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BOSTON HARBOR MASSACHUSETTS DEEP DRAFT NAVIGATION IMPROVEMENT PROJECT

COMMUNICATION

FROM

THE ASSISTANT SECRETARY, CIVIL WORKS, THE DEPARTMENT OF DEFENSE

TRANSMITTING

THE FINAL FEASIBILITY REPORT AND FINAL SUPPLEMENTAL ENVIRONMENTAL IMPACT STATEMENT

PART 1 OF 3

MAY 1, 2014.—Referred to the Committee on Transportation and Infrastructure and ordered to be printed

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DEPARTMENT OF THE ARMY
OFFICE OF THE ASSISTANT SECRETARY
CIVIL WORKS
108 ARMY PENTAGON
WASHINGTON DC 20310-0108

FEB 26 2014

Honorable John Boehner
Speaker of the House
of Representatives
U.S. Capitol Building, Room H-232
Washington, D.C. 20515-0001

Dear Mr. Speaker:

In response to a study conducted under the authority contained in a Senate Subcommittee on Public Works Resolution dated September 11, 1969, and a Senate Committee on Environment and Public Works Resolution adopted June 5, 1997, the Secretary of the Army supports the authorization that would enable construction of the Boston Harbor Navigation Improvement Project. The proposal is described in the report of the Chief of Engineers dated September 30, 2013, which includes other pertinent reports and comments. The Secretary of the Army plans to implement the project at the appropriate time, considering National priorities and the availability of funds.

The recommended plan provides for deep draft navigation features consisting of improvements accessing four segments of the port:

a. Main Channels Improvement Plan: The first improvement would provide deeper access from Massachusetts Bay to Massport's Conley Terminal on the Reserved Channel in South Boston. A depth of -51 feet at mean lower low water (MLLW) would be provided in the present 40-foot deep lane of the Broad Sound North Entrance Channel from the Bay to the Outer Confluence (approximately 3.4 miles), with the channel widened in the bend opposite Finn's Ledge. A depth of -47 feet MLLW would be provided in the Main Ship Channel between the Outer Confluence and the Reserved Channel, the President Roads Anchorage, the lower Reserved Channel along the Conley Terminal, and the Reserved Channel Turning Area (approximately 4.5 miles). The Main Ship Channel above the Roads would be widened to 900 feet downstream of Castle Island and 800 feet upstream of Castle Island to the turning area (approximately 1.7 miles), with additional width provided in the channel bends. The Reserved Channel Turning Area would be widened to 1,500 by 1,600 feet, and further widened in its transition to the Reserved Channel (approximately 0.5 miles).

b. Main Ship Channel Deepening Extension to Massport Marine Terminal: The second improvement would extend the deepening of the Main Ship Channel upstream of the Reserved Channel Turning Area to the Massport Marine Terminal (approximately 0.5 miles), at a depth of -45 feet MLLW and width of 600 feet. Massport would provide a depth of at least -45 feet MLLW in the berth at the Marine Terminal.

c. Mystic River Channel at Medford Street Terminal: The third improvement would deepen an approximately nine acre area (1,350 feet by 575 feet) of the existing -35 foot MLLW lane of the Mystic River Channel to -40 MLLW feet to improve access to Massport's Medford Street Terminal in Charlestown. Massport has already deepened the berth at this terminal to -40 feet MLLW and would maintain that depth in the future.

d. Chelsea River Channel: The fourth improvement would deepen the existing -38 foot MLLW Chelsea River Channel to -40 feet MLLW (approximately 1.9 miles). The channel would be widened by about 50 feet along the East Boston shore in the bend immediately upstream (approximately 0.3 miles) of the McArdle Bridge and in the bend downstream of the Chelsea Street Bridge (approximately 0.3 miles). This recommended improvement is contingent on agreement of the five principal terminals to deepen their berths to at least -40 feet MLLW.

The recommended plan is the National Economic Development Plan and for each project segment reasonably maximizes net national economic development benefits, while avoiding or minimizing significant adverse impacts. The channel improvements will also result in transportation cost savings by allowing cargo to shift from overland transport to ship transport and allowing the larger Post-Panamax vessels to operate more efficiently and experience fewer tidal and transit delays.

The estimated project first cost of construction is $308,381,000 (October 2013 price level), which includes the cost of constructing General Navigation Features (GNF) and the value of lands, easements, rights-of-way and relocations (LERR) estimated as follows: $290,428,000 for channel modification and dredged material placement; $171,000 for LERR provided by the non-federal sponsor; $6,609,000 for planning, engineering and design efforts; and $11,174,000 for construction management. In addition, there are associated costs of $3,724,000 which include $3,447,000 for dredging non-federal berthing areas adjacent to the federal channel (non-federal expense) and $277,000 for aids to navigation (U.S. Coast Guard expense).

The Massachusetts Port Authority (Massport) has expressed their intent to be the non-federal cost sharing sponsor for the project. In accordance with the cost sharing provisions of Section 101(a) of the Water Resources Development Act (WRDA) 1986, as amended (33U.S.C.2211(a)), deep-draft navigation is cost shared differently depending on the depth of the modification. As such, construction of the Boston Harbor improvements are cost shared on a prorated amount of 70 percent federal and 30 percent non-federal due to its crossing of cost share boundaries for a total of $214,650,000 federal and $93,560,000 non-federal. The cost for deepening the various reaches of the GNF will be shared as follows:

The deepening of the GNF for the main channel to -47 feet (-51 feet in the entrance channel) to access the Conley Container Terminal is estimated at two different cost sharing percentages: the cost of $210,339,000 for deepening to -45 feet MLLW is apportioned at 75 percent federal and 25 percent non-federal (or $157,754,000 federal and $52,585,000, non-federal) and the $66,030,000 for deepening the GNF from -45

feet to -47 feet MLLW (from -49 feet to -51 feet in the entrance channel) is apportioned at 50 percent federal and 50 percent non-federal sponsor (or $33,015,500 each federal and non-federal). The cost of deepening the Main Ship Channel Extension to the Massport Marine Terminal reach to -45 feet MLLW is $17,517,000 and is apportioned at 75 percent federal and 25 percent non-federal (or $13,138,000 federal and $4,379,000 non-federal). The cost of deepening the Mystic River Channel at Medford Street Terminal reach to -40 feet is $2,448,000 and will be apportioned at 75 percent federal and 25 percent non-federal (or $1,836,000, federal and $612,000 non-federal). The cost of deepening the Chelsea River Channel reach to -40 feet MLLW is $11,876,000 and will be apportioned at 75 percent federal and 25 percent non-federal (or $8,907,000 federal and $2,969,000, non-federal).

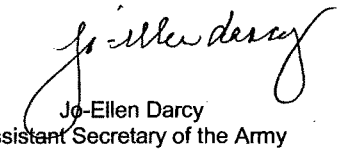
The drainage area above Boston Harbor is comprised mostly of bedrock, as is the harbor itself, and this condition results in very little sediment being carried into the harbor. This geology is responsible for a less frequent need for maintenance dredging. As a result, the existing maintenance frequency at Boston Harbor ranges between 16 and 41 years depending on the project segment. The additional annual cost of operation, maintenance, repair, replacement, and rehabilitation (OMRR&R) for the recommended plan is estimated to be $342,000, over the existing estimated OMRR&R of about $1,616,000. In accordance with Section 101(b) of WRDA 1986, as amended, the non-federal sponsor will be responsible for 50 percent of the cost of OMRR&R for the project depth in excess of 45 feet, which amounts to a total of $32,000 to be cost shared. The total federal share of annual incremental OMRR&R is estimated to be $326,000 and the non-federal share is estimated to be $16,000.

Based on the FY 2014 discount rate of 3.5 percent, October 2013 price levels, and a 50-year period of economic analysis, the total equivalent project average annual benefits and costs of the project are estimated to be $103,496,000 and $13,824,000, respectively with resulting net excess benefits of $89,672,000. The benefit-cost ratio is approximately 7.5 to 1. 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 be considered for construction funding. A Limited Re-Evaluation Report must be prepared during the design phase to confirm anticipated benefits and depth optimization of the recommended improvements for those two segments.

All environmental and review issues were resolved. Construction sequencing will be planned in the design phase to minimize impacts to environmental resources, once the final rock removal extent and quantities are known. The recommended base plan calls for the placement of all dredged material and rock in the Massachusetts Bay Disposal Site. However, during design, the Corps will investigate the potential to beneficially use dredged material and rock. An Independent External Peer Review was completed in June 2008 and all issues were resolved.

The Office of Management and Budget (OMB) advises that there is no objection to the submission of the report to Congress and concludes that the report recommendation is consistent with the policy and programs of the President. A copy of OMB's letter, dated, February 12, 2014, is enclosed. I am providing a copy of this transmittal and the OMB letter to the Subcommittee on Water Resources and Environment of the House Committee on Transportation and Infrastructure, and the Subcommittee on Energy and Water Development of the House Committee on Appropriations. I am also sending an identical letter to the President of the Senate.

Very truly yours,



Jo-Ellen Darcy
Assistant Secretary of the Army
(Civil Works)

Enclosures

9 Enclosures

1. Record of Decision, dated February 26, 2014
2. OMB Clearance Letter, dated February 12, 2014
3. Chief's Report, Sept 30, 2013
4. Sponsor letter of support, Massport, Feb 27, 2013
5. Approval letter, EPA, Jul 22, 2013
6. Approval letter, DOC Jul 22, 2013
7. Approval letter, DOT, Jul 26, 2013
8. Executive Summary
9. Boston Harbor Report

RECORD OF DECISION
BOSTON HARBOR, BOSTON, MASSACHUSETTS
NAVIGATION IMPROVEMENT PROJECT

The Final Feasibility Report and Final Supplemental Environmental Impact Statement/Environmental Impact Report (FR/FSEIS/EIR), dated April 2013, for the Boston Harbor Navigation Improvement Project, Massachusetts addresses navigation improvement opportunities for Boston Harbor. Based on the report, the reviews of other federal, state, and local agencies, input from the public, and the review by my staff, I find the plan recommended in the report of the Chief of Engineers, dated September 30, 2013, to be technically feasible, economically justified, environmentally acceptable and in the public interest.

In addition to the no action alternative, the FR/FSEIS/EIR evaluates various structural and non-structural alternatives to improve the existing federal navigation project in Boston Harbor and is incorporated herein by reference. It also supplements the 1995 Environmental Impact Statement/Environmental Impact Report for the Boston Harbor. The recommended plan is the environmentally preferable alternative and the plan preferred by the local sponsor, the Massachusetts Port Authority (Massport). All depths are referenced to the mean lower low water (MLLW) datum. The recommended plan consists of the following:

- Main Ship Channels: Deepen the Broad Sound North Entrance Channel to -51 feet for approximately 3.4 miles from the Massachusetts Bay to the Outer Confluence. Provide a depth of -47 feet for approximately 4.5 miles in the Main Ship Channel between the Outer Confluence and the Reserved Channel up to the Reserved Channel Turning Area. The Main Ship Channel above President Roads would be widened up to 900 feet up to the Castle Island turn and then widened to 800 feet up to the Reserved Channel.

- Main Ship Channel Extension to Massport Marine Terminal: Extend the Main Ship Channel above the Reserved Channel Turning Area to the Massport Marine Terminal to a depth of -45 feet and width of 600 feet.

- Mystic River Channel to Medford Street Terminal: Deepen a portion of the existing -35 foot lane of the Mystic River Channel to -40 feet.

- Chelsea River Channel: Deepen the Chelsea River Channel to -40 feet and widening a portion of the channel by about 50 feet in the vicinity of the McArdle and Chelsea Street bridges.

The proposed project would remove about 11 million cubic yards (mcyds) of dredged material and up to 1 mcyds of rock. The disposal site is a U.S. Environmental Protection Agency (EPA) designated ocean disposal site. The draft report was released for public and agency review on April 11, 2008. A public meeting was held May 20,

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2008 to address agency and public comments. The public comment period closed on June 2, 2008. The Corps of Engineers headquarters' Civil Works Review Board requested additional economic analysis of the project which was completed in May 2012. A final determination as to the project depth was made in September 2012. Coordination was reinitiated with the federal and state agencies and the tribes once the final plan was identified. Essential Fish Habitat conservation recommendations were provided by the National Marine Fisheries Service (NMFS) November 26, 2012. These conservation recommendations included time-of-year restrictions for particular areas of the harbor, a blasting sequencing and fish deterrent technology plan, and additional investigation of beneficial use alternatives for the rock. The Corps of Engineers and Massport are committed to continuing coordination with the Boston Harbor Technical Working Group.

Endangered Species Act coordination was completed with NMFS November 27, 2012. Coordination with the U.S. Fish and Wildlife Service was completed January 11, 2013. Coastal Zone Management Consistency Concurrence was provided by the Commonwealth of Massachusetts November 29, 2012. Cultural Resource coordination was completed with the Massachusetts Historical Commission October 18, 2012. The FR/FSEIS/EIR was filed with EPA on July 22, 2013.

All practicable means to avoid or minimize adverse environmental effects have been incorporated into the recommended plan. The following actions will be taken to minimize project impacts: notice will be given to lobstermen and other harbor users of the initiation of dredging and the areas to be dredged; barges and scows will be required to use a short-tow line when in the harbor; whale observers will be on board scows transiting to the disposal site between February 1 and May 31; and various techniques will be used to minimize blast impacts to natural resources.

Technical and economic criteria used in the formulation of alternative plans were those specified in the Water Resource Council's Economic and Environmental Principles and Guidelines for Water and Related Land Resources Implementation Studies. All applicable laws, executive orders, regulations, and local government plans were considered in the evaluation of alternatives. Based on review of these evaluations, I find that the public interest would best be served by implementing the recommended plan. This Record of Decision completes the National Environmental Policy Act process.

Feb. 26, 2014
Date

Jo-Ellen Darcy
Assistant Secretary of the Army
(Civil Works)

EXECUTIVE OFFICE OF THE PRESIDENT
OFFICE OF MANAGEMENT AND BUDGET
WASHINGTON, D.C. 20503

February 12, 2014

The Honorable Jo-Ellen Darcy
Assistant Secretary of the Army (Civil Works)
108 Army Pentagon
Washington, DC 20310-0108

Dear Ms. Darcy:

As required by Executive Order 12322, the Office of Management and Budget has reviewed your report on an April 2013 Army Corps of Engineers (Corps) feasibility report (report) that recommends a set of four channel improvements at the Port of Boston, at a first cost of $308.374 million (October 2012 prices).

Based on the estimates of the benefits and costs in the Corps report, we have concluded that an authorization to construct this project would be consistent with the program and policies of the President. The Office of Management and Budget does not object to you submitting this study to the Congress. However, when you do so, please inform the Congress that each of the four elements of this project would need to compete as a separable element with other proposed investments in future Budgets.

Sincerely,

John Pasquantino
Deputy Associate Director
Energy, Science, and Water

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DEPARTMENT OF THE ARMY
CHIEF OF ENGINEERS
2600 ARMY PENTAGON
WASHINGTON, DC 20310-2600

DAEN

SEP 3 0 2013

SUBJECT: Boston Harbor Navigation Improvement Project, Massachusetts

THE SECRETARY OF THE ARMY

1. I submit for transmission to Congress my report on navigation improvements for Boston Harbor, Massachusetts. It is accompanied by the reports of the New England District Engineer and the North Atlantic Division Engineer. These reports were prepared in response to a study authority contained in a Senate Subcommittee on Public Works Resolution dated September 11, 1969, which directed the Secretary of the Army to conduct a study to determine whether any modifications of the recommendations contained in the report of the Chief of Engineers on Boston Harbor, Massachusetts, published as House Document Numbered 733, Seventy-ninth Congress, and other pertinent reports, 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. Further, the Energy and Water Development Appropriations Act for Fiscal Year 2000 provided funds to initiate the study with language requesting an evaluation of the deepening of the Main Ship, Reserved and Entrance Channels to Boston Harbor. Preconstruction, engineering and design activities for the Boston Harbor Navigation Improvement Project will continue under the authorities cited above.

2. The reporting officers recommend authorization of a project that will contribute significantly to the economic efficiency of commercial navigation in the New England region. Boston Harbor is located on the North Atlantic U.S. coast about 240 miles northeast of New York City and is New England's largest port. The harbor consists of entrance channels extending about three miles from Massachusetts Bay to President Roads, the main ship channel connecting the Roads to the inner harbor, anchorage areas in the Roads and lower inner harbor, and three principal deep-draft industrial tributaries in the Reserved Channel, Mystic River and Chelsea River. Improvements were considered from deep water in Massachusetts Bay to the heads of deep draft navigation on the three tributaries. The recommended plan will result in transportation cost savings by allowing cargo to shift from overland transport to ship transport and allowing the larger Post-Panamax vessels to operate more efficiently and experience fewer tidal and transit delays. The Massachusetts Port Authority (Massport) is the non-federal cost-sharing partner.

3. The reporting officers identified a plan for navigation improvements to four separable segments of the existing project which will contribute significantly to the economic efficiency of commercial navigation in the region. The recommended plan is the National Economic Development (NED) Plan and is supported by the non-federal sponsor.

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DAEN
SUBJECT: Boston Harbor Navigation Improvement Project, Massachusetts

a. Main Channels Improvement Plan: The first improvement would provide deeper access from Massachusetts Bay to Massport's Conley Terminal on the Reserved Channel in South Boston. A depth of -51 feet at mean lower low water (MLLW) would be provided in the present 40-foot deep lane of the Broad Sound North Entrance Channel from the Bay to the Outer Confluence (approximately 3.4 miles), with the channel widened in the bend opposite Finn's Ledge. A depth of -47 feet MLLW would be provided in the Main Ship Channel between the Outer Confluence and the Reserved Channel, the President Roads Anchorage, the lower Reserved Channel along the Conley Terminal, and the Reserved Channel Turning Area (approximately 4.5 miles). The Main Ship Channel above the Roads would be widened to 900 feet downstream of Castle Island and 800 feet upstream of Castle Island to the turning area (approximately 1.7 miles), with additional width provided in the channel bends. The Reserved Channel Turning Area would be widened to1500 by1600 feet, and further widened in its transition to the Reserved Channel (approximately 0.5 miles).

b. Main Ship Channel Deepening Extension to Massport Marine Terminal: The second improvement would extend the deepening of the Main Ship Channel upstream of the Reserved Channel Turning Area to the Massport Marine Terminal (approximately 0.5 miles), at a depth of -45 feet MLLW and width of 600 feet. Massport would provide a depth of at least -45 feet MLLW in the berth at the Marine Terminal.

c. Mystic River Channel at Medford Street Terminal: The third improvement would deepen an approximately nine acre area (1350 feet by 575 feet) of the existing -35-foot MLLW lane of the Mystic River Channel to -40 MLLW feet to improve access to Massport's Medford Street Terminal in Charlestown. Massport has already deepened the berth at this terminal to -40 feet MLLW and would maintain that depth in the future.

d. Chelsea River Channel: The fourth improvement would deepen the existing -38-foot MLLW Chelsea River Channel to -40 feet MLLW (approximately 1.9 miles). The channel would be widened by about 50 feet along the East Boston shore in the bend immediately upstream (approximately 0.3 miles) of the McArdle Bridge and in the bend downstream of the Chelsea Street Bridge (approximately 0.3 miles). This recommended improvement is contingent on agreement of the five principal terminals to deepen their berths to at least -40 feet MLLW.

4. The project would require the removal of approximately 11 million cubic yards of dredged material and one million cubic yards of rock. The U.S. Environmental Protection Agency (EPA) has concurred in the determination that the improvement project dredged materials are parent materials (material below the authorized depth and not previously disturbed) of largely glacial origin and acceptable for unconfined ocean water placement. The recommended plan requires placement of all dredged material and rock at the Massachusetts Bay Disposal Site. However, it is the policy of the U.S. Army Corps of Engineers to use dredged material, where practicable, for beneficial use. Potential beneficial uses for the rock and other dredged materials were considered by the reporting officers. Use of the rock for offshore reef creation and shore

protection projects will be investigated in partnership with the state during project design. The feasibility of a concept from EPA to use the other dredged materials to cap the former Industrial Waste Site in Massachusetts Bay will also be investigated in partnership with that agency and others during project design to finalize plans. None of these potential beneficial uses are expected to add to the cost of the project and will be done within budgeted authorized amount.

5. Project costs are allocated to the commercial navigation purpose and are based on July 2011 price levels escalated to October 2012.

a. Project First Cost. The estimated project first cost of construction is $304,695,000 which includes the cost of constructing General Navigation Features (GNF) and the value of lands, easements, rights-of-way (LER) and relocations estimated as follows: $286,971,000 for channel modification and dredged material placement; $169,000 for LER provided by the non-federal sponsor; $6,525,000 for planning, engineering and design efforts; and $11,030,000 for construction management.

b. Estimated federal and non-federal shares: The estimated federal and non-federal shares of the project first cost are $212,084,000 and $92,611,000, respectively, as apportioned in accordance with the cost sharing provisions of Section 101(a) of the Water Resources Development Act (WRDA) of 1986, as amended (33 U.S.C. 2211(a)), as follows:

(1) The cost for deepening GNF under the Main Channels Improvement Plan to -47 feet (-51 feet in the entrance channel) to access the Conley Container Terminal will be shared as follows:

(a) The cost of $207,825,000 for deepening the GNF to -45 feet MLLW (49 feet in the entrance channel) will be shared at the rate of 75 percent by the government and 25 percent by the non-federal sponsor. Accordingly, the federal and non-federal shares of this zone of deepening are estimated to be $155,869,000 and $51,956,000, respectively.

(b) The cost of $65,241,000 for deepening the GNF from -45 feet to -47 feet feet MLLW (from -49 feet to -51 feet in the entrance channel) will be shared at the rate of 50 percent by the government and 50 percent by the non-federal sponsor. Accordingly, the federal and non-federal shares of this zone of deepening are estimated to be $32,620,500 and $32,620,500, respectively.

(2) The costs of for deepening GNF under the Main Ship Channel Deepening Extension to Massport Marine Terminal segment to 45 feet will be shared at the rate of 75 percent by the government and 25 percent by the non-federal sponsor for depths up to 45 feet. The total cost for GNF in this reach is $17,308,000 with $12,981,000 in federal costs and $4,327,000 in non-federal costs. A Limited Re-evaluation Report (LRR) is anticipated for this project segment during project design to confirm anticipated benefits and depth optimization.

(3) The costs for the deepening GNF under Mystic River Channel at Medford Street Terminal segment to 40 feet will be shared at the rate of 75 percent by the government and 25 percent by the non-federal sponsor. The total cost for GNF in this reach is $2,419,000 with $1,814,000 in federal costs and $605,000 in non-federal costs. A LRR will be prepared for this project segment during project design to confirm anticipated benefits and depth optimization.

(4) The costs for the deepening GNF under Chelsea River Channel segment to 40 feet will be shared at the rate of 75 percent by the Government and 25 percent by the non-federal Sponsor. The total cost for GNF in this reach is $11,734,000 with $8,801,000 in federal costs and $2,933,000 in non-federal costs.

(5) In addition to payment by the non-federal sponsor of its share of costs as estimated and described in sub-paragraphs b(1), b(2), b(3) and b(4) above, the estimated non-federal share of $92,611,000 includes $169,000 for the estimated value of LER that it must provide pursuant to Section 101(a)(3) of WRDA 1986, as amended (33 U.S.C.2211(a)(3)).

c. Additional 10 Percent Payment. In addition to payment by the non-federal sponsor of its share of the project first costs determined in sub-paragraphs b(1), b(2), b(3), and b(4) above, pursuant to Section 101(a)(2) of WRDA 1986, as amended (33 U.S.C. 2211(a)(2)), the non-federal sponsor must pay an additional 10 percent of the cost of the general navigation features of the project in cash over a period not to exceed 30 years, with interest. The additional 10 percent payment without interest is estimated to be $30,453,000. The value of LER and relocations, estimated as $169,000, provided by the non-federal sponsor under Section 101(a)(3) of WRDA 1986, as amended, will be credited toward payment of this amount.

d. Operations and Maintenance Costs. Due to lack of sediment sources the existing maintenance frequency at Boston Harbor ranges between 16 and 41 years depending on the project segment. The additional annual cost of operation and maintenance for this recommended plan is estimated at $338,000. In accordance with Section 101(b) of WRDA 1986, as amended (33 U.S.C. 2211(b)), the non-federal sponsor will be responsible for an amount equal to 50 percent of the excess of the cost of the operation and maintenance of the project over the cost which would be incurred for operation and maintenance of the project if the project had a depth of 45 feet. The federal government would be responsible for $322,000 of the incremental annual operations and maintenance costs and the non-federal sponsor would be responsible for the remaining $16,000.

e. Associated Costs. Estimated associated costs of $3,679,000 include $3,405,000 for dredging of non-federal berthing areas adjacent to the federal channel (non-federal expense) and $274,000 for aids to navigation (U.S. Coast Guard expense).

f. Authorized Project Cost and Section 902 Calculation. The project first cost for the purpose of calculating the maximum cost of the project pursuant to Section 902 of WRDA 1986, as amended, includes the cost of constructing the GNFs and the value of LER. Accordingly, as

set forth in paragraph 5.a, above, based on July 2011 price levels escalated to October 2012, the total estimated project first cost for these purposes is $304,695,000 with an estimated federal share of $212,084,000 and an estimated non-federal share of $92,611,000. Based on a discount rate of 3.75 percent, and a 50-year period of economic analysis, the project average annual benefits and costs are estimated at $103,469,000 and $14,305,000, respectively, with resulting net excess benefits of $89,191,000 and a benefit-to-cost ratio of 7.2 to 1.

6. The goals and objectives included in the Campaign Plan of the Corps have been fully integrated into the Boston Harbor planning process. The recommended plan was developed in coordination and consultation with various federal, state and local agencies using a systematic and regional approach to formulating solutions and evaluating the benefits and impacts. The project supports the President's National Export Initiative (Executive Order 13534) by improving the private sector's ability to export products at the Boston Harbor.

7. Risk and uncertainty were evaluated for economic benefits, costs, and sea level rise. Economic sensitivities examined the effects of reducing or increasing the number of carrier services calling on Boston, confidence limits on container volume shifts and growth, use of different vessel loading factors, limits on vessel drafts, and changes in sizes of vessels in service. In accordance with the Corps Engineering Circular on sea level change the study analyzed four sea level rise rates. Historic, baseline, mid-level and maximum expected sea level rise were estimated at 0.4, 0.9, 1.6 and 2.3 feet, respectively, over the 50-year project life. The study concluded that no impact would result from sea level rise with respect to dredging and channel use, and that terminal facilities would continue to operate under all conditions.

8. In accordance with the Corps Engineering Circular on review of decision documents, all technical, engineering, and scientific work underwent an open, dynamic, and vigorous review process to ensure technical quality. This included District Quality Control, Agency Technical Review (ATR), Policy and Legal Compliance Review, Cost Engineering Directory of Expertise (DX) Review and Certification, Model Review and Approval, and Independent External Peer Review (IEPR). All concerns of the ATR have been addressed and incorporated into the final report. The IEPR was completed by Battelle Memorial Institute in June 2008. The panel had 14 comments, five of which they considered significant. The comments pertained to transportation cost savings documentation, port fees, vessel fleet analysis, impacts to water quality and air quality, blasting impacts, beneficial use of rock, and design analyses. In response to economic comments by both the IEPR and Corps Headquarters, more extensive analysis of the project's economic assumptions and benefits evaluation was conducted from 2009 to 2012. A revised economic analysis was conducted which resulted in a project depth of -47 feet MLLW that reasonably maximizes net benefits in the inner harbor segments of the Main Channels Improvement Plan. In response, the final Feasibility Report and Final Supplemental Environmetal Imapct Statement were expanded to include additional information and the revised recommendation.

DAEN
SUBJECT: Boston Harbor Navigation Improvement Project, Massachusetts

9. Washington level review indicates that the plan recommended by the reporting officers is technically sound, environmentally and socially acceptable, and economically justified. The plan complies with all essential elements of the U.S. Water Resources Council's 1983 Economic and Environmental Principles and Guidelines for Water and Land Related Resources Implementation Studies. Further the recommended plan complies with other administration and legislative policies and guidelines. The views of interested parties, including federal, state and local agencies, have been considered. State and agency comments received during review of the final report and environmental assessment were addressed. Concerns expressed by the National Ocean and Atmospheric Administration's National Marine Fisheries Service included dredging effects, potential blasting effects, the capping of the industrial waste site, Essential Fisheries Habitat impacts, Fish and Wildlife Coordination Act, and Endangered Species Act effects. The EPA expressed concerns regarding the beneficial use of both ordinary dredged material and rock, removal of rock from the project area by blasting, and air quality impacts. The Federal Aviation Administration expressed concerns that birds will be attracted to the exposed dredged material during the dredging process in the flight path for Boston Logan International Airport.

10. I concur with the findings, conclusions, and recommendation of the reporting officers. Accordingly, I recommend that navigation improvements for Boston Harbor be authorized in accordance with the reporting officers' recommended plan at an estimated cost of $304,695,000, with such modifications as in the discretion of the Chief of Engineers may be advisable. My recommendation is subject to cost sharing, financing, and other applicable requirements of federal and state laws and policies, including Section 101 of WRDA 1986, as amended (33 U.S.C. 2211). The non-federal sponsor would provide the non-federal cost share and all lands, easements, and rights-of-way, including those necessary for the borrowing of material and the disposal of dredged or excavated material, and would perform or assure the performance of all relocations, including utility relocations. This recommendation is subject to the non-federal sponsor agreeing, in a Design Phase Agreement prior to initiating project design, and in a Project Partnership Agreement prior to project implementation, to comply with all applicable federal laws and policies, including but not limited to the following requirements:

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 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 provided 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 LER 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 Public Law 91-611, Flood Control Act of 1970, as amended, (42 U.S.C. 1962d-5b) and Section 101(e) of the WRDA 1986, Public Law 99-662, 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 LER, 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;

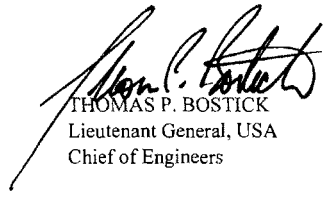
n. Comply with all applicable federal and state laws and regulations, including, but not

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 one 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.

11. The recommendation contained herein reflects the information available at this time and current departmental policies governing formulation of individual projects. It does not reflect program and budgeting priorities inherent in the formulation of a national civil works construction program or the perspective of higher review levels within the Executive Branch. Consequently, the recommendation may be modified before it is transmitted to the Congress as a proposal for authorization and implementation funding. However, prior to transmittal to Congress, the Commonwealth of Massachusetts, Massport (the non-federal sponsor), interested federal agencies, and other parties will be advised of any significant modifications and will be afforded an opportunity to comment further.



THOMAS P. BOSTICK
Lieutenant General, USA
Chief of Engineers

Massachusetts Port Authority
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East Boston, MA 02128-2909
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February 27, 2013

Colonel Charles P. Samaris
District Engineer
New England District
U.S. Army Corps of Engineers
696 Virginia Road
Concord, MA 01742-2751

Re: Boston Harbor Deep Draft Navigation Improvement Project

Dear Colonel Samaris:

The Massachusetts Port Authority ("Massport") and the U.S. Army Corps of Engineers ("the Corps") New England District have had a long and productive history of working together to deepen and maintain the Port of Boston's navigation channels and we look forward to continuing this partnership under your leadership. We greatly appreciate the ongoing hard work of your staff on the Boston Inner Harbor Maintenance Dredging Project (BIHMDP), which is currently underway in the harbor, as well as on the Boston Harbor Deep Draft Navigation Improvement Project (BHDDNIP), for which the Final Feasibility Report/Supplemental Environmental Impact Statement/Environmental Impact Report ("Final FR/SEIS/EIR") will be submitted for public review in the coming weeks.

Massport has reviewed the Final FR/SEIS/EIR for the BHDDNIP. We concur with the report's conclusions and support the Recommended Plan of Improvement. Specifically, the following four improvements to Boston Harbor's system of General Navigation Features are proposed:

1. Deepen the federal navigation channels from Massachusetts Bay to Massport's Conley Container Terminal in South Boston to enable deeper draft containerships to access the Port. A depth of -51 feet at mean lower low water (MLLW) would be provided in the Broad Sound North Entrance Channel, and -47 feet in the Main Ship Channel between the Outer Confluence and the Reserved Channel, the President Roads Anchorage, the lower Reserved Channel, and the Reserved Channel Turning Area. The Main Ship Channel above the Roads would be widened to 900 feet below Castle Island and 800 feet above Castle Island, with additional width provided in the bends of the Main Ship and North Entrance Channels. Massport would deepen the two active berths at Conley Terminal to a depth of at least three feet greater than that provided in the improved channel.

2. Extend the deepening of the Main Ship Channel above the Reserved Channel Turning Area to the Massport Marine Terminal, at a depth of -45 feet MLLW and width of 600 feet. Massport or our tenant at this facility would provide a depth of at least -45 feet MLLW in the berth at the Marine Terminal. We understand this recommended

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improvement is contingent on development of an active bulk cargo operation requiring the deeper channel prior to initiation of construction for the deeper channel.

3. Deepen an approximately 9-acre area of the 35-foot lane of the Mystic River Channel to -40 MLLW feet to improve access to Massport's Medford Street Terminal in Charlestown. Massport has already deepened the berth at this terminal to -40 feet MLLW and would maintain that depth in the future. We understand this recommended improvement is also contingent on development of an active bulk cargo operation requiring the deeper channel prior to initiation of construction for the deeper channel.

4. Deepen the existing 38-foot Chelsea River Channel to -40 feet MLLW. The channel would be widened by about 50 feet along the East Boston shore in the bend immediately upstream of the McArdle Bridge and in the bend downstream of the Chelsea Street Bridge. The channel would also be widened through the new navigation opening of the Chelsea Street Bridge. We understand this recommended improvement is contingent on replacement of the Chelsea Street Bridge by the Commonwealth of Massachusetts and the City of Boston, and the agreement of the five principal Chelsea River marine terminals to deepen their berths to at least -40 feet MLLW.

All of these improvements are integral to ensuring the future competitiveness, safety and security of the Port of Boston. The Port of Boston is New England's only full service port, providing infrastructure and value-added services to enhance the competitiveness of New England trade-dependent companies, and ultimately benefitting New England residents and consumers. The Port generates an estimated 34,000 total jobs and $2.4 billion annual economic impact to the Commonwealth of Massachusetts and the New England region, and provides significant environmental benefits by reducing the number of trucks and related air emissions on the region's roadways. Key port cargos include containerized cargo, petroleum products, and dry bulk cargo (automobiles, cement, road salt, gypsum and scrap metal) – most of which will benefit from the proposed improvements.

Of particular importance to Massport is the channel deepening to Conley Terminal. Container volumes at Conley have increased significantly since 1995 and we expect annual volumes to more than double over the coming decades to exceed 500,000 TEUs. The shipping lines calling Conley continually seek to bring larger ships into their east coast rotation and this pressure will increase once the Panama Canal expansion is completed. If the Port of Boston cannot accommodate the deeper draft vessels, the shipping lines will not call Boston and the cargo will need to be trucked into the region from other ports resulting in significant economic and environmental impacts.

Massport is actively working to increase our terminal capacity, efficiency and minimize our environmental impact to allow us to accommodate our projected future growth. Specifically, we recently completed the following projects:

- a $25 million repaving and equipment purchasing project to increase Conley Terminal capacity by 50 percent;
- Implementation of a terminal productivity improvement program and an upgraded terminal operating system;
- Increased the container handling footprint of Conley Terminal and purchased three additional dockside cranes and more yard equipment to support the increased vessel activity;
- Purchased the former Coastal Oil Terminal abutting Conley to preserve our future terminal expansion options;
- Implemented a comprehensive ISO 14001 Certified Environmental Management System;
- Retrofitted our existing yard equipment and purchase new "greener" equipment to reduce air emissions; and
- Converted all of our yard equipment to Ultra Low Sulfur Diesel to reduce air emissions.

In addition we are designing and planning to construct a dedicated freight corridor to Conley Terminal and Phase I of the expansion of container operations onto the former Coaster Oil property to accommodate further growth.

Contingent on the approval of Massport's Board and appropriation of the needed funding by our Board, the Commonwealth of Massachusetts or other funding sources, Massport intends to enter into a Design Phase agreement to share the cost of project design with the Corps. Design Phase activities are expected to commence as early as 2013 and be completed in two years. We understand the Design Phase cost for the Federal project features is estimated at $6,584,000, with Massport responsible for an initial 25 percent, or $1,646,000 plus an additional 10% or $658,000 prior to or after construction for a total design non-Federal cost share of $2,304,000.

We further understand that the Construction Phase costs for the Federal project features is estimated at $309,001,000 with the non-Federal sponsor responsible for an initial cost share of $94,389,000 based on: (1) division of cost-sharing between the cost of deepening the channels to 45 feet requiring a 25 percent cost share and the cost of deepening the channels beyond 45 feet requiring a 50 percent cost share; plus (2) the remaining non-Federal share of Design Phase costs allocated to deepening beyond 45 feet. The non-Federal sponsor will also provide an additional ten percent of the total design and construction costs at the completion of construction, currently estimated at $30,900,000, for a total non-Federal cost share of $125,289,000 in addition to approximately $5 million for berth dredging and other non-federal costs. We understand that construction commencement by the Corps is contingent on Congressional authorization of the project and appropriation of Federal funds. Construction is estimated to take approximately three years to complete. Massport intends to actively pursue funding for the non-Federal project costs, and to serve as the non-Federal sponsor, contingent on approval by our Board and appropriation of adequate funds.

Subject to the approval of Massport's Board and provision of the needed funding by our Board or other funding sources, Massport also intends to fully fund any work performed by

the Corps for design and construction activities associated with berth dredging, and will provide all lands, easements, rights of way and relocations (LERR) required for construction and future maintenance of the project. We further understand that any LERR costs incurred by Massport for construction of the project, currently estimated at $165,000, will be credited against the 10 percent post-construction share of project costs.

Massport is a legislatively-chartered independent State authority. Massport owns and operates Logan International Airport, the Conley Container Terminal, the Black Falcon Cruise Terminal, and several bulk cargo terminals. Massport has the statutory authority to set and collect fees for the use of its facilities, enter agreements for lease and operation of facilities, and issue bonds to raise funds for capital improvements of its facilities.

Massport is the non-Federal Sponsor for the BHDDNIP Feasibility Study, the 1990-authorized deepening of the harbor's major tributary channels constructed in 1998-2001 (the Boston Harbor Navigation Improvement Project), and construction of the confined disposal cells being constructed in the harbor for the ongoing BIHMDP. Massport has reviewed the cost-sharing and other responsibilities of the Sponsor as detailed in the Feasibility Report. Massport intends to work with the Commonwealth and other potential funding sources to provide the non-Federal share of design and construction of the improvements recommended in the Feasibility Report. The completed "Non-Federal Sponsor's Self-Certification of Financial Capability for Decision Documents" is attached to this letter, as requested by the Corps.

We look forward to continuing to work with you and your staff on this exciting and critical project for the Port of Boston.

Sincerely,

Deborah A. Hadden
Acting Port Director

Enclosure: Non-Federal Sponsor's Self-Certification of Financial Capability for Decision Documents

cc: Thomas Glynn, Massport CEO and Executive Director

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UNITED STATES ENVIRONMENTAL PROTECTION AGENCY
REGION 1
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BOSTON, MA 02109-3912

OFFICE OF THE
REGIONAL ADMINISTRATOR

July 22, 2013

Michael Keegan
Army Corps of Engineers New England District
Programs and Project Management Division (Mr. Michael Keegan)
696 Virginia Road
Concord, Massachusetts 01742-2751

RE: Final Supplemental Environmental Impact Statement for the Boston Harbor Deep Draft Navigation Improvement Dredging, Boston, Massachusetts (CEQ # 20130172)

Dear Mr. Keegan:

In accordance with our responsibilities under the National Environmental Policy Act (NEPA) and Section 309 of the Clean Air Act, we have reviewed the U. S. Army Corps of Engineers, New England District (Corps) Final Supplemental Environmental Impact Statement (FSEIS) for the Boston Harbor Deep Draft Navigation Improvement Dredging project proposed in various areas of Boston Harbor. The DSEIS was prepared by the Corps in partnership with the Massachusetts Port Authority (Massport).

The FSEIS details Massport's continuing goal to establish a deeper channel for access to the Conley Container Terminal in South Boston and to make port improvements in the Mystic and Chelsea Rivers and in the Main Ship Channel above the Reserved Channel. The proposed channel deepening is intended to help reduce tidal delays currently experienced by container ships and bulk carriers that use Boston Harbor. The project is expected to generate a total of 10.2 million cubic yards of non-rock dredged material (parent material) and approximately 900,000 cubic yards of rock.

The FSEIS proposes disposal of the majority of the dredged material at the Massachusetts Bay Disposal Site (MBDS)[1] and use of some of the non-rock dredged material (parent material) as cover at the former Industrial Waste Site.[2] EPA continues to have no objection to the use of the MBDS for disposal of the dredged material or to the use of parent material as cover at the former Industrial Waste Site. Furthermore we continue to view the proposed capping plan as a means to further reduce risk associated with waste barrels that may still exist at the site.

[1] The MBDS is approximately 17 nautical miles east of the entrance to Boston Harbor adjacent to the Stellwagen Bank National Marine Sanctuary.

[2] The Industrial Waste Site is located 20 miles east of Boston in 300 ft. of water.

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In our review of the FSEIS, we focused on the areas we commented on in our previously on the DSEIS, namely, air quality impacts, removal of rock in the project area by blasting, and the potential for beneficial reuse of rock material to construct rock reefs. The attachment to this letter provides detailed comments regarding outstanding air quality issues and it expresses our willingness to work with the Corps to resolve them prior to construction of the project. The FSEIS lacks information to fully describe the potential impacts associated with proposed rock blasting and the creation of rock reefs. We continue to be concerned that there is only limited information available at this point regarding the potential for those impacts and whether measures can be implemented to successfully minimize and mitigate blasting impacts. Many of our other comments on impacts to the marine environment (from our DSEIS comment letter) have not been addressed in the FSEIS and the Corps intends to address them during post EIS design and permitting. We continue to believe that the NEPA process would have been the ideal forum to provide that information and analysis to interested state and federal agencies and the public. Despite our concerns, we remain willing to participate actively on the technical advisory committees related to blasting, sequencing and possibly beneficial re-use of material generated by the project. We also continue to have an interest in exploring the use of clean material to cap the former Industrial Waste Site.

Please feel free to contact me at 617/918-1025 to discuss our comments.

Sincerely,

Timothy Timmermann
Associate Director, Office of Environmental Review

Attachment

Additional Detailed Air Quality Comments on the Final Supplemental Environmental Impact Statement (FSEIS) for the Boston Harbor Deep Draft Navigation Improvement Dredging, Boston, Massachusetts

- Chapter 4 of the FSEIS, "Environmental Consequences," includes air quality analyses for Alternative 1 (proposed deepening of Boston Harbor to the minus 45-feet MLLW depth), and Alternative 2 (proposed deepening of Boston Harbor to the minus 50-feet MLLW depth). The proposed action is to deepen Boston Harbor to the minus 47-feet MLLW depth. The FSEIS reports that a qualitative air quality analysis associated with direct emissions would be expected to lie between (be bracketed by) the emissions of Air Quality Analysis Alternatives 1 and 2. Should general conformity be triggered by the final designed/selected project, we request that a quantitative air quality analysis be prepared for the selected navigation improvement project during the design phase.

- Because the Corps of Engineers (Corps) has postponed its general conformity determination to the design phase we request that the NEPA Record of Decision include a commitment to satisfy the provisions of Section 176 (c) of the Clean Air Act, (the general conformity requirements), prior to "take or start the Federal action." Furthermore, we request that the Corps define the project milestone associated with this "take or start the Federal action." As pointed out in the Corps' feasibility report, "take or start Federal action" is defined in the general conformity regulations at 40 CFR 93.152 as 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 under this subpart.

- On June 6, 2013 (78 FR 34178 – 34239), EPA proposed the revocation of the 1997 eight-hour ozone National Ambient Air Quality Standard (NAAQS) and anti-backsliding requirements that would apply when the 1997 ozone NAAQS is revoked. This rulemaking is currently open for comment until August 5, 2013. The FSEIS correctly points out that since the project area is attainment for the 2008 ozone NAAQS, general conformity would not apply for ozone after revocation of the 1997 ozone standard. This rule is expected to be finalized in the Spring 2014 time frame. EPA is willing to work with the Corps during the design phase to address general conformity and insure general conformity is satisfied prior to "take or start Federal action."

- With respect to general conformity to the Boston area (nine communities) carbon monoxide maintenance plan, EPA points out that the maintenance plan will end on April 1, 2016, twenty years after redesignation of the area to attainment. Therefore, the general conformity provisions will not apply to the Boston area after April 1, 2016 for carbon monoxide. General conformity with respect to carbon monoxide must be satisfied should the Corps take or start final action prior to April 1, 2016. The FSEIS identifies a number of emission reduction options to develop a project that remains below the carbon monoxide de minimis threshold of 100 tons per year in order to avoid triggering general conformity for carbon

monoxide. It is possible that the final designed/selected navigation improvement project will exceed the de minimis threshold for carbon monoxide and trigger general conformity. EPA will work with the COE during the design phase to insure the Federal Deep Draft Navigation Improvement Project is in full compliance with Section 176(c) of the Clean Air Act.

- Should general conformity be applicable to the final designed/selected project, then in accordance with 40 CFR 93, the Corps must make public its draft conformity determination by placing a notice by prominent advertisement in a daily newspaper of general circulation in the area affected by the action and by providing 30 days for written public comment prior to taking any formal action on the draft determination. The final conformity determination must also be made public by placing a notice by prominent advertisement in a daily newspaper of general circulation in the area affected by the action within 30 days of the final conformity determination. If the action would have multi-regional or national impacts, the Federal agency, as an alternative, could publish the notice in the Federal Register.

DEPARTMENT OF THE ARMY
U.S. ARMY CORPS OF ENGINEERS
441 G STREET, NW
WASHINGTON, DC 20314-1000

Planning and Policy Division

SEP 13 2013

Mr. Timothy Timmermann
Associate Director, Office of Environmental Review
United States Environmental Protection Agency
Region 1
5 Post Office Square, Suite 100
Boston, Massachusetts 02109-3912

Dear Mr. Timmermann,

This is in response to your letter dated July 22, 2013, providing comments on the Final Feasibility Report and on the Final Supplemental Environmental Impact Statement/Environmental Impact Report (FSEIS/EIR) for the Boston Harbor Deep Draft Navigation Improvement Project, Boston, Massachusetts. Your comments pertain to the beneficial use of both ordinary dredged material and rock, removal of rock from the project area by blasting, and air quality impacts.

Detailed responses to each of your comments on beneficial use of dredged material, blasting of rock, and air quality are provided in the Enclosure. The Corps has been working for many years with your agency and the other Federal, State and Local agencies and stakeholders through the Boston Harbor Technical Working Group (TWG), to define and address the issues associated with this project and other Corps actions in Boston Harbor before it. We have been working with your office since 2006 regarding the beneficial use of the ordinary dredged material to cap the former Industrial Waste Site (IWS) approximately 20 miles offshore of Boston Harbor. We also consulted your office in preparing the discussion of air quality impacts and mitigation included in the FSEIS. We will continue to work with your office and the TWG participants as this project moves through its design and construction phases to ensure that all stakeholder concerns are adequately addressed.

We look forward to continuing our work together to bring this project to a successful and environmentally responsible completion. If you have further questions or concerns please contact Mr. Thomas Hughes at (202) 761-5543.

Sincerely,

Theodore A. Brown, P.E.
Chief, Planning and Policy Division
Directorate of Civil Works

Enclosure

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ENCLOSURE

Responses to U.S. Environmental Protection Agency (EPA)
Comments on the Final Supplemental Environmental Impact Statement
Boston Harbor Deep Draft Navigation Improvement Project, Massachusetts
(August 2013)

Beneficial Use of Unconsolidated Dredged Material to Cap the Former Industrial Waste Site (IWS):

Comment: EPA continues to have no objection to the use of the Massachusetts Bay Disposal Site (MBDS) for disposal of the dredged material or to the use of the parent material as cover of the former Industrial Waste Site. Furthermore, we continue to view the proposed capping plan as a means to further reduce risk associated with waste barrels that may still exist at the site.

Response: We support EPA's goal of reducing risk associated with waste containers exposed at the IWS by using the unconsolidated dredged material from this project to cap areas of the site. As we have since 2006, the Corps will continue to work with EPA and other agencies to develop placement methods, identify priority areas for capping, identify cultural resources to be documented and/or avoided, and measure and monitor the effectiveness of the capping efforts. As portions of the IWS that appear to contain waste container concentrations lie outside of the existing designated boundary of the MBDS, EPA will need to administratively approve the placement of capping material at portions of the IWS. We look forward to working with you to implement this important beneficial use opportunity.

Beneficial Use of Rock and Other Hard Material Removed for the Project and Impacts of Blasting:

Comment: The FSEIS lacks information to fully describe the potential impacts associated with proposed rock blasting and the creation of rock reefs. We continue to be concerned that there is only limited information available at this point regarding the potential for those impacts and whether measures can be implemented to successfully minimize and mitigate blasting impacts.

Response: The Corps has committed in the Final Feasibility Report/FSEIS/EIR and in a letter dated October 26, 2012, to the Massachusetts Office of Coastal Zone Management to work with the State and Technical Working Group (TWG) members to investigate potential beneficial uses and users for the rock and hard materials, and identify methods to reduce and avoid impacts of blasting, including rock removal and construction sequencing plans. Before that effort can proceed, we need first better identify and quantify where rock and other hard material exist in the project. In the preliminary stages of our design efforts we intend to undertake an extensive subsurface exploration program to quantify the amount of rock as well as characterize the rock to determine the appropriate removal methods. We believe this will result in a reduction in the volume of rock that must be removed and the volume that would require drilling and blasting. Where appropriate rock removal by rock buckets or hydraulic rams will be employed to reduce the blasting impacts.

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Once the location, volumes and appropriate removal methods have been identified for the rock and hard material, we will work with you and the TWG members to determine the range of potential beneficial uses for this material, the costs, impacts and benefits of such uses, and the willingness and capability of cost-sharing partners where necessary. The Final Feasibility Report/FSEIS/EIR proposed using rock to create inshore reef habitat in Massachusetts Bay. Other suggested uses include making the materials available for other parties to transport and use in their own upland or shore protection projects.

Air Quality Impacts and Emissions Mitigation:

Comment: Chapter 4 of the FSEIS, "Environmental Consequences," includes air quality analyses for Alternative 1 (proposed deepening of Boston Harbor to the minus 45- feet MLLW depth), and Alternative 2 (proposed deepening of Boston Harbor to the minus 50-feet MLLW depth). The proposed action is to deepen Boston Harbor to the minus 47-feet MLLW depth. The FSEIS reports that a qualitative air quality analysis associated with direct emissions would be expected to lie between (be bracketed by) the emissions of Air Quality Analysis Alternatives 1 and 2. Should general conformity be triggered by the final designed/selected project, we request that a quantitative air quality analysis be prepared for the selected navigation improvement project during the design phase.

Response: The Final Feasibility Report/FSEIS/EIR proposed use of a construction shut-down period for the last three months of the first year and the first three months of the second full year of construction to limit work to nine months per year. This construction schedule would allow for project implementation and keep annual project emissions below the established acceptable thresholds.. While extension of the construction duration and demobilization/remobilization of equipment are costly, we determined that this method was likely less expensive than other means of mitigating project emissions to a zero level.

In response to concerns advanced by Massport and other TWG members, we agreed to revisit the issue of emissions mitigation once our design phase investigations were completed. Those investigations will allow us to better identify rock versus ordinary dredge material quantities and the appropriate removal methods. This information coupled with possible time of year restrictions and sequencing of the project which will be developed in coordination with the TWG will allow us to develop an air quality analysis that is more reflective of the actual project that will be constructed. There will be a commitment in the Record of Decision to conduct the air quality analysis for the designed project should one be warranted.

Comment: Because the Corps of Engineers (Corps) has postponed its general conformity determination to the design phase we request that the NEPA Record of Decision include a commitment to satisfy the provisions of Section 176 (c) of the Clean Air Act, (the general conformity requirements), prior to "take or start the Federal action." Furthermore, we request that the Corps define the project milestone associated with this "take or start the Federal action." As pointed out in the Corps' feasibility report, "take or start Federal action" is defined in the general conformity regulations at 40 CFR 93.152 as the date that the Federal agency signs or approves the permit, license, grant or contract or otherwise

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physically begins the Federal action that requires a conformity evaluation under this subpart.

Response: The Corps defines the project milestone associated with this "take or start the Federal action" as the award of the construction contract. There will be a commitment in the Record of Decision to conduct the air quality analysis for the designed project should one be warranted.

Comment: On June 6, 2013 (78 FR 34178-34239), EPA proposed the revocation of the 1997 eight-hour ozone National Ambient Air Quality Standard (NAAQS) and anti-backsliding requirements that would apply when the 1997 ozone NAAQS is revoked. This rulemaking is currently open for comment until August 5, 2013. The FSEIS correctly points out that since the project area is attainment for the 2008 ozone AAQS, general conformity would not apply for ozone after revocation of the 1997 ozone standard. This rule is expected to be finalized in the Spring 2014 time frame. EPA is willing to work with the Corps during the design phase to address general conformity and insure general conformity is satisfied prior to "take or start Federal action."

Response: We recognize as detailed in the attachment to your letter that USEPA is proposing the revocation of the 1997 eight-hour ozone National Ambient Air Quality Standard (NAAQS) and that this revocation is expected to be finalized in the Spring 2014 timeframe. We concur with your assessment that after this revocation, general conformity for the project related to ozone would not apply.

Comment: With respect to general conformity to the Boston area (nine communities) carbon monoxide maintenance plan, EPA points out that the maintenance plan will end on April 1, 2016, twenty years after redesignation of the area to attainment. Therefore, the general conformity provisions will not apply to the Boston area after April 1, 2016 for carbon monoxide. General conformity with respect to carbon monoxide must be satisfied should the Corps take or start final action prior to April 1, 2016. The FSEIS identifies a number of emission reduction options to develop a project that remains below the carbon monoxide de minimis threshold of 100 tons per year in order to avoid triggering general conformity for carbon monoxide. It is possible that the final designed/selected navigation improvement project will exceed the de minimis threshold for carbon monoxide and trigger general conformity. EPA will work with the COE during the design phase to insure the Federal Deep Draft Navigation Improvement Project is in full compliance with Section 176(c) of the Clean Air Act.

Response: We also recognize, as you have stated, that the general conformity carbon monoxide provisions will not apply to the project area after the carbon monoxide maintenance plan expires on April 1, 2016. The timing of these changes relative to the timing of project construction will largely determine whether mitigation is required and what the most cost-effective means of addressing air quality requirements will be.

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Comment: Should general conformity be applicable to the final designed/selected project, then in accordance with 40 CFR 93, the Corps must make public its draft conformity determination by placing a notice by prominent advertisement in a daily newspaper of general circulation in the area affected by the action and by providing 30 days for written public comment prior to taking any formal action on the draft determination. The final conformity determination must also be made public by placing a notice by prominent advertisement in a daily newspaper of general circulation in the area affected by the action within 30 days of the final conformity determination. If the action would have multi-regional or national impacts, the Federal agency, as an alternative, could publish the notice in the Federal Register.

Response: If general conformity requirements remain applicable to the final designed project we will make public our draft and final conformity determinations in accordance with 40 CFR 93 prior to the "take or start Federal action" of contract award. We look forward to your continued guidance in appropriately addressing the air quality impacts of this project.

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UNITED STATES DEPARTMENT OF COMMERCE
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NATIONAL MARINE FISHERIES SERVICE
NORTHEAST REGION
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CECW-P (SA)
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JUL 22 2013

RE: FSEIS/FEIR for Boston Harbor Deep Draft Navigation Improvement Project

Dear Mr. Brown:

We have received your letter, dated June 21, 2013, requesting our comments and recommendations on the Final Feasibility Report (FFR), Final Supplemental Environmental Impact Statement (FSEIS), and the Final Environmental Impact Report (FEIR), dated April 2013, for the proposed Boston Harbor Deep Draft Navigation Improvement Project (BHDDNIP). As you know, we provided our Essential Fish Habitat (EFH) conservation recommendations pursuant to the Magnuson-Stevens Fishery Conservation and Management Act (MSA) in a letter, dated November 26, 2013. In that letter, we also provided recommendations pursuant to the Fish and Wildlife Coordination Act (FWCA). In addition, an Endangered Species Act (ESA), Section 7 consultation was completed by our agency for this project on November 27, 2012.

Following State and Federal agency review of the FFR, FSEIS, and FEIR, a record of decision will be prepared by the Assistant Secretary of the Army for Civil Works, and the reports forwarded to Congress for authorization through the Water Resources Development Act. Initiation of the Design phase of the proposed project is expected to occur in fiscal year 2014.

As you know, we reviewed the Draft Supplemental Environmental Impact Statement and Draft Environmental Impact Report for the proposed project in 2008. We also received an EFH assessment for the project at that time. However, we concluded that these documents did not contain sufficient information necessary for us to fully assess the effects of the proposed project on our trust resources. By letter dated June 2, 2008 (see attachment to this letter), we requested additional information regarding aspects of the proposed project, including: 1) development of a dredging sequencing plan; 2) development of a comprehensive blasting plan to be approved by an interagency technical working group; 3) evaluation of alternative beneficial reuses for disposal of rock removed from the dredging project, and; 4) a review of the results from a capping demonstration study for the former offshore Industrial Waste Site (IWS) to assess potential impacts associated with disposing of dredged material at the IWS. However, the additional information requested by us in 2008 was not provided.

Our letter to you, dated November 26, 2012 (see attachment to this letter), indicated that our

Encl 6

need for additional information to evaluate the effects of the project on EFH, federally-managed species, and other trust resources remain, but we are obliged by our regulations at 50 CFR 600.920(i)(5) to provide EFH conservation recommendations using the best scientific information available. Consequently, we provided to you the following EFH conservation recommendations:

1. A time of year restriction (i.e., no dredging or underwater blasting), from February 1 to 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 west of the Conley Terminal, to avoid winter flounder spawning, egg, larvae, and juvenile development habitat;
2. A time of year restriction (i.e., no dredging or underwater blasting), from March 1 to June 30 of any year in any areas of the Mystic River, 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 in order to protect EFH forage species (e.g., upstream spawning migrations of alewife, blueback herring, rainbow smelt).
3. An underwater blasting plan should be developed for the BHDDNIP by a technical working group (TWG), which should be convened as soon as possible to begin evaluating data from past Boston Harbor Federal Navigation projects, as well as 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, and should be incorporated into the FSEIS/FEIR;
4. Alternative beneficial reuse of rock material that avoid and minimize adverse impacts to biologically productive soft bottom habitats should be evaluated more fully and incorporated into the FSEIS/FEIR, including using the rock for upland construction purposes and the use for ongoing shore protection projects;
5. The results of the demonstration capping project within the Industrial Waste Site (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.

In your response letter, dated December 10, 2012, you provided the following responses to each of the conservation recommendations listed above:

1. You will seek to accommodate the February 1 to June 15 environmental window for winter flounder to the extent practicable. The window will be evaluated during the Design Phase once overall project sequencing plans are developed and potential blasting and air quality emissions impacts are taken into account.
2. Regarding our recommendation to implement a no-dredge window of March 1 to June 30 to protect diadromous fish, you will coordinate with the TWG during the Design Phase to determine what species may be present and then determine the appropriate means to minimize impacts.
3. You will support the development of a plan for blasting/rock removal mitigation measures during the Design Phase of the project through the TWG, but this will not be conducted during the National Environmental Policy Act (NEPA) or MSA consultations.
4. Although the current federal base plan for rock disposal is placement in the Massachusetts Bay Disposal Site (MBDS), you will carry out additional consultation and collaboration with

interested agencies or others to determine if other economically-practical beneficial use options exist. This consultation and collaboration will be conducted during the Design Phase, and not within the NEPA or MSA consultation processes.

5. You agreed to summarize the results of the demonstration capping project within the IWS in the FSEIS/FEIR. According to your letter, you believe the results of the pilot project indicated the industrial waste barrels in the IWS can be successfully capped.

We continue to believe that all of the information previously requested in our letters is critical to fully evaluating the effects of the project on EFH and our other trust resources, including information necessary to evaluate the effects of dredging and blasting. While we understand you intend to coordinate with us on these remaining questions and concerns during the Design Phase through the TWG, we maintain that this information is central to evaluating the effects of the project on our trust resources and the appropriate time to acquire and evaluate this information is during NEPA consultation process. NEPA requires any major Federal action that significantly affects the quality of the human environment assess (i) the environmental impact of the proposed action, (ii) any adverse environmental effects which cannot be avoided should the proposal be implemented, and (iii) alternatives to the proposed action. 42 USC § 4332. Furthermore, NEPA procedures must insure that environmental information is available to public officials and citizens before decisions are made and before actions are taken. 40 CFR § 1500.1.

Comments on the FFR, FSEIS, and FEIR

A large amount of information related to the proposed project has yet to be evaluated, including the environmental conditions existing in the project area, the expected environmental impacts of the project, and an evaluation and comparison of environmental impacts for various project alternatives and mitigation opportunities. According to the FFR, FSEIS, and FEIR, upon completion of the Feasibility Phase and NEPA consultations, you intend to gather and evaluate data during the Design Phase of the project the following information:

- 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;
- Conduct additional resource characterization investigations for the dredging and beneficial use areas; and
- Investigate additional air quality compliance methods as alternatives to the construction shutdowns presently scoped;

The above listed studies are not trivial, but are in fact pertinent to the primary environmental resource concerns we have expressed during the NEPA and MSA consultations beginning in 2008, and which have generally been identified in the FFR, FSEIS, and FEIR for this project. Specifically, the collection of geologic and geotechnical data to better determine the distribution

(and amount) of rock to be dredged directly effects the duration, timing, and magnitude of underwater blasting that will be required for this project. According to information provided through your letters and the FSEIS, the rock removal by blasting is anticipated to require approximately 26 months, including one daily blast for each of the two barges. Although some rock may be removed by hydraulic hammer, the FSEIS notes that the depth of the rock (8-15 feet) suggests it will be unlikely that removal by blasting is avoidable. Any rock that is not removed by blasting will be done using a hydraulic hammer, but this method takes a longer time than blasting and creates significant and more constant noise than drilling and blasting, according to the FSEIS. Consequently, the uncertainty involving the location and amount of rock to be removed, and what methods of removal will be used, suggests a high degree of uncertainty regarding the impacts on fishery resources during the construction period.

As you know, underwater blasting was conducted to remove rock from the Boston Harbor Federal Navigation Maintenance Dredging project between October 24 and November 14, 2007. Four separate fish kill events occurred within the President Roads area of Boston Harbor, impacting approximately 2,500 fish, primarily comprised of alewife, blueback herring, and rainbow smelt, which are all identified by NMFS as "Species of Concern", although other species such as menhaden, cunner, red hake, butterfish, and Atlantic herring were also killed. Species of Concern are those species about which NOAA's National Marine Fisheries Service (NMFS) has some concerns regarding status and threats, but for which insufficient information is available to indicate a need to list the species under the Endangered Species Act (ESA). You indicated in the draft Environmental Assessment for the Boston Harbor Main Ship Channel and the Weymouth Fore River Channel Rock Removal project that through lessons learned from the previous blasting in Boston Harbor, a number of new blasting best management practices (BMPs) would be incorporated into the Contractor's blasting plan. In fact, several of these BMPs were incorporated in the blasting conducted in September 2012, and you reported no fish kills during that recent rock removal work. However, this project involved removing just over 3,000 cy in approximately 6 days of blasting in September, which is a time when minimal presence of diadromous fish are expected in Boston Harbor. Because the proposed BHDDNIP involves removing approximately 1 million cy of rock over a 26-month period, some of which may occur during a time of year when diadromous fish densities are the highest, we believe the potential risk of injury and mortality are orders of magnitude larger than the rock removal project in September 2012.

The sequencing plans for dredging and rock removal activities that are expected to be developed in the Design Phase will likely be, in large part, influenced by the volume and location of rock in the BHDDNIP. However, our mandates to protect and conserve living marine resources require us to provide recommendations that avoid and minimize project impacts, and the primary factor that establishes time-of-year restrictions for dredging and blasting impacts is the presence of sensitive life history stages in the project area. Our concerns of potential adverse effects on our trust resources are heightened by the proposed construction sequence developed to avoid exceeding air quality standards. Specifically, according to the FFR for each plan and depth increment evaluated, the construction sequence would include a 6-month shutdown period every other year from October 1 to March 31 (12 months total). Because the proposed shutdown period coincides with the typical recommended dredge window for tidal and marine projects in Massachusetts (i.e., November 15 to January 31), we are concerned that the proposed plan may

result in a shift of dredging and blasting operations to times of the year when sensitive life stages of aquatic species are present. For example, because winter flounder spawning and egg development generally occurs between February and mid-June, and diadromous fish spawning migrations occur from March through June, these months are considered highly sensitive periods for fishery resources in Boston Harbor and should be avoided. We believe the shutdown period for air quality purposes should be re-evaluated, taking into account potential impacts on aquatic life stages.

Lastly, as a technical comment on the FFR, page ES-13 of the Environmental Coordination, Impacts, and Benefits section of the Executive Summary, states the "Endangered Species Act and Fish and Wildlife Coordination Act efforts were concluded in November 2012 and January 2013, respectively, with no adverse impacts identified." This statement is inaccurate and confusing to the public. As you recall, we provided EFH conservation recommendations and FWCA recommendation to you in a letter, dated November 26, 2012. In this letter, we identified a number of concerns regarding potential adverse impacts to our trust resources, and provided recommendations to avoid and minimize, as well as outstanding information necessary to fully evaluate adverse impacts.

Essential Fish Habitat and Fish and Wildlife Coordination Act Consultations
As discussed in our previous letters to you on the BHDDNIP, Boston Harbor supports living marine resources that provide for valuable recreational and commercial fisheries, as well as species and habitats that are critical to healthy marine and estuarine ecosystems. The area provides habitats for a number of federally-managed species such as winter flounder, as well as a number of NOAA trust resources such as rainbow smelt, alewife, blueback herring, shellfish, and American lobster.

As discussed above, we provided you EFH conservation recommendations for the proposed project on November 26, 2012. Although we indicated that our need for additional information to evaluate the effects of the project on EFH, federally-managed species, and other trust resources remain, we were obliged by our regulations at 50 CFR 600.920(i)(5) to provide EFH conservation recommendations using the best scientific information available. However, a distinct and further EFH consultation must be reinitiated pursuant to 50 CFR 600.920(1) if new information becomes available or the project is revised in such a manner that affects the basis for the prior EFH conservation recommendations. The FFR, FSEIS, and FEIR listed a number of remaining issues and additional information that will be generated during the Design Phase of the BHDDNIP. New information identified during the Design or later phases of the project, if it may affect the basis of our EFH conservation recommendations, would require the reinitiation of our EFH consultation.

Endangered Species Act
As stated above, an Endangered Species Act Section 7 consultation was completed for this project on November 27, 2012. The consultation letter provided on that date (see attachment to this letter) stated that we agreed with your determination 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. After review of the provided FSEIS, that determination still stands since no

significant changes to the project scope are proposed. As referenced in the FSEIS, the project proponents plan to prepare a blasting monitoring plan and share it with us before blasting begins.

Reinitiation of consultation is required and shall be requested by you or us, where discretionary Federal involvement or control over the action has been retained or is authorized by law and, (a) if new information reveals effects of the action that may affect listed species or critical habitat in a manner or to an extent not previously considered in the consultation; (b) if the identified action is subsequently modified in a manner that causes an effect to the listed species or critical habitat that was not considered in the consultation; or (c) if a new species is listed or critical habitat designated that may be affected by the identified action. No take is anticipated or exempted. If there is any incidental take of a listed species, reinitiation would be required. As noted above, we expect that you will provide us with refined project plans once they are available. At that time, if we determine the project will cause effects not considered here, reinitiation of this consultation will be necessary.

Conclusion

Thank you for the opportunity to provide comments on the proposed project. We look forward to collaborating with you on the TWG for the proposed project. Should you have any questions about EFH and fishery related issues, contact Michael Johnson at 978-281-9130, at mike.r.johnson@noaa.gov, or at the letterhead address of this letter. Should you have any questions regarding the ESA consultation, please contact Kevin Madley at (978) 282-8494, or by e-mail (Kevin.Madley@Noaa.gov).

Sincerely,

Louis A. Chiarella
Assistant Regional Administrator for Habitat Conservation

cc:
Madley/Colligan, FNER3
Cowie-Haskell, SBNMS
Keegan/Rogers/Mackay, USACE NAE
Colarusso/Timmermann, USEPA
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UNITED STATES DEPARTMENT OF COMMERCE
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JUN 2 2008

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Ian A. Bowles, Secretary
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Executive Office of Energy and Environmental Affairs
Suite 900
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Boston, MA 02114

Re: Boston Harbor Deep Draft Navigation Improvement Dredging Project, Feasibility Report and Draft Supplemental Environmental Impact Statement; Draft Environmental Impact Report

Dear Colonel Thalken and Secretary Bowles:

The National Marine Fisheries Service (NMFS) has reviewed the Draft Supplemental Environmental Impact Statement (DSEIS) and the Commonwealth of Massachusetts' Draft Environmental Impact Report (DEIR) for the Boston Harbor Deep Draft Navigation Improvement Dredging Project. This project involves the improvement dredging of approximately 12.1 million cubic yards (cy) of material from the Broad Sound entrance channel, the Main Ship channel, the Reserved channel, the Mystic River channel, and the Chelsea River channel. Dredged material from the proposed project will be placed at Massachusetts Bay Disposal Site (MBDS). In addition, approximately 1.2 million cy of rock will be removed from the Broad Sound entrance channel, Main Ship channel, and the Chelsea River channel by blasting.

The Magnuson-Stevens Fishery Conservation and Management Act (MSA) and the Fish and Wildlife Coordination Act require federal agencies to consult with one another on projects such as this. Insofar as a project involves essential fish habitat (EFH), as this project does, this process is guided by the requirements of our EFH regulation at 50 CFR 600.905, which mandates the preparation of EFH assessments and generally outlines each agency's obligations in this consultation procedure. While the EFH assessment contained in the DSEIS/DEIR addresses many of the issues associated with this project, specific information necessary to evaluate anticipated impacts has not been received. This information, as described below, is necessary for NMFS to fully evaluate anticipated

impacts on fishery resources and habitat. Upon receipt of additional information, NMFS will provide specific EFH conservation recommendations, as appropriate.

Presence of Fishery Resources in Boston Harbor

Boston Harbor provides habitat for a variety of living marine resources, including, but not limited to, the commercially and recreationally important winter flounder (*Pseudopleuronectes americanus*), rainbow smelt (*Osmerus mordax*), alewife (*Alosa pseudoharengus*), blueback herring (*Alosa aestivalis*), and American lobster (*Homarus americanus*). There is ample evidence that winter flounder utilize the proposed project area for spawning and juvenile development habitat. According to the NOAA Technical Memorandum NMFS-NE-138 (EFH Source Document), winter flounder generally spawn over sand, silt, and mud substrates in nearshore habitats from less than five meters deep, as well as offshore areas at depths of up to 90 meters on Georges Bank (Pereira et al. 1999). With the exception of Georges Bank and Nantucket Shoals populations, mature winter flounder spawn in the shallow waters of inshore bays and estuaries (Pereira et al. 1999). Because winter flounder eggs are demersal and adhesive in nature and larval and young of year winter flounder also prefer shallow inshore waters, spawning, egg development and early juvenile development habitat tend to be close together (Pereira et al. 1999). According to the EFH Source Document, winter flounder eggs and larvae have been collected at temperatures ranging from 0 to about 20.5 degrees Celsius. As such, it is anticipated that winter flounder eggs and larvae would be present within Boston Harbor during the winter, spring, and early summer. In addition, NOAA's Estuarine Living Marine Resources Program has identified winter flounder eggs and larvae as being abundant in Boston Harbor during this portion of the year (US Department of Commerce 1994).

The 2004-2005 final report for the Mystic Power Generating Station along the Mystic River in Everett, Massachusetts contains detailed information regarding the impingement and entrainment of fishery resources as a result of operations. This power station is located upstream of the proposed dredging footprint. As noted within the final report, approximately 16 million winter flounder larvae were entrained into the facility in this 12-month period (Shaw 2006). While this facility is located upstream of the proposed project footprint, this study suggests that inner portions of Boston Harbor are currently being utilized for winter flounder spawning and juvenile development.

The May 1995 Finfish Sampling and Description Report prepared by Normandeau Associates for the Army Corps of Engineers (ACOE) 1995 improvement dredging project of the inner Boston Harbor identified substantial winter flounder presence in the project area. This study included sampling at stations located within the inner and outer harbor. The trawl data identify winter flounder as being the most numerous finfish at each station, and winter flounder catch per unit effort (CPUE) as the highest of all species for all stations combined (Normandeau 1995). In view of these data provided in the reports and publications provided above, NMFS maintains that Boston Harbor and the Mystic and Chelsea Rivers support populations of winter flounder that utilize the area for spawning and juvenile development.

In addition to winter flounder, anadromous rainbow smelt, alewife, and blueback herring currently utilize Boston Harbor, the Mystic River, and the Chelsea River as a migratory pathway between upstream spawning locations and Massachusetts Bay. The 1995 Normandeau study associated with the improvement dredging of Boston Harbor found use of the area by alewife, blueback herring, and rainbow smelt through gill net sampling. Over all stations combined, blueback herring (26%), rainbow smelt (25%), and alewife (15%) were found to be the most abundant species sampled using gill nets (Normandeau 1995). Entrainment studies within the Mystic Station final report for 2004-2005 found that approximately 1.8 million rainbow smelt larvae were entrained in the facility (Shaw 2006). Further, this study found that 497 alewife and 27,379 blueback herring juveniles and adults were subject to impingement resulting from operations (Shaw 2006). As such, NMFS maintains that this area is being utilized by anadromous fish, including blueback herring, rainbow smelt, and alewife. It is important to note that due to the low populations of alewife and blueback herring throughout the Commonwealth of Massachusetts, the Massachusetts Division of Marine Fisheries has prohibited all harvest of these species. In addition, rainbow smelt has been identified as a "species of concern" by NMFS, who is assessing whether the species warrants listing under the Endangered Species Act. These actions underscore the importance of these species in Massachusetts and New England as well as the need for measures which avoid and minimize impacts on anadromous fishery resources.

The substrate found within the project area also serves as habitat for benthic organisms, such as shellfish and other invertebrates living within and on the surface of the sediment. These organisms contribute to the productivity of the federally managed species as a food source for both juvenile and adult life stages of finfish. The commercially important American lobster has been documented extensively within Boston Harbor by the Massachusetts Division of Marine Fisheries through the 1990-2002 Massachusetts Bay Lobster Trawl Sampling Program.

Issues associated with dredging

The proposed dredging and the resulting suspended sediment and deposition may result in adverse effects to fishery resources and habitats. The EFH Source Document states that winter flounder eggs range in size from 0.74-0.85 mm in diameter, and are demersal and adhesive (Pereira et al. 1999). The eggs have been shown to be adversely affected by minimal levels of sediment deposition. Research conducted at the NMFS Northeast Fisheries Science Center's Milford Lab found that sediment deposition at depths of ½ the egg diameter (~0.5 mm) resulted in reduction in hatch of eggs (David Nelson, personal communication, 2003). In addition, a recent study found that deposition of suspended sediments can have adverse effects on winter flounder eggs at approximately 1.0 mm (Walter Berry, personal communication, 2006). While this study found that deposition at greater than 3mm reduced hatch significantly, there was also a reduction in hatching success (approximately 60 percent down to 35 percent) at deposition levels of 0.5mm-1.0mm (Berry et al. 2006). It is important to note that this study dealt solely with total hatch success, and did not deal with sublethal effects, such as developmental deformities, which may result from burial. There is also evidence that egg burial of approximately 1.0 mm results in increased time for winter flounder eggs to hatch, which results in a greater

risk of predation (Berry et al. 2006). Furthermore, it has been indicated that larval stages of winter flounder may be susceptible to impacts from suspended sediment due to abrasion (Walter Berry, personal communication, 2006).

As stated above, Boston Harbor, Mystic River, and Chelsea River serve as habitat for a number of anadromous fishery resources. These anadromous fishery resources serve as prey for a number of federally managed species and are considered a component of EFH pursuant to the MSA. In addition, these are NOAA trust resources that are covered under the Fish and Wildlife Coordination Act. NMFS remains concerned that dredging activities and associated plumes of contaminated sediment have the potential to impair migration of anadromous species. Chiasson (1993) found an increase in swimming activity of rainbow smelt when suspended sediments were present. Such alarm reactions have been found to disrupt schooling behavior of fishes (Wildish and Power 1985). In a laboratory study, Wildish and Power (1985) found that rainbow smelt avoided suspended sediment when concentrations were in excess of 20 Mg/L. Furthermore, sublethal effects to estuarine fishes can include decreased feeding, impacts from lowered oxygen levels, as well as impacts on gills and associated respiratory impacts (Wilber and Clarke 2001).

The DSEIS/DEIR states that the sediment plume from the dredging is expected to be contained within the vicinity of the proposed dredge area. The primary means for this determination was the use of the SSFATE model for the 2004-2005 Outer Boston Harbor maintenance dredging project, as well as the plume tracking performed for the construction of the CAD cell within Boston Harbor during the previous improvement dredging project in 1998-2002. During the review of the Boston Harbor Inner Harbor Maintenance Dredging project in 2006, NMFS raised concerns regarding the applicability of the SSFATE model used in the suspended sediment dispersion analysis, as described in our May 12, 2006 letter to the ACOE. In a letter dated February 22, 2007, the ACOE developed a water quality monitoring plan for the inner harbor maintenance dredging project to be performed in 2008. This plan includes a real-time dredge plume tracking effort in order to identify the extent of suspended sediment dispersion resulting from dredge operations. Results of this effort should be utilized, in part, to develop a dredge sequencing plan to avoid and minimize adverse effects to fishery resources in certain areas and times when they would be most susceptible to adverse impacts.

Issues associated with blasting

The DSEIS/DEIR contains limited information regarding anticipated effects resulting from the proposed blasting. Specifically, the DSEIS/ DEIR and EFH assessment does not include an analysis of the location, timing, and methods of the proposed blasting and the anticipated impacts on living marine resources. NMFS acknowledges the need to advance the project, however, this blasting impact information is important in order to fully anticipate adverse effects to fishery resources and to identify suitable minimization techniques. This detailed assessment of impacts should be incorporated into the proposed blasting plan.

The recent blasting events associated with the Boston Harbor Maintenance Dredging project resulted in a series of fish kills. As noted in the DSEIS/ DEIR, the ACOE is

currently in the process of preparing an "after action report" to provide information and determine what lessons can be learned from the 2007 fish kill events, and to identify corrective measures that can be used to avoid and minimize impacts on fishery resources during the proposed deep draft improvement project. This "after action report" should be incorporated into the recommended blasting plan.

The DSEIS/DEIR discusses the formation of an interagency underwater blasting technical working group in order to discuss construction sequencing and potential constraints as well as operational procedures and equipment for the proposed blasting. NMFS believes that this can be an effective approach in the development of a comprehensive blasting plan. In addition to an assessment of impacts, the blast plan should address potential operational impact minimization measures, sequencing options, impact thresholds, and an adaptive management protocol. This blasting plan should be developed and approved by the interagency technical working group prior to any blast operations.

Beneficial uses of rock as artificial reefs

According to the DSEIS/DEIR, the ACOE is considering the utilization of the blasted rock to create artificial reefs over an area of approximately 220-530 acres of soft bottom habitat within Broad Sound. The DSEIS/DEIR discuss three alternatives considered as beneficial reuse, including the use of rock for upland construction purposes, use for ongoing shore protection projects, and use of rock as artificial reefs. The document states that upland alternatives and shore protection alternatives were eliminated from consideration due to uncertainty. Due to recent discussions with MassPort regarding the potential use of the Marine Terminal as a transfer facility, NMFS maintains that the upland alternatives should be more fully explored.

In the context of the beneficial reuse of blasted rock for creating artificial reefs, the DSEIS/DEIR assumes that hard bottomed habitat is preferable to soft bottom habitat. Although less structurally complex, soft bottom habitats serve as habitat for a variety of resources. As noted in the DSEIS/DEIR, soft bottom areas of the Broad Sound preferred reef site are utilized by benthic invertebrates, lobster, and fishery resources such as flounder, red hake, and sculpin. As the Broad Sound reef site contains areas of both hard and soft substrates, the FSEIS/FEIR should consider the loss of soft bottom habitats as a result of the creation of artificial reefs relative to the overall ecosystem functions and values.

Capping of the former Industrial Waste Site

As noted in the DSEIS/DEIR, the ACOE is considering the use of dredged material to cover potential hazardous and radioactive waste located within the former Industrial Waste Site (IWS) located adjacent to the MBDS. In order to test a methodology for capping of the IWS, a demonstration project is planned for the dredged material disposal in the MBDS associated with the upcoming Boston Harbor Maintenance Dredging project. While the results of the demonstration project will be unavailable for the FSEIS/FEIR, information should be presented to federal and state resource agencies in order to determine if this method is acceptable for use for the IWS capping project.

Essential Fish Habitat Assessment

As noted in the EFH assessment included in the DSEIS/DEIR, this portion of Boston Harbor serves as EFH for 23 federally managed species, including, but not limited to, Atlantic cod, haddock, pollock, whiting, red hake, white hake, winter founder, yellowtail flounder, windowpane flounder, American plaice, ocean pout, Atlantic mackerel, and summer flounder. As noted above, our ability to assess potential impacts on EFH and associated marine resources was complicated by insufficient information in the document. Section 305(b)(2) of the MSA requires all federal agencies to consult with NMFS on any action authorized, funded, or undertaken by that agency that may adversely affect EFH. Included in this consultation process is the preparation of a complete and appropriate EFH assessment to provide necessary information on which to consult. NMFS recommends that the following additional information regarding project impacts and issues relative to fishery resources and habitats be provided in order for us to fully assess the adverse effects of the proposed project. Upon receipt of this information, NMFS will provide specific EFH conservation recommendations, as appropriate.

1) A sequencing plan should be developed for dredging activities. This plan should avoid and minimize adverse impacts on winter flounder and anadromous fish resulting from increased levels of suspended sediment and deposition. This sequencing plan should be coordinated with federal and state resource agencies.

2) A comprehensive blasting plan should be developed by an interagency underwater blasting technical working group. As noted above, this plan should have a detailed discussion of anticipated impacts on fishery resources, and should address potential operational impact minimization measures, sequencing options, impact thresholds, and an adaptive management protocol. This blasting plan should be approved by the interagency technical working group.

3) Alternative beneficial reuse options that avoid and minimize adverse impacts on biologically productive soft bottom habitats should be evaluated more fully within the FSEIS/FEIR.

4) In order to assess potential impacts resulting from the proposed capping at the IWS, the results of the upcoming demonstration capping project within MBDS should be presented to federal and state resource agencies.

Endangered Species Act

Three species of federally threatened or endangered sea turtles and three species of endangered whales may be found in Massachusetts waters. The sea turtles in Massachusetts nearshore waters are typically small juveniles with the most abundant being the federally threatened loggerhead (*Caretta caretta*), followed by the federally endangered Kemp's ridley (*Lepidochelys kempi*). Loggerheads and Kemp's ridleys have been documented in waters as cold as 11°C, but generally migrate northward when water

temperatures exceed 16°C. These species are typically present in Massachusetts waters from June through November. Federally endangered leatherback sea turtles (*Dermochelys coriacea*) are located in New England waters during the warmer months as well. While leatherbacks are predominantly pelagic, they may occur close to shore, especially when pursuing their preferred jellyfish prey. Green sea turtles *(Chelonia mydas)* may also occur sporadically in New England waters, and any occurrence in Massachusetts waters is likely to be rare. Sea turtles are known to occur on Stellwagen Bank and in Massachusetts Bay. While no surveys for sea turtles have been conducted in Boston Harbor, suitable forage and habitat exists in this area and it is likely that sea turtles occasionally are present in Boston Harbor.

Federally endangered North Atlantic right whales (*Eubalaena glacialis*) and humpback whales (*Megaptera novaeangliae*) are also found seasonally in Massachusetts waters. North Atlantic right whales have been documented in the nearshore waters of Massachusetts from December through June. Humpback whales feed during the spring, summer, and fall over a range that encompasses the eastern coast of the United States, including Massachusetts Bay. While these whale species are not considered residents of the Boston Harbor area, transients occasionally enter the area as they complete seasonal migrations in nearby Massachusetts Bay. For example, in April 1996 a right whale was documented in Boston Harbor, and in the fall of 2000, a humpback whale was documented in Boston Harbor. Fin (*Balaenoptera physalus*), Sei (*Balaenoptera borealis*), and Sperm (*Physter macrocephalus*) whales are also seasonally present in New England waters, but are typically found in deeper offshore waters and are not likely to occur in Boston Harbor.

The ACOE requested consultation pursuant to Section 7 of the Endangered Species Act (ESA) of 1973, as amended, regarding the Boston Harbor Deep Draft Navigation Improvement Project in 2005. In a letter dated September 6, 2005, NMFS concurred with the ACOE's determination that the project was not likely to adversely affect listed species. However, at that time, the ACOE had indicated that the removal of 2-6 million cy of material was likely and the ACOE did not indicate to NMFS that blasting would be necessary. As such, the consultation only considered the effects of dredging 2-6 million cy of material, as opposed to the 12.1 million cy currently proposed for removal, and did not contemplate the effects of the currently proposed blasting operations.

Reinitiation of consultation is required and shall be requested by the federal agency or by the Service, where discretionary federal involvement or control over the action has been retained or is authorized by law, and: (a) if new information reveals effects of the action that may affect listed species or critical habitat in a manner or to an extent not previously considered in the consultation; (b) if the identified action is subsequently modified in a manner that causes an effect to the listed species or critical habitat that was not considered in the consultation; or (c) if a new species is listed or critical habitat designated that may be affected by the identified action. As the action has been modified from the action considered by NMFS in the September 6, 2005 letter, reinitiation of consultation is necessary. As such, the ACOE will need to provide NMFS with a determination of effects to listed species that analyzes the potential for impacts of the

additional dredging as well as from the proposed blasting. In order to determine the likely effects of blasting on listed species, additional information on the underwater noise resulting from the project as well as information on timing, sequencing, and monitoring is necessary. Should you have any questions about these comments, or the reinitiation of consultation, please contact Julie Crocker in NMFS' Protected Resources Division at (978) 281-9300 ext. 6530, or by e-mail (Julie.Crocker@Noaa.gov).

Conclusion

In summary, NMFS requests additional information be provided in order to fully evaluate potential impacts on listed species, fishery resources, and habitats. Specifically, we recommend that a dredging sequencing and comprehensive blasting plan be developed for this project. Further, we recommend that alternative beneficial reuse options for blasted rock be explored. Finally, NMFS recommends that further coordination regarding the capping demonstration project and proposed capping at the IWS should occur. Upon receipt of this information, NMFS will provide specific EFH conservation recommendations, as appropriate. Additionally, as noted above, section 7 consultation must be reinitiated to consider the effects of the additional dredging as well as the effects of blasting on listed species. Should you have any questions regarding these comments, please contact Christopher Boelke of my staff at (978) 281-9131.

Sincerely,

Peter D. Colosi
Assistant Regional Administrator
for Habitat Conservation

cc: US ACOE - Michael Keegan, Cathy Rodgers
US EPA - Robert Varney, Phil Colarusso
US FWS – Vern Lang, Maria Tur
MA DMF - Paul Diodati, Kathryn Ford
MA CZM - Leslie Ann McGee, Bob Boeri
MA DEP - Lealdon Langley, Ken Chin
MassPort Maritime Department - Deb Hadden
MEPA - Deerin Babb-Brott
Boston Conservation Commission – Chris Busch
NOA/PPI – Steve Kokkinakis

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UNITED STATES DEPARTMENT OF COMMERCE
National Oceanic and Atmospheric Administration
NATIONAL MARINE FISHERIES SERVICE
NORTHEAST REGION
55 Great Republic Drive
Gloucester, MA 01930-2276

NOV 26 2012

John R. Kennelly
Deputy Chief, Engineering/Planning Division
Department of the Army, Corps of Engineers
New England District
696 Virginia Road
Concord, MA

RE: Boston Harbor Deep Draft Navigation Improvement Project

Dear Mr. Kennelly:

We have received your October 24, 2012, letter requesting our Essential Fish Habitat (EFH) conservation recommendations and completion of the EFH consultation pursuant to the Magnuson-Stevens Fishery Conservation and Management Act (MSA) regarding the proposed Boston Harbor Deep Draft Navigation Improvement Project (BHDDNIP). A Final Feasibility Report (FR) and a joint Final Supplemental Environmental Impact Statement/Final Environmental Impact Report (FSEIS/FEIR) is being prepared and expected to be released to the public sometime in early 2013. At that time, a Feasibility Report will be released and the US Army Corps of Engineers (USACE) will initiate the Planning, Engineering, and Design phase of the proposed project.

As you know, we reviewed the Draft Supplemental Environmental Impact Statement (DSEIS) and Draft Environmental Impact Report (DEIR) for the proposed project in 2008. An EFH assessment for the project was also received by us at that time. However, we concluded that these documents did not contain sufficient information necessary for us to fully assess the effects of the proposed project on our trust resources. By letter dated June 2, 2008 (see attachment to this letter), we requested additional information regarding aspects of the proposed project, including: 1) development of a dredging sequencing plan, 2) development of a comprehensive blasting plan to be approved by an interagency technical working group, 3) evaluation of alternative beneficial reuses for disposal of rock removed from the dredging project and, 4) a review of the results from a capping demonstration study for the former offshore Industrial Waste Site (IWS) to assess potential impacts associated with disposing of dredged material at the IWS. Since 2008, the proposed project has undergone additional economic studies, resulting in a reduced scope of dredging improvements. However, the additional information requested by us in 2008 has not yet been provided. Although your letter indicates that you will share additional information and details of the project as they are developed during the design phase of this project, it does not specify whether or not the information we requested in our June 2, 2008 letter will be provided. We continue to believe that this previously requested information is critical to fully evaluating the effects of the project on EFH and our other trust resources, and for us to develop specific and effective conservation recommendations for the proposed project.

Although our need for additional information for this project remain, we are obliged by our regulations at 50 CFR 600.920(i)(5) to provide EFH conservation recommendations using the best scientific information available.

As you are aware, the MSA and the Fish and Wildlife Coordination Act require Federal agencies to consult with one another on projects such as this. Insofar as a project involves EFH, as this project does, this process is guided by the requirements of our EFH regulation at 50 CFR 600.905, which mandates the preparation of EFH assessments and generally outlines each agency's obligations in this consultation procedure. We offer the following comments and recommendations on this project pursuant to the above referenced regulatory processes.

Project Description
Based upon your letter, dated October 24, 2012, as well as additional project information provided to our Protected Resources Division (PRD) on November 7, 2012, the proposed project involves dredging approximately 10 to 11 million cubic yards (cy) of clays, sands, and tills from the harbor bottom using a mechanical dredge. In addition, up to about 1 million cy of rock will be removed, some of which will require blasting. In association with the improvement work, approximately 150,000 cy of material will be removed from some of the terminal berths, and about 500,000 cy will be removed for maintenance of the improved and adjacent Federal channels. All materials have been tested and found suitable for ocean disposal at the Massachusetts Bay Disposal Site (MBDS), which is located about 18 miles seaward of the harbor. The Federal base plan for all material includes disposal at the MBDS; however, unconsolidated material may be disposed of at the former IWS, which is adjacent to the MBDS, and the rock may be used to create reef habitat or shoreline restoration projects in Massachusetts Bay. The project would take about three years to construct.

Specific improvements include:

- Deepening the harbor's 40-foot deep MLLW channels, turning basin and anchorage to a depth of -47 feet MLLW to provide container ships access to the Conley Terminal, with an additional two to five feet of depth in the Broad Sound North Entrance Channel (up to -52 feet MLLW) to accommodate exposure of vessels to increased seas. ;

- Deepening the 40-foot lane of the Main Ship Channel above the Reserved Channel and below the Ted Williams Tunnel to -45 feet MLLW, to improve access to Massport's Marine Terminal in South Boston;

- Deepening the existing 35-foot lane of the lower Mystic River Channel to -40 feet MLLW to improve access to Massport's Medford Street Terminal; and

- Deepening the existing 38-foot channel in the Chelsea River to -40 feet MLLW to improve access to its petroleum terminals.

- Terminal berths at Massport facilities on the Reserved and Main Ship channels, as well as private terminal berths on the Chelsea River would be deepened commensurate with the deepening of the Federal channels.

- Required maintenance of the Federal navigation channels being improved would be carried out concurrently, as would maintenance of adjacent Federal channels needed to route shipping traffic around the deepening operation, including maintenance of the 35-foot deep lane of the North Entrance Channel, 30-foot deep Broad Sound South Entrance Channel, 15-foot deep Nubble Channel and 35-foot deep MLLW Barge Anchorage.

Rock removal by blasting is anticipated to require approximately 26 months to complete, including: 16 months in the Broad Sound North Entrance Channel; two months in the President Roads Anchorage; two months in the lower Main Ship Channel; three months in the Main Ship Channel extension area below the Ted Williams Tunnel; five months in the Reserved Channel and its Turning Area; and one month in the upper Chelsea River. The rock areas and construction times would be further refined after design phase subsurface explorations are completed.

You propose to implement several conditions during dredging, blasting and dredged material disposal, which include:

- Development of a monitoring plan for blasting that will be submitted to us for review and comment.

- No blasting will occur when schools of fish are observed in the area (assuming that safety is not jeopardized). A fish observer will use hydro-acoustic monitoring (i.e., side-scan sonar) prior to any blasting event to determine that schools of fish are not located within or transiting the blast zone area. In addition to the sidescan sonar, a fish startle system will be employed to deter fish (most effective with species from the clupeid family). Lessons learned from the previous blasting in Boston Harbor will be incorporated where appropriate into the Contractor's blasting plan. Some of these lessons include the development of a communication plan between the fish observer and the Contractor, and the location of the fish startle system on an alternate vessel instead of the blast barge.

Fishery Resources in Boston Harbor

Boston Harbor supports living marine resources that provide for valuable recreational and commercial fisheries, as well as species and habitats that are critical to healthy marine and estuarine ecosystems. As discussed in our June 2, 2008 letter to you, Boston Harbor provides habitats for a number of federally-managed species such as winter flounder, as well as a number of NOAA trust resources such as rainbow smelt, alewife, blueback herring, shellfish, and American lobster.

Inshore spawning winter flounder occur in water depths between 1 and 30 meters over sand, mud, cobble, rock, and boulder substrates (Pereira et al. 1999). Because winter flounder eggs are demersal and adhesive in nature, and larval and young-of-the-year winter flounder prefer shallow

inshore waters (1-30 meters) and similar habitat types, spawning, egg development, and early juvenile development habitat tend to be close together (Pereira et al. 1999). NOAA's Estuarine Living Marine Resources Program has identified winter flounder eggs and larvae as being abundant in Boston Harbor during this portion of the year (US Department of Commerce 1994). The Mystic Power Generating Station 2004-2005 Final Report indicated approximately 16 million winter flounder larvae were entrained into the Everett, Massachusetts power plant facility in a 12-month period (Shaw 2006). While this facility is located upstream of the project footprint, these data strongly suggests that inner portions of Boston Harbor are being utilized for winter flounder spawning and juvenile development. In addition, in May 1995 Normandeau Associates prepared the Finfish Sampling and Description Report for the USACE (Normandeau 1995). This study included trawl sampling at stations in the inner harbor (i.e., Mystic and Chelsea rivers, Inner Confluence) and the outer harbor (i.e., Spectacle Island CAD and Subaqueous E/Outer Harbor). The trawl data identify winter flounder as being the most numerous finfish at each station, and winter flounder catch per unit effort (CPUE) as the highest of all species for all stations combined. The Chelsea River, Outer Harbor, and Mystic River stations had the highest CPUE of all trawl stations sampled. We also note that the trawl stations sampled by Normandeau in the Chelsea River, Mystic River, and the Inner Confluence were all within or at the edges of the Boston Harbor federal channels (Fig. 1, page 24). Based on these reports and other winter flounder literature, we continue to be confident that winter flounder are abundant in both the inner and outer Boston Harbor area. As such, it is anticipated that winter flounder eggs and larvae would be present within Boston Harbor during the winter, spring, and early summer.

In addition to winter flounder, the anadromous rainbow smelt, alewife, and blueback herring currently utilize Boston Harbor, the Mystic River, and the Chelsea River as a migratory pathway between upstream spawning locations and Massachusetts Bay. The 1995 Normandeau study associated with the improvement dredging of Boston Harbor provided evidence of an abundance of alewife, blueback herring, and rainbow smelt. For all gill net sampling stations combined, blueback herring (26%), rainbow smelt (25%), and alewife (15%) were found to be the most abundant species in the area (Normandeau 1995). Entrainment studies within the Mystic Station final report for 2004-2005 found that approximately 1.8 million rainbow smelt larvae were entrained in the facility (Shaw 2006). This study also reported 497 alewife and 27,379 blueback herring juveniles and adults were impinged by power plant operations. It is important to note that due to concerns of declining populations of blueback herring and alewife, these species were designated as "candidate species" under the Endangered Species Act (ESA) in November 2011. Our agency is currently reviewing this information as well as any other available information to determine if listing blueback herring and alewife under the ESA is warranted. Due to the depressed populations of rainbow smelt, this species has also been designated since 2004 as a "species of concern" under the ESA. Status reviews and research on rainbow smelt populations are ongoing. The declining population status of these anadromous species should warrant caution and a risk-averse approach in the activities that can adversely affect them, including dredging and blasting during the time of year when sensitive life history stages are present.

In addition, the substrate within the project area also serves as habitat for benthic organisms, such as shellfish and other invertebrates living within and on the surface of the sediment. These organisms contribute to the productivity of the federally-managed species as a food source for

juvenile and adult life stages of finfish. The commercially-important American lobster has been documented within Boston Harbor by the Massachusetts Division of Marine Fisheries through the Massachusetts Bay Lobster Trawl Sampling Program.

Impacts Associated with Dredging

We provided details on some of the known adverse effects to living marine resources associated with dredging and blasting in our June 2, 2008 letter. Although we do not intend to duplicate the information contained in that letter, we would like to emphasize two concerns associated with this proposed project: dredging and blasting impacts on winter flounder spawning, egg, larval, and young-of-the-year habitats and diadromous fish spawning migration passage.

Winter flounder eggs have been shown to be adversely affected by relatively small levels of sediment deposition. Research conducted at the NMFS Northeast Fisheries Science Center's Milford Lab found that sediment deposition at depths of ½ the egg diameter (~0.5 mm) resulted in reduction in the number of hatched eggs (David Nelson, personal communication, 2003). An in-situ experiment with winter flounder (*Pseudopleuronectes americanus*) eggs exposed to sediment deposition from a navigational dredging project found a slightly lower larval survival rate compared to control sites, but the differences were not statistically significant (Klein-MacPhee et al. 2004). However, the viability of the larvae in this experiment was not monitored beyond burial escapement. Similarly, laboratory experiments with winter flounder eggs buried to various depths (i.e., control, <0.5 mm, and up to 2 mm) indicated a decreased hatch success and delayed hatch with increasing depth; but differences were not statistically significant (Berry et al. 2004). More recently published laboratory studies investigating burial of winter flounder eggs reported variability among experiments, making it difficult to determine a maximum threshold level for egg burial. Berry et al. (2011) reported trends of decreasing hatching success and increased time to hatch with increasing sediment depth relative to controls. However, the percent total hatch of eggs exposed to ≤ 1.0 mm of sediment was not statistically different from the controls in the study. Although the percent total hatch was highly variable in eggs buried ≤ 2.5 mm of sediment in all experiments, less than 1 percent of winter flounder eggs hatched when sediment burial depths were > 2.5 mm. It is important to note that this study dealt solely with total hatch success, and did not deal with sublethal effects, such as developmental deformities, which may result from burial; nor did the study involve contaminated sediments. While an absolute maximum threshold for winter flounder egg burial remains uncertain, these studies indicate that sediment burial at even minimal levels can reduce hatching success and increase time to hatch.

We remain concerned that dredging activities and associated plumes of contaminated sediment have the potential to impair migration of anadromous species. Chiasson (1993) found an increase in swimming activity of rainbow smelt when elevated suspended sediments (≥ 10 mg/L) were present (such alarm reactions have been found to disrupt schooling behavior of fishes). In a laboratory study, Wildish and Power (1985) found that rainbow smelt avoided suspended sediment when concentrations were > 20 mg/L. Sublethal effects to estuarine fishes can include decreased feeding, decreased oxygen transfer in fish, as well as impacts on gills and associated respiratory impacts (Wilber and Clarke 2001; Nightingale and Simenstad 2001; Wilber et al. 2005).

Impacts Associated with Blasting

As you are aware, underwater blasting and other noise-producing activities, in addition to potential lethal affects, can disrupt fish behavior including spawning and spawning migrations into and from freshwater rivers. In previous letters to you, we discussed our concerns for the potential adverse effects to federally-managed species and other NMFS trust resources, including diadromous fish in the Boston Harbor area. Specifically, we have recommended that underwater blasting be conducted during a time of year that avoids and minimizes impacts on sensitive life history stages.

As you recall, in the fall of 2007 you conducted underwater blasting between October 24 and November 14 in order to remove rock from the Boston Harbor Federal Navigation Maintenance Dredging project. As a result of this blasting, four separate fish kill events occurred within the President Roads area of Boston Harbor, impacting approximately 2,500 fish. The majority of the fish killed during the blasting were alewife, blueback herring, and rainbow smelt, which are all identified by NMFS as "species of concern", although other species such as menhaden, cunner, red hake, butterfish, and Atlantic herring were also killed. We add that the reported number of fish killed in those blasting events may have been underestimated, since some fish may not float to the surface after being killed or injured, and others may have been preyed upon below the surface of the water by other fish and not accounted for by the observer on board the barge (Keevin 1998).

Following the 2007 fish kill event, you developed a post-project blasting report in June 2008, which provides an overview of the fish kill events, as well as corrective measures to be instituted for future blasting. You indicated in the draft Environmental Assessment for the Boston Harbor Main Ship Channel and the Weymouth Fore River Channel Rock Removal project that through lessons learned from the previous blasting in Boston Harbor, a number of new blasting best management practices (BMPs) would be incorporated into the Contractor's blasting plan (e.g., a communication plan between the fish observer and the Contractor and relocating the fish startle system to an alternate vessel instead of the blast barge). In fact, several of these BMPs were incorporated in the blasting conducted in September 2012, and we note that you reported no fish kills during that recent rock removal work. However, this project involved removing just over 3,000 cy over a three-day period of blasting in September, which is a time when minimal presence of diadromous fish are expected in Boston Harbor. Because the proposed BHDDNIP involves removing approximately 1 million cy of rock over a three-year period, some of which may occur during a time of year when diadromous fish densities are the highest, we believe the potential risk of injury and mortality are orders of magnitude larger than the rock removal project in September 2012.

Although utilizing the BMPs incorporated in the rock removal project for the Boston Harbor Main Ship Channel and Weymouth Fore River Channel may provide some level of protection for fishery resources, we continue to contend that an underwater blasting technical working group is needed for the proposed BHDDNIP. The complexities of underwater blasting, as well as the diverse technologies and best management practices that are available, require a thorough review by a technical working group composed of federal and state resource and permitting agencies. This is particularly relevant for a project such as the BHDDNIP, which is proposed over a three-year period and involves removing approximately 1 million cy of rock.

Beneficial Uses of Rock as Artificial Reefs
According to your letter, dated October 24, 2012, the rock removed from the BHDDNIP may be used to create reef habitat in Massachusetts Bay. The DSEIS/DEIR issued in 2008 indicated that this could involve placing rock over an area of approximately 220-530 acres of soft bottom habitat. The DSEIS/DEIR also included two additional disposal alternatives: using the rock for upland construction purposes and the use for ongoing shore protection projects. As we discussed in our letter, dated June 2, 2008, the DSEIS/DEIR assumes that hard bottom habitat is preferable to soft bottom habitat. Although less structurally complex, soft bottom substrates serve as habitat for a variety of resources, including benthic invertebrates such as lobsters and Atlantic sea scallops, and demersal and benthic fishes such as flounder, red hake, and sculpin. We continue to believe the FSEIS/FEIR should consider the effects of the loss of soft bottom habitats as a result of the creation of artificial reefs relative to the overall ecosystem functions and values.

Capping of the Former Industrial Waste Site
According to your letter, dated October 24, 2012, and the DSEIS/DEIR, the USACE is considering the use of dredged material to cover potential hazardous and radioactive wastes located within the former IWS. A demonstration project to test the methodology and effectiveness of capping the IWS was scheduled during the 2007 Boston Harbor Federal Navigation Maintenance Dredging project. We continue to believe the results of this demonstration project should be considered in the FSEIS/FEIR to determine the efficacy of using the dredged material from the proposed BHDDNIP to cap the IWS.

Essential Fish Habitat
Section 305(b)(2) of the MSA requires all federal agencies to consult with us on any action authorized, funded, or undertaken by that agency that may adversely affect EFH. The area of the BHDDNIP and the MBDS has been identified as EFH under the MSA for 24 federally-managed species. In our letter to you dated June 2, 2008, we requested additional EFH information, but have not received it. Such information would assist us in developing specific conservation recommendations that minimize impacts to fishery resources and habitats, while providing the flexibility for you to carry out the required dredging and blasting. Nonetheless, we are obligated by our regulations to provide our EFH conservation recommendations using the best scientific information available. Furthermore, a lack of site-specific information for a project of this magnitude requires that we take a risk-averse approach in the issuance of our EFH conservation recommendations in order to ensure protection of fishery resources and habitats. We recommend pursuant to Section 305(b)(4)(A) of the MSA that you adopt the following EFH conservation recommendations:

1. To avoid impacts to winter flounder spawning, egg, 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.

2. 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.

3. For the remaining sections 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-foot 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 FSEIS/FEIR

4. 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.

5. 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 potential impacts to biological communities within the MBDS.

Please note that Section 305(b)(4)(B) of the MSA requires you to provide us with a detailed written response to these EFH conservation recommendations, including a description of measures you intend to adopt for avoiding, minimizing, or offsetting the impact of the project on EFH. In the case of a response that is inconsistent with our recommendations, Section 305(b)(4)(B) of the MSA also indicates that you must explain your reasoning for not following the recommendations. Included in such reasoning would be the scientific justification for any disagreements with us over the anticipated effects of the proposed action and the measures needed to avoid, minimize, mitigate, or offset such effects pursuant to 50 CFR 600.920(k).

Please also note that a distinct and further EFH consultation must be reinitiated pursuant to 50 CFR 600.920(l) if new information becomes available or the project is revised in such a manner that affects the basis for the above EFH conservation recommendations. Since additional information will be generated as you undertake the Planning, Engineering, and Design phase of the BHDDNIP, it may affect the basis of our EFH conservation recommendations, which would require the reinitiation of our EFH consultation

Fish and Wildlife Coordination Act
As discussed above, the BHDDNIP supports populations of shellfish and American lobster, and a number of species of anadromous fish that use the area for various stages of their life history, including the spawning migrations of blueback herring, alewife, and rainbow smelt. In order to avoid adversely affecting the sensitive spawning periods of these species, we recommend all EFH conservation recommendations listed above be adopted.

Protected Resources and Endangered Species Act Consultation
Information regarding Section 7 of the Endangered Species Act (ESA) was provided to you by our Protected Resources Division in a separate letter. For questions regarding Protected Resources and ESA consultation issues, please contact Julie Crocker at 978-281-9480.

Conclusions
Information that we requested in a letter to you dated June 2, 2008 was not provided, and has hampered our ability to consult on this action. However, we are obligated by our regulations to provide our EFH conservation recommendations using the best scientific information available. Unfortunately, the lack of site-specific details for a project of this magnitude required us to take a risk-averse approach in the issuance of our EFH conservation recommendations in order to ensure protection of fishery resources and habitats. As additional information becomes available which would affect the basis of our EFH conservation recommendations, reinitiation of the consultation may be warranted. Should you have any questions about EFH and fishery related issues, contact Michael Johnson at 978-281-9130, at mike.r.johnson@noaa.gov, or at the letterhead address of this letter.

Sincerely,

Louis A. Chiarella
Assistant Regional Administrator
for Habitat Conservation

cc: Crocker/Colligan, F/NER3
Rogers/Mackay, ACOE NE
Colarusso/Timmermann, USEPA
Boeri, MA CZM
Chin, MA DEP
Evans, MA DMF

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UNITED STATES DEPARTMENT OF COMMERCE
National Oceanic and Atmospheric Administration
NATIONAL MARINE FISHERIES SERVICE
NORTHEAST REGION
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NOV 27 2012

John R. Kennelly
Deputy Chief, Engineering/Planning Division
Department of the Army, Corps of Engineers
New England District
696 Virginia Road
Concord, MA

RE: Boston Harbor Deep Draft Navigation Improvement Project

Dear Mr. Kennelly:

Your November 7, 2012, letter, requests consultation pursuant to section 7 of the Endangered Species Act (ESA) of 1973, as amended regarding the U.S. Army Corps of Engineer's proposed Boston Harbor Deep Draft Navigation Improvement Project. You have made the determination that the proposed action is not likely to adversely affect any species listed by NOAA's National Marine Fisheries Service (NMFS) under the ESA and have requested our concurrence with this determination. We agree 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. The justification for our determination is provided below.

Proposed Project
The project will involve dredging approximately 10 to 11 million cubic yards of clays, sands, and tills, all parent materials largely of glacial origin, from the harbor bottom. All dredging will be with a mechanical dredge. In addition, you will remove up to about 1 million cubic yards of rock from the harbor, some of which may require blasting to allow removal with a dredge. In association with this improvement work, you will remove about 150,000 cubic yards of material to deepen some terminal berths, and about 500,000 cubic yards for maintenance of the improved and adjacent Federal channels. All materials have been tested and found suitable for ocean disposal at the Massachusetts Bay Disposal Site (MBDS), which is located about 18 miles seaward of the harbor. The project would take about three years to complete. You are currently planning to dispose all material, including rock, at MBDS; unconsolidated material may be disposed of at the former Industrial Waste Site (IWS) which is adjacent to the MBDS.

Specific project activities include:

- Deepening the harbor's 40-foot deep MLLW channels, turning basin and anchorage to a depth of -47 feet MLLW to provide container ships access to the Conley Terminal, with an additional two to five feet of depth in the Broad Sound North

Entrance Channel (up to -52 feet MLLW) to accommodate exposure of vessels to increased seas. The final depth selected for the entrance channel accounts for the range in quantities given above;

- Deepening the 40-foot lane of the Main Ship Channel above the Reserved Channel and below the Ted Williams Tunnel to -45 feet MLLW, to improve access to Massport's Marine Terminal in South Boston;

- Deepening the existing 35-foot lane of the lower Mystic River Channel to -40 feet MLLW to improve access to Massport's Medford Street Terminal; and

- Deepening the existing 38-foot channel in the Chelsea River to -40 feet MLLW to improve access to its petroleum terminals.

- In addition, terminal berths at Massport facilities on the Reserved, Main Ship and Mystic River channels, as well as private terminal berths on the Chelsea River would be deepened commensurate with the deepening of the Federal channels.

- Any required maintenance of the Federal navigation channels being improved would be carried out concurrently, as would maintenance of adjacent Federal channels needed to route shipping traffic around the deepening operation, including maintenance of the 35-foot deep lane of the North Entrance Channel, 30-foot deep Broad Sound South Entrance Channel, 15-foot deep Nubble Channel and 35-foot deep MLLW Barge Anchorage.

Rock removal by blasting will occur over approximately 26 months, with the required times approximately broken down as follows (work in some areas will be simultaneous with work in other areas): 16 months in the Broad Sound North Entrance Channel; two months in the President Roads Anchorage; two months in the lower Main Ship Channel; three months in the Main Ship Channel extension area below the Ted Williams Tunnel; five months in the Reserved Channel and its Turning Area; and one month in the upper Chelsea River. The precise rock areas and construction times would be further refined after design phase subsurface explorations are completed.

The USACE will implement several special conditions during dredging, blasting and dredged material disposal, those include:

- USACE will develop a monitoring plan for blasting that will be submitted to NMFS for review and comment.
- One or more NMFS-approved endangered species observers will be present at each blast site. The number of observers will depend on the number that is necessary to observe the entire safety zone. No blasting will occur until the safety zone is free from any observations of whales or sea turtles for 60 minutes.
- The Right Whale Sightings Advisory System will be monitored as well as other communication media (i.e., NOAA weather radio, U.S. Coast Guard NAVTEX

broadcasts, Notices to Mariners, and U.S. Coast Pilots) for general information regarding North Atlantic Right Whale sighting locations. In addition, the Contractor will be required to monitor the Right Whale Listening Network for information on Right Whales detected near the shipping lanes.

- No blasting will occur if any whales or sea turtles are present within the safety zone of the blast area.
- In the unlikely event that any whales or sea turtles are observed within the safety zone during a blast event, all reasonable attempts to monitor the condition and behavior of the animal will be undertaken. These incidences will be reported immediately to NMFS to determine whether the incident would require reinitiating Section 7 Consultation.
- All blasting will be conducted using inserted delays of a fraction of a second per borehole as well as the use of stemming, which will be placed into the top of the borehole to deaden the shock wave reaching the water column.
- No blasting will occur when schools of fish are observed in the area (assuming that safety is not jeopardized). A fish observer will use hydro-acoustic monitoring (i.e. side-scan sonar) prior to any blasting event to determine that schools of fish are not located within or transiting the blast zone area (including any listed Atlantic sturgeon). In addition to the sidescan sonar, a fish startle system will be employed to deter fish. Existing startle systems are most effective with species from the Clupeid family. The startle system uses high amplitude sound at specific frequencies. Lessons learned from the previous blasting in Boston Harbor will be incorporated where appropriate into the Contractor's blasting plan. Some of these lessons include the development of a communication plan between the fish observer and the Contractor and the location of the fish startle system that will be deployed on an alternate vessel instead of the blast barge.
- All project vessels will comply with voluntary speed restrictions (10 knots or less) to minimize the risk of ship strikes as implemented in Dynamic Management Areas (DMAs) that may be established by NOAA Fisheries Service. NOAA Fisheries Service will announce DMAs to mariners through its customary maritime communication.
- All previously established permit conditions for use of the MBDS and IWS, including use of lookouts for whales and sea turtles and vessel speed restrictions, will be required, including:

    - Use NMFS guidelines to minimize interaction with and harassment of marine mammals during transit (i.e., tugs/scows will not approach within 100 feet of threatened or endangered species of whales (http://www.nero.noaa.gov/prot_res/mmv/approach.html) or within 500 yards of a right whale 50 CFR§224.103 (c)). Any vessel finding itself within the 500 yard buffer zone around a right whale must depart the area immediately at a safe, slow speed, unless one of the exceptions applies (see 50 CFR§224.103 (c));

    - When sea turtles are sighted, attempt to maintain a distance of 50 yards or greater between the animal and the vessel whenever possible;

- Report all sightings of right whales to NMFS as soon as possible (978-585-8473); and, Report within 24 hours any interactions with listed species to NMFS (1-866-755-NOAA and incidental.take@noaa.gov). This includes any reports of injuries or mortalities.

NMFS Listed Species in the Action Area

The action area is defined as "all areas to be affected directly or indirectly by the Federal action and not merely the immediate area involved in the action" (50 CFR§402.02). For this project, the action area includes the project footprint as well as the underwater area where effects of dredging (i.e., increase in suspended sediment) and blasting (i.e., increase in underwater noise and pressure) will be experienced. The action area also includes the disposal sites and the vessel transit routes.

Whales

Federally endangered North Atlantic right whales (*Eubalaena glacialis*), Fin (*Balaenoptera physalus*), sei (*Balaenoptera borealis*), and humpback whales (*Megaptera novaeangliae*) are found seasonally in Massachusetts waters. North Atlantic right whales have been documented in the nearshore waters of Massachusetts from December through June. Humpback whales feed during the spring, summer, and fall over a range that encompasses the eastern coast of the United States. Fin (*Balaenoptera physalus*), sei (*Balaenoptera borealis*) and sperm (*Physter macrocephalus*) whales are also seasonally present in New England waters but are typically found in deeper offshore waters.

Sei whales occur in deep water throughout their range, typically over the continental slope or in basins situated between banks (NMFS 2011). Sperm whales occur on the continental shelf edge, over the continental slope, and into mid-ocean regions. Based on the known habitats of these two species which do not overlap with the action area, we do not expect sei or sperm whales to occur in any portion of the action area.

Sightings and satellite tracking data along the East Coast indicate that endangered large whales rarely venture into bays, harbors, or inlets (70 FR 35849, June 25, 2005, NMFS 2007, 72 FR 57104, October 5, 2007). Right whale sightings from May 1997 to the present have been mapped (see http://www.nefsc.noaa.gov/psb/surveys/SASInteractive2.html). There are no recorded right whale sightings in Boston Harbor. The nearest sighting is a sighting listed as "probable" from April 7, 2012, approximately 4 miles offshore of Deer Island. The seasonal presence of right whales in Massachusetts waters is thought to be closely associated to the seasonal presence of dense patches of their preferred copepod prey (primarily *Calanus finmarchus* but also *Pseudocalanus* spp. and *Centropages* spp.; Pace and Merrick 2008). Dense concentrations of copepods are not known to occur in Boston Harbor. While small numbers of humpback whales may be present in Massachusetts waters year round, sightings are most frequent from mid-March through November between 41°N and 43°N, from the Great South Channel north along the outside of Cape Cod to Stellwagen Bank and Jeffreys Ledge (CETAP 1982) and peak in May and August (Waring *et al.*. 2010). We have records of only one humpback whale occurring in Boston Harbor (2001) and consider this incident to be an outlier. There are no records of fin whales in Boston Harbor. Based on the best available information, it is extremely unlikely that any right, humpback or fin whales will occur in the channels where

blasting and dredging will occur. These species, may however be present at MBDS and IWS and along the transit route.

Sea Turtles

Four species of federally threatened or endangered sea turtles under our jurisdiction may be found seasonally in the coastal waters of Massachusetts, typically when water temperatures are higher than 15°C. The highest concentrations of sea turtles are normally present from June – October. The sea turtles in northeastern nearshore waters are typically small juveniles with the most abundant being the federally threatened Northwest Atlantic Ocean Distinct Population Segment (DPS) of loggerhead (*Caretta caretta*) followed by the federally endangered Kemp's ridley (*Lepidochelys kempi*) sea turtle. While green sea turtles *(Chelonia mydas)* may also occur sporadically in New England waters, any occurrence in Massachusetts waters is rare. Federally endangered leatherback sea turtles (*Dermochelys coriacea*) may be found in Massachusetts waters during the warmer months as well.

Suitable forage and habitat exists for sea turtles in small localized areas around the Boston Harbor area (e.g., Hull and Hingham Bay; shores of Long Island Spectacle Island, and Thompson Island, MA; Town River Bay; and Rock Island Cove). The harbor is not known to be a high use area for sea turtles and presence is likely limited to occasional transient sea turtles. In the channels where dredging and blasting will occur, limited forage for sea turtles exists (e.g., no submerged aquatic vegetation (SAV), limited benthic invertebrates) and as such, this site is not expected to serve as foraging area for sea turtles. Based on this information, it is extremely unlikely that sea turtles will occur within the channel where dredging and blasting will occur. However, sea turtles may be present at MBDS and IWS and along the transit routes.

Atlantic Sturgeon

Five DPSs of Atlantic sturgeon are listed; the Gulf of Maine DPS is threatened and the New York Bight, Chesapeake Bay, South Atlantic and Carolina DPSs are endangered (77 FR 5880; 77 FR 5914; February 6, 2012). The marine range of all five DPSs extends along the Atlantic coast from Canada to Cape Canaveral, Florida.

Atlantic sturgeon spawn in their natal river. The Kennebec (Maine) and Hudson (New York) Rivers are the nearest rivers to the action area that are known to currently support spawning populations. Sturgeon remain in the river/estuary for two to five years until 50-75 cm in length. After emigration from the natal river/estuary, subadults and adult Atlantic sturgeon travel within the marine environment, typically in waters less than 50 meters, using coastal bays, sounds, and ocean waters.

There is limited information on Atlantic sturgeon in Boston Harbor. In February 2012, an Atlantic sturgeon was documented in the Charles River. In the summer of 2012, a dead Atlantic sturgeon was found floating in the North River, Massachusetts. These represent the first reported occurrences of Atlantic sturgeon in this area. No tributary of Boston Harbor has been identified as a historic spawning river for this species. Due to the limited presence of suitable forage, the presence of Atlantic sturgeon in Boston Harbor in general is considered to be limited to occasional transient subadults or adults. Atlantic sturgeon are most likely to be present in the channels where dredging and blasting will occur if suitable forage is present. Based on the best

available information, only occasional transient subadult or adult Atlantic sturgeon are likely to be present in the channels where dredging and blasting will occur.

Effects of the Action

Below, we consider the effects of dredging, disposal of dredged material, blasting, and disposal of rock on listed species. This analysis relies on the full implementation of all special conditions listed above; we consider these to be part of the proposed action. It is important to note that project plans may be refined in the future. Prior to the USACE entering into any contracts or carrying out any dredging or blasting, updated project plans and special conditions will be provided to us. At that time we will determine if there are likely to be any effects that we did not consider here and, if there are, reinitiation of this consultation will be necessary.

Dredging

A clamshell bucket dredge will be used to remove sediments and to remove loose rock after blasting. As explained above, whales are extremely unlikely to occur in the areas where dredging will occur. As such, they will not be exposed to any effects of dredging. Occasional transient sea turtles and Atlantic sturgeon may be present in the channels where dredging will occur, particularly in areas where benthic invertebrates are present. Here, we consider the potential for individuals to be captured in the dredge bucket and effects of increased turbidity/suspended sediment and loss of benthic resources/forage opportunities.

Capture in the Dredge Bucket

Bucket dredges are relatively stationary. Bucket dredging entails lowering the open bucket through the water column, closing the bucket after impact on the bottom, lifting the bucket up through the water column, and emptying the bucket into a barge. Aquatic species can be captured in dredge buckets and may be injured or killed from entrapment in the bucket or burial in sediment during dredging and/or when sediment is deposited into the dredge scow.

No sea turtles have been captured in mechanical dredges operating in the action area. The USACE has no records of any sea turtles being captured in mechanical dredges anywhere. As such, we do not anticipate any capture of sea turtles during any mechanical dredging considered here.

In rare occurrences, sturgeon have been captured in dredge buckets and placed in the scow. The USACE has reported four incidences of sturgeon captured in dredge buckets along the U.S. East Coast since 1990. One of these was in the Cape Fear River and the other three were at the Bath Iron Works facility in the Kennebec River, Maine. No sturgeon have ever been observed during dredging operations in the action area. Based on all available evidence, the risk of capture in a mechanical dredge is low due to the slow speed at which the bucket moves and the relatively small area of the bottom it interacts with at any one time. Atlantic sturgeon are highly mobile and it is anticipated that they will be able to avoid the dredge bucket in nearly all instances. The potential for a capture is further reduced by the small number of Atlantic sturgeon in the action area and the transient use of the area by these fish. Given the relatively low level of risk that an individual Atlantic sturgeon would be captured in a slow moving dredge bucket and the low likelihood that Atlantic sturgeon will be present in the channels where dredging will occur, it is

extremely unlikely that any Atlantic sturgeon will be captured, injured or killed during dredging activities.

Turbidity Associated with Mechanical Dredging
The proposed dredging will cause a temporary increase in the amount of turbidity in the action area; however, suspended sediment is expected to settle out of the water column within a few hours and any increase in turbidity will be short term. The size of a sediment plume is influenced by many factors. The turbidity plume associated with a typical mechanical dredging operation extends approximately 1,000 feet at the surface and 1600 feet near the bottom (ACOE 1983). The maximum distance reported in the literature is 1,500 meters (4,921 feet), which occurred in an area with very strong tidal currents (ACOE 2007). Several studies have monitored sediment plumes associated with dredging projects along the Atlantic coast. Turbidity levels associated with these sediment plumes typically range from 26-350mg/L (ACOE 2007, Anchor Environmental 2003) with the highest levels detected adjacent to the dredge bucket and concentrations decreasing with greater distance from the dredge (see ACOE 2007).

No information is available on the effects of turbidity or suspended sediment (TSS) on juvenile and adult sea turtles. Studies of the effects of turbid waters on fish suggest that concentrations of suspended solids can reach thousands of milligrams per liter before an acute toxic reaction is expected (Burton 1993). TSS is most likely to affect sea turtles if a plume causes a barrier to normal behaviors or if sediment settles on the bottom affecting sea turtle prey. As sea turtles are highly mobile they are likely to be able to avoid any sediment plume and any effect on sea turtle movements is likely to be insignificant. Additionally, the TSS levels expected (26-350mg/L) are below those shown to have an adverse effect on fish (580mg/L for the most sensitive species, with 1,000mg/L more typical; see summary of scientific literature in Burton 1993) and benthic communities (390mg/L (EPA 1986) upon which turtles depend. Based on this information, the effects of suspended sediment resulting from dredging operations on sea turtles will be insignificant.

Fish eggs and larvae can be buried or smothered as suspended solids settle out of the water column. Because no early life stages of Atlantic sturgeon occur in the action area, none will be exposed to any increase in TSS. TSS is most likely to affect subadult or adult Atlantic sturgeon if a plume causes a barrier to normal behaviors or if sediment settles on the bottom affecting their benthic prey. As Atlantic sturgeon are highly mobile they are likely to be able to avoid any sediment plume and any effect on their movements or behavior is likely to be insignificant. Additionally, the TSS levels expected (26-350 mg/L depending on site specific conditions during dredging and up to 500.0 mg/L for disposal) are below those shown to have an adverse effect on fish (580.0 mg/L for the most sensitive species, with 1,000.0 mg/L more typical; see summary of scientific literature in Burton 1993) and benthic communities (590.0 mg/L (EPA 1986)); therefore, effects to benthic resources that sturgeon may eat are extremely unlikely. Based on this information, it is likely that both the effect of the suspension of sediment resulting from dredging operations and the effects of the discharge of sediments at the disposal site will be insignificant.

Effects on Prey
As noted above, sea turtles and Atlantic sturgeon are rare in Boston Harbor; however, they are most likely to occur where suitable forage (benthic invertebrates or SAV) are present. Dredging can affect sea turtles and sturgeon by reducing prey species through the alteration of the existing biotic assemblages. Some reduction in the amount of potential prey in the area to be dredged is likely; however, these areas are not thought to be used by foraging sturgeon or sea turtles. Regardless, the action will not result in the permanent removal of forage items, as prey species will continually recolonize the area following a disturbance. In summary, as (1) the area affected by dredging is not known to support significant amounts of benthic resources which Atlantic sturgeon and sea turtles forage on; and, (2) recolonization of the benthic community will be rapid (weeks to months), we have determined that any effects of dredging and disposal to foraging Atlantic sturgeon and sea turtles will be insignificant.

Blasting
Sound waves generated by blasting are known as "transient" or short, powerful pulses of noise. Peak pressure, measured in Pascals (Pa) or pounds per square inch (psi), and impulse, measured in Pascal seconds (Pa.sec), are the units used to describe severity of blast transients. Impulse is defined as the average pressure level of the wave acting over a given time.

Sound in water follows the same physical principles as sound in air. The major difference is that due to the density of water, sound in water travels about 4.5 times faster than in air (approx. 4900 ft./s vs. 1100 ft./s), and attenuates much less rapidly than in air. As a result of the greater speed, the wavelength of a particular sound frequency is about 4.5 times longer in water than in air (Rogers and Cox 1988; Bass and Clarke 2003). The term decibel (dB) is most often used to compare the level, or intensity of a sound, but the reference medium must be stated so that the reader understands whether in-air or underwater acoustics are being used. In water, acousticians use the standard reference sound pressure of 1 micropascal, abbreviated re 1 μPa (the in-air reference is 20 μPa).

Whales, sea turtles and sturgeon have differing levels of tolerance to underwater noise. Below, we present the underwater noise and pressure levels that are likely to result in mortality, injury and behavioral disturbance of these species.

Table 1. Effects, Criteria, and Thresholds (for Marine Mammals) for Impulsive Sounds from Underwater Detonation (provided by NMFS Headquarters)

Effect	Criteria	Metric	Threshold	Effect
Mortality	Onset of Extensive Lung Injury	Goertner modified positive impulse	indexed to 30.5 psi-msec (assumes 100 percent small animal at 26.9 lbs)	Mortality
Injurious Physiological	50% Tympanic Membrane Rupture	Energy flux density	1.17 in-lb/in^2 (about 205 dB re 1 microPa^2-sec)	Level A

Injurious Physiological	Onset Slight Lung Injury	Goertner modified positive impulse	indexed to 13 psi-msec (assumes 100 percent small animal at 26.9 lbs)	Level A
Non-injurious Physiological	TTS[1]	Greatest energy flux density level in any 1/3-octave band (> 100 Hz for toothed whales and > 10 Hz for baleen whales) - for total energy over all exposures	182 dB re 1 microPa^2-sec	Level B
Non-injurious Physiological	TTS	Peak pressure over all exposures	23 psi	Level B
Non-injurious Behavioral	Multiple Explosions Without TTS	Greatest energy flux density level in any 1/3-octave (> 100 Hz for toothed whales and > 10 Hz for baleen whales) - for total energy over all exposures (multiple explosions only)	177 dB re 1 microPa^2-sec	Level B

Sea Turtles

Pressure oscillations created by blasting cause a rapid contraction and over- extension of gas filled cavities (e.g., swim bladders, lungs, blood vessels) as pressure gradients change resulting in internal damage and/or mortality to aquatic species. For sea turtles, tissues that could be affected by detonations are mainly those at the air-fluid interface (e.g., ear cavities, lungs, gastrointestinal tract; Koschinski 2011).

Several studies have been undertaken that have demonstrated that explosions can injure and kill sea turtles (Duronslet *et al.* 1986; Gitschlag 1990; Gitschlag and Herczeg 1994; Kilma *et al.* 1988; O'Keefe and Young 1984); however, these studies have been based on the removal of large oil platforms, which involved the use of large, undelayed charges (i.e., 50 to 1,200 pounds per detonation) that were detonated in the open water (i.e., unconfined), whichwill produce greater levels of underwater noise and pressure levels.[2] In general, most sea turtles assessed in these studies suffered internal injuries (e.g., dilation of blood vessels, unconsciousness); only those exposed to the 1,200 pound charge within 656 feet of the blast succumbed to death. Although NMFS has not yet developed acoustic criteria for blasting activities, based on studies done by Yelverton and Richmond (1981), Finneran *et al.* 2002, and Southall *et al.* 2007, we believe that for sea turtles, blasting levels:

[1] TTS-Temporary, fully recoverable reduction in hearing sensitivity caused by exposure to sound.
[2] Information on the associated underwater noise and pressure levels (i.e., psi) were not available for these studies.

- ≥46 psi, 230_{peak} dB re 1 µPa or 198 dB re 1 μPa^2-s (SEL) will cause injury or mortality[3];
- ≥23 psi, 224_{peak} dB re 1 µPa or 183 dB μPa^2-s will cause harassment, via temporary threshold shifts (TTS); and,
- levels at or above 166 dB_{RMS} re 1µPa will cause behavioral modification (Baker, 2008).[4]

Atlantic sturgeon

There have been numerous studies that have assessed the direct impact of underwater blasting on fish (e.g., Teleki and Chamberlain 1978; Wiley *et al.* 1981; Burton 1994; Moser 1999). While none of the studies have focused on Atlantic sturgeon, the results demonstrate that blasting can have an adverse impact on fish. Teleki and Chamberlain (1978) found that several physical and biological variables were the principal components in determining the magnitude of the blasting effect on fish. Physical components include detonation velocity, density of material to be blasted, and charge weight; while the biological variables are fish shape and size, location of fish in the water column, and swim bladder development. Composition of the explosive, water depth, and bottom composition also interact to determine the characteristics of the explosion pressure wave and the extent of any resultant fish kill. Furthermore, the more rapid the detonation velocity, the more abrupt the resultant hydraulic pressure gradient, and thus, the more difficulty fish have in adjusting to the pressure changes. That is, it is the pressure oscillations created by the detontation that cause a rapid contraction and over-extension of the swim bladder as pressure gradients change; this results in internal damage and/or mortality to species of fish (Wiley *et al.* 1981). If blasting detonations are undertaken at one time (i.e., not set up to be delayed), fish cannot recover from these pressure oscillations, resulting in internal injuries (e.g., swim bladder ruptures) that may result in death.

Currently, NMFS has no acoustic guidelines or criteria for effects of blasting on listed species of fish. However, lethal threshold peak pressure levels for a variety of marine fish species exposed to open water (unconfined) dynamite blasts have been suggested by Hubbs and Rechnitzer (1952). These thresholds varied from 40 pounds per square inch (psi) to 70 psi, the former being the more conservative in estimating mortality in fishes (Hempen *et al.* 2007; Kevin 1995; ACOE 2004) since this waveform of mortality for this value was established from an open-water testing program and not from confined shots, which are known to reduce the pressure waves of detonations[5]. Keevin (1995) found no mortality or internal damage to bluegill exposed to a high explosive at pressures at or below 60 psi. Similarly, Yelverton *et al.* (1975) measured the impulse pressures resulting in 1%, 50%, and 99% mortality in large carp. The result of this study showed 1%, 50%, and 99% mortality at 35.1 pounds per square inch-milliseconds (psi-ms), 49.5

[3] Sound Exposure Level (SEL) is defined as that level which, lasting for one second, has the same acoustic energy as the transient sound and is expressed as dB re: 1μPa^2•sec.

[4] Root Mean Square (RMS) pressure is the square root of the time average of the squared pressure and is expressed as dB re: 1 µPa.

[5] The 40 psi criterion suggested by Hubbs and Rechnitzer (1952) is an estimate of 50 % mortality, rather than the onset of mortality (i.e., 1 % mortality) or threshold where no mortality is observed (Baker 2008).

psi-ms, and 69.7 psi-ms. Although this criteria is generally conservative for many non-listed species under the ESA, based on these studies, NMFS believes that the 40 psi threshold may not avoid mortality or serious injury for small size classes of listed fish species, especially eggs, fry, and juveniles that are vulnerable at much lower thresholds of injury than adults, but may overestimate ranges for larger individuals.

Although effects of blasting on Atlantic sturgeon have never been studied, effects of blasting on shortnose sturgeon have been examined and will serve as the best available information on potential effects of blasting on Atlantic sturgeon. Test blasting was conducted in Wilmington Harbor, North Carolina, in December 1998 and January 1999 in order to adequately assess the impacts of blasting on shortnose sturgeon and the size of the LDI area (the lethal distance from the blast where 1% of the fish died). As explained in Moser (1999), the test blasting consisted of 32-33 blasts (3 rows of 10 to 11 blast holes per row with each hole and row 10 feet apart), about 24 to 28 kg of explosives per hole, stemming each hole with angular rock, and an approximate 25 msec delay after each blast. During test blasting, 50 hatchery reared juvenile striped bass and shortnose sturgeon were placed in 0.25" plastic mesh cylinder cages (2 feet in diameter by 3 feet long) 3 feet from the bottom (worst case scenario for blast pressure as confirmed by test blast pressure results) at 35, 70, 140, 280, and 560 feet upstream and downstream of the blast location.

Results of the study indicated that there was a low survival rate for both species of fish located 35 feet from the detonation site; however, at distances of 70 feet, caged fish showed no sign of hemorrhage or swim bladder damage, although two fish exhibited extended intestines, which may have been caused by the blast. At distances at, and beyond 140 feet, there was no difference in survival or impulse pressure. In addition, necropsy results indicated that shortnose sturgeon juveniles were less seriously impacted by test blasting than were the juvenile striped bass. It is believed, therefore, that survival rates for shortnose sturgeon would have been higher than striped bass following blasting treatments, even within the 35-foot distance of the blast area (i.e., 88% of shortnose sturgeon would have survived versus 34 % of the striped bass; Moser 1999)[6]. Moser (1999) stipulated that shortnose sturgeon may be less susceptible and less sensitive to blasting effects due to the fact that the swim bladder in shortnose sturgeon is connected to the esophagus, allowing gas to be expelled rapidly without damage to the swimbladder (i.e., physostomus).

Based on the Moser (1999) studies, peak pressure levels at, or below, 75.6 psi, and peak impulse levels at or below18.4 psi-msec, will cause no injury or mortality to species of sturgeon, including Atlantic sturgeon.

It should be noted that for both marine mammals and turtles, injury and behavioral effects are only expected when these animals are exposed to peak pressure levels above 23 psi. Therefore, levels below 23 psi would be expected to be non-injurious to both seas turtles and marine mammals. Also peak pressures below 75.6 psi would not be expected to cause injury or mortality to sturgeon. Therefore, peak pressures below 23 psi would be expected to be protective of marine mammals, sea turtles and Atlantic sturgeon (i.e., not result in any injury, mortality or harassment).

[6] After 24 hrs of the blast treaments, fish were necropsied.

Expected Noise and Pressure Associated with Boston Harbor Blasting

When the blast is detonated, shock waves are diminished as they spread outward from the blast according to the cube root of the charge weight. As the wave travels further through the water away from the detonation point, it reflects repeatedly from the surface and seabed and loses energy. This reduction, referred to as "cube root scaling", was utilized by Cole (1948) in conjunction with small land animals and humans, to construct an open-water (detonations set without stemming) mortality radius (MR_{ow}) (i.e., the distance from the detonation where mortality would be experienced) for single, open-water shots according to the following formula:

$$MR_{ow} = 260 \times W_{ow}^{1/3} \quad \textbf{(Equation 1)}$$

where W_{ow} = the maximum charge weight (in pounds.) per delay of a single, open-water blast (i.e., the amount of explosive set in a single un-stemmed location).

Based on this equation, the mortality radius for a single, confined shot (MRc) was defined by the following formula: $MRc=56\ wc^{1/3}$ (Equation 2) where wc= the maximum charge weight (in pounds) per delay of a single confined blast (Hempen et al. 2005; Hempen et al. 2007).

Given the blast attenuation facilitated by confined borehole charges and the ability of marine animals to withstand pressure levels higher than land-based test subjects (small land animals and humans), the above equations provides a conservative calculation of safety ranges around a blasting project. This approach is further supported by Young (1991) who suggested that "cube root scaling may be used to provide an upper limit in the absence of data for a specific effect."

USACE Blasting in Boston Harbor September 2012

Blasting was conducted in Boston Harbor for the Boston Rock Removal Project from September 6 – September 2, 2012. For the three blasts[7] that occurred on September 6, 8 and 10, underwater sound monitoring was conducted to determine sound pressure levels at specific distances from the blast relative to protective criteria for marine mammals. Based on these data, protective zones were adjusted to ensure that they would be beyond the behavioral (Level B) threshold for marine mammals. The total weights of explosives per blast were 314 pounds for blast 1 (12 delays), 407 pounds for blast 2 (15 delays) and 554 pounds for blast 3 (17 delays). For blasts 1-3, calculated distances (based on the sound measurements) where sound pressure had attenuated to below Level B harassment thresholds for marine mammals were 773 feet, 783 feet, and 930 feet, respectively y. As expected, the area where injury, mortality or harassment would be experienced increases with the total weight of explosives per blast.

When using Equation 2 (above) to calculate the protective radii for confined blasting, the protective radius does not change regardless of the weight of the total charge. This is because the equation calculates the mortality radius using the weight of a single charge per delay only, rather than the total blast weight. When comparing the calculated protective distances (using Cole's equation) to the observations based on sound measurements in September 2012, it appears that the radius calculated on the single delay underestimates the distance where effects may be

[7] Each blast consists of a series of delays, or individual detonations of explosives, set inside the rocks, that are set off within milliseconds of each other.

experienced. For example, during blast 1 in September 2012, the total weight of explosives was 314 pounds, for 12 delays. Based on the blast reports, the maximum weight of charge per delay was 32 pounds. Therefore, using equation 2 above, the zone where there would be mortality would be 178 feet (MR_C(feet) = $56(32)^{1/3}$ = 178 feet).

The USACE determined based on the sound measurements made during the September 2012 blasting that the distances provided by Cole's equation were not sufficiently protective of listed species as they were likely to underestimate the size of the area where adverse effects could be experienced. They found that doubling the mortality zone results in the distance that would be protective (i.e., below Level B harassment thresholds) and then added fifty feet for an additional margin of safety. This additional calculation suggests that an area 406 feet beyond the blast site would have been below the Level B harassment thresholds. However, based on the measured sound data (i.e. Tech Environmental report), the calculated distance to protect from Level B harassment was 783 feet. Similarly for Blast 2, (total weight of explosives was 407) the maximum charge per delay was 33.5 pounds. The mortality zone for this single charge would be 181 feet, and doubling it and adding 50 feet would be 412 feet. However the calculated distance based on the measured sound data to protect from Level B harassment was 830 feet. Also for Blast 3, using 38.8 pounds per charge (total of 554 pounds of explosives) the protective zone based on Cole's equation 2 is 429 feet, but the calculated zone based on the sound data was 920 feet (see Appendix A in USACE BA for copy of Tech Environmental report). In addition, since Cole's equation 2 is calculated on the weight of the charge per single delay, and not on the total weight of explosives per blast, the exclusion zones will not change regardless of the total weight of explosives per blast event. However, the data collected from the September 2012 blasting events suggests attenuation distance does increase with an increase in the total weight of explosives per blast event. These data are summarized in Table 2 below.

Table 2. Comparison of Calculated Blast Safety Distances using Cole's Equation with those Measured from Tech Environmental for Boston Harbor Blasts 1-3, September 2012

Blast #	Number of Holes	Charge/ Hole (lbs)	Total lbs/ Blast	Calculated Mortality Zone (feet) (Coles) (D)	Safety Zone Dx2 +50	Safety Zone (Feet) (from Tech Envir. data) (ft)	Cole's Calculated on Total Wt x2 (ft) (Protective Radius)
1	12	32	314	178	408	773	761
2	15	33.5	407	181	411	783	830
3	17	38.8	554	190	429	930	920

If Cole's equation 2 is used on the total amount of explosives per blast event and then multiplied by 2, then the estimated distances to protect animals from Level B harassment approximate those calculated from the actual measured data (Table 2, last two columns). Therefore, when using Cole's equation 2 to calculate distances where Level B harassment could be experienced, one can use the total weight of explosives used in each blast and then double it to calculate the safety zone (i.e., the area outside of which Level B harassment would not occur). This is the method that USACE used to estimate the safety zones for the proposed blasting. Because this method is based on established calculations and actual monitoring in Boston Harbor, it is a reasonable way to estimate the areas where noise will be higher than 177 dB re 1uPa and peak pressure will be higher than 23 psi.

