SEARSPORT HARBOR
SEARSPORT, MAINE
NAVIGATION IMPROVEMENT PROJECT

APPENDIX A

PERTINENT CORRESPONDENCE AND PUBLIC INVOLVEMENT

<u>List of Pertinent Meetings</u>:

Agency Coordination Meeting: August 26, 2006 (See memorandum.)

<u>List of Pertinent Correspondence</u>:

Letter from NMFS to Corps dated February 14, 2013

Letter from Corps to SHPO dated January 28, 2009 with SHPO concurrence stamp March 9, 2009

Letter from SHPO to Corps dated February 28, 2008

Letter from NOAA to Corps dated May 14, 2007

Letter from USFWS to Corps dated May 25, 2007 and Sept. 27, 2006

CENAE-EP-VE August 25, 2006

MEMORANDUM FOR THE RECORD

MEETING DATE: August 24, 2006

LOCATION: Penobscot Marine Museum, Searsport Maine

SUBJECT: Searsport Harbor Navigation Improvement Project, Agency Coordination Site Visit

1. An initial coordinated site visit was held between the staff of the Corps of Engineers-New England District, the Maine Department of Transportation, Penobscot Bay and River Pilots, Sprague Energy and the environmental resource agencies at the Penobscot Marine Museum building in Searsport, Maine on August 24, 2006. The purpose of the meeting was to discuss the proposed navigation improvement project for Searsport Harbor. In attendance were:

Name	Organization	Phone
Brian Nutter	Maine Port Authority	(207) 624-3564
Duane Seekens	Sprague Energy	(207) 548-2531
David Smith	Penobscot Bay and River Pilots	(207) 338-6600
Skip Strong	Penobscot Bay and River Pilots	(207) 338-6600
Jeff Murphy	NOAA/NMFS	(207) 866-7379
Steve Timpano	Maine Dept. of Inland Fisheries	(207) 287-5258
Mark Habel	Corps of Engineers (USACOE)	(978) 318-8871
Cathy Rogers	Corps of Engineers (USACOE)	(978) 318-8231

Invited but not in attendance were:
USFWS, Concord, NH
US EPA, Water Quality Unit
Maine State Planning Office
Maine Department of Marine Resources
Maine Department of Environmental Protection
Town Manager, Searsport, Maine

2. After introductions, Mark Habel (USACOE) provided an overview of the proposed navigation improvement project. The current 35 foot deep MLLW authorized navigation channel would be deepened an extra five feet to 40 feet MLLW. The actual proposed depth would be dependent on the results of the benefit to cost analysis. The proposed navigation channel would also extend beyond the current dimensions north, to just east of the existing State berth, and seaward to the justified depth contour. At 40' MLLW, approximately 760,000 cy of material, of which 30,000 cy would be maintenance material, would be dredged from the channel. Some rock may also need to be removed. The project was constructed in 1964 and has not needed maintenance dredging since that time. The material has not been characterized yet, but is suspected to be composed of

glacial till material, silt maintenance material, and blue clay in the improvement material. Borings and sediment physical and chemistry testing is proposed for next year, when additional funding is available. Brian Nutter added and emphasized that this project is for Mack Point only. No work on Sears Island is proposed.

3. Two proposed aquatic disposal sites include Belfast Bay and the Rockland Disposal Site. Belfast Bay was used for disposal of material during construction of the project in 1964-1968. According to the two Pilots, there is little lobster gear or fishing gear at the Belfast Bay site. It is a deep hole and may be the remnant of a methane gas pocket. It is not known if this gas pocket is still active or not. It was suggested that we contact Steve Dickson from the Maine Geological Survey for additional information about this site.

4. Another tentative disposal site suggested by Brian Nutter is to bulkhead a portion of Mack Point just northeast of the State Pier and backfill with material from the new channel. This would fill inter-tidal and sub-tidal lands. No other disposal sites were suggested by the group.

5. A potential wreck is located in the proposed channel area. Mark Habel proposes to perform side scan surveys, magnetometer, and cores to determine the character of the sediments and the type of wreck, if present. It was suggested that we contact Billy Abbot, a retired pilot, at (207) 338-2729 to obtain additional information about this wreck.

6. Next Brian Nutter (Maine Port Authority) described the potential benefits of an improved channel. The State pier was constructed three years ago and is designed to handle a 45' deep channel. Currently the berth is 40' deep. Ships have to wait for the tides to access the berth. Ships won't have to wait in the anchorage area if the channel is deepened. Cargo is up 27% from three years ago at Mack Point. There are several customers interested in the site. Brian does not see the growth stopping anytime soon. Mack Point transfers petroleum, bulk products, road salt, gypsum, tapioca, and wood chips. The port would also be able to accommodate short-sea shipping; that is barges transferring goods up and down the coast from bigger ports such as Boston. This could take many trucks off the highway. Brian Nutter thought that approximately 100,000 trucks would be taken off the roads in Portland, ME in 5 years if short-sea shipping were available (although he was not certain of the final numbers). There are some downsides to short-sea shipping that may make it less attractive as an option to shippers.

7. Steve Timpano (MDIFW) provided information about resources in the project area, most notably intertidal habitat, and eagle nesting sites. The eagle nesting sites are on the east side of Sears Island and are not expected to be impacted from the proposed project. If eagles begin to nest on the western side of the island, closer to the project area, then further discussion would be needed. No eelgrass areas in the project area are known to occur, but a review of the Maine GIS site would be needed to confirm this; we can also contact Brian Swan for more information about eelgrass in the area.

8. Jeff Murphy (NMFS) noted that listed Atlantic salmon and shortnose sturgeon may occur in the project area. Shortnose sturgeons have been noted in Winterport and maybe in Searsport Harbor even though they haven't been collected yet. May have to have a Section 7 formal consultation if blasting and/or dredging occurs while these species are in the project during construction. If dredging and blasting occurs between November 8 and April 9 then a formal consultation would not be needed. Impacts to whales from the increased ship traffic from the proposed project would also need to be assessed. An EFH assessment would also need to be prepared.

9. Additional comments were noted about the blasting. Mark Habel mentioned that New York district has been collecting blast shock wave data which might be useful for this project. Brian Nutter mentioned that silt curtains were used in 1999-2002 for siltation control during pier dredging work.

10. Next the attendees took a tour of Mack Point. It was noted that several lobster buoys were located in Long Cove as well as numerous seagulls and a few cormorants on the piers. A history and current use of the State Pier and the Sprague Pier was provided to the attendees. The location of the proposed bulkhead alternative was identified. This area has a few abandoned pier pilings. This proposed fill area would be used for short-sea access, access to the railroad line, and bulk shipments. A second alternative fill area between the State Pier and the Sprague Pier was also identified; this would provide additional deck space. There are no known salt marshes in the two proposed fill areas.

17. **Action Item:** The State and Federal agencies will respond in written format to the request for specific information requested in the initial coordination letter dated July 31, 2006. Corps will provide these meeting minutes to the other agencies that did not provide staff to the meeting for their review and ask for their formal comments.

Catherine Rogers
Ecologist (Regional Expert)

CF:
PDT members and meeting attendees

CORRESPONDENCE RECEIVED DURING PREPARATION OF THE DRAFT REPORT

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

FEB 14 2013

John R. Kennelly
Department of the Army
New England District, Corp of Engineers
696 Virginia Road
Concord, MA 01742-2751

RE: Searsport Harbor Navigation Improvement Project

Dear Mr. Kennelly:

We have completed an Endangered Species Act (ESA) section 7 consultation in response to your letter of December 18, 2012, and concur with your determination that the proposed project is not likely to adversely affect any species listed as threatened or endangered under the ESA of 1973, as amended. Our supporting analysis is provided below.

Proposed Action

The proposed project is in Searsport Harbor, Searsport, Maine. The proposed project would deepen both the existing entrance channel and turning basin from a depth of 35 feet to a depth of 40 feet. In addition, the entrance channel would be widened from its current 500 feet at the narrowest point, to 650 feet, and a maneuvering area adjacent to the State Pier's east berth in Long Cove would be created. The rectangular maneuvering area would have a length between about 875 feet on the west side and 1,066 feet on the east side and a width of 400 feet. This area would also be deepened to 40 feet. Approximately 892,000 cubic yards of material would be dredged for the improvement project. Concurrent with the improvement dredging, some maintenance dredging is proposed to bring the existing project to its authorized depth (35-feet plus two feet allowable overdepth). Approximately 37,100 cubic yards of material would be removed for maintenance dredging. The total quantity of material to be removed from the proposed project is approximately 929,100 cubic yards. The material will be removed from approximately 100 acres of habitat.

Material from the entrance channel, turning basin, and Long Cove maneuver area were tested for physical and chemical characteristics to determine if the material would be suitable for unconfined open water disposal. Based on similar physical and chemical characteristics at the dredge and disposal sites, you determined that the material from the Searsport Harbor site would be suitable for disposal in Penobscot Bay at the Penobscot Bay Disposal Site. This disposal site is located approximately six miles from the project area, adjacent to the island of Islesboro. Material will be transported from the dredge site in Searsport Harbor to the disposal site using a barge or a scow.

Based on information provided in your EA, it appears that sediment plumes that result from the proposed activities are expected to extend between 1500 feet and one mile downstream of the dredging and disposal areas prior to dissipating. Therefore, the footprint of this project includes both the 100 acres of habitat that will be directly affected by the dredging activity, as well as the habitat downstream that will be exposed to elevated turbidity associated with the sediment plumes.

A waterborne mechanical dredging plant will be used. Dredging and disposal will take approximately five months to complete and will occur between November 8th and April 9th to protect migrating fish and other natural resources in Penobscot Bay.

NMFS Listed Species and Critical Habitat in the Action Area

The Gulf of Maine Distinct Population Segment (GOM DPS) of Atlantic salmon (*Salmo salar*) is listed as endangered under the ESA. The GOM DPS includes all anadromous Atlantic salmon whose freshwater range occurs in the watersheds from the Androscoggin River northward along the Maine coast to the Dennys River. Included are all associated conservation hatchery populations used to supplement these natural populations; currently, such conservation hatchery populations are maintained at Green Lake National Fish Hatchery (GLNFH) and Craig Brook National Fish Hatchery (CBNFH). This project occurs within the GOM DPS of Atlantic salmon.

Critical habitat has been designated for listed Atlantic salmon pursuant to section 4(b)(2) of the ESA. The critical habitat designation for the GOM DPS includes 45 specific areas occupied by Atlantic salmon at the time of listing that include approximately 19,571 km of perennial River, stream, and estuary habitat and 799 square km of lake habitat within the range of the GOM DPS and in which are found those physical and biological features essential to the conservation of the species. The entire occupied range of the GOM DPS in which critical habitat is designated is within the State of Maine. This project is not located within the designated critical habitat for the GOM DPS of Atlantic salmon.

Federally endangered shortnose sturgeon (*Acipenser brevirostrum*) are known to occur in Maine primarily in the estuarine complex formed by the Sheepscot, Kennebec, and Androscoggin rivers and in the Penobscot River. A Schnabel estimate using tagging and recapture data from 1998, 1999 and 2000 indicates a population estimate in the Kennebec Complex of 9,488 (95% CI, 6,942 to 13,358). Fernandes (2008) used capture data from 2006 and 2007 to calculate Peterson and Schnabel estimates of abundance in the Penobscot. The Peterson estimate of shortnose sturgeon abundance was 1,425 with a confidence interval of 203-2,647. The Schnabel estimate was 1,531 with a confidence interval of 885-5,681. Recent data collected by the University of Maine indicates that several other rivers in Maine (St. George, Damariscotta, Medomak, etc.) also seasonally support shortnose sturgeon (Zydlewski *et al.* 2010). The proposed project is within the range of listed shortnose sturgeon.

Five DPSs of Atlantic sturgeon (*Acipenser oxyrinchus oxyrinchus*) were listed under the ESA in February 2012; the New York Bight, Chesapeake Bay, Carolina, and South Atlantic DPSs were listed as endangered, and the Gulf of Maine DPS was listed as threatened (77 FR 5880 and 77 FR 5914, February 6, 2012). The range of Atlantic sturgeon from all five DPSs extends from Labrador Inlet, Labrador, Canada to Cape Canaveral, Florida. Based on the best available information on the distribution of Atlantic sturgeon, it has been determined that most Atlantic sturgeon in the action area are likely to be GOM DPS origin. However, it is possible that some Atlantic sturgeon in the action area are Canadian origin (and therefore, not listed under the ESA), and a small portion may originate from the New York Bight (NYB). As a result, in this consultation, effects of the proposed action on the GOM and NYB DPSs of Atlantic sturgeon are considered.

Effects of the Action

Several factors were considered in assessing the potential effects of this project on listed Atlantic salmon, shortnose sturgeon, and Atlantic sturgeon. These include the frequency of occurrence of the species in the project area and the likelihood that the species, if present in the action area, would be impacted by the proposed action.

The ACOE proposes to conduct all dredging and disposal activities between November 8 and April 9 to minimize effects to listed species. During this period Atlantic salmon are generally not present in estuarine or marine waters off the coast of Maine. Atlantic salmon smolts typically commence their downstream movements between mid-April and June. As post-smolts, they move off the coast of Maine rapidly (Kocik *et al.* 2009). As no dredging or disposal activities will occur after April 9, no smolts or post-smolts are expected to be affected by the project. Returning adults are typically present in estuarine and marine areas from May through early November. Given the low probability that salmon would occur in the action area at the time dredging and disposal activities are occurring, we do not expect any Atlantic salmon to be exposed to effects of the proposed action. Therefore, effects to listed Atlantic salmon from the proposed dredge project will be discountable.

Telemetry studies conducted by the University of Maine indicate that while shortnose sturgeon are present in the Penobscot River and estuary throughout the year, their movements vary by season in response to water temperature and flow. From mid-October to mid-April, most tagged shortnose sturgeon concentrate in a relatively small section of river in the Bangor area. Following this overwintering period, they move downstream into the estuary, until returning upstream in summer during low flows. Tagged fish were observed to move as far upstream as two kilometers (1.2 miles) below the Veazie Dam by August. At the end of summer, shortnose sturgeon moved downstream to the location of the overwintering site in the Bangor area (Fernandes 2008, Zydlewski 2009b). As shortnose sturgeon are expected to be overwintering upriver from Searsport Harbor between November 8th and April 9th, they are not likely to occur in the area affected by the proposed dredging and disposal activities. As such, all effects will be discountable.

Although Atlantic sturgeon are known to use the Penobscot River from May until October, they differ from shortnose sturgeon in that they generally overwinter in the marine environment (Fernandes *et al.* 2010). The University of Maine has been monitoring the movements of tagged Atlantic sturgeon in Penobscot Bay using acoustic receivers. In 2011, all tagged Atlantic sturgeon had left the river (past Islesboro) by November 1st and returned in April (G. Zydlewski, pers. comm.). Although in warmer springs, it may be possible for individual sturgeon to migrate into Penobscot Bay in late March or early April, in general, it is not expected that they would be present until after April 9th. As such, we do not expect any Atlantic sturgeon to be exposed to effects of the proposed dredging and disposal project and all effects to listed Atlantic sturgeon from the proposed dredge project would be discountable.

Conclusions

Based on the determination that all effects, if adverse, will be insignificant or discountable, we concur with the ACOE's determination that the proposed project is not likely to adversely affect any threatened or endangered species under our jurisdiction. This concludes consultation pursuant to section 7 of the ESA for this project. Re-initiation of consultation is required and shall be requested by the ACOE or by NMFS, 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 (such as changing the timing of in-water work) 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. We look forward to continuing to work with you and your staff on issues related to listed species in Maine. Questions concerning this consultation and ESA issues can be directed to Dan Tierney at (207) 866-3755 or by e-mail at Dan.Tierney@noaa.gov.

Consultation for Essential Fish Habitat (EFH) under the Magnuson-Stevens Fishery Conservation and Management Act (MSA) was requested in your December 18, 2012 initiation letter due to the presence of habitats used by federally managed species in the project area. Our response in regards to potential effects to EFH will be issued in a separate letter.

Sincerely,

for
John K. Bullard
Regional Administrator

CC:
Dan Tierney-F/NER3
Mike Johnson-F/NER4
Wende Mahaney-USFWS
Oliver Cox-MDMR

File Code: Sec. 7 ACOE Maine Searsport Harbor Dredge
PCTS: NER-2013-9431

DEPARTMENT OF DEFENSE
UNITED STATES OF AMERICA

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

REPLY TO:
ATTENTION OF:

RECEIVED
FEB 2 2009
By 0248-08

January 28, 2009

Engineering/Planning Division
Evaluation Branch

Mr. Earle G. Shettleworth, Director
Maine Historic Preservation Commission
55 Capitol Street, Station 65
Augusta, Maine 04333

Dear Mr. Shettleworth:

The U.S. Army Corps of Engineers, New England District, through its contractor the Public Archaeology Laboratory, Inc. (PAL), has recently completed a preliminary assessment for a Searsport Harbor shipwreck in Searsport, Maine. A copy of the draft shipwreck assessment report is enclosed for your review and comment.

We have previously coordinated with your office on the original remote sensing archaeological survey of the Searsport project area, also performed by PAL, and the scope of work for the follow-up wreck assessment. Comments on both were received by letter dated February 28, 2008 and a copy is enclosed for your information. Lastly, Dr. Arthur Spiess and Lee Cranmer of your staff participated in a conference call with Corps and PAL staff on June 13, 2008 to further refine the scope of the wreck assessment.

To summarize, PAL completed a preliminary assessment of a large wooden-hulled shipwreck identified during the 2006 remote sensing archaeological survey for a proposed Corps navigation improvement project in Searsport Harbor. The goals of the assessment were to further interpret and define the wreck site and its boundaries and develop research contexts for future assessment of its National Register eligibility. These goals were met through a combination of additional post-processing of remote sensing data recorded at the site and supplemental archival research focused on Searsport's maritime trade during the first half of the 20th Century and the role of schooner barges in the history of North American ship design and technology, maritime commerce, and Maine's shipbuilding industry.

Based on the results of this study and consultation with your office, it was recommended that a comprehensive site examination be completed consisting of diver-based archaeological documentation, subsurface testing, and supplemental archival research to conclusively confirm the shipwreck's identity, assess in detail the condition and integrity of the remains, and fully evaluate the site's National Register eligibility.

During the initial stages of the project, it was thought that the shipwreck was located within the area of potential effect for proposed navigation improvements. However, the most recent channel alignment indicates that the wreck falls outside of this area and would not be impacted by project improvements. A figure showing the current proposed channel alignment is enclosed. Therefore, the current project should not impact the shipwreck and the further archaeological investigations summarized above are not required at this time. However, should the channel alignment change during final project design in such a manner as to encroach upon the wreck, we would resume our coordination efforts with your office and conduct the additional recommended work.

Therefore, the proposed navigation improvement project at Searsport Harbor should have no effect upon any structure or site of historic, architectural or archaeological significance as defined by Section 106 of the National Historic Preservation Act of 1966, as amended, and implementing regulations 36 CFR 800. We would appreciate your concurrence with this determination.

If you have any questions, please contact Mr. Marc Paiva, project archaeologist, at 978-318-8796.

Sincerely,

John R. Kennelly
Chief of Planning

Enclosures

Copies furnished (with enclosures):

Ms. Bonnie Newsom
Tribal Historic Preservation Officer
Penobscot Indian Nation
12 Wabanaki Way
Indian Island, Maine 04468

Mr. Donald Soctomah
Tribal Historic Preservation Officer
Passamaquoddy Indian Tribe
Indian Township Reservation
P.O. Box 102
Princeton, Maine 04668

CONCUR

Kirk F. Mohney — 3/9/09

Kirk F. Mohney,
Deputy State Historic Preservation Officer — **Date**

AINE HISTORIC PRESERVATION CO ISSION
55 CAPITOL STREET
65 STATE HOUSE STATION
AUGUSTA, MAINE
04333

JOHN ELIAS BALDACCI
GOVERNOR

EARLE G. SHETTLEWORTH, JR.
DIRECTOR

February 28, 2008

Mr. John R. Kennelly
New England District, Corps of Engineers
696 Virginia Rd.
Concord, MA 01742-2751

Re: Searsport Harbor proposed dredging (Contract # DACW33-03-D-0002 IDIQ), MHPC #0248-08

Dear Mr. Kennelly:

Dr. Arthur Spiess and Leon Cranmer of our staff have reviewed the report entitled "Marine Archaeological Survey Searsport Harbor" by PAL (Pawtucket, R.I.) dated July 2007, and the scope-of-work dated October 29, 2007. We received both documents on February 21, 2008. We accept the report as written.

Specifically we accept both recommendations made on p83 of the report: 1) vibratory coring to explore a possible paleo-land surface in the vicinity of a paleo-channel for archaeologically sensitive paleosols, and 2) visual inspection of the shipwreck target (probably *Cullen No.* 18).

The *Cullen No. 18* shipwreck site has a Maine Historic Archaeological Sites Inventory number which is ME 385-004. It would be helpful if this site number were used in subsequent reports.

In the Statement of Work for the completion of an optional task (#9), the evaluation of the *Cullen No. 18* shipwreck, six objectives for a site examination investigation are listed. Of these six objectives, the first four would not be totally achieved if the visual inspection is replaced with an archival investigation only. We agree with the recommendations in the original report that a visual inspection either by a diver or an ROV be conducted. In addition, as with any other site, an archival investigation should also be undertaken to provide background information of a National Register eligibility determination.

Thus, we can not concur that the proposed scope of work is adequate.

Sincerely,

Kirk Mohney

Kirk Mohney
Deputy State Historic Preservation Officer

PHONE: (207) 287-2132

PRINTED ON RECYCLED PAPER

FAX: (207) 287-2335

UNITED STATES DEPARTMENT OF COMMERCE
National Oceanic and Atmospheric Administration
NATIONAL MARINE FISHERIES SERVICE
NORTHEAST REGION
One Blackburn Drive
Gloucester, MA 01930-2298

MAY 14 2007

John R. Kennelly
Chief of Planning
New England District, US Army Corps of Engineers
696 Virginia Road
Concord, Massachusetts 01742-2751

Dear Mr. Kennelly:

Thank you for requesting preliminary comments on the US Army Corps of Engineers' (ACOE) proposed Section 107 Navigation Improvement and Maintenance Project in Searsport Harbor, Searsport, Maine. As proposed, the project would seek to determine the navigation-related needs of the Mack Point deep-draft commercial cargo port in Searsport Harbor. This will include the advisability of deepening the existing 35-foot mean low water (MLW) channel and turning basin to 40-feet MLW, extension of the existing channel seaward, and extension of the channel northeasterly to access the berth at the State of Maine's recently reconstructed pier at Mack Point. An estimated 817,000 cubic yards (CY) of material (57,000 CY for maintenance and 760,000 CY for improvement/expansion) would be dredged and disposed of at a site at sea or in the shore/intertidal area at Mack Point.

Regulatory Authority and Points of Contact

Endangered Species Act

The lower Penobscot River including Searsport Harbor is included in the range of the Distinct Population Segment (DPS) of Atlantic salmon (*Salmo salar*) and shortnose sturgeon (*Acipenser brevirostrum*), both listed as endangered species under the Endangered Species Act (ESA). The Atlantic salmon DPS encompasses all naturally reproducing remnant populations of Atlantic salmon from the Kennebec River downstream of the former Edwards Dam site, northward to the mouth of the St. Croix River. To date, the Services have determined that these populations are found in the Dennys, East Machias, Machias, Pleasant, Narraguagus, Ducktrap, and Sheepscot Rivers, Kenduskeag Stream, and Cove Brook. The proposed project is located within the geographic range of the DPS and has the potential to affect the listed salmon. The United States Fish and Wildlife Service (USFWS) and NOAA's National Marine Fisheries Service (NMFS), collectively called the Services, jointly listed the Gulf of Maine DPS. For projects in the marine and estuarine environment (below head of tide), the Services have agreed that all comments and correspondence regarding consultation under section 7 of the ESA will be channeled through NMFS.

A population of the federally endangered shortnose sturgeon (*Acipenser brevirostrum*) is known to exist in the Penobscot River (NMFS 1998). On June 30, 1978, one shortnose sturgeon was captured in Penobscot Bay during sampling conducted by the Maine Department of Marine Resources (Squiers and Smith 1979). From June through August 2006, 43 shortnose sturgeon were captured incidental to an ongoing study to document the use of the river by Atlantic sturgeon. The extent of this species' range in the Penobscot is likely from the lower estuary to the area downstream of the Veazie Dam. Therefore, NMFS expects that shortnose sturgeon could be present in the action area of the proposed project in Searsport Harbor.

Atlantic sturgeon (*Acipenser oxyrinchus oxyrinchus*) are distributed along the entire East Coast of the US and have been designated a Species of Concern by NMFS. Many populations, including those found in Maine rivers, have undergone drastic declines in abundance since the late 1800s. Consequently, NMFS has initiated a status review for this species to determine if listing as threatened or endangered under the ESA is warranted. If it is determined that listing is warranted, a final rule listing the species could be published within a year from the date of publication of the listing determination or proposed rule. Four Atlantic sturgeon were captured from June to August, 2006 during the ongoing study of the species in the Penobscot. Atlantic sturgeon are also likely to occur in the project area.

Several listed species of whales and sea turtles seasonally occur in Maine waters, including Penobscot Bay. These include: the endangered humpback (*Megaptera novaeangliae*), fin (*Balaenoptera physalus*) and North Atlantic right whale (*Eubalaena glacialis*); the threatened loggerhead turtle (*Caretta caretta*) and the endangered Kemp's ridley (*Lepidochelys kempii*) and leatherback turtles (*Dermochelys coriacea*). Listed sea turtles are generally present in Maine waters from June through October of any year. Listed whales are generally present in Maine waters from April 15 to November 1. These species are unlikely to occur in Searsport Harbor where the dredging will occur.

The effect your federal activity may have on listed species in the Penobscot River/Bay under NMFS jurisdiction must be analyzed in the course of an ESA Section 7 consultation. The ACOE should state its ESA determination to the NMFS and seek our concurrence before proceeding with the project. A formal consultation, which may require that the ACOE develop an ESA Biological Assessment, is a more intensive evaluation of the project and its likely effects and is used when the proposed federal activity may have an adverse impact on ESA listed species. If a formal consultation is required, the ESA consultation will be handled separately from the other impact assessments described below. Please contact Jeff Murphy, NMFS, (207-866-7379 or Jeff.Murphy@noaa.gov) regarding ESA compliance.

Essential Fish Habitat – Magnuson-Stevens Act

The Penobscot River is also designated as Essential Fish Habitat (EFH) for several federally managed species under the Magnuson-Stevens Fishery Conservation and Management Act (MSA), including Atlantic salmon, Atlantic cod, and winter flounder. The MSA requires Federal agencies such as the ACOE to consult with the Secretary of Commerce regarding any action or proposed action authorized, funded, or undertaken by the agency that may adversely affect EFH identified under the MSA. Based on precedent established in other activities, dredging and disposal are likely to have direct and indirect adverse effects on EFH, and the ACOE will be obligated to consult with NMFS to develop an EFH assessment. The required contents of an EFH Assessment includes: 1) a description of the action; 2) an analysis of the potential adverse effects of the action on EFH and the managed species; 3) the ACOE's conclusions regarding the effects of the action on EFH; and 4) proposed mitigation, if applicable. Other information that should be contained in the EFH Assessment, if appropriate, includes: 1) the results of on-site inspections to evaluate the habitat and site-specific effects; 2) the views of recognized experts on the habitat or the species that may be affected; 3) a review of pertinent literature and related information; and 4) an analysis of alternatives to the action that could avoid or minimize the adverse effects on EFH. Based on the detail of the assessment, NMFS will provide conservation recommendation, as appropriate, which should serve to avoid, minimize, or mitigate potential adverse project related impacts. The EFH regulations, 50 CFR Section 600.920, outlines that consultation procedure and further enables Federal agencies to use existing consultation/environmental review procedures, such as the NEPA process, to satisfy the MSA consultation requirements in certain circumstances. A guide to essential fish habitat designations in the Northeastern United States is located on the Habitat Conservation Division web site at http://www.nero.noaa.gov/hcd/webintro.html. Questions concerning EFH assessments can be directed to Sean McDermott at 978-281-9113 or Sean.McDermott@noaa.gov).

Fish and Wildlife Coordination Act

The Fish and Wildlife Coordination Act (FWCA) requires that federal action agencies coordinate their activities with the state and federal resource agencies if the activity if likely to affect natural resources. Potential impacts of the ACOE's project on ESA-listed species and federally managed commercial fish species should be assessed in accordance with the specific procedural guidance summarized above, however, those species not covered by ESA or MSA should still be addressed in the comprehensive impact assessment you will be preparing under the National Environmental Policy Act (NEPA).
For questions regarding those fishery resources not covered by the ESA or MSA, such as river herring and shad, the ACOE should also contact Sean McDermott.

Preliminary Comments on the Proposed Project

The comments below highlight only a few of the NMFS key concerns, based on your cursory description of the project and the August 24, 2006 coordinated site visit in Searsport, Maine. The ACOE's impact assessment should address these matters, but also must comprehensively describe all the potential adverse impacts of the dredging project and then consider practicable alternatives to them.

Time of Year

In the Project Information Sheet distributed at the August 24, 2006 coordinated site visit, the ACOE states that "construction would be limited to the fall and early spring timeframe to protect fisheries and shellfish resources in the harbor and bay". The time of year in which dredging and disposal occurs will be an important factor in determining the potential effects of the project. The presence of dredge, the audible disruption, blasting impacts, and dredge/disposal plume are known to impact migrating Atlantic salmon and foraging shortnose sturgeon and Atlantic sturgeon. For the protection of Atlantic salmon, NMFS typically recommends that dredging, blasting, and disposal activities occur between November 8 and April 9. This work window should help ensure that dredging and disposal operations will not disturb, injure, or kill migrating Atlantic salmon.

The ACOE proposes to dispose of the dredge material in open water (Belfast Bay or Rockland Disposal Sites) or to construct a bulkhead just north of Mack Point in the shore/intertidal area and place material behind the bulkhead. Studies conducted by NMFS in 2001-2005 in Penobscot Bay have found that the Belfast Bay and Rockland Disposal Sites are directly in the path of outmigrating Atlantic salmon smolts. Adherence to our recommended November 8 and April 9 work window will serve to protect Atlantic salmon smolts during disposal activities at either site.

As the population dynamics of shortnose sturgeon and Atlantic sturgeon in the Penobscot system are largely unknown, it is difficult to recommend a time of year when effects of dredging are unlikely. In addition to the potential for dredge operations to destroy forage items and to displace sturgeon from the area due to noise and increases in suspended sediment, shortnose sturgeon are also vulnerable to direct effects of dredging operations. Shortnose sturgeon have been killed by clamshell, pipeline, and hopper dredging operations in the Northeast. Shortnose sturgeon are particularly vulnerable to entrainment in dredges during the winter months when this species is less active and has delayed response time; however, shortnose sturgeon have also been entrained in dredges during warmer months. For example, dredging of the 27-foot Kennebec River (Maine) Federal navigation channel in October 2005 resulted in the entrainment of 5 shortnose sturgeon in the dredge, with 3 of these sturgeon mortally injured. Only 10,000 cy of material was removed during this project over the course of 4 days. Based on the water temperature at the time, these sturgeon were presumed to be actively migrating to the upstream overwintering area when they were entrained in the dredge.

