 BOSTON HARBOR DEEP DRAFT NAVIGATION IMPROVEMENT STUDY ASSOCIATED AND ADDITIONAL MAINTENANCE DREDGING QUANTITIES				
Existing Project Feature	**Cut to Design Depth**	**2-Foot Overdepth**	**Total CY**	**Dredging Footprint (Acres)**
Maintenance of Project Features for Navigation Traffic Management During Construction (All Suitable Material for Placement at MBDS)				
Chelsea River - Remaining O&M Volume (2008 Report Adjusted for 2012 Afterdredge of Bridge Area)	100,900	82,100	183,000	Included in Improvement
Broad Sound South Entrance Channel - 30 Feet (2008 Report)	53,300	86,000	139,300	70.2
Broad Sound North Entrance - 35-Foot Lane (2008 Report)	33,400	22,600	56,000	8.2
Nubble Channel (2008 Report)	200	1,300	1,500	2.3
35-Foot Lower Middle Ground Barge Anchorage (2007 Survey)	2,300	64,400	66,700	60.1
TOTAL	190,100	256,400	446,500	140.8
Maintenance of Existing Project Features Remaining from 2007 SEIS Plus Charles River Channel				
Main Ship Channel 35 & 40-Foot Lanes above Massport Marine Terminal to Inner Confluence Area (From 2007 Specs)	568,900	384,200	953,100	467.6
Mystic River 35-Foot South Channel Lane in Vicinity of Medford Street Terminal (From 2007 Specs)	10,000	30,600	40,600	Included in Improvement
Charles River Portion of 35-Foot MSC - Lower Area	124,400	85,800	210,200	25.5
Charles River Portion of 35-Foot MSC - Upper Area	110,200	51,600	161,800	13.6
TOTAL	813,500	552,200	1,365,700	506.7
Remaining Area of Main Ship Channel CAD Cell for Unsuitable Maintenance from 2007 SEIS				
Main Ship Channel CAD Cell Excavation - Remaining Area (Option 0008 from 2007 Spec - Suitable Material to MBDS)	1,624,100	NA	1,624,100	Included in Maintenance
Volume Required for Capping of MSC CAD Cell (Option 16 from 2007 Spec)	102,300	NA	80,000	NA
Total Remaining and Associated Maintenance Volumes				
Total Suitable Channel Materials to MBDS	190,100	256,400	446,500	
Total Suitable CAD Cell Excavate to MBDS	1,624,100	NA	1,624,100	
Total Unsuitable Channel Materials to MSC CAD Cell	813,500	552,200	1,365,700	


Maintenance of 35-Foot Lane of Broad Sound North Entrance Channel
Maintenance of 35-Foot President Roads Anchorage
Maintenance of 30-Foot Broad Sound South Entrance Channel
Maintenance of 15-Foot Nubble Channel
Not Shown: Remaining Upper Harbor Main Ship Channel Maintenance and CAD Cell Excavation Covered by 2007 SEIS
N
35-FOOT LANE OF NORTH ENTRANCE CHANNEL
Deer Island
MARINE TERMINAL
CONLEY TERMINAL
35-FOOT ANCHORGAE
PRESIDENT ROADS ANCHORAGE
MAIN SHIP CHANNEL
30-FOOT SOUTH ENTRANCE CHANNEL
Lovell Island
Spectacle Island
15-FOOT NUBBLE CHANNEL
Long Island
Georges Island
Un-Scaled
BOSTON HARBOR, MASSACHUSETTS
DEEP DRAFT NAVIGATION PROJECT
FIGURE 45
ASSOCIATED MAINTENANCE DREDGING

ENVIRONMENTAL IMPACT ANALYSIS

The environmental impact analysis evaluated direct, indirect and cumulative impacts associated with planned channel navigation improvements, including air quality impacts from construction equipment. Upland or inland impacts resulting from Port growth were also examined as most benefits from port deepening would involve transfer of landed cargo from other ports. The analysis also identified an opportunity to beneficially use rock removed for the project to create areas in Massachusetts Bay that would expand habitat for lobster and other species.

RESOURCE INVESTIGATIONS

Data collected for the Boston Harbor deep draft project included collection of benthic samples from the proposed sections of the navigation channel to be deepened and the berth areas. These samples were collected in September 2003. Discussion with the project's Technical Working Group (TWG) indicated the belief by some agencies that the proposed biological sampling plan for finfish and lobster would not be adequate to describe the resources in the harbor. Since their data collection approach would be very costly and time consuming without certainty that even that data would be satisfactory, an alternative approach for assessing the impacts to biological resources in the harbor was identified. See Section 3.3.2 of the SEIS/EIR and Appendix U.

To address the TWG's concerns that a limited field data collection effort would not yield enough information to sufficiently address impacts from the project, a conservative impact assessment approach was taken. That is, significant resources are assumed to be present unless other information indicates otherwise.

Significant resources were determined from institutional, technical or public recognition. Institutional recognition of a resource or effect means its importance is recognized or acknowledged in the laws, plans and policies of government and private groups. Technical recognition of a resource or an effect is based upon scientific or other technical criteria that establish its significance. Public recognition means some segment of the general public considers the resource or effect to be important (ER 1105-2-100).

Significant resources were identified through Federal and state laws, plans and policies such as the species identified in the Essential Fish Habitat (EFH) designation and managed species under the Magnuson-Stevens Fishery Conservation and Management Act, species identified from the U.S. Fish and Wildlife Service, the National Marine Fisheries Service and the Massachusetts Division of Marine Fisheries under the Fish and Wildlife Coordination Act, threatened and endangered species identified under the State and Federal Endangered Species Act, and special aquatic sites recognized as significant under the 404 (b) (1) Clean Water Act. The Technical Working Group may also identify additional species and/or habitat. Once a list of significant species and/or habitat that may occur in Boston Harbor was identified, the known physical and biological attributes of Boston Harbor were coordinated with the known habitat requirements of a species to determine if the project specific habitat matches the particular species.

For example, existing information obtained from previous sampling efforts supplemented with information gathered from pertinent literature and previous environmental studies (i.e. previous EIS's, EA's etc.) relative to water quality/hydrology, sediment type, subsurface physical characteristics and benthic community structure will be used to determine the likelihood of the presence of a biological resource in a particular area (i.e. implied presence). This characterization approach, although likely conservative in nature, would assume that a resource is present in a given area provided the right environmental conditions exist. This strategy would serve to limit the expenditure of funds on what would likely be a significant field sampling effort that would produce data of limited quality and from which no definitive conclusions may be drawn.

The following outlines the approach to resource assessment:

- Benthic - Benthic data was collected from the channel areas and the proposed beneficial use sites. (See SEIS Section 3.3.2)
- Early Benthic Phase Lobster – Battelle, under contract to the Corps, prepared a report that supports the theory that particular sediment types are more likely to support EBP lobster than others. Additional information from MA DMF on the preferred habitat type for EBP was used to further discriminate habitat types and determine the likelihood for presence in a particular area (whether or not EBP lobster is likely to be present).
- Adult Lobster – Assumed presence in all project areas. Discussions and field trips with local lobstermen were used to refine the location, time of year and relative density of lobsters in Boston Harbor.
- Winter Flounder - Agency concerns to date have focused on winter flounder spawning habitat on Governor's Island flats off of the President Roads anchorage area (from the Boston Harbor maintenance dredging project). Existing data was reviewed regarding sediment type and physical characteristics of the area to determine if it is a likely spawning area.
- Finfish – Used NMFS EFH database and species designations for Boston Harbor area. Used life history of the fish species, and physical and hydrological characteristics of the project area to determine if and when a particular species is likely to utilize/inhabit the project area.
- Anadromous Fish – Obtained list of species from NMFS/MA DMF, assumed presence in project area.

Once conclusions were drawn from the above (i.e. that a species is assumed to be present at a particular time of year, utilizing a particular type habitat in a significant manner), an assessment of potential project impacts was conducted. The SSFATE model did not predict any impacts to winter flounder spawning habitat outside the navigation channels. A mitigation/sequencing strategy will be developed during the design phase in consultation with the resource agencies once additional design phase investigations are completed.

Marine mammals that can occur in the harbor include harbor porpoise and harbor seals. Dredging and disposal operations are not expected to affect these species. Blasting operations will need to be monitored by trained marine mammal observers to avoid blasting when these species are present in the immediate area. Using the After Action Report from the 2007 rock pinnacle removal project (see Appendix Y) and the four fish kill events as a base, a blasting plan will be developed in consultation with the resource agencies, along with additional information.

Four fish mortality events were observed and recorded during 13 underwater blasting events in Boston Harbor during the ledge pinnacle removal project in the late fall of 2007. These fish kills happened despite following procedures that have been successfully employed for underwater blasting in Boston Harbor and other locations. Methods employed to reduce or eliminate fish kills involved the use of a side scan sonar fish finder to detect and avoid passing schools of fish, a fish startle system to deter fish from entering the blast area, and a fish observer to oversee and determine the appropriate blast time.

Following the first mortality event, the Corps immediately met with the blast contractors and fish observer to determine the causes of the event and identify measures to correct the problem. Resource agencies were also notified and briefed on initial corrective actions before blasting was resumed. Despite these measures, subsequent fish kills occurred. In response to these unexpected events, the Corps prepared an “after action report” to provide information on all of the blasting events and convened an interagency underwater blasting technical working group with Federal and State resources agencies. The goal of the working group was to determine what lessons can be learned from the 2007 fish kill events, and apply that knowledge and any other corrective measures that may be identified and found practicable to minimize potential fish impacts during blasting for the Deep Draft Project. A rock removal effort in 2012 that utilized blasting did not experience any fish kills. The lessons learned from that project will be incorporated into the deepening project design. The technical group will focus on construction sequencing for several areas of the harbor, constraints on work during certain tidal and weather conditions, potential operational changes, and equipment changes. The results of this research will form the basis for agency discussions on measures to be implemented for the Deep Draft Project.

Outer Harbor Resource Concerns

Areas within the navigation channels that contain rocks and cobbles may be assumed to support lobster and juvenile cod habitat. In particular, areas in the Broad Sound channel and rock ledges are likely lobster habitat. Investigations have been conducted to determine if deepening the navigation channel will alter the sediment type and reduce the rock and cobble area utilized by marine resources in the navigation channel. Additional data on lobster resources in the harbor were obtained from the MA DMF. Meetings with the local lobstermen have occurred and surveys concerning their fishing habits collected to gain local knowledge of lobster resources in the harbor.

Winter flounder occur throughout the harbor but are suspected to spawn in the Winthrop or Logan flat area located north of the navigation project areas along the east side of the airport and north to Snake Island in Winthrop. (See SEIS Section 3.3.5) Shellfish species of concern include soft-shelled clams, blue mussels, sea scallops, and surf clams. These resources occur outside the direct footprint of the navigation channels. Surf clams are present within the vicinity of Broad Sound. No long-term or significant adverse impacts to finfish or shellfish resources are projected from channel deepening.

SSFATE Modeling results show that the concentration of the turbidity plume at the mid-depth water column level would generally range from 30 to 60 mg/l with occasional readings of 80-90 mg/l near the dredge. In general the plume stayed within the navigation channel throughout the tidal cycle. The SSFATE model also predicted the resulting thickness of the re-suspended material deposited and overlaying the bottom once the plume settled. Bottom thicknesses ranged from 0.01 to 0.1 mm outside the navigation channel. The SSFATE model is usually conservative in predicting turbidity plumes from dredging operations. Actual monitoring of the plume during dredging and disposal of the Boston Harbor Navigation Improvement Project (the Tributaries Deepening Project) in 1998-2001 showed that the plume stayed confined to the navigation channel and was generally difficult to discern beyond 600 feet down-current of the dredge or disposal event.

No adverse impacts to threatened or endangered species are expected from the proposed channel deepening. Observers will be provided for dredging, blasting and towing vessels. Submarine blasting noise is limited to a short distance (about 3,000 feet) from the blast site.

Inner Harbor Resource Concerns

Anadromous rainbow smelt, alewife, American shad, and blueback herring utilize Boston Harbor, the Mystic River, and the Chelsea River for passage to upstream spawning locations. Channel deepening will be scheduled to minimize interference with migrating anadromous fish. Winter flounder may also spawn in the Mystic River and Chelsea River.

Dredging Footprints for Channel Improvements

Dredging and ledge removal would deepen existing subtidal bottom in the harbor. While these areas would eventually be re-colonized by benthic organisms and other marine life, they would be temporarily impacted. With minor exceptions, all the areas proposed for improvement dredging are subject to periodic maintenance dredging, which has the same effect in removing benthic organisms. The following tables show the acres of dredging footprint for each plan and channel segment. For the recommended plan this footprint totals 1182.2 acres, including side slopes (one-on-three except in rock where slopes are one-on-one). The areas where project limits have been expanded beyond those existing total about 18.2 acres, including side slopes, and are as follows:

- Broad Sound North Entrance Channel – Bend widened opposite Finns Ledge
- Reserved Channel – Channel transition to turning basin widened to north off the end of the former Army Base Pier
- Reserved Channel Turning Area – Basin widened by 100 feet outside northeasterly limit of the Main Ship Channel
- Chelsea River Channel – Channel widened by 50 feet along East Boston shore in area immediately upstream of McArdle Bridge, and also by 50 feet at the sharp bend in the channel between the two bridges just downstream of the Sunoco Logistics terminal

The dredging footprints for the plans under consideration are shown in the following tables, including the incremental depths evaluated for each. Table 54 shows the Main Channels Improvement Plans. Table 55 shows the plans and increments for the Main Ship Channel Extension, Mystic and Chelsea Rivers; Plans D, E and F.

The total dredging footprints for the several recommended plans and for the channel segments for the main channels improvement plan are shown in Table 56 below. The main channels improvements for deepened access to the Conley Terminal would impact about 1,083 acres of subtidal harbor bottom. The total area of impact for all four improvement plans is about 1182 acres of subtidal harbor bottom, of which about 18 acres, or 1.5 percent of the total, is from widening to expand the turning area and widen channel bends into areas outside the existing maintained project limits.

DISPOSAL SITE INVESTIGATIONS AND BENEFICIAL USE

Environmental Enhancement Opportunity

Rock and cobble material removed from the navigation channels may be placed for beneficial use in one of more of the following nearshore areas: Nantasket Roads, Broad Sound, Massachusetts Bay, Nahant Bay and an area off of Magnolia. Because the material is expected to be of various sizes and shapes, it is anticipated that the habitat enhancement project will attract different life history stages of marine species. In particular, species such as American lobsters, sea scallops, sea urchins, Atlantic cod, and numerous other species of fish and invertebrates could benefit from construction of hard-bottom habitat.

The five sites selected were based on information provided by local lobstermen and the MA Division of Marine Fisheries. Additional information was gathered to determine which site or sites would be appropriate for habitat enhancement. Benthic information, side scan sonar and sediment type was collected. The following criteria are proposed to rank the five (5) potential beneficial use sites, from most beneficial to least beneficial, for hard bottom habitat creation:

- The first criteria to consider are the biological productivity of each site. Sites with lower productivity, as determined by benthic habitat community or Organism Sediment Index (OSI), will be given higher priority for hard bottom habitat creation.

- The second criteria to consider is the existing bottom type for each site. Sites with abundant existing rock bottom habitat would be given lower priority. Sites may contain some rock bottom if it doesn’t significantly reduce the volume of area available for disposal of rock and/or cobble, or the location of the existing rock bottom would essentially preclude the site from further consideration (i.e. rock bottom is located in the middle of the site). Rock and/or cobble would not be placed on existing rock bottom.

- An extension of the second criteria above is to determine the capacity of each site to accommodate the dredged rock/cobble from the navigation channel. Will more than one site be needed for disposal of the rock/cobble? Priority may be given to sites that can accept all of the rock/cobble.

TABLE 54
DREDGING FOOTPRINT FOR ALTERNATIVE MAIN CHANNELS INCREMENTAL DEPTHS
PLAN ABC - MAIN CHANNELS DEEPENING PLANS TO CONLEY TERMINAL (IN ACRES)

Improvement Plan or Depth Increment (Feet) MSC/BSNEC	BROAD SOUND NORTH ENTRANCE CHANNEL		PRESIDENT ROADS ANCHORAGE	MAIN SHIP CHANNEL INCLUDING PRESIDENT ROADS REACH		RESERVED CHANNEL TURNING AREA		RESERVED CHANNEL		TOTAL MAIN CHANNELS PLANS	
	Existing Project Limits	Widened Bend at Finn's Ledge	Existing Project Limits	40-Foot Lane Area	35-Foot Lane Area	Existing Project Limits	Expanded Northeast Area	Existing Project Limits	Widened Transition to MSC	Total All Areas Within Existing Project Limits	Total Areas Outside Existing Project Limits
42/44	203.6	10.9	296.5	143.8	57.1	48.0	2.7	39.3	2.9	788.3	16.5
43/45	224.7	10.9	318.3	171.3	57.8	52.7	2.7	40.2	2.9	865.0	16.5
44/46	236.3	10.9	329.8	195.2	58.1	78.4	2.7	40.5	2.9	938.2	16.5
45/47	243.8	10.9	337.4	221.0	58.1	80.2	2.7	40.6	2.9	981.2	16.5
46/48	251.2	10.9	341.6	242.9	58.1	80.3	2.7	40.6	2.9	1,014.7	16.5
47/49	259.6	10.9	345.7	261.7	58.1	80.3	2.7	40.6	2.9	1,046.0	16.5
48/50	270.2	10.9	350.0	275.3	58.1	80.3	2.7	40.6	2.9	1,074.5	16.5
49/51	280.1	10.9	355.0	285.9	58.1	80.3	2.7	40.6	2.9	1,100.0	16.5
50/52	290.7	10.9	361.6	295.1	58.1	80.3	2.7	40.6	2.9	1,126.5	16.5
45/49	259.6	10.9	337.4	221.0	58.1	80.2	2.7	40.6	2.9	997.0	16.5
46/50	270.2	10.9	341.6	242.9	58.1	80.3	2.7	40.6	2.9	1,033.8	16.5
47/51	280.1	10.9	345.7	261.7	58.1	80.3	2.7	40.6	2.9	1,066.5	16.5
48.52	290.7	10.9	350.0	275.3	58.1	80.3	2.7	40.6	2.9	1,095.0	16.5

Note: All areas include full area of 2-foot overdepth allowance and side slopes of 1:3

TABLE 55
DREDGING FOOTPRINT FOR ADDITIONAL CHANNEL IMPROVEMENTS - PLANS D, E AND F

Improvement Design Depth (Feet MLLW) Including 2-Foot Overdepth Allowance	**PLAN D MAIN SHIP CHANNEL DEEPENING EXTENSION TO MASSPORT MARINE TERMINAL**	**PLAN E MYSTIC RIVER CHANNEL DEEPENING AT MEDFORD STREET TERMINAL**	**PLAN F CHELSEA RIVER CHANNEL DEEPENING AND WIDNEING**				**TOTAL FOR RECOMMENDED DEPTHS FOR ALL THREE ADDITIONAL IMPROVEMENT PLANS**	
	Existing Project Limits for 40-Foot Chanel Lane at 600-Foot Width	Existing Project Limits for 35-Foot Channel Lane Accessing Terminal	Existing 38-Foot Channel Area	50-Foot Bend Widening above McArdle Bridge	50-Foot Bend Widneing between Bridges	Total Chelsea River Dredge Area	Total All Areas Within Existing Project Limits	Total Areas Outside Existing Project Limits
37 Feet		8.3						
38 Feet		8.6	6.1	0.8	0.7	7.7		
39 Feet		9.0	23.8	0.9	0.8	25.5		
40 Feet	23.5	9.1	51.7	1.0	0.8	53.4		
41 Feet	32.2						97.5	1.7
42 Feet	35.4							
43 Feet	36.2							
44 Feet	36.5							
45 Feet	36.6							

Note: All areas include full area of 2-foot overdepth allowance and side slopes of 1:3. Rock removal to 2 feet additional with 1/1

TABLE 56 DREDGING FOOTPRINTS FOR DEEP DRAFT IMPROVEMENT PROJECT RECOMMENDED PLANS			
(Areas in Acres - Including Side Slopes)			
Plan and Project Feature	Area Within Existing Project Limits	Area Outside Existing Project Limits	Total Dredging Footprint
PLAN ABC TOTAL	1,066.5	16.5	1,083.0
Broad Sound North Entrance Channel to 51 Feet with Bend Widening Opposite Finns Ledge	280.1	10.9	291.0
Lower Main Ship Channel to 47 Feet	319.8	0.0	333.4
Lower Reserved Channel to 47 feet, with the Channel's Transition to the Turning Basin Widened off the Army Base Pier	40.6	2.9	43.5
Reserved Channel Turning Area to 47 Feet with 100-Foot Widening Northeast of the Main Ship Channel	80.3	2.7	83.0
President Roads Anchorage to 47 Feet	345.7	0.0	350.0
PLAN D			
Main Ship Channel Extension Deepening to 45 Feet by 600 Feet for Massport Marine Terminal	36.6	0.0	36.6
PLAN E			
Mystic River Channel Deepening to 40 Feet for Medford Street Terminal	9.1	0.0	9.1
PLAN F			
Chelsea River Channel Deepening to 40 Feet	51.7	1.8	53.4
TOTAL ALL PROJECT SEGMENTS	1163.9	18.3	1182.2

- Site(s) selected for placement of rock/cobble cannot interfere with other uses such as fishing or navigation.
- If no significant difference is found between sites, based on the above criteria, than the site(s) closest to the navigation channel will be given higher priority.