Calculation of Boston Harbor Deep Draft Blasting Safety Zones
Table 3 below provides the range in feet from the blast for the mortality and safety zones calculated by USACE on both the weight of charge per delay (i.e. individual borehole) and total estimated charge per blast (using 60 holes and a maximum charge of 40 pounds/hole) and multiplied by 2, in order to approximate the zones calculated by actual sound measurements (noted above). This is done for both the approximate mean weight of explosives expected to be used per charge (28.5 pounds), and the expected maximum weight of explosives to be used per blast/hole (40 pounds). Note that a total charge weight per blast using 60 holes and 40 pounds of explosives per hole would be 2,400 pounds. Based on the calculations used to protect species for the recent September 2012 Boston Harbor Rock Removal, it is presumed that the safety zone which is calculated on the single charges per delay, doubled with 50 feet added to it (column 5), would be sufficient to protect the listed species (i.e., it would provide the distance outside of which noise would be less than 177 dB re 1uPa and pressure would be less than 23 psi). However given the actual sound measurement from Boston Harbor blasting in September 2012, the safety zone calculated based on the total charge per blast and then doubled (last column) would be expected to be completely protective of marine mammals, sea turtles and Atlantic sturgeon; that is where no behavioral effects would be incurred at all (Level B Harassment).

Table 3. Estimated Safety Zones for Blasting in Boston Harbor

Number of Holes and/or Delays	Charge per Hole/Delay (lbs)	Total Charge per Blast (lbs)	Mortality Zone Based on Charge/Delay (feet)	Safety Zone Based on Charge/Delay x 2 + 50'	Mortality Zone Based on Total Charge/Blast (feet)	Safety Zone Based on Total Charge/Blast x2 (feet)
60	28.5	1995	171	392	705	1410
60	40	2400	192	433	750	1500

Therefore based on the above calculations it would be expected that a safety zone radius of 1,500 feet (based on the estimated maximum total charge of 2,400 pounds) would be completely protective of marine mammals, sea turtles and Atlantic sturgeon for the Boston Harbor blasting. That is, outside of this "danger zone" noise would less than 177 dB re 1uPa and peak pressure would be below 23 psi.

Effects of Blasting on Listed Species
Up to two blast rigs may be working during the project. These blast sites will be separated by at least one mile. Each rig will detonate no more than one blast each day. All blasting will occur between sunrise and sunset. The USACE has determined that at distances of more than 1,500 feet from the blast site, peak pressures will be below 23 psi and underwater noise levels will be less than 177 dB re 1uPa.

As explained above, whales are extremely unlikely to occur in the channels where blasting will occur. There are no historical records or sightings of any whales in these areas with the exception of one transient humpback in 2002. The area where pressure may be greater than 23 psi and noise may be louder than 177 dB re 1uPa will be monitored by an endangered species observer. No blasting will occur if a whale is sighted in the safety zone and blasting will not

occur until the area is free of whales for at least 60 minutes. Each blast will last less than seven seconds. Because no blasting will occur if a whale is present within the danger zone, we do not anticipate that any whales will be exposed to underwater noise or pressure that could result in death, injury or behavioral disturbance.

Similarly, the danger zone will be monitored for sea turtles. No blasting will occur until the danger zone is clear of sea turtles for at least 60 minutes. Sea turtles are generally not expected to occur near the blast sites; it is extremely unlikely that a sea turtle will be present in the danger zone, (i.e., within a radius of 1,500 feet from theblasting site) during the seven seconds twice each day when the detonations will occur. An observer is expected to be able to detect sea turtles in the danger zone as sea turtles must come up for air at least every 45 minutes. No blasting will occur if sea turtles are present in the danger zone. Because of this, we do not anticipate that any sea turtles will be exposed to underwater noise or pressure that could result in death or injury. Sea turtles may exhibit behavioral avoidance when exposed to underwater noise of 166 dB re 1uPa. The area where this noise level will be experienced is just outside the danger zone. If a sea turtle was exposed to noise louder than 166 dB but less than 177 dB, we expect that behavior would result in swimming away from the sound source. Given the extremely short duration of the increase in underwater noise (seven seconds), and that this increase in noise will be experienced no more than twice per day, we do not expect this avoidance to result in any impacts to the sea turtles ability to carry out normal behaviors such as migration or foraging. The energy expenditure would be so small it would be undetectable; there would be no impact to fitness. In summary, we do not anticipate any sea turtles to be injured or killed and any behavioral effects will be extremely minor and limited to avoidance behavior for several seconds; these effects will be insignificant.

Atlantic sturgeon

Because Atlantic sturgeon surface only occasionally, it is unlikely that an observer monitoring the water's surface will be able to detect the presence of Atlantic sturgeon in the danger zone. Also, while sonar will be used to monitor the area prior to blasting and no blasting will occur if schools of fish are in the area, the monitor is not likely to be able to identify detected fish to species. In order for a sturgeon to be affected by the blasting, it would need to be within the danger zone when the detonation occurred. While detonations will occur once or twice per day for up to 26 months, each will last only seven seconds. The area where pressure and noise could cause negative effects to Atlantic sturgeon will be within 1,500 feet of the detonation. As established above, only occasional transient Atlantic sturgeon are likely to be present in Boston Harbor. These individuals are most likely to occur in areas where suitable forage is present. The rocky areas where blasting will occur are not known to support benthic resources that Atlantic sturgeon may forage on. Based on the rarity of Atlantic sturgeon in the blasting area, the small size affected by each blast (1,500 foot radius), the very short duration of the blast (seven seconds) and the lack of forage resources which could serve to attract sturgeon to the blasting areas, it is extremely unlikely that any Atlantic sturgeon will be present in the danger zone during blasting. Therefore, we do not expect any Atlantic sturgeon to be injured or killed. Any Atlantic sturgeon that are nearby may avoid the blasting area; however, because the increase in underwater noise and pressure will last for only a few seconds, we expect any behavioral effects to be extremely minor and limited to avoidance behavior for no more than a few seconds a day. These effects will be insignificant.

Effect of Fish Startle System on Listed Species
We have considered whether the use of the fish startle system would affect any listed species. The system emits high frequency noise (110-140 kHz or 110,000-140,000 Hz). The operating frequency is above hearing threshold of any species of sea turtle, Atlantic sturgeon or large whale (Ketten and Bartol 2005; Lovell *et al.* 2005; Meyer *et al.* 2010; Richardson *et al.* 1995; Ketten 1998). Therefore, these species will not be able to perceive the noise emitted by the system. As such, no listed species will be exposed to any increased underwater noise resulting from the fish startle system.

Disposal of Dredged Material and Rock
All material removed from the Boston Harbor channels will be disposed at the MBDS and/or IWA. The MBDS is a circular area two nautical miles (nm) in diameter, located approximately 10 nm south-southeast of Eastern Point in Gloucester, 12 nm southeast from Gales Point in Manchester, Mass. and 18 nm from the entrance to Boston Harbor. The IWS is located adjacent to the MBDS. Material will be loaded onto a barge and towed to the MBDS or IWS with a tug boat.

Vessel Interactions
Collision with vessels remains a source of anthropogenic mortality for sea turtles, Atlantic sturgeon, and whales. The proposed project will lead to a small temporary increase in vessel traffic (i.e., tug and scow) within the action area; however, the increase is not expected to be significant relative to the existing combined vessel traffic in Boston Harbor and Massachusetts Bay (i.e., 4,561 large vessel trips and an additional 54,914 transits from medium-sized cruise ships, ferries, whale watching vessels, commercial fishing vessels, and dredging vessels per year (USCG 2006)). With any increase in vessel traffic, some increased risk of vessel strike to listed species is possible. However, due to the limited information available regarding the incidence of ship strikes and the factors contributing to ship strike events, it is difficult to determine how a particular number of vessel transits or a percentage increase in vessel traffic will translate into a number of likely ship strike events or percentage increase in collision risk. In spite of being one of the primary known sources of direct anthropogenic mortality to whales, and to a lesser degree, sea turtles and Atlantic sturgeon, ship strikes remain relatively rare, stochastic events, and a small, temporary increase in vessel traffic in the action area would not necessarily translate into an increase in ship strike events. The risk of a vessel interaction with listed species in the portion of the action area located in MBDS and IBS is discussed below.

Sea Turtles
Interactions between vessels and sea turtles occur and can result in injury or death. Most forms of vessel interactions result from contact between sea turtles and boat propellers. Information is lacking on the type or speed of vessels involved in turtle vessel strikes. However, there does appear to be a correlation between the number of vessel struck turtles and the level of recreational boat traffic (NRC 1990). Although little is known about a sea turtle's reaction to vessel traffic, it is generally assumed that turtles are more likely to avoid injury from slower-moving vessels since the turtle has more time to maneuver and avoid the vessel. The speed of the tug/scow is not expected to exceed 10 knots while transiting to and from the disposal site. As such, the 10 knot or less speed of the vessels is likely to reduce the chances of collision with a

sea turtle. In addition, the presence of lookouts who can advise the vessel operator to slow the vessel or maneuver safely when sea turtles are spotted will further reduce to a discountable level the potential for interaction with vessels (see mitigation measures above). Based on this and the best available information, we believe the potential interaction of a tug/scow and a sea turtle will be discountable.

Atlantic Sturgeon

The factors relevant to determining the risk to Atlantic sturgeon from vessel strikes are currently unknown, but they may be related to size and speed of the vessels, navigational clearance (i.e., depth of water and draft of the vessel) in the area where the vessel is operating, and the behavior of Atlantic sturgeon in the area (e.g., foraging, migrating, etc.). It is important to note that vessel strikes have only been identified as a significant concern in the Delaware and James Rivers and current thinking suggests that there may be unique geographic features in these riverine areas (e.g., potentially narrow migration corridors combined with shallow/narrow river channels) that increase the risk of interactions between vessels and Atlantic sturgeon. These geographic features are not present in Massachusetts Bay, generally, or in the action area, specifically, and thus, the risk of vessel strikes are not considered to be a significant threat in Massachusetts Bay. In contrast to areas like the Delaware and James Rivers, where several individuals which have been struck by vessels have been identified each year, no Atlantic sturgeon with injuries consistent with vessel strike have been observed in Massachusetts Bay. Given the geographic features of Massachusetts Bay and the action area, the likelihood of a vessel collision with Atlantic sturgeon in the ocean environment is expected to be extremely low. Based on this and the best available information, the potential interaction of a scow/tug and an Atlantic sturgeon is likely to be discountable.

Whales

Large whales, particularly right whales, are vulnerable to injury and mortality from ship strikes. Ship strike injuries to whales take two forms: (1) propeller wounds characterized by external gashes or severed tail stocks; and (2) blunt trauma injuries indicated by fractured skulls, jaws, and vertebrae, and massive bruises that sometimes lack external expression (Laist *et al.* 2001). Collisions with smaller vessels may result in propeller wounds or no apparent injury, depending on the severity of the incident. Laist *et al.* (2001) reports that of 41 ship strike accounts that reported vessel speed, no lethal or severe injuries occurred at speeds below ten knots, and no collisions have been reported for vessels traveling less than six knots. Most ship strikes, however, have occurred at vessel speeds of 13-15 knots or greater (Jensen and Silber 2003; Laist *et al.* 2001). An analysis by Vanderlaan and Taggart (2006) showed that at speeds greater than 15 knots, the probability of a ship strike resulting in death increases asymptotically to 100%. At speeds below 11.8 knots, the probability decreases to less than 50%, and at ten knots or less, the probability is further reduced to approximately 30%. As noted above, under the proposed action, the speed of the dredge is not expected to exceed 10 knots while transiting to and from the disposal sites. Based on this information, and the fact that vessel strike avoidance measures will be in place throughout the proposed action (see mitigation measures above), the potential interaction of a scow/tug and a listed species of whale is discountable.

Habitat Alteration
The MBDS and IWS consist of a low density of benthic organisms, primarily sponges, tunicates, bryozoans, and worms. Due to depths, no SAV is known to grow at the MBDS or IWS. Based on this information, the habitat characteristics of the MBDS and IWS are sub-optimal for sea turtle and sturgeon foraging and as such, Atlantic sturgeon and sea turtles are not expected to be foraging at this site. As such, the alteration of the habitat as a result of the placement of dredged material and rock debris within the existing MBDS and IWS is not expected to remove critical amounts of prey resources for these species. Additionally, disposal operations are not likely to alter the habitat in any way that prevents Atlantic sturgeon, or sea turtles from using this portion of the action area as a migratory pathway to other areas of the Bay that are more suitable for foraging and therefore, there would not be any disruption of essential behaviors such as migrating or foraging. Based on this information, the effects of disposing rock debris at the MBDS and/or IWS on Atlantic sturgeon, or sea turtles migration and foraging are expected to be insignificant and discountable.

Generally speaking, the placement of rock debris has the potential to injure Atlantic sturgeon, sea turtles, or whales by being struck by the debris while it is being placed. However, these species are likely to move from the area upon the arrival of the scow/tug, making it extremely unlikely that any of these species will remain stationary beneath the scow before or during the disposal of rock debris. As noted above, sea turtles and sturgeon are also not expected to be found foraging at the MBDS or IWS, and as such, are not expected to be found within or near the reef benthos for any period of time. In addition, the MBDS has been in use since 1992 and the IWS even longer. Since that time, there have been no reports of injuries to any listed species at this site. In addition, with lookouts present on board the vessels, should an animal be located in the vicinity of the disposal area, disposal operations will be conducted accordingly to avoid injury to the species. Based on this information, we believe that the risk of being struck by rock debris during its placement at the MBDS or IWS on Atlantic sturgeon, whales, or sea turtles is discountable.

Turbidity
Disposal of dredged material and rock debris will cause a temporary increase in suspended sediment. If any sediment plume does occur, it is expected to be small and suspended sediment is expected to settle out of the water column within a few hours. Turbidity levels associated with debris disposal is expected to be only slightly elevated above background levels (average range of 10.0 to 120.0 mg/l) (ACOE 2007, Anchor Environmental 2003).

Studies of the effects of turbid waters on fish suggest that concentrations of suspended solids can reach thousands of milligrams per liter before an acute toxic reaction is expected (Burton 1993). The studies reviewed by Burton demonstrated lethal effects to fish at concentrations of 580.0 mg/L to 700,000.0 mg/L depending on species. Studies with striped bass adults showed that pre-spawners did not avoid concentrations of 954.0 to 1,920.0 mg/L to reach spawning sites (Summerfelt and Moiser 1976 and Combs 1979 in Burton 1993). While there have been no directed studies on the effects of total suspended solids (TSS) on Atlantic sturgeon, Atlantic sturgeon subadults and adults are often documented in turbid water and Dadswell (1984) reports that sturgeon are more active under lowered light conditions, such as those in turbid waters. As such, Atlantic sturgeon are assumed to be as least as tolerant to suspended sediment as other estuarine fish such as striped bass. The TSS levels expected for debris disposal (10.0 to 120.0

mg/L) are below those shown to have an adverse effect on fish (580.0 mg/L for the most sensitive species, with 1,000.0 mg/L more typical; see summary of scientific literature in Burton 1993) and benthic communities (390.0 mg/L (EPA 1986)). Based on this information, the effect of suspended sediment resulting from dredging on Atlantic sturgeon will be insignificant.

No information is available on the effects of total suspended solids (TSS) on juvenile and adult sea turtles or whales. TSS is most likely to affect sea turtles or whales if a plume causes a barrier to normal behaviors or if sediment settles on the bottom affecting sea turtle prey. As Atlantic sturgeon, sea turtles and whales are highly mobile they are likely to be able to avoid any sediment plume and any effect on Atlantic sturgeon, sea turtle or whale movements is likely to be insignificant. Additionally, the TSS levels expected are below those shown to have an adverse effect on fish (580.0 mg/L for the most sensitive species, with 1,000.0 mg/L more typical (Breitburg 1988 in Burton 1993; Summerfelt and Moiser 1976 and Combs 1979 in Burton 1993)) and benthic communities (390.0 mg/L (EPA 1986)); therefore, effects to benthic resources that sturgeon and sea turtles may eat are extremely unlikely.

While the increase in suspended sediments may cause Atlantic sturgeon, sea turtles or whales to alter their normal movements, any change in behavior is likely to be insignificant as it will only involve movements to alter their course out of the sediment plume. Based on this information, any increase in suspended sediment is not likely to hinder the movement of Atlantic sturgeon, sea turtles or whales between foraging areas or while migrating or otherwise negatively affect listed species in the action area. Based on this information, we believe that the effects of suspended sediment on sea turtles, whales, and sturgeon, resulting from the disposal of rock debris, will be insignificant.

Conclusion

Based on the analysis that all effects of the proposed project will be insignificant or discountable, we concur with your determination that the proposed Boston Harbor Deep Draft Navigation Improvement Project is not likely to adversely affect any listed species under our jurisdiction. Therefore, no further consultation pursuant to Section 7 of the ESA is required.

Reinitiation of consultation is required and shall be requested by the Federal agency or by the Service, where discretionary Federal involvement or control over the action has been retained or is authorized by law and: (a) If new information reveals effects of the action that may affect listed species or critical habitat in a manner or to an extent not previously considered in the consultation; (b) If the identified action is subsequently modified in a manner that causes an effect to the listed species or critical habitat that was not considered in the consultation; or (c) If a new species is listed or critical habitat designated that may be affected by the identified action. No take is anticipated or exempted. If there is any incidental take of a listed species, reinitiation would be required. As noted above, we expect that you will provide us with refined project plans once they are available. At that time, if we determine the project will cause effects not considered here, reinitiation of this consultation will be necessary. Should you have any questions about this correspondence please contact Julie Crocker at (978) 282-8480 or by e-mail (Julie.Crocker@Noaa.gov).

Coordination between NMFS' Habitat Conservation Division and your office regarding effects of the action on Essential Fish Habitat (EFH) and NOAA Trust Resources considered under the Fish and Wildlife Coordination Act is still ongoing. By completing this ESA consultation, you are not relieved of your obligations to complete consultation and coordination under these other authorities. I look forward to continuing to work with you and your staff as this action moves forward.

Sincerely,

for John K. Bullard
Regional Administrator

EC: Crocker, F/NER3
Chiarella, Johnson – F/NER4
Rogers – ACOE NE

File Code: Sec 7 USACE NE – Boston Harbor Deep Draft Improvement Project
PCTS NER-2012-9217

DEPARTMENT OF THE ARMY
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Planning and Policy Division

SEP 17 2013

Mr. Louis A. Chiarella
Assistant Regional Administrator for Habitat Conservation
National Marine Fisheries Service
55 Great Republic Drive
Gloucester, Massachusetts 01930-2276

Dear Mr. Chiarella:

This is in response to your letter dated July 22, 2013, providing comments on the Final Feasibility Report and Final Supplemental Environmental Impact Statement/Environmental Impact Report (FSEIS/EIR) for the Boston Harbor Deep Draft Navigation Improvement Project, Boston, Massachusetts. Your comments pertain to ongoing concerns with dredging effects, potential blasting effects, the capping of the industrial waste site, Essential Fisheries Habitat (EFH) impacts, Fish and Wildlife Coordination Act (FWCA), and Endangered Species Act (ESA). Your letter provided a helpful summary of our prior coordination and commitments with your agency.

Detailed responses to each of your comments on dredging effects, potential blasting effects, capping of the industrial waste site, EFH, FWCA, and ESA concerns related to the project are provided in the Enclosure. The Corps has been working for many years with your agency and the other federal, state and local agencies and stakeholders through the Boston Harbor Technical Working Group (TWG), to define and address the issues associated with this project and other recent Corps actions in Boston Harbor. Many of these concerns have been discussed at previous TWG meetings. We are committed to continuing to work with your office and the TWG participants as this project moves through its design and construction phases to ensure that all stakeholder and trust resource concerns are adequately addressed.

We look forward to continuing our work together to bring this project to a successful and environmentally responsible completion. If you have further questions or concerns please contact Mr. Michael Keegan of the New England District at (978) 318-8087.

Sincerely,

Theodore A. Brown, P.E.
Chief, Planning and Policy Division
Directorate of Civil Works

Enclosure

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ENCLOSURE

Responses to National Marine Fisheries Service (NMFS)
Comments on the Final Supplemental Environmental Impact Statement
Boston Harbor Deep Draft Navigation Improvement Project, Massachusetts
(September 2013)

General:

The Corps has committed in the Final Feasibility Report/FSEIS/EIR to work with your agency and other TWG members to investigate resource impact-based restrictions, construction sequencing, potential beneficial uses and users for the rock and hard materials, and to identify methods to reduce and avoid impacts of blasting on environmental resources. Before that effort can proceed, we need to better identify and quantify where rock and other hard material exist in the project footprint, and determine what critical environmental resources are present in the various areas of the harbor at different times of year.

In the preliminary stages of our design efforts we intend to undertake an extensive subsurface exploration program to quantify the amount of rock as well as characterize the rock to determine the appropriate removal methods. We believe this will result in a reduction in the volume of rock that must be removed and the volume of rock that would require drilling and blasting. Where appropriate, rock removal by rock buckets or hydraulic rams will be employed to reduce blasting impacts.

We will also work with you to identify and map-out what critical resources are present in the harbor, the locations and times of year they are present, and develop a construction sequencing plan that will minimize impacts to those resources to the extent practical while allowing construction of the project to proceed.

The Final Feasibility Report/FSEIS/EIR identified potential beneficial use opportunities, however, there was no consensus amongst the agencies on a plan to use the material to provide hard bottom habitat. We also discussed beneficial re-use for construction material or shore protection, but timing is critical and no one was willing or able to commit to share in the added costs associated with the action at this time. Absent a willing non-Federal sponsor, the recommended plan is to deposit all of the material at the Massachusetts Bay disposal site. The Corps is committed to identifying viable opportunities to use dredged material in a beneficial manner whenever possible. During the Design Phase when the location, volumes and appropriate removal methods have been identified for the rock and hard material, we will work with you and the TWG members to determine the range of potential beneficial uses for this material; including the costs, impacts and benefits of such uses, and the willingness and capability of cost-sharing partners where necessary.

As stated in your comment letter, ESA Section 7 consultation was completed for this project in a letter dated November 27, 2012.

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Responses to Specific Comments:

1. Comment: A time of year restriction (i.e., no dredging or underwater blasting), from February 1 to June 15th 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 west of the Conley Terminal, to avoid winter flounder spawning, egg, larvae, and juvenile development habitat.

Response: The Corps will seek to accommodate the February 1 to June 15 environmental window for winter flounder to the extent practicable. The window will be evaluated during the Design Phase once subsurface investigations have determined the extent of the various materials to be removed, the appropriate methods for removal, and critical resource distribution by area and time of year have been determined. With this information in hand, the overall project sequencing plans will be developed with the assistance of the TWG members. The schedule presented in the Final Feasibility Report/FSEIS/EIR is based on the existing air quality standards. We have been informed by EPA that it anticipates revising the Boston area's attainment status. Any changes to the project necessary to meet the revised air quality standards will be are taken into account when developing the project sequencing plans. If still warranted based on the latest air quality standards, any cost effective alternatives available to meet the emissions requirements other than construction period shutdowns will be investigated.

2. Comment: A time of year restriction (i.e., no dredging or underwater blasting), from March 1 to June 30 of any year in any areas of the Mystic River, 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 in order to protect EFH forage species (e.g., upstream spawning migrations of alewife, blueback herring, rainbow smelt).

Response: As described in the discussions above, the Corps will coordinate with your agency and the other TWG members during the Design Phase. After design phase field investigations are complete, we will determine what critical resources may be present and then determine the appropriate practical means to minimize impacts while allowing construction of the project to proceed.

3. Comment: An underwater blasting plan should be developed for the BHDDNIP by a technical working group (TWG), which should be convened as soon as possible to begin evaluating data from past Boston Harbor Federal Navigation projects, as well as 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, and should be incorporated into the FSEIS/FEIR.

Response: The Corps will support the development of a plan for blasting/rock removal, including any necessary and practicable mitigation and monitoring measures during the Design Phase of the project through the TWG. This activity cannot be conducted until the Design Phase subsurface investigations and critical resource characterization efforts are conducted that will

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identify and characterize the material to be removed and the resources present in the various areas of the harbor.

4. Comment: Alternative beneficial reuse of rock material that avoid and minimize adverse impacts to biologically productive soft bottom habitats should be evaluated more fully and incorporated into the FSEIS/FEIR, including using the rock for upland construction purposes and the use for ongoing shore protection projects.

Response: The Corps has committed in the Final Feasibility Report/FSEIS/EIR, and in our letter to the Massachusetts Office of Coastal Zone Management, dated October 26, 2012, to work with the State and TWG members during the Design Phase to evaluate potential alternative beneficial uses. Once the location, volumes and appropriate removal methods have been identified for the rock and hard material, we will work with the TWG members to determine the range of potential beneficial uses for this material; including the costs, impacts and benefits of such uses, and the willingness and capability of cost-sharing partners where necessary. The Final Feasibility Report/FSEIS/EIR suggested using rock to create inshore reef habitat in Massachusetts Bay. Other suggested uses include making the materials available for other parties to transport and use in their own upland or shore protection projects.

5. Comment: The results of the demonstration capping project within the Industrial Waste Site (IWS) should be evaluated within the FSEIS/FEIR in order to determine the efficiency of using the dredged material from the proposed BHDDNIP to cap the IWS.

Response: The demonstration capping project was conducted within the Massachusetts Bay Disposal Site (MBS), not the IWS. The reason for using the MBDS was because the IWS is no longer a designated disposal site and placement within the IWS was not possible. We are working with USEPA so that placement of dredged material within the IWS as a cap for the site will be possible when project construction starts. The expansion of the Massachusetts Bay Disposal Site to accommodate the capping of the barrel field is an EPA action and is not the responsibility of the Corps of Engineers. The Corps did present the results of the capping project to the TWG after the capping demonstration was completed. A report on the capping demonstration is scheduled to be published under the Corps New England District's Disposal Area Monitoring System program in Fiscal Year 2014.

Your previous letters have requested the results of the capping demonstration project within the Industrial Waste Site be evaluated as part of the Boston Harbor FSEIS/EIR. The capping demonstration project was not conducted as part of the Boston Harbor feasibility effort but as part of our Disposal Area Monitoring System (DAMOS) program. (The demonstration project was actually performed within the existing Massachusetts Bay disposal site). The recommended plan in the Final Feasibility Report/FSEIS/EIR requires that all of the material be disposed at the EPA designated Massachusetts Bay disposal site. We recognize that the barrel field exists adjacent to the designated site and that the material could be used to cap the site with no additional cost to the project. EPA acknowledges that it is their responsibility to expand the boundaries of the site to give the Corps permission to use the material to cap the barrel field. This is an EPA action and is not the responsibility of the Corps of Engineers.

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6. Comment: EFH conservation recommendations were provided by your office in a letter dated November 26, 2012, given the best scientific information available. However, a distinct and further EFH consultation must be reinitiated pursuant to 50 CFR 600.920(1) if new information becomes available or the project is revised in such a manner that affects the basis for prior EFH conservation recommendations.

Response: While the information provided has a certain level of detail, we will continue working with your agency and TWG as detailed design progresses, as outlined in the above responses. It is understood that additional EFH consultation would need to be conducted should any future investigations require a revision to the project.

7. Comment: As stated in your comment letter, ESA Section 7 consultation was completed for this project on November 27, 2012. The consultation letter provided on that date stated that we agreed with your determination that as effects to listed species will be insignificant and discountable, the proposed action is not likely to adversely affect any NMFS listed species. After review of the FSEIS, that determination still stands since no significant changes to the project scope are proposed. As referenced in the FEIS, the project proponents plan to prepare a blasting monitoring plan and share it with us before blasting begins.

Reinitiation of consultation is required and shall be requested by you or us, where discretionary Federal involvement or control over the action has been retained or is authorized by law and: (a) if new information reveals effects of the action that may affect listed species or critical habitat in a manner or to an extent not previously considered in the consultation; (b) if the identified action is subsequently modified in a manner that causes an effect to the listed species or critical habitat that was not considered in the consultation; or (c) if a new species is listed or critical habitat designated that may be affected by the identified action. No take is anticipated or exempted. If there is any incidental take of a listed species, reinitiation would be required. As noted above, we expect that you will provide us with refined project plans once they are available. At that time, if we determine the project will cause effects not considered here, reinitiation of this consultation will be necessary.

Response: It is understood that ESA Section 7 consultation will be reinitiated with your office should any additional information obtained during design demonstrate that it may affect listed species or critical habitat or cause significant revision to the project that may affect listed species or critical habitat, or a new species is listed or critical habitat is designated. As we will be working with your agency as part of the TWG, these potential issues can be brought to our attention and properly addressed or avoided in an efficient and timely manner.

8. Comment: By letter dated June 2, 2008 (see attachment to this letter), we requested additional information regarding aspects of the proposed project, including: 1) development of a dredging sequencing plan;2) development of a comprehensive blasting plan to be approved by an interagency technical working group; 3) evaluation of alternative beneficial reuses for disposal of rock removed from the dredging project, and; 4) a review of the results from a capping demonstration study for the former offshore Industrial Waste Site (IWS) to assess potential impacts associated with disposing of dredged material at the IWS. However, the additional information requested by us in 2008 was not provided.

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Response: Your letter reiterates conservation recommendations that your agency expressed in previous letters to the Corps New England District dated June 2, 2008 and November 26, 2012. In addition to your conservation recommendations, you requested additional information you felt necessary to fully evaluate the effects of the project. The detailed investigations you requested are beyond the scope of a feasibility investigation and are generally conducted during the Design Phase. The feasibility study conducted initial investigations to estimate the amount of rock that would require removal for each of the alternatives and conservatively assumed that all of the material would require blasting. The report's findings, cost estimates and implementation schedule were based on this assumption.

9. Comment: While we understand you intend to coordinate with us on these remaining questions and concerns during the Design Phase through the TWG, we maintain that this information is central to evaluating the effects of the project on our trust resources and the appropriate time to acquire and evaluate this information is during NEPA consultation process. NEPA requires any major Federal action that significantly affects the quality of the human environment assess (i) the environmental impact of the proposed action, (ii) any adverse environmental effects which cannot be avoided should the proposal be implemented, and (iii) alternatives to the proposed action. 42 USC § 4332. Furthermore, NEPA procedures must insure that environmental information is available to public officials and citizens before decisions are made and before actions are taken. 40 CFR §1500.1.

Response: Your letter expressed a need to use the requested information to evaluate the alternatives during the NEPA consultation process. The Corps NEPA evaluation and the development of the recommended plan were based on the feasibility level estimates of rock locations and volumes and the conservative assumption that all the material would require blasting. If additional investigations conducted during design result in significant changes to the recommended plan, the Corps is prepared to reinitiate consultation.

10. Comment: The collection of geologic and geotechnical data to better determine the distribution (and amount) of rock to be dredged directly effects the duration, timing, and magnitude of underwater blasting that will be required for this project. According to information provided through your letters and the FSEIS, the rock removal by blasting is anticipated to require approximately 26 months, including one daily blast for each of the two barges. Although some rock may be removed by hydraulic hammer, the FSEIS notes that the depth of the rock (8-15 feet) suggests it will be unlikely that removal by blasting is avoidable. Any rock that is not removed by blasting will be done using a hydraulic hammer, but this method takes a longer time than blasting and creates significant and more constant noise than drilling and blasting, according to the FSEIS. Consequently, the uncertainty involving the location and amount of rock to be removed, and what methods of removal will be used, suggests a high degree of uncertainty regarding the impacts on fishery resources during the construction period.

Response: Investigations conducted as part of the feasibility phase determined the maximum potential volume of material that will require removal to achieve the recommended depth. These investigations did not provide sufficient information to determine the exact quantity nor the likely methods of removal. The Final Feasibility Report/FSEIS/EIR assumed all rock would

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require blasting. Extensive subsurface exploration efforts are planned during design to refine the amount of rock as well as characterize the rock to determine the appropriate removal methods. Efforts are also planned to identify and map-out critical resources in the harbor, the locations and times of year they are present. This will be used along with the subsurface information to develop a construction sequencing plan that will minimize impacts to those resources to the extent practical while allowing construction of the project to proceed.

11. Comment: Because the proposed BHDDNIP involves removing approximately 1 million cy of rock over a 26-month period, some of which may occur during a time of year when diadromous fish densities are the highest, we believe the potential risk of injury and mortality are orders of magnitude larger than the rock removal project in September 2012.

Response: The proposed Boston Harbor deepening project will require a significantly greater quantity of rock removal than the September 2012 project. As discussed previously, detailed efforts are planned during design to better define the quantity and characteristics of the rock, the proper removal method and to identify critical resources within the harbor. This information will be used to develop construction requirements and a sequencing plan to minimize impacts to those resources to the extent practical.

12. Comment: Our concerns of potential adverse effects on our trust resources are heightened by the proposed construction sequence developed to avoid exceeding air quality standards. Specifically, according to the FFR for each plan and depth increment evaluated, the construction sequence would include a 6-month shutdown period every other year from October 1 to March 31 (12 months total). Because the proposed shutdown period coincides with the typical recommended dredge window for tidal and marine projects in Massachusetts (i.e., November 15 to January 31), we are concerned that the proposed plan may result in a shift of dredging and blasting operations to times of the year when sensitive life stages of aquatic species are present. For example, because winter flounder spawning and egg development generally occurs between February and mid-June, and diadromous fish spawning migrations occur from March through June, these months are considered highly sensitive periods for fishery resources in Boston Harbor and should be avoided. We believe the shutdown period for air quality purposes should be re-evaluated, taking into account potential impacts on aquatic life stages.

Response: Compliance with the existing air quality standards required two three-month shut downs over two years during the period of construction. These two occurrences were combined to reduce expensive de-mobilization and re-mobilization costs. EPA has indicated to us in their letter that they are revising the Boston area's attainment status and we will consider this along with planned design investigations to develop construction requirements and a sequencing plan to minimize impacts to those resources to the extent practical. If still warranted based on the latest air quality standards, any cost effective alternatives available to meet the emissions requirements other than construction period shutdowns will also be investigated.

13. Comment: Lastly, as a technical comment on the FFR, page ES-13 of the Environmental Coordination, Impacts, and Benefits section of the Executive Summary, states the "Endangered Species Act and Fish and Wildlife Coordination Act efforts were concluded in November

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2012 and January 2013, respectively, with no adverse impacts identified." This statement is inaccurate and confusing to the public. As you recall, we provided EFH conservation recommendations and FWCA recommendation to you in a letter, dated November 26, 2012. In this letter, we identified a number of concerns regarding potential adverse impacts to our trust resources, and provided recommendations *to* avoid and minimize, as well as outstanding information necessary to fully evaluate adverse impacts.

Response: The Corps agrees that this statement is a bit confusing with regards to comments made by your agency in its 2012 comment letter which stated under the Fish and Wildlife Coordination Act that EFH recommendations be adopted. The statement "with no adverse impacts identified" will be deleted. We would like to point out that the concerns identified in your letters are discussed extensively in the Executive Summary along with commitments made by the Corps to work with the TWG to address these issues as part of the project design. See responses to specific comments 1 through 5.

14. Comment: As discussed above, we provided you EFH conservation recommendations for the proposed project on November 26, 2012. Although we indicated that our need for additional information to evaluate the effects of the project on EFH, federally-managed species, and other trust resources remain, we were obliged by our regulations at 50 CFR 600.920(i)(5) to provide EFH conservation recommendations using the best scientific information available. However, a distinct and further EFH consultation must be reinitiated pursuant to 50 CFR 600.920(1) if new information becomes available or the project is revised in such a manner that affects the basis for the prior EFH conservation recommendations. The FFR, FSEIS, and FEIR listed a number of remaining issues and additional information that will be generated during the Design Phase of the BHDDNIP. New information identified during the Design or later phases of the project, if it may affect the basis of our EFH conservation recommendations, would require the reinitiation of our EFH consultation.

Response: If additional investigations conducted during the Design Phase result in significant changes to the recommended plan, then the Corps is prepared to reinitiate EFH consultation.

15. Comment: (An) Endangered Species Act Section 7 consultation was completed for this project on November 27, 2012. Reinitiation of consultation is required and shall be requested by you or us, where discretionary Federal involvement or control over the action has been retained or is authorized by law and: (a) if new information reveals effects of the action that may affect listed species or critical habitat in a manner or to an extent not previously considered in the consultation; (b) if the identified action is subsequently modified in a manner that causes an effect to the listed species or critical habitat that was not considered in the consultation; or (c) if a new species is listed or critical habitat designated that may be affected by the identified action. No take is anticipated or exempted. If there is any incidental take of a listed species, re-initiation would be required. As noted above, we expect that you will provide us with refined project plans once they are available. At that time, if we determine the project will cause effects not considered here, re-initiation of this consultation will be necessary.

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Response: As we stated above, it is understood that ESA Section 7 consultation will be reinitiated with your office should any additional information obtained during the Design Phase demonstrate that it may affect listed species or critical habitat. This could include significant revision to the project that may affect listed species or their critical habitat, a new species is listed, or critical habitat is designated. As we will be working with your agency as part of the TWG, these potential issues can be brought to our attention and properly addressed or avoided in an efficient and timely manner.

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U.S. Department of Transportation
Federal Aviation Administration

Office of Airport Safety and Standards

800 Independence Ave., SW
Washington, DC 20591

JUL 26 2013

Theodore A. Brown, P.E.
Chief, Planning and Policy Division
U.S. Army Corps of Engineers
7701 Telegraph Road
Alexandria, VA 22315

Dear Mr. Brown:

We received the proposed report of the Chief of Engineers and the report of the district engineer on the Boston Harbor Navigation Improvement Project, Massachusetts.

In accordance with established coordination procedures on water resources reports, we submit the following comments and recommendations on the project about its potential effect on airport safety.

Based on information contained in the reports, we have determined that the proposed dredging associated with the project will have no long-term effects on airport safety. However, we are concerned that birds will be attracted to any exposed dredge material during the dredging process. If dredging occurs in the flight path of aircraft on approach or takeoff for Boston Logan International Airport and birds are attracted to the dredge spoil, this could potentially result in bird strikes with aircraft. We recommend that the dredge spoil be covered at all times, if possible, to limit its exposure to birds. We also recommend and that the Corps coordinate with the airport to monitor any increase in bird activity during the dredging process.

Please contact me at (202) 267-3053 if you have any questions or comments.

Sincerely,

Michael J. O'Donnell
Director of Airport Safety
and Standards

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DEPARTMENT OF THE ARMY
U.S. ARMY CORPS OF ENGINEERS
441 G STREET, NW
WASHINGTON, DC 20314-1000

REPLY TO
ATTENTION OF

Planning and Policy Division

SEP 13 2013

Mr. Michael J. O'Donnell
Director of Airport Safety and Standards
US Department of Transportation
Federal Aviation Administration
800 Independence Avenue, SW
Washington, DC 20591

Dear Mr. O'Donnell,

This is in response to your letter dated July 26, 2013, providing comments on the Boston Harbor Navigation Improvement Project, Massachusetts. Your comments pertain to concerns that birds will be attracted to the exposed dredged material during the dredging process in the flight path for Boston Logan International Airport. We fully understand this important safety concern.

The Corps New England District has conducted several maintenance dredging projects in Boston Harbor over the past 15 years, including two with dredging activity close to Logan Airport, the most recent of which was completed in 2009. The District staff coordinated with Federal Aviation Administration (FAA) staff at Logan Airport regarding dredging activities and an FAA specialist from St. Louis on a hazard analysis in both the design and construction of these efforts. The District staff experience is that birds are not attracted to dredge material in scows that are being loaded. There were no issues with attracting birds during these recent maintenance dredging activities.

The material that will be removed as part of this project is a mixture of rock, clays, and gravels that do not contain any food sources that would be attractive to birds. A bucket dredge would remove material from the channel bottom and place it into scows. Once full, scows would be towed from the site. No dredged material would be stored or transferred at facilities within the airport flight paths.

As the District has done in the past, they will coordinate with FAA staff through both the design and construction of this project to address any concerns raised, including monitoring any bird activity in the vicinity of dredging operations. We look forward to working with the FAA and Massport to complete a project that avoids any impact to airport safety and operations.

We will continue to coordinate with the FAA as the project moves forward. If you have further questions or concerns please contact Mr. Thomas Hughes at (202) 761-0523.

Sincerely,

Theodore A. Brown, P.E.
Chief, Planning and Policy Division
Directorate of Civil Works

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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

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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

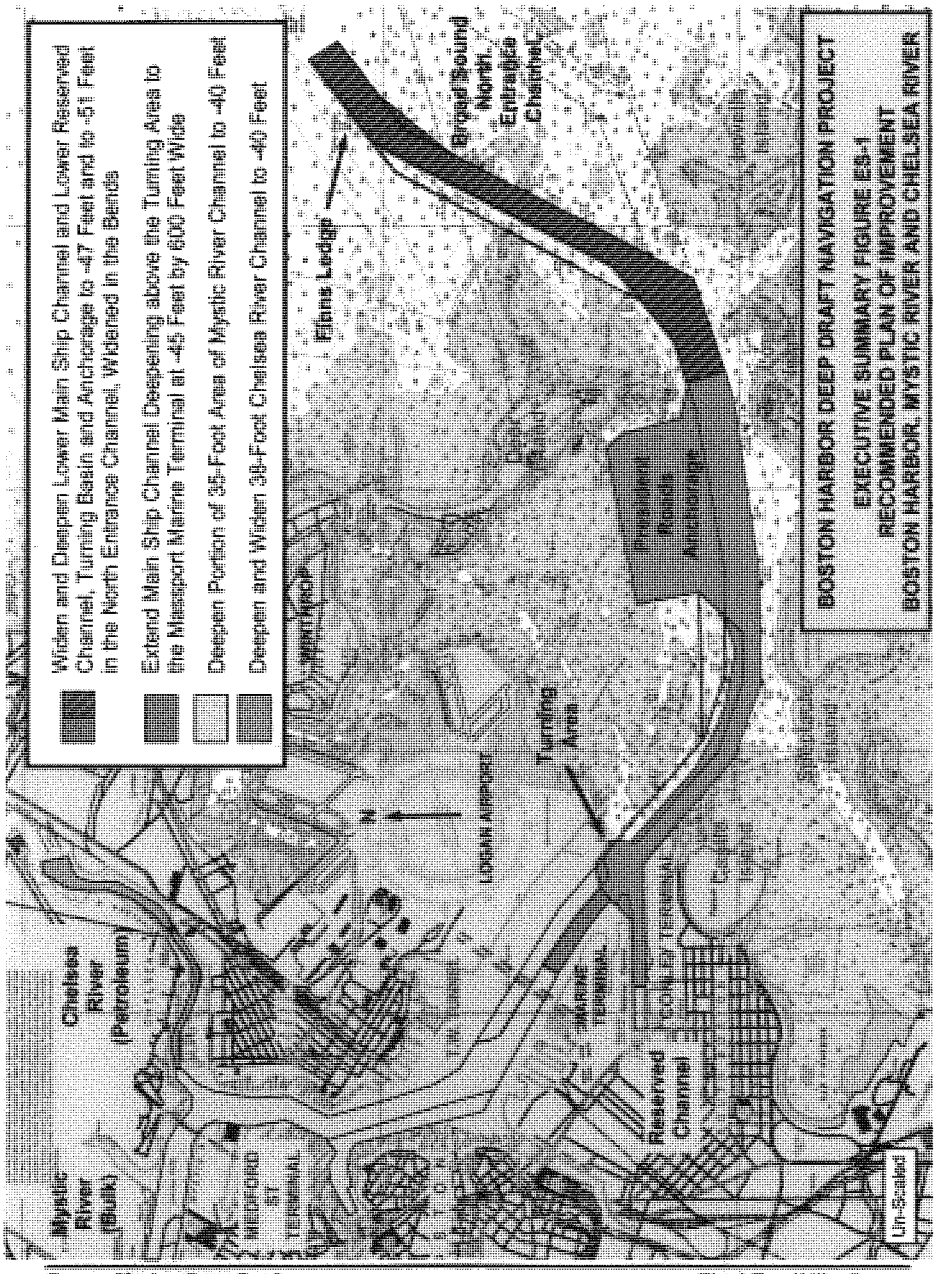
The City of Boston, Massachusetts is the hub of the nation's eleventh largest metropolitan area, with a population of nearly 4.6 million. The Federal Government, principally through the Corps of Engineers, has a long history of supporting waterborne commerce by contributing to the nation's water resources 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).


Widen and Deepen Lower Main Ship Channel and Lower Reserved Channel, Turning Basin and Anchorage to -47 Feet and to -51 Feet in the North Entrance Channel, Widened in the Bends
Extend Main Ship Channel Deepening above the Turning Area to the Massport Marine Terminal at -45 Feet by 600 Feet Wide
Deepen Portion of 35-Foot Area of Mystic River Channel to -40 Feet
Deepen and Widen 38-Foot Chelsea River Channel to -40 Feet
Flats Ledge
Broad Sound North Entrance Channel
President Roads Anchorage
Turning Area
LOGAN AIRPORT
Chelsea River (Petroleum)
Mystic River (Bulk)
MEDFORD ST TERMINAL
MARINE TERMINAL
CONLEY TERMINAL
Reserved Channel
Lin-Scaled
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.

- Main Channels Improvements for Conley Terminal Access – Containers: 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.
- Extend Main Ship Channel Deepening to Massport Marine Terminal (MMT) – Dry Bulk: 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.
- Mystic River Channel Access to Medford Street Terminal (MST) – Dry Bulk: 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.
- Chelsea River Channel Deepening – Liquid Petroleum: 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. 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) PLAN ABC	Main Ship Channel Extension to Marine Terminal PLAN D	Mystic River Channel Deepening PLAN E	Chelsea River Channel Deepening PLAN F	Total All Recommended Improvements 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.

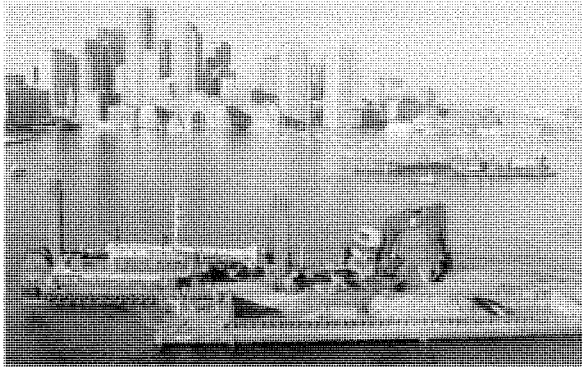
The NSTAR high voltage cable supplying the regional sewage treatment plant on Deer Island crosses the harbor beneath the Reserved and Main Ship Channels. The cable was installed subject to a 1989 River and Harbors Act Section 10 permit, but it was not fully embedded beneath the Reserved Channel to the 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.

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

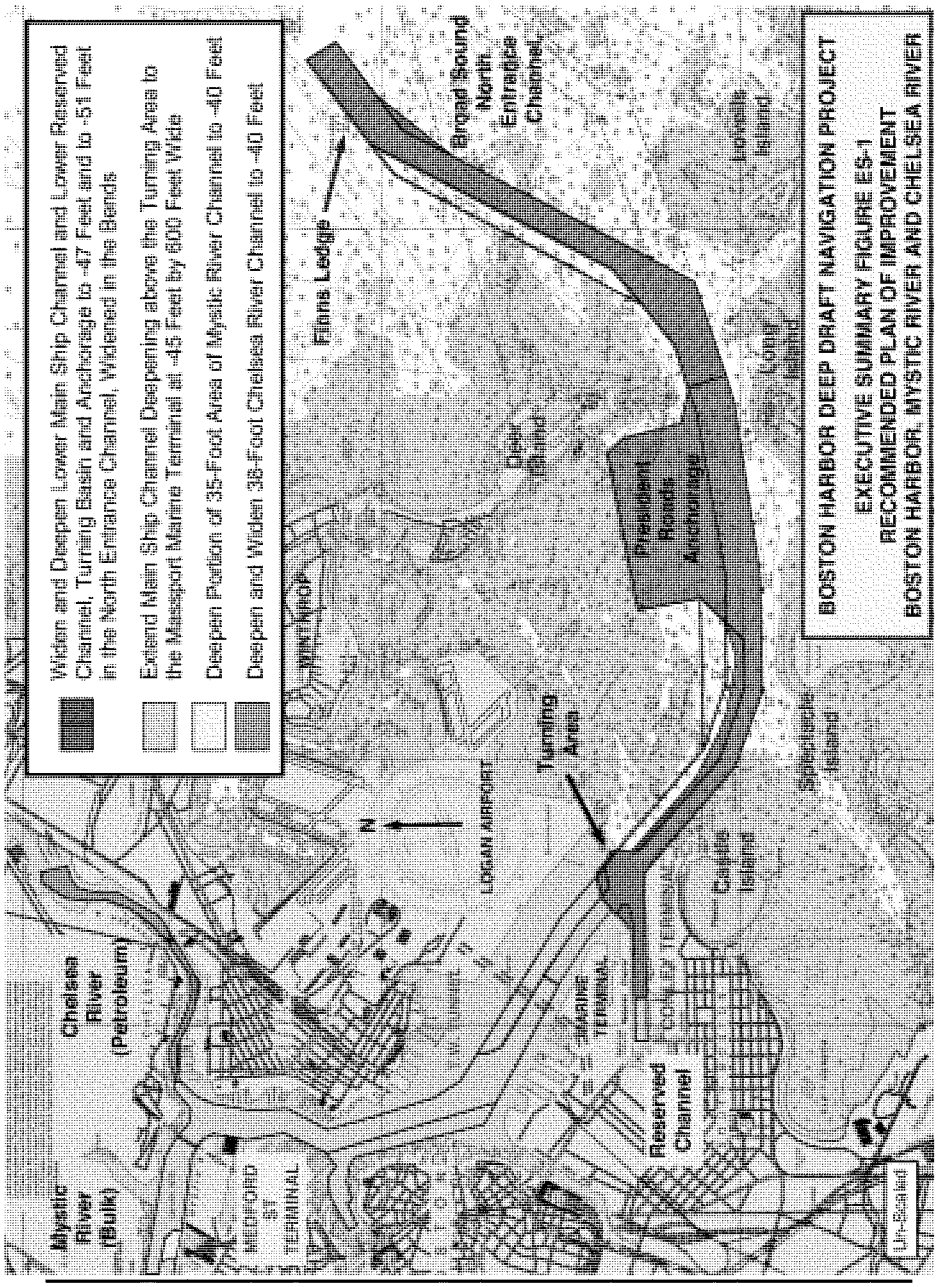
The City of Boston, Massachusetts is the hub of the nation's eleventh largest metropolitan area, with a population of nearly 4.6 million. The Federal Government, principally through the Corps of Engineers, has a long history of supporting waterborne commerce by contributing to the nation's water resources 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).


Widen and Deepen Lower Main Ship Channel and Lower Reserved Channel, Turning Basin and Anchorage to -47 Feet and to -51 Feet in the North Entrance Channel, Widened in the Bends
Extend Main Ship Channel Deepening above the Turning Area to the Massport Marine Terminal at -45 Feet by 600 Feet Wide
Deepen Portion of 35-Foot Area of Mystic River Channel to -40 Feet
Deepen and Widen 38-Foot Chelsea River Channel to -40 Feet
BOSTON HARBOR DEEP DRAFT NAVIGATION PROJECT
EXECUTIVE SUMMARY FIGURE ES-1
RECOMMENDED PLAN OF IMPROVEMENT
BOSTON HARBOR, MYSTIC RIVER AND CHELSEA RIVER
Mystic River (Bulk)
Chelsea River (Petroleum)
MEDFORD ST TERMINAL
LOGAN AIRPORT
N
Turning Area
Reserved Channel
MARINE TERMINAL
Castle Island
Spectacle Island
President Roads Anchorage
Deer Island
Long Island
Lovells Island
Broad Sound North Entrance Channel
Finns Ledge
Un-Scaled

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.

- Main Channels Improvements for Conley Terminal Access – Containers: 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.
- Extend Main Ship Channel Deepening to Massport Marine Terminal (MMT) – Dry Bulk: 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.
- Mystic River Channel Access to Medford Street Terminal (MST) – Dry Bulk: 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.
- Chelsea River Channel Deepening – Liquid Petroleum: 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 ageneies in October 2012. Endangered Speeies Act and Fish and Wildlife Coordination Act efforts were concluded in November 2012 and January 2013, respectively. 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.

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) PLAN ABC	Main Ship Channel Extension to Marine Terminal PLAN D	Mystic River Channel Deepening PLAN E	Chelsea River Channel Deepening PLAN F	Total All Recommended Improvements 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

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-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

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.

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.

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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Appendix Y	After-Action Report – 2007 Blasting Operation Impacts
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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.

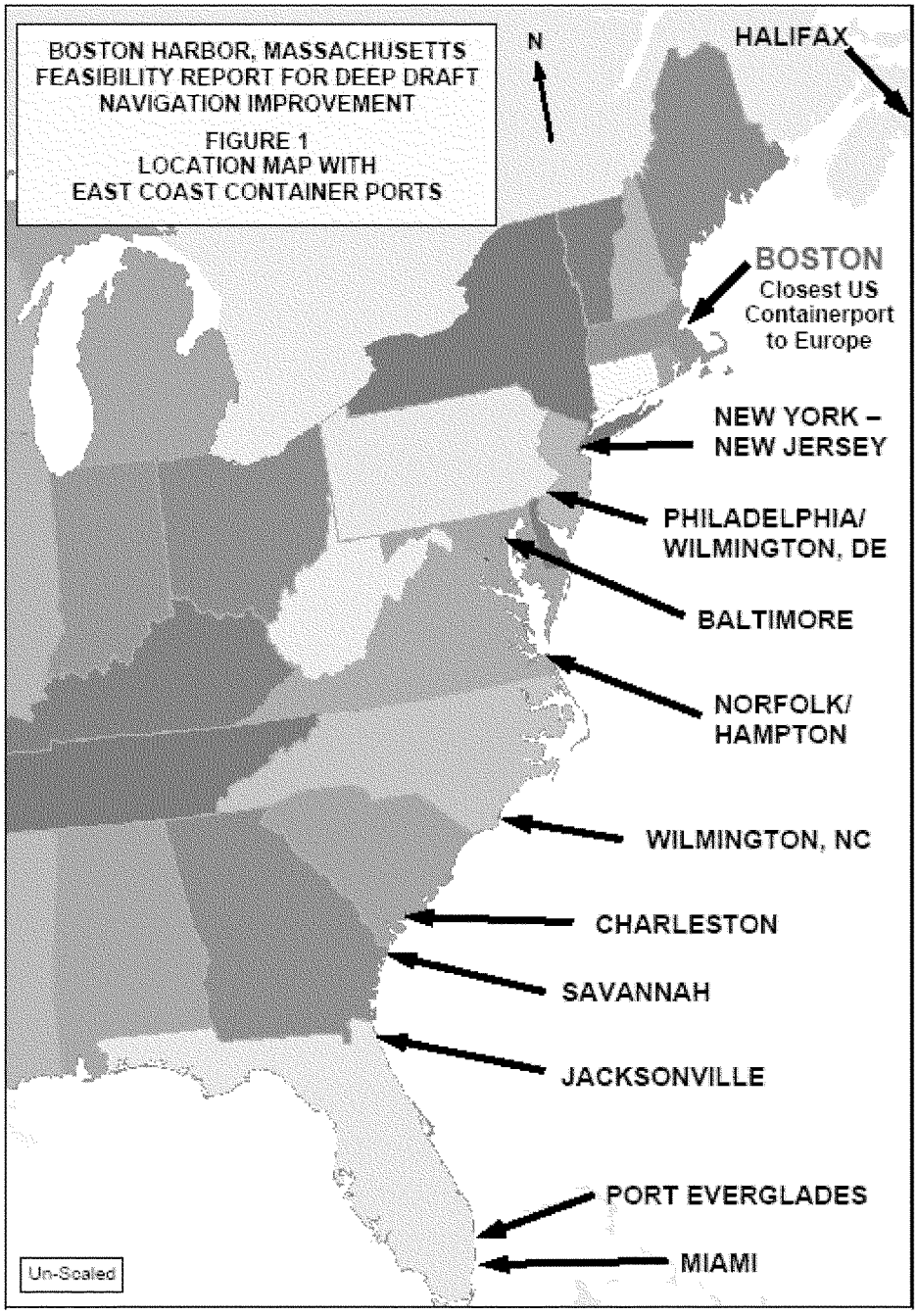
The City of Boston, Massachusetts is the hub of the nation's tenth largest metropolitan area, with a population of nearly 4.6 million. The Port of Boston is the largest port in New England, serving a regional population of 14.3 million residents in the six states. The Port handles about 20 million tons 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
U.S. Coast Guard – First District
National Park Service
National Marine Fisheries Service
U.S. Fish and Wildlife Service
Federal Aviation Administration

State Agencies and Authorities

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

Municipal Agencies

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

Interested Organizations and Harbor Users

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

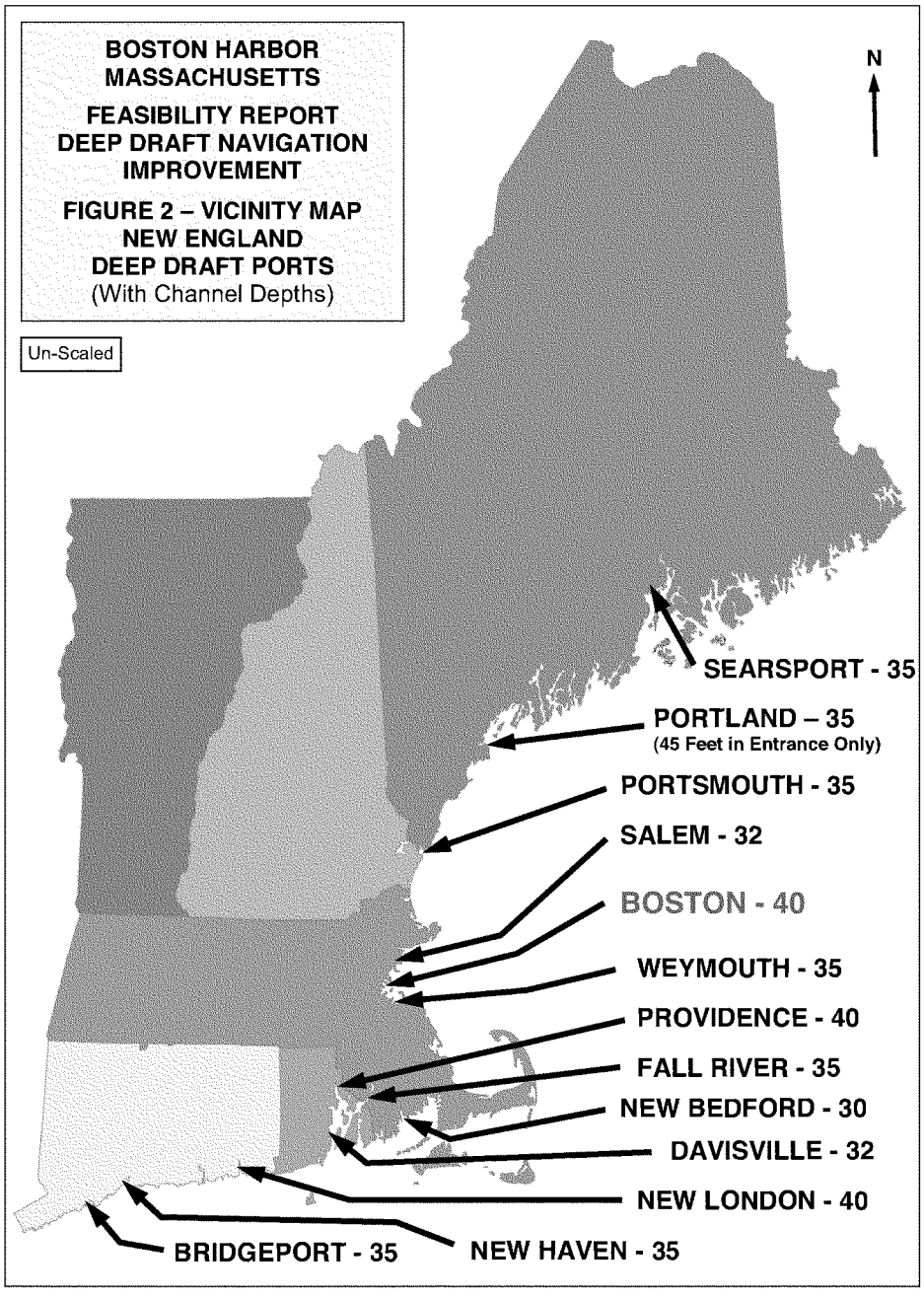
The climate of eastern New England is highly variable, and characterized by a wide range of temperatures and frequency but short periods of precipitation. Boston's latitude (42°N) places it in a prevailing west to east air flow, with periodic intrusions of tropical and polar air masses, leading to rapid change. While the City's coastal location has a moderating effect on seasonal extremes (average 49°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.

Mystic River – 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:

Winter Flounder – 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.

Anadromous Fish – 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.

Lobster – 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.

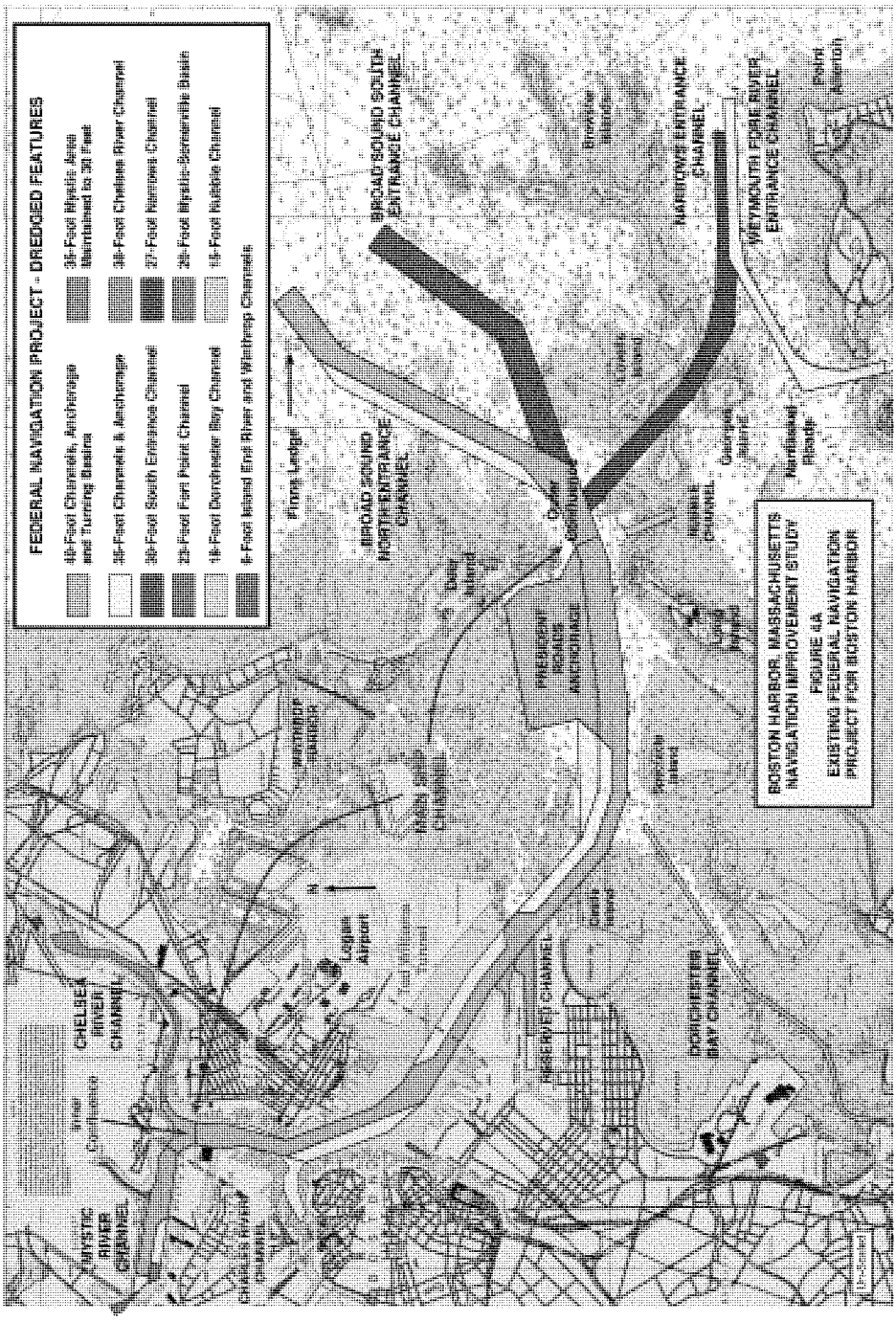
The Long Island anchorage ground is located in the area bounded roughly by Long, Gallops, Georges, and Rainsford Islands. The deeper parts of this area have natural depths of between 18 to 30 feet with a rocky bottom. This area has never been improved due to extensive ledge and is rarely used by large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

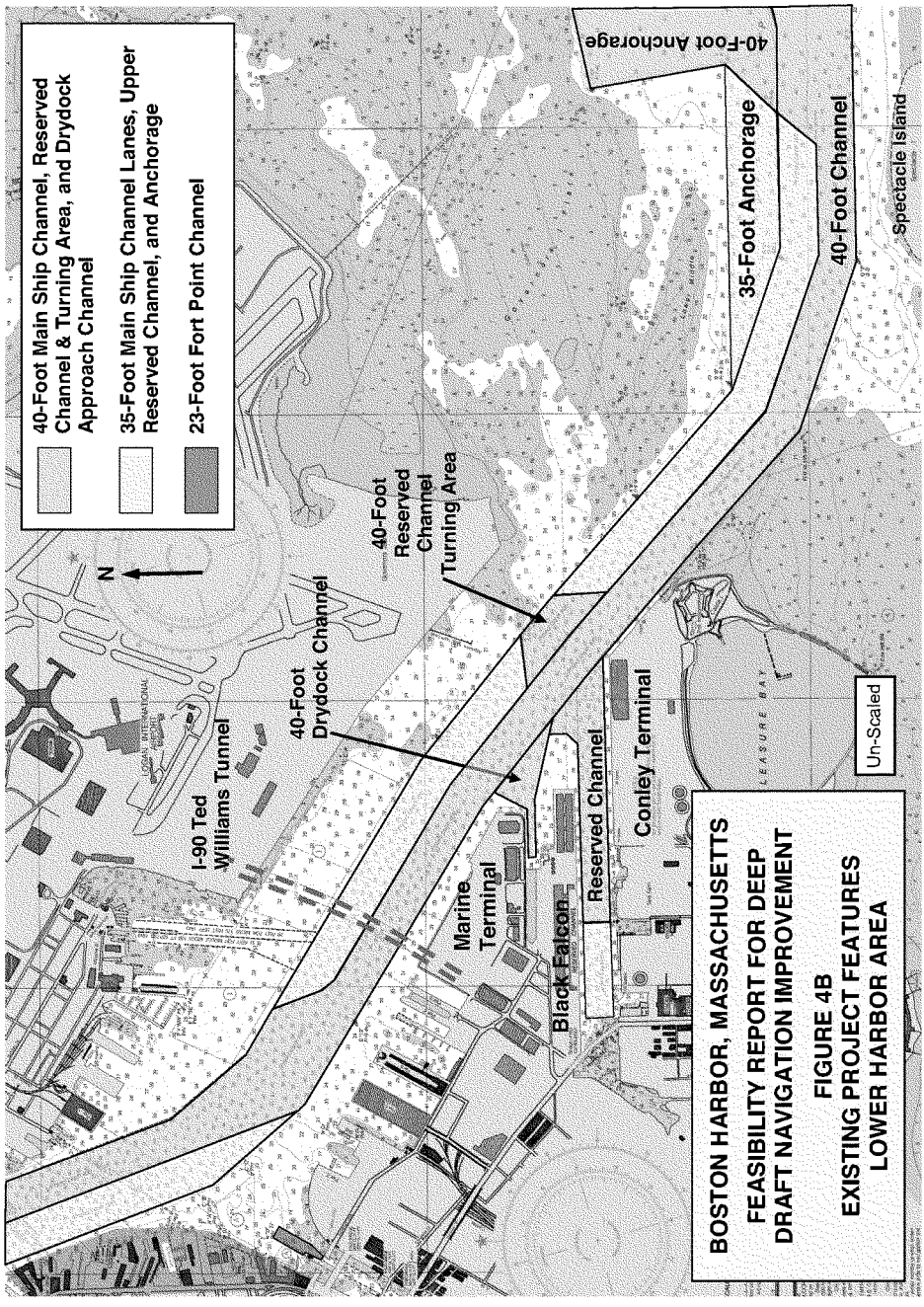

FEDERAL NAVIGATION PROJECT - DREDGED FEATURES
40-Foot Channels, Anchorage and Turning Basins
35-Foot Channels & Anchorage
30-Foot South Entrance Channel
23-Foot Fort Point Channel
18-Foot Dorchester Bay Channel
8-Foot Island End River and Winthrop Channels
35-Foot Mystic Area Maintained to 30 Feet
30-Foot Chelsea River Channel
27-Foot Narrows Channel
20-Foot Mystic-Sorrenville Basin
15-Foot Nubble Channel
BROAD SOUND SOUTH ENTRANCE CHANNEL
BROAD SOUND NORTH ENTRANCE CHANNEL
NARROWS ENTRANCE CHANNEL
WEYMOUTH FORE RIVER ENTRANCE CHANNEL
Firing Ledge
Outer Confluence
Deer Island
PRESIDENT ROADS ANCHORAGE
WINTHROP HARBOR
MAIN SHIP CHANNEL
Logan Airport
CHELSEA RIVER CHANNEL
MYSTIC RIVER CHANNEL
CHARLES RIVER CHANNEL
RESERVED CHANNEL
DORCHESTER BAY CHANNEL
Rainsford Island
Georges Island
Nantasket Roads
Point Allerton
BOSTON HARBOR, MASSACHUSETTS
NAVIGATION IMPROVEMENT STUDY
FIGURE 4A
EXISTING FEDERAL NAVIGATION PROJECT FOR BOSTON HARBOR

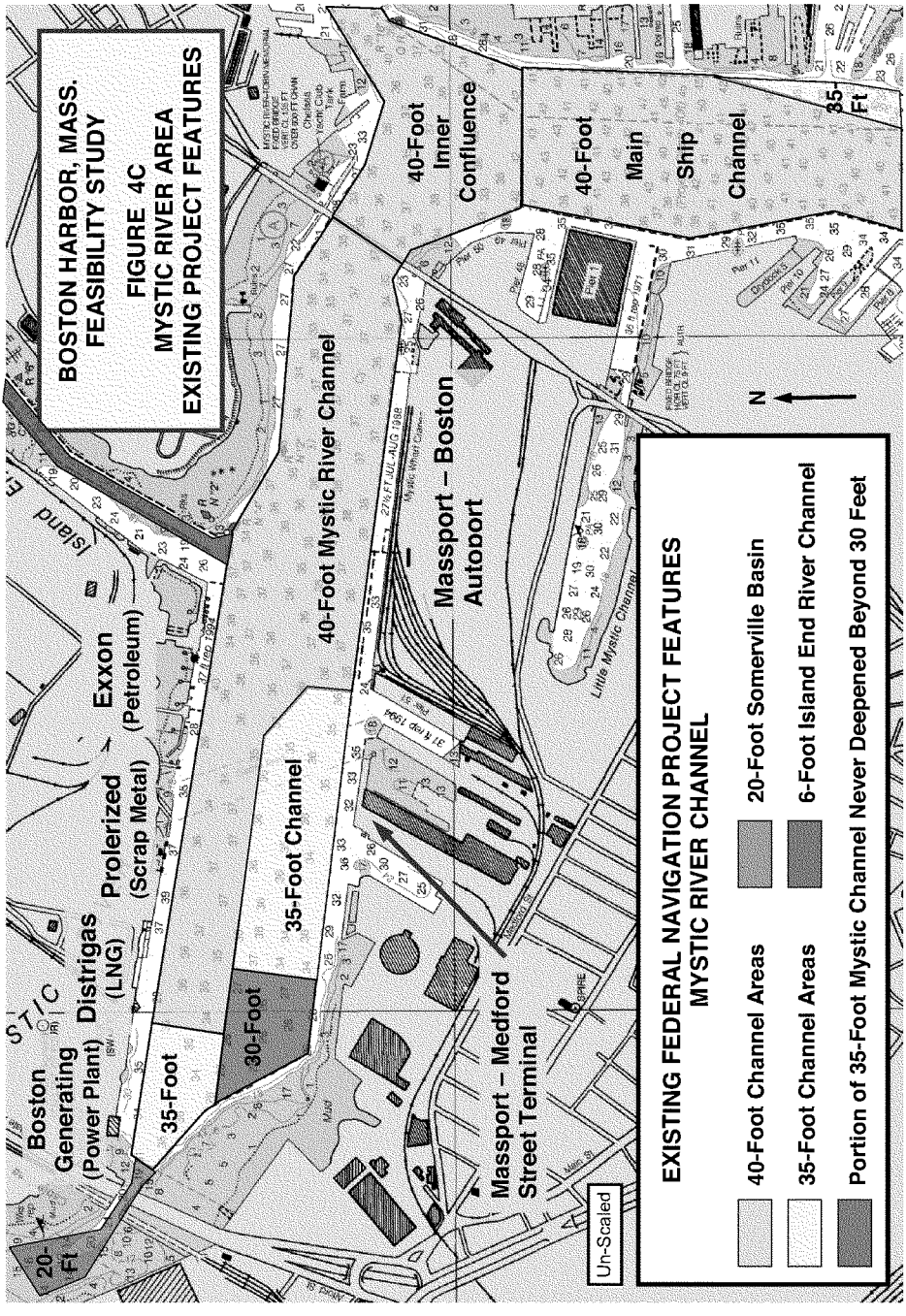
The 40-foot Main Ship Channel cut shifted sides of the wider 35-foot cut in order to access the three former US Navy facilities located on different sides of the harbor. Deep-draft traffic today follows the 40-foot channel with shallower-draft traffic using the adjacent 35-foot lanes in passing situations. 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.


40-Foot Main Ship Channel, Reserved Channel & Turning Area, and Drydock Approach Channel
35-Foot Main Ship Channel Lanes, Upper Reserved Channel, and Anchorage
23-Foot Fort Point Channel
N
I-90 Ted Williams Tunnel
40-Foot Drydock Channel
40-Foot Reserved Channel Turning Area
Marine Terminal
Black Falcon
Reserved Channel
Conley Terminal
40-Foot Anchorage
35-Foot Anchorage
40-Foot Channel
Spectacle Island
Un-Scaled
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
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
Un-Scaled
N
Boston Generating (Power Plant)
Distrigas (LNG)
Prolerized (Scrap Metal)
Exxon (Petroleum)
35-Foot
30-Foot
35-Foot Channel
40-Foot Mystic River Channel
Massport – Medford Street Terminal
Massport – Boston Autoport
40-Foot Inner Confluence
40-Foot Main Ship Channel
35-Ft
20-Ft
Little Mystic Channel
Island End

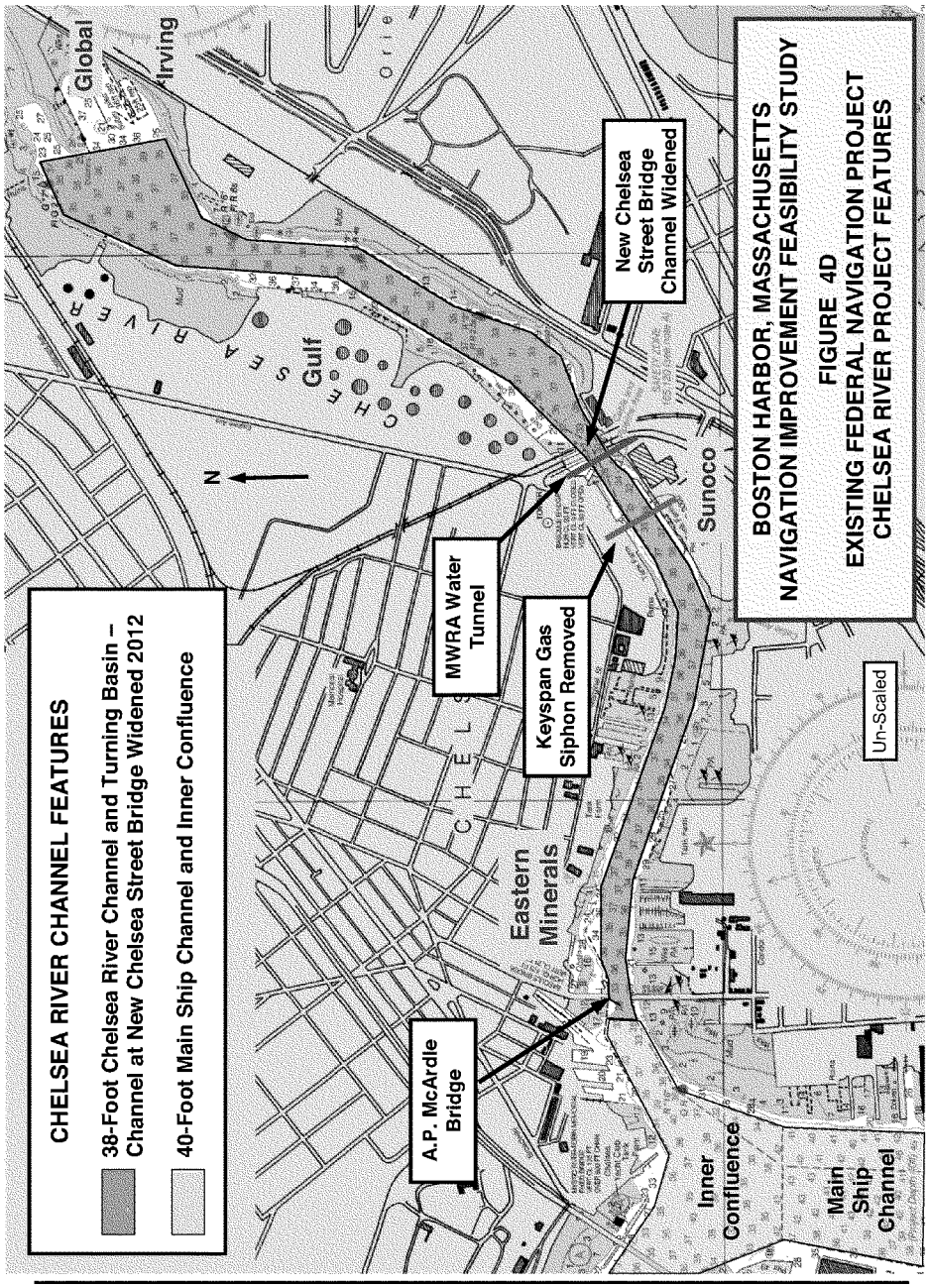
Chelsea River – see Figure 4D: Chelsea River is New England's largest petroleum port for products intended for domestic use. Portland, Maine imports more petroleum products due to crude offloaded into pipelines discharging in Canada. Five major fuel terminals are located along the Chelsea River, mainly 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
BOSTON HARBOR, MASSACHUSETTS
NAVIGATION IMPROVEMENT FEASIBILITY STUDY
FIGURE 4D
EXISTING FEDERAL NAVIGATION PROJECT
CHELSEA RIVER PROJECT FEATURES
A.P. McArdle Bridge
MWRA Water Tunnel
Keyspan Gas Siphon Removed
New Chelsea Street Bridge Channel Widened
Inner Confluence
Main Ship Channel
Eastern Minerals
Sunoco
Global
Irving
Gulf
CHELSEA RIVER
N
Un-Scaled

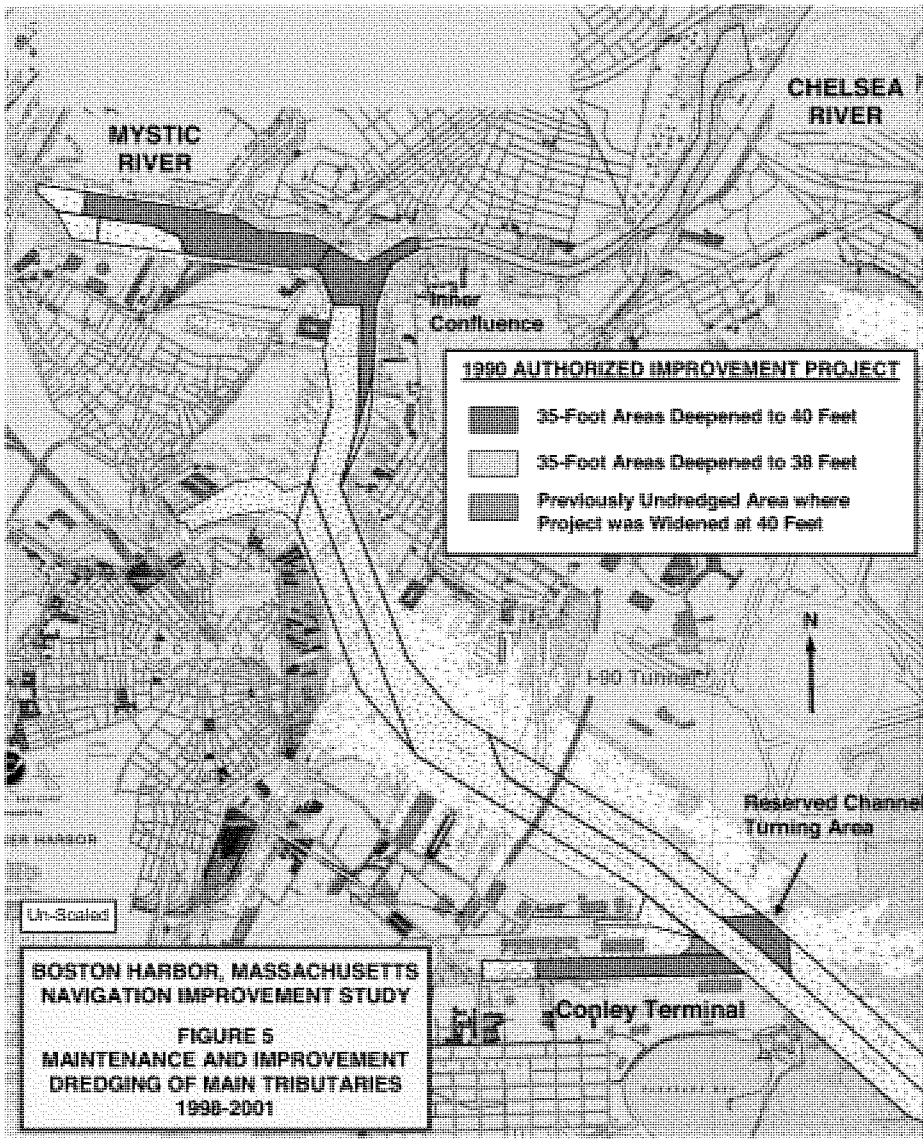
The authorized dimensions of these channels are all adequate for their existing and prospective navigation needs and no improvements are contemplated.

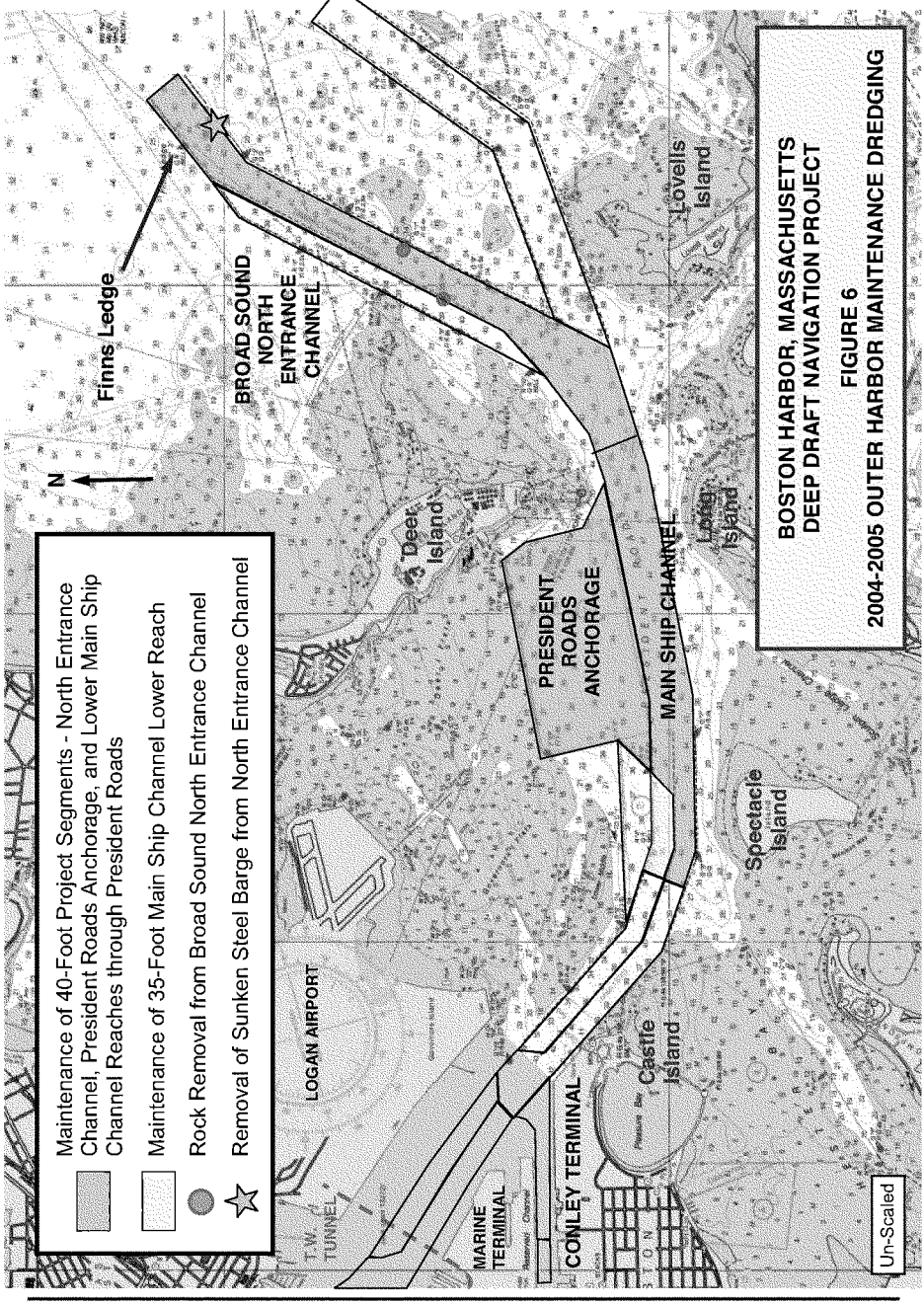
Harbor Seawalls: Stone shore protection works were constructed on several of the harbor islands and headlands between 1827 and 1874 to curtail deposition of shoal material in the harbor channels from erosion of these shorelines. These works of preservation were constructed on Deer Island, Castle Island, 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
Un-Scaled
Copley Terminal
BOSTON HARBOR, MASSACHUSETTS
NAVIGATION IMPROVEMENT STUDY
FIGURE 5
MAINTENANCE AND IMPROVEMENT DREDGING OF MAIN TRIBUTARIES
1998-2001


Maintenance of 40-Foot Project Segments - North Entrance Channel, President Roads Anchorage, and Lower Main Ship Channel Reaches through President Roads
Maintenance of 35-Foot Main Ship Channel Lower Reach
Rock Removal from Broad Sound North Entrance Channel
Removal of Sunken Steel Barge from North Entrance Channel
N
Finns Ledge
BROAD SOUND NORTH ENTRANCE CHANNEL
Deer Island
PRESIDENT ROADS ANCHORAGE
MAIN SHIP CHANNEL
Long Island
Lovells Island
Spectacle Island
Castle Island
LOGAN AIRPORT
T.W. TUNNEL
MARINE TERMINAL
CONLEY TERMINAL
Un-Scaled
BOSTON HARBOR, MASSACHUSETTS
DEEP DRAFT NAVIGATION PROJECT
FIGURE 6
2004-2005 OUTER HARBOR MAINTENANCE DREDGING

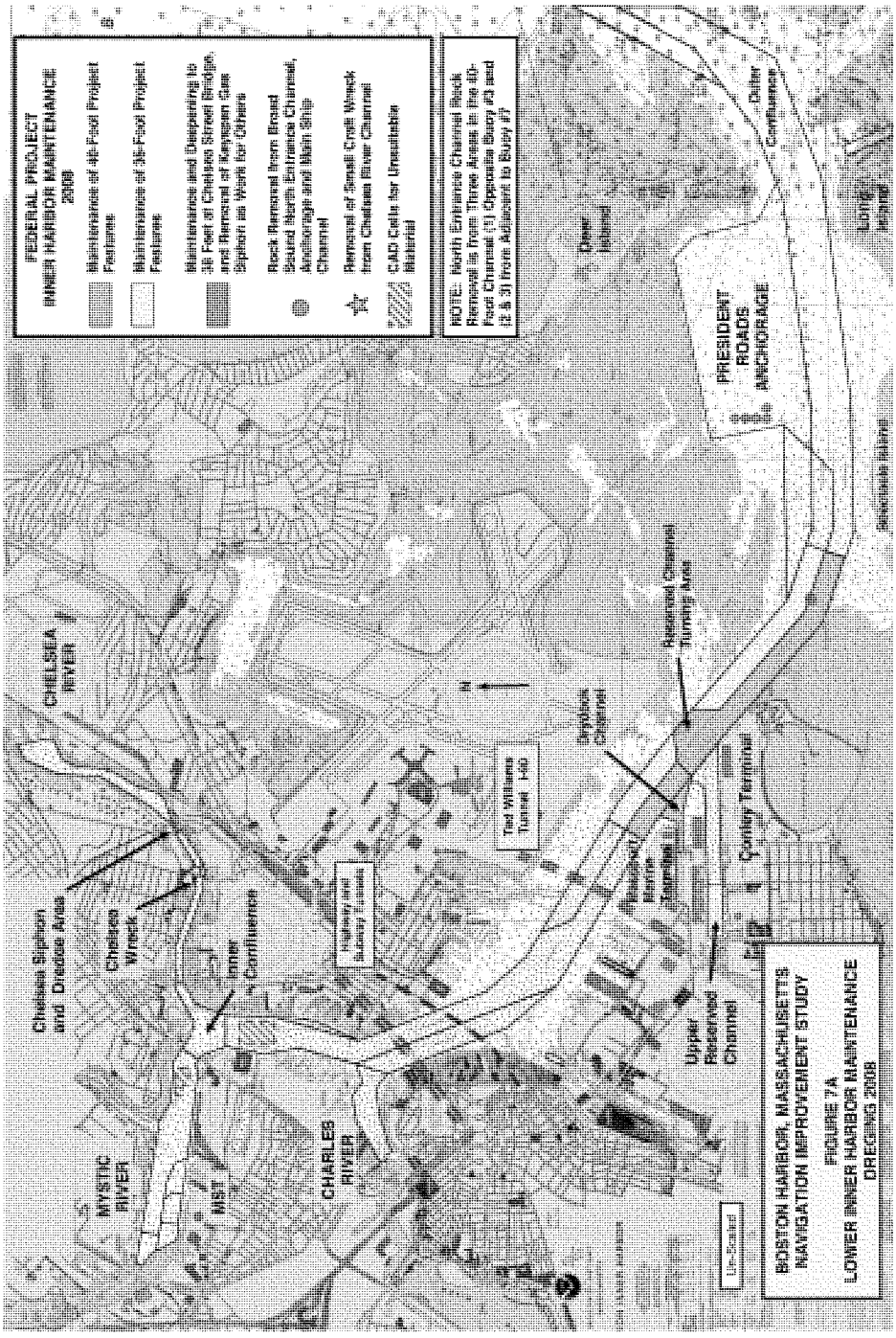
Additional rock areas lying above the project depth were discovered during the outer harbor maintenance in the North Entrance Channel and President Roads Anchorage. Another known area of ledge located in the side-slope transition between the 35 and 40-foot lanes of the Main Ship Channel just upstream 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.

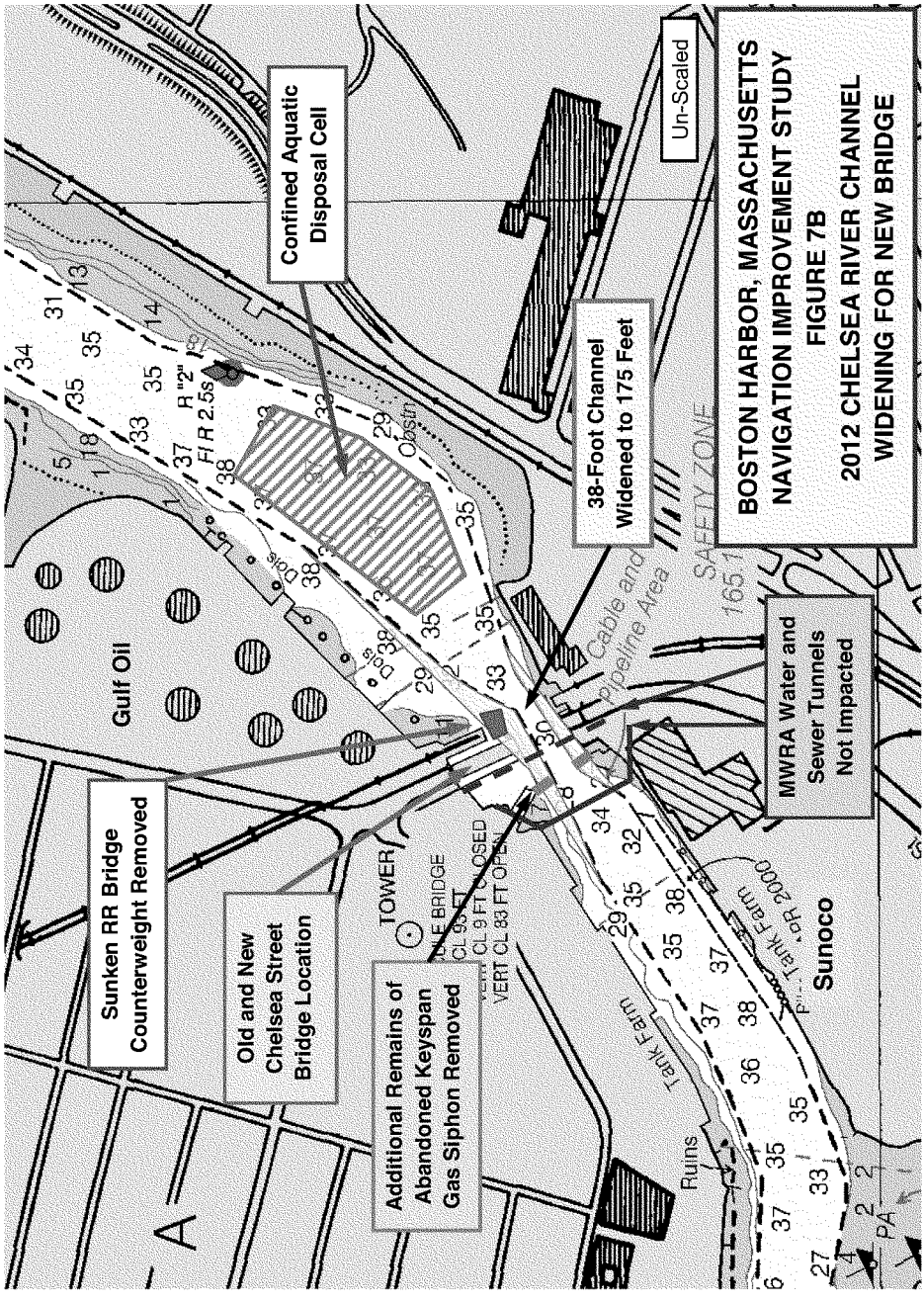
Construction began on a maintenance dredging contract for the deep draft portions of the Boston Harbor project in the lower inner harbor above Spectacle Island up to the Commonwealth Pier crossover (the Boston Inner Harbor maintenance dredging project) in April 2008. This work includes dredging the 35 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.

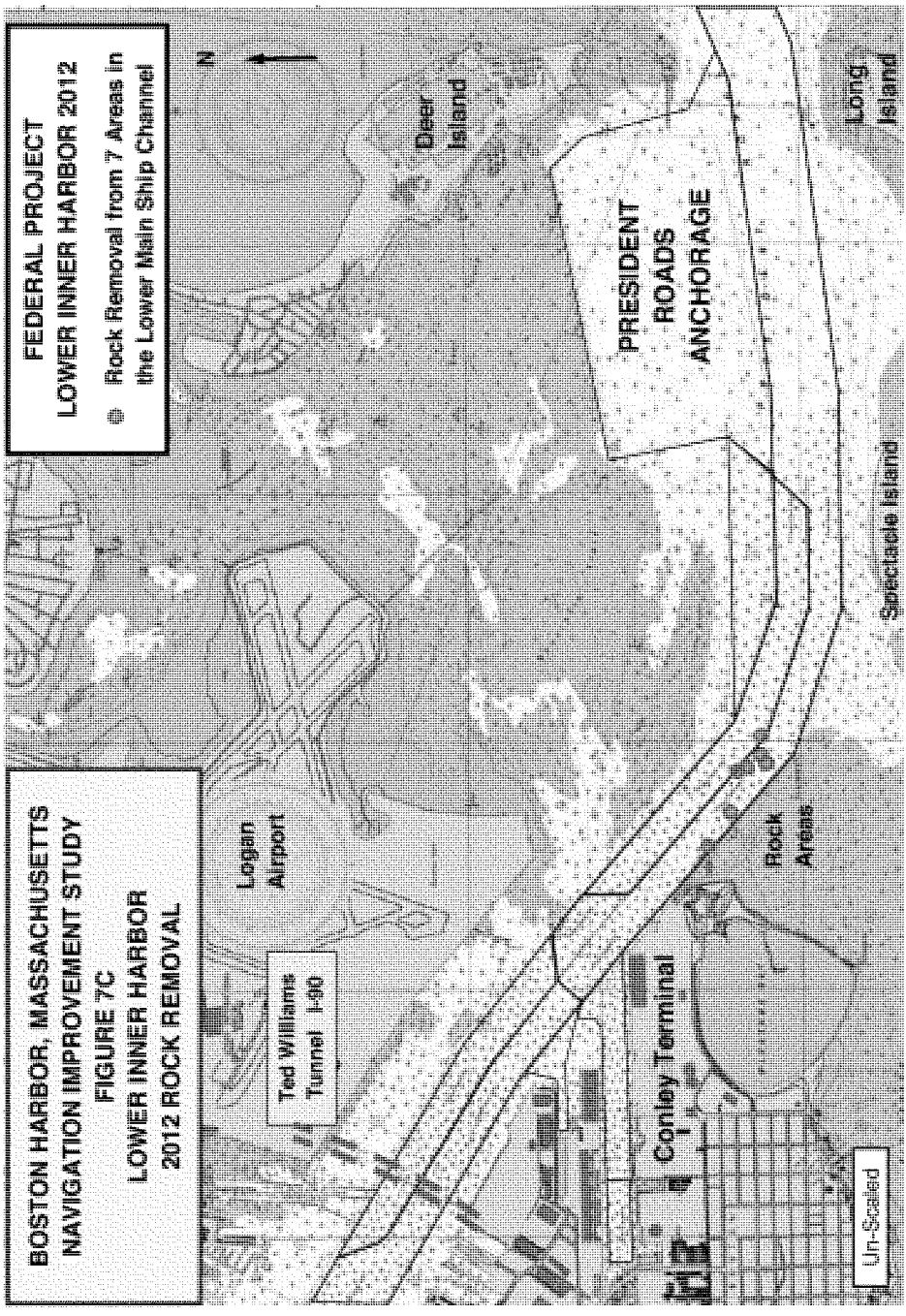
In March to April 2012 additional work was carried out on the 38-foot Chelsea River Channel after completion of the new Chelsea Street Bridge and removal of the old span by the State and others. This work was done to widen the Federal channel to 175 feet through the area of the former highway bridge. 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


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
CHELSEA RIVER
Chelsea Siphon and Dredge Area
Chelsea Wreck
Inner Confluence
MYSTIC RIVER
MST
CHARLES RIVER
Highway and Subway Tunnels
Ted Williams Tunnel I-90
Drydock Channel
Reserved Channel Turning Area
Upper Reserved Channel
Conley Terminal
Deer Island
Outer Confluence
PRESIDENT ROADS ANCHORAGE
Long Island
Sandwich Island
Un-Scaled
BOSTON HARBOR, MASSACHUSETTS
NAVIGATION IMPROVEMENT STUDY
FIGURE 7A
LOWER INNER HARBOR MAINTENANCE
DREGING 2008


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


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
N
Logan Airport
Ted Williams Tunnel I-90
Deer Island
PRESIDENT ROADS ANCHORAGE
Long Island
Spectacle Island
Conley Terminal
Rock Areas
Un-Scaled

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.

FEDERAL PROJECT
REMAINING INNER HARBOR
MAINTENANCE
Maintenance of 40-Foot Upper Main Ship Channel Reaches
Maintenance of 35-Foot Project Features
Maintenance of 30-Foot Broad Sound South Entrance Channel
Maintenance of 15-Foot Nubble Channel
CAD Cells for Unsuitable Material
MYSTIC RIVER
CHELSEA RIVER
CHARLES RIVER
Inner Confluence
Ted Williams Tunnel
Deer Island
PRESIDENT ROADS ANCHORAGE
Outer Confluence
Long Island
Reserved Channel
Conley Terminal
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.

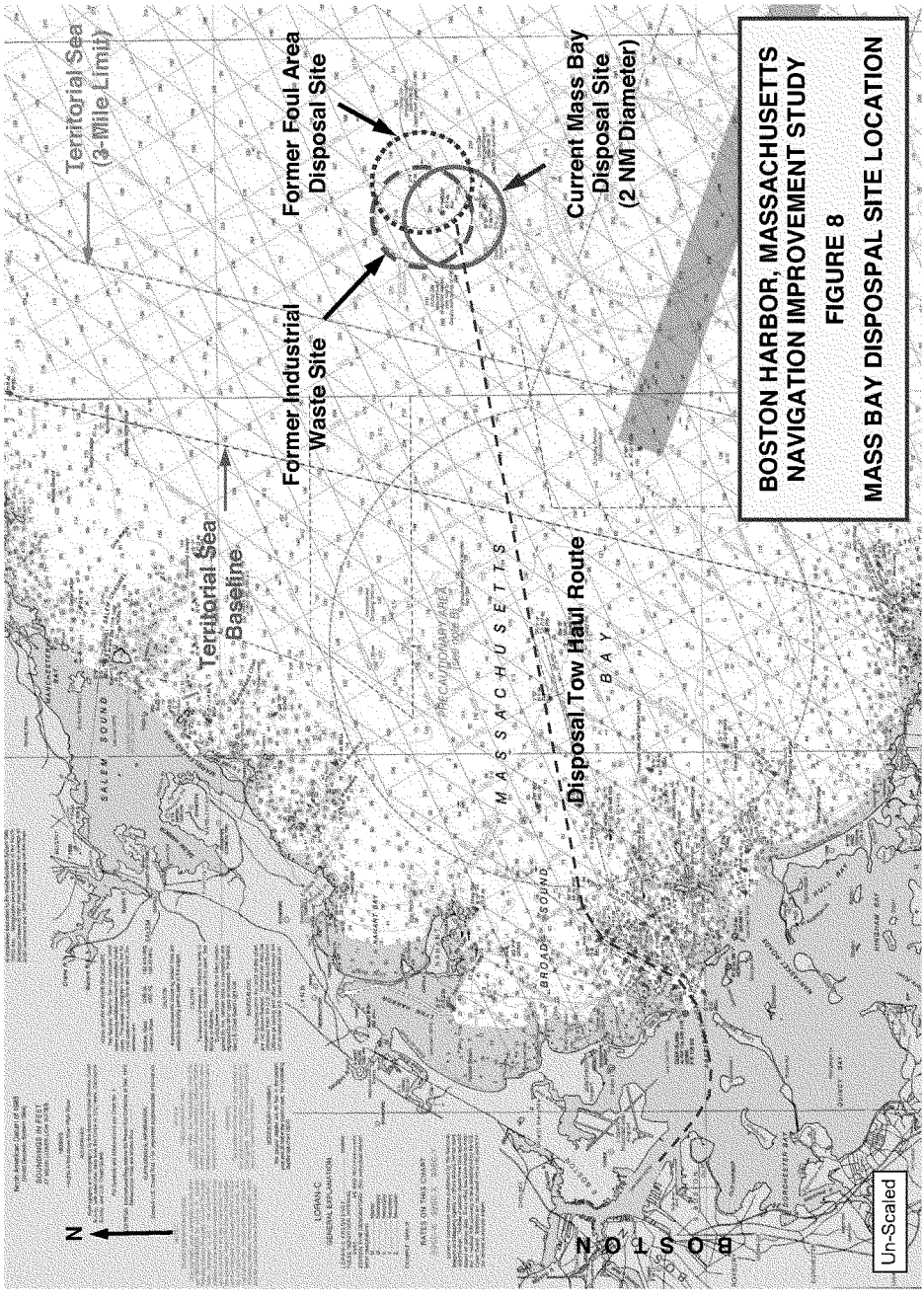
The Massachusetts Bay Disposal Site (MBDS – see Figure 8) has been the principal disposal site used for Boston Harbor dredged materials and for the other harbors of northeastern Massachusetts for the past half century. The MBDS is located in Stellwagen Basin off the western edge of Stellwagen Bank in 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.

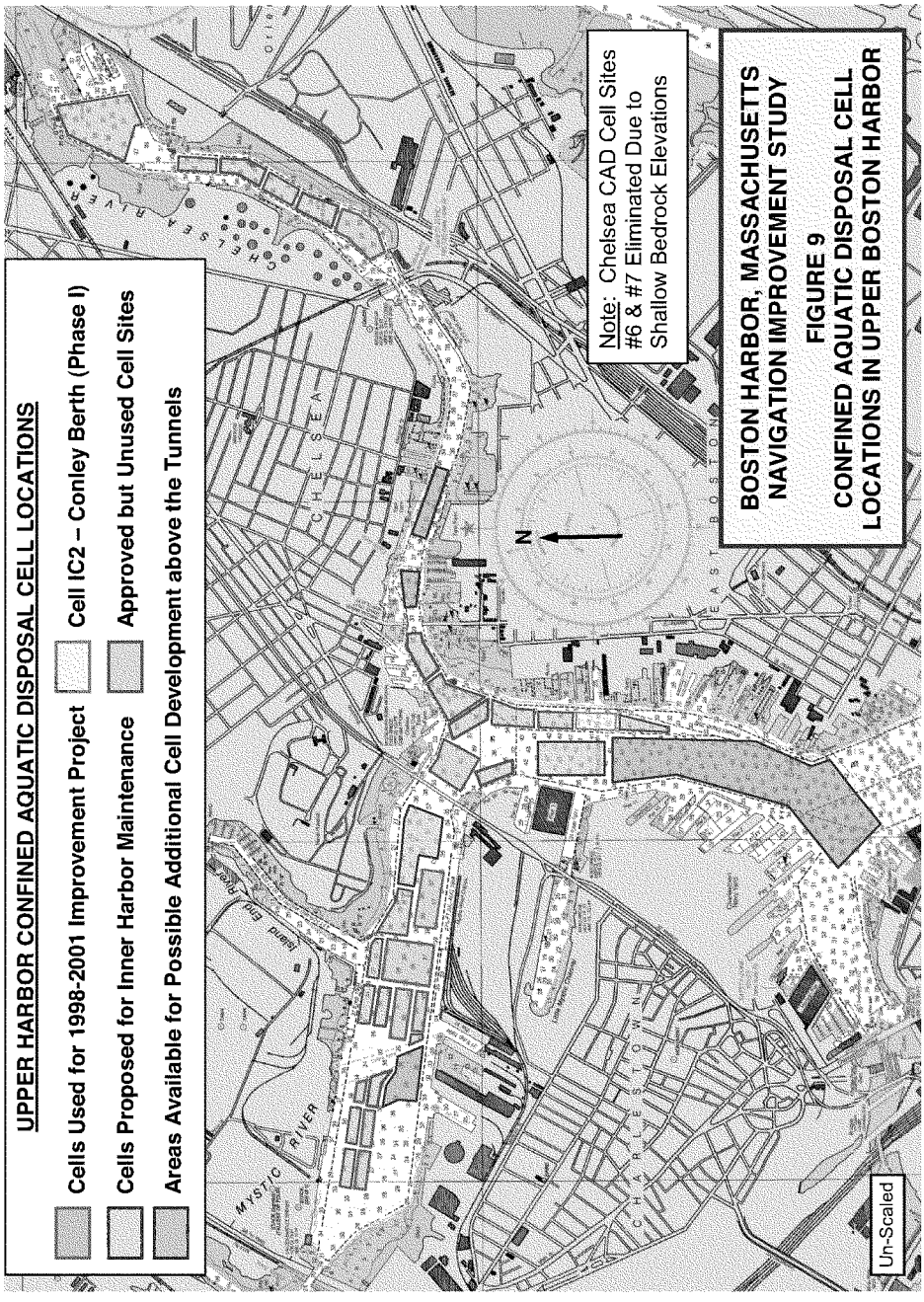
The Stellwagen Bank National Marine Sanctuary is located east of the Mass Bay Disposal Site and is administered by NOAA. The 639 square nautical mile Marine Sanctuary was designated in November 1992. Fishing, including bottom trawling, is allowed in the Sanctuary, while mineral extraction is prohibited.

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.


Territorial Sea
(3-Mile Limit)
Former Foul Area
Disposal Site
Current Mass Bay
Disposal Site
(2 NM Diameter)
Former Industrial
Waste Site
Territorial Sea
Baseline
Disposal Tow Haul Route
MASSACHUSETTS
BAY
BOSTON
N
Un-Scaled
BOSTON HARBOR, MASSACHUSETTS
NAVIGATION IMPROVEMENT STUDY
FIGURE 8
MASS BAY DISPOSAL 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
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
N
CHELSEA
EAST BOSTON
CHARLESTOWN
MYSTIC RIVER
CHELSEA RIVER

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.

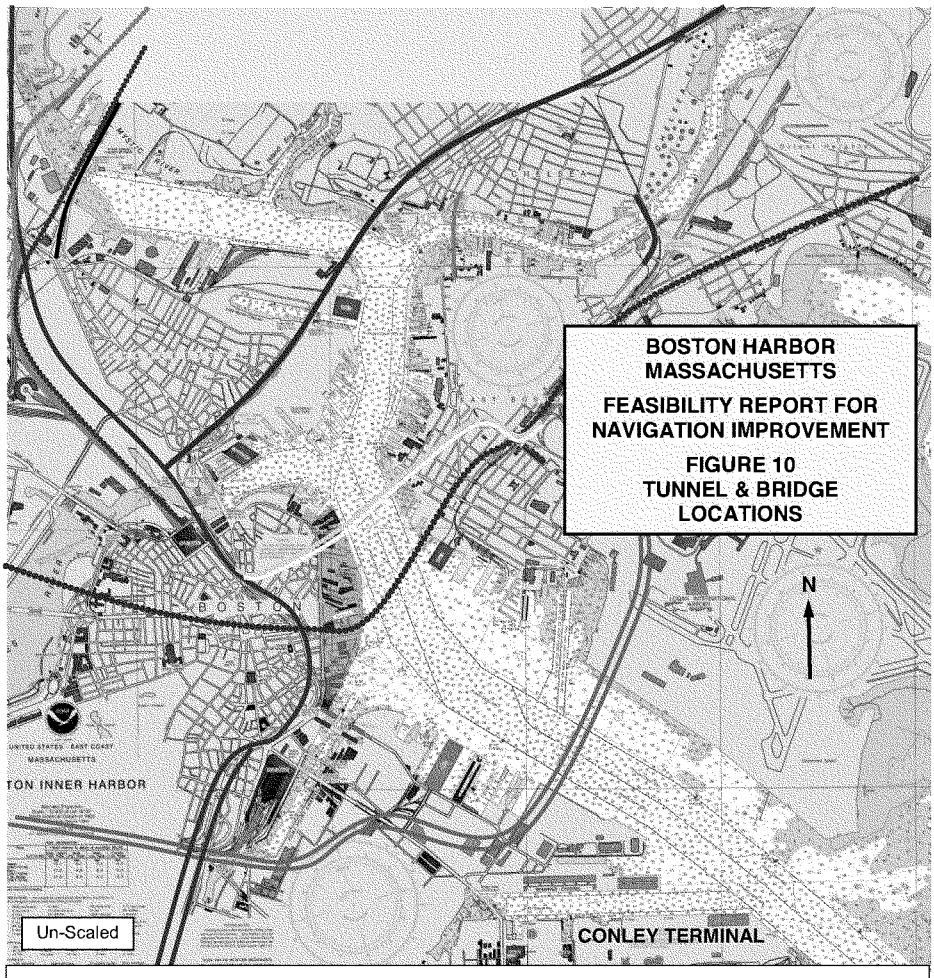
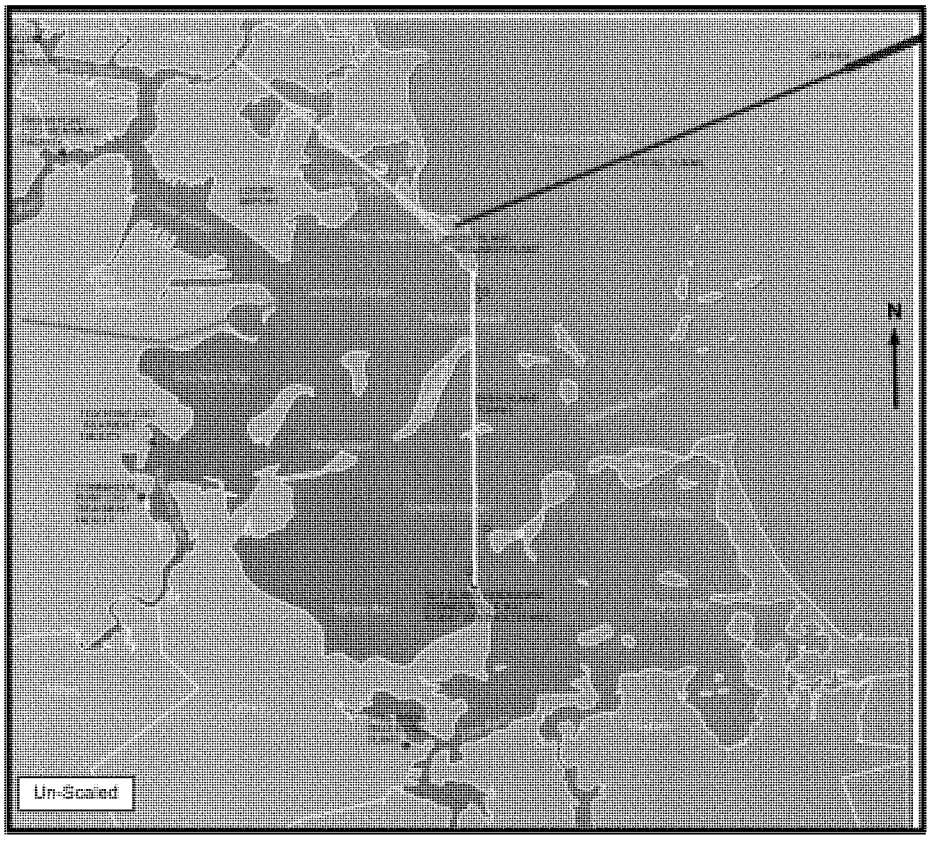

BOSTON HARBOR
MASSACHUSETTS
FEASIBILITY REPORT FOR
NAVIGATION IMPROVEMENT
FIGURE 10
TUNNEL & BRIDGE
LOCATIONS
N
Un-Scaled
CONLEY TERMINAL
BRIDGES & TUNNELS
I-90 Ted Williams Tunnel
I-93 Central Artery – Charles River Br.
Old & New Northern Avenue Bridges
MBTA Blue Line Subway Tunnel
MBTA Commuter Rail Line
A. P. McArdle Bridge
Callahan & Sumner Tunnels
Chelsea Street Bridge
Mystic Tobin Bridge & US 1
State Route 90 Malden Br
MBTA Orange Line

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

Outfall Tunnel from Deer Island to Massachusetts Bay

Main Drainage Tunnel from South Boston to Deer Island (1959)

Chelsea Drainage Tunnel from Chelsea to Deer Island

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.

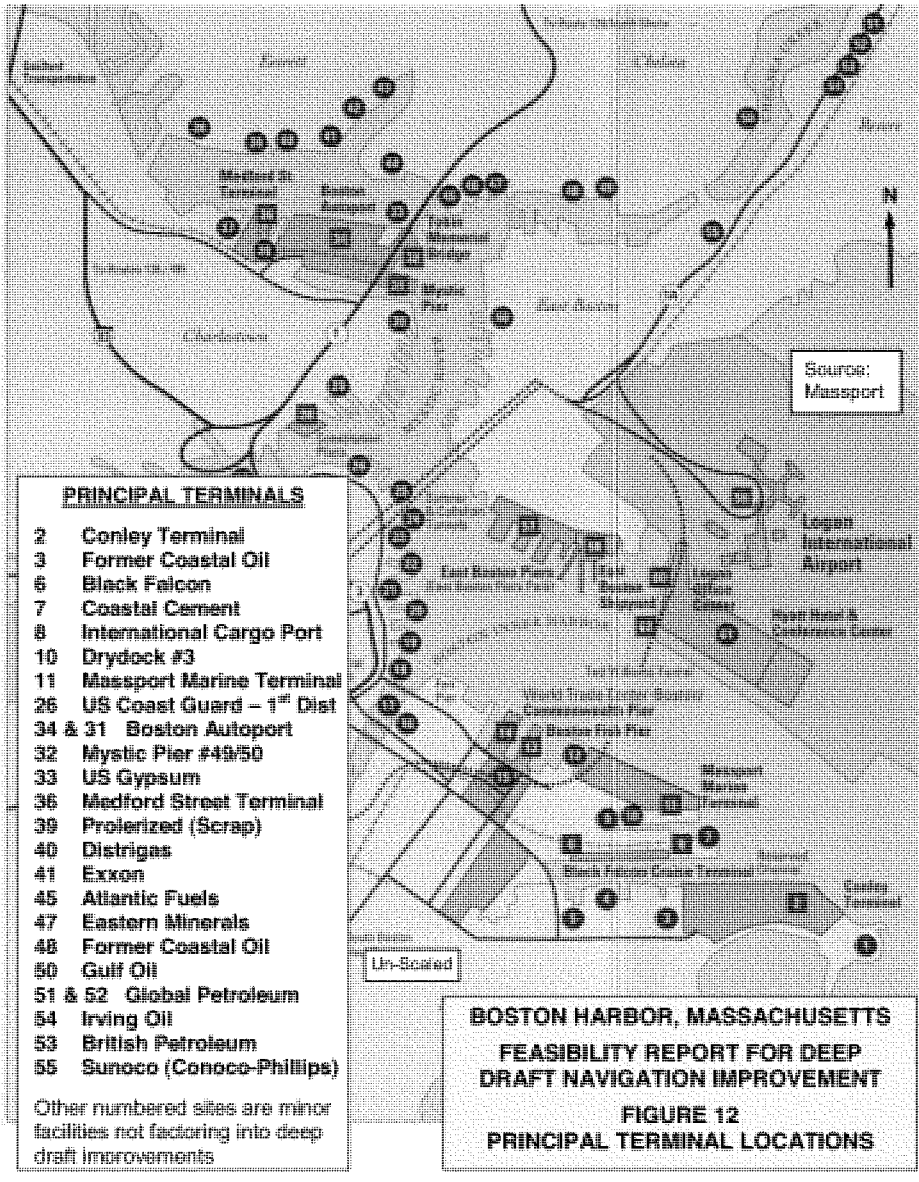

PRINCIPAL TERMINALS
2 Conley Terminal
3 Former Coastal Oil
6 Black Falcon
7 Coastal Cement
8 International Cargo Port
10 Drydock #3
11 Massport Marine Terminal
26 US Coast Guard – 1st Dist
34 & 31 Boston Autoport
32 Mystic Pier #49/50
33 US Gypsum
36 Medford Street Terminal
39 Prolerized (Scrap)
40 Distrigas
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
Source: Massport
N
Un-Scaled
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).

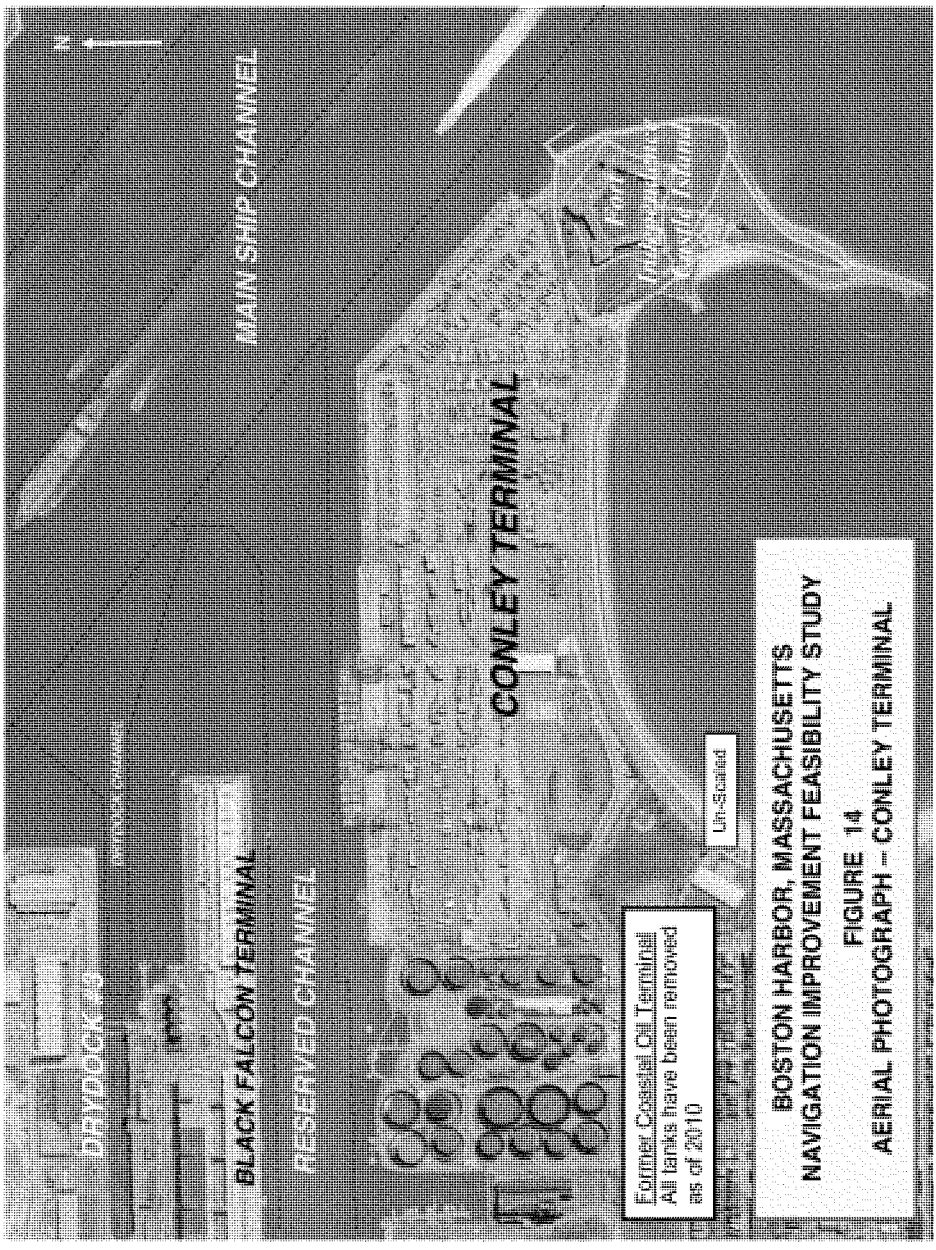

MAIN SHIP CHANNEL
BLACK FALCON TERMINAL
RESERVED CHANNEL
CONLEY TERMINAL
Former Coastal Oil Terminal
All tanks have been removed
as of 2010
Un-Scaled
N
BOSTON HARBOR, MASSACHUSETTS
NAVIGATION IMPROVEMENT FEASIBILITY STUDY
FIGURE 14
AERIAL PHOTOGRAPH – CONLEY TERMINAL

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.

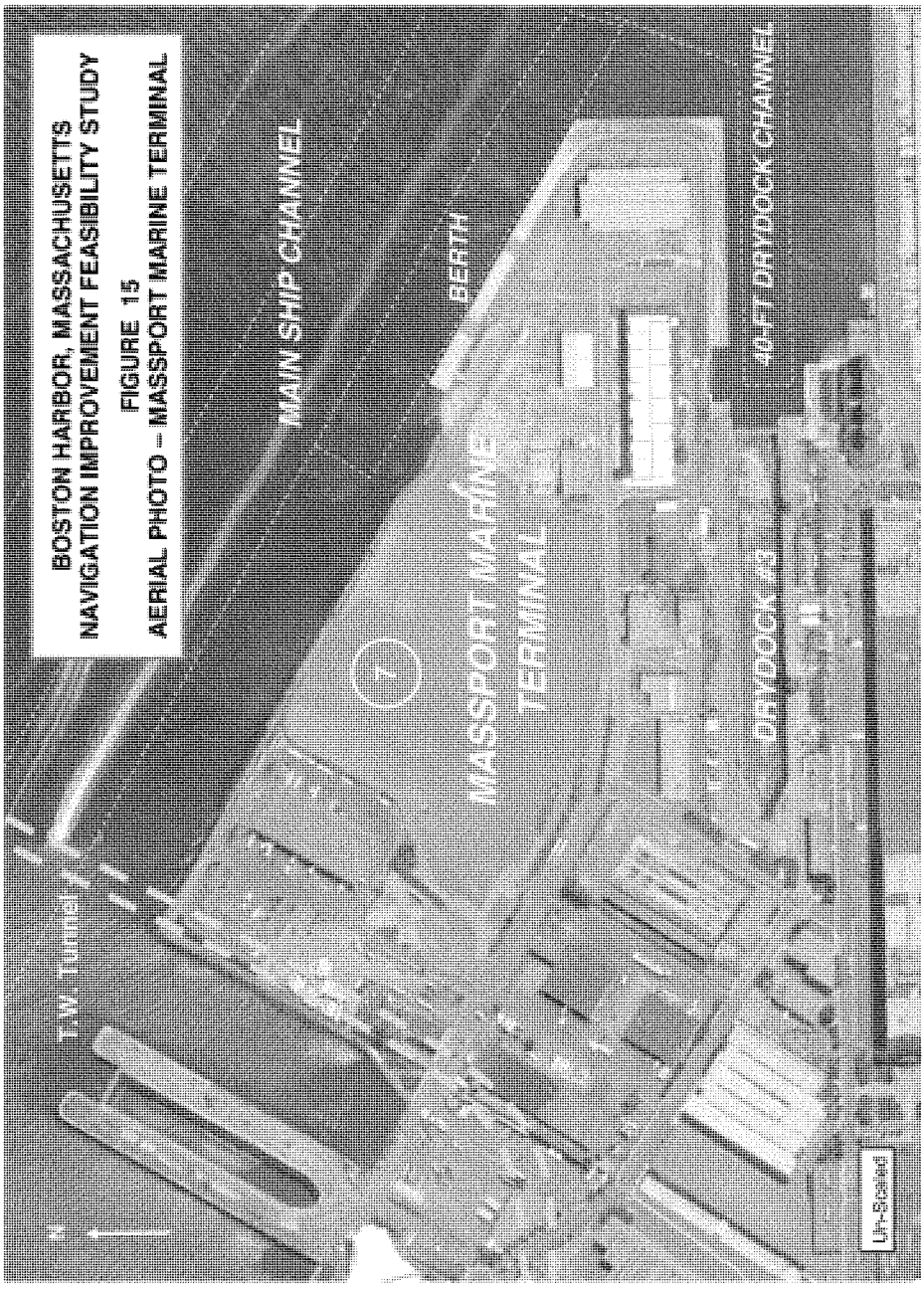
Between May and November 2011 Hanjin, in alliance with COSCO and others, operated a weekly service from southern Asia via the Suez Canal to the US East Coast, with Boston as its first port of call. That service included the ports of Boston, New York, Norfolk, Kaohsiung, Hong Kong, Yantian, Vuna Tao, 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
MAIN SHIP CHANNEL
MASSPORT MARINE TERMINAL
BERTH
DRYDOCK #4
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.

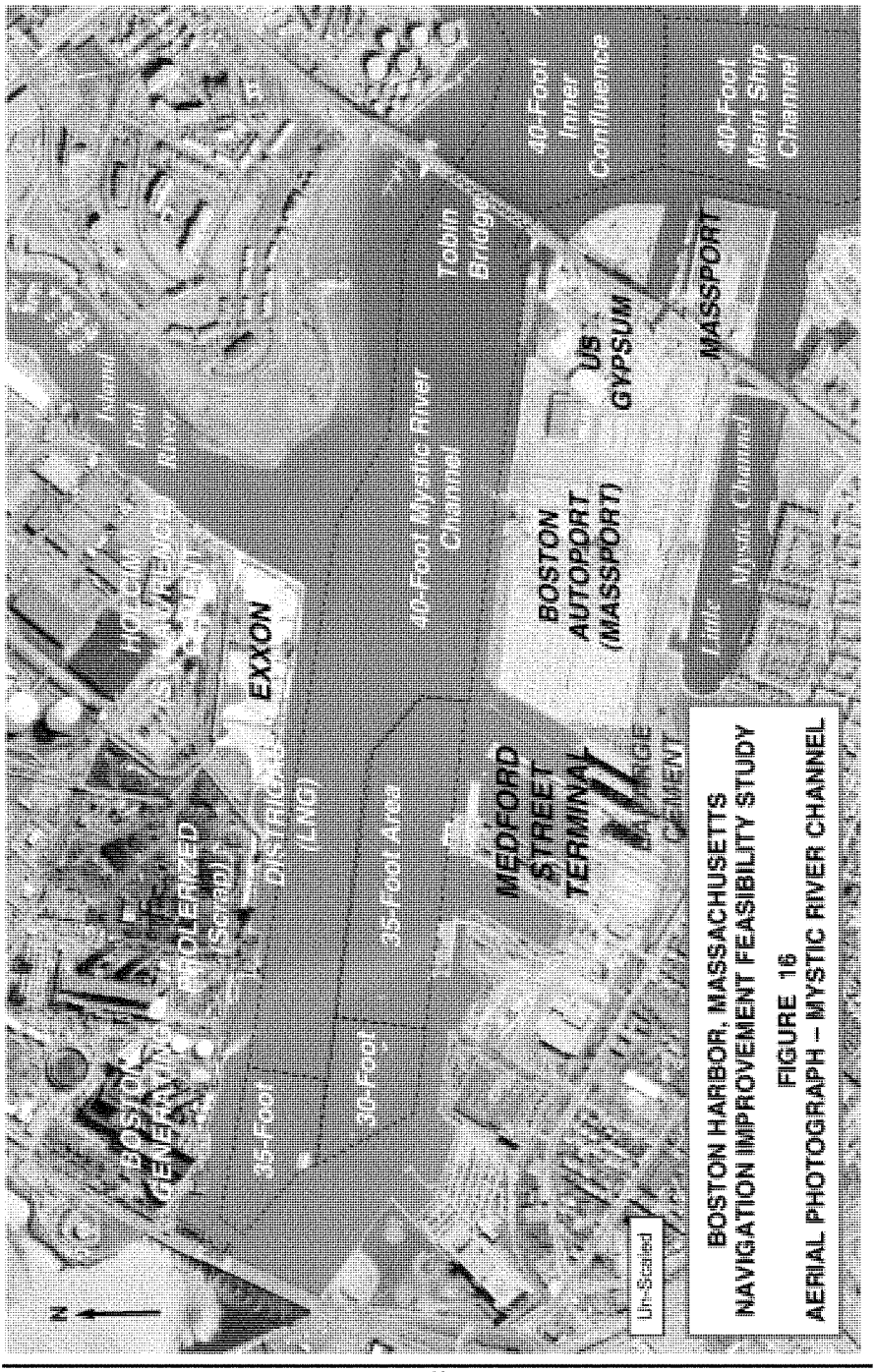
Massport redeveloped the former Moran container terminal as an auto receiving facility in the 1990s. The 65-acre Boston Autoport terminal is accessed by the 40-foot Mystic River Channel. The terminal has on-dock rail and has the capacity to import and process up to 100,000 cars a year. The existing 40-foot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

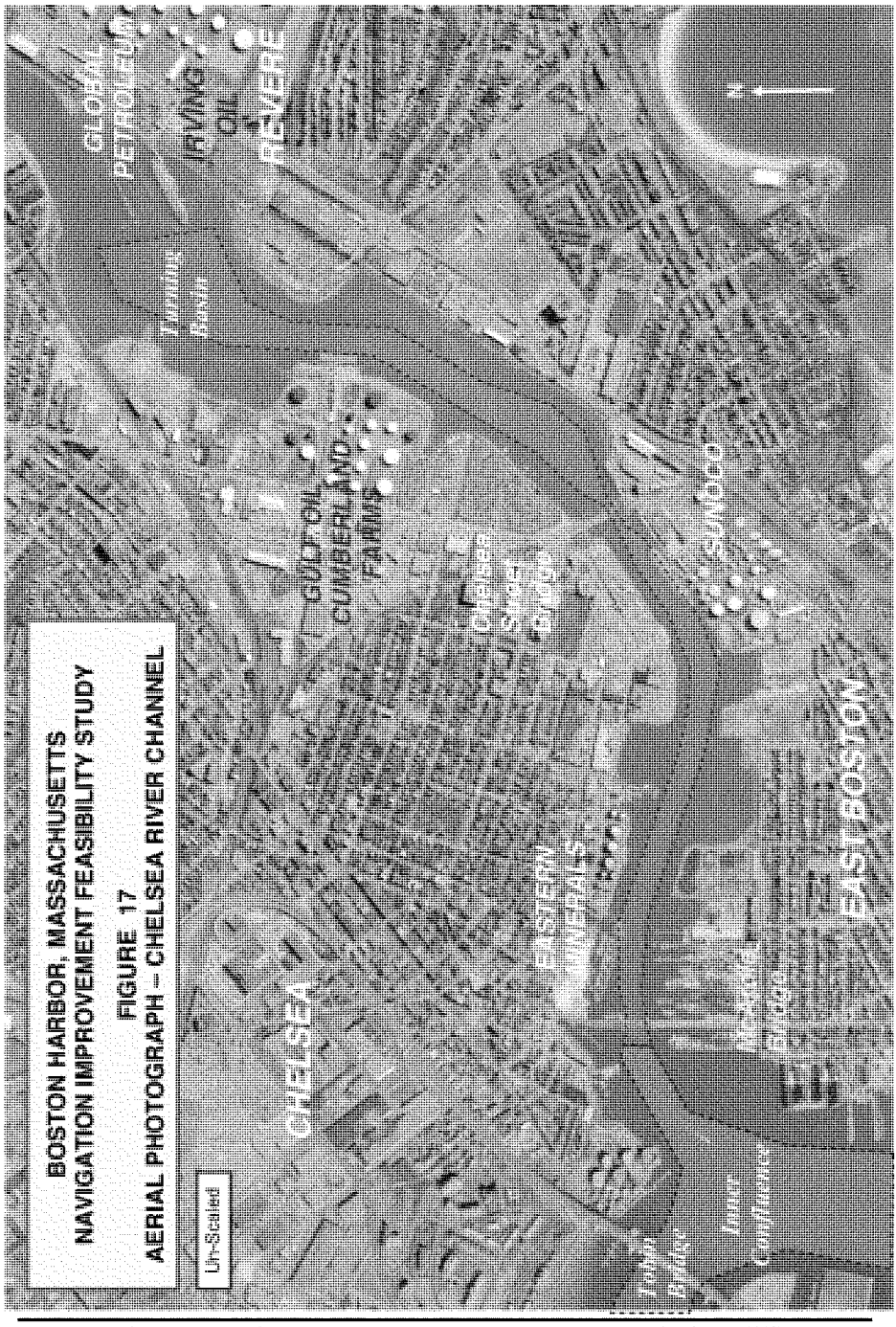
Immediately upstream of the Moran Terminal is the former Revere Sugar Terminal, now Massport's Medford Street Terminal. Massport purchased this 14-acre property in 1986 to preserve it for future maritime use and has redeveloped the facility for bulk cargo operations. Massport deepened the berths at this 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.


N
EXXON
MEDFORD STREET TERMINAL
BOSTON AUTOPORT (MASSPORT)
US GYPSUM
MASSPORT
Un-Seated
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
Un-Scaled
GLOBAL PETROLEUM
IRVING OIL
REVERE
Turning Basin
GULF OIL CUMBERLAND FARMS
Chelsea Street Bridge
SUNOCO
EASTERN MINERALS
CHELSEA
EAST BOSTON
McArdle Bridge
Tobin Bridge
Inner Confluence
N

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

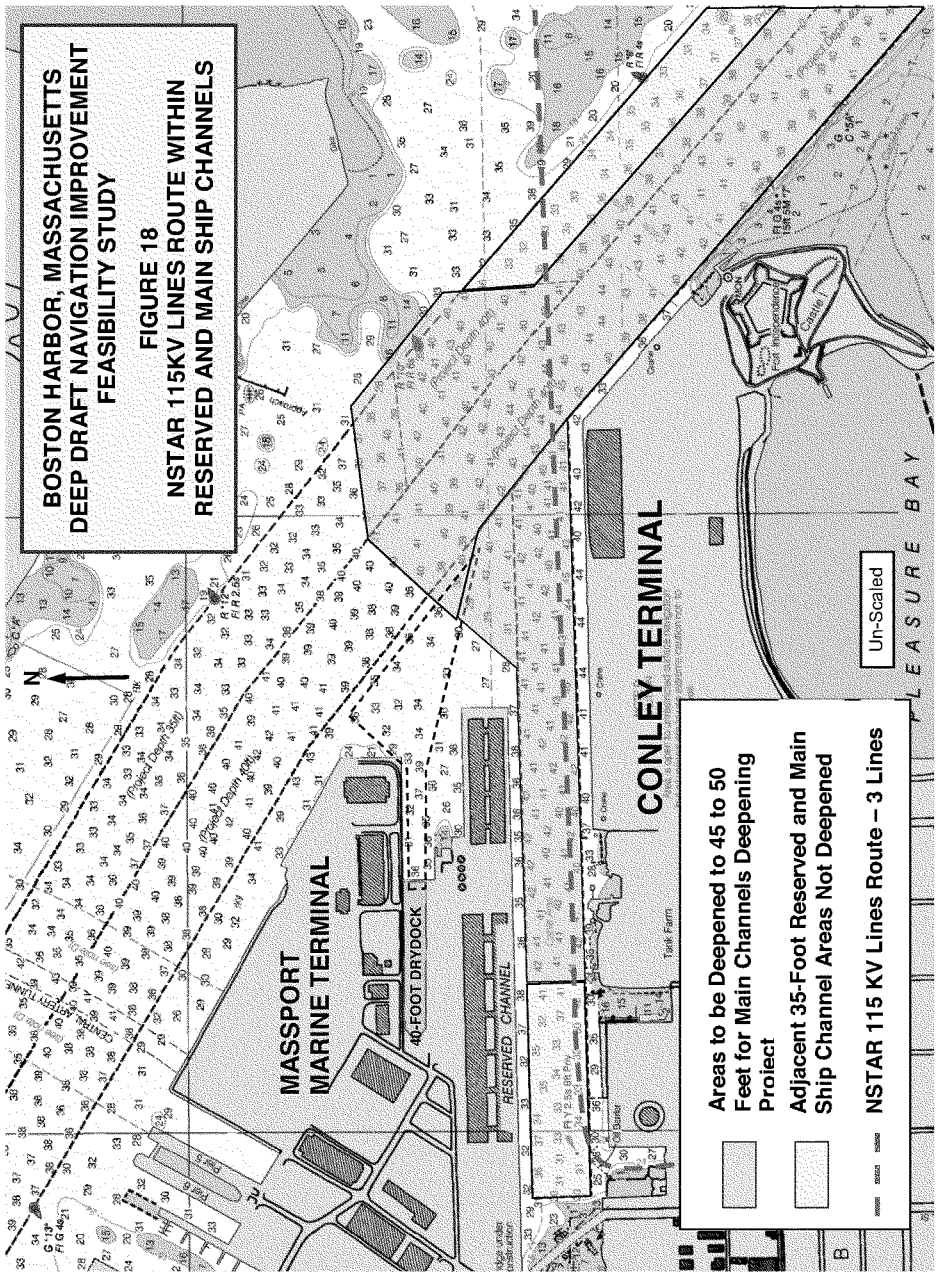
There are a number of utilities crossing the harbor, particularly in its upper reaches. Within the areas proposed for deepening under this improvement project utilities are located beneath the Reserved Channel and the Chelsea River.