In order to assess the likely impacts of this project on shortnose sturgeon and Atlantic sturgeon, NMFS will need to know the type of dredge to be used, and a description of the project area including sediment type, the presence of submerged aquatic vegetation (SAV) or shellfish beds, and current velocity. This information will allow NMFS to assess the potential for shortnose sturgeon and Atlantic sturgeon to use the site and the likely impact of dredging on this species. Information collected as part of an ongoing sturgeon study in the Penobscot system may be useful in determining the potential affects of the proposed project. Questions regarding potential impacts to sturgeon can be addressed to Julie Crocker ((978)281-9300 ext. 6530 or Julie.Crocker@noaa.gov).

Ship Strikes

Collision with vessels is the leading human-caused source of mortality for the endangered Northern Atlantic right whale (*Eubalaena glacialis*). Ship strikes have also been known to injure and kill endangered fin (*Balaenoptera physalus*) and humpback (*Megaptera novaengliae*) whales. If the Navigation Improvement and Maintenance Project in Searsport Harbor has the potential to increase ship traffic in Penobscot Bay, then ACOE will need to assess the potential for an increased likelihood of whale/vessel interactions. Any questions regarding this topic should be directed to Kristen Koyama, NMFS Northeast Region Ship Strike Coordinator (978-281-9300 ext. 6531 or Kristen.Koyama@noaa.gov).

Submerged Aquatic Vegetation

In Maine, eelgrass has been observed at depths out to 33 feet and extensive eelgrass patches have been mapped in Penobscot Bay. Eel grass is an extremely important habitat type for many federally managed and commercially important fish and shellfish species. Vegetated shallows, which include eelgrass, are defined as special aquatic sites under section 404(b)(1) guidelines of the Clean Water Act due to their functional attributes as finfish and shellfish nurseries, wave buffers, sediment stabilizers, and absorbers of excess organic nutrients. In New England, juvenile American lobsters and winter flounder seem to be particularly dependent upon eelgrass for forage and cover habitat. In addition, eelgrass aerates sediments, produces carbon that fuels the food web, recycles nitrogen, and serves as a seed source. Mapping provided by the Maine Department of Marine Resources indicate that eelgrass resources occur in Searsport Harbor. As such, the ACOE should survey the project area for eelgrass and, if present, delineate the extent of the resource.

Intertidal Habitats

The ACOE proposes to dispose of the dredge material in open water (Belfast Bay or Rockland Disposal Sites) or to construct a bulkhead just north of Mack Point in the shore/intertidal area and place material behind the bulkhead. Of these two alternatives, open water disposal at an approved location may be preferential. Intertidal mudflats are designated a "special aquatic site" under the 404(b)(1) Guidelines of the Clean Water Act for their ecological value as refuge for benthic and demersal organisms, and nursery and forage habitat for a variety of species. Filling of the intertidal mudflat and construction of a bulkhead will permanently alter the local habitat's biological, chemical, and physical functions in the ecosystem and use by living marine resources (LMRs). Marine worms, soft-shell clams (*Mya arenaria*), amphipods, and crustaceans depend on mudflats for some or all of their life stages. These species, in turn, act as forage for larger predatory species including federally managed finfish. Mudflats also have a role in the chemical and physical processes associated with the ecosystem, such as decomposition, sediment deposition, and wave energy attenuation. Similarly, nearshore shallow water habitat provides an important refuge for egg, larval, and juvenile life stages of many finfish, and supports additional important ecosystem functions. Changing the depth and contour by directly eliminating intertidal and shallow water habitat may exclude organisms such as soft shell clams and marine worms from populating the site. Loss of shallow water habitat may also result in unintentional secondary impacts, such as erosion of the adjacent mudflat due to increased wave energy reflecting off the bulkhead and nearshore use by vessels.

In summary, the ACOE should develop a comprehensive document that will assess potential effects of the Searsport Harbor dredging on natural resources and subsequently satisfy consultation requirements under the ESA, MSA, and FWCA. The MSA and FWCA assessments may be subsumed by an Environmental Assessment or Environmental Impact Statement prepared pursuant to NEPA. As stated above, the ESA consultation must be handled separately from these other assessments. NMFS appreciates the ACOE's preliminary coordination and look forward to working with you further.

Sincerely,

Mary Colligan
Assistant Regional Administrator
For Protected Resources

cc: M. Habel (ACOE NAE)
C. Rogers (ACOE NAE)
W. Mahaney (USFWS)
N. Dube (MASC)
B. Swan (MDMR)
J. Murphy (NMFS)
J. Crocker (NMFS)
K. Koyama (NMFS)

File Code: Sec 7 Maine ACOE Dredge Searsport Harbor
PCTS I/NER/2006/04150

U.S. Fish & Wildlife Service

Fax

Ecological Services
Maine Field Office

1168 Main Street, Old Town, ME 04468
207/827 5938 Fax: 207/827 6099 http://northeast.fws.gov

TO: Catherine Rogers

FAX NO:

FROM: Wende Mahaney

DATE: 5-25-07

PAGES TO FOLLOW: 2

SUBJECT: Searsport Harbor

As mentioned, the Atlantic salmon should have been included in this letter.

Wende

U.S. DEPARTMENT OF THE INTERIOR
MARCH 3, 1849

United States Department of the Interior

FISH AND WILDLIFE SERVICE

Maine Field Office – Ecological Services
1168 Main Street
Old Town, ME 04468
(207) 827-5938 Fax: (207) 827-6099

In Reply Refer To: MEFO 06-420
FWS/Region5/ES/MEFO

September 27, 2006

John R. Kennelly
Department of the Army
New England District, Corps of Engineers
696 Virginia Road
Concord, MA 01742-2751

Dear Mr. Kennelly:

Thank you for your letter dated July 31, 2006 requesting information or recommendations from the U.S. Fish and Wildlife Service. This letter provides the Service's response pursuant to Section 7 of the Endangered Species Act (ESA), as amended (16 U.S.C. 1531-1543), and the Fish and Wildlife Coordination Act, as amended (16 U.S.C. 661-667d).

Project Name/Location: Mack Point/Sears Island harbor navigation project

Log Number: 06-420

Based on the information currently available to us, no federally-listed species under the jurisdiction of the Service are known to occur in the project area, with the exception of occasional, transient bald eagles (*Haliaeetus leucocephalus*). A bald eagle nest occurs on the southeast shore of Sears Island, but this is not located near the project areas as described on the maps provided to us. Accordingly, no further action is required under Section 7 of the ESA, unless: (1) new information reveals impacts of this identified action that may affect listed species or critical habitat in a manner not previously considered; (2) this action is subsequently modified in a manner that was not considered in this review; or (3) a new species is listed or critical habitat determined that may be affected by the identified action.

Please contact the Maine Department of Inland Fisheries and Wildlife and Maine Natural Areas Program for an up to date account of state-listed species in the project area.

If you have any questions, please call me at (207) 827-5938.

Sincerely,

Mark McCollough

TAKE PRIDE IN AMERICA

Mark McCollough, Ph.D.
Endangered Species Biologist

SEARSPORT HARBOR
SEARSPORT, MAINE
NAVIGATION IMPROVEMENT PROJECT

APPENDIX B

SUITABILITY DETERMINATION
FOR DREDGED MATERIAL PLACEMENT

CENAE–R-PT 18 February 2009

MEMORANDUM THRU

Ruth M. Ladd, Chief, Policy Analysis and Technical Support Branch

FOR: Barbara Blumeris, Project Manager, CENAE-EP-PS

SUBJECT: Suitability Determination for Searsport Harbor Federal Navigation Maintenance and Improvement Project, Penobscot Bay, Searsport, Maine.

1. **Project Description:**

The CENAE is proposing to dredge an area of approximately **101 acres** in Penobscot Bay, which will produce a volume of approximately **760,000 cu. yds**. of sandy, silty and clayey material. The material is principally improvement dredging material from the proposed deepening and widening of the channel and turning basin. A lesser amount of overlying maintenance material would also be removed. This material is proposed to be mechanically dredged and disposed of at either the Penobscot Bay Disposal Site (**PBDS**), the Belfast Bay Disposal Site (**BDS**) or the Rockland Disposal Site (**RDS**). All three sites are located inshore of the Territorial Sea baseline. The RDS is an active disposal site which receives dredged material in most years. The BDS is the site last used in 1964 for disposal of material from Searsport Harbor. The PBDS is a deep "hole" in the western area of the Bay identified by local interests as having received dredged material from past projects. All three sites were considered in this analysis.

A sampling plan for this project was prepared on 9 August 2007. The plan was coordinated with the U.S. Environmental Protection Agency, the U.S. Fish and Wildlife Service, the National Marine Fisheries Service, and the Maine Department of Environmental Protection. The federal agencies all responded to say they concurred.

The sampling plan called for eleven cores to be taken from the project area and three cores from BDS. The project area cores were composited into four composite samples for bulk sediment chemistry analysis. Three cores were also taken from PBDS, which was added as a possible disposal site after the SAP was finalized. The six cores from the disposal sites were individually analyzed for bulk sediment chemistry.

2. **Summary:**

This memorandum addresses compliance with the regulatory evaluation and testing requirements of 40 CFR Section 230.60 and 230.61, subpart G and testing requirements of 40 CFR Section 230.60 and 230.61, subpart G under the Clean Water Act 404(b)(1) guidelines. This evaluation confirms that sufficient information was obtained to properly evaluate the suitability of this material for open water disposal under the guidelines and finds the sediments suitable for disposal as proposed.

3. **Clean Water Act Regulatory Requirements:**

The disposal of sediments waterward of the high tide line in **Penobscot Bay** is regulated under Section 404 of the Clean Water Act. Subpart G of the Section 404(b)(1) guidelines describes the procedures for conducting this evaluation, including any relevant testing that may be required.

§230.60 General Evaluation of Dredged or Fill Material

(a) Further testing was necessary as it could not be determined with the existing information that the sediment is not a carrier of contaminants. The sediments proposed to be dredged were not mostly sand and not located in areas of high energy.

(b) Spills and Outfalls: The project area is a working port area with outfalls and recent spills. This subsection therefore does not apply.

(c) The material to be dredged and the material at the disposal site are not adjacent to each other, composed of the same materials and subject to the same sources of contaminants. Further testing was therefore required.

(d) This subsection states that further testing may not be necessary if the material to be dredged is constrained to reduce contamination within the disposal site and to prevent transport of contaminants beyond the boundaries of the disposal site. As such constraints in handling are not proposed, this subsection does not apply.

§230.61 Chemical, Biological and Physical Evaluation and Testing

(a) This subsection describes the purpose of §230.61 and does not give any criteria for the evaluation of sediments.

(b) Water column and benthic bioassay testing is not needed as it was determined, on the basis of evaluation of §230.61 (c), that the likelihood of contamination is low.

(c) An inventory of the total concentration of contaminants is of value in comparing sediment at the disposal and dredging sites. When the concentrations of the contaminants of concern from the project site are compared to the concentrations from the reference areas for PBDS, BDS or RDS, all are less than or slightly higher than the means plus twice the standard deviations. See the attached spreadsheets for details. Therefore, the sediments from this project are suitable for disposal at any of the proposed disposal sites.

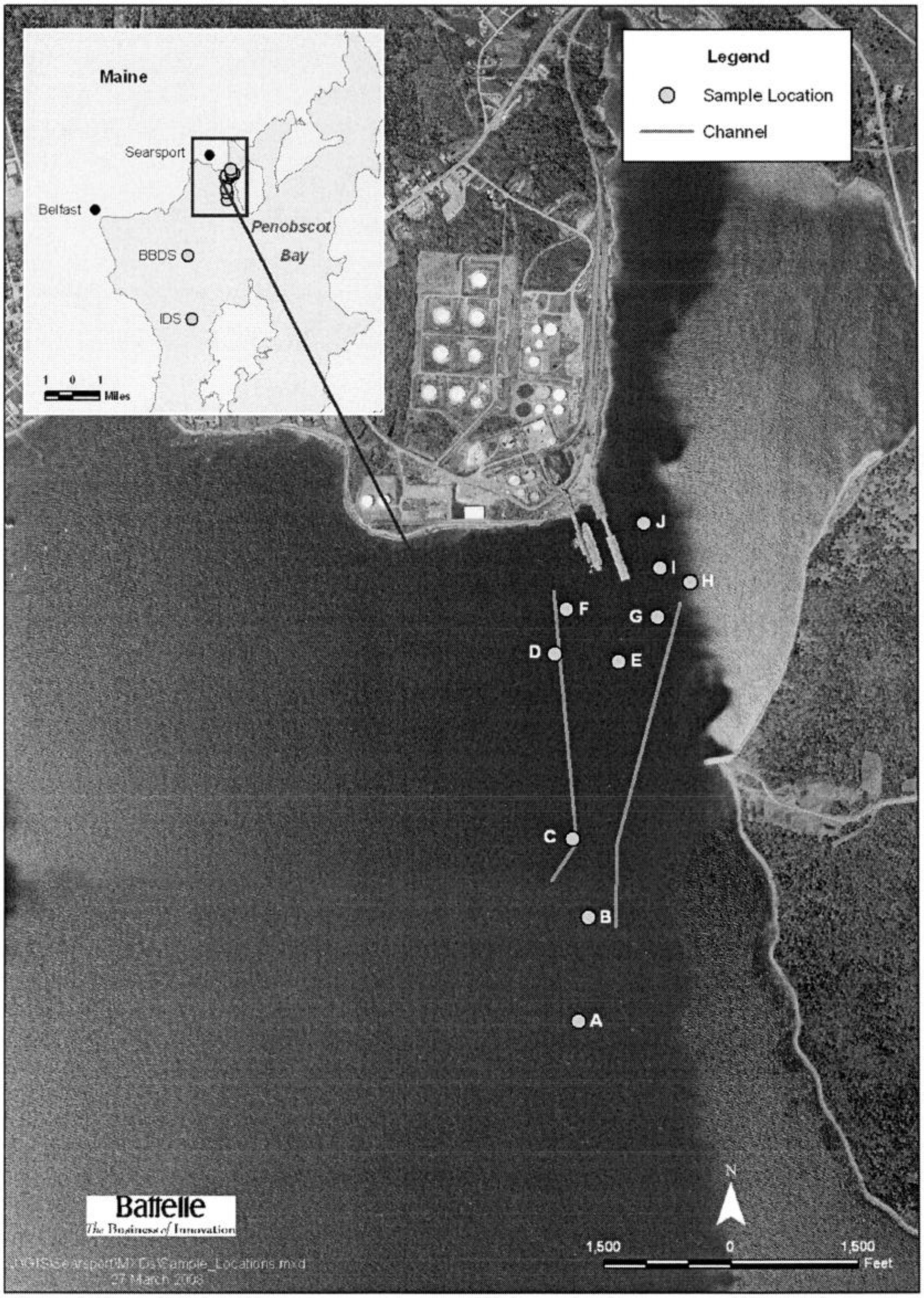
After review of the physical and chemical test data and site information, CENAE and the federal agencies did not think an analysis of biological community structure was needed for this project.

(d) The physical effects of the disposal of the dredged material at the disposal site should be minimal. Although some benthic marine organisms will be buried by the disposal, the disposal site should be rapidly re-colonized.

4. Copies of the above mentioned data and of the draft suitability determination were sent to the State DEP, US EPA, and US F&WS for their review. No responses were received from the Federal agencies within the 10-day response period so their concurrences may be assumed.

5. If you have any questions concerning this suitability determination, please contact me at (978) 318-8660.

Phillip Nimeskern
PHILLIP NIMESKERN
Project Manager,
Marine Analysis Section


Maine
Searsport
Belfast
Penobscot
Bay
BBDS
IDS
1 0 1
Miles
Legend
Sample Location
Channel
J
I
H
F
G
D
E
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B
A
N
Battelle
The Business of Innovation
1,500
0
1,500
Feet
\GIS\Searsport\MXDs\Sample_Locations.mxd
27 March 2008

Non Normalized Pollutant Concentrations
Project: Searsport Harbor 2008 DO #41
USACE Contract Number: DACW3303D0004

		Belfast Bay DS			Belfast Bay DS			Belfast Bay DS			Penobscot DS		
Analyte	RDS	HAC-012			HAC-013			HAC-014			HAC-015		
Metals (ppm)	mean + 2sd	Raw Data	Qualifier	Comparison	Raw Data	Qualifier	Comparison	Raw Data	Qualifier	Comparison	Raw Data	Qualifier	Comparison
Arsenic	16.9	13.49		OK	14.16		OK	14.29		OK	12.51		OK
Cadmium	0.4	0.09		OK	0.09		OK	0.09		OK	0.07		OK
Chromium	45.4	87.39		1.92	87.13		1.92	87.00		1.92	81.97		1.81
Copper	15.9	19.62		1.23	18.84		1.19	19.54		1.23	17.52		1.1
Lead	31.5	26.38		OK	26.78		OK	26.65		OK	22.50		OK
Mercury	0.1	0.28		2.78	0.29		2.89	0.26		2.61	0.14		1.36
Nickel	33.2	37.63		1.13	36.78		1.11	37.74		1.14	36.91		1.11
Zinc	128.5	113.57		OK	110.77		OK	113.95		OK	106.07		OK
% fines													
PAH's (ppb)													
Acenaphthene	15	4.02		OK	4.19		OK	4.69		OK	2.42		OK
Acenaphthylene	13	23.38		1.8	24.68		1.9	23.87		1.84	14.12		1.09
Anthracene	24	22.93		OK	22.99		OK	23.24		OK	12.69		OK
Fluorene	18	7.70		OK	7.85		OK	8.56		OK	4.53		OK
Naphthalene	8	10.66		1.33	11.12		1.39	12.38		1.55	6.28		OK
Phenanthrene	57	79.11		1.39	80.78		1.42	79.36		1.39	46.42		OK
Benzo(a)anthracene	47	68.90		1.47	70.48		1.5	70.55		1.5	40.23		OK
Benzo(a)pyrene	55	91.75		1.67	96.94		1.76	93.14		1.69	55.58		1.01
Benzo(g,h,i)perylene	42	75.56		1.8	80.52		1.92	76.86		1.83	47.89		1.14
Chrysene	58	82.30		1.42	86.62		1.49	87.54		1.51	51.30		OK
Dibenzo(a,h)anthracene	15	17.69		1.18	18.50		1.23	18.25		1.22	10.98		OK
Fluoranthene	93	172.09		1.85	177.95		1.91	173.59		1.87	104.52		1.12
Indeno(1,2,3-cd)pyrene	49	81.69		1.67	87.13		1.78	83.19		1.7	52.12		1.06
Pyrene	96	158.29		1.65	164.93		1.72	161.85		1.69	93.85		OK
Total Benzofluoranthenes	106	172.42		1.63	188.00		1.77	178.94		1.69	111.60		1.05
TOC		2.67			2.66			2.67			2.15		
Sum of PAHs		1068.49			1122.68			1096.01			654.53		
Pesticides (ppb)													
4,4'-DDD	-999	0.56		*No Ref*	0.63		*No Ref*	0.60		*No Ref*	0.25	J	*No Ref*
4,4'-DDE	-999	0.30	J	*No Ref*	0.35	J	*No Ref*	0.31	J	*No Ref*	0.19	J	*No Ref*
4,4'-DDT	-999	0.45		*No Ref*	0.52		*No Ref*	0.56		*No Ref*	0.36	J	*No Ref*
Aldrin	-999	1.73		*No Ref*	0.39	U	*No Ref*	0.40	U	*No Ref*	0.41	U	*No Ref*
Cis-Chlordane	-999	0.41	U	*No Ref*	0.39	U	*No Ref*	0.40	U	*No Ref*	0.41	U	*No Ref*

Delta-BHC	-999								
Dieldrin	-999	0.41 U	*No Ref*	0.39 U	*No Ref*	0.40 U	*No Ref*	0.41 U	*No Ref*
Endosulfan II	-999	0.31 J	*No Ref*	0.32 J	*No Ref*	0.39 J	*No Ref*	0.20 J	*No Ref*
Endrin	-999	0.41 U	*No Ref*	0.39 U	*No Ref*	0.40 U	*No Ref*	0.41 U	*No Ref*
Heptachlor	-999	0.41 U	*No Ref*	0.39 U	*No Ref*	0.40 U	*No Ref*	0.41 U	*No Ref*
Heptachlor epoxide	-999	0.41 U	*No Ref*	0.39 U	*No Ref*	0.40 U	*No Ref*	0.41 U	*No Ref*
Hexachlorobenzene	-999	0.41 U	*No Ref*	0.39 U	*No Ref*	0.20 J	*No Ref*	0.13 J	*No Ref*
Lindane	-999	0.41 U	*No Ref*	0.39 U	*No Ref*	0.40 U	*No Ref*	0.41 U	*No Ref*
Methoxychlor	-999	0.41 U	*No Ref*	0.39 U	*No Ref*	0.40 U	*No Ref*	0.41 U	*No Ref*
Oxychlordane	-999	0.41 U	*No Ref*	0.39 U	*No Ref*	0.40 U	*No Ref*	0.41 U	*No Ref*
Toxaphene	-999	32.47 U	*No Ref*	31.55 U	*No Ref*	31.83 U	*No Ref*	32.02 U	*No Ref*
Trans-chlordane	-999	0.41 U	*No Ref*	0.40 U	*No Ref*	0.40 U	*No Ref*	0.41 U	*No Ref*
endosulfan I	-999	0.41 U	*No Ref*	0.39 U	*No Ref*	0.40 U	*No Ref*	0.41 U	*No Ref*
Total Pesticides									
PCBs (ppb)									
PCB 101	-999	0.41 U	*No Ref*	0.39 U	*No Ref*	0.40 U	*No Ref*	0.40 U	*No Ref*
PCB 105	-999	0.41 U	*No Ref*	0.39 U	*No Ref*	0.40 U	*No Ref*	0.41 U	*No Ref*
PCB 118	-999	0.41 U	*No Ref*	0.34 J	*No Ref*	0.36 J	*No Ref*	0.41 U	*No Ref*
PCB 128	-999	0.41 U	*No Ref*	0.39 U	*No Ref*	0.40 U	*No Ref*	0.41 U	*No Ref*
PCB 138	-999	0.35 J	*No Ref*	0.41	*No Ref*	0.32 J	*No Ref*	0.20 J	*No Ref*
PCB 153	-999	0.28 J	*No Ref*	0.39	*No Ref*	0.29 J	*No Ref*	0.20 J	*No Ref*
PCB 170	-999	0.41 U	*No Ref*	0.39 U	*No Ref*	0.40 U	*No Ref*	0.41 U	*No Ref*
PCB 18	-999	0.41 U	*No Ref*	0.39 U	*No Ref*	0.40 U	*No Ref*	0.41 U	*No Ref*
PCB 180	-999	0.41 U	*No Ref*	0.39 U	*No Ref*	0.40 U	*No Ref*	0.41 U	*No Ref*
PCB 183	-999	0.40 U	*No Ref*	0.39 U	*No Ref*	0.39 U	*No Ref*	0.40 U	*No Ref*
PCB 184	-999	0.40 U	*No Ref*	0.39 U	*No Ref*	0.39 U	*No Ref*	0.40 U	*No Ref*
PCB 187	-999	0.41 U	*No Ref*	0.39 U	*No Ref*	0.40 U	*No Ref*	0.40 U	*No Ref*
PCB 195	-999	0.41 U	*No Ref*	0.39 U	*No Ref*	0.40 U	*No Ref*	0.41 U	*No Ref*
PCB 206	-999	0.41 U	*No Ref*	0.39 U	*No Ref*	0.40 U	*No Ref*	0.41 U	*No Ref*
PCB 209	-999	0.41 U	*No Ref*	0.39 U	*No Ref*	0.40 U	*No Ref*	0.41 U	*No Ref*
PCB 28	-999	0.41 U	*No Ref*	0.39 U	*No Ref*	0.40 U	*No Ref*	0.41 U	*No Ref*
PCB 44	-999	0.41 U	*No Ref*	0.39 U	*No Ref*	0.40 U	*No Ref*	0.40 U	*No Ref*
PCB 49	-999	0.41 U	*No Ref*	0.40 U	*No Ref*	0.40 U	*No Ref*	0.41 U	*No Ref*
PCB 52	-999	0.41 U	*No Ref*	0.40 U	*No Ref*	0.40 U	*No Ref*	0.41 U	*No Ref*
PCB 66	-999	0.41 U	*No Ref*	0.40 U	*No Ref*	0.40 U	*No Ref*	0.41 U	*No Ref*
PCB 8	-999	0.41 U	*No Ref*	0.39 U	*No Ref*	0.40 U	*No Ref*	0.40 U	*No Ref*
PCB 87	-999	0.41 U	*No Ref*	0.39 U	*No Ref*	0.40 U	*No Ref*	0.41 U	*No Ref*
Total PCBs		14.38		14.02		13.94		13.84	

Total PCBs is 2 x [sum of Congeners 8, 18, 28, 44, 52, 66, 101, 105, 118, 128, 138, 153, 170, 180, 187, 195, 206, 209]
Cells in Orange are greater than 10X above reference value
Cells in Yellow are 3-10X above reference value

Penobscot DS			Penobscot DS			Composite ABC			Composite DF			Composite EGHI			Sample J		
HAC-016			HAC-017			HAC-019			HAC-020			HAC-021			HAC-022		
Raw Data	Qualifier	Comparison	Raw Data	Qualifier	Comparison	Raw Data	Qualifier	Comparison	Raw Data	Qualifier	Comparison	Raw Data	Qualifier	Comparison	Raw Data	Qualifier	Comparison
12.50		OK	12.43		OK	15.80		OK	17.99		1.06	14.87		OK	17.04		1.01
0.07		OK	0.08		OK	0.09		OK	0.17		OK	0.12		OK	0.16		OK
85.37		1.88	84.28		1.86	81.80		1.8	75.71		1.67	63.25		1.39	47.39		1.04
17.93		1.13	17.68		1.11	16.96		1.07	16.17		1.02	15.84		OK	8.76		OK
22.46		OK	23.34		OK	18.28		OK	15.67		OK	11.37		OK	10.09		OK
0.15		1.5	0.15		1.5	0.13		1.29	0.11		1.1	0.04		OK	0.04		OK
36.78		1.11	36.34		1.09	36.92		1.11	33.98		1.02	30.51		OK	19.84		OK
108.91		OK	107.21		OK	97.71		OK	89.02		OK	65.05		OK	48.39		OK
2.47		OK	2.33		OK	2.50		OK	6.68		OK	1.19		OK	7.00		OK
14.70		1.13	14.11		1.09	11.72		OK	16.12		1.24	4.12		OK	8.71		OK
12.93		OK	12.55		OK	13.14		OK	29.83		1.24	5.23		OK	20.60		OK
4.52		OK	4.50		OK	5.45		OK	11.21		OK	2.59		OK	12.27		OK
6.63		OK	6.55		OK	10.08		1.26	17.66		2.21	5.06		OK	23.57		2.95
47.58		OK	46.26		OK	45.42		OK	69.24		1.21	16.93		OK	48.41		OK
41.00		OK	39.45		OK	39.49		OK	61.20		1.3	14.07		OK	35.87		OK
56.22		1.02	54.51		OK	47.59		OK	69.75		1.27	15.08		OK	37.17		OK
48.27		1.15	46.97		1.12	38.32		OK	47.13		1.12	11.65		OK	24.45		OK
51.39		OK	49.62		OK	47.19		OK	83.63		1.44	16.24		OK	50.20		OK
11.20		OK	10.72		OK	9.73		OK	13.18		OK	3.34		OK	7.52		OK
108.07		1.16	103.58		1.11	87.46		OK	114.65		1.23	26.62		OK	71.62		OK
52.98		1.08	51.36		1.05	40.02		OK	49.02		1	11.65		OK	24.57		OK
97.18		1.01	93.82		OK	89.64		OK	143.83		1.5	32.03		OK	113.71		1.18
112.84		1.06	110.66		1.04	91.80		OK	143.24		1.35	31.50		OK	78.20		OK
2.16			2.12			2.41			2.53			1.58			0.97		
667.98			646.99			579.55			876.37			197.30			563.87		
0.32	J	*No Ref*	0.32	J	*No Ref*	0.29	J	*No Ref*	0.30	J	*No Ref*	0.12	J	*No Ref*	0.21	J	*No Ref*
0.24	J	*No Ref*	0.24	J	*No Ref*	0.12	J	*No Ref*	0.13	J	*No Ref*	0.29	U	*No Ref*	0.23	U	*No Ref*
0.38	J	*No Ref*	0.35	J	*No Ref*	0.36	U	*No Ref*	0.30	J	*No Ref*	0.28	U	*No Ref*	0.23	U	*No Ref*
0.40	U	*No Ref*	0.39	U	*No Ref*	0.36	U	*No Ref*	0.38	U	*No Ref*	0.28	U	*No Ref*	0.23	U	*No Ref*
0.40	U	*No Ref*	0.39	U	*No Ref*	0.36	U	*No Ref*	0.38	U	*No Ref*	0.28	U	*No Ref*	0.23	U	*No Ref*