The sites have been ranked in order of preference. Additional investigations will be conducted during the design phase in consultation with the TWG agencies to further refine the goals of reef habitat creation, target species, siting criteria, valuation of displaced habitat from reef creation, and tradeoff analysis. Current meters and larval settlement collectors will be placed at the candidate sites to determine which site is most suitable for habitat enhancement. Should preferred sites be selected for reef creation, the load bearing capacity of the substrate to support disposal of rock and cobble would need to be determined, along with physical oceanographic baseline data collection, cultural resource surveys, and development of recolonization monitoring plans.

Federal and State resource agencies in New England have questioned whether creation of rock reefs actually results in a benefit to the marine environmental, or if created hard-bottom habitat is of greater value than natural soft-bottom habitat. The Massachusetts Office of Coastal Zone Management, in their letter of October 24, 2012, requested the Corps commit to working with the agencies during the design phase to investigate other potential beneficial uses of the rock material. The Corps in their response of October 26 concurred in CZM's request. During the project's design phase the Corps, working through the TWG will seek to identify other potential uses upland and for shore protection projects in the area and determine the existence and level of support by other parties for implementing such uses and sharing in their costs if required. For purposes of the final Feasibility Report and FSEIS the Federal base plan for disposal of the rock will remain placement at the MBDS rock site.

Ocean Disposal Site Concerns

The Massachusetts Bay Disposal Site (MBDS) is an EPA-designated dredged material disposal site. Material suitable for ocean disposal has been disposed at this site from the last two Boston Harbor dredging projects (navigation improvement and outer harbor maintenance dredging). No specific concerns are anticipated which have not been addressed previously. Marine mammals and threatened and endangered species that may occur in the project area while transporting dredged material to the disposal site include the loggerhead, leatherback and Kemp's ridley sea turtles, and the North Atlantic right whale, humpback whale, and fin whales. To reduce the potential for ship strikes, whale observers will be on board scows transiting to the MBDS from February 1 through May 31.

Confined Disposal Facilities for Maintenance Increment

Confined aquatic disposal (CAD) cells were built during construction of the previous navigation project in the Mystic River, Chelsea River and Inner Confluence for disposal of the unsuitable maintenance material. Additional CAD cells were constructed in the Mystic River and upper Main Ship Channel as part of the 2008 inner harbor maintenance project. A sand cap was placed on top of the dredged material in the CAD cells, except for one cell in the upper Chelsea River which has been left uncapped to retain future capacity. Additional CAD cells could be built in the Inner Confluence, upper Main Ship Channel, and the Mystic River beneath the Federal navigation channels to accommodate maintenance material from the remaining upper inner harbor maintenance dredging area and for future maintenance if needed. Maintenance material from areas of the harbor below Massport's Marine Terminal and other areas were determined to be suitable for ocean disposal. Most of the CAD cells that have been or could be built in the areas above were described in the previous Environmental Impact Statement (EIS), EA and SEIS. At this time, as described previously, the only remaining maintenance areas expected to require CAD Cell placement are the upper inner harbor Main Ship Channel reaches between the Massport Marine Terminal and the Inner Confluence which were included in the 2006 SEIS but were dredged under the 2008 contract, and the Charles River reach of the Main Ship Channel accessing the USCG Station. This work would require construction of the remaining southerly CAD cell section of the cell identified in the 2006 SEIS beneath the upper Main Ship Channel. Quantities for the excavation and capping of this cell were shown in Table 53 above. Previous studies have indicated that the dredged material and cap is stable within the cells and there is minimal movement when ships cross the cells. A one-year and a five-year monitoring report of the CAD cells constructed for the previous navigation improvement project showed the continued stability of the CAD cells and their caps. The sand cap material came from the maintenance and advanced maintenance of the Cape Cod Canal channel, as was the cap source for the 1998-2001 project.

ENVIRONMENTAL COORDINATION AND COMPLIANCE

Status of NEPA Documentation (Supplemental EIS)

A Supplemental Environmental Impact Statement (SEIS) is being prepared for this proposed project. The SEIS augments the Boston Harbor, Massachusetts Navigation Improvement Project and Berth Dredging Project Final EIS dated June 1995. A Notice of Intent was published in the Federal Register on August 23, 2002. The U.S. Fish and Wildlife Service, the National Marine Fisheries Service, the U.S. Environmental Protection Agency, and the Massachusetts Executive Office of Energy and Environmental Affairs (Coastal Zone Management office) are cooperating agencies for the SEIS. For all cooperating agencies except US EPA involvement in the study was limited to coordination, scoping and interdisciplinary support as a member of the Technical Working Group. EPA Region I has also conducted a number of investigations at the disposal site and is assisting the USACE in investigation of beneficial use potential for ocean capping.

Although a scoping meeting is not needed for a supplemental EIS, a public meeting was held in conjunction with the Massachusetts Port Authority (Massport) in September 2002 to hear the public's comments and concerns on the proposed project. Massport is required to prepare an Environmental Impact Report (EIR) in accordance with the Massachusetts Environmental Policy Act (MEPA) based on the level of their involvement and scope of the proposed project. This Draft SEIS and State Environmental Impact Report (EIR) are published together to provide an opportunity for consolidated public review and comment. This also complies with the regulations of the National Environmental Policy Act (NEPA) to the fullest extent possible by reducing duplication between NEPA and comparable State requirements, such as joint environmental impact statements. A minimum 45-day public comment is provided once a Notice of Availability of the Draft SEIS/EIR is published in the Federal Register. This NOA for this project was published in the register on 18 April 2008, and the public comment period closed on 2 June 2008. A Final SEIS/EIR addressing all comments received was prepared together with this Final Feasibility report. The Department of the Army will prepare a Record of Decision for publication in the Federal Register not sooner than 30 days after the public release of the FSEIS/EIR.

Public Involvement

As stated above, a public meeting was held in September 2002 at the beginning of the proposed project to inform the public of the proposed project and to provide an opportunity for the public to identify issues pertinent to the proposed project. Topics raised during the meeting included the location of disposal of dredged material for the navigation improvement project, the effect on lobsters, improvements in shore side infrastructure related to the project, the timeline for channel deepening, and cumulative impacts. These issues have been addressed in the SEIS/EIR.

As with the Boston Harbor Navigation Improvement Project (BHNIP constructed 1998-2001), a Technical Working Group (TWG) was established to assist in the planning and review of the SEIS/EIR for this Deep Draft Navigation Improvement Project, the SEIS (and State Notice of Project Change) for the Boston Harbor Inner Harbor Maintenance Dredging Project (IHMDP), and the Environmental Assessment for the Outer Harbor Maintenance Dredging Project (OHMDP). The initial focus of the TWG was on this deep draft improvement project. However, as a result of the maintenance dredging projects moving forward before this project, some of the TWG meetings were primarily focused on issues associated with the maintenance projects. Nevertheless, many of those issues were also relevant to the deep draft improvement project.

The TWG is comprised of representatives from Federal, State, and local resource agencies, environmental advocates, scientists, and Port-of-Boston stakeholders. Eleven TWG meetings were been held during the preparation of the Draft Feasibility Report and SEIS/EIR. The first meeting was held June 10, 2003 and the last meeting was held 3 December 2013. Two additional TWG meetings were held after release of the draft documents for public review and prior to the public release of the Final Feasibility Report and SEIS/EIR. The TWG provides a forum for exchange of information between the project team and the agencies and interest groups participating in the TWG. The project team provided information on the proposed project, lessons learned from the previous BHNIP, a review of the scope of work for biological and physical testing, and a review of the physical, chemical, and biological sediment testing. The TWG provided comments and information on known sources of information for the literature and data gap search, proposed biological resource assessment, proposed locations for habitat enhancement proposed hard bottom habitat, and cumulative impact assessment.

The Draft Feasibility Report and SEIS/EIR were released for public review on 11 April 2008, with the Notice of Availability published in the Federal Register on 18 April 2008, and in the Massachusetts Environmental Monitor on 23 April 2008. The Federal and State public comment periods both closed on 2 June 2008. In response to the draft documents comment letters were received from four Federal agencies and departments, seven State agencies, the City of Boston, the Town of Winthrop, and four local non-governmental organizations. These letters and a comment-response section are included in the Appendix A – Public Involvement (letters in Part 4). Summaries of critical comments and responses are provided in the sections below.

In preparation of the Final Feasibility Report and the SEIS/EIR, another set of letters was sent on October 11, 2012 to four Federal agencies, four State agencies and two tribes to determine if their previous determinations in 2008 remain valid and to inform them that the project had a reduced scope of proposed improvements. We also stated in the letter that if no written comments were received by us on November 9, 2012, then we would determine that the previous comments on the Draft Feasibility Report and SEIS/EIR remained valid. In addition, a Coastal Zone Consistency Determination, Essential Fish Habitat Consultation, and Section 7 Consultation was requested and completed. The responses to the respective 2012 letters are provided below.

Status of Fish and Wildlife Coordination Act, Endangered Species Act Coordination, and Essential Fish Habitat (EFH) Coordination

Initial letters were sent to the U.S Fish and Wildlife Service on January 25, 2005 and the National Marine Fisheries Service on January 10, 2005 requesting comments under the Fish and Wildlife Coordination Act and the a list of Federally listed endangered and threatened species. Letters from the U.S Fish and Wildlife Service and the National Marine Fisheries Service stated that the proposed project was unlikely to adversely affect any threatened and/or endangered species listed under the jurisdiction of either agency. Coordination with the State Division of Fisheries and Wildlife confirmed that they do not have any rare species concerns in the project area. In response to the draft Feasibility Report and SEIS/EIR, letters were received from the U.S Fish and Wildlife Service, the Department of the Interior, and the National Marine Fisheries Service. These letters and responses to comments can be found in Appendix A – Public Involvement (letters in Part 4). A summary of each agency's comments and concerns, as expressed through correspondence and involvement on the TWG is provided below.

U.S. Fish and Wildlife Service

The U.S Fish and Wildlife Service responded to the draft Feasibility Report and SEIS/EIR by letter dated 14 May 2008, providing its final comments under Section 7 of the Endangered Species Act and stated that "no Federally-listed or proposed threatened or endangered species or critical habitat under the Service's jurisdiction are known to occur in the project area.". In their Fish and Wildlife Coordination Act Report letter of May 29, 2007 (See Appendix A – Part 4), the Service stated that "Our resource concerns have been adequately addressed in the documents and we support the project as proposed. We favor the creation of artificial reefs with the bedrock material." No letter was received from the U.S. Fish and Wildlife Service in response to our October 11, 2012 letter.

U.S. Department of the Interior

The Department of the Interior, Office of Environmental Policy Compliance, Boston (DOI), in their letter of 2 June 2008 (See Appendix A – Part 4), submitted comments from that office as well as the US Geological Survey, U.S. Fish and Wildlife Service and National Park Service. The DOI requested that the following concerns and potential impacts be addressed:

- Project impacts on intertidal habitat and the shoreline, beaches and cliffs of the harbor islands
- Noise and light impacts on park visitors and habitat
- Construction impacts on park viewshed
- Impacts on cultural resources from erosion and ship traffic
- Suspended sediment from dredging operations and sediment chemistry
- Disposal impacts on ship traffic
- Analysis of deepening other New England ports than Boston
- Revising resource characterization at the dredge sites before construction
- Performing hydrographic surveys for 1000 feet outside the channels

The more significant of these comments relate to the impact of dredging deeper channels and operating large ships and a perceived potential for these actions to increase erosion on the shores of the harbor islands, part of the Boston Harbor Islands National Recreation Area. The channels proposed for deepening are already periodically dredged for maintenance purposes every 16 to 40 years. The shoaling rates in Boston's channels are very low leading to the conclusion that their presence, maintenance and the deepening under this project will have no effect on wave energy reaching the shores of the harbor islands, most of which are directly exposed to the open Atlantic. There is a significant distance between nearly all of the harbor islands and the channels to be dredged. The closest of the harbor islands to the dredged channels, Lovells, Gallops, and the Nixes Mate shoal are located in areas where the channel will not require dredging to deepen it as natural scouring of the bottom by tidal currents provides depths of 50 to 90 feet. The northern end of Long Island at the former Fort Strong was armored by previous projects, and some ledge removal is required along the channel margin closest to this headland. However no impacts are anticipated given the hard nature of the material at that location.

Shipping is not expected to increase with the recommended improvements. In fact the number of ships transiting the harbor is expected to decrease, primarily due to conversion of the petroleum tankships and cement carriers to less frequent calls by larger vessels. The base economic case for containership traffic increases vessel size, but only for the three weekly services now calling on the port. Other economic scenarios projected the addition of a single service for a total of four ship calls weekly. There have been four ship calls weekly in the past with no impact. No increase in vessel-related erosion is anticipated at the harbor islands. Without erosion, cultural resource impacts would not occur. It is also noted that Fort Warren is located more than 1.4 nautical miles from the nearest dredging location along a channel (The Narrows Channel) that is not proposed for dredging under this project.

With respect to noise and light, the dredge plant activities will be minor sources of noise and light compared to the other activities of the Port, airport and City. Lovells and Gallops Islands are located more than ¾ of a mile from the nearest dredging areas. Submarine blasting will not result in surface noise and will only occur in daylight. Lighting on dredge equipment working at night will be insignificant compared to lights from the airport, seaport or the MWRA sewage treatment plant (STP) on Deer Island.

With respect to viewshed impacts, the dredging plant vessels would be insignificant objects compared to the 1000+-foot long tankships and containerships transiting the channel several times a day and using the anchorage. The port, airport and STP are far larger objects than a 100-foot long dredge barge ¾ of a mile to several miles distant. The dredge and drilling plants will move over the entire project area of more than 10 miles of channel. The floating plant would only be in any particular channel reach for several months before moving on to the next area of the project.

<u>National Marine Fisheries Service – 2 June 2008</u> (See Appendix A – Part 4)

In their letters of 19 May 2003 and 28 April 2005 (included in Appendix A – Part 6) the NMFS agreed to participate in development of the SEIS as a cooperating agency. The NMFS habitat conservation staff were active participants in the TWG for the project, providing input and advice throughout the study process. Through the TWG and correspondence the NMFS voiced its principal concerns with the project, including impacts on fisheries in the harbor such as winter flounder and anadromous fish species, impacts of blasting on threatened and endangered whales at the disposal site and elsewhere in Massachusetts Bay, impacts of dredging and blasting on resources in and around the channel areas, and impacts of proposed reef creation on existing habitat in the Bay.

The NMFS, in their letter of 2 June 2008 and subsequent discussions and TWG meetings, declined to provide EFH conservation recommendations on the basis of the Draft or Final Feasibility Report and SEIS/EIR, as information critical to their evaluation, such as the specific locations and volumes of rock requiring blasting, a detailed rock removal plan, detailed construction contingency plan, and final decisions on beneficial use opportunities for the rock, would not be prepared or made until after design phase site investigations were completed. Upon submittal of a revised EFH assessment once design phase investigations a completed, the NMFS will provide conservation recommendations. The NMFS' other concerns included:

- Impacts to winter flounder from sediment plumes, burial of eggs, mortality to juveniles from abrasion and predation
- Impacts to anadromous fish, including herring, alewives and smelt from suspended sediment and blasting, and a need for dredge plume tracking

- Blasting impacts and development of a detailed rock removal plan
- Need for an After Action Report on blasting impacts from the 2007 work
- Additional beneficial use investigations for rock
- Loss of soft-bottom habitat from reef creation
- Impacts of noise from blasting on marine mammals including whales in the Bay

Throughout the study, winter flounder was identified by the National Marine Fisheries Service (NMFS) as a species of particular interest. NMFS raised the issue of winter flounder impacts during review of the SEIS for the Inner Harbor Maintenance project now under construction. For that project their concerns were resolved with inclusion of a monitoring program during construction to measure the impacts of turbidity from dredging operations within and outside of the channel areas. A similar effort is anticipated for this improvement project and costs for monitoring are included in the project cost estimates.

NMFS initially expressed cautious optimism about the rock reef creation beneficial use option during interagency discussion by the TWG. Upon review of the draft SEIS, the NMFS raised concerns over such habitat being substituted for soft-bottom habitat and the need to have a greater level of detail on existing site resources and impacts. During the design phase the rock reef and other beneficial use options will be investigated further as to practicability, Sponsorship, and Federal interest. The District will work closely with the NMFS, State agencies and EPA to determine if a reef construction site and plan can be developed that will satisfy the agencies concerns and expectations. If opposition to this beneficial use option remains, then the base plan for disposal of this material at the MBDS will be followed, unless other beneficial use investigations yield practicable alternatives and sponsors.

Under the Fish and Wildlife Coordination Act, benthic habitat was identified by NMFS as contributing to the biological productivity of finfish by acting as a food source for both juvenile and adult life stages of finfish. Shellfish resources of concern within the project area include soft-shelled clams, blue mussels, and surf clams. In addition, the following anadromous species were also recognized: rainbow smelt, alewife, and blueback herring. These species use Boston Harbor, the Mystic and Chelsea Rivers for passage to upstream spawning locations. The detailed construction sequencing plan, to be developed with the assistance of the TWG once design phase investigations are completed, will address these resources and minimize impacts to the extent practicable.

NMFS in a letter dated 26 November 2012 provided Magnuson-Stevens Fishery Conservation and Management Act Essential Fish Habitat (EFH) conservation recommendations. Because they did not receive the site-specific information requested in their 2008 letter, they took a risk-averse approach to their EFH conservation recommendations. The recommendations provided include:

- To avoid impacts to winter flounder spawning, eggs, larvae, and juvenile development habitat, no dredging or underwater blasting should be conducted between February 1-June 15 of any year in any areas of the Mystic River and Chelsea River, and the Reserved Channel, and the Main Ship Channel and Turning Basin landward of the Conley Terminal;

- In order to protect EFH forage species, no dredging or underwater blasting should be conducted between March 1-June 30 of any year in any areas of the Mystic River and Chelsea River channels and private terminal berths, the Reserved Channel and terminal berths at Massport facilities, the Main Ship Channel and terminal berths, and the Turning Basin west of the Conley Terminal to avoid adverse impacts on upstream spawning migrations of alewife, blueback herring, rainbow smelt;
- For the remaining section of the BHDDNIP (i.e., Main Ship Channel east of the Conley Terminal, President Roads Anchorage, Broad Sound North Entrance Channel, maintenance of the 35-foot deep lane of the North Entrance Channel, 30-foot deep Broad Sound South Entrance Channel, 15-foo deep Nubble Channel and 35-foot deep MLLW Barge Anchorage), an underwater blasting plan should be developed during the Planning, Engineering, and Design phase of the proposed project. The underwater blasting plan should be directed and developed on an underwater blasting technical working group, which should be convened as soon as possible to begin evaluating data from the proposed Boston Harbor Main Ship Channel rock removal project, as well as gathering information from other past underwater blasting projects in this and other regions. This technical working group should identify and evaluate the most current knowledge on the science and management of underwater blasting and monitoring needs that can be directly related to the proposed BHDDNIP. Recommendations of this Technical Working Group should be incorporated into the FSIES/FEIR;
- Alternative beneficial reuse of rock material that avoid and minimize adverse impacts on biologically productive soft bottom habitats should be evaluated more fully within the FSEIS/FEIR, including using the rock for upland construction purposes and the use for ongoing shore protection projects;
- The results of the demonstration capping project within the IWS should be evaluated within the FSEIS/FEIR in order to determine the efficacy of using the dredged material from the proposed BHDDNIP to cap the IWS and to assess portential impacts to biological communities within the MBDS.

Although the District doesn't necessarily agree with the need for the first two EFH conservation recommendations, based on previous plume monitoring in Boston Harbor, the District in partnership with Massport will work with the TWG throughout the Design Phase and Construction Phase of the project to address specific issues. In particular, we will develop construction sequencing plans including rock removal, blasting mitigation measures, and consider beneficial use options for the rock and other dredged material.