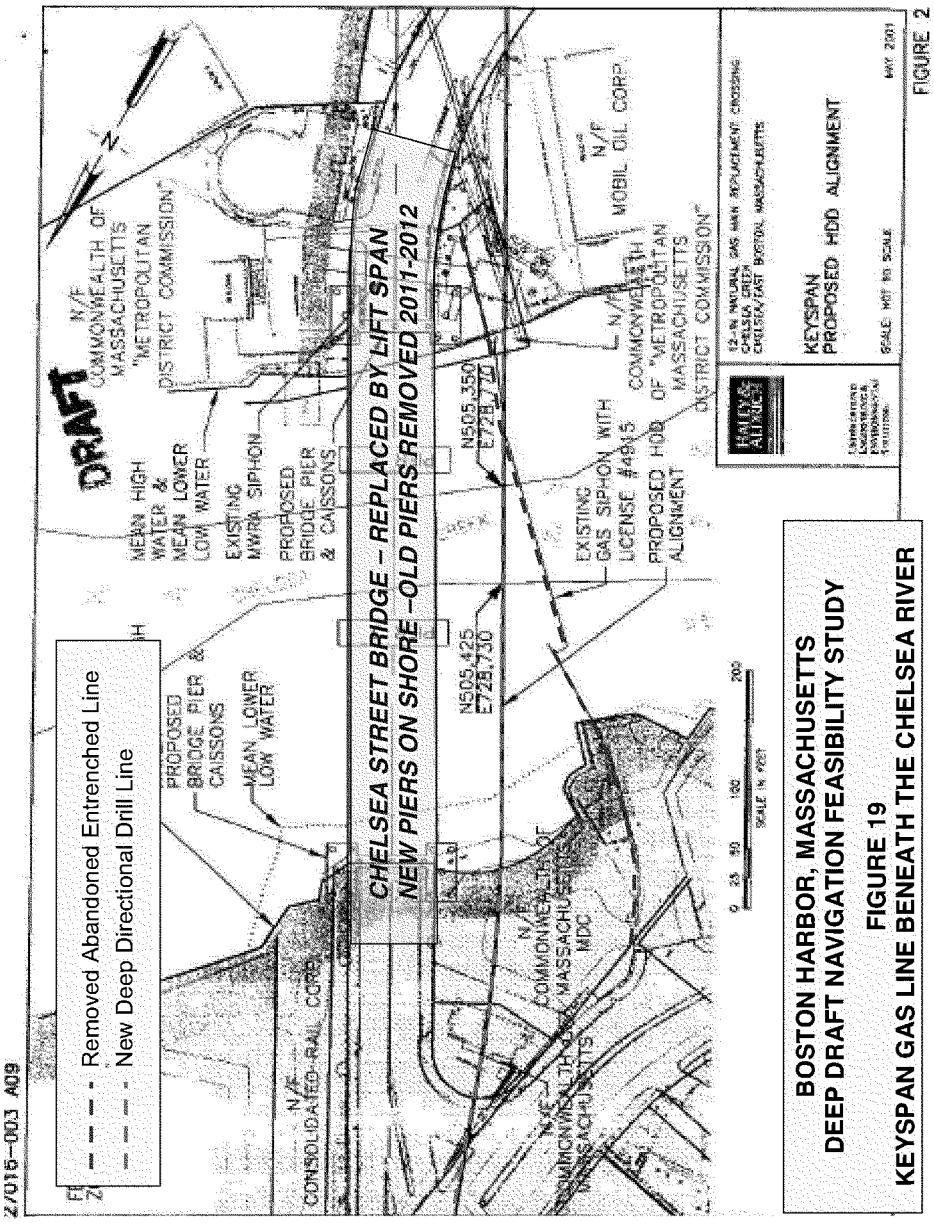
The MWRA's main power supply line to its Deer Island Treatment Plant runs from the South Boston generating plant on the Reserved Channel, beneath the Reserved Channel and Main Ship Channel, and across the flats southeast of Logan Airport, to Deer Island. These 115KV hydraulically cooled power lines were 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
MASSPORT
MARINE TERMINAL
40-FOOT DRYDOCK
RESERVED CHANNEL
CONLEY TERMINAL
Tank Farm
Un-Scaled
PLEASURE BAY
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


DRAFT
CHELSEA STREET BRIDGE – REPLACED BY LIFT SPAN
NEW PIERS ON SHORE –OLD PIERS REMOVED 2011-2012
Removed Abandoned Entrenched Line
New Deep Directional Drill Line
N/F COMMONWEALTH OF MASSACHUSETTS "METROPOLITAN DISTRICT COMMISSION"
MEAN HIGH WATER & MEAN LOWER LOW WATER
EXISTING MWRA SIPHON
PROPOSED BRIDGE PIER & CAISSONS
N505,350 E728,730
N505,425 E728,730
EXISTING GAS SIPHON WITH LICENSE #4945
PROPOSED HDD ALIGNMENT
N/F COMMONWEALTH OF MASSACHUSETTS DISTRICT COMMISSION
N/F MOBIL OIL CORP
N/F CONSOLIDATED RAIL CORP
N/F COMMONWEALTH OF MASSACHUSETTS MDC
SCALE IN FEET
0 25 50 100 200
12-IN NATURAL GAS MAIN REPLACEMENT CROSSING CHELSEA CREEK CHELSEA/EAST BOSTON, MASSACHUSETTS
KEYSPAN PROPOSED HDD ALIGNMENT
SCALE NOT TO SCALE
MAY 2001
BOSTON HARBOR, MASSACHUSETTS
DEEP DRAFT NAVIGATION FEASIBILITY STUDY
FIGURE 19
KEYSPAN GAS LINE BENEATH THE CHELSEA RIVER
FIGURE 2

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.

Tankship Operations: 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.

Bulk Carrier Operations: 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).

Tidal Advantage: 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.

Light-Loading: 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.

Lightering: 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.

Air Draft: 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.

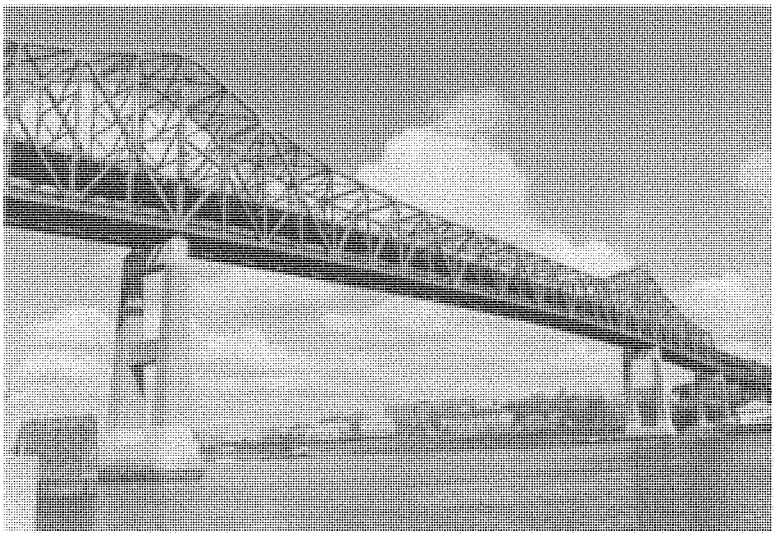


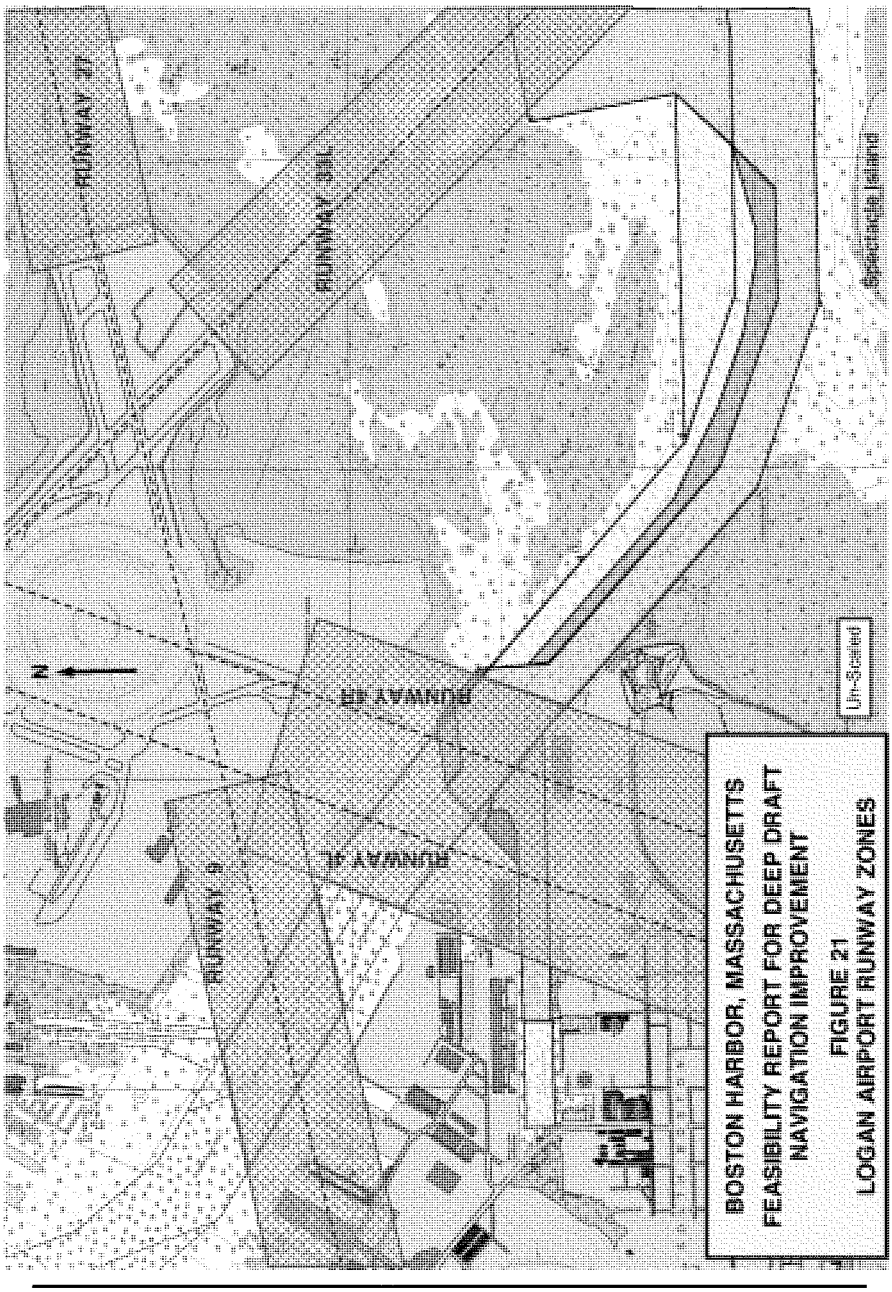
Figure 20 - Mystic-Tobin Bridge – Northwest through Navigation Opening

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

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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

	Current	Proposed		Containers in TEUs								
Harbor	Depth	Depth	Year	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	21,046,096	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	14,730,000
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

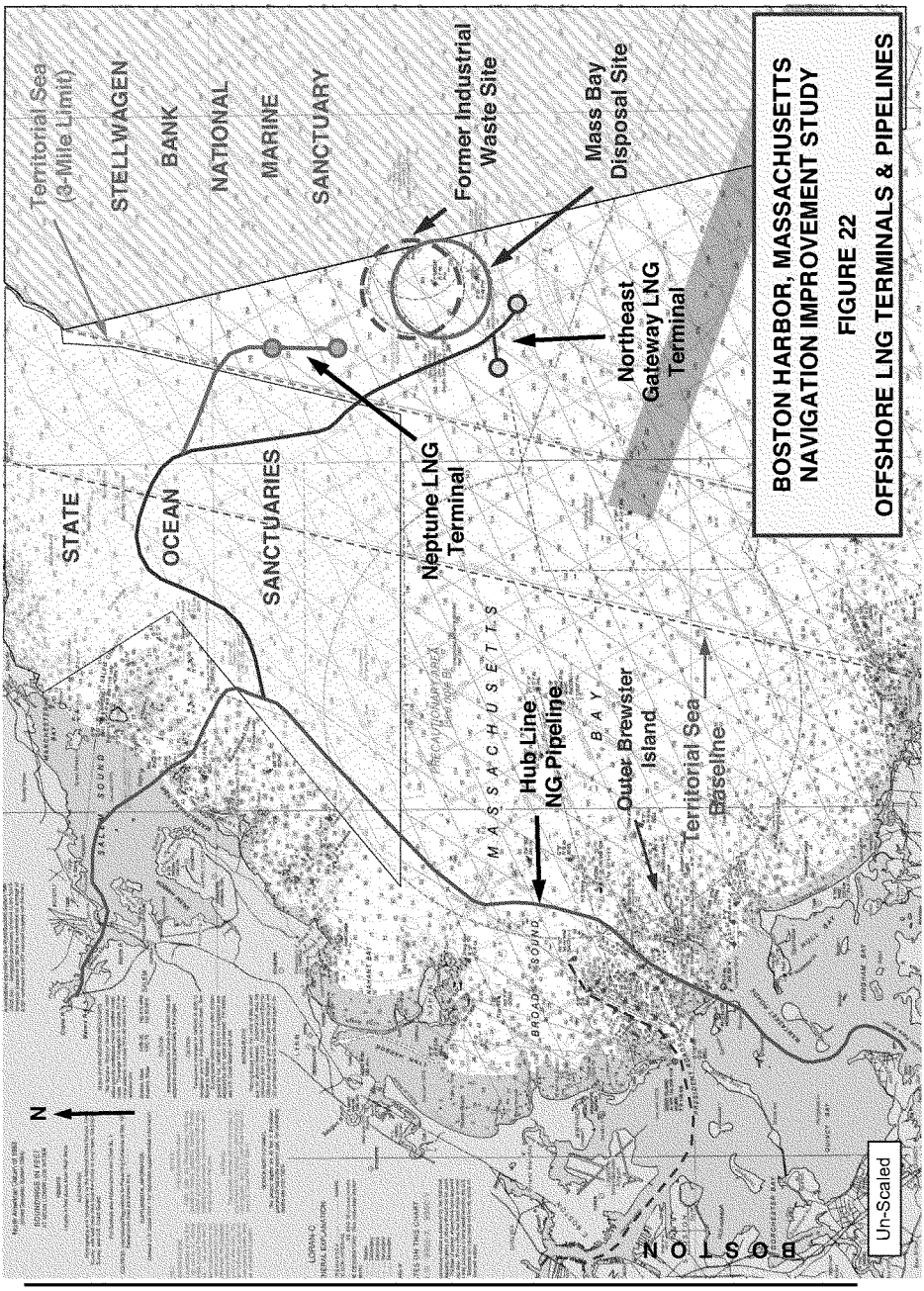
As described briefly earlier, Massport port development plans consist of five actions. These actions will all proceed under the without project condition.

- 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
Territorial Sea (3-Mile Limit)
STELLWAGEN BANK NATIONAL MARINE SANCTUARY
STATE OCEAN SANCTUARIES
Former Industrial Waste Site
Mass Bay Disposal Site
Neptune LNG Terminal
Northeast Gateway LNG Terminal
Hub Line NG Pipeline
Outer Brewster Island
Territorial Sea Baseline
MASSACHUSETTS BAY
BROAD SOUND
BOSTON
N
Un-Scaled

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

Container Shipping: 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.

Dry Bulk Cargo: 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.

Liquid Petroleum Cargo: 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

Reduced Underkeel Clearance Requirements: 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

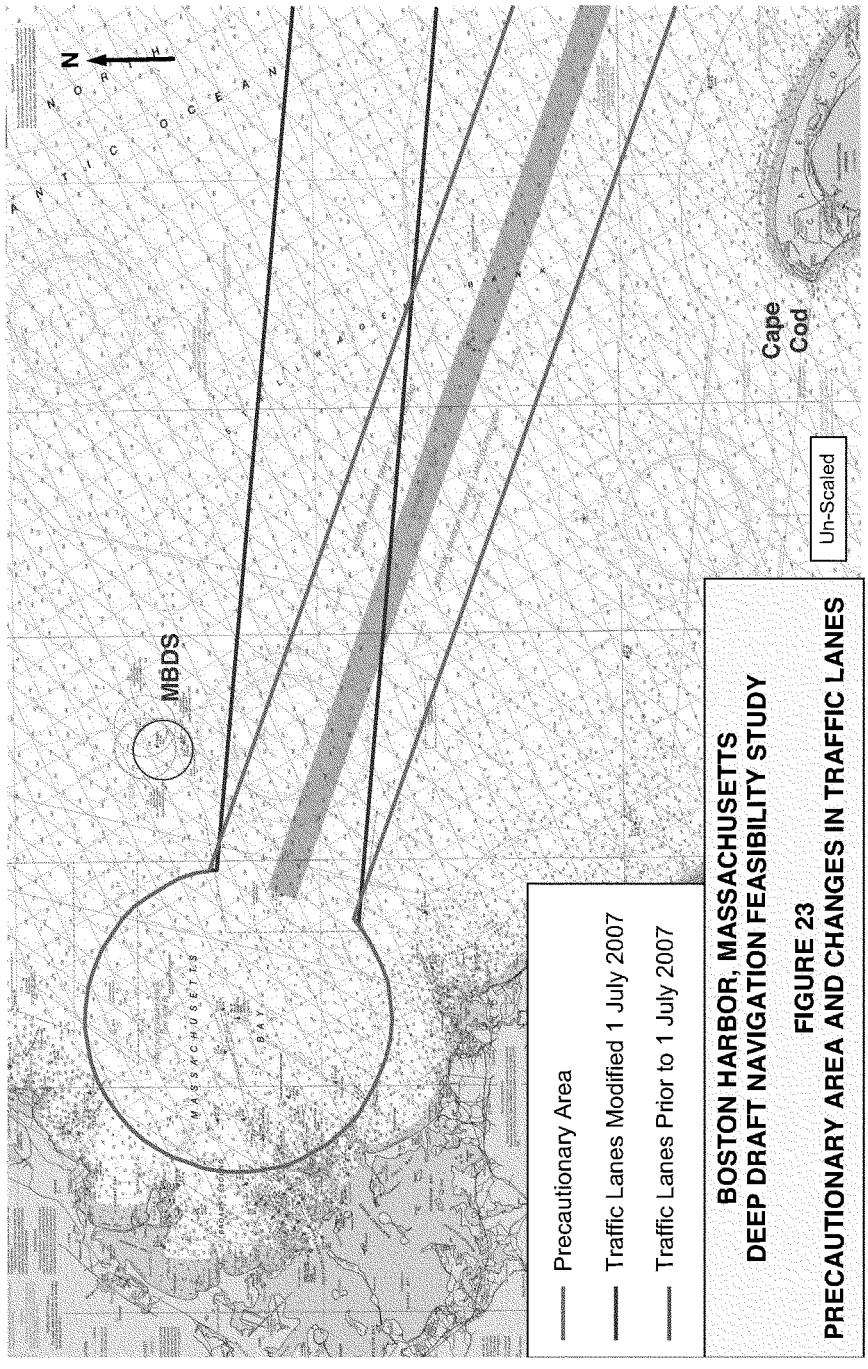
narrow (600 foot) and turning Main Ship Channel, and in the turning basins. The pilots and US Coast Guard believe that existing practices make maximum safe use of the available depth given the tides and current conditions, and that any reduction in the current underkeel clearance practices for large 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.

Improved Traffic Management Practices: 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.


N
NORTH ATLANTIC OCEAN
MBDS
MASSACHUSETTS BAY
Cape Cod
Un-Scaled
Precautionary Area
Traffic Lanes Modified 1 July 2007
Traffic Lanes Prior to 1 July 2007
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.

Changes in System of Aids to Navigation: 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.

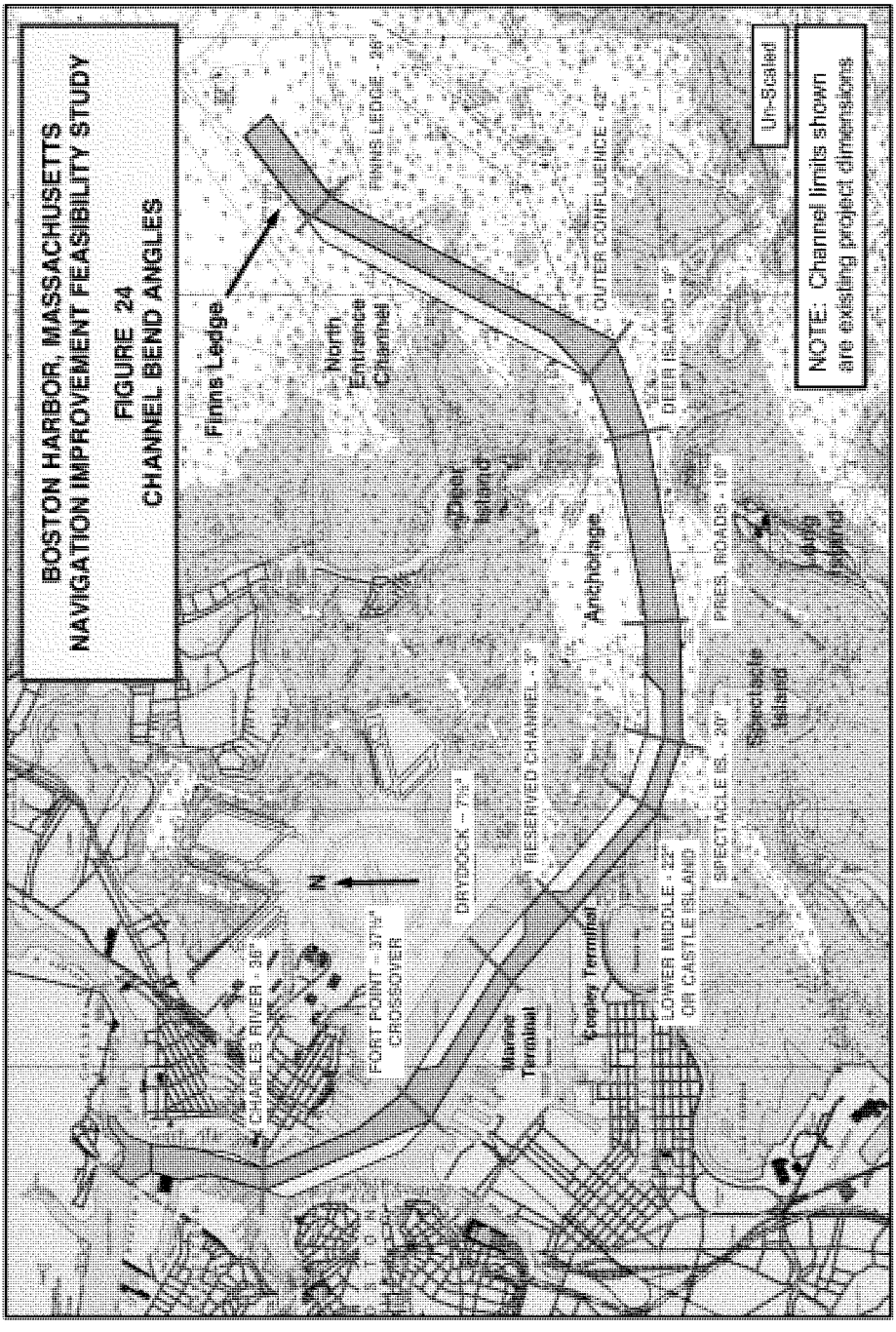
Offshore terminal development for liquid petroleum products is more problematic. The EIS studies for the gas terminals narrowed the areas available to offshore terminal placement to discrete areas inshore of Stellwagen Bank and seaward of ecologically sensitive and protected state waters, after considering 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	26°
Turn from Entrance through Outer Confluence	RB-10, GB-15 & FG/R PR	42°
Deer Island Bend	FG-17 & DI Lt.	9°
President Roads Bend	FG-1 & FR-2	10°
Spectacle Island Turn	FG-3 & FRB-4	20°
Lower Middle Ground Turn	FR-6	22°
Reserved Channel Bend	FR-10	3°
Drydock Bend	FR-12	7½°
Fort Point Crossover Turn	FG-13	37½°
Charles River Turn	Light R-14	36°


BOSTON HARBOR, MASSACHUSETTS
NAVIGATION IMPROVEMENT FEASIBILITY STUDY
FIGURE 24
CHANNEL BEND ANGLES
Finns Ledge
North Entrance Channel
FINNS LEDGE - 36°
OUTER CONFLUENCE - 42°
DEER ISLAND - 8°
Deer Island
Anchorage
RESERVED CHANNEL - 3°
DRYDOCK - 75°
CHARLES RIVER - 36°
FORT POINT - 37½°
CROSSOVER
N
Marine Terminal
Coppey Terminal
LOWER MIDDLE - 22°
CASTLE ISLAND
SPECTACLE IS. - 20°
FREES ROADS - 18°
Spectacle Island
Lovells Island
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 Mystie 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	

Offshore Petroleum Terminal Development: 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.

Regional Pipeline: 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 28 - TYPICAL NAVIGATION TRANSIT USING TIDAL ASSIST		
Channel Transit Depth Minimums Under Calm Conditions		
Existing Loaded Max Draft - Inbound - 4300 TEU Ship	Feet	42.0
Underkeel Clearance - Minimum		4.0
Water Needed - Inner Channels		46.0
Water Needed - In Entrance Channel (+2 Feet Minimum)		48.0
Channel Transit Times		
Entrance Channel Transit Time	Time (Hours)	0.24
Main Channel Transit Time		0.43
Turning Vessel in Basin		0.40
Tug Assist to Conley Berth		0.13
Secure and Begin Offloading (after 1.20 hour transit)		0.50
Total		1.70
Tidal Elevation Change Corrections		
Mean Tidal Range	Feet	9.5
Controlling Depth of Channel		40.0
Total Depth		49.5
Rate of Rise/Fall (Feet per Hour)		1.6
Entrance Channel Transit		
Channel Depth Needed – Entrance	Feet	48.0
Transit Time X Rate of Change/Hour (0.24 X 1.6)		0.4
Depth in Entrance 1 Hour Either Side of HW		47.9
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		
Inner Channels Transit		
Water Depth Needed - Inner Channels	Feet	46.0
Depth at 1 Hour After High Water (40.0 + 9.5 – 1.6)		47.9
Fall During Transit to Conley Terminal ((1.20 - 0.24) X 1.6)		1.5
Depth before Offloading		46.4
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.		

- 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.

Entrance Channel Alternatives: 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.

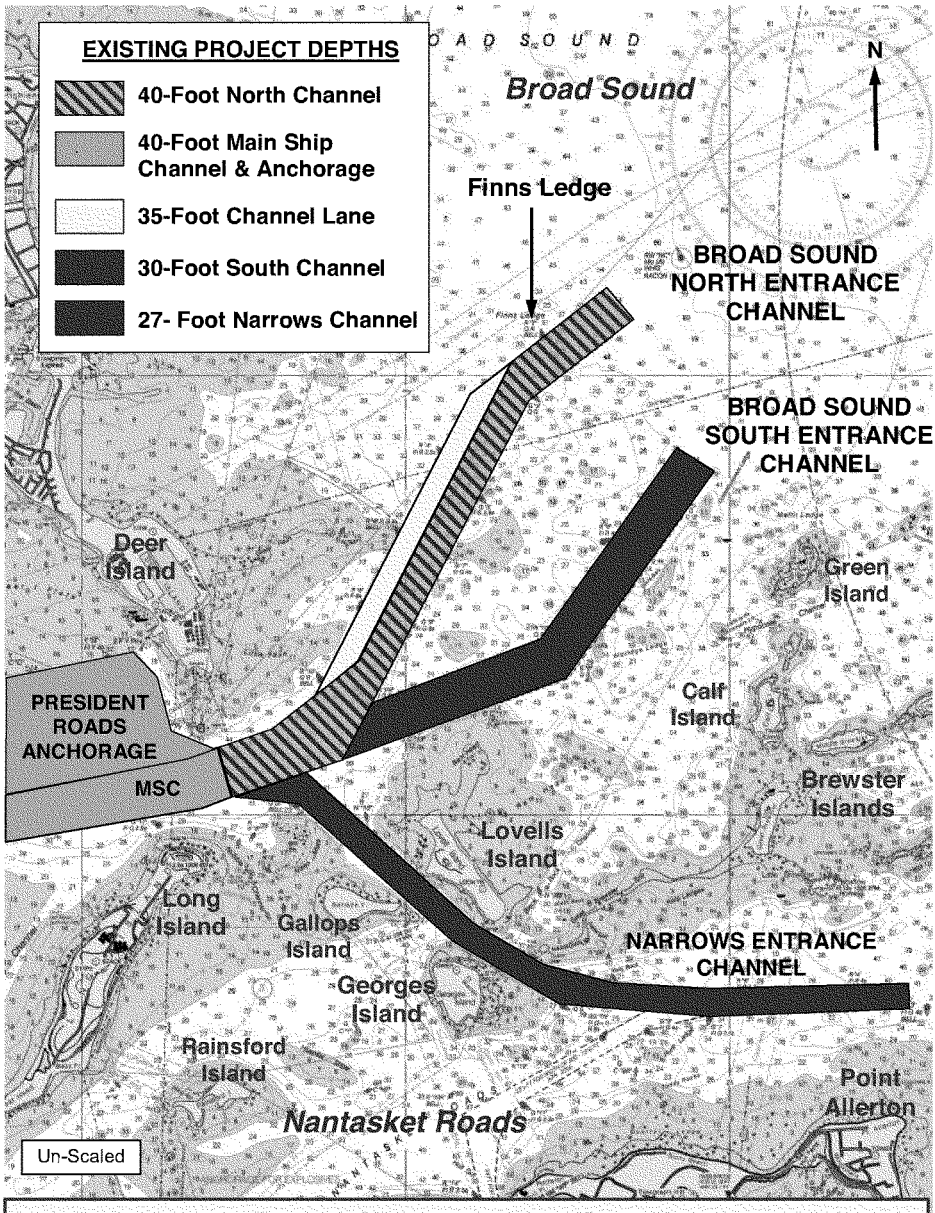


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FIGURE 25 – EXISTING ENTRANCE CHANNELS

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

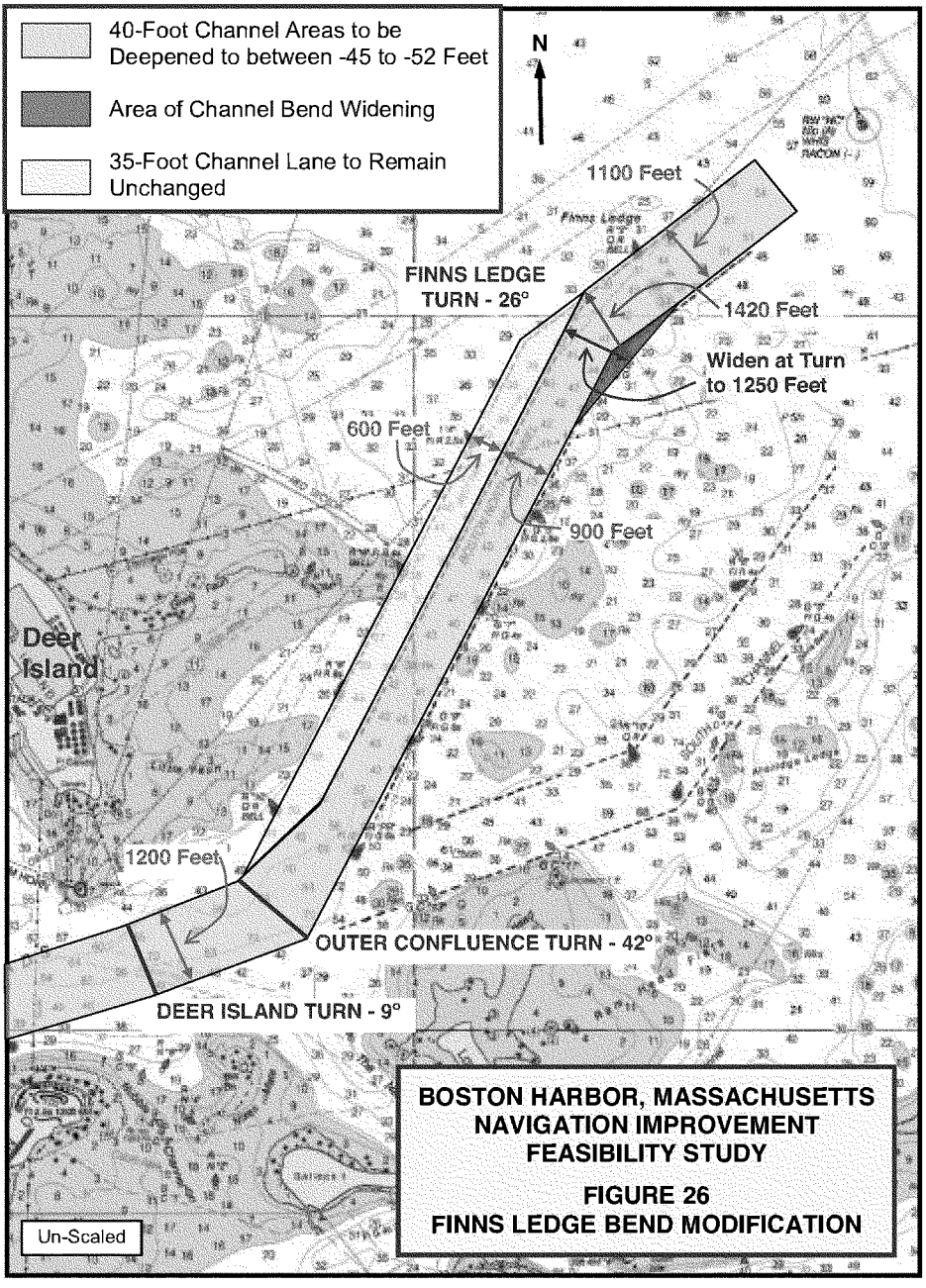
District's initial design, beyond calling for widening the lower Main Ship Channel to 800 feet between the Roads and the Reserved Channel, also included further widening in four areas: (1) the 26 degree bend at the entrance to the Broad Sound North Entrance Channel opposite Finns Ledge, (2) the transition 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.


40-Foot Channel Areas to be Deepened to between -45 to -52 Feet
Area of Channel Bend Widening
35-Foot Channel Lane to Remain Unchanged
N
1100 Feet
FINNS LEDGE TURN - 26°
1420 Feet
Widen at Turn to 1250 Feet
600 Feet
900 Feet
Deer Island
1200 Feet
OUTER CONFLUENCE TURN - 42°
DEER ISLAND TURN - 9°
Un-Scaled
BOSTON HARBOR, MASSACHUSETTS
NAVIGATION IMPROVEMENT
FEASIBILITY STUDY
FIGURE 26
FINNS LEDGE BEND MODIFICATION

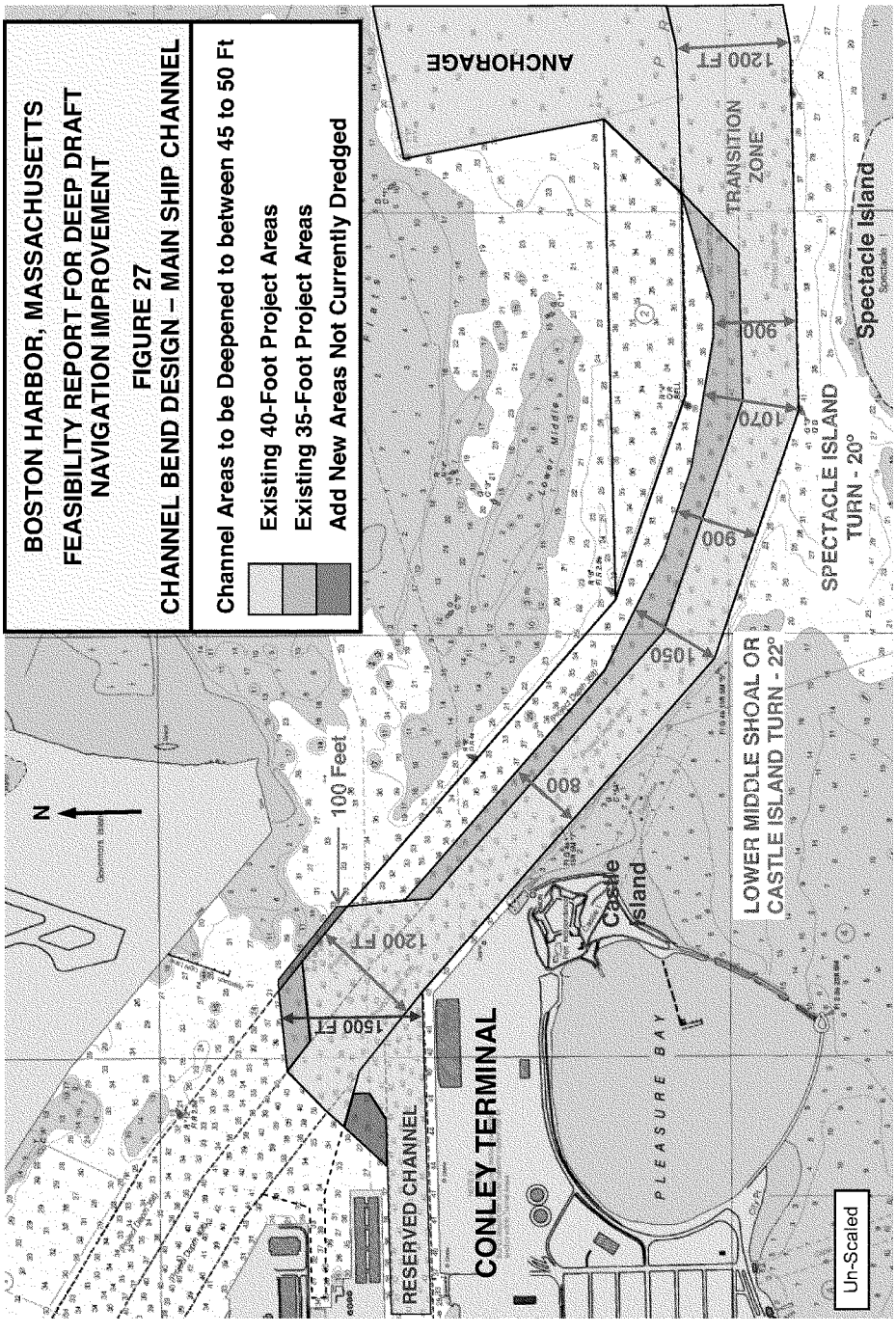
Widening the inside of the deepened bends further north into the existing 35-foot channel lane would permit the pilots to adjust their turn angle and keep a safe distance from the channel limits in both directions. Accordingly the modified design for these turns provides an apex cutoff of 1070 feet (as 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
100 Feet
1500 FT
1200 FT
RESERVED CHANNEL
CONLEY TERMINAL
800
1050
Castle Island
PLEASURE BAY
LOWER MIDDLE SHOAL OR
CASTLE ISLAND TURN - 22°
900
1070
900
SPECTACLE ISLAND
TURN - 20°
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.

NORTHWEST BASIN ALTERNATIVE
1500-FOOT DIAMETER
LOGAN AIRPORT
CONLEY TERMINAL
Un-Scaled
N
NORTHEAST BASIN ALTERNATIVE
1500-FOOT DIAMETER
LOGAN AIRPORT
CONLEY TERMINAL
Un-Scaled
N
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.

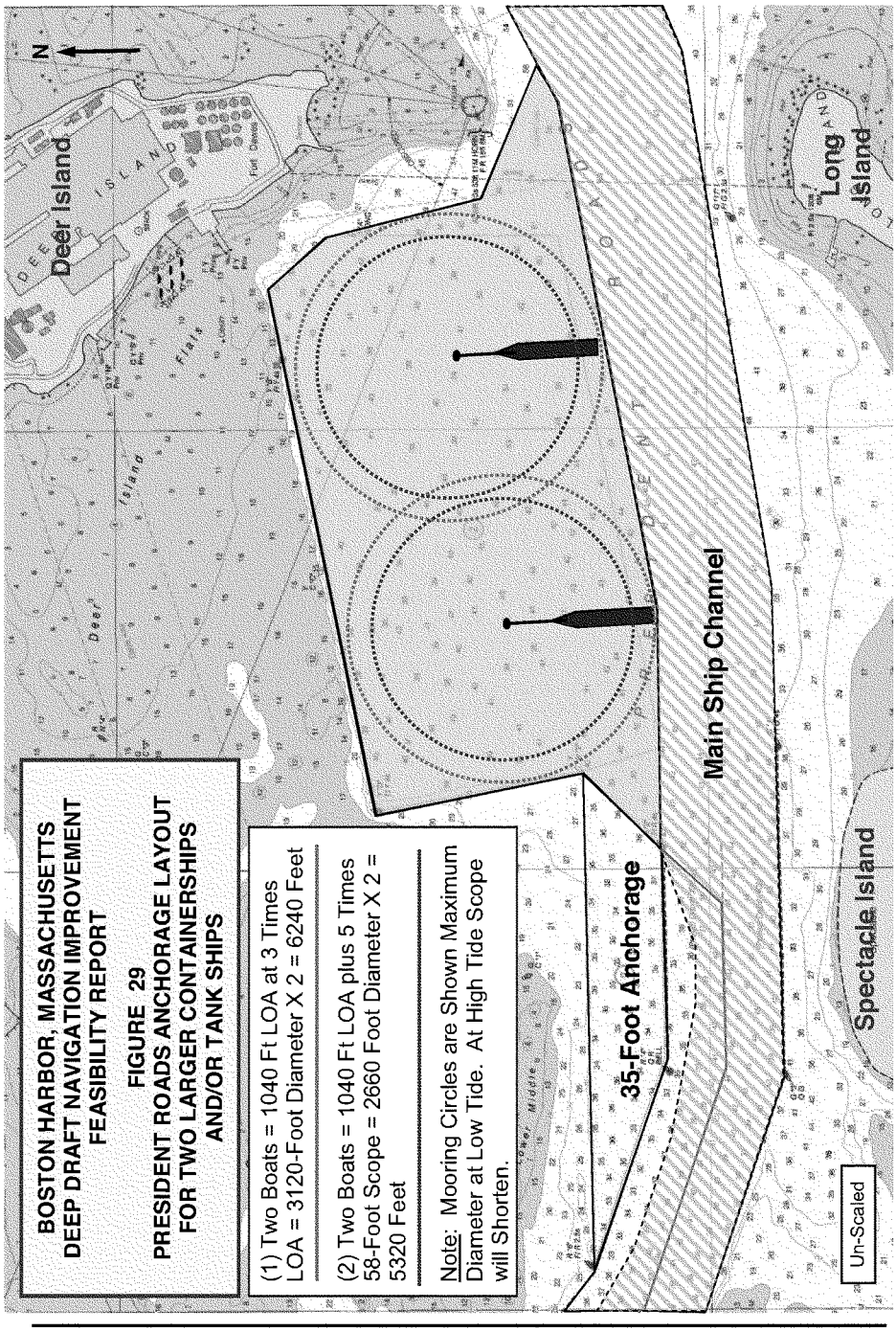

BOSTON HARBOR, MASSACHUSETTS
DEEP DRAFT NAVIGATION IMPROVEMENT
FEASIBILITY REPORT
FIGURE 29
PRESIDENT ROADS ANCHORAGE LAYOUT
FOR TWO LARGER CONTAINERSHIPS
AND/OR TANK SHIPS
(1) Two Boats = 1040 Ft LOA at 3 Times LOA = 3120-Foot Diameter X 2 = 6240 Feet
(2) Two Boats = 1040 Ft LOA plus 5 Times 58-Foot Scope = 2660 Foot Diameter X 2 = 5320 Feet
Note: Mooring Circles are Shown Maximum Diameter at Low Tide. At High Tide Scope will Shorten.
N
Deer Island
Long Island
Spectacle Island
35-Foot Anchorage
Main Ship Channel
PRESIDENT ROADS
Un-Scaled

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.

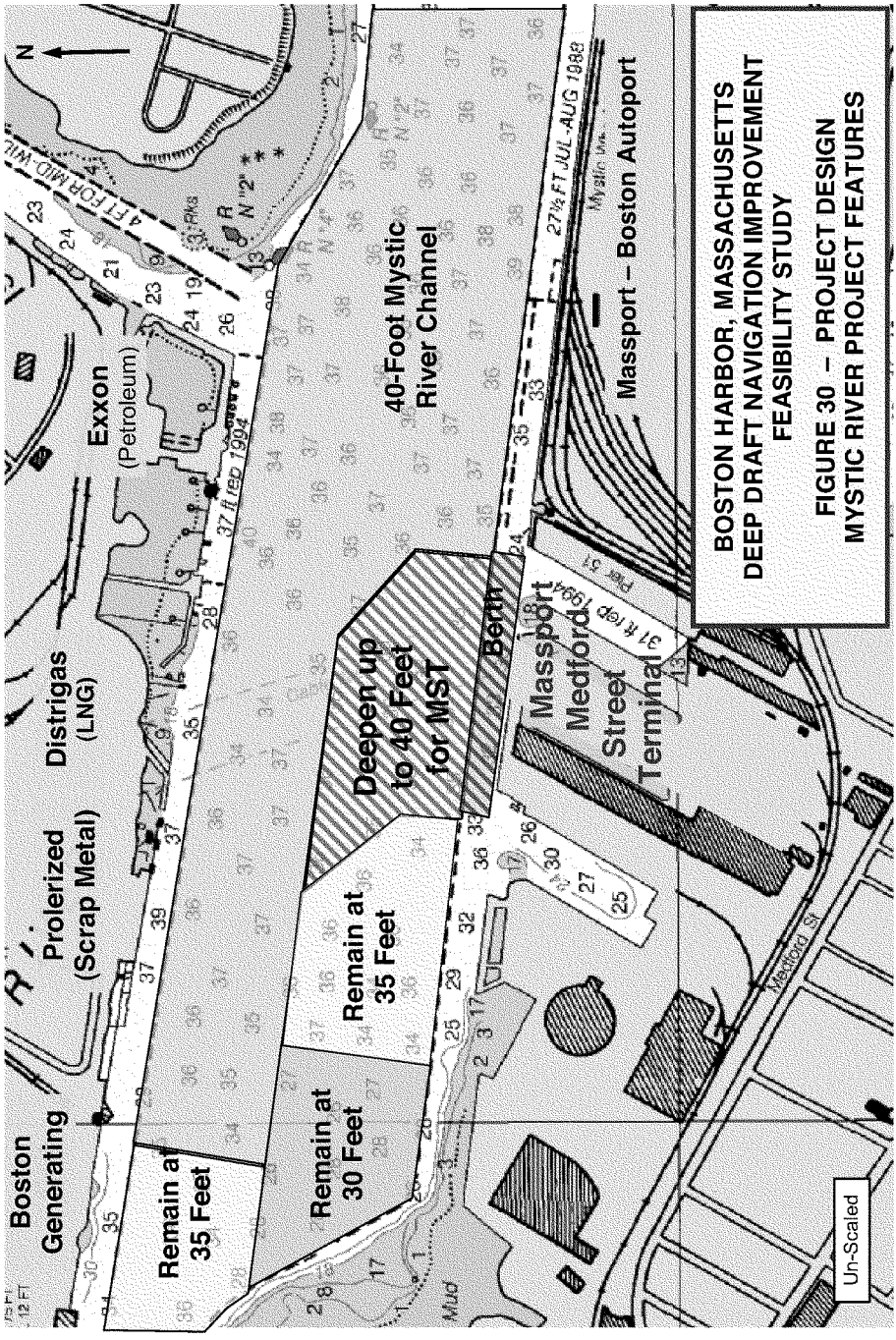
As with the seaward reaches of the main ship channel, two-way traffic of large commercial cargo ships is not a consideration for this reach of the channel. Channel transit information by vessel draft is provided in Appendix D-1 (Engineering Design). Nearly all of the inner harbor's small craft traffic, 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.

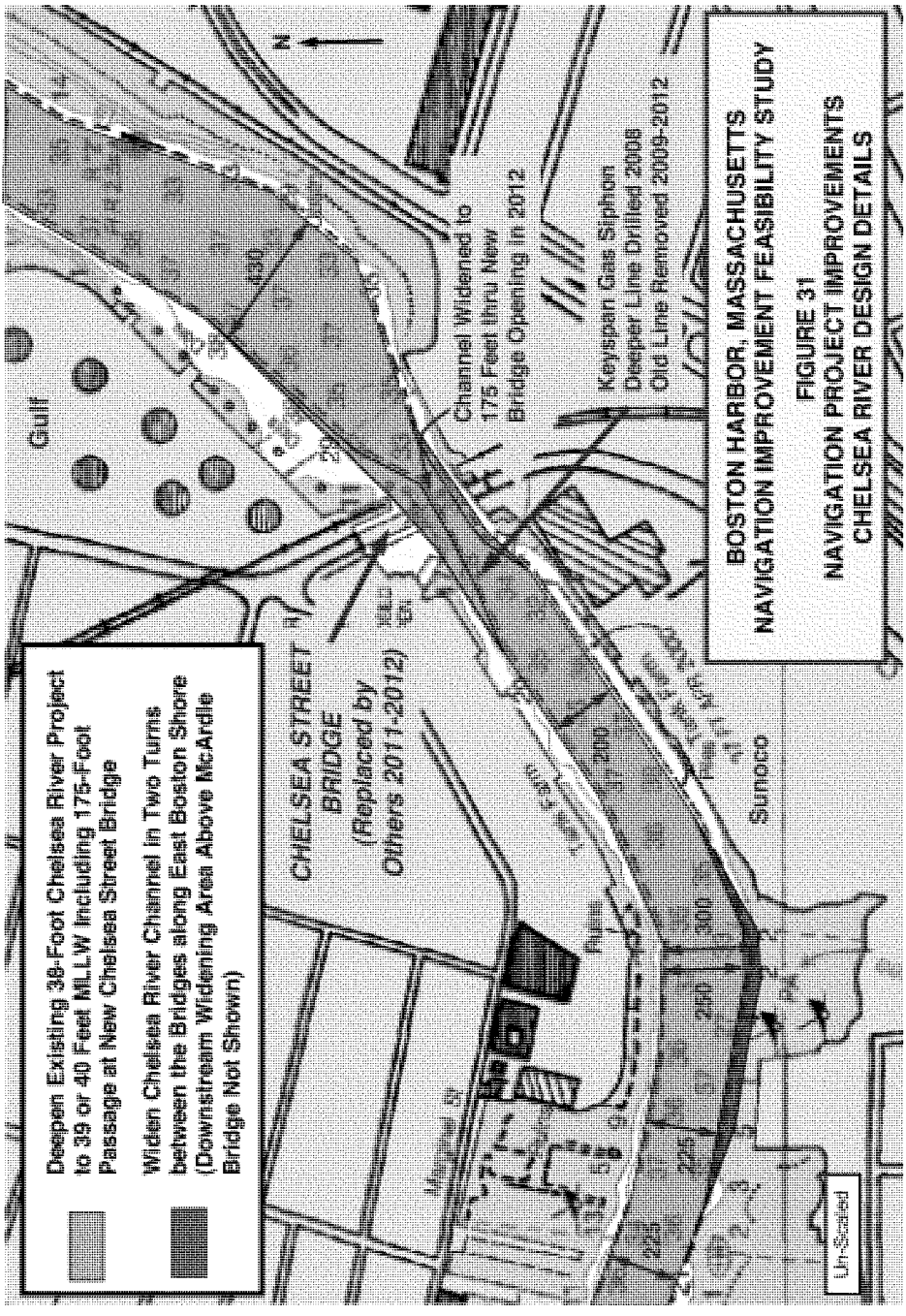
Mystic River Channel Modification

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
Boston Generating
Prolerized (Scrap Metal)
Distrigas (LNG)
Exxon (Petroleum)
40-Foot Mystic River Channel
Massport – Boston Autoport
Deepen up to 40 Feet for MST
Berth
Massport Medford Street Terminal
Remain at 35 Feet
Remain at 30 Feet
Remain at 35 Feet
Medford St
Un-Scaled


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)
CHELSEA STREET BRIDGE (Replaced by Others 2011-2012)
Channel Widened to 175 Feet thru New Bridge Opening in 2012
Keyspan Gas Siphon
Deeper Line Drilled 2008
Old Line Removed 2009-2012
Gulf
Sunoco
Un-Stated
N
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).

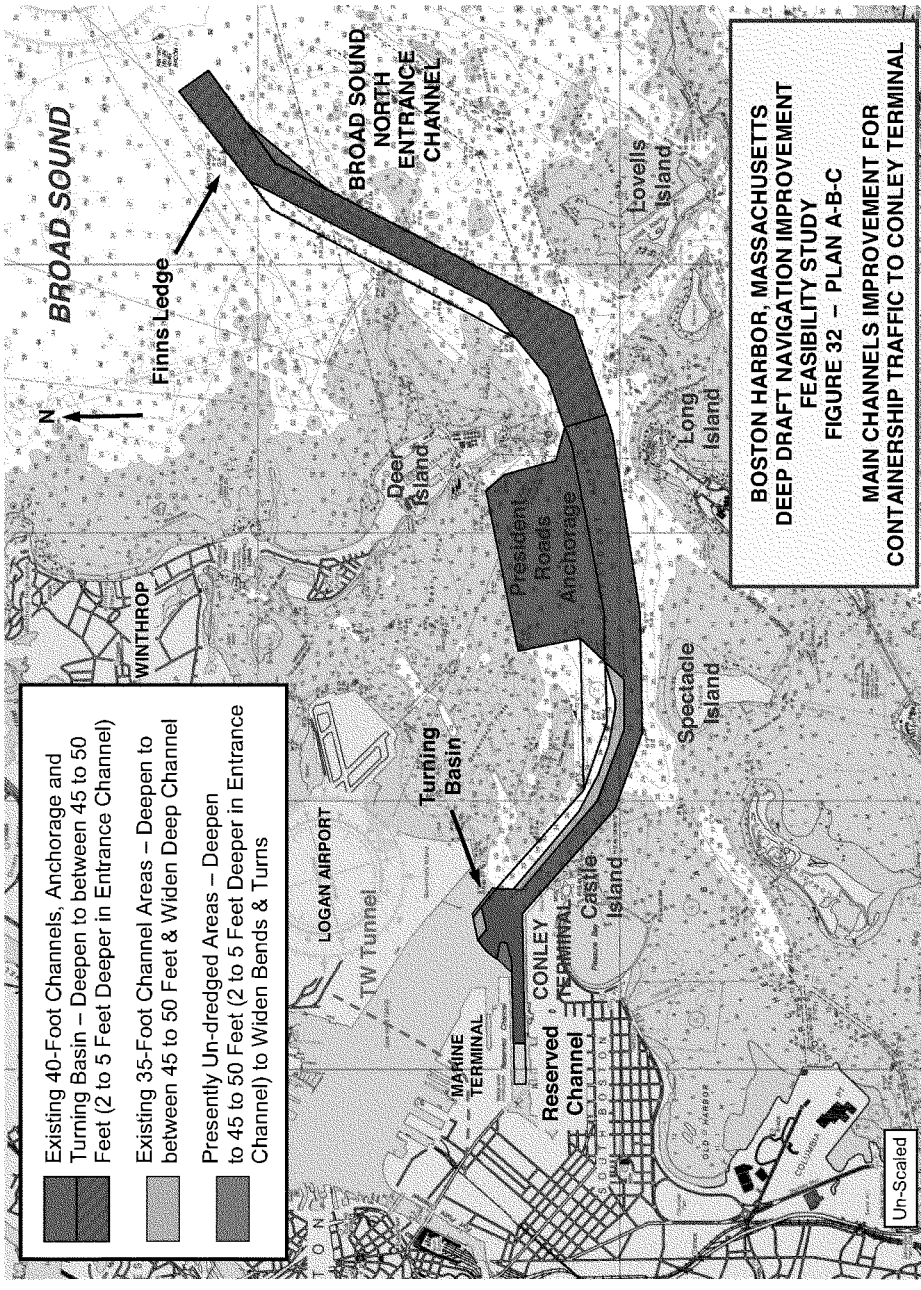
NAVIGATION IMPROVEMENT ALTERNATIVES

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.


BROAD SOUND
Finns Ledge
BROAD SOUND NORTH ENTRANCE CHANNEL
N
WINTHROP
Deer Island
President Roads Anchorage
Lovells Island
Long Island
Spectacle Island
LOGAN AIRPORT
TW Tunnel
Turning Basin
MARINE TERMINAL
CONLEY TERMINAL
Reserved Channel
Castle Island
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
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.

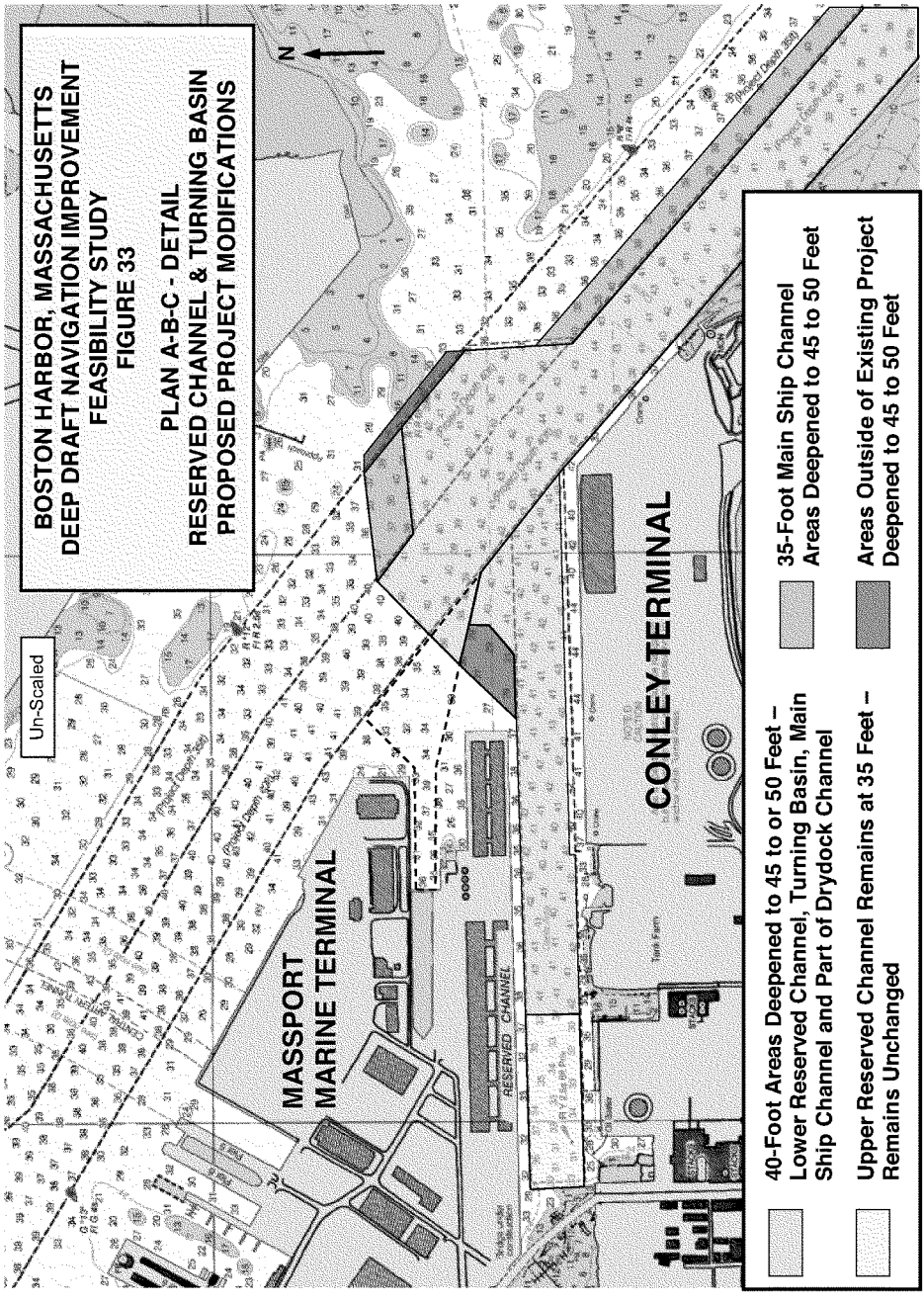
Bulk Cargo Terminals Access Plans

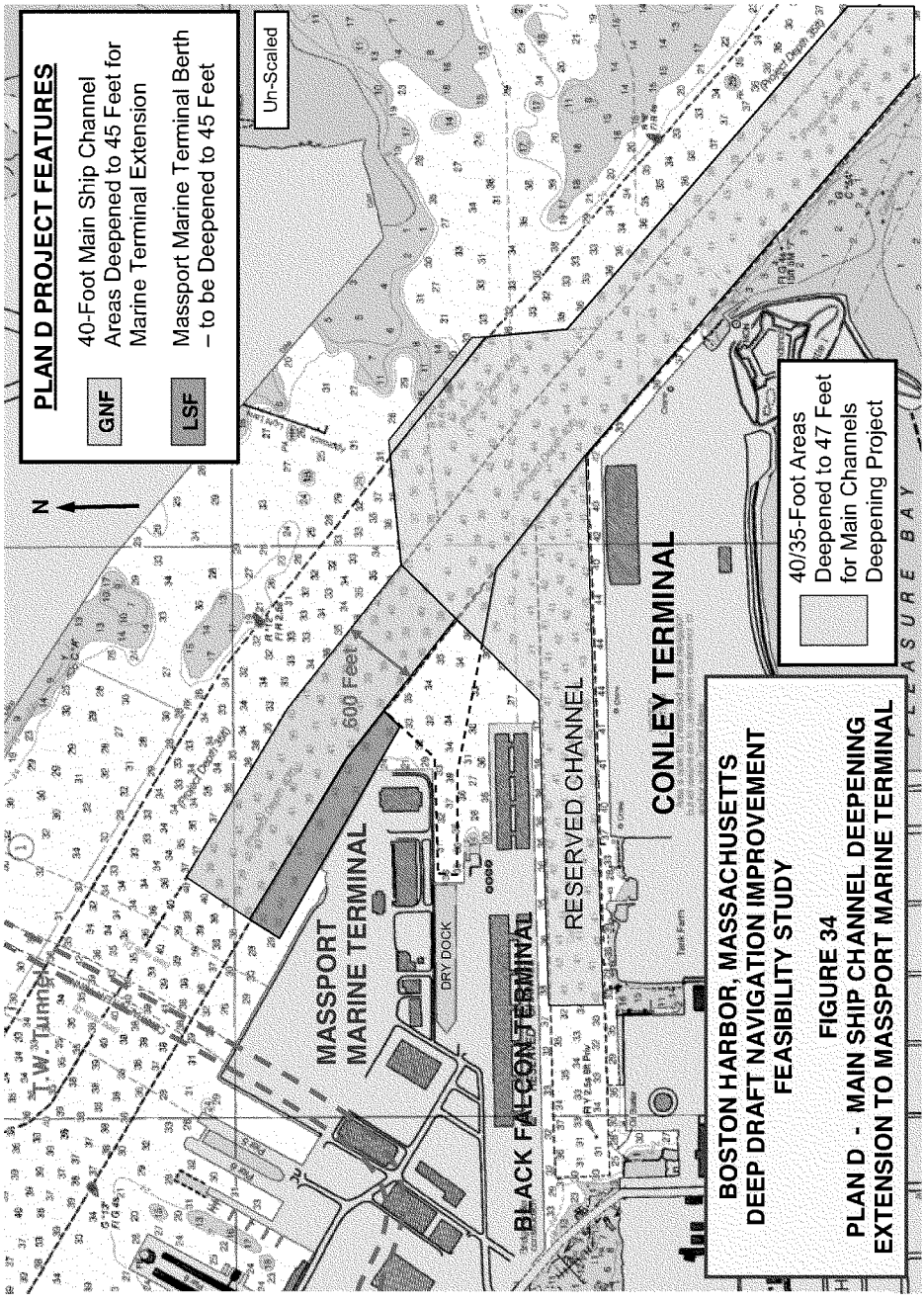
PLAN D – Main Ship Channel Deepening Extension: Plan D, shown in Figure 34, consists of extending the deepened lane of the Main Ship Channel up-harbor along the Massport Marine Terminal above the Reserved Channel in South Boston to a depth of up to –45 feet MLLW. This plan's costs would be incremental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

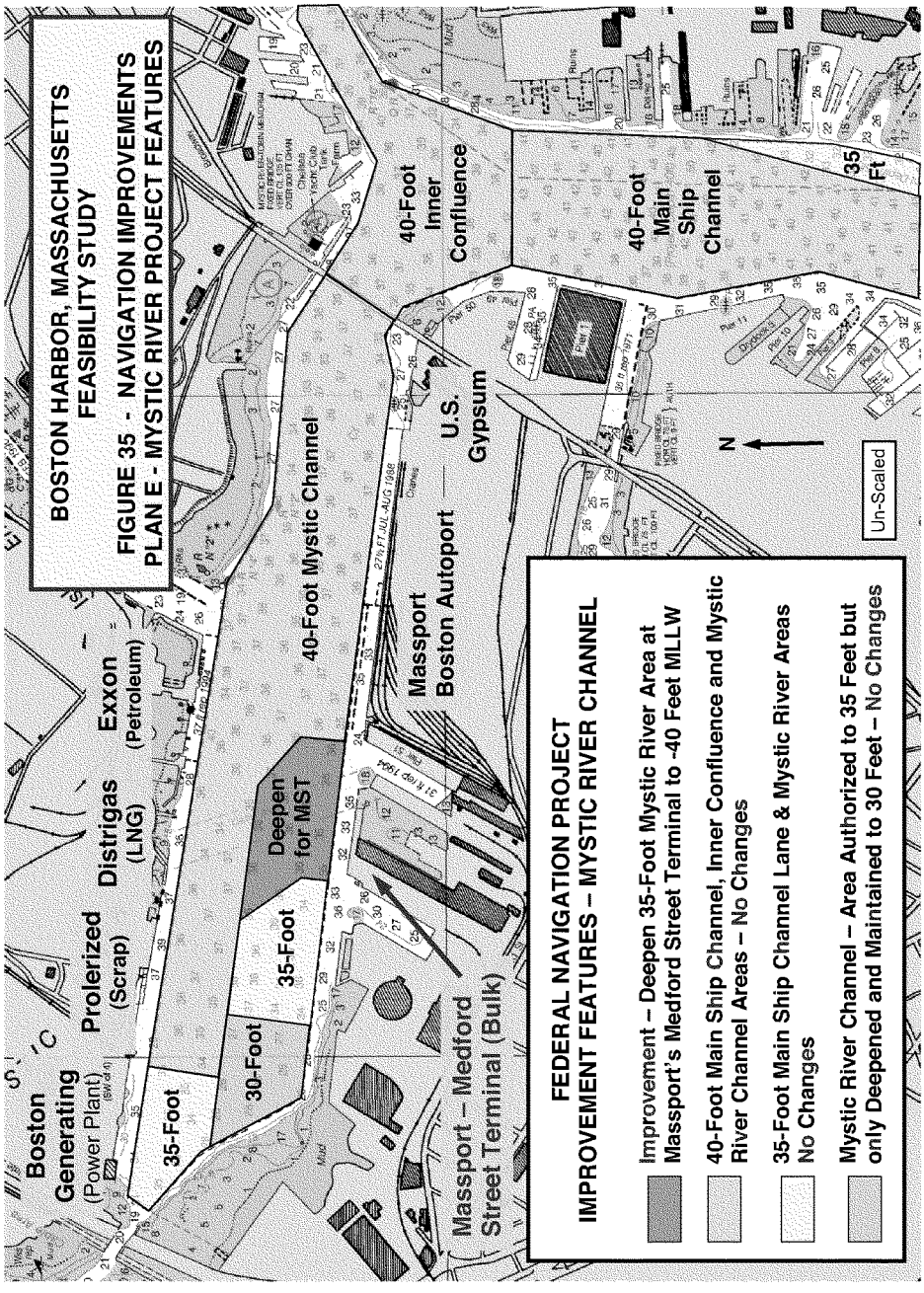
PLAN E – Mystic River Channel Deepening: Plan E, shown in Figure 35, consists of deepening a small area of the Mystic River Channel from 35 to 40 feet to access Massport's Medford Street Terminal in Charlestown. This area was not deepened as part of the 1990 authorized improvement as the benefits of 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.

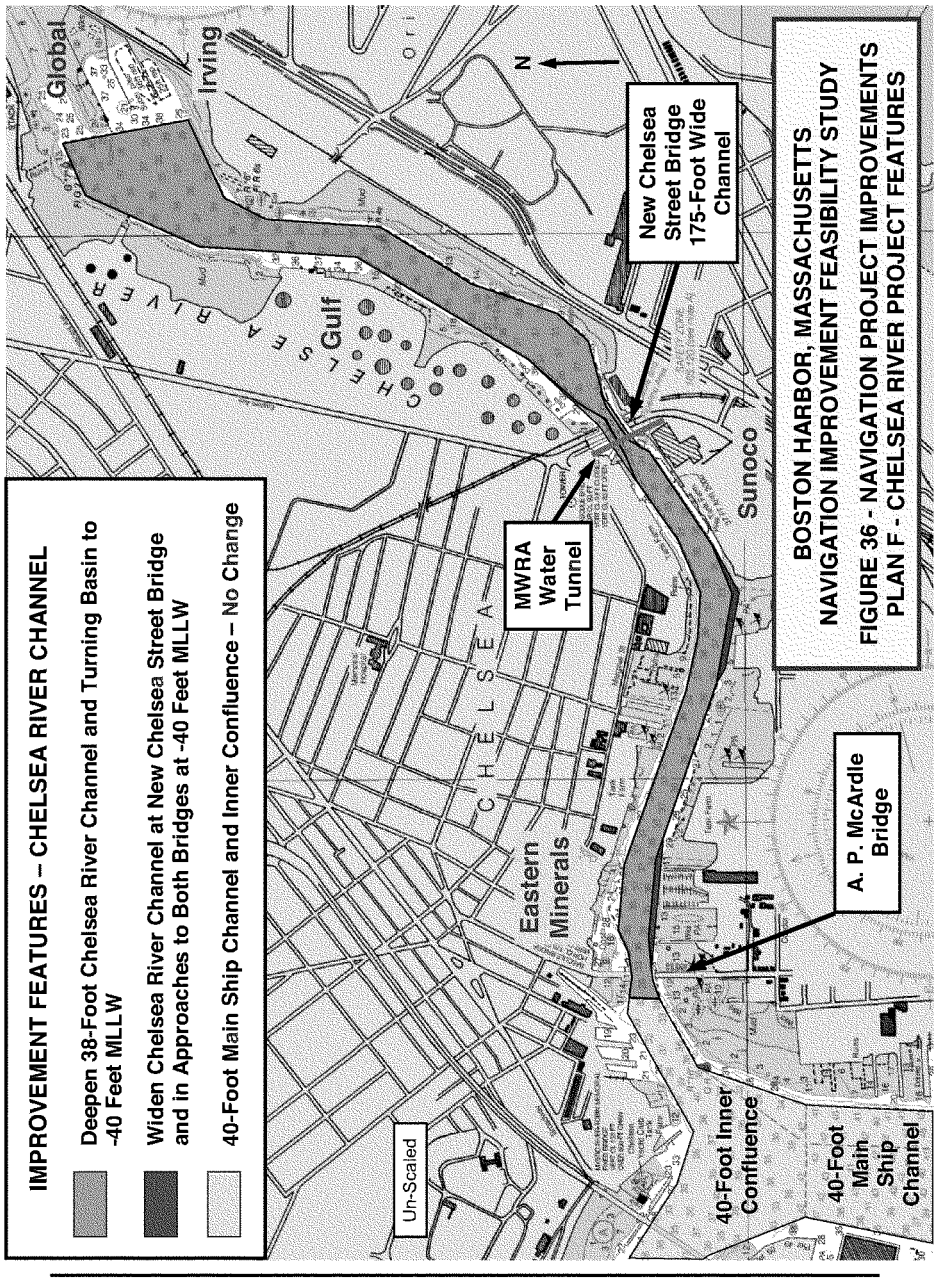
Petroleum Terminal Access Plan

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
RESERVED CHANNEL
CONLEY TERMINAL
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
40/35-Foot Areas Deepened to 47 Feet for Main Channels Deepening Project
600 Feet
MASSPORT MARINE TERMINAL
DRY DOCK
BLACK FALCON TERMINAL
RESERVED CHANNEL
CONLEY TERMINAL
T.W. Tunnel
BOSTON HARBOR, MASSACHUSETTS
DEEP DRAFT NAVIGATION IMPROVEMENT
FEASIBILITY STUDY
FIGURE 34
PLAN D - MAIN SHIP CHANNEL DEEPENING
EXTENSION TO MASSPORT MARINE TERMINAL


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
Massport Boston Autoport
U.S. Gypsum
40-Foot Inner Confluence
40-Foot Main Ship Channel
35 Ft
Massport – Medford Street Terminal (Bulk)
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
Un-Scaled
N


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
Sunoco
New Chelsea Street Bridge 175-Foot Wide Channel
A. P. McArdle Bridge
40-Foot Inner Confluence
40-Foot Main Ship Channel
N
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.

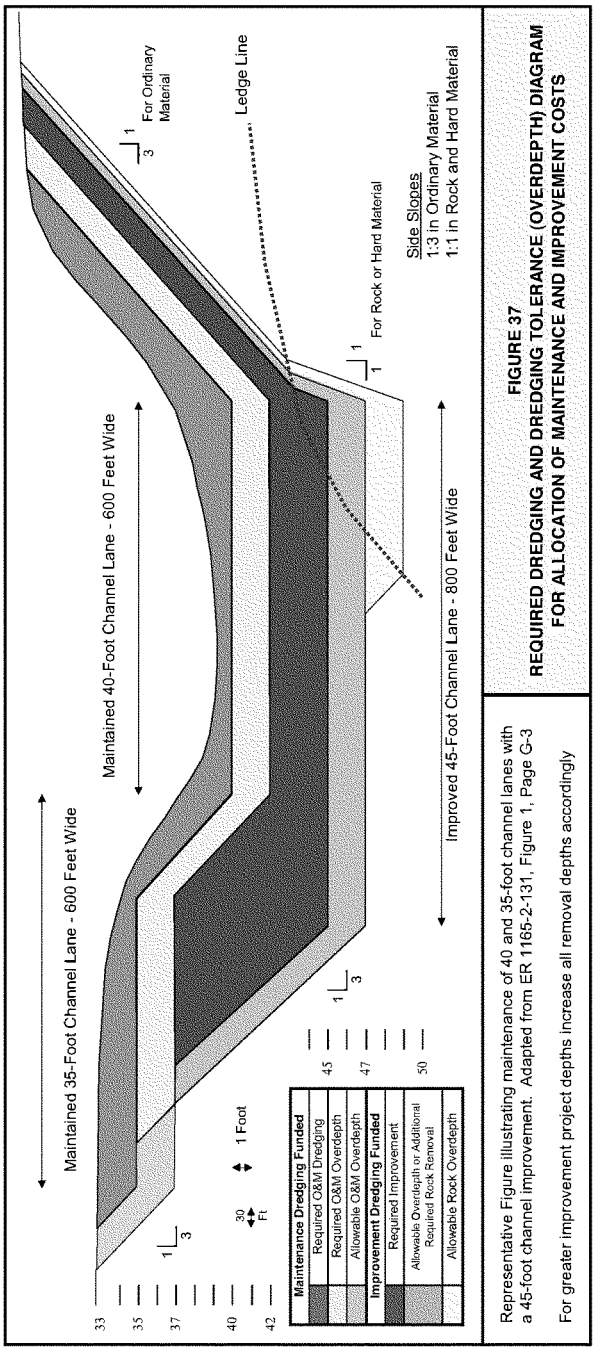
Current and historic boring and probing data, and vibracores performed for this study for environmental sediment characterization and cultural resource surveys, were used together with records from recent channel and CAD cell construction activities to characterize the unconsolidated material. Quantity 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.

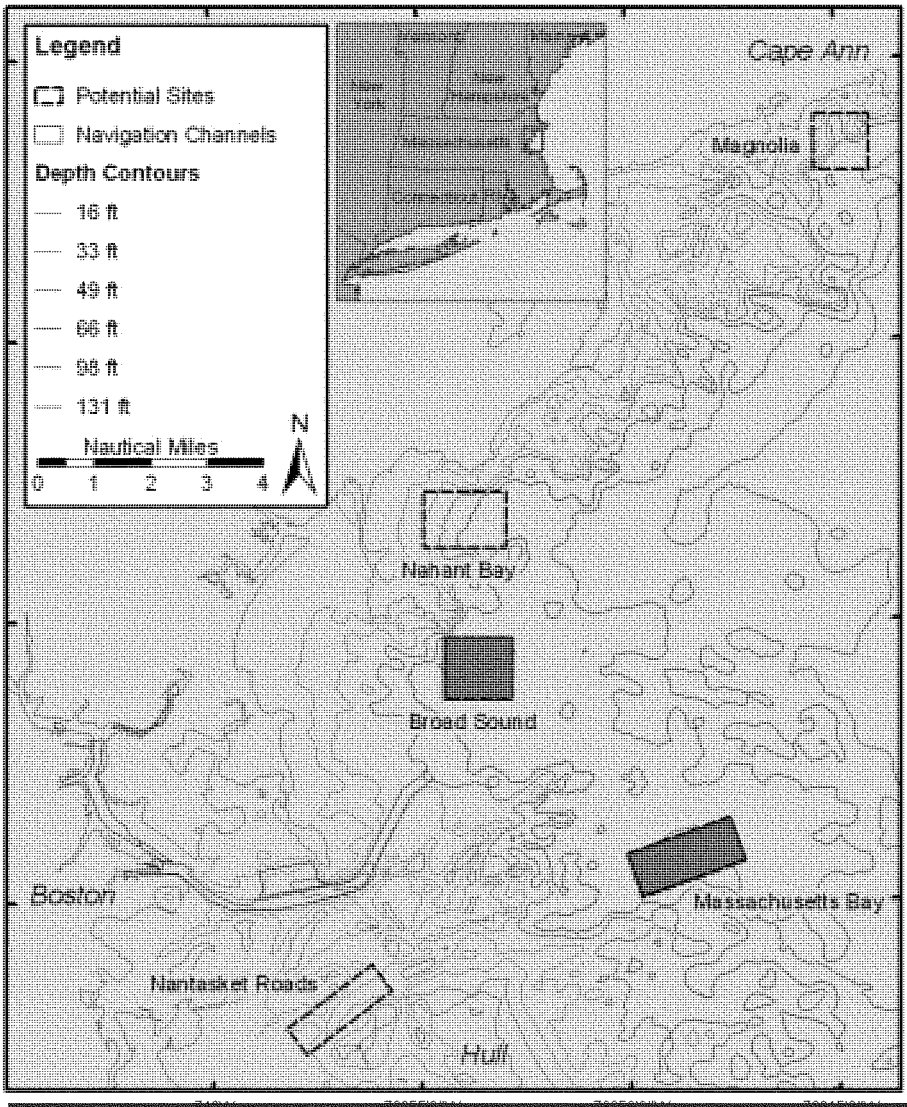
Beneficial Use Opportunity - Hard-Bottom Habitat Creation

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.

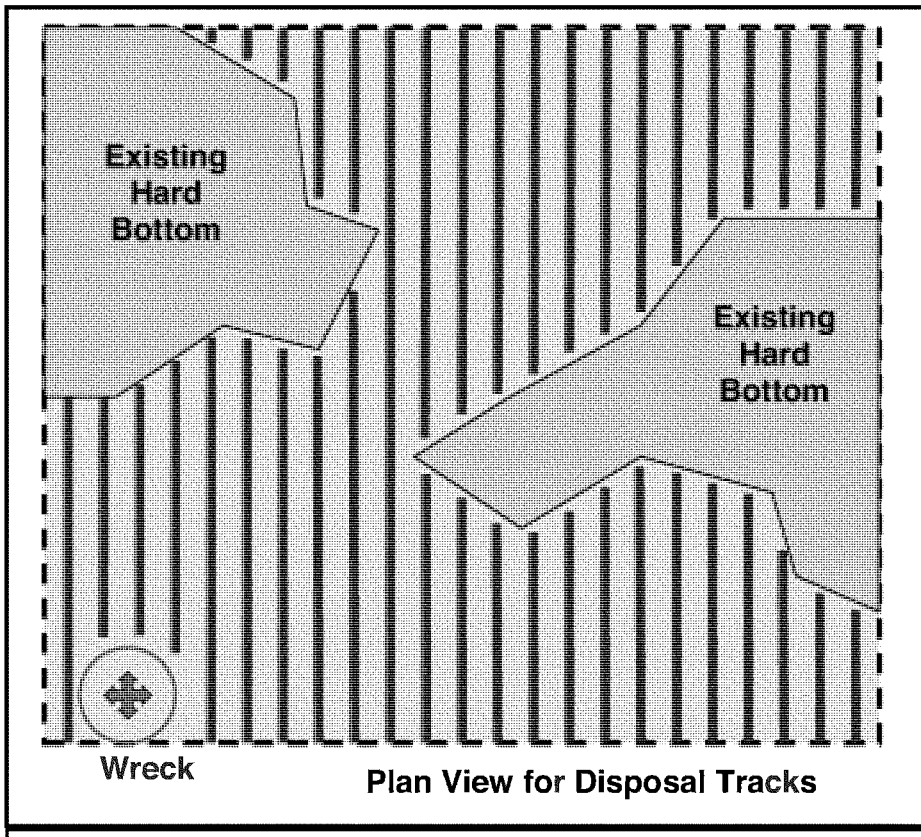


Most Suitable Sites for Creating Hard Bottom Habitat

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	59,360	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	2.86	3.03	3.24	3.65
With 6-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	4.16														
IWS is 2 NM Diameter															
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).

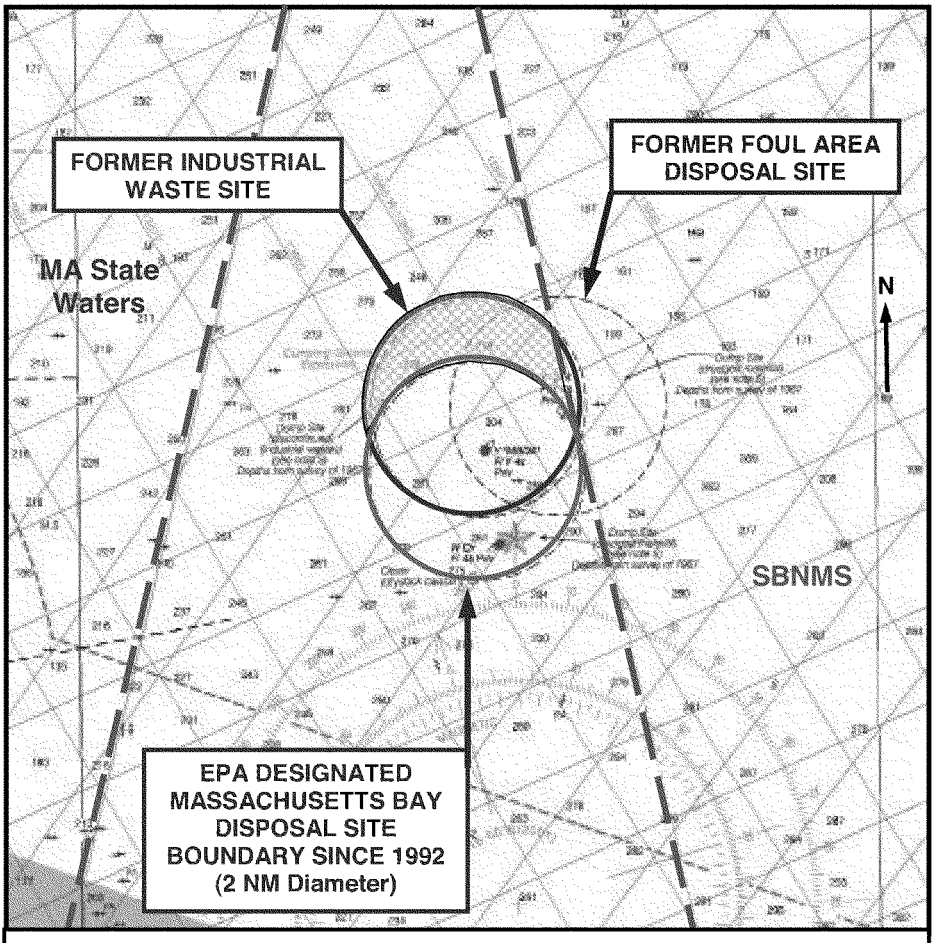

FORMER INDUSTRIAL WASTE SITE
FORMER FOUL AREA DISPOSAL SITE
MA State Waters
N
SBNMS
EPA DESIGNATED MASSACHUSETTS BAY DISPOSAL SITE BOUNDARY SINCE 1992 (2 NM Diameter)
3-Mile Limit
Stellwagen Bank NMS Boundary
Area of IWS that May be Added to MBDS Designation
BOSTON HARBOR, MASSACHUSETTS
NAVIGATION IMPROVEMENT FEASIBILITY STUDY
FIGURE 40
BENEFICIAL USE POTENTIAL FOR UNCONSOLIDATED MATERIALS TO CAP THE FORMER INDUSTRIAL WASTE SITE
Un-Scaled

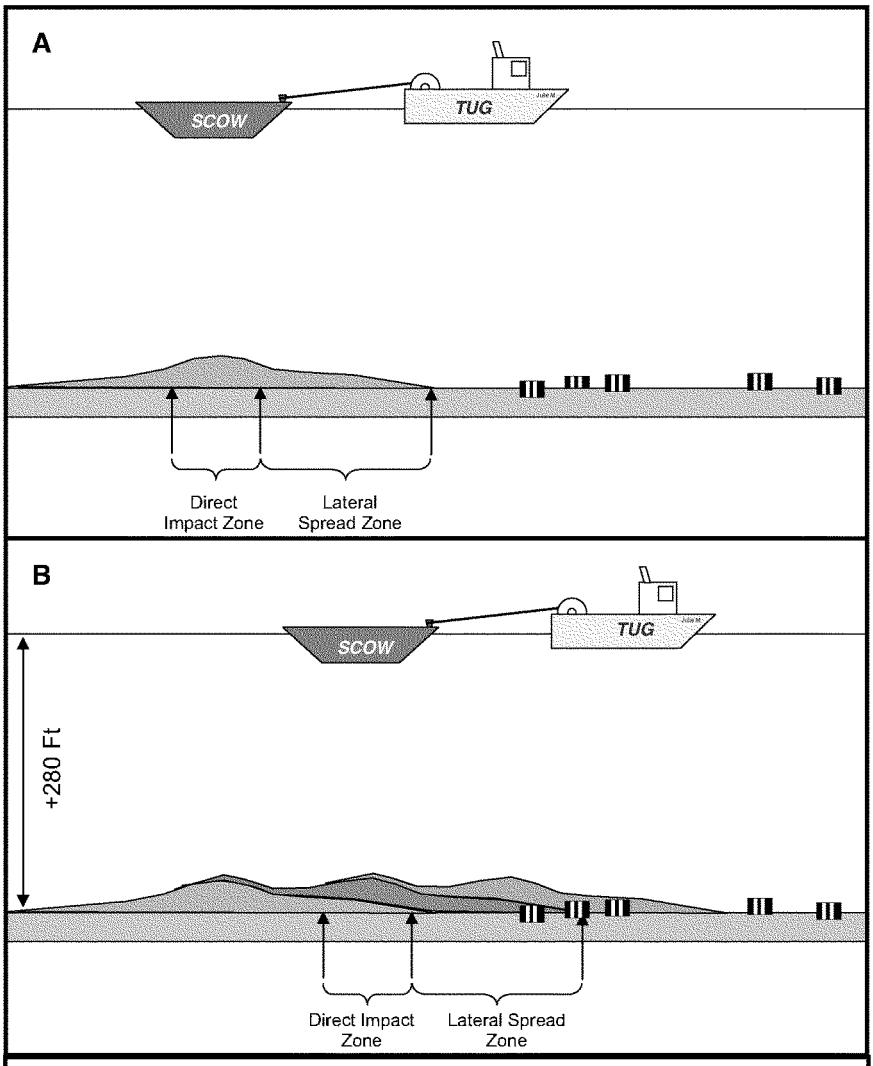
Table 33 shows the amount of improvement material that could be used to cap the IWS under the several improvement increments being considered and the depth to which that material would cap either the entire site or the one-half of the area containing barrel concentrations. Additionally any material dredged 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.

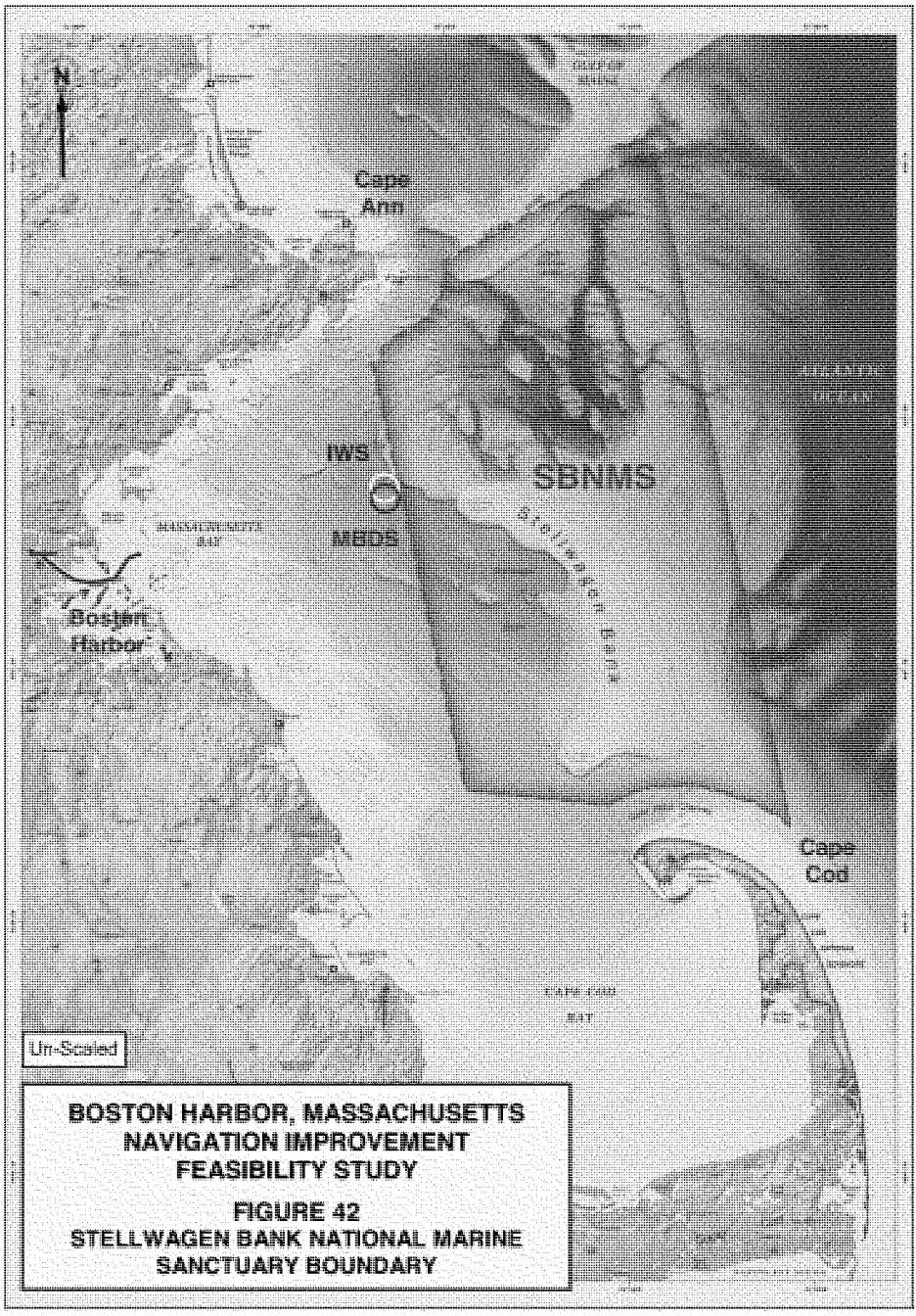


A. Initial cap placement events to occur outside barrel field creating zones of direct bottom impact and zones where sediment spreads laterally.

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.

Massport Marine Terminal (Plan D): 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 faeility for this site even if it is limited to the eurrent 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.

Mystic River – Medford Street Terminal (Plan E): 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.

Chelsea River – Petroleum Terminals (Plan F): 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.

Planning, Engineering and Design Costs (PED): 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.

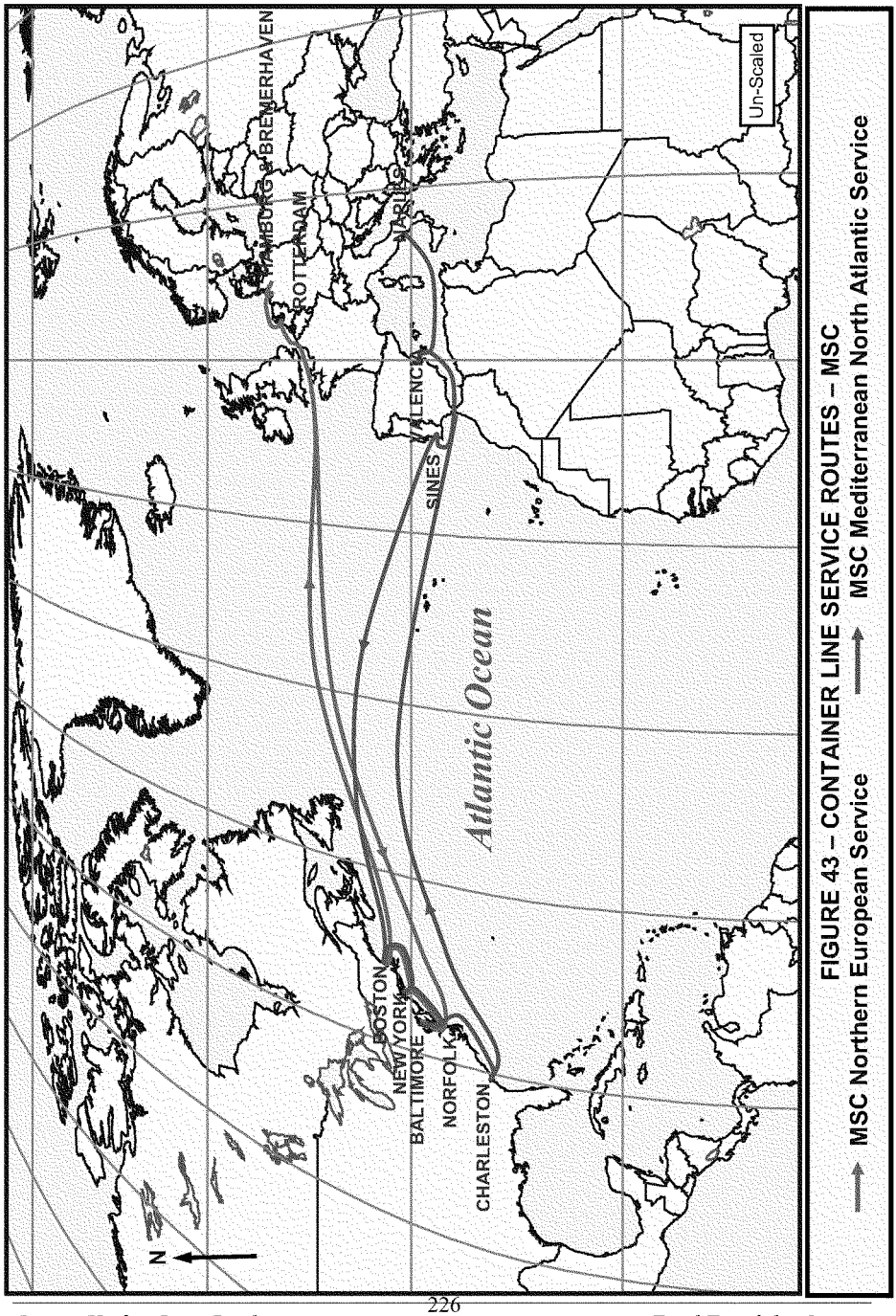


FIGURE 43 – CONTAINER LINE SERVICE ROUTES – MSC

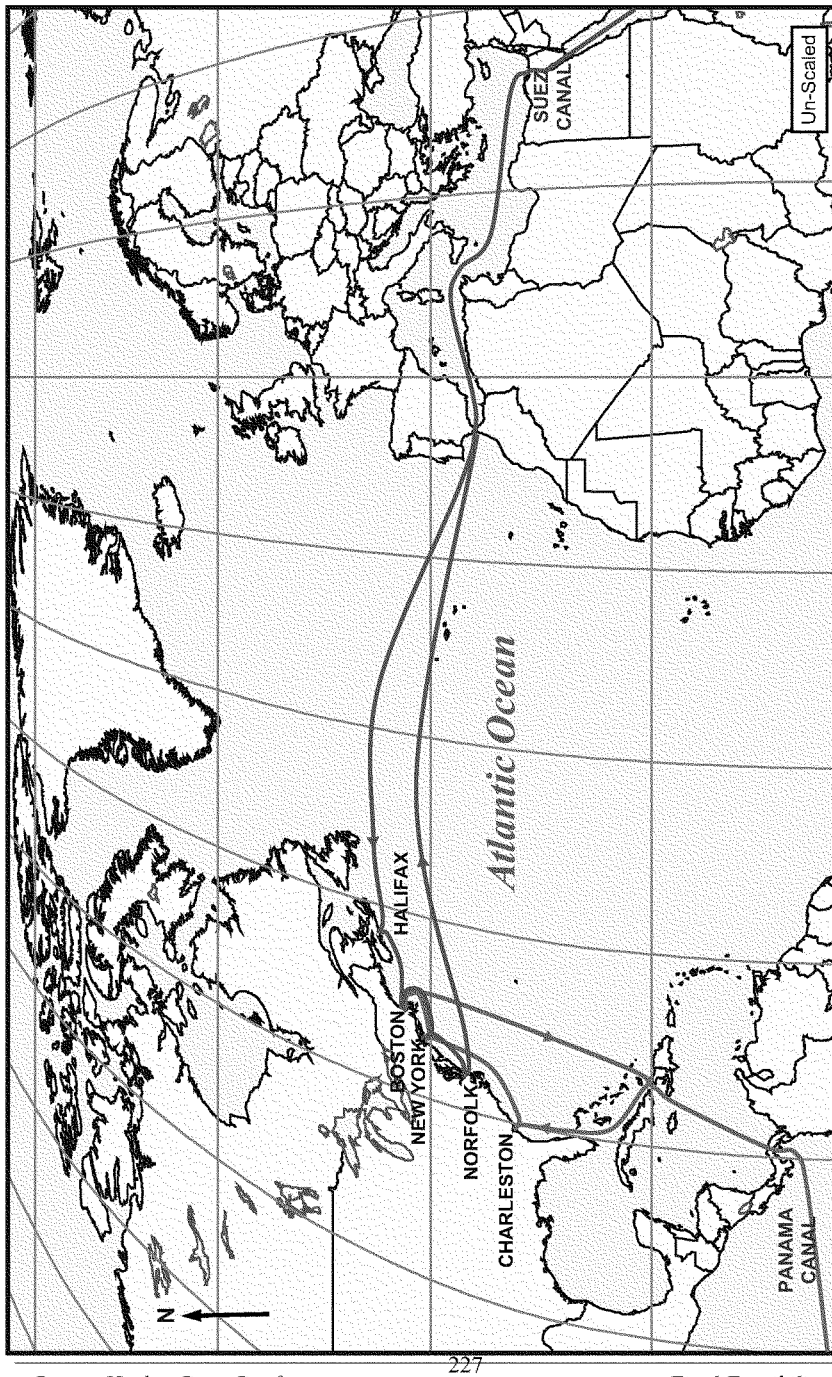


FIGURE 44 – CONTAINER LINE SERVICE ROUTES – COSCO

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	$157,726,000	$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	$10,918,000	$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 Vessles: 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	$12,128,000	$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

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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	$71,060,000	$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	$103,648,000	$106,271,000	$107,163,000	$107,485,000	$94,769,000	$99,928,000	$103,648,000	$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	$85,126,000	$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	$60,026,000	$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	$26,326,000	$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	2.26	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	$166,151,000	$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	$74,667,000	$77,820,000	$78,746,000	$78,876,000	$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	$76,571,000	$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

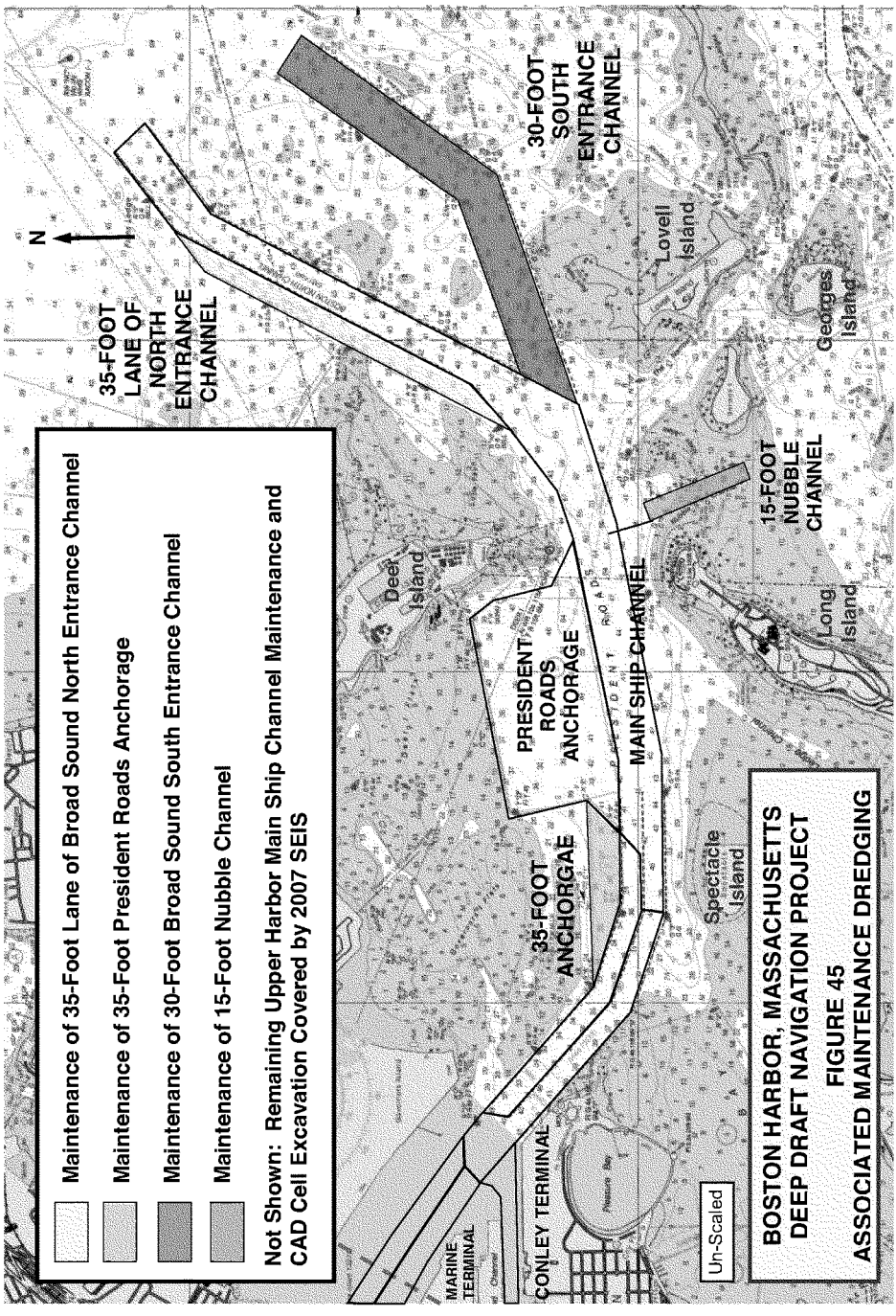
improvement project. These areas include the 30-foot Broad Sound South Entrance Channel, the 35-foot northern lane of the Broad Sound North Entrance Channel, the 15-foot Nubble Channel, and the 35-foot West Anchorage at President Roads (the barge anchorage). Minimizing navigation traffic disruptions 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
30-FOOT SOUTH ENTRANCE CHANNEL
Lovell Island
Georges Island
Deer Island
PRESIDENT ROADS ANCHORAGE
MAIN SHIP CHANNEL
15-FOOT NUBBLE CHANNEL
Long Island
Spectacle Island
35-FOOT ANCHORGAE
CONLEY TERMINAL
MARINE TERMINAL
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	97.5	1.7
41 Feet	32.2							
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.

National Marine Fisheries Service – 2 June 2008 (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."

Massachusetts Division of Fisheries and Wildlife

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."

Massachusetts Division of Marine Fisheries

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.

Massachusetts Department of Environmental Protection

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.

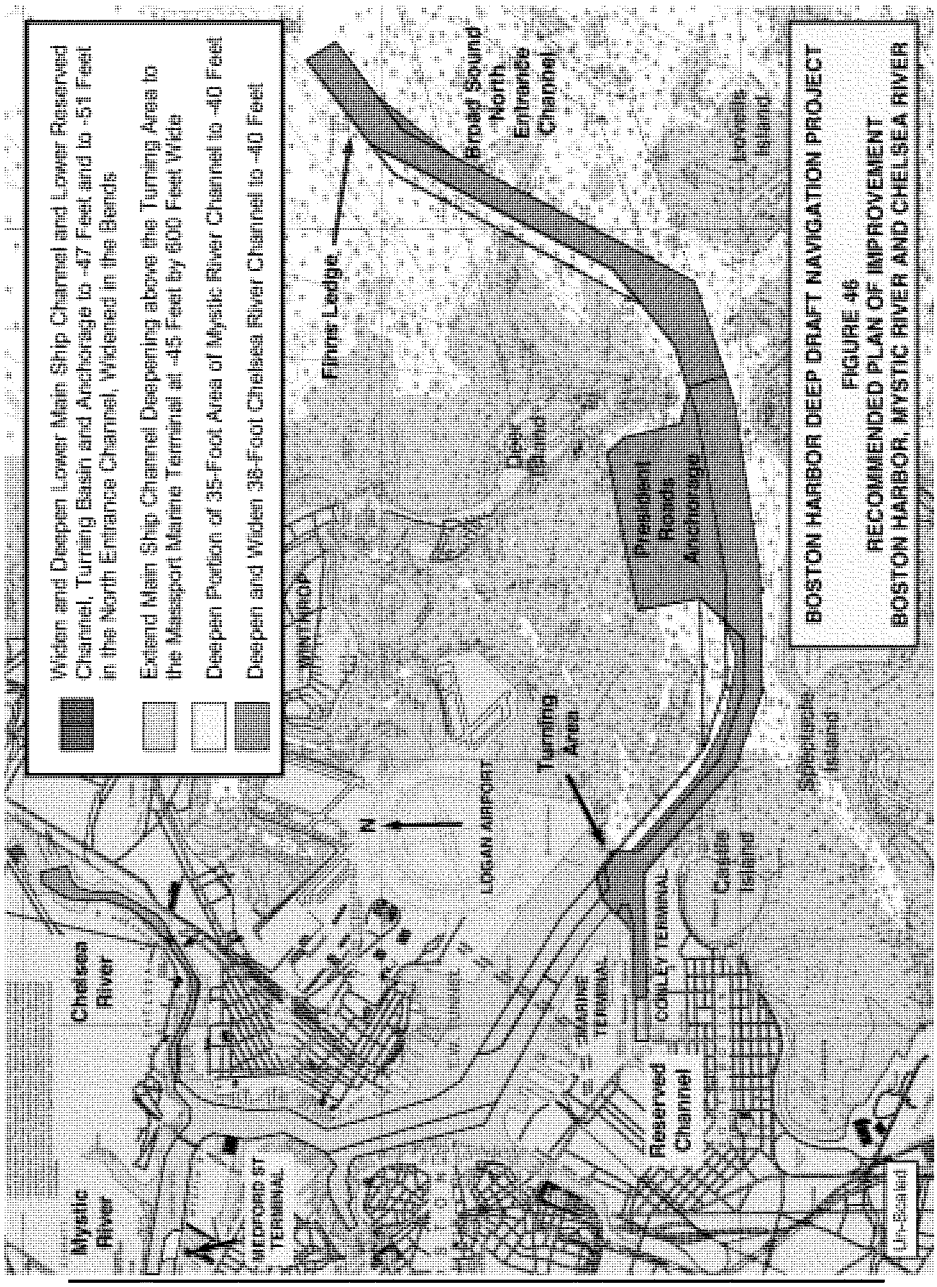

Widen and Deepen Lower Main Ship Channel and Lower Reserved Channel, Turning Basin and Anchorage to -47 Feet and to -51 Feet in the North Entrance Channel, Widened in the Bends
Extend Main Ship Channel Deepening above the Turning Area to the Massport Marine Terminal at -45 Feet by 600 Feet Wide
Deepen Portion of 35-Foot Area of Mystic River Channel to -40 Feet
Deepen and Widen 38-Foot Chelsea River Channel to -40 Feet
Mystic River
Chelsea River
MEDFORD ST TERMINAL
WINTHROP
LOGAN AIRPORT
Turning Area
Finns Ledge
Broad Sound North Entrance Channel
Deer Island
President Roads Anchorage
Lovells Island
Spectacle Island
Reserved Channel
MARINE TERMINAL
CONLEY TERMINAL
Castle Island
Un-Boarded
N
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

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 Details of Segment Increments Provided for Sponsor's Information	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 Distriet 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

BOSTON HARBOR
MASSACHUSETTS

FEDERAL DEEP DRAFT
NAVIGATION IMPROVEMENT PROJECT

FINAL SUPPLEMENTAL
ENVIRONMENTAL IMPACT STATEMENT

AND

MASSACHUSETTS FINAL
ENVIRONMENTAL IMPACT REPORT
(EOEA #12958)

APRIL 2013

FINAL SUPPLEMENTAL ENVIRONMENTAL IMPACT STATEMENT AND FINAL ENVIRONMENTAL IMPACT REPORT (EOEA# 12958) FOR THE FEDERAL DEEP DRAFT NAVIGATION IMPROVEMENT PROJECT BOSTON HARBOR, MASSACHUSETTS

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U.S. Environmental Protection Agency, NOAA - Fisheries, U.S. Fish & Wildlife Service, U.S. Coast Guard and the Massachusetts Office of Coastal Zone Management

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This joint Federal and State document builds on lessons learned from the Boston Harbor, Massachusetts Navigation Improvement Project (BHNIP), which was the subject of a Final Environmental Impact Report/Statement (EIR/S) prepared in 1995 (EOEA #8695). That combined maintenance and improvement project was constructed from 1998 to 2002. Additional major maintenance dredging of the harbor's deep draft channels was undertaken in 2005 to 2006 (outer harbor), 2007 to 2008 (inner harbor), 2012 (channel widening in Chelsea River at the Chelsea Street Bridge), and 2012 (inner harbor rock removal). These maintenance projects were discussed in separate NEPA documents. The currently proposed Boston Harbor Federal Deep Draft Navigation Improvement Project consists of a base plan to allow larger containerships to access the Massachusetts Port Authority's (Massport) Conley Terminal in South Boston, and three smaller improvements to other harbor channels. The base plan would deepen the harbor's main navigation channels from their existing -40-foot depth at mean lower low water (MLLW) to a depth of -47 MLLW. The entrance channel would be deepened by an additional four feet to -51 feet MLLW.

The base plan would improve access to Conley Terminal by:

- Deepening and widening the -40-foot deep lane of the lower Main Ship Channel from President Roads to the Reserved Channel to a depth of -47 feet MLLW, for the full 1200-foot width through the Roads, then with the deep lane widened to 900 feet between President Roads and Castle Island, and to 800 feet between Castle Island and the Reserved Channel, with further widening to 1,050 feet in the two bends below Castle Island;
- Deepening the President Roads Anchorage to -47 feet MLLW;

- Deepening the -40-foot lane of the Broad Sound North Entrance Channel to -51 feet MLLW to account for greater seas in the bay, with widening of the channel in the bend opposite Finns Ledge;
- Deepen the lower -40-foot portion of the Reserved Channel at the Conley Terminal to -47 feet MLLW;
- Deepening and widening the existing -400 foot by 1,200 foot Reserved Channel Turning Area to -47 feet MLLW deep with a minimum turning radius of 1,600 feet, and with limits eased to transition to the Reserved Channel along its northern side.

The other three separate navigation channel improvements include:

- Deepening the existing -40-foot MLLW Main Ship Channel from the reach above the Reserved Channel to just below the Third Harbor Tunnel to -45 feet MLLW to improve access to Massport's Marine Terminal in South Boston;
- Deepening a portion of the existing 35-foot channel of the lower Mystic River Channel to -40 feet MLLW to improve access to Massport's Medford Street Terminal.
- Deepening the -38-foot MLLW Chelsea River Channel to -40 feet MLLW, with the channel widened up to 50 feet along the East Boston shore immediately above the McArdle Bridge, and at the bend between the two bridges; primarily to improve access to the petroleum terminals along the river.

About 150,000 cy of material would be removed to deepen terminal berths at Massport facilities located on the Reserved Channel, and the Main Ship Channel, as well as private berths on the Chelsea River. In addition, about 500,000 cy of maintenance material would be removed from the proposed improved navigation channels where needed, and from other Federal navigation entrance channels and the barge anchorage to provide additional access and traffic management to the port's facilities during construction. Approximately one million cy of maintenance material remaining from the Inner Harbor Maintenance Dredging Project above Massport's Marine Terminal could be also be removed concurrent with this proposed project, as well as appromimately 370,000 cy from the Charles River portion of the Main Ship Channel.

These improvements would require the disposal of between 10 to 11 million cubic yards of parent material at the Massachusetts Bay Disposal Site (MBDS) located approximately 20 miles east from Boston Harbor. Rock removed from the project area would total up to one million cubic yards, some of which may require blasting. The base plan for disposal of the rock is also the MBDS. However, a proposal to use the rock for habitat enhancement to create a rock reef in Broad Sound and/or Massachusetts Bay or other beneficial use alternatives such as shoreline restoration or for use in shore protection projects are being considered and are discussed in this document. In addition, the use of the parent material as cover at the Industrial Waste Site is also considered.

The Federal Register will announce the availability of the Final SEIS/EIR for public review. The Massachusetts Environmental Policy Act process provides a public comment period on the FEIR. Commens on the FEIR can be sent to the Massachusetts Executive Office of Energy and Environmental Affairs, MEPA Office, 100 Cambridge Street, Boston, MA 02111 by the dates indicated in the Massachusetts Environmental Monitor. Additional information can be obtained from Mr. Mark Habel, study manager, at (978) 318-8871, Mr. Mike Keegan, project manager, at (978) 318-8087 or Ms. Catherine Rogers, ecologist, (978) 318-8231 at the U.S. Army Corps of Engineers, or Mr. Stewart Dalzell, Deputy Director, Massachusetts Port Authority, at (617) 568-3524.

FEDERAL DEEP DRAFT NAVIGATION IMPROVEMENT PROJECT BOSTON HARBOR, MASSACHUSETTS

FINAL SUPPLEMENTAL ENVIRONMENTAL IMPACT STATEMENT AND FINAL ENVIRONMENTAL IMPACT REPORT

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FEDERAL DEEP DRAFT NAVIGATION IMPROVEMENT PROJECT BOSTON HARBOR, MASSACHUSETTS

FINAL SUPPLEMENTAL ENVIRONMENTAL IMPACT STATEMENT AND FINAL ENVIRONMENTAL IMPACT REPORT

EXECUTIVE SUMMARY

Introduction

The Port of Boston, Massachusetts 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 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 below mean lower low water (MLLW; all depths are referenced to below MLLW) to the Port's principal terminals, except for the Chelsea River which has an authorized depth of 38 feet, and portions of the Mystic River which provide a depth of 35 feet. Deep water access to the harbor is provided by three entrance channels improved and maintained by the U.S. Army Corps of Engineers (USACE). The three entrance channels are: 1) the Broad Sound North Channel with two shipping lanes at 35 and 40 feet deep, 2) the Broad Sound South Channel at 30 feet deep, and 3) the Narrows Channel at 27 feet deep.

Response to Draft Feasibility and Draft Supplemental Environmental Impact Statement/Environmental Impact Report Public Review Comments

The Draft Feasibility and Draft Supplemental Environmental Impact Statement/Environmental Impact Report (DSEIS/EIR) was published in the Federal Register on 18 April 2008. The public comment period for both the Federal and State review processes closed on 2 June 2008. After presentation of the project to the Civil Works Review Board in August 2008, additional economic analyses were requested, which were completed in May 2012. Resolution of the recommended project depth was made in August 2012. Additional coordination letters were then sent to Federal and State agencies on October 11, 2012 before proceeding with issuing the Final Feasibility Report and Final SEIS/EIR. These letters were sent to confirm that previous determinations provided by the agencies to the USACE and Massport on the Draft SEIS/EIR were still valid. The Massachusetts Environmetal Policy Act (MEPA) Office was also asked to formally review their 2008 Scope Certificate for consistency with the current project. No significant changes to previous comments or the Secretary's Certificate were received. A number of commenting parties had common concerns with certain aspects of the proposed project. Many of these comments requested additional investigations, which can not be performed until the Planning, Engineering, and Design phase (Design Phase) of the project (which is after public release of the Final SEIS/EIR), due to Federal time and funding constraints. The findings from these

investigations may result in the need for additional planning, resource coordination and consultation, and additional NEPA and MEPA documents to comply with specific areas and topics. Any additional NEPA and MEPA documents generated would be available for public review.

Additional investigations and plans to be developed during the Design Phase include:

- Development of a Blasting Mitigation Plan once the extent of rock that may require blasting is identified during final design;
- Investigations of potential rock reef sites for beneficial use of rock;
- Investigation of other beneficial uses for rock removed from the project;
- Development of an overall Construction Sequencing Plan;
- Benthic resource definition and recolonization studies for dredged area; and
- Air quality compliance methodology and alternatives.

Details on the above investigations are available in Appendix A – Pertinent Correspondence. Other general topics discussed in this appendix include a description of the USACE Civil Works Process and the Continuation of the Interagency Technical Working Group (TWG) during the Design Phase of the project.

Purpose and Need for the Project

The purpose of this Boston Harbor Federal Deep Draft Navigation Improvement Study (Deep Draft Project) is to evaluate the feasibility of providing navigation channel deepening and related improvements at the Port of Boston, consistent with the goals of the study sponsor, the Massachusetts Port Authority (Massport), and in response to direction from Congress in the authorizing resolution and appropriations acts. Massport's goal is to provide deeper access to their Conley Container Terminal on the Reserved Channel in South Boston for the future needs of vessels calling at the Conley Terminal. Additional minor port improvements in the Mystic and Chelsea Rivers and in the Main Ship Channel above the Reserved Channel are also under consideration.

Various preliminary alternatives were formulated and screened. Alternatives were selected for detailed study on the basis of the estimated costs and benefits of the proposed channel and anchorage modifications. Project costs include the costs of channel deepening and widening through dredging and rock ledge removal, costs for disposal of dredged material, and costs for environmental mitigation.

Without channel deepening, the containerships and bulk carriers currently using Boston Harbor will continue to experience tidal delays and many vessels will continue to be light loaded or depart Conley Terminal without loading/unloading all of their cargo to ensure that they do not miss the tidal window. In some cases, vessels that would experience a tidal delay in Boston, would bypass Boston all together so as not to jeopardize their arrival schedule in other ports. As carriers add larger vessels to the services that currently include Boston, they may be forced to eliminate Boston from their rotation. Because of tidal delays and the increase in vessel size servicing the U.S. East Coast, a large part of New England cargo will continue to be shipped in or out of the Port of New York/New Jersey (PONYNJ), increasing total transportation costs to shippers. Large carriers that would use the expanded Panama Canal would not call on Boston if it meant they needed to light-load. Substantial quantities of import and export cargo have shifted from the PONYNJ to Boston Harbor in recent years

because of the lower landside transportation costs for cargo shipped directly into Boston Harbor. However, the shift in cargo from the PONYNJ to the Port of Boston Harbor will reverse itself once the carrying capacity and draft of the ships calling along the U.S. East Coast increases, and the tidal restrictions caused by the current 40-foot deep maintenance dredging become unsustainable from an economic and scheduling standpoint.

Project Description, Alternatives, and Beneficial Use

This Final Supplemental Environmental Impact Statement/Environmental Impact Report builds on the lessons learned from the Boston Harbor Navigation Improvement Project (BHNIP) located in Massachusetts, which was the subject of a Final Environmental Impact Report/Statement prepared in 1995 (USACE and Massport, 1995). The currently proposed Boston Harbor Deep Draft Project (Deep Draft Project) would remove between 10 to 11 million cubic yards (cy) of dredged material from Federal navigation channels in Boston Harbor. The dredged material is composed of Boston blue clay and glacial till matter. In addition, up to about one million cy of rock will need to be removed.

The following currently authorized 40-foot depth navigation features would be deepened to between 47 to 51-feet, and widened where necessary:

- Broad Sound North Entrance Channel (deepened an additional four feet over inner harbor depths);
- President Roads Anchorage;
- Main Ship Channel from President Roads to the Reserved Channel (also widened to 800 feet, 900 feet in the bends);
- The lower 4,000-foot portion of the Reserved Channel; and
- The Reserved Channel Turning Area (also widened to a 1,600-foot minimum radius).

Other incremental improvements include:

- Deepening the Main Ship Channel to 45-feet in the reach above the Reserved Channel to just below the Third Harbor Tunnel for Massport's Marine Terminal;
- Deepen to 40-feet the 35-foot deep area of the Mystic River Channel off of Massport's Medford Street Terminal; and
- Deepen the Chelsea River an additional two feet to 40-feet.

In conjunction with these improvements, the berths at the Conley Container Terminal would be deepened to at least 50 feet (three feet deeper than the recommended channel depth of 47 feet) and the berth at the Massport Marine Terminal would be deepened to at least 45 feet MLLW. Private berths on the Chelsea River could also be deepened commensurate with the deepening of the Federal channels.

Under all options, the Broad Sound North Entrance Channel would be deepened an additional four feet over the projected Main Ship Channel depth to account for higher sea states. In areas where ledge is encountered, an additional two feet of required rock removal will be performed for vessel safety. In all areas an overdepth dredging allowance of two feet would be specified.

Maintenance dredging of the existing Federal navigation features in Boston Harbor would be carried out concurrent with the Deep Draft Project in two ways. First, while major

maintenance dredging of the outer and inner harbor areas was accomplished in the 1998-2000, 2004-2005 and 2007-2008 year timeframes, respectively, and additional ledge pinnacles removed from the lower Main Ship Channel in 2012, minor amounts of maintenance material may remain at the time of the improvement dredging due to the low shoaling rates in Boston Harbor and the recent dredging operations. Second, channel and anchorage areas not maintained in the past three dredge operations may be maintained at the time of the improvement dredging. Areas under consideration 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) for a total of approximately 500,000 cy of dredged material. This would minimize navigation traffic disruptions of the drilling, blasting, and dredging operations for the Deep Draft Project by providing alternative routes for shallow-draft traffic not needing the 40-foot channels that would be 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 anchorage area and entrance channel materials would be found suitable for ocean disposal and would be disposed at the Massachusetts Bay Disposal Site. Unsuitable material would be disposed into a previously approved Confined Aquatic Disposal (CAD) cell.

The U.S. Environmental Protection Agency (EPA) has determined that the parent material is suitable for unconfined ocean water disposal. In developing the Federal National Economic Development (NED) plan for dredge material placement/disposal the USACE must select the least cost, environmentally acceptable placement plan. The Federal NED Plan identified for this project would involve the placement of all of the dredged material and rock at the Massachusetts Bay Disposal Site (MBDS). However, it is the policy of the U.S. Army Corps of Engineers to use dredged material, where practicable, for beneficial use. Beneficial use opportunities have been identified and will be examined further in the detailed design phase of the project, if the State and the U.S.EPA express an interest in pursuing those options.

A beneficial use option was identified for the rock that will be removed from the navigation channels. Five sites were evaluated for placement of rock, two of which were selected for further analysis. The two beneficial use sites selected for further study in the design phase of the project are located in Broad Sound and Massachusetts Bay. The rock reef would increase biological diversity in an area with limited hard bottom material. The reef would provide habitat for lobsters, reef finfish, and encrusting organisms. Other potential beneficial uses for the rock will also be explored with State and local agencies, including shoreline restoration/protection projects, and upland construction projects.

The Boston blue clay, sand and less consolidated glacial till material could be used to cap debris previously dumped at the Industrial Waste Site (IWS). The IWS was used historically as an industrial waste site in the 1930's through early 1970's. Chemical waste and low level radioactive material and debris were dumped at the IWS which overlaps the EPA designated MBDS.

A requirement of the BHNIP Water Quality Certification (WQC) dated January 16, 1998 was to monitor the CAD cells one year and five years after they were capped to assess the

effectiveness of isolating the unsuitable material within the CAD cells with sand. A survey was performed in 2001 and in 2004 and included bathymetry, side scan sonar, video sled and sediment-profile imaging. The results of the survey confirmed that the sediment layers of the cells remained physically stable, with additional natural deposition occurring over the tops of the cells which remained depressed below the surrounding harbor bottom. Towed video footage revealed numerous small fish and crustaceans at the bottom over the CAD cells, and sediment profile imaging revealed a stressed biological community similar to ther surrounding harbor as expected for the urban harbor setting. A follow up survey was performed in 2009 including bathymetry, sub-bottom profiling, and collection of short cores. This survey confirmed the continued stability of the cells and their contents, with ongoing natural deposition further sequestering the material contained within the CAD cells.

No new CAD cell construction is currently anticipated for this Deep Draft Project for disposal of any accumulated silty maintenance material unsuitable for ocean water disposal. However, maintenance dredging of the Main Ship Channel above Massport's Marine Terminal to the Inner Confluence (both the -35' and -40' deep navigation channels), which was not accomplished during maintenance dredging of the IHMDP in 2008, would need to be dredged to realize the economic benefits of a deeper Chelsea River and Mystic River. This unsuitable material would be disposed at a CAD cell located in the Inner Confluence and proposed in the 2006 IHMDP SEIS. Additional areas of the Federal navigation channels in the upper inner harbor, and not included in the 2006 SEIS, include the Charles River branch of the 35-foot Main Ship Channel may also be maintained at this time.

Public Involvement

Public involvement in the development of a joint National Environmental Policy Act (NEPA) Supplemental Environmental Impact Statement (SEIS) and Massachusetts Environmental Policy Act (MEPA) Environmental Impact Report (EIR) document is critical to the success of the project. Several mechanisms have been employed to inform the pubic of the proposed project and to provide the opportunity for public input into the process. This Deep Draft Project builds on the public process established during the original BHNIP. A technical working group (TWG) was established during development of the BHNIP EIR/EIS to provide input and guidance on sampling plans, modeling and alternatives development. This group continued to provide input during construction of the BHNIP. Member contributions were valuable in addressing concerns raised during dredging, disposal, and CAD cell development. Below are brief summaries of the past and proposed activities used to solicit public and agency input into the development of the current proposed project.

- Federal Register Notice of Intent

A Notice of Intent (NOI) to prepare a SEIS was published in the Federal Register on August 23, 2002. The NOI notifies the public that a SEIS will be prepared and allows the public to submit comments or ask questions about the proposed action. Interested individuals can also request to be placed on mailing lists for potential meetings and future publications of the SEIS.

- Scoping Meeting

- Scoping Meeting

A scoping meeting is not required for preparation of a supplemental EIS. However, the public was invited to a public information session hosted by Massport on September 5, 2002 at the Black Falcon Cruise Ship Terminal in South Boston, MA. The purpose of the meeting, undertaken during the MEPA public comment period, was 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 potential effect on lobsters, improvements in shore side infrastructure related to the project, the timeline for channel deepening, and cumulative impacts. A public scoping meeting for the EIR was held on February 23, 2003. Copies of written comments are provided in Appendix P of the projct Feasibility Report and SEIS/EIR.

- Cooperating Agencies

Federal agencies that have jurisdiction by law or special expertise were invited to be a cooperating agency on the development of the SEIS/EIR and include the U.S. Environmental Protection Agency, the U.S. Fish and Wildlife Service, NOAA-Fisheries, and the U.S. Coast Guard. The Massachusetts Executive Office of Energy and Environmental Affairs (EEA) and the Wampanoag Tribe of Gay Head (Aquinnah) also have jurisdiction by law or special expertise that is relevant to the proposed project. A letter requesting cooperating agency participation was sent by the USACE to the four Federal agencies, the lead State environmental agency, and Indian tribe on April 11 and 18, 2003.

All four Federal agencies agreed to participate as cooperating agencies on this SEIS/EIR. The Massachusetts Office of Coastal Management agreed to represent the State environmental agencies in the development of the SEIS/EIR. No response was received from the Wampanoag Tribe of Gay Head (Aquinnah).

- Technical Working Group (TWG)

As with the Boston Harbor Navigation Improvement Project, a Technical Working Group (TWG) was established to assist in the planning and review of the SEIS/EIR for this Deep Draft Navigation Improvement Dredging Project, the SEIS/Notice of Project Change for the Boston Harbor Inner Harbor Maintenance Dredging Project (IHMDP), and the recently-completed Outer Harbor Maintenance Dredging Project (OHMDP). Ten TWG meetings were held during the preparation of this Final SEIS/EIR. The first meeting was held June 10, 2003 and the last meeting on December 18, 2007. An additional meeting was held May 19, 2008 during the Draft SEIS/EIR comment period and another on December 3, 2012 to update the agencies on the status of Boston Harbor navigation projects prior to the release of the Final SEIS/EIR. The initial focus of the TWG was on the Deep Draft Project. However, since maintenance dredging projects discussed above were planned and constructed prior to the Deep Draft Project, some of the TWG meetings also included information related to issues associated with these maintenance projects. Many of those issues were also relevant to the Deep Draft Project. It is anticipated that the TWG will be an integral part of the project strategy through the design and construction phases of the proposed Deep Draft Project.

- Specific Topic Meetings

When warranted, a separate meeting was held to address a specific topic with pertinent representatives. A meeting was held August 3, 2004 between the USACE, Massport, and the Boston Harbor and Massachusetts lobstermen, and Massachusetts Division of Marine Fisheries. The purpose of the meeting was to obtain input on areas that may be appropriate for habitat enhancement sites using rock. A subgroup of the TWG was formed and will be continued in the Design Phase of the Deep Draft Project to provide input and guidance in the development of a blast mitigation plan for the proposed project.

- Massachusetts State Dredging Team and New England Regional Dredging Team (NERDT)

The Massachusetts Coastal Zone Management Office hosts recurring meetings on dredging projects within the State including relevant issues and topics for discussion. Local, State, and Federal agencies as well as public interest groups attend these meetings. The status of the recent Boston Harbor dredging projects, including this proposed project, is provided to the group for information and comment.

In addition, the status and relevant topics of the Deep Draft Project are presented to the regional subteam of the National Dredging Team. This regional subteam meets to discuss relevant dredging issues faced by the Federal and State agencies of the coastal New England States.

- Draft and Final SEIS/EIR Public Review Process

The Draft and Final SEIS and EIRs are published jointly to provide an opportunity for combined public review and comment. This format complies with the regulations of the NEPA to the fullest extent possible by reducing duplication between NEPA and comparable State requirements, such as joint environmental impact statements, and complies with the MEPA, whose governing regulations also encourage coordinated reviews under NEPA and MEPA where possible. A minimum 45-day public comment is provided once a Notice of Availability of the Draft SEIS/EIR is published in the Federal Register and Environmental Monitor. A Final SEIS/EIR is prepared once comments have been received on the Draft SEIS/EIR. The USACE 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. A Final Section 61 Findings under MEPA cannot be finalized until further details become available in the Design Phase of the project. As required by the Secretary's Certificate on the Draft EIR, a Draft Section 61 Findings is included in this Final EIR that reflects the current project mitigation elements to the extent possible in this Final SEIS/EIR.

Lessons Learned from the BHNIP and Mitigation

Experience gained from the BHNIP has guided development of the dredging and disposal plans for this Deep Draft Project. Environmental monitoring required as part of the BHNIP WQC included:

- Silt plume tracking during dredging of and after disposal into CAD cells;
- Water quality testing after disposal into the CAD cells;
- Biological testing for toxicity and contaminant uptake;

- Dissolved oxygen (DO) monitoring within and outside the CAD cells; and
- Fisheries monitoring during blasting operations.

The lessons learned as a result of the extensive environmental monitoring conducted during construction of Phase 1 and Phase 2 of the BHNIP performed from 1997-2000 allowed determinion of what methodologies worked best to minimize environmental impacts. These methodologies will be implemented, where applicable, to reduce and minimize potential Deep Draft Project impacts during the course of construction. Monitoring programs may be proposed to confirm that the dredging and disposal methodologies have minimal environmental impact.

Additional investigations, outside the scope of the WQC, were performed during BHNIP construction to address concerns raised by the Technical Advisory Committee or to address potential impacts from changes in operations suggested by the dredging contractor. These additional investigations included:

- Water quality monitoring during disposal at low tide;
- Monitoring turbidity during use of a closed environmental bucket for silt removal;
- Monitoring turbidity during vessel passage over an uncapped and capped CAD cell;
- Bathymetric measurements; and
- Lobster monitoring.

Results of the monitoring showed no water quality violations or significant environmental impacts from construction of the project

Four fish kills were experienced and recorded during 14 underwater blasting events in Boston Harbor during the ledge pinnacle removal project in the late fall of 2007. These fish kills occurred despite following procedures that have been successfully employed during prior underwater blasting events in Boston Harbor and other locations. Methods employed to reduce the probability of fish kills involved the use of side scan sonar to detect and avoid blasting during times when passing schools of fish were present in the immediate projecr area, a fish startle system to deter fish of the Clupeid family (i.e. blueback herring and alewife) from entering the blast area, and a fish observer to oversee and determine the appropriate blasting times. In addition, blast delays and stemming (filling the borehole with rock) are both methods that were employed to reduce the shock waves.

Following the firstfish kill event, the USACE immediately met with the blast contractor and designated fish observer to determine the likely causes of the event and to identify corrective measures for future blasting activities. Resource agencies were also notified of the event and briefed on initial corrective actions before blasting was resumed. Despite these initial corrective measures, subsequent fish kills occurred. In response to these unexpected events, the USACE prepared an "After Action Report" to provide information on all of the blasting events and convened an interagency underwater blasting subgroup of the technical working group with Federal and State resources agencies. The goal of the "After Action Report" and the working group was to determine what lessons could be learned from the 2007 fish kill events, and apply that knowledge and any other identified corrective practicable measures to minimize potential fish impacts during blasting activities for future projects as well as for the Deep Draft Project. Lessons learned were applied to the Boston Harbor Rock Removal Project in 2012 which resulted in no fish kills during the course of the project. The "After Action Report" can be found in Appendix Y of this Final SEIS/EIR.

The blasting mitigation working group of the TWG will focus on ways to minimize impacts during construction of the proposed Deep Draft Project. These measures may include construction sequencing for several areas of the harbor time of year restrictions, operational changes and equipment changes. Some of these decisions must wait until additional rock probes and borings have been completed in the forthcoming Design Phase of the project which will identify the location and quantity of rock in the harbor. The goal of the working group discussions will be to identify practicable and implementable measures to be enacted during project operations to minimize the potential for impact.

FEDERAL DEEP DRAFT NAVIGATION IMPROVEMENT PROJECT BOSTON HARBOR, MASSACHUSETTS

FINAL SUPPLEMENTAL ENVIRONMENTAL IMPACT STATEMENT/ENVIRONMENTAL IMPACT REPORT

1. INTRODUCTION

Boston, Massachusetts is the hub of the nation's tenth largest metropolitan area, with a population of nearly 4.6 million as of 2010. The Port of Boston, which is located within the city of Boston and the adjacent cities of Everett, Chelsea, Hull, and Revere, and the town of Winthrop, is the largest port in New England. The Port handles about 20 million tons of cargo, worth about $9 billion annually to the regional economy. It serves a regional population of 14.3 million residents in the six New England states.

The Port of Boston, Massachusetts, as shown in Figure 1-1, 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 below mean lower low water (MLLW; all subsequent depths are referenced to below MLLW) to the Port's principal terminals, except for the Chelsea River which has an authorized depth of 38 feet, and portions of the Mystic River that remain at 35 feet deep. Deep water access to the harbor is provided by three entrance channels improved and maintained by the U.S. Army Corps of Engineers (USACE); the Broad Sound North Channel in two shipping lanes at 35 and 40 feet deep, 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. The majority of the cargo through the port by volume is petroleum (about 16.5 million tons annually between 2001 and 2010). Autos are landed at the Massachusetts Port Authority's (Massport) Boston Autoport which is located on the Mystic River. Cruise ships call on Massport's Black Falcon Terminal located on the Reserved Channel in South Boston. Containerized cargo is handled at the Massport's Conley Terminal, which is also located on the Reserved Channel in South Boston, which makes up about seven percent of the 22 million tons of cargo. 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.

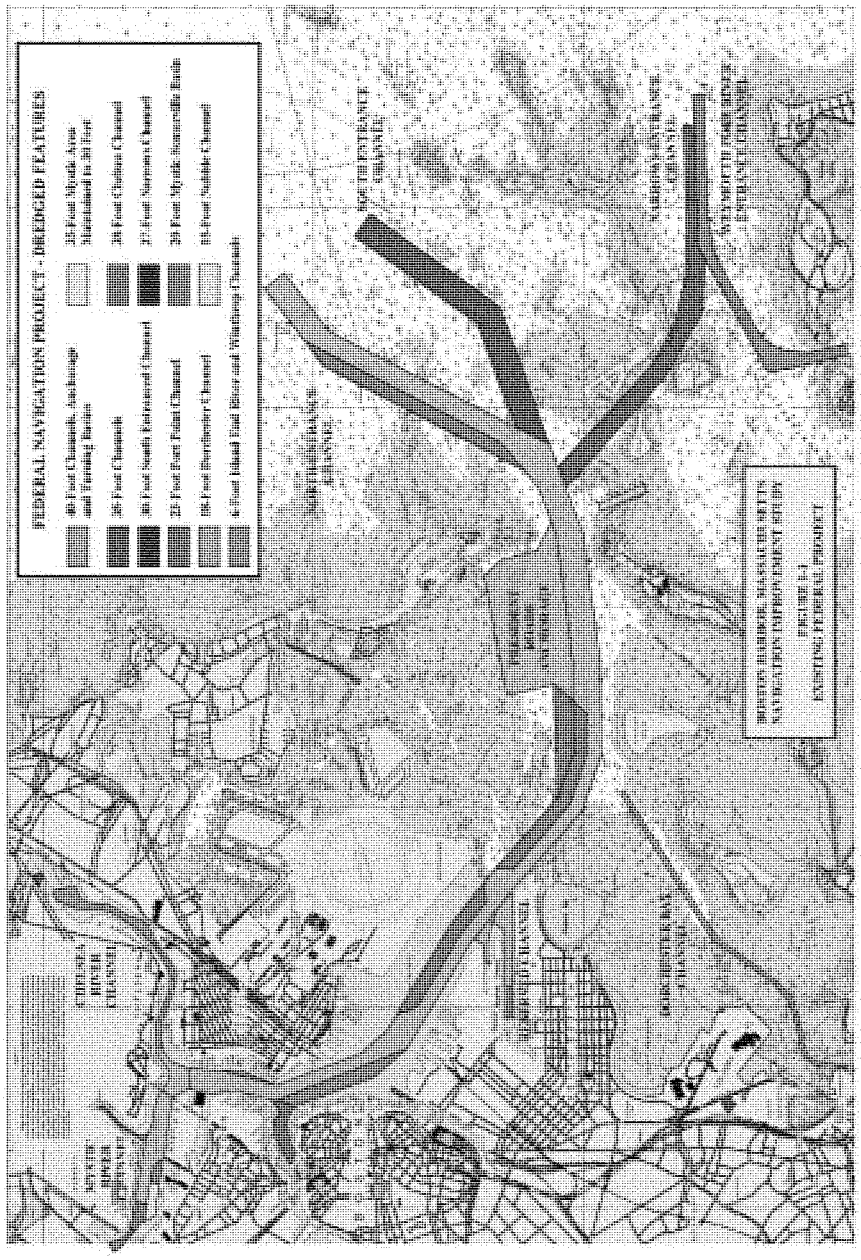


Figure 1-1. Currently Authorized Federal Navigation Project

1.1 Response to Draft Feasibility and Draft Supplemental Environmental Impact Statement/Report Comments

Notice of the availability for public review of the Draft Feasibility and joint Federal and State Draft Supplemental Environmental Impact Statement/Environmental Impact Report (DSEIS/EIR) prepared for this proposed navigation improvement project was published in the Federal Register on 18 April 2008. The public comment period for both the Federal and State review processes closed on 2 June 2008. After presentation of the project to the Civil Works Review Board in August 2008, additional economic analyses were requested, which were completed in May 2012. Resolution of the recommended project depth was made in August 2012. Additional coordination letters were sent to Federal and State agencies on October 11, 2012 to request confirmation that previous determinations provided by the agencies on the Draft SEIS/EIR remain valid before proceeding with issuing the Final Feasibility Report and Final SEIS/EIR. The Massachusetts Environmental Policy Act (MEPA) Office was also asked to formally review their 2008 Scope Certificate for consistency with the current project. No significant changes to previous comments or the Secretary's certificate were received. A number of commenting parties had common concerns with certain aspects of the proposed project. Many of these comments requested additional investigations, which can not be performed until the Planning, Engineering, and Design phase (Design Phase) of the project (which is after public release of the Final SEIS/EIR) due to Federal time and funding constraints. These investigations may result in the need for additional planning, resource agency coordination and consultation, and additional NEPA and MEPA documents to comply with specific areas and topics. Any additional NEPA and MEPA documents generated would be available for public review.

Additional investigations and plans to be developed during the Design Phase include:

- Development of a Blasting Mitigation Plan once the extent of rock thay may require blasting is identified during final design;
- Investigations of potential rock reef sites for beneficial use of rock;
- Investigation of other beneficial uses for rock removed from the project;
- Development of an overall Construction Sequencing Plan;
- Benthic resource definition and recolonization studies for dredged area; and
- Air quality compliance methodology and alternatives.

Details on the above investigations are available in Appendix A – Pertinent Correspondence. Other general topics discussed in this appendix include a description of the USACE Civil Works Process and the continuation of the interagency Technical Working Group (TWG) during the forthcoming Design Phase of the project.

1.2 Project Purpose and Need

1.2.1 Purpose of the Action

The purpose of this Boston Harbor Deep Draft Navigation Improvement Study (Deep Draft Project) is to identify, formulate, screen, and evaluate the feasibility of alternatives for channel deepening and related improvements in the Port of Boston, consistent with the goals of the study sponsor, Massport, and in response to direction from Congress in the authorizing resolution and appropriations acts. Massport's goal is to provide deeper access to their Conley Container Terminal located on the Reserved Channel in South Boston at a depth at least equal to the 45 feet depth 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 being investigated.

Various preliminary alternatives were formulated and screened. 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 rock ledge removal, costs of disposal of dredged material, and costs for environmental mitigation. Project costs also include the associated berthing improvements needed to accommodate the deepened channels.

1.2.2 Need for Improvement Dredging

Without channel deepening, the containerships and bulk carriers currently using Boston Harbor will continue to experience tidal delays. In some cases, vessels that would experience a tidal delay in Boston Harbor, would bypass Boston all together so as not to jeopardize their arrival schedule in other ports. As other ports proceed with channel deepening projects in response to the expansion of the Panama Canal carriers will add larger vessels to the services that currently include Boston Harbor. These carriers may be forced to eliminate Boston from their rotation, as the tidal restraints caused by the 40-foot deep channel make a stop in Boston Harbor more costly. Because of these factors, a large part of New England cargo will continue to be shipped in or out of the Port of New York/New Jersey (PONYNJ), increasing total transportation costs. Substantial quantities of import and export cargo have shifted from the PONYNJ to Boston Harbor because of the lower landside transportation costs for cargo shipped directly into of from Boston Harbor. However, the shift in cargo from the PONYNJ to the Port of Boston Harbor will reverse itself once the carrying capacity and draft of the ships calling along the U.S. East Coast increases, and the tidal restrictions caused by the 40-foot deep Boston Harbor navigation channel depth becomes unsustainable from an economic and scheduling standpoint.