0.40 U	*No Ref*	0.39 U	*No Ref*	0.36 U	*No Ref*	0.38 U	*No Ref*	0.28 U	*No Ref*	0.23 U	*No Ref*
0.20 J	*No Ref*	0.21 J	*No Ref*	0.36 U	*No Ref*	0.22 J	*No Ref*	0.28 U	*No Ref*	0.23	*No Ref*
0.40 U	*No Ref*	0.39 U	*No Ref*	0.36 U	*No Ref*	0.38 U	*No Ref*	0.28 U	*No Ref*	0.23 U	*No Ref*
0.40 U	*No Ref*	0.39 U	*No Ref*	0.36 U	*No Ref*	0.38 U	*No Ref*	0.28 U	*No Ref*	0.23 U	*No Ref*
0.40 U	*No Ref*	0.39 U	*No Ref*	0.36 U	*No Ref*	0.38 U	*No Ref*	0.28 U	*No Ref*	0.23 U	*No Ref*
0.10 J	*No Ref*	0.13 J	*No Ref*	0.36 U	*No Ref*	0.12 J	*No Ref*	0.28 U	*No Ref*	0.23 U	*No Ref*
0.40 U	*No Ref*	0.39 U	*No Ref*	0.36 U	*No Ref*	0.38 U	*No Ref*	0.28 U	*No Ref*	0.23 U	*No Ref*
0.40 U	*No Ref*	0.39 U	*No Ref*	0.36 U	*No Ref*	0.38 U	*No Ref*	0.28 U	*No Ref*	0.23 U	*No Ref*
0.40 U	*No Ref*	0.39 U	*No Ref*	0.36 U	*No Ref*	0.38 U	*No Ref*	0.28 U	*No Ref*	0.23 U	*No Ref*
31.17 U	*No Ref*	31.17 U	*No Ref*	28.71 U	*No Ref*	30.55 U	*No Ref*	22.76 U	*No Ref*	18.64 U	*No Ref*
0.40 U	*No Ref*	0.39 U	*No Ref*	0.36 U	*No Ref*	0.38 U	*No Ref*	0.29 U	*No Ref*	0.23 U	*No Ref*
0.40 U	*No Ref*	0.39 U	*No Ref*	0.36 U	*No Ref*	0.38 U	*No Ref*	0.28 U	*No Ref*	0.23 U	*No Ref*
0.40 U	*No Ref*	0.39 U	*No Ref*	0.36 U	*No Ref*	0.38 U	*No Ref*	0.28 U	*No Ref*	0.23 U	*No Ref*
0.40 U	*No Ref*	0.39 U	*No Ref*	0.36 U	*No Ref*	0.38 U	*No Ref*	0.28 U	*No Ref*	0.23 U	*No Ref*
0.40 U	*No Ref*	0.22 J	*No Ref*	0.36 U	*No Ref*	0.23 J	*No Ref*	0.29 U	*No Ref*	0.24 U	*No Ref*
0.40 U	*No Ref*	0.39 U	*No Ref*	0.36 U	*No Ref*	0.38 U	*No Ref*	0.28 U	*No Ref*	0.23 U	*No Ref*
0.25 J	*No Ref*	0.20 J	*No Ref*	0.36 U	*No Ref*	0.21 J	*No Ref*	0.29 U	*No Ref*	0.24 U	*No Ref*
0.20 J	*No Ref*	0.19 J	*No Ref*	0.18 J	*No Ref*	0.26 J	*No Ref*	0.28 U	*No Ref*	0.13 J	*No Ref*
0.40 U	*No Ref*	0.39 U	*No Ref*	0.36 U	*No Ref*	0.38 U	*No Ref*	0.28 U	*No Ref*	0.23 U	*No Ref*
0.40 U	*No Ref*	0.39 U	*No Ref*	0.36 U	*No Ref*	0.38 U	*No Ref*	0.28 U	*No Ref*	0.23 U	*No Ref*
0.40 U	*No Ref*	0.39 U	*No Ref*	0.36 U	*No Ref*	0.38 U	*No Ref*	0.28 U	*No Ref*	0.23 U	*No Ref*
0.40 U	*No Ref*	0.39 U	*No Ref*	0.36 U	*No Ref*	0.38 U	*No Ref*	0.28 U	*No Ref*	0.23 U	*No Ref*
0.40 U	*No Ref*	0.39 U	*No Ref*	0.36 U	*No Ref*	0.38 U	*No Ref*	0.28 U	*No Ref*	0.23 U	*No Ref*
0.40 U	*No Ref*	0.39 U	*No Ref*	0.36 U	*No Ref*	0.38 U	*No Ref*	0.28 U	*No Ref*	0.23 U	*No Ref*
0.40 U	*No Ref*	0.39 U	*No Ref*	0.36 U	*No Ref*	0.38 U	*No Ref*	0.28 U	*No Ref*	0.23 U	*No Ref*
0.40 U	*No Ref*	0.39 U	*No Ref*	0.36 U	*No Ref*	0.38 U	*No Ref*	0.28 U	*No Ref*	0.23 U	*No Ref*
0.40 U	*No Ref*	0.39 U	*No Ref*	0.36 U	*No Ref*	0.38 U	*No Ref*	0.28 U	*No Ref*	0.23 U	*No Ref*
0.40 U	*No Ref*	0.39 U	*No Ref*	0.36 U	*No Ref*	0.38 U	*No Ref*	0.28 U	*No Ref*	0.23 U	*No Ref*
0.40 U	*No Ref*	0.39 U	*No Ref*	0.36 U	*No Ref*	0.38 U	*No Ref*	0.28 U	*No Ref*	0.23 U	*No Ref*
0.40 U	*No Ref*	0.39 U	*No Ref*	0.36 U	*No Ref*	0.38 U	*No Ref*	0.29 U	*No Ref*	0.23 U	*No Ref*
0.40 U	*No Ref*	0.39 U	*No Ref*	0.36 U	*No Ref*	0.38 U	*No Ref*	0.29 U	*No Ref*	0.23 U	*No Ref*
0.40 U	*No Ref*	0.39 U	*No Ref*	0.36 U	*No Ref*	0.38 U	*No Ref*	0.29 U	*No Ref*	0.23 U	*No Ref*
0.40 U	*No Ref*	0.39 U	*No Ref*	0.36 U	*No Ref*	0.38 U	*No Ref*	0.28 U	*No Ref*	0.23 U	*No Ref*
0.40 U	*No Ref*	0.39 U	*No Ref*	0.36 U	*No Ref*	0.38 U	*No Ref*	0.28 U	*No Ref*	0.23 U	*No Ref*
13.70		12.92		12.60		12.80		10.16		8.12	

Non-Normalized Pollutant Concentrations
Project: Searsport Harbor 2008 DO #41
USACE Contract Number: DACW3303D0004

		Composite ABC			Composite DF			Composite EGHI			Sample J		
Analyte	Belfast Bay DS	HAC-019			HAC-020			HAC-021			HAC-022		
Metals (ppm)	mean + 2sd	Raw Data	Qualifier	Comparison	Raw Data	Qualifier	Comparison	Raw Data	Qualifier	Comparison	Raw Data	Qualifier	Comparison
Arsenic	14.84	15.8		*	17.99		*	14.87		*	17.04		*
Cadmium	0.10	0.09125		OK	0.172		*	0.1184		*	0.1589		*
Chromium	87.57	81.79518		OK	75.71439		OK	63.2504		OK	47.38917		OK
Copper	20.19	16.96471		OK	16.1666		OK	15.83822		OK	8.75812		OK
Lead	27.01	18.27706		OK	15.67054		OK	11.37257		OK	10.0929		OK
Mercury	0.30	0.12852		OK	0.11042		OK	0.044		OK	0.04201		OK
Nickel	38.44	36.9238		OK	33.98498		OK	30.50859		OK	19.83592		OK
Zinc	116.24	97.70847		OK	89.02053		OK	65.04621		OK	48.38832		OK
% fines													
PAH's (ppb)													
Acenaphthene	5.00	2.5		OK	6.68		*	1.19		OK	7		*
Acenaphthylene	25.29	11.72		OK	16.12		OK	4.12		OK	8.71		OK
Anthracene	23.38	13.14		OK	29.83		*	5.23		OK	20.6		OK
Fluorene	8.96	5.45		OK	11.21		*	2.59		OK	12.27		*
Naphthalene	13.17	10.08		OK	17.66		*	5.06		OK	23.57		*
Phenanthrene	81.55	45.42		OK	69.24		OK	16.93		OK	48.41		OK
Benzo(a)anthracene	71.84	39.49		OK	61.2		OK	14.07		OK	35.87		OK
Benzo(a)pyrene	99.32	47.59		OK	69.75		OK	15.08		OK	37.17		OK
Benzo(g,h,i)perylene	82.79	38.32		OK	47.13		OK	11.65		OK	24.45		OK
Chrysene	91.08	47.19		OK	83.63		OK	16.24		OK	50.2		OK
Dibenzo(a,h)anthracene	18.98	9.73		OK	13.18		OK	3.34		OK	7.52		OK
Fluoranthene	180.63	87.46		OK	114.65		OK	26.62		OK	71.62		OK
Indeno(1,2,3-cd)pyrene	89.62	40.02		OK	49.02		OK	11.65		OK	24.57		OK
Pyrene	168.34	89.64		OK	143.83		OK	32.03		OK	113.71		OK
Total Benzofluoranthenes	195.44	91.8		OK	143.24		OK	31.5		OK	78.2		OK
TOC		2.41			2.53			1.58			0.97		
Sum of PAH's		579.55			876.3699			197.3			563.87		
Pesticides (ppb)													
4,4'-DDD	0.67	0.29	J	OK	0.3	J	OK	0.12	J	OK	0.21	J	OK
4,4'-DDE	0.37	0.12	J	OK	0.13	J	OK	0.29	U	OK	0.23	U	OK
4,4'-DDT	0.62	0.36	U	OK	0.3	J	OK	0.28	U	OK	0.23	U	OK
Aldrin	2.38	0.36	U	OK	0.38	U	OK	0.28	U	OK	0.23	U	OK
Cis-Chlordane	0.42	0.36	U	OK	0.38	U	OK	0.28	U	OK	0.23	U	OK
Delta-BHC	0.00												
Dieldrin	0.42	0.36	U	OK	0.38	U	OK	0.28	U	OK	0.23	U	OK
Endosulfan II	0.43	0.36	U	OK	0.22	J	OK	0.28	U	OK	0.23		OK
Endrin	0.42	0.36	U	OK	0.38	U	OK	0.28	U	OK	0.23	U	OK
Heptachlor	0.42	0.36	U	OK	0.38	U	OK	0.28	U	OK	0.23	U	OK
Heptachlor epoxide	0.42	0.36	U	OK	0.38	U	OK	0.28	U	OK	0.23	U	OK
Hexachlorobenzene	0.57	0.36	U	OK	0.12	J	OK	0.28	U	OK	0.23	U	OK
Lindane	0.42	0.36	U	OK	0.38	U	OK	0.28	U	OK	0.23	U	OK
Methoxychlor	0.42	0.36	U	OK	0.38	U	OK	0.28	U	OK	0.23	U	OK
Oxychlordane	0.42	0.36	U	OK	0.38	U	OK	0.28	U	OK	0.23	U	OK
Toxaphene	33.18	28.71	U	OK	30.55	U	OK	22.76	U	OK	18.64	U	OK
Trans-chlordane	0.41	0.36	U	OK	0.38	U	OK	0.29	U	OK	0.23	U	OK
endosulfan I	0.42	0.36	U	OK	0.38	U	OK	0.28	U	OK	0.23	U	OK
Total Pesticides													

PCBs (ppb)									
PCB 101	0.42	0.36 U	OK	0.38 U	OK	0.28 U	OK	0.23 U	OK
PCB 105	0.42	0.36 U	OK	0.38 U	OK	0.28 U	OK	0.23 U	OK
PCB 118	0.44	0.36 U	OK	0.23 J	OK	0.29 U	OK	0.24 U	OK
PCB 128	0.42	0.36 U	OK	0.38 U	OK	0.28 U	OK	0.23 U	OK
PCB 138	0.45	0.36 U	OK	0.21 J	OK	0.29 U	OK	0.24 U	OK
PCB 153	0.44	0.18 J	OK	0.26 J	OK	0.28 U	OK	0.13 J	OK
PCB 170	0.42	0.36 U	OK	0.38 U	OK	0.28 U	OK	0.23 U	OK
PCB 18	0.42	0.36 U	OK	0.38 U	OK	0.28 U	OK	0.23 U	OK
PCB 180	0.42	0.36 U	OK	0.38 U	OK	0.28 U	OK	0.23 U	OK
PCB 183	0.40	0.36 U	OK	0.38 U	OK	0.28 U	OK	0.23 U	OK
PCB 184	0.40	0.36 U	OK	0.38 U	OK	0.28 U	OK	0.23 U	OK
PCB 187	0.42	0.36 U	OK	0.38 U	OK	0.28 U	OK	0.23 U	OK
PCB 195	0.42	0.36 U	OK	0.38 U	OK	0.28 U	OK	0.23 U	OK
PCB 206	0.42	0.36 U	OK	0.38 U	OK	0.28 U	OK	0.23 U	OK
PCB 209	0.42	0.36 U	OK	0.38 U	OK	0.28 U	OK	0.23 U	OK
PCB 28	0.42	0.36 U	OK	0.38 U	OK	0.28 U	OK	0.23 U	OK
PCB 44	0.42	0.36 U	OK	0.38 U	OK	0.28 U	OK	0.23 U	OK
PCB 49	0.41	0.36 U	OK	0.38 U	OK	0.29 U	OK	0.23 U	OK
PCB 52	0.41	0.36 U	OK	0.38 U	OK	0.29 U	OK	0.23 U	OK
PCB 66	0.41	0.36 U	OK	0.38 U	OK	0.29 U	OK	0.23 U	OK
PCB 8	0.42	0.36 U	OK	0.38 U	OK	0.28 U	OK	0.23 U	OK
PCB 87	0.42	0.36 U	OK	0.38 U	OK	0.28 U	OK	0.23 U	OK
Total PCBs		12.6		12.8		10.16		8.12	

Total PCBs is 2 x [sum of Congeners 8, 18, 28, 44, 52, 66, 101, 105, 118, 128, 138, 153, 170, 180, 187, 195, 206, 209]

Cells in Orange are greater than 10X above reference value

Cells in Yellow are 3-10X above reference value

Non-Normalized Pollutant Concentrations
Project: Searsport Harbor 2008 DO #41
USACE Contract Number: DACW3303D0004

		Composite ABC			Composite DF			Composite EGHI			Sample J		
Analyte	Penobscot DS	HAC-019			HAC-020			HAC-021			HAC-022		
Metals (ppm)	mean + 2sd	Raw Data	Qualifier	Comparison	Raw Data	Qualifier	Comparison	Raw Data	Qualifier	Comparison	Raw Data	Qualifier	Comparison
Arsenic	12.57	15.8		*	17.99		*	14.87		*	17.04		*
Cadmium	0.08	0.09125		*	0.172		*	0.1184		*	0.1589		*
Chromium	87.34	81.79518		OK	75.71439		OK	63.2504		OK	47.38917		OK
Copper	18.12	16.96471		OK	16.1666		OK	15.83822		OK	8.75812		OK
Lead	23.76	18.27706		OK	15.67054		OK	11.37257		OK	10.0929		OK
Mercury	0.16	0.12852		OK	0.11042		OK	0.044		OK	0.04201		OK
Nickel	37.27	36.9238		OK	33.98498		OK	30.50859		OK	19.83592		OK
Zinc	110.25	97.70847		OK	89.02053		OK	65.04621		OK	48.38832		OK
% fines													
PAH's (ppb)													
Acenaphthene	2.55	2.5		OK	6.68		*	1.19		OK	7		*
Acenaphthylene	14.99	11.72		OK	16.12		*	4.12		OK	8.71		OK
Anthracene	13.11	13.14		*	29.83		*	5.23		OK	20.6		*
Fluorene	4.55	5.45		*	11.21		*	2.59		OK	12.27		*
Naphthalene	6.85	10.08		*	17.66		*	5.06		OK	23.57		*
Phenanthrene	48.19	45.42		OK	69.24		*	16.93		OK	48.41		*
Benzo(a)anthracene	41.78	39.49		OK	61.2		*	14.07		OK	35.87		OK
Benzo(a)pyrene	57.16	47.59		OK	69.75		*	15.08		OK	37.17		OK
Benzo(g,h,i)perylene	49.05	38.32		OK	47.13		OK	11.65		OK	24.45		OK
Chrysene	52.76	47.19		OK	83.63		*	16.24		OK	50.2		OK
Dibenzo(a,h)anthracene	11.45	9.73		OK	13.18		*	3.34		OK	7.52		OK
Fluoranthene	110.13	87.46		OK	114.65		*	26.62		OK	71.62		OK
Indeno(1,2,3-cd)pyrene	53.77	40.02		OK	49.02		OK	11.65		OK	24.57		OK
Pyrene	98.81	89.64		OK	143.83		*	32.03		OK	113.71		*
Total Benzofluoranthenes	113.89	91.8		OK	143.24		*	31.5		OK	78.2		OK
TOC		2.41			2.53			1.58			0.97		
Sum of PAH's		579.55			876.3699			197.3			563.87		
Pesticides (ppb)													
4,4'-DDD	0.38	0.29	J	OK	0.3	J	OK	0.12	J	OK	0.21	J	OK
4,4'-DDE	0.28	0.12	J	OK	0.13	J	OK	0.29	U	*	0.23	U	OK
4,4'-DDT	0.39	0.36	U	OK	0.3	J	OK	0.28	U	OK	0.23	U	OK
Aldrin	0.42	0.36	U	OK	0.38	U	OK	0.28	U	OK	0.23	U	OK
Cis-Chlordane	0.42	0.36	U	OK	0.38	U	OK	0.28	U	OK	0.23	U	OK
Delta-BHC	0.00												
Dieldrin	0.42	0.36	U	OK	0.38	U	OK	0.28	U	OK	0.23	U	OK
Endosulfan II	0.21	0.36	U	*	0.22	J	*	0.28	U	*	0.23		*
Endrin	0.42	0.36	U	OK	0.38	U	OK	0.28	U	OK	0.23	U	OK
Heptachlor	0.42	0.36	U	OK	0.38	U	OK	0.28	U	OK	0.23	U	OK
Heptachlor epoxide	0.42	0.36	U	OK	0.38	U	OK	0.28	U	OK	0.23	U	OK
Hexachlorobenzene	0.15	0.36	U	*	0.12	J	OK	0.28	U	*	0.23	U	*
Lindane	0.42	0.36	U	OK	0.38	U	OK	0.28	U	OK	0.23	U	OK
Methoxychlor	0.42	0.36	U	OK	0.38	U	OK	0.28	U	OK	0.23	U	OK
Oxychlordane	0.42	0.36	U	OK	0.38	U	OK	0.28	U	OK	0.23	U	OK
Toxaphene	33.37	28.71	U	OK	30.55	U	OK	22.76	U	OK	18.64	U	OK
Trans-chlordane	0.42	0.36	U	OK	0.38	U	OK	0.29	U	OK	0.23	U	OK
endosulfan I	0.42	0.36	U	OK	0.38	U	OK	0.28	U	OK	0.23	U	OK

Total Pesticides								-89.36	
PCBs (ppb)									
PCB 101	0.41	0.36 U	OK	0.38 U	OK	0.28 U	OK	0.23 U	OK
PCB 105	0.42	0.36 U	OK	0.38 U	OK	0.28 U	OK	0.23 U	OK
PCB 118	0.56	0.36 U	OK	0.23 J	OK	0.29 U	OK	0.24 U	OK
PCB 128	0.42	0.36 U	OK	0.38 U	OK	0.28 U	OK	0.23 U	OK
PCB 138	0.27	0.36 U	*	0.21 J	OK	0.29 U	*	0.24 U	OK
PCB 153	0.21	0.18 J	OK	0.26 J	*	0.28 U	*	0.13 J	OK
PCB 170	0.42	0.36 U	OK	0.38 U	OK	0.28 U	OK	0.23 U	OK
PCB 18	0.42	0.36 U	OK	0.38 U	OK	0.28 U	OK	0.23 U	OK
PCB 180	0.42	0.36 U	OK	0.38 U	OK	0.28 U	OK	0.23 U	OK
PCB 183	0.41	0.36 U	OK	0.38 U	OK	0.28 U	OK	0.23 U	OK
PCB 184	0.41	0.36 U	OK	0.38 U	OK	0.28 U	OK	0.23 U	OK
PCB 187	0.41	0.36 U	OK	0.38 U	OK	0.28 U	OK	0.23 U	OK
PCB 195	0.42	0.36 U	OK	0.38 U	OK	0.28 U	OK	0.23 U	OK
PCB 206	0.42	0.36 U	OK	0.38 U	OK	0.28 U	OK	0.23 U	OK
PCB 209	0.42	0.36 U	OK	0.38 U	OK	0.28 U	OK	0.23 U	OK
PCB 28	0.42	0.36 U	OK	0.38 U	OK	0.28 U	OK	0.23 U	OK
PCB 44	0.41	0.36 U	OK	0.38 U	OK	0.28 U	OK	0.23 U	OK
PCB 49	0.42	0.36 U	OK	0.38 U	OK	0.29 U	OK	0.23 U	OK
PCB 52	0.42	0.36 U	OK	0.38 U	OK	0.29 U	OK	0.23 U	OK
PCB 66	0.42	0.36 U	OK	0.38 U	OK	0.29 U	OK	0.23 U	OK
PCB 8	0.41	0.36 U	OK	0.38 U	OK	0.28 U	OK	0.23 U	OK
PCB 87	0.42	0.36 U	OK	0.38 U	OK	0.28 U	OK	0.23 U	OK
Total PCBs		12.6		12.8		10.16		8.12	

Total PCBs is 2 x [sum of Congeners 8, 18, 28, 44, 52, 66, 101, 105, 118, 128, 138, 153, 170, 180, 187, 195, 206, 209]

SEARSPORT HARBOR
SEARSPORT, MAINE
NAVIGATION IMPROVEMENT PROJECT

APPENDIX C

BENTHIC
RESOURCES DATA

IDENTIFICATION AND ENUMERATION OF BENTHIC MACROFAUNA FROM SEARSPORT, PENOBSCOT BAY, MAINE

Contract No. W912WJ-07-M-0218

SUBMITTED BY:

PETER FOSTER LARSEN

COASTAL SCIENCES
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This report represents analytical results of benthic samples transferred on August 15, 2007 to Coastal Sciences by representatives of the U.S. Army Corps of Engineers.

Peter F. Larsen, Ph.D.
Coastal Sciences

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CASE NARRATIVE

Seventeen benthic samples from Searsport, Penobscot Bay, Maine were transferred on August 15, 2007 to Coastal Sciences by representatives of the U.S. Army Corps of Engineers. The samples had been collected by Corps personnel on August 14, 2007 using a 0.04 m^2 modified Van Veen grab. The samples were then sieved on a 0.5 mm screen and fixed in formalin with Rose Bengal.

In the laboratory, the samples were resieved on nested 1.0 and 0.5 mm sieves and preserved in 70% ethanol. The benthic macrofauna in each size fraction of each sample was separated from the organic and inorganic debris and sorted to major taxonomic categories. This tedious process was accomplished by trained personnel using binocular dissecting microscopes. A subsample of the residue of each sample was reexamined to insure complete removal of the fauna. No problems were detected. Each taxonomic group was examined by experienced marine taxonomists who identified each individual to the lowest practical taxonomic level, usually species, and enumerated the number of individuals in each taxon. The results were tabulated and are presented in the enclosed tables, which are submitted in both paper and digital formats.

The tabular results are presented as individuals per sample. A summary tabulation is presented on each station sheet indicating the number of species in the sample, density on a per square meter basis and species diversity on a natural log base.

A total of 104 putative species were identified (Table 1). This number of species is large for a small benthic survey on the Maine coast. Most stations had a small to modest number of species while a few were surprisingly rich. The species per station showed a range from 4 to 53 with a mean of 17 (Table 2). Densities varied from 300 to 51,520 with a rather high mean of 7,327/m^2. Diversity values were low with a mean of 2.15. Sixty-three species were annelids while only 10 were arthropods. More interesting, the arthropods, often a numerically dominant group, were represented by very few individuals. The debris that remained after sieving, at most stations, was principally sawdust and tiny particles of coal.

TABLE 1
List of Species Collected From the Searsport Benthic Survey.

PHYLUM PORIFERA
Desmospongia
PHYLUM CNIDARIA
Halcampidae sp.
Sertularia sp.
PHYLUM RHYNCHOCOELA
Amphiporus sp.
Cerebratulus lactea
Lineus sp.
Micrura sp.
Tubulanus sp.
PHYLUM ASCHELMINTHES

PHYLUM MOLLUSCA
Alvania carinata
Aricidea suecica
Bivalve – juvenile (Arctica ?)
Cerastoderma pinnulatum
Chaetoderma nitidulum
Cylichna alba
Ensis directus
Gemma gemma
Hydrobia minuta
Lyonsia hyalina
Macoma balthica
Modiolus modiolus
Mya arenaria
Nucula proxima
Retusa obtusa
Tellina agilis
Thyasira sp.
Yoldia sapotilla
PHYLUM ANNELIDA
Aglaophamus neotenus
Ampharete acutfrons
Antioella angustus
Apistobranchus tullbergi
Aricidea jeffreysii
Aricidea quadrilobata
Brada villosa
Capitella capitata
Chaetozona setosa
Cirratulus cirratus
Clymenella sp.
Cossura longocirrata
Eteone heteropoda
Eteone lactea
Eteone longa
Eteone trilineata
Euchone rubrocincta
Eunicidae?
Exogone hebes
Fabricia sabella
Gyptis vittata
Harmothoe imbricata
Hartmania moorei
Hesionidae sp.
Heteromastus filiformis
Lepidonotus squamatus
Lumbrineris fragilis
Lumbrineris tenuis
Maldane sarsi
Mediomastus ambiseta
Myriochele heeri
Nephtys incisa
Nereis diversicolor
Nereis virens
Ninoe nigripes
Oligochaeta
Ophelina acuminuta
Paraonis fulgens
Paraonis gracilis
Pectinaria gouldii
Pholoe minuta
Phyllodoce groenlandia
Phyllodoce mucosa
Polydora quadrilobata
Polydora sp. A
Polydora quadrilobata
Polydora socialis
Polydora websteri
Potamilla nedlecta
Praxillella sp.
Prionospio steenstrupi
Pygospio elegans
Scoloplos acutus
Scoloplos robustus
Sphaeroropsis minuta
Spio filicornis
Sphaerodoropsis minuta
Stauronereis caecus
Sternapsis scutata
Streblospio benedicti
Syllis gracilis
Terebellides stroemi
Tharyx acutus
Unknown Polychaete
PHYLUM ARTHROPODA
Ampelisca vadorum
Balanus balanoides
Corophium crassicorne
Diastylis polita
Diastylis sp.
Eudorella truncatula
Gammarus sp.
Leptocheirus pinguis
Mite
Photis macrocoxa
PHYLUM ECHINODERMATA
Holothurian – juvenile
PHYLUM POGONOPHORA
Pogonophora?
PHYLUM CHORDATA
Molgula sp.
Praxillella sp.

TABLE 2
Summary of Species Numbers, Densities (m^2), and Diversity in the Searsport Samples.

Sample #	**# Species**	**Density**	**Diversity**
1	4	360	1.00
2	11	1,840	1.43
3	6	720	1.16
4	20	2,200	2.61
5	23	3,680	2.41
6	19	4,000	2.48
7	21	4,200	1.99
8	10	600	2.21
9	11	1,000	2.12
10	12	960	2.21
11	7	1,800	0.76
12	12	9,280	1.16
13	20	8,240	2.13
14	14	3,040	2.02
15	34	19,640	1.91
16	18	11,480	1.68
17	53	51,520	2.08
Mean	17	7,327	1.84
Min	4	360	0.76
Max	53	51,520	2.61

COMMUNITY STRUCTURE TABLES

Searsport Sample 1					
Number of Species:	4				
Density (m^2):	360				
Diversity (H'):	1.0027				
Species	**Total**	**Cum. Tot.**	**%**	**Cum. %**	**Higher Taxon**
Cossura longocirrata	6	6	66.7	66.7	Annelida
Oligochaeta	1	7	11.1	77.8	Annelida
Ampharete acutfrons	1	8	11.1	88.9	Annelida
Nucula proxima	1	9	11.1	100.0	Mollusca

Searsport Sample 2					
Number of Species:	11				
Density (m^2):	1840				
Diversity (H'):	1.4345				
Species	**Total**	**Cum. Tot.**	**%**	**Cum. %**	**Higher Taxon**
Cossura longocirrata	29	29	63.04	63.04	Annelida
Nucula proxima	4	33	8.70	71.74	Mollusca
Paraonis gracilis	4	37	8.70	80.43	Annelida
Ninoe nigripes	2	39	4.35	84.78	Annelida
Ampharete acutfrons	1	40	2.17	86.96	Annelida
Antioella angustus	1	41	2.17	89.13	Annelida
Bivalve - juvenile (Arctica ?)	1	42	2.17	91.30	Mollusca
Capitella capitata	1	43	2.17	93.48	Annelida
Hartmania moorei	1	44	2.17	95.65	Annelida
Holothurian - juvenile	1	45	2.17	97.83	Echinodermata
Nephtys incisa	1	46	2.17	100.00	Annelida

Searsport Sample 3					
Number of Species:	6				
Density (m^2):	720				
Diversity (H'):	1.1568				
Species	**Total**	**Cum. Tot.**	**%**	**Cum. %**	**Higher Taxon**
Cossura longocirrata	12	12	66.67	66.67	Annelida
Nucula proxima	2	14	11.11	77.78	Mollusca
Gammarus sp.	1	15	5.56	83.33	Arthropoda
Mediomastus ambiseta	1	16	5.56	88.89	Annelida
Paraonis fulgens	1	17	5.56	94.44	Annelida
Paraonis gracilis	1	18	5.56	100.00	Annelida

Searsport Sample 4					
Number of Species:	20				
Density (m^2):	2200				
Diversity (H'):	2.6067				
Species	**Total**	**Cum. Tot.**	**%**	**Cum. %**	**Higher Taxon**
Ninoe nigripes	10	10	18.18	18.2	Annelida
Tharyx acutus	8	18	14.55	32.7	Annelida
Ampharete acutfrons	7	25	12.73	45.5	Annelida
Cossura longocirrata	6	31	10.91	56.4	Annelida
Heteromastus filiformis	4	35	7.27	63.6	Annelida
Terebellides stroemi	3	38	5.45	69.1	Annelida
Aricidea jeffreysii	2	40	3.64	72.7	Annelida
Maldane sarsi	2	42	3.64	76.4	Annelida
Syllis gracilis	2	44	3.64	80.0	Annelida
Aglaophamus neotenus	1	45	1.82	81.8	Annelida
Aricidea quadrilobata	1	46	1.82	83.6	Annelida
Cerebratulus lactea	1	47	1.82	85.5	Nemertea
Chaetoderma nitidulum	1	48	1.82	87.3	Mollusca
Eteone heteropoda	1	49	1.82	89.1	Annelida
Lumbrineris fragilis	1	50	1.82	90.9	Annelida
Mediomastus ambiseta	1	51	1.82	92.7	Annelida
Nucula proxima	1	52	1.82	94.5	Mollusca
Praxillella sp.	1	53	1.82	96.4	Annelida
Priapulus caudatus	1	54	1.82	98.2	Priapulida
Scoloplos robustus	1	55	1.82	100.0	Annelida

Searsport Sample 5					
Number of Species:	23				
Density (m^2):	3680				
Diversity (H'):	2.4112				
Species	**Total**	**Cum. Tot.**	**%**	**Cum. %**	**Higher Taxon**
Terebellides stroemi	30	30	32.6	32.6	Annelida
Nucula proxima	18	48	19.6	52.2	Mollusca
Euchone rubrocincta	5	53	5.4	57.6	Annelida
Ampharete acutfrons	4	57	4.3	62.0	Annelida
Aricidea jeffreysii	4	61	4.3	66.3	Annelida
Spio filicornis	4	65	4.3	70.7	Annelida
Aricidea quadrilobata	3	68	3.3	73.9	Annelida
Cylichna alba	3	71	3.3	77.2	Mollusca
Ninoe nigripes	3	74	3.3	80.4	Annelida
Amphiporus sp.	2	76	2.2	82.6	Nemertea
Cossura longocirrata	2	78	2.2	84.8	Annelida
Molgula sp.	2	80	2.2	87.0	Chordata
Yoldia sapotilla	2	82	2.2	89.1	Annelida
Alvania carinata	1	83	1.1	90.2	Mollusca
Apistobranchus tullbergi	1	84	1.1	91.3	Annelida
Cerastoderma pinnulatum	1	85	1.1	92.4	Mollusca
Halcampidae sp.	1	86	1.1	93.5	Cnidaria
Lyonsia hyalina	1	87	1.1	94.6	Annelida
Maldane sarsi	1	88	1.1	95.7	Annelida
Nephtys incisa	1	89	1.1	96.7	Annelida
Pholoe minuta	1	90	1.1	97.8	Annelida
Scoloplos robustus	1	91	1.1	98.9	Annelida
Tharyx acutus	1	92	1.1	100.0	Annelida