In its 2 June 2008 letter, the NMFS (See Appendix A – Part 4) stated that §7 ESA Consultation would need to be re-initiated, as the Service's ESA staff was unaware of the extent of ledge blasting and dredging required for the project and had concerns potential impacts of blasting on whales and other species. While prior correspondence between the agencies does mention the need for blasting, and numerous presentations to the TWG clearly provided the quantities and construction durations expected for the recommended plan, the Corps agreed to re-initiate consultation and did so in its letter of 30 June 2008 (see Appendix A, Section 3). In that letter the Corps transmitted the results of its investigation and evaluation of noise impacts from blasting on threatened and endangered species. NMFS responded in an email dated 1 August 2008 questioning how different blast safety zones aligned with marine mammal noise criteria. Because these questions were never answered, Section 7 consultation was never completed.

During the period of time while the economic analysis was being updated for the Deep Draft Project, the Gulf of Maine Distinct Population Segment of the Atlantic sturgeon was listed as threatened in the Federal Register on February 6, 2012. A meeting was held between staff from NMFS and the USACE on 10 October 2012 at NMFS office in Gloucester, MA to discuss options to finalize informal Section 7 consultation for the previously listed species and the newly listed Atlantic sturgeon. This meeting and the request for supporting information was documented in a letter dated 24 October 2012 from USACE to NMFS. In our letter dated 7 November 2012, we provided supporting information concerning the effects of blasting in Boston Harbor on listed species, and requested confirmation that the Deep Draft Project would not likely adversely affect listed species.

In NMFS' letter dated 27 November 2012, they concurred that "as all effects to listed species will be insignificant and discountable, the proposed action is not likely to adversely affect any NMFS listed species."

<u>Massachusetts Division of Fisheries and Wildlife</u>

In its letter of 31 May 2005 (See Appendix A – Part 4), the DF&W stated that they did "not have any rare species concerns with the work proposed."

<u>Massachusetts Division of Marine Fisheries</u>

Comments were also solicited from the Massachusetts Division of Marine Fisheries (MADMF) under the Fish and Wildlife Coordination Act, as well as requests for information the State has collected on early benthic lobster, shellfish and finfish resources in the project area. This data was used to assess impacts from the proposed project.

In their letter of 2 June 2008 (See Appendix A – Part 4) to the MA Executive Office of Energy and Environmental Affairs providing comment on the Draft Feasibility Report and SEIS/EIR, the Division stated a number of concerns:

- That cumulative impacts analysis should have addressed all dredging of all waterways in the State due to concern with cumulative impacts on the overall ecosystem of the State, and that.
- That improvement and maintenance dredging combined represent a chronic long-term impact.
- The DEIR relies heavily on information collected and examined for previous efforts. The proponents have not conducted a sufficient impact assessment.
- Fish kills during blasting events this past year in Boston Harbor were not addressed in the DEIR.
- A sequencing plan should be generated based on biological surveys to assess resources, trends and their use.
- Requested the extent of hard bottom habitat to be impacted, removed and created within the project site be clarified and that examinations be made of recovery time for these habitats, including sampling of EBP lobsters, and that a monitoring plan be developed to evaluate recovery of impacted areas.
- Recommended that upland disposal alternatives for rock, and site selection for any rock reef creation be revisited (see above discussions of similar comments from MA CZM).

- Recommends identifying measures to prevent the spread of invasive species, such as by contractor barges coming to Boston

The cumulative impact section of the FSEIS/EIR discusses cumulative impacts. The combined subtidal impact from all projects in Boston Harbor represents only about 18 percent of the harbor bottom. The areas proposed for dredging within Boston Harbor associated with this project are contained within existing previously impacted navigation channels. Table 1-2 in the SEIS shows the years dredging has occurred in Boston Harbor. Dredging has not been continuous over this period allowing impacted areas to recolonize and recover and would therefore not be considered a chronic condition. In addition, past dredging has occurred in different areas of the harbor allowing areas to recover over varying extended periods. While construction of the Deep Draft Improvement Project will impact some of the same previously dredged areas, the shoaling rates within Boston Harbor are low. Maintenance dredging is not needed more than once every 16 to 40 years, dependent on the channel segment, thereby allowing ample time for recovery.

The FEIS/EIR is a supplement to the EIR/S prepared for the previous Boston Harbor Navigation Improvement Project (BNHIP) constructed in 1998 to 2001. The Supplemental FEIS/EIR builds on the lessons learned from the BHNIP. The BHNIP and the Outer Harbor and Inner Harbor maintenance dredging projects used the same channels now proposed for deepening under the Deep Draft Improvement Project. The data and investigations used for those prior projects, and used for this project, were deemed relevant and sufficient to evaluate the proposed navigation project. Even so, the Corps and Massport will provide greater specificity in supplemental NEPA/MEPA documentation following completion of the design phase investigations.

The 2008 DSEIS/EIR did address the four fish kill events in Boston Harbor in the fall of 2007 in Section 4.13. An After-Action Report has been prepared to provide information on those blast events, has been coordinated with the TWG, and has been included in the Final SEIS/EIR as Appendix Y. An interagency subgroup of the TWG will be developing a blasting plan using information developed over the next year. A project construction sequencing plan will also be developed, and following completion of additional resource surveys conducted during the design phase of the project. The TWG will participate in the development of these plans.

Appendix Q to the Feasibility Report/FSEIS/EIR contains mapping prepared to show the harbor bottom types under the existing condition, with deepening for a 45-foot channel (to -47 feet) and with deepening for a -48 foot channel (to -50 feet). In general the area of hard bottom, including exposed bedrock, will increase with channel depth, particularly in the main ship channel above Spectacle Island, where ledge is shallow and widespread. More areas of till and cobble would be exposed in the lower harbor and entrance channel with greater depth. These areas and comparisons will be further detailed once the subsurface exploration program is completed as an early step in the design phase. The Corps also proposes to conduct pre- and post-construction monitoring of the benthic habitat to provide a baseline and to monitor and evaluate recovery. This may include sampling for EBP lobster or other species based on further consultations with the TWG.

The Corps will develop, with input from the TWG, requirements for inspection of contractor equipment for invasive species if that equipment is coming to Boston from origins of concern, including submittal of certification that inspections have been performed by qualified inspectors and the vessels found free of such species. These requirements would be included in the Specifications for the project.

Coastal Zone Management Consistency

A Federal Consistency Determination is required from the Massachusetts Office of Coastal Zone Management for review and concurrence that the proposed deep draft project is consistent to the maximum extent practicable with the CZM policies of the Commonwealth of Massachusetts.

CZM letter of 2 June 2008 (See Appendix A – Part 4)

In their letter of 2 June 2008 (See Appendix A – Part 4) MA CZM stated its support for the project and related a number of concerns following its review of the Draft Feasibility Report and SEIS/EIR:

- Continuation of TWG through design
- Need more resource characterization for the dredging areas
- Need to characterize rock blasting areas
- Need for a comprehensive blast plan and construction sequencing plan
- Pre-construction harvesting of lobsters, crabs and other species
- Suspended solids modeling

The Corps concurs with the need to continue involvement of the TWG throughout the project and with the need for additional resource characterization once the current maintenance dredging cycle for the harbor is complete. Based on discussions with the TWG, a conservative approach was determined to be the best method for describing natural resources considered important to the discussion of the Affected Environment and Environmental Impact sections of the SEIS/EIR. This approach assumes that a natural resource is in the area unless the physical environment or other data suggests the habitat is not suitable for a particular species or community. Additional resources surveys will be conducted during the design phase to inform the development of the construction sequencing plan and to serve a baseline for the monitoring surveys measuring habitat recovery post-construction.

All areas proposed for dredging and blasting, with very limited exceptions where the entrance bend at Finns Ledge and the turning area off the Army Base pier will be widened, are within the existing channel and subjected to periodic maintenance dredging. In fact, maintenance of the 40-foot lane of the north entrance channel was accomplished in 2004-2005. Most areas to be blasted will need to be dredged first to remove overlying unconsolidated substrate, before drilling can occur. Only a small portion of the ledge areas are exposed bedrock.

The Corps agrees to perform a pre and post monitoring program to document the condition of resource immediately prior to construction and to monitor the recovery of the impacted areas. The details of the monitoring program will be discussed with the TWG and included in a supplemental NEPA/MEPA document filing.

CZM supports the plan to use parent material (clay) to cap the IWS. Results of the pilot capping project are provided in the Final SEIS/EIR.

The USACE in a letter dated 16 October 2012 requested that MA CZM reaffirm their support for and concurrence with our Federal consistency determination for the Deep Draft Project. To address MA CZM's major concerns detailed in their letter dated 2 June 2008, we confirmed that we would continue to involve the TWG through the design phase of the project to address concerns about potential impacts to natural resources by conducting additional resources surveys of the benthic and shellfish communities. This information and the information from the rock boring and probing program in the design phase of the project would be used to construct a dredge sequencing plan and blast sequencing plan. USACE also committed to working with the TWG to determine the value of the existing soft-bottom habitat relative to the anticipated value of the rock reef.

MA CZM responded in a letter dated 24 October 2012 requesting USACE commitment and planning to pursue viable options regarding alternatives for beneficial reuse beyond the creation of rock reefs, including both shore protection and upland use, before MA CZM would initiate their Federal consistency review. USACE responded in the affirmative in a letter dated 26 October 2012. USACE received Federal consistency determination from MA CZM on 29 November 2012.

Water Quality Certification

Section 404 of the Clean Water Act governs the disposal of fill, including dredged material into waters of the United States within the three mile territorial sea. This applies to discharges landward of the baseline of the territorial sea and in instances seaward of the baseline when the intent is to fill or nourish beaches. A draft Section 404(b)(1) Evaluation and Compliance Review will be prepared for the placement of rock within potential habitat enhancement sites, and material placed into CAD cells, if needed. A Section 404 (b) (1) evaluation was already prepared in 2006 for Phase 2 (area above the Massport Marine Terminal) of maintenance material that may need to be dredged from the Inner Harbor Maintenance Dredging Project.

Under Section 401 of the Clean Water Act, any Federal activity that will result in a discharge to waters or wetlands subject to Federal jurisdiction is required to obtain a State Water Quality Certification (WQC) to ensure compliance with State water quality standards. An application shall be filed with the Commonwealth of Massachusetts for a WQC pursuant to Section 401 of the Clean Water Act for the disposal of dredged maintenance material into CAD cells, if needed, within Boston Harbor, and for the placement of hard material (blasted rock, cobbles, etc) at the proposed habitat enhancement sites in Massachusetts Bay, should that activity become part of the project plan once design phase investigations are completed.

<u>Massachusetts Department of Environmental Protection</u>

In its letter of 2 June 2008, the Massachusetts Department of Environmental Protection (MADEP) provided comments on the draft Feasibility Report and SEIS/EIR. This letter and responses to comments are included in Appendix A – Public Involvement (Letter in Section 4). The DEP offered comments on the following topics:

- Requirement for a Water Quality Certification for the Project
- Need to canvass coastal communities for beneficial use opportunities for shore erosion projects and beach nourishment
- Use of clean dredged materials as CAD Cell cap
- Further consultation on use of rock for habitat development
- Development of a construction sequencing plan
- Continuation of the TWG during the design phase
- Explore use of emission credits and offsets by engine retrofit opportunities

The Corps and Massport are working with MACZM to identify additional potential uses for rock and other hard materials. There is unlikely to be any significant sandy materials practical for use as traditional beach nourishment. Should design phase subsurface investigations determine such materials are present in sufficient localized quantities to make the additional cost of segregating those materials practicable and identifiable, the State and other interested parties will be canvassed to determine their willingness to receive any such materials at their cost.

As all improvement dredging materials are clean and have been found suitable for unconfined ocean disposal at the Massachusetts Bay Disposal Site, no CAD cells are proposed for the improvement project. If CAD cells are required for any concurrent maintenance dredging activities yielding materials unsuitable for ocean disposal, the use of clean improvement materials for capping CAD cells will be considered, as the Department suggests.

Air Quality Analysis

Section 176 (c) of the Clean Air Act requires any entity of the Federal government that engages in, supports, or in any way provides financial support for, licenses or permits, or approves any activity to demonstrate that the action conforms to the applicable State Implementation Plan (SIP) required under the Clean Air Act. In this context, conformity means that such Federal actions must be consistent with a SIP's purpose of eliminating or reducing the severity and number of violations of NAAQS and achieving expeditious attainment of those standards. The air quality impact analysis evaluates the existing conditions and impacts in and around Boston Harbor. Boston Harbor is located in the Metropolitan Boston Intrastate Air Quality Control Region (AQCR), which includes the City of Boston and its outlying suburbs. The Boston Harbor Deep Draft Navigation Project dredging equipment, delivery and container trucks, and employee traffic would generate emissions within this air quality region.

Expected dredge and ancillary equipment needed to construct the proposed project were input into a model to determine if the project would exceed air quality emission thresholds. Based on the results of that model, it was determined that the project would need to stop construction for three months each year to avoid exceeding current air quality standards. For each plan and depth increment evaluated, a construction sequence was developed that would include a shutdown period of six months duration every other year from 1 October to 31 March, resulting in a nine-month work period annually. The longer shutdown every two years was developed to minimize additional mobilization-demobilization costs. Alternative air emissions offsets will be considered as the project proceeds during the design phase to determine if a less-costly means than construction period shut-downs exists for meeting the requirements of the Clean Air Act.

Air emissions from increased ship volume and/or truck traffic after the proposed project has been constructed has been modeled to determine if the project would cause unacceptable air quality standards. These air emissions are known as indirect emissions because they occur after construction of the project. As the Corps does not have control on the type or schedule of ships calling on Boston Harbor, these emissions would not be included in the conformity analysis. The modeling results for these indirect emissions indicated that air emissions would decrease in the New England region. This reduction is due to the decrease in truck traffic transporting goods from the PONYNJ to New England, and the reduction in ship anchoring time. These reductions more than offset the minor increase in truck traffic emissions transporting goods from Boston Harbor.

During review of the Draft Feasibility Report and SEIS/EIR, comments on the Corps air quality analysis and the plan presented in the Draft report for avoiding triggering emissions conformity requirements were provided by the U.S. EPA, the MA DEP, the MA EOEEA, and others. These letters and responses to comments are included in Appendix A – Public Involvement (Letters in Section 4).

Massachusetts Department of Environmental Protection

In its letter of 2 June 2008, the Massachusetts Department of Environmental Protection (MADEP) requested further consideration of the use of emission credits and offsets (by engine retrofit opportunities) as an alternative to the plan for construction shutdowns.

U.S. Environmental Protection Agency, Region I

In its letter of 25 May 2008, EPA requested the Corps consider means of ensuring air quality compliance other than construction shutdowns and to provide an analysis of tradeoffs and costs for shutdowns compared to securing credits or offsets. EPA also stated in their letter that: "Should the Corps adopt ... enforceable environmental commitments that ensure the use of new equipment with more stringent EPA emissions standards, and enforceable dredging schedule, then general conformity would be satisfied by the action falling below emission thresholds."

EPA noted in its letter of 9 November 2012, that since their 2008 letter a number of changes have occurred related to air quality issues. The first noted change is EPA's final rule designating nonattainment areas for the 2008 ozone NAAQS which became effective on July 20, 2012. This rule established Dukes County in Massachusetts as the only county in Massachusetts not in attainment for the 2008 ozone standard (Boston is in Suffolk County). However, general conformity requirements remain in place for Massachusetts due to their initial nonattainment designation for the 1997 ozone standard until such time as EPA revokes that standard.

This means, as mentioned in Section 3.6 of the FSEIS/EIR, that if the Deep Draft Project commences construction after EPA revokes the 1997 eight-hour O_3 NAAQS (possibly by July 20, 2013), it is anticipated that the general conformity rule would no longer apply to the Deep Draft Project with respect to O_3 and its precursor compounds, NO_x and VOC. Under that scenario, the general conformity applicability analysis presented for NO_x and VOC for the Deep Draft Project would be moot. However, the Boston area is in maintenance plan for CO so general conformity provisions still apply for CO.

Other air quality changes mentioned in EPA’s 2012 letter include additional flexibility and benefits offered in the revised general conformity regulation dated April 25, 2010, the publishing of “clean data determination” for Boston-Lawrence-Worcester with regard to the 1997 ozone standard, and EPA’s new state-of-the-art model MOVES for estimating emissions from highway vehicles. Should any new on-road mobile modeling be required, MOVES should be used in developing on-road mobile emission inventories.

Massachusetts Executive Office of Energy and Environmental Affairs (MEPA Office)

MA EOEEA restated the comments and concerns of the US EPA and the MA DEP concerning the need for additional examination of credits and offsets as alternatives to the proposed construction period shutdowns.

City of Boston, Environment Department

As NOx and VOCs are pre-cursors to ozone, an air pollutant most problematic during the summer months, the proponents should provide more detail as to why dredging is not occurring during the winter months.

Save the Harbor Save the Bay

In its letter of 2 June 2008, this organization noted its concern with air quality. The organization stated that they viewed the proposal to impose construction shutdowns as ‘gaming the numbers’, and ‘working dirty for nine months … then averaging the numbers to artificially meet annual air quality standards.’

Discussion of Air Quality Comments

Air emissions thresholds are measured on an annual basis. Projects that fall under those thresholds are not required to undergo conformity analysis. The Corps “goal” was to develop and present an implementable project. When commitments to availability of future credits proved unobtainable and offset opportunities for the construction period were not able to be identified at this time, the combination of shutdowns and use of cleaner equipment proved the only option which could be said with any certainty was available to meet the requirements.

Construction shutdowns entail a significant cost ($4 to $6 million per occurrence) to avoid exceeding the annual emissions thresholds. The current plan for air quality compliance is 6-month construction shutdowns every other winter to limit work to 9 months in any one calendar year. With the winter shutdown period a single shutdown will accommodate two years of work, cutting demobilization-remobilization costs in half for the shutdowns.

As stated above, the Corps and Massport have committed to investigating alternative means of air quality compliance during the design phase to determine the most cost effective and environmentally acceptable means of meeting the requirements.

Cultural Resources Investigation and Coordination

All of the material to be removed by the deep draft improvement project consists of parent glacial material and rock determined suitable for disposal at the Massachusetts Bay Disposal Site (MBDS) by the Corps and US EPA. The main channels improvement plan (up to 50 feet) and the three additional plans (main ship channel extension, Mystic River and Chelsea River) would together generate up to 14.5 million cubic yards of ordinary unconsolidated material and up to 1.5 million cubic yards of blasted rock. This rock would either be used for beneficial purposes as described below or placed at the MBDS.

Each improvement plan is discussed in detail below with reference to the investigations and coordination already undertaken, conclusions reached about the potential for submerged cultural and archaeological resources, and any need for additional investigations.

It its letter of 2 June 2008 (See Appendix A – Part 4), the Massachusetts Bureau of Underwater Archaeological Resources (MABUAR) stated that no further surveys were required for the project except for the Mystic and Chelsea Rivers. The Corps will work with the BUAR to develop survey plans and analyze results. As these areas have been extensively modified by past dredging, no cultural resources are expected to be located.

The Massachusetts Historical Commission (SHPO) in its letter of 5 May 2008 concurred with BUAR and the recommendation for additional studies in the Mystic and Chelsea Rivers. The SHPO restated this view in their October 18, 2012 letter.

The Main Channels Improvement Plans: The main channels improvements to provide deeper-draft vessel access from Broad Sound to the Conley Terminal are being examined to provide a depth of between -45 to -50 feet at mean lower low water (MLLW), with an additional two feet in the north entrance channel under all plans. These improvements would deepen the Broad Sound North Entrance Channel, the Main Ship Channel through President Roads and up-harbor to the Reserved Channel, the President Roads Anchorage Area, the lower two-thirds of the Reserved Channel and the Reserved Channel Turning Area. All the project areas to be deepened under the main channels plan are presently part of the existing 40-foot and 35-foot deep Federal navigation project features, with the exception of small ledge areas that would be removed to widen the outer approach turn in the entrance channel opposite Finns Ledge and enlargement of the Reserved Channel Turning Area.

The remote sensing survey and vibracore investigations did not cover the northern-most areas of the President Roads Anchorage, as those areas were not proposed for inclusion in the deepening project at the time of the fieldwork. Under prior improvement dredging projects from the 1940s to the present, this area had been excavated into the blue clay and bedrock. Significant cultural resources will not be present in this area due to the prior dredging. However, additional remote sensing surveys and borings will be conducted during the design phase of the project to confirm this determination.

Based upon the aforementioned remote sensing survey (Mulholland et al. 2003) and follow-up inspection of magnetic anomalies (Robinson and Ford 2003), and vibracore investigation, significant cultural resources should not be affected by the proposed improvement dredging of the Federal navigation project for the main channels improvement.

The Main Ship Channel Deepening Extension Plan: The Main Ship Channel deepening extension plan would deepen that channel in the reach above the Reserved Channel Turning Area and below the Ted Williams Tunnel to access the Massport Marine Terminal in South Boston. The 600-foot width of the existing 40-foot channel cut and a 50-foot width of the adjacent 35-foot channel would be deepened to a depth of up to 45 feet MLLW. This improvement will require ledge removal over most of its area. This area was also included in the remote sensing survey and magnetic anomaly inspection. Significant cultural resources would not be affected by the proposed improvement dredging under this plan.