1.2.3 Congressional Authorization

Boston Harbor and its navigable tributaries have been extensively improved and developed by the USACE, State, and local interests. The first Federal Boston Harbor navigation project was authorized in 1822. The most recent improvements and modifications were authorized by the Water Resources Development Act of 1990, for which the Boston Harbor Navigation Improvement and Berth Dredging Project (BHNIP) Environmental Impact Report/Statement (EIR/S) (USACE and Massport, 1994, 1995), which this document supplements, was prepared. These modifications consisted of deepening portions of the Mystic River, Inner Confluence, and lower Reserved Channel from -35 feet MLLW to -40 feet MLLW. In addition, a small section of the 35-foot deep Main Ship Channel across from the Reserved Channel was deepened to –40 feet MLLW to aid in turning of vessels into the Reserved Channel. The Chelsea River channel, which serves the majority of the petroleum needs of the region and supplies fuel to Boston's Logan International Airport, was deepened from -35 feet MLLW to -38 MLLW. In addition, non-structural improvements to realign the main entrance and approach channels by designating Federal channel limits and repositioning navigation buoys were also authorized. These modifications, known as the Boston Harbor Navigation Improvement Project, were completed in 2002. See Figure 1-1. Additional work to widen the Chelsea River channel through the new Chelsea Street Bridge opening was completed in 2012.

The New England District, U.S. Army Corps of Engineers has been authorized to conduct the current Feasibility Study to evaluate whether or not Federal participation in additional navigation improvements at Boston Harbor 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."

An expedited reconnaissance investigation was initiated at the request of Massport, the study sponsor, in December 1999 using funds provided in the Fiscal Year 2000 Energy and Water Development Appropriations Act. This Act directed a study to provide a channel depth of at least 45 feet to the Conley Terminal. The 905(b) Reconnaissance Report was approved by U.S. Army Corps of Engineers North Atlantic Division and Headquarters in August 2000.

The USACE and Massport executed the Feasibility Cost-Sharing Agreement (FCSA) for this project on June 27, 2002 and the study was initiated in July 2002. A Notice of Intent to prepare a Supplemental Environmental Impact Statement for the project was published in the Federal Register on August 23, 2002, and the first public involvement meeting on the proposed project was held on September 5, 2002. An Environmental Notification Form was submitted on January 31, 2003 by Massport to the Massachusetts Environmental Policy Act (MEPA) Office and published in the Environmental Monitor on February 8, 2003 by Massport to initiate the MEPA process. The Secretary of Environmental Affairs determined on March 10, 2003 that an EIR would be required for the project. As before, to avoid duplication, a joint Federal and State environmental document was prepared (SEIS/EIR).

The preferred alternative will be selected based on the USACE economic guidance related to project net benefits as well as input from the study sponsor, while minimizing environmental impacts.

1.2.4 Laws and Regulations Governing Dredged Material Disposal

The primary authorities that apply to the disposal of dredged material in United States waters are the Marine Protection, Research, and Sanctuaries Act (MPRSA) of 1972 and the Clean Water Act (CWA) of 1972. Which requirements apply depend on whether disposal activities occur landward of the territorial sea baseline, seaward of the three-mile limit, or in the overlap area between the two lines. The jurisdiction of MPRSA and CWA overlaps within the territorial sea, which is defined as the open water between the baseline and the States' three-mile territorial limit. Where jurisdiction overlaps, CWA takes precedence where dredged material is used as fill, such as beach nourishment, while MPRSA takes precedence for transit of dredged material for disposal purposes other than fill. MPRSA does not apply to disposal actions inside the baseline, and the CWA does not apply outside the three-mile limit. The Massachusetts Bay Disposal Site (MBDS) lies seaward of the three mile limit and is therefore subject only to MPRSA. Disposal of rock from the project for beneficial use within Broad Sound or Massachusetts Bay to create habitat enhancement sites would be subject to the CWA and not MPRSA as these sites lie landward of the baseline.

Congress enacted the MPRSA of 1972 to address and control the disposal of dredged materials in ocean waters. Regulations implementing MPRSA were promulgated by U.S. EPA and are codified at 40 CFR Parts 220-228. Title 1 of the MPRSA authorized the EPA and the USACE to regulate disposal in U.S. ocean waters. EPA and the USACE share responsibility for managing dredged material. The MPRSA prohibits the disposal of dredged materials into water under its jurisdiction unless conducted in compliance with a permit issued by the USACE under Section 103 of the MPRSA or authorization under the USACE Civil Works Program (33 U.S.C. Section 1411(a) and Section 1413(a)). USACE dredged material disposal permits and authorizations are issued under MPRSA Section 103 and may include conditions deemed necessary by the USACE related to the type of material to be disposed of, time of disposal, and other matters (33 U.S.C. Section 1413 and Section 1414(a)). The dredged material disposal permitting process requires consideration of a range of disposal alternatives, including beneficial reuse and upland treatment and disposal.

The USACE approves a dredging project under its Civil Works Authority only if it has determined that dredged material disposal "will not unreasonably degrade or endanger human health, welfare, or

amenities, or the marine environment, ecological systems, or economic potentialities" (33 U.S.C. Section 1413(a)). The USACE makes MPRSA Section 103 determinations by the standards set forth in EPA regulations (33 U.S.C. Section 1413(b)). EPA has promulgated its ocean disposal regulations pursuant to MPRSA Section 102(a) (33 U.S.C. Section 1412(a), at 40 CFR Parts 220 to 229). The Section 404 permit program is implemented by the USACE and covers the discharge or placement of dredged and fill material into inland waters of the United States. As in MPRSA above, the USACE does not issue itself a CWA permit for projects under the USACE Civil Works Authority but does apply the 404 (b)(1) guidelines and other substantive requirements of the CWA and other environmental laws (33 CFR Part 335).

For most dredged material disposal projects, the USACE solicits comments from the NOAA – Fisheries, U.S. Fish and Wildlife Service (FWS), EPA, and State regulatory agencies to ensure that the project conforms to applicable State water quality standards (if within the State's territorial waters) and is consistent with the State Coastal Zone Management Act program. USACE permit determinations and civil works approvals are also subject to any applicable requirements of other laws (e.g. the Endangered Species Act, the Fish and Wildlife Coordination Act, etc.). See the Environmental Compliance Section below for applicable laws.

1.3 Summary of Major Changes and Lessons Learned from the 1995 Final Environmental Impact Report/Statement and Subsequent Maintenance Dredging Projects

This Final Supplemental Environmental Impact Statement/Environmental Impact Report builds on the lessons learned from the Boston Harbor Navigation Improvement Project (BHNIP) located in Massachusetts, which was the subject of a Final Environmental Impact Report/Statement prepared in 1995 (USACE and Massport, 1995) and on lessons learned from the Outer and Inner Harbor Maintenance Dredging Projects and 2012 Boston Harbor Rock Removal Project. Since the mid-1990's, the BHNIP has been constructed (see Figure 1-2 for location) and additional maintenance dredging of the navigation channels in Boston Harbor has been completed. The Boston Harbor Outer Harbor Maintenance Dredging Project (OHMDP) restored the navigation channels to their authorized depths in 2004 and 2005 in the 40-foot channel reach approximately halfway between Castle and Spectacle Island seaward to deep water in Broad Sound North Channel, as well as the President Roads Anchorage. See Figure 1-3.

In 2007 and 2008, the Boston Harbor Inner Harbor Maintenance Dredging Project (IHMDP) removed rock outcrops and dredged shoals from the 35-foot and 40-foot deep Main Ship Channel to its authorized depth from the point where the previous maintenance dredging project left off (from approximately halfway between Castle and Spectacle Islands) to a point upstream of the North Jetty (located just below the Third Harbor Tunnel), the upper Reserved Channel, and the approach channel to the Navy Dry Dock. In addition, approximately 3,600 cubic yards (cy) of material was dredged from Boston Redevelopment Authority berth #4 to a depth of -30-feet, and the abandoned Keyspan gas siphon was also removed from the channel in the vicinity of the Chelsea Street Bridge to allow for the deepening of the Chelsea River navigation channel to its authorized depth.

Two Confined Aquatic Disposal (CAD) cells were constructed in association with these efforts. One larger CAD cell was constructed in the Mystic River located near the Inner Confluence, and another smaller CAD cell constructed in the Main Ship Channel just south of the Inner Confluence. Approximately one million cy of dredged material was placed at the MBDS from construction of the CAD cells (720,000 cy) and maintenance dredging (310,000 cy). Another 380,000 cy was placed into the two CAD cells for a total of 1.4 million cy of dredged material. About 2,000 cy of rock was also removed from the project. Construction of the IHMDP began in mid-May of 2008 and was completed in mid-December 2008. The capping of the cells began on January 5, 2010 and was completed on

February 2, 2010. The CAD cells were capped with sand dredged from the Cape Cod Canal. See Figure 1-4 for project location of the IHMDP.

In 2012 the Chelsea River navigation channel was widened at the location of the Chelsea Street Bridge when MA Department of Transportation (MADOT) replaced the existing bridge with a new vertical lift bridge. The original opening for ship traffic through the Chelsea Street Bridge was only 96-feet wide. The bridge replacement included the removal of the existing fender system which would have created a navigation hazard if the channel was not widened. The navigation channel was widened to a minimum of 175 feet. In addition, the remainder of the Keyspan gas siphon (that was located under the fender system) was removed as well as a railroad bridge counterweight that was located out of the existing channel but within the widened channel area. Both the pipeline and counterweight were disposed of upland. Dredging was initiated on March 24, 2012 and completed on April 19, 2012. A total of about 33,000 cy of dredged material was removed and disposed at the MBDS. See Figure 1-5 for project location of the Chelsea River/Bridge widening.

Rock was removed from seven areas near Castle Island that were above the authorized depth in the 40-foot deep lane of the Main Ship Channel. Holes were drilled in the rock beginning on August 18, 2012 and completed on August 31, 2012. Blasting began on September 6, 2012 and was completed on September 21, 2012. The blasted rock was removed with a mechanical dredge between September 23 and October 1, 2012. All material was placed at the MBDS. See Figure 1-6 for project location of the rock removed for the Boston Harbor Rock Removal Project (BH Rock Removal).

Table 1-1 lists the construction dates for the various Boston Harbor Federal navigation maintenance and improvement projects and their acronyms.

Table 1-1. Recent and Proposed Boston Harbor Federal Navigation Projects (and Acronyms)

Project Name	Dates Constructed
Boston Harbor Navigation Improvement and Berth Dredging Project (BHNIP)	1998 to 2000 (additional minor work in 2001 and 2002)
Boston Harbor Outer Harbor Maintenance Dredging Project (OHMDP)	2004 to 2005
Boston Harbor Inner Harbor Maintenance Dredging Project (IHMDP)	2007 to 2008 (CAD cell capping in early 2010)
Chelsea River Navigation Widening (Chelsea River Widening)	2012
Boston Harbor Rock Removal Project (BH Rock Removal)	2012
Boston Harbor Deep Draft Navigation Improvement Project (Deep Draft Project)	Anticipated 2015 to 2017+

Experience gained from these projects have been used to guide development of the dredging and disposal plans for this Deep Draft Project. The lessons learned as a result of the extensive environmental monitoring conducted during construction of Phase 1 and Phase 2 of the BHNIP allowed us to identify and implement measures and techniques to reduce potential Deep Draft Project impacts. Additional plume monitoring performed during the IHMDP generally confirmed the monitoring results of the BHNIP monitoring; that except for the area below Castle Island where several bodies of water meet, all the dredged and disposal plumes stayed confined to the navigation channel. This monitoring has been used to assess potential impacts for the Deep Draft Project.

Environmental monitoring conducted as part of the BHNIP WQC included:

- Silt plume tracking during different periods if dredging of and after disposal into CAD cells;

- Water quality testing after disposal into the CAD cells;
- Biological testing for contaminants;
- Dissolved oxygen (DO) monitoring within and outside the CAD cells; and
- Fisheries monitoring during blasting operations (including a fish observer, startle system, etc.).

Additional investigations were also performed during BHNIP construction from 1997 to 2000 to address concerns raised by the Technical Advisory Committee or to address potential impacts from changes in operations requested by the dredging contractor. These additional investigations included:

- Turbidity monitoring during disposal at low tide;
- Monitoring turbidity during use of the closed environmental bucket for silt removal;
- Monitoring turbidity during vessel passage over an uncapped and capped CAD cell;
- Bathymetric measurements; and
- Lobster monitoring.

Lessons learned from Phase I (deepening berths 11 and 12 at Conley Terminal) and Phase II (the remaining project) during construction and monitoring are described below and show that with proper operational controls, physical and biological water quality impacts from dredging and disposal activities in the harbor is localized and temporary. Environmental monitoring showed that dredging silt material with a closed bucket did not result in any water quality violations either from turbidity or resuspended contaminants, according to the standards set in the WQC (USACE/Normandeau Associates 1998a-f, 1999a-k, 2000a). Turbidity values returned to normal within 600 to 1,000 feet downstream of dredging. Additionally, no water quality violations were observed during removal of parent material.

Turbidity interfered with the electronic depth sensors on the closed bucket during Phase I which resulted in under and overdredging. Other problems arose with the electronic sensors on the closed bucket when the electric wires on the closed bucket used to determine bucket closure were severed in the first few hours. A decision was made to return to traditional methods for determining the closed bucket depth, which were successful.

Monitoring of silt disposal into CAD cells was reduced from a 12 hour period after disposal in Phase I to between four and six hours in Phase II because a discernable plume could not generally be found six hours after disposal. In addition, no difference was noted in the intensity or areal expansion of the disposal plume when silt was disposed during high or low slack tides. Also, data revealed that there was no substantial difference in plume development when disposal operations occurred when the CAD cell was more than 50% full. The results of the monitoring indicate that the disposal plume did not violate any water quality standards at any time nor did the plume leave the navigation channel. Results from a vessel passage study indicated that more material was resuspended in the navigation channel by a transiting vessel heading toward sea than resuspended by the vessel passing over the uncapped the CAD cells. Biological tests (bioaccumulation, sea urchin fertilization, and bioassays) also did not reveal any significant impacts from dredging and disposal into the CAD cells in the harbor. Data referenced in USACE/Normandeau Associates Water Quality Monitoring Reports (1998a-f, 1999a-k, 2000a-b)

Lobstermen expressed concern that dredging the navigation channels when lobsters were present in greater numbers during the warm months could impact overall catch and affect their livelihood. The scows were checked in the summer when they were located in the Reserved Channel (where there is traditionally a higher concentration of lobsters) to see if lobsters were removed along with the dredged material by the dredge bucket. The results of these scow inspections indicated that lobsters were not impinged during dredging operations, which served to alleviate or eliminated the lobstermen's

concerns. It is believed that the lobsters either avoid or left the areas that were being disturbed by dredging actions.

Fisheries protection measures (i.e. time restrictions on blasting and/or a fisheries observer, sonar system and fish startle system) implemented during the course of the BHNIP dredging operations appeared to be effective during blasting and CAD cell disposal activities as no fish kills were observed. Dredging operations and protective measures appeared to deter fish from the project area. However, four fish mortality events were observed and recorded during 14 underwater blasting events in Boston Harbor during the ledge pinnacle removal project as part of the IHMDP in the late fall of 2007. These fish kills occurred despite following procedures that have been successfully employed for underwater blasting for prior projects in Boston Harbor at and other locations. Methods employed during these prior projects to reduce the potential for fish kills involved the use of a side scan sonar to detect and avoid passing schools of fish, a fish startle system to deter fish of the Clupeid family (i.e. blueback herring and alewife) from entering the blast area, and a fish observer to oversee and determine the appropriate blast time. Blast delays and stemming (filling the borehole with rock) are both methods to reduce the shock wave from blasting and were employed during blasting of the ledge.

Following the first fish kill event, the USACE immediately met with the blast contractor and designated fish observer to determine the likely causes of the event and to identify corrective measures for future blasting activities. Resource agencies were notified of the event and briefed on initial corrective actions before blasting was resumed. Despite these initial corrective measures, subsequent fish kills occurred. One of these fish kills was caused by a safety/regulatory requirement that charges in the water must be fired and the area cleared prior to dusk. Detonation has been delayed by several hours waiting for the fish to clear the area, but due to human safety concerns, detonation occurred.

In response to these unexpected events, the USACE prepared an "After Action Report" to provide information on all of the blasting events and convened an interagency underwater blasting subgroup of the technical working group with Federal and State resources agencies. The goal of the "After Action Report" and the working group was to determine what lessons sould be learned from the 2007 fish kill events, and apply that knowledge and any other identified corrective practicable measures to minimize potential fish impacts during blasting activities for future projects as well as for the Deep Draft Project. Lessons learned were applied to the Boston Harbor Rock Removal Project in 2012 which resulted in no fish kills during the course of the project. The "After Action Report" can be found in Appendix Y of this Final SEIS/EIR. The blasting working group will focus on ways to minimize impacts during construction of the proposed Deep Draft Project. These measures may include construction sequencing for several areas of the harbor, time of year restrictions, potential operational changes, and equipment changes. The goals of the working group discussions will be to identify practicable and implementable measures to be enacted during project operations to minimize the portential for impact.

A hydrophone was placed in the water during three blast events for the Boston Harbor Rock Removal Project constructed in 2012. The purpose of the hydrophone was to collect sound pressure (waves) from actual blasting events. The data was used in calculations to determine protective zones for protected species such as whales, sea turtles and the Atlantic sturgeon that could be impacted from the proposed project. More detail on this data and the calculations can be found in Section 4.2.5.

From an operational perspective, one of the primary "lessons learned" from the Phase I and II dredging/disposal activities was the method to effectively cap the silt material in the CAD cells with sand and assess rates of silt consolidation. Initially, regulators were concerned that the silty dredged material deposited in the CAD cell could become resuspended by passing vessel traffic. For this reason, they required that the CAD cell be capped as soon as possible after the last placement of dredged mataerial into the cell. The initial sand caps were not successful because the silty dredged material had not consolidated sufficiently to support a sand cap. Silt consolidation increased from two

weeks in Phase 1 to 60 days prior to cap placement in the Water Quality Certification for Phase II. During Phase II, the time allowed for silt consolidation was increased again from two months to more than seven months to try and create a model cap, that is, a distinct cap separating the silt from the rest of the harbor bottom. A simple "plop test" was used to determine when the silt material exhibited enough solidification to hold a sand cap. The "plop test" consisted of piece of wood with concentric circles. The silt was placed in the center of the wood. The distance the silt moved and the amount of time was measured. When the material showed minimal movement, it was determined to be of sufficient strength to support a cap. It was also determined that cap placement was far more effective when performed from a moving rather than a stationary platform. Other measures such as not anchoring (spudding) or mechanically disturbing the cap material also served to minimize overall disturbance to cell structure. In subsequent projects with CAD cell placement, the CAD cell would be surveyed at different intervals. As the material consolidates, it settles. When the settlement rate slows, the material has consolidated enough to support a cap.

Minimal or no silty maintenance material, unsuitable for ocean disposal, is expected to be removed during the Deep Draft Project, unless deferred maintenance of the upper Main Ship Channel (above the Massport Marine Terminal) is pursued. Therefore the construction of new CAD cells to hold the silty shoal material from the Deep Draft Project is unlikely, but would be needed to hold the remaining maintenance material not dug during the IHMDP.

Figure 1-2. Boston Harbor Navigation Improvement Project (BHNIP)

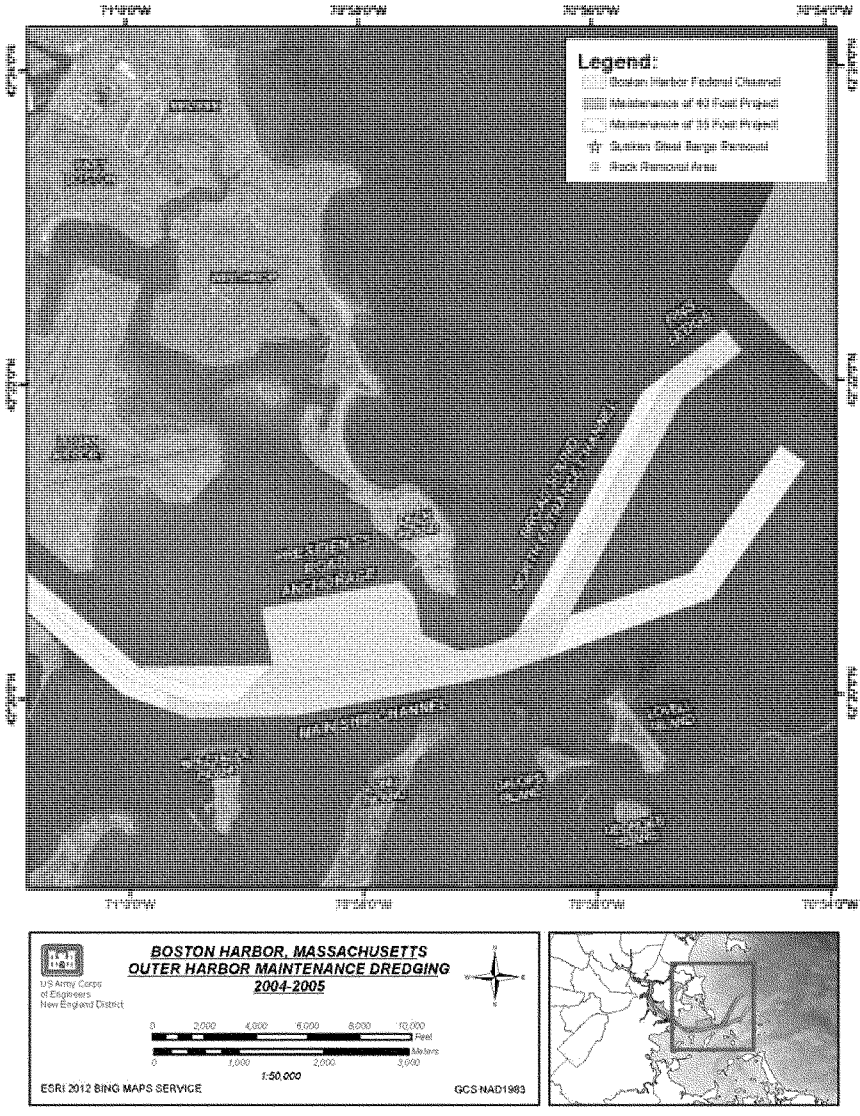


Figure 1-3. Outer Harbor Maintenance Dredging (OHMDP)

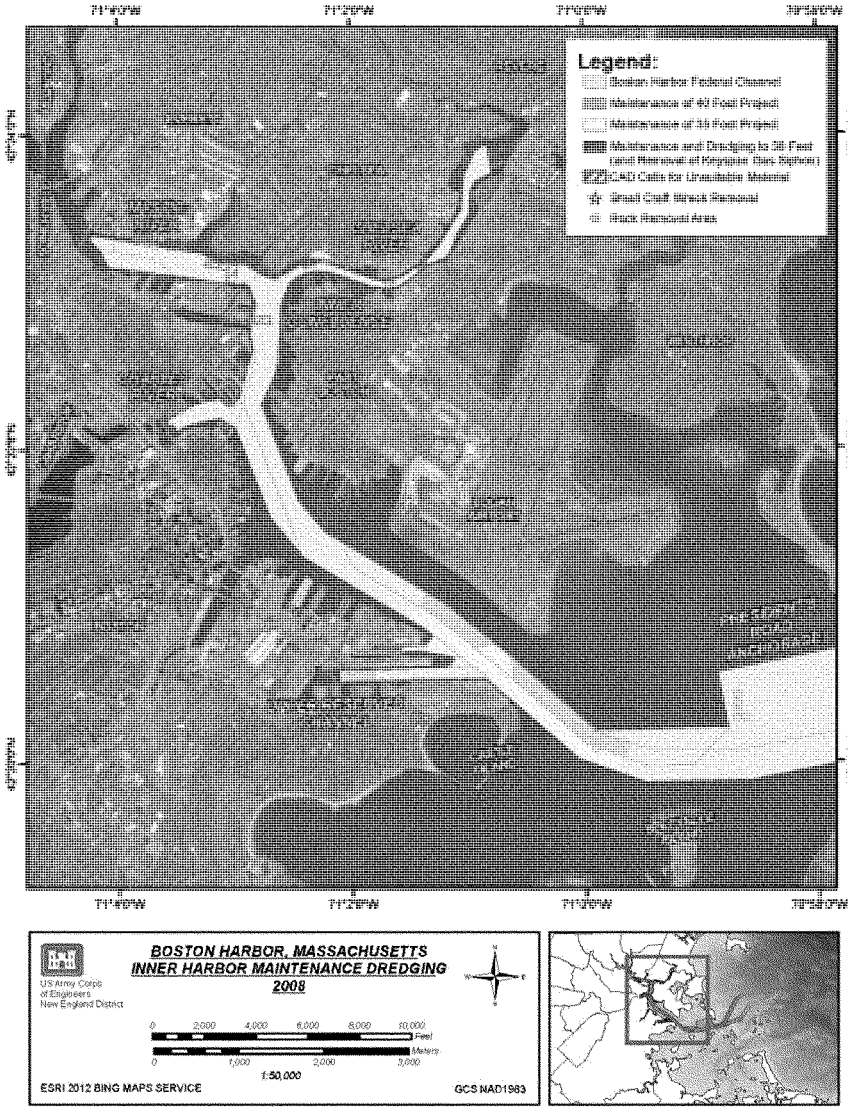


Figure 1-4. Inner Harbor Maintenance Dredging Project (IHMDP)

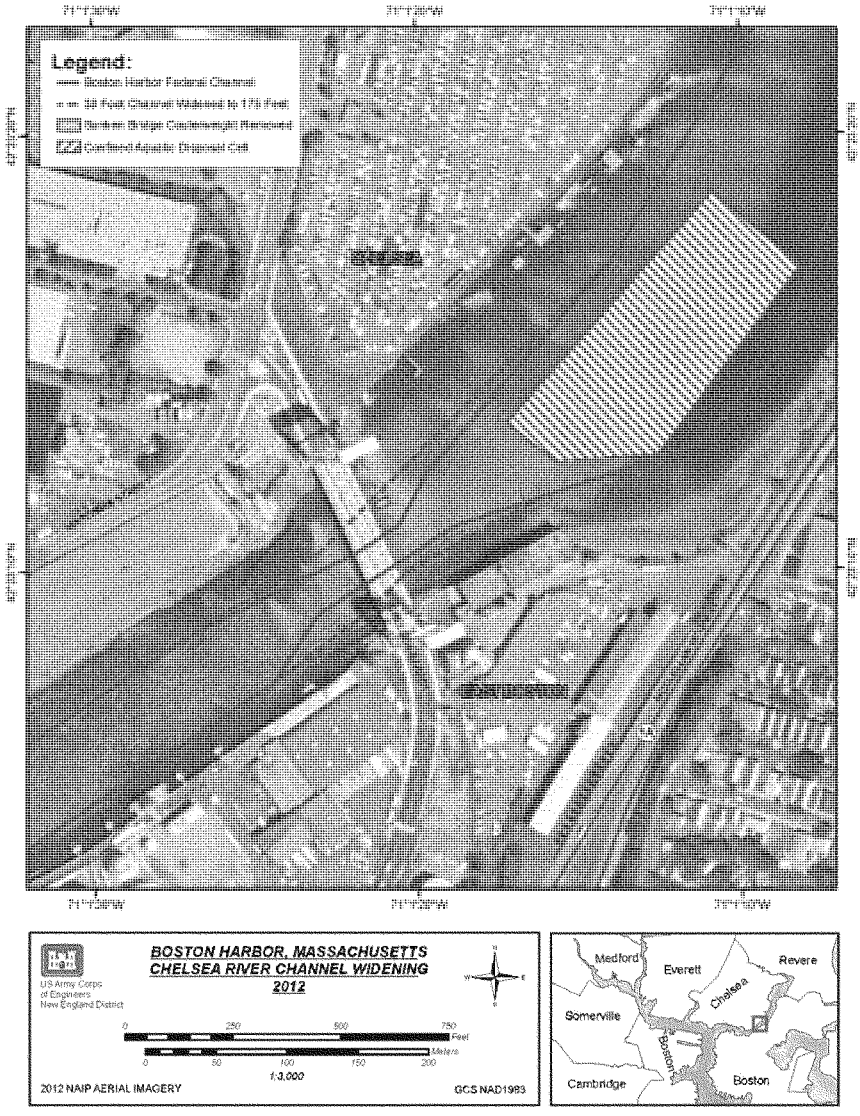


Figure 1-5. Chelsea River Navigation Widening (Chelsea River Widening)

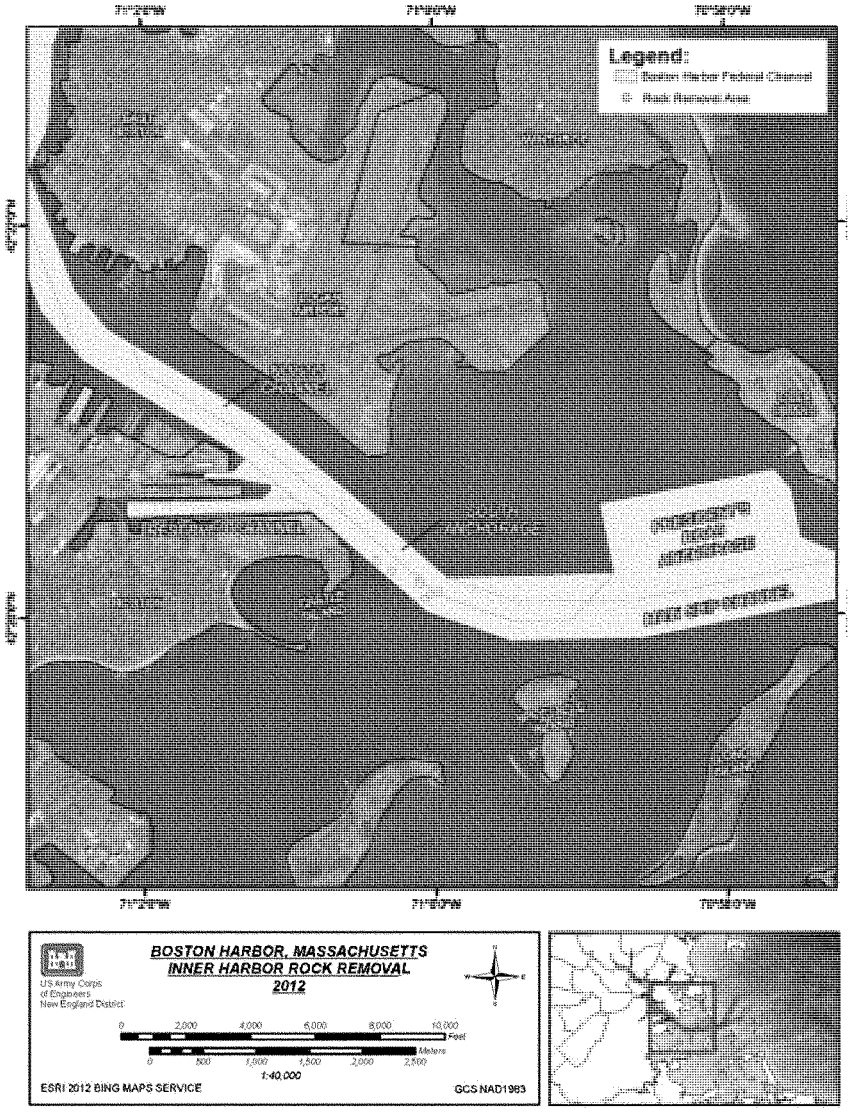


Figure 1-6. Inner Harbor Rock Removal (BH Rock Removal)

2. ALTERNATIVES

The objective of the Boston Harbor Deep Draft Navigation Improvement Study is to develop an optimal plan for effectively and efficiently accommodating existing and likely future deep-draft vessel traffic in the Port of Boston. The optimal plan for Federal participation must be consistent with the USACE National Economic Development (NED) perspective as set forth in the USACE 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 USACE of Engineers 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[1]. Alternative plans were evaluated based on the extent to which they meet one or more of the following planning objectives:

- Contribute to National Economic Development by minimizing the cost of transporting cargo to and from New England in an environmentally acceptable and sustainable manner;
- Reduce current and expected future tidal delays at Boston Harbor;
- Reduced current and expected future light loading requirements for vessels calling at Boston Harbor;
- Reduce current lightering requirements and potential future increases in lightering for petroleum tank ships calling at Boston Harbor;
- Reduce current and expected future turning and maneuvering access problems in Boston Harbor;
- Maximize the beneficial use of dredged material for habitat creation and other purposes; and
- Consider all the previously identified opportunities in the formulation and evaluation of alternative plans, while achieving the above-listed objectives.

The National Environmental Policy Act (NEPA) and Massachusetts Environmental Policy Act (MEPA) scope also require a discussion of project alternatives, including the "No Action Alternative." The following sections provide a detailed overview of alternatives to the proposed project including non-structural alternatives, alternative structural/navigation channel depth alternatives, and dredging methods. Since this is a Supplemental EIS/EIR, the preferred design is evaluated in the context of disposal alternatives addressed in the BHNIP EIR/S. Options for beneficial use of dredged materials are also considered.

2.1 No Action Alternative

Under the No Action Alternative, the proposed project would not be constructed and the benefits and impacts associated with the proposed project would not occur. The No Action Alternative would become the recommended plan if 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 benefits) or is deemed environmentally unacceptable. Future conditions under the No Action Alternative are detailed below.

Alternative means of cargo transport consist mainly of trucking the cargo landed at more distant ports into the region. Under the existing and No Action Alternative, large volumes of New England destined cargo are landed at the Port of New York and New Jersey (PONYNJ). This cargo is then trucked into the region or loaded onto railcars for transport to Boston or to Worcester in the case of

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

rail. Barge and other feeder services linking Boston to the PONYNJ, Halifax, Portland, ME, and Portsmouth, NH have been tried in recent years, but all have failed and ceased sercie due to a lack of cargo. The practice of trucking the majority of New England's container cargo from PONYNJ is expected to continue under the No Aetion Alternative, with some diversion of New York landed cargo destined for eastern New England landing at the Port of Boston. As this practice is already captured in the cargo routing and volume analysis for the improvement alternatives at Boston, it is not carried as a separate alternative.

The changes in world container fleet characteristics must also be considered in determining the future No Action Alternative, as well as in analyzing channel improvements. New containerships under construction are increasing the overall average size of vessels in the world fleet substantially. There are new vessels under construction in the 7,000 to 13,000 TEU range. While the largest of the these ships will likely only serve on the Paeific trade routes, several steamship lines already engaged in North Americean east coast service have stated their intent to shortly begin operating vessels of 8,000 TEUs. As the average size of vessels in service continues to increase, ports that don't making corresponding improvements in channel depth could see themselves dropped from the lines' port rotation. That would leave these ports and their market regions more heavily reliant on rail, barge feeder service, and overland transportation of cargos. Increased truck, rail or barge transportation of containers destined for or originating in eastern New England is a likely result of failure to make channel depth improvements in the Port of Boston.

Containerships currently using Boston Harbor will continue to experience tidal delays to make the tidal window for arrival or departure. A large part of New England cargo will continue to be shipped in or out of the Port of New York/New Jersey (PONYNJ), increasing total transportation costs and air pollution. Recent trends show some cargo being shifted from the PONYNJ to Boston Harbor. This is due to the lower landside transportation costs when cargo is shipped directly to Boston Harbor. This trend will continue in the near term only to the extent that the ships can utilize the current 40-foot deep maintained navigation channel.

Under the No Action Alternative, the relatively shallow controlling depth in Boston Harbor would make it unlikely that any cargo liner services calling at Boston Harbor could upgrade their existing fleet with larger vessels beyond the fleet adjustments that will be made in response to the upcoming maintenance dredging. Any line that decides to increase their vessel size would likely need to drop Boston Harbor from their port call rotation for that liner service. In addition, it is unlikely that any new services with larger vessels would call at Boston Harbor. Growth of container shipping through Boston Harbor, measured in twenty-foot equivalent unit (TEU) volumes, for the two Mediterranean Shipping Company (MSC) liner services would be limited to the additional sailing draft for some of the MSC vessels afforded by the current channel depths. TEU volume growth for the China Overseas Shipping Company (COSCO) liner service is expected to continue as cargo is shifted from the PONYNJ. Boston Harbor TEU growth on the COSCO service will end when the vessels achieve their maximum sailing drafts given the existing channel depth. However it is important to note that COSCO would likely add larger vessels to this service (which runs through the Panama Canal) once the Panama Canal is deepened and widened, which is expected to be completed by late 2014 to 2015. At this point, COSCO may need to drop Boston from their rotation due to inadequate depth.

Currently, the PONYNJ handles about 62 percent of the delivered New England containerized cargo, while the Port of Boston only handles 38 percent of New England TEUs. A small volume of New England containerized cargo is handled at Los Angeles/Long Beach and is trans-shipped to New England by rail, or is landed at other ports. Since 2003, cargo volumes at Boston have increased by 22%. New vessel services have been added, and existing services have regularly increased the size of their vessels. Most of the containerships calling the port now are generally loaded to capacity given the channel depth and operating constraints of each line. As liner serviees have become available at Boston over the past few years, New England importers and exporters have been shifting from the PONYNJ to Boston Harbor to take advantage of lower total transportation costs via Boston Harbor.

Based on an analysis of current trucking costs and port fees at Boston versus PONYNJ, it is estimated that the average cost savings for New England cargo using Boston Harbor versus PONYNJ is $464/TEU imports and $500/TEU exports, including port fees. The trucking cost savings are based on a weighted average of actual cargo origins and destinations in New England. Some locations in southern New England, particularly much of Connecticut, are located closer to PONYNJ.

Besides container ships, tank ships and other bulk carriers also transit Boston Harbor to import and export cargo. 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.

Over the period of 2001 to 2005, the Port of Boston handled an average of about 22,000,000 tons of cargo annually, of which about 17,000,000 tons were petroleum products. The Distrigas (LNG) and Exxon-Mobil terminals are located on the Mystic River's 40-foot deep navigation channel. Sunoco Logistics Petroleum, Gulf Oil, Irving Oil, and Global Petroleum are located on the Chelsea River 38-foot deep channel. Seventy percent (70%) of the harbor's fuel shipments, including all aviation fuel for Logan International Airport, comes through the Chelsea River.

Due to tidal conditions and draft restrictions, tank vessels often wait on the tide in the President Roads Anchorage where they occasionally lighter onto smaller ships or barges before completing transit to the berth, particularly Chelsea River bound vessels. Chelsea River bound vessels were, in the past, 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 due to safety concerns. However, a new and wider bridge replaced the old Chelsea Street Bridge in the summer of 2012. The current 38-foot deep Federal channel was the maximum that could be justified without bridge replacement, removal of the Keyspan gas siphon, and other improvements to ease turns and bridge approaches in what has been a narrow channel. The channel has now been widened to 175 feet, and deepening the channel to 40 feet is being examined in this study.

Non-tank bulk carriers currently import cement, salt, 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 Terminal 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 could transit further up-harbor above the tunnels. The Massport Marine Terminal currently has 40 foot deep channel 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).

In addition to the Massport Marine Terminal in South Boston, Massport also plans on deepening the two deepest Conley Terminal Berths (#11 and #12) to at least three feet deeper than any recommended channel improvement. The additional berth depth would allow vessels to take advantage of Boston's tides and the short six-mile transit distance between the Bay and Conley Terminal, as many presently do with the berths already deeper than the 40-foot channels. Massport has and will continue to invest in new post-panamax cranes, new terminal layouts, and other infrastructure to achieve greater terminal capacity and efficiency to accommodate the increase in cargo expected from larger vessels.

Impacts avoided with the No Action Alternative include the effect from construction such as a temporary decrease in water quality from turbidity, potential impacts to biological resources from dredging and blasting, and temporary water quality, and biological impacts from the disposal of

dredged material. The environmental benefits that would not be realized from the No Action Alternative are: a reduction in regional air pollution from a decline in truck traffic, the loss of potential to use the rock to create a rock reef or other beneficial use,, and the potential to use the parent material as cover for barrel fields at the Industrial Waste Site. See Beneficial Use Alternatives Section 2.7 below.

2.2. Non-Structural Alternatives

Non-structural alternatives for achieving the planning objectives for this project, in whole or in part were examined. These alternatives do not involve improving the Port's existing General Navigation Feature's (GNF) and fall into three broad categories:

- Measures that allow for greater unit-loading of vessels without deepening;
- Alternative sites for cargo transfer (other terminals or ports); and
- Alternative means of cargo transport.

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

At Boston, the largest carriers for all cargo categories already have maximum navigation drafts in excess of the channel depths and use the tide to time their transits through the harbor to and from the terminals. Continued port operations using these loading and routing measures will only continue the problems encountered under the without-project condition, as cargo volumes increase. The sizes of vessels commonly employed in trans-Atlantic and Asian trade continue to increase, and all of the lines calling on Boston have plans to increase vessels sizes on these services, to the point that some or all of the deep draft container liner services may need to drop Boston from their rotations in the near future.

The use of alternative sites for cargo transfer of Boston-bound cargo has severe limitations. As stated above, container operations at Boston are segregated in a single terminal (Conley), the terminal located closest to the sea. In the heavily developed metropolitan area of eastern Massachusetts, no other sites exist at which a new terminal could be constructed. In any event, the cost of developing a new container terminal (several billion dollars) would far exceed the cost of improving the channel depths to the existing site.

Several years ago the State of Rhode Island had proposed to develop a new regional deep-draft container port at Quonset-Davisville, a former U.S. Navy facility. However, the proposal became a major issue in the 2004 Rhode Island gubernatorial campaign, and the new governor terminated planning efforts for development of this container port. The proposal is not expected to be resurrected in the foreseeable future. No other New England ports have the facilities and depths sufficient to provide a viable alternative to the Port of Boston for containerized cargo.

No practicable non-structural alternatives are apparent for meeting New England's need for container cargo shipping beyond continuation of the existing condition or improvement to shipping access to the Port of Boston.

2.3 Alternative Structural/Navigation Channel Depths

2.3.1. Entrance and Main Ship Channel Deepening

Containerships are currently the deepest draft vessels calling on the Port of Boston, and will remain so under the No Action and with-project Alternatives. Two classes of containership were modeled in a

ship simulation study; a large 4,700-5,100 TEU Panamax ship, and a larger 5,600 TEU Post-Panamax containership. Over the project's economic life, still larger vessels may be used in the harbor if sufficient depth is available and current industry trends toward the use of larger vessels continue. These large containerships generally require an underkeel clearance of ten percent of their operating draft (about four feet in the inner harbor), depending on their sailing draft. The Boston Harbor Pilots require 10 percent of sailing draft as underkeel clearance. The anticipated transit drafts for these vessels at Boston are provided in the economic analysis conducted for containership benefits. With underkeel clearance, the Panamax vessels would require a 45-foot channel depth in the harbor and a 49-foot depth in the entrance channel due to the increased sea state. The 5,600 TEU vessel class would require a maximum of a 47-foot depth in the inner harbor and a 51-foot depth in the entrance channel to operate most tidal conditions. Larger 6,700 to 8,500 TEU ships would require 50 foot depths (54 feet in the entrance channel) to operate with most tidal conditions or 47 feet (51 in the entrance) with tidal assistance. A two-foot overdepth allowance would be added to these elevations, with an additional two feet of required over depth in areas of ledge or other hard bottom material.

Channel widths would also need to be adjusted for these ships. Additional width would be required in the channel bends, Main Ship Channel, and turning area to compensate for vessel motion relative to maneuvering lane requirements, passing vessel clearances, bank clearances, turning radius and use of tugs. Channel design calculations concluded, that in general, the 4,700 to 8,500 TEU classes of container ships will require a channel design width of: 1) at least 800 feet in the Main Ship Channel (widened to up to 900 feet through the bends at Spectacle and Castle Islands), 2) retaining the present width of 900 feet in the entrance channel, (with 1,100 feet in the transition seaward of Finn's Ledge bend, widened further in that bend itself), and 3) retaining the present width of 1,200 feet in the President Roads channel reach where the channel abuts the anchorage.

2.3.2. Reserved Channel and Turning Area

The Reserved Channel provides access between the Main Ship Channel and several terminals on the Reserved Channel, including the Conley Container Terminal. Massport has already deepened its berths at the Conley Terminal to -45 feet MLLW, to enable ships with a draft of up to 43 feet to reach the berths using the nine-foot average tide. The design vessels described under the economic scenarios above would require channel depths of -45 foot MLLW to -50 feet MLLW. The economic analysis examined all channel depths from -42 to -50 feet MLLW in one-foot increments. A two-foot payable overdepth allowance would be added to these depths, with an additional two feet of required over depth 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 because of the channel's narrow 400-foot width. A portion of the Federal channel limits in the lower Reserved Channel were deauthorized in 1996 to allow for wider berths under the BHNIP. No further adjustments in channel width are included in the project design for the containership base plan. The upper reach of the Reserved Channel lying beyond the Conley Terminal would remain at its authorized depth of -35 feet MLLW for access to the upper berths at the Black Falcon Terminal.

The Reserved Channel Turning Area located at the confluence of that channel and the Main Ship Channel is currently configured with a radius of 1,200 feet spanning the two lanes of the Main Ship Channel at a depth of 40 feet with some widening of the confluence along the north side of the Reserved Channel. The new design container vessels would require a slightly larger turning radius of 1,500 feet. The Boston Harbor Pilots were consulted in the design of the expanded turning area. The two considerations in their 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), 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 westward to take these forces and hazards into consideration, and 2) that any

expansion of the basin be in the Main Ship Channel and upstream of the Reserved Channel to avoid the ledge and berths. The redesigned turning basin with a radius of 1,600 feet, widened to the west towards the former Army Base pier and to the northeast outside the existing channel limit makes these adjustments.

2.3.3. President Roads Anchorage Deepening Plans

The 40 foot deep President Roads Anchorage was initially constructed in 1933-35 and enlarged by dredging in 1960. The harbor pilots, U.S. Coast Guard, Massport and others 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 the growing use of the anchorage for lightering of petroleum tank ships, vessels waiting for favorable tide conditions, berth access, or for inspections. Although the proposed project would deepen the anchorage, it would not eliminate the need for all lightering in the anchorage because of the larger ships that would use Boston Harbor. 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 or bay.

USACE 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." 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 guidanee also states, "While benefits will be identified and quantified to the extent possible, security will be considered an absolute criterion and its appropriate cost effective measures will be included in navigation projects without regard to any incremental eeonomic justification." Accordingly, deepening of the President Roads Anchorage to a depth equal to the design depth for the Main Ship Channel, either 45, 47, or 50 feet (plus a two-foot overdepth allowance and plus an additional two feet in ledge or hard bottom areas) will be included in the project plan to accommodate safety and security requirements.

2.3.4. Massport Marine Terminal (MMT) - Main Ship Channel Deepening Extension above the Reserved Channel

An incremental extension of the deepened Main Ship Channel upstream of the Reserved Channel Turning Area was considered to access the Massport Marine Terminal (MMT) in South Boston, the last terminal located seaward of the Ted Williams tunnels to and from the airport. Berths for this terminal front the Main Ship Channel and are currently at a depth of 40 feet. Massport plans call for the redevelopment of this terminal for bulk cargo shipping. Improvements to the existing bulkhead will be required to support bulk terminal operations at this location, and the berth may need to be deepened whether or not any channel improvements take place. Bulk operations at a new terminal at the Massport Marine Terminal are anticipated to require channel and berth depths of -45 feet. The assumed design vessel for this use is the dry bulk carrier described above. Massport or their tenant would need to deepen the berths at this terminal to a depth commensurate with that of any improved Federal channel. Extension of the Main Ship Channel deepening above this area is restricted by the clearances for the Ted Williams Tunnel and the MBTA Blue Line tunnel, which limits the upper harbor navigation channel areas to no deeper than 40 feet. Depths of 42 to 45 feet have been analyzed for this channel deepening extension to the Massport Marine Terminal. A two-foot overdepth allowance would be added to these elevations, with an additional two feet required over depth in areas of ledge or other hard bottom material.

Two-way traffic is a factor in this area of the Main Ship channel. 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. 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 and tank vessels does occur frequently. A typical dry bulk vessel that would require a -45-foot channel would have a 105-foot beam. Two-way traffic in the -40-foot channel between such a ship and a Chelsea max tank vessel, the most likely passing situation, would require a 600-foot channel width.

2.3.5. Mystic River Channel Modification

The only modification under consideration for the Mystic River Channel is an extension of the 40-foot channel cut along the northern Charlestown shoreline, upstream above Massport's Boston Autoport (former Moran Terminal) to the Medford Street Terminal, which Massport has planned for bulk cargo operations. This area of the Federal project is authorized and maintained to a depth of -35 feet. Massport has already deepened the berth at the Medford Street Terminal to -40 feet during the recent improvement dredging of the Mystic River Channel. As the Ted Williams and MBTA Blue Line Tunnels clearance limits access to the upper harbor areas to -40 feet MLLW, deepening this additional portion of the Mystic River Channel is only considered to this depth.

Subsurface investigations revealed no ledge or other hard material present in the proposed dredging footprint for this area of the Mystic River. Accordingly, only a two-foot allowable overdepth increment for soft bottom materials need be added to the feature design and quantity estimates. Improvement dredging carried out for the 40-foot deepening project from 1998-2002 penetrated into glacial epoch blue clays and till. Dredging required for the deepening of the Medford Street channel area to -40 feet will very likely be limited to this type of material.

2.3.6. Chelsea River Channel Deepening

Deepening the Chelsea River beyond the current -38 foot project depth is possible now that the Chelsea Street Bridge has been replaced by others and the Keyspan gas siphon was removed in 2012. Ship simulation studies prepared in 1992 for the last improvement project, 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 require removal and replacement of the bridge. As the Ted Williams and MBTA Tunnels clearance limits access to the upper harbor areas to -40 feet MLLW, deepening the Chelsea River Channel to 40 feet is the only increment considered. The design vessel for a 40-foot MLLW Chelsea channel is an 80,000 (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 template 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 material in the vicinity of the Chelsea Street Bridge, also along the East Boston Shore. In these areas an additional two feet required over depth will be incorporated into the dredging design and quantity estimates. Improvement dredging carried out for the -38-foot deepening project from 1998-2002 penetrated into glacial epoch blue clays, till and rock. Dredging required for the deepening the majority of the Chelsea River of to -40 feet MLLW will likely be limited to this type of parent material.

2.3.7. Project Dredge Feature Alternative Summary

Containership Improvement Alternatives for Conley Terminal Access

Plan ABC – The plans for Main Ship Channel improvements were developed for the primary benefit of containership traffic to Conley Terminal. These plans consist of dredging and rock removal, as needed, to deepen the Broad Sound North Entrance Channel, the President Roads Anchorage, the Main Ship Channel between the anchorage and the Reserved Channel, the Reserved Channel Turning Area/Basin 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 alternative plans, the Broad Sound North Entrance Channel would be deepened an additional 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 were not quantified.

The Main Ship Channel plans differ only with respect to depth optimization which evaluated a range of channel depths from -42 to -50 feet in one-foot increments. These plans are referred to collectively as Plan ABC. Plan ABC includes expansion of the Reserved Channel Turning Area to a 1,600-foot diameter, widened at its junctions with the Main Ship and Reserved Channels widened to the northeast as recommended by the ship simulation study. These plans also include widening the channels at three critical bends at Finns Ledge, Spectacle Island and the Lower Middle Shoal below Castle Island.

Bulk Cargo Terminals Access Plans

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

Plan E – Mystic River Channel Deepening: Plan E 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 consists of deepening the entire Chelsea River Channel, including its upstream turning basin from its current depth of -38 feet to -40 feet. This plan is now possible with the replacement of the Chelsea Street Bridge and the widened navigation channel. The deepening will occur within the exising channel limits with the exception of widening at two bends. This improvement would benefit the four active petroleum terminals along this waterway.

2.3.8. 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, allowable overdepth was two feet, with an additional two feet of required overdepth in ledge and other hard-bottom areas. Quantities for both ordinary material and ledge were calculated at one-foot increments beginning at the overdepth elevation for the existing project depth. Table 2-1 shows the dredging quantities for each alternative.

Quantity calculations are presented in Appendix D, Engineering Design and Cost Estimates. Quantities for the various project features were combined to form preliminary plans of improvement for the two design container vessels and for the other additional improvements under consideration. All channel segments are maintained at their authorized depths and most have been either dredged within the past five years. Maintenance material quantities that will likely 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 a 16 to 41 year frequency, depending on the channel. The frequency of dredging would not change with the proposed improvements.

2.4. Alternative Dredging Methods

Several types of dredges can be used to remove material from deep draft navigation channels, including hydraulic pipeline dredges, hopper dredges, and various types of mechanical bucket dredges. For the improvement dredging of the rock, hard tills, stiff clays and other glacial deposits at Boston, hydraulic and hopper dredges would be incapable of doing the work. Only large capacity bucket dredges and excavators would be capable of performing the work. Dredging to depths of -55 feet (the overdepth limit on rock excavation for a 47-foot design depth, with four feet additional in the entrance, two feet additional required removal in hard material and a two-foot allowable overdepth), plus a spring tidal range of 12 feet, allowance for the height of the dredge barge deck, and allowances for seas on the dredging platform (barge) will require equipment with a very long reach of at least 80 feet.

Mechanical dredging involves the use of a barge-mounted crane with a clamshell bucket, or a backhoe arm to dig the material from the harbor bottom. Typical dredging buckets come in various sizes from five cubic yards to thirty or more cubic yards. The material is placed in a scow for transport to the disposal site by tug. For open-water or ocean disposal, a split-hull scow is generally used for ease of disposal and to minimize the discharge plume. Although some overflow of water from the scow is typical to maintain efficiency during dredging, it is minimal in comparison to hopper dredge activities. The nature of the material being dredged under the improvement project; rock, till, other hard materials, and consolidated clay, makes the impact of dredging overflow on adjacent waters minimal. If substantial amounts of silt are encountered during project construction, then a closed environmental clamshell bucket will be used. An environmental bucket typically contains flaps on top of the bucket to contain spillage of the less consolidated dredged material.

Material at the disposal site is typically discharged at a dump buoy, or by using preset coordinates monitored by the tug. This point dumping is intended to form a discrete mound of dredged material at the disposal site to minimize possible off-site migration and assist in monitoring the disposal operation and post-disposal activities at the site such as benthic recolonization. If the proposed beneficial use involving burial of sites within the IWS, then a series of smaller overlapping mounds would be created.

A mechanical clamshell dredge is proposed and recommended for this project due to the nature of the parent material for the deepening activities.

Table 2-1. Boston Harbor Deep Draft Improvement Project - Dredging Quantities (Cubic Yards)

Detailed Plans	Ordinary Material			Rock Removal			Total Quantity - All Material		
	Cut to Design Depth	2-Foot Overdepth	Total Ordinary Material	Cut to Design Depth	2-Foot Additional Required Plus 2-Ft Overdepth	Total All Rock Removal	Cut to Design Depth	All Overdepth	Total All Material
CONTAINERSHIP DEEPENING PLANS Broad Sound North Entrance Channel, President Roads Channel & Anchorage, Lower Main Ship Channel, Reserved Channel & Turning Area									
Plan A: 45-Foot Containership Improvement	3,538,500	2,855,000	6,393,500	84,400	363,300	446,700	3,780,500	3,059,700	6,840,200
Plan B: 47-Foot Containership Improvement	7,093,800	3,127,100	10,220,900	409,300	583,600	992,900	7,774,700	3,439,100	11,213,900
Plan C: 50-Foot Containership Improvement	11,096,200	3,330,000	14,426,200	627,900	753,000	1,380,900	12,078,000	3,729,100	15,807,100
OTHER DEEPENING PLANS									
Plan D: 45-Foot Marine Terminal Improvement for MSC Extension	151,800	94,500	246,300	12,600	65,800	78,400	193,900	130,800	324,700
Plan E: Mystic River Channel at Medford Street Terminal to –40 Feet	38,500	28,600	67,100	0	0	0	38,500	28,600	67,100
Plan F: Chelsea River Channel to –40 Feet	80,200	262,400	342,600	0	540	540	80,200	262,900	343,100

MSC = Main Ship Channel

2.5 Disposal Alternatives-Site Selection Process

During preparation of the BHNIP EIS, over three hundred and seventy (370) disposal sites were identified and evaluated. A Disposal Options Working Group was convened to develop criteria for use in the evaluation and screening of a universe of potential disposal sites. A short-list of preferable disposal and beneficial use options for parent material (Boston blue clay), rock, and silt was developed as well as disposal alternatives for future maintenance dredged material. Because of the large quantity of parent material, mostly Boston blue clay, to be dredged during the BHNIP, and the limited alternatives available for disposal, it was determined that the most practicable and environmentally acceptable alternative was to dispose of the material at the Massachusetts Bay Disposal Site (MBDS). Therefore, the screening process in the BHNIP focused primarily on developing disposal alternatives for the 1.3 million cubic yards of silty maintenance material, which was unsuitable for unconfined open water disposal.

The amount of parent material proposed to be dredged from the current Deep Draft Project is approximately three to six times greater than amount of parent material disposed from the BHNIP, depending on the selected depth alternative. As with the BHNIP, it was also determined that due to the large volume of parent material to be disposed, that the most practicable and environmentally acceptable alternative is to dispose of the material at the Massachusetts Bay Disposal Site. However, potential opportunities for beneficial use of the parent material were identified and are discussed below along with the site screening methodology.

Although a minimal amount, if any, of silty maintenance dredged material is expected to be dredged for this Deep Draft Project, a brief summary of the site screening process used in the BHNIP for the disposal of the silty maintenance material follows in case a need arises for disposal of this material during construction. A more detailed description of the site screening process can be found in the 1995 Final Environmental Impact Report/Environmental Impact Statement (EIR/S) for the Boston Harbor Navigation Improvement Project. Any changes regarding the acceptability of any of the alternatives from the short list of potential dredged material disposal sites for this improvement dredging project is described in the following section.

The BHNIP disposal site evaluation process used a Tiered approach and consisted of four phases. Phase 1 of the screening process was limited to identifying "fatal flaws" for sites that precluded further evaluation. Fatal flaws included characteristics such as the nearby location of existing water supply wells, the presence of threatened, endangered, or rare species and/or their critical habitat, sites in or abutting State, local or Federal parks, sites containing a 21E hazardous waste property, and upland sites with less than 15 acres of developable land.

Phase II screening consisted of evaluating potentially acceptable disposal sites against objective criteria relevant to the environment and physiography of the site. Criteria were used that reflected regulatory guidelines and requirements (e.g. Clean Water Act, Coastal Zone Management Act, Massachusetts Wetlands Protection Act, Site Suitability Criteria for Solid Waste Site Assignments, etc.). Phase II criteria were applied to all sites identified as potentially feasible after Phase I screening. Quantitative evaluation of sites was performed for each disposal site category by assigning a numerical score to identify and allow comparison among sites within an individual category to focus attention on the most practicable sites. If a disposal site did not satisfy a particular criterion, a further review was conducted to determine if those concerns could be avoided or reduced through site planning and management or readily mitigated. Data for all sites were examined both quantitatively and qualitatively before determining whether a site should be short-listed.

Phase III screening involved the development of additional site-specific information for short-listed sites from Phase II screening through site visits, aerial photographs, and discussions with appropriate resources agencies. The short-listed sites were re-evaluated against Phase II criteria in light of the additional information resulting in a revised short-list.

In response to comments received during the BHNIP Draft EIR/S public comment period, the site screening process was revisited. Additional data collection activities, performed after publication of the DEIR/S, were used to upgrade the data base/criteria upon which the sites would be evaluated. A confirmatory aquatic sampling program was undertaken in October 1994 to assess finfish, benthic and lobster resources at the aquatic disposal sites. Fate and transport modeling to determine sediment load and contaminant transport was performed for all aquatic disposal options. In addition, agency files and resources were used to update and upgrade the information for the land-based sites. This fourth-phase screening process narrowed the list of least environmentally damaging alternatives (LEDA) from 376 sites (and eight treatment technologies) to 23 sites. See Figure 2-1. These 23 sites were then reviewed in terms of cost and capacity as a first step in assessing their practicability. Table 2-2 lists the LEDA sites and their capacity and costs from the Final BHNIP EIR/S.

A review of these sites in the FEIR/S concluded that most of the LEDA sites were less desirable for the BHNIP because of either the high cost or low capacity. The remaining sites were Squantum Point, Little Mystic Channel (partial fill), Mystic River (in-channel CAD cell), Chelsea River (in-channel CAD cell), and Inner Confluence (in-channel CAD cell). Further examination of the environmental impacts and practicability issues for these sites was undertaken to further distinguish among the remaining alternatives.

Squantum Point was eliminated at this stage because of intertidal dredging and wildlife habitat impacts (Table 4-2 in the BHNIP FEIR/S) and its low practicability for availability, permitting, ease of engineering and logistics (Table 4-7 in the BHNIP FEIR/S). Of the remaining four sites, use of the Little Mystic Channel would result in filling outside the footprint of the dredging project and a permanent alteration in depth from subtidal to intertidal, both of which were viewed, and would still be viewed currently, as more substantial impacts. In addition, Little Mystic Channel was lower in practicability for most issues (availability, permitability, ease of engineering, and logistics; see Table 4-7 in the BHNIP FEIR/S), than the in-channel sites.

The BHNIP FEIR/S assumed the CAD cells would be developed to a depth of approximately 20 feet below the bottom surface. During the BHNIP additional borings indicated that the CAD cells could be dug to deeper depths increasing the capacity for the in-channel CAD cells. The construction of the BHNIP has reduced the remaining CAD cell capacity for the in-channel sites. Also, the results of additional probes and borings indicate that the remaining CAD cell capacity in the Mystic River and Inner Confluence is limited. Therefore, investigations into other in-channel CAD cell sites, within the dredging footprint, were conducted and are discussed further in Section 2.8 Disposal Sites Evaluated below.

Table 2-2. List of Least Environmental Damaging Alternatives (LEDA) from the BHNIP FEIR/EIS

ALTERNATIVE	CAPACITY (CY)	COST*
UPLAND SITES		
Lined Landfill		
East Bridgewater	200,000	$62
Plainville	200,000	$94
Fitchburg/Westminster	200,000	$108
Coastal Sites		
Squantum Point	210,000	$51
Everett	37,000	$76
Inland Sites		
Woburn	159,000	$69
Wrentham	450,000	$62
AQUATIC SITES		
Shoreline-Partial Fill		
Amstar	128,000	$62
Cabot Paint	18,000	$362
Little Mystic Channel	373,000	$47
Mystic Piers	98,000	$47
Reserved Channel	86,000	$45
Revere Sugar	186,000	$93
Subaqueous Depressions		
Subaqueous B	562,000	$20
Subaqueous E	591,000	$19
Borrow Pits		
Meisburger 2	1,300,000+	$31
Meisburger 7	1,300,000+	$33
Spectacle Island CAD	1,300,000+	$21
Historic Disposal Site		
Boston Lightship	1,300,000+	$16
Existing Disposal Site		
MBDS	1,300,000+	$16
In-Channel CAD Cell		
Mystic River	742,000	$30
Chelsea River	332,000	$30
Inner Confluence	246,000	$30

*1995 Dollars

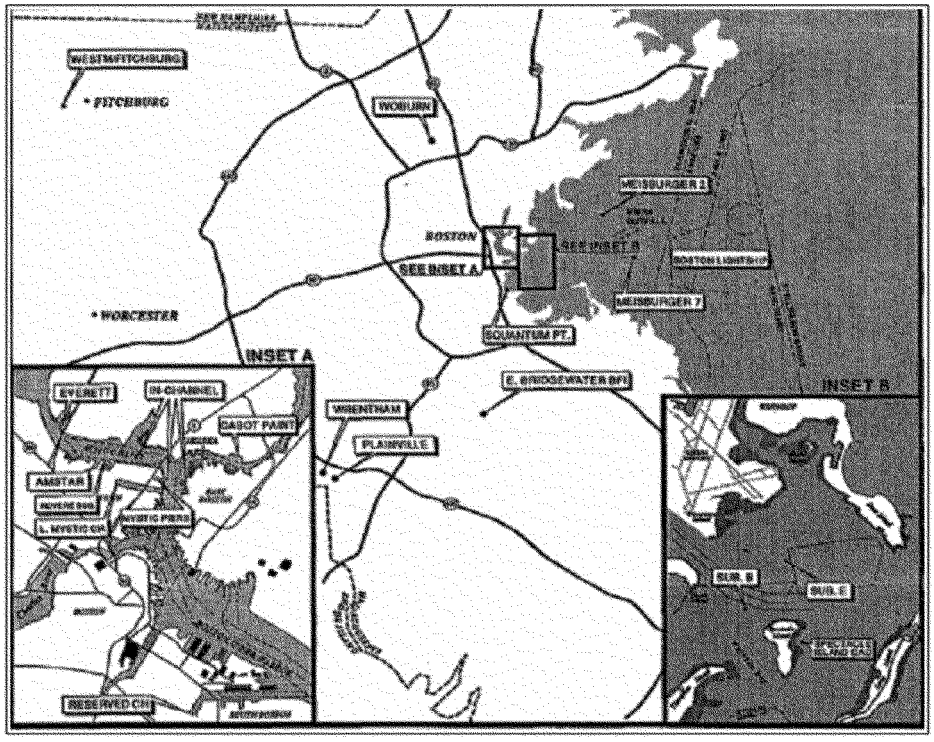


Figure 2-1. Boston Harbor Navigation Improvement Project Short-List of Disposal Sites

2.6 Disposal Alternatives Identified in the BHNIP FEIR/S for Future Maintenance Dredging

The BHNIP FEIR/S identified seven sites as potential disposal sites for future maintenance dredged material. These sites could also be used to screen for the disposal of parent material from this project. The seven sites include: the Massachusetts Bay Disposal Site (MBDS), Subaqueous B and E, Meisburger 2 and 7, Boston Lightship, and Spectacle Island CAD. The MBDS is an EPA-designated ocean disposal site that is currently open for disposal of material that after a testing protocol has been determined to be suitable for ocean disposal. The Boston Lightship site is a former disposal site, no longer open for placement of material. Both sites are located outside State waters and are subject to MPRSA. Dredged material that does not meet the ocean disposal criteria would not be allowed at the MBDS.

Subaqueous sites B or E, located in the outer harbor outside the navigation channels, would provide 562,000 cy and 591,000 cy of capacity respectively. The Meisburger sites and the Spectacle CAD sites would most likely require that a subaqueous cell be dug prior to disposal of the parent material and possibly capped with suitable material such as sand. The Spectacle Island CAD cell site is located east of Spectacle Island in the shallow subtidal (-10 feet MLW) area and is totally disassociated with the island itself. However, it is located near the Boston Harbor Island National Park, which may detract from its suitability as a disposal site. The offshore borrow pit sites, Meisburger 2 and 7, support high benthic productivity and fisheries resources that are relatively abundant. The Subaqueous B and E sites, the Meisburger sites and the Spectacle CAD sites are all located in

previously undisturbed areas. None of the sites, except the MBDS, were determined to be suitable for disposal of the parent material from the Deep Draft Project for the following reasons. Disposal would occur at sites not previously disturbed, the site is recovering from past disposal activities, or the capacity of the site to hold the dredged material is too limited. Therefore these sites are not as desirable as disposal sites that have been previously impacted and have the capacity to hold the parent material.

2.7 Beneficial Use Alternatives

The materials that would be removed to deepen the navigation channels for the Deep Draft Project are composed of glacial parent material and rock ledge. The glacial materials are composed mainly of Boston blue clay and mixed tills with compacted sands, gravel and cobble. Suggested beneficial uses for the parent material include cap material for confined aquatic dredged material disposal sites or contaminated aquatic sites, creation of subtidal or intertidal habitat, construction uses, or for use in a landfill as a liner or as daily or final cap for landfill closures.

2.7.1 Parent Material

Parent material is defined as the material below the authorized/maintained depth in the navigation channel that has not been impacted by anthropogenic activities. It is generally composed of glacial till material in the outer harbor and Boston blue clay in the inner harbor. The use of the parent material to establish shallow subtidal or intertidal habitat was evaluated for the Reserved Channel and the Little Mystic River Channel in the BHNIP EIR/S. However, since this alternative would impact a previously undisturbed area, it was dropped from further consideration. No additional opportunities for creation of subtidal or intertidal habitat were identified in that document and none have been identified during Technical Working Group meetings for other previous and current Boston Harbor projects.

The parent material may also be useful for lining landfills or other upland sites that may require liner material. Some of the parent material is primarily clay, which is highly impermeable and could be suitable for this purpose. This material could also be useful for daily capping or final closure material at landfills. Before the material could be used at a landfill, a site suitable for dewatering the material in Boston Harbor would need to be identified. Massport owns several lots along the Boston waterfront that are currently vacant (D. Hadden, pers. com.). They are the Medford Street terminal, Mystic Piers 48-49-50, and the Massport Marine Terminal. However, Massport is actively seeking partners to redevelop the terminals in support of Boston Harbor port activities. Restricting land use at the terminals for several years would not be the best use for the port. In addition, the cost to double handle the material for dewatering makes this alternative less attractive.

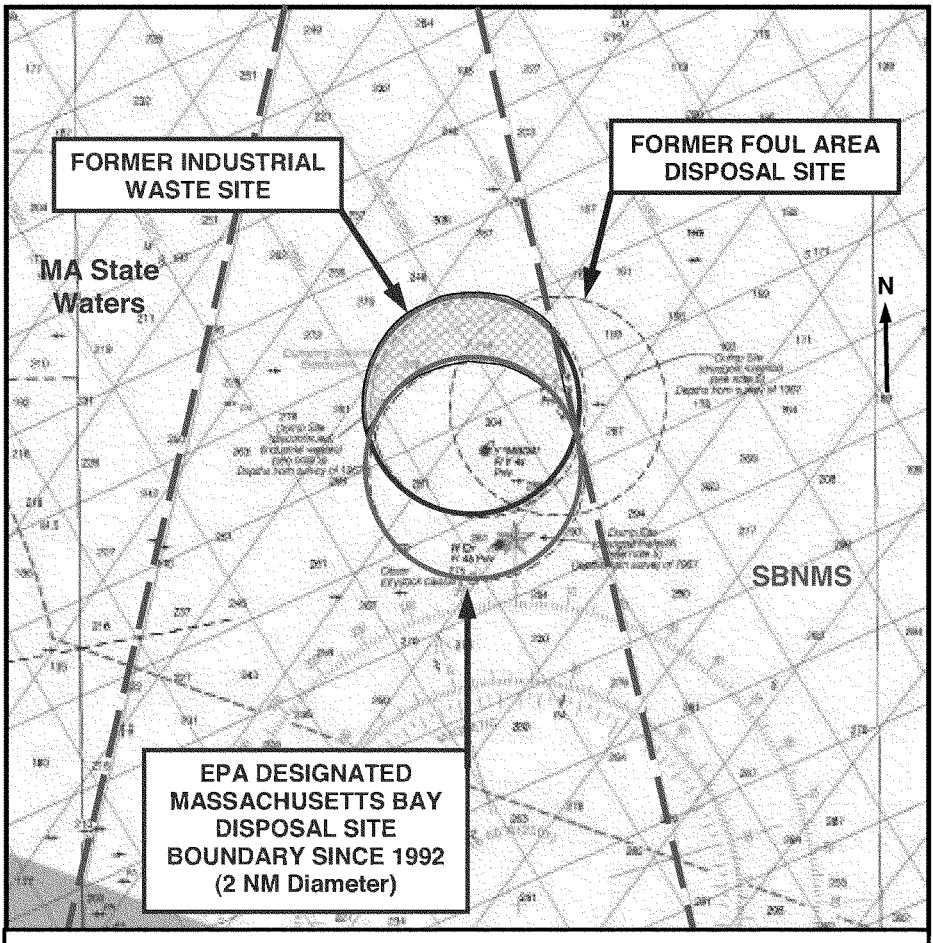
The use of parent material to cap debris at the Industrial Waste Site (IWS) located in Massachusetts Bay is another potential beneficial use option for this material. This concept was initiated by the USACE and the U.S. EPA. The IWS site in Massachusetts Bay was the repository of chemical, industrial, and low level radioactive wastes, construction debris, and dredged material at various periods from the 1940's until 1976, with dredged material disposal continuing into the 1990's. Industrial waste containers include thousands of 55-gallon metal drums (barrels), concrete encased drums, and coffin shaped concrete barrels. The IWS is located in an area 20 miles east of Boston in water up to 300 feet deep, also known as the "Foul Area." This site overlaps the northern portion of the MBDS and an area known as the Interim Massachusetts Bay Disposal Site. It is located just west of the Stellwagen Bank National Marine Sanctuary. Investigations have determined that the majority of barrels are located to the north, and outside the boundary of the MBDS (Wiley, et al. 1992; NOAA 1996; Capone, 2007). See Figure 2-2.

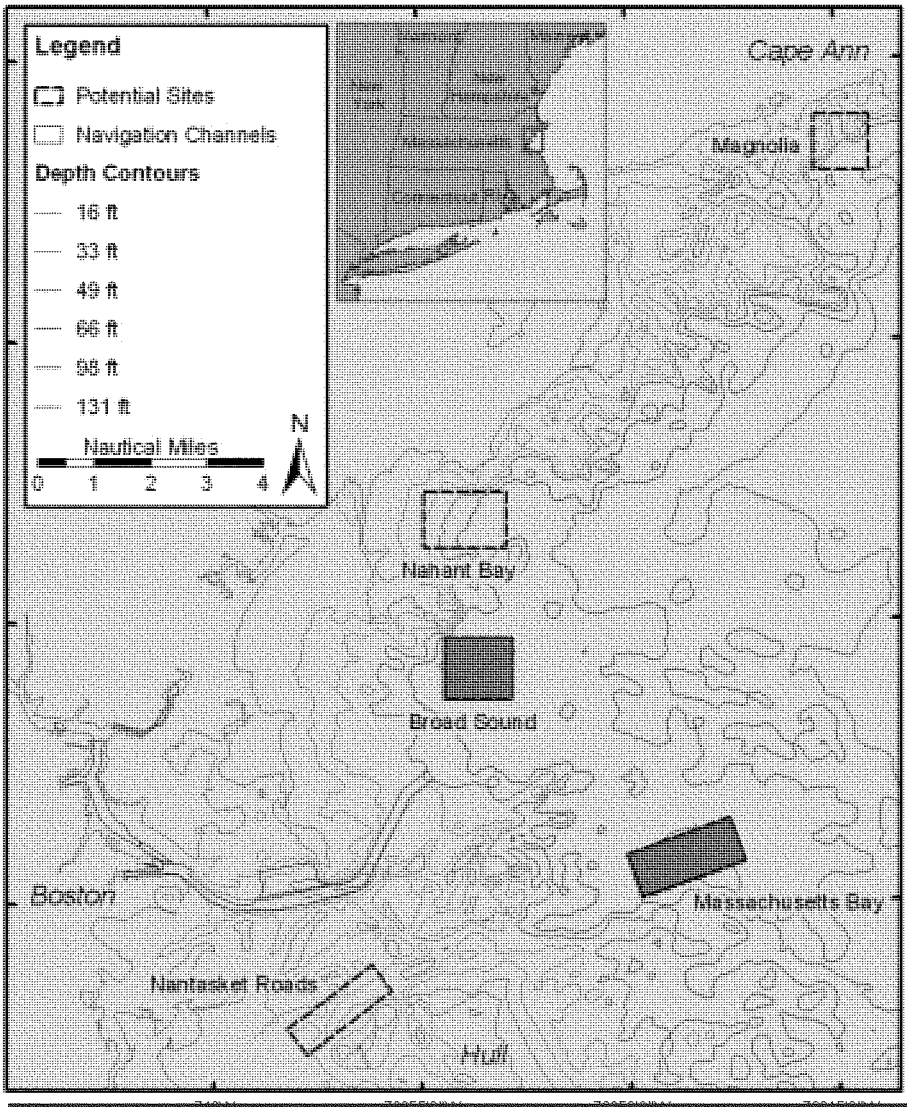
In surveys at the IWS, most of the visually observed barrels or drums were corroded, and it is assumed that much of the contents have dispersed over time. Direct radiation measurements from the barrels,

or from sediment near the barrels, were found to be at background levels and has been determined to pose no risks to human health. Based on the survey conducted in 1992 at the IWS (NOAA, 1996), the contributing agencies concluded that the low level radioactive waste or hazardous substances investigated did not pose an imminent and widespread human health or ecological threat. "However the documented presence and large concentration of waste containers along with known ordnance disposal in some areas of the IWS, pose potentially significant occupational risks to users of bottom-tending mobile gear.... The existing fish advisory and the closure for surf clam and ocean quahog harvesting should continue. Further documentation of the location of likely waste container fields within and contiguous to the IWS should be undertaken. Positions of concentrations of likely waste containers should be noted on nautical chart" (NOAA, 1996). The benefit to covering the site with parent material would be to isolate the barrels from potential occupational risk of fish trawls contact with the barrels. A cap demonstration project at the adjoining MBDS was performed in 2008 using material from the IHMDP to assess the feasibility of using material from the deepening of Boston Harbor to cap the area of the IWS that was identified as having a high density of barrels on the seafloor. The cap demonstration project revealed that material could be precisely placed in water depths comparable to the IWS using standard split-hulled scows. The project also identified a procedure for placement of material that would reduce impact to the ambient seafloor, thus limiting the potential disturbance and release of material on the seafloor (USACE, in preparation – expected early 2013).

2.7.2 Rock

Depending on the final optimized main channel depth selected, up to one million cy of rock will need to be removed. It is possible that the rock and cobble from the project could be used to enhance fish habitat diversity by providing structure and depth to areas that currently have little bottom relief in Massachusetts Bay. The rocks will vary in size from fairly large stones and small cobble to boulders. The rocks can provide interstitial space and hard substrate used for both cover and habitat for fisheries and other benthic resources that could increase the diversity and productivity of the existing habitat (niches). Five sites were identified as potential hard bottom enhancement sites based on a meeting with representatives from the Massachusetts Lobstermen Association, the Boston Harbor Lobstermen Association, and the Massachusetts Division of Marine Fisheries. Most of the five sites are in water depths of 30 feet or greater, are not readily used by lobstermen or other fishermen (according to the lobstermen). The five sites are located in Nantasket Roads, Massachusetts Bay, Broad Sound, Nahant Bay, and Magnolia (see Figure 2-3).


FORMER INDUSTRIAL WASTE SITE
FORMER FOUL AREA DISPOSAL SITE
MA State Waters
N
SBNMS
EPA DESIGNATED MASSACHUSETTS BAY DISPOSAL SITE BOUNDARY SINCE 1992 (2 NM Diameter)
3-Mile Limit
Stellwagen Bank NMS Boundary
Area of IWS that May be Added to MBDS Designation
BOSTON HARBOR, MASSACHUSETTS
NAVIGATION IMPROVEMENT FEASIBILITY STUDY
FIGURE 2-2
LOCATION OF MASS BAY DISPOSAL SITE, INDUSTRIAL WASTE SITE AND FOUL AREA
Un-Scaled



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 2-3
ROCK REEF HABITAT CREATION SITES INVESTIGATED

A set of five criteria (USACE, 2006) was used to perform an initial ranking and prioritization of the five potential habitat enhancement sites. These five criteria included: the biological productivity of the area, bottom type, and capacity to accept the material, other existing uses, and navigable distance to the sites from the project area. Sites with lower biological productivity, sufficient capacities and water depths were given a higher priority for habitat enhancement than those with existing abundant rock bottom habitat. The fourth criterion was the potential for the disposed material to interfere with other uses such as navigation or fishing. The last criterion was proximity to the navigation channel (project area). If no significant difference was found between the sites, based on the four criteria, then the sites closest to the navigation channel were given higher priority. Additional information on the habitat enhancement sites can be found in the appropriate sections in Chapter 3, Affected Environment.

Table 2-3, gives the final site ranking by criteria for each site. Based on the initial site ranking, the list of potential enhancement sites in the order of most suitable to least suitable is: Broad Sound, followed by Magnolia, Nahant Bay, Massachusetts Bay, and Nantasket Roads (USACE, 2006). Due to depth constraints and location, it was determined that Broad Sound and Massachusetts Bay were the most suitable sites for creating hard bottom habitat.

Other potential beneficial uses for the rock, as identified by the Massachusetts State Dredging Team in a letter from Massachusetts Coastal Zone Management (CZM), include using the material for medium to large scale shore protection efforts in the Boston Harbor region. These projects are still in the planning stage and it is unknown at this time if the rock would be suitable and available for these proposed shore protection projects. In addition, required permitting would need to be obtained in advance by the responsible respective State agency landowner.

Also, the potential exists for all or a portion of the rock to be used beneficially for construction purposes. Logistical issues regarding this alternative include the legal and policy issues of a private contractor accepting rock from a Federal project, shoreside handling facilities, and permit issues.

The feasibility of the last two options will be explored during the Design Phase of the project. All necessary permits and additional funding by others (if required) would need to be in place prior to construction for these beneficial use options to be feasible and implementable.

2.7.3 Silt

No known beneficial use options for the silt material have been identified at this time

2.8 Disposal Site Alternatives Evaluated in this SEIS/EIR

2.8.1 Confined Aquatic Disposal (CAD) Cells

At this time there is no expected need for creation of additional confined aquatic disposal (CAD) cells in Boston Harbor for this improvement dredging project. However, by the time the project is finally authorized by Congress and approved and funded for construction, some minor maintenance dredging of adjacent channel areas not maintained in the operations conducted between 1998 and 2012 may be found necessary. If so, construction of one or more smaller CAD cells from the population of previously approved but unconstructed sites may be required to properly dispose of that material or disposal in the uncapped Chelsea River CAD cell. That will be an action separate and distinct from the Deep Draft Project covered by this SEIS/EIR. Although previously permitted, maintenance material not removed near the Ted Williams Tunnel and above to the Inner Confluence during Phase 1 of the IHMDP in 2008 would need to be removed if economic benefits assessed for this proposed project are to be realized in the Mystic River and Chelsea River.

Table 2-3. Final Habitat Enhancement Site Ranking by Criteria

RANK	RANKING CLASS	BENTHIC HABITAT QUALITY	FISH	SHELLFISH	LOBSTER	BOTTOM TYPE QUALITY	CAPACITY OF SOFT BOTTOM	OTHER HUMAN USES	NAVIGABLE DISTANCE
Most suitable	1	MA, NB	NR, BS, NB	MB	NR	MB, NB, MA	NB	BS, NB, MA	NR
	2	BS	MA	BS	MA, NB, BS	BS	MB, BS, MA	MB, NR	BS
	3	NR	MB	NR, MA, NB	MB	NR	NR		NB, MB
Least suitable	4	MB							MA

BS - Broad Sound; MA - Magnolia; MB - Massachusetts Bay; NB - Nahant Bay; NR - Nantasket Roads

2.8.2 Massachusetts Bay Disposal Site

All materials proposed for dredging associated with the improvement project are parent glacial materials and rock that have been determined to be suitable for unconfined ocean disposal at the Massachusetts Bay Disposal Site. The parent material from the previous BHNIP was disposed at the EPA-designated MBDS. Regular monitoring is performed at the MBDS as part of the USACE's Dispoal Area Monitoring System Program. This monitoring has not indicated any significant impacts from previous disposal operations associated with the other Boston Harbor projects. During the Outer Harbor Maintenance Dredging Project in 2004-2005, approximately 1.1 million cy of material was placed at the MBDS. Approximately 1.5 million cy of parent material was dredged during construction of the IHMDP CAD cells. In addition to the parent material removed for construction of the IHMDP CAD cells, approximately 400,000 cy of shoal material suitable for ocean disposal was also be removed from the inner harbor sections of the Main Ship Channel during the IHMDP and disposed at the MBDS.

As with the previous Boston Harbor dredging projects, the base plan for disposal of the parent material from this Deep Draft Project is at the MBDS. This material has been determined by the EPA to be suitable for ocean disposal.

2.8.3 Industrial Waste Site

If found to be practicable, all or a portion of the parent material could potentially be used as cover to cap and isolate the barrel field identified by the EPA just north of the MBDS from biological resources and human interaction. The use of this site for disposal will be dependent on a number of factors and ultimately on the approval of the EPA to allow material placement in an area outside of the current designated MBDS (i.e. EPA will need to temporarily or permantely expand the boundary of the MBDS to include the IWS). EPA supports investigations to use project generated material to cap the IWS.

2.8.4 Habitat Enhancement Site

During the proposed improvement dredging, rock ledge will be removed from the channels. This material may be used to enhance bottom habitat in the nearshore area of Massachusetts Bay. As stated above, the two potential habitat enhancement sites selected for further evaluation based on depth, biological indices, and distance are Broad Sound and Massachusetts Bay. Future efforts may include additional field work to determine the suitability of the site for rock reef species recruitment. During the design phase, this proposal will be further examined in cooperation with the Commonwealth and the NMFS to further evaluate the two candidate sites identified by the USACE screening process, and develop a plan for placing the materials on the ocean floor. Monitoring of these habitat creation sites for several years after disposal may be necessary subject to cost-sharing by others to determine rates of colonization important for future consideration of this beneficial use option for other projects.

2.9 Preferred Design and Disposal Alternatives

2.9.1 Federal Project

Table 2-4 below provides a qualitative description of the potential benefits and impacts from a select range of proposed channel depth alternatives, including the preferred alternative, and disposal alternatives carried forward in this SEIS/EIR. 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.

Criteria for evaluating the navigation alternatives is based on engineering feasibility, economic viability and justification, social and environmental impact considerations, and environmental enhancement opportunities. Selection of a final recommended dredging plan will depend on economic optimization of channel depth based on the number of shippers that would take advantage of deeper channel depths by modifying their shipping practices for U.S. east coast services. This will be dependent on:

- Projected growth in cargo volumes arriving at and being exported from the east coast;
- Changes in navigable depth at the various ports called at by carriers with services to Boston, including the expanded Panama Canal;
- How shippers allocate space on their vessels to cargo destined for particular ports;
- How shippers add or drop ports of call from their vessel rotation;
- How shippers manage rotation (order of calls/routing) among the ports they do use; and
- How the changes in fleet mix (range of vessel sizes and numbers of each class in service for each shipper) force adjustments to changes in navigable depth at the various ports to how the shipper manages rotation discussed above.

Boston has a roughly nine-foot mean tide range and the transit from the Bay into the terminal covers about six miles. This enables ships to use tidal advantage to some extent without compromising underkeel clearance requirements, which are generally ten percent of vessel operation draft or about four feet depending on the requirements of the different shippers, the cargo, the USCG and the pilots.

The recommended Federally preferred navigation improvement alternative includes:

- Deepening and widening the 40-foot lane of the Broad Sound North Entrance Channel to – 51 feet MLLW;
- Deepening and widening the 40-foot deep lane of the Main Ship Channel, the 40-foot deep President Roads Anchorage, the lower portion of the Reserved Channel, and the Reserved Channel Turning Basin to -47 feet MLLW to provide access to Conley Terminal in South Boston;
- Deepen the 40-foot lane of the Main Ship Channel above the Reserved Channel and below the Ted Williams Tunnel (aka Third Harbor Tunnel) to -45 feet MLLW to improve access to Massport's Marine Terminal in South Boston;
- Deepen a portion of the existing 35-foot lane of the lower Mystic River Channel to -40 feet MLLW to improve access to Massport's Medford Street Terminal; and
- Deepen the existing 38-foot deep channel in the Chelsea River to -40 feet MLLW to improve access to its petroleum terminals with widening of the channel in the two bends on the East Boston side of the river between the two bridges.

Table 2-4. Comparison of a Selected Range of Channel Depth Alternatives, Including the Preferred Alternative

Resource	45'/47' Deep MSC/BSNC (includes all plans)	47'/51' Deep MSC/BSNC (includes all plans)	50'/52' Deep MSC/BSNC (includes all plans)	MBDS	IWS	Habitat Enhancement Sites
Period of Construction (includes additional months to reduce air quality impacts)	3 years	3 years	5 years	3-5 years dependent on channel depth selected	Same as MBDS	3-5 years
Subbottom (acres, unless otherwise noted)	1,079[1] (includes 18.2 acres outside existing project limits)	1,164[1] (includes 18.2 acres outside existing project limits)	1,224[1] (includes 18.2 acres outside existing project limits)	0.75 to 2 square miles	Up to 3 square miles.	186, 365, or 518 dependent on channel depth selected.
Water Quality	Temporary turbidity impacts during construction.	Slightly longer period of temporary turbidity impact.	Longest period of temporary turbidity impaet.	Temporary turbidity impact during disposal of dredged material.	Same as MBDS.	Minimal turbidity from rock impact on floor bottom and possible washing of rock.
Benthos	Temporary disruption	Slightly longer period of temporary disruption	Longest period of temporary disruption	Temporary disruption dependent on channel depth selected	Same as MBDS	Permanent conversion from soft bottom to mix of soft and hard bottom. Habitat for reef species
Fisheries	No significant impact expected to movement, or spawning habitat. Potential fish kills from blasting.	No significant impact expected to movement, or spawning habitat. Potential fish kills from blasting.	No significant impact expected to movement, or spawning habitat. Potential fish kills from blasting.	Possible entrainment from disposal. Temporary disruption to benthos.	Possible entrain-ment from disposal. Temporary disruption to benthos. Permanent displacement of some reef species.	Permanent enhanced habitat for reef species
Lobsters	Temporary disruption of habitat.	26% longer period of disruption than the 45' deep.	90% longer period of disruption than the 45'deep.	Possible burial and temporary disruption to habitat.	Same as MBDS. Permanent loss of cover.	Permanent enhanced habitat/cover.

Table 2.4 (cont.). Comparison of Alternatives

Resource	45'/47' Deep MSC/BSNC (includes all plans)	47'/51' Deep MSC/BSNC (includes all plans)	50'/52' Deep MSC/BSNC (includes all plans)	MBDS	IWS	Habitat Enhancement Sites
T &E Species	Rare occurrence of species.	Same.	Same.	Small potential for whale strikes.	Same as MBDS.	Minor chance for whale strike.
Geology	No significant change expected.	Same.	Same.	Dredged material is similar to MBDS. Mound created.	Same as MBDS. Slight decrease in bottom depth.	Permanent change from soft bottom to mixed hard bottom.
Cultural	No impact expected, some investigations required.	No impact expected, some investigations required.	No impact expected, some investigations required.	No impact expected. This is a designated disposal site.	Some investi-gation may be needed, if wrecks seen.	No impact expected, some investigations required.
Socioeconomic	Some temporary displacement of lobstermen fishing illegally in the channels.	Same.	Same.	No significant impact.	Positive reduction in fishermen snagging debris.	Not significant fishing areas, but expected to increase permanent abundance of reef species.
Air Quality	Slight temporary increase from construction equipment. Permanent reduction in regional air emissions after construction.	Slight temporary inerease from construction equipment. Permanent reduction in regional air emissions after construction.	Slight temporary increase from construction equipment. Permanent reduction in regional air emissions after construction.	Slight temporary increase from construction equipment	Slight temporary increase from construction equipment.	Slight temporary increase from construction equipment.

[1] 18.2 acres does not include the additional side slope area outside the channel from deepening the channel, but is the new sections of the channel to be expanded. The new side slope areas are included in the total acres.

Construction is expected to take about three years. Rock removal is anticipated to require 26 months to complete with the required times approximately broken down as follows: 16 months in the Broad Sound North Entrance Channel; two months in the President Roads Anchorage; two months in the lower Main Ship Channel; three months in the Main Ship Channel extension above the Reserved Channel, five months in the Reserved Channel and its Turning Basin; and one month in the upper Chelsea River. Blasting if found to be required in certain areas may be accomplished by using two blast plants working in the harbor, with each plant detonating no more than one blast per day for a maximum of two blasts per day. No blasting will occur at night. The rock areas and construction times will be further refined in the Planning, Engineering, and Design Phase of the project after subsurface explorations are completed. Additional time may be needed to meet air quality standards (see the Air Quality Section). See Section 2.3 above for additional dredge plan details.

The preferred dredged material disposal alternative for the parent material and rock is the Massachusetts Bay Disposal Site, regardless of the dredged alternative selected. This material has been determined to be suitable for ocean disposal. No other environmentally acceptable alternative is currently known that can and will accept the large quantity of potential parent material to be removed from the project area. This material may be used beneficially if EPA approves the use of this material as cover at the IWS. Other beneficial uses for the rock will be explored with the Technical Working Group during the Design Phase.

The next two sections describe the berth deepening and maintenance dredging associated with the Deep Draft Project.

2.9.2 Associated Berth Deepening

Conley Terminal: Massport has already deepened its two principal berths 11 and 12 at the Conley Terminal to 45 feet. Massport completed an improvement project in 2010 to increase the efficiency of the existing terminal. Furthermore, Massport currently has underway a project to design and permit the integration of the 30-acre former Coastal Oil property into the Conley Terminal footprint to provide additional capacity, efficiency, and access improvements. The existing terminal lands (lay-down area and access), 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 benefit. 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 containership plans.

For main channel improvement depths of 43 feet and beyond, including the recommended 47-foot deepening project, deepening of the Conley berths would be required to continue the tidal navigation practices of shippers. Massport intends to deepen its two 45 foot- deep 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. All other facility improvements noted will be implemented by Massport in the near term and are not dependent on the Federal deepening project. Quantity estimates for non-Federal berth deepening are provided in Table 2-5.

Massport Marine Terminal (MMT): For the 45-foot-deep Main Ship Channel extension to the Massport Marine Terminal above the Reserved Channel, bulkhead replacement and 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 paving, bollards, and other terminal facilities to support dry bulk operations would also be required. However, Massport and its partners are likely to construct these facilities, regardless of whether or not the Main Ship Channel is deepened to 45 feet up to this facility.

Mystic River – Medford Street Terminal: For the 40-foot-deep 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. Therefore, no dredging will be needed at this terminal.

Table 2-5. Non-Federal Berth Deepening Quantities

	Berth Design Depth	Quantity (cy) (including 2-foot overdepth)
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 – FOUR TERMINALS QUANTITY		
39-Foot Channel	39 Feet	16,400
40-Foot Channel	40 Feet	32,800

Chelsea River – Petroleum Terminals: For the Chelsea River Channel, the main petroleum terminals would need to deepen their berths to -40 feet MLLW 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 Logistics 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 Logistics pass through the bridge twice in order to turn in the basin before transiting outbound. Therefore, all four beneficiary terminals 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 Federal channel deepening.

Utilities: Boston Harbor has several utility crossings. Only the MWRA/NSTAR power cable in the Reserved Channel would be affected by the deepening of the proposed project. The USACE 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.

2.9.3 Associated Maintenance Dredging

Maintenance dredging of existing Federal navigation features could be carried out concurrent with the Deep Draft Project in four different ways. First, while major maintenance dredging in association with the BHNIP and of the outer and inner harbor areas was accomplished in the 1998-2000, 2004-2005 and 2008 timeframes respectively, minor amounts of maintenance material may have accumulated since that time and before improvement dredging of the Deep Draft Project or was not removed entirely from the previous maintenance dredging projects. In particular, the Chelsea River will need to have some additional maintenance dredging for material not dug to project overdepth.

Second, maintenance dredging to project depth will be needed to assist in harbor traffic management during the construction of the Deep Draft Project. Areas recommended for maintenance for this purpose include the 30-foot deep Broad Sound South Entrance Channel, the 35-foot deep northern lane of the Broad Sound North Entrance Channel, the 15-foot deep Nubble Channel, and the 35-foot deep West Anchorage at President Roads (the barge anchorage). Minimizing navigation traffic disruptions of the drilling, blasting, and dredging operations for the Deep Draft Project can be accomplished by providing alternative routes for shallow-draft traffic not needing the 40-foot deep channels that would be deepened. Routing of shallower-draft vessels, consistent with tidal navigation, through the South Entrance Channel with its 30-foot deep authorized depth, and later also through the 35-foot deep 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 deep anchorage would enable more barge and smaller cargo vessels to use that area instead of the 40-foot deep President Roads Anchorage while the latter area is being deepened.

Third, maintenance material located between the Massport Marine Terminal and the Inner Confluence that was not removed during Phase 1 of the IHMDP. Maintenance dredging of the Main Ship Channel above the Massport Marine Terminal would realize the economic benefits of deepening the Chelsea River and the Mystic River. Maintenance dredging of the IHMDP was covered under previous 2006 NEPA and MEPA documents

Fourth, maintenance material that has accumulated in the 35-foot Charles River segment of the Main Ship Channel that provides access to the U.S Coast Guard Station, and has not been analyzed in a previous NEPA document, may also be removed.

Table 2-6 below provides quantities of associated maintenance dredged material.

Table 2-6. Associated Maintenance Dredging of the Deep Draft Project

Existing Project Feature	Dredging Volume (cy)	2-Foot Overdepth (cy)	Total Quantity (cy)	Dredging Footprint (Acres)
Maintenance of Project Features for Navigation Traffic Management During Construction Plus Chelsea River Navigation Channel (All Material Suitable for Placement at MBDS)				
Chelsea River – Remaining Overdepth O&M Volume	101,000	82,000	183,000	Included in Improve-ment
Broad Sound North Entrance Channel – 35-Foot Lane	53,000	86,000	139,000	8.2
Broad Sound South Entrance Channel – 30 Feet	33,000	23,000	56,000	70.2
Nubble Channel - 15-Foot	200	1,300	1,500	2.3
Barge Anchorage - 35-Foot	2,000	65,000	67,000	60.1
Maintenance of Project Features Remaining after Phase I IHMDP Construction Plus Charles River Navigation Channel (All Material for MSC CAD Cell Placement)				
Main Ship Channel from Massport Marine Terminal to Inner Confluence – 35-Foot & 40-Foot Lanes	569,000	384,000	953,000	467.6
Mystic River – 35-Foot Lane	10,000	31,000	41,000	Included in Improve-ment
Charles River – 35-Foot	255,000	137,000	372,000	39.1
TOTAL FOR ALL DREDGED CHANNEL MATERIAL	**1,023,200**	**809,300**	**1,812,500**	**647.5**
Excavation of Main Ship Channel CAD Cell for Unsuitable Material Remaining after Phase I IHMDP				
Main Ship Channel CAD Cell Excavated Material to MBDS – Cell For Remaining Unsuitable Phase I IHMDP Material	1,624,00	NA	1,624,000	Included in Mainten-ance
Volume Required to Cap MSC CAD Cell	102,000	NA	102,000	NA
TOTAL REMAINING AND ASSOCIATED MAINTENANCE VOLUMES				
Suitable Channel Materials to MBDS - **TOTAL**	190,000	256,000	446,000	
Suitable CAD Cell Excavated Material to MBDS - **TOTAL**	1,624,000	NA	1,624,000	
Unsuitable Channel Materials to MSC CAD Cell - **TOTAL**	814,000	552,000	1,366,000	

Volumes include side slopes

Removal of any remaining maintenance material from the project areas being deepened under the Deep Draft Project would be accomplished concurrent with removal of the improvement materials. Given the recent 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. These areas include the Broad Sound North Entrance Channel (deep lane), the Barge Anchorage, the lower Reserved Channel and its Turning Area, and the Main Ship Channel from President Roads to Spectacle Island, and from Castle Island to the Massport Marine Terminal.

Therefore, the following maintenance areas are initially determined to be suitable for ocean water disposal (MBDS):

- Chelsea River (overdepth in parent material not removed during the BHNIP);
- Broad Sound North Entrance – 35-foot lane;
- Broad Sound South Entrance – 30-foot lane;
- Nubble Channel – 15-foot lane; and
- Barge Anchorage – 35-foot depth.

In channel areas where the maintenance material was determined unsuitable for ocean disposal, the USACE will place that material into the Main Ship Channel CAD cell previously identified for the IHMDP. Approximately 1,176,000 cy of material would need to be removed to create the Main Ship Channel CAD cell. The USACE may 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 the:

- Main Ship Channel above the Massport Marine Terminal to the Inner Confluence, including both the 35-foot and 40-foot lanes;
- Mystic River 35-foot section near the Medford Street Terminal; and
- Charles River – 35-foot MSC.

See Table 2-7 for volumes of disposal material and their estimated suitability for ocean water disposal and CAD cell excavation. See Figure 2-4 for the previously constructed and currently proposed Main Ship CAD cell for disposal of unsuitable maintenance dredged material.

Table 2-7. Volume of Material to be Excavated for CAD Cell and Disposal

Project Feature	Dredging Volume (cy)	2-Foot Overdepth (cy)	Total Quantity (cy)
Main Ship Channel CAD Cell Excavation	1,624,000	NA	1,624,000
Cap Material for the MSC CAD Cell	102,000	NA	102,000
Total Suitable Channel Material to MBDS	190,000	256,000	446,000
Total Unsuitable Channel Material to MSC CAD Cell	814,000	552,000	1,366,000

2.9.4 Summary

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 Basin, and the President Roads Channel Reach and Anchorage, deepened further to -51-feet MLLW in the harbor's North Entrance Channel from Broad Sound is the NED Plan (See Figure 2-5). This plan meets the NED criteria and the intent of the Environmental Operating Principals in that it meets USACE benefit policy for the recommended plans and does not result in insurmountable environmental impacts.

During design, the incorporation of environmental benefits through the potential for beneficial use of dredged material will be investigated further with the State, Sponsor, and U.S. EPA. The use of rock and other hard material for creation of lobster habitat in the nearby waters of Broad Sound and Massachusetts Bay, for for shoreline protections, or other beneficial uses will be further considered and evaluated 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.

The deepening of the small section of the Mystic River to 40-feet MLLW for access the Medford Street Terminal is also economically justified, environmentally acceptable and otherwise in the Federal interest.

The deepening of the Chelsea River Channel to 40-feet MLLW is also economically justified, environmentally acceptable, and otherwise in the Federal interest, and is included in the recommendation.

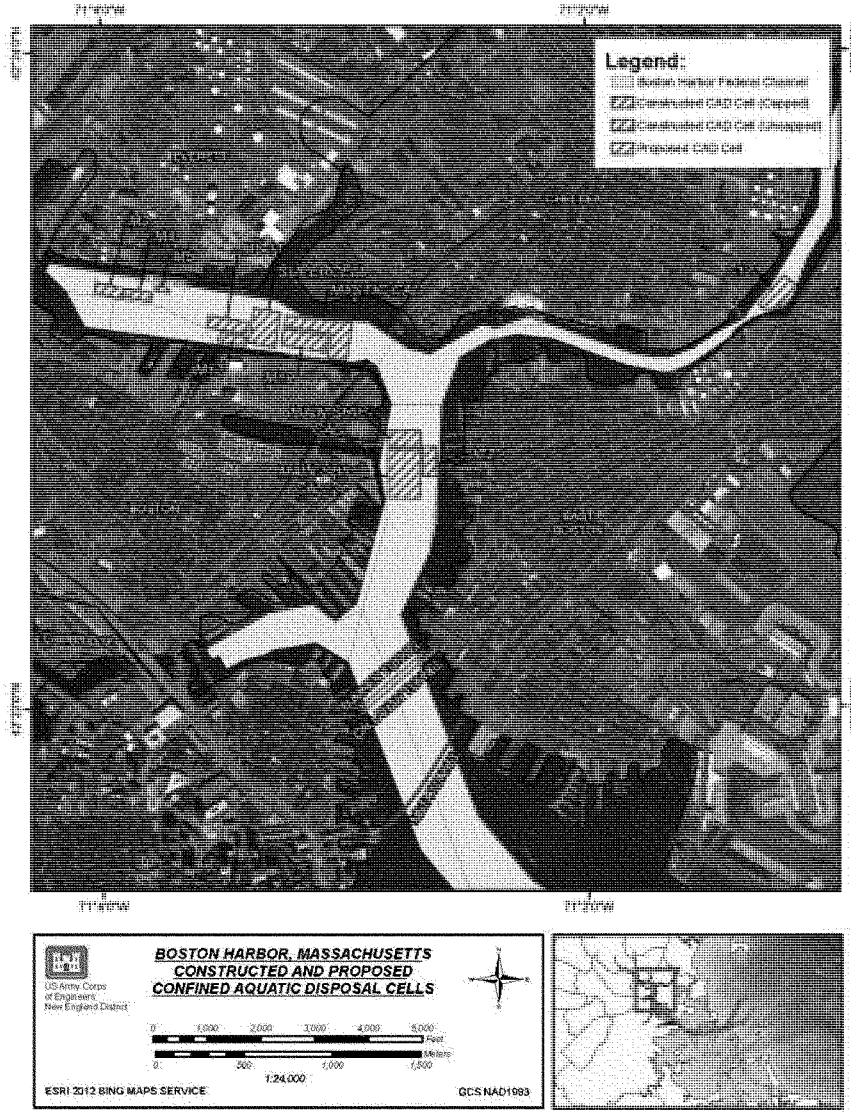
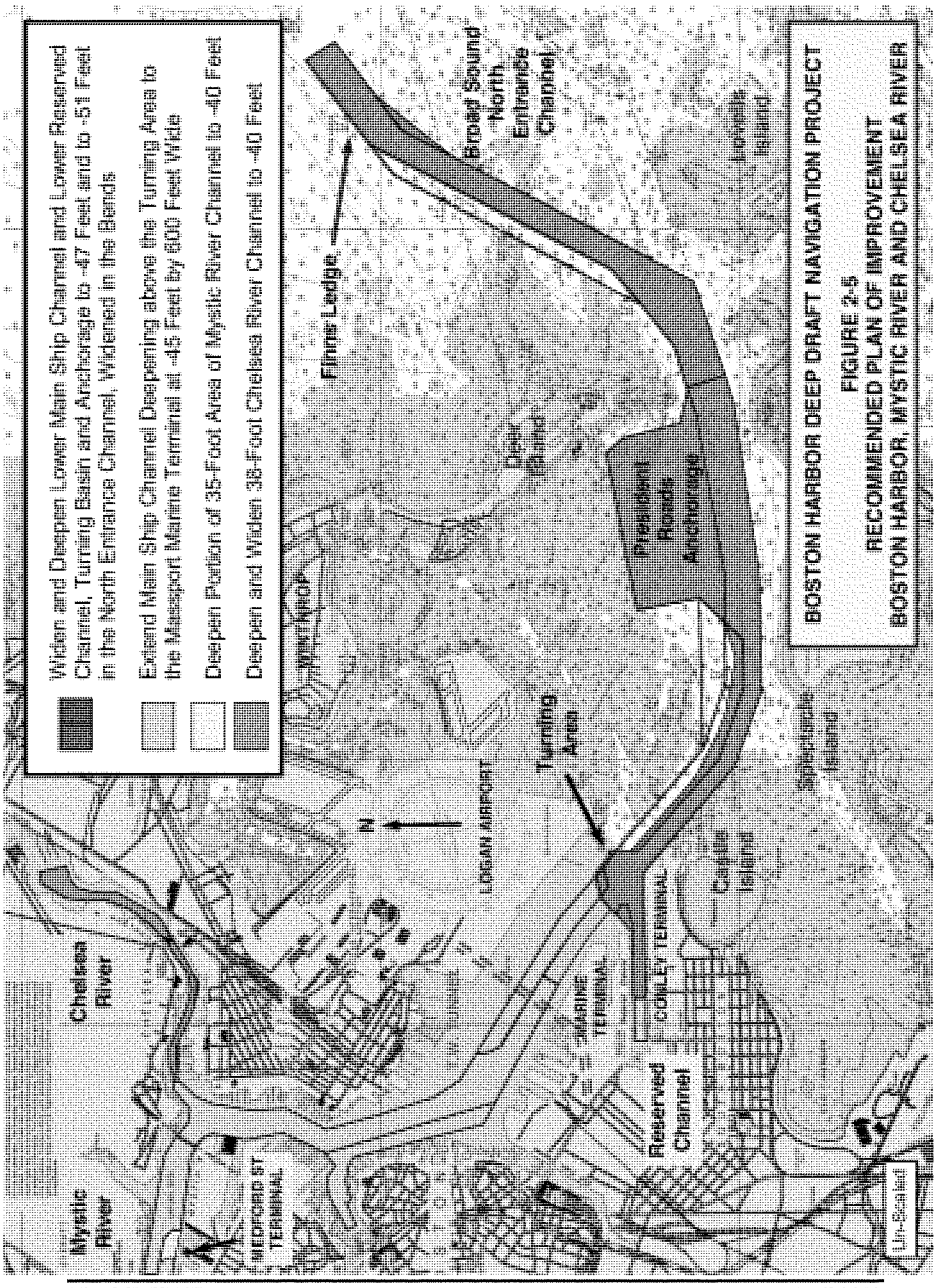


Figure 2-4. Previously Constructed and Proposed Confined Aquatic Disposal Cells



BOSTON HARBOR DEEP DRAFT NAVIGATION PROJECT
FIGURE 2-5
RECOMMENDED PLAN OF IMPROVEMENT
BOSTON HARBOR, MYSTIC RIVER AND CHELSEA RIVER

3. AFFECTED ENVIRONMENT

3.1 Historical Environment

3.1.1 Boston Harbor

Boston Harbor was historically one of the most contaminated estuaries in the United States. The shallow depths, and flow of pollutants and excessive nutrients from streams and rivers in eastern Massachusetts, contributed to the poor condition of the estuary. In addition, decades of urban runoff and an antiquated sewage treatment plant resulted in significant water quality and human health concerns (Battelle, 2000).

The environmental conditions in Boston Harbor began to change when a Federal court order was issued in 1985 to the Massachusetts Water Resources Authority (MWRA). The court order instructed the MWRA to construct a new sewage treatment plant and related facilities to address the water quality and human health concerns. These improvements occurred gradually from 1988 to 2000 (MWRA, 2004). In 1988, sewage scum was no longer discharged into the harbor but placed into a landfill instead. Sludge discharges into the harbor from the old Deer Island Treatment Plant (DITP) and the Nut Island Treatment Plant (NITP) ended in December of 1991. The beginning of secondary treatment in 1997 marked a dramatic decrease in biological oxygen demand (BOD) and continuing declines of bacteria, solids, nitrogen, and phosphorus. The new ocean outfall diffuser came on line in September 2000, beginning the discharge of treated effluent through a 9.5 mile outfall in Massachusetts Bay.

In addition to these major construction projects, MWRA continues to address the problem of combined sewer overflows (CSOs). CSOs discharge a mixture of stormwater runoff and sewage directly into the harbor during heavy rainstorms.

Since effluent discharges to the harbor have decreased, water quality has improved and the water quality classification in the Inner Harbor and President Roads area of Boston Harbor has improved from SC to SB. Class SB waters are defined as designated habitat for fish, other aquatic life and wildlife, including their reproduction, migration, growth and other critical functions, and for primary and secondary contact recreation. Where designated, these waters shall be suitable for shellfish harvesting with depuration (Restricted and Conditionally Restricted Shellfish Areas) and shall have consistently good aesthetic value. Dissolved oxygen levels shall not be less than 5.0 mg/l unless background conditions are lower. Class SC waters are similar to SB waters except they are designated for secondary contact recreation only, suitable for certain industrial cooling and process uses. Dissolved oxygen levels shall not be less than 5.0 mg/l at least 16 hours out of any 24 hour period and not less than 4.0 mg/l at any time.

The improvements to water quality within Boston Harbor should create more favorable conditions for the return of flora and fauna more typical of a healthy estuary.

Boston Harbor includes the lower portions of the Mystic River and the Chelsea River (Creek), the Inner Confluence where the two rivers meet, and the Inner Harbor, Lower Harbor and Outer Harbor portion of the Main Ship Channel area. Some of the Affected Environment sections below describe conditions in Boston Harbor as a whole or as subsection (i.e. by the rivers, Inner Harbor, Lower Harbor, and Outer Harbor).

3.1.2 Habitat Enhancement Sites

As mentioned in the Alternatives Section above, Broad Sound and Massachusetts Bay were identified as potential habitat enhancement sites for the placement of rock removed from the project. All the sites are located in Massachusetts Bay. See Figure 2-3.

Model and field results confirm that the new effluent plume from the MWRA outfall is generally confined to within 12 miles of the Massachusetts Bay outfall (Libby, et. al, 2006). With the relocation of the outfall to Massachusetts Bay, it is possible that all the sites could be minimally influenced by the diluted effluent.

Water quality at the Broad Sound and Massachusetts Bay enhancement sites are classified as SA waters. SA waters are defined as excellent habitat for fish, other aquatic life and wildlife, including for their reproduction, migration, growth and other critical functions, and for primary and secondary contact recreation. Where designated, these waters are suitable for shellfish harvesting without depuration, and have excellent aesthetic value. Dissolved oxygen levels are not to be less than 6.0 mg/l unless background conditions are lower.

3.1.3 Massachusetts Bay Disposal Site

The Massachusetts Bay Disposal Site (MBDS) is located in Massachusetts Bay in some of the deepest waters in Stellwagen Basin. The general vicinity of the MBDS received a wide range of disposed materials dating back at least to the 1940's. Intentionally sunken derelict vessels, organic and inorganic compounds, and construction debris are some of the waste disposed in the vicinity (Hubbard, et. al., 1988).

The water quality above MBDS would not have differed from the remaining portion of Massachusetts Bay prior to the relocation of the sewage outfall and has not been affected by the relocation of the effluent discharge from Boston Harbor to Massachusetts Bay. This conclusion is based on three-dimensional circulation models for Massachusetts Bay and the outfall and far field water quality monitoring. This data has also not shown any adverse impacts to areas in Massachusetts Bay where the MBDS is located (USGS, 2005).

The MBDS is located outside State waters and therefore does not have a water quality classification. However, if there was a designation, the waters of the MBDS would be expected to have a Class SA designation. The water above the MBDS is not significantly influenced by anthropogenic sources and the dredged material disposed at the site has met the suitability testing requirements. Class SA is the same classification as Massachusetts Bay waters located within the State boundaries.

3.1.4 Industrial Waste Site

The Industrial Waste Site (IWS) overlaps much of the MBDS and extends further north in Stellwagen Basin. The IWS received a wide range of wastes beginning in the 1940's until it was closed in 1977, including industrial and chemical wastes, munitions, construction debris, and derelict vessels. Disposal of low-level radioactive wastes took place at the IWS between 1946 and 1959. The area identified with a high density of waste on the seafloor (termed the barrel field) is located outside and to the north of the MBDS and has a similar environment to the MBDS. Refer to Section 2.7 for additional information.

3.2 Physical Environment

3.2.1 Physical Oceanography

3.2.1.1 Boston Harbor

Boston Harbor is relatively shallow with an average depth of about 15 feet, and is well flushed by strong tides. The water within Boston Harbor is replaced by Massachusetts Bay and river waters within five to seven days (MWRA, 2004). USGS (2005) computer modeling shows the deep channels at the mouth of the harbor to be more rapidly flushed than the Inner Harbor and shorelines of Boston Harbor.

The dominant currents in the harbor are tidal in origin, although wind driven currents occur during storms. Freshwater flow discharges from the Mystic, Charles, and Chelsea Rivers generally overlie the more dense seawater flows from the tides. Freshwater flows average 350 to 500 cubic feet per second (cfs) in the summer. Tidal inputs are orders of magnitude greater with flows averaging 320,000 cfs for a six hour period and volumes ranging from 10.6 billion gallons at low tide to 179.9 billion gallons at high tide (Metcalf and Eddy, 1976; and MDWPC, 1986). At the mouth of the Inner Harbor near Castle Island, the recorded mean tide range is 9.4 feet and the spring tide range is 10.9 feet (NOAA, 1999). The mean tide level is 5.0 feet. The fastest tidal currents in Boston Outer Harbor occur in the deep ship channels (up to 1.4 knots) during spring tides in the southern lane of the Main Ship Channel (USACE/Massport, 1994).

3.2.1.2 Habitat Enhancement Sites

Broad Sound – The Broad Sound site is located in waters southeast from the coast of Nahant in open water. The proposed site is square, measuring approximately 1.4 miles by 1.3 miles, enclosing an area of 1.73 square miles. This site has intermediate depth, with depths ranging from approximately 45 to 90 feet. This site would be expected to be influenced by local tidal conditions as well as the physical conditions described below for Massachusetts Bay.

Massachusetts Bay – The Massachusetts Bay site is located approximately three miles east of Hull in open water. The proposed site is rectangular, measuring approximately 2.2 miles by 1 mile enclosing an area of 2.12 square miles. This site is the deepest of the survey areas, with depths ranging from approximately 75 to 110 feet. This site would be expected to have physical characteristics most similar to the characteristics described below for Massachusetts Bay.

3.2.1.3 Massachusetts Bay Disposal Site

The Massachusetts Bay Disposal Site is located in the depressed Stellwagen Basin on the western edge of the Stellwagen Bank National Marine Sanctuary in Massachusetts Bay. Massachusetts Bay is a semi-enclosed embayment surrounded by the Boston metropolitan region in the north and west and by Cape Cod to the south. The bay is open to the Gulf of Maine in the east. It is about 60 miles long and 30 miles wide, and has average depth of 115 feet. Stellwagen Basin is the only deep basin in Massachusetts Bay with a depth up to 300 feet. It is bounded in the east by Stellwagen Bank with the shallowest depth of about 65 feet, and is connected to the Gulf of Maine through the North Passage off Cape Ann and the South Passage off Race Point (Jiang and Zhou, 2004a).

Previous studies have indicated that the circulation in Massachusetts Bay/Cape Cod Bay varies in response to short and long-term local and remote forcing (Geyer *et al.*, 1992; Signell, *et al.*, 1996 in Jiang and Zhou, 2004a). The local and remote forces include: 1) wind stresses and heat fluxes at the sea surface, 2) tides and mean surface slopes at the open boundary, and 3) freshwater runoff including outfall effluents. A counterclockwise circulation characterizes the yearly-mean current in Massachusetts Bay/Cape Cod Bay. Tides are semi-diurnal. Tidal currents vary from two knots in Stellwagen Basin, to 9.7 knots off the tip of Cape Cod. In most of Massachusetts Bay, the flow-through flushing for the surface waters ranges from 20 to 45 days (USGS, 1998).

A modeling study conducted for the MWRA indicates pronounced seasonal variation in the circulation pattern (Jiang and Zhou, 2004b). In western Massachusetts Bay, the currents are strongly driven by surface winds. In winter and spring seasons, northerly winds drive a southward coastal current thus creating a counterclockwise circulation that is consistent with the annual mean pattern (Geyer et al., 1992 in Jiang and Zhou, 2004a). In summer and early fall, predominant southwest winds produce offshore Ekman transport and coastal upwelling, which induce an overall northward coastal current along the upwelling front near the western coast, thereby reversing the counterclockwise circulation. This is confirmed by the moored Acoustic Doppler Current Profiler (ADCP) current measurements at the U.S. Geological Survey buoys (Butman *et al.*, 2002) and the MWRA modeling study (Jiang and

Zhou, 2004b). The coastal upwelling and downwelling have also been discussed in previous studies (e.g., Geyer, *et al.*, 1992; HydroQual and Signell, 2001 *in* Jiang and Zhou, 2004a).

3.2.1.4 Industrial Waste Site

As the IWS overlaps much of the MBDS and its extension to the north still lies within Stellwagen Basin, it has similar physical characteristics as described above for the MBDS. The IWS is located in water depths of 240 to 300 feet. The only significant topographic features include rises in the north and northeast quadrant where the bottom shoals toward Stellwagen Bank. A circular mound rises in its north-central section, and a small depression is near its center (NOAA, 1996).

3.2.2 Water Temperature and Salinity

3.2.2.1 Boston Harbor

Water temperature and salinity were measured for seven years (from 1993 to 1999) in Boston Harbor to characterize the baseline conditions prior to the discharge of wastewater from the new outfall (Taylor, 2001). Sampling stations were located in the North Harbor (north of Long Island and in the project area) and in the South Harbor region (south of Long Island and outside the project area). The average water temperature was 9.6 °C (Taylor, 2002a). Highest water temperature in the summer averaged approximately 20°C and showed very little variation over the years. The minimum temperature did, however, show a slight increase from the winter 1993/1994 to the winter of 1998/1999. In general the water temperature for the two regions in Boston Harbor, the North Harbor and the South Harbor, were similar (Taylor, 2001).

Variations for salinity within a year were considerable for the harbor (Taylor, 2001). Salinity ranged from about 26 parts per thousand (ppt) to 33 ppt. Average annual salinity levels in the North Harbor, where the project area is located, were consistently lower than the average annual salinity levels in the South Harbor (Taylor, 2001). Average salinity did increase very slightly after the interisland transfer of wastewater from NITP to DITP from 29.8 to 29.9 ppt in the North Harbor and 30.8 to 30.9 in the South Harbor (Taylor, 2002a). It might be expected that salinity levels would decrease in the Inner Harbor as one moves closer to the mouth of the three rivers (Charles River, Mystic River and Chelsea River) discharging into Boston Harbor. As no significant trends in water temperature or salinity were observed in the harbor as a whole or in either the two regions (North Harbor where the project is located or South Harbor), this suggests the trends were not the result of long-term trends in freshwater flows or water temperature (Taylor, 2001).

3.2.2.2 Habitat Enhancement Sites

No site specific water temperature or salinity data are available for the Broad Sound or Massachusetts Bay enhancement sites. Although these sites are closer to the coast, they would still be considered open water sites, subject to many similar conditions described below for Massachusetts Bay with coastal influences.

River discharges influence the salinity, the stratification, and the strength of the coastal circulation, where the habitat enhancement sites are located. The Charles River mainly influences surface conditions at the outfall site, whereas the Merrimack River has more influence on bottom salinity (Libby, *et al.*, 2006). Air temperature has a substantial effect on water properties during the winter, when it sets the minimum water temperature.

3.2.2.3 Massachusetts Bay Disposal Site

Although Massachusetts Bay generally follows an annual cycle typical for temperate coastal waters, the timing of the events over the cycle is strongly influenced by regional meteorological and oceanographic conditions (Libby, *et al.*, 2006). In winter, the water column in Massachusetts Bay is

well-mixed and nutrient levels are high. Stratification occurs later in the spring due to the increased spring freshets that decrease the surface salinity. This increase in stratification separates the bottom and top layers of the water column, effectively reducing the availability of nutrients to the surface from the bottom and oxygen to the bottom layer (Libby, *et al.*, 2004). The summer is generally a period of strong stratification, and depleted surface water nutrients. In the fall, strong winds and cooling temperatures promote mixing of the water column (Libby, *et al.*, 2004). By early winter, the water column is well-mixed and reset to winter conditions. The MBDS would be expected to follow this same annual cycle. Salinity minima occur in late spring as a result of increased spring runoff, but vary only a few parts per thousand. Most values range from 31 ppt to 33 ppt (Hubbard, *et al.*, 1988).

3.2.2.4 Industrial Waste Site

The description described above for the MBDS is relevant to the IWS.

3.2.3 Water Column Turbidity

3.2.3.1 Boston Harbor

Turbidity refers to the clarity or clearness of the water. The greater the amount of total suspended solids (TSS) in the water, the murkier it appears and the higher the measured turbidity. Although turbidity is not an inherent property of water such as temperature or pH (Davies-Colley and Smith, 2001, *in* Wilde, F.D., 2005), it is an indicator of water body health. Turbidity is caused by suspended and dissolved matter; such as clay, silt, finely divided organic matter, plankton and other microscopic organisms, organic acids, and dyes (ASTM International, 2003, *in* Wilde, F.D., 2005). Natural causes of turbidity include runoff, phytoplankton and zooplankton, minute fragments of dead plants, and storm events. Anthropogenic sources of turbidity include runoff from agricultural fields, stormwater runoff from construction sites and urban areas, shoreline erosion from heavy boat traffic, bottom sediment resuspension from vessel traffic, dissolved nutrients released in treated wastewater, and organics released by sewage treatment plants.

High levels of turbidity, outside the normal range of turbidity levels, over sustained periods of time can be a concern for the health and productivity of the estuarine ecosystem for several reasons. Turbid waters can decrease light penetration into the water, thereby lowering photosynthetic activity and reducing the area available for submerged aquatic plants to grow. Algae can greatly limit light penetration and can limit primary production to the uppermost layers of water. This can cause invertebrate population decline (caused by fewer photosynthetic organisms available for food). This in turn can result in fish population decline (caused by fewer invertebrates available for food). Suspended material in large quantities for sustained periods can foul the filter-feeding systems of certain estuarine animals. Particles may accumulate on the gills of fish and inhibit breathing. High levels of turbidity can hinder aquatic predators from spotting and tracking down prey. Dissolved oxygen can be depleted if turbidity is largely due to organic particles.

Water clarity has improved in Boston Harbor since 1993 (MWRA, 2004). The water clarity gradient shows an increase from west to east. Water is more turbid toward the river and shallow margins of the harbor and clearer toward the mouth of the harbor and bay. Secchi disk measurements (a white disk lowered into the water column until it disappears) showed that up until July 1998 Secchi disk depths were generally greater than 6.6 feet over most of the harbor, but were noticeably shallower around the Nut Island outfalls and in Dorchester Bay. After closing the NITP in July 1998, Secchi disk depths increased by more than three feet near the old NITP outfalls. In other parts of the harbor, the water clarity only increased eight inches to two feet or near the DITP, not at all.

3.2.3.2 Habitat Enhancement Sites

The Broad Sound and Massachusetts Bay habitat enhancement sites are located in open water areas where conditions would be similar to Massachusetts Bay.

3.2.3.3 Massachusetts Bay Disposal Site

No apparent changes to the water clarity have been noted near the outfall (Libby *et al.,* 2006). As the MBDS is located several miles further east of the outfall, no changes to water clarity is expected. Water quality at the Massachusetts Bay Disposal Site (MBDS) has not been affected by the relocation of effluent discharge from Boston Harbor to Massachusetts Bay. Three dimensional circulation models and water quality monitoring have not shown any adverse impacts to the MBDS (USGS, 2005).

3.2.3.4 Industrial Waste Site

The description above for the MBDS is relevant for the IWS.

3.2.4 Dissolved Oxygen

3.2.4.1 Boston Harbor

Dissolved oxygen (DO) in marine waters is essential for most healthy aquatic life. If levels are too low it can be a sign of human induced impacts such as excessive runoff or nutrients or natural causes such as seasonal variations. Healthy conditions for aquatic life exist when dissolved oxygen are above 5.0 mg/L. Concentrations between 5.0 mg/L and 3.5 mg/L are generally healthy, except for the most sensitive species. When concentrations fall below 3.5 mg/L, conditions become unhealthy. The most severe effects occur if concentration levels fall below 2.0 mg/L, even for short periods of time (EPA, 1997). EPA's new recommended marine dissolved oxygen standard is an average of 4.8 mg/l with a minimum of 2.3 mg/l, currently applicable from Cape Cod south to Cape Hatteras (MWRA website).

Monitoring of DO levels in Boston Harbor show that, even before the MWRA improvements were implemented, DO levels were high enough to support healthy marine life (MWRA, 2004). With the completion of MWRA improvements, DO levels have remained relatively unchanged. This is due to the tidal flushing of the harbor that results in a well-mixed water column. Monitoring has shown that even at the end of summer, when DO levels are typically at their lowest, concentrations are still within what is considered a healthy range (Libby *et al.,* 2011). DO levels increase with distance from the shoreline and are lowest in the Inner Harbor and the mouths of rivers. DO levels in the harbor range from 4.9 mg/L in the Mystic River/Inner Harbor, to 8.1 mg/L in the area south of Long Island (MWRA, 2004).

3.2.4.2 Habitat Enhancement Sites

In Massachusetts Bay, DO concentrations show a consistent trend since 1992 of maximum water bottom DO levels in the winter, a decrease over the course of the summer during seasonal stratification, and then reaching annual minimum levels just prior to stratification breaking down in the fall – usually October (Libby *et al.,* 2006). Since the outfall came on line there as has been little change in the DO cycle (Libby *et al.,* 2006). The MWRA monitoring stations closest to the outfall, and most representative of the Massachusetts Bay habitat enhancement site, show mean bottom water DO levels ranging from a low of about 7.5 mg/l to a high of 11 mg/l. The Broad Sound and Massachusetts Bay habitat enhancement sites are located in open water areas which would be similar to conditions observed in Massachusetts Bay.

3.2.4.3 Massachusetts Bay Disposal Site

MWRA monitoring stations most representative of the MBDS by water depth show healthy mean bottom water DO concentrations ranging from a low of 7.5 mg/l to a high of 10.5 mg/l (Libby *et al.,* 2006). These DO bottom water concentrations have changed little with the outfall coming on line.

3.2.4.4 Industrial Waste Site

The IWS would be expected to have similar DO levels as the MBDS due to the close proximity and similar conditions as the MBDS.

3.2.5 Nutrients

3.2.5.1 Boston Harbor

Nutrients such as nitrogen and phosphorus are necessary in a productive marine ecosystem. However, too much nitrogen, especially in the form of ammonia, can fuel and stimulate the excessive overgrowth of algae and seaweed. The dense algae blooms cloud the water and shade the bottom. When the algae die and settle to the bottom, they are decayed by baeteria that can use up oxygen. Oxygen is necessary for aquatic organisms to feed, grow, and live. In extreme conditions, some organisms may suffocate and die, while others flee the hypoxic (low dissolved oxygen level in the water) zones. Dense algae blooms can prevent enough light from reaching shallow water bottoms to support the growth of submerged aquatie vegetation, an important habitat for shellfish and juvenile fish (EPA, 1997).

Nutrient load has improved significantly in Boston Harbor since the discharges from the NITP ended and discharges from the DITP were moved in September 2000 to the diffuser offshore in Massachusetts Bay. There has been a statistically significant decrease in ammonia (NH_4), nitrate (NO_3), and phosphorus (PO_4) in Boston Harbor (Libby, *et al.*, 2006, 2011). Significant decreases in ammonia levels at the NITP outfall site were noted after discharges from NITP ended. In addition, the average concentrations of dissolved inorganic nitrogen (5.5 *u*mole l^{-1}) and dissolved inorganic phosphorus (0.73 *u*mole l^{-1}) decreased 55% and 31% respectively after the diffuser came on-line (Taylor, 2002b). Now ammonia in Boston Harbor shows a typical, low seasonal cycle seen in healthy estuaries (MWRA, 2004; Libby *et al.*, 2011).

3.2.5.2 Habitat Enhancement Sites

Seasonal trends in nutrient concentrations are closely linked with both physical and biological factors in Massachusetts Bay (Libby, *et al.*, 2006). Physical mixing or stratification combined with biological utilization and remineralization act to increase or decrease the concentrations of nutrients over the course of the year. Nutrient concentrations are high in the winter when consumption is low and mixing is thorough; concentrations decrease in the surface waters during the winter/spring bloom due to consumption by phytoplankton, while the onset of stratification cuts off the supply of nutrients from deeper waters. As stratification strengthens, nutrients are generally depleted in surface waters and increase at depth in the summer; nutrients then return to elevated levels in the surface waters following the fall bloom and mixing of the water column (Libby, *et al.*, 2006).

Since the outfall came on line, dissolved inorganic nutrients (except SiO_4) have exhibited increases through Massachusetts (Libby, *et al.*, 2006). Statistically significant increases of ammonia were noted during each season in the area near the outfall (most representative of the Massachusetts Bay habitat enhancement site), and Broad Sound. Significant increases in NO_3, and PO_4 concentrations were also noted near the outfall and Broad Sound monitoring stations during the summer and fall. These increases are due to both the direct input of nutrients to the area near the outfall and by an apparent regional increase in ambient concentrations as evidenced by significant increase in NO_3 at the northern boundary of Massachusetts Bay (Libby, *et al.*, 2006).

3.2.5.3 Massachusetts Bay Disposal Site

The effluent plume, as measured during dye studies and characterized by NH_4 distribution during each MWRA survey, appears to be confined to within about 12 miles of the outfall(Libby, *et al.*, 2006).

Since the MBDS is located near the outside edge of this range, changes due to the effluent plume should not effect the MBDS.

3.2.5.4 Industrial Waste Site

The effluent plume from the MWRA outfall pipe should have no significant influence on the IWS due to its distance from the pipe.

3.2.6 Sediment Characteristics

3.2.6.1 Boston Harbor

Sidescan Sonar is a technique using ultrasonic sound to visualize the structure of the seafloor using backscatter images. Bright areas on the backscatter images represent hard objects like rock which reflect sound readily (*i.e.*, strong backscatter) while dark areas showing weaker reflectance represent soft objects

Sedimentary environments in the affected environment, including Boston Harbor and Massachusetts Bay, have been mapped and interpreted from an extensive collection of sidescan sonar records and supplemental marine geologic data gathered by Knebel and Circe (1995). While this area represents a relatively complex sedimentary environment, Knebel (1993, 1995) identified three primary sedimentary environments that show direct correlation with processes of erosion, deposition, and sediment reworking. Figure 3-1, adapted from work presented by Knebel (USGS, 1999a) and available on the United States Geological Survey (USGS) web site (http://pubs.usgs.gov/of/of99-439), provides an overview of the sedimentary environments recognized in the area.

Erosional marine environments consist of subtidal, exposed bedrock, glacial drift, and coastal-plain rocks. Non-depositional areas consist of coarse-grained lag deposits. On the sidescan sonar records, these areas are recognized by patterns with isolated reflections or by patterns of strong backscatter. These areas contain bottom types ranging from boulder fields to gravelly sands and occur in areas of high energy. Inside the harbor, erosional areas were found near mainland and insular shorelines, harbor approaches, and over scattered knolls and ridges. Subbottom profile data acquired in these areas show bedrock and/or glacial till outcropping on the seafloor. As depicted on Figure 3-1, erosional/non-depositional environments are isolated to the southern shoreline regions of the Inner Harbor, but are predominant across the Outer Harbor.

Depositional environments are areas blanketed by muddy sands and/or muds that have accumulated under predominantly weak bottom current conditions. The sediments in depositional areas are fine-grained and contain relatively high concentrations of organic matter. Depositional environments are characterized on the side scan sonar records as uniform patterns of weak backscatter. They occupy a large portion of Boston Inner and Lower Harbor.

Sediment reworking environments are areas where bottom currents fluctuate considerably in strength causing sediments in the areas to be intermittently eroded and deposited. Reworked areas are characterized by sandy-gravels to mud. Environments interpreted as sediment reworking are less common in the harbor than the preceding two types of environments mentioned.

Additional sidescan and sub-bottom profile analyses were performed within the Boston Harbor Navigation channel in 2002 (USACE, 2003a). Based on these data, a similar analysis of sedimentary environment was conducted (Figure 3-2). The navigation channel passes through a number of sedimentary environments. The Lower Harbor portion of the channel appears to change from an area characterized as sediment reworking (consisting of mud and sand) in the eastern portion, to erosional in the western portion (characterized by sand and gravel). The Outer Harbor portion of the navigation channel is an erosional area characterized by poorly sorted coarse to fine grained sand, consistent with

the sediment reworking classification of Knebel (USGS, 1999b), with isolated areas of gravel, rock and ledge.

Limited sidescan data in the Inner Harbor and Mystic and Chelsea Rivers (Figure 3-1), in conjunction with the grain-size data shown on Figure 3-2, appear to indicate that the sedimentary environments in these areas consist predominantly of silt, clay, and mud, which is characteristic of a depositional area. This estuarine environment, because of its protected nature, low wave climate, and large supply of sediments, is an effective trap for fine-grained material. Isolated areas of gravel were noted near the mouth of both the Mystic and Chelsea Rivers (Figure 3-1).

Physical samples were colleeted in August 2002 to determine grain size of the material to be dredged (see Figure 3-3). This material is located beneath the silty maintenance material which has been or will be removed during maintenance dredging. The results of the test show that the improvement material corresponds to the sidescan and sub-bottom profile data, i.e. coarser grained sediment in the lower portion of the harbor and finer grained sediment in the upper portion of the harbor and rivers. A summary of the grain size results can be found in Table 3-1.

3.2.6.2 Habitat Enhancement Sites

Broad Sound – The dominant substrate texture classes were (in decreasing order of dominance): muddy sand and a gravel/cobble mix. The coarser gravel/cobble mix roughly bisected the site along an east/west orientation. Soft bottom covered 0.99 square mile, or 57% of the site. Sediment Profile Imaging (SPI) stations at the Broad Sound site indicated that the substrate was both sandy and silty. The northern sampling stations were separated from southern stations by a broad swath of hard bottom, including coarse gravel and small cobbles. The three infaunal stations within the Broad Sound site (BR1,

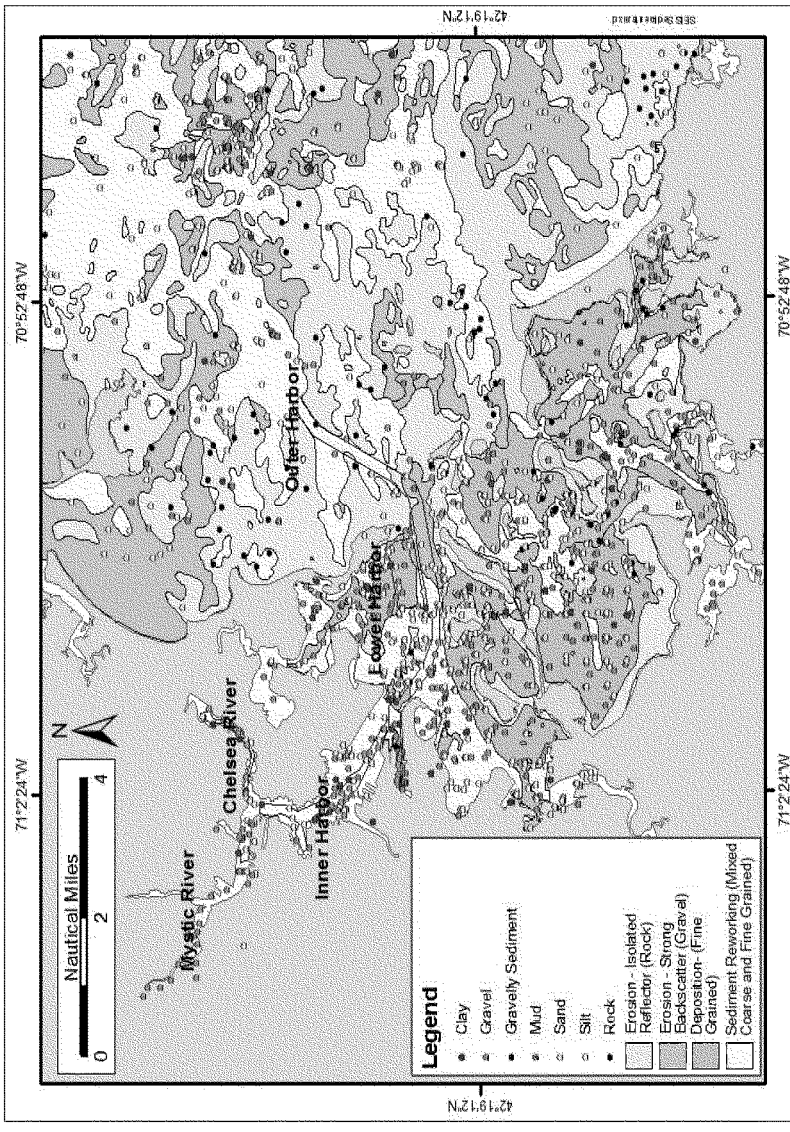
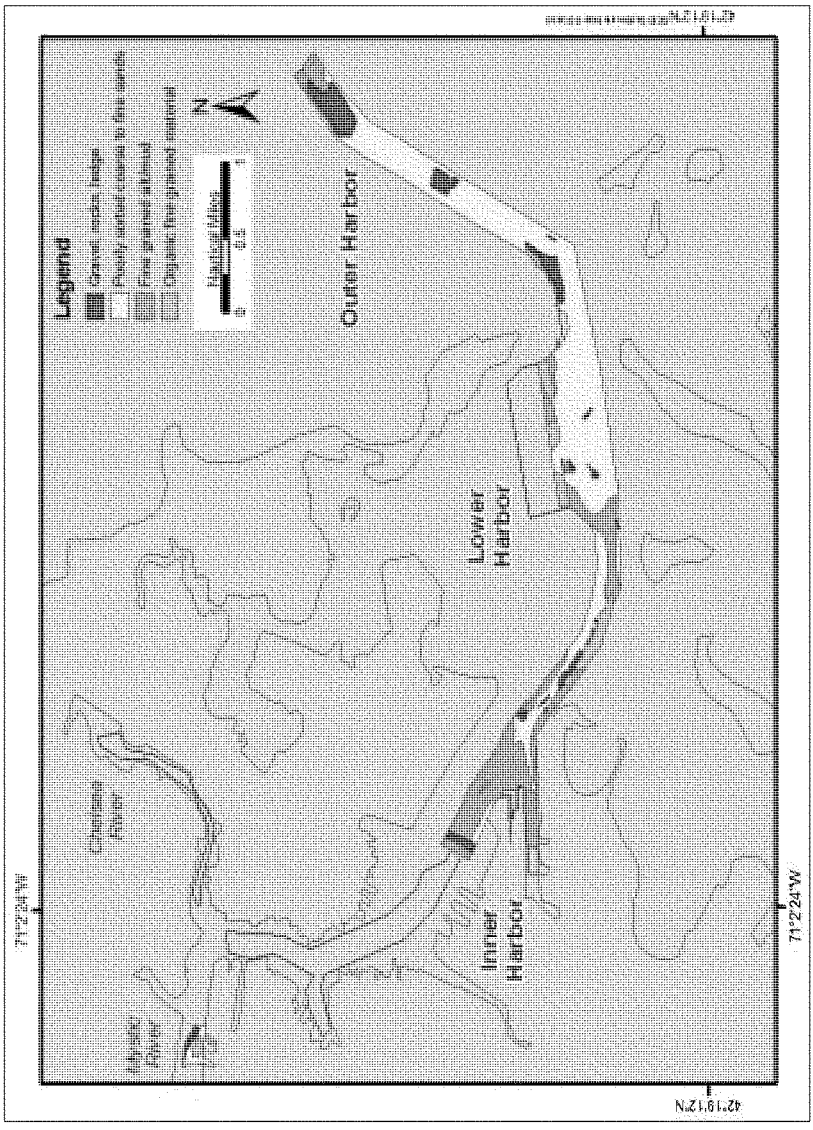


Figure 3-1. Sedimentary Environments and Sediment Botttom Types in Boston Harbor and Massachusetts Bay
Source: USGS, 1999
Note: Bottom type locations are approximate.