Searsport Sample 6					
Number of Species:	19				
Density (m^2):	4000				
Diversity (H'):	2.4812				
Species	**Total**	**Cum. Tot.**	**%**	**Cum. %**	**Higher Taxon**
Cossura longocirrata	26	26	26	26	Annelida
Oligochaeta	12	38	12	38	Annelida
Apistobranchus tullbergi	11	49	11	49	Annelida
Ninoe nigripes	9	58	9	58	Annelida
Ampharete acutfrons	6	64	6	64	Annelida
Aricidea jeffreysii	5	69	5	69	Annelida
Nucula proxima	5	74	5	74	Mollusca
Tharyx acutus	5	79	5	79	Annelida
Terebellides stroemi	4	83	4	83	Annelida
Amphiporus sp.	3	86	3	86	Nemertea
Euchone rubrocincta	3	89	3	89	Annelida
Mya arenaria	3	92	3	92	Mollusca
Mediomastus ambiseta	2	94	2	94	Annelida
Clymenella sp.	1	95	1	95	Annelida
Eudorella truncatula	1	96	1	96	Arthropoda
Molgula sp.	1	97	1	97	Chordata
Priapulus caudatus	1	98	1	98	Priapulida
Sternapsis scutata	1	99	1	99	Annelida
Syllis gracilis	1	100	1	100	Annelida

Searsport Sample 7					
Number of Species:	21				
Density (m^2):	4200				
Diversity (H'):	1.9933				
Species	**Total**	**Cum. Tot.**	**%**	**Cum. %**	**Higher Taxon**
Oligochaeta	53	53	50.5	50.5	Annelida
Aricidea jeffreysii	10	63	9.5	60.0	Annelida
Mediomastus ambiseta	10	73	9.5	69.5	Annelida
Streblospio benedicti	4	77	3.8	73.3	Annelida
Cossura longocirrata	3	80	2.9	76.2	Annelida
Photis macrocoxa	3	83	2.9	79.0	Arthropoda
Pygospio elegans	3	86	2.9	81.9	Annelida
Tharyx acutus	3	89	2.9	84.8	Annelida
Cerastoderma pinnulatum	2	91	1.9	86.7	Mollusca
Cirratulus cirratus	2	93	1.9	88.6	Annelida
Ninoe nigripes	2	95	1.9	90.5	Annelida
Ampharete acutfrons	1	96	1.0	91.4	Annelida
Aricidea quadrilobata	1	97	1.0	92.4	Annelida
Macoma balthica	1	98	1.0	93.3	Annelida
Mya arenaria	1	99	1.0	94.3	Mollusca
Nephtys incisa	1	100	1.0	95.2	Annelida
Nucula proxima	1	101	1.0	96.2	Mollusca
Paraonis gracilis	1	102	1.0	97.1	Annelida
Polydora quadrilobata	1	103	1.0	98.1	Annelida
Scoloplos acutus	1	104	1.0	99.0	Annelida
Tubulanus sp.	1	105	1.0	100.0	Nemertea

Searsport Sample 8					
Number of Species:	10				
Density (m^2):	600				
Diversity (H'):	2.2111				
Species	**Total**	**Cum. Tot.**	**%**	**Cum. %**	**Higher Taxon**
Cossura longocirrata	3	3	20.0	20.0	Annelida
Oligochaeta	2	5	13.3	33.3	Annelida
Aricidea jeffreysii	2	7	13.3	46.7	Annelida
Ampharete acutfrons	2	9	13.3	60.0	Annelida
Chaetozone setosa	1	10	6.7	66.7	Annelida
Apistobranchus tullbergi	1	11	6.7	73.3	Annelida
Heteromastus filiformis	1	12	6.7	80.0	Annelida
Thyasira gouldii	1	13	6.7	86.7	Mollusca
Lineus sp.	1	14	6.7	93.3	Nemertea
Paraonis gracilis	1	15	6.7	100.0	Annelida

Searsport Sample 9					
Number of Species:	11				
Density (m^2):	1000				
Diversity (H'):	2.1234				
Species	**Total**	**Cum. Tot.**	**%**	**Cum. %**	**Higher Taxon**
Nucula proxima	8	8	32.0	32.0	Mollusca
Euchone rubrocincta	3	11	12.0	44.0	Annelida
Lumbrineris tenuis	3	14	12.0	56.0	Annelida
Cossura longocirrata	2	16	8.0	64.0	Annelida
Ampharete acutfrons	2	18	8.0	72.0	Annelida
Terebellides stroemi	2	20	8.0	80.0	Annelida
Aricidea suecica	1	21	4.0	84.0	Annelida
Alvania carinata	1	22	4.0	88.0	Mollusca
Retusa obtusa	1	23	4.0	92.0	Mollusca
Scoloplos robustus	1	24	4.0	96.0	Annelida
Tharyx acutus	1	25	4.0	100.0	Annelida

Searsport Sample 10					
Number of Species:	12				
Density (m^2):	960				
Diversity (H'):	2.2062				
Species	**Total**	**Cum. Tot.**	**%**	**Cum. %**	**Higher Taxon**
Cossura longocirrata	7	7	29.2	29.2	Annelida
Ampharete acutfrons	4	11	16.7	45.8	Annelida
Apistobranchus tullbergi	2	13	8.3	54.2	Annelida
Aricidea jeffreysii	2	15	8.3	62.5	Annelida
Maldane sarsi	2	17	8.3	70.8	Annelida
Hesionidae sp.	1	18	4.2	75.0	Annelida
Lineus sp.	1	19	4.2	79.2	Nemertea
Mya arenaria	1	20	4.2	83.3	Mollusca
Nucula proxima	1	21	4.2	87.5	Mollusca
Paraonis gracilis	1	22	4.2	91.7	Annelida
Scoloplos robustus	1	23	4.2	95.8	Annelida
Tharyx acutus	1	24	4.2	100.0	Annelida

Searsport Sample 11					
Number of Species:	7				
Density (m^2):	1800				
Diversity (H'):	0.7644				
Species	**Total**	**Cum. Tot.**	**%**	**Cum. %**	**Higher Taxon**
Cossura longocirrata	37	37	82.2	82.2	Annelida
Nucula proxima	3	40	6.7	88.9	Mollusca
Aricidea jeffreysii	1	41	2.2	91.1	Annelida
Aricidea quadrilobata	1	42	2.2	93.3	Annelida
Mya arenaria	1	43	2.2	95.6	Mollusca
Paraonis gracilis	1	44	2.2	97.8	Annelida
Priapulus caudatus	1	45	2.2	100.0	Priapulida

Searsport Sample 12					
Number of Species:	12				
Density (m^2):	9280				
Diversity (H'):	1.1604				
Species	**Total**	**Cum. Tot.**	**%**	**Cum. %**	**Higher Taxon**
Cossura longocirrata	167	167	72.0	72.0	Annelida
Ampharete acutfrons	14	181	6.0	78.0	Annelida
Apistobranchus tullbergi	12	193	5.2	83.2	Annelida
Ninoe nigripes	11	204	4.7	87.9	Annelida
Prionospio steenstrupi	10	214	4.3	92.2	Annelida
Aricidea jeffreysii	8	222	3.4	95.7	Annelida
Lineus sp.	4	226	1.7	97.4	Nemertea
Mediomastus ambiseta	2	228	0.9	98.3	Annelida
Nemertea	1	229	0.4	98.7	Nemertea
Nephtys incisa	1	230	0.4	99.1	Annelida
Oligochaeta	1	231	0.4	99.6	Annelida
Terebellides stroemi	1	232	0.4	100.0	Annelida

Searsport Sample 13					
Number of Species:	20				
Density (m^2):	8240				
Diversity (H'):	2.1280				
Species	**Total**	**Cum. Tot.**	**%**	**Cum. %**	**Higher Taxon**
Cossura longocirrata	47	47	22.8	22.8	Annelida
Prionospio steenstrupi	44	91	21.4	44.2	Annelida
Apistobranchus tullbergi	37	128	18.0	62.1	Annelida
Ampharete acutfrons	31	159	15.0	77.2	Annelida
Ninoe nigripes	13	172	6.3	83.5	Annelida
Terebellides stroemi	9	181	4.4	87.9	Annelida
Aricidea suecica	4	185	1.9	89.8	Mollusca
Tharyx acutus	4	189	1.9	91.7	Annelida
Aglaophamus neotenus	3	192	1.5	93.2	Annelida
Aricidea jeffreysii	2	194	1.0	94.2	Annelida
Lineus sp.	2	196	1.0	95.1	Nemertea
Oligochaeta	2	198	1.0	96.1	Annelida
Aricidea quadrilobata	1	199	0.5	96.6	Annelida
Capitella capitata	1	200	0.5	97.1	Annelida
Mediomastus ambiseta	1	201	0.5	97.6	Annelida
Pholoe minuta	1	202	0.5	98.1	Annelida
Photis macrocoxa	1	203	0.5	98.5	Arthropoda
Pogonophora?	1	204	0.5	99.0	Pogonophora
Retusa obtusa	1	205	0.5	99.5	Mollusca
Scoloplos acutus	1	206	0.5	100.0	Annelida

Searsport Sample 14					
Number of Species:	14				
Density (m^2):	3040				
Diversity (H'):	2.0209				
Species	**Total**	**Cum. Tot.**	**%**	**Cum. %**	**Higher Taxon**
Oligochaeta	28	28	36.8	36.8	Annelida
Aricidea quadrilobata	13	41	17.1	53.9	Annelida
Prionospio steenstrupi	9	50	11.8	65.8	Annelida
Cossura longocirrata	7	57	9.2	75.0	Annelida
Gyptis vittata	5	62	6.6	81.6	Annelida
Modiolus modiolus	3	65	3.9	85.5	Mollusca
Ampharete acutfrons	2	67	2.6	88.2	Annelida
Ninoe nigripes	2	69	2.6	90.8	Annelida
Scoloplos acutus	2	71	2.6	93.4	Annelida
Brada villosa	1	72	1.3	94.7	Annelida
Lineus sp.	1	73	1.3	96.1	Nemertea
Mediomastus ambiseta	1	74	1.3	97.4	Annelida
Terebellides stroemi	1	75	1.3	98.7	Annelida
Tharyx acutus	1	76	1.3	100.0	Annelida

Searsport Sample 15					
Number of Species:	34				
Density (m^2):	19640				
Diversity (H'):	1.9079				
Species	**Total**	**Cum. Tot.**	**%**	**Cum. %**	**Higher Taxon**
Cossura longocirrata	180	180	36.7	36.7	Annelida
Prionospio steenstrupi	164	344	33.4	70.1	Annelida
Tharyx acutus	35	379	7.1	77.2	Annelida
Ninoe nigripes	29	408	5.9	83.1	Annelida
Aglaophamus neotenus	10	418	2.0	85.1	Annelida
Modiolus modiolus	8	426	1.6	86.8	Mollusca
Ampelisca vadorum	7	433	1.4	88.2	Arthropoda
Lineus sp.	7	440	1.4	89.6	Nemertea
Polydora websteri	6	446	1.2	90.8	Annelida
Ampharete acutfrons	5	451	1.0	91.9	Annelida
Aricidea suecica	5	456	1.0	92.9	Mollusca
Brada villosa	3	459	0.6	93.5	Annelida
Harmothoe imbricata	3	462	0.6	94.1	Annelida
Scoloplos acutus	3	465	0.6	94.7	Annelida
Tellina agilis	3	468	0.6	95.3	Mollusca
Balanus balanoides	2	470	0.4	95.7	Arthropoda
Diastylis sp.	2	472	0.4	96.1	Arthropoda
Fabricia sabella	2	474	0.4	96.5	Annelida
Pectinaria gouldii	2	476	0.4	96.9	Annelida
Aricidea jeffreysii	1	477	0.2	97.1	Annelida
Aricidea quadrilobata	1	478	0.2	97.4	Annelida
Cerastoderma pinnulatum	1	479	0.2	97.6	Mollusca
Eteone heteropoda	1	480	0.2	97.8	Annelida
Eteone trilineata	1	481	0.2	98.0	Annelida
Lepidonotus squamatus	1	482	0.2	98.2	Annelida
Leptocheirus pinguis	1	483	0.2	98.4	Arthropoda
Mediomastus ambiseta	1	484	0.2	98.6	Annelida
Micrura sp.	1	485	0.2	98.8	Nemertea
Nephtys incisa	1	486	0.2	99.0	Annelida
Oligochaeta	1	487	0.2	99.2	Annelida
Pholoe minuta	1	488	0.2	99.4	Annelida
Potamilla neglecta	1	489	0.2	99.6	Annelida
Sphaeroropsis minuta	1	490	0.2	99.8	Annelida
Terebellides stroemi	1	491	0.2	100.0	Annelida

Searsport Sample 16					
Number of Species:	18				
Density (m^2):	11480				
Diversity (H'):	1.6755				
Species	**Total**	**Cum. Tot.**	**%**	**Cum. %**	**Higher Taxon**
Cossura longocirrata	156	156	54.4	54.4	Annelida
Oligochaeta	36	192	12.5	66.9	Annelida
Aricidea suecica	33	225	11.5	78.4	Mollusca
Ninoe nigripes	14	239	4.9	83.3	Annelida
Prionospio steenstrupi	10	249	3.5	86.8	Annelida
Scoloplos acutus	10	259	3.5	90.2	Annelida
Ampharete acutfrons	4	263	1.4	91.6	Annelida
Apistobranchus tullbergi	4	267	1.4	93.0	Annelida
Mediomastus ambiseta	4	271	1.4	94.4	Annelida
Nephtys incisa	4	275	1.4	95.8	Annelida
Lineus sp.	3	278	1.0	96.9	Nemertea
Gyptis vittata	2	280	0.7	97.6	Annelida
Tharyx acutus	2	282	0.7	98.3	Annelida
Brada villosa	1	283	0.3	98.6	Annelida
Molgula sp.	1	284	0.3	99.0	Chordata
Myriochele heeri	1	285	0.3	99.3	Annelida
Polydora sp. A	1	286	0.3	99.7	Annelida
Polydora socialis	1	287	0.3	100.0	Annelida

Searsport Sample 17					
Number of Species:	53				
Density (m^2):	51520				
Diversity (H'):	2.084805691				
Species	**Total**	**Cum. Tot.**	**%**	**Cum. %**	**Higher Taxon**
Prionospio steenstrupi	679	679	52.72	52.72	Annelida
Aglaophamus neotenus	161	840	12.50	65.22	Annelida
Pholoe minuta	53	893	4.11	69.33	Annelida
Cossura longocirrata	48	941	3.73	73.06	Annelida
Brada villosa	40	981	3.11	76.16	Annelida
Ninoe nigripes	36	1017	2.80	78.96	Annelida
Oligochaeta	36	1053	2.80	81.75	Annelida
Pectinaria gouldii	26	1079	2.02	83.77	Annelida
Ampelisca vadorum	19	1098	1.48	85.25	Arthropoda
Mediomastus ambiseta	16	1114	1.24	86.49	Annelida
Heteromastus filiformis	11	1125	0.85	87.34	Annelida
Modiolus modiolus	11	1136	0.85	88.20	Mollusca
Nereis virens	11	1147	0.85	89.05	Annelida
Capitella capitata	10	1157	0.78	89.83	Annelida
Phyllodoce mucosa	10	1167	0.78	90.61	Annelida
Ampharete acutfrons	9	1176	0.70	91.30	Annelida
Mya arenaria	9	1185	0.70	92.00	Mollusca
Tellina agilis	9	1194	0.70	92.70	Mollusca
Hartmania moorei	8	1202	0.62	93.32	Annelida
Polydora quadrilobata	7	1209	0.54	93.87	Annelida
Tharyx acutus	7	1216	0.54	94.41	Annelida
Cerastoderma pinnulatum	6	1222	0.47	94.88	Mollusca
Spio filicornis	6	1228	0.47	95.34	Annelida
Lineus sp.	5	1233	0.39	95.73	Nemertea
Terebellides stroemi	5	1238	0.39	96.12	Annelida
Corophium crassicorne	4	1242	0.31	96.43	Arthropoda
Eteone lactea	4	1246	0.31	96.74	Annelida
Scoloplos robustus	4	1250	0.31	97.05	Annelida
Apistobranchus tullbergi	3	1253	0.23	97.28	Annelida
Balanus balanoides	3	1256	0.23	97.52	Arthropoda
Eudorella truncatula	3	1259	0.23	97.75	Arthropoda
Nereis diversicolor	3	1262	0.23	97.98	Annelida
Diastylis polita	2	1264	0.16	98.14	Arthropoda
Ensis directus	2	1266	0.16	98.29	Mollusca
Eunicidae?	2	1268	0.16	98.45	Annelida
Exogone hebes	2	1270	0.16	98.60	Annelida
Leptocheirus pinguis	2	1272	0.16	98.76	Arthropoda
Nucula proxima	2	1274	0.16	98.91	Mollusca
Ophelina acuminuta	2	1276	0.16	99.07	Annelida
Eteone longa	1	1277	0.08	99.15	Annelida

Gemma gemma	1	1278	0.08	99.22	Mollusca
Hydrobia minuta	1	1279	0.08	99.30	Mollusca
Lyonsia hyalina	1	1280	0.08	99.38	Annelida
Mite	1	1281	0.08	99.46	Arthropoda
Phyllodoce groenlandia	1	1282	0.08	99.53	Annelida
Retusa obtusa	1	1283	0.08	99.61	Mollusca
Sphaerodoropsis minuta	1	1284	0.08	99.69	Annelida
Stauronereis caecus	1	1285	0.08	99.77	Annelida
Syllis gracilis	1	1286	0.08	99.84	Annelida
Tubulanus sp.	1	1287	0.08	99.92	Nemertea
Unknown Polychaete	1	1288	0.08	100.00	Annelida
Desmospongia	+				Porifera
Sertularia sp.	+				Cnidaria

SEARSPORT HARBOR
SEARSPORT, MAINE
NAVIGATION IMPROVEMENT PROJECT

APPENDIX D

ESSENTIAL FISH HABITAT
LIFE HISTORY

ESSENTIAL FISH HABITAT EVALUATION
PENOBSCOT BAY, MAINE

ESSENTIAL FISH HABITAT SETTING

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", 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' squares of latitude and longitude which include Penobscot Bay are: Atlantic salmon, Atlantic cod, haddock, pollock, whiting, red hake, white hake, winter flounder, yellowtail flounder, windowpane flounder, American plaice, ocean pout, Atlantic halibut, Atlantic sea herring, bluefish, Atlantic mackerel, bluefin tuna.

The following lists the managed species and their appropriate life stage history for the designated 10' x 10' squares which include Saco Bay.

ATLANTIC SALMON (*Salmo salar*)

Juveniles: Bottom habitats of shallow gravel/cobble riffles interspersed with deeper riffles and pools in rivers and estuaries. Generally, the following conditions exist where Atlantic salmon parr are found: clean, well-oxygenated fresh water, water temperatures below 25^0 C, water depths between 10 cm and 61 cm, and water velocities between 30 and 92 cm per second. As they grow, parr transform into smolts. Atlantic salmon smolts require access downstream to make their way to the ocean. Upon entering the sea, "post-smolts" become pelagic and range from Long Island Sound north to the Labrador Sea.

Adults: For adult Atlantic salmon returning to spawn, habitats with resting and holding pools in rivers and estuaries. Returning Atlantic salmon require access to their natal streams and access to the spawning grounds. Generally, the following conditions exist where returning Atlantic salmon adults are found migrating to the spawning grounds: water temperatures below 22.8^0 C, and dissolved oxygen above five ppm. Oceanic adult Atlantic salmon are primarily pelagic and range from the waters of the Continental Shelf off southern New England north throughout the Gulf of Maine.

ATLANTIC COD (*Gadus morhua*)

Larvae: Pelagic waters of the Gulf of Maine, Georges Bank, and the eastern portion of the Continental Shelf off of southern New England. Generally, the following conditions exist where cod larvae found: sea surface temperatures below 10^0 C, water depths from 30 to 70 meters, and a salinity range from 32-33‰. Cod larvae are most often observed in the spring.

Juveniles: Bottom habitats with a substrate of cobble or gravel in the Gulf of Maine, Georges Bank, and the eastern portion of the Continental Shelf off southern New England. Generally, the following conditions exist where cod juveniles found: water temperatures below 20^0 C, water depths from 25 to 75 meters, and a salinity range from 30-35‰.

Adults: Bottom habitats with a substrate of rocks, pebbles, or gravel in the Gulf of Maine, Georges Bank, southern New England, and the middle Atlantic south to Delaware Bay. Generally, the following conditions exist where cod adults are found: water temperatures below 10^0 C, water depths from 10 to 150 meters, and a wide range of oceanic salinities.

HADDOCK (*Melanogrammus aeglefinus*)

Adults: Bottom habitats with a substrate of broken ground, pebbles, smooth hard sand and smooth areas between rocky patches on Georges Bank and the eastern side of Nantucket Shoals, and throughout the Gulf of Maine, plus additional area of Nantucket Shoals and the Great South Channel inclusive of the historic range. Generally, the following conditions exist where haddock adults are found: water temperatures below 7^{o} C, depths from 40 to 150 meters, and a salinity range from 31.5 - 35‰.

POLLOCK (*Pollachius virens*)

Juveniles: Bottom habitats with aquatic vegetation or a substrate of sand, mud or rocks in the Gulf of Maine and Georges Bank. Generally, the following conditions exist where pollock juveniles are found: water temperatures below 18^0 C, water depths from 0 to 250 meters, and salinities between 29-32‰.

WHITING (*Merluccius bilinearis*)

Juveniles: Bottom habitats of all substrate types in the Gulf of Maine, on Georges Bank, the Continental Shelf off southern New England, and the middle Atlantic south to Cape Hatteras. Generally, the following conditions exist where most whiting juveniles are found: water temperatures below 21^o C, depths between 20 and 270 meters and salinities greater than 20‰.

Adults: Bottom habitats of all substrate types in the Gulf of Maine, on Georges Bank, the Continental Shelf off southern New England, and the middle Atlantic south to Cape Hatteras. Generally, the following conditions exist where most whiting adults are found: water temperatures below 22^o C, depths between 30 and 325 meters.

RED HAKE (*Urophycis chuss*)

Juveniles: Bottom habitats with a substrate of shell fragments, including areas with an abundance of live scallops, in the Gulf of Maine, on Georges Bank, the Continental Shelf off southern New England, and the middle Atlantic south to Cape Hatteras. Generally, the following conditions exist where red hake juveniles are found: water temperatures below 16^o C, depths less than 100 meters and a salinity range from 31 - 33‰.

Adults: Bottom habitats in depressions with a substrate of sand and mud in the Gulf of Maine, on Georges Bank, the Continental Shelf off southern New England, and the middle Atlantic south to Cape Hatteras. Generally, the following conditions exist where red hake adults are found: water temperatures below 12 ^{o} C, depths from 10 to 130 meters, and a salinity range from 33 - 34‰.

WHITE HAKE (*Urophycis tenuis*)

Juveniles: *Pelagic stage* – Pelagic waters of the Gulf of Maine, the southern edge of Georges Bank, and southern New England to the middle Atlantic. White hake juveniles in the pelagic stage are most often observed from May through September. *Demersal stage* – Bottom habitats with seagrass beds or a substrate of mud or fine-grained sand in the Gulf of Maine, the southern edge of Georges Bank, and southern New England to the middle Atlantic. Generally, the following conditions exist where white hake juveniles are found: water temperatures below 19 ^{o} C and depths from 5 - 225 meter.

Adults: Bottom habitats with a substrate of mud or fine-grained sand in the Gulf of Maine, the southern edge of Georges Bank, and southern New England to the middle Atlantic. Generally, the following conditions exist where white hake adults are found: water temperatures below 14 ^{o} C and depths from 5 - 325 meter.

WINTER FLOUNDER (*Pleuronectes americanus*)

Eggs: Bottom habitats with a substrate of sand, muddy sand, mud, and gravel on Georges Bank, the inshore areas of the Gulf of Maine, southern New England, and the middle Atlantic south to the Delaware Bay. Generally, the following conditions exist where winter flounder eggs are found: water temperatures below 10 ^{o} C, salinities between 10 - 30‰ and water depths less than 5 meters. On Georges Bank, winter flounder eggs are generally found in water less than 8 ^{o} C, and less than 90 meters deep. Winter flounder eggs are often observed from February to June with a peak in April on Georges Bank.

Larvae: Pelagic and bottom waters of Georges Bank, the inshore areas of the Gulf of Maine, southern New England, and the middle Atlantic south to the Delaware Bay. Generally, the following conditions exist where winter flounder larvae are found: sea surface temperatures less than 15^{0} C, salinities between 4 - 30‰, and water depths less than six meters. On Georges Bank, winter flounder larvae are generally found in water less than 8 ^{o} C, and less than 90 meters deep. Winter flounder larvae are often observed from March to July with peaks in April and May on Georges Bank.

Juveniles: *Young-of-the-Year*: Bottom habitats with a substrate of mud or fine-grained sand on Georges Bank, the inshore areas of the Gulf of Maine, southern New England and the middle Atlantic south to the Delaware Bay. Generally, the following conditions exist where winter flounder young-of-the-year are found: water temperatures below 28^{o} C, and depths from 0.1 – 10 meters, and salinities between 5 - 33‰. *Age 1 + Juveniles*: Bottom habitats with a substrate of mud or fine-grained sand on Georges Bank, the inshore areas of the Gulf of Maine, southern New England and the middle Atlantic south to the Delaware Bay. Generally, the following conditions exist where juvenile winter flounder are found: water temperatures below 25^{o} C, and depths from 1 – 50 meters, and salinities between 10 - 30‰.

Adults: Bottom habitats including estuaries with a substrate of mud, sand and gravel on Georges Bank, the inshore areas of the Gulf of Maine, southern New England and the middle Atlantic south to the Delaware Bay. Generally, the following conditions exist where adult winter flounder are found: water temperatures below 25^o C, and depths from 1 – 100 meters, and salinities between 15 - 33‰.

Spawning Adults: Bottom habitats including estuaries with a substrate of sand, muddy sand, mud, and gravel on Georges Bank, the inshore areas of the Gulf of Maine, southern New England and the middle Atlantic south to the Delaware Bay. Generally, the following conditions exist where spawning adult winter flounder are found: water temperatures below 15^o C, depths less than 6 meters, except on Georges Bank where they spawn as deep as 80 meters, and salinities 5.5 - 36‰. Winter flounder are most often observed spawning during the months of February to June.

YELLOWTAIL FLOUNDER (*Pleuronectes ferruginea*)

Eggs: Surface waters of Georges Bank, Massachusetts Bay, Cape Cod Bay, and the southern New England continental shelf south to Delaware Bay. Generally, the following conditions exist where yellowtail eggs are found: sea surface temperatures below 15^0 C, water depths from 30-90 meters and a salinity range from 32.4-33.5‰. Yellowtail flounder eggs are most often observed during the months from mid-March to July, with peaks in April to June in southern New England.

Larvae: Surface waters of Georges Bank, Massachusetts Bay, Cape Cod Bay, the southern New England shelf and throughout the middle Atlantic south to the Chesapeake Bay. Generally, the following conditions exist where yellowtail larvae are found: sea surface temperatures below 17^0 C, water depths from 10 – 90 meters, and a salinity range from 32.4 – 33.5‰. Yellowtail flounder larvae are most often observed from March through April in the New York bight and from May through July in southern New England and southeastern Georges Bank.

WINDOWPANE FLOUNDER (*Scopthalmus aquosus*)

Eggs: Surface waters around the perimeter of the Gulf of Maine, on Georges Bank, southern New England, and the middle Atlantic south to Cape Hatteras. Generally, the following conditions exist where windowpane flounder eggs are found: sea surface temperatures less than 20^0 C, water depths less than 70 meters. Windowpane flounder eggs are often observed from February to November with peaks in May and October in the middle Atlantic and July through August on Georges Bank.

Larvae: Pelagic waters around the perimeter of the Gulf of Maine, on Georges Bank, southern New England, and the middle Atlantic south to Cape Hatteras. Generally, the following conditions exist where windowpane flounder larvae are found: sea surface temperatures less than 20^0 C, water depths less than 70 meters. Windowpane flounder larvae are often observed from February to November with peaks in May and October in the middle Atlantic and July through August on Georges Bank.

Juveniles: Bottom habitats with a substrate of mud or fine-grained sand around the perimeter of the Gulf of Maine, on Georges Bank, southern New England and the middle Atlantic south to Cape Hatteras. Generally, the following conditions exist where windowpane flounder juveniles are found: water temperatures below 25^0 C, water depths from 1 – 100 meters, and a salinity range from 5.5 – 36‰.

Adults: Bottom habitats with a substrate of mud or fine-grained sand around the perimeter of the Gulf of Maine, on Georges Bank, southern New England and the middle Atlantic south to the Virginia-North Carolina border. Generally, the following conditions exist where windowpane flounder adults are found: water temperatures below 26.8^0 C, water depths from 1 – 75 meters, and salinities between 5.5 – 36‰.

Spawning Adults: Bottom habitats with a substrate of mud or fine-grained sand in the Gulf of Maine, Georges Bank, southern New England and the middle Atlantic south to the Virginia-North Carolina border. Generally, the following conditions exist where spawning windowpane flounder adults are found: water temperatures below 21^0 C, water depths from 1 – 75 meters, and salinities between 5.5 – 36‰. Windowpane flounder are most often observed spawning during the months February – December with a peak in May in the middle Atlantic.

AMERICAN PLAICE (*Hippoglossoides platessoides*)

Eggs: Surface waters of the Gulf of Maine and Georges Bank. Generally, the following conditions exist where most American plaice eggs are found: sea surface temperatures below 12^0 C, water depths between 30 and 90 meters and a wide range of salinities. American plaice eggs are observed all year in the Gulf of Maine, but only from December through June on Georges Bank, with peaks in both areas in April and May.

Larvae: Surface waters of the Gulf of Maine, Georges Bank and southern New England. Generally, the following conditions exist where most American plaice larvae are found: sea surface temperatures below 14^0 C, water depths between 30 and 130 meters and a wide range of salinities. American plaice larvae are observed between January and August, with peaks in April and May.