Mystic River Channel Deepening: This plan consists of deepening a small portion of the 35-foot area of the Mystic River Channel to -40 feet MLLW to access Massport's Medford Street Terminal. This area was also included in the remote sensing survey and no anomalies were identified. Vibracore samples were also taken from this area of the Mystic River during the study. Significant cultural resources would not be impacted by the proposed improvement dredging under this plan.

Chelsea River Channel Deepening: This plan consists of deepening the Chelsea River Channel from its currently authorized depth of -38 feet MLLW to a depth of -40 feet MLLW (Figure 31). The work involves dredging to deepen the existing project limits, except for two small areas along the Chelsea River Channel. The area immediately upstream of the A.P. McArdle Bridge, and the area of the bend between the bridges just downstream of the Sunoco Logistics Terminal, both along the East Boston side of the channel, would be widened by no more than 50 feet.

The Chelsea River Channel was deepened from 35 feet to 38 feet in 1998-2001. Dredging for this deepening extended into the blue clay, yellow till and granite ledge, all deposits that pre-date habitation of the region. The two areas where the channel will be widened in the bridge approach and the bend between the bridges will need to be examined during the design phase of the project. A remote sensing archaeological survey of these three areas is recommended in order to identify the presence of submerged archaeological resources including shipwrecks in these areas. The original remote sensing survey of the Federal navigation channel (Mulholland et al. 2003) did not include the Chelsea River. Borings of the Chelsea Channel are also proposed for the project's design phase to confirm material types and examine the areas of channel widening for the presence of buried land surfaces and pre-Contact archaeological sites.

Disposal of Dredged Material under all Channel Improvement Plans: The Massachusetts Bay Disposal Site (MBDS) is the Federal base plan for disposal of all dredged material from the deep draft navigation improvement project. The MBDS was designated by the US EPA for disposal of dredged material in 1992 after preparation of an Environmental Impact Statement. The former Industrial Waste Site (IWS) is located north of and overlaps the northern portion of the MBDS. The IWS was used from the 1940s to 1970s for disposal of chemical, medical and low level radiological waste. The site was also used for general disposal of dredged material, construction debris and other materials before and during that time. Remains of waste barrels are located throughout the IWS and most are concentrated in several areas. The Corps and US EPA are investigating the potential to use the improvement project's millions of cubic yards of unconsolidated dredged materials to form a cap over these barrel “fields”. A side scan sonar survey of the IWS and portions of the MBDS was conducted by US EPA Region I in July 2006. A number of shipwrecks were identified within the IWS and the MBDS in the area where those two sites overlap. Disposal activities, including any capping of areas of the IWS would be designed to avoid these shipwrecks.

The MBDS and IWS are located seaward of the territorial sea (three-mile limit) in Federally regulated waters. If the IWS is ultimately recommended for capping via beneficial use of the dredged material from the improvement project, further data on the significance of the wrecks may be required if the capping plan were determined to have an impact on those resources. If impacts are unavoidable, a Phase II site examination level survey of the wrecks may be needed to determine the boundaries of these potentially significant resources and determine whether any are eligible for listing on the National Register of Historic Places. The scope of any studies and results would be coordinated with EPA. However, given the large area available for disposal and capping at these sites, unavoidable impacts are unlikely.

The deepening of Boston Harbor’s channels would also generate up to 1.5 million cubic yards of removed ledge rock. Beneficial use of this rock has been suggested for one or two candidate sites outside the harbor. The rock could be used to create reefs (hard bottom habitat) for lobster and other species habitat. One site is located in Broad Sound southeast of Nahant, and the other is located in Massachusetts Bay easterly of the Brewster Islands. Since these areas were not included in the remote sensing surveys conducted for the channel areas, it is recommended that such surveys be conducted if these features are included in the final project plan. This work will be planed and evaluated in coordination with the MA BUAR and the MA SHPO, as confirmed in their letters of 2 June 2008 and 5 May 2008 (See Appendix A – Part 4), respective, in response to the Draft Feasibility Report and DSEIS/SEIR .

In summary, the remaining cultural resource investigation work to be accomplished during the design phase of the project will consist of:

(1) Remote sensing surveys of the northern portion of the President Roads Anchorage and the two areas of the Chelsea River Channel proposed for widening
(2) Borings for both of these areas.
(3) Laying-out a disposal plan at the MBDS and a capping plan for the IWS (if that is to be included in the project) so as to avoid the located shipwrecks.
(4) Remote sensing surveys of any of the proposed rock reef sites included in the final plan and avoidance of any resources identified.
(5) The Corps view that no further investigations are needed for the Mystic River will be coordinated with the MHC and BUAR and resolved.

The investigations completed for the remaining project areas did not identify any significant cultural or archaeological resource impacts. No additional investigations are planned for those areas.

Environmental Justice

No adverse impacts are anticipated. All construction work, including disposal, is located within the waters of the United States. The channels to be deepened are existing commercial/ industrial waterways and all beneficiary terminals are existing operations under the without project condition. The closest residential areas, South Boston and the Admirals Hill development in Chelsea, have smaller minority and low income populations than their overall respective municipalities.

Identification of Environmental Mitigation Requirements

With the exception to human safety concerns, no blasting will occur when schools of fish, sea turtles or mammals are observed in the vicinity of the blasting, as determined by the fisheries, sea turtle, and marine mammal observer. To reduce fish mortality, all blasting will be conducted using inserted delays of a fraction of a second per hole and stemming shall be rock or similar material placed into the top of the borehole to deaden the shock wave reaching the water column.

As noted above, underwater blasting in 2007 showed that the above mitigation may not always be sufficient to reduce fish kills. In light of these events, the Corps prepared an "After Action Report" on the 2007 blasting events, included as Appendix Y to this report, to provide information on all of the blasting events and has convened an interagency underwater blasting technical working group with Federal and State resources agencies. The goal of the working group is to determine what lessons can be learned from the 2007 fish kill events, and the 2012 blasting events that had no fish kills, and apply that knowledge and any other corrective measures that may be identified and found practicable to minimize potential fish impacts during blasting for the Deep Draft Project. The group will focus on construction sequencing for several areas of the harbor, constraints on work during certain tidal and weather conditions, potential operational changes, and equipment changes. The results of this research will form the basis for agency discussions on measures to be implemented for the Deep Draft Project.

As mentioned above, whale observers will be on board scows transiting to the MBDS between February 1 and May 31 to avoid potential ship strikes with the endangered northern right whales, or other marine mammals and sea turtles.

A Public Notice will be issued prior to the initiation of the project. Although it is illegal to place lobster traps in the Federal channel without Federal permits which usually are not granted due to navigational safety concerns, this notice will provide the lobstermen an opportunity to move any of their equipment out of the navigation channel being dredged for the construction period.

By the end of 2009, The Federal channels of Boston Harbor will have completed a major maintenance cycle. The areas maintained include all the areas now under consideration in this improvement project for deepening. However by 2015, the earliest improvement dredging is projected to begin, some silty shoal material may remain in the maintenance horizon overlying the parent material to be removed by the improvement project. The cores taken during the subsurface characterization program during design will determine if any significant shoal material remains in the improvement areas. If areas of shoal material are identified that can be removed separately (thickness of greater than two feet) then a closed bucket will be used to reduce turbidity impacts and no scow overflow will be allowed. This will minimize potential impacts to finfish or shellfish and their habitat. Any costs for special methods required to deal with maintenance shoal material are operations and maintenance costs and are not allocable to the improvement project.

Under the base plan, construction activities will be shut down for three months each year to avoid exceeding annual air quality emission thresholds. These shut-downs will be sequenced to occur in six-month periods every two years from October to March to minimize additional mobilization-demobilization costs to the project. The air quality shut-down periods were developed in response to a lack of available credits for purchase or identified opportunities for creating offsets. This situation will be examined further during the design phase as credits and/or offsets may result in cost savings and environmental benefits to the project. Any changes to the Federal base plan for air quality compliance that would trigger conformity analysis will be coordinated with EPA and the MA DEP, and comments will be solicited.

No additional mitigation requirements have been identified with the project. Dredging is limited to existing project limits and adjacent side slopes and limited areas of bend widening. No significant environmental or other impacts have been identified that would require mitigation.

Other Social Effects

Deepening of the port could have other social effects. The regional reduction in truck miles resulting from the shift in New England cargo from New Jersey landings to direct landing at Boston would reduce regional emissions of pollutants. This would have long terms benefits to air quality and the health of the region's population.

Saving millions of truck miles would also benefit the region's highways. Reduced truck traffic would reduce highway congestion and potentially extend the maintenance life of highway system components such as road surfaces and bridges. Reduced truck traffic and highway congestion should also reduce motor vehicle collisions.

Deepening of Chelsea Creek to permit the metropolitan area's fuel deliveries to arrive on larger vessels would reduce the need for lightering and hasten the upgrade of the fleet to more modern vessels. Each lightering operation and each vessel transit and offloading carries a risk of spillage. These effects would reduce the potential for petroleum products spills into the region's waters, and resulting delays in fuel deliveries which can spike process in the critical high-demand colder months.

The loss of benthic habitat for deepening the channels at Boston Harbor would have a temporary impact on lobstering activity in the channel and its side slopes. Despite lack of permits and loss of gear from ship passage, lobstermen still place unauthorized traps in the harbor's navigation channels. The channels proposed for deepening are maintained on a 16 to 40 year cycle. Other than a slight increase in side-slope width (about 25 feet on either slope) the dredged footprint from deepening is nearly the same as that for ongoing maintenance, except for minor areas of channel bend widening at Finns Ledge and in the Chelsea River, and for expansion of the Reserved Channel Turning Basin. Of the 1,206 acres of expected dredging footprint, only about 20 acres are located outside the existing channel footprint.

Lobstermen will be informed of dredging progress and schedule as with the current maintenance efforts so that they may relocate their gear as construction progresses. Recently dredged areas will re-colonize with benthic species recruited from adjacent undredged areas of the harbor and the lobster will return once this food source is re-established.

Draft SEIS/EIR Coordination

A Notice of availability of the Draft SEIS/EIR was published in the Federal Register on 18 April 2008 after release of the document for public and agency review on 11 April 2008. A Public Notice and Press Release were also released by the New England District and Massport upon release of the Draft Feasibility Report and SEIS/EIR document. A 45-day comment period was provided which closed on 2 June 2008. A meeting of the TWG was held on 19 May 2008 to provide the agencies and other TWG participants with an opportunity for detailed discussion on the project, process and documents. Another meeting of the TWG was held 21 July 2008 to discuss Design Phase commitments for additional investigations, development of detailed management and monitoring plans, and the process for further coordination and TWG involvement through completion of the project.

A public meeting was held in Boston at Massport's Black Falcon Terminal on 20 May 2008 to further solicit comment on the project. Notices and hearings were prepared and conducted in satisfaction of both Federal NEPA and State MEPA process requirements.

Following identification of the recommended main channels improvement depth in September 2012, coordination was re-initiated with the member agencies of the TWG. Commitments made in 2008 for additional design phase investigations and eventual development of construction sequencing plans and air quality impact avoidance were reviewed and re-confirmed. Coordination under the Endangered Species Act, Fish & Wildlife coordination Act, Coastal Zone Management Act, Clean Air Act, Historic Preservation and Essential Fisheries Habitat were updated and documented in letters exchanged by the various agencies between October 2012 and January 2013. The specifics of each are discussed in specific topical areas of this report and in the FSEIS/EIR.

All comments, as discussed above and as presented in detail in the revised Public Involvement Appendix (Appendix A – Letters in Part 4) were analyzed and considered in preparing the Final SEIS/EIR and Feasibility Report.

RECOMMENDED PLAN OF IMPROVEMENT

Based on costs, benefits and environmental screening conducted to date, a plan that provides harbor deepening improvements to the Port of Boston consisting of a 47-foot MLLW depth in the lower Main Ship Channel, the Reserved Channel and its Turning Area, and the President Roads Channel Reach and Anchorage, deepened further to 51 feet in the harbor's North Entrance Channel from Broad Sound is the NED Plan (See Figure 46) for the main channels containership benefits improvement. This plan meets the NED and other criteria in that it has reasonably maximized significant annual net benefits and does not result in insurmountable environmental impacts.

During the design phase, incorporation of environmental benefits through the potential for beneficial use of dredged material will be investigated further with the State, Sponsor and US EPA. The use of rock and other hard material for creation of lobster habitat in the nearby waters of Broad Sound and Massachusetts Bay and other alternatives for using this material will be further considered should a sponsor be identified and an acceptable plan developed. The use of unconsolidated materials to cap the former Industrial Waste Site in Massachusetts Bay will be considered further in consultation with EPA and others if issues of sponsorship, monitoring, placement impact, and liability are worked-out.

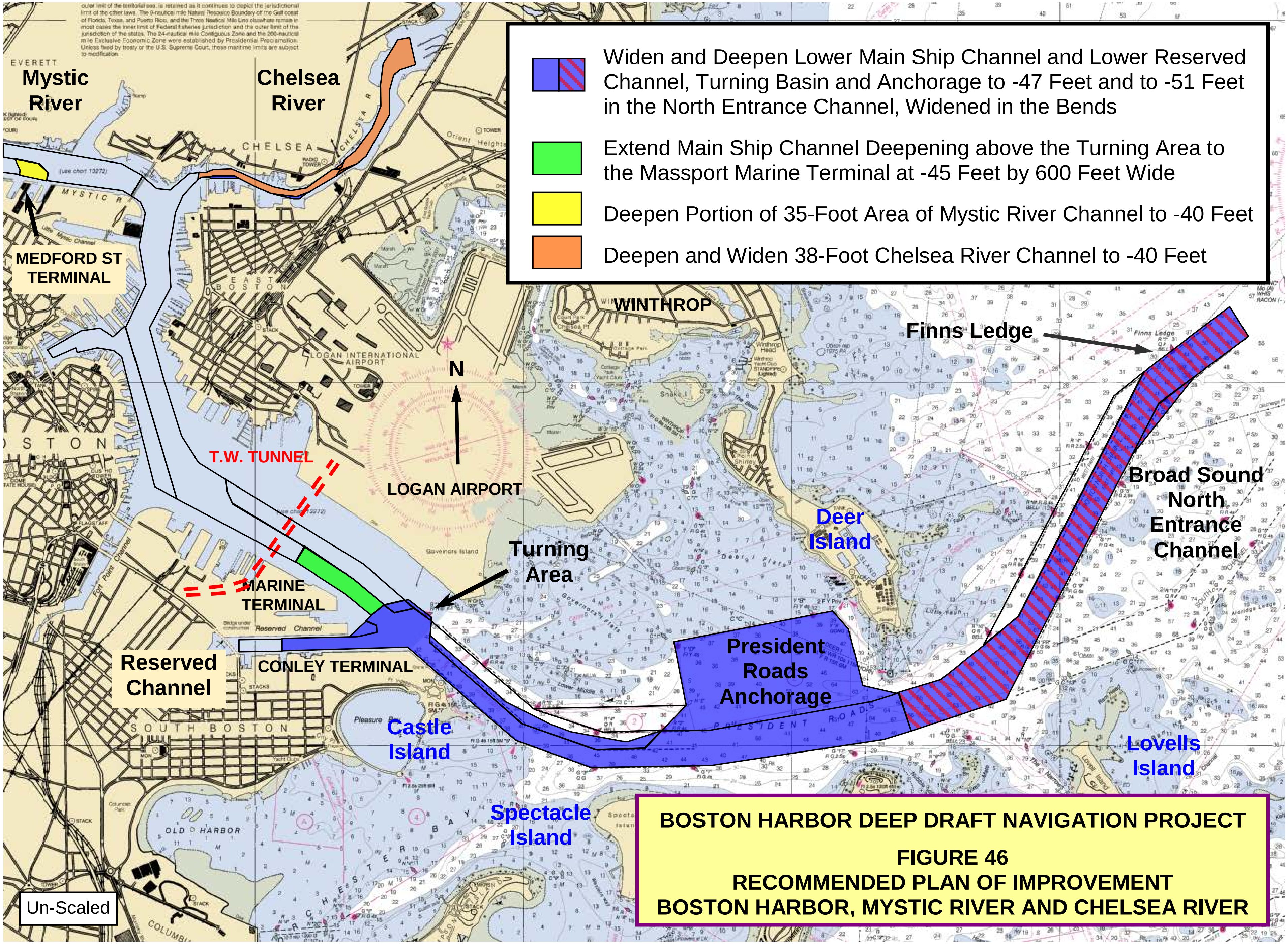
Analysis of the proposed improvements to extend the deepening of the Main Ship Channel above the Reserved Channel Turning Area to –45 feet MLLW to access the redeveloped Massport Marine Terminal in South Boston indicates that improvement is also economically justified, environmentally acceptable and otherwise in the Federal interest. Optimization will be further examined in design as the use of the site for bulk cargo operations continues to develop.

The deepening of the small section of the Mystic River to –40 feet MLLW to access the Medford Street Terminal is also economically justified, environmentally acceptable and otherwise in the Federal interest. This determination will be re-examined during the project design phase as use of the terminal for bulk cargo operations develops.

The deepening of the Chelsea River Channel to –40 MLLW to benefit the liquid petroleum and dry bulk terminals using this waterway is also economically justified, environmentally acceptable, and otherwise in the Federal interest, and is included in the recommendation.

Costs and benefits for each of the three smaller-scale up-harbor improvements are evaluated separately in the Feasibility Report and in the Economic Assessment (see Appendix C-2). The Main Ship Channel extension deepening (Plan D) was evaluated as an incremental improvement beyond the main channel deepening plan. The Mystic and Chelsea River deepening plans could proceed as independent improvements as their target depth of 40 feet is not greater than the existing depth of the main channels between these tributaries and the open Bay.

The economic optimization for the tentatively recommended main channel improvements (plan ABC) is shown in Table 57 below. The economic base case representing the most likely future with-project scenario is shown for each of the incremental project depths analyzed. Table 58 presents the cost for the recommended depths for Plans D, E and F.