Source: USACE, 2003

Figure 3-2. Navigation Channel Sedimentary Environments (Existing Bottom Surface)

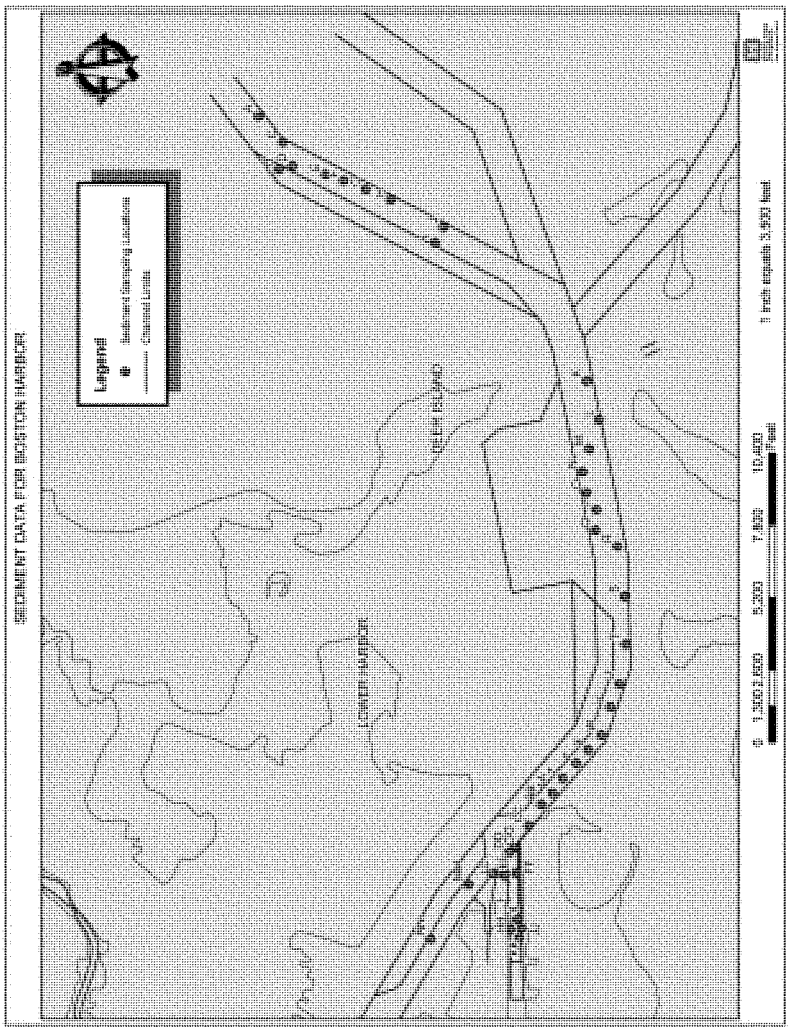


Figure 3-3a. Sediment Sample Locations

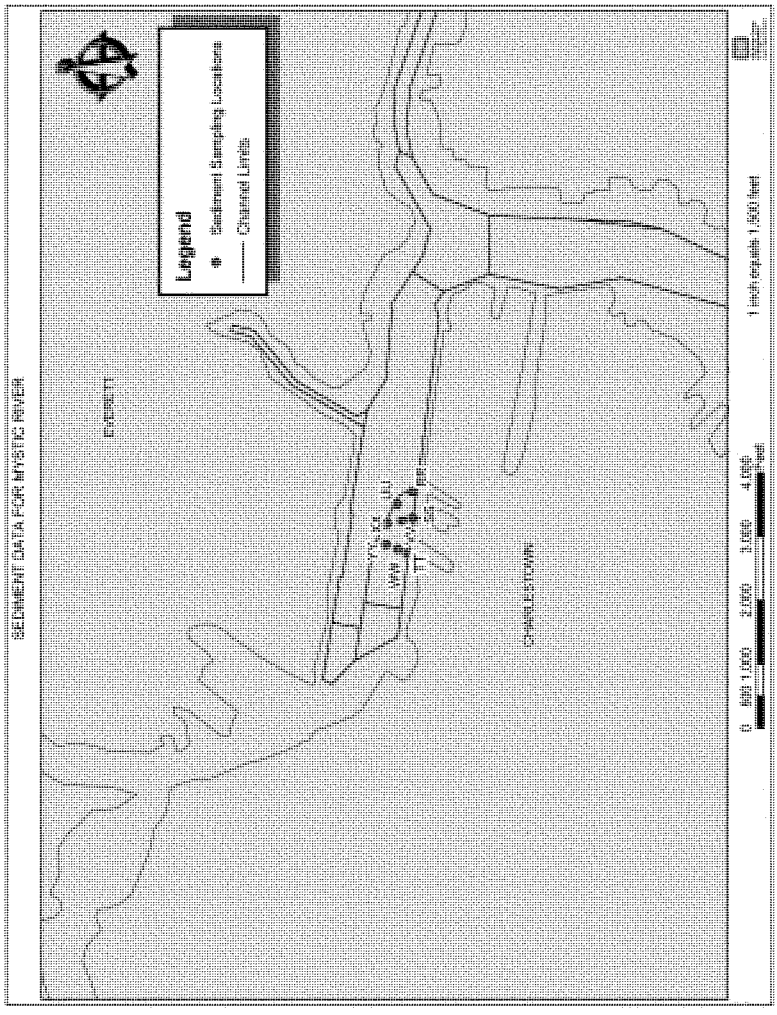


Figure 3-3b. Sediment Sample Locations

Table 3-1. Grain Analysis of Boston Harbor Samples

SAMPLE	GRAVEL %	SAND %	SILT/CLAY %
Broad Sound North Channel			
A	68.29	23.46	8.25
B	90.11	9.17	0.72
C	only cobble	0.00	0.00
D	64.82	31.00	4.18
E	26.40	69.50	4.10
F	67.88	29.96	2.16
G	91.47	7.94	0.59
H	53.19	42.09	4.72
I	81.94	15.53	2.53
J	19.78	61.44	18.78
Main Ship Channel			
K	84.36	11.28	4.36
L	42.28	32.16	25.56
M	82.87	15.06	2.07
N	10.23	63.72	26.05
O	8.60	68.92	22.48
P	61.81	25.98	12.21
Q	0.86	47.93	51.21
R	0.17	17.72	82.11
S	0.12	33.75	66.13
T	0.92	7.29	91.79
U	0.30	58.34	41.36
V	9.78	54.99	35.23
W	0.00	7.00	93.00
X	0.00	14.67	85.33
Y	0.00	94.20	5.80
Z	1.87	7.25	90.88
Reserved Channel and Adjacent Main Ship Channel			
AA	0.41	8.82	90.77
BB	0.56	3.13	96.31
CC	0.00	14.94	85.06
DD	16.25	55.27	28.48
EE	0.08	20.15	79.77
FF	0.00	12.00	88.00
GG	0.10	4.77	95.13
HH	14.41	32.95	52.64
II	31.01	44.02	24.97
JJ	23.63	65.15	11.22
KK	17.45	14.91	67.64
LL	0.07	7.92	92.01
MM	0.00	8.98	91.02
NN	0.62	4.05	95.33
Mystic River			
RR	0.00	10.54	89.46
SS	0.00	4.86	95.14
TT	0.00	7.55	92.45
UU	0.00	6.22	93.78
VV	0.00	10.63	89.37
WW	0.00	10.09	89.91
XX	0.00	5.71	94.29
YY	3.01	32.36	64.63

BR3, and BR6) were located in two large areas of sand or muddy sand. Sediments were moderately coarse at station BR1 (61% sand and gravel) and fine at stations BR3 and BR6 (66% and 78% silt and clay). Total organic carbon (TOC) content was very low at station BR1 (0.5%) and low at stations BR3 and BR6 (1.3-1.9%).

Massachusetts Bay – The dominant substrate texture classes were (in decreasing order of dominance): sand, coarse sand and gravel, mud, and cobble. A wide area of mud was located in the center of the site, surrounded by extensive areas of hard bottom to the east and southwest. Soft bottom covered 1.06 square miles or 50% of the site. Anthropogenic debris and fixed fishing gear (e.g., lobster traps) were widespread at this survey area. Sidescan sonar imagery identified many ring-shaped features, interpreted to be small mounds of disposed coarse material (e.g., construction debris). Sand waves of varying size were also widespread at the Massachusetts Bay site. SPI stations at the Massachusetts Bay site were sandy or silty. The three infaunal stations within the Massachusetts Bay site (MB1, MB4, and MB7) were located within a broad area of fine to medium sand or very fine sandy mud surrounded by extensive areas of hard bottom. Sediments generally were evenly mixed coarse and fine textures at stations MB1 and MB4, but were predominantly fine at station MB7. TOC content was low at stations MB1 and MB4, just less than 1%, and moderate at station MB7, about 3%.

3.2.6.3 Massachusetts Bay Disposal Site

The bottom in the deeper portions of the MBDS is a broad depression with natural sediments composed of fine grained material. Shoal areas to the north and northeast are covered by coarser deposits (Hubbard, *et al.*, 1988). Dredged material has been disposed at the MBDS from harbors located on the east coast of Massachusetts north of Cape Cod. The dredged material disposed at the site is composed predominantly of fine silts and clays. Dredged material disposed at the site has covered a large area, but periodic monitoring at the site by the USACE has not identied disturbance or redistribution of material once placed. A section of the previously defined disposal site was set aside as an area for rock disposal (north of the existing MBDS) to enhance the biological diversity at the site, and a similar site will be considered for the existing MBDS.

3.2.6.4 Industrial Waste Site

Most of the seafloor surveyed was characterized as soft sediment with a uniform horizon typical of a depositional basin (NOAA, 1996). Within the uniform flat mud basin, topographic rises, approximately 60 feet shallower than the surrounding bottom, were observed. These glacial knolls are composed of coarser sand and cobble substrate in patches with occasional 1 ½ to three-foot diameter exposed bounders (NOAA, 1996).

3.3 Biological Environment

3.3.1 Submerged Aquatic Vegetation

3.3.1.1 Boston Harbor

Dense meadows of seagrass are characteristic of pristine, shallow depositional environments in New England (MWRA, 2004). A century ago, seagrass meadows covered hundreds of acres of subtidal flats of Boston Harbor. Eelgrass can successfully dominate areas that have sediments ranging from soft mud to coarse sand with average salinities of 10 to 30 ppt (Thayer *et al.*, 1984). Light availability is a primary factor limiting both depth and upstream estuary penetration of eelgrass within its temperature and salinity ranges (Thayer *et al.*, 1984).

The eelgrass meadows in Boston Harbor had all but vanished by the late 1980's, due to turbid water, viral diseases, and excessive nutrients that promote the growth of algae on seagrass leaves (MWRA, 2004). Boston Harbor now supports only small areas of seagrasses in Hull and Hingham Bay and the northwest shoreline of Long Island as part of MA DMF eelgrass restoration project (MA DMF eelgrass website). The only area to show a significant increase in eelgrass acreage is near Logan Airport. From 1995 to 2001 this patch of eelgrass increased from 20.6 acres to 27.7 acres (MA DEP eelgrass website). Video mapping by Massport in 2007 through 2011 indicates that this eelgrass bed covers nearly 50 acres. Until recently, nutrient concentrations in the harbor have been very high, and the water in most areas has not been clear enough to support seagrasses. With the reduction in

nutrients in the water and the increases in clarity, an effort to restore seagrasses in Boston Harbor was started by the MA Division of Marine Fisheries in the spring of 2004 through fall 2007. The MA DMF study resulted in two hectares of restored eelgrass adjacent to Long Island and Peddocks Island within Boston Harbor (Lescher *et al.*, 2010). The successful restoration occurred in well flushed areas with sediments that contained less than 35% silt/clay (Lescher *et al.*, 2010). These eelgrass restoration sites are located outside the influence of any Federal navigation dredging activity and related impacts.

3.3.1.2 Habitat Enhancement Sites

None of the habitat enhancement sites are known to contain submerged aquatic vegetation based on site information prepared for this SEIS/EIR, coordination with State agencies, and the physical characteristics of some of the sites.

3.3.1.3 Massachusetts Bay Disposal Site and Industrial Waste Site

The water depths at the MBDS and the IWS are too deep to support submerged aquatic vegetation. Eelgrass needs sufficient light for growth, generally not found in waters any deeper than 12 meters MLW in clear offshore waters (Buzzards Bay National Estuary Program website). Water depths at the MBDS are 82 meters and deeper.

3.3.2 Benthic Invertebrates

3.3.2.1 Boston Harbor

The continuing studies of the benthos in Boston Harbor that are being conducted by the MWRA provide a considerable data source for a description of the changes that have occurred within the harbor since discharge modifications began over 20 years ago. As summarized by Maciolek *et al.* (2005, 2008), the major changes in discharge regimes that have occurred since the 1995 EIR/S was prepared were the stoppage of effluent discharge from Nut Island, the complete conversion to secondary treatment in 1998, and the diversion of all treatment discharges from the harbor to the new outfall in September 2000. Maciolek *et al.* (2008) compiled a concise summary of conditions in the Harbor since the mid-1970s. Maciolek *et al.* (2008, 2011) also documented the changes that have occurred in the harbor since the cessation of sludge discharge in 1991. The primary changes have involved stations in the northern part of the harbor (comprising the Inner and Lower Harbor regions considered in this SEIS/EIR, see Figure 3-4 for benthic sample locations), which were once considered to be heavily polluted. Changes in the northern harbor have been dramatic; fluctuations in infaunal abundance and an increase in species numbers and diversity have been observed through 2003. Stations in the southern part of the harbor, which were less influenced by the former treatment discharges, have not shown changes in the benthos similar to those experienced at the northern stations. Since 1992 the improvements in benthic habitat quality led to increases in deeper, bioturbating species, which likely increased trophic complexity (Maciolek *et al.*, 2011). The amphipod *Ampelisca* populations had a major peak in 2003 and were virtually eliminated from the harbor in 2005, probably as a consequence of several severe storms that affected benthic habitats (Maciolek *et al.*, 2008).

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, to the vicinity of the Reserved Channel. Within this region, infaunal abundances (Appendix U) are very low (<1,000/m^2) to low (1,000–5,000/m^2) and species numbers (Appendix U) are also very small (<5/sample) or small (5–15/sample). Polychaete, such as *Nephtys incisa*, *Polydora cornuta*, and *Scoletoma fragilis*, predominate among the few infaunal species present. MWRA sampling at the entrance to Fort Point channel, north of the Reserved Channel, (not included on Figure 3-4) has recorded new taxa from this area since 2004. However, the fauna has been dominated by the polychaete *Nephtys cornuta* (Maciolek *et al.*, 2011). The second region extends from east of Reserved Channel to the mouth of the harbor and includes the Lower Harbor, Main Ship Channel, and

Presidents Roads Anchorage area. Infaunal abundances here (based on USACE 2003 and Massport 2003 data only; Appendix U) range from medium (5,000–25,000/m^2) to large (25,000–80,000/m^2) and species numbers (Appendix U) range from medium (15–25/sample) to large (25–40/sample). Predominant taxa in this region often include several polychaete species, such as *Aricidea catherinae*, *Prionospio steenstrupi*, *Scoletoma fragilis*, and *Tharyx acutus*. The tube-dwelling amphipod, *Ampelisca abdita*, is numerically important in the region and other amphipods, such as *Orchomenella pinguis* and *Leptocheirus pinguis*, are also relatively common. As stated above, the *Ampelisca* tube mat densities had a major peak in 2003 and were virtually eliminated from the harbor in 2005, probably as a consequence of several severe storms that affected benthic habitats (Maciolek *et al.*, 2008). Between 1993 through 2003 amphipod tube mats occurred in all regions of Boston Harbor, declined to zero in 2004 to 2005 and been on the rebound since, with most increases occurring from the Lower Harbor out to the Presidents Roads Anchorage area (Maciolek *et al.*, 2011).

Infaunal abundances in the Outer Harbor, generally 5,000 to 25,000/m^2, are somewhat lower than those in the Lower Harbor, Main Ship Channel, and Presidents Roads Anchorage (Appendix U). Species numbers, generally 15 to 25 species per sample, in the Outer Harbor region, which is actually part of Massachusetts Bay, are similar to those in the Lower Harbor, Main Ship Channel, and Presidents Roads Anchorage region. Predominant taxa in this region include several polychaete species, such as *Aricidea catherinae*, *Prionospio steenstrupi*, *Scoletoma fragilis*, and *Tharyx acutus*. The small bivalve, *Hiatella arctica*, was very abundant at one Outer Harbor station.

Additional benthic information can be found in Appendix U.

3.3.2.2 Habitat Enhancement Sites

In September 2004 a series of surveys (sidescan, SPI, and benthic) were conducted to collect information to describe the benthic community at the five potential habitat enhancement sites. Sidescan sonar data were collected within each site and a towed underwater video sled was deployed at five locations within each site to ground-truth the sonar data and to provide more detailed descriptions of the benthic substrates and visible biota. Based on interpretation of the sidescan mosaics and video observations, suitable locations for the SPI survey were selected and mapped. SPI locations were chosen based on identification of soft bottom areas representing the range of soft bottom habitat types with a given site.

Sediment grab samples were also collected in September 2004 at three stations within each of the five potential hard bottom enhancement sites. Station coordinates were determined based on the sidescan and SPI data collected during the earlier surveys and were chosen to represent the range of soft bottom sediments within each area. At each of the benthic infaunal stations, sediment was collected for infaunal, grain-size distribution, and total organic carbon analyses. From this information, a description of the benthic habitat for each habitat enhancement site is provided.

Rhoads and Germano (1986) established the index for estuaries and coastal waters, Organism Sediment Index (OSI) values >6 indicate good habitat conditions and are generally associated with bottoms that are not heavily influenced by stress. The OSI level that defines this breakpoint for dynamic offshore bottom, such as Massachusetts Bay, Broad Sound, and Nahant Bay, has not been determined and could be higher or lower than 6. For this document, the OSI is used as a relative indicator of habitat conditions with higher OSI values associated with higher benthic habitat quality.

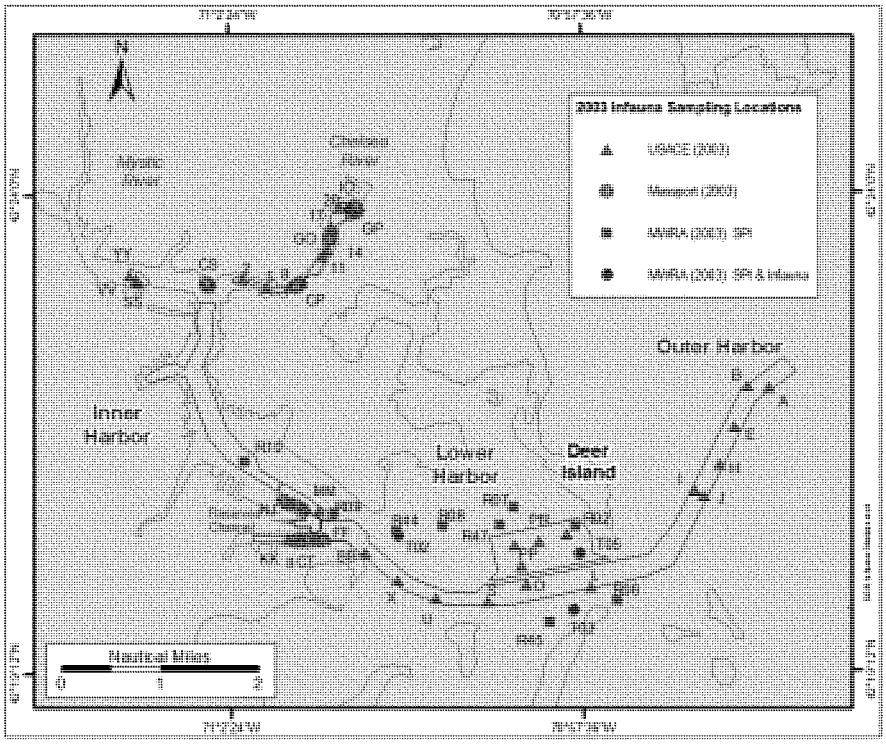


Figure 3-4. Infauna Sampling Stations

Several ecological metrics were calculated for each infaunal sample within a geographic subset: total abundance, total species, Shannon-Weiner Diversity (H'), Evenness (J'), the ten most abundant species, and log-series *alpha* diversity. Log-series *alpha* is a diversity measure used to characterize infaunal communities. Several diversity estimators increase markedly with increasing sample size. Log-series *alpha* is recommended for use because it does not exhibit much sample size bias (Rosenzweig, 1995) and is used here as an unbiased estimator of species richness.

Broad Sound – The OSI at the Broad Sound SPI stations ranged from 4.0 to 7.5. Infaunal abundance varied less than two-fold across the three Broad Sound stations, ranging from 1,367 to 2,429 individuals per sample, or about 34,000 to 61,000/m^2. Variability was low to high among the samples collected at Broad Sound. The number of species occurring at each station was relatively consistent, ranging from 28 to 35 species per sample. Variability in species numbers within each station was moderately low (13 to 23%). Species diversity among the Broad Sound stations was moderately low and consistent among all three stations with log-series alpha ranging from 4.5 to 6.7 and Shannon's *H'* ranging from 2.9 to 3.9. Variability in species diversity within each station was low to moderate, with coefficient of variation (CV) for log-series alpha ranging from 12 to 33%.

The species composition of the samples from the three Broad Sound stations was also typical for Massachusetts Bay sediments. Polychaete worms accounted for the largest proportion of the species-

level infaunal abundance. *Prionospio steenstrupi, Tharyx acutus, Mediomastus californiensis, Levinsenia gracilis*, and *Spio limicola* characterized the samples from two of the stations. Despite the numerical importance of *Prionospio steenstrupi* and *Mediomastus californiensis* at the third station, the fauna at that station differed from the other two in that the polychaete *Owenia fusiformis* accounted for 22% of the species-level infaunal abundance there. Additionally, the isopod crustacean *Edotia montosa*, was among the ten most abundant taxa at one station, but was uncommon or not found at the other two stations. The small bivalve mollusk *Nucula delphinodonta* was the third or fourth most abundant species among the Broad Sound stations.

Northern starfish were also observed in the video transects from within this site.

Massachusetts Bay – OSI at the Massachusetts Bay SPI stations ranged from 6.0 to 9.0. Infaunal abundance varied slightly more than two-fold across the three Massachusetts Bay stations, ranging from 438 to 1,067 individuals per sample, or approximately 11,000 to 27,000 m^2. Variability was moderate to high among the samples collected at each of the three Massachusetts Bay stations. The number of species occurring at each station also varied moderately, ranging from 21 to 31 species per sample. Variability in species numbers within each station was moderately low (19 to 26%). Species diversity among the Massachusetts Bay stations was moderately low and consistent among all three stations with log series alpha ranging from 5.5 to 6.7 and Shannon's *H'* ranging from 3.3 to 3.5. Variability in species diversity within each station was moderately low (15 to 26%).

Most of the numerically dominant taxa at the three Massachusetts Bay stations were polychaete worms. All of these worms, especially *Prionospio steenstrupi, Tharyx acutus, Mediomastus californiensis, Levinsenia gracilis*, and *Spio limicola*, are typically among the predominant species in Massachusetts Bay. The small deposit feeding clam, *Nucula delphinodonta*, also was relatively abundant and is a common taxon among Massachusetts Bay samples.

3.3.2.3 Massachusetts Bay Disposal Site

As would be expected, benthic recolonization and community type on the disposal mounds at the MBDS would be dependent on the type of material disposed at the site and the age of the mounds. Older mounds have a more stable, later successional Stage II and Stage III (burrowing and deposit feeding populations), while the newly deposited mounds would be dominated by Stage I pioneering benthic organisms. Boston blue clay disposed at the MBDS tends to be more cohesive and less conducive to burrowing Stage III organisms. More mixed materials would have a diversity of organism types. See Section 4.4.3 for a more extensive discussion regarding benthic community structure at the MBDS.

3.3.2.4 Industrial Waste Site

The soft bottom sediments at the IWS are marked with features of biogenic origin characterized by small-scale bioturbation associated with polychaete worms and amphipods (NOAA, 1996). At the transition depths, about 280 feet, high densities of anemone *(Cerianthus* spp.) forests were found (NOAA, 1996). The attached hard-rock faunal assemblage (*Telia* anemones, tunicates, brachiopods, hydroids, bryozoans, and sponges) increased dramatically on the glacial knolls. Water turbidity was less at these slightly shallower depths, presumably due to a lesser effect of flocculent settlement characteristic of the deeper nepheloid layer found at the deeper 280 to 300-foot depths (NOAA, 1996).

3.3.3 Shellfish

3.3.3.1 Boston Harbor

Several commercially and recreationally important species of shellfish, such as softshell clam (*Mya arenaria*), blue mussels (*Mytilus edulis*), razor clams (*Ensis directus*), rock crabs (*Cancer irroratus*), and Jonah crabs (*C. borealis*) occur within the affected environment and are discussed in this section.

Lobsters are discussed in Section 3.3.4. Infaunal invertebrates that occur in the project area are discussed in Section 3.3.2. Shellfish that are designated as having Essential Fish Habitat (EFH) within the project area (Atlantic sea scallop [*Placopecten magellanicus*], Atlantic surf clam [*Spisula solidissima*], and ocean quahog [*Arctica islandica*]) are discussed in more detail in the Essential Fisheries Habitat (EFH) Evaluation (Appendix T).

Recent data (*i.e.*, since 1995) describing the distribution of shellfish in Boston Harbor are very limited. The National Marine Fisheries Service (NMFS) identified softshell clam, blue mussels, and Atlantic surf clams (in nearby Broad Sound) as shellfish resources of concern within or near the project area (NMFS, 2005).

The Massachusetts Department of Marine Fisheries (MA DMF), in collaboration with the Massachusetts Office of Coastal Zone Management (CZM) and the NOAA Coastal Services Center (CSC), developed a map of shellfish suitability areas that shows the approximate location of potential habitats suitable for ten species of shellfish along the coast of Massachusetts (Figure 3-5). These areas were determined to be suitable for shellfish based on the expertise of the MA DMF, the opinion of local Massachusetts Shellfish Constables, and information contained in maps and studies of shellfish in Massachusetts. These areas include sites where shellfish have historically been sighted but may not currently support any shellfish.

Site-specific shellfish studies were not conducted for this project. Recent samplings conducted within the harbor (Pellegrino, 2003; Massport, 2003) (Figure 3-4 in the Benthic Infaunal section) in September 2003 were designed to collect benthic infaunal community data, although some data regarding the presence of shellfish were generated. Absence of a species from samples collected does not necessarily mean that the species does not occur in the project area.

Mystic River - Habitat for softshell clams has been identified by MA DMF along the northern bank of the Mystic River (Figure 3-5). The bottom type within these areas is mostly mud (Figure 3-1), which is consistent with the preferred substrate of softshell clams (fine sediments). Grab samples collected within the deepening area did not contain harvestable shellfish species (Pellegrino, 2003).

Chelsea River - The bottom type within the Chelsea River is a heterogeneous mix of gravel and sand, with areas of finer sediments (silt, mud, clay) (Figure 3-1). Softshell clam habitat is present along the banks of the Chelsea River (Figure 3-5), with smaller areas of razor clam and blue mussel habitat in the upper reaches of the river. The presence of softshell clam was confirmed by one grab sample collected in the general area of this identified habitat (Massport, 2003).

Inner Harbor - Mud and clay is the predominant sediment type within the Inner Harbor (Figure 3-1). No suitable shellfish habitat is identified by MA DMF within the Inner Harbor (Figure 3-5) project areas. Blue mussel and Jonah crab were present in grab samples collected at North Jetty, just to the north of the Reserved Channel, in an area of mud and sand (Massport, 2003). Blue mussels were also present in samples from Conley Terminal within the Reserved Channel. EPA staff have noted European oysters (*Ostrea edulis)* along the East Boston shoreline (letter dated May 23, 2008).

Lower Harbor - Suitable habitat for several shellfish species is present along the coastline of the Lower Harbor, although none is located within the Presidents Roads Ship Channel or Anchorage to be dredged (Figure 3-5). Softshell clam habitat exists along almost the entire coastline of the harbor north of the channel and along the coastline and shores of the islands (*i.e.*, Long Island, Spectacle Island, Thompson Island) to the south of the channel. This habitat is interspersed with large areas of blue mussel habitat and smaller, localized razor clam habitat. Blue mussel habitat is also located just outside the Presidents Roads Anchorage and Channel at the tip of Deer Island. These habitats coincide with areas of mixed coarse and fine-grained sediment or rock (Figure 3-1). Rock crabs were present in the grab samples collected within the Presidents Roads Anchorage and Main Ship Channel

(Pellegrino, 2003). EPA staff have noted European oysters along the Winthrop shoreline (letter dated May 23, 2008).

Outer Harbor - The bottom type of the Outer Harbor is much more erosional and rockier than other portions of the harbor. In general, sediments consist mostly of sand, gravel, and rock, with isolated areas of finer sediments (silt, mud, and clay) (Figure 3-1). The closest shellfish habitat to the channel in the Outer Harbor is along the coast of Long Island (softshell clam, blue mussel, razor clam), and an area of scallop habitat between Long Island and Gallops Island (Figure 3-5). Areas of softshell clam, blue mussel, razor clam, and Atlantic surf clam habitat are present in nearby areas of Broad Sound to the north. Habitat for these species, as well as European oyster, also exists in Quincy Bay to the south of the channel, though little evidence of live oysters has been found in this area or elsewhere in Boston Harbor (MA DMF, 1996).

In nearby areas, HubLine surveys conducted in 2002 and 2004 identified various types of shellfish habitat off the mouth of Boston Harbor, approximately 1.5 nautical miles (nmi) east of the project area (TRC Environmental and Normandeau Associates, 2003; Normandeau Associates, 2005). Scallop survey results showed that the bottom type near the mouth of Boston Harbor generally consisted of medium- to coarse-grained sediments, with areas of coarse glacial till and fine grained sediment (mud, clay) (Figure 3-6) (TRC Environmental and Normandeau Associates, 2003; Normandeau Associates, 2005). The highest scallop densities in 2002 and 2004 off the mouth of Boston Harbor were found on medium- to coarse-grained substrate, with the majority of scallops observed being greater than 4 inches in shell height, exceeding the minimum harvest size of 3.5 inches. Glacial till sampling in 2004 at the mouth of Boston Harbor determined that small mussels, including blue mussels, were very abundant at the two sampling station near the mouth of Boston Harbor (Figure 3-6) (TRC Environmental and Battelle, 2005). Decapod crustaceans, such as juvenile rock crabs, and softshell clams were also present in areas of sand, fine gravel, cobble, and some boulder. The hard bottom study conducted in October and November 2004 characterized the bottom type at those stations to the east of the project area (Figure 3-6) as an exposed bedrock ledge surrounded by cobbles, mussel shells, and sand, with some boulders (TRC Environmental *et al.*, 2005). Commonly observed fauna included mussels, *Cancer* sp. crabs, and a few scallops. These data illustrate the variability of habitat type in the Outer Harbor in areas surrounding the project area.

Life history information, landing data and shellfish designation areas for species with habitat within the project area are presented in Appendix V and summarized in Table V3-2.

Recent data describing the distribution of shellfish in Boston Harbor are very limited. Potential habitat for several commercially and recreationally important species of shellfish (softshell clam, blue mussels, razor clams, and sea scallops) occurs along the banks of the Chelsea and Mystic Rivers and along the coastlines of the Lower and Outer Harbors. The presence of softshell clam, blue mussel, rock crab, and Jonah crab was confirmed by grab samples collected within the project area (Pellegrino, 2003; Massport, 2003). Of these species, softshell clam is the most common commercially harvested shellfish within Massachusetts and Boston Harbor

Most of the productive softshell clam beds within the project area are closed to harvesting, except for conditionally restricted areas near Logan Airport in North Boston Harbor and areas near the Neponset River and Dorchester Bay.

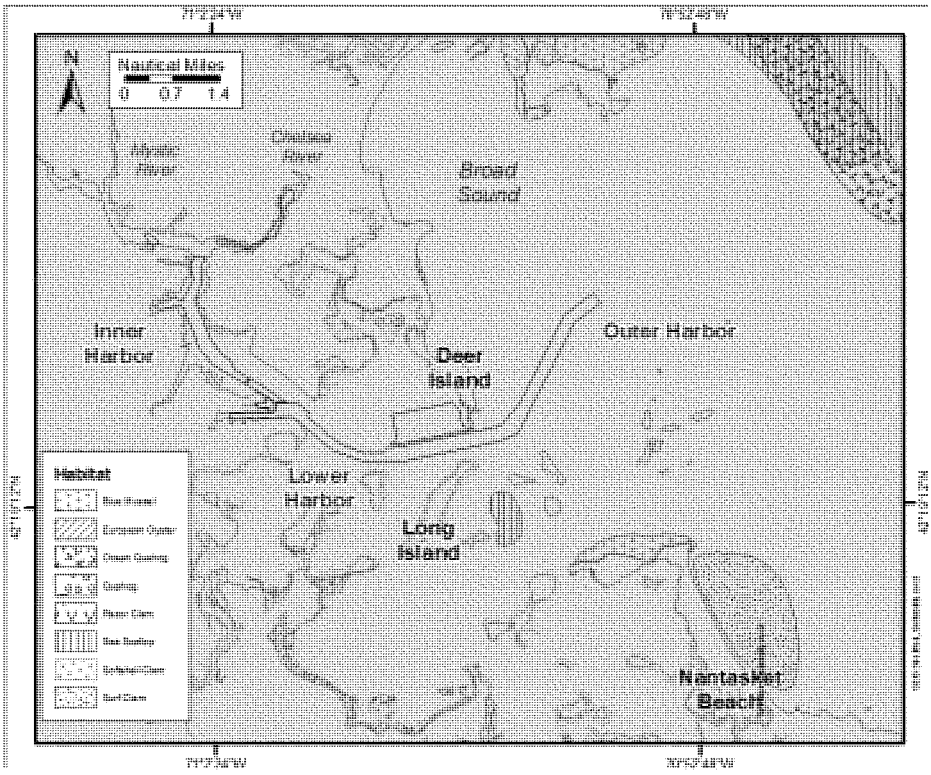


Figure 3-5. Shellfish Suitability Areas (MA DMF, 2004)

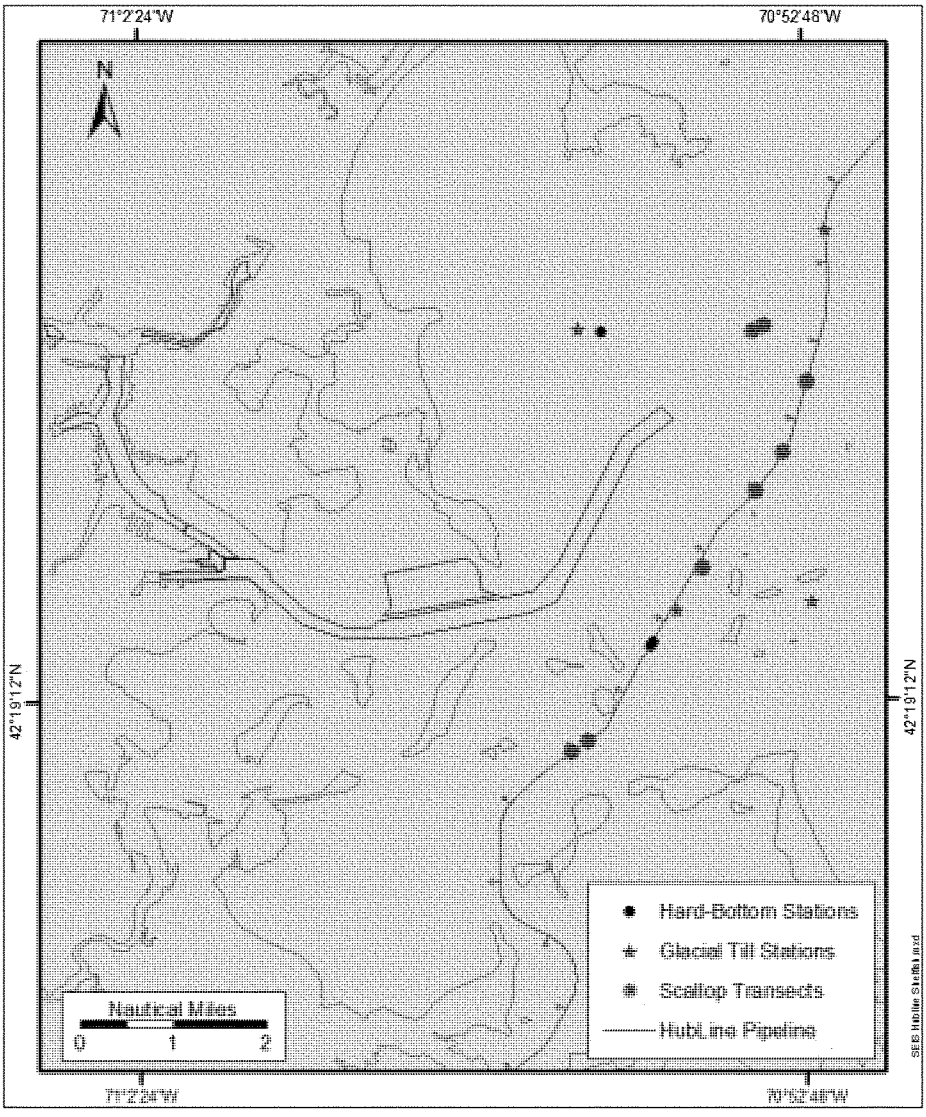


Figure 3-6. Hubline Pipeline Sampling Stations in the Outer Harbor

3.3.3.2 Habitat Enhancement Sites

The potential for shellfish habitat to exist in the two habitat enhancement sites is illustrated by Essential Fish Habitat (EFH) descriptions for the area, a MA DMF map of shellfish suitability areas, and by video drift footage of the sites. The two potential habitat enhancement sites are covered by two 10 x 10 minute EFH squares. Sea scallops (all life stages), and surf clams (juvenile and adults only) are EFH designated within all sites.

Broad Sound – None of the potential shellfish habitats identified by MA DMF occur within the Broad Sound site. Rock crabs were predominant in the mud/sand bottom drift video footage within this site.

Massachusetts Bay – None of the potential shellfish habitats identified by MA DMF occur within the Massachusetts Bay site. Rock crabs were predominant in the mud/sand bottom drift video footage within this site.

3.3.3.3 Massachusetts Bay Disposal Site and Industrial Waste Site

No commercial shellfish species are known to occur at the MBDS based on benthic data collected for the USACE's Disposal Area Monitoring System (DAMOS) Program. Given its overap with the MBDS, similar conditions are expected at the IWS.

3.3.4 Lobster

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 (Estrella and Glenn, 2001; Dean, *et al.*, 2005; Dean, 2010), where it has been found to occur from the intertidal zone offshore to water depths of 2,360 feet (ft) (MacKenzie and Moring, 1985). This section describes the habitat requirements, and fishery data for lobster within the affected environment. The life history of lobsters can be found in Appendix N.

3.3.4.1 Boston Harbor and Surrounding Project Area

Published scientific literature and results from larger scale lobster studies conducted by the Massachusetts Division of Marine Fisheries (MA DMF) may be used to predict the distribution of lobster and their various life stages within the project area based on the substrate present. In general, lobster habitats are highly variable (Cooper and Uzmann, 1980). Inshore habitats used by populations of early benthic phase (EBP), juveniles, adolescents, and adults include mud, cobble, bedrock, peat reefs, eelgrass beds, sand, and for smaller individuals, the intertidal zone (Thomas, 1968; Cooper, 1970; Cobb, 1971; Cooper *et al.*, 1975; Hudon, 1987; Able *et al.*, 1988; Heck *et al.*, 1989; Wahle and Steneck, 1991; Lawton and Robichaud, 1992; Cowan *et al.*, 2002). Young-of-the-year (YOY) (EBPs, <15 mm CL) are typically restricted to shelter-providing habitats that protect them from predators (Lavalli and Barshaw, 1986; Hudon, 1987; Johns and Mann, 1987; Barshaw and Lavalli, 1988; Able *et al.*, 1988; Wahle and Steneck, 1991; Wahle and Steneck, 1992). Larger juveniles may be less susceptible to inshore predators and, thus, are able to exploit a wider range of habitats, including those less likely to provide ready-made shelter, and habitat that allows them to build shelters (e.g., mud) (Cobb, 1971; Berrill and Stewart, 1973; and Botero and Atema, 1982). Adolescents (sub-legal lobsters) and adults (mostly legal-sized lobsters), particularly those that remain in shallow coastal waters, have fewer predators and are found in featureless substrates, such as sand and fine-grained mud (Cooper and Uzmann, 1980). While shelters are necessary for the purposes of molting and mating (Tremblay and Smith, 2001; Karnofsky, *et al.*, 1989), these larger lobsters show little shelter fidelity within a home range over a period of several days, except during over-wintering months (Watson, 2005). Thus, there is a trend of increased ability to exploit all available habitats, both featureless and shelter providing, as the size of a lobster increases.

In 1995, MA DMF began a suction-sampling program to monitor densities of newly settled postlarvae and subsequent YOY. The goals of this program were to document important nursery habitat and develop a lobster settlement index to better understand environmental factors influencing population trends. Currently 18 sites are sampled in Massachusetts, including seven within the Boston Harbor/Massachusetts Bay area, spanning from the Inner Harbor to the Outer Harbor and southwards towards Cohasset (Figure 3-7). It should be noted that not all sites are sampled every year. As a result, there is no long-term time series of abundance of EBP lobster within Boston Harbor. This severely limits the ability to correlate changes in EBP density with any natural or anthropogenic events in this region. Nevertheless, interannual variability in EBP density and settlement appears to be synchronous over a broad regional area, from New Brunswick, Canada to Cape Cod (and including Boston Harbor), suggesting that factors such as annual egg production, larval survival, or oceanographic transport patterns may play important roles (Wahle *et al.*, 2004). Table 3-2 lists the EBP lobster sampling sites within Boston Harbor and the substrate and water depth at each sampling location.

While there is great interannual variability in densities of YOY (up to 12 mm CL) among the sites within Boston Harbor, most sites in the Outer Harbor near the navigation channel (Brewster Island, Long Island and Sculpin Ledge) have a greater density than the other sites in Boston Harbor (Figure 3-8). The density of early benthic phase lobsters from 0 to 40 mm CL appears to follow the same location trend, but at higher densities than the YOY (Figure 3-9). The same trends continue through 2011 although the data is not included in Figures 3-8 and 3-9. After a recent drop in the young-of-the-year lobster (5-12 mm) index, the Boston Harbor sites in the 2011 Early Benthic Phase Juvenile Lobster Suction Survey increased to $0.17/m^2$, approximating the time-series (1997-2011) mean of $0.18/m^2$. There was an average density of 0.42 early benthic phase lobsters (5-40 mm) per square meter in 2011 (MA DMF, unpublished data). This was below the time-series mean of $0.80/m^2$.

Table 3-2. EBP Lobster Sampling Site Characteristics

Location	Sampling Site	Substrate	Water Depth
Inner Harbor	Castle Island (located 164 ft south of green can 5A, at a distance of 656 to 984 ft from the shore)	cobble interspersed with kelp holdfasts	10–20 ft
	Long Island (located 246 ft from shore off the southeast corner of the island)	cobble bottom with moderate kelp cover that changes to mud/gravel toward shore	12-20 ft
	Sculpin Ledge Reef (located ¼ mile south of the Sculpin Ledge Channel)	"man-made" rip-rap rock approximately 2 to 6 inches in diameter, stacked 3 to 4 layers deep	NA
	Bumpkin Island	cobble mixed with loose shell rubble and sparse macroalgae	10-15 ft
	Grape Island (located 246 ft from shore off the northwest corner of the island),	gravel/mussel shell rubble with small patches of cobble	10-15 ft
Outer Harbor	Greater Brewster Island (located 328 ft from shore off the southeast portion of the island)	cobble interspersed with boulders and moderate macroalgae cover	15-20 ft
	Point Allerton (located 492 ft from shore off the eastern-most portion of the point)	large boulder/sand substrates with moderate patches of cobble and heavy to moderate macroalgae cover	15-20 ft

NA = not available
Source: Robert Glenn, Coastal Lobster Investigations Project, MA DMF, Pocasset, MA.

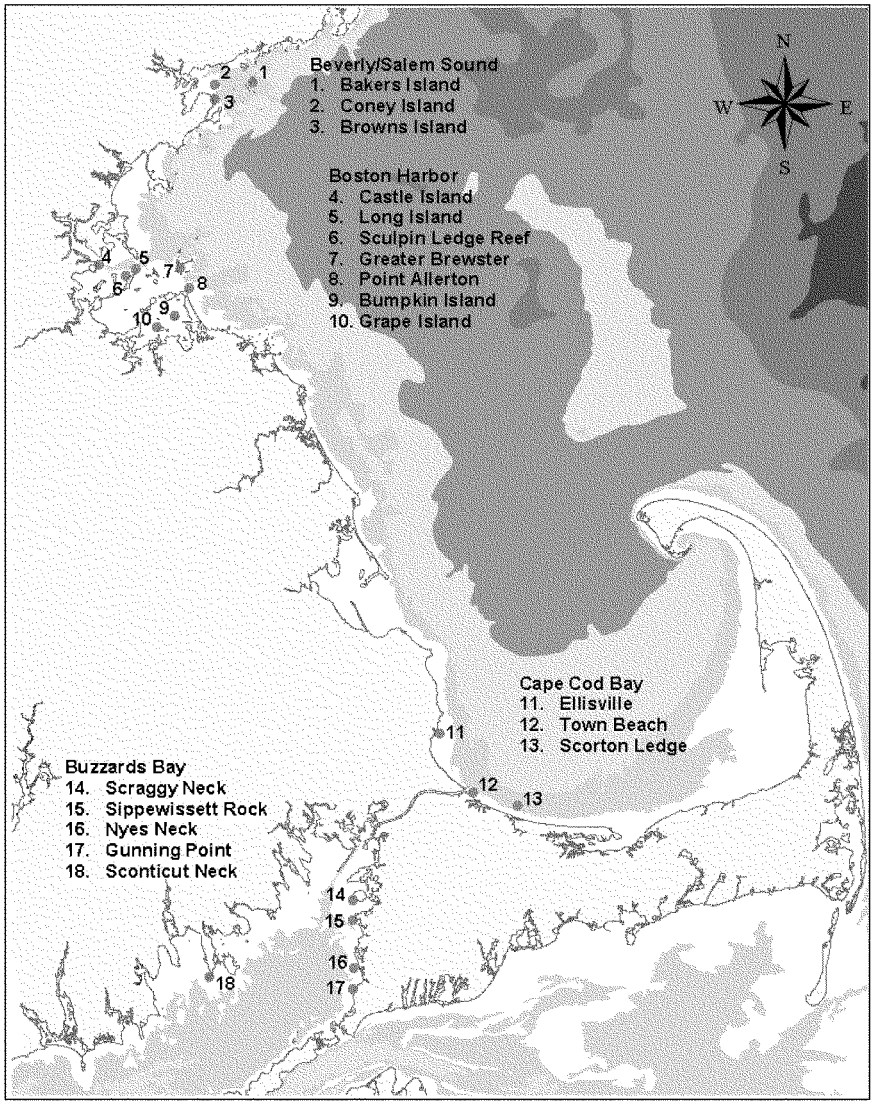
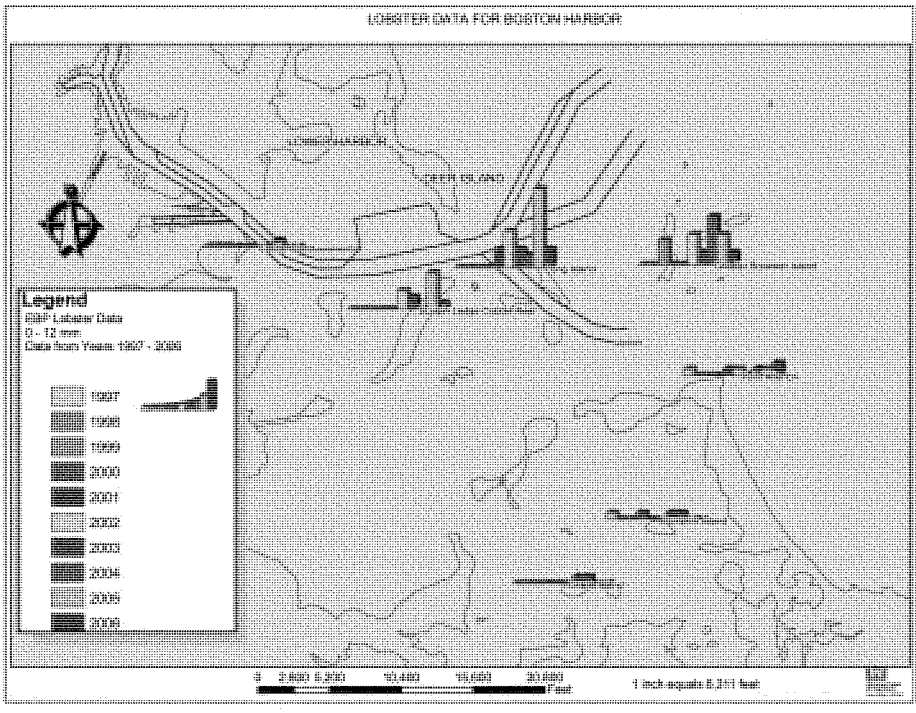


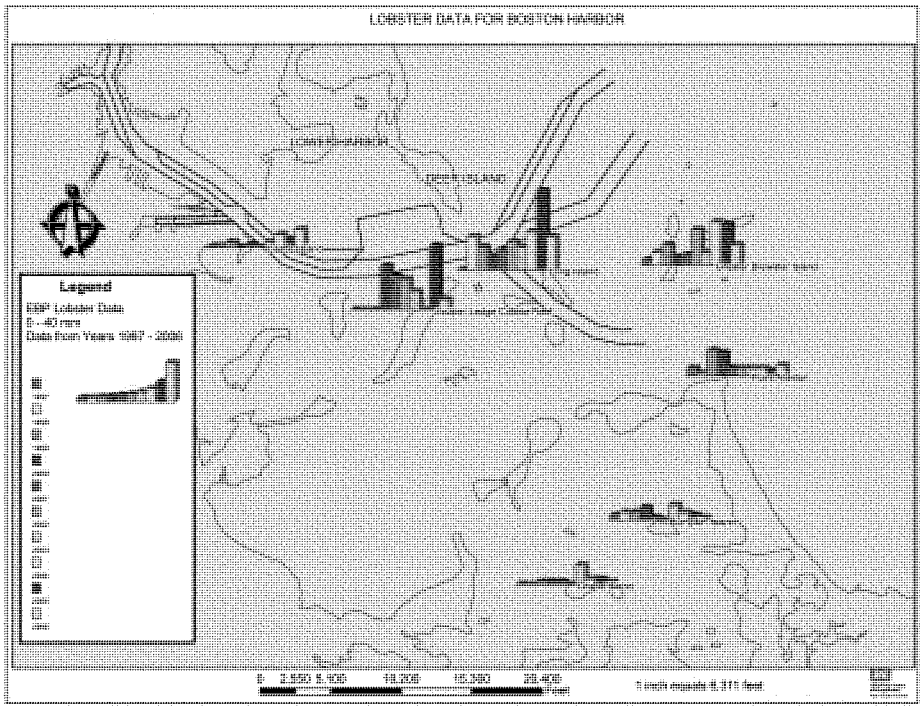
Figure 3-7. EBP Sampling Sites with Massachusetts State Waters

Source: Robert Glenn, Coastal Lobster Investigations Project, MA DMF, Pocasset, MA.



Note: Bars show relative densities.
Note: Sculpin Ledge was not sampled until 2000, and it was not sampled in 2004 due to inclement weather. Castle and Grape Islands were not sampled until 1999.

Figure 3-8. Average Annual Densities (# per m2) of Early Benthic Phase Lobsters (0-12 mm CL) for Sampling Sites within Boston Harbor, 1997-2006



Source: Robert Glenn, Coastal Lobster Investigations Project, MA DMF, Pocasset, MA.
Note: Bars show relative densities.
Note: Sculpin Ledge was not sampled until 2000, and it was not sampled in 2004 due to inclement weather.
Castle and Grape Islands were not sampled until 1999.

Figure 3-9. Average Annual Densities (# per m2) of Early Benthic Phase Lobsters (0-40 mm CL) for Sampling Sites within Boston Harbor, 1997-2006

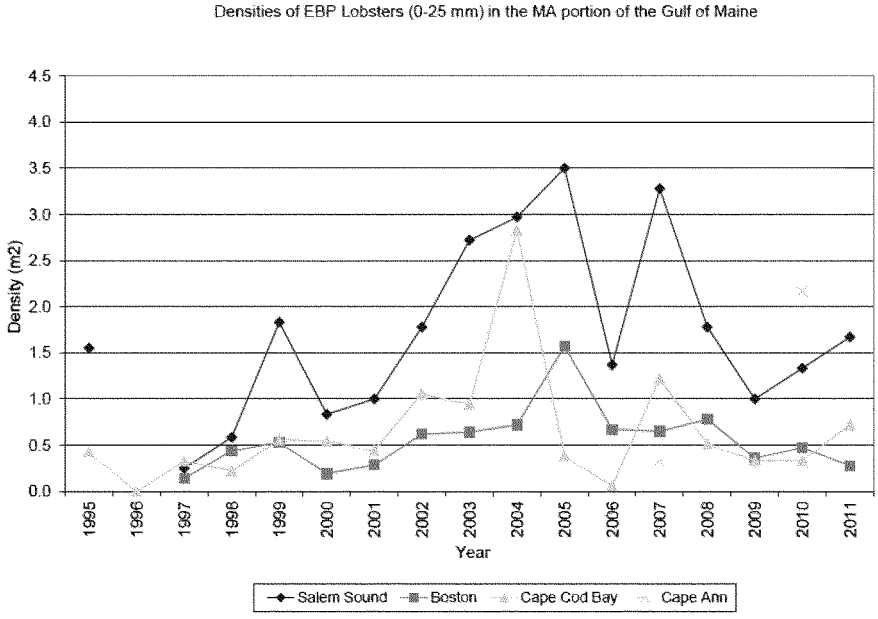
The density differences among sites adjacent to the navigation channel, and those south of the channel, appear to be the result of habitat type at these locations, but also may be reflective of post-larval supply to these sites, as well as preferred habitat selection of post-larvae during settlement. At the sites closer to the channels, the bottom type is predominately cobble where the southern sites are gravel, sand, or larger boulder. As the EBP lobster appears to be dependent on the sediment type, this may explain the difference in densities.

The small increases in the larger juveniles (12-40 mm CL) in Boston Harbor between 1997 and 2005could have been due to "walk-ins[2]" from other settlement sites, as well as from growth of settlers in the previous year. Although there are some increases in average densities of EBPs within the harbor, the rate of increase is significantly lower than the multi-fold increase in Salem Sound and Cape Cod Bay during the same period (Figure 3-10). It should be noted that the fluctuations in these areas are generally synchronous, such that low densities EBP (2000, 2006) are seen at all sites, while increases in densities occur in the same years (2001-2006), although the Boston Harbor populations stopped following the trend from 2007 through the 2011 sampling (Figure 3-10). Harbor densities are likely dependent on surface currents during the months when larvae and postlarvae are present in the water column, and/or to the numbers of resident, ovigerous (i.e., egg-bearing) females within the harbor (which have also been slowly increasing during this same time period). Such surface currents may affect the Boston Harbor region differently from Salem Sound and Cape Cod Bay and, thus, may impact EBP densities.

Since 2005 MA DMF has been conducting a multi-year ventless trap survey in an effort to characterize the importance of substrate type and depth to lobster abundance and size distribution (Glenn *et al.*, 2005; Glenn *et al.*, 2007). The sampling involves 80 randomly selected, but fixed, stations in Massachusetts Bay (including several in Boston Harbor; Figure 3-11) with each stratum (depth and substrate) represented by at least seven stations. Sampling occurs twice monthly from May through November aboard commercial vessels using a six-trap haul at each station, in which vented and ventless traps are alternately strung on the trawl line. The samples are combined to reflect spring (May and June), summer (July, August, and September), and fall (October and November) months. No sampling is done directly in the Boston Harbor navigation channel because the traps can only be recovered by grappling without buoys present to mark their location, and thus there is great potential for loss of these trawl lines and data. In addition, lobstering is not allowed within the Federal channels because it is a hazard to navigation. Instead, several stations that are in close proximity to the channel are sampled.

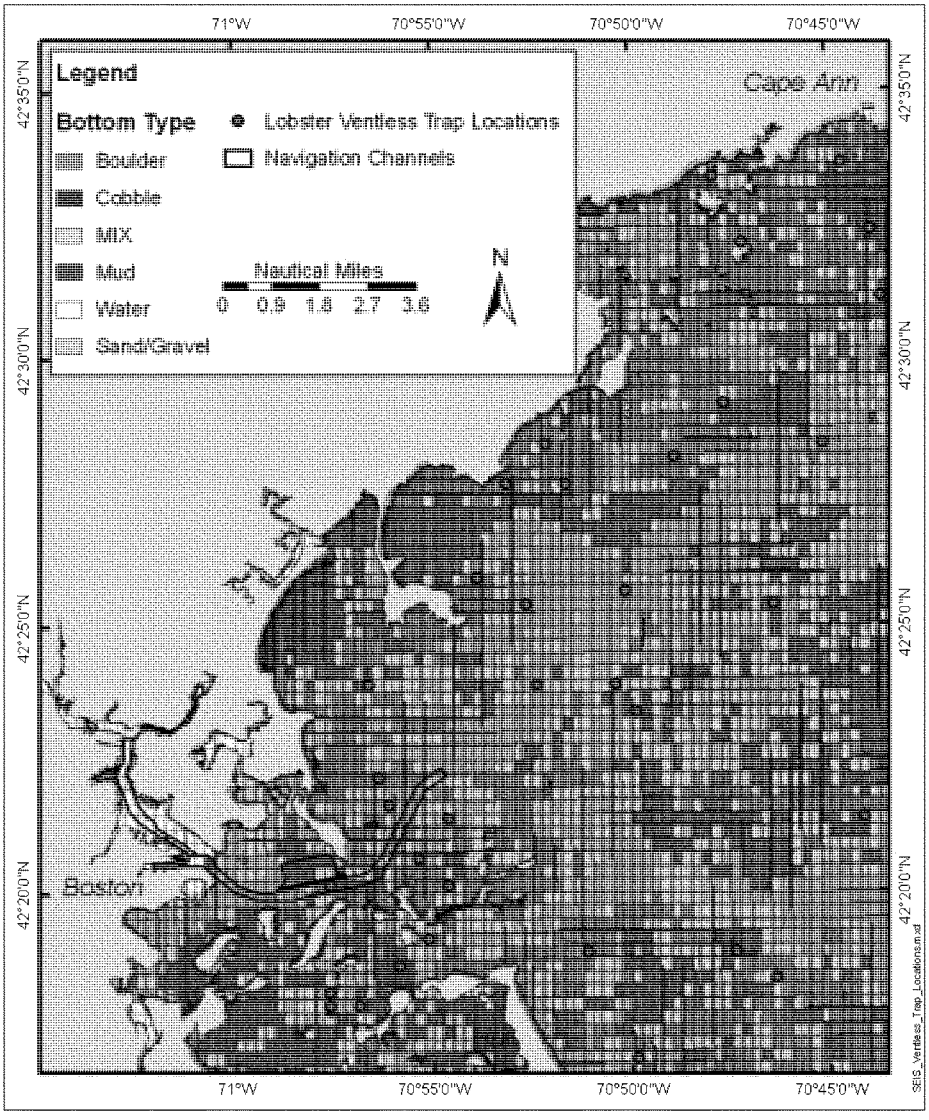
Data from the 2005 ventless trap survey provide initial information on the size distribution of lobsters in various types of bottom habitats in the Massachusetts Bay/Boston Harbor area. As expected from previous studies, juvenile (41-58 mm CL) and adolescent (59-70 mm CL) lobsters were more common in the shelter-providing habitats of boulder and cobble than in sand/gravel or mud (Figure 3-12), and were more common in shallow waters (0-15 m depth) (Figure 3-13). Again, these data reflect the needs of smaller juveniles for shelter-providing habitats that offer protection against predators. The data for sub-legal sized adult lobsters (71-82 mm CL) also show a preference for boulder and cobble habitat over mud and sand/gravel habitat, and of sand/gravel habitat over mud (Figure 3-12). This size of lobster is also more abundant than legal-sized adult lobsters (> 83 mm CL), indicative of the highly exploited nature of this resource (Glenn *et al.*, 2005; and see Appendix N demonstrating the decline in lobsters after attaining legal size). Both of these larger size classes of lobsters have fewer inshore predators than do the smaller class size lobsters and, thus, fewer restrictions in habitat usage, as is noted by their high numbers in shallow, mid, and deep waters (see Figure 3-13).

[2] The term "walk-in" refers to juvenile lobsters that are greater than 12-15 mm CL and somewhat more mobile; they tend to be more vagile in their movements and can move from site to site over short distances. Thus, if a particular settlement site becomes saturated, the larger juveniles can fan out from that site, immigrating to non-saturated sites. This movement pattern will result in different densities for YOY (0-12 mm CL) versus larger EBPs (12-40 mm CL), as is seen in the Boston Harbor sampling program.



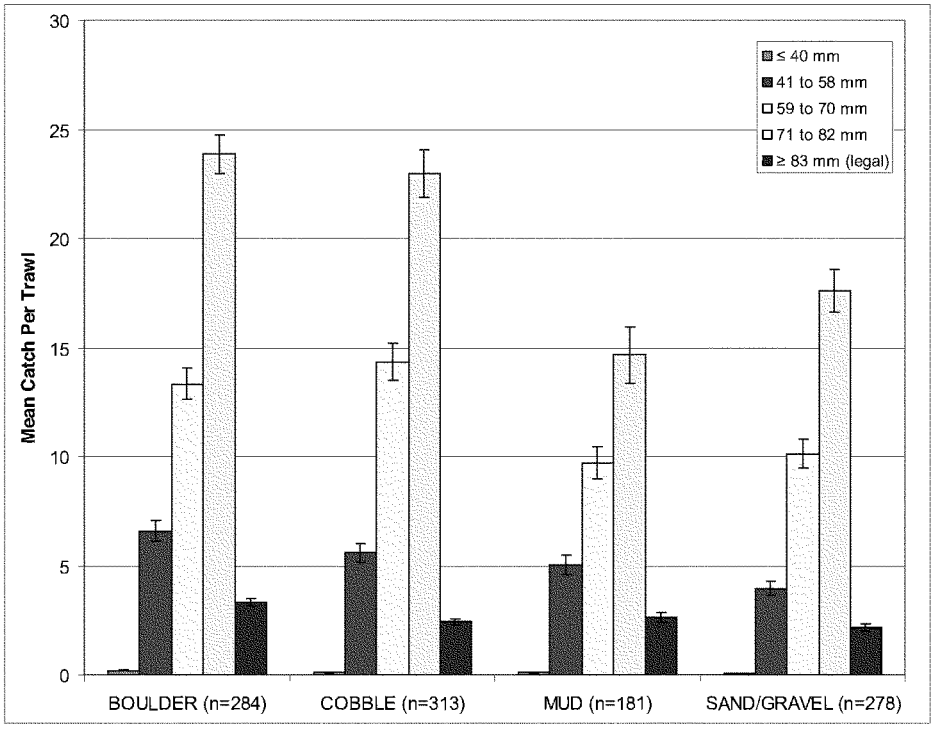
Source: Robert Glenn and Derek Perry, Coastal Lobster Investigations Project, MA DMF, Pocasset, MA.

Figure 3-10. Densities of EBP Lobsters (0-25 mm CL) in the Massachusetts Portion of the Gulf of Maine



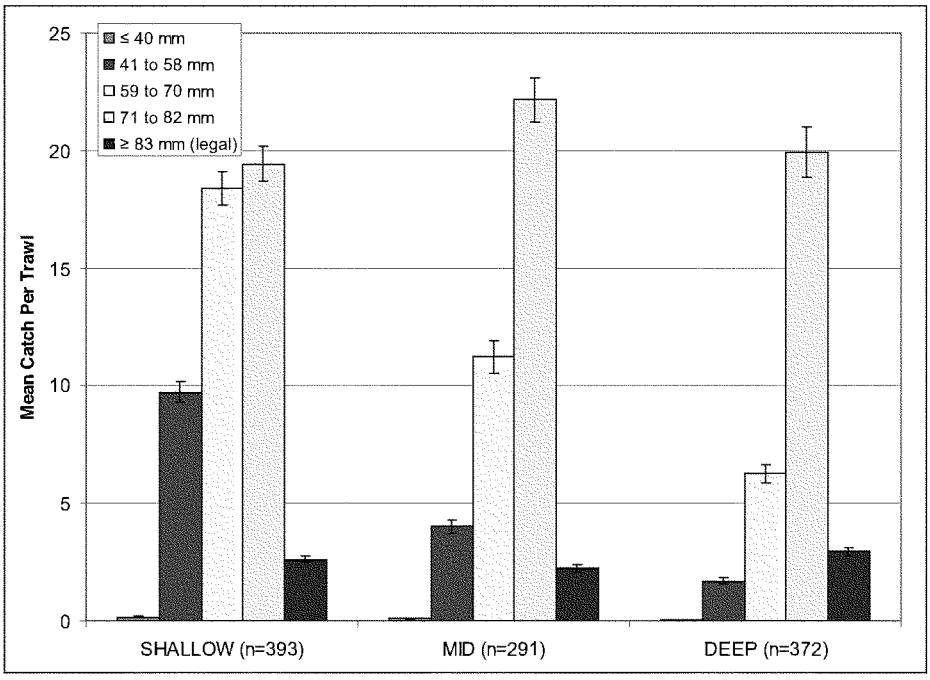
Source: Glenn *et al.*, 2005.
Note: One location appears to be within the navigation channel; however, sampling at this station occurred just outside the channel

Figure 3-11. MA DMF Massachusetts Bay Ventless Trap Study Area Showing the 2005 Sample Locations and Strata



Source: Robert Glenn, MA DMF.
Note: Bars represent ± one standard error. "n" represents sample size.

Figure 3-12. Catch-per-Trawl During the Ventless Trap Study of Four Size Classes of Lobster by Sediment Type: Juveniles (30-58 mm CL), Adolescents (59-70 mm CL), Sub-Legal (71-82 mm CL), and Legal (> 83 mm CL)



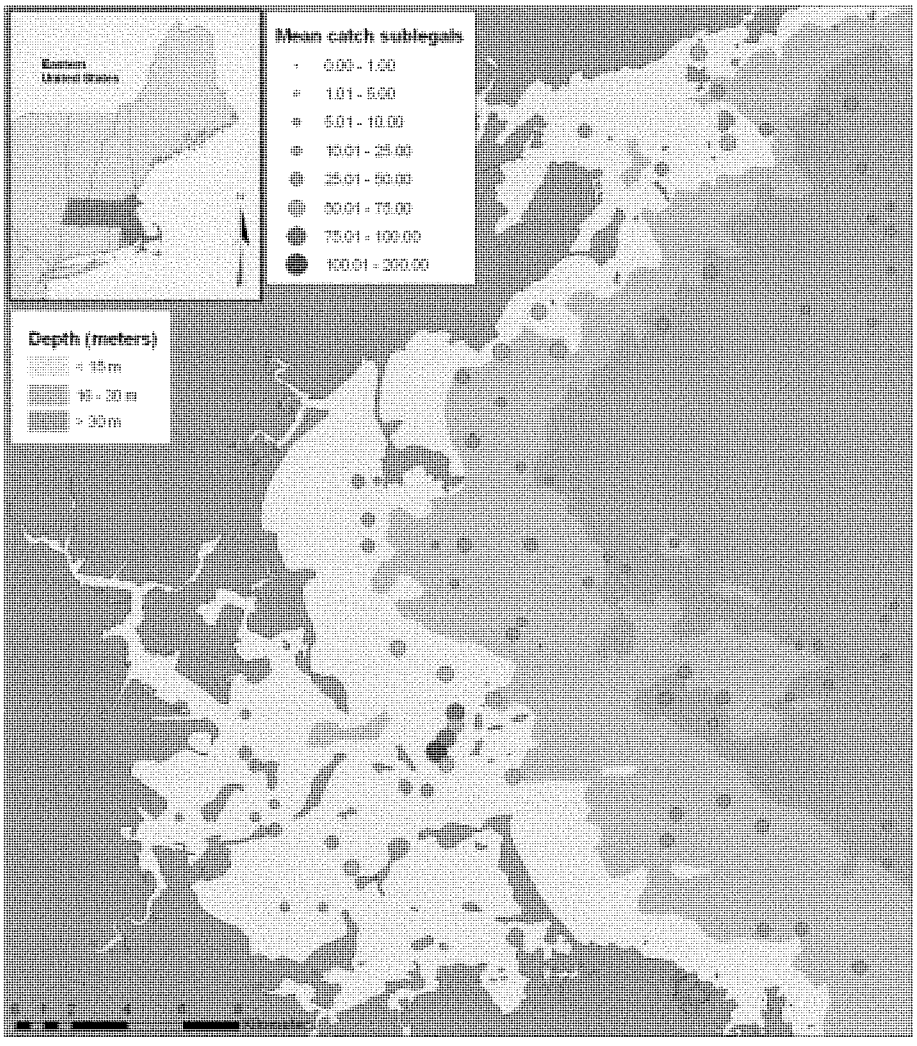
Source: Robert Glenn, MA DMF.
Note: Bars represent ± one standard error. "n" represents sample size.

Figure 3-13. Catch-per-Trawl During the Ventless Trap Study of Four Size Classes of Lobster by Depth: Juveniles (30-58 mm CL), Adolescents (59-70 mm CL), Sub-Legals (71-82 mm CL), and Legal (> 83 mm CL); Shallow, 0-15 m; Mid, 16-30 m; Deep, > 30 m

Populations of EBP lobsters less than 12 mm CL are known to exist in high densities just outside 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 and bottom substrate of the navigation channel may restrict habitat exploitation by EBPs, which prefer shallower, non-depositional habitats outside of the footprint of the channel (see Table 3-2). EBPs lobsters are found in very high densities in the intertidal zone, where salinity varies widely (Cowan *et al.*, 2001). The presence of these high densities would indicate that there are no recruitment impacts from salinity gradients within the Inner Harbor.

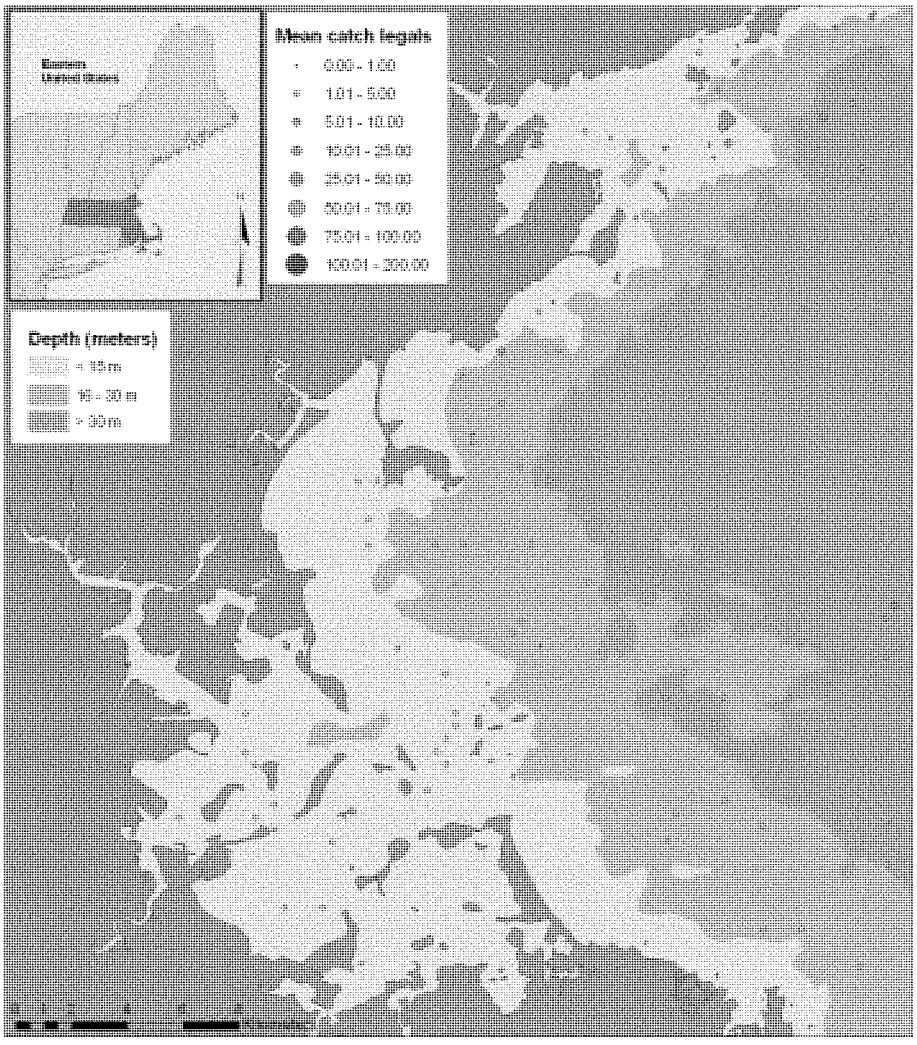
The other size classes of lobsters (i.e., larger juveniles [> 40 mm CL], sub-legal sized lobsters [> 59 mm CL], and adults) are capable of utilizing all of the described habitats in the navigation channel (see Figure 3-1), as shown in the ventless trap study by MA DMF, and are found in all of these environments in Boston Harbor (Figures 3-14 and Figure 3-15). Within the planned dredge footprint for the navigation channel, both non-depositional and depositional environments exist; therefore, lobsters of these larger class sizes are likely to exploit the habitats in the same manner as they are exploiting the habitats outside of the planned dredge footprint.

Summary - Lobsters captured from Massachusetts State waters have been increasing, with 6.9 million pounds and 7.4 million pounds landed in 2010 and 2011, respectively. Despite these years being the highest annual landings values since 2002, both years are still below the time-series mean of 7.5 million pounds. Likewise, Greater Boston Harbor (Massachusetts Stat. Area 4) lobster landings have been increasing with 1.7 million pounds landed in both 2010 and 2011, which were the highest landings since 2000. Despite the increase, both 2010 and 2011 are below the time-series mean of 2.2 million pounds. Greater Boston Harbor accounted for 24% of Gulf of Maine commercial lobster landings in Massachusetts state waters in 2011, which is consistent with recent years. Lobsters continue to be an important fishery in the State, and as such, are being carefully studied and managed. Recent studies have focused on lobster larval development and movement within Massachusetts Bay. Populations of EBP lobsters less than 12 mm CL are known to exist in high densities 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 likely restrict habitat exploitation by EBPs, which prefer shallower, non-depositional habitats outside of the footprint. Other size classes of lobsters, such as larger juveniles (> 40 mm CL and <59 mm CL), sub-legal sized lobsters (≥ 59 mm CL and < 83 mm CL), and adults/legal-sized lobsters (≥ 83 mm CL) capable of utilizing all of the described habitats in the navigation channel (see Figure 3-2), as shown in the ventless trap study by MA DMF, are found in all of these environments in Boston Harbor. Within the planned dredge footprint for the navigation channel, both non-depositional and depositional environments exist; therefore, lobsters of these larger class sizes are likely to exploit the habitats in the same manner as they are exploiting the habitats outside of the planned dredge footprint.



Source: Robert Glenn, Coastal Lobster Investigations Project, MA DMF, Pocasset, MA, 2005.

Figure 3-14. Mean Catch per Trawl Haul of Sub-legal Lobsters (<83 mm CL) at each Ventless Trap Survey Sampling Station for the 2005 Season



Source: Robert Glenn, Coastal Lobster Investigations Project, MA DMF, Pocasset, MA, 2005.

Figure 3-15. Mean Catch per Trawl Haul of Legal Lobsters (≥83 mm CL) at each Ventless Trap Survey Sampling Station for the 2005 Season

3.3.4.2 Habitat Enhancement Sites

Data from the October through November 2004 ventless trap pilot study (16 sampling trips, 40 stations, three depth strata, four substrate strata for 936 trap hauls) provided initial information on the size distribution of lobsters in various types of bottom habitats in the Massachusetts Bay/Boston Harbor area. As expected from previous studies, juvenile (30-58 mm CL) and adolescent (59-70 mm CL) lobsters were more common in the shelter providing habitats of boulder and cobble than in sand/gravel or mud, and were more common in shallow waters (0-15 m depth). Again, these data reflect the needs of smaller juveniles for shelter providing habitats that offer protection against predators. In contrast, sublegal sized adult lobsters (71-82 mm CL) were nearly equally distributed in all habitats at all depths, sampled, and were more abundant than legal-sized adult lobsters (> 83 mm CL), indicative of the highly exploited nature of this resource (Glenn *et al.*, 2005). Both of these larger size classes of lobsters have fewer inshore predators than do the smaller size class lobsters and, thus, fewer restrictions in habitat usage.

The results of the ventless trap program can be used to generally describe the expected distribution of lobster within the two potential enhancement sites based on the substrate present and depth of these sites. Based on the substrate classifications identified by the ventless trap study, juvenile, and adolescent lobsters are expected to be more abundant at the Broad Sound sites, which are characterized as containing predominantly boulder, cobble, and sand/gravel substrate (see Section 3.2.2). Conversely, the Massachusetts Bay enhancement site, which contains mostly sand/gravel and mud, would be expected to contain less juvenile and adolescent lobsters relative to the Broad Sound site. The Massachusetts Bay enhancement site, which falls into the "deep" category, is expected to have fewer juvenile and adolescent lobsters and more sublegal-sized adults.

3.3.4.3 Massachusetts Bay Disposal Site

Although there are no direct reports of lobster activity at the disposal site, lobster activity has been noted at the nearby reference site FG-23 where some benthic disturbance due to lobster fishing activity was noted (USACE, 2002). It is probable that the disposal site and disposal mounds may provide forage and habitat for some larger sized adults.

3.3.4.4 Industrial Waste Site

Lobster resource data within the IWS is limited. However, investigations of the IWS have shown disruptions of the mud surface from burrowing activities from lobsters as well as beneath boulders and 55-gallon drums (NOAA, 1996).

3.3.5 Fish

The coastal waters of Massachusetts have extensive finfish resources including numerous demersal, pelagic, migratory, and anadromous species, as well as smaller ecologically important forage 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 or through the Federal Endangered Species Act. The Massachusetts Division of Marine Fisheries (MA DMF) also regulates several key fisheries in the nearshore coastal waters. The sections below discuss the finfish species that may occur in the project area. Because no long-term finfish monitoring occurs in the project area, limited site-specific finfish data in terms of catch-per-unit- effort (CPUE) are available for review. MA DMF does conduct long-term bi-annual bottom trawl surveys that are designed to describe the groundfish resources over a particular area (*i.e.*, coastal MA) but these are conducted outside the project area (see Figure 3-16). A list of species from this sampling effort is included as some of these species may be present in the project area (see Table 3-3).

Therefore, the discussion below will focus on the life-history characteristics of the managed species and several forage/inshore species of ecological importance that may occur in the project area based on geographic locale and bottom type. A short summary of which species are likely to occur in the specific locations within Boston Harbor (Mystic and Chelsea Rivers, Inner, Lower and Outer Harbor) and the habitat enhancement sites based on species life history characteristics as well as the bottom type in that area is also presented.

Federally Managed Species Including Essential Fish Habitat - The 1996 amendments to the Magnuson-Stevens Fishery Conservation and Management Act strengthened the ability of NMFS and the Fishery Management Councils to "protect and conserve the habitat of marine, estuarine, and anadromous finfish, mollusks, and crustaceans." This habitat, referred to as essential fish habitat (EFH), is defined as "those waters and substrate necessary to fish for spawning, breeding, feeding, or growth to maturity." The Magnuson-Stevens Act requires the Fishery Management Councils to describe and identify EFH for managed species and to draft Management Plans for these species that describe ways to minimize, to the extent practicable, adverse effects on EFH from fishing practices and to identify other actions to encourage the conservation and enhancement of EFH.

The Magnuson-Stevens Act, the Fish and Wildlife Coordination Act, and the Federal Endangered Species Act requires that Federal agencies proposing or undertaking activities that may impact fish populations or their habitat consult with NMFS and Fish and Wildlife Service before permits for the proposed activities may be issued. An EFH consultation has been conducted for this SEIS/EIR and is included as Appendix T. The consultation includes a detailed description of the fish species and their life-history stages that may be impacted from the proposed action. The consultation also includes a description of how these species may be affected and measures that would be considered to mitigate these impacts. The NMFS 10 x 10 minute squares of latitude/longitude that encompass the project area were queried to determine which of the Federally managed species and their respective life-history stages have EFH designated within the project area. The 10 x 10 minute squares included in the project area are presented in Figure 3-17.

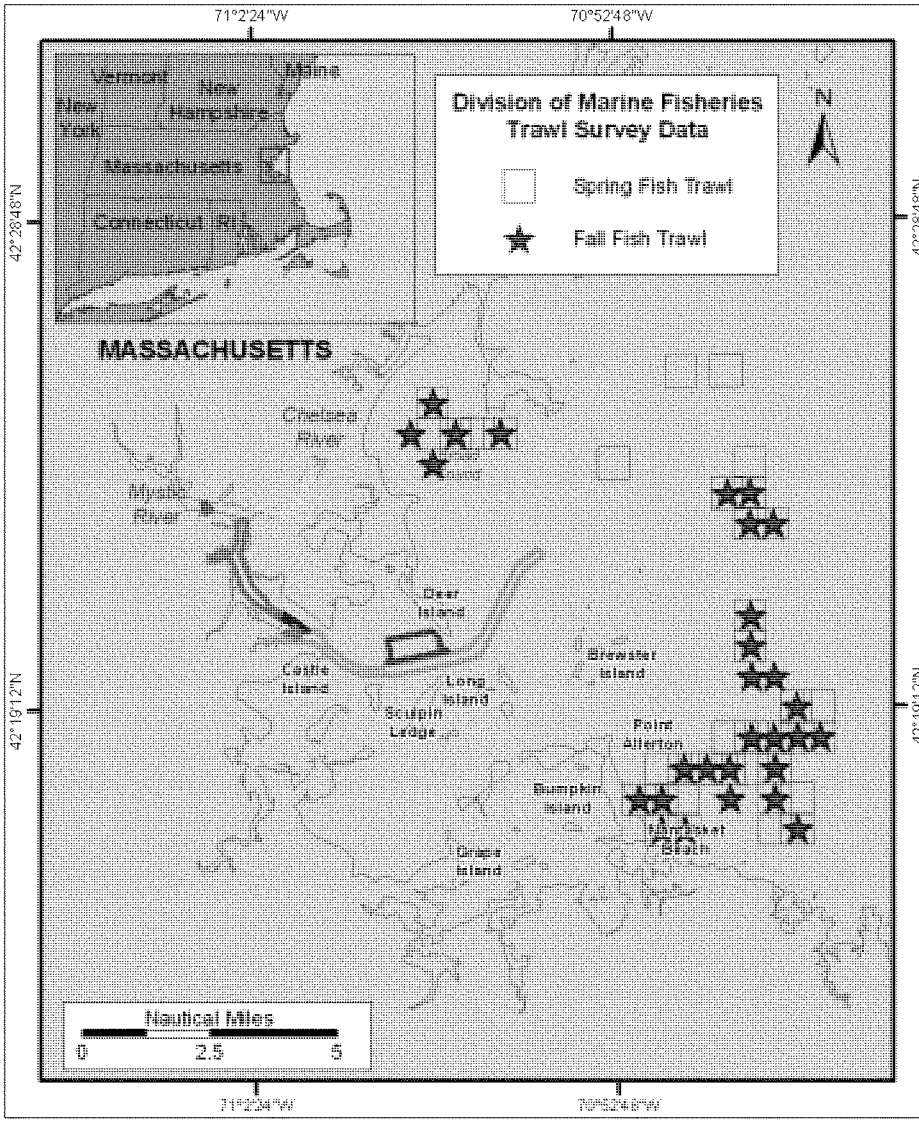


Figure 3-16. MA Division of Marine Fisheries Spring and Fall Trawl Locations

Table 3-3. Spring and Fall Survey Trawls 1978-2005

Spring Survey Trawls 1978 - 2005			Fall Survey Trawls 1978 – 2005		
Common Name	Scientific Name	Total Number (1978-2005)	Common Name	Scientific Name	Total Number (1978-2005)
Spiny dogfish	*Squalus acanthias*	1	Spiny dogfish	*Squalus acanthias*	511
Winter skate	*Leucoraja ocellata*	144	Winter skate	*Leucoraja ocellata*	132
Clearnose skate	*Raja eglanteria*	3	Little skate	*Leucoraja erinacea*	1621
Little skate	*Leucoraja erinacea*	1145	Atlantic herring	*Clupea harengus*	204
Thorny skate	*Amblyraja radiata*	41	Alewife	*Alosa pseudoharengus*	12
Atlantic herring	*Clupea harengus*	274	Blueback herring	*Alosa aestivalis*	96
Alewife	*Alosa pseudoharengus*	256	American Shad	*Alosa sapidissima*	2
Blueback herring	*Alosa aestivalis*	248	Rainbow smelt	*Osmerus mordax*	12864
American Shad	*Alosa sapidissima*	49	Silver hake	*Merluccius bilinearis*	577
Rainbow smelt	*Osmerus mordax*	1807	Atlantic cod	*Gadus morhua*	5043
Silver hake	*Merluccius bilinearis*	173	Haddock	*Melanogrammus aeglefinus*	19
Atlantic cod	*Gadus morhua*	5308	Pollock	*Pollachius virens*	75
Haddock	*Melanogrammus aeglefinus*	2	White hake	*Urophycis tenuis*	635
Pollock	*Pollachius virens*	377	Red hake	*Urophycis chuss*	259
White hake	*Urophycis tenuis*	60	Spotted hake	*Urophycis regia*	1
Red hake	*Urophycis chuss*	207	American plaice	*Hippoglossoides platessoides*	120
American plaice	*Hippoglossoides platessoides*	263	Summer flounder	*Paralichthys dentatus*	2
Summer flounder	*Paralichthys dentatus*	2	Fourspot flounder	*Paralichthys oblongus*	48
Fourspot flounder	*Paralichthys oblongus*	36	Yellowtail flounder	*Limanda ferruginea*	807
Yellowtail flounder	*Limanda ferruginea*	2502	Winter flounder	*Pseudopleuronectes americanus*	6475
Winter flounder	*Pseudopleuronectes americanus*	10510	Windowpane	*Scophthalmus aquosus*	548
Witch flounder	*Glyptocephalus cynoglossus*	20	Atlantic silverside	*Menidia menidia*	378
Windowpane	*Scophthalmus aquosus*	1199	Northern pipefish	*Syngnathus fuscus*	2
Atlantic silverside	*Menidia menidia*	2	Atlantic mackerel	*Scomber scombrus*	11
Threespine stickleback	*Gasterosteus aculeatus*	20	Butterfish	*Peprilus triacanthus*	19720
Northern pipefish	*Syngnathus fuscus*	1	Atlantic moonfish	*Selene setapinnis*	31
Atlantic mackerel	*Scomber scombrus*	6	Scup	*Stenotomus chrysops*	103
Butterfish	*Peprilus triacanthus*	1	Longhorn sculpin	*Myoxocephalus octodecemspinosus*	361
Striped bass	*Morone saxatilis*	5	Sea raven	*Hemitripterus americanus*	17
Black sea bass	*Centropristis striata*	3	Lumpfish	*Cyclopterus lumpus*	17
Scup	*Stenotomus chrysops*	1	Atlantic seasnail	*Liparis atlanticus*	4
Longhorn sculpin	*Myoxocephalus octodecemspinosus*	2878	Cunner	*Tautogolabrus adspersus*	129
Sea raven	*Hemitripterus americanus*	66	Rock gunnel	*Pholis gunnellus*	16
Lumpfish	*Cyclopterus lumpus*	2	Ocean pout	*Macrozoarces americanus*	170
Northern searobin	*Prionotus carolinus*	2	Goosefish	*Lophius americanus*	2
Cunner	*Tautogolabrus adspersus*	44	Atlantic saury	*Scomberesox saurus*	1
Rock gunnel	*Pholis gunnellus*	1	Mackerel scad	*Decapterus macarellus*	984
Snakeblenny	*Lumpenus lumpretaeformis*	2	Bigeye scad	*Selar crumenophthalmus*	3
Daubed shanny	*Lumpenus maculatus*	1	Rough scad	*Trachurus lathami*	21
Atlantic wolffish	*Anarhichas lupus*	1	American lobster	*Homarus americanus*	18322
Ocean pout	*Macrozoarces americanus*	2766	Jonah crab	*Cancer borealis*	511
Goosefish	*Lophius americanus*	1	Atlantic rock crab	*Cancer irroratus*	3729
American lobster	*Homarus americanus*	4833	Spider crab-unclassified	*Majidae*	1
Jonah crab	*Cancer borealis*	170	Lady crab	*Ovalipes ocellatus*	88
Atlantic rock crab	*Cancer irroratus*	1890	Moon snail, Shark eye, and baby	*Naticidae*	226
Spider crab-unclassified	*Majidae*	2	northern horsemussel	*Modiolus modiolus*	1
Horseshoe crab	*Limulus polyphemus*	2	Blue mussel	*Mytilus edulis*	18
Moon snail, Shark eye, and baby	*Naticidae*	265	Sea scallop	*Placopecten magellanicus*	25
Blue mussel	*Mytilus edulis*	93	Atlantic surfclam	*Spisula solidissima*	1
Northern moonsnail	*Euspira heros*	3	Ocean quahog	*Arctica islandica*	14
Sea scallop	*Placopecten magellanicus*	11	Northern shortfin squid	*Illex illecebrosus*	4
Ocean quahog	*Arctica islandica*	6	Longfin squid	*Loligo pealeii*	33152
Razor and Jackknife clams	*Solenidae*	1	Longfin squid egg mops	*Loligo pealeii egg mops*	
Longfin squid	*Loligo Pealeii*	4			

The latitude/longitude coordinates for these squares are:

Table 3-4. Coordinates for Essential Fish Habitat Squares in the Project Area

	North	East	South	West
Square 1	42° 30.0' N	71° 00.0' W	42° 20.0' N	71° 10.0' W
Square 2	42° 20.0' N	71° 00.0' W	42° 10.0' N	71° 10.0' W
Square 3	42° 30.0' N	70° 50.0' W	42° 20.0' N	71° 00.0' W
Square 4	42° 20.0' N	70° 50.0' W	42° 10.0' N	71° 00.0' W

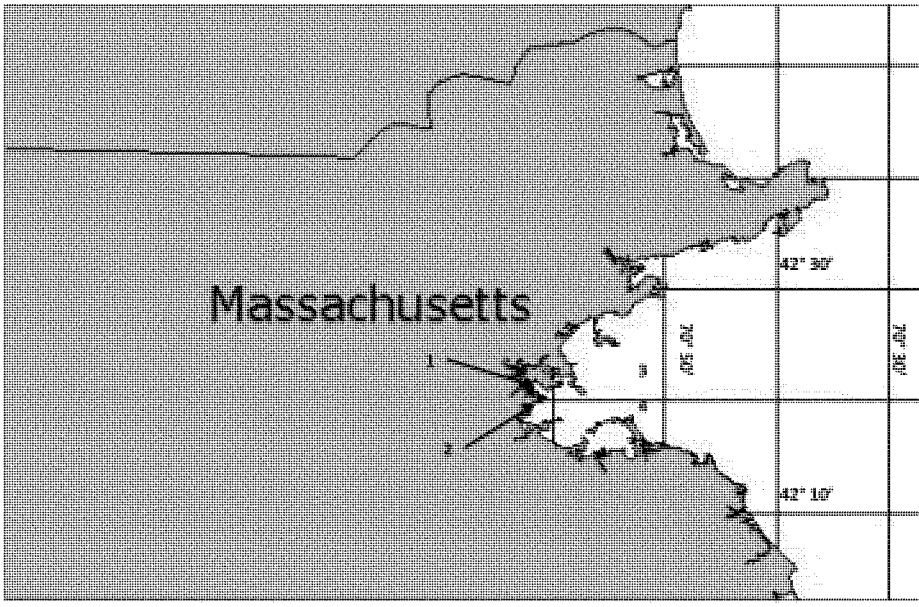


Figure 3-17. Essential Fish Habitat 10 x 10 Minute Squares Encompassing the Project Area

The species that may be present in the project area based on the bottom habitat present are listed below in Table 3-5. Fourteen of these species are managed by the New England Fishery Management Council. Nine are managed by the Mid-Atlantic Fishery Management Council, and one, the bluefin tuna, is managed as a highly migratory species. Two shellfish species (Atlantic sea scallop [*Placopecten magellanicus*] and surf clam [*Spisula solidissima*] [see Section 3.3.3 for discussion of shellfish resources]), two invertebrates (long-finned squid [*Loligo pealei*] and short-finned squid [*Illex illecebrosus*]), and 20 finfish species have EFH designated within the project area. Finfish species include demersal and pelagic species, several of which are migratory to the northeast region and within the project area. In addition to the EFH species mentioned above, on February 6, 2012, five distinct population segments (DPS) of Atlantic sturgeon (*Acipenser oxyrinchus oxyrinchus*) that inhabit the waters of the northeast and the southeast were listed under the Endangered Species Act. This species will be discussed further in the Endangered and Threatened Species Section of this report.

Table 3-5. Essential Fish Habitat Species within the Project Area

Species	Eggs	Larvae	Juveniles	Adults	Spawning Adults
Atlantic cod* *Gadus morhua*	S	S	S	M,S	M,S
Haddock* *Melanogrammus aeglefinus*	S	S			
Pollock* *Pollachius virens*	S	S	S	S	S
Whiting (silver hake)* *Merluccius bilinearis*	S	S	M,S	X	
Red hake* *Urophycis chuss*	X	S	S	S	
White hake* *Urophycis tenuis*	S	S	S	S	
Winter flounder* *Pseudopleuronectes americanus*	M,S	M,S	M,S	M,S	M,S
Yellowtail flounder* *Pleuronectes ferruginea*	S	S	S	S	S
Windowpane flounder* *Scophthalmus aquosus*	M,S	M,S	M,S	M,S	M,S
American plaice* *Hippoglossoides platessoides*	S	S	S	S	S
Ocean pout* *Macrozoacres americanus*	X	X	S	S	
Atlantic halibut* *Hippoglossus hippoglossus*	S	S	S	S	S
Atlantic sea scallop* *Placopecten magellanicus*	S	S	S	S	S
Atlantic sea herring* *Clupea harengus*		S	M,S	M,S	
Bluefish** *Pomatomus saltatrix*			M,S	M,S	
Long-finned squid** *Loligo pealei*	n/a	n/a	X	X	X
Short-finned squid** *Illex illecebrosus*	n/a	n/a	X	X	X
Atlantic butterfish** *Peprilus triacanthus*	S	S	X	X	
Atlantic mackerel** *Scomber scombrus*	M,S	M,S	M,S	M,S	
Summer flounder** *Paralichthys dentatus*				X	
Scup** *Stenotomus chrysops*			X	X	
Black sea bass** *Centropristus striata*			X	X	
Surf clam** *Spisula solidissima*	n/a	n/a	X	X	
Bluefin tuna *Thunnus thynnus*			X	X	
M = Mixing Seawater/Brackish Salinity Zone; S – Seawater (Salinity ≥25 ppt; X = EFH designated for given species and lifestage.					

Source: NOAA Fisheries Service, Habitat Conservation Division, http://www.nero.noaa.gov/hcd/ma1.html
*Managed species by the New England Fishery Management Council
**Managed species by the Mid-Atlantic Fishery Management Council

Demersal species are those that live on or near the bottom and feed on benthic organisms or other bottom dwelling fish. Flat-bodied groundfish species such as winter flounder, summer flounder, yellowtail flounder, windowpane flounder, and the American plaice, as well as the more full-bodied species such cod, haddock, halibut, pollock, hakes, ocean pout, sea bass, and scup are considered demersal. Pelagic species are those that occupy open waters between the coast and edge of the continental shelf, often in depths of 66 to 1,312 ft. Pelagic species tend to be more mobile than demersal species, and many are highly migratory. Some species also form large schools. Examples of pelagic species include herrings, butterfish, squid, mackerels, and bluefish. Species such as the Atlantic mackerel, bluefin tuna, and bluefish are also highly migratory. More detailed information pertaining to the life-history characteristics, such as geographic distribution, bottom type preferences, migrations, spawning and food preferences are described in Table 3-6 for these Federally managed species.

The Estuarine Living Marine Resource Database (ERLM; Jury *et al.*, 1994) categorizes the species present in Boston Harbor in terms of highly abundant, abundant, common, or rare. Highly abundant species are numerically dominant relative to other species with similar life modes; abundant species are those that are often encountered in substantial numbers relative to other species with similar life modes; common species are defined as those that are frequently encountered, but not in large numbers; and rare species are those that are definitely present but not frequently encountered.

In the project area, Jury *et al.* (1994) suggest that highly abundant Federally managed species include winter flounder. Abundant species include Atlantic herring, American plaice, and yellowtail flounder. Common species include Atlantic cod, whiting (silver hake), pollock, red hake, white hake, bluefish, ocean pout, Atlantic mackerel, and windowpane flounder. Rare species include spiny dogfish, haddock, scup, butterfish, and smooth flounder.

In a July 21, 2005 letter from the U.S. Department of Commerce, NOAA Fisheries, Northeast Region to Mr. Michael Keegan at the U.S. Army Corps of Engineers, NOAA Fisheries suggested that among the species listed with EFH in the project area, particular attention should be focused on the winter flounder (*Pseudopleuronectes americanus*). 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 (Klein-MacPhee, 1978), generally over sandy bottoms in water from 6 to 20 ft in depth (Bigelow and Schroeder, 2002). Winter flounder eggs are demersal and adhesive (Pearcy, 1962) and may be found on tidally submerged gravel bars and attached to fronds of macroalgae (Crawford and Carey, 1985). In Boston Harbor, eggs are abundant between February and May (Jury *et al.*, 1994). Winter flounder larvae stay near the bottom (Pearcy, 1962) and are highly abundant in Boston Harbor in March through May (Jury *et al.*, 1994), including the tributaries. The presence of larvae, young-of-year, juveniles, and winter flounder adults in the Mystic River indicate that eggs are also likely in the Mystic River, even though they were not collected during biomonitoring of the Mystic Station. The demersal and adhesive nature of winter flounder eggs may have accounted for their absence in the entrainment samples (Boston Generating, 2006). However, winter flounder larvae densities were low (0.7 to 4.0 fish per 100 m^3) in the Mystic River, even during their spawning season (March through June) (Boston Generating, 2006).

Table 3-6. Life History Information of Managed Species and Non-managed Species Likely to be Found in the Project Area

Species	Distribution	General Habitat	Bottom Type	Migrations	Spawning	Eggs and Larvae	Food
Federally Managed Species							
Demersal Species							
American plaice (*Hippoglossoides platessoides*)	Labrador and to Montauk Point New York	Bays and continental shelf waters from 148 to 574 ft in depth	Bottom habitats with fine-grained sediments or sand and gravel	Move inshore in spring for spawning	March through mid June	Pelagic eggs and larvae	Small crustaceans, polychaetes, sand dollars sea urchins and primarily brittle stars
Atlantic cod (Gadus morhua)	Greenland to North Carolina	Continental shelf waters from 33 to 492 ft in depth	Rocky slopes or ledges, rock, gravel, mud, sand, clay	Extensive migrations with seasons, and in response to food	November through May	Pelagic eggs and larvae	Extensive diet but mainly mollusks, crabs, lobsters, shrimp, brittle stars
Atlantic halibut (Hippoglossus hippoglossus)	Greenland and Labrador to Virginia	Bays and continental shelf waters from 328 to 2297 ft in depth	Bottom habitats with a substrate of soft mud, sand, gravel or clay; rough or rocky bottoms along slopes of outer banks	Juveniles have extensive migrations	Late fall through early spring peaking in Nov. – Dec.	Bathypelagic eggs (170-656 ft) and pelagic larvae	Changes with increasing size including a variety of crustaceans, mollusks and fish
Black sea bass (Centropristis striata)	Maine to Florida	Estuaries, Bays and continental shelf waters from 66 to 164 ft in depth	Structured hard bottom (shellfish beds, pilings, wrecks, offshore ledges, reefs)	Move inshore during spring and summer	May through July	Pelagic eggs and larvae	Crabs, lobsters, shrimp, mollusks
Haddock (Melanogrammus aeglefinus)	Greenland to North Carolina	Continental shelf waters from 40 to 492 ft in depth	Sand, rock, pebbles, broken shell	May move in response to food	January through June	Pelagic eggs and larvae	Extensive diet of crustaceans, mollusks, worms, shrimp
Ocean pout (Macrozoarces americanus)	Labrador to Delaware	Continental shelf waters 105 to 112 ft in depth	Sand-mud, sticky sand, gravel, rocks	Changes habitats when seasons change: winter-spring in sand-gravel areas; summer-fall in rocky area	September and October	Demersal eggs and larvae	Shelled mollusks, crustaceans, echinoderms
Pollock (Pollachius virens)	Scotian Shelf, Georges Bank, Great South Channel and Gulf of Maine	Continental shelf waters from 49 to 1198 ft in depth	Hard, stony or rocky bottoms, including artificial reefs	As juveniles, inshore-offshore movements linked to temperatures eventually staying offshore as adults	September through April peaking in Dec – Feb.	Pelagic eggs and larvae	Euphausiid crustaceans, fish and mollusks
Red hake (Urophycis chuss)	Gulf of St. Lawrence to Virginia	Continental shelf waters from 33 to 427 ft in depth	Soft mud and silt (juveniles near shellfish beds)	Extensive seasonal migrations – inshore in spring and summer and offshore in winter	May through November	Pelagic eggs and larvae	Shrimp, crustaceans, squid, small fish
Scup (Stenotomus chrysops)	Massachusetts to North Carolina	Continental shelf waters from shoal areas (7 ft) to deeper waters (607 ft)	Rocky bottoms	Move inshore in spring-summer and offshore in winter	Summer	Pelagic eggs and larvae	Crustaceans, worms, hydroids, sand dollars, young squid
Summer flounder (Paralichthys dentatus)	Gulf of Maine to South Carolina	Estuaries, Bays and continental shelf waters to 82 ft in depth	Mud or sand	Move offshore in fall	Fall and early winter	Pelagic eggs and larvae	Small fish, shrimp, crustaceans squid, mollusks, worms, sand dollars
Whiting (Merluccius bilinearis)	Newfoundland to South Carolina	Continental shelf waters from 98 to 1066 ft in depth	All substrate types	Move inshore in spring and offshore in fall – vertical migrations in response to prey	Late spring and early summer	Pelagic eggs and larvae	Herring, other small schooling fish
White hake Urophycis tenuis	Gulf of St. Lawrence to Mid-Atlantic Bight	Estuaries, Bays and continental shelf and slope waters from 16 to 1066 ft in depth	All substrate types	May retreat to the deeper waters during winter	Early spring off Southern Georges Bank	Pelagic eggs and larvae	Polychaetes, shrimps, crustaceans and fish
Windowpane flounder (Scophthalmus aquosus)	Gulf of St. Lawrence to Florida	Large estuaries in waters up to 246 ft in depth	Sand, mixtures of sandy silt or mud	Not likely to undergo inshore – offshore migrations	Late spring and summer	Pelagic eggs and larvae	Squid, crabs, small mollusks, worms
Winter flounder (Pseudopleuronectes americanus)	Labrador to Georgia	Estuaries, Bays and continental shelf waters from tide mark to 328 ft in depth	Muddy sand with patches of eelgrass, sand, clay, gravel or cobble	Generally localized small scale migrations inshore in winter	February – June	Demersal eggs, pelagic larvae	Mollusks, crustaceans, worms, sea cucumbers
Yellowtail flounder (Pleuronectes ferruginea)	Labrador to Chesapeake Bay	Continental shelf waters from 66 to 164 ft in depth	Sand or sand and mud mixtures	Not likely to undergo inshore – offshore migrations	Spring and summer – may spawn at depths up to 410 feet	Pelagic eggs and larvae	Small bivalves, crustaceans, shrimp, worms

Table 3-6 (continued). Life History Information of Managed Species and Non-managed Species Likely to be Found in the Project Area

Species	Distribution	General Habitat	Bottom Type	Migrations	Spawning	Eggs and Larvae	Food
Pelagic Species							
Atlantic butterfish (*Peprilus triacanthus*)	Newfoundland to Florida	Estuaries and Bays to continental shelf waters generally less than 394 ft in depth	Surface waters over sand bottoms	Move offshore and south during winter	June through August	Pelagic eggs and larvae	Small fish, squid, amphipods, shrimp
Atlantic mackerel (*Scomber scombrus*)	Gulf of St. Lawrence to North Carolina	Continental shelf waters from surface to 1247 ft in depth	Not dependent on coastline or bottom	Highly migratory – appear near coast in spring – disappear in fall	Spring and early summer	Pelagic eggs and larvae	Copepods, pelagic crustaceans, small fish
Atlantic sea herring(*Clupea harengus*)	Labrador to North Carolina	Continental shelf waters from 66 to 427 ft in depth; in large schools	Only during spawning – in gravel, cobble, sand substrates	May migrate to inshore areas during spawning	July through November	Demersal eggs, demersal, then pelagic larvae	Plankton (larval snails, diatoms, crustaceans)
Bluefish (*Pomatomus saltatrix*)	Highly migratory: Maine to Florida	Continental waters (~80 nautical miles (nmi) offshore) in schools	Juveniles may occur along beaches, estuaries, tidal creeks over sand and gravel	Migrate north in spring and south in fall	June through October	Pelagic eggs and larvae	Fish, crustaceans
Bluefin tuna(*Thunnus thynnus*	Highly migratory, worldwide in temperate and tropical waters	Continental shelf and slope waters	All substrate types	Known to migrate across the Atlantic	Appear in New England waters in June, unknown when spawning occurs	Pelagic eggs and larvae	Fish
Long-finned squid (*Loligo pealei*)	Gulf of Maine through Cape Hatteras, NC	Continental shelf waters to 1000 ft	All substrate types; eggs found in sandy-mud bottoms; attached to rocks, pilings or algae	Move inshore during spring and summer and offshore in mid-late fall and winter	Spawn in May, hatch in July	Eggs are demersal and enclosed in gelatinous capsules of up to 200 eggs	Small planktonic prey, crustaceans, small fish
Short-finned squid*Illex illecebrosus*	Gulf of Main through Cape Hatteras, NC	Continental shelf waters to 597 ft	All substrate types	Move offshore in late fall	Spawn December through March	Gelatinous egg balloons containing 10,000 – 100,000 eggs	Small planktonic prey, crustaceans, small fish
Non-Federally Managed Species							
Anadromous Species							
Alewife (*Alosa seudoharengus*)	Newfoundland and Gulf of St. Lawrence to SC	Streams, Rivers, Estuaries and Bays and out to 60 nmi offshore	Spends most of life at sea as a pelagic schooling species; will run up rivers/streams to spawn in still water	Run up rivers in May through June to spawn and may be seen moving out of rivers after spawning as late as August	May through August	Eggs and larvae develop in freshwater where spawning occurred, after a month, begin movement downstream. Eggs stick to brush or stones	Generally a Plankton feeder: copepods, amphipods, shrimps, appendicularians
American shad (*Alosa sapidissima*)	Newfoundland and Gulf of St. Lawrence to FL	Streams, Rivers, Estuaries and Bays and offshore to depth of 156 to 408 ft	Spends most of life at sea as a pelagic schooling species; will run up rivers/streams to spawn in areas with sandy or pebbly shallows	Enter rivers in spring and early summer to spawn and may be seen moving out of rivers as late as August	May through August	Eggs and larvae develop in freshwater where spawning occurred, after a month, begin movement downstream. Eggs are semi buoyant	Generally a Plankton feeder: copepods, euphausiid shrimps, fish eggs and occasionally bottom dwelling amphipods
Blueback herring (*Alosa aestivalis*)	Southern New England to Northern FL	Streams, Rivers, Estuaries and Bays and near bottom in shelf waters	Spends most of life at sea as a pelagic schooling species; will run up rivers/streams to spawn in still water	Similar to the alewife, runs up rivers to spawn, only runs later in the season that the alewife (when water temps are warmer)	May through August	Eggs and larvae develop in freshwater where spawning occurred, after a month, begin movement downstream. Eggs stick to brush or stones	Generally a Plankton feeder: copepods, pelagic shrimps, launce and small fish fry
Rainbow smelt (*Osmerus mordax*)	Labrador to northern NJ, Alaska and Arctic Canada	Harbors, Estuaries, Bays, River mouths and Inshore areas not more than 0.9 nmi out	Spends most of life in harbors or brackish estuaries as a pelagic schooling species; will run upriver to spawn; generally not as far upstream as others	Runs up rivers to spawn, may also move slightly offshore from the Bays and Harbors if water gets too warm during summer months	March through May	Eggs and larvae develop in freshwater where eggs stick to rocks, brush *etc.* larvae begin moving into more saline waters at about 1¼ inch.	Small crustaceans, sea worms, small fish

Table 3-6 (continued). Life History Information of Managed Species and Non-managed Species Likely to be Found in the Project Area

Species	Distribution	General Habitat	Bottom Type	Migrations	Spawning	Eggs and Larvae	Food
American eel (*Anguilla rostrata*) Catadromous species	Eastern North America to northern South America including the Bahamas	Streams. Rivers, Estuaries and Bays and coastal waters	Muddy bottom and still water	Reside in freshwater regions and migrate to sea water during winter and early spring to spawn	Spawns midwinter far out at sea	Thought to have pelagic eggs; have pelagic leptocephalus larvae	Scavengers; will eat anything living or dead including a variety of small fish and crustaceans
Forage/Shore Species							
Atlantic menhaden (*Brevoortia tyrannus*)	Nova Scotia to Florida; Gulf of Mexico, and South to Argentina	Bays, estuaries and continental shelf waters	Pelagic schooling species, all substrate types	Migrate north in spring and south in fall	Spawns June through August	Pelagic eggs and larvae	Microscopic plants and small crustaceans
Atlantic tomcod (*Microgadus tomcod*)	Gulf of St. Lawrence to Virginia	Estuaries, Bays, Harbors, mouths of rivers	Strictly an inshore fish, demersal, muddy bottoms, salt marshes	Do not carry out inshore-offshore migrations regularly, but some more south populations may move into deeper (cooler) waters during summer	Spawn November through February in estuaries and moths of streams/rivers	Demersal eggs masses which stick to seaweeds or stones; unknown larval stages	Small crustaceans, worms, small mollusks, squid, fish fry
Cunner (*Tautogolabrus adspersus*)	Newfoundland and the Gulf of St. Lawrence to Chesapeake Bay	Coastal waters just below the tidemark; generally in waters 15 – 20 ft deep. Will run into deep salt creeks	Demersal species on bottom substrates of eelgrass, pilings of wharves, under floats in harbors, rock pools	Are year-round residents but may move into slightly deeper water during winter or to escape really high temperatures during summer	Spawn late spring through early summer	Pelagic eggs and larvae	Omnivorous and will feed on eelgrass, amphipods, shrimp, lobsters, crabs, bivalves, mollusks, worms, sea urchins and fish such as silversides, sticklebacks, pipefish, mummichogs and fish fry
Tautog (*Tautoga onitis*)	Nova Scotia to SC	Coastal waters not more than 3 nmi from land or 30 to 60 ft in depth	Demersal species around steep rocky shores, breakwaters, ledges, wrecks, piers and cocks and rock piles/boulders and mussel beds	No apparent migrations with seasons. Like cunner, may move into slightly deeper water during extreme cold or warm periods	Spawn primarily in June	Pelagic eggs and larvae	Primarily bivalve and univalve mollusks, crabs, hermit crabs, sand dollars, shrimps, lobsters
Striped bass (*Morone saxatilis*)	Gulf of St. Lawrence to north FL, northern Gulf of Mexico, pacific coast	Inshore coastal waters, seldom more than a few nautical miles from shore; may move into estuaries, river mouths and rivers	Powerful swimmers, often swim at surface, congregate in small groups, may sink to the bottom during the daylight ; sandy, rocky substrates	Move north in the spring and south in the fall. May run into estuaries or freshwater rivers to spawn	Spawn primarily in June	Eggs are semi-buoyant and are spawned in turbulent waters to prevent eggs from settling; pelagic larvae	Other fish and a wide variety of invertebrates (lobsters, crabs, shrimps, squid, mussels)
White perch (*Morone americana*)	Gulf of St. Lawrence and Nova Scotia to SC	Estuaries, Bays, River mouths, land-locked freshwater ponds. Generally shallow water	Not a bottom fish (except in winter), are a schooling species	May run up into freshwater or brackish water for spawning. Tend to be year-long residents but will move to deeper locations in Bays/creeks during winter	Spawn April through June	Eggs will stick together in masses and sink or stick to objects they encounter. Larvae are pelagic	Small fish fry, spawn of other fish, young squid, shrimps, crabs.
Mummichog (*Fundulus heteroclitus*)	Gulf of St. Lawrence to Texas	Salt marshes, tidal creeks, shores of harbors, moths of streams and estuaries	Sheltered shores where tide flows over eelgrass or *Spartina*, will bury in mud	No migration, a stationary fish – will overwinter in mud	Spawn June through early August in a few inches of water	Eggs are sticky and will mass in clumps and stick to sand grains, or other objects	Omnivorous – plant and animal (diatoms, eelgrass, shrimps, small crustaceans), dead or alive
Silversides (*Menidia spp*)	Southern Gulf of St. Lawrence to Chesapeake Bay	Confined to coastline in inner bays, brackish water and mouths of rivers	Sandy shores, gravelly shores, among the *Spartina* in salt marshes	Resident throughout the year but may sink deeper in winter	May through early July on sandy bottom or among Spartina	Eggs sink and stick in ropy clusters or sheets	Omnivorous – algae, diatoms, copepods, mysids, shrimps, small decapods, fish eggs, young squid, annelid worms and mollusk larvae
Northern searobin (*Prionotus carolinus*)	Bay of Fundy to SC	Coastal waters from the tide line to depths of 30 to 180 ft	Around rocks, smooth hard grounds, less often on mud	Seasonal inshore – offshore migrations (appear inshore in may-June and move to deeper waters of the shelf in October	June through September with peaks in July and August	Pelagic eggs and larvae	Shrimps, crabs, amphipods, crustaceans, squid, bivalve mollusks and small fish
Longhorn sculpin (*Myoxocephalus ctodecemspinosus*)	Newfoundland and Gulf of St. Lawrence to VA	Estuaries, Bays, Harbors and coastal waters where it may come to flats at high tides and to depths of 300 ft	Demersal on shoals and flats, wharves	No seasonal migrations but will stay in the deeper channels in coldest part of winter and during heat of summer	Spawning November through January	Eggs sink and stick together in clumps and will adhere to anything (empty clamshells, finger sponges *etc.*); planktonic larvae	Shrimps, crabs, amphipods, hydroids, worms, mussels, other mollusks and fish fry; are scavengers

Table 3-6 (continued). Life History Information of Managed Species and Non-managed Species Likely to be Found in the Project Area

Species	Distribution	General Habitat	Bottom Type	Migrations	Spawning	Eggs and Larvae	Food
Shorthorn sculpin (*Myoxocephalus scorpius*)	Northern Labrador to Southern New England	Bays and ledges rising from smooth bottom in shoal waters	Demersal fish on substrates of mud, sand, pebbles, bare bottom or among weeds, wharves,	No seasonal migrations but will stay in the deeper channels in coldest part of winter and during heat of summer	Spawning November through February	Eggs sink and stick together in spongy masses on sandy bottoms, pools in rocks, seaweeds, or any crevice or hollow; planktonic larvae	Crabs, shrimps, sea urchins, worms, fish fry; are scavengers and will eat debris
Grubby (*Myoxocephalus aenaeus*)	Gulf of St. Lawrence and Nova Scotia to NJ	Estuaries, Bays, and coastal waters from tide mark to 90 ft in depth	Demersal on many substrates including eelgrass	Local resident, no apparent migrations	Spawning continues throughout the winter	Eggs sink and adhere to any object it encounters; planktonic larvae	Annelid worms, shrimps, crabs, copepods, snails, nudibranch mollusks, ascidians and small fish
Threespine stickleback (*Gasterosteus aculeatus*)	Labrador and Newfoundland to Chesapeake Bay	Strictly a shore fish; freshwater and saltwater; may drift out to sea	A small fish (< 4 inches); ditches and creeks of tidal marshes; brackish ponds and lagoons; weedy shores in shallow water; hiding under clumps of floating eelgrass and rockweed if away from shore	No apparent migrations	Spawning in estuaries; likely to be May and June	Male builds nest of grass/weeds and eggs stick to nest; male guards eggs and young fry until fry drift away.	Small invertebrates, small fish fry and fish eggs
Fourspine stickleback (*Apeltes quadracus*)	Gulf of St. Lawrence and Nova Scotia to Virginia	Strictly a shore fish; freshwater and saltwater	A small fish (< 2 ½ inches); ditches and creeks of tidal marshes, brackish ponds/lagoons, weedy shores in shallow water	No apparent migrations	Spawning in May through July	Male builds a nest and places eggs in the nest and guards	Assumed to be similar to the diet of the Threespine stickleback
Ninespine stickleback (*Pungitius pungitius*)	Arctic seas south to New York	Strictly a shore fish; freshwater and saltwater	A small fish (< 3 inches); Creeks in tidal marshes; shore lines in harbors	No apparent migrations	Likely during summer months	Male may build a nest in grass or weeds. May be similar to the Threespine stickleback	Spawn and young of other fish
Northern pipefish *Syngnathus fuscus*)	Southern Gulf of St. Lawrence to SC	Salt marshes, harbors and river mouths; may drift out to sea	A small fish (4-8 inches); found among eelgrass or seaweeds; hiding under clumps of rockweed if found at sea	No apparent migrations	March to August	Males nurse eggs in a brood pouch; males maintain young in brood pouch until 8-9 mm	Minute crustacean, fish eggs and small fry
Rock gunnel (*Pholis gunnellus*)	Hudson Strait to Delaware Bay; numerous north of Cape Cod	Shoal waters; along low tide mark; also on offshore banks to depths of 240 ft	Under stones, among seaweed, prefers, pebbly, gravelly, stony ground or shell beds	No apparent migrations	Assumed to be November through February or March	Eggs are laid in holes or crannies, adhesive eggs,; planktonic larvae	Assumed to be carnivorous – small mollusks and crustaceans
American sand lance (*Ammodytes americanus*)	Labrador, Newfoundland and Gulf of St. Lawrence to Cape Hatteras, NC	Sandy foreshores; shoaled parts of offshore banks, congregate in dense schools	Sandy substrates where they burrow in the sand	Moves offshore into deeper water during the winter	Unknown, but egg production appears to be in late fall/early winter	Eggs appear to be deposited on sandy bottoms where they stick to sand grains; pelagic larvae	Small crustaceans and fish fry
Skates (*Raja spp*)	Eastern coast of the US spp vary, but may extend from Nova Scotia south to FL	Bottom dwelling in Bays, estuaries and continental shelf waters at various depths	Smooth, rocky, soft bottoms or sand and gravel	Variable, some species may move inshore and offshore seasonally	Variable, eggs may be laid during winter months and hatch in spring, laid in the summer and into autumn	Lay large eggs which become fastened to seaweeds or other objects	Omnivorous, shrimps, crabs, lobsters, mollusks worms and fish
Spiny dogfish (*Squalus acanthias*)	Labrador to Florida	Coastal waters and shelf edge waters	All substrate types	Seasonal migrations moving north in spring and summer and south in fall and winter. Also make inshore-offshore migrations in response to temperature	Female dogfish bear young live (1-15 pups). This occurs offshore in winter	Fertilization in internal, embryonic development is internal and young are born live	Fish, crustaceans

Source: Bigelow and Schroeder, 2002; Cross et al., 1999; U.S. Fish and Wildlife, EFH source documents: http://www.nefsc.noaa.gov/nefsc/habitat/efh/

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 (Crawford and Carey, 1985; Pearcy, 1962). In the fall, young-of-the-year (YOY) winter flounder will move out of estuaries and shallow-water areas to deeper water. Juvenile winter flounder less than four years of age are common in shallow waters during the summer along the New England coast.

Juvenile and adult winter flounder are highly abundant in Boston Harbor year-round (Jury *et al.*, 1994). During summer months when temperatures are high, juveniles and adults move to deeper channels and areas where water temperatures are cooler (McCracken, 1963; Howe and Coates, 1975). In late fall and winter, when temperatures drop, juveniles and adults move into deeper waters or move out of the estuary (Pearcy, 1962). In the spring, winter flounder return to their natal estuary to spawn (Saila, 1961; Howe and Coates, 1975).

In support of long-term monitoring for the Massachusetts Water Resource Association (MWRA) outfall, winter flounder are collected annually from 1991 to the present to obtain tissue for chemical analysis. The specific objective of this sampling program is not to address winter flounder abundance and distribution, but to obtain sufficient numbers of specimens for contaminant analysis of tissues. To collect sufficient numbers of fish for tissue samples, otter trawls are conducted during the late spring of each year and the numbers of fish collected during each trawl are counted and standardized to the length of time of the tow to calculate a catch of winter flounder per unit effort (CPUE). Although these data cannot be used to quantitatively describe winter flounder abundance in the study area, the methods and sampling timeframe have been consistent over the 21 year period and some general observations can be made by comparing the numbers of fish observed at four locations within the study area. These locations include Deer Island, Nantasket Beach, the Outfall location, and East Cape Cod Bay.

Figure 3-18 presents the results of 21 years of winter flounder catch data in support of the MWRA program (Moore *et al.*, 2011). Winter flounder catches appeared to fluctuate at several of the locations. Deer Island also shows some of the largest variations in catch. Peaks in the catch are seen in 2002 at three of the four locations including Deer Island Flats, Nantasket Beach, Outfall Site, and East Cape Cod Bay. At the outfall location CPUE fluctuated consistently until 1999. A large increase in catch was observed in 2000, and catch appeared to be increasing through the 2004 sampling period with 2005 CPUE falling back to pre-outfall startup levels, except for Deer Island which did not reach its highest peak until 2010. The presence of winter flounder at all sites suggests that adequate habitat may exist at these locations to support winter flounder. The differences observed may be due to fish moving to different locations throughout the harbor and surrounding areas to feed or escape temperature extremes.

State-Regulated Species - In addition to the Federally managed species, MA DMF regulates various finfish species that are restricted by quotas. MA DMF also regulates fisheries by gear types other than hook and line. MA DMF compiles data by gear type for sea bass, conch, and scup from fish pots, and for a variety of finfish collected by fish weirs and gill nets. Quotas on landings are set as a means of conserving various species and may be adjusted for any given year based on projected landings. Quota-managed species for 2012 include black sea bass, bluefish, dogfish, summer flounder, scup, tautog, and striped bass.

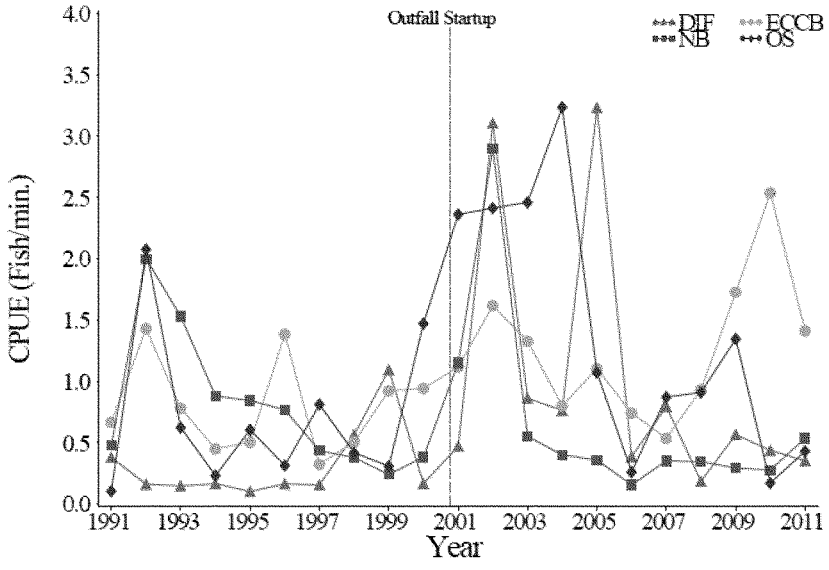


Figure 3-18. Winter Flounder CPUE Data from Locations within Boston Harbor

Of the fish managed by MA DMF, one of the most heavily fished species in and around the project area is the striped bass (Vin Malkoski, personal communication, Aug. 2005). The striped bass, or "striper," is one of the most avidly pursued of all U.S coastal sport fish. It is native to most of the eastern Atlantic coast, ranging from the lower St. Lawrence River in Canada to Northern Florida, and along portions of the Gulf of Mexico. Striped bass have been introduced into the west coast and, because of its adaptability to freshwater, its range has expanded to include inland areas as well. Striped bass are stocked into lakes and reservoirs in at least 31 states.

Striped bass can live up to 40 years and reach weights greater than 100 pounds, although individuals larger than 50 pounds in Massachusetts state waters are rare (MA DMF, 2005b). Sexual maturity is attained at two or three years of age for males and after age four for females. The size of females at sexual maturity has been used as a criterion for establishing minimum legal size limit regulations.

In general, the striped bass is a migratory species and is seen in Massachusetts's waters from the spring through autumn. Although juveniles less than two years of age do not appear to migrate, adults will move north to the New England coastal areas during the spring and return to more southern locales in the autumn. Striped bass are most abundant in the New England states following years when reproduction in the Chesapeake Bay has been particularly successful. While in Massachusetts's coastal waters, striped bass are rarely found more than several nautical miles from the shoreline. These fish are generally located in river mouths, in small, shallow bays and estuaries, and along rocky shorelines and sandy beaches. They are particularly active within tidal and current flows and in the wash of breaking waves. Most feeding occurs from dusk to dawn. Their diet is extensive and includes alewives, flounder, sea herring, menhaden, mummichogs, sand lance, silver hake, tomcod, smelt, silversides, and eels, as well as lobsters, crabs, soft clams, small mussels, annelids (sea worms), and squid.

Other Regulated and Non-Regulated Species - In addition to the Federally managed species and State-regulated species, the Estuarine Living Marine Resource Database (ERLM; Jury *et al.*, 1994) identifies additional Atlantic States Marine Fisheries Commission (ASMFC) regulated species and non-regulated species present in the project area and categorizes them in terms of highly abundant, abundant, common or rare. Highly abundant species include mummichog and silversides. Abundant species include skates, American eel, alewife, rainbow smelt, Atlantic tomcod, and cunner. Common species include blueback herring, Atlantic menhaden, fourspine stickleback, threespine stickleback, ninespine stickleback, northern pipefish, grubby, longhorn sculpin, striped bass, tautog, rock gunnel, and American sand lance. Rare species include American shad, northern searobin, shortfin sculpin and white perch. Alewives, blueback herring, American eel, striped bass, and tautog are regulated by the ASMFC. Life history characteristics of these species, including general distribution, habitat and food preferences, as well as spawning and migratory information, are presented in Table 3-6.

In a July 21, 2005 letter from the U.S. Department of Commerce, NOAA Fisheries Northeast Region to Mr. Michael Keegan at the USACE, three anadromous species included in the ELMR database (Jury *et al.*, 1994) have been identified through the Fish and Wildlife Coordination Act as species requiring particular attention. Although not regulated by Federal or State agencies, the coastal waters, bays, and estuaries off Massachusetts also support a variety of anadromous fish species. Anadromous species are those that 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. Due to the low populations of alewife and blueback herring (collectively known as river herring) throughout the Commonwealth of Massachusetts, the MA DMF has extended into perpetuity the moratorium on the harvest, possession, and sale of river herring in Massachusetts; the moratorium has been in effect since 2006. In addition, the alewife, blueback herring, and rainbow smelt have been identified as a "species of concern" by NMFS, who is assessing whether the species warrants listing under the Endangered Species Act. Alewife and blueback herring are also "candidate species", which are species that are undergoing a status review which has been announced in a *Federal Register* notice by NMFS.

The rainbow smelt is an inshore species that spends most of the year in harbors and estuaries (Bigelow and Schroeder, 2002). The smelt is not a large fish, generally not exceeding 13-14 inches in length, and is very slender, weighing from one to six ounces. Adults are common in Boston Harbor except during the summer months (Jury *et al.*, 1994). During the warmest periods of the summer, smelt leave the harbor to find slightly cooler water (Collette and Klein-MacPhee, 2002). Spawning occurs in freshwater in early spring. Rainbow smelt migrate into the Mystic and Chelsea Rivers; however this species generally does not move too far upstream and may only venture a few hundred yards above the tidewater (Bigelow and Schroeder, 2002). There is a dam on the Mystic River and currently, the fish do not move above this dam; however, there are plans to have a fish passage constructed for this area. Adult smelts return to the harbors and estuaries immediately after spawning. Eggs remain in freshwater areas adhering in clumps to pebbles, sticks, grass, or weeds; hatching occurs in about 13 days (Bigelow and Schroeder, 2002). Young fry appear to move out of the river spawning areas in early summer. Juveniles are abundant or common in Boston Harbor year-round (Jury *et al.*, 1994).

The alewife is common in Boston Harbor from April through October, with adults becoming abundant during May and June (Jury *et al.*, 1994). The alewife is not a particularly large fish, never attaining lengths much more than 15 inches and weights of 8 – 9 ounces (Bigelow and Schroeder, 2002). The alewife spends most of its life in large schools in coastal waters. Spawning occurs in the spring when adults move up into freshwater rivers where they were hatched, such as the Chelsea and Mystic Rivers, to spawn (Bigelow and Schroeder, 2002). Spawning takes place in sluggish waters, with females depositing from 60,000 to 100,000 eggs, dependant on body size. Following spawning, the alewife immediately returns from freshwater to the coastal areas. Eggs remain in fresh water attached to brush, stones, or anything they settle upon, and hatch in approximately six days. When fry are

about one month old, they begin making their way downstream to more saline environments (Bigelow and Schroeder, 2002).

The blueback herring is closely related to the alewife and is very similar in size and habitats. It is a schooling species that spends most of its life in seawater, but swims into freshwater regions to spawn. Together with the alewife, these two species comprise the commercially important river herring fishery in the Gulf of Maine. The blueback herring is common in Boston Harbor from May through October (Jury *et al.*, 1994). Blueback herring migrate into the freshwater Mystic and Chelsea rivers to spawn; however, unlike the alewife, the blueback migrate into these rivers a little later in the season and does not go as far upstream as the alewife (Bigelow and Schroeder, 2002). Eggs sink and will stick to anything they encounter. Hatching occurs in approximately 50 hours. Within one month, young show characteristics of the adult and begin moving downstream into saltwater regions (Bigelow and Schroeder, 2002).

In addition to the anadromous species listed above, and the Federally-managed and State-regulated species that support many fisheries, the project area is home to many species of small, local fish populations such as mummichog, silverside, various species of stickleback, sculpin, grubby, gunnel, and the sand lance. Although these fish serve no commercial or recreational fishery, they are ecologically important. Many are small and confined to inshore areas only. They can be found in saltwater canals and creeks, particularly in marsh areas bordering harbors and estuaries. Many of these species serve as food sources for coastal and shore birds, foraging mammals, and the commercial and recreationally important fish species. More detailed life history information for these species is presented in Table 3-6.

3.3.5.1 Boston Harbor

Mystic River - The bottom type within the Mystic River is predominately fine sediments (mud, silt and clay) (Figure 3-1). All of the anadromous species listed in Table 3-6 (alewife, American shad, blueback herring, and the rainbow smelt) may be found moving into the Mystic to spawn during the spring and early summer months. The Atlantic tomcod, a demersal inshore species, may also be present around the mouth of the river feeding and spawning (fall and early winter). White perch are generally a schooling species that is often found in the mouths of rivers along the Massachusetts coastline. This species may also run up into more freshwater portions of the river during spring for spawning. Striped bass may also be found in the mouths of rivers, particularly in areas where there is tidal and current flow. Several small forage species including mummichogs, silversides, sticklebacks and pipefish are also year-round residents in inshore areas both in freshwater and saltwater. These species are often found along weedy shorelines or hiding under clumps of floating eelgrass or rockweed if away from the immediate shoreline.

Chelsea River - The bottom type within the Chelsea River is a heterogeneous mix of gravel and sand, with areas of finer sediments (silt, mud, clay) (Figure 3-1). The same fish species that are likely to be present in the Mystic River are also likely to use various regions of the Chelsea River for feeding and/or spawning.

Inner Harbor - Mud and clay are the predominant sediment types within the Inner Harbor (Figure of 3-1) and any number of the fish species presented in Table 3-6 above may be present in the harbor at various times or may be permanent residents. Many of the anadromous species that move into the Mystic and Chelsea Rivers will migrate through the Inner Harbor en route to spawning locations in the rivers. Some species like the rainbow smelt may spend most of its life in the harbor area. Striped bass may also be found moving through the Inner Harbor to locations near the mouths of the Mystic and Chelsea Rivers. Local, inshore species present in the Inner Harbor may include Atlantic tomcod, cunner, tautog, white perch, mummichogs, silversides, northern pipefish, longhorn and shorthorn sculpins, and threespine, fourspine and ninespine sticklebacks. Several Federally managed demersal species may also be found in the Inner Harbor based on their preference for muddy bottom types and

life history characteristics. These include: black sea bass, summer flounder, winter flounder, windowpane flounder, and white hake. These species will move to inshore locations during spring and summer, but if temperatures get too warm may stay in the deeper channels in those inshore areas.

Lower Harbor - The Lower Harbor consists primarily of muddy and sandy substrate. This type of bottom habitat (Figure 3-1) is suitable to a number of the fish species presented in Table 3-6. Similar to the Inner Harbor, many of the anadromous species migrate through the lower portions of the harbor en route to spawning locations in the Mystic and Chelsea Rivers. Rainbow smelt are likely to be found in pelagic schools for a large portion of their life in the Lower Harbor region migrating to the river regions to spawn. Striped bass may also migrate through the area to reach more rocky shorelines or sandy areas of the small islands located in the lower harbor region. Several of the small inshore forage fish species including mummichogs, silversides, sculpins, grubby, shorthorn and longhorn sculpin, and ninespine stickleback may be present along the shorelines of many of the small islands in the Lower Harbor region. Various species of skates as well as spiny dogfish are also likely to be present, moving between more inshore and offshore locations depending on water temperature.

Of the managed species, many demersal fish preferring either muddy and more fine grained substrates or sandy substrates will be found foraging in the Lower Harbor and may make seasonal migrations between the Lower and Inner and/or the Lower and Outer Harbor in response to water temperatures. The demersal species likely to be present include American plaice, Atlantic halibut, summer flounder, winter flounder, windowpane flounder, red and white hake, and yellowtail flounder. Scup and black sea bass may also be present in the Lower Harbor around any rocky outcroppings or structured hard bottom such as shellfish beds pilings, or ledges. Pelagic species such as Atlantic butterfish and Atlantic mackerel may make seasonal migrations to the Lower Harbor areas for spawning and foraging.

Outer Harbor - The bottom type of the Outer Harbor is much more erosional and rockier than other portions of the harbor. In general, sediments consist mostly of sand, gravel, and rock, with isolated areas of finer sediments (silt, mud, and clay) (Figure 3-1). In the areas of finer sediment, many of the demersal species observed in the Lower Harbor may also be present in the Outer Harbor, including the American plaice, Atlantic halibut, summer flounder, winter flounder, windowpane flounder, red and white hake, and yellowtail flounder. Other demersal species such as black sea bass, cod, haddock, ocean pout, and pollock prefer more structured hard bottom areas with rocky or gravel bottoms and will likely be found in these regions within the Outer Harbor. Pelagic species such as Atlantic butterfish, Atlantic sea herring, and Atlantic mackerel, as well as long-finned and short-finned squid are also likely to be present in the Outer Harbor. These pelagic species are often seasonal in the waters of Boston harbor and may move between the Lower harbor and further offshore depending on water temperatures. Highly migratory species such as bluefish and bluefin tuna may appear in Outer Harbor waters when in pursuit of prey.

3.3.5.2 Habitat Enhancement Sites

The two habitat enhancement sites are located outside Boston Harbor and within Massachusetts Bay. Massachusetts Bay is located between Cape Ann and Cape Cod, in the southwest corner of the Gulf of Maine. Cape Cod is generally considered the biogeographic boundary between the Virginian province to the south and the Scotian province to the north. However, this boundary is not considered absolute but as a selective filter (Gosner, 1978) because many of the cold-temperate, boreal fauna that dominate the North Atlantic have ranges extending south of the of the Cape and several eurythermal migrants from the south enter the Gulf of Maine seasonally (Jury, *et. al*, 1994). The bay's most prominent submarine feature, Stellwagen Bank, is located at the bay's eastern edge. Stellwagen Bank is a shallow (average water depth of 100 to 120 feet), glacially deposited, primarily sandy feature with high biological productivity that provides habitat for a number of fish species.

The following finfish species and their abundance in Massachusetts Bay were identified by Jury, et al. (1994). Species that are highly abundant in Massachusetts Bay during at least one lifestage and during at least one month of the year include: silversides, cunner, American plaice, and winter flounder. Species with at least one lifestage classified as abundant in Massachusetts Bay include spiny dogfish, skates, American eel, alewife, Atlantic menhaden, Atlantic herring, rainbow smelt, pollock, red hake, mummichog, silversides, longhorn sculpin, cunner, American sand lance, Atlantic mackerel, American plaice, winter flounder, and yellowtail flounder. See Table 3-7 for fish species present at various times of the year in Massachusetts Bay, as reported by Jury *et al.* (1994).

Species having EFH designated in the two 10 x 10 minute squares that encompass the two potential enhancement sites include two shellfish species, two squid species, and 24 finfish species. Skates, such as little skate (juvenile and adult), thorny skate (juvenile), and winter skate (juvenile) also have EFH in coastal Massachusetts waters which include all five of the potential sites. See Table 3-8 for the list of EFH species. In addition, several species of finfish were observed in the video-drift footage collected within the two potential sites. These species included flounders, red hake, sculpin, cunner, and ocean pout.

In general, sediments within the potential enhancement sites consisted mostly of sand, coarse sand and gravel, cobble, and rock, with isolated areas of fine sediment (i.e., mud). In the areas of finer sediment, demersal species including the American plaice, Atlantic halibut, summer flounder, winter flounder, windowpane flounder, witch flounder, red and white hake, and yellowtail flounder may be present. Other demersal species (black sea bass, cod, haddock, ocean pout, pollock, redfish, and scup) prefer more structured hard bottom areas and may be present in areas with rocky or gravelly bottom. Pelagic species, such as Atlantic butterfish, Atlantic sea herring, juvenile bluefish, and monkfish, are likely to be present in areas with sand and/or gravel bottom. Atlantic mackerel, bluefin tuna, and long- and short-finned squid are pelagic species that are associated with all substrate types. Forage and shore species, such as cunner, sculpin, skates, and spiny dogfish, may also be present within the potential enhancement sites. Little skate and juvenile thorny and winter skate prefer sandy, gravelly, or muddy substrates.

Broad Sound – EFH for 20 finfish species is designated within square 30, which encompasses the Broad Sound site. See Table 3-8. Flounder, red hake, and sculpin were observed in the video transects from within this site.

Massachusetts Bay – EFH for 22 finfish species is designated within square 31, which encompasses the Massachusetts Bay site. See Table 3-8. Of the four squares, square 6 is the only one that contains EFH for witch flounder, monkfish, and spiny dogfish. Several red hake were observed at the soft bottom video transects within this site. In the gravel and cobble bottom and in areas of sand waves, cunner, flounder, sculpin, and ocean pout were observed.