Juveniles: Bottom habitats with fine-grained sediment or a substrate of sand or gravel in the Gulf of Maine. Generally, the following conditions exist where American plaice juveniles are found: water temperatures below 17^0 C, depths between 45 and 150 meters, and a wide range of salinities.

Adults: Bottom habitats with fine-grained sediments or a substrate of sand or gravel in the Gulf of Maine and Georges Bank. Generally, the following conditions exist where most American plaice adults are found: water temperatures below 17^0 C, water depths between 45 and 175 meters, and a wide range of salinities.

Spawning Adults: Bottom habitats of all substrate types in the Gulf of Maine and Georges Bank. Generally, the following conditions exist where most spawning American plaice adults are found: water temperatures below 14^0 C, water depths less than 90 meters, and a wide range of salinities. Spawning begins in March and continues through June.

OCEAN POUT (*Macrozoarces americanus*)

Eggs: Bottom habitats in the Gulf of Maine, Georges Bank, southern New England and the middle Atlantic south to Delaware Bay. Due to low fecundity, relatively few eggs (<4,200) are laid in gelatinous masses, generally in hard bottom sheltered nests, holes, or crevices where they are guarded by either female or both parents. Generally, the following conditions exist where ocean pout eggs are found: water temperatures below 10^0 C, depths less than 50 meters, and a salinity range from 32-34‰. Ocean pout egg development takes two to three months during late fall and winter.

Larvae: Bottom habitats in the Gulf of Maine, Georges Bank, southern New England and the middle Atlantic south to Delaware Bay. Larvae are relatively advanced in development and are believed to remain in close proximity to hard bottom nesting areas. Generally, the following conditions exist where ocean pout larvae are found: sea surface temperatures below 10^0 C, depths less than 50 meters, and salinities greater than 25‰. Ocean pout larvae are most often observed from late fall through spring.

Juveniles: Bottom habitats, often smooth bottom near rocks or algae in the Gulf of Maine, Georges Bank, southern New England and the middle Atlantic south to Delaware Bay. Generally, the following conditions exist where ocean pout juveniles are found: water temperatures below 14^0 C, depths less than 80 meters, and salinities greater than 25‰.

Adults: Bottom habitats in the Gulf of Maine, Georges Bank, southern New England and the middle Atlantic south to Delaware Bay. Generally, the following conditions exist where ocean pout adults are found: water temperatures below 15^0 C, depths less than 110 meters, and a salinity range from 32-34‰.

Spawning Adults: Bottom habitats with a hard bottom substrate, including artificial reefs and shipwrecks, in the Gulf of Maine, Georges Bank, southern New England and the middle Atlantic south to Delaware Bay. Generally, the following conditions exist where spawning ocean pout adults are found: water temperatures below 10^0 C, depths less than 50 meters, and a salinity range from 32-34‰. Ocean pout spawn from late summer through early winter, with peaks in September and October.

ATLANTIC HALIBUT (*Hippoglosus hippoglossus*)

Eggs: Pelagic waters to the sea floor of the Gulf of Maine and Georges Bank. Generally, the following conditions exist where Atlantic halibut eggs are found: water temperatures between 4 and 7^0 C, water depths less than 700 meters, and salinities less than 35‰. Atlantic halibut eggs are observed between late fall and early spring, with peaks in November and December.

Larvae: Surface waters of the Gulf of Maine and Georges Bank. Generally, the following conditions exist where Atlantic halibut larvae are found: salinities between 30 and 35‰.

Juveniles: Bottom habitats with a substrate of sand, gravel, or clay in the Gulf of Maine and Georges Bank. Generally, the following conditions exist where Atlantic halibut juveniles are found: water temperatures above 2^0 C, water depths from 20 - 60 meters.

Adults: Bottom habitats with a substrate of sand, gravel, or clay in the Gulf of Maine and Georges Bank. Generally, the following conditions exist where Atlantic halibut adults are found: water temperatures below 13.6^0 C, water depths from 100 - 700 meters, and salinities between 30.4 – 35.3‰.

Spawning Adults: Bottom habitats with a substrate of soft mud, clay, sand, or gravel in the Gulf of Maine and Georges Bank, as well as rough or rocky bottom locations along the slopes of the outer banks. Generally, the following conditions exist where spawning Atlantic halibut adults are found: water temperatures below 7^0 C, water depths less than 700 meters, and salinities less than 35‰. Atlantic halibut are most often observed spawning between late fall and early spring, with peaks in November and December.

ATLANTIC SEA SCALLOP (*Placopecten magellanicus*)

Eggs: Bottom habitats in the Gulf of Maine, Georges Bank, southern New England and the middle Atlantic south to the Virginia-North Carolina border. Eggs are heavier than seawater and remain on the seafloor until they develop into the first free-swimming larval stage. Generally, sea scallop eggs are thought to occur where water temperatures are below 17^0 C. Spawning occurs from May through October with peaks in May and June in the middle Atlantic area and in September and October on Georges Bank and in the Gulf of Maine.

Larvae: Pelagic waters and bottom habitats with a substrate of gravelly sand, shell fragments, and pebbles, or on various red algae, hydroids, amphipod tubes and bryozoans in the Gulf of Maine, Georges Bank, and southern New England and the middle Atlantic south to the Virginia-North Carolina border. Generally, the following conditions exist where sea scallop larvae are found: sea surface temperatures below 18^0 C and salinities between 16.9‰ to 30‰.

Juveniles: Bottom habitats with a substrate of cobble, shells and silt in the Gulf of Maine, Georges Bank, southern New England and the middle Atlantic south to the Virginia-North Carolina border that support the highest densities of sea scallops. Generally, the following conditions exist where most sea scallop juveniles are found: water temperatures below 15^0 C, water depths from 18 - 110 meters.

Adults: Bottom habitats with a substrate of cobble, shells, coarse/gravelly sand, and sand in the Gulf of Maine, Georges Bank, southern New England and the middle Atlantic south to the Virginia-North Carolina border that support the highest densities of sea scallops. Generally, the following conditions exist where most sea scallop adults are found: water temperatures below 21^0 C, water depths from 18 - 110 meters, and salinities above 16.5‰.

Spawning Adults: Bottom habitats with a substrate of cobble, shells, coarse/gravelly sand, and sand in the Gulf of Maine, Georges Bank, southern New England and the middle Atlantic south to the Virginia-North Carolina border that support the highest densities of sea scallops. Generally, the following conditions exist where spawning sea scallop adults are found: water temperatures below 16^0 C, water depths from 18 - 110 meters, and salinities above 16.5‰. Spawning occurs from May through October, with peaks in May and June in the middle Atlantic area and in September and October on Georges Bank and in the Gulf of Maine.

ATLANTIC SEA HERRING (*Clupea harengus*)

Larvae: Pelagic waters in the Gulf of Maine, Georges Bank, and southern New England that comprise 90% of the observed range of Atlantic herring larvae. Generally, the following conditions exist where Atlantic herring larvae are found: sea surface temperatures below 16^0 C, water depths from 50 - 90 meters, and salinities around 32‰. Atlantic herring larvae are observed between August and April, with peaks from September through November.

Juveniles: Pelagic waters and bottom habitats in the Gulf of Maine, Georges Bank, southern New England and the middle Atlantic south to Cape Hatteras. Generally, the following conditions exist where Atlantic herring juveniles are found: water temperatures below 10^0 C, water depths from 15 - 135 meters, and salinity range from 26 to 32‰.

Adults: Pelagic waters and bottom habitats in the Gulf of Maine, Georges Bank, southern New England and the middle Atlantic south to Cape Hatteras. Generally, the following conditions exist where Atlantic herring adults are found: water temperatures below 10^0 C, water depths from 20 - 130 meters, and salinities above 28‰.

BLUEFISH (*Pomatomus saltatrix*)

Juveniles: Pelagic waters over the Continental Shelf (from the coast out to the limits of the EEZ). Generally, juvenile bluefish occur in North Atlantic estuaries from June through October. Distribution of juveniles by temperature, salinity, and depth over the continental shelf is undescribed.

Adults: Pelagic waters over the Continental Shelf (from the coast out to the limits of the EEZ). Adult bluefish are found in North Atlantic estuaries from June through October in the “mixing” and “seawater” zones. Bluefish adults are highly migratory and distribution varies seasonally and according to the size of the individuals comprising the schools. Bluefish are generally found in normal shelf salinities (> 25 ppt).

ATLANTIC MACKEREL (*Scomber scombrus*)

Juveniles: EFH is the pelagic water found over the Continental Shelf (from the coast out to the limits of the EEZ). EFH is also the “mixing” and /or “seawater” portions of all the estuaries where Atlantic mackerel are “common”, “abundant,” or “highly abundant”. Generally, juvenile Atlantic mackerel are collected from shore out to 1,050 feet and in water temperatures between 39^0 F and 72^0 F.

Adults: EFH is the pelagic waters found over the Continental Shelf (from the coast out to the limits of the EEZ), from the Gulf of Maine through Cape Hatteras, North Carolina; in areas that encompass the highest 75% of the catch where adult Atlantic mackerel were collected in NEFSC trawl surveys. EFH is also the "mixing" and/or "seawater" portions of all the estuaries where

Atlantic mackerel are "common", "abundant", or "highly abundant" on the Atlantic coast, from Passamaquoddy Bay, Maine to James River, Virginia. Generally, adult Atlantic mackerel are collected from shore out to 1,250 feet and in water temperatures between 39^0 F and 61^0 F.

BLUEFIN TUNA (*Thunnus thynnus*)

Adults: In pelagic waters of the Gulf of Maine from the 50 meter isobath to the Exclusive Economic Zone (EEZ), including the Great South Channel, then south of Georges Bank to 39^0 N from the 50 meter isobath to the EEZ.

SEARSPORT HARBOR
SEARSPORT, MAINE
NAVIGATION IMPROVEMENT PROJECT

APPENDIX E

ECONOMICS ANALYSIS

Searsport Harbor, Maine
Navigation Improvement Study
Feasibility Report

Economics Appendix

October 2012

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1.0 Introduction

The purpose of this appendix is to determine the economic justification of deepening the Federal Navigation project (entrance channel and turning basin) at Searsport Harbor in Searsport, Maine. A proposed improvement project is considered economically justified if the benefits of the project exceed the costs.

This economic analysis was conducted in accordance with current Corps of Engineers guidance contained in ER 1105-2-100, Appendix E, Section II, Navigation (April 22, 2000), and additional guidance contained in the Institute for Water Resources Report 91-R-13, National Economic Development Procedures Manual, Deep Draft Navigation (November 1991). Benefits and costs are compared in annual terms, and are converted to average annual equivalents using the FY 2013 Federal interest rate for water resources projects of 3.75 percent. All benefits and costs are presented in 2011 prices. The base year of the analysis is 2015, and a 50 year period of analysis is used.

The purpose of the economic analysis is to estimate the economic benefits of the proposed deepening project, and to compare those benefits against the estimated costs to determine the project's economic justification. The primary benefits calculated for this study are National Economic Development (NED) benefits. NED benefits are contributions to national economic development that increase the value of the national output of goods and services. For deep-draft navigation projects, the most common type of NED benefit is waterborne transportation cost savings. The NED benefits are estimated by comparing the transportation costs without the project to the transportation costs with the project. Any decrease in total transportation costs resulting from the project equal the benefits of the project. This economic analysis is based on detailed Waterborne Commerce Statistics data from the Corps of Engineers Waterborne Commerce Statistics Center, as well as on information provided by the Maine Department of Transportation, the operators and users of the terminals in the harbor, and the Searsport Harbor Pilots.

2.0 Description of Study Area

Searsport Harbor is located on Penobscot Bay, about 100 miles north of the city of Portland, Maine and halfway up the Maine coast. The western side of the harbor contains a municipal landing facility as well as mooring areas for commercial fishing and recreational vessels. The eastern side of the harbor, known as Mack Point, contains two deep draft terminals, one of which is a liquid cargo pier and the other a dry cargo pier.

The liquid cargo pier at Mack Point is used by two oil companies, Sprague Energy and Irving Oil. The berths at the pier are dredged to 37 feet on the eastern side and 25 feet on the western side. The dry cargo pier was newly constructed by the Maine Department of Transportation and became operational in 2003. It is designed to accommodate bulk cargo vessels up to 80,000 DWT and up to 750 feet in length. The berths of the dry cargo pier are dredged to 40 feet on the eastern side and 32 feet on the western side. The harbor has a tidal range of 10 feet.

The port has direct rail access, with railway operated by the Montreal, Maine, and Atlantic Railway (MM&A) providing access to the loading and storage areas of the port. The rail link provides rail access to points throughout the US and Canada, including direct linkages to eight other railroad lines. Paper and forest products account for about 60 percent of the MM&A's annual cargo volume (www.mmarail.com).

Commodities received at the port include petroleum and petroleum products, of which 1.6 million tons were received in 2006 and 1.3 million tons in 2008, and various bulk and break-bulk commodities, of which about 400,000 tons were received in 2006 and 540,000 tons in 2008. The port currently handles mostly imports, although the state of Maine is working to increase exports from the port. Oil and gasoline are the dominant imports at the port, generally making up 70 to 80 percent of the total tonnages. Of the bulk and break-bulk commodities, the most common imports are road salt, wood pulp, clay, chemicals, and gypsum. Many of these commodities are inputs to the paper product manufacturing businesses in the area.

2.1 Existing Federal Project

The existing Federal project in Searsport Harbor includes a channel that is 35 feet deep (mean lower low water) and 500 feet wide. The channel extends from deep water in Penobscot Bay to the terminal berths at Mack Point, for a total length of 3,500 feet, and widens to 1,500 feet off the terminals to provide a turning basin. A detailed description of the features of the existing project is contained in the Main Report.

2.2 Economic Setting

According to the US Census Bureau, in 2000 the town of Searsport, Maine had a population of 2,641 and contained 1,370 housing units. Searsport is located in Waldo County, in central coastal Maine. The nearest cities are Bangor to the north and Augusta, the state capital, to the southwest. The economy of Maine is heavily dependent on natural-resource based industries, more so than other states in the northeastern US. Industries such as commercial fishing, forest product manufacturing, agriculture, and recreation-based tourism are dominant. The paper industry is the largest manufacturing industry in Maine, and makes up about 4.1 percent of the total gross state product (Maine Pulp & Paper Association, www.pulpandpaper.org). Ship building and the businesses which support recreational boating are also very important. While southern Maine, which contains the city of Portland and is located near the large employment and population center of Boston, has a large and more diverse economic base, central and northern Maine, including Searsport, contain smaller towns with less dense populations and more resource-dependent industries.

In 2009 the population of Waldo County, which includes Searsport, was estimated at 38,287 (Maine Department of Labor). In March, 2010, Waldo County had a labor force of 18,689 and an unemployment rate of 10.7 percent (Maine Department of Labor). This is somewhat higher than the unemployment rate for the state as a whole, which was 8.9 percent for the same period. The average weekly wage in Waldo County in 2009 was $588, which compares to the average weekly wage in the state of $759 (Maine Department of Labor). In general, the central and northern portions of Maine typically have slightly higher unemployment and somewhat lower wages than the southern part of the state. Major employers in Waldo County with greater than 100 employees include several frozen seafood product manufacturers, a frozen potato product manufacturer, several wood products manufacturers, a shipyard, and several health care companies (Maine Department of Labor, Labor Market Information Services).

The port of Searsport is very important to the Maine economy, particularly to the economy of central and northern Maine. It is the only deepwater commercial port north of Portland, and is the primary point of entry for critical heating and fuel oil deliveries for central Maine. Four-fifths of Maine households use oil for heating, the highest proportion in the US (Energy Information Administration, State Energy Profiles). In addition, manufacturing industries play a larger, more important role in the economy of Maine than in other northeastern states, industries which import key material and energy resources through Searsport Harbor.

3.0 Proposed Improvement Project

The proposed improvement project for Searsport Harbor consists of deepening the existing Federal channel and turning basin from the current 35-foot authorized depth to potential depths of 37 to 42 feet. Additional channel width and maneuvering area at the state berth would be provided to allow adequate space for larger vessels to maneuver. Details regarding the proposed improvement plans are described in the Main Report in the sections Alternative Plans (pages 38-47) and Description of Selected Plan (pages 59 - 61), and in the Engineering Appendix, Appendix H (pages 14 – 20).

The local sponsor for the proposed improvement project is the State of Maine Department of Transportation (DOT). Maine DOT owns and operates the dry cargo pier at Mack Point, and works closely with Sprague Energy and Irving Oil, operators of the liquid pier, in its management of the port.

4.0 Existing Conditions

Although the existing Federal channel in Searsport Harbor is authorized to a depth of 35 feet, portions of the channel have shoaled to 33 feet. Currently many vessels experience significant tidal delays, and must wait until mid-tide or higher to enter or exit the harbor. The large tidal range of 10 feet, combined with berths dredged significantly deeper than the channel, allow larger vessels to use the port than would normally be possible. Larger vessels are able to enter the harbor at mid to high tide and lay over low tide at the deepened berths.

4.1 Current Vessel Usage

In 2008, there were 170 vessel calls at Searsport Harbor, of which 133 were foreign-flag vessels and 37 were US-flag vessels. Oil and gasoline were brought to the port on a mix of barges and tankers. Oil tankers and barges call the port most frequently, followed by chemical tankers, bulk carriers and general cargo carriers. In terms of total tonnages received at the port, in 2008 petroleum and petroleum products made up about 70 percent of the total tonnage. Other than petroleum products, the most significant commodities at the port in terms of tonnage include salt and clay, which made up 7 and 6 percent of the total tonnage respectively (2008 Waterborne Commerce Statistics). In terms of vessel origins, 48 percent of the vessels which called at Searsport originated at Canadian ports, 21 percent came from other New England ports, 12 percent from South American ports, and 8 percent from European ports (2006 detailed Waterborne Commerce Statistics).

Irving Oil currently brings petroleum products to Searsport on double-hulled tankers which average 35,000 to 40,000 DWT (deadweight tons), are 600 to 700 feet long, 90 feet wide, and have operating drafts up to 35 feet. However, Irving Oil's tankers are often light-loaded so that actual operating drafts entering Searsport Harbor are only 33 feet, the controlling depth of the channel. Sprague Energy brings petroleum products to the port on a mix of tankers and barges, roughly half of each, although in terms of volume about 75% of their product volume is brought on tankers. The tankers used by Sprague tend to be somewhat larger than those used by Irving, with operating drafts up to 36 feet and maximum drafts up to 40 feet. Some Sprague vessels lighter in New York before calling on Searsport. The barges used by Sprague are typically large, some with drafts of 30 feet and greater. The typical tanker remains at the dock for about 30 hours to offload, while the typical bulker remains at the dock for 65 to 70 hours (about three days).

Currently, many vessels use the tide to access the harbor, particularly large bulk cargo vessels. Oil tankers use the tide to varying degrees, with one of the two companies somewhat more willing to bring in larger vessels on the tide, the other company limiting the size of its vessels, and both companies light loading to some degree. Given the sizes and drafts of the vessels using the existing channel to capacity, many are using the tide in order to gain underkeel clearance. The harbor pilots and the terminal operators indicated that many larger vessels experience significant tidal delays in using the harbor.

4.2 Waterborne Commerce Statistics – Commodity Volumes

A summary of the total commodity volumes landed at Searsport Harbor since 1995 is shown below in Table 1. Commodity volumes were obtained from the publication "Waterborne Commerce of the United States," from the Corps of Engineers Waterborne Commerce Statistics Center. As can be seen from the data, total cargo volumes at Searsport were fairly consistent from 1995 to 2003, with volumes between 1.0 and 1.4 million tons. However, in 2004, 2005, and 2006, volumes increased significantly, to near or above 2 million tons. While this increase roughly coincides with the completion of the state's dry cargo pier in the harbor in 2002, much of the increase is the result of a significant increase in the shipments of petroleum and petroleum products. Total volumes decreased slightly in 2007 and 2008, part normal fluctuations and part due to decreased economic activity with the recession. However, total volumes remain significantly above the 2003 and prior year volumes.

Table 1
Total Commodity Volumes, 1995-2008

Year	Volume
	(short tons)
2008	1,856,000
2007	1,782,000
2006	2,039,000
2005	1,965,000
2004	1,832,000
2003	1,264,000
2002	1,040,000
2001	1,196,000
2000	1,441,000
1999	1,302,000
1998	1,329,000
1997	1,537,000
1996	1,433,000
1995	1,263,000

Source: Waterborne Commerce of the United States, 1995 - 2008

A detailed listing of the commodities brought into Searsport Harbor in 2006 and 2008 is shown in Table 2 below.

Table 2
Volumes by Commodity, 2006 and 2008

Commodity	2006 Volume (Tons)	Proportion	2008 Volume (Tons)	Proportion
Petroleum/Petr. Products	1,621,000	79.5%	1,296,000	69.8%
Road Salt	126,000	6.2%	330,000	17.8%
Clays	101,000	5.0%	55,000	3.0%
Pulp & Waste Paper	56,000	2.7%	11,000	0.6%
Gypsum	45,000	2.2%	69,000	3.7%
Ammonia	44,000	2.2%		
Iron Oxides	25,000	1.2%		
Slag			16,000	0.9%
Sodium Hydroxide	2,000	0.1%	62,000	3.3%
Machinery	2,000	0.1%	1,000	0.1%
Other	17,000	0.8%	16,000	0.9%
Total	2,039,000	100%	1,856,000	100%

Source: Waterborne Commerce of the United States, 2006 and 2008

Historical volumes of petroleum and petroleum products are shown below in Table 3. Deliveries fluctuated around 1 million tons from 1995 to 2004, increased to 1.4 million tons in 2004 and 2005, and increased further to 1.6 million tons in 2006. Volumes increased significantly from 2004 to 2006 because, in that time period, both Irving Oil and Sprague Energy consolidated some operations from harbors in nearby Bucksport and Bangor, Maine to Searsport. Deliveries fell somewhat in 2007 and 2008, with the recession.

Table 3
Historical Petroleum and Petroleum Product Volumes

Year	Volume
	(short tons)
2008	1,296,000
2007	1,488,000
2006	1,621,999
2005	1,465,000
2004	1,402,000
2003	984,000
2002	883,000
2001	1,060,000
2000	1,129,000
1999	1,005,000
1998	1,013,000
1997	1,043,000
1996	1,024,000
1995	808,000

Source: Waterborne Commerce of the United States, 1995 - 2008

A variety of other cargo is landed at Searsport Harbor, particularly bulk and break-bulk commodities. Major commodity categories in recent years include construction materials, clay slurry and chemicals (inputs to the paper industry), and road salt. A listing of the major bulk and break-bulk commodities brought into the port in recent years is shown in Table 4 below. While there has been significant variation in the volumes and types of bulk commodities brought into the port over the years, total volumes have averaged at least 400,000 tons per year since 2004, after completion of the state dry cargo pier. This is a near doubling of the typical bulk volumes from prior years.

Table 4
Recent Bulk and Break Bulk Commodity Volumes

Commodity	2008	2007	2006	2005	2004	2003	2002	2001	2000
Chemicals	70,000	45,000	75,000	60,000	50,000	56,000	43,000	65,000	48,000
Road Salt	330,000	73,000	126,000	172,000	233,000	195,000	115,000	63,000	118,000
Gypsum	69,000	46,000	45,000	40,000	40,000	29,000			25,000
Pulp & Waste Paper	11,000	10,000	56,000	56,000	28,000				51,000
Cement & Concrete					34,000				
Machinery	1,000	2,000	2,000	71,000	20,000				
Iron/Steel Pipes/Tubes				31,000					
Clay	55,000	78,000	101,000	28,000					
Total, Major Bulk	536,000	254,000	405,000	458,000	405,000	280,000	158,000	128,000	242,000

Source: Waterborne Commerce of the United States, 2000 - 2008

4.3 Waterborne Commerce Statistics – Vessel Movements

Detailed waterborne commerce statistics were obtained for the port of Searsport, Maine from the Corps of Engineers Waterborne Commerce Statistics Center in New Orleans, Louisiana. As opposed to the published summary statistics shown in the tables above, detailed statistics show individual ship movements in and out of a port and are available only by request. Detailed statistics for Searsport Harbor were obtained for 2006, the most recent year available at the time the main economic analysis was conducted.

Based on the detailed Waterborne Commerce Data, vessels calling Searsport in 2006 originated most commonly in Canada, predominantly from the port of St. John, New Brunswick and from various other ports in Quebec and Nova Scotia. Nearly half of all vessel calls to Searsport originated in Canada, largely reflecting shipments of petroleum products brought to the port by Irving Oil, a Canadian company. The next highest proportion of vessel origins were from New England ports, primarily Portland (Maine), Portsmouth (New Hampshire) and Boston (Massachusetts), reflecting the regional nature of some oil shipments. After Canadian and New England ports, the most common vessel origins were South American ports, particularly Brazil, Chile and Venezuela, followed by a few European ports.

A detailed breakdown of vessel drafts for vessels entering and exiting Searsport Harbor is shown below in Table 5. Total vessel trips for the years 2005 through 2008 are shown, as well as the four-year average. Annually, the number of vessel trips per year has averaged about 330 vessels, representing 165 vessel calls. On average over the four-year period, there were 142 vessel trips (43%) with drafts of 24 feet or less, 109 trips (33%) with drafts of 25 to 29 feet, 55 trips (17%) with drafts of 30 to 34 feet, and 25 trips (7%) with drafts of 35 feet or greater (Waterborne Commerce Statistics of the United States, Trips and Drafts of Vessels, 2005 - 2008). In 2008, 78% of the vessel calls were made by foreign flag vessels and 22% were made by US-flag vessels. Since nearly all shipments to the port are imports, Searsport vessels usually have deeper drafts inbound than outbound. Since vessels require underkeel clearance of two to three feet, and since the controlling depth in the channel is 33 feet, vessels with drafts greater than 30 feet are considered to be using the channel to capacity. Based on the 2008 trips and drafts data, there were 80 vessel trips with drafts greater than 30 feet, or 24 percent of the total 339 vessel trips which used the channel to capacity. Many of those vessels had to use the tide to enter or exit the harbor.

Table 5
Vessel Trips by Draft, 2005 – 2008

Draft (ft)		2005	2006	2007	2008		Average	%
44		0	1	0	0		0	0
43		0	0	0	0		0	0.0%
42		0	0	0	0		0	0.0%
41		0	1	0	0		0	0.0%
40		0	0	0	3		1	0.3%
39		1	2	1	4		2	0.6%
38		2	0	1	2		1	0.3%
37		2	2	1	0		1	0.3%
36		16	6	1	2		6	1.8%
35		13	15	10	17		14	4.2%
34		10	8	6	14		10	3.0%
33		8	7	11	11		9	2.7%
32		9	9	17	18		13	3.9%
31		11	10	5	9		9	2.7%
30		12	12	11	20		14	4.2%
29		11	30	24	20		21	6.3%
28		19	23	20	33		24	7.3%
27		19	29	19	21		22	6.6%
26		18	20	19	17		19	5.7%
25		29	20	21	21		23	6.9%
24		12	26	34	18		23	6.9%
23		8	10	5	4		7	2.1%
22		12	20	3	7		11	3.3%
21		5	14	14	7		10	3.0%
20		9	14	16	16		14	4.2%
<20		77	65	92	75		77	23.3%
Total		303	344	331	339		331	100.0%

Source: Waterborne Commerce of the United States, Trips and Drafts of Vessels, 2005 - 2008
Waterborne Commerce Statistics Center, US Army Corps of Engineers

4.4 Existing Navigation Inefficiencies

Currently, Searsport Harbor has inadequate depth in the Federal channel, which results in significant tidal delays for larger vessels, some lightloading of vessels, and restrictions in the size of vessels which can be used to bring cargo to the port. Irving Oil lightloads some of its vessels to arrive at the port at drafts of 33 feet, even though their vessels have the capacity to be loaded to 35 feet. With drafts of 33 feet, vessels are able to access the harbor through most of the tidal cycle, using the tide for underkeel clearance when necessary. Sprague Energy does not lightload its vessels as regularly, nor do the bulk cargo shippers. When larger vessels with deeper drafts are used, they can experience significant tidal delays of up to 12 hours, depending when they arrive in the tidal cycle. Some oil tankers which call on Searsport also call on other New England ports or may call at New York and offload some product before proceeding to Searsport. This practice depends on many factors including market demand and vessel routing concerns, and may continue to occur in the future to some degree regardless of the channel depth at Searsport.

5.0 Searsport Harbor Hinterland

The hinterland of a port is the area served by the port, or the reach of the port into the surrounding region. For Searsport Harbor, the hinterland varies somewhat by type of cargo, but consists primarily of the northern, eastern, and central portions of Maine for oil deliveries, and the eastern and central portions of Maine for bulk cargo deliveries. Southern Maine is served by the port of Portland for most cargo including oil, and northern Maine is largely served by Canadian ports for bulk cargo. In general, the hinterland of Searsport Harbor consists of the area within a 150 mile radius of the port. Periodically some shipments are destined for more distant locations such as the mid-west, Canada, and the south, but such shipments do not occur frequently.

6.0 Benefit Methodology

The NED benefits for deepening the channel in Searsport Harbor were calculated based on the detailed Waterborne Commerce Statistics for the port from 2006, as well as on information provided by the terminal operators and Maine DOT. The 2006 Waterborne Commerce data was used because it was the most recent available at the time of the primary economic analysis, and because it is likely more representative of activity in the harbor over the 50-year period of analysis than data from the more recent years of recession. The 2006 Waterborne Commerce Statistics were analyzed in detail, and those vessels that used the existing channel to capacity, defined as vessels with drafts greater than 30 feet, were identified. The basic characteristics of those vessels were determined, including type of vessel (bulk carrier or tanker), size in terms of Deadweight Tonnage (DWT), maximum draft, sailing draft, type of cargo, originating port, and travel distance (port to port).

The detailed fleet information for 2006 was then combined with information obtained from Irving Oil, Sprague Energy, Maine DOT, and the Searsport Harbor Pilots, and with published information regarding world vessel fleets, to develop a fleet forecast for the port of Searsport. The fleet forecast is detailed in Section 10, below. A fleet forecast was made for both the without and with project conditions.

An analysis of the commodities which have moved through the port in recent years was also performed, much of which is summarized in Tables 1 – 4 above. This information was combined with information obtained in interviews with the terminal operators and Maine DOT regarding likely future activity at the port, and with published information regarding trends in energy imports and energy demand, to develop a commerce forecast for the port of Searsport. The commerce forecast is detailed in Section 9, below. The commerce forecast is the same for both the without and with project conditions.

The commerce forecast and the fleet forecast were then combined to determine the waterborne transportation costs for moving the forecasted cargo volume on the forecasted vessel fleet under the without project condition (35-foot channel depth) and for each with-project condition analyzed (channel depths of 37 to 42 feet). Waterborne transportation costs were determined by combining information about the type of vessel, shipment origin, travel distance, travel speed, and typical hourly operating costs for deep draft vessels. Hourly vessel operating costs as developed by the Army Corps of Engineers, Institute for Water Resources, in Economic Guidance Memorandum #11-05, Deep-Draft Vessel Operating Costs FY 2011, were used. Once the total waterborne transportation costs of each condition were determined, the NED benefits could be calculated. The NED benefits of each channel depth analyzed equal the difference between the waterborne transportation costs without the project and the expected waterborne transportation costs with the alternative channel depth. Economic benefits are calculated for the base case condition as well as for two sensitivity analyses, in which a few key assumptions are changed. The sensitivity analyses are presented to show the possible range of benefit values with varying assumptions.