BOSTON HARBOR DEEP DRAFT NAVIGATION PROJECT

FIGURE 46
RECOMMENDED PLAN OF IMPROVEMENT
BOSTON HARBOR, MYSTIC RIVER AND CHELSEA RIVER

TABLE 57
BOSTON HARBOR DEEP DRAFT NAVIGATION IMPROVEMENT STUDY
OPTIMIZATION RECOMMENDATION - MAIN CHANNEL DEEPENING PLAN
(in $1,000s at 3-3/4% Interest Rate)

Inner Channel Depth Entrance Channel Depth	42 Feet 44 Feet	43 Feet 45 Feet	44 Feet 46 Feet	45 Feet 47 Feet	46 Feet 48 Feet	47 Feet 49 Feet	48 Feet 50 Feet	49 Feet 51 Feet	50 Feet 52 Feet	45 Feet 49 Feet	46 Feet 50 Feet	47 Feet 51 Feet	48 Feet 52 Feet
First Cost	$89,598	$121,407	$151,653	$176,057	$204,045	$234,427	$266,870	$303,142	$350,563	$200,710	$245,015	$263,648	$297,717
Investment Cost	$91,729	$124,686	$157,728	$183,399	$212,891	$244,978	$279,766	$322,368	$379,403	$209,411	$256,042	$277,707	$315,091
Annual Cost	$4,311	$5,791	$7,261	$8,410	$9,734	$11,174	$12,732	$14,643	$17,210	$9,571	$11,651	$12,641	$14,316
BENEFITS AND BENEFIT-COST ANALYSIS – BASE ECONOMIC CASE													
Annual Benefit	$6,627	$8,611	$10,049	$91,222	$96,306	$100,176	$102,555	$103,426	$103,720	$91,222	$96,306	$100,176	$102,555
Benefit/Cost Ratio	1.54	1.49	1.38	10.85	9.89	8.97	8.05	7.06	6.03	9.53	8.27	7.92	7.16
Net Annual Benefit	$2,316	$2,820	$2,788	$82,812	$86,572	$89,002	$89,823	$88,783	$86,510	$81,651	$84,655	$87,535	$88,239

Curves for

Total Annual Benefits

and

Net Annual Benefits

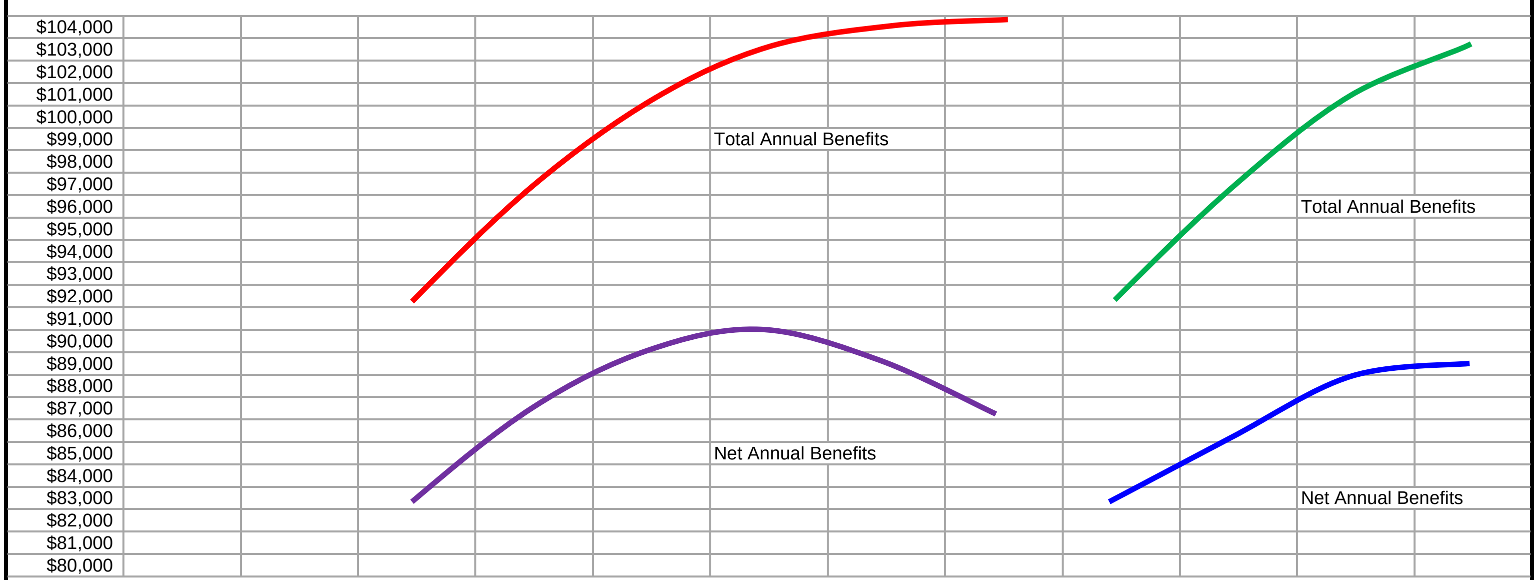


TABLE 58
BOSTON HARBOR DEEP DRAFT NAVIGATION IMPROVEMENT STUDY
RECOMMENDED PLAN SUMMARY
ADDITIONAL CHANNELS PLANS D, E AND F

	PLAN D Main Ship Channel Extension to MMT	PLAN E Mystic River Channel Deepening at MST	PLAN F Chelsea River Channel Deepening
3-3/4%	45 Feet	40 Feet	40 Feet
First Cost GNF (July 2011)	$16,730,000	$2,337,000	$11,380,000
Cost with IDC	$16,809,000	$2,337,000	$11,451,000
Annual Cost of GNF and NF Berths	$831,000	$115,000	$718,000
Annual Benefits (FY 2011)	$1,163,000	$221,000	$1,936,000
Benefit Cost Ratio	1.40	1.92	2.70
Net Benefits	$332,000	$106,000	$1,218,000
7%	45 Feet	40 Feet	40 Feet
Annual Cost of GNF and NF Berths	$1,338,000	$180,000	$1,064,000
Annual Benefits (FY 2011)	$1,163,000	$221,000	$1,936,000
Benefit Cost Ratio	0.87	1.23	1.82
Net Benefits	($175,000)	$41,000	$872,000

Cost Sharing for the Recommended Improvements

Implementation of Federal Navigation Projects under the Corps civil works authority requires non-Federal cost-sharing as required by Section 101 of the WRDA of 1986, as amended. Cost sharing is required for design and construction of projects based on the recommended project depth. For projects greater than 20 feet in depth (at mean lower low water) and up to 45 feet, the non-Federal share is 25 percent up-front plus a 10 percent contribution due following construction, which may be paid over a period not to exceed 30 years. For projects greater than 45 feet the upfront share is increased to 50 percent for the increment of the project greater than 45 feet plus 10 percent after construction. In all cases, the non-Federal share of design phase cost is required during the design phase, through execution of a design phase agreement prior to the initiation of project design.

Non-Federal cost-sharing is also required for future maintenance where the project depth is greater than 45 feet. Fifty percent of the increment of maintenance assigned to deepening beyond 45 feet must be paid for by the non-Federal sponsor. One hundred percent of the increment of future maintenance assigned to the 45-foot depth or less remains 100 percent Federal.

The three minor additional recommended improvements: Plan D – the main ship channel deepening extension, Plan E – the Mystic River Channel deepening at Medford Street Terminal, and Plan F – the Chelsea River Channel deepening, are all 45 feet or less. Non-Federal cost-sharing for these plans is 25 percent up-front and 10 percent post-construction. Table 59 displays the project cost-sharing for the recommended improvements.

Cost Sharing for Additional Depth in Entrance Channels: Provision of additional depth in the Broad Sound North Entrance Channel to compensate for increased seas and navigational safety is recommended in the project design for all depth alternatives. The entrance channel lies in the unprotected waters of Massachusetts Bay outside the relative shelter of the outer harbor islands and headlands. Sea states in the open Bay, particularly in adverse weather, increase vessel motion in terms of pitch, yaw and roll. These conditions increase the effective draft of vessels transiting the harbor entrance. Design guidance followed for the 2008 draft report concluded that an additional two feet of depth was required in the entrance channel for safe navigation considering these factors. Changes in Corps design guidance, and recent studies conducted for other east coast entrance channels necessitated another look at this situation in 2012. Pilots now estimate, and designers confirm, that an additional four feet is added to the effective draft of large container and tank vessels. Alternative plans for channel improvements include an additional four feet of design depth in the entrance to compensate for these factors. The preceding tables provide information for the plans as developed in 2008 with a two-foot difference, and for the four plans bracketing the range of greatest net benefits using the four foot difference as developed in 2012. In both cases, the 47-foot inner channels design depth was determined the appropriate recommended plan based on net annual benefits and the flattening of the benefit-cost curve at that depth.

TABLE 59
RECOMMENDED PLANS OF IMPROVEMENT
MAIN CHANNELS DEEPENING TO CONLEY TERMINAL
WITH MAIN SHIP CHANNEL EXTENSION TO MMT, MYSTIC RIVER CHANNEL DEEPENING TO MST, AND CHELSEA RIVER CHANNEL DEEPENING

RECOMMENDED PLANS OF IMPROVEMENT BY PROJECT SEGMENT Components of Recommended Plan (PLAN D, PLAN E, PLAN F) Details of Segment Increments Provided for Sponsor's Information (PLAN ABC)	PLAN ABC MAIN CHANNELS 45/49 FEET	PLAN ABC MAIN CHANNELS 46/50 FEET	PLAN ABC MAIN CHANNELS 47/51 FEET	PLAN ABC MAIN CHANNELS 48/52 FEET	PLAN D MSC TO MMT 45 FEET	PLAN E MYSTIC RIVER 40 FEET	PLAN F CHELSEA RIVER 40 FEET	TOTAL COMBINED 4 PLANS ABC-47/51 + D, E & F
FIRST COST - JULY 2011 ESTIMATE								
General Navigation Features - Construction	$188,628,000	$231,998,000	$249,405,000	$282,529,000	$15,481,000	$1,894,000	$9,960,000	$276,740,000
GNF - PED Costs	$4,830,000	$5,039,000	$5,361,000	$5,533,000	$367,000	$170,000	$394,000	$6,292,000
GNF - Construction Management Costs	$6,957,000	$7,680,000	$8,565,000	$9,327,000	$843,000	$269,000	$960,000	$10,637,000
Total GNF - July 2011 Estimate	$200,415,000	$244,717,000	$263,331,000	$297,389,000	$16,691,000	$2,333,000	$11,314,000	$293,669,000
Real Estate (LERRs)	$103,000	$106,000	$125,000	$136,000	$15,000	$4,000	$18,000	$162,000
Aids to Navigation	$192,000	$192,000	$192,000	$192,000	$24,000	$0	$48,000	$264,000
Utility Relocations	$0	$0	$0	$0	$0	$0	$0	$0
Local Service Facilities (Berths)	$338,000	$396,000	$443,000	$502,000	$1,348,000	$0	$1,493,000	$3,284,000
Total First Cost - July 2011 Estimate	$201,048,000	$245,411,000	$264,091,000	$298,219,000	$18,078,000	$2,337,000	$12,873,000	$297,379,000
PROJECT FIRST COST - CONSTANT DOLLAR BASIS - 2013 BUDGET YEAR								
General Navigation Features - Construction	$195,591,000	$240,562,000	$258,612,000	$291,080,000	$16,052,000	$1,964,000	$10,328,000	$286,956,000
GNF - PED Costs	$5,013,000	$5,229,000	$5,564,000	$5,742,000	$381,000	$176,000	$409,000	$6,530,000
GNF - Construction Management Costs	$7,220,000	$7,970,000	$8,889,000	$9,679,000	$875,000	$279,000	$997,000	$11,040,000
Total GNF First Cost - PY2013 Basis	$207,824,000	$253,761,000	$273,065,000	$306,501,000	$17,308,000	$2,419,000	$11,734,000	$304,526,000
Real Estate (LERRs)	$107,000	$110,000	$130,000	$140,000	$16,000	$4,000	$19,000	$169,000
Aids to Navigation	$199,000	$199,000	$199,000	$198,000	$25,000	$0	$50,000	$274,000
Utility Relocations	$0	$0	$0	$0	$0	$0	$0	$0
Local Service Facilities (Berths)	$350,000	$411,000	$459,000	$521,000	$1,398,000	$0	$1,548,000	$3,405,000
Total Project First Cost - PY2013 Basis	$208,480,000	$254,481,000	$273,853,000	$307,360,000	$18,747,000	$2,423,000	$13,351,000	$308,374,000
FULLY FUNDED PROJECT COST								
General Navigation Features - Construction	$201,511,000	$247,843,000	$267,635,000	$302,547,000	$16,985,000	$1,995,000	$10,492,000	$297,107,000
GNF - PED Costs	$5,055,000	$5,273,000	$5,611,000	$5,790,000	$384,000	$177,000	$412,000	$6,584,000
GNF - Construction Management Costs	$7,708,000	$8,508,000	$9,583,000	$10,528,000	$988,000	$289,000	$1,034,000	$11,894,000
Total GNF Fully Funded Cost - Escalated	$214,274,000	$261,624,000	$282,829,000	$318,865,000	$18,357,000	$2,461,000	$11,938,000	$315,585,000
Real Estate (LERRs)	$110,000	$113,000	$135,000	$146,000	$17,000	$4,000	$19,000	$175,000
Aids to Navigation	$205,000	$205,000	$206,000	$206,000	$26,000	$0	$51,000	$283,000
Utility Relocations	$0	$0	$0	$0	$0	$0	$0	$0
Local Service Facilities (Berths)	$361,000	$423,000	$473,000	$539,000	$1,479,000	$0	$1,573,000	$3,525,000
Escalated/Fully Funded Project Cost	$214,950,000	$262,365,000	$283,643,000	$319,756,000	$19,879,000	$2,465,000	$13,581,000	$319,568,000

TABLE 59 (Continued)
RECOMMENDED PLANS OF IMPROVEMENT
MAIN CHANNELS DEEPENING TO CONLEY TERMINAL
WITH MAIN SHIP CHANNEL EXTENSION TO MMT, MYSTIC RIVER CHANNEL DEEPENING TO MST, AND CHELSEA RIVER CHANNEL DEEPENING

RECOMMENDED PLANS	PLAN ABC MAIN CHANNELS 45/49 FEET	PLAN ABC MAIN CHANNELS 46/50 FEET	PLAN ABC MAIN CHANNELS 47/51 FEET	PLAN ABC MAIN CHANNELS 48/52 FEET	PLAN D MSC TO MMT 45 FEET	PLAN E MYSTIC RIVER 40 FEET	PLAN F CHELSEA RIVER 40 FEET	TOTAL COMBINED 4 PLANS
DESIGN PHASE UP-FRONT COST SHARING								
GNF PED Phase Costs (Escalated)	$5,055,000	$5,273,000	$5,611,000	$5,790,000	$384,000	$177,000	$412,000	$6,584,000
Initial Federal Share of GNF PED	$3,791,000	$3,955,000	$4,208,000	$4,343,000	$288,000	$133,000	$309,000	$4,938,000
Initial Non-Federal Share of GNF PED	$1,264,000	$1,318,000	$1,403,000	$1,447,000	$96,000	$44,000	$103,000	$1,646,000
Non-Federal Berths Design Phase Costs	$10,000	$10,000	$10,000	$11,000	$6,000	$0	$52,000	$68,000
Total Non-Federal Share of Design	$1,274,000	$1,328,000	$1,413,000	$1,458,000	$102,000	$44,000	$155,000	$1,714,000
Recovery of Sponsor 50% Share of Excess Feasibility Study Costs (EFSC)	$425,000	$425,000	$425,000	$425,000	$0	$0	$0	$425,000
Total Sponsor Design Cost-Share Due at Design	$1,699,000	$1,753,000	$1,838,000	$1,883,000	$102,000	$44,000	$155,000	$2,139,000
FULLY-FUNDED CONSTRUCTION PHASE COST SHARING								
GNF Construction Phase Costs	$209,219,000	$256,351,000	$277,218,000	$313,075,000	$17,973,000	$2,284,000	$11,526,000	$309,001,000
Non Federal Berths Construction Phase Costs	$351,000	$413,000	$463,000	$528,000	$1,473,000	$0	$1,521,000	$3,457,000
LERR Costs (Escalated)	$110,000	$113,000	$135,000	$146,000	$17,000	$4,000	$19,000	$175,000
Distribution of Excess PED Costs (If Incurred - 50%)	TBD	TBD	TBD	TBD	TBD	TBD	TBD	TBD
Initial Federal Share of GNF Construction	$156,914,000	$192,263,000	$207,914,000	$234,806,000	$13,480,000	$1,713,000	$8,645,000	$231,752,000
Initial Non-Federal Share of GNF Construction ≤45 Feet	$52,305,000	$64,088,000	$69,305,000	$78,269,000	$4,493,000	$571,000	$2,881,000	$77,250,000
Increased Non-Fed Share GNF >45 Feet (25% of Difference Greater than 45 Feet)	$0	$11,783,000	$17,000,000	$25,964,000	NA	NA	NA	$17,000,000
Additional Non-Federal GNF Design Cost for Project Depth >45 Feet (25% of Difference)	$0	$55,000	$139,000	$184,000	NA	NA	NA	$139,000
Total Non-Federal Upfront Share of GNF Construction	$52,305,000	$75,926,000	$86,444,000	$104,417,000	$4,493,000	$571,000	$2,881,000	$94,389,000
Total Federal Upfront Share of GNF Construction	$156,914,000	$180,425,000	$190,775,000	$208,658,000	$13,480,000	$1,713,000	$8,645,000	$214,613,000
Total Non-Federal Construction (GNF-LSF-LERRs)	$52,766,000	$76,452,000	$87,042,000	$105,091,000	$5,983,000	$575,000	$4,421,000	$98,021,000
SPONSOR'S POST-CONSTRUCTION CONTRIBUTION AND FINAL (ULTIMATE) NON-FEDERAL PROJECT COST-SHARING								
Post Construction Non-Fed Contribution (10%)	$21,427,000	$26,162,000	$28,283,000	$31,887,000	$1,836,000	$246,000	$1,194,000	$31,559,000
LERR Credit	$110,000	$113,000	$135,000	$146,000	$17,000	$4,000	$19,000	$175,000
Sponsor GNF Contribution Share after Credit	$21,317,000	$26,049,000	$28,148,000	$31,741,000	$1,819,000	$242,000	$1,175,000	$31,384,000
Sponsor Total GNF Cost & EFSC after Credit	$75,311,000	$103,718,000	$116,420,000	$138,030,000	$6,408,000	$857,000	$4,159,000	$127,844,000
Sponsor Total Project Costs for LS (Berths)	$361,000	$423,000	$473,000	$539,000	$1,479,000	$0	$1,573,000	$3,525,000
Total Non-Federal Project Cost (GNF + LSF)	$75,672,000	$104,141,000	$116,893,000	$138,569,000	$7,887,000	$857,000	$5,732,000	$131,369,000
POST-CONSTRUCTION FINAL (ULTIMATE) FEDERAL PROJECT COST-SHARING								
Federal Share of Design Phase	$3,791,000	$3,955,000	$4,208,000	$4,343,000	$288,000	$133,000	$309,000	$4,938,000
Federal Share of GNF Construction	$156,914,000	$192,263,000	$207,914,000	$234,806,000	$13,480,000	$1,713,000	$8,645,000	$231,752,000
Minus Sponsor 10% Contribution after LERR Credit	($21,317,000)	($26,049,000)	($28,148,000)	($31,741,000)	($1,819,000)	($242,000)	($1,175,000)	($31,384,000)
Plus LERR Credit	$110,000	$113,000	$135,000	$146,000	$17,000	$4,000	$19,000	$175,000
Total Ultimate Federal Investment - Civil Works GNF	$139,498,000	$170,282,000	$184,109,000	$207,554,000	$11,966,000	$1,608,000	$7,798,000	$205,481,000
Aids to Navigation Costs (USCG)	$205,000	$205,000	$206,000	$206,000	$26,000	$0	$51,000	$283,000

ER 1105-2-100, 22 April 2000, Appendix E, Part II (E-8)(b)(2), Page E-23 provides that cost-sharing for a deeper entrance channel in such situations is the same as for the deepest reach of the interior channels. This effects the cost-sharing for alternative channel depths where the interior channels are deepened to 45 feet or less (25 percent non-Federal up-front cost-share) and the entrance channel is deepened to greater than 45 feet. In the absence of this regulation, the cost-sharing for channels greater than 45 feet is increased to a 50 percent non-Federal up-front cost-share. For the recommended main channels improvements at Boston the interior channels would be deepened to -47 feet MLLW while the entrance channel would be deepened to 51 feet (four feet deeper). According to the ER, the cost-sharing for entrance channel depths would increase only in alternative depth increments where the interior channels would be deepened beyond 45 feet.

REMAINING FEASIBILITY PHASE TASKS AND SCHEDULE

Feasibility Report and SEIS/EIR Schedule

As stated above, the public review period for the Draft Feasibility Report and Draft SEIS/EIR closed on 2 June 2008. The Draft Feasibility Report and Draft SEIS/EIR were also concurrently submitted to the Corps Planning Center of Expertise for Deep Draft Navigation at the Mobile District for Independent Technical Review and External Peer Review. The Draft SEIS/EIR augments the Boston Harbor, Massachusetts Navigation Improvement Project and Berth Dredging Project final EIS/EIR dated June 1995, and the May/June 2006 SEIS prepared for the Inner Harbor Maintenance Operation.

The project was reviewed by the CWRB at its August and September 2008 meetings, following which the District was requested to conduct additional economic investigations in support of its container-shipping benefits assessment. Scoping of those additional studies was carried-out during 2008 and 2009, and the initial studies were concluded in 2010. Review and additional analyses were carried out in 2011-2012, after which a final recommendation for project depth optimization was made as described earlier.

The Final Feasibility Report and Final SEIS/EIR have been completed and Agency Technical Review of the revised report was conducted in January/February 2013. The final reports were then submitted to Corps Headquarters for re-presentation to the CWRB along with proposed draft reports of the North Atlantic Division Commander and the Chief of Engineers. Once approved by the CWRB the remaining steps in the Feasibility Phase are as follows:

- Circulation of the Draft Chief of Engineers Report State Executive and Federal Department review, concurrent with public notice and opportunity to comment on the Final Feasibility Report and FSEIS/EIR,
- Publication of the Record of Decision by the Assistant Secretary of the Army for Civil Works
- Preparation of the Final Chief of Engineers Report and transmittal of the Chief's Report and project documents to Congress
- These actions would conclude the Feasibility Phase of the project.
- The Design Phase would then begin contingent on funding and the execution of a Design Agreement with the project sponsor.

Public Involvement

The District and Massport released the Draft Feasibility Report and SEIS/EIR for agency and public review on 11 April 2008, with advance notice to the Governor and Congressional interests, publication of the Notice of Availability on the Federal Register on 18 April 2008, and publication in the Massachusetts Environmental Monitor on 23 April 2008. Press releases and other advance materials consisting of project summaries and fact sheets were also distributed to Congressional interests and other interested parties. A public information meeting was held 20 May 2008 in South Boston to provide a further opportunity for public comment. Meetings of the TWG for the project were also held on 19 May and 21 June 2008. Consultations with individual Federal and State regulatory agencies on specific topics of interest to the agencies were also held.