Table 3-7. Relative Abundance, Temporal Distribution, and Habitat Prefernces of Fishes by Lifestage in Massachusetts Bay

SPECIES	TYPE[1]	LIFE STAGE	RELATIVE ABUNDANCE BY MONTH[2]											
			J	F	M	A	M	J	J	A	S	O	N	D
Spiny dogfish	D	Adults						C	A	A	A	C		
	D	Juvenile						C	A	A	A	C		
		Eggs	C	C	C	C	C	C	C	C	C	C	C	C
Skates	D	Adults	C	C	C	A	A	A	A	A	A	C	C	C
		Spawning	C	C	C	C	C	C	C	C	C	C	C	C
American eel	D	Adults									C	C		
	D	Juvenile				C	A	A	C					
		Larvae				C	C	C						
Blueback herring	P	Adults					C	C	C	C	C	C		
	P	Juvenile					C	C	C	C	C	C	C	
Alewife	P	Adults				C	A	A	C	C	C	C		
	P	Juvenile				C	C	A	A	A	A	C	C	
Atlantic menhaden	P	Adults					C	C	A	A	A	C	C	
		Spawning					C	C	C	C				
	P	Juvenile					C	C	C	C	C	C	C	
	P	Larvae						C	C	C	C			
	P	Eggs					C	C	C	C	C			
Atlantic herring	P	Adults	A	A	A	A	C				C	C	A	A
	P	Juvenile	A	A	A	A	A	C	C	C	A	A	A	A
	P	Larvae	A	C	C	C	C					A	A	A
Rainbow smelt	P	Adults	C	C	C	C	C	C				C	C	C
	P	Juvenile	A	A	A	A	A	A	A	A	A	A	A	A
Atlantic cod	D	Adults			C	C	C	C				C	C	C
		Spawning	C	C	C	C	C							C
	D	Juvenile	C	C	C	C	C	C	C	C	C	C	C	C
	P	Larvae	C	C	C	C	C	C	C					C
	P	Eggs	C	C	C	C	C	C						C
Silver hake	D	Adults				C	C	C	C			C	C	
		Spawning					C	C	C	C	C			
	D	Juvenile				C	C	C	C	C	C	C	C	
	P	Larvae					C	C	C	C	C	C		
	P	Eggs					C	C	C	C	C	C		
Atlantic tomcod	D	Adults			C	C	C	C	C	C	C	C	C	
	D	Juvenile	C	C	C	C	C	C	C	C	C	C	C	
Pollock	P/D	Adults	C	C	C	C	C	C			C	C	C	C
		Spawning	C	C										
	P/D	Juvenile	C	C	C	A	A	A	C	C	A	A	C	C
		Larvae	C	C	C									C
		Eggs	C	C	C									C
Red hake	D	Adults	C	C	C	C	C	C	C	C	C	C	C	C
		Spawning						C	C	C	C	C		
	D	Juvenile	C	C	C	C	C	C	C	C	C	C	C	C
	P	Larvae						A	A	A	A	C	C	
	P	Eggs						A	A	A	A	A		
White hake	D	Adults			C	C	C	C	C	C	C			
	D	Juvenile			C	C	C	C	C	C	C	C	C	
	P	Larvae					C	C	C	C	C	C	C	
	P	Eggs					C	C	C	C	C	C		
Mummichog	D	Adults	C	C	C	A	A	A	A	A	A	A	A	C
		Spawning					C	C	C	C				
	D	Juvenile	C	C	C	A	A	A	A	A	A	A	A	C
		Larvae					C	C	C	C				
	D	Eggs					C	C	C	C				
Silversides	P/D	Adults	C	C	A	A	H	H	H	H	H	H	A	C
		Spawning				C	H	H	A					
	P/D	Juvenile				A	H	H	H	H	H	H	H	C
	P	Larvae				C	H	H	A	C				
	D	Eggs				A	H	H	A					
Fourspine stickleback	D	Adults	C	C	C	C	C	C	C	C	C	C	C	C
	D	Juveniles	C	C	C	C	C	C	C	C	C	C	C	C
Threespine stickleback	P/D	Adults	C	C	C	C				C	C	C	C	C
	D/P	Juvenile	C	C	C	C	C	C	C	C	C	C	C	C

SPECIES	TYPE[1]	LIFE STAGE	RELATIVE ABUNDANCE BY MONTH[2] J	F	M	A	M	J	J	A	S	O	N	D
Northern pipefish	D	Adults			C	C	C	C	C	C	C	C	C	
		Spawning				C	C	C	C	C				
		Juvenile				C	C	C	C	C	C	C	C	
		Larvae				C	C	C	C	C	C			
Northern searobin	D	Adults					C	C	C	C				
	D	Juvenile					C	C	C	C				
Grubby	D	Adults	C	C	C	C	C	C	C	C	C	C	C	C
		Spawning	C	C	C	C								C
	D	Juvenile	C	C	C	C	C	C	C	C	C	C	C	C
		Larvae	C	C	C	C	C							
		Eggs	C	C	C	C								C
Longhorn sculpin	D	Adults	A	A	A	A	A	A	A	A	A	A	A	A
		Spawning	A	A	C	C								C
	D	Juvenile	A	A	A	A	A	A	A	A	A	A	A	A
		Larvae	A	A	A	C	C	C						
		Eggs	A	A	C	C								C
Shorthorn sculpin	D	Adults	C	C	C	C	C	C	C	C	C	C	C	C
		Spawning	C	C	C									C
	D	Juvenile	C	C	C	C	C	C	C	C	C	C	C	C
		Larvae		C	C	C								
		Eggs	C	C	C									C
Striped bass	P	Adults				C	C	C	C	C	C	C		
	P	Juvenile				C	C	C	C	C	C	C		
Bluefish	P	Adults						C	C	C	C	C		
	P	Juvenile						C	C	C	C	C		
Scup	D	Juvenile							C	C	C			
Tautog	D	Adults	C	C	C	C	C	C	C	C	C	C	C	C
		Spawning					C	C	C	C				
	D	Juvenile	C	C	C	C	C	C	C	C	C	C	C	C
	P	Larvae						C	C	C	C			
	P	Eggs					C	C	C	C				
Cunner	D	Adults	A	A	A	A	A	A	A	A	A	A	A	A
		Spawning						A	A	A	A			
		Juvenile	A	A	A	A	A	A	A	A	A	A	A	A
	P	Larvae						H	H	H	A	C		
	P	Eggs						H	H	H	A			
Ocean pout	D	Adults	C	C	C	C	C	C	C	C	C	C	C	C
		Spawning								C	C	C		
	D	Juvenile	C	C	C	C	C	C	C	C	C	C	C	C
	D	Larvae	C									C	C	C
	D	Eggs								C	C	C	C	
Rock gunnel	D	Adults	C	C	C	C	C	C	C	C	C	C	C	C
		Spawning	C	C	C									C
	D	Juvenile	C	C	C	C	C	C	C	C	C	C	C	C
		Larvae	C	C	C	C	C	C						
		Eggs	C	C	C	C								C
American sand lance	D/P	Adults	C	C	C	A	A	A	A	A	A	A	C	C
		Spawning	C	C	C								C	C
	D/P	Juvenile	C	C	C	A	A	A	A	A	A	A	C	C
		Larvae	A	A	A	A	A	A	C					C
	D	Eggs	A	A	A	A	A	C					A	A
Atlantic mackerel	P	Adults					C	C	C	C	C	C		
		Spawning					C	C	C	C				
	P	Juvenile					C	C	C	C	C	C		
	P	Larvae					C	A	A	A				
	P	Eggs					C	A	A	A				
Butterfish	P	Adults							C	C	C			
	P	Juveniles							C	C	C			
	P	Eggs						C	C	C	C			
Windopane	D	Adults			C	C	C	C	C	C	C	C	C	
		Spawning					C	C	C	C	C			
	D	Juvenile	C	C	C	C	C	C	C	C	C	C	C	C
		Larvae					C	C	C	C	C	C		
		Eggs					C	C	C	C	C			
American plaice	D	Adults	H	H	H	H	H	H	H	H	H	H	H	H
		Spawning			H	H	H	H						
	D	Juvenile	H	H	H	H	H	H	H	H	H	H	H	H

SPECIES	TYPE[1]	LIFE STAGE	RELATIVE ABUNDANCE BY MONTH[2]											
			J	F	M	A	M	J	J	A	S	O	N	D
		Larvae			C	A	A	A	A					
		Eggs			A	A	A	A						
Winter flounder	D	Adults	H	H	H	H	H	H	H	H	H	H	H	H
		Spawning	C	A	A	A	C	C						
	D	Juvenile	H	H	H	H	H	H	H	H	H	H	H	H
	D/P	Larvae		A	H	H	H	A	C	C				
	D	Eggs	C	A	A	A	A	A	C					
Yellowtail flounder	D	Adults	A	A	A	A	A	A	A	A	A	A	A	A
		Spawning				A	A	A	A	A				
	D	Juvenile	A	A	A	A	A	A	A	A	A	A	A	A

[1]D=Demersal, P=Pelagic
[2]H=Highly Abundant, A= Abundant, C=Common, Blank=Not Present Or Rare

3.3.5.3 Massachusetts Bay Disposal Site

As stated above, many of the species described for the habitat enhancement sites would be expected to also inhabit the MBDS as part of the Gulf of Maine/Massachusetts Bay ecosystem. Although the majority of species likely to be present in the vicinity of the MBDS are year-round residents in Massachusetts Bay, 12 species are seasonal (mostly summer) migrants. Approximately 80% of the species likely to occur near the MBDS are demersal, semi-demersal, or semi-pelagic. Twenty-three species, including 10 seasonal migrants, are of importance to commercial and/or sport fisheries (Hubbard, *et al.*, 1988).

The MBDS is located within a depression with deposits of dredged material and areas dominated by fine grained sediment (i.e., mud). Hard sand is located in the northeast portion of the MBDS (EPA, 1989). In the areas of finer sediment, demersal species including the American plaice, Atlantic halihut, summer flounder, winter flounder, windowpane flounder, witch flounder, red and white hake, and yellowtail flounder may be present. Other demersal species (cod, haddock, ocean pout, pollock, and redfish) prefer more structured hard bottom areas and are not likely to be present in large numbers at the disposal site. Pelagic species, such as Atlantic butterfish, Atlantic sea herring, and monkfish, prefer areas with sand and/or gravel bottom, which is not common at the MBDS. Atlantic mackerel, bluefin tuna, and long- and short-finned squid are pelagic species that are associated with all substrate types.

Site specific finfish information was collected in 1985 and 1986 for the Massachusetts Bay Disposal Site Designation study (Hubbard, *et al.*, 1988) using gill nets, trammel nets, bottom trawls, submersible video observations, and interviews with local fishermen. A total of 32 species were documented at the MBDS. See Table 3-9 for a list of species caught at MBDS and nearby reference location. American plaice, witch flounder, and redfish were the predominant non-migratory, demersal species at MBDS (Hubbard, *et al.*, 1988). Principal seasonal migrants are silver hake, red hake, and spiny dogfish (Hubbard, *et al.*, 1988). Species reported from MBDS by fishermen, but not otherwise noted in the USACE studies, were bluefish and bluefin tuna (Hubbard, *et al.*, 1988). Both are pelagic, summer migrants to the Gulf of Maine.

The resident finfish community on the muddy bottom of the MBDS is dominated by American plaice and witch flounder (Hubbard, *et. al.*, 1988). Hard bottom communities at MBDS (approximately 25 percent of the total area) are likely dominated by redfish, ocean pout, sculpins, and Atlantic wolffish. Although stock assessments have shown changes over the past twenty years, the species described above are likely the same now as described in 1985 and 1986 at the MBDS (Hubbard, *et. al.*, 1988).

EFH designated species in the 10 x 10 minute squares that encompass Massachusetts Bay Disposal Site include one shellfish species, two squid species, and 18 finfish species. See Table 3-10 for the list of EFH species.

3.3.5.4 Industrial Waste Site

Finfish species collected from the IWS for chemical analysis included American plaice, winter flounder, yellowtail flounder, witch flounder, silver hake, blueback herring, Atlantic herring, goosefish, longhorn sculpin, sea raven, spiny dogfish, skate, redfish, wrymouth, ocean pout, and cod. Other species captured included whelk, sea scallop, squid, spider crab, rock crab, Pandalid shrimp, and lobster (NOAA, 1996). Higher concentrations of fish were noted on the glacial knolls or rises, such as cod, redfish, American plaice, witch flounder, and ocean pout (NOAA, 1996). Redfish were frequently found near barrels resting on the flat surfaces, demonstrating a strong attraction to the relief and refuge offered by these waste containers (NOAA, 1996).

Table 3-8. Essential Fish Habitat Species within the Two Potential Habitat Enhancement Sites

SPECIES	MASSACHUSETTS BAY	BROAD SOUND
Atlantic cod	E, L, J, A	E, L, J, A
Haddock	E, L, J	E, L
Pollock	E, L, J, A	E, L, J, A
Whiting	E, L, J, A	E, L, J, A
Red hake	E, L, J, A	E, L, J, A
White hake	E, L, J, A	E, L, J, A
Redfish	L, J, A	
Witch flounder	E, L, A	
Winter flounder	E, L, J, A	E, L, J, A
Yellowtail flounder	E, L, J, A	E, L, J, A
Windowpane flounder	E, L, J, A	E, L, J, A
American plaice	E, L, J, A	E, L, J, A
Ocean pout	E, L, J, A	E, L, J, A
Atlantic halibut	E, L, J, A	E, L, J, A
Atlantic sea herring	L, J, A	L, J, A
Monkfish	E, L	
Bluefish	J, A	J, A
Atlantic butterfish	E, L, J, A	E, L, J, A
Atlantic mackerel	E, L, J, A	E, L, J, A
Summer flounder		A
Scup	J, A	J, A
Spiny dogfish	J, A	
Bluefin tuna	J, A	J, A
Black sea bass		A
Long-finned squid	J, A	J, A
Short-finned squid	J, A	J, A
E=eggs; L=larvae; J=juvenile; A=adult		

Table 3-9. List of Finfish Species Noted at or Near the Massachusetts Bay Disposal Site

Species	Method[1]	Species	Method[1]
Demersal		***Pelagic***	
American plaice	G, I, T	Atlantic herring	G
Thorny skate	G, N, T	Alewife	G
Red hake	G, T	Atlantic mackerel	G, I
Fourbeard rockling	G, T	Bluefish	I
Longhorn sculpin	G, T	Bluefin tuna	I
Atlantic wolfish	I, T[2]	Blueback herring	
Cusk	I, T	American shad	
Yellowtail flounder	I, T		
Witch flounder	I, T	***Semi-Demersal or Semi-Pelagic***	
Winter flounder	I, N, T	Silver hake	G, I, N, T
Ocean pout	S, T	Atlantic cod	G, I, T
Snakebleny	S	Redfish	G, I, T
Sandlance	S	Spiny dogfish	G, S, T
White hake	T	Haddock	I
Windowpane	T	Pollock	I
Alligatorfish	T	Butterfish	
Wrymouth	T		
Goosefish	T		
Clearnose skate	T		
Pipefish	T		
Northern searobin	T		
Unidentified Skate	S		
Unidentified Flounder	S		
Unidentified Sculpin	S		

[1] G=gill net; I=interview with commercial or sport fishermen; N=tramel net; S=submersible observations; T=bottom trawl

Table 3-10. Essential Fish Habitat Species within the Massachusetts Bay Disposal Site Square

Species	Eggs	Larvae	Juveniles	Adults	Spawning Adults
Atlantic cod* *Gadus morhua*	X	X	X	X	X
Haddock* *Melanogrammus aeglefinus*	X		X		
Whiting (silver hake)* *Merluccius bilinearis*	X	X	X	X	X
Red hake* *Urophycis chuss*	X	X	X	X	X
White hake* *Urophycis tenuis*	X	X	X	X	X
Redfish* *Sebastes fasciatus*	n/a	X	X	X	X
Witch flounder* *Glyptocephalus cynoglossus*	X	X	X	X	X
Winter flounder* *Pseudopleuronectes americanus*	X	X	X	X	
Yellowtail flounder* *Pleuronectes ferruginea*	X	X	X	X	X
Windowpane flounder* *Scophthalmus aquosus*	X	X			
American plaice* *Hippoglossoides platessoides*	X	X	X	X	X
Ocean pout* *Macrozoacres americanus*	X	X	X	X	
Atlantic halibut* *Hippoglossus hippoglossus*	X	X	X	X	X
Atlantic sea scallop* *Placopecten magellanicus*	X	X	X	X	X
Atlantic sea herring* *Clupea harengus*		X	X	X	
Monkfish* *Lophius americanus*	X	X	X	X	X
Long-finned squid** *Loligo pealei*	n/a	n/a	X	X	X
Short-finned squid** *Illex illecebrosus*	n/a	n/a	X	X	X
Atlantic butterfish** *Peprilus triacanthus*	X	X	X	X	X
Atlantic mackerel** *Scomber scombrus*	X	X	X	X	
Bluefin tuna *Thunnus thynnus*			X	X	

Source: NOAA Fisheries Service, Habitat Conservation Division, http://www.nero.noaa.gov/hcd/ma1.html
M = Mixing water/brackish salinity zone (0.5 ppt < salinity < 25 ppt); S = Seawater salinity zone (salinity ≥ 25 ppt)
n/a = species does not have this lifestage in its life history
X = EFH has been designated within a 10 x 10 minute square for the species and lifestage; however, no additional information as to salinity zone is reported
*Managed species by the New England Fishery Management Council
**Managed species by the Mid-Atlantic Fishery Management Council

3.3.6 Marine and Coastal Birds

Many different types of resident, migratory, and coastal birds may potentially use the areas of Boston Harbor and Massachusetts Bay as feeding, nesting or resting areas. The diversity of birds nesting in Boston Harbor is high (Paton *et al.*, 2005). Besides the many species that nest on islands throughout

the Harbor, broad arrays of migrants use the area during spring and fall migration. In general, shallow open water areas may provide feeding habitat for many wading birds. Deeper open water areas may provide feeding habitat for several species of waterfowl and waterbirds such as cormorants, grebes, and loons.

For over 100 years, the Audubon Society Christmas Bird Counts (National Audubon Society, 2005) have identified and recorded many species along the Massachusetts coastline and Stellwagen Bank. Appendix W lists the coastal and marine birds that have been recorded in the Boston Harbor and Massachusetts Bay areas from these surveys as well as other local surveys. These birds are classified by their marine habitat as pelagic, shorebirds, waterfowl, colonial water birds, raptors, and marsh birds.

3.3.7 Marine Mammals and Reptiles

All marine mammals in U.S. waters are protected under the Marine Mammal Protection Act of 1972 (MMPA), reauthorized most recently in 1994. The MMPA established a moratorium, with certain exceptions, on the taking of marine mammals in U.S. waters and on the taking of marine animals by U.S. citizens on the high seas. The term "take" is statutorily defined to mean "to harass, hunt, capture, or kill, or attempt to harass, hunt, capture or kill any marine mammal." The moratorium also prohibits the importation of marine mammals and marine mammal products into the United States. NOAA Fisheries (NMFS) has responsibilities under MMPA that include monitoring populations of marine mammals to ensure that they stay at optimum levels. If a population falls below its optimum level, it can be designated as "depleted," and a conservation plan is developed to guide research and management actions to restore the population to healthy levels.

In general, only transient marine mammals and reptiles (sea turtles) are found in the Boston Harbor area. However it is noted that harbor seals and harbor porpoises are regular seasonal visitors to the harbor (EPA letter dated May 23, 2008). Harbor porpoise are routinely observed near the Charles River dam in the spring during the inward migration of anadromous fish. They have also been observed in Chelsea Creek. Harbor seals have been observed year round throughout the harbor. The likelihood of finding marine mammals and sea turtles increases in Massachusetts Bay. Most marine mammals and reptiles that may be possible visitors to Boston Harbor and Massachusetts Bay areas are listed as Federally threatened or endangered and are discussed in the section below. Marine mammal species that may travel within the project areas and are not discussed in another section include the harbor seal, white-sided dolphin, harbor porpoise, gray seal, and minke whale. Their life history can be found in Appendix X.

Information on other marine mammals and sea turtles that are listed on the Federal threatened and endangered species list and that may be possible visitors to Boston Harbor and/or Massachusetts Bay areas can be found in the following section.

3.4 Threatened and Endangered Species and Species of Special Concern

The Federal Endangered Species Act (ESA) provides for the conservation of species that are endangered or threatened with extinction throughout all or a significant portion of their range, and the conservation of the ecosystems on which they depend. Endangered species are species that are in danger of extinction throughout all or part of their range, or that are in danger of extirpation. Threatened species are native species that are likely to become endangered in the foreseeable future, or that are declining or rare (NOAA Fisheries, n.d.). State governments are also concerned with species of special concern, which are native species that have experienced a decline which, if continued unchecked, could threaten the species, or that are so restricted in abundance, distribution, or specialized habitat requirements that they could easily become threatened. 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 NHESP, 2004). However, no State-protected rare species have been identified in the project area (letter dated May 31, 2005).

Section 7 of the Endangered Species Act of 1973 (ESA, P.L. 93-205) requires that all Federal agencies ensure that any action they authorize, fund, or carry out will not jeopardize the continued existence of any Federally endangered or threatened species or result in the destruction or adverse modification of any critical habitat of such species. The USACE is mandated by Section 7 of the ESA to consult with the Department of Commerce (NOAA Fisheries) and the Secretary of Interior (U.S. Fish and Wildlife Service [USFWS]) to determine if any Federally protected species may be affected by a project. This consultation may include preparation of a Biological Assessment to determine if the proposed action is likely to result in adverse effects to threatened or endangered species. The USACE initiated consultations with NOAA Fisheries and USFWS to determine the presence of any Federally Protected species that may coincide with the proposed project.

In response to the consultations with NMFS, the USACE was notified of the following ten Federally endangered or threatened marine mammals, reptiles and fish. All ten species are also considered to be endangered or threatened by the Commonwealth of Massachusetts. While it is possible that any of these species may be found in the project area, it is an unlikely event, especially within the dredge site or during certain seasons.

The Federally endangered North Atlantic right whales *Eubalaena glacialis*, humpback whales *Megaptera novaeangliae*, fin whales *Balaenoptera physalus*, sei whales *Balaenoptera borealis*, and sperm whales *Physter macrocephalus* may all be found seasonally in Massachusetts' waters. North Atlantic right whales have been documented in the nearshore waters of this region 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. 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.

The sea turtles in northeastern nearshore waters are typically small juveniles with the most abundant being the Federally threatened loggerhead *Caretta caretta* followed by the Federally endangered Kemp's ridley *Lepidochelys kempi*. Federally endangered leatherback sea turtles *Dermochelys coriacea* are located in New England waters during the warmer months as well. While leatherbacks are predominantly pelagic, they may occur close to shore, especially when pursuing their preferred jellyfish prey. The Federally threatened green sea turtles *Chelonia mydas* may also occur sporadically in Massachusetts' waters, but those instances would be rare.

Humpback Whale (*Megaptera novaeangliae*) – Humpback whales occur in all oceans of the world, except possibly the Arctic (NMFS, 1991). Until the early 20th century, humpback whales were an important commercial species throughout most of their range, including New England waters (Allen, 1916), and some taking of the species occurred in northwest Atlantic waters until the mid-1950's. The International Convention for the Regulation of Whaling (adopted in 1946) afforded the North Atlantic population of humpback whales full protection in 1955 (Best, 1993). Humpback whales were afforded endangered species status in the United States in 1970 (USFWS, 1986). The best abundance estimate currently available for humpbacks in the Gulf of Maine is 902 whales, with a minimum population estimate of 647 individuals (Waring *et al.*, 2004).

The humpback whale is a migratory species that spends the summer in highly productive northern latitude feeding grounds (40° to 75° N latitude) (NMFS, 1991). Humpback whales regularly visit the waters of southern New England, including the deeper, continental shelf areas of Massachusetts, where they are present in greatest abundance between June and September. All age classes, including mother/calf pairs, are present during the summer. Humpback whales spend most of their time in New

England waters concentrated in areas where their preferred foods are most abundant. One of the primary feeding grounds is Stellwagen Bank, located off the coast of Massachusetts at the mouth of Massachusetts Bay. Humpback whales are the top carnivores in a relatively simple food chain consisting of phytoplankton, zooplankton, small forage fish (sand lance), and crustaceans. During their seasonal northern residency in the area, they may also feed on several commercially important fish and invertebrates, such as herring (*Clupea harengus*), mackerel (*Scomber scombrus*), menhaden (*Brevoortia tyrannus),* pollock (*Pollachius virens*), small haddock (*Melanogrannus aeglfinus*), and squid (*Illex ilecebrosus*) (Overholtz and Nicolas 1979; Whitehead and Class 1985; Whitehead 1987; Piatt *et al.* 1989; NMFS 1991).

There may be seasonal movement (May to October) of humpback whales in the vicinity of MBDS.

Fin Whale (*Balaenoptera physalus*) - Fin whales are present in all major oceans of the world, from the Arctic to the tropics, with greatest numbers in temperate and boreal latitudes (Evans, 1987). Fin whales were identified as endangered throughout their range in 1970 by the Federal government. Because of their high cruising speed, fin whales were not harvested commercially in large numbers until other species, such as slow-moving right whales, were depleted and whalers developed high speed boats (Leatherwood *et al.*, 1976). A fishery for this species existed in Nova Scotia from 1964 to 1972 (Mitchell, 1974), and commercial harvesting of fin whales elsewhere in the world continued at least into the early 1990s. For the western North Atlantic fin whale population, the best estimate of abundance is 2,814, with a minimum population estimate of 2,362 (Waring *et al.*, 2004). Due to the fin whale's extended distribution and poorly understood population structure, this is considered to be an extremely conservative estimate.

Fin whales are commonly seen on the continental shelf in waters less than 328 feet deep. New England waters are important summer feeding grounds for fin whales, and the species is most abundant off of the Massachusetts coast along the 130 to 165-foot depth contour, particularly in the Great South Channel east of Cape Cod, across Stellwagen Bank, and northeastward to Jeffrey's Ledge (north of Cape Ann, Massachusetts) (Hain *et al.*, 1992). During the fall and winter, the majority of these whales migrate south to wintering grounds offshore of the Delmarva Peninsula and the Outer Banks of North Carolina (Winn, 1982). Others concentrate at the mid-shelf region east of New Jersey as well as areas on Stellwagen Bank and Georges Bank. Year after year, juveniles will return to the same feeding areas they first visited with their mothers (Seipt *et al.*, 1990; Clapham and Seipt, 1991). The fin whales' preferred feeding grounds in the coastal areas (130 to 165-foot depth contour) indicate that these whales may be found in the area of the MBDS.

Northern Right Whale (*Eubalaena glacialis*) - The northern right whale (also known as the North Atlantic Right Whale) was a prime target of early whale fisheries along the coast of the eastern United States from the 1600s through the early 1900s, due to its coastal distribution, slow swimming speed, high oil yield, and characteristic of floating when dead (Brown, 1986; Aguilar, 1987). Due to intense exploitation, it is now the rarest of the large whales and is in danger of extinction. The northern right whale was classified as endangered in 1970 (35 FR 8495) by the Federal government. Three areas have been designated as critical habitat for the northern right whale: the Great South Channel, Cape Cod Bay, and southeastern U.S. waters 13 nmi offshore from the Alameda River, Georgia to Sebastian Inlet, Florida. The western North Atlantic population will be considered "recovered" when it reaches 60 to 80 percent of its pre-exploitation number (NMFS, 1991), or about 7,000 animals. The 1998 population estimate was 291 individuals (Kraus *et al.*, 2001). Despite the cessation of whaling and the implementation of the MMPA (1972) and the ESA (1973), it is unclear if the population of northern right whales is static, growing at a very slow rate, or declining as recent modeling exercises suggest (NOAA, 2006).

Generally, right whales are found along the east coast of North America (Winn, 1982). Some female right whales have been observed to migrate more than 1,500 nmi from their northern feeding grounds

to the southern calving/wintering grounds (Knowlton *et al.*, 1992). Right whales can be expected to visit Massachusetts Bay and Cape Cod Bay throughout the year (Brown *et al.*, 2002), but Cape Cod Bay is a primary feeding ground and nursery used from late winter until early spring. Most whales are found in areas where their primary food sources, including copepods and juvenile euphasiids, can be easily located.

The most significant human impacts to right whales are collisions with vessels and entanglement in fishing gear. Habitat change is believed to be another cause of decline in right whale populations. Anthropogenic sources of change include pollution, oil and gas exploration, seabed mining, wastewater discharges, dredged material disposal, and a general increase in coastal activities due to an increase in human population along the U.S. east coast (NMFS, 1991; Steinback *et al.*, 1999).

Sei Whale (*Balaenoptera borealis*) - The sei whale breeds and feeds in open oceans and is generally restricted to more temperate waters, although it can be found in the North Atlantic Ocean from Iceland south to Venezuela. These whales are generally found in deeper waters characteristic of the continental shelf edge region (Hain *et al.*, 1985). During feeding season, the sei whale population is generally centered in northerly waters with occasional trips into more shallow and inshore waters. The sei whale, like the right whale, is largely planktivorous, feeding primarily on euphausiids and copepods. It feeds mostly by filtering plankton while swimming (skim feeding) but is also known to gulp-feed on krill, shrimp, and small fish (New York State Department of Environmental Conservation [NYSDEC], 2005). Reduced predation on copepods by other predators, and thus greater abundance of this food source, has increased the reports of sei whales in more inshore locations such as Stellwagen Bank (Waring *et al.*, 2004). Mitchell (1975) described two "runs" of sei whales, in June-July and in September-October. The sei whale population migrates from south of Cape Cod and along the coast of eastern Canada in June and July, and returns on a southward migration again in September and October; however, such a migration remains unverified. Sei whales are typically found in deeper offshore waters so they are unlikely to be found in Boston Harbor.

The total number of sei whales in the U.S. Atlantic is unknown. Two estimates by two different methods have estimated the western North Atlantic stock to range from 253 individuals (Cetacean and Turtle Assessment Program [CETAP], 1982) to between 1,393 and 2,248 individuals (Mitchell and Chapman, 1977). Sei whales are listed as endangered by both the Federal government and the State of Massachusetts. There are no reports of fishery-related mortality or serious injury to sei whales in fisheries observed by NMFS during 1991-1997. There are also no reports of mortality, entanglement, or injury in Northeast Fisheries Science Center (NEFSC) databases with the exception of one reported ship strike.

Sperm Whale (*Physeter macrocephalus*) - Sperm whales are generally found on the continental shelf edge, over the continental slope, and into mid-ocean regions and are listed as endangered under the ESA. This offshore distribution is more commonly associated with the Gulf Stream edge and other features as suggested by Waring *et al.* (1993). The best available abundance estimate for sperm whales is from two studies that encompass the area from the Gulf of St. Lawrence to Florida, which estimate the population to be approximately 4,702 individuals. The sperm whale is the deepest diver of the great whales; it can descend to depths of over 3,300 feet and stay submerged for over an hour. Average dives are 20 to 50 minutes long to depths of 980 to 1,970 feet (American Cetacean Society [ACS], 2004). In winter, sperm whales are concentrated east and northeast of Cape Hatteras. In spring, the distribution shifts northward to east of Delaware and Virginia and is widespread throughout the central portion of the mid-Atlantic bight and the southern portion of Georges Bank. In summer, the distribution is similar to the spring but also includes areas east and north of Georges Bank and the continental shelf of New England. In the fall, sperm whales tend to migrate south of New England on the continental shelf. The main food source of the sperm whale is medium sized deep-water squid, but it also feeds on species of fish, skate, octopus, and smaller squid.

There is documentation of sperm whales being entangled in fishing gear. The estimated number of hauls of sperm whales in the pelagic drift net fishery increased from 714 individuals in 1989 to 1,144 in 1990 (Waring *et al.*, 2004). In 1999, NMFS issued a Final Rule prohibiting the use of driftnets in the North Atlantic swordfish fishery. Fishing-related mortality or serious injury to the sperm whale decreased to zero from 1991 to 1998. Eighteen sperm whale strandings were documented along the Atlantic coast between Maine and Florida during 1994-2000 (NMFS, unpublished data). The potential for accumulation of stable pollutants such as PCBs, pesticides, PAHs, and heavy metals in long-lived high trophic-level animals is possible, but there is no definitive evidence at this time.

Loggerhead Turtle (*Caretta caretta*) - The loggerhead sea turtle is listed as threatened under the ESA. It is the most common and seasonally abundant turtle in inshore coastal waters of the western North Atlantic. The Turtle Expert Working Group (TEWG) (2000) reports that the South Florida subpopulation appears to be increasing and that no trends are apparent in the northern subpopulation.

Loggerhead turtles are abundant during spring and summer months in coastal waters off New York and the mid-Atlantic States; small numbers of individuals may reach as far north as New England. In New England coastal waters, loggerheads feed primarily on small benthic crabs such as spider crabs, rock crabs, and green crabs, typically in water depths less than 20 m (Burke *et al.*, 1990; Morreale and Standora, 1992, 1993). In the fall, loggerheads migrate south to coastal waters off the south Atlantic states, particularly Florida, and to the Gulf of Mexico. During the winter, the turtles tend to aggregate in warmer waters along the western boundary of the Gulf Stream off the Florida coast (Thompson, 1988). In the spring, they congregate off southern Florida before migrating north to their summer feeding ranges (Winn, 1982).

For loggerheads that have not migrated south as water temperatures cool, strandings due to cold stunning may occur, particularly between November and January in Long Island, Rhode Island, and Massachusetts waters. Strandings due to the cold may occur when the water temperature drops below 12 °C. The metabolic rate of these cold-blooded reptiles decreases to the point where they are unable to swim and digest food; they become comatose and may die if not warmed quickly. Information from strandings, entanglements, mariner reports, and the U.S. Coast Guard suggest that loggerheads can be expected to occur in the project area in the summer and fall months, but most of the strandings are recorded from Cape Cod beaches. The major sources of mortality of loggerheads caused by human activities include incidental take in bottom trawls, particularly sbrimp trawls (Henwood and Stuntz, 1987; Thompson, 1988), coastal gill net fisheries, ingestion or entanglement of marine debris, and channel dredging (hopper dredges) (Thompson, 1988; NMFS, 1992). Collisions with vessels and entrainment in electric power plant cooling water may also cause loggerhead mortality.

Kemp's Ridley Turtle (*Lepidochelys kempii*) - The Kemp's ridley sea turtle is the most endangered sea turtle in the world. It is distributed throughout coastal areas of the Gulf of Mexico and the northwestern Atlantic Ocean and is assumed to constitute a single stock (TEWG, 1998). Juveniles dominate the Atlantic population. Recovery efforts are increasing the population from the low of 500 individuals reported by Carr and Mortimer in 1980. Kemp's ridley population has declined since 1947 when an estimated 42,000 females nested in one day, to a nesting population of approximately 1000 in the mid-1980's (NMFS, n.d.).

Although the Kemp's ridley sea turtle is found primarily in the Gulf of Mexico, juveniles do occur during the summer along the Atlantic seaboard from Florida to Long Island Sound, Martha's Vineyard, and occasionally north of Cape Cod, in Cape Cod Bay, Massachusetts Bay, the Gulf of Maine, and as far north as the Canadian Maritime Provinces (Lazell, 1980). Prey species include various crabs and other crustaceans. Although rare, ridleys may visit project areas in Massachusetts Bay and Boston Harbor. Ridleys begin leaving northern waters in mid-September and most are gone by early November. Some may hibernate in nearshore sediments during the winter (Carminati *et al.*, 1994). However, most observed in northern waters after the beginning of November are cold-stunned.

Leatherback Turtle (*Dermochelys coriacea*) - The Federally endangered leatherback turtle is the second most common sea turtle along the eastern seaboard of the United States and is the most common sea turtle north of the 42°N latitude. Leatherbacks forage in temperate and subpolar waters and nest on tropical beaches. They have a layer of subcutaneous fat and circulatory adaptations to reduce the rate of heat loss through their flippers (Greer *et al.*, 1973), thus allowing them to survive and feed in colder temperate waters than other sea turtles.

Because leatherback turtles are a largely pelagic, open ocean species, estimates of their population status and trends have been difficult to obtain. In addition, only a small fraction of the North Atlantic population nests on beaches of the continental United States, mostly in Florida (Meylan *et al.*, 1994) and the U.S. Virgin Islands (Boulon *et al.*, 1994); others nest on islands in the Caribbean.

Adult leatherback turtles are common during the summer months in North Atlantic waters from Florida to Massachusetts (Goff and Lien, 1988). New England and Long Island Sound waters support the largest populations on the Atlantic coast during the summer and early fall (Lazell, 1980; Prescott, 1988; Shoop and Kenney, 1992). During the summer, leatherbacks move into fairly shallow coastal waters (but rarely into bays), apparently following their preferred jellyfish prey. In the fall, they move offshore and begin their migration south to the winter breeding grounds in the Caribbean (Payne *et al.*, 1984).

Being a temperate water species, leatherbacks do not seem to be sensitive to cold temperatures, and strandings cannot be attributed to cold stunning. Leatherbacks are very susceptible to entanglement in shrimp nets and other fishing gear and plastic debris (Mager, 1985; Witzell and Teas, 1994). On their way south in August and September, they often stop in Cape Cod Bay where they occasionally get entangled in lobster pot lines (Mass Audubon, 2003).

Green Turtle (*Chelonia mydas*) - The green turtle is the largest of the hard-shelled sea turtles. The species is distributed throughout the Caribbean Sea, the Gulf of Mexico, and in the western North Atlantic from Florida to Massachusetts. Primary nesting sites are on the east coast of Florida. Current population trends are unavailable. However, since 1980, the number of green turtles nesting each year and the total population of green turtles in Florida waters appear to have increased gradually (Thompson, 1988; Steinback *et al.*, 1999).

During the summer, small numbers of green turtles venture as far north as New England. Green turtles are herbivorous as adults and feed in shallow coastal waters on sea grasses and marine algae. Some green turtles become cold-stunned each year by falling water temperatures in the fall and winter, especially in northern waters (Morreale *et al.*, 1992). Green turtles occasionally strand on Cape Cod beaches (4 stranding in 2003 (Mass Audubon, 2003)). Natural and anthropogenic disturbances affect green turtles at their nesting locations and in offshore waters. Nesting habitat is lost to erosion, shoreline fortification, and beach renourishment.

Atlantic Sturgeon (*Acipenser oxyrinchus oxyrinchus*) - On February 6, 2012, five distinct population segments (DPS) of the Atlantic sturgeon (*Acipenser oxyrinchus oxyrinchus*) that inhabit the waters of the northeast and the southeast United States were listed under the endangered species act. These include in the northeast, the Gulf of Maine (GOM) DPS, listed as threatened, the New York Bight (NYB) DPS, listed as endangered, and the Chesapeake Bay (CB) DPS listed as endangered; and in the Southeast, the Carolina DPS listed as endangered, and the South Atlantic, listed as threatened. Atlantic sturgeon belonging to each of the five DPSs occur in marine and estuarine habitat, including freshwater reaches of large rivers with access to the sea, ranging from Hamilton Inlet, Labrador, Canada, to Cape Canaveral, Florida, in the U.S. The ranges of all five DPSs overlap (http://www.nero.noaa.gov/prot_res/esp/ListE&Tspec.pdf). Despite extensive mixing in coastal waters, Atlantic sturgeons return to their natal river to spawn (ASSRT, 2007). Therefore, although individual sturgeon from each of the distinct population segments would generally be expected to be

found within the designated areas for their populations, because their ranges overlap it is possible that fish from a given DPS may be found throughout the entire geographic range of the species.

The Federally threatened GOM DPS of Atlantic sturgeon includes all Atlantic sturgeon whose range occurs in watersheds from the Maine/Canadian border and extending southward; to include all associated watersheds draining into the Gulf of Maine as far south as Chatham, MA. It also includes wherever these fish occur in coastal bays, estuaries, and the marine environment from the Bay of Fundy, Canada, to the Saint Johns River Florida (FR, 2010). Only one river located in Massachusetts, the Merrimack, is known to support Atlantic sturgeon. Boston Harbor is not known to have been used historically by Atlantic sturgeon (NMFS, 1998; Julie Crocker, NMFS, Personal Communication, October 17, 2012).

Generally, the life history pattern of Atlantic sturgeon is that of a long lived, (approximately 60 years; Mangin, 1964; Stevenson and Secor, 1999), late maturing, estuarine dependent, anadromous species (in ASSRT, 2007). It can reach lengths of up to 14 feet (4.26 m) and weigh over 800 pounds (364 kg) (FR, October 6, 2010 [2010]). They generally grow faster and mature earlier in the southern populations. For example, Atlantic sturgeons mature in South Carolina rivers at 5 to 19 years of age, in the Hudson River at 11 to 21 years, and in the Saint Lawrence River at 22 to 34 years (www.nmfs.noaa.gov/pr/species/fish/atlanticsturgeon). They are bluish-black or olive brown (on their back) with paler sides and a white belly. They have five major rows of dermal "scutes". Atlantic sturgeons are omnivorous benthic feeders and filter quantities of mud along with their food. The diets of adult sturgeon include mollusks, gastropods, amphipods, isopods and fish. Juvenile sturgeon feed on aquatic insects and other invertebrates (ASSRT, 2007).

Atlantic sturgeon spawn in freshwater, but spend most of their adult life in the marine environment. Generally, spawning adults migrate upriver in the spring/early summer; February-March in southern systems, April-May in mid-Atlantic systems, and May-July in Canadian systems (Murawski and Pacheco, 1977; Smith, 1985; Bain, 1997; Smith and Clugston, 1997; and Caron *et al.,* 2002; *in* ASSRT, 2007). In addition, a fall spawning migration may occur in some southern rivers (Rogers and Weber, 1995; Weber and Jennings, 1996; Moser *et al.*, 1998). Atlantic sturgeons likely do not spawn every year, and multiple studies have indicated spawning intervals ranging from 1-5 years for males (Smith, 1985; Collins, *et al.*, 2000; Caron *et al.*, 2002) and 2-5 years for females (Vladykov and Greeley, 1963; Van Eenennaam *et al.*, 1996; and Stevenson and Secor, 1999; *in* FR, 2010). Fecundity of female Atlantic sturgeons is correlated with age and body size and ranges from 400,000 to 8 million eggs.

Spawning is believed to occur between the salt front of estuaries and the fall line of large rivers in flowing waters with optimal flows ranging from 46-76 cm/s and depths from 11-27 meters (Borodin, 1925; Leland, 1968; Scott and Crossman, 1973; Crance, 1987; and Bain *et al.*, 2000; *in* FR, 2010). Their highly adhesive eggs are deposited on the bottom substrate usually on hard surfaces such as cobble (Gilbert, 1989 and Smith and Clugston, 1997, *in* FR, 2010). It is likely that cold, clean water is important for proper larval development. Following spawning, males may remain in the river or lower estuary until the fall; females typically exit the rivers within four to six weeks (www.nmfs.noaa.gov/pr/species/fish/atlanticsturgeon).

Eggs hatch in approximately 94 and 104 hours after deposition at temperatures of 20° – 18° C respectively; the larvae are demersal after hatching (Smith *et al.*, 1980; *in* FR 2010).

The yolk sac larval stage is completed in about 8-12 days, during which time the larvae move downstream to rearing grounds over a 6-12 day period (Kynard and Horgan, 2002; *in* ASSRT, 2007). Downstream movement occurs only during the night in the first half of their migration (Kynard and Horgan, 2002), and in the latter half of their migration during both day and night. During the first half of their downstream migration, the larvae use benthic structure such as gravel matrix for refuge during

the day. The larvae continue downstream movement toward the estuary, transitioning to juveniles in the process and developing a tolerance for increased salinity.

Juveniles (subadults)[3] move downstream and inhabit brackish waters for a few months. When they reach a size of about 30 to 36 inches (76-92 cm) they move into nearshore coastal waters. Tagging data indicate that these immature Atlantic sturgeons travel widely once they emigrate from their natal (birth) rivers. Subadults and adults live in coastal waters and estuaries when not spawning, generally in shallow (10-50 meter depth) nearshore areas dominated by gravel and sand substrates (www.nmfs.noaa.gov/pr/species/fish/atlanticsturgeon). When at sea, the adults mix with populations from other rivers, but return to their natal rivers to spawn as indicated from tagging records (Collins *et al.*, 2000a, K. Hattala, NYSDEC, Pers. Comm. 1998; *in* ASSRT, 2007) and from population genetic studies showing relatively low rates of gene flow (King *et al.*, 2001 and Waldman *et al.* 2002; *in* ASSRT, 2007).

Atlantic Sturgeon in Boston Harbor

Based on the above life history description (i.e. subadult and adult Atlantic sturgeon live in shallow coastal waters 10-50 meter deep), Atlantic sturgeon would not be expected to occur at the Massachusetts Bay Disposal Site (which is about 90 meters deep). Therefore, this description will only evaluate the portion of Boston Harbor that has the potential to be affected by the proposed blasting and dredging.

Within the U.S. Gulf of Maine, Atlantic sturgeon have been documented from the following rivers: Penobscot, Kennebec, Androscoggin, Sheepscot, Saco, Piscataqua, Presumpscott, and Merrimack. Table 3-11 below provides a list of the historic and current spawning rivers in the Gulf of Maine as well as their current use by Atlantic sturgeon.

Table 3-11. Historic and Current Spawning Status of Atlantic Sturgeon in the U.S. Gulf of Maine and its Current Uses in the Riverine Habitat (ASSRT, 2007 and FR 2012)

Canadian Prov/State	River	Historical Spawning Status	Current Spawning Status	Use of River by Atlantic Sturgeon
NB/ME	Saint Croix	Yes	Possibly	Nursery
ME	Penobscot	Yes	Possibly	Nursery
ME	Kennebec	Yes	Yes	Spawning, Nursery
ME	Androscoggin	Yes	Possibly	Nursery
ME	Sheepscot	Yes	Possibly	Nursery
ME	Saco[4]	Unknown	Unknown	Unknown
ME/NH	Piscataqua	Unknown	No	Unknown
NH/MA	Merrimack River	Yes	No	Nursery

The first consideration in evaluating the effect of the proposed project is whether or not the species may be in the project area, or at a minimum, during the time of construction, and which life stages may potentially be affected by either direct or indirect impacts. As noted above in Table 3-11, neither

[3] Juveniles and subadults are used interchangeably in the ASSRT, 2007 report (and therefore in this Biological Assessment), and are defined as any sturgeon that is not considered a young-of-year (Age 0) or mature adult.

[4] Atlantic sturgeons are using the Saco River for significant portions of the year. Studies are underway to determine how the fish are using the river (e.g., just a foraging area or attempting to reestablish a spawning population). Email from NMFS dated May 1, 2012.

Boston Harbor nor its tributaries are known spawning or nursery habitat; therefore, no spawning Atlantic sturgeon adults, eggs or larval life stages would be expected in the project area. Life stages that may appear in Boston Harbor are juveniles and adults. This was confirmed recently when a three foot long juvenile Atlantic sturgeon was observed this past February in the Charles River, a tributary to Boston Harbor (Boston Globe, February 20, 2012). Boston Harbor is not known as a concentration area for Atlantic sturgeon based on the FR 2010. However, the sighting of a juvenile in the Charles River would not be inconsistent with the life-history description above that immature Atlantic sturgeon travel widely once they leave their natal rivers. Age-1 and age-2 juveniles (called early juveniles) occur in the uppermost part of the estuaries, while older juveniles and subadults have a wider distribution, extending into more saline waters (Munro *et al.*, 2007).

Dunton *et al.* (2010) discusses the results from five fish surveys of captured juvenile Atlantic sturgeon from Maine to North Carolina. Essential habitat for juvenile marine migrant Atlantic sturgeon can be broadly defined as coastal waters <20 meters in depth, and concentrated in areas adjacent to estuaries such as the Hudson River-NY Bight, Delaware Bay, Chesapeake Bay, Cape Hatteras, and the Kennebec River, Maine. This narrow band of shallow water appears to represent an important habitat corridor and potential migration path. Other authors reported by Dunton *et al.* (2010) have reported concentrations of Atlantic sturgeon in Long Island Sound, North Carolina, and bycatch data indicated concentrations in Massachusetts Bay, Rhode Island, New Jersey, and Delaware. None of this data indicates Boston Harbor as a concentration area for juveniles.

In addition, catches reported by Dunton *et al.* (2010) were greatest during the fall and spring months. Winter appears to be the next highest season of captured juvenile Atlantic sturgeon, with the summer months showing very low capture rates. However, the bycatch mortality estimates by Stein *et al.* (2004) and ASMFC (2007b) do not include the bycatch that occurs in estuaries and rivers, which are not covered by the observer programs. Many juveniles and adults stay in marine foraging areas from fall through spring and then migrate into the estuaries and rivers in the summer seeking thermal refuges (Stein *et al.*, 2004). While bycatch decreases in the ocean during the summer relative to fall through spring due to the migration to estuaries and rivers, bycatch likely increases in estuaries and rivers during that time.

Tagging studies of adult Atlantic sturgeon from the Hudson River (Erikson *et al.*, 2011) indicate that 13 of the 15 tagged fish that left the Hudson River remained within the mid-Atlantic Bight. Of the two fish that traveled outside the mid-Atlantic Bight, one traveled north to the terminal end of the Bay of Fundy, Nova Scotia and the other fish traveled south to the coast of Georgia. This would indicate that, in general, fish from the mid-Atlantic Bight do not travel to the Gulf of Maine and that most areas of concentration are located south of Cape Cod.

For the Gulf of Maine DPS of Atlantic sturgeon, FR 2012 lists the rivers of known habitat use by Atlantic sturgeon. Only one river located in Massachusetts, the Merrimack, is known to support Atlantic sturgeon. Boston Harbor is not known to have been used historically by Atlantic sturgeon (NMFS, 1998). Although the presence of foraging juvenile or adult Atlantic sturgeon in Boston Harbor during the summer months could occur, it is expected to be low based on the lack of sightings of Atlantic sturgeon in the summer, or in Boston Harbor in general, and that the only recent sighting of an Atlantic sturgeon was in the winter (February). It should be noted however, that due to the overlapping of the ranges of the five DPSs, any Atlantic sturgeon found in Boston Harbor could have originated from any of the five DPSs.

Therefore, although this species is not believed to forage or spawn in Boston Harbor or its tributaries, transient individuals may occasionally be found in these areas (as noted a juvenile was observed in the Charles River in February of 2012). However, there have been only anecdotal reports of Atlantic sturgeon being in the area, and no other confirmed reports other than the single fish observed in the Charles River in February, 2012 (Julie Crocker, NMFS, Personal Communication, October 17, 2012).

Any single sturgeon that may be found in Boston Harbor could have originated from any of the five DPSs due to the overlapping of the species range. However, due to the fact that the Gulf of Maine includes Boston Harbor, it is more likely that any sturgeon found in Boston Harbor would be from the GOM DPS, which is listed as threatened.

3.5 Historical and Archaeological Resources

3.5.1 Boston Harbor

The following narrative is culled from several investigations conducted on behalf of the USACE during planning for the Deep Draft Project Supplemental EIS/EIR. The subject studies include the following: *Remote Sensing Archaeological Survey and Geologic Interpretation, Boston Harbor Navigation Improvement Study, Boston Harbor, Boston, Massachusetts* prepared by the University of Massachusetts Archaeological Services (UMAS) (Mulholland *et al.*, 2003); *Inspection of Magnetic Anomalies, Remote Sensing Archaeological Survey, Boston Harbor Deep Draft Navigation Improvement Study* prepared by the Public Archaeology Laboratory Inc. (PAL) (Robinson and Ford, 2003); and *Archaeological Subsurface Testing for the Boston Harbor Navigation Improvement Study, Boston Harbor, Boston, Massachusetts* prepared by UMAS (Lynch *et al.*, 2004). More detailed information is available in these references. For purposes of this SEIS/EIR, a brief summation of the pre-Contact context and Historic Period Shipwreck background for the project area is included.

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. Dena Dincauze's survey of the archaeological resources in the greater Boston area, conducted in 1967-8, included the Boston Harbor islands and revealed the potential for significant archaeological data from sites within the harbor district. A later investigation of the 12 Harbor Islands by Luedtke resulted in the Boston Harbor Islands being nominated as a National Register Historic District. Luedtke's studies confirmed that the harbor islands contained the best-preserved concentration of Native American archaeological sites in the metropolitan Boston area. Currently, 60 documented sites spanning the Early Archaic to the Late Woodland Periods are distributed among 21 islands within the district (Robinson and Ford, 2003).

The Boston Basin area included two core areas of Native American settlement during the Contact Period: the Neponset core situated in the southern part of Massachusetts Bay and the Mystic core situated in the northern portion of the Bay. The Mystic River area included several smaller adjacent coastal river drainages such as the Malden, Pines, and Saugus Rivers. Larger lakes and ponds including Fresh and Spy Pond near the estuary, and Spot Pond and Crystal Lake in the Middlesex Fells formed part of the inland section of the Mystic core area. Contact era sites in the Boston Basin include isolated burial and cemetery locations. Contact Period burials from the Mystic River area are known from West Medford, Winthrop, Revere Beach, and Nahant (Robinson and Ford, 2003).

Historic Period Shipwreck Context - Many historic period shipwreck sites are known to exist in Boston Harbor, with a large number of probable sites within the study area. State and Federal Government compilations of vessel losses date only from the late 1800s and most of these are incomplete (Mulholland *et al.*, 2003).

In addition to any recorded vessel losses, many more were likely lost in Boston Harbor and simply not recorded. Many lost vessels are simply recorded as missing at sea, whether they had just left the harbor, were returning from a long voyage, or were blown in while trying to sail past the shore. In these cases, their actual fate can only be revealed through the efforts of underwater archaeologists. Such vessels would include small and large fishing boats, coasters, transoceanic merchantmen, and warships (Mulholland *et al.*, 2003).

Because little is known of the early vessels, how they were made and used, and life aboard the early merchant vessels, the remains of any historic ship or boat would be archaeologically and historically significant on a local, regional, and national level. Historic shipwreck sites in New England are sources that provide archaeologists with information about shipping, vessel construction, lifeways of mariners, and also about early terrestrial life in New England (Mulholland *et al.*, 2003).

Major changes took place in shipping during the latter 19th and early 20th centuries that would affect the number and size of boats and ships lost throughout the United States and especially the Boston Harbor region. During this time, the introduction of important technical and safety innovations allowed seamen to keep their vessels afloat. Engine power, rather than sail and oar, made nearshore voyages much safer. First, tugboats, and then internal engines could move a vessel away from danger. Navigation aids along the sides of channels, buoys and beacons, on-shore ranges, and electric navigation lights all assisted small and large vessels navigate through the harbor. Wireless telegraphy and later radio communications helped crews call for assistance and communicate with other vessels. Federal agencies such as the U.S. Life Saving Service and eventually the U.S. Coast Guard were established to search for and assist vessels in distress (Mulholland *et al.*, 2003).

All of the potentially significant historic period sites that might be found in the study area are likely to 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. There is no complete listing of shipwreck files for the Boston region; however, even incomplete records or compilations suggest numerous types, sizes, and cargoes lost in Boston Harbor (Mulholland *et al.*, 2003).

Most recorded shipwrecks are large, transoceanic and coastal ships because until the late 19th century researchers and the media were primarily interested in larger vessels. Therefore, the potential for other, unknown smaller vessels in a larger, urban harbor is usually high. The remains of pre-20th century small oceanic and coastal vessels would be particularly significant due to their archaeologically important cargoes and hulls. However, since these vessels typically did not carry large amounts of iron, they are more difficult to discern through only the use of a marine magnetometer. Additional remote sensing data, including side scan sonar records, would need to be utilized in conjunction with magnetic anomalies to determine the existence of cultural resources (Mulholland *et al.*, 2003).

3.5.2 Habitat Enhancement Sites

Beneficial use of the dredged material at several sites for hard-bottom habitat creation has been identified offshore in Broad Sound and Massachusetts Bay. No shipwrecks were observed during physical or biological sampling of the areas. Since these areas were not included in the original navigation improvement EIR/S, it is recommended that further evaluation of any beneficial use sites, outside of the previously surveyed Federal navigation channel footprint, be conducted as part of the recommended remote sensing archaeological survey. Once selected habitat areas are identified, these locations should be subject to further study and possible survey, if required, and in coordination with the MA Board of Underwater Archaeological Resources and the MA State Historic Preservation Office.

3.5.3 Massachusetts Bay Disposal Site and Industrial Waste Site

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 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 a wide range of hazardous wastes. 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 just north of the MBDS. The USACE and 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 areas with a high density of barrels exposed on the seafloor. A side scan sonar survey of the IWS and portions of the MBDS was conducted by 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 shipwrecks determined to be of archeological significance.

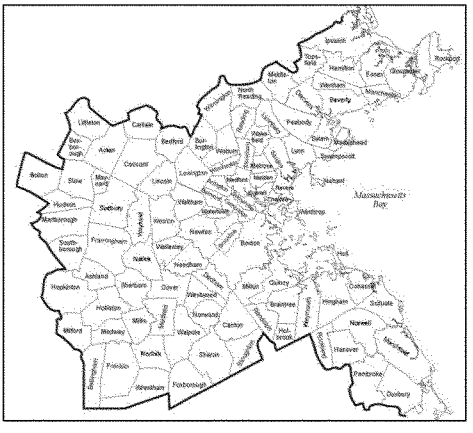
3.6 Air Quality

This section describes the air quality analysis study area, as well as the regulatory and environmental setting. The regulatory setting is described in terms of Federal and State requirements. The environmental setting is described in terms of climate and meteorological conditions, and existing ambient air concentrations.

3.6.1 Area of Analysis

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.[5] It also extends to the State Territorial Seas Boundary, which is three nautical miles from the Massachusetts coastline.[6] The project area is also in an area designated as nonattainment or is subject to a maintenance plan. The relevant areas for the project are the Boston-Lawrence-Worcester (Eastern Massachusetts), MA moderate eight-hour ozone nonattainment area and the Boston area carbon monoxide attainment area with an associated maintenance plan. The Deep Draft Navigation Improvement Project (Project) dredging equipment, delivery and container trucks, and construction employee traffic would generate emissions within this air quality region. Figure 3-19 shows the air quality area of analysis.

Figure 3-19. Air Quality Area of Analysis



Source: Central Transportation Planning Staff, Boston Region Metropolitan Planning Organization Transportation Improvement Program Air Quality Conformity Determination Fiscal 2006-2010, 2006.

[5] Beverly, Brockton, Cambridge, Chelsea, Everett, Gloucester, Lynn, Malden, Marlborough, Medford, Melrose, Newton, Peabody, Quincy, Revere, Salem, Somerville, Waltham, Woburn.

[6] Marc Wallace, CDM Smith telephone conversation with Don Cooke, U.S. EPA Region 1, October 26, 2005.

3.6.2 Regulatory Setting

Ambient Air Quality Standards and Attainment Status

The Clean Air Act (Act) was passed in 1970 and was amended three times (including in 1990, 42 USC 7401 et seq.). The Act establishes the framework for modern air pollution control, and delegates primary responsibility for regulating air quality to the States, with oversight by the U.S. Environmental Protection Agency (EPA). EPA develops rules and regulations to preserve and improve air quality as minimum requirements of the Act, and delegates specific responsibilities to State and local agencies. EPA has identified seven specific pollutants (called criteria pollutants) that are of concern with respect to the health and welfare of the general public. The criteria pollutants are carbon monoxide (CO), sulfur dioxide (SO_2), nitrogen dioxide (NO_2), ozone (O_3), particulate matter 10 micrometers or less in aerodynamic diameter (PM_{10}), particulate matter 2.5 micrometers or less in aerodynamic diameter ($PM_{2.5}$), and lead (Pb). Since publication of the Draft SEIS/EIR for the Project, EPA has promulgated several new National Ambient Air Quality Standards (NAAQS) for criteria pollutants, including an eight-hour average O_3 standard of 0.075 parts per million (ppm), a one-hour average NO_2 standard of 100 parts per billion (ppb), a one-hour average SO_2 standard of 75 ppb, and a rolling three-month average Pb standard of 0.15 micrograms per cubic meter ($\mu g/m^3$); EPA has also revoked the NAAQS for the PM_{10} annual averaging time as well as the NAAQS for the SO_2 annual and 24-hour averaging times. As can be noted in Table 3-11, both the 1997 eight-hour O_3 NAAQS and the 2008 eight-hour O_3 NAAQS are in existence at the time of this report. Although these changes have been approved, implementation of the new standards and monitoring of ambient conditions relative to these new standards is an ongoing process.

Similarly, the Massachusetts Department of Environmental Protection (MADEP) has established Massachusetts Ambient Air Quality Standards (MAAQS), which are equal to current or former NAAQS. Currently, Massachusetts has not adopted the 1997 or 2008 eight-hour average O_3 standards, the 24-hour and annual average $PM_{2.5}$ standards, the three-month Pb standard, the one-hour NO_2 standard, or the one-hour SO_2 standard. Table 3-12 lists the National and Massachusetts standards for criteria pollutants. The standards are divided into primary and secondary standards; the former are set to protect the public (i.e., human) health with an adequate margin of safety, and the latter to protect the public welfare (e.g., environmental quality, such as plant and animal life).

Areas that do not meet the NAAQS are called non-attainment areas. For non-attainment areas, the Act requires States to develop and adopt State Implementation Plans (SIPs). SIPs are air quality plans showing how air quality standards will be attained. SIPs, which are reviewed and approved by EPA, must demonstrate how the NAAQS will be achieved. Failing to submit a plan to EPA or secure approval from EPA could lead to denial of Federal funding (i.e., grants to States) and permits for activities such as highway construction and sewage treatment plants. In cases in which a SIP is submitted by the State but fails to demonstrate achievement of the standards, EPA is directed to prepare a Federal Implementation Plan for that area.

Table 3-12. National and Massachusetts Ambient Air Quality Standards

Pollutant	Averaging Period	NAAQS Primary	NAAQS Secondary	MAAQS	Compliance Method
Carbon monoxide	1 hour	35 ppm	NA	35 ppm	Not to be exceeded more than once/year
	8 hour	9 ppm	NA	9 ppm	Not to be exceeded more than once/year
Lead	Calendar quarter	NA	NA	1.5 $\mu g/m^3$	Not to be exceeded
	3 months	0.15 $\mu g/m^3$	0.15 $\mu g/m^3$	NA	Not to be exceeded
Nitrogen dioxide	1 hour	100 ppb	NA	NA	98th percentile averaged over 3 years
	Annual	0.053 ppm	0.053 ppm	0.05 ppm	Not to be exceeded
Ozone	1 hour	NA	NA	0.12 ppm	Expected number of days at standard of 1
	8 hour (1997)	0.080 ppm	0.08 ppm	NA	Annual average 4th highest
	8 hour (2008)	0.075 ppm	0.075 ppm	NA	Annual 4th highest over 3 years
PM_{10}	24 hour	150 $\mu g/m^3$	150 $\mu g/m^3$	150 $\mu g/m^3$	Not to be exceeded more than once/year
	Annual	NA	NA	50 $\mu g/m^3$	Not to be exceeded
$PM_{2.5}$	24 hour	35 $\mu g/m^3$	35 $\mu g/m^3$	NA	98th percentile averaged over 3 years
	Annual	15.0 $\mu g/m^3$	15.0 $\mu g/m^3$	NA	Not to be exceeded
Sulfur dioxide	1 hour	75 ppb	NA	NA	99th percentile averaged over 3 years
	3 hour	NA	0.5 ppm	0.5 ppm	Not to be exceeded more than once/year
	24 hour	NA	NA	0.14 ppm	Not to be exceeded more than once/year
	Annual	NA	NA	0.03 ppm	Not to be exceeded
Notes:					
ppb = parts per billion					
ppm = parts per million					
$\mu g/m^3$ = micrograms per cubic meter					

Sources: 310 CMR 6.00, April 2002.
40 CFR 50, July 2012.

As stated above, the Deep Draft Project is located in the Metropolitan Boston Intrastate AQCR (40 CFR 81.19). As shown in Table 3-13, the AQCR is considered to be in attainment with all NAAQS, with the exception of O_3 for which it is designated as "non-attainment" , although the area is considered "attainment/maintenance" for CO [7] (40 CFR 81.322). On December 12, 1994, the MADEP submitted a request to redesignate the Boston area CO non-attainment area to attainment for CO. As part of the redesignation request, MADEP submitted a maintenance plan, which included a base year (1993 attainment year) emission inventory for CO and a demonstration of maintenance of the CO NAAQS with projected emissions inventories to the year 2010 (U.S. EPA, *Massachusetts; Boston Harbor Area Carbon Monoxide Redesignation to Attainment*, December 2005). Maintenance plans are required to contain measures to keep newly redesignated attainment areas from backsliding into non-attainment. Therefore, stringent emission thresholds continue to apply to Federal actions in maintenance areas.

Table 3-13. Attainment/Non-Attainment Designations for Metropolitan Boston

Pollutant	Designation
Carbon Monoxide	Attainment/Maintenance
Lead	Attainment
Nitrogen Dioxide	Attainment
Ozone (1997 8-hour)	Non-attainment
Ozone (2008 8-hour)	Attainment
Particulate Matter (<10 microns)	Attainment
Particulate Matter (< 2.5 microns)	Attainment
Sulfur Dioxide	Attainment

Source: U.S. EPA, 2012.

Massachusetts was designated non-attainment for the one-hour O_3 NAAQS State-wide, with a classification of "serious." Accordingly, MADEP was required to demonstrate attainment in Eastern Massachusetts and proposed to attain the one-hour NAAQS by December 15, 2007 (MADEP, Final Eastern Massachusetts 1-Hour Ozone NAAQS Attainment Demonstration SIP, September 2002). However, EPA revoked the one-hour NAAQS on June 15, 2005. Subsequently, Eastern Massachusetts was designated non-attainment for the 1997 eight-hour O_3 NAAQS, with a classification of "moderate." On May 29, 2012, EPA issued a final rule (77 FR 31496) with an effective date of June 28, 2012, finding that Eastern Massachusetts attained the 1997 eight-hour O_3 NAAQS by the applicable attainment date of June 15, 2010. It should be noted that as part of that rule, EPA indicated its finding did not constitute a redesignation to attainment for the 1997 eight-hour O_3 NAAQS. Therefore, the area remains a moderate non-attainment area for the 1997 eight-hour O_3 NAAQS until such time as the area is redesignated to attainment for the 1997 eight-hour O_3 NAAQS or the 1997 eight-hour O_3 NAAQS is revoked. On May 21, 2012, EPA issued a final rule (77 FR 30088), with an effective date of July 20, 2012, with the area designations for the 2008 eight-hour O_3 NAAQS. With the exception of Dukes County, Eastern Massachusetts is designated as attainment for the 2008 eight-hour O_3 NAAQS. As of the time of writing this report (March 2013), the Deep Draft Project would be subject to addressing the general conformity requirements for O_3 precursors, NO_x and VOC because the area remains a non-attainment area for the 1997 eight-hour O_3 NAAQS.

[7] Attainment means there are no recorded exceedances of the NAAQS in the area; non-attainment means exceedances of the NAAQS have occurred in the area; and attainment/maintenance means the area was non-attainment but now is in attainment and is required to implement additional measures through a maintenance plan to remain in attainment.

General Conformity

Section 176 (c) of the 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 SIP required under the 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. In 1993, the EPA promulgated regulations prescribing general criteria and procedures for analysis of transportation and general conformity which apply in non-attainment and maintenance areas only. Since that date, most if not all State and local air pollution control agencies have adopted conformity requirements at least as stringent as the EPA regulations.

EPA promulgated two regulations to address the conformity requirements of the Act. On November 24, 1993, EPA issued final transportation conformity regulations at 40 CFR 93 Subpart A to address Federally assisted transportation plans, programs, and projects. These regulations have been revised several times since they were first issued to clarify and simplify them. On November 30, 1993, EPA issued final general conformity regulations at 40 CFR 93 Subpart B for all Federal activities except those covered under transportation conformity. On April 5, 2010, EPA promulgated revised general conformity requirements at 40 CFR 93 Subpart B (75 FR 17254), with an effective date of July 6, 2010, to simplify and add flexibility to the requirements and reduce paperwork burdens.

The general conformity regulations apply to a Federal action (in this case, the Federal portion of the Deep Draft Project) if the total of direct and indirect (only for actions that the Federal agency has control over) emissions for a criteria pollutant from the action equals or exceeds the de minimis thresholds. By requiring an analysis of direct and indirect emissions, EPA intended the Federal agency to make sure that only those emissions that the Federal agency can practicably control, and that are subject to that agency's continuing program responsibility, will be reasonably controlled.

The 2010 revisions to the general conformity rule made several notable changes to the original rule. For example, the regional significance test was removed from the rule. EPA also added an allowance for Federal agencies to work with States in developing facility-wide emissions budgets for inclusion in the respective SIPs. Furthermore, the rule now allows for interpollutant trading of precursor emissions as offsets. While the rule generally requires that emissions offsets and mitigation occur in the calendar year when the Federal action takes place, the 2010 revision would allow alternate schedules for mitigating emission increases in future years (beyond project implementation) if there would be a long-term reduction in emissions from the Federal action. The reader is directed to the April 5, 2010, Federal Register notice for a more detailed discussion of these and other revisions to the rule.

The Deep Draft Project is subject to the general conformity rule since the U.S. Army Corps of Engineers is the lead Federal agency (i.e. Federally funded). For the Deep Draft Project, the de minimis thresholds for general conformity analysis are presented in Table 3-14.

In addition to projects where the total of direct and indirect emissions of a pollutant are projected to be less than the de minimis levels, the following types of projects are also exempt from a conformity analysis:

- Actions which carry out plans which previously have been determined to conform to the SIP;
- Special actions where conformity is not required;
- Actions where the emissions are not reasonably foreseeable; and
- Actions which are presumed to conform (e.g., maintenance dredging).

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. If a general conformity determination is required for a Federal action, the action must meet certain criteria spelled out in the regulations. These include either:

- Having the emissions specifically identified and accounted for in the SIP's attainment or maintenance demonstration; or
- Fully offsetting the emissions 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
- Including the emissions within the SIP's emissions budget; or
- Conducting dispersion modeling analyses to demonstrate that the emissions do not cause or contribute to any new violation of the NAAQS and do not increase the frequency or severity of any existing violation of the NAAQS.

Table 3-14. General Conformity De Minimis Thresholds for the Eastern MA Area

Pollutant	Federal Status	De Minimis Value (tons/yr)
Nitrogen Oxides (NO_x) (as an Ozone Precursor)	Non-attainment, moderate 8-hour Ozone	100
Carbon Monoxide (CO)	Attainment/Maintenance	100
Volatile Organic Compounds (VOCs) (as an Ozone Precursor)	Non-attainment, moderate 8-hour Ozone	50

Sources: U.S. EPA 2010, 2010

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[8]. 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[9] 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.

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

[9] 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.

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.

3.6.3 Environmental Setting

The climatic characteristics of the Boston area (42.4°N, 71.03°W) include a variety in seasonal weather throughout the year with a large range in temperatures but with an equitable distribution of precipitation. Annual average daily temperatures range from about 26°F (January) to 72°F (July) and the area receives an average of about 54.1 inches per year of precipitation in the form of rain and snow. Winds are predominantly out of the west (prevailing westerlies). However, sea breeze effects are a common diurnal occurrence near the coastline during the spring and summer months. Although infrequent, violent storms (tornadoes, tropical storms and hurricanes) are a concern during the spring, summer and fall months. Nor'easters are more frequent than the other types of violent storms and they often occur during the fall and winter months (data based on 1982 – 2011 average weather observations at Blue Hill Observatory in Milton, MA and retrieved from http://www.ncdc.noaa.gov/oa/climate/research/cag3/w7.html, accessed on November 16, 2012).

3.6.4 Existing Air Quality

The quantitative description of existing air quality conditions is based upon the EPA's AIRDATA internet-based database and supplemented with annual MADEP air quality reports. Table 3-15 shows the relevant pollutant concentration metrics as measured at the closest monitoring sites to the project area for each pollutant. Monitoring data available for the most recent three-year period (2009 - 2011) are presented. The monitoring data indicate that criteria pollutant concentrations, with the exception of the 8-hour average O_3 concentrations, meet the applicable NAAQS and MAAQS at the monitoring stations near the project area. The 2008 eight-hour O_3 NAAQS was exceeded 3, 1, and 1 days in 2009, 2010, and 2011, respectively.

Table 3-15. Background Pollutant Concentrations

Pollutant	Averaging Period	2009 (1)	2010 (2)	2011 (3)	Metric	NAAQS/ MAAQS
Carbon Monoxide	1 hour	2 ppm	3 ppm	2 ppm	2nd highest	35 ppm
Lead	8 hour	1 ppm	2 ppm	1 ppm	2nd highest	9 ppm
	Calendar quarter	0.01 µg/m³	0.03 µg/m³	0.02 µg/m³*	Highest 24-hour	1.5 µg/m³
	3 months	ND**	ND	ND	Highest rolling 3 months	0.15 µg/m³
Nitrogen dioxide	1 hour	54 ppb	52 ppb	53 ppb	98th percentile	100 ppb
	Annual	0.020 ppm	0.019 ppm	0.020 ppm	Mean	0.053 ppm
Ozone	1 hour	0.086 ppm	0.087 ppm	0.082 ppm	2nd highest	0.120 ppm
	8 hour	0.080 ppm	0.074 ppm	0.074 ppm	2nd highest	0.075 ppm
PM_{10}	24 hour	43 µg/m³	37 µg/m³	38 µg/m³	2nd highest	150 µg/m³
$PM_{2.5}$	Annual	21 µg/m³	16 µg/m³	17 µg/m³	Mean	50 µg/m³
	24 hour	24 µg/m³	24 µg/m³	24 µg/m³	98th percentile	35 µg/m³
	Annual	10.2 µg/m³	10.0 µg/m³	10.3 µg/m³	Mean	15.0 µg/m³
Sulfur dioxide	1 hour	23 ppb	21 ppb	19 ppb	99th percentile	75 ppb

	3 hour	ND	ND	ND	2nd highest	0.5 ppm
	24 hour	0.01 ppm	0.01 ppm	0.01 ppm	2nd highest	0.14 ppm
Notes:						
*Calendar quarter value not available; data point represents highest 24-hour average.						
** ND = no data calculated for this averaging period.						
ppb = parts per billion						
ppm = parts per million						
$\mu g/m^3$ = micrograms per cubic meter						

Sources: (1) Data from "Commonwealth of Massachusetts 2009 Air Quality Report", Massachusetts Department of Environmental Protection, August 2010.
(2) Data from "Commonwealth of Massachusetts 2010 Air Quality Report", Massachusetts Department of Environmental Protection, June 2011.
(3) Data from "Massachusetts 2011 Air Quality Report", Massachusetts Department of Environmental Protection, August 2012.
(4) http://www.epa.gov/airdata/, accessed November 16, 2012.

3.7 Socioeconomic Environment

Boston Harbor is an active harbor with many users. These users include recreational boaters, shipping, and fishing interests. In addition, the towns surrounding the harbor are home to a large and diverse group of people. Additional information is provided below.

3.7.1 Shipping

Improvement dredging is critical to the economic viability of the region and to ships reaching their destination in Boston safely, reliably and without significant delays. In the last few years the Port of Boston handles approximately 22 million tons of cargo-including more than one million tons of containerized cargo and 12,000 automobiles. In addition, 107 passenger ships called on the Port of Boston carrying 310,238 cruise passengers in the year 2011. In recognition of the importance of the marine industry to the State, the Commonwealth has designated certain coastal areas around the State as Designated Port Areas (DPAs). Four DPAs partially or completely fall within the boundaries of the City of Boston. They are: 1) the Chelsea Creek DPA; 2) the East Boston DPA; 3) the Mystic River DPA; and 4) the South Boston DPA. DPAs benefit the greater Boston region as well as the Commonwealth of Massachusetts in a variety of ways.

These benefits, as described by The Boston Harbor Association (2003), include:

- Provide direct economic benefits and job creation through industries including shipping, cruise activity, and fishing processing;
- Generate an indirect multiplier effect on the regional economy through increased opportunities for importing and exporting goods;
- Contain vital regional infrastructure, including key components of the region's energy supply and preponderance of road salt;
- Protect and maintain the character of Boston's working port, which serves as both
  - a key source of the city's historical identity, and
  - a means to differentiate its "sense of place" amidst a landscape of increasingly homogenized American cities; and
- Allow flexibility in responding to unforeseen future marine industrial demands.

The importance of the Designated Port Areas and the attendant result is clear. Each year the working port generates $2.4 billion in economic benefit for the region, directly or indirectly employs over 34,000 workers, provides an economic edge for countless regional businesses, furnishes critical regional infrastructure, and protects and maintains Boston's maritime character and diverse workforce (Massport, 2005). The support of all marine businesses of all sizes – from shipping terminals to

tugboats and salvage companies - is vital to the economy. DPAs provide a place of affordable rent and financial viability. Without DPAs, these maritime users could fail, threatening the foundations and vitality of the working port, as well as the regional economy that is dependent on its use (The Boston Harbor Association, 2003).

3.7.2 Commercial Fishing

Commercial finfishing does not occur within Boston Harbor due to the shipping activity and shallow depths. In contrast, lobsters are commercially fished within Boston Harbor. Although it is illegal to do so, due to potential impacts to navigation (Section 10 of the Rivers and Harbor Act of 1899), lobster fishing also occurs in the navigation channels. The amount of commercial lobster activity is dependent on the season and the movement of these animals. Questionnaires were sent to commercial lobstermen in 2005 in which they were requested to voluntarily provide information on where and when they fish in Boston Harbor. The following discussion is based on the information received from these surveys. For survey purposes, Boston Harbor was divided into seven areas; five of those areas are pertinent to this project. See Table 3-16 for area locations.

Table 3-16. Commerical Lobster Fishing Survey Locations

Area	Location
A	Mystic River
B	Chelsea River
C	Main Ship Channel – From Ted Williams Tunnel Seaward to Spectacle Island
D	Main Ship Channel – President Roads Anchorage and President Roads Ship Channel
E	Main Ship Channel – Broad Sound North Entrance Channel

No commercial lobstering, or very little, was reported in either the Mystic or Chelsea Rivers between August and the end of April. Minor lobstering activity was noted in May, June and July for these two rivers. Areas C, D, and E are fished year around, but at varying intensities. More lobstermen fish the Main Ship Channel (areas C, D, and E) from May through November with a peak in the summer months and early fall. Area D, the President Roads Anchorage and Channel, generally report the most lobstermen compared to the other two Areas C and E. Area C, below the Ted Williams Tunnel, reported more lobstermen than Area E, Broad Sound Entrance Channel, between March and August. The reverse occurred in Areas C and E during the months of September through February (i.e. more lobstermen fished Area E than Area C during these months). If the number of lobstermen fishing in an area is indicative of the lobster population, then it would appear that the lobsters tend to move out into the open water areas during the cooler months of the year.

3.7.3 Population

Boston Harbor is located in a metropolitan area bordered by the cities of Boston, Chelsea, and Revere, all located within Suffolk County. Boston is the capital of the Commonwealth of Massachusetts as well as the largest city in the State with a population of 617,594. The population of Boston makes up 86% of the total population of Suffolk County.

Suffolk County has a diverse and dense population compared to the rest of the State. According to the 2010 U.S. Census Bureau, 56 percent of the Suffolk County population is White, 22 percent African American, 20 percent Hispanic and eight (8) percent is Asian. The number of families and individuals that live below the poverty line in Suffolk County is higher than the State average; however the number of children less than 18 years of age is slightly below the State average. See Table 3-17 below for a comparison with the rest of the State.

Table 3-17. Population Data for the Commonwealth of Massachusetts and Suffolk County

Data	Massachusetts	Suffolk County
Total Population	6,547,629	722,023
White (%)	80.4	56.0
Black or African American (%)	6.6	21.6
Asian (%)	5.3	8.2
Hispanic (%)	9.6	19.9
Density/Square Mile of Land	840	12,416
Individuals below the Poverty Line (%)	10.7	20.8
Children under 18 Years of Age (%)	21.3	17.6

Source: 2010 and 2011 U.S. Census Bureau

3.8 Harbor Infrastructure

In addition to the many users of the harbor, the harbor also supports several important infrastructure components critical to the metropolitan area. A discussion of the tunnel crossings, subway crossings, and utility cable crossings in Boston Harbor is provided below.

3.8.1 Harbor Tunnel Crossings

There are four tunnels crossing beneath the Main Ship Channel; one subway tunnel and three highway tunnels. The Ted Williams Tunnel I-90 (TWT) is the most seaward crossing, although it is located upstream of the Massport Marine Terminal in South Boston. The three remaining tunnels upstream of the TWT are the Massachusetts Bay Transportation Authority's Blue Line subway tunnel, which connects downtown Boston with Logan Airport, East Boston and the City of Revere, and the paired Callahan and Sumner Tunnels connecting downtown Boston with East Boston which carries US Route 1A beneath the harbor.

3.8.2 Sewer Tunnel Crossings

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. 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. 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.

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. 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.

3.8.3 Utility Crossings

There are a number of utilities crossing the harbor, particularly in the upper reaches. Utilities located beneath the Reserved Channel are of particular noteworthy importance. MWRA's main power supply line to its Deer Island Treatment Plant runs from the South Boston generating plant on the Reserved Channel, underneath the Reserved Channel and Main Ship Channel, and across the flats southeast of Logan International 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.

4. ENVIRONMENTAL CONSEQUENCES

4.1 No Action Alternative

The No Action Alternative is required to be evaluated as prescribed by NEPA and the Council on Environmental Quality (CEQ). Similarly, the MEPA regulations require projects to evaluate a No-Build Alternative. The No Action (or No-Build) Alternative serves as a baseline against which the proposed action can be evaluated. Evaluation of the No Action Alternative involves assessing the environmental effects that would result if the proposed action does not take place.

In this case, the No Action Alternative means that the Federal navigation channel in Boston Harbor would not be deepened; existing conditions would persist, and current practices (e.g., light-loading, tidal delays, etc.) would continue. If deep draft vessels cannot safely and efficiently transit the harbor to access the Port terminals, significant economic and potential environmental impacts could result. Failure to deepen the port to its optimum depth could result in some ships bypassing the port altogether. It could also increase the need for lightering as well as the likelihood of a grounding, both of which could result in adverse environmental consequences.

Without the project, more truck traffic would be required to transport goods from the Port of New York/New Jersey (PONYNJ) to New England. This would result in a continued decrease in air quality from the additional truck traffic miles to transport goods from PONYNJ. With the proposed project, there would be a slight increase in truck traffic and associated air emissions from the proposed project within the immediate Boston metropolitan area. However, the overall regional air quality in New England would improve. This is because there would be a corresponding decrease in truck traffic miles transporting goods from the Port of New York/New Jersey (PONYNJ) throughout New England (in particular northern New England).

The following potential environmental impacts could be avoided if the proposed project is not constructed: temporary turbidity impacts from deepening the channels, temporary disruption of benthic habitat and EFH in the navigation channels, as well as potential disruption of lobster habitat in the channels, and potential impacts to fish from blasting. Temporary disruption of benthic and EFH would also be avoided at the disposal site if the project does not proceed.

Potential environmental benefits that would not accrue from the proposed project include the benefit of better regional air quality gained through more efficient regional transport of waterborne commernce in and out of New England, the regulated removal of (potentially contaminated) silt removal and reduction of silt resuspension associated with vessel propwash, reduction of risks to the aquatic environment associated with container vessels lightering and/or riding the tides, and reduction of ship calls as pertains to potential marine mammal ship strikes. In addition, the potential permanent creation of hard bottom habitat for rock reef species, and the covering of submerged chemical waste, low level radioactive and debris barrels at the Industrial Waste Site (IWS), would be lost. These benefits are discussed in more detail below.

4.2 General Impacts of Dredging in Boston Harbor

The primary impacts of dredging are generally attributable to suspended plumes which result from both dredging and disposal operations. Sediments and other materials suspended in a water body are referred to as total suspended solids (TSS) and are measured in milligrams of solids per liter of water (mg/L). Turbidity, a related parameter, is an expression of the optical properties of water that cause light to be scattered and absorbed rather than transmitted in a straight line. During dredging, a plume would be created containing elevated levels of suspended sediments and associated contaminants. The three broad categories of sediment plume impacts are physical, chemical and biological. Sediments temporarily suspended during dredging and disposal can affect aesthetics, light penetration, feeding by benthic organisms and fish, and, at very high levels, can destroy or injure fish and benthic organisms.

Therefore, concentrations of TSS resulting from dredging and disposal operations, over time, can be predicted either through modeling or previous monitoring to assess potential impacts. Contaminants within the sediments to be dredged may dissolve when the dredged material is exposed to the water column that can kill or impair marine animals if they are exposed to high concentrations over a sufficiently long period of time. The following sections describe the potential impacts from dredging and disposal to the physical, chemical and biological environment, and the lessons learned from monitoring during the BHNIP.

The proposed project would dredge between approximately 10 to 11 million cy of dredged material to achieve the -47-foot Main Ship Channel and -51-foot deep Broad Sound North Channel. In addition, up to about 1,000,000 cy of rock would also be removed. Blasting impacts are described below in Section 4.2.5. The project is expected to take about three years to complete; approximately 26 months to remove rock by blasting could be needed. Additional rock boring and probes in the Design Phase will determine the amount and location of rock in Boston Harbor to be removed.

4.2.1 Physical Impacts

All types of dredge equipment create some form of sediment plume in the water column. The nature, degree, and extent of dredged material dispersion around a dredging operation are controlled by many factors (Barnard, 1978 in Herbich and Brahme, 1991). These factors include the characteristics of the dredged material such as its size distribution, solids concentration, and composition; the nature of the dredging operation such as the dredge type and size; and the characteristics of the hydrologic regime in the vicinity of the operation, including salinity and hydrodynamic forces (waves, currents, etc.). The relative importance of these factors varies from site to site. The amounts of sediments suspended during dredging are generally highest in the immediate vicinity of the dredging operations and return to background levels within a short distance of the dredging site based on monitoring results from Boston Harbor.

Bohlen *et al.* (1979), estimated that 1.5% to 3.0% of the volume of substrate (fine-grained sands and silts) contained in an open clamshell dredge bucket is introduced into the water column. However, a number of operational variables, such as bucket size and type (open or enclosed), prohibiting scow overflow, volume of sediment dredged per cycle, operator experience, hoisting speed, and hydrodynamic conditions in the dredging area can significantly affect the quantity of material suspended (LaSalle, 1988; Lunz *et al.*, 1984). Sediment resuspension from clamshell dredges can be reduced by using an enclosed clamshell bucket or by slowing the raising or lowering of the bucket through the water column. The latter reduces the production rate of the dredge (Hayes, 1986), increases air emissions and prolongs the time at the dredge site. An enclosed bucket was used to dredge the silty material which was unsuitable for open water disposal during the BHNIP.

A substantial amount of information about TSS concentrations and turbidity plumes was collected during dredging and disposal of Phase 1 (Conley Terminal) and Phase 2 of the Boston Harbor Navigation Improvement Project (BHNIP), as well as the Boston Inner Harbor Maintenance Dredging Project (IHMDP). This information, in conjunction with information from the New Haven Harbor and Providence River dredging projects, was used to predict anticipated turbidity and TSS impacts to the water column in the area of the dredging operations for this Deep Draft Project (see below). As minimal, if any disposal of silty material is expected, only a brief description of potential disposal impacts based on Boston Harbor monitoring results is included below.

New Haven

Monitoring of dredge induced suspended sediment concentrations was conducted at New Haven Harbor under the Army Corps of Engineers, Disposal Area Monitoring System (DAMOS) Program to address concerns relative to winter flounder spawning grounds near the Federal channel (USACE, 1996). Dredging at New Haven Harbor was conducted with an enclosed bucket. The sediments from

New Haven Harbor are siltier than the sediments to be dredged in Boston Harbor. The parent material to be dredged in Boston Harbor is composed of either Boston blue clay or glacial till material. Both types of material are less likely to be suspended for long distances compared to silt. The two major objectives of the New Haven monitoring were to: 1) establish the background suspended solids concentration before and after dredging, and 2) document the movement of the dredge plume relative to fisheries resource areas such as winter flounder spawning grounds.

The results of the acoustic survey revealed that the dredge-induced sediment plume did protrude into the shoal areas to the east and west of the navigation channel. These excursions onto the shoals only occurred when the dredge was in the immediate vicinity. The DAISY (Disposal Area In-Situ System), which was deployed on the eastern end of the winter flounder spawning area, also showed elevated suspended materials concentrations attributable to the dredge operating in the upper reaches of the harbor. The time series of the DAISY data showed numerous aperiodic short duration spikes of 100 mg/L. The observed concentrations were an order of magnitude higher than the preceding background concentrations. However, in the last half of the deployment, while the dredge was located well south of the DAISY site, there were several long duration (1-3 days), and very high perturbations. During these events concentrations reached 700 mg/L that could not be related to the dredging operation. Evidence from the meteorological data and wastewater effluent records indicate that these events were likely the result of winds and wind-generated waves, alone or in combination with discharges from wastewater treatment plant outfalls.

Based on these findings, dredged induced sediment resuspension was found to be a minor perturbation to the much longer duration, larger amplitude events associated with wind, wind-waves, and effluent discharges from outfalls. The effects of dredge related spikes in suspended sediments on the winter flounder spawning grounds, and the regional water quality in general, appear to have been limited in duration and of relatively low amplitude (USACE, 1996).

Boston Harbor

Monitoring was conducted for dredging of the surface silty material during construction of the first confined aquatic disposal (CAD) cell for Phase 1 of the BHNIP. This monitoring included: 1) documentation of the spatial and temporal distribution of the sediment plume for the four extremes of tidal currents (high water slack, maximum ebb, low water slack, maximum flood) on two days within the first week of dredging; 2) collection of water samples from the lower half of the water column at two locations – 1,000 feet up current of the dredging and 500 feet down current from the dredging; and 3) analysis of water samples for TSS. Additional parameters (turbidity, DO, arsenic, and copper) were analyzed when dredging the parent material.

During dredging, turbidity measurements ranged from 3-5 NTU (Nephelometric Turbidity Units) at the reference station 1,000 feet up current from dredging the silty surface material using an environmental bucket. Turbidity was only slightly elevated at the station 500 feet down current of the dredging ranging from 4-11 NTU. TSS ranged from 4-5 mg/L at the reference station and from 5-9 mg/L at the down current station. No plume was visible at the surface outside the immediate area of the dredging operation, and no significant plume was detected in the water column (ENSR, 1997).

Suspended solids in the water column were visible for a greater distance when dredging the parent material, which contained comparatively higher amounts of fine clay, during CAD cell construction with an open clamshell bucket (ENSR, 1997). The parent material dredged from the CAD cell is a better indication of the material proposed to be dredged for this Deep Draft Project. Turbidity measurements ranged from 3-7 NTU at the reference station 1,000 feet up current of the dredging, while 300 feet down current of the dredging turbidity ranged from 8-56 NTU. TSS ranged from 8-60 mg/L at the reference station and from 19-48 mg/L at the down current station. All values were well

below the 200 mg/L performance criteria established by the WQC for a point 500 feet down current of the dredging in the navigation channel.

Monitoring of the turbidity plume associated with dredging of silty maintenance material (using the environmental bucket) was performed on one occasion during Phase 2 of the project in September 1998 (USACE/Normandeau, 1998b). Mapping of the turbidity associated with use of the environmental bucket to dredge maintenance (silty) material in Boston Harbor was required as part of the Water Quality Certificate (WQC) for the BHNIP. Monitoring was performed during periods of high and low water slack and during maximum flood and ebb tides in the Mystic River. The mapping required generation of plan views of turbidity at mid-depth and near bottom extending from 300 feet up current to 1,000 feet down current of continuous dredging operations. Generation of a cross section of turbidity located 300 feet down current of the dredging was also required.

Near bottom turbidity values were highest for all measurements with values no higher than 100 NTU approximately 300 feet down current of the dredging operation. Mid-depth turbidity was much less, and all values returned to background levels (10-20 NTU) between 600 and 1,000 feet down current (ENSR, 2002). A separate monitoring trial was performed when the dredging contractor (Great Lakes Dredge and Dock Company [GLDD]) proposed to use their own environmental bucket (in addition to the approved Cable Arm® bucket).

The WQC for the BHNIP required the use of a closed environmental bucket for maintenance dredging. The bucket manufactured by Cable Arm® was specified as acceptable, and other closed buckets could be used if they could meet specified performance standards of suspended solids not to exceed 25 mg/L over background and turbidity not to exceed background by more than 30% at 75 feet from the dredge.

Monitoring of GLDD's closed environmental bucket was performed in September 1998 (USACE/Normandeau, 1998b). The bucket met the performance standard for total suspended solids, but not for turbidity. It was noted that the turbidity standard (not to exceed 30% above background at 75 feet) was a much more stringent standard for the conditions of this test when compared to the TSS. With a background turbidity of three NTU, the resulting performance threshold at 75 feet was only four NTU. Consequently, the MA Department of Environmental Protection (MA DEP) ultimately allowed the use of the environmental bucket based on its performance as related to suspended solids (ENSR, 2002). A more detailed bucket study performed by the USACE Engineer Research Development Center was also conducted in August 1999 during the BHNIP.

A conventional (open-faced) clamshell bucket, a Cable Arm® clamshell bucket, and an enclosed environmental clamshell bucket were evaluated relative to sediment resuspension and loading characteristics under similar operating and environmental conditions in Boston Harbor during August 1999 (Welp, *et al.*, 2001). Monitoring was conducted to characterize each bucket's near and far field sediment resuspension characteristics.

Sediment resuspension data consisted of suspended solids samples and turbidity measurements collected within 26 feet (in the horizontal plane) of the bucket position (near field) and 82 to 1312 feet from the dredge (far field). Near field data included continuous turbidity measurements taken at four depths (5, 18, 26, 34.5, and 38 feet in a water depth of about 38 feet) and discrete water samples were analyzed for TSS. Far field data included indirect turbidity observations using a Broad Band Acoustic Doppler Current Profiler (BBADCP), and direct turbidity, conductivity, temperature measurements, and direct water samples for TSS analysis collected by the Battelle Ocean Survey System (BOSS). The BBADCP collected acoustic measurements of the suspended sediment plume to produce images of the relative distribution of suspended-sediment concentrations in the water column.

Near field monitoring results showed that the conventional bucket generated the highest turbidity and suspended sediment, probably because of loss of sediments from the open top. The conventional bucket distributed turbidity throughout the water column. The TSS ranged from 105 mg/L in the

middle of the water column to 455 mg/L near the bottom. Average turbidity varied a bit less and ranged from 46 to 64 FTU (formazin turbidity units). Although both the Cable Arm® and the GLDD enclosed bucket leaked substantially through the seals and grated vents in the upper part of the buckets, neither resulted in as much turbidity or TSS as the conventional bucket. The depth-averaged turbidities were 57 FTU, 31 FTU and 12 FTU for the conventional bucket, Cable Arm® and GLDD enclosed buckets respectively. The depth averaged TSS values for the conventional bucket, Cable Arm® and enclosed buckets were, respectively, 210 mg/L, 31 mg/L and 50 mg/L. The most significant difference was in the middle water column where turbidity values were substantially less than at the bottom or near the surface. Turbidity for the Cable Arm® bucket ranged from 6 to 55 FTU, and TSS from 14 mg/L to 66 mg/L. The GLDD enclosed bucket resulted in turbidity from 1 to 31 FTU and TSS from 14 to 112 mg/L.

Monitoring was also completed for the Boston IHMDP during dredging, ship passage and disposal into the CAD cell from June 30, 2008 through October 28, 2008. Plume tacking included cross channel transects 300 feet up-current of the dredge and from 100 to 1500 feet down-current of the dredge. Dredge plumes were monitored during four slack tides (two high and two low), two ebb and two flood tides in each study area (near the Inner Confluence and halfway between Castle Island and Spectacle Island). Additional ADCP transects and CTD/turbidity vertical profiles were opportunistically taken in the wake of large vessels that transited the area during monitoring (USACE, 2009).

The above results show that a turbidity plume can be produced during dredging but is generally limited to the immediate vicinity of the dredge. An environmental (closed) bucket or Cable Arm bucket can reduce the amount of suspended solids in the water column during silt dredging. Due to the low turbidity associated with hard pack Boston blue clay and glacial till material that will be removed for the Deep Draft Project, a conventional, and not an environmental dredge bucket will be used to dredge the project. Also, an environmental bucket can not remove the clay and hard pan material. Dredging of the parent material (i.e. Boston blue clay) from the CAD cell in Boston Harbor did not show substantial turbidity plumes within or outside the navigation channel.

Plume tracking following disposal into a CAD cell was performed five times during Phase 2 of the BHNIP. Results of the turbidity measurements showed that elevated turbidity levels generally remained within the boundaries of the disposal cell itself, with limited down current transport. During one of the largest disposal events in Boston Harbor (7,200 cy of maintenance material in one 3-hour high tide window), elevated turbidity extended beyond the cell boundaries, but a significant plume was not identified beyond 300 feet down current of the cell. The Boston IHMDP monitoring of disposal into the Mystic River CAD cell occurred during five disposal events. The densest part of the plumes (40-50 NTU above background) were never observed beyond 500 feet from the point of release and usually well within the CAD cell or on one occasion at the CAD cell boundary. Any plume filament observed outside the CAD cell at or within 500 feet of the CAD cell boundary were at low concentrations (<20 NTU above background) (USACE, 2009).

4.2.2 Contaminant Impacts

Dissolved organic and inorganic contaminants in the environment may become adsorbed to sediment particles that can affect water quality during the dredging process. However, since the material to be dredged is far removed from anthropogenic influences, that is, the parent material which underlies material previously exposed to contaminants, (see Section 4.4.2 below) no or very minimal release of contaminants to the water column during dredging is anticipated. No significant water quality impacts from contaminants are predicted for this Deep Draft Project. No water quality violations were noted during dredging and disposal of silt material during construction of the BHNIP.

4.2.3 Dissolved Oxygen

Dissolved oxygen (DO) measurements were taken during disposal of silty surface material into the CAD cell for Phase 1 of the BHNIP at the reference point, 300 feet down current and 200 feet lateral of the cell, and 1,000 feet down current of the cell (ENSR, 1997). DO concentrations ranged from 6.4-8.2 mg/L over the five monitoring events. There was no apparent difference between reference and down current locations. Lower DO concentrations were consistently noted at all monitoring locations during the later stages of ebb tide.

For Phase 2 water quality monitoring, DO levels varied widely from 4-11 mg/L as the monitoring was performed throughout the year (ENSR, 2002). However, during any given monitoring event, background and down current concentrations were very similar.

After completion of the first round of capping, the elevations of the tops of capped cells M4, M5, and M12 ranged from 9 to 15 feet below the surrounding harbor bottom. Concern was raised that the DO levels might be further lowered due to reduced circulation over the depressed CAD cells. MADEP amended the WQC to require measurement of DO in near bottom (within three feet) waters over the three cells and in surrounding waters during the months of July-October 1999 (USACE/Normandeau, 2000b).

DO levels displayed a clear decrease as water temperatures increased in the late summer, with values dropping below the State's 5.0 mg/L standard. However, the decrease was similar to that noted in the surrounding areas beyond the boundaries of the cells (ENSR, 2002). Although the high organic content of the newly exposed dredged material in the cells was expected to cause anoxic conditions at the sediment-water interface, the depressed nature of the cells did not appear to affect dissolved oxygen content of the immediate overlying waters.

As the material to be dredged will have low organic matter and be disposed outside Boston Harbor, no impacts to DO are expected from the proposed project. The change in elevation within the navigation channel will not cause a significant difference in DO levels as this area is well flushed by the tides and currents passing in and out of Boston Harbor.

4.2.4 Biological Resource Impacts

4.2.4.1 Eelgrass

There are no eelgrass beds within the Boston Harbor Federal Navigation Project. The eelgrass bed closest to the project would be the MA DMF restored bed off of northern Long Island (Leschen *et al.*, 2010) which is at least 2,000 feet south of the Federal channel. The Boston IHMDP monitoring showed that at most low concentration dredge plume filaments traveled outside the channel as far 650 feet from the edge of the channel (USACE, 2009). The northern Long Island eelgrass bed would not be expected to be impacted by any dredge plumes since the plumes typically stay within the channel, and any plume filaments that do leave the channel boundaries are not expected to travel the distance necessary to reach the eelgrass bed.

4.2.4.2 Benthic

Most shallow benthic habitats in estuarine systems are subject to deposition and resuspension events on daily or even tidal time scales (Oviatt and Nixon, 1975). Many organisms have behavioral or physiological responses to sediments that settle on or around them. Many organisms avoid the area of disturbances while others have a tolerance to attenuated light conditions or anaerobic conditions caused by partial or complete burial. Direct effects of sedimentation include smothering, toxicity (exposure to anaerobic sediment layers), reduced light intensity, and physical abrasion, where as indirect effects include changes in habitat quality (Wilber, *et al.*, 2005).

Studies of burial of estuarine invertebrates found species specific responses. According to Hinchey *et al.* (in Berry, *et al.*, 2003), the responses varied as a function of motility, living position and inferred physiological tolerance of anoxic conditions while buried. The deposition of dissimilar sediments has a greater impact on organisms than sedimentation of like materials (Maurer, *et al.*, 1978, 1986). In the navigation channel, the benthic community already experiences and has adapted to sedimentation stress caused by resuspension of sediments due to large vessel traffic. Monitoring of previous dredging activities has shown that any sediment plumes settle out predominantly in the dredge area (see Section 4.2.1 General Impacts of Dredging in Boston Harbor) limiting the extent of additional stress to the system.

Temporary increases in turbidity can have a short-term localized effect on the benthic community and potential effect on fish. Effects associated with turbidity include reduced vision and masked odors, both of which are important to foraging organisms. Suspended silts may also clog or abrade gill structures and interfere with feeding mechanisms of filter feeders. The usually high organic content of silt/clay material would reduce ambient, dissolved oxygen concentrations. Increased turbidity would reduce light penetration lessening primary productivity, and, therefore, oxygen release from primary producers would be lessened. Finally, upon settling, the suspended sediment load could cover non-motile plants and animals.

Turbidity impacts are dependent on the concentration and the duration of the suspended sediments (Clarke and Wilber, 2000). Motile organisms can generally avoid unsuitable conditions in the field. Under most dredging scenarios, fish and other motile organisms encounter localized suspended-sediment plumes for exposure durations of minutes to hours, unless the organism is attracted to the plume and follows its location. Adult fish responses to suspended sediments for durations of less than one day at concentrations $\leq$1,500 mg/l, i.e., conditions relevant to most dredging project scenarios, have not been sufficiently studied to reach definite conclusions (Clarke and Wilber, 2000). Fish eggs and larvae are more sensitive to suspended sediment impacts than older life history stages; however, most of the available data for eggs and larvae pertain to freshwater conditions (Clarke and Wilber, 2000).

Although adult bivalve mollusks are silt-tolerant organisms (Sherk, 1972 in Clarke and Wilber, 2000), they can be affected by high suspended sediment concentrations. Hard clams (Pratt and Campbell, 1956 in Clarke and Wilber, 2000), and oysters (Kirby, 1994 in Clarke and Wilber, 2000), exposed to fine silty-clay sediments have exhibited reduced growth and survival, respectively. Suspended sediment concentrations required to elicit these responses and mortality, however, are extremely high, i.e., beyond the upper limits of concentrations reported for most estuarine systems under natural conditions, as well as typical concentrations associated with dredging operations. Sublethal effects, such as reduced pumping rates and growth, were evident for adult bivalves at concentrations that occur under natural conditions, but may be of a short-term (i.e. hours to days) duration, for example, during a storm (Schubel, 1971; Turner and Miller, 1991 in Clarke and Wilber, 2000). As with estuarine fish, the egg and larval stages of shellfish are more sensitive to suspended sediment impacts than adults. Estimates of suspended sediment impacts to these pelagic, early life history stages must consider the local hydrodynamics of the dredging site, which strongly influence the likelihood of extended exposure to suspended sediment plumes (Clarke and Wilber, 2000).

The benthic community in the navigation channel will be initially eliminated by direct removal from the dredge. Once dredging is completed, the benthic community is expected to return to pre-dredge conditions within a relatively short period of time (months in some cases), depending on the time of year of disturbance, location within the harbor and substrate. The Benthic Subsection of the Affected Environment (Section 3.3.2) presents details on benthic communities that were sampled about three years after being dredged. Monitoring of the CAD cells located in the Inner Confluence, Mystic River and Chelsea River four to seven years after they were capped with sand, showed that the benthic community in this portion of the harbor was stressed. Both the CAD cell stations and the reference

stations were predominated by pioneering Stage I fauna (ENSR, 2007). However, despite the stressed nature of the benthic community in the Inner Harbor, abundant small and medium-sized fish, including juvenile flounder, and shrimp and crabs were evident in the video images. Monitoring revealed that the sand caps on top of the CAD cells are accumulating a layer of silt/clay. Areas both within and outside of the CAD cells appear to be providing comparable epibenthic habitat (ENSR, 2007). Studies by McCauley *et al.* (1977) in Oregon indicated that pre-dredging conditions in a channel could be reestablished in as little as 28 days after dredging ceases. However, complete recolonization by sedentary adult forms of many pre-dredging organisms could take up to several years.

Side scan sonar, core samples, grab samples, and subbottom profile data was collected as part of geological study for the proposed Deep Draft Project in the Main Ship Channel (Ocean Surveys, 2006, Appendix J). Ocean Surveys, Inc. correlated coring data with the remote sensing data to enhance the previously presented surface map and generate sediment type maps of the seafloor and at -47 feet MLLW and -50 feet MLLW. This information can be used to help predict what type of sediment may be exposed after dredging. Based on Ocean Surveys, Inc. data, the surficial material east of Deer Island appear to be Type 1 (predominantly coarse grained materials consisting of gravel and/or bedrock) and Type 2 (poorly sorted fine to coarse grained material, consisting of coarse to fine grained sand). West of Deer Island the material was predominantly Type 2 and further west the material became Type 3 (predominantly fine grained materials, consisting of fine sands, silt and mud. Although the data was sparser at the deeper depths, significant amounts of clay were mapped in the eastern part of the Reserved Channel, continuing southeastward in the Main Ship Channel and the President Roads area at the -47 feet MLLW depth. In other areas of the Main Ship Channel north of the Reserved Channel, it was also estimated that clay existed at the -47 feet depth, but with lower confidence. Although there was no direct evidence of clay at the -50 foot depth MLLW, areas were classified as clay to -50 feet MLLW where the subbottom record indicated a clear continuation of the acoustic properties of clay. It was also considered likely that silt may be encountered at water depths at or below -47 and -50 feet because of the silt contained at the surface of the cores.

The results of this mapping effort indicate that dredging in the Main Ship Channel, Reserved Channel and Presidents Roads may expose a finer surface than currently exists. If significant amounts of Boston blue clay are exposed, than the benthic community may be reduced in the number of species and the number of organisms. New material deposited in the new navigation channel will encourage the return of a more diverse benthic community in the future.

While the Federal navigation channels, anchorage area, and berth areas are previously disturbed sites, they still provide some habitat for estuarine organisms. However, approximately 22 acres of previously undisturbed bottom would be impacted from the Deep Draft Project. The benthic community inhabiting this undisturbed habitat would be expected to vary with the sediment type and location within the harbor. Sediment type would be expected to range from coarse grained sand and gravels to fine grained silts and mud. The exposed sediment may be similar to what is described above for the deepened navigation channels.

Most mobile organisms living on the surface would be displaced during dredging operations, but would return as benthic organisms recolonize the area and are available to serve as a food source. Some motile organisms such as crabs and lobster are not always capable of leaving their shelter due to physiological circumstances such as molting or cold temperatures in which case dredging would directly impact these individuals.

The MA Division of Marine Fisheries (DMF) has identified suitable shellfish habitat for softshell clams, blue mussels, and razor clams in the vicinity of some of the dredge areas. No significant populations of shellfish are noted in the navigation channels. However, the presence of softshell clams was confirmed by one grab sample collected in the Chelsea River outside the navigation

channel. The deepening of the Chelsea River may impact some shellfish beds (see Figure 3-5). No other shellfish beds are expected to be directly impacted from the widening of the navigation channels (see Figure 3-5). If any shellfish inhabit the Federal channel areas, they will be removed and destroyed from dredging. Any shellfish inhabiting the surrounding areas are not expected to be significantly impacted by sedimentation given the nature of the turbidity plume to stay within the confines of the navigation channel and because the shellfish beds are located close to shore. Any shellfish inhabiting adjacent areas near the navigation channel, outside the direct impact of dredging, would be expected to be capable of tolerating short-term temporary increase in suspended sediments, such as experienced during ship traffic or naturally occurring storm events.

4.2.4.3 Lobsters

Lobsters are present in Boston Harbor and the larger class sizes are likely to inhabit the navigation channel in the same manner as they use the habitats outside the dredge footprint. The larger lobsters are motile and have the ability to leave any area of disturbance, except during the winter when movements are restricted due to the cold temperatures or when molting (Cobb, 1976). The early benthic phase (EBPs) and juvenile lobsters that need shelter for survival tend to inhabit the more shallow areas outside the navigation channel and along island coastlines, and not in depositional areas such as the Entrance Channel, Mystic and Chelsea River channel areas, as discussed in the Lobster subsection of the Affected Environment. All lobsters <40 mm CL are defined as early benthic phase lobsters (Wahle and Steneck, 1991), as determined by their presence in the same habitats as YOY and by their restricted mobility (Wahle and Steneck, 1991). Both YOY and second year lobsters (those between 12-40 mm CL) are found in the greatest densities in depths between 5 and 10 meters (Wilson, 1998). This is confirmed by MA DMF in their suction sampling program in Boston Harbor by contrasting the lower density of YOY (<12 mm CL; Figure 3-13) with the higher densities of larger EBPs (Figure 3-14), at the same location, and by noting that the depths at which these lobsters occur range from 12-20 ft (see Table 3-12).

As YOY lobsters will not likely settle in the deeper navigation channels, due to depth restrictions and possible presence of thermoclines, and lobsters <40 mm CL are less mobile than those >40 mm CL, then it is likely that such lobsters will remain in the same habitats as the YOY and be subject to the same perturbations as the YOY. Thus, actual dredging activities are unlikely to have an effect on such lobsters because they are unlikely to be located in the navigation channels.

The larger juveniles, and adult lobsters could be present in the areas of ledge removal. However, they are expected to have the ability to move away from project activities associated with rock removal (drilling and setting the charges) operations. Blast activities, which could spread plumes of sedimentary material and shockwaves, are expected to impact those locations near the navigation channel where YOY and EBP lobsters (<40 mm CL) are likely to be found (see Figures 3-14 for known locations). There is currently no information on effects of blast shockwaves on these life history stages, so no predictions can be made with regard to how they will be impacted by such perturbations. These sizes of lobsters are capable of sediment digging activities (Cobb, 1972) and presumably could withstand increased particulate matter in the water column, as long as it is not of such a degree as to clog their gills. Since lobsters do not have a swim bladder they should be resistant to the shockwave effects of any blasting activity (Keevin and Hampen, 1997), unless in they are in the immediate vicinity of the blast.

Lobster investigations were conducted during the BHNIP to address concerns that the fishery was being impacted by the dredging operations. In response to this concern, the MA DMF increased the number of MA DMF observers on lobster trips and additional efforts were made to assess and document catches/landings in the Reserved Channel by the Independent Observer hired by the State for the BHNIP (ENSR, 2002). Dredged material was screened in the barges for lobster and an underwater video was used to survey areas to be dredged. The results of these surveys showed

juvenile lobsters in the project area, but not in large numbers. In addition, no lobsters were observed during any of the dredging oversight or on screened material (ENSR, 2002).

It is assumed that some ovigerous (egg bearing) females are likely to remain in Boston Harbor, spawning early, and brooding and hatching their eggs annually within the harbor (see Subsection 3.3.4). If the females remain resident in the area throughout the year, they are likely to remain within their shelters and move little during the winter months. As a result, any physical disruption of their habitat in winter months could directly impact these individuals and their brooding embryos due to their reduced ability to move quickly during cold temperatures. Lobsterman fish within the Boston navigation channels year round (although it is illegal to do so), indicating that at least some of the lobsters are mobile within the channel areas during the winter months. It is unknown what percentage of this mobile population are ovigerous females. Consequently, there may be some direct impact to these individuals. However, dredging operations would only impact a small area at any one time allowing the lobsters capable of moving to leave the area of disturbance. Also, the elimination of illegal lobster fishing due to the construction activities in the navigation channels could potentially offset construction impacts to lobsters as lobsters may be expected to more likely avoid a dredge bucket than a lobster pot.

Surveys submitted by the lobstermen indicate that most of the lobster fishing activity occurs below the Third Harbor Tunnel. It is assumed that this may be an indication of the relative abundance of lobster in the Boston Harbor project area. Although fishing in the navigation channel is prohibited, the lobstermen will be notified by email prior to movement of the dredge so that they may relocate their pots to not be impacted by dredging activities. A similar notification process was effectively employed for BHNIP, the OHMDP, and the IHMDP to minimize impacts to lobster gear by the dredging operation.

4.2.4.4 Fisheries

Minimal levels of sedimentation can potentially have an adverse impact on early and/or critical life stages of fish and shellfish. Sediments have the potential to bury demersal eggs, while larvae may be trapped or buried by the sediments (Wilbur and Clarke, 2001; Berry *et al.*, 2003). Winter flounder is a Federally managed demersal (bottom dwelling) fish that is commercially exploited and found in the project area. Winter flounder eggs are demersal and larvae are found near the bottom in shallow areas. However, since winter flounder spawn on various substrates and in areas less than 16 feet deep, the navigation channel with it's greater depths (> 16 feet) and ship disturbance would not be considered spawning habitat for winter flounder.

Monitoring from BHNIP showed that the dredging plume was generally localized to the immediate dredge area (within 600 feet) irrespective of tide direction and stayed within the navigation channel (USACE/Normandeau, 1998c-f, 1999a,b,d-i,k-n, 2000a). Monitoring from the IHMDP also showed the dredging plumes to be of relatively low concentrations and localized to the immediate dredge area (within 500 feet for the highest turbidity readings) (USACE, 2009). Therefore, it is expected that most of the suspended sediments from this dredging operation, which are composed of glacial till or Boston blue clay, will resettle quickly in nearby areas. Consequently, any impacts associated with sediment resuspension and transport are expected to be limited to the near-field areas. Also, plume modeling of the Boston Harbor Outer Harbor Maintenance Dredging Project using the SSFATE model (USACE, 2003b) showed that the heaviest deposition of sediment would occur within the immediate vicinity of the dredge. Some deposition occurred outside the navigation channel, but the majority was contained with the channel or anchorage area. Monitoring from the IHMDP did show low concentration plume filaments (<10 NTU) on two occasions as far as 650 feet from the channel. This was only observed in the southern monitoring area (half way between Castle Island and Spectacle Island) where current flows are more complex than within the inner harbor between Castle Island and the Inner Confluence (USACE, 2009).

The sedimentation rate predicted from modeling is significantly less than the amount reported to affect winter flounder eggs, as reported in two separate experiments (one laboratory and one field). In the laboratory experiment, Berry *et al.* (2005) performed a series of three tests to better determine the effects of burial in clean sediment on the hatching success of winter flounder eggs. Recently spawned eggs (three to five days after fertilization) were exposed to clean, fine-grained sediment with burial depths from a dusting (<0.5 mm) to 9.3 mm (> 10 egg diameters), and a control (no sediment). Results showed that percent total hatch eggs buried in < 1.0 mm sediment was generally not statistically different from that of controls. Percent total hatch was highly variable in eggs buried in about 3 mm of sediment, while there was little or no hatch of eggs buried in sediment > 3 mm. The "dusting" (<0.5 mm) is five times greater than the sediment deposition the SSFATE predictive model indicated would be deposited outside the channel (0.01 to 0.1 mm). In addition, no statistical difference was noted between the control test and burial of < 1.0 mm of sediment, which is 10 times greater than the amount of deposition predicted by the SSFATE model.

In the second experiment, field tests were conducted in 2003 and 2004 with winter flounder eggs and larvae during dredging of the Providence River and Harbor Maintenance Dredging Project (Klein-MacPhee, Macy, and Berry, 2004). Newly spawned flounder eggs were placed in weighted arrays holding nine chambers with 100 winter flounder eggs per chamber. One array was placed adjacent to the dredge (test) and another outside the influence of the dredge (reference). There was a significant difference in the amount of sediment deposited within the chambers, depending on the location; 3.59 g dry weight in the test chamber vs. 0.69 g dry weight in the reference chamber. Sediment deposition in the test chamber was 8 mm thick and 4 mm thick in the reference chamber (Klein-MacPhee and Macy, 2005). However, there was no statistically significant difference in response between the reference and test chambers containing the live eggs and larvae as a result of deposition. There was, though, a slightly higher greater survival in the reference chambers of eggs and larvae when compared to the experiment (15.5% vs. 14.1%). Larvae were observed hatching and wriggling up through the sediment in both chambers.

Although the above described results of the predictive modeling did not include the Mystic River and the Chelsea River, dredge plumes tend to generally follow the same pattern of heaviest deposition within the navigation channel based on the above dredge plume monitoring results. Taken in context the predictive model results with available laboratory and field experiments, dredging is likely to have little, if any, impact on the survival of winter flounder eggs and larvae outside the navigation channels. Monitoring from the IHMDP (USACE, 2009) did address the potential for suspended sediment to be transported and deposited on potential winter flounder spawning grounds during dredging and disposal activities. At no time were any dredge plume remnants found to migrate onto sensitive resource areas. Juveniles and adults of demersal fish are motile and have the ability to swim away from any disturbances caused by dredging activities.

The SSFATE model also predicted where the turbidity plume might disperse depending on the location of the dredge. Turbidity values were predicted for the mid-depth of the water column and generally ranged from 30 to 50 mg/l. The plume and associated elevated turbidities were confined primarily to the navigation channel. This was far less than the disposal criteria as required in the WQC for the BHNIP.

The results of the SSFATE modeling as noted above generally agree with the plume monitoring conducted when dredging a CAD cell in the Mystic River during the previous BHNIP. Monitoring of the dredge plume was conducted on one occasion during the four required tidal events: slack ebb, slack flood, maximum ebb, and maximum flood. For each tidal cycle, sufficient data was collected to produce a plan view of turbidity contours, both upstream and downstream of the dredging activity, as well as a cross section 300 feet down current to reflect the full depth of the water column.

The overall results of the dredge plume monitoring show that near-bottom turbidity levels were highest for all measurements with values as high as 100 NTUs (from disturbance during spud removal) approximately 300 feet down current of the dredging operations during maximum flood tide. Mid-depth turbidity levels were much less. Turbidity levels for the near bottom and mid-depth levels were generally lower, ranging from between 25 and 60 NTUs. The plume dissipated between 600 and 1,000 feet down current where all values returned to background levels (10-20 NTUs) irrespective of the tide direction or intensity. Typically, the plume also returned to background levels within 200 feet or less laterally (or to the side) of the dredge (USACE/Normandeau, 1998).

The Boston IHMDP dredge plume monitoring (USACE, 2009) showed that in strong tidal currents the plumes were narrow and concentrated near the dredge (150-250 feet wide), up to 20 NTU above background, and usually present from surface to bottom; then they widened, dissipated and settled to the lower half to two-thirds of the waver column as they were carried down the channel by the tide. The plumes dissipated to background levels typically between 1000 and 1500 feet down-current. As the dredge plumes dissipated they tended to be found across the full width of the channel in the lowest one-third (or less) of the water column at low concentrations (<5 NTU above background) as they approached background levels. During slack tide conditions the dredge plumes pooled beneath the dredge, typically no wider than 100-150 feet wide and dissipated to background levels in as little as 500 to 1000 feet down-current of the dredge. The dredge plumes were typically confined to the channel, although low concentration plume filaments were observed on two occasions as far as 650 feet from the channel in the southern monitoring area, but did not impact any nearby sensitive resource areas.

Plume tracking during the BHNIP and IHMDP also showed limited turbidity transport during disposal into a CAD cell. Any elevations in turbidity were generally limited to the boundaries of the disposal cell, with minor down current transport. During the largest disposal event of the BHNIP (7,200 cy of dredged material disposed during high slack tide), elevated turbidity levels extended beyond the cell boundaries, but a significant plume was not identified beyond 300 feet down current of the CAD cell. Monitoring from the IHMDP showed that within 15 minutes of release all observed disposal plumes were limited to the lower two-third of the water column, where the plumes were confined to the channel. The lack of a substantial plume at the surface of the water column, to the sides of the dredge, or 600 feet downstream indicates that the plume from dredging or disposal is narrow when compared to the overall width of the harbor and should not impede the passage of any anadromous fish movements.

Turbidity was also monitored for the Providence River and Harbor Maintenance Dredging Project. The purpose of the Providence River and Harbor Maintenance Dredging Project monitoring was to ensure compliance with the State of Rhode Island Water Quality Standards. The timing and intensity of the monitoring were triggered by specific disposal events with the results compared to specific project compliance criteria along downfield transects. The results of this monitoring showed that the sediments resuspended by the CAD cell disposal events (as well as nearby dredging) generally returned to background levels within 500-800 feet of the disposal cell. No elevations were observed at the 1,800 feet down current compliance transect, even when the dredges were working adjacent to the disposal cell.

Turbidity studies conducted for the previous BHNIP, as discussed above, indicated that the turbidity only affected a small portion of the cross section of river at the time of dredging. No large schools of fish were observed in the vicinity of cell excavation or disposal. Although fish may be deterred by the construction activities, there was no evidence that construction presented an overall impediment to fish passage (ENSR, 2002) given the dredge footprint and nearfield water quality impact. Anadromous fish such as smelt, alewife, and blueback herring use Boston Harbor, the Mystic River and Chelsea River for passage to upstream spawning locations. These species spawn in freshwater located upstream of the project area. Based on the above modeling and turbidity studies; dredging is not

expected to have a significant impact on anadromous fish species migrating towards their spawning areas during the course of dredging.

4.2.4.5 Marine and Coastal Birds

The effects of dredging on marine and coastal birds in the Federal channel would be minimal. Most of the species of birds identified in the Marine and Coastal Birds Section and Appendix W may be found in various areas of Boston Harbor and Massachusetts Bay, depending on the season and species-specific foraging habits. Many of these bird species have large foraging and migrating ranges; therefore, the chances of dredging having an adverse effect on a particular species' population in these areas are small. Most birds in the Boston Harbor area would use the shallow and intertidal habitats and not the channel areas where dredging operations would occur. The operation of the dredge in the channel would likely cause most birds to avoid or leave the immediate project area(s). The food value for any waterfowl, especially diving birds in the area is limited by depth. Dredging may temporarily decrease the prey availability for some species; however, impacts would be minimal given the overall project footprint relative to other potential feeding areas within the harbor.

4.2.4.6 Marine Mammals and Reptiles

The use of Boston Harbor by whales, dolphins, seals, or sea turtles is possible but not common. The potential for finding any of these species does increase at the MBDS and the areas used to travel through to get to the disposal site. All of the sea turtle and most of the whale species that have any potential of being in Boston Harbor and Massachusetts Bay are endangered species and discussed in the Threatened and Endangered Section in the Affected Environment. The harbor seal, harbor porpoise, gray seal, white-sided dolphin, and minke whale all have the potential to be present in some area of the project operations. The white-sided dolphin has the least potential to be impacted by the dredging and disposal operations since they tend to be found further out on the continental shelf. Minke whales are found in Massachusetts Bay and while none have been recorded at the MBDS they have been identified in surrounding areas (Short and Schaub, 2005). The harbor seal, harbor porpoise, and gray seal have the potential to be found at both the dredge areas and along the path to the disposal area, but if any wander into the harbor during dredging activities their mobility will allow them to avoid impact. Therefore, no significant impacts to any of these species are expected as a result of dredging or disposal activities. Potential impacts to marine mammals from rock blasting are discussed in the next section.

4.2.5 Underwater Blasting Impacts

Up to about one million cy of rock could be removed from the harbor, some of which may require blasting to deepen the navigation channels and anchorage area in Boston Harbor. Potential aquatic impacts associated with blasting include noise, thermal energy release, increased turbidity, damage to structures, and effects on aquatic life, all of which are expected to be minor and temporary in nature due to the precautions to minimize the shock wave. These impacts would be generated as a result of vibrations, explosion-induced surface water waves, or air overpressure.

Similar construction techniques used in previous Boston Harbor dredging and blasting projects did not result in any observed damage to piers, bulkheads, tunnels, or bridge foundations. Because the same techniques will be used for the Deep Draft Project, it is unlikely that permanent damage to these structures will occur.

Any impacts to aquatic populations would be localized and temporary, with the most pronounced effect on aquatic species in the immediate vicinity. Below is a discussion of potential impacts to aquatic resources by group. Additional discussions on blasting impacts to threatened and endangered species are provided in Section 4.6 below.

4.2.5.1 Invertebrates

The effect of blasting on hard-bodied invertebrates would tend to be small except in the immediate vicinity of the blast. Damage to hard-bodied invertebrates near the blast site might include cracked or broken shells and carapaces. Soft-bodied invertebrates in the immediate vicinity would be killed, while populations of those in outlying areas would sustain less damage. Long term impacts are not expected.

4.2.5.2 Sea Turtles

The sea turtles in Massachusetts nearshore waters are typically small juveniles. While no surveys for sea turtles have been conducted in Boston Harbor, National Marine Fisheries Service (NMFS) believes that suitable forage and habitat exists in this area and it is likely that sea turtles may occasionally visit Boston Harbor. Measures to protect sea turtles are described in more detail in Section 4.6 below. Due to the protective measures that will be in place and the rare presence of sea turtles in Boston Harbor, any impacts to sea turtles from blasting are not expected to be significant.

4.2.5.3 Fish

The extent of damage to fish populations depends primarily on the proximity to the blast and the presence or absence of a swim bladder. Fish with swim bladders (e.g., Atlantic herring) will be unable to adjust to the abrupt change in pressure propagated by the blast. If they are within a zone of influence, fish with swim bladders may be injured or killed. Fish without swim bladders (e.g., winter flounder) are less likely to be injured, and would likely sustain injuries only if they are in the immediate vicinity of the blast. Blasting may displace resident fishes, although this impact is expected to be only temporary. Blasting impacts will be avoided or minimized by the methods discussed in the following paragraphs.

Several precautionary measures were put in place to avoide or minimize the incidence of injury to fish and marine mammals from blasting in Boston Harbor for the BHNIP and IHMDP. Blasting mitigation measures included:

- Use of a fish detecting and startle system to avoid blasting when fish are present or transiting through the area;
- Require the use of sonar and the presence of a fisheries and marine mammal observer;
- Prohibiting blasting during the passage of schools of fish, or in the presence of marine mammals, unless human safety was a concern;
- Using inserted delays of a fraction of a second per blast drill hole, and;
- Placing material on top of the borehole (stemming) to deaden the shock wave reaching the water column.

No injuries to fish were reported during blasting for the BHNIP. However some fish kills were noted during blasting in Boston Harbor for the IHMDP.

Four fish mortality events were observed and recorded during 13 underwater blasting events in Boston Harbor during the ledge pinnacle removal project in late fall of 2007. These fish kills happened despite following procedures that had 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 of the Clupeidae family (i.e. blueback herring and alewife) from entering the blast area, and a fish observer to oversee and determine the appropriate blast time.

Following the first mortality event, the USACE 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 USACE prepared an "After Action Report" to summarize information on all of the blasting events.

One of the lessons learned from the above fish kills is that the fish startle system appeared to be less effective when it was placed on the blast barge. The blast barge is stationary and moved away from the blast site just prior to the blast, thougth there is some lag time. For the Boston Harbor Rock Removal Project in 2012, the fish startle system was placed on separate boat whieh circled the blast area. With the fish startle turned on, fish could be seen scattering from the safety area. By having the startle system on a smaller more mobile boat, the startle system could be employed until seconds before the blast, thereby significantly reducing the time for fish to re-enter the blast area. No fish kills were reported with any of the six separate blast events in 2012.

This lesson learned will be added to the list of precautionary measures for the Deep Draft Project and conveyed to the interagency underwater blasting technical working group of 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 2012 rock removal, the knowledge and other corrective measures identified and found practicable to minimize potential fish impacts from blasting during construction of the Boston Harbor Deep Draft Project.

The above group will also focus on construction sequencing for several areas of the harbor, constraints on work during certain tidal and weather conditions, and potential air emission mitigation. The results of this research will form the basis for agency discussions on measures to be implemented for the Deep Draft Project and the development of a Dredging/Blasting Mitigation Measures Plan. See Appendix A for response to General Topic #3 for additional details.

4.2.5.4 Marine Mammals

Although marine mammals are infrequent visitors of Boston Harbor, they could be potentially be affected by blasting if they should occur too close to the blast site. If present during a detonation, individuals would likely sustain injuries as a result of pressure waves produced by the blast. To avoid this potential impact, a marine mammal observer will be present during all blasting events and will provide guidance to the contractor on when to restrict blasting if a marine mammal is within or in close proximity to the established safety zone (assuming no human safety concerns exist). Additional details on protective measures for marine mammals can be found in Section 4.6 below.

4.2.6 Confined Aquatic Disposal (CAD) Cells

The potential for use of CAD cells for the Deep Draft Project is limited. As described above in Sections 4.2.1, 4.2.2, and 4.2.4, physical, chemical, and biological impacts from constructing and disposing of dredged material are temporary and not significant, based on the monitoring results for the BHNIP.

4.3 Benefits and Impacts at the Potential Habitat Enhancement Sites

The placement of blasted rock in a shallow area with low biological productivity has the potential to provide critical reef habitat for several life stages of commercially important species such as American lobsters. This hard-bottom substrate type exhibits surficial complexity which provides the relief and interstitial spaces necessary to shelter cryptic species such as lobster and juvenile finfish (MA DMF, 2006). Numerous other species of fish and shellfish such as Atlantic herring, ocean pout, and Atlantic wolfish also find refuge in cobble/gravel habitat areas during vulnerable early life stages (MA DMF, 2006). Sessile invertebrates, important to the productivity and diversity of an area, also are dependent on complex hard bottom (MA DMF, 2006).

Rock removed from Boston Harbor will have an assortment of sizes and shapes. The pieces are expected to range from cobble to boulder size. This variation in size and shape would accommodate a variety of species and life stages. Proper placement of the reef is of critical importance.

Selection of an appropriate reef site is based on the criteria presented in Section 2.7. Other criteria are also important for successful reef placement such as the presence of hard substrate located at or near the ocean floor to prevent the reef from sinking. Natural sedimentation rates in the placement area should be low enough to prevent burial of structures over time. In high-energy coastal waters, reef structures usually require mechanical stabilization to prevent shifting or relocation by waves or storm surges. The area should exhibit good water quality. Areas with chronic low DO (hypoxia), and rapid changes in salinity, water clarity, temperature, and nutrient concentrations will negatively impact reef fish and invertebrate communities (USACE, 2003). Based on these considerations, the Broad Sound and Massachusetts Bay sites would be most compatible nearshore areas to Boston Harbor for rock placement.

Prior to selection of the final site for rock placement, the USACE expects to conduct additional studies in coordination with State and Federal resource agencies. The results of the study will help determine which of the two remaining sites is most suitable for habitat enhancement.

Depending on the design of the reef(s), the placement of between 450,000 and 1.4 million cy of rock would cover between 220 acres to 530 acres of soft bottom habitat. See Table 4-1 below. This amount of cover assumes linear rows of rock placed 100 feet apart, and five feet high. Rock placed in rows would create more edge habitat and increase circulation.

Table 4-1. Hard Bottom Habitat Creation

Navigation Channels Improvements – plus Plans D and F	45 Foot Main Channel	47 Foot Main Channel	50 Foot Main Channel
Volume of Rock Generated by the Project			
Main Channels Improvements – A-B-C	446,700	899,800	1,380,900
Main Ship Channel Extension to MMT	78,400	78,400	78,400
Chelsea River Channel (40 Feet)	500	540	500
Total Rock (Cubic Yards)	**525,600**	**978,740**	**1,459,800**
Area of Bay Bottom Needed for Habitat Creation Site			
Cross-Sectional Area (SF) of 5-Foot High Mound with 50-Foot Base and 1:3 Slopes	175	175	175
Linear Feet of Mound Formed	81,093	151,006	225,226
Square Miles Covered at 100-Ft Spacing (Approximate Acres)	0.29 (186 acres)	0.57 (365 acres)	0.81 (518 acres)

Like any water disposal option, the placement of rock for habitat enhancement could have a temporary impact on water quality. Turbidity from the placement of rock can occur during two phases. One when sediment clinging to the rocks is washed away during placement, and two, from displacement of the floor bed as the rock hits the bottom. Turbidity levels would be expected to return to background levels within a few minutes or hours after disposal.

Biological productivity and diversity may be temporarily reduced in the habitat enhancement area prior to the colonization of the rocks by encrusting organisms and larval settlement. It would be expected that mobile macroinvertebrates, fish and solitary tunicates would be able to utilize the new habitat rapidly, as well as crabs and lobsters (Barber, *et. al.*, 2007).

Demersal species such as American plaice, Atlantic halibut, summer flounder, winter flounder, windowpane flounder, witch flounder, red and white hake, and yellowtail flounder may be present in the finer sediments at the proposed enhancement sites. The placement of a rock reef in the fine sediment areas of the proposed enhancement sites would displace some of these EFH listed species, but not all. Some EFH species such as juvenile and adult American plaice, juvenile Atlantic halibut, and adult winter flounder may also continue to use the rock reef as habitat.

Artificial reefs were recently created from cobble and rocks to mitigate for the loss of hard bottom habitat from construction of the HubLine (gas pipeline). Although there are similarities between the artificial reefs created for the HubLine project and natural reefs, there are also several differences. These differences may be attributed to the lack of time (about a year) for the artificial reef to develop ecologically or to real differences in structure between the artificial reef and natural reef used for comparison. The following information is based on the first year progress report prepared by the MA DMF (Barber, *et. al.*, 2007).

Diversity analysis on enumerated species indicated that there was no significant difference between the artificial reefs created for the HubLine project and the natural reef located in Massachusetts Bay for mobile macroinvertebrates, solitary tunicates, bivalves, and fish. The diversity analysis conducted on species assessed using percent cover (i.e. encrusting tunicates, sponges, barnacles, and macroalgae) revealed no differences across sites or seasons; although it is possible with a larger sample size that the variance would decrease and trends in these results would be more evident.

Some differences noted between the natural reef and artificial reef included the greater sponge diversity and abundance on the natural reef than the artificial reef. The natural reef had five species of sponges with a cover per square meter of 4% while the artificial reef only had three species of sponge cover of less than 1%. Red filamentous algae and common kelp (*Laminaria* sp.) cover was higher on the natural reef but is expected to catch up on the artificial reef.

The fish tagging study indicated that the artificial reef is likely to continue supporting relatively large cunner populations, a structure-oriented fish, as compared to the natural reef or sand areas due to the high relief and large number of variable-sized interstial spaces of the artificial reef. However the report cautioned that the large cunner population could have an influence, although unlikely, on species composition of the reef. The air-lift monitoring program is able to sample larvae, young-of-year fish and crustaceans. The results of this program showed that the larval settlement on the artificial reefs reached comparable levels to that of the nearby natural reef in a matter of months. Artificial reefs reached similar levels of species diversity relative to the natural reefs within five months of their deployment.

Although the first year progress report prepared by MA DMF (2007) cautions the use of artificial reefs as direct mitigation as was the case for the HubLine project, the proposed beneficial use of rock from this proposed project would be used for enhancement in an area with little or no hard bottom habitat, and not as mitigation. It appears from the results of the MA DMF first year progress report that an artificial reef can support a diverse and productive reef habitat in a short amount of time, especially when the reef provides various sized interstial spaces for different life stages of organisms and edge relief. The proposed Deep Draft Project would provide various size rocks created during blasting and/or dredging. MA DMF plans to continue monitoring the progress of the HubLine artificial reefs in Massachusetts Bay. The proposed rock reef design for this project can be modified if the results of the MA DMF monitoring program indicate that a particular design is more favorable for rock reef ecology than another. The artificial rock reef created by the Deep Draft Project would be monitored after construction to determine if the rock reef can provide a greater level of species diversity and abundance than the habitat it replaced.

4.4 Disposal Impacts at the Massachusetts Bay Disposal Site (MBDS)

4.4.1 Physical Impacts at the MBDS

Dredged material is released from scows operating on the surface and passes through several phases as it travels to the seafloor at the Massachusetts Bay Disposal Site. Several factors influence the behavior of the descending plume, including the properties of the sediment (e.g., silt, sand, clumps, etc.), water depth, water column stratification, and the interplay of the descending sediment with the water through which it passes. In general, the behavior of the plume can be described as occurring in three phases: convective descent, dynamic collapse, and passive diffusion. The three phases are discussed in more detail below.

- **Convective descent** -The first phase of plume following release of the dredged material from the barge into the water column is the convective descent. This phase begins with the release of the material from the transport device (disposal scow). During this phase, the material descends through the water column under the influence of gravity, generally maintaining its identity as a single mass (Brandsma and Divoky, 1976). During its descent, the area occupied by the plume expands as the local water is entrained into the descending cloud of dredged material. Kraus (1991) found that plumes resulting from the disposal of up to 5,000 cy of sediment (most scows fall in this range of size) in waters up to 65 feet deep spread 300 to 600 feet during the convective descent phase. In addition, the suspended sediment concentration was reduced by turbulence and dilution with the surrounding water mass. The duration of this phase depends on the depth of water, lasting from seconds in relatively shallow areas to minutes in waters over 984 feet. Field and laboratory studies indicate that approximately 1 to 5 percent of the sediment discharged from a barge remains in the water column following the convective descent phase (Ruggaber and Adams, 2000a; Ruggaber and Adams, 2000b; Tavolaro, 1984; USACE, 1986).
- **Dynamic Collapse** – This phase occurs when the descending plume impacts the bottom or reaches a neutrally buoyant position in the water column and diffuses horizontally under its own momentum. In areas with strong stratified water columns, particularly in water columns of several thousand feet, this process is complicated because portions of the plume may attain neutral buoyancy before hitting the seafloor. In those situations, a portion of the descending mass loses its downward momentum and comes to reside as a plume at its neutrally buoyant depth. The plume can oscillate around the depth of neutral buoyancy, creating a vertical oscillation of material. The residence of the materials within such an oscillation results in increased turbulence in the water column and increases the speed with which the plume dilutes and spreads horizontally as it comes into hydrostatic equilibrium. Studies have shown that this condition does not occur in water less than 262 feet. This is because the sediment impacts the bottom regardless of the water stratification. This is due to the fact that the initial momentum and specific gravity are too great to be overcome by plume buoyancy. Depending on water depth, dredged materials may have sufficient momentum to travel laterally for hundreds of feet upon impacting the bottom.
- **Passive diffusion** - Passive diffusion refers to the transport and dispersion of the disposed material by the ambient oceanographic conditions (currents and turbulence) rather than the hydrodynamics occurring during the descent of the plume body. This phase results in the dispersion and transport of the suspended sediments and may last for several hours. Numerous field studies have confirmed that plumes are transient features of dredged material disposal from barges (Dragos and Lewis, 1993; Dragos and Peven, 1994; SAIC, 1988).

Verification of Dredged Material Disposal Plume Dynamic – During the disposal operation, a portion of the dredged material released (generally a fraction of any fine silt and clay particles present) may remain in the water column as a turbid plume for several hours, where it will drift with the current. Dredged material plume dynamics for offshore operations have been verified at several sites

in New England and in other locations in the United States. For example:500 to 5,000 cy of dredged material released in shallow depths of 50 to 66 feet in the Gulf of Mexico (Krause, 1991) had an associated plume spread (widening) of 110 to 220 yards during the convective descent phase.

Increased turbidity from the plumes in the water column has been documented for up to two hours after disposal of 4,000 to 6,000 cy of dredged material in the New York Bight (water depth approximately 92 feet) (Dragos and Lewis, 1993; Dragos and Peven, 1994). Dilution of the dredged material within 2 ½ hours of disposal had achieved ratios of 3,000:1 to 600,000:1 (based on total suspended solids (TSS) analyses of water samples). Observed plume spreading at the time was generally less than 550 yards, and local currents carried the plumes up to about 0.6 mile from the discharge point, which was consistent with the current velocities at the time of the survey. Turbidity profiles collected throughout the disposal site and surrounding areas before and after disposal events did not find elevated turbidity in the vicinity of the disposal site that could be attributed to dredged material disposal (Dragos and Lewis, 1993; Dragos and Peven, 1994).

Plume transport at the Rockland Disposal Site in Maine was limited to approximately 500 yards from the point of discharge for a 1,900 cy disposal event (SAIC, 1988). However, the plume from a larger barge volume (3,640 cy) was transported approximately 1 mile from the disposal point over a two hour period, with suspended solids concentrations decreasing by 99 percent of those initially measured (~1,500 mg/L, decreasing to 14 mg/L).

Studies at the Massachusetts Institute of Technology (MIT) (Ruggaber and Adams, 2000a; Ruggaber and Adams, 2000b) used "flow visualization" devices in a laboratory setting to confirm that a small percentage of sediment remains in the water column after a disposal event. This laboratory study evaluated how plumes form and how sediment particle characteristics affect the plume formation. The study was also designed to determine how much material is incorporated into the descending cloud and how much is lost during convective descent. The study estimated that less than one percent of the original mass exiting the barge separates from the material contained within the collapse phase during the discharge and remains in the water column. This is consistent with the lower range reported from field studies (Tavolaro, 1984; USACE, 1986).

Extensive plume monitoring was performed at the Rhode Island Disposal site following placement of large volumes of material from the Providence River and Harbor Maintenance dredging project. These surveys found rapid plume reduction related to settling of material and dispersion in the open ocean setting, with a return to background conditions within several hours of placement (SAIC 2005a, 2005b).

These studies show that only a small amount of sediment remains in the water column after a disposal event and that, in general, the material is rapidly diluted and dispersed and is not discernible after two to three hours. The concern about the small amount of material that remains in the water column pertains to potential impacts from: (1) reduced light penetration induced by the residual sediment in the water column which may reduce photosynthesis and, (2) the possible release of nutrients or contaminants from the sediments during the descent phase. Reduction in light penetration is usually short in duration (on the order of hours). Studies of the nutrient and other contaminant releases from the descending dredged materials show that the release is limited with no toxicity to sensitive marine organisms as determined through biotoxicity testing. The incremental addition of nutrients or contaminants from dredged material disposal, relative to other sources such as rivers, wastewater treatment facilities and nonpoint sources is small and inseparable from ambient conditions (USACE, 1982). The intermittent nature of the disposal operations, the short time period that material stays in the water column (usually less than two to three hours), along with rapid dilution and settling further limit any potential effects.

Topographic change occurs within an open water dredged material disposal site over the course of the site's history. Initially, the disposed material creates a mound, changing the local topography. Mound building may be intermittent or continuous, depending on dredging cycles and projects. Final site topography depends on site management practices. Several long-term processes can reduce mound height or modify the mound topography after disposal is complete. These include physical and biological processes that act to "smooth" the roughness of the mound (Rhoads, 1994). Also, newly deposited dredged material compacts under its own weight and often deforms the seafloor beneath it. Both actions reduce the mound height. Bottom currents winnow, transport, and redistribute materials from the mound surface. The amount of transport and redistribution depends on the sediment texture (grain size), sediment cohesiveness, and current strength. Biological processes such as colonization (including burrowing) and foraging by megafauna also act to smooth the mound's surface, modify its response to erosion forces, and change its topography. These physical and biological processes may also modify the nature of the surface sediments on the mound over time. Many studies have demonstrated that the upper inch or two of dredged material mounds can be winnowed of fine-grained sediments, leaving behind coarse sediments that are more resistant to erosion. Such winnowing eventually reaches an equilibrium distribution that reflects the critical erosion velocity at the site.

The location of the Massachusetts Bay Disposal Site (MBDS) in a deep water basin (almost 300 feet deep), protects the site from the effects of major storms. Studies from the Disposal Area Monitoring System (DAMOS) program have shown that the material disposed at a specified target within the MBDS forms a distinct mound. Multiple disposal mounds have been formed within the boundaries of the MBDS. MBDS had been subject to at least two major storms, Hurricane Bob in 1991 and the Halloween Storm also in 1991. Monitoring surveys were conducted at the MBDS in 1990 and 1992 (pre- and post-storm) as part of the DAMOS. Surveying and monitoring were conducted with precision bathymetry and REMOTS® sediment profile photography. Previous bathymetric/REMOTS monitoring surveys at MBDS occurred in August 1990. Since 1990, initiation of a major construction project in the Boston area, the Central Artery/Third Harbor Tunnel project, resulted in increased disposal activity at the site. One of the objectives of the 1992 DAMOS field work was to map the distribution and thickness of dredged materials that MBDS received following the 1990 survey.

It was predicted that the dredged materials disposed since 1990 would have increased the size of the mound detected by bathymetry in 1990. The precision bathymetric survey detected the maximum thickness of the disposal mound approximately 300 feet west of the target buoy, which was the location of the active disposal within the MBDS at that time. Dredged material detected by the 1992 REMOTS® survey extended up to 2,000 feet from the buoy location. The results of the survey showed there to be no substantial resuspension or transport of dredged material as a result of Hurricane Bob and the Halloween Storm. Periodic monitoring is performed at the MBDS as part of the USACE's Disposal Area Monitoring System Program, with the most recent survey in October 2012 (Battelle, in preparation, expected April 2013).

Sediments in the area of the MBDS are composed predominantly of fine-grained silts and clays. The dredged sediments are silt and clays with some sand and gravel that is considered to be suitable for unconfined open water disposal. Only material that is found suitable for ocean water disposal after testing will be disposed at the MBDS. However, DAMOS studies indicate levels of metals and organics in the dredged material within the disposal site can be above background levels, indicative of the industrial nature of the areas dredged that utilize the site. On average, approximately 300,000 cy of dredged material a year has been disposed at the MBDS from previous Boston Harbor dredging projects and other harbors in the region. As our waterways become cleaner (i.e. Boston Harbor), material disposed at the MBDS has not and is not expected to significantly change the present character of the disposal site in Massachusetts Bay.