7.0 Without Project Condition

In the without project condition, it is assumed that the existing channel will be dredged to the authorized depth of 35 feet. The removal of shoaled areas and the restoration of a 35-foot channel will make harbor operations more efficient. The significant tidal delays currently experienced by some vessels will be reduced. The lightloading of many vessels to 33 feet will be no longer be necessary. There will continue to be some tidal delays for larger vessels, since vessels with drafts up to 39 feet currently call on the port, and three feet of underkeel clearance is generally needed. Without a deepening project, shippers will continue to be limited in the size of vessel they can use to call the port, leaving them unable to achieve the economies of scale of larger vessels. Many shippers, particularly of bulk commodities, prefer to use larger vessels with lower overall costs per ton, particularly for trips over long distances (from South America or Europe). Without a project, the degree to which commodities brought to Searsport can be shipped on the most cost-effective vessels will be limited by the 35-foot authorized channel depth.

8.0 With Project Condition

In the with project condition, the Federal channel in Searsport Harbor would be deepened. Depths of 37 to 42 feet are examined for the economic analysis. Additional channel width and maneuvering area would also be provided as needed. It is assumed that berth depths will be dredged to 3 feet beyond the additional channel depth provided, in order to allow vessels to continue to use the large tidal range in the harbor for gaining underkeel clearance for large vessels. Currently, the berths at the liquid pier are dredged to 37 and 25 feet and the berths at the new state pier are dredged to 40 and 32 feet. The costs of the additional berth deepening are included in the total costs of the project. Based on the existing use of the harbor, some use of the tide, at least to obtain underkeel clearance, is judged by vessel operators to be manageable, and so it is projected that this practice will continue to some degree in the future, even with channel deepening. Given that shippers usually attempt to use the most cost-effective vessels possible, it is assumed for this analysis that the additional channel depth provided in the with project condition beyond the maintenance dredging will be used to allow shippers to shift to larger, more cost-effective vessels, thereby achieving the lower cost per ton of larger vessels. The benefits to channel deepening thus equal the reduction in waterborne transportation costs that can be achieved with larger vessels. The degree to which shippers would use larger vessels was determined based on extensive interviews with Irving Oil and Sprague Energy, the constraints of other ports in the New England Region, the overall composition of the world fleet, and the past usage of Searsport Harbor.

It is assumed that the maintenance dredging, bringing the channel from 33 to 35 feet, will be used primarily to reduce the significant tidal delays currently experienced at Searsport Harbor. The benefits from reduced tidal delays accrue to the maintenance dredging and are not claimed as benefits for the proposed deepening project. The maintenance dredging will also reduce the extent of lightloading currently practiced by Irving Oil. The degree to which oil tankers arrive at Searsport below their maximum draft (lightloaded) due to inadequate channel depth, versus due to a port rotation in which some product is offloaded at another New England port as part of a regional delivery, was difficult to determine. The base case economic analysis was performed assuming all lightloading is due to inadequate depth at Searsport. A sensitivity analysis was also performed in which it is assumed that, on average, tankers are still loaded in the with-project condition at somewhat below their maximum draft, although not to the degree currently seen under existing conditions. The resulting benefits using both sets of assumptions are shown for comparison purposes. This is not an issue for bulk traffic, because the 2006 data show that bulk vessels are generally calling on Searsport fully loaded (at maximum draft).

9.0 Commerce Forecast

Historically, the majority of cargo received at Searsport has been petroleum and petroleum products, with the remainder a varying mix of bulk and break-bulk products. In 2006, the total volumes received topped 2 million tons. The port usually has few exports, although Maine DOT has been working to develop exports and so they may become important in the future. Since 2003, total volumes of both petroleum products and bulk/break-bulk commodities have increased significantly (see Tables 3 and 4 in Section 4.2, above). The recent increase in volumes shows that the port is thriving and is a key part of the Maine economy. Even with the slight drop-off in volumes with the recession in 2008, volumes remain significantly above their 2003 and prior-year levels. In the future, particularly as the recession ends, it is likely that total volumes will remain at least at the 2006 levels. Future use of the harbor could increase beyond 2006 levels if the channel is deepened and use of the port becomes more attractive to shippers, or if renewed economic growth after the recession ends spurs increased demand.

The base case commerce forecast for this study is based on 2006 cargo volumes, and is essentially a no-growth scenario. Cargo volumes are kept constant at the 2006 levels over the 50-year period of analysis. Volumes in 2006 included 1,600,000 tons of petroleum and petroleum products, and 400,000 tons of bulk cargo. Total volumes from 2006 are used since those volumes reflect economic conditions prior to the severe recession of 2007 – 2009, and were judged to reflect the most likely condition over the 50-year period of analysis for this study. Growth in volumes beyond the 2006 level could occur in the future through increased demand for existing commodities, or from new types of cargo brought through the port. For petroleum products, growth in demand is typically directly related to population growth and growth in economic activity. For bulk and break-bulk products, growth in demand is related primarily to growth in the industry or business using the cargo, and secondarily to the general level of economic activity in the region.

According to the US Census Bureau, the population of Maine is expected to grow from 1,274,923 in 2000, to 1,411,097 by 2030, an increase of slightly over 10 percent over 30 years (US Census Bureau, 2005, Interim Projections of Population by State to 2030). This is a relatively slow growth rate of about 0.35 percent per year, putting Maine with other northeastern US states in the low to moderate range of expected population growth over the period relative to other regions in the US. In general, the southern and western regions of the US are projected to have higher growth rates than the northeast. In comparison to southern and western states, Maine has a somewhat older population, has fewer minorities, and is not a major immigration destination, factors which contribute to lower population growth rates (Maine State Planning Office, Maine Economic and Demographic Trends). However, some growth in population is projected, growth which will support continued energy demand and continued business activity in the region, supporting the continued use of Searsport for petroleum and bulk cargo imports at current, if not higher, levels.

A scenario in which cargo volumes through the port increase slowly over the period of analysis, in keeping with projected low to moderate increases in population for the region, is analyzed as a sensitivity analysis. In that scenario, cargo volumes are projected to increase by 0.35 percent per year over the 50 year period of analysis, with petroleum products landed at Searsport increasing to 2 million tons by 2064, and bulk cargo volumes increasing to 485,000 tons. The terminals have shown the capacity to readily accommodate increases in cargo volumes. In 2006, the petroleum terminal put nine oil storage tanks back into service to accommodate increased demand. Since 2005, four tanks were constructed on the site to store imported clay. Clay slurry has been a significant growth commodity at Searsport. It is brought from Brazil, processed on-site at the harbor, and then shipped to paper mills in Maine by truck. In the future, additional slurry could be brought from the port by rail to locations in the mid-west, and clay volumes could increase further.

10.0 Fleet Forecast

In analyzing the vessels which use Searsport Harbor, the vessels are divided into two broad categories, the tanker fleet and the bulk carrier fleet. Both sets of vessels often use the existing channel in the harbor to capacity and would benefit from additional channel depth.

In 2007, the world tanker fleet consisted of 5,300 vessels (*Propulsion Trends in Tankers*, MAN Diesel A/S, Copenhagen, Denmark, 2007). The current size distribution of the world tanker fleet is shown in Table 6 below.

Table 6
World Tanker Fleet, 2007

Vessel Size Class	Deadweight Tonnage (DWT)	Proportion of World Fleet
Small	< 10,000	21.1%
Handysize	10,000-35,000	19.8%
Handymax	35,000-55,000	24.4%
Panamax	60,000-80,000	5.8%
Aframax	80,000-120,000	13.4%
Suezmax	125,000 - 170,000	6.7%
> Suezmax	200,000 +	8.8%

Source: *Propulsion Trends in Tankers,* MAN Diesel A/S, Copenhagen, Denmark, 2007, www.manbw.com/technical papers

The oil tankers which are currently brought to Searsport by Irving Oil are generally in the upper end of the Handysize category or the lower end of the Handymax category, vessels of 35,000 to 40,000 DWT, 600 to 700 feet long, and 90 to 100 feet wide. Sprague Oil uses a mix of barges and sometimes larger tankers, tankers which can be at the upper end of the Handymax size category up to 55,000 DWT. As can be seen in the above table, the tankers which currently call Searsport fall within the most common size categories in the world tanker fleet, generally either larger Handysize vessels or smaller Handymax vessels.

In 2007, the world bulk carrier fleet consisted of 6,200 vessels (*Propulsion Trends in Bulk Carriers,* MAN Diesel A/S, Copenhagen, Denmark, 2007). The current size distribution of the world bulk carrier fleet is shown in Table 7 below. Generally, within the Handymax size category, the smaller 35,000 DWT bulk carriers typically have loaded drafts up to 35 feet, and the larger 50,000 to 55,000 DWT bulk carriers have loaded drafts up to 39 or 40 feet. The bulk carriers which call on Searsport Harbor range in size depending on the carrier and the commodity, but range in size from 20,000 to 42,000 DWT. These vessels fall into the Handysize category or the low end of the Handymax category. As can be seen in Table 7, these are the two most common size categories, but there are also many larger vessels in the world fleet.

Table 7
World Bulk Carrier Fleet, 2007

Vessel Size Class	Deadweight Tonnage (DWT)	Proportion of World Fleet
Small	< 10,000	4.3%
Handysize	10,000-35,000	33.4%
Handymax	35,000-55,000	28.6%
Panamax	60,000-80,000	20.5%
Capesize and larger	80,000-200,000	13.2%

Source: *Propulsion Trends in Bulk Carriers,* MAN Diesel A/S, Copenhagen, Denmark, 2007, www.manbw.com/technical papers

For the fleet forecast for Searsport Harbor, the focus is on vessels which currently use the channel to capacity, vessels with drafts greater than 30 feet, for it is only those vessels which would be affected by increased channel depth. For the remaining vessels, vessels with drafts less than 30 feet, it is assumed that there is no change in the fleet between the without and with project conditions.

Under existing conditions (channel depth of 33 feet), the bulk carriers currently using the channel to capacity have an average size of 32,500 DWT. For the without project condition (channel depth of 35 feet), it is projected that the average vessel size for bulk carriers using the channel to capacity will increase only slightly 35,000 DWT, with most of the increased channel depth being used to reduce the significant tidal delays currently experienced. With channel deepening beyond 35 feet, it is projected that the increased channel depth will be used to increase vessel size, as shippers seek the lower costs per ton of larger vessels. With improved channel depths of 37 to 40 feet, it is projected that the average bulk carrier size for vessels using the channel to capacity will increase to between 40,000 and 60,000 DWT, depending on the channel depth provided.

The fleet forecast for bulk carriers in Searsport Harbor is shown below in Table 8. The table shows the average vessel size projected under each condition, for vessels currently using the channel to capacity. Vessels size categories and the corresponding maximum drafts are taken from the Corps of Engineers Deep Draft Vessel Operating Cost tables, interpolated as necessary. It is assumed that actual vessel sizes would be distributed around the average as they are currently. It is also assumed that bulk carriers will continue to use the extensive tidal range in the harbor for underkeel clearance, and that berths will be dredged 3 feet deeper than the channel depth analyzed in order to facilitate such use of the tide. Finally, it is assumed that bulk vessels will continue to be loaded at or near their maximum draft, as they are currently.

Table 8
Bulk Carrier Fleet Forecast

Condition	Average Deadweight Tonnage	Maximum Draft[2]	Actual Average Draft (Current and Projected)
	(DWT)	(feet)	(feet)
Existing Conditions (33')[1]	32,500	34.4	34.6
Without Project Condition (35')	35,000	35.2	35.2
With Project - 37'	40,000	36.6	36.6
With Project - 38'	45,000	37.9	37.9
With Project - 39'	50,000	39.3	39.3
With Project - 40'	53,300	40.0	40.0
With Project - 41'	56,600	40.8	40.8
With Project - 42'	60,000	41.6	41.6

[1] average of vessels currently using channel to capacity (drafts > 30’)

[2] from Corps of Engineers Deep Draft Vessel Operating Costs

Officials at Sprague Energy and Irving Oil were interviewed to determine the likely oil tankers that would be used with different channel depths. With additional channel depth, Irving projects that they would shift to larger vessels up to 55,000 DWT. Sprague would also increase to larger vessels, with a higher proportion of larger vessels than currently used and some vessels up to 65,000 DWT.

Under existing conditions (channel depth of 33 feet), oil tankers currently using the channel to capacity have an average size of 40,000 DWT. For the without project condition (channel depth of 35 feet), it is projected that there will be no change in the average vessel size for oil tankers. It is assumed that maintenance dredging will be used to reduce the significant tidal delays currently experienced, and also reduce some of the lightloading which currently occurs. Improvement dredging to 37 feet will allow the current average 40,000 DWT tanker to be fully loaded. With further channel deepening, it is projected that the average tanker size will increase to between 45,000 and 55,000 DWT, depending on the channel depth provided. It is assumed that, in the with project condition, actual vessel sizes would be distributed around the average as they are currently. It is also assumed that oil tankers will continue to use the large tidal variation in the harbor to gain underkeel clearance when needed. For oil tankers, it is projected that the average vessel size will not increase beyond 55,000 DWT given the limited depths of other New England ports and the regional nature of many oil shipments.

The fleet forecast for oil tankers for the base case analysis of Searsport Harbor is shown below in Table 9. The average vessel size categories and maximum draft data are taken from the Corps of Engineers deep draft vessel operating cost tables. When actual vessels sizes and drafts are examined, there is some variation in the deadweight tonnage of various vessels and their maximum and operating drafts. The information provided by Sprague Energy and Irving Oil regarding their current and potential future fleets with channel dredging was combined with the size categories and draft data in the deep draft vessel operating cost tables to develop the specific fleet forecast.

Table 9
Oil Tanker Fleet Forecast – Base Case Analysis

Condition	Average Deadweight Tonnage	Maximum Draft[2]	Actual Average Draft (Current and Projected)
	(DWT)	(feet)	(feet)
Existing Conditions (33')[1]	40,000	36.6	34.0
Without Project Condition (35')	40,000	36.6	35'
With Project - 37'	40,000	36.6	36.6
With Project - 38'	45,000	37.5	37.7
With Project - 39'	50,000	38.7	38.7
With Project - 40'	55,000	39.7	39.7
With Project - 41'	55,000	39.7	39.7
With Project - 42'	55,000	39.7	39.7

[1] average of vessels currently using channel to capacity (drafts > 30’)

[2] from Corps of Engineers Deep Draft Vessel Operating Costs

The oil tanker fleet forecast for the base case analysis assumes that the additional channel depth provided by maintenance dredging as well as the 37-foot improvement depth are used to reduce tidal delays and lightloading. A sensitivity analysis is performed in which this assumption is changed. In the sensitivity analysis, it is assumed that some lightloading of tankers will still occur with channel depths of 37 to 40 feet, due to shippers making regional shipments (stopping at other ports before arriving at Searsport), or due to factors unrelated to channel depth at Searsport. With some continued lightloading, it is assumed in the sensitivity analysis that shippers use the additional channel depth provided with the project to shift to larger vessels at slightly lesser channel depths than in the base case, as shown in Table 10 below.

Table 10
Oil Tanker Fleet Forecast – Sensitivity Analysis
Searsport Harbor

Condition	Average Deadweight Tonnage	Maximum Draft[2]	Actual Average Draft (Current and Projected)
	(DWT)	(feet)	(feet)
Existing Conditions (33')[1]	40,000	36.6	34.0
Without Project Condition (35')	40,000	36.6	35'-36'
With Project - 37'	45,000	37.5	36' - 37'
With Project - 38'	50,000	38.7	37' - 38'
With Project - 39'	55,000	39.7	38' - 39'
With Project - 40'	55,000	39.7	38' - 39'
With Project - 41'	55,000	39.7	38' - 39'
With Project - 42'	55,000	39.7	38' - 39'

[1] average of vessels currently using channel to capacity (drafts > 30')
[2] from Corps of Engineers Deep Draft Vessel Operating Costs

11.0 Design Vessels

The design vessels were chosen based on information provided by the terminal operators and harbor pilots regarding the likely vessels that would use the harbor if additional channel depth were available. The harbor pilots provided a set of data cards for the largest vessels that would likely call, with data including each vessel's deadweight tonnage, length, beam and draft. The oil tanker design vessel chosen was 65,000 DWT with a length of 700', a beam of 106' and a draft of 45'. The bulk carrier design vessel chosen was 80,000 DWT with a length of 800, a beam of 116', and a draft of 45'. The design vessels were chosen to ensure that the designed channel with improvements would be able to safely accommodate the largest vessels that would likely use the harbor, although in rare cases an even larger vessel could use the harbor. Very large vessels have used the harbor in the past, at sporadic intervals.

The economic analysis calculates benefits using the typical average-sized vessel, which is projected to increase as more depth is available. This assumption was made based on discussions with the terminal owners/operators. Both companies said they would use larger vessels if more depth were available, although there would be a limit to the increase. The companies indicated they would not increase beyond 55,000 – 60,000 DWT vessels. The fleet forecast was made based on the information provided by the terminal owners, and by comparing this information with the vessels available in the world fleet. Since both the without and with project vessels are very common vessel sizes in the world fleet, and since the information was provided by companies with a long history of operating vessels in harbors in the northeast, the information provided by the terminals was judged to be reasonable.

The current average-sized vessel using the channel to capacity, based on detailed waterborne commerce data, is 35,000 – 45,000 DWT. The vessel size increases slowly as more channel depth is provided in the with project condition, as described in the report text, to a maximum of 55,000 – 60,000 DWT. The average-sized vessel at each depth increment analyzed is smaller than the design vessel, but it is assumed that the actual vessel sizes would be distributed around the average vessel size as they are currently, and that the upper end of the distribution would likely include the design vessel or similarly-sized vessels.

12.0 Calculation of Benefits

The economic benefits of deepening the channel in Searsport Harbor equal the reduction in waterborne transportation costs between the without and with project conditions. The first step in calculating the benefits was to determine the waterborne transportation costs of moving the current level of cargo on the vessels used currently. The detailed Waterborne Commerce Statistics for 2006 were analyzed, and the characteristics of the current vessels using the current channel to capacity, those vessels with drafts greater than 30 feet, were examined in detail. Average statistics, including average DWT, average draft arriving at Searsport, and average travel distance, were then determined for two groups of vessels, bulk carriers using the channel to capacity and oil tankers using the channel to capacity. The hourly vessel operating cost and typical speed for vessels were taken from the Corps of Engineers Deep Draft Vessel Operating Cost tables. Combining the average trip distance, speed, size and type of vessel, and hourly operating cost, the total waterborne transportation cost for the current cargo volume under existing conditions (33-foot channel depth) was determined.

Total waterborne transportation costs were then estimated for the without project condition (with maintenance dredging to 35 feet) and the with project conditions (37 to 42 feet channel depth), based on the commerce forecast and fleet forecasts presented above. The benefits to channel dredging equal the reduction in waterborne transportation costs between the without and with project conditions. Cargo tonnages at Searsport are projected to be the same for both the without and with project conditions, but it is assumed that, in the with project condition, shippers will be able to bring the cargo on larger vessels, resulting in fewer total trips per year and a decreased overall cost per ton. Benefits were calculated for the base case analysis as well as for several sensitivity analyses.

Total transportation costs are determined by combining fleet forecast information with commerce forecast information. However, only cargo moved on vessels which currently use the channel to capacity, vessels with drafts greater than 30 feet, is considered as cargo which could be moved more cheaply with channel deepening. While the base case analysis projects that total petroleum volumes will equal 1.6 million tons per year, the analysis of the detailed Waterborne Commerce data showed that 700,000 tons, or 44 percent of the total, were brought on vessels currently using the channel to capacity. As a result, the benefits from reducing waterborne transportation costs for petroleum products are calculated based on 700,000 tons of cargo in the base case. For the sensitivity analyses, this proportion is retained. That is, it is assumed that 44 percent of future petroleum product volumes will be brought on vessels which would benefit from channel deepening.

In the base case analysis for bulk cargo, projected cargo volumes equal the 2006 level of 400,000 tons per year. In the analysis of the 2006 detailed Waterborne Commerce data, it was determined that 300,000 tons, or 75 percent of the total, were brought on vessels currently using the channel to capacity (vessels with drafts greater than 30 feet). As a result, the benefits from reducing waterborne transportation costs for bulk cargo are calculated based on 300,000 tons of cargo, the volume of bulk cargo brought on ships using the channel to capacity. For the sensitivity analyses, this proportion is retained. For example, in the commerce growth scenario in which it is projected that bulk cargo volumes grow to 485,000 tons by 2064, it is assumed that 75 percent of that cargo, or 364,000 tons will be brought on vessels which would benefit from channel deepening.

12.1 Base Case Economic Benefits

In the with project condition, it is projected that the average vessel size for vessels currently using the channel to capacity will increase, as shippers seek to achieve the lower cost per ton of larger vessels. For the base case analysis, the average size of vessels using the channel to capacity is projected to increase as detailed in Tables 8 and 9, above. Total transportation costs are calculated using the base case commodity forecast, 1.6 million tons of petroleum products and 400,000 tons of bulk cargo, of which 700,000 tons and 300,000 respectively are shipped on vessels which would benefit from channel deepening. The annual economic benefits to channel dredging equal the difference in waterborne transportation cost between the without project condition and the with project condition for each channel depth analyzed.

Total waterborne transportation costs for existing conditions, the without project condition, and each improvement depth increment are shown in Table 11, below. The annual benefits to dredging equal the difference between the without project transportation costs and those of each improvement dredging increment, as shown in Table 12.

Table 11
Waterborne Transportation Costs – Base Case

Condition	Annual Waterborne Transportation Costs - Bulk Carriers	Annual Waterborne Transportation Costs - Oil Tankers	Total Annual Waterborne Transportation Costs
Existing Conditions (33')	$3,214,181	$3,499,136	$6,713,317
Without Project Condition (35')	$3,045,609	$3,346,667	$6,392,276
With Project - 37'	$2,833,932	$3,128,554	$5,962,486
With Project - 38'	$2,652,194	$2,888,191	$5,540,385
With Project - 39'	$2,491,690	$2,709,306	$5,200,996
With Project - 40'	$2,378,457	$2,616,586	$4,995,042
With Project - 41'	$2,264,824	$2,616,586	$4,881,410
With Project - 42'	$2,172,807	$2,616,586	$4,789,392

Table 12
Annual Benefits to Channel Dredging - Base Case

Condition	Annual Benefits Bulk Carriers	Annual Benefits Oil Tankers	Total Annual Benefits - Base Case
With Project - 37'	$211,677	$218,113	$429,790
With Project - 38'	$393,414	$458,476	$851,890
With Project - 39'	$553,919	$637,361	$1,191,280
With Project - 40'	$667,152	$730,082	$1,397,233
With Project - 41'	$780,785	$730,082	$1,510,866
With Project - 42'	$872,802	$730,082	$1,602,884

The assumptions used in the base case analysis regarding vessel sizes, drafts, the use of tide, and the overall calculated waterborne transportation cost per ton are summarized in Tables 13 and 14, below. Information is shown for the without project condition (35’ channel depth) and each with project condition (37’ – 42’ channel depths). The assumptions for Bulk Carriers are shown in Table 13, and the assumptions for Oil Tankers in Table 14.

Table 13
Sailing Draft Assumptions, Bulk Carriers

	Channel Depth						
	35'	37'	38'	39'	40'	41'	42'
Average DWT (Actual & Projected)	35,000	40,000	45,000	50,000	53,300	56,600	60,000
Design Draft (feet)	35.2	36.6	37.9	39.3	40.0	40.8	41.6
Average Draft (Projected)	35.2	36.6	37.9	39.3	40.0	40.8	41.6
Cargo on Board (tons)	31,500	36,000	40,500	45,000	47,970	50,940	54,000
Average Draft Plus 10% Underkeel Clearance	38.7	40.3	41.7	43.2	44.0	44.9	45.8
Tide-related Assumptions	tide used for underkeel clearance	tide used for underkeel clearance	tide used for underkeel clearance	tide used for underkeel clearance	tide used for underkeel clearance	tide used for underkeel clearance	tide used for underkeel clearance
Average Travel Distance (nautical miles)	4,100	4,100	4,100	4,100	4,100	4,100	4,100
Cost per ton	$10.15	$9.45	$8.84	$8.31	$7.93	$7.55	$7.24

Table 14
Sailing Draft Assumptions, Oil Tankers

	Channel Depth						
	35'	37'	38'	39'	40'	41'	42'
Average DWT (Actual & Projected)	40,000	40,000	45,000	50,000	55,000	55,000	55,000
Design Draft (feet)	36.6	36.6	37.5	38.7	39.7	39.7	39.7
Average Draft (Projected)	35.0	36.6	37.5	38.7	39.7	39.7	39.7
Cargo on Board (tons)	33,700	36,000	40,500	45,000	49,500	49,500	49,500
Average Draft Plus 10% Underkeel Clearance	38.5	40.3	41.3	42.6	43.7	43.7	43.7
Tide-related Assumptions	lightloaded to reduce draft	tide used for underkeel clearance	tide used for underkeel clearance	tide used for underkeel clearance	tide used for underkeel clearance	tide used for underkeel clearance	tide used for underkeel clearance
Average Travel Distance (nautical miles)	1,700	1,700	1,700	1,700	1,700	1,700	1,700
Cost per ton	$4.78	$4.47	$4.13	$3.87	$3.74	$3.74	$3.74

12.2 Sensitivity Analyses

Two sensitivity analyses were conducted, one examining growth in cargo volumes and one examining the impacts of changed assumptions regarding oil tanker loading. As described in the commerce forecast section (Section 9.0), for the sensitivity analysis examining growth in cargo volumes, total tonnages through Searsport are projected to grow at the rate of 0.35 percent per year over the 50 year period of analysis, corresponding with projected population growth. Total annual transportation costs were then calculated as in the base case but including this growth in cargo volumes. This average annual equivalent value of this stream of benefits was then calculated using the current FY13 Federal interest rate for water resources projects of 3.75%. The resulting annual benefits at each channel depth are shown below in Table 15.

Table 15
Average Annual Benefits
Commerce Growth Sensitivity Analysis

Commerce Volume Growth Sensitivity Analysis	
Condition	**Annual Benefits**
With Project - 37'	$466,669
With Project - 38'	$925,414
With Project - 39'	$1,294,034
With Project - 40'	$1,517,468
With Project - 41'	$1,639,912
With Project - 42'	$1,739,064

A second sensitivity analysis was conducted in which the assumptions regarding tanker loading practices in the with project condition were changed. In the base case, it is assumed that petroleum shippers would first use increased channel depth to decrease the tidal delays and light loading, and only shift to larger vessels after eliminating current light loading. In the sensitivity analysis, it is assumed that some light loading of oil tankers occurs for reasons not related to channel depth, and so some light loading would likely occur in the future even with increased channel depth. In this sensitivity analysis, it is assumed that petroleum shippers move to larger vessels at slightly lesser channel depths than in the base case. As a result, the benefits shift slightly from the greater channel depths to the lesser channel depths, but the overall effect is minor. There is no change to benefits derived from bulk cargo.

A comparison of the annual transportation costs for oil shipments between the base case and the tanker loading sensitivity analysis is shown below in Table 16. The resulting annual benefits for the tanker loading sensitivity analysis are shown in Table 17. It can be seen in Table 16 that total transportation costs in the sensitivity analysis are similar to those of the base case at channel depths of 33 and 35 feet, decrease more quickly in the sensitivity analysis at 37 and 38 feet, and then converge with the base case at 40 feet. Similarly, in comparing Table 17 to Table 12, it can be seen that the annual benefits in the sensitivity analysis exceed those of the base case at channel depths of 37 and 38 feet, and then are slightly lower than the base case at channel depths of 39 feet and greater.

Table 16
Oil Tanker Transportation Costs
Base Case versus Tanker Loading Sensitivity Analysis

Condition	Annual Transportation Costs - Base Case (Oil Tankers)	Annual Transportation Costs - Sensitivity Analysis (Oil Tankers)
Existing Condition (33')	$3,499,136	$3,499,136
Without Project (35')	$3,346,667	$3,275,309
With Project - 37'	$3,128,554	$3,005,657
With Project - 38'	$2,888,191	$2,837,707
With Project - 39'	$2,709,306	$2,736,140
With Project - 40'	$2,616,586	$2,616,586
With Project - 41'	$2,616,586	$2,616,586
With Project - 42'	$2,616,586	$2,616,586

Table 17
Average Annual Benefits
Tanker Loading Sensitivity Analysis

	Tanker Loading Sensitivity Analysis		
Condition	Annual Benefits Bulk Carriers	Annual Benefits Oil Tankers	Total Annual Benefits
With Project - 37'	$211,677	$269,653	$481,330
With Project - 38'	$393,414	$437,603	$831,017
With Project - 39'	$553,919	$539,170	$1,093,088
With Project - 40'	$667,152	$658,724	$1,325,876
With Project - 41'	$780,785	$658,724	$1,439,509
With Project - 42'	$872,802	$658,724	$1,531,526

13.0 Other Benefit Categories

New Corps Guidance, EC 1105-2-409, “Planning in a Collaborative Environment,” 31 May 2005, allows new studies to include benefits from the Regional Economic Development (RED) and Other Social Effects (OSE) accounts. While project justification and the determination of economic feasibility (positive benefit to cost ratio) are still determined using National Economic Development (NED) benefits as calculated above, benefits identified in the RED and OSE accounts can be used to guide selection of a recommended plan, to integrate Corps planning goals with the goals of the local sponsor, and to show the complete benefits of a project. RED benefits are derived from the impacts of a project on local income and employment, even if the project would cause no net change in income or employment on a national level. RED benefits are often a primary factor motivating local development projects. OSE benefits are those effects that are not captured in the NED, RED or environmental quality accounts, and can include effects relating to community cohesiveness, health and safety, energy conservation, emergency preparedness, and security.

The NED benefits calculated in this report for project justification are derived from transportation cost savings. However, improved efficiencies at the port would also have positive regional economic effects (RED benefits). The transportation costs savings of the NED benefit analysis would be seen in lower costs of bringing products to Maine manufacturers and consumers. Fuel costs to residents with the dredging project could be somewhat lower compared to the without project condition. Lower costs of transporting inputs to the region's paper and other manufacturing businesses could make these businesses more cost-competitive relative to businesses in other regions, which in turn could increase employment. If channel deepening promotes increased use of Searsport Harbor by importers and exporters, this could also result in increased employment in the region. Employment could increase at the harbor itself, as increased shipments require additional dock workers, truckers, and other workers. Employment could increase at businesses located in the region which receive inputs at the harbor if they are able to become more competitive in the marketplace and obtain greater market share. If employment in the region increases, incomes and tax revenues in the region would also increase. These types of positive effects would be RED benefits to channel deepening.