Between 2008 and 2012 the District and Massport kept the Federal and State agencies and other interested parties informed of progress on the study through the New England Regional Dredging Team meeting, the State Dredging Team meetings hosted by MACZM, the Port Operators Group meetings, and other outreach. Once the additional economic analyses were concluded and the final recommendation on project dimensions made, the Boston Harbor Technical Working Group was re-convened on 3 December 2012. The TWG will continue to meet during the final reviews of the Feasibility Report and Final SEIS/EIR to provide input into the methods used for environmental analysis. The TWG will also continued to meet during the design phase to provide guidance to the Corps and Massport on project implementation issues including opportunities for additional beneficial uses for dredged material, air quality mitigation needs, and project construction sequencing.

Technical Review and Documentation

The Planning Center of Expertise for Deep Draft Navigation (PCX), the Corps South Atlantic Division (SAD) through its Mobile District (SAM) coordinated the Agency Technical Review (ATR) of the Draft Feasibility Report and SEIS/EIR, and other documents prepared for submission during the project review process. Prior to the initiation of PCX involvement in ATR for feasibility studies which were already underway at the time the PCX was established, the New England District had already engaged the New York District (NAN) in ATR of the economic analysis and cost estimates for rock removal. The PCX agreed to continue the role of NAN as the principal ATR performing organization for this study. ATR review activities were continued throughout the process of scoping and conducting the additional economic analyses and in review of the revised Economic Assessment between 2008 and 2012. A project review plan incorporating this framework has been updated and posted to the project's website on the District homepage. Additional review of cost estimates for projects of this size is performed by the Corps directorate of expertise for cost estimating at its Walla Walla District (NWW). NAN and NWW provided technical review of the project documents for the AFB Report (August to September 2007), the draft Feasibility Report and SEIS (April to June 2008), and the draft final Feasibility Report and SEIS (July 2008), and the revised final feasibility report and FSEIS (November/December 2012). Technical review comments have been addressed in the Final Feasibility Report and Final SEIS/EIR.

Independent External Peer Review Requirement

Independent External Peer Review (IEPR) involves review of project decision documents by a panel of subject matter experts drawn from outside the Corps and managed by an independent contractor. Until 2008 the Boston Harbor study had been exempt from IEPR requirements as the FCSA had been signed in 2002, prior to the effective date of the IEPR guidance. The PCX advised that IEPR would be required for this project due to its scope, as new guidance and language in the WRDA of 2007 also required IEPR for any project with a first cost of more than $45 million. Despite the non-controversial and straightforward nature of the study and its recommendation, the sheer cost of the recommended improvement, more than $300 million, necessitated an external review. The PCX coordinated an IEPR of the draft Feasibility Report and Draft SEIS/EIR concurrent with public review of the Draft documents in the spring of 2008. The IEPR comments were received by the District on 3 June 2008. The responses to these comments by the District, Massport and their contractors were prepared and shared with the vertical team prior to the August 2008 CWRB meeting.

After the CWRB's request for additional economic studies, the Framework for these studies was submitted to the IEPR team for input. The IEPR team responded that completion of these studies would address their concerns with project economic justification.

Legal Review and Certification

The Draft Feasibility Report and Draft Supplemental Environmental Impact Statement/EIR were reviewed by District and Division counsel prior to approval for public release and review in April 2008. The Draft Final Feasibility Report and Final SEIS/EIR were reviewed by District and Division counsel prior to submission to Headquarters for the August CWRB meeting. The Final Feasibility Report and Final SEIS/EIR must also be reviewed and certified as legally sufficient prior to submission for re-consideration by the CWRB in 2013. No special issues are anticipated.

Civil Works Review Board

All General Investigations recommending project implementation with a total cost of more than $10 million are required to be presented to the Civil Works Review Board (CWRB). The CWRB is composed of high-level Corps officers and staff from the Office of the Assistant Secretary of the Army for Civil Works (ASA(CW)), and the Office of Management and Budget (OMB). The Corps District and Division Commanders, Headquarters review staff, and the Sponsor each presents their views on the recommended project and respond to questions raised by the Board. The Board meeting is held after submission by the District and Division Commanders of their proposed final reports and the draft Chief of Engineers Report. The Board votes on whether or not to recommend release of the draft Chief's report referring the project for authorization.

As described above the project and reports were presented at the CWRB meetings of August and September 2008, after which the Board requested additional economic studies be performed on project depth optimization. The project with its final recommendation will be re-presented to the Board in the spring of 2013.

Chief of Engineers Report

Upon approval at the Washington level, including favorable action by the Civil Works Review Board, the Draft Chief of Engineers Report would be circulated for comment accompanied by the Division Engineer's report and the Final Feasibility Report and Final SEIS/EIR. Comments will be solicited from the Federal Departments and Agencies, State and Municipal Agencies and the Governor of Massachusetts. Availability of these documents to the public will be provided through Public Notice and the Federal Register.

Following review of those documents, and resolution of any significant comments received, a Final Chief of Engineers report would be submitted for transmittal to Congress in answer to the Resolution calling for this study. The Assistant Secretary of the Army would issue a Record of Decision on the Final SEIS and publish that ROD in the Federal Register. The Chief's Report would then be forwarded to Congress for consideration. These actions would conclude the Feasibility Phase of the project. The Design Phase would then begin contingent on funding.

DESIGN PHASE INVESTIGATIONS

The design phase of the project, known as Planning, Engineering and Design, or PED, will complete any necessary field investigations needed to support detailed design of the project, prepare and publish any supplemental NEPA/MEPA documents if needed to present design phase investigations and to cover significant changes made in the project during design phase, secure any amended regulatory approvals required due to design changes, and prepare the documents necessary to solicit bids for the project.

The Feasibility Report includes a list and estimate of the costs of the several tasks to be undertaken in the design phase. These include: subsurface investigations to define the exact nature of hard materials at depth and differentiate between rock and other materials; development of several "plans" in consultation with the Technical Working Group as detailed below (blasting mitigation plan, project construction sequencing plan), further investigation and recommendation on potential beneficial uses of rock and other dredged material, and development of monitoring plans for various aspects of the project. Funding for the design phase can not be accessed until the final Feasibility Report is approved and forwarded to Congress.

The Design Phase investigations will yield more detailed data on the several technical issues and topics listed in the discussions below. A number of these may result in changes to or refinements of the Federal project base plan, and may require preparation of supplemental NEPA/MEPA documents to present findings and recommended actions consistent with those investigations and negotiations with the Federal and State agencies,, other TWG participants, and seek public comment. One or more supplemental NEPA/MEPA documents may be prepared to address these changes. At this time the following principal study areas are expected to be covered:

- Conduct Design Phase subsurface investigations, revised dredged material quantities and subsequent preparation of the blasting mitigation plan if necessary.

- Conduct Design Phase resource characterization efforts and dredge area monitoring baseline for impacts and recovery of the benthic environmental, fisheries and shellfisheries.
- The rock reef habitat creation opportunity will be further investigated with the NMFS, EPA, the State, and other interested TWG members. Modification to the site selection, site investigations, reef design, placement methods, and recolonization monitoring will, if any proposal is found desirable and feasible, be developed in concert with these agencies.
- Evaluate other beneficial use opportunities for rock. Once final rock quantities, types and locations are known, that material's potential for beneficial use other than reef creation will be further investigated with the State and local communities.
- The use of dredged material to cap the former Industrial Waste Site will require U.S. EPA approval to permit placement of these materials as cap at that site.
- Develop detailed construction sequencing plan drawing from the dredged materials estimates, blasting mitigation plan and resource characterization effort.
- Air Quality emissions conformity will be further evaluated, with assistance of US EPA, MADEP and other interested TWG members, to determine if mitigation requirements may have changed due to anticipated changes in attainment reulations by EPA in 2013, if any more cost-effective means of meeting the emissions requirements exist other than construction period shutdowns. Availability and cost of credits and offset opportunities will be investigated. Adjustments to the construction sequencing plan would be made according to whatever final means of meeting air quality requirements is selected.

Detailed discussions of each of these topics are provided below. The Corps and Massport have also committed to continuing involvement of the TWG throughout the design and construction of this project. During the last several major projects for Boston Harbor, the Boston Harbor Dredging Technical Working Group (TWG) has continued to meet and serve as a means for soliciting comment, input and advice from the participating agencies and organizations during the design and construction of those projects. The TWG will be involved in the process both as a means of outreach to the participating parties, and as a means of engaging and soliciting technical input on design phase investigations and adaptive management during construction and any post-construction monitoring. In addition, interested agencies from the TWG are invited to participate in sub-groups to help develop and comment on specific plans for blasting mitigation, construction sequencing, and consideration of beneficial use options for the rock and dredged material, as described below. The TWG would continue to include Federal, State and municipal agencies with a regulatory interest in the harbor and port, and those established non-governmental organizations (NGOs) with the technical expertise and experience critical to developing and providing comment on the necessary investigations and planning for detailed design of the project.

Subsurface Exploration Program and Development of the Blasting Plan

The design phase of the project includes an extensive boring and probing program to supplement and refine the results of the acoustic surveys and historic boring data that the Feasibility Report relied on for its estimates. This work is critical to most of the remaining design efforts and will be accomplished during the first year of the design phase. Once the subsurface exploration program is completed, the division between rock and glacial till, and the exact nature of the rock to be removed, will be understood. In the Feasibility Report, all hard material identified by the acoustic surveys is classified as rock requiring blasting for removal. This is assumed to be a worst case scenario, as prior work at Boston and other New England harbors in recent years has shown that acoustic surveys overestimate the volume of bedrock.

Once the subsurface design effort is completed, the Corps will determine whether or not blasting may still be required for all or part of the rock to be removed from each project segment. Using this information, the Corps and Massport will work with interested TWG agencies to develop a blasting mitigation plan for the project. The blasting mitigation plan will be developed in concert with the larger construction sequencing plan (discussed separately) for the entire project. The blasting mitigation plan will address environmental concerns as well as structural concerns. Funds are included in the design phase estimate for these analyses.

The subsurface effort may show areas where rock can be removed economically by means other than drilling and blasting. During construction of the last Boston Harbor Navigation Improvement Project between 1998 and 2001, areas of rock in the Reserved Channel Turning Area and in the inner confluence at the Head of the Main Ship Channel were removed by ripping the ledge with a large toothed bucket. The cut into the ledge in those areas was approximately two to eight feet, and those outcrops at that shallow depth were sufficiently weathered and fractured to permit this method of removal. Some strata, while not sufficiently fractured to permit bucket ripping, may prove removable by other mechanical means, such as a large hydraulic hammer, as has been possible in limited areas with the deepening of the Elizabeth River Channel in New Jersey. A hydraulic hammer was used in the spring 2008 removal of several small rock pinnacle areas in the Broad Sound North Entrance Channel. Some rock areas for the Boston Harbor Deep Draft Improvement Project may lend themselves to similar methods of removal without drilling and blasting. The design phase will provide results to indicate whether this may be the case or not.

However, some level of caution is in order. The depth of the rock cut at Boston is up to eight to fifteen feet in many areas, as the channel is being deepened from -35/40 feet at mean lower low water (MLLW) down to 47/51 feet MLLW in the inner harbor and entrance channel, respectively, with an additional required removal depth of 2 feet in rock, and a 2-foot allowable overdepth in all materials. Rock at that depth is less likely to be weathered or fractured sufficiently to avoid a need for blasting. Removal by rock hammer typically takes a longer time than blasting, and creates significant and more constant noise than drilling and blasting. The blasting estimates for the Boston Harbor Deep Draft Improvement Project currently call for two drill barges, each with a three-gang drill rig, with one blast daily for each, a process that would take about two years for this project. A rock hammer would work around the clock, except when it moves between areas to allow a dredge to remove what has been fractured.

At this time, a few predictions as to likely components of any blasting mitigation plan can be made. For project construction to proceed on schedule, with minimal interruption and minimal excess mobilization-demobilization costs, drilling and blasting operations will need be underway in some area(s) of the harbor at most, if not at all times. Due to weather and sea state concerns, drilling and blasting in the Broad Sound North Entrance Channel would not likely occur between mid-December and late March. Drilling and blasting in the Main Ship Channel may be restricted by anadromous fish runs at certain times of year. Fisheries observers and marine mammal observers would be present on the drilling and blasting plant. Fish detection and fish startle systems would be employed. Additional means of avoiding fish kills during blasting, such as bubble curtains, will be investigated. Divers or some other means of determining whether kills of non-floating fish have occurred will be considered by the agencies. In the Boston Rock Removal Project in 2007-2008, divers who were deployed to the channel bottom after the blast events did not observe any fish or lobster kills. During the 2012 blasting of rock pinnacles in the lower Main Ship Channel the startle system was deployed from a separate craft at a greater distance and no fish kills were observed.

For the Main Ship Channel Extension segment that extends up-harbor to about 1,000 feet downstream of the tunnel, the Corps and Massport will coordinate development of the blasting plan with the Massachusetts Turnpike Authority, the owners of the I-90 (Ted Williams) Tunnel. If necessary, blasting operations will be adjusted to ensure no impact to the tunnel, including the monitoring of test blasts and adapting the final plan to those results.

The blasting efforts conducted for the ledge pinnacle removal project in 2007-2008 employed several means of avoiding and minimizing fish kills, including use of the fish observer and a fish startle system, and blast hole stemming. Even so four of the blast events in November and December of 2007 resulted in fish kills of varying size. An After Action Report was prepared by the Corps on these occurrences and coordinated with the NMFS and other TWG members. For the 2012 rock removal work the contractor performed measurements of sound transmission from blast events and used that data to establish the watch radius for the fish stale system vessel that circled the work area. A report on those measurements is included in Appendix Z. Also in the most recent project the startle system was located on a separate vessel than the blast barge which proved very effective since that project had no fish kill events.

In response to comments from NMFS and others, the potential for noise in the water generated by blasting to impact whales in Massachusetts Bay was also investigated. The results of that investigation have been included in the FSEIS. The investigation concluded that noise would be confined to the short distance from the blast site of no more than 3,000 feet, with allowance for an additional safety zone outside the calculated noise impact zone. The nearest concentrations of whales in the Bay are located several miles seaward around Stellwagen Bank. The potential for blasting noise to interfere with the whale-tracking buoy system in Massachusetts Bay will be investigated during the Design Phase. The nearest of these buoys is located in the shipping lanes seaward of the precautionary buoy, about 10.5 miles east of the seaward-most blasting area in the entrance channel.

Benthic Resource Characterization and Recolonization Monitoring Studies

The benthic community in Boston Harbor has changed dramatically since the cessation in 1991 of sludge disposal in Boston Harbor, the conversion in 1998 of wastewater treatment from primary to secondary treatment, and the relocation of the wastewater discharge outfall from Boston Harbor to Massachusetts Bay in 2000. This is particularly true in the northern part of the harbor, where the proposed Deep Draft Project is located, where an increase in species diversity and numbers has been observed.

Benthic grab samples were collected from the navigation channels in 2003. Infaunal communities within the project study area are clearly separable into two geographic regions. The first extends from the innermost region, the Mystic and Chelsea Rivers to the vicinity of the Reserved Channel. Within this region, infaunal abundances are very low to low, and species numbers are also very small or small. The second region extends from the Reserved Channel to the mouth of the harbor and includes the Lower Harbor, Main Ship Channel, and President Roads Anchorage Area. Infaunal abundances here range from medium to large and species numbers range from medium to large. Infaunal abundances in the Outer Harbor (the entrance channels) are somewhat lower, but the species numbers are similar, than those in the Lower Harbor, Main Ship Channel, and President Roads Anchorage.

The variation in species diversity and abundance can be partially related to the substrate type and the location within the harbor. Physical samples were collected in 2002 to determine grain size of the material to be dredged. The results of these tests show that the improvement material corresponds to the sidescan and sub-bottom profile data. That is, coarser grained (predominantly sand and gravel in the Outer and Lower Harbor) and finer grained sediment (clay) in the upper portion of the harbor and rivers. After improvement dredging of the Chelsea River and Mystic River in 2000, the underlying parent material composed mostly of Boston blue clay was exposed. Until this material is reworked, or silt overlays the blue clay, very low numbers of benthic organisms were or will be observed in this habitat.

Deepening the navigation channels could change the substrate composition, in particular the Lower and Outer Harbor. In areas where recent maintenance or improvement dredging since 1998 has exposed parent glacial material (clay, till and bedrock) the proposed deepening will not be likely to change the current condition as recovery of these areas has not yet been completed. In some areas channel deepening will expose a different substrate. Bedrock exposure will increase slightly as the deepened channels will be closer to the bedrock basement. Appendix Q to the Feasibility Report/SEIS/EIR contains maps which compare the various harbor bottom classifications for the existing condition with improvement for either a 45-foot or 48-foot channel system. Overall the exposed areas of bedrock and course till will increase as channel depth increases.

Pre- and post-monitoring of the benthic and shellfish community is proposed for the various channel segments to document a baseline and to monitor the extent of recovery over time and potential changes in the infaunal and macrofauna benthic community. Potential monitoring may include Sediment Profile Imaging (SPI) camera, benthic grabs, lobster traps (vented/ventless), divers to conduct early benthic phase lobster surveys, and/or a towed camera. Pre-construction baseline characterization surveys would be conducted during the design phase and no more than one year before construction. Post-construction monitoring would be conducted beginning one year after construction has been completed, and three to five years post construction, Monitoring will require cost sharing with the project sponsor. Input from the Technical Working Group participants would be solicited on the details of the monitoring plan. The results of any additional resource characterization investigations and detailed monitoring plans may be published in a supplemental NEPA/MEPA document.

Beneficial Use of Rock - Investigation of Potential Rock Reef Sites

The Corps and Massport would prefer to find an acceptable beneficial use for the approximately one million cubic yards of rock that would be generated by the improvement project, rather than merely placing it in 300 feet of water at the designated Massachusetts Bay Disposal Site (MBDS); the current base plan. Rock and other dredged material should always first be considered as a public resource rather than something to be disposed of. Many environmental resource agencies raise concerns about the potential loss of hard bottom habitat when dredging of hard bottom is proposed at any project in New England. Accordingly the Corps first consideration was to reuse this excess rock material to create new hard bottom habitat. However, some resource agencies believe that creation of additional hard bottom habitat in Massachusetts Bay at the expense of covering existing soft-bottom habitat may not be desirable.

In order for the Corps to recommend including such a beneficial use component in the project it must either (1) entail no or minimal additional cost to the Government, (2) have any additional cost paid for by non-Federal interests, or (3) involve a use where the benefits of that use outweigh the additional cost, and have any additional cost to the project cost-shared between the Corps and a non-Federal public agency. Accordingly, a zone of feasibility for reef creation siting was established whereby the reduced hauling costs to the more distant MBDS would offset by any additional project costs for beneficial use site investigations, controlled dumping practices, and monitoring of site recovery and recolonization.

The intent of the reef creation option was to create hard-bottom habitat, not merely for adult lobster, but also other species that prefer this type of bottom. However, reaching a consensus among State and Federal agencies on the desirability of any specific plan was not possible without first having the detailed data that would be generated during the forthcoming design phase of the project.

The five candidate reef creation sites were selected with input from the local lobstermen and the State marine fisheries staff at a meeting held on 3 August 2004. The charge was to identify large areas where existing rocky habitat was less represented than sandy or softer substrates. The analysis to date as presented in the Feasibility documents was limited to bottom types, bathymetry, Essential Fish Habitat, and benthic resource characterization. As no real consensus developed among the Federal and State agencies during the feasibility study as to the desirability of reef creation in Massachusetts Bay, additional examination was deferred until the design phase, when more specific information on the quantities and types of rock and other hard materials to be generated by the project would become known. Other reviewing agencies also identified concerns about the desirability of replacing soft-bottom habitat with rock reefs that may take years to colonize, and would supplant the functions and value of the existing soft-bottom habitat at these sites.

In response to Federal and State agency concerns expressed during meetings of the project's Technical Working Group, the District has committed to working with these agencies during the design phase to examine these issues, define the exact type and quantity of materials available for such use, and examine alternative uses and candidate sites in greater detail to determine the value of the existing habitat relative to the anticipated value of the reefs. Should reef creation proceed, technical design issues such as mound width and elevation, mound spacing, setbacks from existing hard bottom areas, cultural resource presence and protection, and targeted species will all require determination. A plan for monitoring recovery and recolonization of any constructed reef site will also be developed. Some State agencies have suggested that perhaps only half, or some other portion, of the rock should be made available for reef creation, and making the rest available for other uses if found feasible (see next comment).

If it is determined that rock reef creation is desirable and feasible, and will be included in the final design of the Federal Navigation Improvement Project, then the results of the additional investigations, reef design, and habitat recovery monitoring plans will be coordinated with the appropriate regulatory agencies .