4.4.2 Chemical Impacts at the MBDS

To determine if the dredged material is suitable for disposal below mean low water in Massachusetts Bay, it is regulated according to both Section 103 of the Marine Protection, Research, and Sanctuaries Act or Section 404 of the Clean Water Act. Dredged material which meets the criteria in one of the following three paragraphs is environmentally acceptable for ocean disposal without further testing.

a. Dredged material that is predominately sand, gravel, rock, or any other naturally occurring bottom material with particle size greater than silt and is found in areas of high current or wave energy can be disposed of in a 103 site without further testing. The material from the fourteen samples in the North Channel, Presidents Roads, and Reserved Channel Turning Basin (Samples A through M and Sample DD) had high proportions of gravel and sand. The fines in these samples ranged from 0.59% to 28.48%. The sediments from these areas meet this exclusion and are suitable for unconfined open water disposal at MBDS without further testing.
b. Dredged material that is proposed for beach nourishment and is predominantly sand, gravel or shell with grain sizes similar to the receiving beaches can be disposed of without further testing. None of the material from this project is proposed for beach disposal.
c. When the dredged material is substantially the same as that at the disposal site and the dredged material is taken from a site far removed from known sources of pollution, it can be disposed of without further testing. This project's material meets this exclusion. The sediment to be removed is parent material (mostly silts and clays) underlying the contaminated surficial material, which is being removed by the ongoing maintenance dredging. It is far removed from known sources of contamination, having been laid down by glaciers before the Industrial Revolution and insulated from industrial contaminants by soon-to-be-removed surficial material. It is the same type of material as at the disposal site, as the same glaciers laid sediments at both areas.

The regulations state that if the dredged material does not meet the criteria of paragraph b above, it must undergo further testing of the liquid, suspended particulate and solid phases before it can be considered acceptable for ocean disposal. This section does not apply to this project, as the dredge materials meet the criteria in paragraphs a or c above.

Based on the above criteria, the material to be dredged and disposed at the MBDS meets the testing exclusion criteria and is acceptable for disposal at the MBDS. Therefore no significant long-term impacts are expected. See the suitability testing memo in Appendix L for additional details.

Maintenance materials from the project areas, described in Section 2.9.3, would need to be tested during the design phase of the Deep Draft 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.

4.4.3 Biological Impacts at the MBDS

The MBDS was monitored for benthic recovery in the fall of 2000 (SAIC, 2002), after most of the Boston Harbor Navigation Improvement Project was completed. Most of the material disposed at the MBDS was Boston blue clay, similar to the material to be disposed from the Deep Draft Project. Remote Ecological Monitoring of the Seafloor (REMOTS®) surveys were employed to monitor the recolonization of the disposal mound after disposal. The fall 2000 REMOTS® sediment-profile images examined the surface sediment composition and evaluated the benthic recolonization status over each disposal mound. The images confirmed the presence of the deposited Boston blue clay. Past environmental monitoring surveys at subaqueous dredged material disposal sites have shown that sediments of a glaciomarine origin (i.e., Boston blue clay) tend to be very cohesive and devoid of

organic matter. Although a firm substrate is ideal for surface dwelling, Stage I benthic infauna and epifauna, this type of material can impede the development of a stable Stage III (burrowing and deposit feeding) population. As a result, dredged material mounds showing a high percentage of glacial clay in the surficial layers often display a slower rate of benthic recolonization relative to marine sediment deposits.

As expected, the disposal mounds displayed a benthic infaunal community composed primarily of Stage I pioneering polychaetes with some occurrence of Stage III head-down deposit feeders. The older mounds exhibited a higher occurrence of Stage III activity. However, the benthic community appeared to be recovering on the newer mounds as anticipated, although at a lower community status than the surrounding reference areas. The benthic habitat conditions over the disposal mounds were expected to continue to recover over the next several years, as Stage III activity becomes more widespread and the redox potential discontinuity (RPD) depths deepen as the glacial clay is biologically reworked and additional silts are incorporated through natural deposition. Any benthic organisms inhabiting the disposal area would be buried during disposal events. However, once disposal ceases, recolonization of the mound would begin.

As predicted, the monitoring of the MBDS in September 2004 confirmed that the disposal mounds would fully recover once disposal ceased (ENSR, 2005). Six disposal mounds (MBDS-A, MBDS-B, MBDS-C, MBDS-D, MBDS-E, and MBDS-F) have been formed from dredged material. Three disposal mounds (MBDS-C, MBDS-D, and MBDS-E) were constructed over a short period of time (1998-2000), consisting primarily of Boston blue clay as part of the Boston Harbor Navigation Improvement Project, and monitored during the fall 2000 survey. The MBDS-C mound is the largest of the mounds, formed by the placement of nearly 1.4 million m^3 dredged material between November 1998 and August 1999. The MBDS-D mound is the smallest mound, formed by the disposal of approximately 386,000 m^3 of dredged material from Boston Harbor placed at the site over a 2.5-month period (August-October 1999). The last disposal site to receive a significant amount of material from Boston Harbor is MBDS-E. At this site over 750,000 m^3 of dredged material was disposed between October 1999 and June 2000.

The sixth disposal mound (MBDS-F) was initiated in September 2000, but no obvious mound had formed at the time of the fall 2000 survey (ENSR, 2005). Between the fall 2000 survey and the September 2004 survey, approximately 560,000 m^3 of dredged material has been disposed at MBDS-F, including the material from the Boston Harbor OHMDP. Dredged material from the OHMDP comprised approximately 1/5 (110,000 m^3) of the total material disposed at MBDS-F. Disposal of dredged material at MBDS-F resulted in the distinct formation of a mound, approximately 450 m in diameter and 4 m in height based on comparison of the 2000 and 2004 bathymetry. The measured mound height matched the predicted height of 4 m. Given the limitations in the bathymetric depth difference technique to resolve the outer extent of the mound apron, where dredged material thicknesses are less than 0.25 m, the measured diameter (450 m) was consistent with the predicted diameter of the full extent of the mound (800 m). The MBDS-F mound is expected to continue to increase in size as the disposal marker buoy remained at the same position during the winter of 2004-2005.

During the monitoring survey at MBDS in 2000, it was observed that benthic recolonization within MBDS has proceeded as expected, but there were notably fewer occurrences of mature, deposit-feeding communities present on the MBDS-C mound compared with the MBDS-B mound. This was attributed to the presence of consolidated Boston blue clay at the MBDS-C mound (SAIC, 2002). The closer the clay was to the sediment surface the greater the resistance of the sediment to burrowing infauna and, as a result, the shallower the RPD depths. The 2000 survey was conducted about one year after completion of disposal at MBDS-C mound, and it was anticipated that as time progressed, a more mature infaunal community would develop. Numerous studies performed within the DAMOS program in the past (Germano *et al.,* 1994) as well as at other dredged material disposal sites (e.g.,

Rhoads *et al.*, 1978; Rhoads and Germano, 1986; Hall, 1994; Newell *et al.*, 1998; Smith and Rule, 2001) have shown that even in dredged material deposits exceeding a meter or more, or consisting of highly cohesive, consolidated material, benthic recolonization and community succession will occur with full ecosystem recovery over time. The time for these recoveries has taken from as little as 18 months to as long as three to five years.

The latest survey conducted in September 2004 on both the MBDS-C and MBDS-D mounds showed that, in the five years since disposal activities at these two mounds had ceased, the resident benthic community had completely recovered, and both mounds exhibited benthic conditions comparable to those found on the three reference areas. Equivalence tests supported these observations, demonstrating that differences in RPD depth and organism-sediment index (OSI) values between the MBDS mounds and the reference areas were not significant.

4.4.4 Marine and Coastal Birds

Pelagic birds and waterfowl are more common in the open waters of Massachusetts Bay and would likely be the only species that could potentially be impacted by disposal activities at the MBDS. These birds spend most if not all of their time on the water or foraging in the water for fish, crustaceans, or invertebrates.

Birds in the area of a disposal site would most likely avoid the immediate vicinity during disposal operations. Birds resting on the water or foraging in the area would likely leave during disposal activities and would not be permanently impacted. Some species, such as gulls, would be attracted to disposal operations to forage but they are not expected to be negatively impacted by disposal activities.

4.5 Disposal Impacts at the Industrial Waste Site

The disposal alternative of disposing of dredged material at the IWS would involve capping areas of the site identified with high density of waste containers exposed on the seafloor. If this alternative is implemented, many of the physical, biological, and chemical impacts described above for the MBDS would be expected to occur at the IWS. According to NOAA, 1996, "No evidence was gathered that would support a conclusion that LLW (low level radioactive wastes) or the hazardous substances investigated posed an imminent and widespread human-health or ecological threat. However, the documented presence and large concentration of waste containers along with known ordnance disposal in some areas of the IWS pose potentially significant occupational risks to users of bottom-tending mobile gear. Therefore, according to the conclusion of this screening survey, wastes previously disposed of in the area should be considered only as one of several sources of contamination to Massachusetts Bay." Using the dredged material to cover the existing material at the IWS would reduce the risk to fishermen and further isolate potentially contaminated areas from the environment.

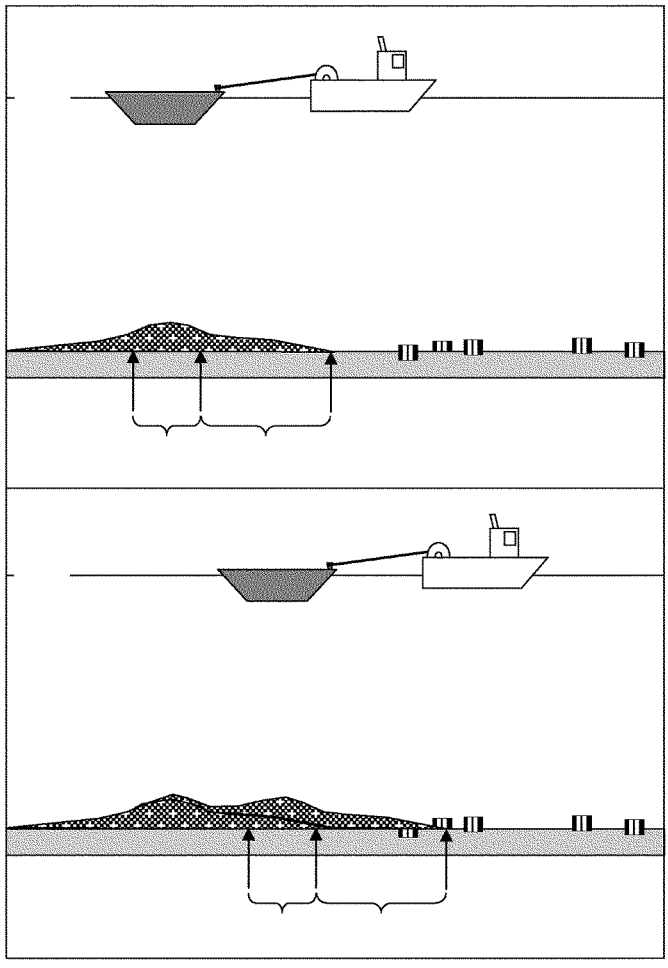
Table 4-2 gives the amount of material that would be dredged for three representative depth alternatives and the area of coverage that would be provided at incremental foot thicknesses. The area of coverage ranges from a low of 0.85 square miles with an eight-foot thick cap and 45-foot depth to 3.65 square miles with a four-foot thick cap and 50-foot depth.

Table 4-2. Industrial Waste Site Capping Areas

Main Channels Improvements – Plans A-B-C Depths	45 Foot Main Channel	47 Foot Main Channel	50 Foot Main Channel
Volume of Ordinary Material Generated by the Project			
Main Channels Improvements - A-B-C	6,393,500	10,220,900	14,754,700
Main Ship Channel Extension to MMT	246,300	246,300	246,300
Mystic River Channel (40 Feet)	67,100	67,100	67,100
Chelsea River Channel (40 Feet)	342,600	342,600	342,600
Total Ordinary Material (Cubic Yards)	**7,049,500**	**10,876,900**	**15,082,200**
Area of Industrial Waste Site Covered at Various Cap Thicknesses			
Square Miles Covered by 4-Foot Cap	1.71	2.63	3.65
With 5-Foot Cap Thickness	1.37	2.11	2.92
With 6-Foot Cap Thickness	1.14	1.76	2.43
With 7-Foot Cap Thickness	0.98	1.50	2.09
With 8-Foot Cap Thickness	0.85	1.32	1.83

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. See Figure 4-1 for a schematic of the proposed cover. A pilot study of this cover method has been proposed and will be conducted at the MBDS by the USACE, outside the barrel field. Depending on the results of this pilot study, this method or a variation of the method will be used at the IWS.

Figure 4-1. Schematic of Remediation Capping Approach. 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.



4.6 Threatened and Endangered Species and Species of Special Concern

As described in Section 3.4, Boston Harbor has served as habitat for a variety of Federally listed threatened and endangered species and State Species of Special Concern. The following sections first describe potential dredging impacts and then blasting impacts to these species.

4.6.1 Dredging Impacts to Sea Turtles, Atlantic Sturgeon and Whales

4.6.1.1 Sea Turtles

According to correspondence from NOAA Fisheries (July 21, 2005) there have been no surveys for sea turtles in Boston Harbor, but suitable forage and habitat exist in the area and it is likely that sea turtles occasionally are present in Boston Harbor. However, no direct impacts to sea turtles are likely from project operations given the low likelihood of their occurrence within the immediate area and because any sea turtles that may be present during dredging operations should be able to avoid the mechanical dredge. Also, sea turtles have been known to be impacted from hopper dredges only, not mechanical dredges (Dickerson, et al. 2004). Since a mechanical dredge is proposed for the project, it is unlikely that any impacts to these species would result from dredging even if they were present in the construction area. Any indirect impacts to sea turtles that may occasionally transit the area, such as impacts to forage items, are expected to be minimal since they are mobile and suitable foraging areas occur elsewhere in the vicinity of the project.

4.6.1.2 Atlantic Sturgeon

Dredging activities can pose significant impacts to aquatic ecosystems by removing, disturbing and resuspending bottom sediments. Environmental impacts of dredging include the following: direct removal/burial of organisms; turbidity/siltation effects; contaminant release and uptake; noise/disturbance; alterations to hydrodynamic regime and physical habitat and actual loss of riparian habitat (Chytalo, 1996 and Winger *et. al,* 2000; *in* ASSRT, 2007). According to Smith and Clugston (1997, *in* ASSRT, 2007), dredging and filling disturbs benthic fauna, eliminates deep holes, and alters rock substrates; all habitat features important to sturgeon.

If sturgeon are in the area, it would be expected that they would have the ability to move from the disturbance caused by the construction and dredging activities. Hatin *et al,* (*in* ASSRT, 2007) compared catch per unit effort (CPUE) before and after dredging events in 1999 and 2000. The authors documented a three to seven-fold reduction in Atlantic sturgeon presence after dredging operations began, indicating that sturgeon avoid these areas during operations.

In addition to the above potential indirect impacts, mechanical, hopper and hydraulic dredging can also have a direct impact on sturgeon. Hydraulic dredging can directly harm sturgeon by lethally sucking fish up through the dredge dragarms and impeller pumps. The number of captures of Atlantic sturgeon as reported by the U.S. Corps of Engineers for the U.S east coast from 1990 to 2005 is located in Table 4-3. It should be noted that this only reports trips when an observer was on board to document capture; the numbers do not reflect all sturgeon captures.

Table 4-3. Atlantic Sturgeon Captured by Dredge Type 1990-2005 (ASSRT, 2007)

Year	Dredge Type		
	Hopper	Clam	Pipeline
1990	1		
1991			
1992			
1993			
1994	3		
1995			
1996			
1997			
1998	2	1	1
1999			
2000	2	1	
2001		1	
2002			
2003			
2004	1		
2005	1		
Totals	**10**	**3**	**1**

None of the documented captures are associated with dredging within Boston Harbor. Also, the use of mechanical bucket (clamshell) dredge for this project would appear to have less potential impacts to Atlantic sturgeon than a hopper dredge, (as noted in the above table where only three Atlantic sturgeon were captured in a bucket dredge as compared to 10 captured in a hopper dredge). Again, the study by Hatin *et al.*, appears to indicate that Atlantic sturgeon, if present, would generally move away from the disturbance caused by the dredging activities.

Based upon the information presented, above, it is unlikely that Atlantic sturgeon juveniles and adults would be present in the Main Ship Channel (either transiting through the area, or possible use as a forage area) during the proposed rock removal within Boston Harbor. Moreover, actions will be taken to lessen the probability for negative impact to this species. These will be discussed in the next section.

Although Atlantic sturgeon are not believed to forage or spawn in Boston Harbor or its tributaries, transient individuals may occasionally be found in these areas. However, as mentioned previously, a mechanical dredge will be used for the removal of the unconsolidated materials and for removal of the rock after it has been fractured. Although sturgeon have been impacted by mechanical dredges, the majority of dredging related injuries to these species have resulted from entrainment in the dragarms of hopper dredges (ASSRT, 2007). Therefore dredging operations are not expected to adversely affect any Atlantic sturgeon (or sea turtles) that may be found in Boston Harbor due to the type of dredge employed and the unlikelihood of their being in the area.

4.6.1.3 Whales

Whales are not likely to occur in Boston Harbor; therefore, it is highly unlikely that they will be affected by the proposed dredging activities.

4.6.2 Blast Impacts on Sea Turtles, Atlantic Sturgeon and Whales

Concerns were raised during the comment period for the Draft SEIS/EIR that blasting during project construction could cause an adverse impact to threatened and endangered whales and sea turtles, as well as the buoy listening and monitoring system recently installed in the separation zone of the Boston Harbor traffic lanes. In addition Atlantic sturgeon were recently listed under the ESA and therefore blasting impacts to this species are also a concern. These concerns are addressed in the following section which discusses the potential effects of blasting with recommended safety zones to avoid potential impacts to threatened and endangered species

Anthropogenic sound waves can impact sea turtles, marine mammals and fish in several ways. Increased ambient noise over extended periods can make it difficult for animals to receive and decipher the sounds relevant to their survival. This may result in poor communication between members of the same species, reduced ability to echolocate and find food, and altered behavior with respect to migration, mating, stranding, and predators.

More intense sounds, such as those generated by underwater explosions, can cause physiological injuries based on the sudden impact of the sound wave as it hits the ears and gas-filled body organs. Impacts range from inner ear damage, tissue shearing in the lungs, intestines, and swim bladders (of fish), and even death depending upon the animal's proximity to the blast. The degree of impact experienced by fish is related to the species, size, life stage of the animal, water depth, the weight of the explosive charge, and the distance of the fish from the charge (Wright, 1982). Fish with swim bladders and smaller fish have been found to be more susceptible to damage from shock waves than non-swim bladder fish and larger sized fish (Wright, 1982; Keevin and Hempen, 1997). Fish eggs and larvae may also be damaged or killed by an explosion.

Sound waves generated by blasting are known as "transients" or short, powerful pulses of noise. Peak pressure, measured in Pascals (Pa) or pounds per square inch (psi), and impulse, measured in Pascal seconds (Pa.sec), are the units used to describe severity of blast transients. Impulse is defined as the average pressure level of the wave acting over a given time. When looking at the effects on marine mammals, sea turtles and fish, it is important to consider both the level of the noise and its duration.

The term decibel (dB) is most often used to compare the level, or intensity of a sound, but the reference medium must be stated so that the reader understands whether in-air or underwater acoustics are being used. In water, acousticians use the standard reference sound pressure of 1 micropascal, abbreviated **re 1 μPa** (the in-air reference is 20 μPa).

The Navy has done considerable research on pressure waves generated by unconfined TNT detonations. These large scale studies have been used to approximate the effects on marine mammals. Table 4-3 shows the ranges developed by the National Marine Fisheries Service (letter from NMFS Headquarters) which reflect the available data on the impact of transient pressure waves to marine mammals.

When it is necessary to use explosives to remove rock for deepening harbors and channels, several measures are put in place to significantly reduce pressure waves. Charges are not only confined in boreholes, but the boreholes are then packed, or stemmed, to further direct the force of the explosion downward into the substrate. Additionally, the charges are detonated on a timed delay so that the pressure is calculated on each individual blast event per 25 millisecond delay, instead of the cumulative weight of all boreholes detonated in the sequence. Criteria provided by NMFS for the effects of blasting on marine mammals, sea turtles and fish (sturgeon) are presented in Table 4-4 below.

Table 4-4. Effects, Criteria, and Thresholds (for Marine Mammals) for Impulsive Sounds from Underwater Detonation (provided by NMFS Headquarters)

Effect	Criteria	Metric	Threshold	Effect
Mortality	Onset of Extensive Lung Injury	Goertner modified positive impulse	indexed to 30.5 psi-msec (assumes 100 percent small animal at 26.9 lbs)	Mortality
Injurious Physiological	50% Tympanic Membrane Rupture	Energy flux density	1.17 in-lb/in^2 (about 205 dB re 1 microPa^2-sec)	Level A
Injurious Physiological	Onset Slight Lung Injury	Goertner modified positive impulse	indexed to 13 psi-msec (assumes 100 percent small animal at 26.9 lbs)	Level A
Non-injurious Physiological	TTS	Greatest energy flux density level in any 1/3-octave band (> 100 Hz for toothed whales and > 10 Hz for baleen whales) - for total energy over all exposures	182 dB re 1 microPa^2-sec	Level B
Non-injurious Physiological	TTS	Peak pressure over all exposures	23 psi	Level B
Non-injurious Behavioral	Multiple Explosions Without TTS	Greatest energy flux density level in any 1/3-octave (> 100 Hz for toothed whales and > 10 Hz for baleen whales) - for total energy over all exposures (multiple explosions only)	177 dB re 1 microPa^2-sec	Level B

Although NMFS has not yet developed acoustic criteria for blasting activities, based on studies done by Yelverton and Richmond (1981), Finneran *et al.* 2002, and Southall *et al.* 2007, they believe that blasting levels have varying impacts by size, as follows:

- ≥46 psi, 230 $_{peak}$ dB re 1 µPa or 198 dB re 1 µPa^2-s (SEL) will cause injury or mortality[10];
- ≥23 psi, 224 $_{peak}$ dB re 1 µPa or 183 dB µPa^2-s will cause harassment, via temporary threshold shifts (TTS)[11]; and,
- levels at or above 166 dB$_{RMS}$ re 1µPa will cause behavioral modification (Baker, 2008).[12]

[10] Sound Exposure Level (SEL) is defined as that level which, lasting for one second, has the same acoustic energy as the transient and is expressed as dB re: 1µPa^2•sec.

[11] TTS-Temporary - fully recoverable reduction in hearing sensitivity caused by exposure to sound.

[12] Root Mean Square (RMS) pressure is the square root of the time average of the squared pressure and is expressed as dB re: 1 µPa.

As the Deep Draft Project involves the removal of rock, minimal amounts of turbidity and siltation impacts from blasting and rock removal are expected. Contaminants do not generally adhere to rock, so insignificant amounts, if any, of contaminant release or uptake would occur. Rock would be removed from seven general areas within Boston Harbor including the Broad Sound North Entrance Channel; the President Roads Anchorage; the lower Main Ship Channel; the Main Ship Channel extension area below the Ted Williams Tunnel; the Reserved Channel and its Turning Area; and the upper Chelsea River. Since these areas are already in existing channels, no effects to the hydrodynamic regime within Boston Harbor or its physical habitat are expected. Although rock would be removed to authorized depth in the shipping channel, the underlying material is rock ledge. Once construction is complete, the ledge will become recolonized with benthic organisms and provide forage habitat again for estuarine animals. Sturgeon are generally associated with muddy and sandy substrates feeding on benthic organisms, but can also be associated with rock and cobble (ASMFC, 2009); therefore it is less likely that they would be using immediate project area for foraging and feeding given these substrates consist primarily of rock. Also, several research studies as well as anecdotal information received from NMFS (email dated May 11, 2012) indicate that sturgeon forage over tidal flats given the occurrence of preferred prey species in these areas. The nearest tidal flats to the project area are outside the channel near Castle Island or located more than 600 feet to the Governors Island Flats.

Based on studies by Moser (1999), peak pressure levels at, or below, 75.6 psi, and peak impulse levels at or below18.4 psi-msec, do not cause injury or mortality to species of sturgeon, including Atlantic sturgeon.

It should be noted that for both marine mammals and turtles, peak pressure levels above 23 psi result in Level B harassment (as noted in the NMFS criteria presented in the above table). Therefore, levels below 23 psi would be expected to be non-injurious to both seas turtles and marine mammals. Also peak pressures below 75.6 psi would not be expected to cause injury or mortality to sturgeon. Therefore, peak pressures below 23 psi would be expected to be protective of marine mammals, sea turtles and Atlantic sturgeon.

Due to the fact that for marine mammals, sound that would cause Level B harassment, (non-injurous behavior) is also measured by energy flux density and defined as having an energy flux density of less than177 dB re 1 μPa^2-sec, it is assumed that any sound below this level would be protective of marine mammals and therefore would have peak pressures of less than 23 psi. Also for sea turtles, criteria for Level B harassment are given as having peak pressures greater than 23 psi as well as energy flux densities equal to 183 dB μPa^2-s (which is greater than the energy flux density criterion given for marine mammals). Therefore it would be assumed that energy flux densities of less than177 dB re 1 μPa^2-see (i.e. the criterion for marine mammals to prevent Level B harassment) would be protective of marine mammals, sea turtles and Atlantic sturgeon (i.e. it is assumed that sound energy at this level would be have peak pressures of less than 23 psi).

When the blast is detonated, shock waves are diminished as they spread outward from the blast according to the cube root of the charge weight. As the wave travels further through the water from the detonation point, it reflects repeatedly from the surface and seabed and loses energy. This reduction, referred to as "cube root scaling", was utilized by Cole (1948) in conjunction with small land animals and humans, to construct an open-water mortality radius (MR_{OW}) for single, open-water shots according to the following formula:

$$\mathbf{MR_{OW} = 260 \times W_{OW}^{1/3}}$$

Where $\mathbf{W_{OW}}$ = the maximum charge weight (in lbs.) per delay of a single, open-water blast.

Given the blast attenuation facilitated by confined borehole charges and the ability of marine animals to withstand pressure levels higher than land-based test subjects (small land animals and humans),

Cole's equation provides a conservative calculation of safety ranges around a blasting project. This approach is further supported by Young (1991) who suggested that "cube root scaling" may be used to provide an upper limit in the absence of data for a specific effect."

Miami Harbor

Blasting was part of the Miami Harbor Channel deepening project performed by the Jacksonville District Corps of Engineers[13]. Three different safety radii around the blast zone were calculated, using Cole's equation (for unconfined open water blasting), to insure the protection of several threatened and endangered species. These zones were calculated as follows:

1) Danger Zone: The represents the inner most circle, with radius measured in feet, around the point of detonation. Any animal within this area during a blast would incur severe injury or death. The area immediately outside of this radius was determined to have no expected mortality or severe injury from any individual explosion.

Danger Zone (Feet) = 260 x W $^{1/3}$

W = charge weight in lbs per delay

2) The Safety Zone (or exclusion zone) is the second concentric circle immediately outside of the Danger Zone. Animals entering this area but not reaching the Danger Zone would potentially experience Level A harassment as defined in the Marine Mammal Protection Act.

Safety Zone (Feet) = 520 x W $^{1/3}$

W = charge weight in lbs per delay

3) The Watch Zone is three times the radius of the Danger Zone to insure animals entering or traveling close to the Safety Zone are spotted and appropriate actions can be implemented before or as they enter any impact areas (i.e., a delay in blasting activities).

Watch Zone (Feet) = 3 x Radius of Danger Zone

Based on explosive weight per delay of 119 lbs (54 kg), the Miami project calculated safety distances as follows:

Danger zone = (260) * (119 lbs)$^{.333}$ = 1,276.8

Safety zone = (520) * (119 lbs)$^{.333}$ = 2,533

Watch zone = 3 * 1,278 = 3,834 ft

Confined Blasting

The radii calculated above for the three zones were based on the effects of open water blasting. The Miami Harbor Channel Deepening Project noted above provided an opportunity to conduct pressure measurements during rock removal and compare those data with computed peak pressures for open water explosions. In that project, water-borne blast pressures from confined blasts were also recorded. The blasting was confined within the rock floor by stemming. Shot patterns of stemmed borings were recorded, as were two open-water shots. One hole of one shot was not confined properly, which allowed comparison of confined and a poorly confined larger charge weights per delay. The pressure

[13] For full project details pertaining to blasting, see Hempen, Keevin, Jordan. 2007. Underwater Blast Pressures from a Confined Rock Removal during the Miami Harbor Deepening Project. International Society of Explosive Engineers. Vol 1.

data were intended to gain information on typical pressure measures from the rock removal program relative to impacts on marine organisms (Hempen et al, 2007).

Results showed that the maximum pressures from the confined blasts were significantly lower than much smaller charges shot in open water. Where the mortality radius was determined to be 260 feet (using Cole's equation noted above) for a 1-lb booster that was shot in open water, it would have been only 56 feet for a 1-lb charge that was confined by stemming within the rock at Miami Harbor. The same charge may only have a mortality radius of 22 ft (6.7 m) or smaller when detonated within rock that was properly stemmed for confinement. Radiation of the wave energy into rock reduced the available energy reaching the water column. The pressures entering the water column were well below those pressures that typically propagate away from open-water (unconfined by solid media that may radiate the energy away with less harm) charges relative to charge weight per delay (Hempen et al, 2007).

Therefore, for confined rock blasting, the coefficient in Cole's equation above (that defined the mortality radius) was reduced from 260, to 56 as follows:

$$\mathbf{MR_C\ (feet) = 56 w_C^{1/3}}$$

where, w_C = the maximum charge weight (in pounds) per delay of a single, confined blast. (Hempen et al, 2007).

Boston Harbor

Blasting was most recently conducted in Boston Harbor in September 2012 and prior to that in 2008. Safety zones for the September, 2012 date were calculated using the equation above for confined blasting by using a maximum charge weight of 42.9 lbs per delay, which was the maximum charge weight used in the 2008 blasting. The radius of the mortality zone was calculated as follows:

$$\mathbf{MR_C\ (feet) = 56\ (42.9^{1/3}) = 196\ feet}$$

Once this maximum mortality zone radius was determined, the calculated radius to determine the potential fish injury zone was doubled. An additional 50 feet was then added to the potential fish injury zone to determine the radius of the safety observation zone for fish. The safety observation zone is the zone that will be monitored by the fish observer prior to blasting events. Therefore, for a single charge of 42.9 lbs of explosives per delay, the safety zone would be calculated as 442 feet. If more than one hole is shot per delay, then the safety zones would be greater, depending upon the total weight of explosives shot per each delay. It should be reiterated that in the formula given above, the variable "**wc**" is the weight of the charge per delay and not the total weight of the explosives shot per blast.

Boston Harbor September 2012 Blasting

Blasting was conducted in Boston Harbor for the Boston Harbor Rock Removal Project from September 6 – September 21, 2012. For the three blasts that occurred on September 6, 8 and 10, underwater sound monitoring was conducted by Tech Environmental to determine sound pressure levels at specific distances from the blast relative to protective criteria for marine mammals. Based on these data, protective zones were adjusted to ensure that they would be beyond the behavioral (Level B) threshold for marine mammals (i.e. 177 dB re 1 μPa^2-sec). The total weights of explosives per blast were 314 lbs for blast 1 (12 delays), 407 lbs for blast 2 (15 delays) and 554 lbs for blast 3 (17 delays). Calculated distances (based on the sound measurements) where sound pressure had attenuated to below Level B harassment thresholds for marine mammals were 773 feet, 783 feet, and 930 feet for the blasts 1-3 respectively. It should be noted that the protective radii from these three blasts increased with the total weight of explosives per blast.

When comparing these protective radii to those calculated using Cole's equation (noted above) for confined blasting, since the distance (using Cole's equation) is calculated only on the weight of the single charge per delay, the protective radius does not change regardless of the weight of the total charge. In addition, this radius calculated on the single delay appears to underestimate the distance necessary to reduce effects. Using the example of blast 1, the total weight of explosives was 314 lbs for 12 delays. Based on the blast reports, the maximum weight of charge per delay was 32 lbs. Therefore, using the equation above, the zone where there would be mortality would be 178 feet from the blast as noted below:

$$\mathbf{MR_C\,(feet) = 56(32)^{1/3} = 178\ feet}$$

Doubling this and adding 50 feet brings it to 406 feet which is the distance that would have been used for the Boston Rock Removal Project. However, based on the measured sound data (i.e. Tech Environmental report), the calculated distance to protect from Level B harassment was 783 feet. Similarly for blast 2, (total weight of explosives was 407 lbs) the maximum charge per delay was 33.5 lbs. The mortality zone for this single charge would be 181 feet, and doubling it and adding 50 feet would be 412 feet. However the calculated distance based on the measured sound data to protect from Level B harassment was 830 feet. Also for Blast 3, using 38.8 lbs per charge (total of 554 lbs of explosives) the protective zone based on Cole's equation is 429 feet, but the calculated zone based on the sound data was 920 feet (see Appendix Z for a copy of the Tech Environmental report). In addition, since Cole's equation is calculated on the weight of the charge per single delay and not on the total weight of explosives per blast, the exclusion zones will not change regardless of the total weight of explosives per blast event. However, the data collected from the September 2012 blasting events suggests attenuation distance does increase with an increase in the total weight of explosives per blast event. These data are summarized in Table 4-5 below.

Table 4-5. Comparison of Calculated Blast Safety Distances using Cole's Equation with those Measured from Tech Environmental for Boston Harbor Blasts 1-3, September 2012

Blast #	Number of Holes	Charge/ Hole (lbs)	Total lbs/ Blast	Calculated Mortality Zone (feet) (Coles) (D)	Safety Zone Dx 2 +50	Safety Zone (feet) (from Tech Envir. data) (ft)	Cole's Calculated on Total Wt x 2 (ft)
1	12	32	314	178	408	773	761
2	15	33.5	407	181	411	783	830
3	17	38.8	554	190	429	930	920

It should be noted that if Cole's equation is used on the total weight of explosives per blast event and then multiplied by 2, then the estimated distances to protect animals from Level B harassment approximate those calculated from the actual measured data (Table 2, last two columns). Therefore, when using Cole's equation to calculate distances to avoid Level B harassment, it may be more accurate to use the total weight of explosives used in each blast and then doubling it to calculate the safety zone.

Calculation of Boston Harbor Deep Draft Project Blasting Safety Zones

For the proposed Boston Harbor Deep Draft blasting, it is anticipated that a maximum of approximately 60 boreholes will be drilled to a maximum depth of approximately 18 feet. Based upon blasting reports from the September 2012 blasting, the pounds of explosives used per hole ranged from 5 to 44 lbs/hole, with an approximate mean weight of 28.5 lbs/hole. Using the formula noted above (Cole's equation), the safety zones are calculated on the approximate mean (28.5 lbs) and the approximate mean of the maximum amounts (40 lbs) of explosives estimated to be shot per bore hole or delay. In addition, safety zones are calculated on the mean (28.5 lbs) and maximum total amount of explosives (40 lbs) used per

blast. In order to estimate the total amount of explosives per blast, the estimated maximum weight of explosives to be shot per hole of 40 lbs is used. This value is used because it slightly exceeds the mean of the maximum weights of charges per hole used in the September 2012 blasting in Boston Harbor (38.8 lbs, as noted in the blast reports).

Table 4-6 below provides the range in feet from the blast for the mortality and safety zones calculated on both the weight of charge per delay (i.e. individual borehole) and total estimated charge per blast (using 60 holes and a maximum charge of 40 lbs/hole) and multiplied by 2, in order to approximate the zones calculated by actual sound measurements (noted above). This is done for both the approximate mean weight of explosives expected to be used per charge (28.5 lbs), and the expected maximum weight of explosives to be used for charge (40 lbs). Note that a total charge weight per blast using 60 holes and 40 lbs of explosives per hole would be 2400 lbs. Based on the calculations used to protect species for the recent September 2012 Boston Harbor Rock Removal , it is presumed that the safety zone which is calculated on the single charges per delay, doubled with 50 feet added to it (column 5), would be sufficient to protect the listed species. However given the actual sound measurement from Boston Harbor blasting in September 2012, the safety zone calculated based on the total charge per blast and then doubled (last column) would be expected to be completely protective of marine mammals, sea turtles and Atlantic sturgeon; that is where no behavioral effects (Level B Harassment) would be incurred at all.

Table 4-6. Estimated Safety Zone for Blasting in Boston Harbor

Number of Holes and/or Delays	Charge per Hole/Delay (lbs)	Total Charge per Blast (lbs)	Mortality Zone Based on Charge/Delay (feet)	Safety Zone Based on Charge/Delay x 2 + 50'	Mortality Zone Based on Total Charge/Blast (feet)	Safety Zone Based on Total Charge/Blast x 2 (feet)
60	28.5	1995	171	392	705	1410
60	40	2400	192	433	750	1500

Therefore based on the above calculations it would be expected that a safety zone radius of 1500 feet (based on the estimated maximum total charge of 2400 lbs) would be completely protective of marine mammals, sea turtles and Atlantic sturgeon for the Boston Harbor blasting. This zone is shown overlain on a map in Figure 4-2 to indicate the extent of the safety zone relative to the outermost area of blasting for the project in the Broad Sound North Entrance Channel. A 50 foot observation zone would be added to observe for animals approaching the safety zone. Figure 4-3 shows the most seaward location of the blast safety zone in relation to the distribution of right whales from 2002 to 2012 in Massachusetts Bay.

Blasting Effects on Individual Species

Sea Turtles - As there have been no known sightings of sea turtles in Boston Harbor reported to the U.S. Army Corps of Engineers (USACE) by the resource agencies, it is likely that a sea turtle in the Boston Harbor navigation channels would be rare.

Atlantic Sturgeon - As noted above, the Atlantic sturgeon occurrences in Boston Harbor are also rare, particularly in those specific areas where blasting would take place in the lower harbor, harbor entrance, and upper Chelsea River. Aside from the Chelsea River turning basin, no blasting or rock removal would occur in the upper harbor (above the tunnels).

Whales - Based on the above analysis of the distance underwater blasting noise would have to travel to have an impact on whales, and the distribution of whales in Massachusetts Bay, no impacts to

whales are expected. The listening buoys, located more than 10.5 miles from the entrance to Boston Harbor, would also not be expected to be impacted by blasting. Therefore there would not be any impairment to the Right Whale Listening Network resulting from blasting activities

Blasting Mitigation Measures

Therefore, based on the above calculations and analysis of effects on listed species, and the distribution and low probability of whales, sea turtles and Atlantic sturgeon occurring in the project area, it is expected that the Boston Harbor Deep Draft Project would not be likely to adversely affect listed species. To further reduce potential impacts to threatened and endangered whales, sea turtles, and Atlantic sturgeon in the project area, the following mitigation measures will be implemented:

- One or more NMFS-approved endangered species observers will be present at each blast site. The number of observers will depend on the number that is necessary to observe the entire safety zone. No blasting will occur until the safety zone is free from any observations of whales or sea turtles for 60 minutes, subject to safety considerations. These rerquirements can be added to the monitoring plan for blasting which can be submitted to NMFS for review and comment.
- The Right Whale Sightings Advisory System will be monitored as well as other communication media (i.e. NOAA weather radio, U.S. Coast Guard NAVTEX broadcasts, Notices to Mariners, and U.S. Coast Pilots) for general information regarding North Atlantic Right Whale sighting locations. In addition, the Contractor will be required to monitor the Right Whale Listening Network for information on Right Whales detected near the shipping lanes.
- No blasting will occur if Right Whales are present within the safety zone of the blast area or within a specified distance agreed to between NMFS and USACE, barring any safety concerns.
- In the unlikely event that any whales or sea turtles are observed within the safety zone during a blast event, all reasonable attempts to monitor the condition and behavior of the animal will be undertaken. These incidences will be reported immediately to NMFS to determine whether or not they would require reinitiating Section 7 Consultation. Detonation would not occur until the animal has moved from the area barring jeopardizing human safety.
- All blasting will be conducted using inserted delays of a fraction of a second per borehole as well as the use of stemming, which will be placed into the top of the borehole to deaden the shock wave reaching the water column.
- No blasting will occur when schools of fish are observed in the area (assuming that human safety is not jeopardized). A fish observer will use hydro-acoustic monitoring (i.e. side-scan sonar) prior to any blasting event to determine that schools of fish are not located within or transiting the blast zone area (including any listed Atlantic sturgeon). In addition to the sidescan sonar, a fish startle system will be employed to deter fish. Existing startle systems are most effective with species from the Clupeid family. The startle system uses high amplitude sound at specific frequencies. Lessons learned from the previous blasting in Boston Harbor will be incorporated, where appropriate, into the Contractor's blasting plan. Some of these lessons include the development of a communication plan between the fish observer and the Contractor, and the location of the fish startle system that will be deployed on an alternate vessel instead of the blast barge.
- All project vessels will comply with voluntary speed restrictions (10 knots or less) to minimize the risk of ship strikes, as implemented in Dynamic Management Areas (DMAs) that may be established by NOAA Fisheries Service. NOAA Fisheries Service will announce DMAs to mariners through its customary maritime communication.
- All previously established permit conditions for use of the MBDS, including use of lookouts for whales and sea turtles and vessel speed restrictions, will be required,including:

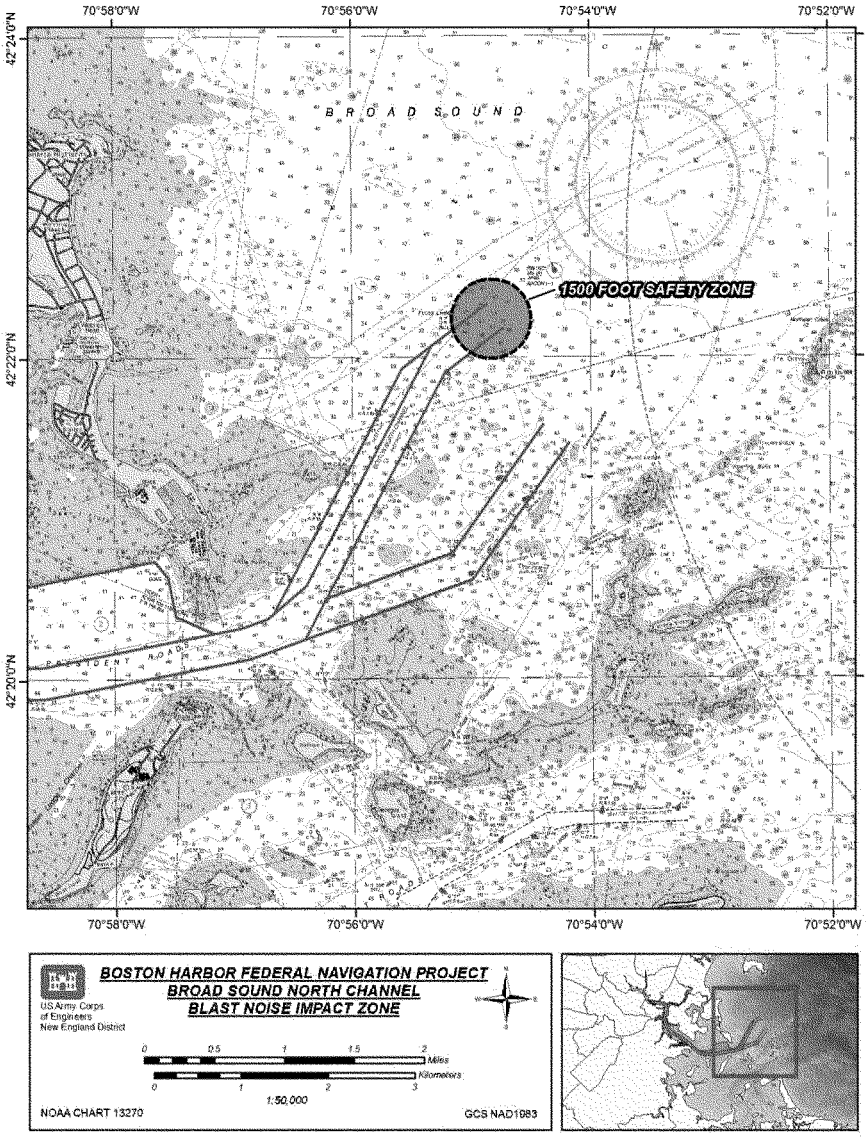


Figure 4-2. Blast Noise Impact Zone for Boston Harbor Federal Navigation Project

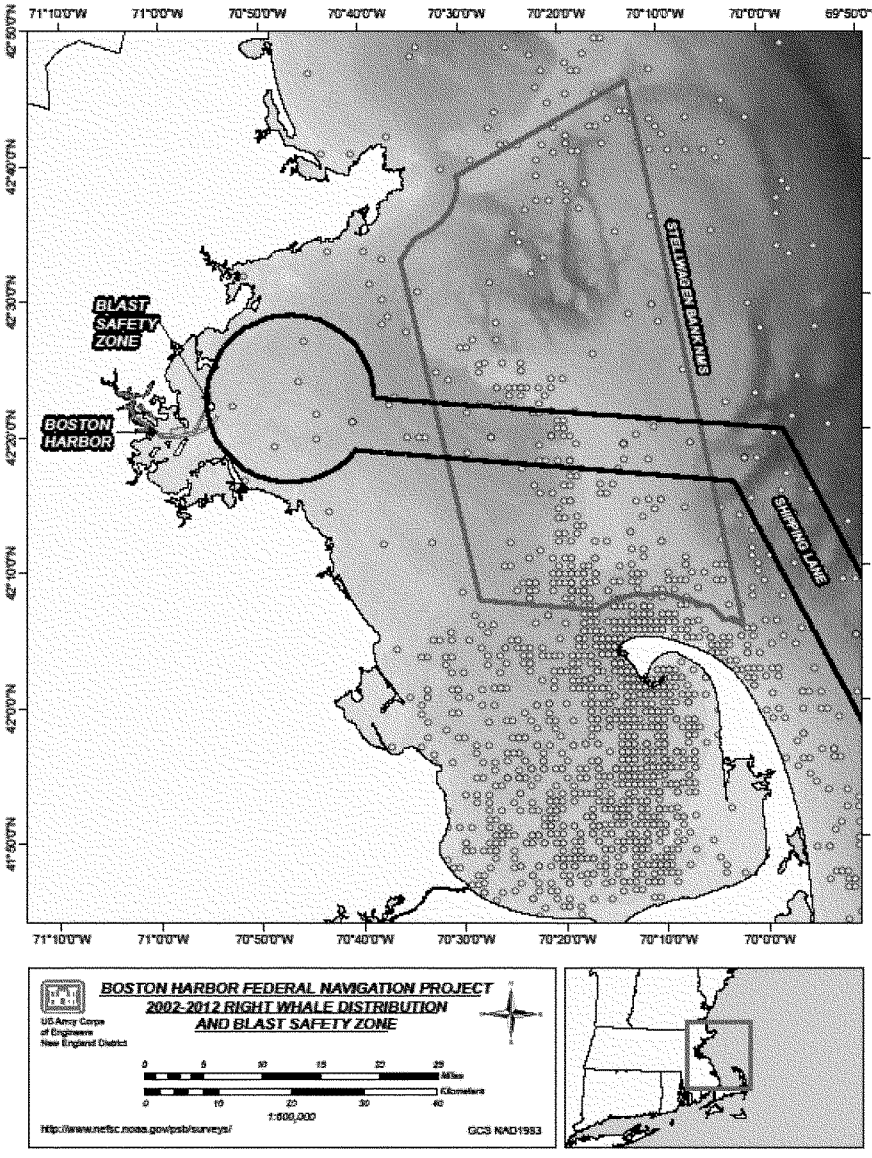


Figure 4-3. Right Whale Distribution from 2002-2012 with Shipping Lane into the Port of Boston

- Use NMFS guidelines to minimize interaction with and harassment of marine mammals during transit (i.e., tugs/scows will not approach within 100 feet of threatened or endangered species of whales (http://www.nero.noaa.qov/prot res/mmv/approach.html) or within 500 yards of a right whale 50 CFR 224.103 (c). Any vessel finding itself within the 500 yard buffer zone around a right whale must depart the area immediately at a safe, slow speed, unless one of the exceptions applies (see 50 CFR 224.103 (c));
- When sea turtles are sighted, attempt to maintain a distance of 50 yards or greater between the animal and the vessel whenever possible;
- Report all sightings of right whales to NMFS as soon as possible and, report within 24 hours any interaction with listed species to NMFS.This includes any reports of injuriesor mortalities.

The above analysis was based on an analysis that was provided to NOAA-Fisheries in response to their comments dated June 2, 2008 during the public review comment period for the Draft SEIS/EIR. Their letter indicated that Section 7 Endangered Species Act Consultation needed to be reinitiated due to potential blasting impacts and additional dredged material volumes not specified in our previous correspondence. As noted, based on our analysis above and that the additional volume of dredged material did not result in an extended period of time to construct the project, we believe that the proposed Boston Harbor Deep Draft Project would not result in a likely adverse effect on a listed species. Also, as noted previously, Section 7 consultation with NOAA Fisheries was reinitiated on November 7, 2012. They have concurred with our determination that the proposed project would not likely adversely affect any NMFS listed species (see letter dated November 27, 2012, (Appendix A)

Sea turtles and/or whales may be encountered by tugs and scows transiting to the MBDS or IWS. Consequently, NOAA Fisheries and the USACE and have agreed to conditions to reduce the potential for vessel collisions with endangered species. From February 1 through May 31 of any year, disposal vessel including tugs, barges, and scows transiting between the dredge site and the MBDS will operate at speeds not to exceed five knots between sunset and sunrise, or in daylight conditions where visibility is less than one nautical mile. From February 1 through May 31 of any year, an approved marine mammal observer will be present aboard disposal vessels transiting between the dredge site and the MBDS during daylight hours. Dredge contractors would also be required to monitor the right whale listening buoys for right whale status in the separation zone of the Boston Harbor traffic shipping lanes. To date, the marine mammal observation reports from previous disposal operations have not indicated any physical contact with whales while transiting to MBDS. The Massachusetts Water Resources Authority has conducted monitoring surveys that have included marine mammal observers as part of the Harbor and Outfall Monitoring Project since 1995. Since 1998 no endangered species have been identified in the MBDS area, but in 2004 two finback whales were identified from an area slightly south of the disposal site (Short and Schaub, 2005).

The MBDS is a EPA designated dredged material disposal site. The U.S. EPA will determine how they will comply with the Endangered Species Act if the boundary of the MBDS is expanded to include the IWS.

Correspondence dated September 16, 2005 received from the Massachusetts Natural Heritage and Endangered Species Program (NHESP) states that there are no state-listed rare animals in the immediate vicinity of the dredge site.

4.7 Historical and Archaeological Resources

4.7.1 Boston Harbor

Each of the four proposed improvement plans are discussed below, along with the investigations and coordination already undertaken, and conclusions reached about the potential for submerged cultural and archaeological resources and any additional investigations determined to be necessary.

Main Channels Improvement Plan: 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.

Earlier cultural resources studies are discussed in greater detail in the Affected Environment Section 3-5 (Historic and Archaeological Resources). Previous studies are noted with references. The 25 and 40-foot channel areas of the lower and outer harbor included in the Main Channel Improvement Plan and the Marine Terminal Extension plan were constructed between 1900 and the 1950s. All of these areas are periodically maintained by dredging.

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 should not be present in this area due to the prior dredging. 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 (Lynch et al. 2004), significant cultural resources should not be impacted by the proposed improvement dredging of the Federal navigation project for the main channels improvement.

Main Ship Channel 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 -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 and no significant resources were encountered. Significant cultural resources should not be impacted 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 should 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. 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 Street Bridge was replaced in 2010-2011 by the City and U.S. Coast Guard, and the Federal channel widened to 175 feet in the vicinity of the new Chelsea Street Bridge in 2012.

The Chelsea River Channel was deepened from 35 feet to 38 feet in 1998-2001. Dredging for this deepening extended into the Boston 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 bends between the bridges will need to be examined during the design phase of the project. A remote sensing archaeological survey of these two 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.

Any maintenance dredging of the project features discussed above is not expected to impact any historical and/or archaeological sites due to the fact that these areas have been previously disturbed.

4.7.2. Habitat Enhancement Sites

Beneficial use of the dredged material at several sites for hard-bottom habitat creation were investigated at five sites: offshore of Magnolia, in Nahant Bay, in Broad Sound south of Nahant, in Massachusetts Bay east of the Brewster Islands, and Nantasket Roads. Two of these areas (Broad Sound and Massachusetts Bay) show potential for development of new hard bottom habitat. 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 planned and evaluated in coordination with the MA BUAR and the MA SHPO.

4.7.3. Massachusetts Bay Disposal Site and Industrial Waste Site

The MBDS and IWS are located seaward of the territorial sea (three-mile limit) in Federally regulated waters. These areas were previously surveyed (side scan sonar) by EPA, Region 1 and a number of shipwrecks were identified. 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 identified 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 as well as the Massachusetts Historical Commission and the Board of Underwater Archaeological Resources. However, given the large area available for disposal and capping and the fact that disposal sites can be shifted to avoid any potentially significant resources, unavoidable impacts are unlikely.

Summary of Additional Cultural Resources Investigations

In summary, the remaining cultural resource investigation work to be accomplished during the design phase of the project will consist of:

- Remote sensing surveys of the northern portion of the areas of the Chelsea River Channel proposed for widening;
- Borings for both of these areas;
- Laying-out a disposal plan at the MBDS and a capping plan for the IWS (if selected) to avoid the located shipwrecks (additional survey and Phase II site investigations may be required to determine the significance of identified shipwrecks); and
- Remote sensing surveys of any of the proposed rock reef sites included in the final plan and avoidance of any resources identified.

The preceding comments are offered in partial compliance with Section 106 of the National Historic Preservation Act (NHPA) of 1966, as amended and implementing regulations 36 CFR 800. The MA BUAR and MA SHPO have concurred with these recommendations via correspondence dated 2 June

2008 and 5 May 2008, respectively (Appendix A). The USACE will work closely with their offices as these additional studies are formulated.

As for earlier studies, the USACE will solicit comment from the MA BUAR and SHPO on the scope of these additional investigations and incorporate these comments in our implementation efforts. Field results and evaluations are provided for those agencies' review and concurrence before the USACE makes its determination on addressing any impacts. Depending upon identified historic properties and impacts to these, if any, the USACE in coordination with BUAR and SHPO will develop appropriate minimization and mitigation measures in an enforceable Agreement document if deemed appropriate.

Lastly, it should be noted that consultation with both the Mashpee and the Aquinnah Wampanoag Tribes, the two Federally recognized Indian Tribes in Massachusetts was initiated. The initial coordination letter, dated 18 April 2003, with the Wampanoag Tribe is included in the Public Involvement Appendix. Letters seeking comment on the draft Feasibility Report and SEIS/EIR were sent to the two tribes on 11 April 2008. No comments were received. However, consultation will continue with the Tribes for any remaining cultural resources studies, again in accordance with Section 106 of the NHPA and 36 CFR 800.

4.8 Air Quality

The air quality impact analysis presented in the Draft SEIS/EIR was conducted for three potential alternatives:

- No Action Alternative;
- Alternative 1 – -45-foot deep MLLW navigation channel; and
- Alternative 2 – -50-foot deep MLLW navigation channel.

After further design review and evaluation, USACE has determined that its proposed action would consist of the following modifications to the existing Federal Navigation Project for Boston Harbor and the Mystic River:

- Deepen the main channels between deep water in Massachusetts Bay and the Conley Terminal to a depth of -47 feet MLLW in the Main Ship Channel at 1200 to 800 feet wide; President Roads Anchorage, lower Reserved Channel and Turning Area, and deepen the 40-foot lane of the Broad Sound North Entrance Channel to a depth of -51 feet MLLW, all with widening of the channels in the bends;
- Deepen that reach of the Main Ship Channel above the Reserved Channel Turning Area to the Ted Williams Tunnel to -45 feet MLLW;
- Deepen the portion of the Mystic River Channel's 35-foot lane accessing the Medford Street Terminal to -40 feet MLLW;
- Deepen the 38-foot Chelsea River Channel to -40 feet MLLW with widening in two bends between the bridges.

Because the air quality impact analysis presented in the Draft SEIS/EIR provides a range of impacts surrounding the proposed action, the following discussion will utilize the data from the previous analyses to bracket the potential impacts of the proposed action and provide context for a qualitative discussion of the anticipated air quality impacts. The resulting proposed action will be for the -47-foot deep MLLW navigation channel, based on a conservative qualitative analysis of the emissions from the initially proposed Alternative 1 and Alternative 2.

Under current conditions (the No Action Alternative), larger cargo ships either delay (i.e., slow down) their arrival to ride the high tide into Boston Harbor, or wait at the berth or in the anchorage area or outside the project area for high tide. The lack of depth in the navigation channels may also cause a ship to delay departure or leave early from Boston Harbor or carry less cargo. In addition, larger cargo

ships are diverted to the Port of New York/New Jersey (PONYNJ). The container boxes are then loaded on trucks at the PONYNJ for delivery to destinations in New England. The No Action Alternative would limit the number of container ships that can sail into Boston Harbor causing economic and air quality impacts. The economic and air quality benefits of the Deep Draft Project would include newer, deeper draft container ships as well as a decrease in truck miles traveled between the PONYNJ and destinations for shipping container boxes into and from New England.

The Deep Draft Project would include harbor deepening of the main ship channels and other areas seaward of the Reserved Channel for improved containership access to the Conley Terminal plus the three smaller improvements listed above. Various navigation depth increments were considered. The two build alternatives considered in the Draft SEIS/EIR cover a range of potential air quality impacts since the final depth of the Main Ship Channel is anticipated to be 47-foot MLLW, which is between (bracketed by) the 45-foot MLLW and 50-foot MLLW build alternatives previously evaluated.

Air Quality Analysis Alternative 1 (45-foot deepening) would require removal of approximately 6,394,000 cubic yards (cy) of dredged material and approximately 447,000 cy of ledge material for the main channels plan and a total of 7,050,000 cubic yards (cy) of dredged material and approximately 526,000 cy of ledge if the three minor improvements were included. This alternative would take approximately three years to complete.

Air Quality Analysis Alternative 2 (50-foot deepening) would require the removal of approximately 14,426,000 cy of dredge material and approximately 1,381,000 cy of ledge material for the main channels plan and a total of 15,082,000 cubic yards (cy) of dredged material and approximately 1,460,000 cy of ledge if the three minor improvements were included. This plan would take approximately four years to complete.

The modified recommended plan for a 47-foot project would require removal of approximately 10,221,000 cy of dredge material and approximately 900,000 cy of ledge material for the main channels plan and a total of 10,877,000 cubic yards (cy) of dredged material and approximately 979,000 cy of ledge with the three minor improvements included. This plan would take approximately three years to complete. It is anticipated that the proposed action would occur from 2014 through 2017.

4.8.1. Standards for Determining Significance

NEPA and MEPA Comparisons

There are two principal criteria for evaluating project air quality impacts:

1. Estimating the increase in air emissions levels above the No Action Alternative as a result of the Deep Draft Project, and
2. Determining compliance with relevant standards and regulations.

The National Environmental Policy Act (NEPA) criteria for determining significance are listed in 40 CFR 1508.27. NEPA requires comparing project-related air quality impacts with the No Action Alternative air quality impacts. The Massachusetts Executive Office of Energy and Environmental Affairs (EEA) is responsible for enforcing the Massachusetts Environmental Policy Act (MEPA) regulations (301 CMR 11.00). The purpose of MEPA is to provide meaningful opportunities for public and state agency review of the potential environmental impacts of projects requiring State permits or proposed by State agencies.

The MEPA regulations do not set environmental significance criteria to evaluate project-related impacts in the same manner as NEPA. They contain impact-related thresholds which presume environmental significance if exceeded, mandating that an EIR be required to examine alternatives that avoid, minimize, and/or mitigate impacts. MEPA also relies on State agencies, such as MADEP,

to determine environmental significance and appropriate avoidance, minimization, and mitigation. Based on other EIR project experience, MADEP requires comparing project build air quality impacts with no-build air quality impacts similar to the NEPA requirements. In addition, MADEP requires estimating secondary air emissions. Under 310 CMR 7.00, secondary emissions are defined as those related to the construction or operation of a major stationary source/facility or major modification not directly related to the source/facility or major modification itself. Secondary emissions may include, but are not limited to: 1) emissions from motor vehicles, ships or trains going to or from the major stationary source/facility, and 2) emissions from any offsite support facility which would not otherwise be constructed, or increase its emissions as a result of the construction or operation of the major stationary source/facility or major modification. The shipping and cargo trucking emissions calculated for the indirect emissions would also represent the No Action Alternative and the Project (Post-Construction) operations. The Deep Draft Project will produce a net benefit to the environment for these secondary emissions.

A comparison of the net changes in indirect emissions for the No Action Alternative and the Deep Draft Project was conducted to compare with the NEPA and MEPA significance criteria. If the project emissions exceed the No Action Alternative emissions, then the project is considered to cause an impact requiring mitigation. For the purposes of this air quality impact analysis, it was also assumed that secondary emissions are the same as indirect emissions associated with cargo trucks and ship operations calculated for the general conformity evaluation. However, from a Clean Air Act conformity determination perspective, 40 CFR 93 Subpart B only requires the inclusion of indirect emissions where the agency has practicable control over future emissions. As the USACE has no control over ship traffic once the project is built, indirect emissions would not typically be included in a general conformity evaluation, so the evaluation of indirect emissions is primarily for compliance with NEPA and MEPA.

General Conformity Thresholds Comparison

The direct and indirect emissions were determined for each piece of equipment that would be used in the Deep Draft Project (e.g. construction equipment, trucks, ships). As noted above, direct emissions are those that occur during construction of the Project, and indirect emissions are those that occur from implementation of the Project after construction. The direct and indirect emissions were then summed on an annual basis for all equipment. The general conformity regulations require that the total of direct and indirect emissions be evaluated for:

- The year of maximum emissions;
- The mandated attainment year (for non-attainment pollutants) or the year of farthest emissions projections in the State Implementation Plan (SIP) (for maintenance pollutants); and
- Any year with an emissions budget specified in the SIP.

The annual emissions were compiled for each appropriate year for each build alternative, and each year's net emissions were then compared to the de minimis threshold values.

4.8.2. Air Emissions Estimation Methodology

Air emissions were estimated for the No Action Alternative and each year for Air Quality Analysis Alternatives 1 and 2. The total of the direct and indirect emissions (the net emissions increases) for a proposed project represent the difference between the build and the no-build scenarios. The general conformity regulations (40 CFR 93.152) define "direct emissions" as the emissions of a criteria pollutant or its precursors that are caused or initiated by the Federal action, originating in the same non-attainment or maintenance area, occurring at the same time and place as the action, and are reasonably foreseeable. Similarly, "indirect emissions" are defined as the emissions of a criteria pollutant or its precursors that are caused or initiated by the Federal action, originating in the same non-attainment or maintenance area, occurring at a different time or place as the action, are reasonably

foreseeable, which the Federal agency can practicably control, and for which the Federal agency has continuing program responsibility.

For the purposes of the general conformity analysis, it was assumed that dredging and construction activities define direct emissions and the effects on cargo vessel operations including scheduling, volume of ship calls, fleet mix and associated trucking operations define indirect emissions. It is anticipated that changes in shipping operations for Alternatives 1 and 2 would occur after the dredging operations are complete. Therefore, there would be no overlapping of either Alternative 1 or 2 indirect emissions with the direct emissions from the dredging operations in any particular year.

Emissions of oxides of nitrogen (NO_x), volatile organic compounds (VOCs) and carbon monoxide (CO) were estimated for the general conformity applicability analysis and support of this SEIS/EIR. Emissions of sulfur dioxide (SO_2) and particulate matter (PM_{10} and $PM_{2.5}$) were only estimated in support of the SEIS/EIR air quality impact analysis. The emission sources for Alternatives 1 and 2 would consist of marine and land-based mobile sources that would be used during the 3 to 5 year dredging activities. The marine sources would include tugboats and barges, as well as support equipment, such as crew and drill boats, and dump scows. The land-based emissions would include both non-road and on-road equipment. The non-road equipment would consist of heavy equipment, such as clamshells, backhoe excavators, loaders, cranes, generators, pumps, etc. The on-road equipment would be made up of construction employee vehicles and any delivery trucks.

Direct Emissions

A dredging operations schedule was estimated for Air Quality Analysis Alternatives 1 and 2. The schedule included a breakout of the number of pieces of equipment, engine sizes, and power loadings for each major phase of dredging. These data were used to estimate emissions from marine vessels, nonroad (dredging) equipment and on-road vehicles. It was assumed that all equipment, except for on-road vehicles, would use diesel fuel. The on-road vehicles were assumed to be a mix of both gasoline- and diesel-fueled engines. Appendix O presents the proposed dredging operations schedule for Air Quality Analysis Alternatives 1 and 2.

Annual emissions calculated from all three types of emissions sources were summed to obtain the total direct emissions for Alternatives 1 and 2, which were compared to the general conformity de minimis thresholds. A detailed discussion of the methods used to estimate emissions from all three types of emissions sources is provided below.

Marine Vessels

Marine vessel (tugboats, survey boats and pushboats) emissions were estimated using the latest U.S. EPA technical report available at the time of the Draft SEIS/EIR for developing load factors and emissions factors for large compression-ignition marine diesel engines as prescribed in U.S. EPA, *Analysis of Commercial Marine Vessels Emissions and Fuel Consumption Data,* EPA420-R-00-002, February 2000. The technical report is a compilation of engine and fuel usage test data from various types of marine vessels including bulk carriers, container ships, dredges, tankers and tugboats. This report was used to determine the load factors and emissions factors for the various ship types that would be used during the dredging operations. The load factors for the marine vessels are based on the suggested operating mode of the vessel. These load factors are based on different operating modes (cruise, slow cruise, maneuvering and hoteling) for different types of vessels.

The report contains emissions factors based on a regression analysis of representative test data for various marine vessels. Emission factor algorithms were derived for different pollutants and also for fuel consumption, which in turn was used to determine the SO_2 emission factor. The sulfur content used to calculate the SO_2 emission factor was based on low sulfur diesel fuel (500 parts per million (ppm)), which is used by local tugboat operators and is required by EPA as part of the marine vessel

emissions standards (U.S. EPA, *Clean Diesel Program for Locomotives and Marine, EPA 420-F-04-041*, May 2004). Table 5-1 of that EPA technical report presents the emission factor and fuel consumption rate algorithms, which are applicable to all engine sizes, since there is no statistically significant difference in emissions across engine sizes. All marine vessels used to support the dredging operations are accounted for in the emissions modeling.

The recommended number of tugboats and the size of the tugboat engines used for the analysis of Air Quality Analysis Alternatives 1 and 2 were used in the emissions calculations based on a conversation with a local tugboat company[14]. It was recommended that a single screw (2,150 horsepower) and a twin screw (3,000 horsepower) tugboat would be used to tow barges to and from the disposal sites for Alternative 1 and a second twin screw tugboat was added for Alternative 2 due to an increased amount of material that would be disposed.

Monthly emissions (tons/month) were calculated based on the number of tugboats, survey boats and pushboats, their rated horsepower, average power load factor, and hours of operation per day. The emissions were summed for each month to calculate the annual emissions. The annual emissions are based on a maximum of 239 days per year of dredging operations. This number of days per year takes into account downtime associated with inclement weather and maintenance of equipment.

Non-Road Equipment

The non-road equipment emissions were calculated using information from an U.S. EPA computer model NONROAD2.5. This model was developed to assist states and regulatory agencies to more accurately predict non-road emissions inventories. NONROAD2.5 calculates emissions for many nonroad equipment types by categorizing them by horsepower rating and fuel type. It estimates exhaust emissions for NO_x, SO_2, CO, PM and VOC. NONROAD2.5 contains several different sets of data files that are used to specify the options for a model run. These data files provide the necessary information to calculate and allocate the emissions estimates. The data files contain information on load factors, emission factors, equipment population, activity, average lifetime hours, growth estimates, equipment scrappage function, geographic location, and temporal allocation. The data files can be modified to reflect the project conditions relative to equipment population, annual hours of use, region of use, fuel source, equipment growth factors, and the phase-in of higher tier emission factors. NONROAD2.5 is best suited for estimating emissions for large-scale emissions inventories at the county, state or regional level. However, at the smaller project level, to modify the model to represent a smaller-scale project, the model can be cumbersome. Based on discussions with the U.S. EPA NONROAD model support specialist regarding this issue, it was recommended that for this project it may be better to estimate emissions using data provided in the U.S. EPA report, *Exhaust and Crankcase Emission Factors for Nonroad Engine Modeling – Compression-Ignition, EPA420-P-04-009*, April 2004. Information in this document was directly incorporated into NONROAD2.5.[15]

NONROAD2.5 includes future emissions standards recently promulgated by U.S. EPA for gasoline- and diesel-fueled equipment. It also estimates the effects of deterioration in the emissions calculations as a function of age of the equipment. A range of 8 to 18 years for the age of the equipment was used for the calculations. A median age of 13 years was used to calculate the deterioration factors for each pollutant.

Since PM and SO_2 emissions are dependent on the sulfur content of the fuel, it was assumed that ultra-low sulfur diesel (ULSD) would be used in all non-road equipment, as required by U.S. EPA (40 CFR 89). A sulfur content of 15 ppm was used in calculating SO_2 and PM emissions.

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[14] Kristin Lemaster, CDM Smith telephone conversation with Dave Clarke, Boston Towing & Transportation Company, November 11, 2005.

[15] Kevin Eagar, CDM Smith telephone conversation with Craig Harvey, EPA, October 13, 2005.

Similar to the marine vessels emissions calculations, monthly emissions (tons/month) were calculated for the dredging operations based on the number of pieces of equipment, rated horsepower, average power load factor, and hours of operation per day. The emissions were summed for each month to calculate the annual emissions.

It should be noted that the current version of the NONROAD model at the time of preparation of this document, NONROAD2008a, became available from U.S. EPA in July 2009. The major differences between NONROAD 2008a and NONROAD2.5 (the model used to determine emissions for the Draft SEIS/EIR) is the accounting for diesel recreational marine standards in the locomotive/marine final rule and for small spark ignition and spark ignition recreational marine final rule. NONROAD2008a predicts substantially less VOC and CO emissions and somewhat less NOx and PM emissions for those types of engines than with NONROAD2.5 with use of comparable scenario inputs; any comparison depends on the pollutant, equipment type, year evaluated, and fuel choice. Since these changes would have little to no effect on the air quality analysis for the Deep Draft Project, no adjustments to the emissions from non-road equipment were deemed necessary.

On-Road Vehicles

The on-road vehicle emissions were calculated using the U.S. EPA model MOBILE6.2. It is an emission factor model that calculates emissions, in grams per mile, for different vehicle types under various operating conditions. Crew sizes and delivery truck sizes were estimated. An average commute of 25 miles each way at an average speed of 27.6 miles per hour was assumed for each vehicle. The number of miles per trip was then multiplied by the total number of days per year to determine the total number of miles traveled[16]. MOBILE6.2 input files representative of 2011 and beyond for eastern Massachusetts were obtained from MA DEP that would be representative of vehicles to be used on the project[17]. The results for the different emission quantities from the MOBILE6.2 model runs were multiplied by the number of vehicle miles traveled during each calendar year. The MOBILE6.2 model input and output files are available.

In March 2010 (75 FR 9411), U.S. EPA replaced MOBILE6.2 with the MOVES (MOtor Vehicle Emission Simulator) model as the primary model for calculating emissions from on-road vehicles. The latest version of MOVES at the time of preparation of this document is MOVES2010b, which was issued by U.S. EPA in April 2012. While MOVES2010b is considered to be more accurate in estimating emissions from on-road vehicles than MOBILE6.2, and may result in a reduction of the contribution of emissions from on-road vehicles for the Deep Draft Project, emissions from on-road vehicles have not been revised for this analysis. The previous analysis assumed emissions from on-road vehicles beginning in 2011, but anticipating that these emissions would not begin until 2014, emission rates would be expected to decline to match improving emission rates with newer model vehicles. So, the on-road vehicle emissions presented in this report would represent a conservative or higher than expected estimate.

Indirect Emissions

Under Air Quality Analysis Alternatives 1 and 2, the Main Ship Channel would be deepened to a depth greater than the currently authorized depth of -40 feet MLLW. Deeper channel depth would put Boston Harbor more in line with channel depths at other U.S. East Coast and foreign container ports, which are mostly 50 feet deep in the U.S. or deeper abroad. A deeper channel would allow larger vessels to access the port facilities in an economically efficient manner; thereby increasing the volume of twenty-foot equivalent units (TEU) loaded and unloaded at Boston Harbor while maintaining

[16] M. Wallace, CDM Smith, Conference Call meeting notes with the USACE on September 28, 2005.
[17] Email to Marc Wallace, CDM Smith from Craig Woleader, MADEP, December 5, 2005.

existing sailing schedules and port rotations[18]. For the purposes of evaluating the potential air quality impacts or benefits of the Project (Post-Construction) shipping and trucking operations, a -48-foot MLLW was selected. This depth was selected because it represented the median depth between the bracketing build alternative depths and has the highest net benefits. Because the channel depth used for the analysis of post-construction shipping is so close to the depth represented by the proposed action (-47-feet), no changes were made to the emissions analysis. Therefore, the indirect emissions analysis in this report would represent a conservative estimate.

The No Action Alternative and Deep Draft Project (Post-Construction) container, cargo and petroleum vessel operations including scheduling, volume of ship calls, fleet mix and associated trucking operations were obtained from the David Miller Associates report, *Boston Harbor Channel Deepening Containerized Cargo Benefits Analysis,* August 2007. (Information on the sizes and numbers of containerships expected for the Deep Draft Project (Post-Construction) from a David Miller Associates 2012 report is included in Table 4-5, but emission estimates are based on data from the 2007 report). The shipping and trucking operations data were used to estimate indirect emissions for the No Action Alternative and Deep Draft Project (Post-Construction). It was assumed that routine shipping operations would be the same under Air Quality Analysis Alternatives 1 and 2 during dredging activities.

Annual emissions (tons/year) were calculated based on changes in sizes of ships (i.e., smaller to larger vessels), changes in ship mode operations (i.e., anchoring, cruising and hoteling) and the number of ship calls per year. The net reductions in trucking emissions for the Deep Draft Project were also calculated using the MOBILE6.2 emissions model. The emissions were summed for each vessel type to calculate the annual emissions. The net change in trucking emissions was added to the total project emissions.

A similar approach was also conducted to estimate the air quality benefit for the New England region because of the reduced truck miles due to cargo trucked from Boston Harbor instead of from the PONYNJ. The results of this analysis are discussed as part of the comparison between No Action Alternative and the Deep Draft Project (Post-Construction) scenarios.

Ship Emissions

The No Action Alternative and Deep Draft Project (Post-Construction) shipping emissions were calculated based on the effects on container, cargo and petroleum vessel operations including scheduling, volume of ship calls, fleet mix and associated trucking operations. The No Action Alternative and Deep Draft Project (Post-Construction) shipping emissions were also estimated using emissions factors presented in the EPA report, *Final Regulatory Support Document: Control of Emissions from New Marine Compression-Ignition Engines at or Above 30 Liters per Cylinder, EPA420-R-03-004,* January 2003. However, for new container ships, it was assumed they would comply with the International MARPOL Annex VI NO_x emissions standards. For ships with Category 3 marine diesel engines, the MARPOL Annex VI NO_x Tier 1 standard applies to engines installed on vessels constructed beginning in 2004 but before 2011; the Tier 2 standard applies to engines installed on vessels constructed beginning in 2011 but before 2016; and the Tier 3 standard applies to engines installed on vessels constructed beginning in 2016. U.S. EPA has adopted these standards under its Tier 1, 2, and 3 standards for Category 3 marine diesel engines (engine sizes 3,000 to 100,000 horsepower). Engines meeting the Tier 1 standards have emission levels about 20 percent lower than uncontrolled levels (U.S. EPA, *Emission Standards Adopted for New Marine Diesel Engines, EPA420-F-03-001, January 2003*) while engines meeting the Tier 3 standards will have emission levels about 80 percent below uncontrolled levels. For the analysis conducted for the Draft SEIS/EIR,

[18] David Miller Associates, Draft Boston Harbor Channel Deepening Project, Containerized Cargo Economic Benefits Analysis, August, 2007.

Tier 1 emission standards were utilized. Therefore, for newer container ships a NO_x emission factor of 23.60 g/kW-hr was used to calculate the Project (Post-Construction) emissions and that analysis is considered a conservative estimate of expected emissions. It should also be noted that on March 26, 2010, the International Maritime Organization established an Emission Control Area (ECA) around the North American coastline extending outwards to 200 nautical miles. Beginning on August 1, 2012, marine vessels in the ECA must use fuel with sulfur content no greater than 1.0 percent, and starting on January 1, 2015, marine vessels in the ECA must use fuel with sulfur content no greater than 0.1 percent. This standard will significantly reduce emissions of sulfur dioxide and particulate matter from these ships in the ECA, and because emissions for these pollutants estimated for this analysis did not account for this standard, those emissions estimates will be conservative.

Under the project condition, Large Post-Panamax containership vessels (6,700 and 8,500 TEU; 48-foot maximum draft) are projected to use Boston Harbor for the Deep Draft Project (Post-Construction). The larger class ships are also expected to be newer models (2002) than the current fleets (average model year of 1994). The No Action Alternative bulk cargo shipments assume 24 bulk shipments/year on 40,000 dead weight tonnage (DWT) bulk carriers. It is estimated that the project bulk cargo shipments would decrease to 16 bulk shipments/year, but the size of the ships would increase to 60,000 DWT bulk carriers. Finally, the net change in petroleum shipments between the No Action Alternative and the Project is projected to be a decrease of 19 ship calls per year. However, the Deep Draft Project would generate a net increase of 34 ship calls/year (77 calls to 114 calls) for larger petroleum tankers 35,000 DWT or greater. Table 4-7 presents a summary of the No Action Alternative and the Deep Draft Project (Post-Construction) shipping operations.

Table 4-7. No Action and Post Construction Alternative Shipping Operations

No Action Alternative		Post Construction Alternative	
Ship Type	**No. of Calls/Year**	**Ship Type**	**No. of Calls/Year**
Containership - 4,000 TEUs (Foreign)	104	Containership - 5,100 TEUs (Foreign)	52
		Containership – 6,700 TEUs (Foreign)	52
Containership - 5,100 TEUs (Foreign)	52	Containership – 8.500 TEUs (Foreign)	52
Bulk Carrier - 40,000 DWT (Foreign)	25	Bulk Carrier - 40,000 DWT (Foreign)	7
Bulk Carrier - 25,000 DWT (Foreign)	12	Bulk Carrier - 55,000 DWT (Foreign)	18
Petroleum Ship - <20,000 DWT	356	Petroleum Ship - <20,000 DWT	337
Petroleum Ship - 20,000 DWT	0	Petroleum Ship - 20,000 DWT	0
Petroleum Ship - 25,000 DWT	6	Petroleum Ship - 25,000 DWT	0
Petroleum Ship - 35,000 DWT	81	Petroleum Ship - 35,000 DWT	38
Petroleum Ship - >35,000 DWT	77	Petroleum Ship - >35,000 DWT	114
TOTAL SHIPS	**713**	**TOTAL SHIPS**	**670**

Annual emissions were calculated based on the number of ship calls per year, engine load factors and anchoring, cruising and hoteling hours of operation per day. The shipping modes of operation (i.e., anchoring, cruising and hoteling) were based on information provided by USACE[19]. The deepening of the harbor would eliminate anchoring activities for petroleum ships and improve ship movement activities in the harbor. The power load factors were 0.1 for anchoring and hoteling modes and 0.25 for cruising mode within the reduced speed zone (RSZ) per guidance in the U.S. EPA report, *Final Regulatory Support Document: Control of Emissions from New Marine Compression-Ignition Engines at or Above 30 Liters per Cylinder, EPA420-R-03-004.*

Cargo Truck Emissions

The cargo truck emissions were calculated using the EPA model MOBILE6.2. The pollutant emission factors from the MOBILE6.2 model runs were multiplied by the number of truck miles traveled. These emission factors and input files were the same as those used to calculate the direct emissions from on-road vehicles one year after dredging is completed. The net change in projected truck emissions were added to the net change in shipping emissions between the No Action Alternative and Deep Draft Project (Post-Construction) scenarios. The MOBILE6.2 model input and output files are available.

4.8.3. Air Emissions Modeling Results

Since the project requires Federal funding and approvals, the Act's general conformity rule (40 CFR 93 Subpart B) requires that an evaluation be made on whether or not the general conformity requirements apply to the Deep Draft Project and, if so, whether the total of the direct plus indirect air emissions (only if the Federal agency has practicable control of indirect emissions) associated with the project would "conform" with the Massachusetts SIP to attain the NAAQS. The Boston area is part of a designated non-attainment area for the 1997 eight-hour O_3 NAAQS and a maintenance area for the one- and eight-hour CO NAAQS. Accordingly the general conformity applicability analysis was conducted for the pollutants that cause O_3 formation (precursor compounds VOC and NO_X) and for CO (See Section 3.6).

A formal general conformity determination is **not** required for projects that are "de minimis". De minimis project emissions are those that have net emissions increases less than the thresholds of 100 tons of NO_X/year, 50 tons of VOC/year, or 100 tons of CO/year. If, however, the maximum potential net emissions increases from the project could exceed these thresholds, then the project must demonstrate conformity with the SIP, or else the Federal approvals and funding must be denied. Making a positive finding of general conformity can be difficult, because the regulations only allow prescribed approaches:

- Showing that the proposed project and its associated net emissions increases are specifically identified in the SIP;
- Showing that the net emissions increases from the proposed project, along with all other emissions in the non-attainment or maintenance area, would not exceed the emissions budgets in the SIP;
- Showing that the net emissions increases from the proposed project are fully offset within the non-attainment or maintenance area, or another nearby non-attainment or maintenance area that impacts the subject area;
- Fully mitigating the net emissions increases from the proposed project to zero; or
- For CO, showing through either local or area wide dispersion modeling that the NAAQS are not threatened.

[19] Telephone conversation between Karen Umbrell, USACE and Marc Wallace, CDM Smith based on information provided by Boston Pilots, January 24, 2007.

A goal of the general conformity applicability analysis is to identify opportunities to modify a project to comply with the SIP. Accordingly, a component of this analysis involves evaluating opportunities to manage the project's emissions rates to be below the de minimis values. The critical pollutant for this analysis was NO_x. The uncontrolled emissions increase associated with the sum of direct and indirect emissions from the proposed Project would likely exceed the 100-ton/year de minimis threshold for NO_x.

The general conformity applicability analysis was conducted by calculating NO_x, VOC and CO emission rates for Air Quality Analysis Alternatives 1 and 2 and for changes in shipping and trueking operations after the eompletion of the project, based on likely equipment and operations data. If the resulting uncontrolled net emission increases exceeded any of the de minimis values, then emissions reduction measures were evaluated. These measures included modifying dredging methods, increasing the duration of dredging aetivities, and/or requiring the use of low-emitting equipment. Such measures would also have to be adopted as part of the project's design.

Note that, as mentioned in Section 3.6, 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 Project with respect to O_3 and its precursor compounds, NO_x and VOC. Under that scenario, the general conformity applicability analysis presented below for NO_x and VOC for the Project would be moot.

4.8.3.1 Direct Emissions

Air Quality Analysis Alternative 1

The projeet dredging emissions represent the estimated total direct emissions that would occur with the proposed deepening of Boston Harbor to the -45-feet MLLW depth. The emissions for the marine, non-road and on-road equipment were determined as discussed in Section 4.8.2. The calculated direct emissions were totaled on an annual basis over the three years of construction for all equipment involved for Air Quality Analysis Alternative 1. The direct emissions represent the net ehange in total emissions, since the indirect emissions would not occur during the three-year dredging schedule. Therefore, the total direct emissions were compared to the general conformity de minimis thresholds.

The estimated emissions for Air Quality Analysis Alternative 1 are summarized in Table 4-6. This table presents a summary of each pollutant's emissions categorized by marine vessels, nonroad equipment and on-road construction, employee, and truck deliveries emissions. The marine vessels include emissions from tugboats, survey boats, and push-boats required to assist the dredging during deepening operations. The non-road equipment would include a clamshell, backhoe excavator, drill towers, and their support equipment (i.e., generators, pumps, winches, and welders).

The first set of emissions calculations, identified as "uncontrolled" emissions, represents preliminary estimates without making adjustments to the dredging operations, schedule or equipment. Table 4-8 shows that the total emissions for the uncontrolled conditions for NO_x and CO exceed the general conformity de minimis thresholds for all three years. In addition, the total emissions for the uncontrolled conditions for VOC are less than the general conformity de minimis thresholds for all three years. Therefore, VOC emissions are exempt from further analysis under the general conformity rule.

The peak year direct emissions (Year 2) for NO_x and CO are 256 and 151 tons, respectively, which far exceed the 100 ton/year de minimis thresholds for both pollutants. The major contributors to these exceedances are the marine construction vessels and in particular the tugboat operations and the nonroad equipment, specifically the clam shell and backhoe operations. The on-road vehicle emissions are a minor contributor to the total emissions (i.e., less than five percent of the total emissions). The tugboat NO_x emissions represent 92 percent of the total marine vessel NO_x emissions

and 23 percent of the total direct NO_x emissions. The clamshell and backhoe NO_x emissions represent 86 percent of the total non-road NO_x emissions and 64 percent of the total direct NO_x emissions, respectively. Similarly the tugboat CO emissions represent 95 percent of the total marine vessel CO emissions, but only represent approximately five percent of the total direct CO emissions. The clamshell and backhoe CO emissions represent 81 percent and 88 percent of the total non-road CO emissions and total direct CO emissions, respectively.

Since the uncontrolled direct emissions for NO_x and CO substantially exceeded the de minimis thresholds, two options were evaluated to reduce the net emissions increases. The first option would require replacing older, higher emitting equipment with newer and cleaner burning equipment that has been available since 2011. The second option would require using new, lower-emitting equipment and extending the proposed three-year dredging schedule. This approach would allow for spreading the peak year emissions over the entire dredging schedule. These options are presented in Table 4-8.

Emission Reduction Option 1 requires replacing all nonroad equipment with newer, lower-emitting equipment that would meet EPA Tier 3 and 4 emissions standards that are required for equipment model years 2011 and beyond. Appendix O presents a summary of the EPA Nonroad Emissions Standards. The clamshell and backhoe engines would need to meet Tier 4 emissions standards and support equipment would need to comply with Tier 3 and Tier 4 emissions standards, depending on the equipment category and engine size. In addition, the tugboats would also have to be equipped with engines that meet EPA's Tier 2 marine diesel engine emissions standards (U.S. EPA, *Overview of EPA's Emission Standards for Marine Engines, EPA420-F-04-031,* August 2004). Table 4-9 presents the Tier 2 emissions standards for Category 2 marine diesel engines.

Table 4-8 shows that the NO_x, CO, and VOC emissions for Emissions Reduction Option 1 were reduced significantly for each year. Table 4-8 shows that the replacement of older equipment with newer, lower-emitting equipment would reduce total NO_x, CO and VOC emissions by 53, 57 and 63 percent, respectively. Under this option, the marine vessel and non-road NO_x and CO emissions totals are separately below their respective 100 ton/yr thresholds in each of the three years of dredging operations. However, the peak year total emissions (Year 2) for NO_x would be 119 tons, which would still exceed the 100 ton/yr de minimis threshold. The use of new equipment would reduce peak year CO emissions below the 100 ton/year de minimis threshold, even though tugboats equipped with Tier 2 engines were projected to increase CO by 263 percent (from 8 tons to 29 tons in Year 2). This is because engine modifications to reduce NO_x emissions would cause CO emissions to increase. As noted above, uncontrolled VOC emissions are less than the de minimis thresholds and are exempt from further analysis under the general conformity rule.

Emission Reduction Option 2 would include both the replacement of older equipment with newer, lower-emitting equipment and increasing the dredging scheduling by six months (from 36 months to 42 months). The extension of the dredging schedule over four calendar years is based on nine months of operation per year. Table 4-8 shows that the peak year (Year 3) total NO_x and CO emissions for Emissions Reduction Option 2 would be reduced to 91 tons and 50 tons, respectively. As noted above, uncontrolled VOC emissions are less than the de minimis thresholds and are exempt from further analysis under the general conformity rule. Table 4-10 shows that the replacement of older equipment with newer equipment and stretching the dredging schedule to four calendar years would reduce total NO_x and CO emissions by 65 and 67 percent, respectively. Emission Reduction Option 2 demonstrates dredging operations would remain below the de minimis levels and therefore be exempt from the general conformity rule. Figures 4-4 through 4-6 present graphs for Uncontrolled Emissions, Emissions Reductions Option 1, and Emissions Reductions Option 2 respectively, for NO_x, CO and VOC emissions for Alternative 1 direct emissions.

Table 4-8. Summary of Dredging Operation Emissions for 45-Foot MLLW Alternative

Year	Pollutant	Emissions (tons/year)												General Conformity Thresholds (tons/year)
		Uncontrolled Conditions				Emission Reduction Option 1				Emission Reduction Option 2				
		Marine	Non-Road	On-Road	Total	Marine	Non-Road	On-Road	Total	Marine	Non-Road	On-Road	Total	
1	$PM_{2.5}$	3	13	0.02	16	3	2	0.02	5	2	1.1	0.02	3	-
	PM_{10}	3	13	0.04	16	3	2	0.04	5	2	1.1	0.04	3	-
	SO_2	187	0.1	0.01	187	187	0.1	0.01	187	126	0.1	0.01	126	-
	NO_x	61	142	0.84	**203**	50	49	0.84	99	34	30	0.84	65	100
	CO	7	101	8.77	**117**	27	20	8.77	56	18	13	8.8	40	100
	VOC	1	16	0.37	17	1	5	0.37	6	0	3	0.4	4	50
2	$PM_{2.5}$	3	17	0.02	20	3	2	0.02	5	2	1.8	0.02	4	-
	PM_{10}	3	18	0.03	21	3	3	0.03	6	2	1.9	0.03	4	-
	SO_2	200	0.2	0.01	200	200	0.2	0.01	200	154	0.1	0.01	154	-
	NO_x	65	191	0.71	**256**	54	65	0.71	**119**	41	48	0.7	90	100
	CO	8	135	8.40	**151**	29	27	8.40	64	22	20	8.4	50	100
	VOC	1	21	0.34	22	1	7	0.34	8	1	5	0.3	6	50
3	$PM_{2.5}$	3	17	0.02	19	3	2	0.02	5	2	1.9	0.02	4	-
	PM_{10}	3	17	0.03	20	3	2	0.03	5	2	2.0	0.03	4	-
	SO_2	174	0.1	0.01	174	176	0.1	0.01	176	154	0.1	0.01	154	-
	NO_x	56	182	0.61	**239**	47	55	0.61	**103**	41	49	0.61	91	100
	CO	7	128	8.09	**143**	25	24	8.09	57	22	20	8.1	50	100
	VOC	1	20	0.31	21	1	6	0.31	7	1	5	0.31	6	50
4	$PM_{2.5}$	-	-	-	-	-	-	-	-	2	1.7	0.02	4	-
	PM_{10}	-	-	-	-	-	-	-	-	2	1.7	0.03	4	-
	SO_2	-	-	-	-	-	-	-	-	127	0.1	0.01	128	-
	NO_x	-	-	-	-	-	-	-	-	34	41	0.5	75	100
	CO	-	-	-	-	-	-	-	-	18	18	7.9	44	100
	VOC	-	-	-	-	-	-	-	-	0	4	0.3	5	50

Notes: 1. Values in bold print and underline represent exceedances of the general conformity de minimis thresholds

2. Emission Reduction Option 1 is based on replacing older equipment with newer ones meeting EPA emissions standards. Emission Reduction Option 2 is based on lengthening the construction schedule from 36 months to 42 months and requiring the contractor to use their new equipment meeting applicable EPA non-road emissions standards.

Table 4-9. Tier 2 Standards for Category 2 Marine Diesel Engines

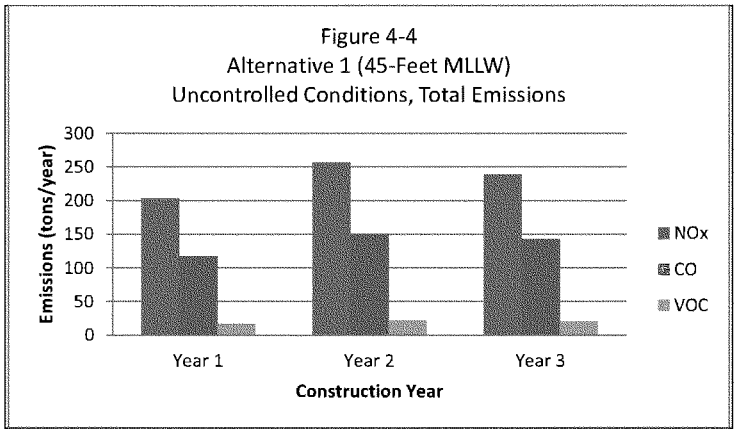
Displacement (liter/cylinder)	Power (kW)	HC+ NOx (g/kW-hr)	PM (g/kW-hr)	CO (g/kW-hr)
5.0</= disp. <15	--	7.8	0.27	5.0
15</= disp. <20	<3300	8.7	0.50	5.0
15</= disp. <20	>/= 3300	9.8	0.50	5.0
20</= disp. <25	--	9.8	0.50	5.0
25</= disp. <30	--	11.0	0.50	5.0

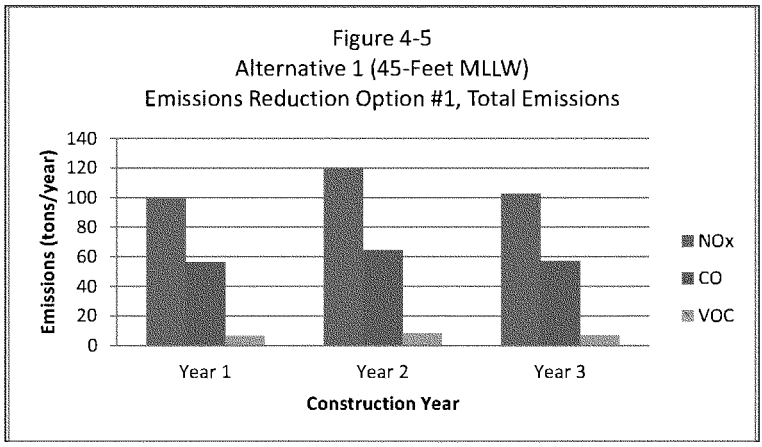
Source: U.S. EPA, Overview of EPA's Emission Standards for Marine Engines, EPA420-F-04-031, August 2004.

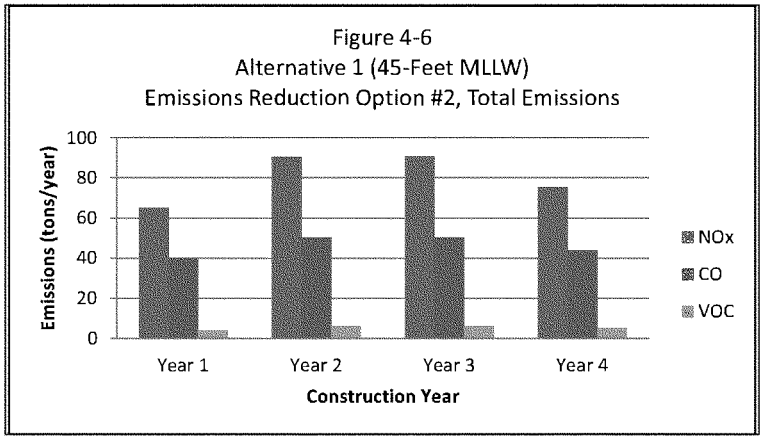
Table 4-10. Summary of % Emission Reduction with Newer Equipment and More Construction Time for Alternative 1.

Pollutant	Emission Reduction Option 1			Emission Reduction Option 2		
	Marine	Non-Road	Total	Marine	Non-Road	Total
NO_x	-18%	-66%	-53%	-36%	-75%	-65%
CO	263%	-80%	-57%	175%	-85%	-67%
VOC	0%	-66%	-63%	0%	-75%	-72%

Note: CO emissions increased with tugboat operations.







Air Quality Analysis Alternative 2:

The project dredging emissions represent the estimated total direct emissions that would occur with the proposed deepening of Boston Harbor to the -50-feet MLLW depth. The estimated emissions for Air Quality Analysis Alternative 2 are summarized in Table 4-11. This table presents a summary of each pollutant's emissions categorized by marine vessels, nonroad equipment and on-road construction employee and truck deliveries emissions. The marine vessels include emissions from tugboats, survey boats, and push-boats required to assist the dredging during deepening operations. The nonroad equipment would include two clamshells, a backhoe excavator, drill towers, and their support equipment (i.e., generators, pumps, winches, and welders).

The first set of emissions calculations identified as "uncontrolled" emissions represents preliminary estimates without making adjustments to the dredging operations, schedule or equipment. Table 4-11 shows that the total emissions for the uncontrolled conditions for NO_x and CO exceed the general

conformity de minimis thresholds for all four years and the uncontrolled conditions for VOC exceed the general conformity de minimis threshold in two out of four years. The peak year emissions (Year 2) for NO_x and VOCs would be 557 tons and 53 tons, respectively, which would far exceed the 100 tons/year de minimis threshold for NO_x and exceed the 50 tons/year de minimis threshold for VOCs. In addition, the peak year emissions (Year 3) for CO would be 352 tons, which also far exceeds the 100 tons/yr de minimis threshold for CO. The major contributors to these exceedances are the marine vessels and in particular the tugboat operations and the nonroad equipment, specifically the clamshells and backhoe operations. The on-road vehicle emissions are a minor contributor to the total emissions (i.e., less than five percent of the total emissions). The tugboat NO_x emissions represent 96 percent of the total marine vessel NO_x emissions and 22 percent of the total direct NO_x emissions. The clamshells and backhoe NO_x emissions represent 83 percent of the total non-road NO_x emissions and 64 percent of the total direct NO_x emissions, respectively. Similarly the tugboat CO emissions represent 96 percent of the total marine vessel CO emissions, but only represent less than five percent of the total direct CO emissions. The clamshells and backhoe CO emissions represent 76 percent and 71 percent of the total non-road CO emissions and total direct CO emissions, respectively.

Since the uncontrolled direct emissions substantially exceeded the de minimis thresholds for NO_x, CO, and VOC, the two options that were evaluated to reduce the net emissions increases under Air Quality Analysis Alternative 1 were also used to reduce net emissions increases under Air Quality Analysis Alternative 2. Emission Reduction Option 1 would require replacing all older non-road equipment with newer, lower-emitting equipment that would meet EPA Tier 2, 3 and 4 emissions standards that would be required for equipment model years 2011 and beyond. Under Emission Reduction Option 1, VOC emissions would be reduced to less than the de minimis thresholds for all four years and therefore would be exempt from further analysis under the general conformity rule.

Since the direct net emissions of NO_x would be significantly higher than the 100 ton/yr de minimis threshold, both the replacement of older equipment with newer equipment and extending the dredging schedule would not eliminate the peak year emissions exceedances. Therefore, the dredging operations were revised to be the same as Air Quality Analysis Alternative 1 and the dredging schedule extended from 48 months (four years) to 73 months over eight calendar years. The extension of the dredging schedule an additional four calendar years is based on 10 months of dredging operations in the first year and nine months of dredging operation for years two through eight. Table 4-11 shows that the peak years (Years 2 and 3) total NO_x and CO emissions for Emissions Reduction Option 2 would be reduced to 96 tons and 56 tons, respectively. Table 4-12 shows that the replacement of older equipment with newer equipment and stretching the dredging schedule over eight calendar years would reduce total NO_x and CO emissions by 83 and 84 percent, respectively. Emission Reduction Option 2 demonstrates dredging operations would remain below de minimis levels and therefore be exempt from the general conformity rule. Figures 4-7 through 4-9 present graphs, respectively, of the uncontrolled and Emissions Reductions Options 1 and 2 for the three pollutants for Air Quality Analysis Alternative 2 direct emissions.

Table 4-11. Summary of Dredging Operation Emissions for Air Quality Analysis Alternative 2

Year	Pollutant	Emissions (tons/yr)												General Conformity Thresholds (tons/yr)
		Uncontrolled Conditions				Emission Reduction Option # 1				Emission Reduction Option # 2				
		Marine	Non-Road	On-Road	Total	Marine	Non-Road	On-Road	Total	Marine	Non-Road	On-Road	Total	
1	$PM_{2.5}$	5	14	0.03	20	5	2	0.03	8	2	1	0.03	3	--
	PM_{10}	5	15	0.04	20	5	3	0.04	8	2	1	0.04	4	--
	SO_2	353	0.1	0.01	353	353	0.2	0.01	353	143	0.1	0.01	143	--
	NO_x	114	141	1.0	**257**	94	68	1.0	**163**	38	38	1.0	77	100
	CO	14	108	10	**131**	52	30	10	93	20	18	10	49	100
	VOC	1	16	0.4	18	1	8	0.4	9	1	4	0.4	5	50
2	$PM_{2.5}$	6	45	0.02	51	6	5	0.02	11	2	2	0.02	4	--
	PM_{10}	6	46	0.04	52	6	5	0.04	11	2	2	0.04	4	--
	SO_2	395	0.4	0.01	396	395	0.3	0.01	396	154	0.1	0.01	154	--
	NO_x	128	428	0.8	**557**	105	123	0.8	**230**	41	53	0.8	96	100
	CO	15	325	9.8	**350**	58	49	9.8	**117**	22	24	9.8	56	100
	VOC	1	51	0.4	**53**	1	14	0.4	16	1	6	0.4	7	50
3	$PM_{2.5}$	6	46	0.02	52	6	5	0.02	11	2	2	0.02	5	--
	PM_{10}	6	47	0.04	53	6	5	0.04	11	2	2	0.04	5	--
	SO_2	395	0.3	0.01	396	395	0.3	0.01	396	154	0.1	0.01	154	--
	NO_x	128	418	0.7	**547**	105	122	0.7	**228**	41	53	0.7	96	100
	CO	15	327	9.4	**352**	58	48	9.4	**116**	22	25	9.4	56	100
	VOC	1	51	0.4	**53**	1	14	0.4	16	1	6	0.4	7	50
4	$PM_{2.5}$	5	32	0.02	38	5	5	0.02	10	2	2	0.02	5	--
	PM_{10}	5	33	0.04	39	5	5	0.04	11	2	2	0.04	4	--
	SO_2	367	0.3	0.01	367	367	0.3	0.01	367	154	0.1	0.01	154	--
	NO_x	119	342	0.6	**461**	98	108	0.6	**206**	41	53	0.6	95	100
	CO	14	246	9.2	**269**	54	41	9.2	**105**	22	24	9.2	55	100
	VOC	1	36	0.3	37	1	12	0.3	14	1	6	0.3	7	50

Notes:
1. Values in bold print and box represent exceedances of the General Conformity de minimis thresholds.

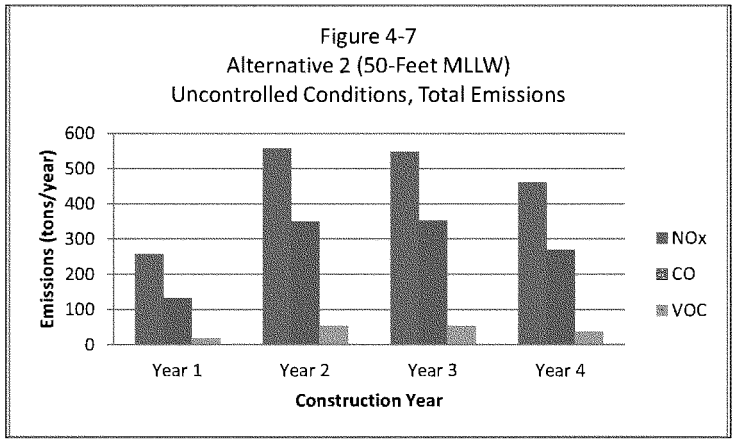
Year	Pollutant	Emissions (tons/yr)												General Conformity Thresholds (tons/yr)
		Uncontrolled Conditions				Emission Reduction Option # 1				Emission Reduction Option # 2				
		Marine	Non-Road	On-Road	Total	Marine	Non-Road	On-Road	Total	Marine	Non-Road	On-Road	Total	
5	$PM_{2.5}$	--	--	--	--	--	--	--	--	2	2	0.02	5	--
	PM_{10}	--	--	--	--	--	--	--	--	2	2	0.03	4	--
	SO_2	--	--	--	--	--	--	--	--	154	0.1	0.01	154	--
	NO_x	--	--	--	--	--	--	--	--	41	53	0.5	95	100
	CO	--	--	--	--	--	--	--	--	22	25	8.9	55	100
	VOC	--	--	--	--	--	--	--	--	1	6	0.3	7	50
6	$PM_{2.5}$	--	--	--	--	--	--	--	--	2	2	0.02	5	--
	PM_{10}	--	--	--	--	--	--	--	--	2	2	0.03	4	--
	SO_2	--	--	--	--	--	--	--	--	154	0.1	0.01	154	--
	NO_x	--	--	--	--	--	--	--	--	41	53	0.5	95	100
	CO	--	--	--	--	--	--	--	--	22	24	8.8	55	100
	VOC	--	--	--	--	--	--	--	--	1	6	0.3	7	50
7	$PM_{2.5}$	--	--	--	--	--	--	--	--	2	2	0.02	5	--
	PM_{10}	--	--	--	--	--	--	--	--	2	2	0.03	4	--
	SO_2	--	--	--	--	--	--	--	--	154	0.1	0.01	154	--
	NO_x	--	--	--	--	--	--	--	--	41	53	0.4	95	100
	CO	--	--	--	--	--	--	--	--	22	25	8.6	55	100
	VOC	--	--	--	--	--	--	--	--	1	6	0.3	7	50
8	$PM_{2.5}$	--	--	--	--	--	--	--	--	2	2	0.02	4	--
	PM_{10}	--	--	--	--	--	--	--	--	2	2	0.03	4	--
	SO_2	--	--	--	--	--	--	--	--	140	0.1	0.01	140	--
	NO_x	--	--	--	--	--	--	--	--	38	44	0.3	82	100
	CO	--	--	--	--	--	--	--	--	20	20	8.5	49	100
	VOC	--	--	--	--	--	--	--	--	0.5	5	0.3	6	50

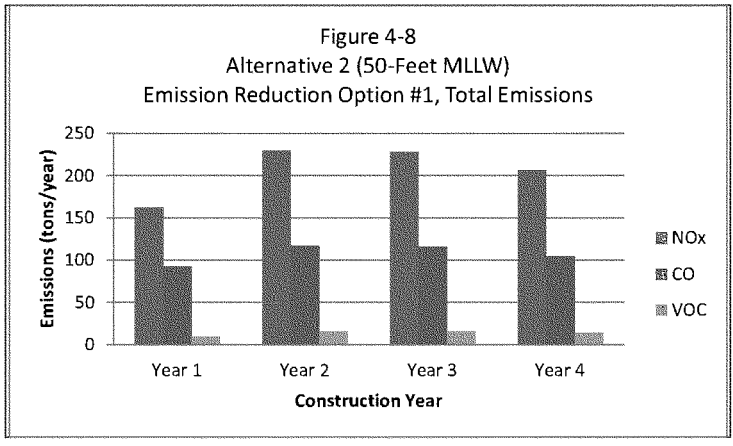
2. Emission Reduction Option #1 is based on replacing older equipment with newer ones meeting EPA emissions standard, Emission Reduction Option #2 is based on lengthening the construction schedule from 48 months to 73 months, the same dredging equipment and operations as Alternative 1 (45-ft MLLW) and requiring the contractor to use new equipment meeting applicable EPA non-road emissions standards.

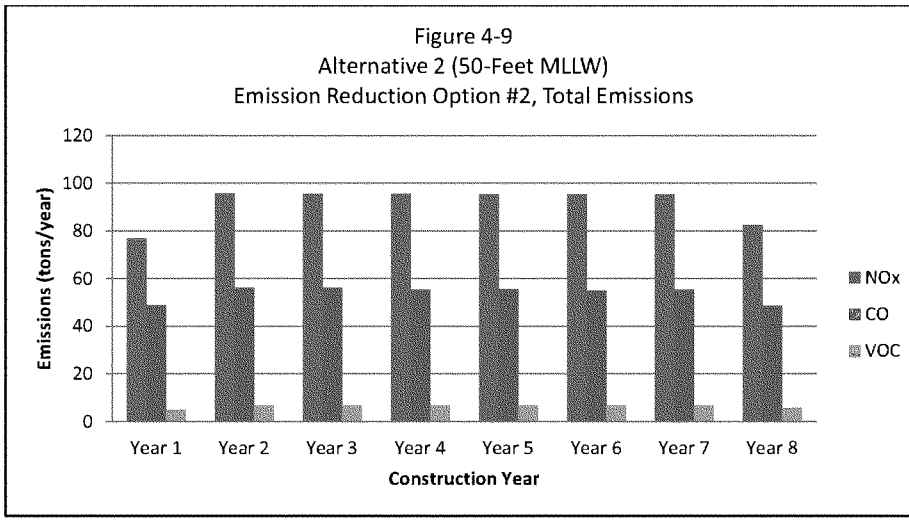
Table 4-12. Summary of Percent Emission Reductions for Air Quality Analysis Alternative 2

Pollutant	Emission Reduction Option 1			Emission Reduction Option 2		
	Marine	Non-Road	Total	Marine	Non-Road	Total
NO_x	-18%	-71%	-59%	-68%	-88%	-83%
CO	287%	-85%	-67%	47%	-93%	-84%
VOC	0%	-73%	-70%	0%	-88%	-87%

Note: CO emissions increased with tugboat operations







Proposed Action

The project dredging emissions represent the estimated total direct emissions that would occur with the proposed deepening of Boston Harbor to the -47-feet MLLW depth. Because the depth of the proposed action lies between (is bracketed by) the depths of Air Quality Analysis Alternatives 1 and 2, the associated direct emissions would be expected to lie between (be bracketed by) the emissions of Air Quality Analysis Alternatives 1 and 2. This limited evaluation of the proposed action is qualitative in nature, focuses solely on NO_x, CO and VOC, and is based on our best professional judgment given the previous quantitative analysis of Air Quality Analysis Alternatives 1 and 2.

Based on a proportional evaluation of the emissions from Air Quality Analysis Alternatives 1 and 2, and assuming a dredging schedule of either 3 or 4 years, it is estimated that the uncontrolled emissions of NO_x and CO in the peak year of dredging operations would exceed the de minimis thresholds and thus be subject to further analysis under the general conformity rule, but that uncontrolled emissions of VOC in the peak year of dredging operations would be less than the de minimis threshold and thus be exempt from further analysis under the general conformity rule. In evaluating the application of Emissions Reduction Option 1 to the proposed action, it is estimated that the controlled emissions of NO_x in the peak year of dredging operations would still exceed the de minimis threshold whether on a 3- or 4-year schedule and that controlled emissions of CO in the peak year of dredging operations would exceed the de minimis threshold on a 3-year schedule but not on a 4-year schedule. In evaluating the application of Emissions Reduction Option 2 to the proposed action, it is estimated that the controlled emissions of NO_x in the peak year of dredging operations would exceed the de minimis threshold on a 5-year schedule but not on a 6-year schedule and that controlled emissions of CO in the peak year of dredging operations would exceed the de minimis threshold on a 3-year schedule but not on a 4-year schedule. Thus, if USACE commences construction on the Project after EPA revokes the 1997 eight-hour O_3 NAAQS, and general conformity no longer applies to emissions of NO_x and VOC, the recommended action could likely be completed with the use of Emissions Reduction Option 1 on a 4-year schedule to remain below the de minimis thresholds for CO; otherwise, the proposed action would likely require use of Emissions Reduction Option 2 on a 6-year schedule to remain below the de minimis thresholds for NOx and CO.

4.8.3.2 Indirect Emissions

The project indirect emissions were calculated based on the net difference of container, cargo and petroleum vessel operations including scheduling, volume of ship calls, fleet mix and associated cargo truck operations comparing the No Action Alternative and Project (Post-Construction) scenarios.

Table 4-13 presents a summary of both the No Action Alternative and Project indirect emissions and the net change in annual emissions.

The Deep Draft Project would reduce annual NO_x, CO and VOC emissions by 71, 28 and 17 tons, respectively, i.e., there would be a net environmental benefit associated with indirect emissions by implementing the Project. The reductions in pollutant emissions are primarily due to changes in fleet mix for all shipping operations (i.e., fewer, but larger ships), no anchoring activities for petroleum ships and less time for ships to move in and out of the harbor. However, the cargo trucking miles in Massachusetts would increase by 766,276 miles under the Project (Post-Construction) shipping operations due to increased truck volumes departing from Conley Terminal[20,21]. An average travel speed of 27.6 miles per hour was assumed in the model. The estimated NO_x, CO and VOC annual emissions from cargo trucking would increase by 1.91, 0.51 and 0.24 tons, respectively in the project area. These small increases in pollutant emissions would be more than offset by the emissions reductions estimated for the changes in shipping activities associated with the Project. Therefore, the Project's indirect emissions would remain below de minimis levels and be exempt from the general conformity rule, even if USACE could be considered to have practicable control over such emissions.

Table 4-13. Shipping and Trucking Operations-Summary of Indirect Emissions

Pollutant	No Action Alternative (tons)	Project, Post-Construction (tons)	Net Change (tons)	Net Change (%)
$PM_{10}/PM_{2.5}$	96	91	-5	-5.2
SO_2	248	247	-0.6	-0.2
NO_x	634	563	-71	-11.2
CO	377	349	-28	-7.3
VOC	231	214	-17	-7.5

Notes:

1. Indirect emissions without project the No Action Alternative are associated with projected shipping operations in 2016 and beyond. It is assumed that the shipping operations would be constant during the dredging years.
2. Indirect emissions with project are associated with projected shipping operations one year after the dredging operations are completed. It is anticipated that there would be no overlap of indirect and direct emissions at the end of the project.
3. With project emissions includes emissions reductions associated with the projected reduction of truck traffic from the Port of New York/New Jersey.

Source: Dave Miller Report for the Deep Draft Navigation Improvement Project

General Conformity Applicability Results

The general conformity regulations (40 CFR 93.159(d)) require that the total of direct and indirect emissions be evaluated for: (1) the year of maximum emissions; (2) the mandated attainment year (for non-attainment pollutants); (3) the year of farthest emissions projections in the SIP (for maintenance

[20] David Miller & Associates, Inc., Technical Memorandum to Karen Umbrell, USACE, July 13, 2006.
[21] Email from Karen Umbrell, USACE, to Marc Wallace, CDM Smith, Revised Truck Miles Saved Spreadsheet, October 13, 2007.

pollutants); and (4) any year with an emissions budget specified in the SIP. The annual emissions were compiled for each appropriate year for Air Quality Analysis Alternatives 1 and 2, and each year's net emissions were then compared to the de minimis values.

The years of maximum emissions for Air Quality Analysis Alternatives 1 and 2 are presented in Tables 4-8 and 4-11, respectively. The mandated attainment year for the 1997 eight-hour O_3 NAAQS was 2010. The CO emissions inventory data for 2010 represents the year of farthest emissions projections in the SIP. Likewise, emissions budgets in the SIPs for O_3 and CO have only been projected to 2010. Annual emissions were estimated based on daily summer projections for NO_x and VOC and daily winter projections for CO. Because the Project could not occur in 2010, the only relevant criteria to examine for the general conformity evaluation are the years of maximum emissions.

In this report, it is assumed that dredging and construction activities define direct emissions. Indirect emissions are assumed to originate from the cargo vessel operations including scheduling, volume of ship calls, fleet mix and associated trucking operations. It is anticipated that changes in shipping operations for Air Quality Analysis Alternatives 1 and 2 would occur after the dredging operations are complete. Therefore, there would be no overlapping of indirect emissions with the direct emissions from the dredging operations in any particular year for Air Quality Analysis Alternatives 1 and 2. Table 4-14 presents the results of the general conformity applicability analysis. This table shows that, under Emission Reduction Option 2, the maximum emissions year for Air Quality Analysis Alternative 1 (Year 3 of dredging operations) and Air Quality Analysis Alternative 2 (Year 2 of dredging operations) would not exceed the general conformity de minimis thresholds.

By extension to the proposed action, the following results are anticipated: (1) if the Project commences construction after the 1997 eight-hour O_3 NAAQS is revoked and general conformity no longer applies to NO_x and VOC emissions, then the Project would avoid applicability of general conformity for CO under Emission Reduction Option 1 on a four-year dredging schedule; and (2) if the Project commences construction before the 1997 eight-hour O_3 NAAQS is revoked and general conformity continues to apply to NO_x and VOC emissions, then the Project would avoid applicability of general conformity for NO_x and VOC under Emission Reduction Option 2 and a six-year dredging schedule. Furthermore, the change in indirect emissions for NO_x, VOC and CO between the No Action Alternative and Air Quality Analysis Alternatives 1 and 2 would decrease. Therefore, Air Quality Analysis Alternatives 1 and 2 direct and indirect emissions, and by extension direct and indirect emissions for the proposed action, would be below the de minimis levels and general conformity would not apply to the Project.

Comparison of No Action Alternative and Project (Post-Construction) Emissions

For the purposes of satisfying the NEPA and MEPA requirements, Table 4-13 shows that the project ship and cargo truck emissions which represent project secondary (indirect) emissions would be less than those for the No Action Alternative. In addition, emissions calculations incorporate potential truck mileage savings estimated for the project in the remainder of New England. These reductions are due to cargo trucked to New England destinations from Boston Harbor instead of from the PONYNJ and total more than 7 million miles per year. Table 4-15 presents the results of the modeling analysis, which indicate that annual NO_x, CO, and VOC emissions would decrease by 18.9, 5.4 and 2.5 tons, respectively, in the remainder of New England (i.e., outside Massachusetts) after dredging operations are complete. The emissions reductions for the other pollutants would be less than one ton. The regional air quality benefits of more direct and efficient cargo transport within New England are expected to offset significantly any potential adverse project air quality impacts.

Table 4-14. Summary of General Conformity Applicability Analysis

		Alternative 1 (45-Ft MLLW)			Alternative 2 (50-Ft MLLW)		
Indirect Emissions with No Action Alternative	**Year**	**Pollutant**			**Pollutant**		
		NO_x	**CO**	**VOC**	**NO_x**	**CO**	**VOC**
	Year After Dredging Complete	634	377	231	634	377	231
Indirect Emissions with Project	**Year**	**Pollutant**			**Pollutant**		
		NO_x	**CO**	**VOC**	**NO_x**	**CO**	**VOC**
	Year After Dredging Complete	563	349	214	563	349	214
Direct Emissions	**Year**	**Pollutant**			**Pollutant**		
		NO_x	**CO**	**VOC**	**NO_x**	**CO**	**VOC**
	Year 1	65	40	4	77	49	5
	Year 2	90	50	6	**96**	**56**	**7**
	Year 3	**91**	**50**	**6**	96	56	7
	Year 4	75	44	5	95	55	7
	Years 5-7	--	--	--	95	55	7
	Year 8	--	--	--	82	49	6
Summary (tons, except where noted)		**Pollutant**			**Pollutant**		
		NO_x	**CO**	**VOC**	**NO_x**	**CO**	**VOC**
	Indirect Emissions Net Change	-71	-28	-17	-71	-28	-17
	Direct Emissions Net Change	91	50	6	96	56	7
	GC Threshold	100	100	50	100	100	50
	SIP Mandate Year	2010	2010	2010	2010	2010	2010

Notes:
1. Indirect emissions with the No-Action Alternative are associated with projected shipping operations in 2010 and beyond.
2. The net change in indirect emissions is based on comparing indirect emissions for the No-Project Alternative and Alternatives 1 and 2.
3. Indirect emissions with Project are associated with projected shipping operations one year after the dredging operations are completed. It is anticipated that there will be no overlap of indirect and direct emissions at the end of the project
4. Direct emissions are based on stretching the construction schedule and requiring new equipment meeting the newest EPA emissions standards
Sources: U.S. Army Corps of Engineers, Boston Harbor, Massachusetts Navigation Improvement Study, Alternative Formulation Briefing Technical Memorandum, July 2005.

Table 4-15. Remainder of New England Cargo Truck Emission Reductions (tons/year)

State	NO_X	CO	VOC	PM_{10}	$PM_{2.5}$	SO_2
Rhode Island	-5.55	-1.71	-1.04	-0.30	-0.19	-0.05
Connecticut	-3.02	-0.78	-0.33	-0.11	-0.08	-0.01
New Hampshire	-5.17	-1.55	-0.70	-0.24	-0.18	-0.03
Maine	-4.26	-1.09	-0.36	-0.16	-0.12	-0.01
Vermont	-0.94	-0.25	-0.10	-0.03	-0.02	0.00
Total	**-18.9**	**-5.4**	**-2.5**	**-0.84**	**-0.60**	**-0.11**

4.8.4. Environmental Commitments

The following environmental commitment has been made regarding air quality to avoid or minimize the effects of the Deep Draft Project:

> ***Environmental Commitment: Use of New Equipment Meeting More Stringent EPA Emissions Standards.***

All construction contractors would be required, as a contractual condition; to use new equipment meeting the most stringent EPA emissions standards in effect at the commencement of construction of the Project, as well as to extend the number of years the project would be constructed as necessary to maintain peak annual emissions below the general conformity de minimis thresholds. The number of years will be dependent on the final dredge depth selected. The additional years for each depth alternative required to conform is presented in Appendix D. This environmental commitment requires replacing all non-road equipment with newer, lower-emitting equipment that would meet EPA Tier 3 and Tier 4 emissions standards that would be required for equipment model years 2014 and beyond. The clamshell and backhoe engines would need to meet Tier 4 emissions standards and support equipment would need to comply with Tier 3 and Tier 4 emissions standards, depending on the equipment category and engine size. Table 4-16 presents the Tier 3 and Tier 4 emissions limits based on engine size, in horsepower. In addition, the tugboats would also have to be equipped with engines that meet EPA's Tier 2 emission standards for Category 2 marine diesel engines presented in Table 4-9. General conformity would be satisfied (i.e., would not be applicable) by the implementation of the above actions falling below the emission thresholds (EPA letter dated May 23, 2008).

Table 4-16. Non-Road Emissions Limits

Engine Power (hp)	Tier 3 and 4 Technology Type Emission Limits * (g/hp-hr)				
	HC	CO	NO_x	PM	SO_2
0 - 11 (Tier4A)	0.55	4.11	4.3	0.28	0.006
12 - 25 (Tier 4A)	0.55	4.11	4.3	0.28	0.006
26 - 50 (Tier 4A)	0.28	1.53	4.7	0.2	0.006
51 - 75 (Tier 4A)	0.18	2.37	3.0	0.2	0.006
76 - 100 (Tier 3B)	0.18	2.37	3.0	0.3	0.006
101 - 175 (Tier 3)	0.18	0.87	2.5	0.22	0.006
176 - 300 (Tier 4 transitional)	0.13	0.075	1.39	0.009	0.006
301 - 600 (Tier 4 transitional)	0.13	0.084	1.39	0.009	0.006
601 - 750 (Tier 4 transitional)	0.13	0.13	1.39	0.009	0.006
>750 (Tier 4)	0.28	0.08	2.39	0.07	0.006

* Tier 3 and 4 emission factors are taken from Table A2 of the EPA Technical Document "Exhaust and Crankcase Emission Factors for Nonroad Engine Modeling --Compression-Ignition," 2004.

Emission Reduction Credits

Another alternative means to meet general conformity, besides those proposed to lengthen the project and use lower-emitting equipment to avoid the applicability of general conformity, would be to offset the net emissions increases from construction through the purchase of emission reduction credits (ERCs). However, alternative project measures to demonstrate general conformity cannot be finalized in the Feasibility Phase due to factors such as uncertainties in the project timeline, the availability of ERCs 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 certain means of complying with air quality requirements at the Feasibility Phase are construction period shutdowns that avoid exceeding the emissions thresholds and thus avoid triggering general conformity applicability.

Emission reduction credits in the form of discrete, or mass-based, credits would be needed for NO_x and CO and would be purchased from companies that have registered a net benefit in air emissions (reduced air pollution) with MADEP. NO_x credits are broken down into ozone season (May 1-September 30) and non –ozone season (October 1-April 30) credits depending on the time of the year, and some of each type would be required. Enough ERCs for each pollutant would be needed for the years in which each pollutant has exceeded the threshold. Credits would be needed for all Project net emissions, not just the amounts over the thresholds, but to bring the net emission level back down to zero. The Commonwealth of Massachusetts Emission Reduction Registry lists all approved ERCs. Currently (as of August 2012), the Registry lists enough ERCs for NOx to complete the proposed project mission, but not enough for CO. The general conformity rule allows a State to approve offsets of different precursors of the same criteria pollutant if such inter-precursor trades are allowed by the applicable SIP, if they are technically justified, and if there is a demonstrated environmental benefit. Thus, it would be conceivable to utilize NO_x and VOC ERCs to offset NO_x emissions, since both NO_x and VOC are precursors for O_3. At this moment in time, the cost to purchase the required ERCs would be approximately equivalent to the cost of one mobilization and demobilization of the construction equipment. However, the credit costs are based on a free market and total costs could change in the future.

The air quality analysis will be re-examined following the final 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. USACE and Massport are committed to working with EPA, the Commonwealth of Massachusetts, 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. 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 Deep Draft Project with air quality requirements result from this review, USACE 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. The final determination on which mitigation method would be used to meet air quality standards will be made during the final Design Phase of the Project.

4.9 Socioeconomic Impacts

Boston Harbor is an active harbor with many users. These users include recreational, shipping, and fishing interests. Without a well maintained harbor, goods can not be shipped as efficiently and jobs associated with this industry, both directly and indirectly, are affected. Dredging and disposal would have minimal beneficial or adverse impacts on recreational boating and vessel passage because the dredge contractor must allow free navigation at all times, and because recreational boats do not need

the deeper channels and have access to additional maintained entrance channels. However, a viable working harbor can benefit all marine users.

4.9.1 Commercial Lobstermen

At least 16 lobstermen fish in the project area at any one time, based on the survey information received in 2005. Most of the lobstermen fish in the area between the Ted Williams Tunnel and Spectacle Island and most of the fishing activity occurs during the summer and early fall months. Although fishing is illegal within the Federal navigation channels without a Section 10 permit, the dredge contractor will issue a public notice at the beginning of the project to notify the lobstermen of the planned dredging and rock removal efforts so that the lobstermen can remove their traps. With the exception of some disruption during the active dredging periods, no long-term adverse affects on commercial lobstering is anticipated.

4.9.2 Environmental Justice

Executive Order 12898, *Federal Actions to Address Environmental Justice in Minority and Low-Income Populations* was signed on February 11, 1994. This EO is designed to focus the attention of Federal agencies on the human health and environmental conditions in minority and low-income communities. Environmental justice analyses are performed to identify potentially disproportionately high and adverse impacts from the proposed actions in minority communities and low-income communities and to identify alternatives that might mitigate these impacts.

No significant adverse environmental impacts to minority or low income populations are anticipated as a result of this project. According to the 2010 U.S. Census Bureau, 64 percent of Suffolk County population, which includes the cities and towns surrounding Boston Harbor, is Caucasian. Twenty one percent of the individuals are below poverty limit. Although the project area has a larger percentage of minorities and low-income population compared to the rest of the Commonwealth of Massachusetts, this dredging and disposal project is not expected to have a significant human health or environmental effect on any portion of the human population. Extensive environmental monitoring for the BHNIP, which contained sediments with higher contaminant levels than this proposed project, did not reveal any water quality violations. In addition, any potential air quality impacts from construction will be mitigated to be in compliance with the State Implementation Plan.

4.9.3 Protection of Children

Executive Order 13045, *Protection of Children from Environmental Health Risks and Safety Risks* was signed on April 21, 1997. A growing body of scientific knowledge demonstrates that children may suffer disproportionately from environmental health risk and safety risks. Based on this risk, each Federal agency has been directed by this EO to identify and assess environmental health risks and safety risks that may disproportionately affect children. Each Federal agency is directed to ensure that its policies, program activities, and standards address disproportionate risks to children that result from environmental health risks or safety risks.

The project activities are located in the waters of Boston Harbor and Massachusetts Bay, not an area that would be used disproportionately by children. The environmental impacts are generally temporary and contained within the aquatic environment. As discussed in the previous sections, any potential air quality impacts will be mitigated to conform to State and Federal emission standards during construction. Completion of the proposed project will reduce future regional air emissions and thereby slightly decreasing potential health risks from poor air quality.

4.10 Harbor Infrastructure

A discussion of the tunnel crossings, subway crossings, and numerous utility cable crossings in Boston Harbor and their potential to be damaged during project construction is provided below.

4.10.1 Harbor Tunnel Crossings

As stated above in Section 3.8, there are four tunnels crossing beneath the Main Ship Channel; one subway tunnel and three highway tunnels. The elevation of armor protection atop the Ted Williams Tunnel I-90 (TWT), which is the most seaward crossing, may permit deepening of the Main Ship Channel up to a depth of 45 feet, as stated by the former Massachusetts Turnpike Authority (MTA) in their letter of 27 February 2003. However, as the letter suggests, this assumption would need to be tested by additional analyses if deepening over the tunnel was proposed.

There are three remaining tunnels upstream of the TWT, including the Massachusetts Bay Transportation Authority's Blue Line subway tunnel. The elevation of the three upstream tunnels, particularly the Blue Line, will not permit any deepening of the Main Ship Channel beyond the 40 feet deep MLLW now provided. However, there are no marine terminal 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 navigation channel 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 foot MLLW, are only practicable in areas downstream of the TWT.

4.10.2 Sewer Tunnel Crossings

The four Massachusetts Water Resources Authority (MWRA) sewer lines that cross beneath the harbor channels are all 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.

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.

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.

4.10.3 Utility Crossings

The only utility line located beneath the Reserved Channel is the main power supply line to MWRA's Deer Island Treatment Plant from NSTAR's South Boston generating plant. These three cables run from the power plant at the head of the Reserved Channel, underneath the Reserved Channel along its southern limit, across the Main Ship Channel, and then 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 as required by Massport and the USACE. However, the cable was placed shallower than the minimum depths specified in the permits in several locations beneath the Reserved Channel. The USACE 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. This action is included in the without-project (no action) condition.

This document will be available for public review, for any additional review of potential project impacts on utility crossings in Boston Harbor.

4.11 Cumulative Impacts

The National Environmental Policy Act (NEPA) defines cumulative effects as: "the impact on the environment which results from the incremental impact of the action when added to other past, present, and reasonably foreseeable future actions regardless of what agency (Federal or non-Federal) or person undertakes such other actions" (40 CFR 1508.7).

Cumulative effects analysis is an emerging discipline, and the continuing challenge of this analysis is to focus on the important cumulative issues, recognizing that a better decision, rather than a perfect cumulative effects analysis, is the goal of NEPA. Determining the threshold beyond which cumulative effects significantly degrade a resource, ecosystem, and human community is often problematic, as no definitive thresholds for cumulative analysis exist. Ultimately, however, cumulative effects analysis under NEPA should be incorporated into the agency's overall environmental planning and the regional planning of other Federal agencies and stakeholders (CEQ 1997). Similarly, the Massachusetts Environmental Policy Act (MEPA) regulations also require discussion of cumulative impacts of the project.

The Certificate of the Secretary of Environmental Affairs on the Environmental Notification Form (ENF) for the Deep Draft Project, dated March 10, 2003 (EOEA Number 12958) required that the following projects be included in the cumulative impacts analysis: the HubLine submarine natural gas pipeline and the Everett Extension to the HubLine; the Army Corps of Engineers Outer Harbor Maintenance Dredging Project; and the NOMES I offshore borrow site for the Winthrop Shores Reservation and Restoration project (this project was initially denied a permit by the USACE; a change in source of beach nourishment material has been proposed). In addition, an ENF comment letter submitted by the MA Department of Environmental Protection listed the following additional projects for consideration for the cumulative impact analysis: the Central Artery/Tunnel project (including opening of the park at Spectacle Island); the Massachusetts Water Resources Authority Boston Harbor Cleanup; and "numerous shore-side development projects" including Pier 4 and Fan Pier. Additional projects have been included for consideration since the submittal of the 2008 Draft SEIS/EIR, including several proposed development projects (Boston East, New Street), Conley Terminal Expansion, Logan Runway Safety Areas project, several maintenance dredging projects, and infrastructure improvement (seawall rehabilitation, pier improvement) projects.

Thus the cumulative impact analysis includes major infrastructure projects within Boston Harbor which have recently been completed, as well as projects in or adjacent to Boston Harbor planned to be undertaken within the timeframe of the Deep Draft Project. The time range of projects extends back to 1985 (MWRA Harbor Cleanup Projects) and 1995 (CA/T project), and into the future to 2019. The year 2019 was selected based on the public informational filings available in the MEPA Office during preparation of the cumulative impact analysis. However, it is important to note that the most information is available on projects recently completed and those currently within the planning (ie public information filings) or permitting phase.

Section 4.11.1 describes the Boston Harbor dredging projects, including the proposed project, to provide an overview of recent and proposed USACE and/or Massport activities. Section 4.11.2 provides information (as available) on other ongoing and planned projects within the inner and outer reaches of Boston Harbor and Massachusetts Bay. Information on the projects listed in Section 4.11.2 was collected from public informational filings with the MEPA Office.

Figure 4-11 depicts the locations of the Boston Harbor dredging projects described in Section 4.11.1 while Figure 4-12 depicts the location of the relevant projects presented in Section 4.11.2. Table 4-15, at the end of Section 4.11.2 presents the summary of cumulative impacts.

4.11.1 Boston Harbor Dredging Projects

1. Boston Harbor Navigation Improvement Project (BHNIP) (1998-2000+, Completed)

The BHNIP (EOEA No. 8695) consisted of maintenance and improvement dredging in a portion of the channels and berths within Boston's Inner Harbor. The lower Mystic River, Inner Confluence, and Reserved Channel Federal navigation channels were deepened from –35 feet MLLW to –40 feet MLLW. The Chelsea River was deepened from –35 feet MLLW to –38 feet MLLW. A number of berths were also deepened to various depths. A portion of the Chelsea River dredging in the vicinity of the Chelsea Street draw bridge was not completed due to the presence of an existing natural gas pipeline siphon. This issue was resolved and the remaining dredging in the Chelsea River was completed as part of the Inner Harbor Maintenance Dredging project, described below.

Phase 1 consisted of dredging Conley Terminal Berths 11 and 12 to –45 feet MLLW and disposing of the material into a CAD cell located in the Inner Confluence in the summer of 1997. Phase 2 included dredging the remainder of the area with disposal into eight CAD cells between August 1998 and September 2000, with some additional work completed by December 2002.

Approximately one million cy of silty maintenance material and one million cy of improvement material (also referred to as parent material) of channel and berth material, plus an additional 1.4 million cy of parent material was removed in the construction of the CAD cells, for a total of 3.4 million cy of dredged material. The maintenance material was placed into CAD cells located within the Mystic River, outside of the Main Ship Channel and in the Chelsea River. All of the CAD cells, with the exception of the Chelsea River CAD cell, were capped with three feet of sand. The Chelsea River CAD cell was not capped to allow for future maintenance material disposal. The parent material was placed at the MBDS. The area of temporary impact associated with this project is estimated to be approximately 1,200 acres.

2. Boston Harbor Outer Harbor Maintenance Dredging Project (OHMDP) (2004-2005, Completed)

Maintenance dredging of the outer harbor channels in Boston Harbor occurred from August 2004 through June 2005. No MEPA filing was required as this was exclusively a Federal project. Approximately 1.1 million cy of material from the Broad Sound North Channel, President Roads Channel and Anchorage, and portions of the Main Ship Channel approximately half way between Spectacle Island and Castle Island outbound was removed to restore this area to its authorized depths. The dredged material was placed at the MBDS. Approximately 520 acres of subtidal habitat was temporarily altered by maintenance dredging in the Outer Harbor. Rock removal from the Main Ship Channel, President Roads Anchorage and Broad Sound North Channel was begun in the fall of 2007.

3. Boston Harbor Inner Harbor Maintenance Dredging Project (IHMDP) (Initial Phase Completed in 2008, Phase 2 Planned concurrent with BHDDNIP)

The Boston Harbor Inner Harbor Maintenance Dredging Project (IHMDP) removed rock ledge and dredged shoals from the 40-foot deep Main Ship Channel to its authorized depth from the point where the previous maintenance dredging project left off (from approximately halfway between Castle and Spectacle Islands) to a point upstream of Massport's Marine Terminal (located just below the Third Harbor Tunnel), the upper Reserved Channel, and the approach channel to the Navy Dry Dock. In addition, approximately 3,600 cy of material was dredged from Boston Redevelopment Authority berth #4 to a depth of -30-feet, and the abandoned Keyspan gas siphon was also removed in the channel downstream of the Chelsea Street Bridge to allow for the deepening of the Chelsea River

navigation channel to its authorized depth. Phase 2 would dredge from Massport's Marine Terminal upstream to the Inner Confluence.

Two CAD cells were constructed. One larger CAD cell was constructed in the Mystic River located near the Inner Confluence, and another smaller CAD cell constructed in the Main Ship Channel just south of the Inner Confluence. Approximately one million cy of dredged material was placed at the MBDS from construction of the CAD cells (720,000 cy) and maintenance dredging (310,000 cy). Another 380,000 cy was placed into the two CAD cells for a total of 1.4 million cy of dredged material. About 2,000 cy of rock was also removed from the project. Construction of the IHMDP began in mid-May of 2008 and was completed in mid-December 2008. The capping of the cells began in January 2010 and was completed in February 2010. The CAD cells were capped with sand dredged from the Cape Cod Canal.

This project was evaluated by MEPA as a project change to the previously discussed BHNIP (EOEA No. 8695). The original IHMDP proposed to dredge 1.7 million cy of maintenance material. The initial phase, completed in 2008, dredged 700,000 cy. Dredging of one million cy of maintenance dredged material from between Massport's Marine Terminal and the Inner Confluence is planned concurrent with Deep Draft Project. Approximately 732 acres of subtidal habitat will be temporarily impacted by the IHMDP.

4. Chelsea River Navigation Channel Widening in the Vicinity of the Chelsea Street Bridge (Chelsea River Widening) (2012)

The Chelsea River navigation channel was widened at the location of the Chelsea Street Bridge when MA Department of Transportation (MADOT) replaced the existing bridge with a new vertical lift bridge. The original opening for ship traffic through the Chelsea Street Bridge was only 95-feet wide. The bridge replacement included the removal of the existing fender system which would have created a navigation hazard if the channel was not widened. The navigation channel was widened to a minimum of 175 feet. In addition, the remainder of the Keyspan gas siphon (that was located under the fender system) was removed as well as a railroad bridge counterweight that was outside of the existing channel but would have been within the widened channel. The counterweight removal was performed by the USACE at the request of and with funding from MA DOT. Both the pipeline and counterweight were disposed of upland. Dredging was initiated in March 2012 and completed in April 2012. A total of about 33,000 cy of dredged material was removed and disposed at the MBDS.

5. Boston Harbor Inner Harbor Rock Removal (Boston Harbor Rock Removal) (2012)

Rock was removed from seven areas near Castle Island that were above the authorized depth in the 40-foot deep lane of the Main Ship Channel. Holes were drilled in the rock beginning in August 2012, followed by blasting which began in September 2012. A total of six blasts were performed. The blasted rock was removed with a mechanical dredge in September 2012. All material was placed at the MBDS.

6. Boston Harbor Deep Draft Navigation Improvement Project (Deep Draft) (2014-2017+)

The proposed Deep Draft Project, which is the subject of this SEIS/EIR, involves deepening the navigation channels in the outer harbor to between –45 feet MLLW and –50 feet MLLW (EOEA No. 12958). The areas proposed to be deepened are the Broad Sound North Channel, the President Roads Anchorage Area and portions of the Main Ship Channel, Reserved Channel, and the Mystic River, and the length of the Chelsea River.

Since the 2008 release of the Draft Feasibility Report and DSEIS/EIR, the USACE conducted additional economic studies of the proposed port improvements at the direction of USACE Headquarters. That process resulted in a slight reduction in the scope of improvements initially

recommended for Boston Harbor. The change consists of a reduction in the recommended project depth in the inner harbor from the President Roads Channel and Anchorage and Main Ship Channel to Massport's Conley terminal from 48 feet to 47 feet at Mean Low Low Water (MLLW). Other project elements remain unchanged from those described in the draft EIR. Past and current improvements recommended include:

- Improving access to Conley Terminal for containerships by deepening the harbor's existing 40-foot channels, turning basin and anchorage to a depth of -47 feet MLLW (formerly -48 feet MLLW), with an additional four feet of depth in the Broad Sound North Entrance Channel (up to -51 feet MLLW).
- Deepening of the berths at the Conley Terminal by Massport to at least 50 feet
- Improving access to Massport's Marine Terminal in South Boston. The 40-foot lane of the Main Ship Channel above the Reserved Channel and below the Ted Williams Tunnel would be deepened to -45 feet MLLW
- Improving access to Massport's Medford Street Terminal on the Mystic River for lesser draft dry and break-bulk carriers. This small area of the existing 35 foot lane of the lower Mystic River Channel accessing the terminal would be deepened to -40 feet MLLW.
- Improving access to the Chelsea River primarily to its petroleum terminals by deepening the existing -38 foot channel to -40 feet MLLW.

Approximately 9.8 million cubic yards of clays, sands, and tills, all parent materials largely of glacial origin, will be dredged from the harbor bottom. In addition, up to one million cubic yards of rock would be removed from the harbor. All material has been tested and found suitable for ocean disposal at the MBDS. Rock removed from the project is proposed to be placed at the MBDS or outside Boston Harbor for habitat enhancement.

Approximately 1,164 acres of subtidal habitat would be temporarily impacted by the dredging activities for the Deep Draft Project. Up to an additional 530 acres of subtidal area could be permanently impacted by the creation of the habitat enhancement sites in one or more of the following locations: Broad Sound or Massachusetts Bay. This is considered a positive impact as the placement of rock from the dredging activities would be used to create additional habitat diversity at the selected locations.

Depending on the design of the reef(s), the placement of between 450,000 and 1.4 million cy of rock, five feet deep, would cover between 186 acres and 518 acres of soft bottom habitat. The placement of rock in rows would create more edge habitat and increase circulation.

Once the Deep Draft Project has been constructed, maintenance dredging in Boston Harbor is not expected for at least another twenty years.

4.11.2 Relationship to Other Projects

Projects were reviewed for their nature, location, and time frame of projected environmental impacts in order to determine what, if any, contributing impacts they might have to the anticipated environmental impacts of the proposed project. Figure 4-12 illustrates the project locations. Table 4-16, presented at the end of this section, presents a summary of the potential impacts to intertidal and subtidal resources in Boston Harbor from the projects described briefly below. Publicly available information sources were consulted to obtain the most up-to-date information possible; however, it is important to note that project scopes are often modified during the planning process, and this information is not always readily available.

An important component of the Deep Draft Project is the development of communication channels and coordination procedures with the agencies and organizations responsible for implementing the projects not yet underway in order to minimize the potential for conflicts and environmental damage. The

Deep Draft Project is not expected to conflict with other projects; the USACE has been, and will continue to be, in communication with other agencies if there is a potential for conflict with infrastructure or utilities. This issue is discussed further in Section 4.10.