In the Other Social Effects (OSE) category, the most significant benefit from channel deepening identified is the improved safety and reliability of oil and gasoline shipments that would be achieved with the project. Channel deepening will help ensure continued reliable and efficient deliveries of oil and gas to the region, deliveries which are of critical importance to the residents and businesses of northern and central Maine. Increased channel depth will improve the safety of vessels using the port, and will allow shipments to be brought on larger, more cost-effective vessels. The improved safety and efficiency of critical energy shipments will improve the energy security of the region. No notable benefits in the Environmental Quality account were identified.

14.0 Project Costs

Project costs are detailed in the Main Report and in the Engineering Appendix. Costs were developed for alternative channel depths of 37 to 42 feet, as well as two alternative disposal sites, disposal within Penobscot Bay or and at the Rockland disposal site. The first cost and annual costs of each alternative are shown in the tables below. Annual costs are determined by amortizing the first costs over the 50-year period of analysis using the FY 13 interest rate of 3.75%.

Table 18
Project Costs – Penobscot Disposal Site

PROJECT COST ESTIMATES FEDERAL BASE PLAN, PENOBSCOT DISPOSAL SITE	**37-Foot Channel**	**38-Foot Channel**	**39-Foot Channel**	**40-Foot Channel**	**41-Foot Channel**	**42-Foot Channel**
	($000's)					
GENERAL NAVIGATION FEATURES (GNF) Improvement						
First Cost (Incl. IDC)	6,462	7,757	10,135	11,512	13,698	15,928
Interest and Amortization (3.75%)	288	346	452	513	611	710
Annual Maintenance Dredging	14	19	28	36	44	54
Annual Cost, GNF	302	365	480	549	655	764
LOCAL SERVICE FACILITIES (LSF) Berth Deepening						
First Cost (Incl. IDC)	272	336	413	499	553	598
Interest and Amortization (3.75%)	12	15	18	22	25	27
Annual Maintenance Dredging	0	0	0	1	1	1
Annual Cost. LSF	12	15	18	23	26	28
TOTAL ANNUAL COSTS ($000)	314	380	498	572	681	792

Table 19
Project Costs – Rockland Disposal Site

PROJECT COST ESTIMATES FEDERAL BASE PLAN, ROCKLAND DISPOSAL SITE	**37-Foot Channel**	**38-Foot Channel**	**39-Foot Channel**	**40-Foot Channel**	**41-Foot Channel**	**42-Foot Channel**
	($000's)					
GENERAL NAVIGATION FEATURES (GNF) Improvement Dredging						
First Cost (Incl. IDC)	9,639	12,434	16,522	19,743	23,489	27,405
Interest and Amortization (3.75%)	430	554	736	880	1,047	1,221
Annual Maintenance Dredging	14	19	28	36	44	54
Annual Cost, GNF	444	573	764	916	1,091	1,275
LOCAL SERVICE FACILITIES (LSF) Berth Deepening						
First Cost (Incl. IDC)	348	443	524	648	706	764
Interest and Amortization (3.75%)	16	20	23	29	31	34
Annual Maintenance Dredging	0	0	0	1	1	1
Annual Cost. LSF	16	20	23	30	32	35
TOTAL ANNUAL COSTS ($000)	460	593	787	946	1,123	1,310

15.0 Determination of Economic Justification and Project Optimization

A proposed project is considered economically justified if it has a benefit to cost ratio greater than 1.0. The net annual benefits of an improvement plan equal its annual benefits minus its annual costs. The National Economic Development (NED) plan is that plan which has the highest net annual benefits. The annual benefits, annual costs, benefit to cost ratio (BCR), and net annual benefits for each channel depth increment examined are shown below. The economic justification for the base case is presented first, following by the results of each sensitivity analysis. Results reflecting the cost of disposal at the Penobscot Bay disposal site are shown in Table 20. Results reflecting the cost of disposal at the Rockland disposal site are shown in Table 21. With either disposal site, the plan which reasonably maximizes net annual benefits under all scenarios is the 40-foot channel depth alternative. It is noted that for the Penobscot Bay disposal site, net annual benefits at the 40-foot and 41-foot improvement plans are within about one percent of each other and thus provide essentially the same net benefit. However, the cost of the 40-foot improvement is the least cost plan of the two and thus is the NED plan[1]. The Recommended Plan, which is the NED plan, is the 40-foot channel with disposal at the nearby Penobscot Bay disposal site.

The base year used for the analysis is 2015. However, the base year chosen has little impact on the economic analysis. The costs used in determining the benefit-cost ratio do not include escalation for inflation, and so are not dependent on the base year. The benefits for the base case and for the tanker loading sensitivity analysis are calculated in annual terms, not changing over the period of analysis, and so are not dependent on the base year. The benefits for the commerce growth sensitivity analysis are related to commerce volumes which change over time, and so would be slightly impacted by use of a different base year, however changing the base year by only one or two years would have a very small impact on the benefit figure calculated.

---

[1] NED GUIDANCE
A plan that reasonably maximizes net national economic development benefits, consistent with the Federal objective is to be formulated. This plan is to be identified as the NED plan. Further, ER 1105-2-100 Appendix G, Amendment #1 30 Jun 2004 page G-8 states that 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.

Table 20
Economic Justification – Penobscot Disposal Site

BENEFIT-COST ANALYSIS, PENOBSCOT DISPOSAL SITE	**37-Foot Channnel**	**38-Foot Channel**	**39-Foot Channel**	**40-Foot Channel**	**41-Foot Channel**	**42-Foot Channel**
	($000's)					
Total Annual Costs (GNF + LSF)	314.0	380.0	498.0	572.0	681.0	792.0
Annual Benefits - Base Case	429.8	851.9	1,191.3	1,397.2	1,510.9	1,602.9
Net Annual Benefits	115.8	471.9	693.3	825.2	829.9	810.9
Benefit-Cost Ratio	1.37	2.24	2.39	2.44	2.22	2.02
Annual Benefits Commerce Growth	466.7	925.4	1,294.0	1,517.5	1,639.9	1,739.1
Net Annual Benefits	152.7	545.4	796.0	945.5	958.9	947.1
Benefit-Cost Ratio	1.49	2.44	2.60	2.65	2.41	2.20
Annual Benefits Tanker Loading	481.3	831.0	1,093.1	1,325.9	1,439.5	1,531.5
Net Annual Benefits	167.3	451.0	595.1	753.9	758.5	739.5
Benefit-Cost Ratio	1.53	2.19	2.19	2.32	2.11	1.93

Table 21
Economic Justification – Rockland Disposal Site

BENEFIT-COST ANALYSIS ROCKLAND DISPOSAL SITE	**37-Foot Channnel**	**38-Foot Channel**	**39-Foot Channel**	**40-Foot Channel**	**41-Foot Channel**	**42-Foot Channel**
	($000's)					
Total Annual Costs (GNF + LSF)	460.0	593.0	787.0	946.0	1,123.0	1,310.0
Annual Benefits Base Case	429.8	851.9	1,191.3	1,397.2	1,510.9	1,602.9
Net Annual Benefits	-30.2	258.9	404.3	451.2	387.9	292.9
Benefit-Cost Ratio	0.93	1.44	1.51	1.48	1.35	1.22
Annual Benefits Commerce Growth	466.7	925.4	1,294.0	1,517.5	1,639.9	1,739.1
Net Annual Benefits	6.7	332.4	507.0	571.5	516.9	429.1
Benefit-Cost Ratio	1.01	1.56	1.64	1.60	1.46	1.33
Annual Benefits Tanker Loading	481.3	831.0	1,093.1	1,325.9	1,439.5	1,531.5
Net Annual Benefits	21.3	238.0	306.1	379.9	316.5	221.5
Benefit-Cost Ratio	1.05	1.40	1.39	1.40	1.28	1.17

SEARSPORT HARBOR
SEARSPORT, MAINE
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APPENDIX F

COASTAL ENGINEERING

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1.0 Introduction

The work described in this appendix was for the Searsport Harbor, Maine Deep Draft Navigation Study. The Water Management Section was tasked with determining the hydrodynamic currents within the study area and providing recommendations for the type of modeling study needed, if any, to support the proposed improvement project. The geographic location of the existing Federal deep draft navigation channel and harbor, as well as a close up of the project area are provided in Figures 1 and 2, respectively.

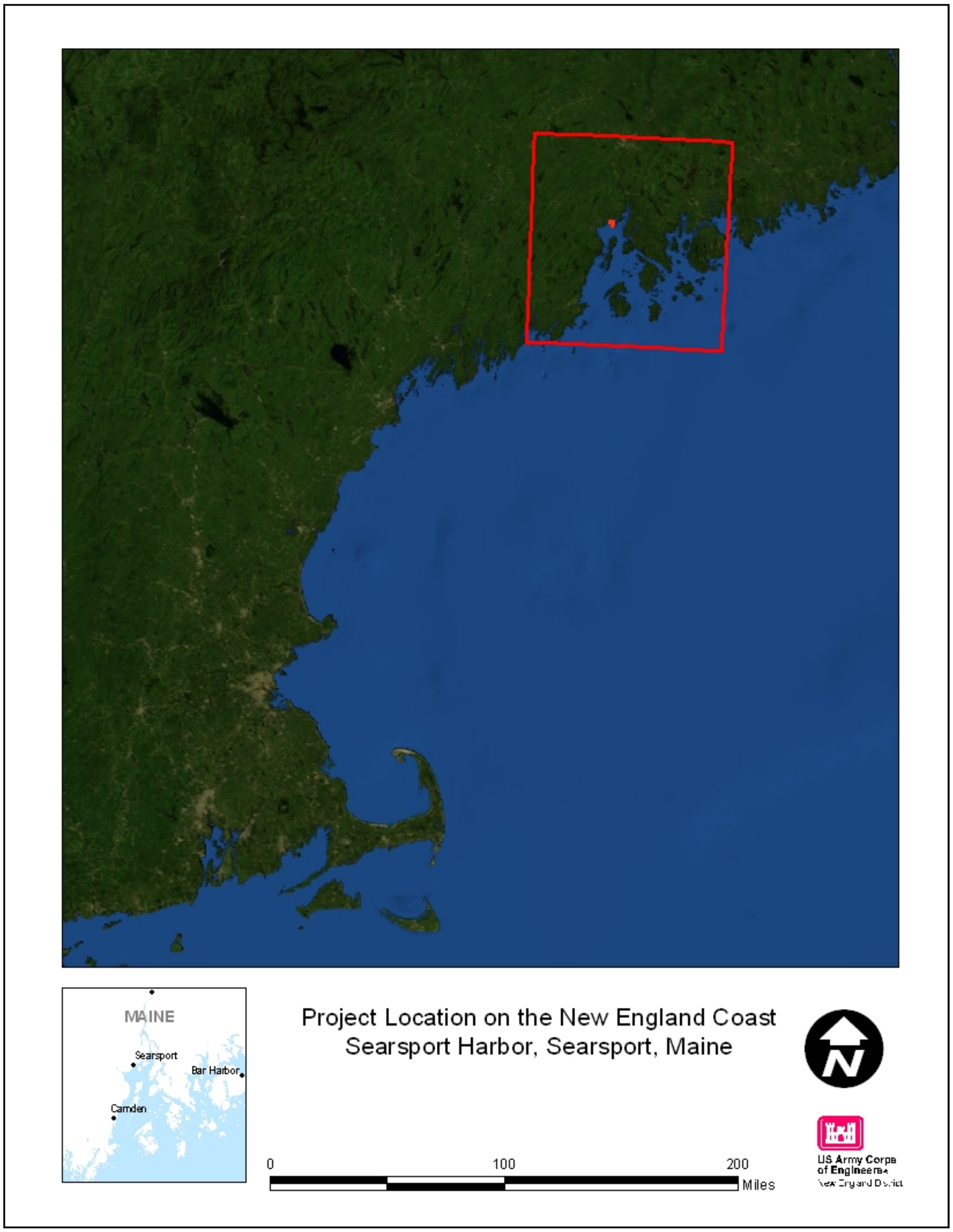

Figure 1. Project Geographic Location

Figure 2. Project Study Area

2.0 Study Approach

As shown in Figures 1 and 2 the project is in a fairly open system with no obvious constrictions or areas that would be considered high flow areas based on geography. The most significant potential for creating higher flows was from the high tide range in the project area. As shown in Table 1, the mean lower low water (MLLW) to mean higher high water (MHHW) range was (11.03) feet.

Table 1. Tide data information

MEAN HIGHER HIGH WATER (MHHW) = 11.03
MEAN HIGH WATER (MHW) = 10.62
NORTH AMERICAN VERTICAL DATUM-1988 (NAVD) = 5.83
MEAN SEA LEVEL (MSL) = 5.56
MEAN TIDE LEVEL (MTL) = 5.51
MEAN LOW WATER (MLW) = 0.39
MEAN LOWER LOW WATER (MLLW) = 0.00

It was assumed that the tidal flows would be less than 1 foot/second since there were no constrictions within the project area or nearby system. Based on this initial assumption, a three tier approach to studying the currents and navigation impacts within the project area was developed.

1st Tier

The first was to collect field data and verify the low current speed assumption. Tidal current velocity data was collected within the channel using a boat mounted, downward looking, acoustic Doppler current profiler to directly measure the currents in the channel. Tide elevation data was also collected in this effort so that tidal elevations/changes could be compared to the measured currents speeds and as additional calibration/validation data if a 2-D hydrodynamic numerical model was needed.

2nd Tier

The second tier in the study, if necessary, would be to perform a 2-D hydrodynamic numerical model if the measured current data was higher than expected or if there was unanticipated flow complexities such as strong eddy formations or sharp direction changes. As discussed, it was strongly anticipated that the latter issues discussed would not be present and that the numerical model would not be needed.

3rd Tier

The third tier would be to perform a ship simulation study at the ship simulation facility at ERDC in Vicksburg, MS. The current data and modeling results from Tiers 1 and 2 would be used as hydrodynamic input. The ship simulator study was not planned for since it was considered very unlikely that the hydrodynamic currents would be fast enough and/or complex enough to warrant the simulation study.

3.0 Data Collection Effort

As described in the 1st Tier discussion in Section 2.0, the first objective was to collect hydrodynamic current data in the project area, and specifically the federal navigation channel. The collected data would then be used to confirm the anticipated low current speeds in the channel and the relatively well behaved nature of the currents. If the data showed the currents met these conditions it would negate the need for modeling studies and a ship simulation effort. Additionally, the data would then be used in the calculations for designing the deeper and wider federal navigation channel dimensions for the study design vessel. The data collection effort was formulated and designed by USACE-New England District and then contracted to The Woods Hole Group (WHG) for final design and execution. A detailed report for the data collection effort was produced by WHG and has been provided as a Technical Report with the Feasibility Study. The Report is entitled “ADCP and Tide Data Collections Searsport Harbor, Searsport, Maine, December 2009 prepared by Woods Hole Group Inc”.

3.1 Acoustic Doppler Current Profiler (ADCP) Data

To cover as much of the federal navigation channel as possible it was decided that using a downward looking, boat mounted acoustic Doppler current profiler (ADCP) would provide the most spatial resolution and temporal resolution. With this technology a boat runs pre determined transects, repeatedly, through a determined time extent. Often these “surveys” are completed over a complete tidal cycle so flood and ebb currents can be captured within a project area. For this study two separate days of surveys were conducted with the two survey days collected approximately one month apart. The days selected were spring tidal condition days or when the moon is either full or new. During these monthly cycles the tides are typically at maximum range since the moon and sun are “pulling” on the ocean to the maximum extent. This is due to the combined gravitation forces of the moon and sun being in a maximum additive configuration (moon, earth, and sun are aligned). Spring tidal conditions were chosen because it was reasoned peak tidal currents would occur with peak monthly tide ranges. This is almost always the case in the coastal zone. Exceptions to this rule are most often caused by storm surges, large fresh water inflows, large basin scale weather patterns, etc.

A serious of 5 transects were set across the channel that the survey boat would follow multiple times throughout the span of a tide cycle (low to high to low). The survey effort was completed on both June 25, 2009 and July 23, 2009. The five transects covered by the boat are shown in Figure 3. It is worth noting that transect #5 is out of order because it was added later in the data collection design effort. In Table 2 the frequency and number of transects completed for each survey date has been provided.

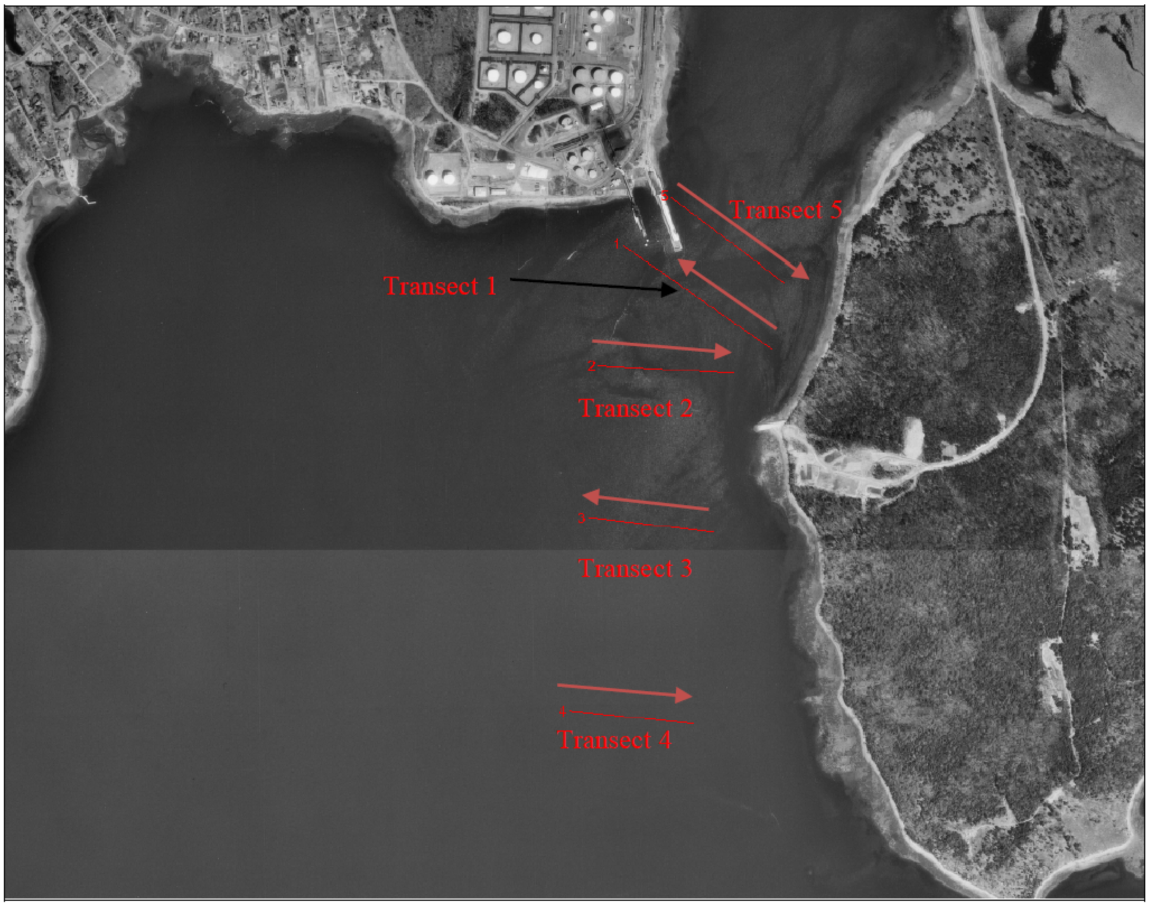

Figure 3. ADCP Transect Locations

Table 2. Survey locations, dates and number of transects

Transect ID	Easting, Northing Transect Start (State Plane NAD83, ft)	Easting, Northing Transect End (State Plane NAD83, ft)	June 25, 2009 Survey		July 23, 2009 Survey	
			Frequency (minutes)	# of Transects	Frequency (minutes)	# of Transects
1	881864, 284719	880017, 286020	~7.5	11	~7.5	13
2	879697, 284535	881388, 284433	~5	11	~5	13
3	881108, 282470	879558, 282652	~5	11	~5	13
4	879310, 280255	880845, 280097	~4	11	~4	13
5	880600, 286616	882020, 285540	~5.5	11	~5.5	13

3.2 Tide Elevation Data

Tide data was also collected at the site for a one month period. Two tide gages were installed during the first ADCP survey trip and removed during the second survey trip, which were approximately one month apart. The tide gages recorded tidal elevation every 6 minutes for the one month deployment. The gages were installed to provide tide data with the ADCP surveys and also for calibration and validation data if a numerical model was needed. The month long record that contained two spring and two neap tidal cycles was determined to be adequate for this purpose. The approximate location of the tide gages can be seen in Figure 4, with the exact locations provided in the WHG report. Tide Gage 2 would be used to drive the model boundary condition and Tide Gage 1 would be used to measure model performance. The ADCP current data would be used as well to calibrate/validate the model.

Figure 4. Tide Gage Locations

4.0 Data Collection Results Discussion

As discussed the key piece of information being sought in the data collection effort were the hydrodynamic current velocities in the federal navigation channel. It was hypothesized that the current speeds would be low and the flow field would be relatively well behaved. Both assumptions were confirmed in the ADCP surveys performed by WHG. In both surveys it was found that maximum depth averaged flow speeds were less than 0.5 ft/sec which is less than 0.5 mph. An example of the depth averaged current velocity vectors has been provided below in Figure 5.

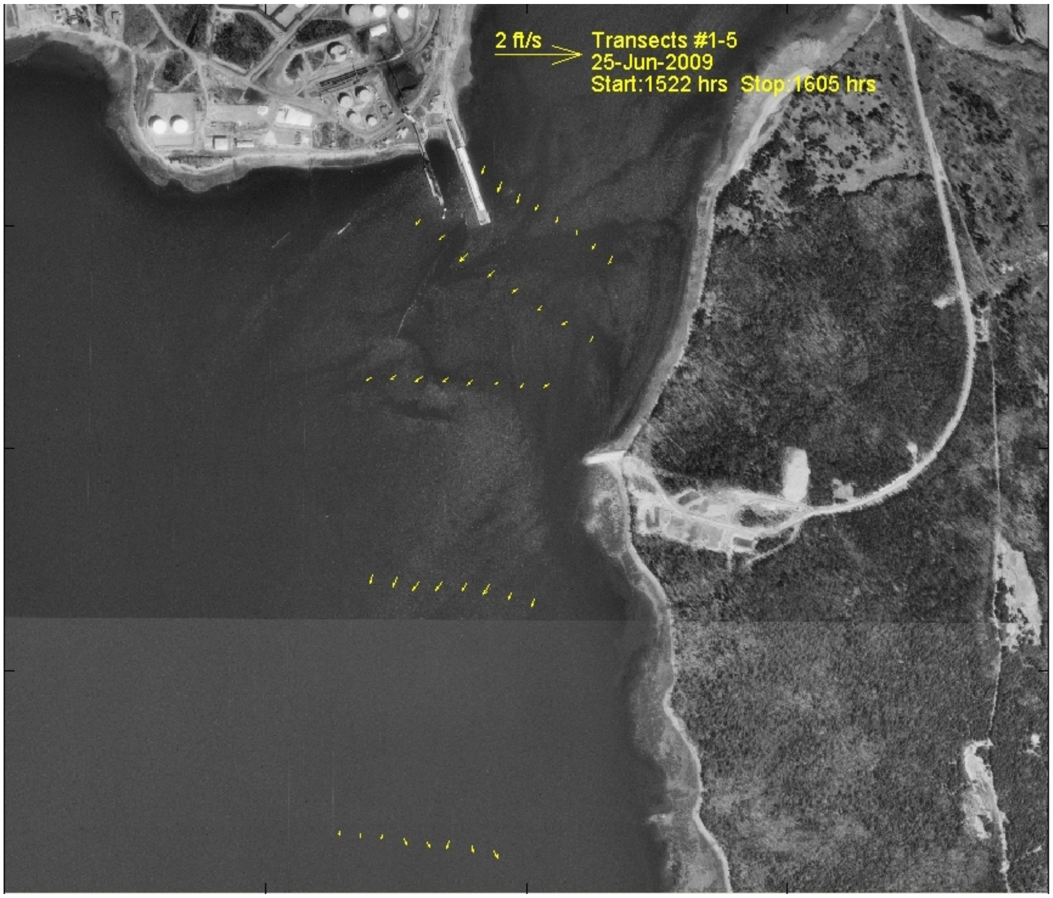

Figure 5. Depth Averaged Current Velocity Vectors

For deep draft vessels that penetrate most of the water column the use of the depth averaged current speeds would be applicable since the ship hull would be subjected to the full vertical flow structure. This in essence is the depth averaged current. However, as highlighted in Figures 6 through 9, there are differences in flow speed and direction at various points in the tidal cycle and if a ship was of shallower draft and most of the hull was in the upper part of the water column then there could be higher speeds. The examples shown represent some of the higher recordings and show more specific and localized current speeds could approach 2 ft/s or 1.4 miles per hour. This is the speed that should be used for shallower draft vessels or as a more conservative number than the depth averaged current speed. Figures 6 through 9 also show the stratification that occurs at times in the flow field.

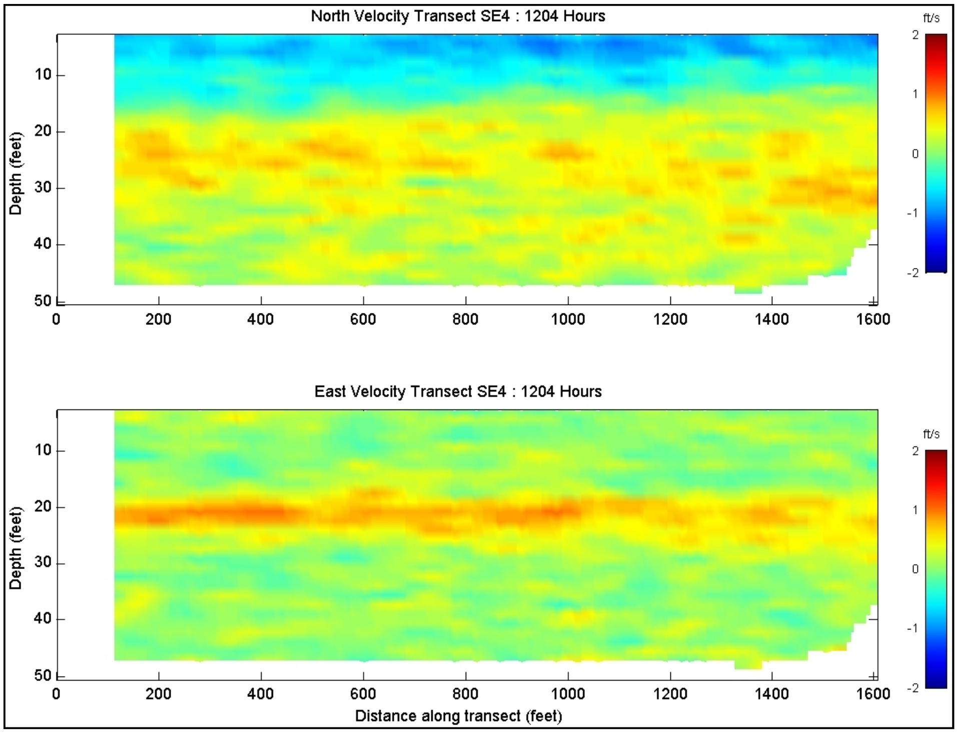

Figure 6. 2-D flow field

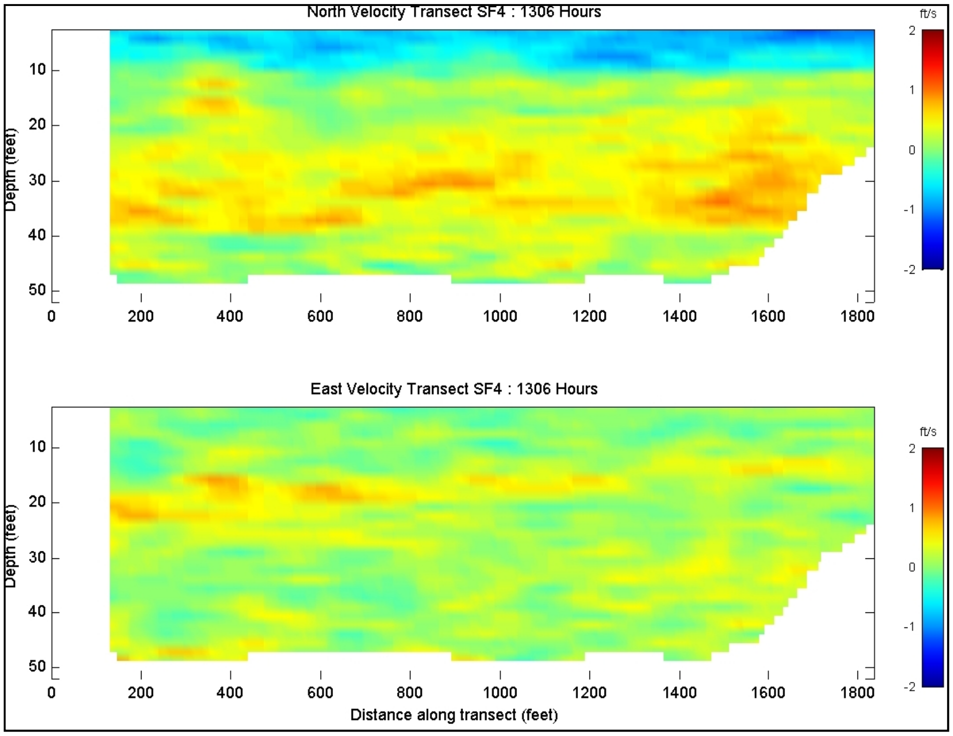

Figure 7. 2-D flow field

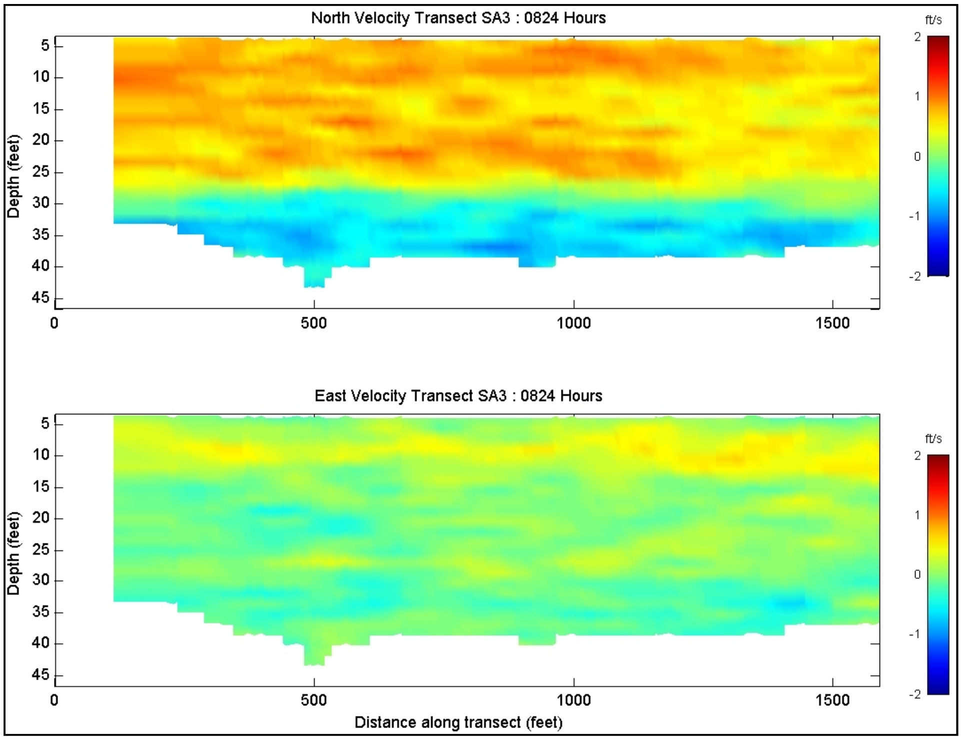

Figure 8. 2-D flow field

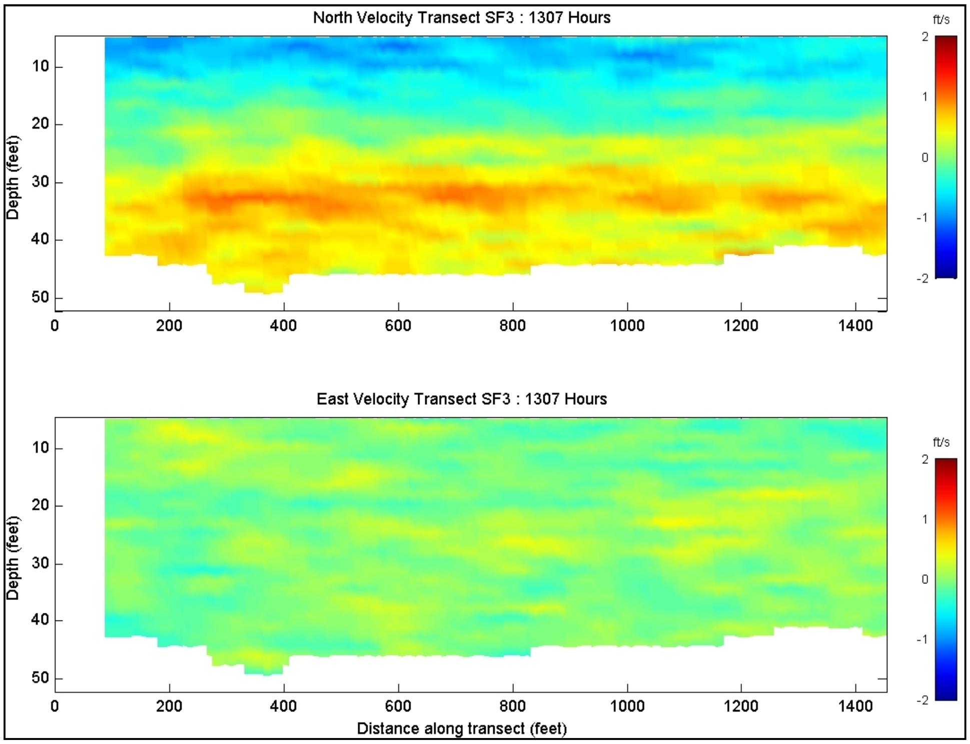

Figure 9. 2-D flow field

5.0 Conclusions and Recommendations

As discussed in Section 4, the currents speeds are low. Considering that the proposed project is to deepen and widen the channel it is likely flow conditions will remain low or with the possibility of speeds dropping due to the increased cross sectional area. Based on the findings it is recommended that a numerical model not be performed, nor a ship simulator and that the flow data provided from this effort be used for designing the alternative ship channel configurations.