Investigations of Other Beneficial Uses for Rock from the Project

In addition to reef habitat creation, some or all of the rock removed could prove suitable for other beneficial uses. Making the rock available to industry for processing as aggregate or for other construction purposes has been mentioned. Making the rock available to State agencies or area municipalities for use in public projects, particularly shore protection, has also been mentioned. Some of these are discussed below. The design phase of this project will include consultation and collaboration with these agencies and others to determine what economically practical beneficial options may exist.
The Massachusetts Office of Coastal Zone Management (MACZM) is working with other State agencies and industry to identify other potential beneficial uses of the rock beyond reef creation. However, without knowing exactly when the Navigation Improvement Project will be authorized and funds appropriated for construction, it is difficult to generate interest or get any commitment from other parties to take the rock. In 2008 only only one construction contractor expressed interest in the rock.

Massport, MACZM and the Corps are discussing how making the rock available to upland users might be accomplished without increasing the cost to, or delaying the construction of the navigation project. The three agencies met on 18 June 2008 with the contractor identified by the State to discuss the nature of the rock material expected to be removed and limitations the dredged process would place on that material and opportunities for rehandling, processing and re-using that material. Massport is investigating whether some of its waterfront property may be available for and capable of rehandling this material ashore. The Massport Marine Terminal and the Boston Autoport are possibilities. Other non-Massport properties such as the Fore River shipyard site in Quincy or partnerships with existing dry bulk terminals like Eastern Minerals should also be explored by any party interested in receiving this material.

Processing this material for aggregate, or use for specific construction projects, including shore protection, would require significant effort. Should the State or a private party agree to accept the rock at the dredge, or pay to rehandle material ashore at some point on the harbor, the Federal Deep Draft Navigation Improvement Project would save some of the transportation cost associated with placement of the rock at the designated ocean site.

Rock removed by dredging will be of a wide range of sizes in any particular scow-load; likely ranging from fist-sized up to several tons. There will be no ability to pick and choose particular sizes of rock from any particular scow-load on the water without causing significant construction delays and increasing costs. Any sorting or processing would need to occur onshore. That said, there are at least two large public shore protection projects proposed in close proximity to Boston Harbor (Winthrop Shores and Nantasket Beach) that might benefit from receipt of this material if it proves to be of a type suitable for those projects, and it can be transported and processed for such use economically compared to other sources for the needed materials.

The State and the Department of the Interior have also alluded to a need for stone as shore protection to stop sections of some of the harbor islands from eroding. Most of the harbor islands are included in both a State Park and a National Recreation Area. The Corps and Massport will consult with the agencies managing these islands during the design phase to determine if such needs can be reasonably met, and whether these agencies are willing to undertake the rehandling and additional transportation costs for these uses and sites.

Once the design-phase subsurface investigations (one of the first design-phase tasks to be performed) have been completed, more exact estimates of rock type and volumes will be known. Estimates can then be made of production rates and potential uses. The Corps and Massport have committed to working with the State to identify any practicable beneficial uses beyond in-water placement once the design phase data has been developed.

Any changes to the Federal base plan for disposal of the rock at the MBDS may require publication of such changes in a supplemental NEPA/MEPA document. Should new proposals for reuse of the rock involve non-Federal projects, then the project proponent would need to fund and conduct any necessary investigations and documentation, and secure all regulatory approvals needed for such use or project(s) before a contract for the construction of the navigation project is solicited.

Beneficial Use of Non-Rock Dredged Material – Former Industrial Waste Site Capping Potential and Demonstration

The Corps and the U.S. Environmental Protection Agency have proposed using some or all of the non-rock dredged material to create a cap atop the former Industrial Waste Site (IWS) located in Massachusetts Bay north of and partially overlapping the existing Massachusetts Bay Disposal Site (MBDS). As outlined in the Draft Feasibility Report, SEIS and EPA's memorandum included in Appendix R, capping the IWS would remove any remaining potential conflict between fishing activities in the Bay and the sediments and disposed materials at that site. While the barrels and containers used to dispose of chemical and medical waste at the IWS from the 1940s to 1970s have largely deteriorated, sampling in the 1990s showed no contaminant levels of concern. However, EPA has indicated that radiological waste disposal containers have been found still intact. Dragger trawl scars are visible throughout the site, and fishermen occasionally bring up corroded waste containers. EPA believes there remains a potential for fishing activity to disturb exposed barrels and sediments at the site. EPA and the Corps believe that the 11 million cubic yards of clay and other parent sediments to be generated by the harbor improvement project represent a one-time opportunity to cap the IWS and isolate any of its sediments and debris from the environment.

The principal concern discussed in the Feasibility Report and SEIS, and voiced by other agencies, is whether or not such a capping operation can be designed and accomplished in a manner that would limit the disturbance and resuspension of existing bottom sediments at the IWS, which may contain some of the dumped waste materials. To address these concerns, and to develop a better understanding of the methods and feasibility of such a deep water capping operation using largely clay material, the Corps conducted a demonstration project in 2008 using Boston blue clay material dredged from Boston Harbor as part of the Boston Inner Harbor Maintenance Dredging Project. In that demonstration, described earlier and shown in Figure 41, the Corps placed clay in rows at an undisturbed site in the MBDS well removed from the IWS. The demonstration sought to minimize displacement of existing bottom sediments by targeting disposal of each scow load to the flank of the mound line created by prior disposal loads. Monitoring and results of the demonstration is being coordinated with the TWG agencies.

Design phase investigations by the Corps and EPA, including the results of the capping demonstration effort, may lead to a decision not to pursue capping of the IWS using the dredged materials from the Boston Harbor Deep Draft Improvement Project. In that case, the Federal base plan for disposal of those materials at the MBDS would be followed, unless another cost-effective beneficial use can be identified. EPA would need to provide permission for placement of dredged materials in areas of the IWS now outside the designated MBDS boundary.

Construction Sequencing Plan Development

The design phase of the project will include development of a Construction Sequencing Plan to limit the impact of construction activities on harbor resources to the extent practicable. The Corps and Massport will work with interested TWG member agencies to develop this plan in a manner similar to the development and adaptive management of the blasting mitigation plan and process. Once the design-phase subsurface exploration program is completed the division between rock and glacial till, and the exact nature and quantities of all dredged material, will be determined. A rock removal plan will then be developed for each separable project and each channel segment. The final determination of the extent of air quality compliance mitigation required and methods to be used for the project will also be determined. This will permit a determination of construction durations for each separable biddable piece of the project.

Critical times of year and geographic distribution within the harbor for various species of concern will be developed after additional resource surveys have been completed and with input from the TWG agencies. These spatial and temporal restrictions will be charted along with the project construction durations. A best fit of construction activities relative to resource concerns will then be developed. The intent will be to minimize to the extent practical any conflict between construction and resources, while permitting the project to proceed with minimal interruption and impact. The construction sequencing plan will be published in a supplemental NEPA/MEPA document.

Air Quality Compliance Methodology and Alternatives

The method presented in the Draft Feasibility Report and SEIS/EIR used construction activity shut-down periods, in combination with a requirement that construction equipment meet projected 2011 emissions requirements, to ensure that construction plant emissions did not exceed compliance thresholds. This prevented the need for the project to undergo a general conformity analysis that would require offsetting 100 percent of the project's construction emissions. While the shut-down method does keep the project in compliance with emissions limits, it extends the construction period by the total of the shutdown terms, delaying project benefits. Project costs are also increased by additional demobilization and remobilization costs, and additional cost escalation for the extended construction duration. Delaying the completion of the project by six months or more would also delay the start of benthic recolonization and ecological recovery of the dredged areas where work was delayed. The Corps and Massport would prefer an approach that further reduces or offsets emissions from project construction if a cost-effective source or method can be identified during the Design Phase.

The Draft Feasibility Report and SEIS/EIR stated that the Corps and Massport would revisit the air quality question during the design phase as construction durations for the various project segments became more defined by design level investigations. Several commenters questioned why commitments to other methods couldn't be made at the Feasibility phase. Construction equipment used for this project would be required in the project specifications to have more efficient cleaner burning technologies so as to be compliant with EPA's 2011 tier 3 and tier 4 emissions standards. Even with this requirement, annual emissions thresholds for some pollutants would be exceeded without further reduction measures. Without construction shutdowns to limit emissions in any one calendar year to below the conformity threshold level, the project would need to mitigate 100 percent of all emissions through some combination of emissions credits or emissions reduction offset measures. Substitution of any of these measures would require a general conformity analysis and additional public notice and opportunity for comment. Even so, such methods may prove less costly than construction shutdowns and require further consideration during project design once the extent of required ledge removal and other components of a construction sequencing plan are better known.

During the preparation of the Draft Feasibility Report and DSEIS/DEIR, available sources of credits were investigated. Credits need to be for the pollutant that needs to be mitigated, for the year(s) in which the project would occur, and from the same non-attainment area as the project. While credits that meet these requirements may be available, it is not known exactly when Congress would authorize the project, or when project construction funds would be appropriated. The Government can not commit to expenditure of construction phase funds until after authorization and appropriation. Until then no commitment can be made to any holder of credits that the Government will actually purchase those credits. As credit holders are looking for a purchase commitment for a specified time, no commitment to use credits for this project can be made until more is know about the project's authorization and funding timeline towards the end of the design phase.

An alternative compliance option is offsets; investments in new technology or replacement of existing sources of emissions with more modern less emitting sources. Some offsets used for other recent navigation projects outside New England include refitting existing vessels with new cleaner engines, and replacement of municipal vehicle fleets in part with alternative fuel vehicles. The Corps and Massport will continue to explore potential offset opportunities during the design phase and will discuss these options with the TWG and agencies.

Project measures to demonstrate Air Quality Conformity cannot be finalized in the Feasibility Phase due to factors such as uncertainties in the project timeline, the availability of credits in the years that they would be required to offset construction- related emissions, and the potential for conformity regulatory changes to occur in the near term. The only means of complying with air quality requirements that is certain at the Feasibility Phase is construction period shutdowns that avoid exceeding the emissions thresholds and thus avoid triggering general conformity analysis. The Corps and Massport concur with reviewers of the Draft Feasibility Report and Supplemental EIS/ EIR that alternative Air Quality compliance strategies that result in real reductions in construction air emissions should be considered when additional information can be developed. Although not currently eligible for consideration in the Conformity Analysis, it should be noted that a key benefit of the proposed harbor deepening is the regional reduction of on-road emissions as a result of more New England based cargo being handled through the Port of Boston.

The Air Quality analysis will be re-examined following the Design Phase field investigations and development of a construction sequencing plan to determine if a more desirable and cost-effective means of compliance exists that would mitigate emissions rather than merely deferring them over a longer construction duration with shutdowns. The Corps and Massport are committed to working with EPA, the State, and interested TWG participants with experience in Air Quality mitigation issues to develop an appropriate air quality compliance strategy, should one still be required. This could be accomplished through establishment of a formal TWG Air Quality subcommittee. EPA has proposed changes in the attainment designations for the Boston area which could be published by July 2013 and would likely reduce the mitigation requirements for the project with respect to one or more pollutants. Changes in Federal and State standards and implementation plans will be incorporated into the revised analysis at that time. Should any change in the method of ensuring compliance of the project with air quality requirements result from this review, the Corps and Massport would give notice of these changes to the public and provide an opportunity for public comment through the General Conformity analysis and review process.

STATUS OF FEDERAL AGENCY SUPPORT

The US EPA, NMFS, US Coast Guard, and US F&WS have been actively involved in the study as participants in the Technical Working Group and other outreach forums. The Public Involvement Appendix for the Feasibility Report and SEIS/EIR details the public involvement plan for the project, the results of those efforts, the comments of the public and agencies on the Draft Feasibility Report and SEIS/EIR, and a comment-response section addressing those comments. Following final identification of the recommended project depth in the fall of 2012, the Corps re-initiated coordination with Federal and State agencies and the TWG for the project was reconvened. The extent of coordination on the study has allowed some of these agencies to make early commitments on the acceptability of the project and assist in the development of planning for such features as dredged material disposal and beneficial use.

Further refinement of project design and anticipated impacts will be made during the Design Phase of the project, as detailed design investigations of subsurface conditions, development of a rock removal plan, further resource characterization, development of blasting mitigation and construction sequencing plans, final determinations on beneficial use opportunities, and final determination on air quality compliance methods, are determined. Comments received from Federal and State agencies, the City of Boston, and those non-governmental organizations participating in the TWG, focused on the need for detailed commitments to undertake further examinations and determinations on these several topics during the Design Phase, and inclusion of the TWG in scoping those efforts and evaluating results. The Corps concurs with these requests and this collaborative approach.

Prior discussions in this report on air quality, endangered species, essential fisheries habitat, cultural resources, coastal zone management consistency, water quality certification have presented specific comment and discussion on issued and concerns raised by the agencies and organizations responding to the Draft Feasibility Report and SEIS/EIR. A detailed comment-response section is provided in the Public Involvement Appendix (Appendix A), as updated in late 2012. The views of the agencies are briefly summarized below.

The US Coast Guard has been consulted on project design issues, particularly as relates to project features and improvements that agency considers essential to port safety and security; namely inclusion of deepening the President Roads Anchorage in any plan for deepening the harbor's main channels. In his 7 November 2012 letter the Commander of USCG Sector Boston reiterated that agencies support for the proposed improvements to the Port.

The U.S. Fish and Wildlife Service, by letter dated 29 May 2007, provided its final coordination report under the Fish and Wildlife Coordination Act based on its review of supporting documents for the improvement project SEIS and the recent SEIS and EA for the major maintenance actions. The F&WS had provided its determination that the project would not impact threatened or endangered species under that agencies jurisdiction in its letter of 2 March 2005. The USF&WS provided additional comments on the Draft Feasibility Report and SEIS/EIR in the consolidated response letter from the Department of the Interior dated 2 June 2008. The comments focused on a perception that channel deepening would cause sedimentation or erosion in harbor areas adjacent to the channels. The service also stated that the project alternatives and cumulative assessments should include the deepening of all other New England ports as they believed deepening of Boston would trigger future deepening of other ports. In their letter of January 11, 2013 the USF&WS stated that the comments, information and determinations in their prior letters remained applicable, and that no further ESA coordination was necessary.

The U.S. Department of the Interior, in its consolidated response letter dated 2 June 2008, provided comments from the National Park Service and U.S. Geological Survey, in addition to the comments from the U.S. Fish and Wildlife Service mentioned above. These comments dealt principally with perceived impacts of the channel deepening on erosion of shorelines (and resulting impacts on cultural resources) in the Boston Harbor Islands National Recreation Area; noise, light and viewshed impacts from construction activities on park visitors.

The US EPA has assisted in surveys and planning for the proposed beneficial use plan for using the unconsolidated dredged materials for capping the former Industrial Waste Site in

Massachusetts Bay. The EPA has requested that the project's Design Phase include more detailed resource characterization of the dredging areas, development of detailed blasting and construction sequencing plans, consideration of air quality mitigation other than the currently proposed construction period shutdowns, continuation of the TWG throughout design and construction, pre and post construction monitoring of the dredging and any in-water beneficial use sites to p a baseline and monitor ecological recovery, additional public involvement through NEPA for any project changes, documenting expected changes in vessel intake of harbor waters with the project, and evaluating blasting noise impacts on marine mammals.

The National Marine Fisheries Service provided comments in the Draft Feasibility Report and SEIS/EIR in their letters of 2 June 2008, and 26 and 27 November 2012. The Service's comments have been presented above in the Sections on Endangered Species and Essential Fisheries Habitat. The service expressed concern with impacts of construction activities (mainly turbidity and blasting) on fisheries, shellfish and marine mammals. The Service also requested that the Corps re-initiate Section 7 Endangered Species Consultation as it hadn't considered the extent of the blasting operations required for the project. The Corps has complied with this request.

The National Marine Fisheries Service had expressed cautious optimism about the rock reef creation beneficial use option during interagency discussion by the TWG. The Service's letter of 2 June 2008 expressed concerns with the reef proposal, including the loss of soft-bottom habitat from rock reef creation. During the design phase the rock reef and other beneficial use options for the rock will be investigated further as to feasibility, impacts and Federal interest. The District will work closely with the NMFS, State and EPA to determine if a reef construction siting and plans can be developed that will satisfy the agencies concerns and expectations. If opposition to this beneficial use option remains, then the base plan for disposal of this material at the MBDS will be followed.

STATUS OF STATE SUPPORT

The Massachusetts Executive Office of Energy and Environmental Affairs, in the Secretary's Certification of the EIR issued 13 June 2008, forwarded and summarized the concerns expressed by the several State agencies in the letters cited below. The Certificated stated that "Comments from resource agencies reflect support for the selection of the preferred alternative while emphasizing the significant amount of work required in the Final EIR to ensure that improvements are planned and implemented with adequate consideration and protection of other interests in the harbor, including fisheries and recreation."

The Massachusetts Office of Coastal Zone Management, writing for the State's Secretary of Energy and Environmental Affairs prior to publication of the Draft Feasibility Report, offered its support for the project, and the assistance of the State in developing the habitat creation plan for beneficial use of rock removed from the project. In their letter of 2 June 2008 upon review of the Draft Feasibility Report and SEIS/EIR CZM expressed concern with the level of information on resources within the dredging and blasting areas, the need for blasting, construction sequencing and monitoring plans, finding beneficial use alternatives for the rock other than reef creation, and expressed support for capping of the Industrial Waste Site. In their letter of November 29, 2012 MACZM stated that the project as proposed in the DSEIS/EIR was consistent with the CZM enforceable program policies

The Massachusetts Historical Commission and the Massachusetts Bureau of Underwater Archaeological Resources both concurred with the Corps finding that no cultural resources would be adversely impacted by the projects in the lower and outer harbor, and that an additional survey in the proposed widening area for the Chelsea River would be conducted in the Design Phase. These agencies restated their concerns and requests in their letters of October 18 and November 27, 2012, respectively. The Corps will seek these agencies' assistance in scoping and evaluating those efforts.

The Massachusetts Department of Environmental Protection requested further investigation of beneficial use options for the rock other than reef creation, use of clean dredged material to cap any confined aquatic disposal cells needed for the harbor, development of detailed construction sequencing and blasting plans, consideration of additional air quality mitigation strategies other than shutdowns, and continuation of the TWG.

The Massachusetts Water Resources Authority expressed its concern with dredging impacts on the power cables supplying its Deer Island Sewage Treatment Plant and the ongoing negotiations with Corps, the U.S. Attorney and the cable owner (NSTAR) for bringing the cable into compliance with the embedment depths required in its permits. The MWRA also cited the need for review of the several water and sewer crossings of the Chelsea River. Investigations have found no conflicts between an additional two feet of channel deepening in the Chelsea River and those utility lines, however MWRA has requested that Massport submit a permit application for that determination. The MWRA restated these requests in their letter of November 9, 2012, with the specific statement that deepening the Chelsea River Channel to -40 feet MLLW would not impact the existing water line provided the 175-foot channel width through the bridge area was not increased.

The Massachusetts Division of Marine Fisheries, in its letter to the State EOEEA expressed concerns (discussed previously in the section of Essential Fisheries Habitat), with the cumulative impacts of the several recent improvement and maintenance dredging projects in the harbor, the systemic ecological impacts of dredging all of the State's waterways, the need for additional resource characterization of the dredging areas, the impacts of blasting on fisheries and need for a blasting plan, the need for a construction sequencing plan, mapping of without-project and with-project bottom classification for the dredging areas, monitoring plans to track recolonization of the dredged areas, further site selection process for any rock reef creation, management measures to prevent construction equipment bringing invasive species into the harbor, and mitigation for any mortality to fisheries resources, conversion of bottom habitat types or delayed recovery of dredged areas.

STATUS OF COMMUNITY AND LOCAL SUPPORT

The City of Boston Environment Department, in its letter of 2 June 2008 responding to the Draft Feasibility Report and SEIS/EIR stated it "supports the project and is aware of the need for the proposed improvement dredging due to the limitations that existing drafts place on upon current and future vessel traffic, and the importance of the Port of Boston's shipping activity to the local and regional economy." The City requested that involvement of the TWG be continued, development of a blasting plan to address fish kills, need to coordinate the results of the capping demonstration project at the MBDS, evaluation of additional beneficial uses of rock, additional site selection process for any rock reef creation, measures to limit turbidity at the dredging sites, need for additional resource characterization and biological monitoring to assess recolonization success, and impacts on lobstering activities.

The Town of Winthrop expressed its concern with the Corps recent denial of a State request for permit to dredge an offshore area of coarse sand a cobble located about eight miles seaward of the shore for borrow material to restore Winthrop Beaches and provide storm protection to Winthrop Shore Drive. The Town attempted to draw a comparison between dredging to deepen the port's existing deep draft navigation channels and dredging of previously undisturbed offshore habitat for sandfill material. The Corps extensive record on the permit denial adequately addresses the rationale for its decision on that project and will not further respond to the Town on that matter in the context of the harbor deepening project, or that the Corps fund the Town to hire "experts" of the Town's choice to perform further investigation.