1. Station #385 – Harbor Walk (2003-2004, Completed)

This project involved the construction of a harborwalk along Boston's Reserved Channel, and was designed to provide public access and improve passive recreational opportunities at the waterfront in compliance with City of Boston zoning requirements. According to the project's ENF, a portion of the harborwalk was proposed to be located approximately 3,000 sq ft above coastal bank, supported by piles with an actual impact of 20 sq ft. This project was implemented as a mitigation measure associated with the expansion of the outdoor electrical switching station #385 in South Boston, which was authorized under Massachusetts General Laws Chapter 91, the Public Waterfront Act. No significant short-term or long-term impacts to marine resources resulted from this project.

2. HubLine Submarine Natural Gas Pipeline (2002 -2004, Completed)

The HubLine natural gas pipeline was constructed by Algonquin Gas Transmission Company in Massachusetts Bay during 2002 and 2003. This project consisted of the construction of 29.4 miles of a 24-inch submarine high-pressure natural gas pipeline from Beverly to Weymouth. The pipeline is buried at a minimum depth of 3 feet, with several exceptions (where it was armored), and installed via a combination of horizontal directional drilling, conventional dredging, jetting, plowing, and blasting. A 5.4 mile lateral pipeline to Deer Island was also proposed as part of the project, with later plans extending the lateral to Everett, but available information indicates that the lateral extension was never constructed. As shown in Figure 4-2, the HubLine pipeline enters the harbor approximately 1.3 mile southeast of the proposed Deep Draft Project area.

Total impacts to subtidal resources resulting from the entire HubLine project (including the Deer Island lateral) were estimated at 7,800 acres in the HubLine DEIS (of this total, approximately 7,300 acres were assumed to be attributable to cable sweep from the pipeline installation activities). If an estimated area of impact associated with the uninstalled Deer Island lateral (which comprised approximately 15 percent of the total number of pipeline miles), is subtracted, then the HubLine area of temporary impacts was approximately 6,630 acres. A permanent impact to subtidal areas due to armoring of the alignment was estimated at 3.7 acres. There was also a 1.7 acre area altered to install six artificial reefs along the HubLine just southeast of Lovell Island in Boston Harbor as mitigation for hard bottom habitat loss.

In terms of the portion of the project that falls within the Boston Harbor area, it was calculated that approximately nine miles of the main HubLine fall within the general area of the Deep Draft Project. This is about 31 percent of the total length of the pipeline. Using that percentage as a multiplier, the area within the harbor experiencing temporary impacts associated with the HubLine project is approximately 2,055 acres; information on the specific location of areas with permanent impacts was not available from public documents, so all of the areas of permanent impact associated with armoring and the artificial reef are conservatively assumed to be within Boston Harbor, resulting in 5.4 acres of permanent impact to subtidal resources in the harbor.

The MA Division of Marine Fisheries (DMF) was designated as the lead agency with respect to providing effective mitigation and/or restoration of aquatic resources and habitat in response to potential HubLine construction impacts. DMF is implementing ongoing monitoring and assessment for lobster impacts, as well as mitigation programs for bottom sediment enhancement (the artificial reefs) and shellfish stock enhancement, and restoration programs for eelgrass and anadromous fish. Assessments are ongoing in terms of the long term impacts to the Boston Harbor area on this large and complex project. Reports issued in 2008 indicate that the permanently altered areas have not

recovered to preexisting conditions, although there is some evidence of the reestablishment of similar function in terms of diversity and abundance of species.

3. MWRA - Boston Harbor Cleanup (1985 to 2000, Completed)

In the mid-1980's the Massachusetts Water Resource Authority (MWRA) embarked on the Boston Harbor Project, a massive clean up project which involved the eventual construction of the new sewage treatment facilities on Deer Island (DITP), the decommissioning of the Nut Island Treatment Plant (NITP), and extensive CSO control improvements.

Activities affecting the subtidal regions of the Harbor include an inter-island tunnel to transfer South System flows from the NITP to the new DITP, and installation of a deep rock tunnel for the 9.5 mile ocean outfall diffuser for discharge of treated effluent into Massachusetts Bay. These activities were completed by 2000. Since that time, significant improvements in Boston Harbor's water quality and clarity (2010 Outfall Monitoring Overview Report, MWRA Report 2011-16), as well as the bottom sediment quality, have been documented. There are no other known plans associated with the cleanup project that involve subtidal work in Boston Harbor. The MWRA's ongoing efforts to improve water quality in Boston Harbor are primarily focused on implementation of CSO and stormwater control projects, which are not expected to have significant subtidal work in the harbor.

4. Winthrop Shores Reservation Restoration Program (2012 – 2013)

The MA Department of Conservation and Recreation (DCR, formerly the MDC) planned to use an offshore borrow site (NOMES I) as a source of sand for the beach restoration efforts at Winthrop Shores Beaches. The project was denied a permit by the USACE, and subsequently two NPC's were filed to address alternate borrow sites. The project's Final EIR (2007) for this project (EEA #10133) and supplemental information from the NPC's described proposed improvements to the beaches, including the following elements that would affect marine resources:

- Removal of an estimated 520,000 cy of nourishment material from two sources (Saugus I-95 highway embankment borrow site and dredged material from the Winthrop Beach tombolo),and transport to the beach by truck;
- Placement of beach nourishment fill along 37 acres of supratidal, intertidal and subtidal areas at Winthrop Beach;
- Reconstruction of existing groins; removal of one groin and construction of a new terminal groin at Winthrop Beach; and
- Construction a new storm drainage system.

The Winthrop Shores Reservation project is currently in the permitting phase. If all necessary approvals are obtained, the project would involve 37 acres of permanent impact. The proposed project is planned for completion by late 2013.

5. Central Artery (1995 – 2003, Completed)

A number of Central Artery activities have occurred in or around Boston Harbor. One component of this large transportation project involved the creation of a new 100-acre public park on Spectacle Island in Boston Harbor. The park has docking access for public ferry and recreational boats, two public bathing beaches, picnic areas, a trail system, recreation areas, and a visitors' center. During construction of the park, a net total of 6.4 acres of intertidal and subtidal area was permanently filled in order to close the abandoned landfill that existed on the island.

Other Central Artery activities that have impacted marine resources include:

- The Ted Williams Tunnel across Boston Inner Harbor which required 3,415 square feet of fill (South Boston/BMIP);

- The I-90 immersed tube tunnel across Fort Point Channel where the top of the tunnel box protrudes above the mud line to the presence of existing MBTA Red Line tunnel. Armor rock was placed on top of the tunnel box, which involved alteration of 2.1 acres of subtidal waters; and,
- The Zakim/Bunker Hill Bridge across the Charles River and the Millers River where the bridge piers required permanent fill of 3,500 square feet in Charles River and 1,500 square feet in Millers River.

6. *Portside at Pier One (Phased Construction to resume in 2012)*

This project involves the redevelopment of the East Boston waterfront into residential apartments and, in the future, condominiums with supporting retail, community and office space. The renovated residential project will also include transient dockage and commuter water transportation services.

The existing marina is being upgraded, and major capital investments, boat building, and ship repair continue in the existing East Boston Shipyard.

7. *Pier 4 (Originally 2003 – 2005, Estimated Completion 2017-2019)*

The Pier 4 project involves redevelopment of a site located on the South Boston waterfront at the location formerly occupied by Anthony's Pier 4 Restaurant and associated parking into a multi-use area with retail, office, residential, hotel uses and public spaces. The project was originally proposed in the early 2000's, but had languished for several years. A Boston Globe article (September 26, 2007) and an editorial (Fan Pier rising, September 27, 2007) indicated that the Pier 4 project was taken over by a new developer and merged with the Fan Pier Development project (below). Both projects were initiated in 2008. Work is expected to include construction of a below-ground parking garage, access ramps, roadways, three buildings, pile-supported structures, and accessory structures associated with open space usage. There will also be dredging, seawall stabilization and repair, and minor filling of subtidal areas as well as a marina and water taxi dock. Information on the area affected is not available from existing public documents. The project received approval by the Boston Redevelopment Authority under the Boston Zoning Code.

8. *Fan Pier Development (2000 – 2007, Estimated Completion 2017-2019)*

This ongoing project (EEA #12083) will redevelop Fan Pier into a multi-use area with retail, office, residential, and hotel uses. The project design and composition has changed from the initial proposal, and was recently merged with the Pier 4 project (above). A new marina and water transportation terminal may be constructed as part of the project; the initial design included an estimated 9,800 cy of dredging (project information did not provide an area estimate). The project has received approval by the Boston Redevelopment Authority under the Boston Zoning Code.

9. *Russia Wharf (Completed)*

This project (EEA #12821) involved refurbishment of several historic buildings on Atlantic Avenue and Congress Street for mixed use as residences with retail space on the ground floor. It also included construction of a new 31-story office tower, a 500-space underground parking garage, and a waterfront plaza on Fort Point Channel that will provide dockage for transient boats. Other than pilings for the transient dock, there was no permanent impact to marine resources. It should be noted that some dredging occurred to support the proposed marina and water ferry dock; however, specific acreage or volumes are not presented in publicly available information.

10. Marina Bay Maintenance Dredging (Completed)

This maintenance dredging project involved dredging of a 107,800 square foot area (2.4 acres), representing less than seven percent of the area of the active boat basin in Marina Bay. Approvals were received for removal of approximately 9,000 cy of dredged material. No improvement dredging was conducted.

11. Clippership Wharf (In Predevelopment Phase: Estimated completion contingent upon financing)

The proposed project (EEA #12556) involves development of 400 housing units, 455 parking spaces, commercial and retail space, and associated infrastructure in five buildings on a 12.9-acre site. The development also includes plans for water transit terminals and water taxi stops; the project's planning strategy fosters development in and around a network of public transportation. Clippership Wharf will incorporate 1,715 linear feet of Harborwalk and will add 4 acres of new open space, including the following landscaped and pedestrian areas: Central Garden, Lewis Mall and Street, the Cove, the Arts Lawn, and Clippership Lane. Offstreet parking will be accommodated in an underground 670-space garage. Work in intertidal areas is likely to include removal or stabilization of old sea walls and the installation of piles to support new docking facilities. No significant impacts to subtidal marine resources are anticipated.

12. Sterling Marine Terminal (Originally 2008-2012)

The proposed project (EEA #13126), situated in East Boston along the Chelsea River, involves the reconstruction of approximately 300 linear feet of existing bulkhead, construction of a new 20-foot by 60-foot pile-supported transfer bridge, maintenance dredging of approximately 101,000 square feet (2.3 acres), and the construction of a confined aquatic disposal (CAD) cell in Boston Inner Harbor in East Boston, outside the boundaries of the Federal navigation channel. The proposed CAD cell is estimated at 3.8 acres. Approximately 155,000 cy will be dredged to create the CAD cell, and 21,000 cy of surficial sediments would be disposed at an approved upland disposal site. The CAD cell would be capped following the completion of dredged material disposal activities. The remainder of the dredged material (134,000 cy) will be disposed of at the MBDS. Based on publically available information, the project proponent is currently seeking to obtain environmental permits for the project and the project schedule is tentative. According to the MEPA Certificate on the DEIR, the results of the proponent's water quality modeling indicate that the proposed project will result in only temporary impacts to water quality and turbidity during dredging and disposal. Water quality will he monitored during this project. Review of publically available information did not yield new updates on this project.

13. Chelsea Sandcatcher Stabilization (Completed)

This project involved removal of crumbling portions of an obsolete concrete-and granite grit collection chamber extending onto the bank of the Chelsea River. The interior of the chamber was cleared of debris and filled with concrete. Steel sheeting and stone riprap were placed along the perimeter of the chamber to stabilize it and blend it into the riverbank, and the deteriorated roof of the chamber will be capped with a layer of concrete. No permanent impacts to subtidal resources resulted from the project.

14. Yard's End Research Center (Completed)

This project involved construction of two new research buildings totaling 527,000 square feet of floor space on 16th Street in the Charlestown Navy Yard. The project also created three acres of public open space along the waterfront, which will be part of the Boston Harborwalk system. The project is located entirely upland, and no permanent impacts to marine resources resulted from this project.

15. Long Island Bridge Abutment Stabilization (Completed)

This project involved the stabilization of bridge abutments on the Long Island Bridge, which links Long Island with the City of Quincy. The abutments are located on the southwest point of Long Island, known as West Head. Based on available information, minor impacts to subtidal resources resulted from abutment repair activities.

16. Shipyard Quarters Marina Extension (Completed)

This project involved expanding the existing marina at Pier 8 in the Charlestown Navy Yard. New piles were constructed to support 55 new slips, increasing the total capacity from 187 slips to 242 slips, and covering an additional 19,460 square feet of water surface.

17. Pier 5, 8th Street (Originally 2004 – 2006, Project Cancelled)

This project entailed construction of a new residential complex with 59 units totaling 170,000 square feet on Pier 5 in the Charlestown Navy Yard. The project would have added 1,400 linear feet of public space to the Boston Harborwalk system, and construct a 21-slip marina along the southern end of Pier 5. The area of impact associated with this project was not available from available information. Publically available information indicated this project was cancelled, with BRDA issuing requests for alternate development in January of 2011.

18. Global Petroleum, Chelsea River Dredging (Originally 2005, Actual Depends on Obtaining Necessary Permits)

This project (EEA #13291) proposes maintenance dredging of the existing Global Petroleum marine terminal located in the Chelsea River. Approximately 14,000 cy of marine sediment will be removed from a 2.5 acre area. Sediment is proposed to be disposed of in one of the following locations: a local landfill; a Rhode Island Dredge Disposal Facility (MBDS is not a disposal option because the material is unsuitable for unconfined ocean disposal); or a CAD cell at the Sterling Marine Terminal site.

19. Irving Oil, Chelsea River Dredging (Originally 2005, Actual Depends on Obtaining Necessary Permits)

This project (EEA #13297) involves maintenance dredging of the existing Irving Oil marine terminal located in the Chelsea River. The work will be done in coordination with the neighboring Global Petroleum dredging project. According to available documentation, approximately 13,000 cy of marine sediment will be removed. Sediment will be disposed of in one of the following: a local landfill; a Rhode Island Dredge Disposal Facility; or a CAD cell at the Sterling Marine Terminal site.

20. Spectacle Island Maintenance Dredging (Completed)

This project involved dredging 16,000 cy of sand from the marina area at Spectacle Island and using dredged materials to restore the northern half of West Beach, which was been eroded by wave action. The marina and beach were created in 1996 and 1997. Since then sand from the beach has washed into the marina area, reducing the water depth by up to 10 feet MLLW. Approximately 175,000 square feet (4 acres) of subtidal area and 215,000 square feet (4.9 acres) of intertidal area were temporarily affected. Periodic maintenance dredging is expected to be required in the future, although the frequency is not known.

21. New South Side Harborwalk (Completed)

This project created 350 linear feet of boardwalk along the south side of Commercial Wharf in Boston, supported by about 22 new timber piles. The boardwalk has a total area of approximately 2,180

square feet and will be part of the Boston Harborwalk system. Minor impacts were likely experienced from the installation of new piles. The area of impact is not specified in available information.

22. Lovejoy Wharf (Completed)

This project resulted in a mixed-use residential and retail complex adjacent to Lovejoy Wharf, which fronts the Charles River in the North End section of Boston. The project involved the renovation of one existing building at 160 North Washington Street and the demolition and replacement of a second building at 131 Beverly street to create 260 residential units and 38,000 square feet of retail space. Lovejoy Wharf will also be rehabilitated and integrated into the Boston Harborwalk system. No specific impacts to intertidal or subtidal areas are known.

23. St. Lawrence Cement/Boston Sand & Gravel, Island End River Dredging (Completed)

This project involved dredging of approximately 10,900 cy of material from an existing commercial wharf owned by Boston Sand & Gravel on the Island End River in Everett. The dredging covered an area of 81,950 square feet (1.9 acres) and increased the bottom depth from 26 feet below mean low water (MLW) to 31 feet below MLW to allow St. Lawrence Cement to dock a new deeper draft vessel at the facility. The dredged material was removed to an upland disposal site.

24. Release Abatement Measure, Island End River (In Progress)

This project (EEA #13443) involves dredging approximately 72,000 cy of contaminated sediment in the Island End River adjacent to a former coal tar processing facility. A 1.9-acre confined disposal facility (CDF) will be constructed on the riverbank to contain about 52,000 cy of the dredged material and prevent leaching of toxic organic compounds; the remainder will be removed to an off-site disposal facility. Constructing the CDF will result in permanent impacts to 1.9 acres of subtidal and a small area of tidal flat (intertidal) area, creating new upland area for marine use in a Designated Port Area. A wharf will be constructed atop the CDF.

25. Old Colony Yacht Club (Completed)

This project included maintenance dredging in the Old Colony Yacht Club Marina, which is located in Boston at the confluence of the Neponset River and Dorchester Bay. Approximately 15,000 cy of sediment was removed from an area of 80,000 square feet (1.8 acres). A portion of the sediment which was contaminated by the former operations of a manufactured gas plant was removed for treatment and upland disposal. The contaminated material was dredged to a depth of 12 feet below MLW, and the maintenance dredge material placed into this deeper channel to recreate the original bottom profile.

26. Mill Creek Center (Original Completion 2005 – 2006; Estimated Completion 2009)

This project involves construction of a 28,000 square foot mixed-use retail and office building adjacent to Mill Creek in Chelsea. A riverwalk and canoe launch dock are planned to be constructed as public open space along the riverbank. No significant permanent impact to intertidal and tidal resources is anticipated. No new information was available on this project.

27. Boston Children's Museum Expansion (Completed)

This project expanded the existing museum building with the construction of a three story, 22,300 square-foot addition adjacent to the Fort Point Channel in Boston. As part of the project, the land surface between the museum and the harborwalk along the water was filled to create a single level area. The building's addition is equipped with a green roof, and the museum also installed a new stormwater reclamation system on the entire building which will significantly reduce stormwater

runoff into Fort Point Channel. The Children's museum reopened to visitors in April 2007. No fill was proposed or placed in Fort Point Channel; impacts were limited to adjacent upland areas only.

28. Weymouth Fore River Maintenance Dredging (Completed)

The project involved maintenance dredging of about 430,000 cy of primarily clay, silt and sand from the project to restore the Federal navigation channel to its authorized channel dimensions. As a result of this project, approximately four million square feet (91.8 acres) of subtidal bottom was temporarily impacted. The material was disposed MBDS.

29. Acushnet Marine (Original Completion 2006-2007; In Progress)

This marina expansion project (EEA #13744) includes the construction of an 8- by 200-foot timber pile deck and access pier supported by 30 pilings, a 4- by 45-foot gangway, and an 18- by 80- foot pile supported steel float roughly located within the footprint of a historic supply pier on Hull Bay in Hull. Approximately 3,080 square feet of subtidal area will be affected by the project.

30. Waveland Marina (2007 – 2008, Completed)

The project included the expansion of an existing marina from 65 floating slips to 150 pile-supported slips; installation of pile-supported piers with a ramp and float system for access; relation of an existing travel lift; installation of steel sheet-pile sections at the location of the abandoned and proposed lift sites, and installation 900 linear feet of pile-supported floating wave attenuators. Approximately 260 square feet of subtidal area were be affected by the project, along with approximately 850 square feet of intertidal impacts.

31. UMass/Savin Hill Cove Dredging (Original Completion 2008)

The project is comprised of improvement dredging of an existing navigation channel in Savin Hill Cove adjacent to the University of Massachusetts-Boston in Dorchester Bay. Approximately 22,000 cy of sediment would be dredged from a navigation channel extending southwesterly from the existing Fort Point Basin docking facility for a distance of approximately 1,000 feet then turning southeasterly for 1,000 feet to connect with the Dorchester Bay Channel. An estimated area of 204,824 square feet (4.7 acres) of subtidal area will be affected by the project. Based on publically available information, the project is in the permit application phase.

32. M Street Seawall Construction (Completed)

The project involved the replacement of approximately 500 linear feet of the existing M Street concrete block seawall in South Boston. Also included was the rehabilitation of the granite block bulkhead adjacent to the new seawall. No subtidal area was affected by the project; approximately three acres of intertidal area was impacted.

33. Thompson Island Salt Marsh Restoration (Completed)

The project included the restoration of a salt marsh and salt pond on the southwestern side of Thompson Island in Boston Harbor. The restoration was accomplished by removing an existing debris pile that prevented tidal flushing. By opening up the hydrologic connection to the ocean, diurnal tidal flushing will replenish the water in the salt pond twice daily during normal high tides, and expose a fringe of mud flat habitat during low tides. Tidal exchange would improve water quality in the pond, increasing dissolved oxygen levels and preventing the formation of algal mats over the pond surface during the growing season. No subtidal areas were expected to be directly affected by the project.

34. Boston Harbor Islands General Management Plan

This is an ongoing effort with multiple activities concerning the long term management of the Boston Harbor Islands park system by the National Park Service (NPS). Concepts for the management plan include; increased opportunities for visitors to discover the natural and cultural history of the islands, preservation of natural and historical resources, providing visitor programs that focus on cultural and natural history, and promoting use and stewardship of natural and historical resources.

Visitor facilities (e.g., dock and transient marina at Spectacle Island) at numerous islands within the park system are existing structures or facilities, and no additional significant construction activities affecting subtidal resources are known. The island's current capital plan contains proposals for some minor dock improvement and seawall rehabilitation projects; however no specific construction or program activities are expected to affect marine resources. This General Management Plan is listed because of the close proximity of the project area to Boston Harbor Islands.

35. Parcel E (Completed)

Parcel E is located at 242 Northern Avenue in Boston's Seaport District, and is the former location of Jimmy's Harborside Restaurant, Jimbo's Fish Shanty and Massport office space. Redevelopment of Parcel E (EEA #14124) consists of two main buildings and a small kiosk building which accommodate restaurant and office space. Project also includes a new 570-foot section of Harborwalk on the harbor side of the building connecting Northern Avenue at the Marine Industrial Park back to Northern Avenue at the Fish Pier. Other public access improvements include an expanded deck area for food service with outdoor seating and the construction of a public landing to support transient dockage, water taxis, and charter fishing vessels. No dredging was conducted for this project. The ENF was filed with MEPA in November 2007 and the Secretary's Certificate issued in December 2007. The project had limited temporary impacts associated with the removal of 450 timber piles and the installation of 160 new 16" pipe piles. The ENF notes expected impacts to Land under Ocean of 142 square feet. The new pilings support the new buildings and deck structure. The project was completed in 2011.

36. Logan Runway Safety Areas (Phase 1 completed 2012, Phase 2 by 2015)

Under this project (EEA #14442) Logan Airport Runway Safety Areas (RSAs) for Runways 33L and 22R will be modified and enhaneed. At runway-end 33L a pile supported deck of approximately 300 feet wide by 500-feet long was constructed over Boston Harbor. In addition to alteration of the constructed riprap coast bank at this location, the project directly or indirectly impacted approximately 66,000 sf of eelgrass and approximately 2,000 sf of subtidal area. This worked commenced in spring 2011 and was completed in November 2012.

Proposed safety improvements at Runway-end 22R will be constructed 2014/2015 and will require alteration of approximately 35,000 ft^2 of saltmarsh, 63,545 ft^2 of shellfish beds, coastal bank, 31,200 ft of coastal beach and a small subtidal area (1800 sf).

The EA/EIR document and subsequent permits incorporated coastal impact mitigation measures including the restoration of previously filled or degraded salt marsh and restoration of eelgrass habitat. The existing storm water collection/treatment system for these RSAs is considered adequate to protect receiving water quality.

37. Cottage Park Marina Expansion and Maintenance (Completion Date 2012/post-2012)

The Cottage Park expansion and maintenance dredging project (EEA #14952) has been proposed to install 561 feet of pile supported floating dock and several finger floats to offer 27 new boat slips, enhanced public transient slips and an area for the youth sailing program. The project as proposed

according to the ENF includes the dredging of 9500 cubic yards (cy) of material over an area of 4.1 acres including 2000 ft^2 of tidelands and shellfish classification area GBH5.1.

An environmental window has been established (Feb 15 to Sept 30) to protect flounder and clam spawning, larval settling and juvenile development.

38. Winthrop Ferry Dock (Completed)

The Town of Winthrop upgraded its public landing to include ferry service with the necessary ramps and safety features (EEA #12940). New pier construction affected 46 ft^2 of wetland directly. Wetland shading occurred over 5820 ft^2, although the design allows light to continue to infiltrate the area.

39. Georges Island Pier Improvement Project (Planned Completion Date Not Available)

The Massachusetts Department of Conservation and Recreation and the National Park Service have cooperated to develop/construct replacement pier and docks at Georges Island, as well as two new pile supported wave screens. The project (EEA #14824) consists of the removal/replacement of existing piles and avoids dredging. Based on publically available information, the completion date for this project is not available.

40. Shaughnessy Pier (Planned Completion 2012)

The Shaughnessy Pier project according to the ENF (EEA #14805) involves the construction of a deck, pier and floating docks at a single-family residence. The proposed structure will extend 162.5 feet into Quincy Bay with a 65 foot extension for floating docks, moorings, storage and a boat lift.

The initial plan would affect 72 feet of coastal beach, 540 ft^2 of rocky intertidal and a 2078 ft^2 of the subtidal zone. A smaller scaled pier and dock were recommended by CZM and DMF.

41. Rock Chapel Marine (Planned Completion 2012)

The Rock Chapel Marine project (EEA #14722), located in Chelsea, has been proposed to repair and/or remove old structures including oil tanks and renovate a garage for reconfiguration into an office building to support marine terminal operations. Installation of multiple truck scales are intended to reduce truck queuing and idling. The project will also create public access to the area. No impacts to wetlands, intertidal or sub tidal areas are proposed.

42. Harbor Towers Seawall Repair (Planned Completion 2011)

The Harbor Towers project (EEA #14662) is located at the Harbor Towers condominiums in Boston and includes repairs and maintenance of an existing seawall and harborwalk. According to the ENF, the project will affect 5250 ft^2 of wetlands, including 1845 ft^2 in the subtidal environment, 1525 ft^2 of the rocky intertidal, and 1880 ft^2 of land subject to coastal storm flows. Coastal bank (690 ft) will also be affected.

The area is not mapped as shellfish habitat and placement of project rip rap will include voids to allow it to function as rocky intertidal habitat. No new updates on project status were publically available.

43. Port Norfolk Yacht Club Maintenance Dredging (Planned Completion 2009)

The Port Norfolk Yacht Club, located in Dorchester, has proposed a dredging project (EEA #14336) to address shoaling areas within the marina. Under the proposed dredging plan, 15,000 cubic yards (cy) of material will be removed from the marina and according to the ENF will affect about 98,527 ft^2 of subtidal and shellfish areas. Information regarding actual completion date is not publically available.

44. Pappas Way Roadway Improvement Project (Planned Completion 2013)

This project (EEA# 14695) involves improvements to the Pappas Commerce Center as part of an overall long term rehabilitation plan from an industrial park to a mixed-use urban center. Site improvements include bulkhead repairs, roadway grading, drainage improvements, a new pedestrian pier and platform with waterfront access, wind turbine installation, and construction of a pedestrian harborwalk.

The proposed project includes revetment that affects approximately 27,500 ft^2 of flowed tidelands. Mitigation measures include enhanced bulkhead habitat, improved storm-water filtration, and habitat restoration totaling approximately 27,500 ft^2 in the Chelsea Creek intertidal zone along Condor Street in East Boston.

45. Boston National Park/Ferry (Planned Completion 2008)

The Charleston Navy Yard in Charlestown includes a ferry landing facility and the National Park Service project plan (EEA #14195) is to construct a new more secure landing that complies with accessibility standards. The pier design includes a concrete deck slab supported by steel pipe piles.

No beach or bank areas occur within the work site and there is no evidence of eelgrass during a recent bathymetry survey. The site is presumed not to contain shellfish habitat. Wetland impacts will be limited to just 18 ft^2. Information regarding an actual completion date is not publically available.

46. Boston East Development Project (Planned Completion 2011)

The Boston East site has historically been used commercial and industrial purposes, contains structures in disrepair, represents 87,118 ft^2 of historically filled wetlands, and is currently inaccessible to vehicular and pedestrian traffic. According to the PNF/ENF (EEA #14123) The project proposes to construct a residential building on the north portion of the site and a two-story marine industrial facility with travel lift and a landscape exhibit on the south side.

Finger piers will be constructed to support the marine travel lift. Coastal impacts will be limited to 100 ft^2 of subtidal area and 19,650 ft of coastal beach as well as 69,650 ft^2 of land subject to coastal storm flowage.

The project provides housing, jobs, public access and tax revenues. Information regarding actual completion date is not publically available.

47. New Street Development (Planned Completion 2010)

This is an East Boston project (EEA# 14102) located on New Street that was designed to develop/redevelop housing units and possibly a hotel facility. Several buildings will be removed from the site and parking capacity added. A small marina will be constructed and 2,300 cy of material dredged. A harbor walk will be added and landscaped.

Information regarding actual completion date is not publically available.

48. Conley Terminal Expansion Project (Beginning in 2013)

The upcoming Conley Terminal expansion project is designed to enhance ground transport to and from the terminal area, create open space buffer between existing parks and playgrounds, and increase container storage facilities at the site.

The transportation infrastructure enhancements will include several components including:

- A dedicated freight corridor to remove Conley Terminal container truck traffic from East First Street and part of Summer Street;
- A new roadway traversing the Coastal Oil Terminal property, the former MBTA/DCR property, and Exelon corporation property, and
- Construction of a bridge across the embayment on the Exelon property to join Summer Street (replacing an existing bridge).

For this project phase, in-water work will be limited to the construction of bridge abutments and pilings. The bridge abutments will replace the existing bulkheads, and will not likely require any new fill area. The new pilings are expected to impact an area of 200 ft^2 or less.

The open space buffer zone will be about 100 feet wide in most areas and will be established along the north side of East First Street extending about 2,000 feet from Farragut Road to the Exelon property. It will create new open space between Castle Island and other parks along the harbor, parks and playgrounds along East First Street and the community to the west.

Added container storage will be established with expansion onto the former Coastal Oil property and include possible reefer storage, full and empty box storage in stacks served by rubber-tire gantries, and container processing facilities. These improvements may potentially expand ground container storage from about 4,050 TEUs to 5,200 TEUs at Conley Terminal. The final security perimeter will incorporate the expanded area onto the former Coastal Oil property and a security checkpoint at the western end of the facility.

Future Conley construction phases could include waterfront improvements. With the deepening of Boston Harbors' navigation channels to -47 feet, Massport is considering deepening existing berths at Conley Terminal (#11 and #12) from -45 feet to -50 feet to maximize shipping efficiencies gained by the continued use of Boston's tidal range.

With the Conley expansion onto adjacent Coastal Oil Terminal property, Massport is also considering the long-range potential of constructing another berth on this property. If it is assumed that the current proposed Coastal Oil berth depth is about -40 feet at present (plus OD), and the (deeper) existing Conley Terminal berth dredging would require only ½ the depth to be dredged vs. the new berth on the Coastal Oil property, then the resulting material volume would be roughly twice at the new Coastal Oil site. The resulting dredged material volume generated from the new Coastal Oil Terminal berth would then likely be on the order of 50,000 cy for placement at either the MBDS or the IWA.

4.11.3 Summary of Cumulative Impacts

The Deep Draft Project will provide deeper access channels for ships using the Port of Boston. Construction will occur in an area that is both heavily utilized by a wide range of human activities and experiencing a large number of projects with potential impacts to biological resources and water quality.

The Boston Harbor dredging projects summarized in Section 4.11 resulted in the cumulative, temporary disturbance to approximately 1,720 acres to-date of subtidal habitat within the inner and outer harbor areas for the completed projects (BHNIP and OHMDP), as well as an additional 1,886 acres of temporary disturbance associated with the recently completed IHMDP and the proposed Deep Draft Project. Thus the major Boston Harbor navigation dredging projects have (or will) temporarily impact a total of 3,600 acres. These areas of disturbance are limited to the boundaries of the existing Federal navigation channels and anchorage areas within the harbor. It is important to note that some of the areas of the dredging projects overlap, as is clearly shown in Figure 4-10. In addition the Deep Draft Project could have permanent beneficial impacts to subtidal areas of between 220 and 530 acres (depending on the selected alternative) if the habitat enhancement program is implemented.

Additionally, there is a range of smaller harbor projects that add to the overall cumulative impacts of completed or planned harbor projects and those have also been addressed. Assessing the cumulative impact associated with projects identified in Section 4.11.2 is based on available information during document development. Some of the available documentation for small projects expresses impacts in terms of cubic yards, not square footage, but most of the large projects (e.g., HubLine, Weymouth Fore River) do have square footage information available so while the totals do not include all projects, they are representative of activity in the harbor.

Roughly half of the projects presented in Section 4.11.2, are completed. These completed projects created temporary impact of about 2,170 acres (95 percent of which is the HubLine project), and permanent impact of approximately 5 acres. Of the remaining projects, about 30 acres of temporary subtidal impacts are anticipated. The total estimated intertidal area within Boston Harbor to be affected by the projects is about 50 acres, including a large fraction (37 acres) of permanent impacts associated with the Winthrop Shores Reservation. These data are comparable to findings presented in the 2008 Draft SEIS/EIR.

Evaluating all completed and anticipated harbor construction projects results in several thousand acres of subtidal impact. Given the roughly 50 square mile area of the harbor (approximately 32,000 acres), the cumulative projects impact will be less than 20 percent of the total, and the vast majority of these subtidal impacts will occur in areas that are already disturbed (i.e., maintained navigation channels). Further, the removal of sediment from these areas will affect the biologically active zone only temporarily, until sedimentation proceeds and benthic biological resources re-colonize these areas, re-work the sediments, and increase in abundance and diversity over time. The majority of the cumulative impacts are the result of the Boston Harbor dredging projects described in Section 4.11.1 and the completed HubLine natural gas pipeline described in Section 4.11.2. See Tables 4-17 and 4-18.

Based on the summary of the cumulative impact of the projects presented in Section 4.11.2 and the timing, location and magnitude of the projects analyzed, the Deep Draft Project is unlikely to result in significant cumulative impacts to water quality with respect to temperature and salinity, dissolved oxygen concentrations or nutrient concentrations. Temporary local increases in water column turbidity will result from dredging operations, and the impacts could be more pronounced if one or more of the proposed development projects are being constructed at the same time and in the vicinity of the dredging activities for the Deep Draft Project. Given that many of the projects are subject to obtaining necessary permits and approvals, it is not possible to determine whether some of these projects will occur at the same time as the Deep Draft Project. Those near the project footprint in Chelsea that could potentially have overlapping timeframes include the Sterling Marine Terminal, Irving Oil, and Global Petroleum. In the harbor, perhaps the UMASS/Savin Hill Cove Dredging and/or the Winthrop Shores Restoration projects could experience overlapping schedules. Implementation of the proposed mitigation measures for dredging and dredged material disposal activities will minimize any potential temporary turbidity impact and will be further mitigated for the development of sensitive fishery resources by observing environmental dredging windows established to protect larval and juvenile life stages.

Likewise, temporary cumulative impacts to biological resources in Boston Harbor could result if any of the adjacent development projects are being constructed at the same time as Deep Draft Project activities. These potential cumulative impacts could result from additional noise, benthic habitat disturbance, and/or permanent displacement of harbor bottom. Implementation of the proposed mitigation measures for the Deep Draft Project will minimize any potential cumulative impacts.

Geological resources in the harbor project areas are represented by subsurface rock material and Boston Blue Clay. The rock resources may be re-used to create additional rocky bottom habitat for the lobster fishery and others, and the clay resource may be used to cap the IWS area near the MBDS

4.11.4 Conclusions

Generally, most of the cumulative impact related to the range of harbor projects will occur in the subtidal areas, where benthic resources reside, but as indicated, the vast majority of these areas already exist within the existing Federal navigation channels and benthic resource impacts related to dredging activities have been documented to be temporary, with gradual re-colonization of these areas with biological resources.

A far lesser impact will occur in the intertidal zone, where roughly 50 acres are/will be affected cumulatively by the range of projects recently completed or planned. Further, the loss of some of these areas may be mitigated with the construction/reconstruction of saltmarsh locally or in the harbor region. Water quality impacts related to turbidity are also expected, but will be temporary, and mitigated by observing environmental dredging windows.

Small impacts will also occur in storm flowage areas where a few acres of expected impacts have been documented, in coastal bank areas (about one acre documented), and in Essential Fish Habitat areas (a few acres documented). Critical habitat has not been identified in any of the harbor project areas.

Overall, the cumulative impacts of the Deep Draft Project are not substantial and temporary in nature. No unique marine resources are expected to be impacted from the proposed project which will therefore not result in a cumulatively significant adverse impact to marine resources. The benthic community will be temporarily disturbed and the substrate exposed may be finer in content. However, this exposed layer will eventually be covered by silt and the benthic community could change slightly again. Less than two percent of the proposed project will impact previously undisturbed areas. The overwhelming portion of the project will deepen only previously disturbed areas in Boston Harbor. The habitat enhancement will be a positive impact, if approved. No CAD cell construction within Boston Harbor is currently expected for the Deep Draft Project. Further, many of projects recently completed or planned for construction will have a positive effect on recreation, the local economy, employment, and housing.

Table 4-17. Subtidal and Intertidal Impacts from Boston Harbor Projects

Figure – 4-11, Key #	Project	City	Location	Subtidal Impacts	Intertidal Impacts	Timeframe	Comments
1	Station #385-Harborwalk	Boston	Boston Harbor Reserved Channel	None	~ 1,400 s.f.	Completed	
2	Hubline	Boston, Weymouth	Mass. Bay, Boston Harbor-Beverly to Weymouth	In Boston Harbor, up to 2,055 acres temporary impact; 5.4 acres permanent impact	None	Completed	These estimates reflect work in Boston Harbor only; estimated at 31 percent of the full length of the HubLine
3	MWRA Harbor Cleanup	Boston, Winthrop	Deer Island, Boston Outer Harbor	Periodic maintenance dredging at Deer Island and Nut Island roll-on/roll-off piers will be required – area to be determined	None	Completed	Maintenance Dredging ongoing. Harbor activities included construction of roll on/roll off pier at Deer Island; Deep bored outfall tunnel to Mass Bay
4	Winthrop Shores Reservation Restoration Program	Winthrop	Broad Sound	450,000 cy embankment borrow site; 91,000 – 98,000 cy from W.B. Tombolo	37 acres of supratidal, intertidal and subtidal impacts	Estimated Completion 2012-2013	Subject to funding and permitting approval.
5	Central Artery	Boston	Spectacle Island; Ted Williams Tunnel; Fort Point Channel	Spectacle Island-6.4 acres; Ted Williams Tunnel-3,415	See comments	Completed	Spectacle Island and Fort Point Channel impacts include minor amounts of Intertidal areas –

Figure – 4-11, Key #	Project	City	Location	Subtidal Impacts	Intertidal Impacts	Timeframe	Comments
				sf; Fort Point Channel-2.1 acres; Charles/Millers Rivers-5,000 sf			beach at Spectacle Island, mud flat in Fort Point Channel. Small salt marsh (supratidal) area on Spectacle Island permanently impacted
6	Portside at Pier One	East Boston	Boston Inner Harbor	None	None	In Progress. Phased Completion recommenced in 2012	
7	Pier 4	Boston	Boston Inner Harbor	Unspecified area of maintenance dredging	None	In Progress. Estimated Completion 2017-2019	Seawall stabilization
8	Fan Pier Development	Boston	Boston Inner Harbor	9,800 cy-no area specified.	None	In Progress. Estimated Completion 2017-2019	Temporary impacts to adjacent seawall
9	Russia Wharf	Boston	Fort Point Channel	Potential dredging	None	Completed	
10	Marina Bay Maintenance Dredging	Quincy	Dorchester Bay	107,800 sf (2.5 acres); 9,000 cy dredged	None	Completed	Maintenance dredging of navigation channel.
11	Clippership Wharf	East Boston	Boston Inner Harbor	201,070 sf (4.6 acres)	14,680 s.f (0.3 acres)	In Progress, Estimated Completion 2016	Marina construction
12	Sterling Marine Terminal	East Boston	Chelsea River	3.38 acres of Subtidal habitat to construct	None	Presently Seeking Permits;	Dredging of 155,000 cy to construct CAD cell; upland disposal

Figure – 4-11, Key #	Project	City	Location	Subtidal Impacts	Intertidal Impacts	Timeframe	Comments
				CAD cell		Estimated completion 2013-2017	of 21,000 cy; MBDS disposal of 134,000 cy
13	Chelsea Sandcatcher Stabilization	Chelsea	Chelsea River	None	~ 800 sf	Completed	
14	Yard's End Research Center	Charlestown	Mystic River	None	None	Completed	Assumed impacts to adjacent upland areas only
15	Long Island Bridge Abutment Stabilization	Boston	Boston Harbor	550 sf (0.01 acres)	24,000 sf temporary; 2,560 s.f. permanent	Completed	
16	Shipyard Quarters Marina Extension	Charlestown	Inner Harbor	170 sf	None	Completed	Installation of pilings
17	Pier 5, 8th Street	Charlestown	Inner Harbor	26 sf	None		Project Cancelled
18	Global Petroleum	Revere	Chelsea River	75,950 sf	None	Dependent on Obtaining Permits	Dependent on obtaining permits. Approx. 14,000 cy dredged and disposed in a landfill or CAD cell
19	Irving Oil	Revere	Chelsea River	85,706 sf	None	Dependent on Obtaining Permits	Approx. 13,000 cy dredged and disposed in a landfill or CAD cell
20	Spectacle Island Maintenance Dredging	Boston	Boston Outer Harbor	175,000 sf (4 acres)	215,000 sf (4.9 acres)	Completed	Dredging of 16,000 cy and nourishment of beach

Figure – 4-11, Key #	Project	City	Location	Subtidal Impacts	Intertidal Impacts	Timeframe	Comments
21	New South Side Harborwalk	Boston	Inner Harbor	17 sf	None	Completed	22 timber piles
22	Lovejoy Wharf	Boston	Inner Harbor	36,213 sf of wharf	None	Completed	Replacement temporary impacts from pile replacement
23	St. Lawrence Cement/Boston Sand & Gravel, Island End River Dredging	Everett	Island End River; Mystic River	81,950 sf (1.8 acres)	None	Completed	10,867 cy of dredged material
24	Release Abatement	Everett; Chelsea	Island End River; Mystic River	53,856 sf (1.2 acres)	None	In Progress	Remedial dredging of contaminated sediments
25	Old Colony Yacht Club	Boston	Neponset River; Dorchester Bay	80,000 sf (1.8 acres)	None	Completed	15,000 cy of sediment dredged
26	Mill Creek Center	Chelsea	Chelsea River; Mill Creek	None	None	In Progress Planned 2009	8,000 sf of salt marsh (supratidal)
27	Boston Children's Museum Expansion	Boston	Fort Point Channel	None	None	Completed	Impacts only to adjacent upland areas
28	Weymouth Fore River	Weymouth	Fore River	Approx. 91.8 acres (9,000,000 sf) temporary impact	None	Completed	
29	Acushnet Marine	Hull	Hull Bay	3,080 sf	None specified	In Progress	Marina expansion
30	Waveland Marina	Hull	Hull Bay	262 sf	850 sf	Completed	Marina expansion

Figure – 4-11, Key #	Project	City	Location	Subtidal Impacts	Intertidal Impacts	Timeframe	Comments
31	UMass/Savin Hill Cove Dredging	Boston	Dorchester Bay	4.7 acres (204,824 sf)	None	2008 Obtaining permits	Improvement dredging of existing navigation channel
32	M Street Seawall Reconstruction	Boston	Dorchester Bay	None	3 acres (129,200 sf)	Completed	Reconstructed in place.
33	Thompson Island Salt Marsh Restoration Project	Boston	Dorchester Bay	None	Conversion of 5,009 sf of Land Under Salt Pond to Intertidal area	Completed	Additional 395 sf of impact to Coastal Bank
34	Boston Harbor Islands General Management Plan	Boston, Hingham, Hull	Boston Harbor	None known	None known	Ongoing	No specific construction activities identified
35	Parcel E/Liberty Wharf	Boston	Boston Harbor	142 sf	None known	Completed	Remove 450 timber pilings and install 160 new 16" pipe piles to support new buildings and deck structure. No dredging.
36	Logan Runway Safety Areas	Boston	Boston Harbor	1745 SF	Saltmarsh (35,040 sf) and shellfish beds (63,545 sf)	Runway-End 33L Completed 2012, Runway-End 22R, completed by 2015	Total wetland impact 215,320 SF
37	Cottage Park Yacht Club	Winthrop	Winthrop Harbor	4.1 acres	2000 sf of flowed tidelands	Planned 2012	Shellfish classification (dredging area) GBH5.1
38	Winthrop Ferry	Winthrop		5820 sf shaded	-	Completed	EIR not required

Figure – 4-11, Key #	Project	City	Location	Subtidal Impacts	Intertidal Impacts	Timeframe	Comments
	Dock						
39	Georges Island Pier Improvement	Boston	Boston Harbor	425 sf	-	Not Available	70 sf coastal beach
40	Shaughnessy Pier	Quincy	Boston Harbor	2078 sf	540 sf	Planned 2012	1596 sf of EFH and 72 sf coastal beach affected
41	Rock Chapel Marina	Chelsea	Mystic	No Impact	No impact anticipated	Planned 2012	
42	Harbor Towers	Boston	Boston Harbor	1845 sf	1525 sf	Planned 2011	Total Wetland 5250 sf including 1880 sf subject to storm flow
43	Port Norfolk Yacht Club	Boston/Dorchester	Neponset	98,527 sf	No impact anticipated	Planned 2009	15,000 cy to be dredged; placement at MBDS
44	Pappas Way Seawall Rehab	S. Boston	Pappas Way	None expected	30190 sf	Planned 2013	Intertidal Revetment
45	Boston National Park/Ferry	Boston	Boston Harbor	18 SF (steel piles)	No impact anticipated	Planned 2008	Upgrade ABAAS compliant, smaller footprint
46	Boston East	Boston	Boston Harbor	100 SF	19670 SF	Planned 2011	Also 69,650 SF subject to coastal storm flowage
47	New Street Development	Boston	Boston Harbor	Not Available	No impact anticipated (marina at existing wharf)	Planned 2010	2,300 cy of dredged material generated
48	Conley Terminal Expansion	Boston	Boston Harbor	12 – 15 acres	No impact anticipated	Planned 2013	Potential for future dredging of 50,000 cy of new dredged material (Coastal Oil Terminal)

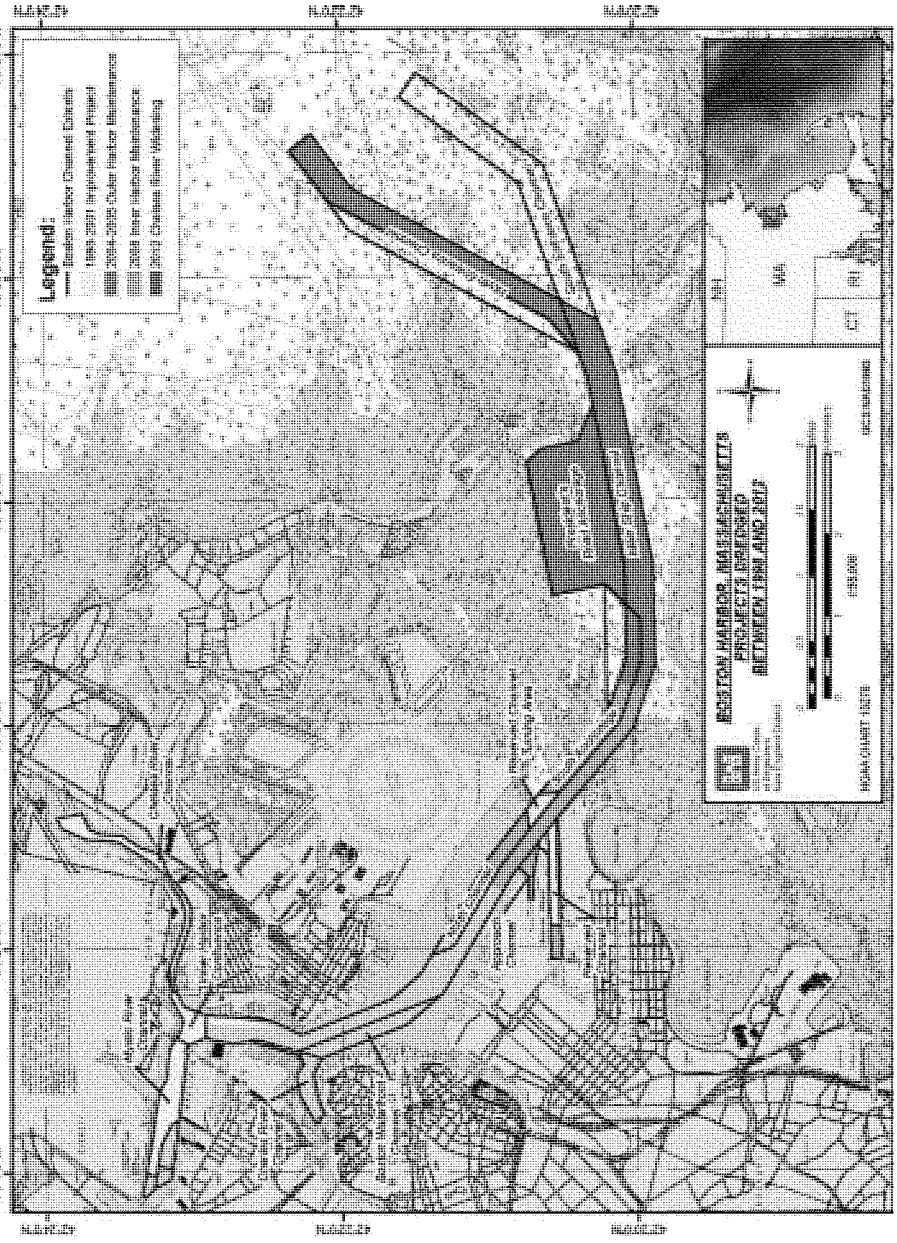
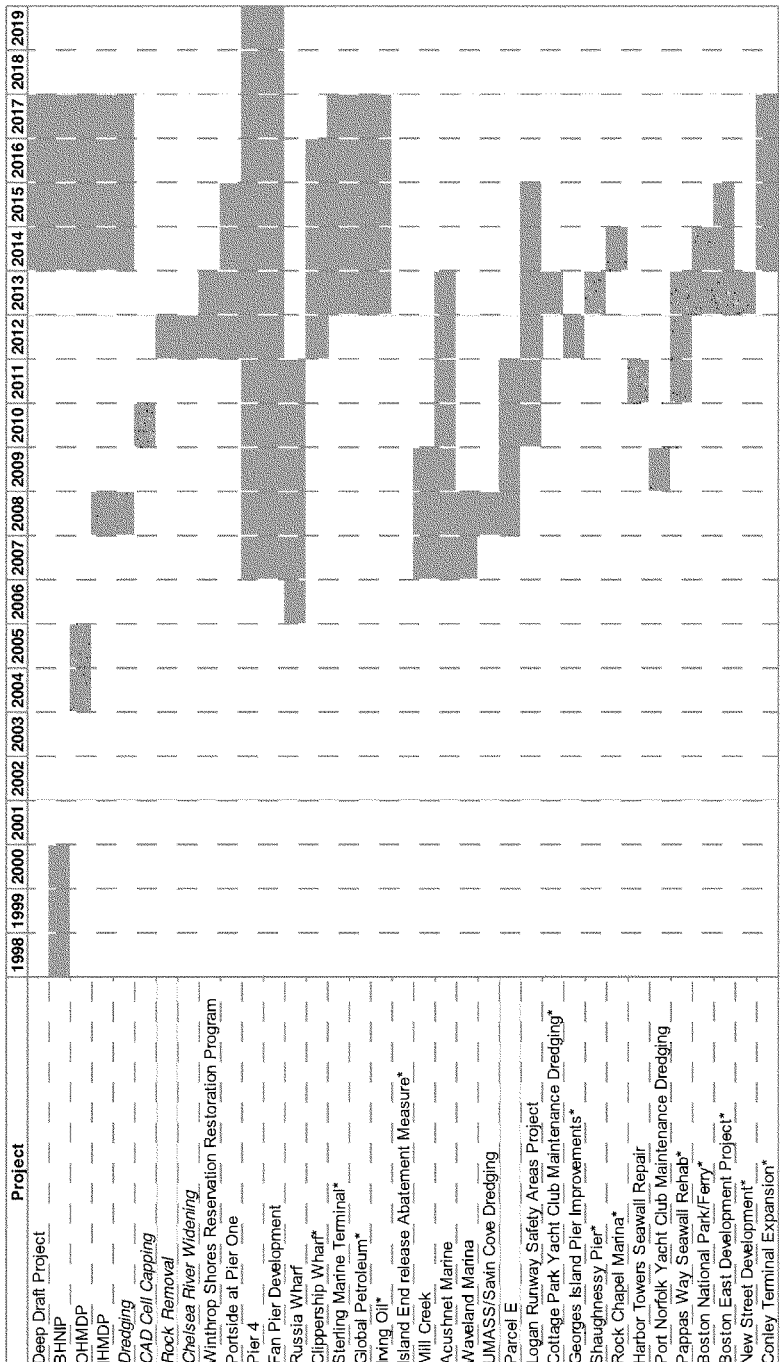
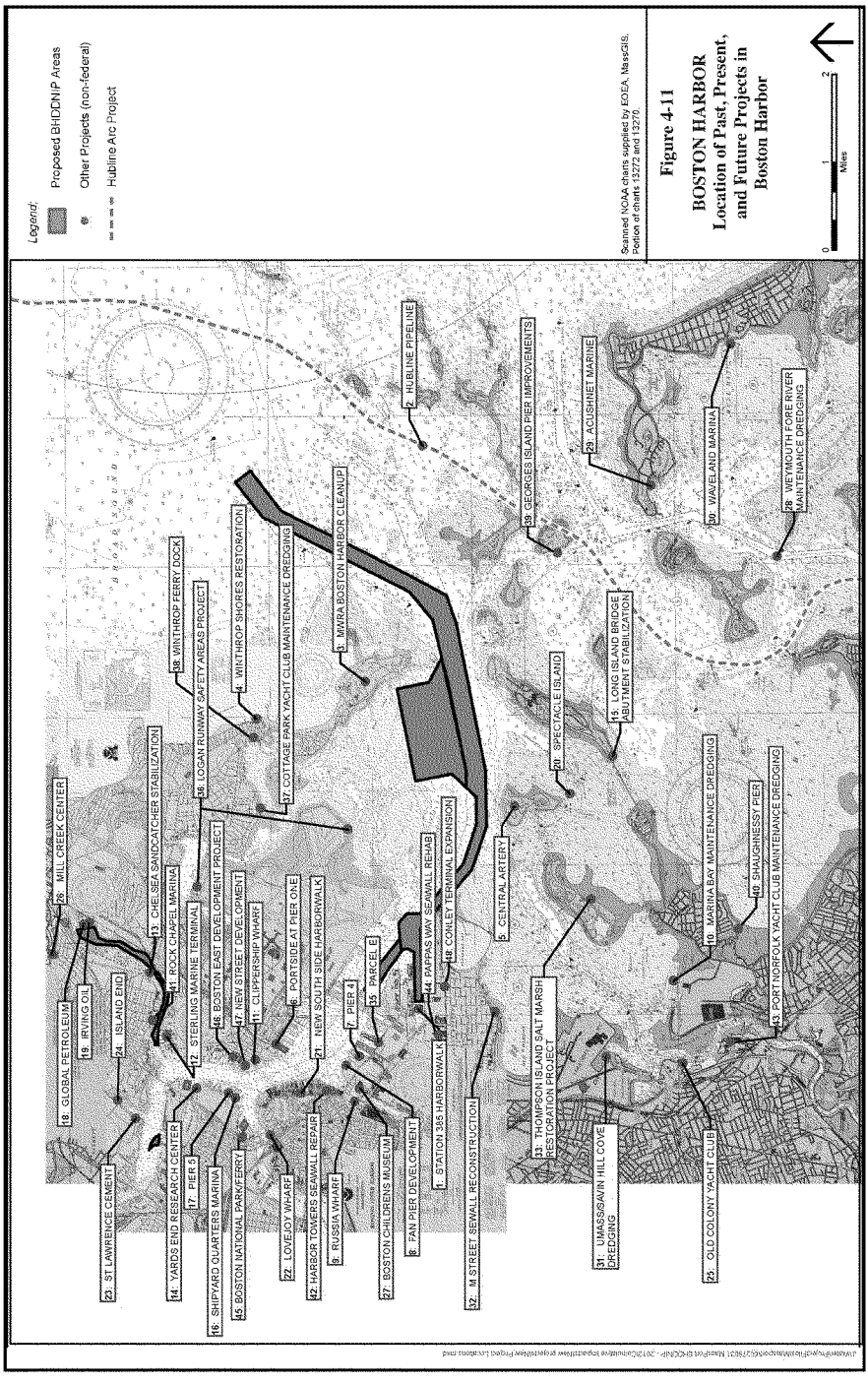


Figure 4-10. All Recent Federal Boston Harbor Dredge Projects Combined

Table 4-18 Cumulative Impacts



* Estimated Schedules; actual completion dates unknown.


Legend:
Proposed BHDENIP Areas
Other Projects (non-federal)
Hubline Arc Project
Scanned NOAA charts supplied by EOEA, Nasshis.
Portion of charts 13272 and 13270.
Figure 4-11
BOSTON HARBOR
Location of Past, Present, and Future Projects in Boston Harbor
0
1
2
Miles
18: GLOBAL PETROLEUM
19: IRVING OIL
23: ST LAWRENCE CEMENT
24: ISLAND END
26: MILL CREEK CENTER
13: CHELSEA SANDDACHER STABILIZATION
11: ROCK CHAPEL MARINA
14: YARDS END RESEARCH CENTER
12: STERLING MARINE TERMINAL
17: PIER 5
16: SHIPYARD QUARTERS MARINA
46: BOSTON EAST DEVELOPMENT PROJECT
45: BOSTON NATIONAL PARK/FERRY
47: NEW STREET DEVELOPMENT
11: CLIPPERSHIP WHARF
22: LOVEJOY WHARF
8: PORTSIDE AT PIER ONE
42: HARBOR TOWERS SEAWALL REPAIR
21: NEW SOUTH SIDE HARBORWALK
6: RUSSIA WHARF
7: PIER 4
27: BOSTON CHILDRENS MUSEUM
15: PARCEL E
8: FAN PIER DEVELOPMENT
44: PAPPAS WAY SEAWALL REHAB
1: STATION 386 HARBORWALK
48: CONLEY TERMINAL EXPANSION
32: M STREET SEWALL RECONSTRUCTION
5: CENTRAL ARTERY
38: WINTHROP FERRY DOCK
36: LOGAN RUNWAY SAFETY AREAS PROJECT
41: WINTHROP SHORES RESTORATION
37: COTTAGE PARK YACHT CLUB MAINTENANCE DREDGING
3: MWRA BOSTON HARBOR CLEANUP
2: HUBLINE PIPELINE
39: GEORGES ISLAND PIER IMPROVEMENTS
29: AQUSHNET MARINE
20: SPECTACLE ISLAND
15: LONG ISLAND BRIDGE ABUTMENT STABILIZATION
30: WAVELAND MARINA
28: WEYMOUTH FORE RIVER MAINTENANCE DREDGING
33: THOMPSON ISLAND SALT MARSH RESTORATION PROJECT
10: MARINA BAY MAINTENANCE DREDGING
40: SHAUGHNESSY PIER
31: UMASS/GAVIN HILL COVE DREDGING
43: PORT NORFOLK YACHT CLUB MAINTENANCE DREDGING
25: OLD COLONY YACHT CLUB

4.12 Secondary Impacts

The proposed Deep Draft Project alternatives would dredge the Main Ship Channel to a depth greater than the currently authorized depth of -40 feet at mean lower low water (MLLW). This would put Boston Harbor more in line with other U.S. east coast and foreign container ports, which are mostly -48 to -50 feet deep. The Deep Draft Project would allow larger vessels to access the port facilities in an environmentally safer and economically efficient manner, thereby increasing the volume of container cargo loaded and unloaded at Boston Harbor while maintaining existing sailing schedules and port rotations[22].

This section discusses the secondary, or indirect, impacts likely associated with the Deep Draft Project and the related increases in the sizes of ships calling on the Port of Boston. Direct effects are caused by the proposed dredging and occur contemporaneously at or near the location of the action. As defined in NEPA, indirect effects:

> "are caused by the action and are later in time or farther removed in distance, but are still reasonably foreseeable. Indirect effects may include growth inducing effects and other effects related to induced changes in the pattern of land use, population density or growth rate, and related effects on air and water and other natural systems, including ecosystems." (40 CFR 1508.8)

The Port of Boston is well established and has experienced a large volume of ship traffic for many years. Within this context, the Deep Draft Project represents a continuation of navigation channel alterations following numerous historical maintenance and improvement projects. Major maintenance dredging generally occurs at a frequency of 16 to 41 years depending on the harbor area.

The proposed Deep Draft Project would allow a greater percentage of New England cargo to be shipped through the Port of Boston, rather than through the Port of New York and New Jersey (PONYNJ) and moved throughout New England by truck. Shipping a greater percentage of New England cargo through the Port of Boston would reduce the overall volumes of cargo moved by truck over New England roads but would increase vehicle trips in the vicinity of the port and on some roads in the Boston area. These transportation changes would, in turn, affect regional air emissions. Therefore, this secondary impacts analysis focuses on air quality, with supporting shipping and ground transportation data to address the post-construction marine fleet mix and schedules, and new trucking patterns.

To evaluate secondary impacts, a dredging depth of -48 feet (MLLW) was selected for modeling purposes (as the approximate midpoint between the potential Project alternative endpoints of -45 and -50 feet) for comparison to the No Action Alternative. Although the final recommended construction depth is -47 feet, the modeling results are considered valid for this modest difference, particularly since vessels would continue using the tidal advantage at the Port of Boston and the fleet mix associated with a minus 47-foot channel (versus a minus 48-foot channel) would not change appreciably.

4.12.1 Shipping Patterns

The Deep Draft Project would allow larger, deeper-draft vessels to access Boston Harbor port facilities in an environmentally safer and economically-efficient manner and for those vessels to carry more cargo. Table 4-19 summarizes the shipping volumes for the No Action and Post Construction alternatives. The table illustrates the following shifts in the projected container, bulk cargo, and petroleum vessel operations in response to the proposed channel deepening:

[22] David Miller Associates, 2012, Draft Boston Harbor Channel Deepening Project, Containerized Cargo Economic Benefits Analysis.

- Loss of direct Asian container service calls to Boston from the existing condition if the harbor is not deepened.
- Resumption in Asian-Panama service and retention of the Northern Europe and Mediterannean services with deepening to at least 45 feet. No change in the number of container ship calls over existing conditions, but an increase over the No Action Alterantive with the Deep Draft Project, and all three services shift to larger container ships—resulting in a substantial increase in container cargo volume.
- A decrease in the number of bulk cargo shipments with the project, offset by a shift to larger bulk cargo ships—resulting in no substantial change in bulk cargo volume.
- A decrease in the number of petroleum ships, offset by a shift to larger petroleum ships—resulting in no substantial change in bulk cargo volume.

4.12.2 Port Throughput

By allowing larger vessels to access the port facilities in an economically-efficient and environmentally safer manner, the Deep Draft Project may not affect bulk carrier or petroleum vessel traffic, but would increase the volume of container cargo loaded and unloaded at Boston Harbor while maintaining existing sailing schedules and port rotations[23]. Table 4-20 summarizes estimates of daily container shipping volume through Boston Harbor, measured in twenty-foot equivalent units (TEUs), identified in the Containerized Cargo Economics Benefits Analysis[24] for the No Action Alternative and several of the many shipping scenarios discussed in the Economic analysis of containership cargo benefits (Appendix C-1).

Table 4-19. No Action Alternative and Post-Deepening Shipping Operations

Ship Type	Number of Calls per Year	
	No Action Alternative	Post Construction
Containership – 4,000 TEUs (Foreign)	52	0
Containership – 5,100 TEUs (Foreign)	52	52
Containership – 6,700 TEUs (Foreign)	0	52
Containership – 8,000 TEUs (Foreign)	0	52
Total Containerships	**104**	**156**
Bulk Carrier - 25,000 DWT (Foreign)	12	0
Bulk Carrier - 40,000 DWT (Foreign)	25	7
Bulk Carrier - 55,000 DWT (Foreign)	0	18
Total Bulk Carriers	**37**	**25**
Petroleum Ship - <20,000 DWT	356	337
Petroleum Ship - 20,000 DWT	0	0
Petroleum Ship - 25,000 DWT	6	0
Petroleum Ship - 35,000 DWT	81	38
Petroleum Ship - >35,000 DWT	77	114
Total Petroleum Ships	**520**	**489**
Total Ships	**713**	**670**

Notes: TEU indicates twenty-foot equivalent unit, a standard measure of container cargo. DWT indicates dead weight tons, a measure of vessel size by displacement.
Source: David Miller Associates, 2012, Boston Harbor Channel Deepening Project, Containerized Cargo Economic Benefits Analysis.

[23] David Miller Associates, 2012, Boston Harbor Channel Deepening Project, Containerized Cargo Economic Benefits Analysis.
[24] David Miller Associates, 2012, Boston Harbor Channel Deepening Project, Containerized Cargo Economic Benefits Analysis.

Table 4-20. Estimated Annual Container Transport Volumes at Conley Terminal under Various Shipping Scenarios

Alternatives	Daily Container Shipping Volume (TEUs)	
	Total	**Increment Over No Action**
Without Project Condition	62,598	-
Base Case	275,261	212,663
	47-foot Deep Project	**Increment Over Base Case**
Base Plus Asia-Suez Service	423,793	361,195
Med Service to 8400 TEU ship	283,048	220,450
Base Plus Second Med Service	314,149	251,551
No Post-Panamax Med Service	267,817	205,219

Source: David Miller Associates, 2012, Boston Harbor Channel Deepening Project, Containerized Cargo Economic Benefits Analysis.

There are several assumptions for each shipping scenario:

- The No Action Alternative assumes that an undeepened Boston Harbor would lose its direct Asian service call via the Panama Canal once both the Canal and the Port of New York and New Jersey have been deepened to their 55 and 50-foot design depths, respective, by 2015;
- The Base Case is the most likely future alternative. The Base Case assumes continuation of the three existing container services currently calling the Port of Boston, but assumes that those services would use larger vessels of up to 8,000 TEUs;
- The four other alternatives presented above include: the base case plus adding a second Asian service via the Suez Canal using an 8,000 TEU vessel, the Base Case plus adding a second Mediterannean service using an 8,400 TEU vessel, the plans case plus a second Medterannean service using a smaller vessel, and the Base Case plus limiting the size of Mediterannean service vessels to 5,100 TEUs (Panamax).

In the Port of Boston, all container cargo is handled at Conley Terminal. Massport has constructed or is planning a number of improvements at Conley Terminal, separate from and unrelated to the Deep Draft Project. These improvements will enhance ground transport to and from the terminal area and storage capacity.

The transportation infrastructure enhancements will include several components:

- A dedicated freight corridor to remove Conley Terminal container truck traffic from East First Street and part of Summer Street;
- A new roadway traversing the Coastal Oil Terminal property, the former Massachusetts Bay Transportation Authority/Department of Conservation and Recreation (MBTA/DCR) property, and the Exelon corporation property; and
- A bridge across the embayment on the Exelon property to join Summer Street.

Added container storage will be established with expansion onto the former Coastal Oil property and will include possible reefer storage, full and empty box storage in stacks served by rubber-tire gantries, and container processing facilities. These improvements potentially would expand ground container storage from about 3,900 TEUs to 6,500 TEUs at Conley Terminal. With these improvements, the terminal capacity will approach 550,000 TEUs annually, an amount that exceeds the total container shipping volumes associated with all project shipping scenarios. Thus, ample landside throughput capacity will exist at the Conley Terminal to process anticipated growth in container cargo volumes.

4.12.3 Ground Transportation

The growth in container volumes at Boston would, in turn, increase trucking operations in the vicinity of the port. As most New England cargo currently 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. Table 4-21 summarizes estimates of daily truck trips that correlate with projected container shipping volume through Boston Harbor, identified in the Draft Containerized Cargo Economics Benefits Analysis[25] for several shipping scenarios.

Table 4-21. Estimated Daily Container Shipping Volume and Truck Trips for Conley Terminal

Alternatives	Container Shipping Volume (TEUs)		Estimated Truck Trips	
	Total	Increment Over Base Case	Total	Increment Over Base Case
2007 Actual Condition	220,139	-	1,024	
Without Project Condition	62,598	-	291	
Base Case	275,261	212,663	1,280	989
	47-foot Deep Project			
Base Plus Asia-Suez Service	423,793	361,195	1,971	1,680
Med Service to 8400 TEU ship	283,048	220,450	1,317	1,025
Base Plus Second Med Service	314,149	251,551	1,461	1,170
No Post-Panamax Med Service	267,817	205,219	1,246	955

Source: David Miller Associates, 2012, Boston Harbor Channel Deepening Project, Containerized Cargo Economic Benefits Analysis.

Most New England cargo landed at Conley Terminal would be trucked to the nearby Interstate 90 ramps, about one mile west of the terminal, mostly through the industrial seaport area. As indicated earlier, planned improvements at the terminal will enhance ground transport to and from the terminal area by providing a dedicated freight corridor to remove Conley Terminal container truck traffic from East First Street and Summer Street; constructing a new roadway that traverses the Coastal Oil Terminal, former MBTA/DCR, and Exelon Corporation properties; and constructing a bridge across the embayment on the Exelon property to join Summer Street.

Massport is preparing a new strategic plan for the seaport that includes forecasts for the port from 2012 to 2025. The projections will be used, among other purposes, to assess and compare several conceptual transportation scenarios (i.e., truck routes) for moving containers from Conley to the nearby haul road and/or interstate roadways. Although the strategic plan forecast methodology differs somewhat from that employed for this FSEIS/EIR, the ratio of annual TEUs to truck trips per day (i.e., 215) is transferable and has been used to calculate the number of truck trips per day for the Deep Draft Project.

As of this writing, work on the strategic plan is too preliminary to assess the level of service and impact of additional trucks from Conley terminal on intersections along the truck route scenarios. However, it is anticipated that this work will advance in time to inform final design.

[25] David Miller Associates, August 2012, Boston Harbor Channel Deepening Project, Containerized Cargo Economic Benefits Analysis.

4.12.4 Air Quality

Section 4.8 incorporates post-construction estimates of ship traffic emissions that considers the traffic volume, the type, size and age of the ships (the latter especially relevant because newer ships operate more efficiently). The results of air quality modeling presented in Section 4.8.3 indicates that the Deep Draft Project would decrease pollutant emissions in the New England region due to changes in fleet mix (i.e., fewer but larger ships), reduced anchoring activities, reduced transit time for ships moving in and out of the harbor, and reduced truck traffic transporting goods from the PONYNJ to New England. The regional decrease would be only slightly offset by a small increase in vehicle emissions from cargo trucking transporting goods from Boston Harbor.

The No Action Alternative and Deep Draft Project (Post-Construction) container, cargo and petroleum vessel scheduling, ship traffic volume, fleet mix and associated trucking operations were obtained from the Draft Containerized Cargo Economics Benefits Analysis[26]. The shipping and trucking operations data were used to estimate indirect emissions for both scenarios. It was assumed that routine shipping operations would be the same under Alternatives 1 and 2 during dredging activities.

Annual emissions (tons/year) were calculated based on changes in sizes of ships (i.e., smaller to larger vessels), changes in ship mode operations (i.e., anchoring, cruising and hoteling) and the number of ship calls per year. The net reductions in trucking emissions for the project were also calculated using MOBILE6.2 emissions model. The emissions were summed for each vessel type to calculate the annual emissions. Detailed air quality modeling information related to shipping and trucking is provided in Section 4.8.

Based on the modeling results, the Deep Draft Project would reduce annual NOx, CO, and VOC emissions by 71, 28, and 17 tons, respectively. The reductions in pollutant emissions are primarily due to changes in fleet mix for all shipping operations (i.e., fewer, but larger ships), no anchoring activities for petroleum ships, reduced time for ships to move in and out of the harbor, and reduced truck traffic transporting goods from the PONYNJ to New England. However, the cargo trucking miles in Massachusetts would increase by 766,276 miles under the project (Post-Construction) shipping operations due to increased truck volumes departing from Conley Terminal. The estimated NOx, CO, and VOC emissions from cargo trucking would increase by 1.91, 0.51, and 0.24 tons, respectively, in the project area. However, these small increases in pollutant emissions would be more than offset by the emissions reductions estimated for the changes in shipping activities associated with the project.

The net secondary emissions are presented in Table 4-22, comparing the No Action Alternative and Project scenarios. Overall, the project would provide a net benefit to long-term regional air quality, as well as significant savings in cost, time, and fuel from shipping New England cargo through Boston rather than the PONYNJ.

[26] David Miller Associates, August 2012, Boston Harbor Channel Deepening Project, Containerized Cargo Economic Benefits Analysis.

Table 4-22. Shipping and Trucking Operations - Summary of Indirect Emissions

Pollutant	No Action Alternative (tons)	Project, Post-Construction (tons)	Net Change (tons)	Net Change (%)
$PM_{10}/PM_{2.5}$	96	91	-5	-5.2
SO_2	248	247	-0.6	-0.2
NO_x	634	563	-71	-11.2
CO	377	349	-28	-7.3
VOC	231	214	-17	-7.5

Notes:
1. Indirect emissions without the project are associated with projected shipping operations in 2016 and beyond. It is assumed that the shipping operations would be constant during the dredging years.
2. Indirect emissions with the project are associated with projected shipping operations one year after the dredging operations are completed. It is anticipated that there would be no overlap of indirect and direct emissions at the end of the project.
3. With-Project emissions include emissions reductions associated with the projected reduction of truck traffic from the Port of New York/New Jersey.
Source: David Miller Associates, Draft Boston Harbor Channel Deepening Project, Containerized Cargo Economic Benefits Analysis, 2012.

4.13 Mitigation

Mitigation will be included in the design of the Deep Draft Project. Best management practices will be utilized to reduce or eliminate impacts from dredging, blasting, and disposal of dredged material on air quality, natural resources, as well as social impacts. In particular, mitigation will be provided for any exceedances of air quality thresholds, for identifiable silty shoal material, for blasting impacts, for reduction of potential barge collisions with whales (in particular right whales), and for notification to lobstermen in Boston Harbor of dredge movements. Additional details are provided in the paragraphs below. The mitigation plan does not include mitigation for temporary impacts such as the temporary loss of benthic habitat, or temporary displacement of lobsters. No impacts to vegetated wetlands or the littoral zone are expected. Additional mitigation may be required based on the results of the investigations conducted in the Design Phase of the project. Supplemental information on these investigations may be found in Section 6.4 below and in Appendix A - Response to General Topics.

It was originally anticipated that two to three large mechanical dredges (bucket or clamshell) would be employed on the job, around 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 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 section above. In addition the construction equipment would use the latest efficient engines to further reduce air emissions. The purchase of emission credits will also be investigated as mitigation for air impact in the event that is required. A determination will be made as to the viability of emission credits for this project during the Design Phase.

Since 2008, Boston Harbor's Federal navigation channels have completed a major maintenance cycle. The areas maintained include all the areas now under consideration in this improvement project for deepening, except for the 35-foot deep section of Mystic River navigation channel proposed to be deepened. However, 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 for the silty shoal material to reduce turbidity impacts and no scow overflow will be allowed. This will minimize potential impacts to finfish or shellfish and their habitat.

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 lending 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 by ripping in most areas of the 1998-2001 work without difficulty.

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 unless required due to human safety considerations. 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. Methods employed during prior projects to reduce the potential for fish kills involved the use of a side scan sonar to detect and avoid blasting during times when passing fish were present in the immediate project area, a fish startle system to deter fish of the Clupeid family (i.e. blueback herring and alewife) from entering the blast area, and a fish observer to oversee and determine the appropriate blasting times.

Following the first event, the USACE immediately met with the blast contractors and designated fish observer to determine the likely causes of the event and to identify potential corrective measures for future blasting activities. Resource agencies were also notified of the event and briefed on initial corrective actions before blasting was resumed. Despite these measures, subsequent fish kills occurred. In response to these unexpected events, the USACE prepared an "After Action Report" (Appendix Y) to provide information on all of the blasting events and to document any lessons learned. Lessons learned from this project were applied to the Boston Harbor Rock Removal Project which resulted in no observed fish kills during the course of the project. The results from this project and the "After Action Report" will provide the basis for convening an interagency underwater blasting technical working group with Federal and State resources agencies. The goal of the working group is to determine potential mitigation measures that may be practicable to minimize potential fish impacts during blasting for the Deep Draft Project. The blasting working group will focus on practicable ways to minimize impacts during construction of the proposed Deep Draft Project. These measures may include construction sequencing for several areas of the harbor, constraints on work during certain tidal and weather conditions, and time of year restrictions if practicable. The goals of the working group discussions will be to identify practicable and implementable measures to be enacted during project operations to minimize the potential for impact.

A hydrophone was placed in the water during three blast events for the Boston Harbor Rock Removal Project constructed in 2012. The purpose of the hydrophone was to collect sound pressure (waves) from actual blasting events in order to determine a safety zone for protected species such as whales, sea turtles, and the Atlantic sturgeon. More details on this monitoring effort can be found in Section 4.2.5.

A Public Notice will be issued at the initiation of the Deep Draft Project to provide mariners and lobstermen notice of the project so that equipment may be moved out of the navigation channels being dredged. In addition the barge and scow will be required to use a short-tow line to minimize dragging which can damage lobster pots that are in the project area.

Between February 1 and May 31, whale observers will be on board scows transiting to the MBDS/IWS to avoid potential ship strikes with the endangered northern right whales, or other marine mammals and sea turtles. Dredge contractors would also be required to monitor the right whale listening buoys for right whale status in the shipping lanes.

During the forthcoming Design Phase of the project, additional investigations may be conducted based on comments received during the Draft Feasibility and Draft SEIS/EIR. See Section 6.4 below for more information on the proposed investigations. If as a result of the above investigations it is determined that additional mitigation is required beyond what has already been identified in the SEIS/EIR, then additional Federal and/or Sponsor funding would be sought to cover those costs as part of the project. It is anticipated that those issues would be addressed in additional NEPA and/or MEPA filings if needed.

5. AGENCY COORDINATION AND COMPLIANCE

5.1 Cooperating Agency Request

The National Environmental Policy Act (NEPA) and the Massachusetts Environmental Policy Act (MEPA) both encourage early agency cooperation. A Federal agency which has jurisdiction by law shall be a cooperating agency upon request of the lead agency (the USACE in this instance). In addition, any other Federal agency which has special expertise on environmental issues, which should be addressed in the SEIS/EIR, may also be a cooperating agency upon request of the lead agency. Where appropriate, the lead agency should also seek the cooperation of the State or local agencies of similar qualifications. Cooperating agencies shall participate in the NEPA process at the earliest possible time, participate in scoping meetings, help prepare information or environmental analyses which the cooperating agency has expertise, and provide staff support as requested by the lead agency (USACE) to enhance interdisciplinary capability. Cooperating Federal agencies that have jurisdiction by law or special expertise include the U.S. Environmental Protection Agency, the U.S. Fish and Wildlife Service, NOAA-Fisheries, and the U.S. Coast Guard. The Massachusetts Executive Office of Energy and Environmental Affairs, and the environmental agencies it oversees, and the Wampanoag Tribe of Gay Head (Aquinnah) also have jurisdiction by law or special expertise that is relevant to the proposed project. A letter requesting cooperating agency participation was sent by the USACE to the four Federal agencies, the lead State Environmental agency, and Indian tribe on April 11 and 18, 2003.

All four Federal agencies agreed to participate as cooperating agencies on this Supplemental EIS/EIR. The Massachusetts Office of Coastal Zone Management agreed to represent the State environmental agencies in the development of the SEIS/EIR. See Appendix A for a copy of the correspondence. No response was received from the Wampanoag Tribe of Gay Head (Aquinnah).

5.2 Threatened and Endangered Species Consultation

The U.S. Fish and Wildlife Service responded that no Federally-listed or proposed, threatened or endangered species or critical habitat under their jurisdiction are known to occur in the project areas(s) and no further consultation was necessary (letter dated March 2, 2005). No response was received from the U.S. Fish and Wildlife to our letter dated October 11, 2012 requesting any updates since 2008. The Massachusetts Division of Fisheries & Wildlife, Natural Heritage and Endangered Species Program (NHESP) stated that they did not have any concerns about State protected rare species in the project area (letter dated May 31, 2005). NOAA Fisheries initially determined that no further consultation pursuant to Section 7 of the Federal Endangered Species Act (ESA) was required if restrictions outlined in a letter dated August 29, 1997 under separate Section 7 consultation between the USACE and National Marine Fisheries Service (NMFS) on the use of the Massachusetts Bay Disposal Site (MBDS) was adhered to for disposal operations (letter dated September 6, 2005). However, based on an understanding that the amount of dredged material would increase and that blasting would occur during project construction, NMFS requested reinitiation of Section 7 consultation. The USACE provided a letter with analysis of the impact area from blasting and additional dredged material. The USACE concluded in a letter dated June 30, 2008 that the Boston Harbor Deep Draft Project is unlikely to adversely affect listed species. Since that time the Gulf of Maine DPS of Atlantic sturgeon (as well as four other Atlantic sturgeon DPSs) have been listed under the Federal Endangered Species Act as either threatened or endangered. Therefore consultation was reinitiated under Section 7 of the Endangered Species Act for the effects of the proposed project (specifically rock removal by blasting) on Federally listed whales, sea turtles and Atlantic sturgeon. A letter with was submitted to NMFS on November 7, 2012 that included an analysis of the effects of blasting on listed species based on updated blasting data and species information, requesting concurrence that the Boston Harbor Deep Draft Project is unlikely to adversely affect Federally listed whales, sea turtles and Atlantic sturgeon. A response was received on November 27, 2012 from

NOAA Fisheries, concurring with the USACE determination that the Boston Harbor Deep Draft Project is not likely to adversely affect listed species (See Appendix A).

5.3 Essential Fish Habitat Consultation

The 1996 amendments to the Magnuson-Stevens Fishery Conservation Management Act strengthen the ability of the National Marine Fisheries Service and the New England Fishery Management Council to protect and conserve the habitat of marine, estuarine, and anadromous finfish, mollusks, and crustaceans. This habitat is termed "essential fish habitat (EFH)" and is broadly defined to include "those waters and substrate necessary to fish for spawning, breeding, feeding, or growth to maturity." Managed species listed for the 10' x 10' square of latitude and longitude for Boston Harbor are: Atlantic cod, haddock, pollock, whiting, red hake, white hake, winter flounder, yellowtail flounder, windowpane flounder, American plaice, ocean pout, Atlantic halibut, Atlantic sea scallop, Atlantic sea herring, long finned squid, short finned squid, Atlantic butterfish, Atlantic mackerel, summer flounder, scup, black sea bass, surf clam, and bluefin tuna. See Section 3.3.5. Except for redfish, monkfish, and spiny dogfish, the same species are listed for the habitat enhancement sites as the Boston Harbor species. The same species are listed for the 10' x 10' square of latitude and longitude which includes the MBDS, except for pollock, summer flounder, scup, black sea bass, and surf clam. See Section 3.3.5. Species listed in the MBDS square that are not listed for Boston Harbor include redfish, witch flounder, and monkfish.

Appendix T lists the managed species and their appropriate life stage history for the designated 10' x 10' EFH squares that include Boston Harbor, the habitat enhancement sites, and the Massachusetts Bay Disposal Site, including the Industrial Waste Site.

The only managed EFH species that may be expected to occur in the dredge area (Boston Harbor) are the: pollock (juveniles), red hake (eggs and larvae), white hake (all life stages), winter flounder (all life stages), windowpane flounder (all life stages), long finned squid (pre-recruits and recruits), short finned squid (pre-recruits and recruits) Atlantic mackerel (eggs, juveniles, and adults), summer flounder (adults), scup (juveniles and adults). The remaining species or life stages are not expected to occur in Boston Harbor due to either incorrect water depths or substrate type.

The only managed EFH species that may be expected at the MBDS, and IWS, are the: pollock (eggs and larvae), whiting (all life stages), red hake (larvae, adults, and spawning adults), white hake (all life stages), redfish (all life stages), witch flounder (all life stages), American plaice (larvae, juveniles and adults), ocean pout (adults), Atlantic halibut (eggs and spawning adults), Atlantic sea scallop (eggs), Atlantic sea herring (juveniles and adults), monkfish (eggs, larvae, juveniles, and adults), long finned squid (both life stages), short finned squid (both life stages), Atlantic mackerel (all life stages), summer flounder (adults), scup (juveniles and adults), and bluefin tuna (juveniles and subadults). The remaining species or life stages are not expected to occur at the MBDS because of improper depths or substrate type, or are not an abundant species.

Due to the various depths, substrate types and locations, managed EFH species and the various life stages may be expected to occur at the habitat enhancement sites. With the addition of rock to the potential habitat enhancement sites, it is expected that several EFH species would benefit from the cover and protection provided by the structure. Several EFH species (and their life stages) that could benefit from the addition of rock habitat, including cobble and gravel are: Atlantic cod (juveniles and adults), pollock (juveniles and adults), whiting (juveniles and adults), redfish (juveniles and adults), winter flounder (eggs and adults), ocean pout (eggs, larvae, juveniles, and adults), Atlantic halibut (juvenile), Atlantic sea herring (adults), black sea bass (juveniles and adults).

Although dredging and disposal are expected to occur intermittently for approximately three to five years due to the large amount of material to be dredged, based on lessons learned from the BHNIP and the limited areas of activity, overall impacts to EFH and associated managed species are expected to

be temporary and insignificant. As mentioned above, turbidity studies conducted in Boston Harbor showed that the silt from the inner portions of Boston Harbor did not travel far from the point of dredging.

The most vulnerable life stages, such as the eggs and larvae, would be the most affected by direct and indirect dredging and disposal activities. Direct impacts include removal by dredging or burial by disposal, and indirect impacts from entrainment in the dredge and disposal plume. While some mortality of eggs and larvae may be expected, the SSFATE plume model does not show a measurable amount of deposit on potential winter flounder spawning habitat in Winthrop Harbor and Logan flats. Juveniles and adults are expected to be able to escape direct impact from dredging and disposal activities and indirect impacts such as turbidity and loss of food. Benthic animals are expected to begin recolonization the area rapidly, depending on the time of year the construction activities occur.

NMFS provided specific EFH conservation recommendations in a letter dated November 26, 2012. The USACE responded to their EFH conservation recommendations in a letter dated December 5, 2012. Some of the information requested by NMFS such as blasting mitigation measures, a sequencing plan for dredging activities, and, alternative beneficial reuse options (i.e. for the rock) will be developed in the Design Phase.

5.4 Coastal Zone Management Consistency Determination

The Coastal Zone Management (CZM) Act of 1972 established a national program to "preserve, protect, develop, and where possible, to restore or enhance, the resources of the Nation's coastal zone for this and succeeding generations" and to "encourage and assist the states to exercise effectively their responsibilities in the coastal zone through the development and implementation of management programs to achieve wise use of the land and water resources of the coastal zone..." (16 U.S.C. 1452, Sec. 303 (1) and (2)). Section 307 (c)(3)(A) of the CZMA provides that "...any applicant for a required Federal license or permit to conduct an activity, in or outside the coastal zone, affecting any land or water use or natural resource of the coastal zone of that state shall provide...a certification that the proposed activity complies with the enforceable policies of the state's approved program and that such activity will be conducted in a manner consistent with the program." Similar requirements are included for activities conducted by or funded by a Federal agency.

A Federal Consistency Determination was sent to the Massachusetts Office of Coastal Zone Management for concurrence that the proposed Deep Draft Project is consistent to the maximum extent practicable with the CZM policies of the Commonwealth of Massachusetts. CZM consistency concurrence was received from the Commonwealth of Massachusetts in a letter dated November 29, 2012. The policies that are applicable to the proposed dredging project and the project's consistency with those policies are as follows:

Water Quality Policy #1. – Ensure that point-source discharges in or affecting the coastal zone are consistent with federally approved state effluent limitations and water quality standards. *The material proposed for dredging is parent material, not associated with contaminants. Any future associated maintenance dredging will be tested for contaminants. Also the dredged material is composed of Boston blue clay and glacial till material, not likely to produce a large sediment plume. The disposal of rock in one of the identified habitat enhancement sites would not create any water quality violations. Only minimal amounts of sediment would adhere to the rock which would be washed away as the rock falls through the water column. Any turbidity created should dissipate rapidly. The material would not be a carrier of contaminants as the rock is surrounded by material suitable for ocean disposal.*

Habitat Policy #1. - Protect coastal resource areas including salt marshes, shellfish beds, dunes, beaches, barrier beaches, salt ponds, eelgrass beds, and fresh water wetlands for their important role as natural habitats. *These resources are outside the zone of influence from the project or the resource*

occurs in limited amounts. Rock removed from the navigation channel is under consideration to be disposed at a beneficial use site to create hard bottom habitat.

Coastal Hazards Policy #1. – Preserve, protect, restore and enhance the beneficial functions of storm damage prevention and flood control provided by natural coastal landforms, such as dunes, beaches, barrier beaches, coastal banks, land subject to coastal storm flowage, salt marshes and land under the ocean. *Deepening a portion of the Boston Harbor navigation channels would result in a very minor increase in land under the ocean. No significant change in the beneficial function of the land under the ocean is expected from the proposed project.*

Coastal Hazards Policy #2. - Ensure construction in water bodies and contiguous land areas will minimize interference with water circulation and sediment transport. *The proposed dredging activities will not interfere with water circulation in Boston Harbor. No permanent structures are proposed in the body of water. Proposed dredging may result in slight increases in water circulation.*

Coastal Hazards Policy #3. - Ensure that state and Federally funded public works projects proposed for location in the coastal zone will not exacerbate existing hazards or damage natural buffers or other natural resources and will not promote growth and development in hazard-prone or buffer areas. *The proposed dredging will improve navigation in Boston Harbor by deepening the navigation channels and berths to accommodate deeper draft ships expected to be added to the fleet to utilize the deeper and wider Panama Canal. The project area is in area of marine commerce and is located in or adjacent to the State's Designated Port Area. Therefore the project is consistent with the State's policy of promoting marine development in Designated Port Areas. The proposed Deep Draft Project will remove ledge that could create a navigation hazard if not removed during deepening of the navigation channels. The proposed project is not expected to have long-term significant adverse damage to natural resources or promote growth and development in hazard-prone or buffer areas.*

Ports Policy #1. - Ensure that dredging and disposal of dredged material minimize adverse effects on water quality, physical processes, marine productivity, and public health. *The material proposed for dredging is parent material, not associated with contaminants. Also the dredged material is composed of Boston blue clay and glacial till material, not likely to produce a large sediment plume. In addition, if feasible, rock removed during construction would be used to enhance biological productivity by increasing hard bottom habitat for marine species that favor rock habitat. Any adverse impacts will be localized and temporary. Therefore, the proposed project is not likely to have a significant long-term impact on water quality, physical processes, or public health, and could benefit marine productivity.*

Ports Policy #2. - Obtain the widest possible public benefit from channel dredging, ensuring that designated ports and developed harbors are given highest priority in the allocation of federal and state dredging funds. Ensure that this dredging is consistent with marine environmental policies. *The proposed improvement dredging is located in the Port of Boston, the largest port in New England. The proposed project would continue to promote commercial navigation in Boston Harbor by allowing larger ships to transit the port more efficiently to load and unload goods.*

Ports Policy #3. - Preserve and enhance the capacity of Designated Port Areas (DPAs) to accommodate water-dependent industrial uses, and prevent the exclusion of such uses from tidelands and any other DPA lands over which a state agency exerts control by virtue of ownership, regulatory authority, or other legal jurisdiction. *Portions of the Port of Boston are in a DPA. Deeping Boston Harbor will enhance the safety of deep draft vessels transiting to these marine terminals in the DPA. This will accommodate and further promote water-dependent industrial uses.*

5.5 Environmental Compliance

This section describes the Federal laws, regulations and programs that are relevant to the dredging and disposal of improvement material from the Boston Harbor Federal navigation channels and berth areas.

Federal Statutes

1. Preservation of Historic and Archeological Data Act of 1974, as amended, 16 U.S.C. 469 et seq.

Compliance: Not applicable; project is not expected to require mitigation of historic or archaeological resources.

2. Clean Air Act, as amended, 42 U.S.C. 7401 et seq.

Compliance: The "general conformity" requirements of Section 17(c)(1) of the Clean Air Act, 42 U.S.C. 7506(x)(1), will be adhered to by limiting construction and using "clean" equipment to avoid exceeding air quality standards or by purchasing emission credits.

3. Clean Water Act of 1977 (Federal Water Pollution Control Act Amendments of 1972) 33 U.S.C. 1251 et seq.

Compliance: 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 will be filed with the Commonwealth of Massachusetts for a WQC pursuant to Section 401 of the Clean Water Act for the disposal of dredged material into CAD cells within Boston Harbor and/or disposal of rock for habitat enhancement.

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 has been prepared for the possible disposal of rock within potential habitat enhancement sites, and potential disposal of silty maintenance material into a CAD cell(s).

4. Coastal Zone Management Act of 1972, as amended, 16 U.S.C. 1451 et seq.

Compliance: The U.S. Army Corps of Engineers completed a Federal consistency determination pursuant to Section 307 of the Coastal Zone Management Act that determined the proposed project is consistent to the maximum extent possible with the MA Office of Coastal Zone Management program. A summary of that determination is provided in Section 5.4, above. Concurrence of the CZM consistency determination was received in a letter dated November 29, 2012.

5. Endangered Species Act of 1973, as amended, 16 U.S.C. 1531 et seq.

Compliance: Coordination with the U.S. Fish and Wildlife Service (FWS) and/or NOAA Fisheries has yielded no formal consultation requirements pursuant to Section 7 of the Endangered Species Act (see letters dated March 2, 2005 and September 6, 2005). Informal consultation under Section 7 of the Endangered Species Act for listed whales, sea turtles and Atlantic sturgeon was initiated with NOAA Fisheries on November 7, 2012. NOAA Fisheries concurred that the proposed action is not likely to adversely affect listed species (See letters dated November 7, 2012 and November 27, 2012). Section 7 consultation has been completed.

6. Estuarine Areas Act, 16 U.S.C. 1221 et seq.

Compliance: The Chief of Engineers Report will beg submitted to Congress.

7. Federal Water Project Recreation Act, as amended, 16 U.S.C. 4601-12 et seq.

Compliance: Public notice of availability of this report to the National Park Service (NPS) and Office of Statewide Planning relative to the Federal and State comprehensive outdoor recreation plans signifies compliance with this Act.

8. Fish and Wildlife Coordination Act, as amended, 16 U.S.C. 661 et seq.

Compliance: Coordination with the U.S. FWS, NOAA Fisheries, and Massachusetts Department of Marine Fisheries signifies compliance with the Fish and Wildlife Coordination Act. See Section 7.0 above and Appendix A.

9. Land and Water Conservation Fund Act of 1965, as amended, 16 U.S.C. 4601-4 et seq.

Compliance: Public notice of the availability of this report to the National Park Service (NPS) and the Office of Statewide Planning relative to the Federal and State comprehensive outdoor recreation plans signifies compliance witb this Act.

10. Marine Protection, Research, and Sanctuaries Act of 1971, as amended, 33 U.S.C. 1401 et seq.

Compliance: Applicable; project involves the transportation or disposal of dredged material in ocean waters pursuant to Sections 102 and 103 of the Act, respectively. No disposal of materials at the MBDS and/or IWS will occur unless it meets the requirements of MPRSA.

11. National Historic Preservation Act of 1966, as amended, 16 U.S.C. 470 et seq.

Compliance: Coordination with the State Historic Preservation Office is ongoing.

12. National Environmental Policy Act of 1969, as amended, 42 U.S.C 4321 et seq.

Compliance: Preparation of this Supplemental Environmental Impact Statement signifies partial compliance with NEPA. Full compliance shall be noted at the time the Record of Decision is issued.

13. Rivers and Harbors Act of 1899, as amended, 33 U.S.C. 401 et seq.

Compliance: This report will be sent to Congress for approval.

14. Watershed Protection and Flood Prevention Act as amended, 16 U.S.C 1001 et seq.

Compliance: Not applicable, project area is not a watershed protection or flood prevention act area.

15. Wild and Scenic Rivers Act, as amended, 16 U.S.C 1271 et seq.

Compliance: Not applicable, project area is not a Wild or Scenic River.

16. Magnuson-Stevens Act, as amended, 16 U.S.C. 1801 et seq.

Compliance: Coordination with the NOAA Fisheries and preparation of an Essential Fish Habitat (EFH) Assessment signifies partial compliance with the EFH provisions of the Magnuson-Stevens Act. A response to EFH conservation recommendations in a letter dated December 10, 2012 completes EFH compliance. See Section 5.3 above and Appendix A.

Executive Orders

1. Executive Order 11593, Protection and Enhancement of the Cultural Environment, 13 May 1971.

Compliance: Coordination with the State Historic Preservation Officer signifies compliance.

2. Executive Order 11988, Floodplain Management, 24 May 1977 amended by Executive Order 12148, 20 July 1979.

Compliance: Not applicable; project is not located within a floodplain.

3. Executive Order 11990, Protection of Wetlands, 24 May 1977.

Compliance: Not applicable; project does not involve nor impact Federal wetlands.

4. Executive Order 12114, Environmental Effects Abroad of Major Federal Actions, 4 January 1979.

Compliance: Not applicable; project is located within the United States.

5. Executive Order 12898, Environmental Justice, 11 February 1994.

Compliance: Not applicable; project is not expected to have a significant impact on minority or low income population, or any other population in the United States.

6. Executive Order 13045, Protection of Children from Environmental Health Risks and Safety Risks, 21 April 1997.

Compliance: Not applicable; the project would not create a disproportionate environmental health or safety risk for children.

7. Executive Order 13175, Consultation and Coordination with Indian Tribal Governments, 6 November 2000.

Compliance: Consultation with Indian Tribal Governments, where applicable, and consistent with executive memoranda, DoD Indian policy, and USACE Tribal Policy Principals signifies compliance.

Executive Memorandum

1. Analysis of Impacts on Prime or Unique Agricultural Lands in Implementing NEPA, 11 August 1980.

Compliance: Not applicable; project does not involve or impact agricultural lands.

2. White House Memorandum, Government-to-Government Relations with Indian Tribes, 29 April 1994.

Compliance: Consultation with Federally Recognized Indian Tribes, where appropriate, signifies compliance.

6. PUBLIC INVOLVEMENT

6.1 Federal Register

A Notice of Intent (NOI) to prepare a Supplemental Environmental Impact Statement (SEIS) was published in the Federal Register on August 23, 2002. The NOI notifies the public that an EIS will be prepared and allows the public to ask questions about the proposed action. Interested individuals can also be placed on mailing lists for potential meetings and future publications of the SEIS/EIR.

The public was invited to a meeting hosted by Massport on September 5, 2002 at the Black Falcon Cruise Ship Terminal in South Boston, MA. The purpose of the meeting was 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.

Consistent with the goals of NEPA and MEPA to reduce duplication between NEPA and comparable State requirements, the Draft and Final SEIS and State Environmental Impact Reports (EIR) are prepared as a joint Federal/State document. The SEIS and EIR will share comment periods and associated public review opportunities to the maximum extent practicable. A minimum 45-day public comment is provided once a Notice of Availability of the Draft SEIS/EIR is published in the Federal Register. A public meeting was held May 20, 2008 during the public comment period for the Draft SEIS/EIR to describe the project, answer questions, and receive comments. This Final SEIS/EIR has been prepared in response to comments received on the Draft SEIS/EIR. The USACE will prepare a Record of Decision for publication in the Federal Register not sooner than 30 days after the public release of the Final SEIS/EIR.

6.2 MEPA Certificate

The Massachusetts Secretary of Environmental Affairs determined that an Environmental Impact Report (EIR) would be required for this project pursuant to the Massachusetts Environmental Policy Act (MEPA) in the Secretary's Certificate dated March 10, 2003 (EOEA number 12958). MEPA requires that State agencies (i.e., Massport, as the local sponsor) study the environmental consequences of their actions, including permitting and financial assistance. It also requires them to take all feasible measures to avoid, minimize, and mitigate damage to the environment. MEPA further requires that State agencies "use all practicable means and measures to minimize damage to the environment, " by studying alternatives to the proposed project, and developing enforceable mitigation commitments, which will be become permit conditions for the project, if and when it is permitted.

To avoid duplication with the requirement to prepare a SEIS, this document combines the requirements of NEPA and MEPA. Issues not covered by NEPA are the responsibility of the local sponsor, Massport.

The scope in the Secretary's Certificate identified the issues to be addressed in the EIR. Scope items include describing this proposed project with the previous improvement and maintenance dredging projects in Boston Harbor and the responsible parties; environmental impacts to biological, archaeological resources, threatened and endangered species, noise and odor; cumulative and secondary impacts, coordination with other harbor utility and infrastructure owners, and mitigation. These scope comments have been addressed in the appropriate sections of this SEIS/EIR. Appendix P contains a copy of the Secretary's ENF Certificate, comment letters on the ENF and a copy of the June 13, 2008 Secretary's Certificate on the Draft SEIS/EIR, and responses to all EIR comments. On December 12 2012, the Secretary of the Executive Office of Energy and Environmental Affairs confirmed that the 2008 scope for the Final EIR remained appropriate for the revised project program (see Appendix A).

6.3 Technical Working Group

As with the Boston Harbor Navigation Improvement Project (BHNIP), a Technical Working Group (TWG) was established to assist in the planning and review of the SEIS/EIR for this deep draft navigation improvement dredging project, the SEIS/NPC for the Boston Harbor Inner Harbor Maintenance Dredging Project (IHMDP), and the recently-completed Outer Harbor Maintenance Dredging Project (OHMDP). The initial focus of the TWG was on this Deep Draft 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 Project.

The TWG is comprised of representatives from Federal, State, and local resource agencies, environmental advocates, scientists, and Port-of-Boston stakeholders. See Table 6-1 for a list of TWG members.

Table 6-1. List of Boston Harbor Deep Draft Technical Working Group Members

Technical Working Group Members	
Federal Agencies	MEPA Office
U.S. Army Corps of Engineers	**Local Agency**
U.S. Environmental Protection Agency	Boston Envir Dept & Conservation Comm
National Marine Fisheries Service	Chelsea Conservation Commission
U.S. Fish and Wildlife Service	Revere Conservation Commission
U.S. Coast Guard	**Academia**
State Agencies	Univ. of Massachusetts - Boston
Coastal Zone Management	MIT Sea Grant Program
Department of Environmental Protection	**Environmental and Private Groups**
Division of Marine Fisheries	The Boston Harbor Association
MA Water Resources Authority	Save the Harbor/Save the Bay
Massachusetts Port Authority(Massport)	Boston Harbor Pilots Association

Ten TWG meetings were held during the preparation of the Draft SEIS/EIR. Two additional TWG meetings were held between the public release of the Draft and Final SEIS/EIR. The first meeting was held June 10, 2003 and the last meeting on December 3, 2012. The agenda items discussed at the first meeting included a description of 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 second meeting was held on January 27, 2004. The benthic results were posted on the USACE webpage. The status of the economic study was discussed as well as the results of the historic and archaeological survey. A subsurface exploration was initiated to determine the amount of bedrock and ledge that will need to be removed based on the preferred depth alternative. Results of a literature search were presented and TWG members invited to add any other known sources of information not included in the report.

During the third TWG meeting held on June 22, 2004, TWG members were informed that maintenance material west of Castle Island in the Federal navigation channel was found to be unsuitable for ocean water disposal. Therefore, this material will not be dredged with the rest of the maintenance material in the outer harbor, but will be dredged and disposed when the IHMDP proceeds. The literature search and data gap analysis were finalized and the results posted on the USACE website. Beneficial reuse of the rock blasted from the proposed project was also discussed and agencies interested in identifying bottom areas that could benefit from creation of new hard bottom habitat were solicited.

The fourth meeting was held on January 5, 2005. The biological resource assessment strategy was developed to address the TWG's concern that the proposed biological sampling plan was too limited. To address this concern, the USACE and Massport proposed to use a conservative approach to assess impacts for biological resources, assuming the resources are there unless a physical, chemical or biological parameter would limit the occurrence of the resource.

The fifth meeting was held November 29, 2005. Concern was raised that preparing a SEIS vs. an EIS was segmenting the project. It was explained that the project area and disposal is similar to the original EIS and that the SEIS builds on the lessons learned from the original EIS. The cumulative impact section of the SEIS/EIR will also discuss all of the past, current and future Boston Harbor projects. A presentation on lessons learned from the original BHNIP was shown. The biological resource studies and the 5-year monitoring report for the CAD cells were posted on the USACE web site.

A sixth meeting was held January 23, 2006 to brief the TWG on the recently released Draft SEIS/Notice of Project Change for the Inner Harbor Maintenance Dredging Project. The seventh and eighth TWG meeting prior to the release of the Final SEIS for the Inner Harbor Maintenance Dredging Project was held on April 10, 2006. Another TWG meeting was held on July 25, 2006 to discuss comments on the Final Supplemental EIS for the Inner Harbor Maintenance Dredging Project (IHMDP) and associated permitting issues. A report on the progress of the feasibility study (deep draft project) was discussed. The USACE continued to focus on project cost reviews, economics and the air quality analysis.

The ninth was held on August 15, 2007. This meeting was held to discuss the development of the potential rock reef in the project vicinity. The tenth meeting, before the release of the Draft SEIS/EIR, was held on December 18, 2007 to discuss the SEIS/EIR recommendations, schedule for the release of the Draft SEIS/EIR and Draft Feasibility Report, and overall project schedule. It is anticipated that future TWG meetings will be held during the FSEIS/EIR, design and construction phases.

The eleventh meeting was held during the comment period for the Draft SEIS/EIR on May 19, 2008. A brief overview of the project and its importance to the Port of Boston was presented and then comments from the TWG were discussed. General comments received on the Draft SEIS/EIR were related to additional design and monitoring information, and benefits of replacing soft bottom habitat for hard bottom habitat for the proposed rock reef, additional information on the capping demonstration for the beneficial reuse of the parent material at the IWS, discussion on the fish kills from the previous fall and reducing blast impacts, discussion of impacts to marine mammals from blasting, and alternatives to meet air quality conformity.

Two meetings were held before the public release of the Final SEIS/EIR. The first meeting was held on July 21, 2008 to discuss the project status to date, our response to comments, and the project schedule. The second meeting was held on December 3, 2012 to discuss maintenance dredging in Boston Harbor and the Deep Draft Project changes since the Draft SEIS/EIR in 2008.

6.4 Design Phase Investigations

Several requests were received during the Draft SEIS/EIR comment period for an explanation of the USACE Civil Works Process and for additional investigations. Before additional investigations can begin the following process needs to occur:

- A Record of Decision (ROD) would need to be issued by the Assistant Secretary of the Army for Civil Work once the draft Chief of Engineers Report, which includes the Final Feasibility Report and Final SEIS/EIR, is reviewed at the Federal cabinet level and the public.
- The State would also need to provide a letter of support for the project before a ROD is released.

- The Chief of Engineers and Final Feasibility Reports would then be forward to Congress for approval.
- Upon submittal of the Chief of Engineers Report, the project would advance into the Design Phase (Planning, Engineering and Design, or PED).
- Construction would require authorization by Congress through a Water Resources Development Act.

The Design Phase will cover the following tasks:

- Complete any necessary field investigations to support detailed design of the project;
- Prepare and publish for public review any needed additional NEPA/MEPA documents to present Design Phase investigations and any project design changes;
- Secure any required regulatory approvals; and
- Prepare the documents necessary to solicit bids for construction of 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 measures, project sequencing plan), further investigation(s) and recommendation(s) on potential beneficial uses of rock and other dredged material, and development of monitoring plans for various aspects of the project.

The Design Phase investigations will yield additional detailed data on several technical issues and topics as listed below. At this time the following principal study areas are expected to include:

- Conduct subsurface investigations, revise dredged material quantities and prepare a blasting mitigation plan.
- Conduct resource characterization efforts and dredge area baseline monitoring to allow for impact and recovery assessment of the benthic, fisheries, and shellfish resources.
- Develop a construction sequencing plan employing the dredged materials estimates, blasting mitigation plan and the resource characterization effort.
- Conduct an air quality emissions conformity evaluation to determine if there are any cost-effective alternatives available to meet the emissions requirements other than construction period shutdowns. The availability and cost of emission credits and offset opportunities will be investigated. Adjustments to the construction sequencing plan would be made according to the selected final plan of meeting air quality requirements.
- Investigate beneficial use opportunities for rock. Once final rock quantities, types and locations are identified, the potential for beneficial use other than rock reef creation will be further investigated with the State and local communities.
- Additional opportunities for the creation of rock reef habitat will be further investigated with the NMFS, EPA, the State, and other interested TWG members. Modification to site selection locations, site investigations, reef design, placement methods, and post-construction monitoring will be developed in coordination with affected resource agencies.
- A USACE pilot project determined that dredged material from Boston Harbor could successfully be deployed to cap the former Industrial Waste Site. In the event this disposal alternative is selected, the U.S. EPA will need to prepare a NEPA document and issue an amendment or rule to permit placement of the dredged material as cap at the IWS.

The information generated by the above investigations may result in changes to the Federal project base plan, which would require preparation of one or more additional NEPA and/or MEPA documents. These document(s) would present the findings and recommended actions consistent with the investigations initiated during the Design Phase and subsequent negotiations with the Federal and

State agencies, and other TWG participants. This will allow for public review and input into the design of the project. If, as a result of the above investigations it is determined that additional mitigation is required beyond what has already been identified in the Draft and Final SEIS/EIR, then additional Federal and/or Sponsor funding would be required to cover those costs as part of the project.

7. LIST OF PREPARERS

U.S. ARMY CORPS OF ENGINEERS

Valerie Cappola: Marine Ecologist, New England District, U.S. Army Corps of Engineers
Education: Ph.D. in Marine, Estuarine and Environmental Sciences from University of Maryland, M.S. in Biology from Texas A&M University, B.S. in Biology from Eckerd College.
Experience: Dr. Cappola is a specialist in benthic marine ecology, and the systematics of crustaceans and cnidarians. After teaching at Salve Regina University in Newport, RI and Emerson College in Boston, MA, she joined the U.S. Army Corps of Engineers. She has spent over three years working on environmental assessments (EAs) for dredging projects.
Role in Preparing this SEIS/EIR: Dr. Cappola was responsible for the sections on birds, mammals, and threatened, endangered and rare species.

Mark L. Habel: Chief, Navigation Planning Section, New England District, U.S. Army Corps of Engineers
Education: B.S. Geology, Northeastern University, 1980. J.D. Suffolk University Law School, 1997.
Experience: Mr. Habel has over 33 years experience with the Corps of Engineers in marine resource studies and project management for design and construction of navigation and coastal protection projects. Mr. Habel has been the chief of the New England District's Navigation Planning Section from 1985 to 1990 and from 2001 to present. He was the study manager for the 1986-1990 Boston Harbor deepening project.
Role in Preparing this SEIS/EIR: Mr. Habel is currently the study manager for the Boston Harbor Deep Draft Improvement Project Feasibility Study, author of the Feasibility Report, and was a technical reviewer of all sections of the SEIS/EIR.

Michael F. Keegan: Project Manager, New England District, U.S. Army Corps of Engineers
Education: B.S. Civil Engineering, Lowell Technological Institute.
Experience: Mr. Keegan is a registered professional engineer and a licensed construction supervisor with over 34 years experience in project management directing the evaluation, design, and construction of civil works projects focusing on navigation, flood risk management and environmental restoration. He was the project manager for the Boston Harbor Inner and Outer Harbor Maintenance Dredging Project and the Boston Harbor Deep Draft Project.
Role in Preparing this SEIS/EIR: Mr. Keegan is currently the project manager for the Boston Harbor Deep Draft Improvement Project Feasibility Study. He is responsible for overall project management, development, and implementation of the public outreach program and was a technical reviewer of all sections of the SEIS/EIR. Mr. Keegan was also responsible for all coordination efforts with Massport.

Kenneth M. Levitt: Biologist, New England District U.S. Army Corps of Engineers
Education: B.S. with a major in Fisheries, University of Washington, 1982.
Experience: Mr. Levitt has been employed as a biologist for the U.S. Army Corps of Engineers since 1988, conducting fisheries and water quality investigations at New England lakes and rivers, as well as preparing NEPA compliance documents (environmental assessments and endangered species biological assessments) for Corps construction/navigation projects. Previous employment in the private sector involved the mass cultivation of microalgae in support of the aquaculture of various marine and freshwater organisms; conducting immunological and microbiological testing at a microbiological laboratory, as well as the ocean ranching of Pacific salmon.
Role in Preparing this SEIS/EIR: Preparation of documentation for consultation under Section 7 of the Endangered Species Act as well preparation of blasting calculations and sections of the EIS on the effects of proposed blasting on threatened and endangered species.

Robert Meader: Civil Engineer, New England District, U.S. Army Corps of Engineers
Education: M.C.R.P. Rutgers, The State University, New Brunswick, NJ; B.S. in Civil Engineering, Worcester Polytechnic Institute, Worcester, MA.
Experience: Over thirty years experience with the Corps of Engineers in planning and design of navigation projects, both shallow and deep draft. Most recently, engineering and design for improvement dredging in Boston Harbor and maintenance dredging in Providence Harbor.
Role in Preparing this SEIS/EIR: Technical oversight of project design.

Marcos A. Paiva: Archaeologist/Tribal Liaison (Regional Technical Specialist), New England District, U.S. Army Corps of Engineers
Education: Ph.D. Candidate in Anthropology at Brandeis University, Waltham, MA; M.A. in History/Historical Archaeology from the University of Massachusetts at Boston; B.A. in History (minor in Anthropology) from the University of Massachusetts at Dartmouth.
Experience: Mr. Paiva has over 24 years of experience in addressing cultural resource impact assessments and compliance as a result of Federal projects including civil works, military, Superfund, project operations and work for others. Underwater archaeology has been addressed as part of the Hyannis Harbor Navigation Improvement Project, Providence River and Harbor Maintenance Dredging Project, and the Boston Harbor Deep Draft Navigation Improvement Dredging Project. Mr. Paiva was a technical reviewer and contract manager for cultural resources for the Providence River and Harbor EIS as well as the Long Island Sound EIS.
Role in Preparing this SEIS/EIR: Mr. Paiva was responsible for the historic and archaeological sections of the SEIS/EIR.

Catherine J. Rogers: Ecologist (Regional Expert), New England District, U.S. Army Corps of Engineers
Education: M.S. in Ecological and Evolutionary Biology/Coastal Zone Study from University of West Florida; B.S. in Plant and Soil Science from University of Massachusetts, Amherst.
Experience: Ms. Rogers serves as a technical lead in the preparation of NEPA documents; Marine Protection, Research and Sanctuaries Act (MPRSA) and Clean Water Act Section 404 compliance; and other applicable environmental compliance for civil works projects. She has prepared numerous Environmental Assessments and prepared and provided technical review of Environmental Impact Statements for USACE water resources development projects including maintenance and improvement dredging projects, shoreline protection projects and environmental restoration projects for over 25 years. Major relevant projects include the Boston Harbor Navigation Improvement Project EIR/S and the Rhode Island Region Long-Term Dredged Material Disposal Site Evaluation Project EIS.
Role in Preparing this SEIS/EIR: Ms. Rogers provided the technical lead on preparation of this SEIS/EIR. She also authored subsections of the Affected Environment and Environmental Consequences Section of the SEIS/EIR, as well as other sections of the SEIS/EIR.

Steven Wolf: Disposal Area Monitoring System Program Manager, New England District, U.S. Army Corps of Engineers
Education: M.S./C.E. in Environmental Engineering from Massachusetts Institute of Technology; M.S. in Marine Science from Universtiy of South Florida; B.S. in Science Education from University of North Carolina, Chapel Hill.
Experience: Mr. Wolf serves as the manager and technical lead for the New England District's monitoring of dredging and dredged material disposal sites. Prior to joining the USACE in 2010, Mr. Wolf worked as a consultant on a wide range of environmental monitoring and assessment programs for the USACE and other agencies as well as a number of private sector clients. Relative project work includes monitoring at the majority of dredged material disposal sites in New England, serving as the lead independent observer for the Boston Harbor Navigation Improvement Project, and performing water column monitoring as part of the Massachusetts Water Resources Authority's Harbor and Outfall Monitoring Program.

Role in Preparing this SEIS/EIR: Mr. Wolf helped provided edits related to disposal site monitoring and the capping demonstration for potential placement of material at the IWS.

MASSPORT

Deborah Hadden: Acting Port Director and Deputy Port Director, Properties and Transportation, Massachusetts Port Authority
Education: M.S. in Biology from Northeastern University, B.S. in Biology from Bucknell University.
Experience: Ms. Hadden has over 26 years of environmental permitting experience including extensive experience preparing Environmental Impact Reports under the Massachusetts Environmental Policy Act and Environmental Impact Statements under the National Environmental Policy Act. For the past nine years, she has served as Massport's project manager for the Boston Harbor Navigation Improvement Project and other harbor dredging projects in coordination with the Army Corps of Engineers. For the past five years, her role at Massport has shifted to focus on maritime property development and management and port transportation and environmental issues in addition to dredging. She is also currently serving as Acting Port Director.
Role in Preparing this SEIS/EIR: Providing port and maritime industry input and overall technical review.

Stewart Dalzell: Deputy Director, Environmental Planning and Permitting, Massachusetts Port Authority
Education: B.S. Biology, Springfield College.
Experience: Mr. Dalzell has over 30 years of private and public sector experience in the preparation of Federal and State environmental permit documentation. Since 2000, he has served as Deputy Director for Massport where he oversees environmental planning and permitting and mitigation tracking for major Massport aviation, port, commercial development, and infrastructure projects. A focus of many of these projects has been coastal and waterfront issues, and mitigation planning associated with port activities and projects along Logan's extensive waterfront.
Role in Preparing this SEIS/EIR: Providing environmental management, overall technical review, managing the MEPA Final EIR preparation and coordination of the Technical Working Group.

Jacquelyn Wilkins: Senior Project Manager, Environmental Planning and Permitting, Massachusetts Port Authority
Education: Working towards an M.S. in Environmental Studies, University of Massachusetts at Lowell; A.B. Geology, Lafayette College.
Experience: Ms Wilkins has over 30 years of varied public and private sector experience in the environmental arena in Massachusetts, including five years as regulator for the Department of Environmental Protection, 11 years as an Environmental Analyst in tbe Massachusetts Environmental Policy Act (MEPA) Office, six years consulting on complex projects requiring various Federal, State, and local; and 10 years managing environmental planning and permitting projects for Massport.
Role in preparing this SEIS/EIR: Managing the MEPA Environmental Impact Report preparation and coordination with the Draft SEIS/EIR.

BATTELLE

Jennifer Field: Principal Research Scientist, Battelle
Education: M.S. in Biological Science from Old Dominion University; B.S. in Biological Science from Florida State University.
Experience: Ms. Field has more than 11 years of experience working on the biology and ecology of marine organisms, including fish, crustaceans, and marine mammals, and five years of experience working on anthropogenic impact studies in the marine environment.
Role in Preparing this SEIS/EIR: Ms. Field was the lead contributor of the fish subsection for the Affected Environment.

Roy Kropp: Senior Research Scientist, Battelle
Education: Ph.D. in Zoology from the University of Maryland; M.S. in Biology from the University of Guam; B.S. in Zoology from San Diego State University.
Experience: Dr. Kropp is a specialist in benthic marine ecology, toxicology, and the systematics of crustaceans and mollusks with 21 years of experience. He has served as the principal investigator for or participated in marine environmental surveys in the tropical and boreal Pacific, off the coast of California, in the Gulf of Mexico, along the Atlantic Coast of the United States, and in the Mediterranean. Currently, Dr. Kropp is a Senior Scientist for Benthic Biology for the Massachusetts Water Resources Authority Monitoring Program. Dr. Kropp has analyzed Rhode Island Sound infaunal data and described infaunal communities in a series of reports for the U.S. Army Corps of Engineers (USACE). Since matriculating to the Marine Sciences Laboratory from Battelle's Duxbury facility, Dr. Kropp has directed several toxicological studies involving the testing of marine and freshwater species. He was the technical project manager for the preparation of the Final EIS prepared for the Providence River dredging project by the USACE.
Role in Preparing this SEIS/EIR: Dr. Kropp contributed the benthic subsection for the Affected Environment.

Kari Lavalli: Assistant Professor of Natural Sciences, Boston University
Education: Ph.D. in Biology from Boston University's Marine Program; B.A. in Bio-Mathematics from Wells College.
Experience: Dr. Lavalli has over 15 years of research experience on the behavioral ecology and basic biology of multiple species of lobsters (clawed, spiny, and slipper) and has worked as a consultant on several projects that could have potential impact on lobsters. Her experience has included aspects of pollutant contaminant loads in lobster tissues and sewage effluent impacts on settling postlarva. She has served as an editor for a book on slipper lobster biology and fisheries, as a section editor on lobster behavioral ecology for a marine journal, and as an associate editor for the Journal of Crustacean Biology.
Role in Preparing this SEIS/EIR: Dr. Lavalli contributed to the lobster subsection of the Affected Environment.

Lisa Lefkovitz: Project/Program Manager, Battelle
Education: M.S. in Water Chemistry from the University of Wisconsin; B.S. in Chemistry from Case Western Reserve University.
Experience: Ms. Lefkovitz has over 15 years of project management and environmental science experience working with public- and private-sector clients. Her project management experience has included all aspects of dredged material management as well as a variety of multidisciplinary environmental and engineering projects.
Role in Preparing this SEIS/EIR: Ms Lefkovitz contributed the sedimentary environment subsection for the Affected Environment.

Stacy Pala: Research Scientist, Battelle
Education: B.A. in Biology, with Chemistry and Russian Minors, Wheaton College, 1994; coursework in Environmental Risk Analysis and Environmental Toxicology, University of Massachusetts, Boston.
Relevant Experience: Ms. Pala has over 11 years of experience in environmental science, including work in biological assessments (BAs) and EAs, environmental microbiology, chemical analyses, and task management.
Role in Preparing SEIS/EIR: Ms. Pala contributed to the shellfish subsection of the Affected Environment.

EARTHTECH (Now AECOM)

Mary Ellen Radovanic, AICP: Senior Environmental Planner, Earth Tech
Education: Master of Urban Affairs from Boston University, a M.B.A. from the University of Rhode Island, and a B.S. in Criminal Justice from Northeastern University.
Experience: Ms. Radovanic has over ten years of experience in the preparation of environmental impacts assessment for major public infrastructure projects.
Role in Preparing this SEIS/EIR: Ms. Radovanic authored the Draft SEIS/EIR Cumulative Impacts Section.

AECOM

Victor P. Frankenthaler: Senior Environmental Planner, AECOM
Education: M.S. in Geography from Boston University and a B.S. in Environmental Planning and Design from Rutgers University.
Experience: Mr. Frankenthaler has over 30 years of experience in the preparation of environmental impact analyses in compliance with the National Environmental Policy Act and Presidential Executive Order 12114—Environmental Effects Abroad of Major Federal Actions, and State regulations.
Role in Preparing this SEIS/EIR: Mr. Frankenthaler authored the revised Secondary Impacts Section.

Dion Lewis: Technical Specialist, AECOM
Education: M.S. in Chemical Oceanography from the University of New Hampshire; B.S. in Geology from Syracuse University.
Experience: Mr. Lewis has 28 years of experience in the planning, performance, and reporting of environmental studies supporting riverine, coastal marine and oceanographic investigations. From 2006 until 2012, Mr. Lewis served as the Sediment Characterization Resource Leader for CENAE's DAMOS program. He has authored several dredged material suitability reports to support agency decision-making under MPRSA §103, CWA §404, and supported EIS documentation for projects in EPA Regions I, II, IV, and IX.
Role in Preparing this SEIS/EIR: Mr. Lewis contributed to the revised Cumulative Impacts Section.

Maura Surprenant: Project/Program Manager, AECOM
Education: B.S. in Biology from Suffolk University.
Experience: Ms. Surprenant has 26 years of experience in the planning, implementation and reporting of environmental monitoring and sediment management programs. She has served for over ten years as project/program manager on evaluations of sediment for dredge and disposal operations for the U.S. Army Corps of Engineers (USACE), under various environmental services and DAMOS contracts. She has also served as technical lead on numerous ocean monitoring programs and sediment characterization studies for private and public sector clients.
Role in Preparing this SEIS/EIR: Ms. Surprenant contributed to the revised Cumulative Impacts Section.

DAYLOR CONSULTING GROUP

Joseph Freeman: Senior Program Director, Daylor Consulting Group
Education: M.A. in Public Policy from Tufts University; B. A. in Liberal Arts from Goddard College.
Experience: Mr. Freeman has more than 30 years experience in the preparation of environmental impact assessment and environmental permitting documentation for major public infrastructure and coastal development projects.

Role in Preparing this SEIS/EIR: Mr. Freeman was the lead contributor of the Cumulative Impacts Section in the Draft SEIS/EIR and was also the principal author of the MEPA Notice of Project Change.

Jessica Dominguez: Environmental Scientist, Daylor Consulting Group
Education: B.S. in Biology-Environmental Science from Colby College.
Experience: Ms. Dominguez has more than five years of experience working on project s involving water quality assessment, endangered species management, field identification of flora and fauna species, developmental impact assessment, wetlands monitoring, environmental permitting, and coastal resource management.
Role in Preparing this SEIS/EIR: Ms. Dominguez was a supporting author for the Draft SEIS/EIR Cumulative Impacts Section.

CDM/Smith

Marc Wallace: Senior Air Quality Scientist QEP, CDM
Education: M.S. in Environmental Studies from the University of Massachusetts at Lowell, B.S. in Meteorology, Lyndon State College, Vermont.
Experience: Mr. Wallace has over 20 years of experience specializing in all aspects of air quality management, including air permitting, control technology evaluations, dispersion modeling, and air monitoring. He has experience using U.S. EPA air quality dispersion models and is familiar with Federal and State agency air quality guidelines and regulations. His project experience includes evaluating construction and operational air quality impacts for transportation, wastewater treatment, composting and industrial facilities siting studies and permit preparations.
Role in Preparing this SEIS/EIR: Mr. Wallace provided the technical lead in the Air Quality General Conformity Applicability Analysis presented in the Draft SEIS/EIR. He also authored the Air Quality Affected Environment and Environmental Consequences Sections of the Draft SEIS/EIR.

George Siple: Associate QEP, CDM Smith
Education: M.B.A. from Duke University, M.S.P.H. in Air and Industrial Hygiene from the University of North Carolina, B.A. in Chemistry from Case Western Reserve University.
Experience: Mr. Siple is a senior environmental scientist with 38 years of experience in all aspects of air quality management, including air permitting, compliance assessments, control technology evaluations, dispersion modeling and air monitoring. His areas of expertise include facility permitting, regulatory assessments, compliance assistance, hazardous waste investigations, and health risk assessments. Mr. Siple has worked on numerous projects for industrial, municipal, and transportation facilities; state and federal environmental agencies; and electric utilities. Currently, as a member of a team conducting a wide variety of environmental projects, he provides senior technical support related to air quality management.
Role in Preparing this SEIS/EIR: Mr. Siple provided the technical lead in the Air Quality General Conformity Applicability Analysis. He also authored the Air Quality Affected Environment and Environmental Consequences Sections of the Final SEIS/EIR.

Lauren Miller: Project Manager, CDM Smith
Education: M.A. in Energy and Environmental Analysis from Boston University, B.S. in Environmental Studies from Elon University.
Experience: Ms. Miller is an environmental scientist with experience in climate change mitigation, climate change adaptation, air quality management, and regulatory compliance. Ms. Miller has worked on numerous projects for industrial and municipal facilities; state and federal environmental agencies; electric utilities facilities; and airports. As a project manager, she is responsible for project execution, budget, and quality.

Role in Preparing this SEIS/EIR: Ms. Miller served as CDM Smith's project manager, responsible for coordination with Massport. She provided support for the Air Quality Affected Environment and Environmental Consequences Sections of the Final SEIS/EIR.

Cynthia Strong Hibbard: Vice President, CDM Smith
Education: M.S. in Environmental Engineering from Harvard University, B.A. in Environmental Engineering from Harvard/Radcliffe College.
Experience: Ms. Hibbard is a Vice President and air quality and greenhouse gas expert with 31 years of experience in air quality management. This includes obtaining air permits, assisting with air regulatory compliance, and conducting emissions and dispersion modeling, control technology evaluations, air pollutant monitoring and sampling, environmental impact assessments and noise studies. She manages projects with major air quality components, provides technical oversight and expert testimony on air quality issues, and negotiates permit and consent agreement conditions on behalf of clients. Her recent experience includes greenhouse gas inventory and management strategy projects for public sector and industrial clients. Ms. Hibbard is a leading air quality expert, and represents CDM Smith at conferences, agency meetings, and with citizens groups, industry groups and professional organizations on air regulatory issues
Role in Preparing this SEIS/EIR: Ms. Hibbard provided senior technical oversight and support for the Air Quality Affected Environment and Environmental Consequences Sections of the Final SEIS/EIR.

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9.0 BOSTON HARBOR SEIS/EIR ACRONYM LIST

IHMDP	Boston Harbor Inner Harbor Maintenance Dredging Project
OHMDP	Boston Harbor Outer Harbor Maintenance Dredging Project
BHNIP	Boston Harbor Navigation Improvement Project and Berth Dredging Project
BUAR	MA Board of Underwater Archaeological Resources
CAD	Confined Aquatic Disposal
CFR	Code of Federal Regulations
COSCO	China Overseas Shipping Company
cm	Centimeter
CPUE	Catch per Unit Effort
CSO	Combined Sewer Overflow
CTD	Conductivity, Temperature, and Density
CWA	Clean Water Act
cy	Cubic Yards
CZMA	Coastal Zone Management Act
DAMOS	Disposal Area Monitoring System
DEIS	Draft Environmental Impact Statement
DITP	Deer Island Treatment Plant
DO	Dissolved Oxygen
EFH	Essential Fish Habitat
EIR	Environmental Impact Report
EIS	Environmental Impact Statement
ENSR	ENSR, International
ERDC	Engineer Research and Development Center
EO	Executive Order
EPA	U.S. Environmental Protection Agency
FEIS	Final Environmental Impact Statement
ft	foot or feet
GLDD	Great Lakes Dredge and Dock Company
LC_{50}	Lethal Concentration (concentration of a substance at which 50% of a group of experimental organisms are killed in a given time)
MA DEP	Massachusetts Department of Environmental Protection
MA DMF	Massachusetts Department of Marine Fisheries
MA DOT	Massachusetts Department of Transportation
Massport	Massachusetts Port Authority
MEPA	Massachusetts Environmental Policy Act
MHC	Massachusetts Historic Commission
MHW	Mean High Water
mi	mile(s)
MLW	Mean Low Water
MLLW	Mean Lower Low Water
mm	Millimeter
MMT	Massport Marine Terminal
MPRSA	Marine Protection Research and Sanctuaries Act
MSC	Mediterranean Shipping Company
MWRA	Massachusetts Water Resources Authority
NEPA	National Environmental Policy Act
NITP	Nut Island Treatment Plant
NMFS	National Marine Fisheries Service
Nmi	nautical mile
NOAA-Fisheries	National Oceanographic and Atmospheric Administration-Fisheries

NOI	Notice of Intent
NTU	Nephelometric Turbidity Units
OSI	Organism Sediment Index
PAH	Polynuclear Aromatic Hydrocarbons
PCB	Polychlorinated Biphenyls
PONYNJ	Port of New York/New Jersey
ppm	Parts per Million
REMOTS	Remote Ecological Monitoring of the Seafloor
RPD	Redox (Reduced Oxygen) Potential Discontinuity
SAIC	Science Applications International Corporation, Inc.
SHPO	State Historic Preservation Officer
SPI	Sediment Profile Imaging
STFATE	Short Term Fate Computer Model
TAC	Technical Advisory Committee
TEU	Twenty-foot Equivalent Unit
TCLP	Toxicity Characteristic Leaching Procedure
TOC	Total Organic Carbon
TSS	Total Suspended Solids
TWG	Technical Working Group
USACE	U.S. Army Corps of Engineers
USCG	U.S. Coast Guard
USGS	U.S. Geological Survey
WRDA	Water Resources Development Act

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CLEAN WATER ACT

SECTION 404(b)(1) EVALUATION

NEW ENGLAND DISTRICT, U.S. ARMY CORPS OF ENGINEERS

CLEAN WATER ACT SECTION 404(b)(1) EVALUATION

PROJECT: Boston Harbor Federal Deep Draft Navigation Improvement, Boston, Massachusetts

PROJECT DESCRIPTION:

The currently proposed Boston Harbor Deep Draft Navigation Improvement Project (Deep Draft Project) involves dredging parent material from navigation channels and related features of the Boston Harbor Federal Navigation Project. The project consists of four separate plans for channel improvements. The first involves providing deeper container vessel access from the Bay to the Conley Terminal in South Boston. This plan would deepen the Broad Sound North Entrance Channel, the President Roads Anchorage Area, the Main Ship Channel Reaches between the Outer Confluence and the Reserved Channel, the lower Reserved Channel, and the Reserved Channel Turning Basin, to a depth of 47 feet deep MLLW, with an additional four feet of depth in the entrance channel (to -51 feet MLLW), and widening of the turning basin and the channel bends. The preferred alternative also involves extending the deepened portion of the Main Ship Channel above the Reserved Channel to the Massport Marine Terminal below the Ted Williams Tunnel to depths of 45 feet, deepening a small area of the lower Mystic River Channel at Massport's Medford Street Terminal from its current 35-foot depth to 40 feet, deepening the Chelsea River Channel and its turning basin to 40 feet from its current 38-foot depth. The project would generate between 10 and 11 million cubic yards of unconsolidated parent glacial material and up to about 1 million cubic yards of rock and other hard materials. These materials would be hauled by scow to the Massachusetts Bay Disposal Site for ocean placement unless one or both of the candidate beneficial use options are ultimately approved as part of the project.

In addition, maintenance dredging of existing Federal navigation features would be carried out concurrent with the Deep Draft Project in two ways. First, maintenance dredging of the Broad Sound South Entrance Channel 30-foot lane, the 35-foot North Lane of the Broad Sound North Entrance Channel, the 15-foot Nubble Channel and the 35-foot Lower Middle Ground Barge Anchorage. These areas would be maintained to facilitate vessel movement during construction of the Deep Draft Project.

Second, remaining areas covered by the 2006 SEIS for the Inner Harbor Maintenance Dredging Project that were not dredged; that is the area between Massport's Marine Terminal and the Inner Confluence.

Third, remaining maintenance material (overdepth) in the Chelsea River, and fourth, maintenance material from the Charles River portion of the 35-foot Main Ship Channel.

Only the maintenance material from the Main Ship Channel, including the Charles River portion, is unsuitable for ocean water disposal and would be disposed into a Confined Aquatic Disposal (CAD) cell located in the Main Ship Channel.

Beneficial use of all or a portion of the unconsolidated material for placement as cap at the overlapping former Industrial Waste Site will be further examined by the USACE and U.S. EPA and other agencies during the Design Phase of the project. Both the MBDS and former IWS lie outside the Territorial Sea in waters regulated by the Federal Government under the Marine Protection Research and Sanctuaries Act, and are not covered by this Draft Clean Water Act Section 404(b)(1) Evaluation.

This Section 404 (b)(1) Evaluation only covers the potential beneficial use of rock material removed from Boston Harbor and disposed at one or both of the two candidate habitat enhancement sites in Massachusetts Bay, and the potential disposal of maintenance material discussed below into a Boston Harbor CAD cell. The two potential beneficial use sites identified to date are the Broad Sound and Massachusetts Bay enhancement sites, both located landward of the Territorial Sea boundary. Up to approximately one million cubic yards of rock could be disposed to provide beneficial hard bottom habitat for lobsters, finfish and other species. An area between 186 acres and 518 acres of subbottom Massachusetts Bay habitat would be covered with rock deposited in rows spaced to leave undisturbed soft bottom between each row to provide a more diverse habitat.

Only maintenance material from the Charles River, and any remaining maintenance material deposited since completion of the Inner Harbor Maintenance Dredging Project or other completed navigation projects are covered under this CleanWater Act analysis. Maintenance dredging that has been deferred, and that will or could be dredged in association with this Deep Draft Improvement Project, has been covered under previous Clean Water Act analyses for disposal into previously identified CAD cells within Boston Harbor. These pre-existing USACE Clean Water Act 404(b)(1) Evaluations and State Water Quality Certificates will be evaluated during the Design Phase to assure thatcompliance with the Clean Water Act continues for the deferred maintenance dredging and for any other identified dredged material determined to be unsuitable for open water disposal.

PROJECT: Boston Harbor Deep Draft Navigation Improvement Dredging Project, Boston, Massachusetts

1. Review of Compliance (Section 230.10(a)-(d)). Draft

a. The discharge represents the least environmentally damaging practicable alternative and if in a special aquatic site, the activity associated with the discharge must have direct access or proximity to, or be located in the aquatic ecosystem to fulfill its basic purpose; X YES ___ NO

b. The activity does not appear to:
1) violate applicable state water quality standards or effluent standards prohibited under Section 307 of the CWA; 2) jeopardize the existence of Federally listed threatened and endangered species or their critical habitat; and 3) violate requirements of any Federally designated marine sanctuary; X YES ___ NO

c. The activity will not cause or contribute to significant degradation of waters of the U.S. including adverse effects on human health, life stages of organisms dependent on the aquatic ecosystem, ecosystem diversity, productivity and stability, and recreational, aesthetic, and economic values; X YES ___ NO

d. Appropriate and practicable steps have been taken to minimize potential adverse impacts of the discharge on the aquatic ecosystem. X YES ___ NO

2. Technical Evaluation Factors (Subparts C-F).

	N/A	Not Signif-icant	Signif-icant
a. Potential Impacts on Physical and Chemical Characteristics of the Aquatic Ecosystem (Subpart C).			
1) Substrate;		X	
2) Suspended particulates/turbidity;		X	
3) Water;		X	
4) Current patterns and water circulation;		X	
5) Normal water fluctuations;	X		
6) Salinity gradients.	X		
b. Potential Impacts on Biological Characteristics of the Aquatic Ecosystem (Subpart D).			
1) Threatened and endangered species;		X	
2) Fish, crustaceans, mollusks and other aquatic organisms in the food web;		X	
3) Other wildlife.		X	
c. Potential Impacts on Special Aquatic Sites (Subpart E).			
1) Sanctuaries and refuges;	X		
2) Wetlands;	X		
3) Mud flats;	X		
4) Vegetated shallows;	X		
5) Coral reefs;	X		
6) Riffle and pool complexes.	X		
d. Potential Effects on Human Use Characteristics (Subpart F).			
1) Municipal and private water supplies;	X		
2) Recreational and commercial fisheries;		X	
3) Water related recreation;		X	
4) Aesthetics;		X	
5) Parks, national and historic monuments, national seashores, wilderness areas, research sites, and similar preserves.	X		

3. Evaluation and Testing (Subpart G).

a. The following information has been considered in evaluating the biological availability of possible contaminants in dredged or fill material. (Check only those appropriate.)

1)	Physical characteristics;	X
2)	Hydrography in relation to known or anticipated sources of contaminants;.....	X
3)	Results from previous testing of the material or similar material in the vicinity of the project;.....	
4)	Known, significant sources of persistent pesticides from land runoff or percolation;	
5)	Spill records for petroleum products or designated hazardous substances (Section 311 of CWA);	
6)	Public records of significant introduction of contaminants from industries, municipalities, or other sources;	
7)	Known existence of substantial material deposits of substances that could be released in harmful quantities to the aquatic environment by man-induced discharge activities;	
8)	Other sources (specify).	

List appropriate references: *Boston Harbor Deep Draft Navigation Improvement Dredging SEIS/EIR Affected Environment/Environmental Consequences Sections.*

b. An evaluation of the appropriate information in 3a above indicates that there is reason to believe the proposed dredge or fill material is not a carrier of contaminants, or that levels of contaminants are substantively similar at extraction and disposal sites and not likely to require constraints in handling the material. The material meets the testing exclusion criteria.

YES	NO
X	___

4. Disposal Site Delineation (Section 230.11(f)).

a. The following factors, as appropriate, have been considered in evaluating the disposal sites.

1) Depth of water at disposal site	X
2) Current velocity, direction, and variability at disposal site	X
3) Degree of turbulence	X
4) Water column stratification.	X
5) Discharge vessel speed and direction.	___
6) Rate of discharge	X
7) Dredged material characteristics (constituents, amount, and type of material, settling velocities)	X
8) Number of discharges per unit of time	___
9) Other factors affecting rates and patterns of mixing (specify: disposal at low and high tide)	X

List appropriate references: *Boston Harbor Deep Draft Navigation Improvement Dredging SEIS/EIR.*

b. An evaluation of the appropriate factors in 4a above indicates that the disposal site and/or size of mixing zone are acceptable.

YES	NO
X	___

5. Actions To Minimize Adverse Effects (Subpart H).

All appropriate and practicable steps have been taken through application of recommendation of Section 230.70 - 230.77 to ensure minimal adverse effects of the proposed discharge

YES	NO
X	___

List actions taken:

This proposed beneficial use of rock disposal would create permanent hard bottom habitat where little or none currently exist.

Monitoring of CAD cell disposal for previous Boston Harbor dredging projects have not revealed any significant water quality violations.

6. Factual Determination (Section 230.11).

A review of appropriate information as identified in items 2 - 5 above indicates that there is minimal potential for short or long term environmental effects of the proposed discharge as related to:

a. Physical substrate (review sections 2a, 3, 4, and 5 above).	YES X	NO___
b. Water circulation, fluctuation and salinity (review sections 2a, 3, 4, and 5).	YES X	NO___
c. Suspended particulates/turbidity (review sections 2a, 3, 4, and 5).	YES X	NO___
d. Contaminant availability (review sections 2a, 3, and 4).	YES X	NO___
e. Aquatic ecosystem structure, function and organisms(review sections 2b and c, 3, and 5)	YES X	NO___
f. Proposed disposal site (review sections 2, 4, and 5).	YES X	NO___
g. Cumulative effects on the aquatic ecosystem.	YES X	NO___
h. Secondary effects on the aquatic ecosystem.	YES X	NO___

7. Findings of Compliance or Noncompliance.

a. The proposed disposal site for discharges of dredged or fill material complies with the Section 404(b) (1) guidelines..... **X**
YES

10 Apr 13
DATE

Charles P. Samaris
Colonel, Corps of Engineers
District Engineer

FOR CONTINUATION OF HOUSE DOCUMENT 113-105

BOSTON HARBOR MASSACHUSETTS DEEP DRAFT NAVIGATION IMPROVEMENT PROJECT

SEE PART 2