The Town of Winthrop also requested that additional resource characterization and bottom type mapping be performed for the Broad Sound North Entrance Channel, again citing comparison between the channel dredging and the offshore borrow project denial. The Town also expressed concern and made the claim that the existing entrance channel, and proposals to deepen the channel, have and would lead to erosion of the Town's shoreline. The requested that the Corps evaluate the long-term impacts of the North Channel on the Town's beaches, sediment transport patterns, and wave climate.

The Boston Marine Society, in its letter of 1 June 2008 stated its concern that the deepening of the President Roads Anchorage be included in the plan for deepening the port's channels as necessary for lightering, bunkering, port security inspections, and emergency use.

The Boston Harbor Association, in their letter of 2 June 2008 stated that it "strongly supports the preferred alternative of the Deep Draft Navigation Improvement Project." The Association requested further revaluation of sites for rock reef creation, development of a monitoring plan for recolonization, and the proposed capping demonstration project at the MBDS. The Association expressed concern with fish mortality during blasting. The Association requested that a fund be established to compensate lobstermen for gear lost during construction of the project, and a monetary fund to support public water transportation in the harbor should adverse environmental impacts be identified.

Save the Harbor Save the Bay, in its letter of 2 June 2008, expressed its concern with air quality (discussed earlier in the Air Quality Mitigation section) and blasting impacts on fisheries.

The Boston Harbor Pilots Association, in their letter of 2 June 2008, stated that they "urge the approval of this project in its entirety." The Pilots also stated their concern with the importance of including the deepening of the President Roads Anchorage in the project, and the need to deepen all of the Chelsea River once the Chelsea Street Bridge was replaced. In October 2012 the Pilots provided assistance to the Corps in its design review of the additional depth needed in the entrance channel to account for increased sea states, winds, and resulting vessel motion. The Pilots calculations indicate they would make full use of a 47-foot inner channel with a 51-foot entrance with ships up to 48-foot draft using the tide.

STATUS OF SPONSOR SUPPORT

The study Sponsor, Massport, was the sponsor for the last Corps improvement project for Boston Harbor, the main tributary improvement and maintenance project constructed in 1998-2001. Massport was also the Sponsor for the 2008 inner harbor maintenance dredging and confined disposal facility construction project. Massport views the proposed main channel deepening project to be crucial to the Port's continued growth and the region's economic health. Accordingly Massport has provided half of the $5.2 million cost of the Feasibility Study, excluding the costs of external peer review which are all Federally funded. The cost of the Framework for Additional Economic Evaluation in 2008-2012 is funded as excess study costs recoverable during the design phase. Massport has reviewed the Feasibility Report and SEIS and concurs in the recommendation.

Project Partnership Agreement and Design Phase Cost-Sharing Agreement

Implementation of this project requires a significant financial commitment on the part of both the Federal Government and the Sponsor. The responsibilities of both the Government and Sponsor for the detailed design, implementation and subsequent operation and maintenance of the project over the project life must be clearly defined and memorialized. Due to the size and complexity of the project, the multi-year implementation schedule, and the need for Congressional authorization and budgeting, it will be necessary for the parties to execute two separate agreements. Execution of a Design phase Cost Sharing Agreement (DCSA) and a Project Partnership Agreement (PPA – formerly referred to as a Project Cooperation Agreement or PCA) between the Corps and the Non-Federal Sponsor will be required for project design and construction, respectively. The DCSA must be executed prior to expenditure of Federal funds for project design. The PPA must be executed prior to solicitation of bids for the first contract for construction.

After the Sponsor's review and concurrence with the final Feasibility Report and FSEIS, and before the District's submission of its final report for approval by the North Atlantic Division and Corps Headquarters, the Sponsor must submit the Non-Federal Sponsor's Self-Certification of Financial Capability for Decision Documents for assessment by the District Commander. The self-certification replaces the formerly required Sponsor's preliminary financing plan and statement of financial capability. The self-certification statement must be signed by the chief financial officer or an equivalent official of the non-Federal sponsor, and is part of the Sponsor's concurrence with, and one component of establishing, the implementability of the recommended plan. In the Self-Certification the Sponsor will state their concurrence with the recommendation contained in the Feasibility Report, their intent to meet their obligations and responsibilities for the design, construction and future operation and maintenance of the project, and outline their plan for financing their share of project costs, including required non-Federal improvements. The self-certification executed by Massport in 2008 will need to be updated for the revised recommendation and re-executed.

The PPA will be based on the Recommended Plan of Improvement as described in this final report, and as adjusted during the design phase in response to changes in information or analyses, including continued review of economic justification and optimization. Massport has a clear understanding of the nature of PPAs and the division of responsibilities embodied in such agreements, as they have been the Sponsor of past port projects requiring execution of a PCA with the Corps, including the 1990 main tributary deepening project and the 2008 inner harbor maintenance dredging and CAD cell construction project. The terms of local cooperation to be required in the PPA for this improvement project are described in the Recommendation section of this Feasibility Report. Massport's letter of intent has been included in the Correspondence Appendix (Appendix A).

Federal commitments relating to the final recommended plan, a construction schedule, or specific provisions of the PPA cannot be made to the non-Federal Sponsor on any aspect of the project until:

- The Final Feasibility Report and Final SEIS/EIR have been prepared and approved and a draft Chief of Engineers Report prepared.
- The project has received a favorable recommendation from the Civil Works Review Board.
- The requirements of NEPA, the Clean Water Act, the Coastal Zone Management Act, Endangered Species Act, Essential Fisheries Habitat Amendments, Fish and Wildlife Coordination Act, and the National Historic Preservation Act have been met.
- The Chief of Engineers Report has been circulated for final comment by Federal executive departments and the State's Executive, and a Record of Decision released by the ASA(CW).
- The Design Phase has been completed and any modifications to the recommendation, including adoption of one or both of the proposed beneficial use opportunities, have been coordinated with the Sponsor, effected agencies and the public, including completion of any required supplemental NEPA/MEPA documents.
- The Recommended Plan is authorized by Congress.
- Construction funds are appropriated by Congress, apportioned by the Office of Management and Budget (OMB), and their allocation is approved by the Assistant Secretary of the Army for Civil Works (ASA(CW)).
- The Draft PPA and the Sponsor's financing plan have been reviewed and approved by the ASA(CW).

RECOMMENDATION

In view of the conclusions presented in this Feasibility Report, it is recommended that implementation of the proposed modifications to the Federal Navigation Project for Boston Harbor, Massachusetts, be authorized in accordance with the recommended plan of improvement, with such modifications as in the discretion of the Chief of Engineers may be advisable, at an initial construction cost currently estimated at $315.8 million (fully funded - $219.6 million Federal, $96.2 million non-Federal), as it reasonably maximizes net benefits. Elements of the recommended plan presented in this report are as follows:

- Deepening the Broad Sound North Entrance Channel, the lower Main Ship Channel through President Roads to the Reserved Channel, the President Roads Anchorage Area, the lower Reserved Channel, and the Reserved Channel Turning Area to -47 Feet at mean lower low water (MLLW), with an additional four feet of depth in the entrance channel (to -51 feet MLLW), widening the entrance channel bend at Finn's Ledge, widening the Main Ship Channel to 900 feet through the reaches between President Roads and Castle Island, and to 800 feet above Castle Island to the Reserved Channel, widening the Reserved Channel Turning Area to 1600 feet, and further width in the channel bends at Spectacle Island and Castle Island.
- Deepening the Main Ship Channel for an additional distance of 2,600 feet above the expanded Reserved Channel Turning Area to -45 feet MLLW by 600 feet wide.
- Deepening the 9.1-acre 35-foot channel lane in the approach to the Medford Street Terminal in the Mystic River to -40 feet MLLW.
- Deepening the 38-foot Chelsea River Channel and Turning Basin to -40 feet MLLW, with two widening areas. One in the McArdle bridge upstream approach, and the other in the bend between the two bridges.

Consideration has been given to all significant aspects of the overall public interest, including environmental, social, and economic effects; engineering feasibility; regional sediment management; and beneficial use opportunities for dredged material. This recommendation is subject to non-Federal cost sharing, financing, and other applicable requirements of Federal and State laws and policies, including the Water Resources Development Act of 1986, as modified by Section 201 of the Water Resources Development Act of 1996. This recommendation is subject to the non-Federal Sponsor entering into a written PPA, as required by Section 221 of Public Law 91-161, as amended to provide local cooperation satisfactory to the Secretary of the Army. All cost-sharing requirements stated in law and regulation will be satisfied prior to initiating project design and construction.

This recommendation is subject to the non-Federal Sponsor agreeing to comply with all applicable Federal laws and policies and non-Federal responsibilities, including:

a. Provide, during the periods of design and construction, funds necessary to make its total contribution for commercial navigation equal to:

(1) 25 percent of the cost of design and construction of the GNFs attributable to dredging to a depth in excess of -20 feet MLLW but not in excess of -45 feet MLLW, plus

(2) 50 percent of the costs attributable to dredging to a depth over -45 feet MLLW;

b. Provide all lands, easement, and rights-of-way (LER), including those necessary for the borrowing of material and placement of dredged or excavated material, and perform or assure performance of all relocations, including utility relocations, all as determined by the Government to be necessary for the construction or operation and maintenance of the GNFs;

c. Pay with interest, over a period not to exceed 30 years following completion of the period of construction of the GNFs, an additional amount equal to 10 percent of the total cost of construction of GNFs less the amount of credit afforded by the Government for the value of the LER and relocations, including utility relocations, provided by the non-Federal sponsor for the GNFs. If the amount of credit afforded by the Government for the value of LER, and relocations, including utility relocations, provided by the non-Federal sponsor equals or exceeds 10 percent of the total cost of construction of the GNFs, the non-Federal sponsor shall not be required to make any contribution under this paragraph, nor shall it be entitled to any refund for the value of LER and relocations, including utility relocations, in excess of 10 percent of the total costs of construction of the GNFs;

d. Provide, operate, and maintain, at no cost to the Government, the local service facilities in a manner compatible with the project's authorized purposes and in accordance with applicable Federal and State laws and regulations and any specific directions prescribed by the Government, including but not limited to the following;

(1) Providing depths in at least two berths at elevations at least three feet deeper than that provide by the Federal channels accessing the Conley Terminal.

(2) For the Main Ship Channel Extension to the Massport Marine Terminal provide a berth depth equal to the depth provided by the adjacent reach of the Federal Main Ship Channel.

(3) For the Medford Street Terminal on the Mystic River, provide a berth depth at least equal to that provided by the adjacent improved portion of the Federal Mystic River Channel.

(4) For the Chelsea River Channel, provide berths at the Eastern Minerals, Sunoco-Logistics, Gulf, Irving and Global Terminals at least equal in depth to the Federal Chelsea River Channel and Turning Basin.

e. In the case of project features greater than -45 feet MLLW in depth, provide 50 percent of the excess cost of operation and maintenance of the project over that cost which the Government determines would be incurred for operation and maintenance if the project had a depth of 45 feet;

f. Give the Government a right to enter, at reasonable times and in a reasonable manner, upon property that the non-Federal sponsor owns or controls for access to the project for the purpose of completing, inspecting, operating and maintaining the GNFs;

g. Hold and save the United States free from all damages arising from the construction or operation and maintenance of the project, any betterments, and the local service facilities, except for damages due to the fault or negligence of the United States or its contractors;

h. Keep and maintain books, records, documents, and other evidence pertaining to costs and expenses incurred pursuant to the project, for a minimum of three years after completion of the accounting for which such books, records, documents, and other evidence is required, to the extent and in such detail as will properly reflect total cost of the project, and in accordance with the standards for financial management systems set forth in the Uniform Administrative Requirements for Grants and Cooperative Agreements to State and local governments at 32 CFR, Section 33.20;

i. Perform, or ensure performance of, any investigations for hazardous substances that are determined necessary to identify the existence and extent of any hazardous substances regulated under the Comprehensive Environmental Response, Compensation, and Liability Act (CERCLA), 42 USC 9601–9675, that may exist in, on, or under LER that the Federal Government determines to be necessary for the construction or operation and maintenance of the GNFs. However, for lands, easements, or rights-of-way that the Federal Government determines to be subject to the navigation servitude, only the Federal Government shall perform such investigation unless the Federal Government provides the non-Federal sponsor with prior specific written direction, in which case the non-Federal sponsor shall perform such investigations in accordance with such written direction;

j. Assume complete financial responsibility, as between the Federal Government and the non-Federal sponsor, for all necessary cleanup and response costs of any hazardous substances regulated under CERCLA that are located in, on, or under LER that the Federal Government determines to be necessary for the construction or operation and maintenance of the project;

k. To the maximum extent practicable, perform its obligations in a manner that will not cause liability to arise under CERCLA;

l. Comply with Section 221 of PL 91-611, Flood Control Act of 1970, as amended, (42 U.S.C. 1962d-5b) and Section 101(e) of the WRDA 86, Public Law99-662, as amended, (33 U.S.C. 2211(e)) which provides that the Secretary of the Army shall not commence the construction of any water resources project or separable element thereof, until the non-Federal sponsor has entered into a written agreement to furnish its required cooperation for the project or separable element;

m. Comply with the applicable provisions of the Uniform Relocation Assistance and Real Property Acquisition Policies Act of 1970, PL 91-646, as amended, (42 U.S.C. 4601-4655) and the Uniform Regulations contained in 49 CFR 24, in acquiring lands, easements, and rights-of-way, necessary for construction, operation and maintenance of the project including those necessary for relocations, the borrowing of material, or the placement of dredged or excavated material; and inform all affected persons of applicable benefits, policies, and procedures in connection with said act;

n. Comply with all applicable Federal and State laws and regulations, including, but not limited to, Section 601 of the Civil Rights Act of 1964, PL 88-352 (42 USC 2000d), and Department of Defense Directive 5500.11 issued pursuant thereto; Army Regulation 600-7, entitled “Nondiscrimination on the Basis of Handicap in Programs and Activities Assisted or

Conducted by the Department of the Army"; and all applicable Federal labor standards requirements including, but not limited to, 40 U.S.C. 3141-3148 and 40 U.S.C. 3701-3708 (revising, codifying and enacting without substantive changes the provision of the Davis-Bacon Act (formerly 40 U.S.C. 276a et seq.), the Contract Work Hours and Safety Standards Act (formerly 40 U.S.C. 327 et seq.), and the Copeland Anti-Kickback Act (formerly 40 U.S.C. 276c);

o. Provide the non-Federal share of that portion of the costs of mitigation and data recovery activities associated with historic preservation that are in excess of 1 percent of the total amount authorized to be appropriated for the project; and

p. Not use funds from other Federal programs, including any non-Federal contribution required as a matching share therefore, to meet any of the non-Federal sponsor's obligations for the project costs unless the Federal agency providing the Federal portion of such funds verifies in writing that such funds are authorized to be used to carry out the project.

It is recognized and understood that upon completion of this feasibility study, extensive review is required at several levels in the Executive Branch of the Federal Government and may also be required at state and local levels. Consequently, the recommendations made in this report may be changed. The following paragraph is required in my recommendations.

The recommendations contained herein reflect the policies governing formulation of individual projects and the information available at this time. They do not necessarily reflect program and budgeting priorities inherent in the local and state programs or the formulation of a national Civil Works construction program. Consequently, the recommendations may be modified at higher review levels within the Executive Branch before they are transmitted to the Congress as proposals for authorization and implementation funding. However, prior to transmittal to the Congress, the non-Federal Sponsor, the Commonwealth of Massachusetts, the Massachusetts Port Authority, and other parties will be advised of any modifications and will be afforded an opportunity to comment further.

10 Apr 13
Date

Charles P. Samaris
Colonel, Corps of Engineers
District Engineer

LIST OF ACRONYMS AND ABBREVIATIONS

AFB	Alternative Formulation Briefing
ASA(CW)	Assistant Secretary of the Army for Civil Works
BCR	Benefit to Cost Ratio
BHNIP	Boston Harbor Navigation Improvement Project – the 1990 authorized project constructed in 1998-2001 along with the main tributaries maintenance dredging
BSNEC	Broad Sound North Entrance Channel
BUAR	Massachusetts Bureau of Underwater Archaeological Resources
CAA	Clean Air Act
CAD	Confined Aquatic Disposal (Cell)
CDF	Confined Disposal Facility
CEDEP	Corps of Engineers Dredge Estimating Program
COSCO	China Overseas Shipping Company
CWA	Clean Water Act
CWCCIS	Civil Works Construction Cost Index System (For Corps cost estimating)
CWRB	Civil Works Review Board
CZM	Coastal Zone Management – In Massachusetts a separate regulatory office under the Executive Office of Energy and Environmental Affairs
DCR	Massachusetts Department of Conservation and Recreation
DDNIP	Deep Draft Navigation Improvement Project – The State's term for the improvement project covered by this Feasibility Report and SEIS
DEP	Massachusetts Department of Environmental Protection
DWT	Dead Weight Tons – A measure of vessel size by displacement
EA	Environmental Assessment – A NEPA document prepared for smaller scale projects without significant impact
EBP	Early Benthic Phase (lobsters)
EC	Engineering Circular
EFH	Essential Fisheries Habitat regulated by the NMFS
EIR	Environmental Impact Report – Massachusetts Corollary to an EIS
EIS	Environmental Impact Statement
EM	Engineering Manual
EPA	US Environmental Protection Agency
EPR	External Peer Review – Review of Corps documents and analyses by a team of experts drawn from outside the Corps of Engineers
ER	Engineering Regulation
ERDC	Engineering Research and Development Center, Corps of Engineers
ESA	Endangered Species Act
FAA	Federal Aviation Administration
FCSA	Feasibility Cost-Sharing Agreement (here between the Corps and Massport)
FONSI	Finding of No Significant Impact
F&WCA	Fish and Wildlife Coordination Act
HQUSACE	Headquarters, US Army Corps of Engineers
IHMDP	Inner Harbor Maintenance Dredging Project of 2007 to 2008
ITR	Independent Technical Review – For General Investigations this is a review of all documents and analyses by personnel from outside the Corps district preparing the report

IWS	Industrial Waste Site – Former Chemical and Radiological Waste Disposal Site in Massachusetts Bay
LNG	Liquid Natural Gas
Massport	Massachusetts Port Authority
MBDS	Massachusetts Bay Disposal Site – US EPA Designated Dredged Material Disposal Site Seaward of the Territorial Sea
MLW	Mean Low Water – the mean of all low water elevations of all tidal cycles
MLLW	Mean Lower Low Water – the mean of all lower tidal elevations where two low tides occur in a cycle
MMT	Massport Marine Terminal in South Boston
MPRSA	Marine Protection Research and Sanctuaries Act
MSC	Main Ship Channel
MSC	Mediterranean Shipping Company
MST	Medford Street Terminal on the Mystic River (Massport)
MWRA	Massachusetts Water Resources Authority (sewage and water supply)
NAD	North Atlantic Division, US Army Corps of Engineers
NAE	New England District, US Army Corps of Engineers
NAN	New York District, US Army Corps of Engineers
NED	National Economic Development – The plan yielding the highest net economic benefit to the nation as a whole
NEPA	National Environmental Policy Act of 1969, as amended
NMFS	National Marine Fisheries Service, NOAA, Department of Commerce
NOAA	National Oceanographic and Atmospheric Administration
NPS	National Park Service, Department of the Interior
OHMDP	Outer Harbor Maintenance Dredging Project of 2004 to 2005
OMB	Office of Management and Budget
PED	Planning, Engineering and Design
PIANC	Permanent International Association of Navigation Congresses
PCX	Planning Center of Expertise – For Deep Draft Navigation Studies the PCX is the Corps South Atlantic Division, Mobile District (SAM) – For Cost Estimating the PCX is the Walla Walla District (NWW)
PONYNJ	Port of New York and New Jersey – New York Harbor
PPA	Project Partnership Agreement (formerly PCA or LCA)
SBNMS	Stellwagen Bank National Marine Sanctuary
SDT	State Dredging Team – Composed of representatives from the various Federal, State and Local agencies and other interests involved in dredging
SEIS	Supplemental Environmental Impact Statement
SHPO	State Historic Preservation Office – In Mass the Secretary of State
SIP	State Implementation Plan – Air Quality Regulation Plan
TEU	Twenty-Foot Equivalent Unit – Standard measure for containerships
TWG	Technical Working Group – Composed of representatives from the various Federal, State and Local agencies and other interests involved in dredging projects in Boston Harbor
TWT	Ted Williams Tunnel – Interstate 90
USCG	United States Coast Guard, Department of Homeland Security
USF&WS	US Fish and Wildlife Service, Department of the Interior
WQC	Water Quality Certificate – Issued by the State
WRDA	Water Resources Development Act