SEARSPORT HARBOR
SEARSPORT, MAINE
NAVIGATION IMPROVEMENT PROJECT

APPENDIX G

GEOTECHNICAL ENGINEERING

PREPARED BY:
DEPARTMENT OF ARMY
NEW ENGLAND DISTRICT, CORPS OF ENGINEERS
GEOTECHNICAL ENGINEERING SECTION
GEOTECHNICAL AND WATER RESOURCES BRANCH
ENGINEERING AND PLANNING DIVISION

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Attachments

A. Haley and Aldrich, Inc., Boring Logs 1998
B. USACOE, Baltimore, Boring Logs 2007

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1.0 PROJECT DESCRIPTION

Searsport Harbor is located in the Town of Searsport, in Waldo County, about 27 miles south of Bangor and 91 miles northeast of Portland, Maine. The small commercial fishing harbor is located near the center of Town to the west, while the deep-draft commercial cargo port is located at Mack Point to the east. The study was entered at the request of the Maine Department of Transportation.

Searsport, Maine has the largest deep draft commercial port north of Portland. It is located approximately 30 miles from the entrance to Penobscot Bay and is protected by several intervening islands. The existing project consists of an entrance channel with a depth of El. -35 mean low low water (MLLW) and 500 feet wide, from Penobscot Bay, west of Sears Island, northward to a turning basin of the same depth at Mack Point, See Figure 1. Mack Point is served by direct rail access to Bangor. The State Pier handles aggregates, forest products and other bulk cargos. The pier was designed and constructed to have rail installed on the deck. The Sprague Energy and Irving Oil terminals are located west of the State Pier. Since completion of the new State Pier and upgrades to the petroleum terminals, the size of ships calling on Mack Point have increased and greater channel dimensions are required to meet the needs of the deeper draft vessels.

The proposed plan calls for maintenance dredging of the existing 35-foot entrance channel and turning basin (37,100 CY) and deepening the channel and basin to El. -40. In addition, the plan calls for extending the basin into Long Cove to access the berths at the State Pier at Mack Point (Figure 2). Dredging the berths is not part of the Federal project. Dredging at the State Pier to 40 feet was completed in 2004. The pier was upgraded and is designed to accommodate berths with up to a 45-foot draft. The berths at the Sprague Energy and Irving Oil pier have been excavated to 37 and 25 foot depths. The proposed improvement work requires removal of about 929,100 CY of material, based on USACE water depth survey done in 2005. Shoaling rates within the harbor are very low.

The project is generally within the existing channel boundaries where up to 5 additional feet of material are to be dredged. See Figure 2. The material on the harbor bottom is primarily marine clay, which is easily excavated. It is mantled by a very thin layer of recent organic silt deposits. Shoaling rates are very low in this area and river sediment is typically carried further south before deposition. The clay in the existing channel has successfully supported side slopes of 1V:3H. Some glacial till is located along the eastern and northeastern edge of the project. The glacial till is very dense with numerous cobbles and boulders. It is anticipated that dredging the till will be difficult because during the drilling it was not easily penetrated with a roller bit. Note that previous expansion of the turning basin to the northeast was not carried to the full depth due to encountering this till. The proposed dredging east of the State Pier will require removal of as much as 15 feet of dense sand or gravel. Encountering bedrock during dredging is not anticipated.

Figure 1. Existing Federal Navigation Improvement Project

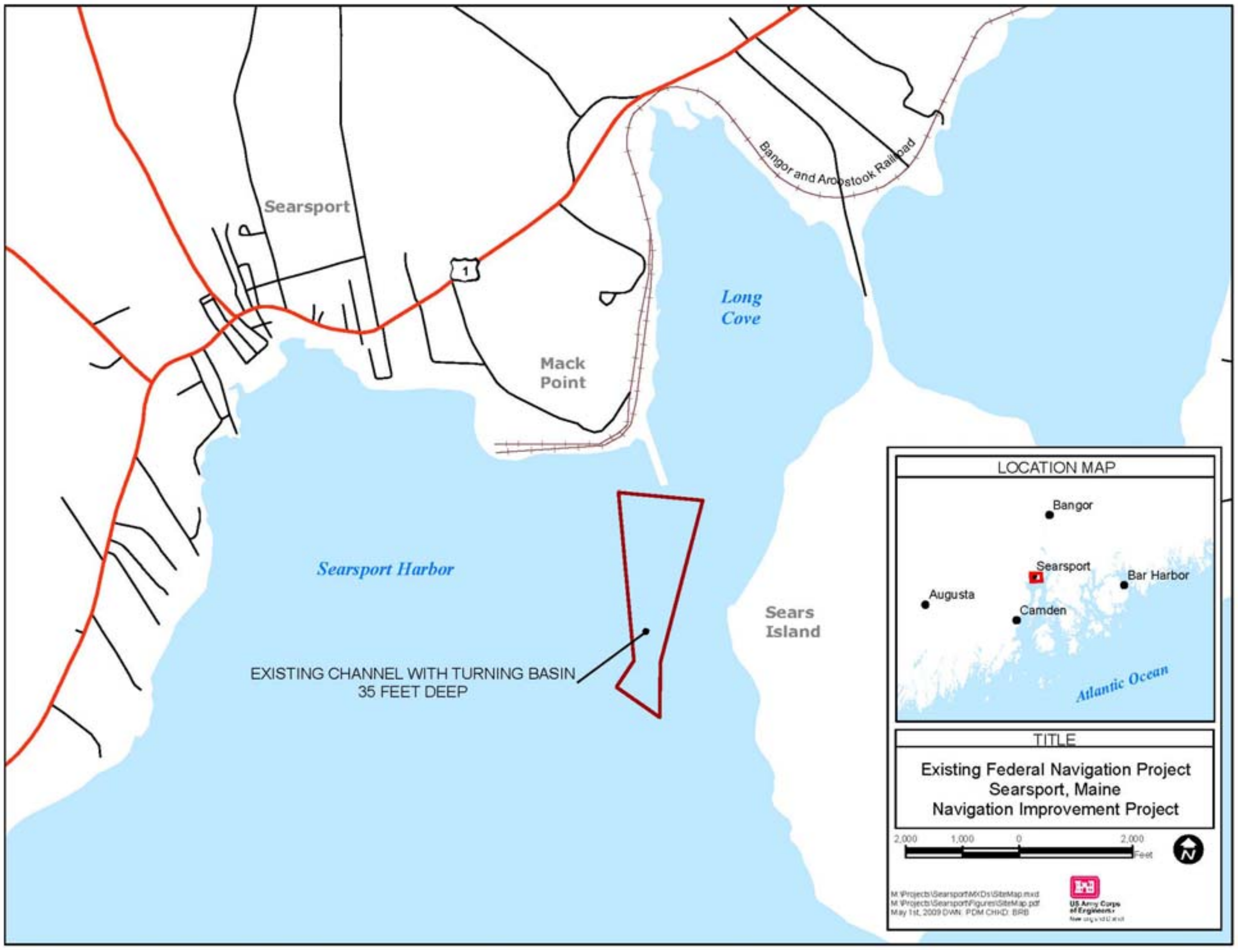
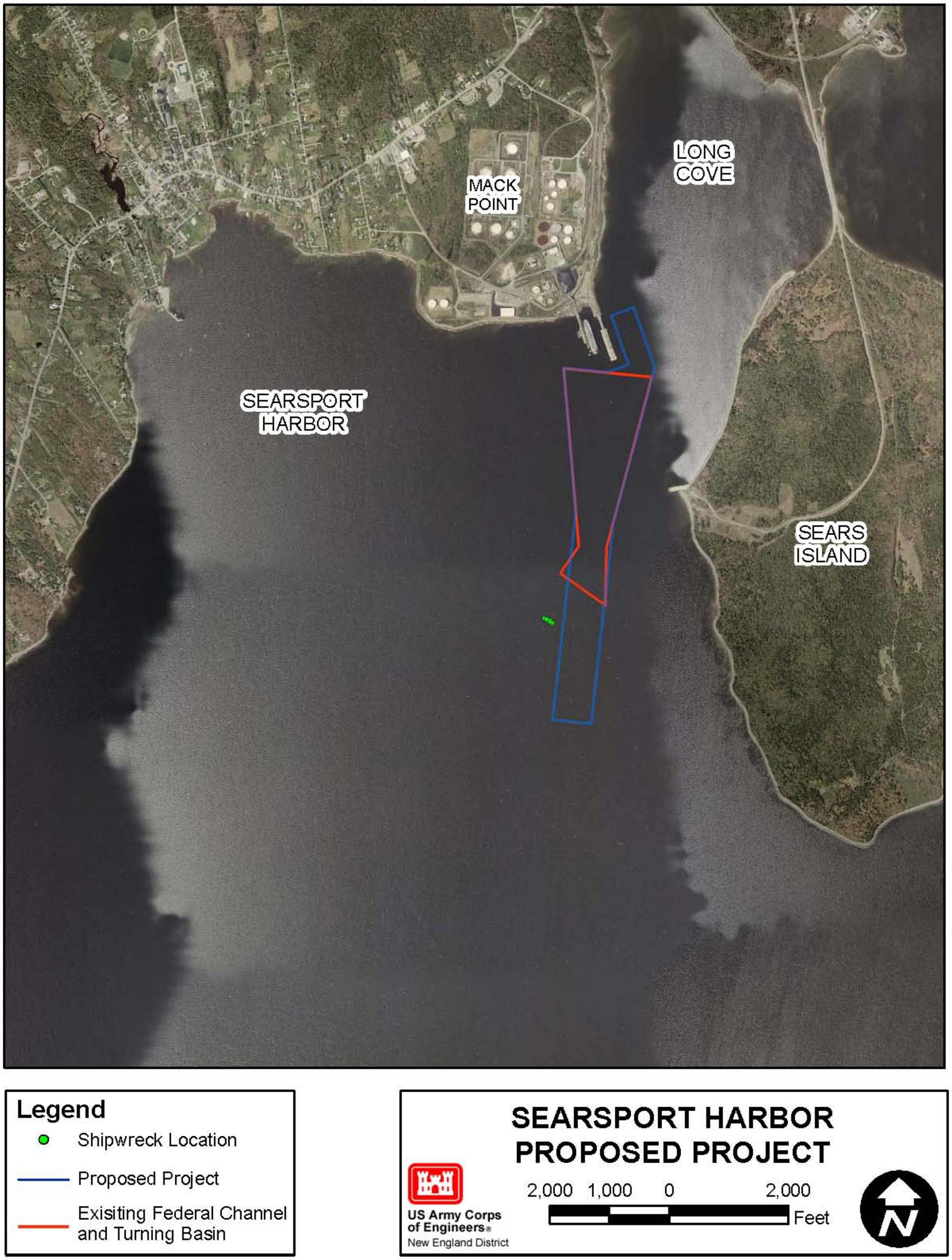


Figure 2. Proposed Improvement Project



2.0 REGIONAL SETTING – GEOLOGY

Submarine geomorphology and stratigraphic framework of the northern Penobscot Bay region encompassing Searsport Harbor has been shaped and built by the processes associated with deglaciation and repeated sea level fluctuations. Topography of the bedrock surface is a controlling factor on the morphology of overlying submarine and subaerial deposits.

The surrounding land masses adjacent to the project site contain a wide range of materials comprising the Presumpscot Formation (Quaternary Age) including mainly glaciomarine muck (clay-silt) with sand layers and gravel lenses locally (Thompson and Smith, 1966). This formation accumulated during retreat of the ice sheet as glaciomarine sediments were deposited over basement rock and glacial drift, particularly in low lying areas. The Penobscott Formation (Ordivician-Cambrian Age) supports the overlying sediment column and consists of metamorphosed lithologic units, mainly sulfphitic/carbonaceous pelite (Anderson 1985), that exhibit significant relief typical of ice scour. Devonian Age intrusive volcanic rock bodies have also been mapped in the region, but not in the immediate vicinity of Searsport.

The project area is located 2-4 miles north of the Turtle Head fault zone which separates the Penobscot Formation from the Ellsworth Formation (Ordovician-PreCambrian Age) to the south, a dominantly interbedded pelite and sandstone rock unit (Anderson, 1985). Exploration of Sears Island identified glacial tills variously folded or displaced on a small scale or intruded locally by a few inches of extremely weathered, plastic phyllite bedrock material located above a weathered bedrock fault zone.

The terrestrial stratigraphy continues into the subaqueous environment where the uppermost layers of the Presumpscot glaciolacustrine/marine (primarily silt-clay) and glaciofluvial deposits are truncated by the Holocene ravinement surface (Kelley et al, 1987). Meltwater streams developed during deglaciation cut across the subaerially exposed nearshore ramps to form fluvial channel deposits in many areas. Many of these paleochannels are positioned offshore from present day rivers, valleys, and other surficial depressions where runoff would congregate. These deposits are comprised mainly of interbedded sand, gravel, and some silt. Recent marine sediments form the uppermost layer of the stratographic column and consist predominantly of silt-clay and sand. Overall, unconsolidated sediment thickness increases towards the south-southeast away from Sears Island and the mainland (Knebel and Scanlon, 1985). Thick glacial moraine deposits on Sears Island are oriented east-west and likely extend westward across Searsport harbor. Observed strata within the till include Laurentide ablation till, submarine outwash, late-advance lodgment till, marine silt-sand, early-advance lodgment till, and outwash sand, all overlying an iron-cemented “Ferruginite”, coarse outwash-till, and basal lodgment till.

Previous studies of areas to the southwest of this investigation identified pockmarks (depressions) from side scan sonar data (Scanlon and Knebel, 1989). The features are circular in shape and vary between 10-125 meters in diameter with depths up to 25 meters below the ambient harbor floor. Seismic profiles reveal the pockmarks extend down to the top of the Presumpscot Formation and no deeper (Kelley and Belknap, 1989). It has been postulated that these features are associated with entrapped natural gas in organic-rich, muddy deposits and its release from the subsurface into the water column. Data show the highest concentration and largest pockmarks are located midway between Belfast Harbor and Isleboro Island and diminish toward the northeast.

3.0 HISTORY AND PREVIOUS SUBSURFACE EXPLORATIONS

1905: Bangor & Aroostook (B&A) Coal Port was established.

1944: The B&A Railroad berth and approach channel were increased to 32 feet depth by the U.S. Army to facilitate wartime cargoes. At that time, Sprague wharf had depth of 21 feet to 27 feet.

June 1960: Hydrographic and topographic surveys were conducted for the US Army Corps of Engineers. The results were reported in "The Report Survey and Plan", dated 6 April 1962, and indicated that there were six piers in Searsport of which 4 were usable. The two most westerly piers at Mack point were shoaled in and abandoned.

1963: The government conducted four Borings, FD-1 through FD-4, and 11 probes, P-1 through P-11, in the northern end of the harbor. Borings location are shown on Figure 3. The explorations were done to verify the subsurface conditions in order to dredge the channel to a depth of -35 ft. MLW. All locations were explored to depths between -38.1 and -43.2 ft MLW. Organic silt and shells were typically encountered in the uppermost 10 feet. The four borings terminated in organic silt or clay. There is no indication that any of the probes encountered refusal. The design memorandum for the project, dated October 1963, specified dredging with a bucket dredge and disposal at sea, and called for no construction within 50 feet of any structure. Hydraulic disposal on land was not considered practical as land areas within reasonable pumping distance would require extensive diking and erosion protection. (Note: The 1963 boring logs are shown on the Specification for Improvement dredging dated February 1964, but are not suitable for reproduction in this Appendix.)

1964: A navigational project was completed with 1:3 slopes along the sides of the channel. Controlling depths at mean low water were 34.6 feet in 35-foot access channel; 34.7 feet in 35 –foot turning basin, except 31.3 feet near northwesterly limit.

1980: Reconnaissance Study was conducted to determine if a Searsport Harbor breakwater (near the Town landing area) was of Federal interest. It concluded that there was insufficient justification to proceed further.

30 Sept to 4 December 1998: A subsurface investigation consisting of 21 test borings was conducted by Haley and Aldrich, Inc. (H&A, 1999) for replacement of two cargo piers and construction of two mooring dolphins. The piers were replaced, but the dolphins were never constructed. The explorations and pier design were done to provide for future dredging to elevation -45 MLLW. The H&A report dated 4 February 1999 recommended underwater slopes no steeper than 1H:3V including susceptible portions protected with riprap. They also recommended pile foundations bearing in the glacial till. The H&A Boring logs are in Attachment A and generalized soil descriptions are provided in section 5.0. The locations of the borings are shown on Figure 3.

2002: A beneficial use project for the dredged material from the berths at Searsport Harbor was conducted by H.E. Sargent, Inc in 2002. They were unable to make the dredged material manageable enough to be economically feasible for use in construction.

2003: Work in a triangular area across the northern limit of Searsport shipping channel to expand the public terminal at Mack Point was completed.

2004: The Government conducted a Navigational Improvement Study, which showed that the Searsport Harbor shoaling rate is low, and confirmed the 1:3 side slopes are stable.

2005: Searsport Condition Study was a government survey conducted to estimate the quantities of dredging for proposed channel improvements based on a 35 foot deep basin.

14 to 20 December 2006: Ocean Surveys, Inc. conducted a geophysical survey of the channel and berth areas. The geophysical testing included a side scan sonar survey to identify coarse materials and manmade items on the bottom, a magnetic intensity survey to identify ferrous items on or below the bottom, and a sub-bottom profile survey to map stratigraphy and large buried obstructions. Results of this work are presented in the report entitled, "Marine Geophysical Investigations Channel Deeping Project Searsport Harbor, Searsport Maine" dated July 2007.

The side scan sonar revealed a section of coarse material along the east side of the channel northward from approximately nun buoy 6. The material extends as much as 500 feet from the side slope and may represent material that has slumped from the slope. Coarse material was also detected east of the Port Authority pier and extending to the shoreline. Numerous manmade objects were identified on the harbor floor. Lobster pots were associated with most of the 376 sonar targets detected. The largest object was a shipwreck located near the west channel slope approximately 1,100 feet northwest of red nun buoy No. 4, see section 2.1.14. The magnetic intensity data detected 152 ferrous objects most of which were near the piers. No utilities were detected. The low readings over the shipwreck site indicate that the ship did not have steel hull.

The sub-bottom profile data identified two typical reflectors which were interpreted as to the top of glacial till and the top of bedrock. These interfaces were both evident in some locations. Only a single reflector was evident in others. Reflections above -52 feet MLLW were detected in the northwest corner, near the piers, and east of the Port Authority Pier. A single point of coarse till or bedrock was detected on the eastern edge of the site south of red nun buoy No. 6. This detection was investigated further by test boring (see section 2.1.12).

2007: The US Army Corps of Engineers, Baltimore District drilled four borings and 2 probes to evaluate anomalies detected by the geophysical investigation. See Figure 3. The data from borings B-1 through B-3 showed that the acoustic basement was the top of glacial till at these locations. A suspected bedrock pinnacle was investigated by boring B-4. Glacial till was penetrated to depths below the proposed dredging elevations. Probe P-1 was advanced N-rods with water jetting and roller-bit in the vicinity of boring B-1 to an elevation of -60 ft. MLLW. It provides data on characteristics of the glacial till. A few cobbles were noted, but overall the wash was silty sand and gravel. The locations of the borings are shown on Figure 3. Copies of the boring logs are in Attachment B.

April 30 and May 1, 2008: Vibracore samples were collected at each of 10 stations. See Figure 3. The vibracore maximizes efficiency and core recovery. Three sampling locations were established within the existing Federal Navigation Project limits (E, F, G) and seven locations were established within the proposed project limits and outside of the existing project (A, B, C, D, H, I, J). Target core depths (ranging from 3 to 10 feet) as defined in the SAP (Battelle 2008) were based on estimated refusal depths resulting from previous boring and geophysical studies. Analytical testing results and the vibracore logs are included in Supporting Document 3. " Field Sampling and Sediment Testing, Searsport Harbor, Federal Navigation Project, Searsport, Maine, September 30, 2008, prepared by Battelle.

2008: Shipwreck study was conducted. A survey of a sunken coal barge was completed using side scan radar techniques. Debris from the barge is strewn across a large area to the west of the shipping channel. The wooden beams are exposed and protruding several feet above the mudline. Lobster traps are entangled in the wreckage. The wreckage is outside the proposed dredging limits.

A geophysical study of the Searsport channel was conducted to map the bedrock surface. An attempt was made to associate bedrock with the acoustic basement. In some cases, the acoustic basement likely coincides with the top of glacial till. Bedrock is at least as deep as the harbor contour map generated from the acoustic basement.

4.0 SITE SURFACE CONDITIONS

Harbor bottom depths in the work areas range from about 10 to 40 feet below MLLW. The tidal range is approximately 9 feet. The slopes on the sides of the existing channel were dredged to 1 vertical to 3 horizontal and remain stable.

According to the Searsport Harbormaster in a telephone conversation on 28 January 2009, there are no utilities within the project boundaries. The only reported utility in the vicinity of the project is a sewer outfall at the end of Mack Point. An historical ship wreck is located west of the channel approximately 1,100 feet northwest of red nun buoy no. 4. The harbor bottom in the vicinity of the wreck is 36-40 feet below MLLW according to various surveys. The wooden wreck protrudes from the bottom approximately 5 feet. The wreck is oriented generally east-west. It is approximately 160 feet long and is surrounded by debris which extends about 50 feet further in all directions. The proposed new channel limits are approximately 200 feet east of the wreck as shown on Figure 3.

The subsurface materials at Searsport Harbor consist of a black organic silt layer that is underlain by marine clay deposits, glacial till, and bedrock.

The shallow marine sediments are very soft black organic silt and brown clayey silt. The black organics have a strong organic odor, and the underlying brown silt has a faint odor. These deposits include trace to little amounts of sand, gravel, wood particles, and shells. In the area of the piers, where most of the deep borings were drilled, coal, slag, and petroleum odor were encountered. These products were not noted in any of the borings located away from the piers. The shallow organics were typically 2 to 5 feet thick and were penetrated by the weight of the drill rods on the split spoon sampler. Grain size analyses indicate that the clay and silt content constitute greater than 90% of the material.

The marine clay deposit ranges in thickness from 0 to 21.7. The top of the stratum is medium stiff where it has been mixed with sand and gravel. This upper portion is generally gray –brown and includes lenses of rust colored sand. The bottom of this stratum behaved like a very soft gray clay. It was penetrated by the weight of the drill rods on the 1 3/8" ID split spoon sampler. However, vane shear testing results measured the undrained shear strength (S_u) in the range 850 – 1670 pounds per square foot which correspond to medium stiff to stiff clay (H&A ,1999). This material overlying the till units is the Presumpscot Formation consisting mostly of glaciomoraine mud with sand layers and gravel drop stones (Belknap, Kelly, and Gontz, 2002)

Soil of glacial origin was encountered in the test borings. It ranged from medium dense gray-brown silty coarse to fine sand, trace clay with variable amounts of gravel to very dense gray sandy silt, some gravel. Cobbles were encountered throughout the glacial till deposits. Boulders were not encountered in the drilling, but are exposed on the beach and may be present in the soil. The glacial material density was measured by standard penetration test which utilizes a 1-3/8 inch inside diameter split spoon driven by a 140# hammer with a 30-inch drop. The thickness of the deposits where fully penetrated ranged in thickness between 19 and 65 feet. The glacial samples from the thick penetrations showed strata as were described for Sears Island as glacial till in the Regional Geology Section. The upper surface of the glacial till is typically well below -40 feet MLLW. However in the area northeast of the State Pier, the dense sandy material is shallow. It was encountered in boring B-2 which was drilled by New Hampshire Boring in 2007 at elevation -36 feet. The surface generally rises towards the east. It was not encountered in borings B-1 or B-3, which were drilled to respective elevations of -40 feet and -47 feet.

Bedrock was not encountered in borings B-1 though B-5. Bedrock was encountered in 12 of the 21 borings conducted for the cargo pier renovation at elevations ranging from -64 to -86 feet MLLW. Weathered rock was encountered in many of the deep borings for the Mack Point pier upgrades. The thickness of the weathered bedrock surface varied from 0.2 feet to 12.5 feet. The weathered bedrock could be penetrated with a roller-bit more easily than the overlying glacial till. Bedrock cores consisted of three types of rock: schist, shale, and pelite. The schist is very soft to moderately hard, slightly weathered to completely weathered gray to dark gray aphanitic graphitic schist with occasional highly fractured zones. The shale is very soft to moderately hard, slightly to highly weathered, dark gray aphanitic graphitic shale. The Pelite is moderately hard, fresh, light gray to gray, fine-grained to aphanitic sulfidic, and carbonaceous.

5.0 CONCLUSIONS

Site explorations including both geophysical testing and soil borings provide data indicating that bedrock will not be encountered in the proposed harbor improvements. Dredging to 45 feet MLLW will encounter primarily marine clay and glacial deposits. The medium stiff clay should provide little resistance to mechanical dredging.

The glacial material includes numerous cobbles and boulders and will require a strong mechanical dredge.

Both the granular soil and clay will support a 1 vertical on 3 horizontal slope, as has been demonstrated by previous dredging of Searsport Harbor.

There are numerous abandoned lobster traps and other man made debris on the harbor bottom. This debris should not impact mechanical dredging operations.

The dredged material from the proposed project will contain an unsorted mix of fine grained organics and clay, sand, gravel, cobbles, and boulders. The dredged material will have little economic value.

The berths at the piers have already been dredged. Extending the dredging from the berths to the edge of the channel should not impact the foundations of the piers. The new State Pier is designed for drafts to 45 feet. Testing of potential dredged material from the berths was not performed as part of this study.

6.0 RECOMMENDATIONS

This work is similar to previous dredging projects within Searsport Harbor. No additional investigations are recommended for the proposed project.

7.0 REFERENCES

1. ASTM D- 2488-06 Standard Practice Description and Identification of Soils

2. Anderson, W.A. 1985 Bedrock Geologic Map of Maine, Maine Geological Survey/ Department of Conservation
3. Haley and Aldrich (H&A), Subsurface and Foundation Investigation Proposed Mack Point Cargo Piers Searsport, Maine, 4 Feb 1999
4. Knebel and Scanlon, 1985, Maps Showing Sea-Floor Topography, Depth to Bedrock, and Sediment Thickness, Penobscot Bay, Maine, Department of the Interior, United States Geological Survey, Miscellaneous Field Studies, MF-1751)

5. Kelley and Belknap, 1989, Geomorphology and Sedimentary Framework of the Inner Continental Shelf of South Central Maine, Maine Geological Survey/ Department of Conservation, Open File No. 87-19

6. Scanlon and Knebel, 1989, Pockmarks in the Floor of Penobsecot Bay, Maine, Geo-Marine Letters, Volume 9.

7. Thompson, W.B. and Smith, G.W., 1986, Surficial Geology of the Castine Quadrangle, Maine, Maine Geological Survey/ Department of Conservation.

8. Ocean Surveys, Inc, Final Report number 06ES102-ME, Marine Geophysical Investigation Channel Deepening Project Searsport Harbor, Searsport, Maine, 16 July 2007.

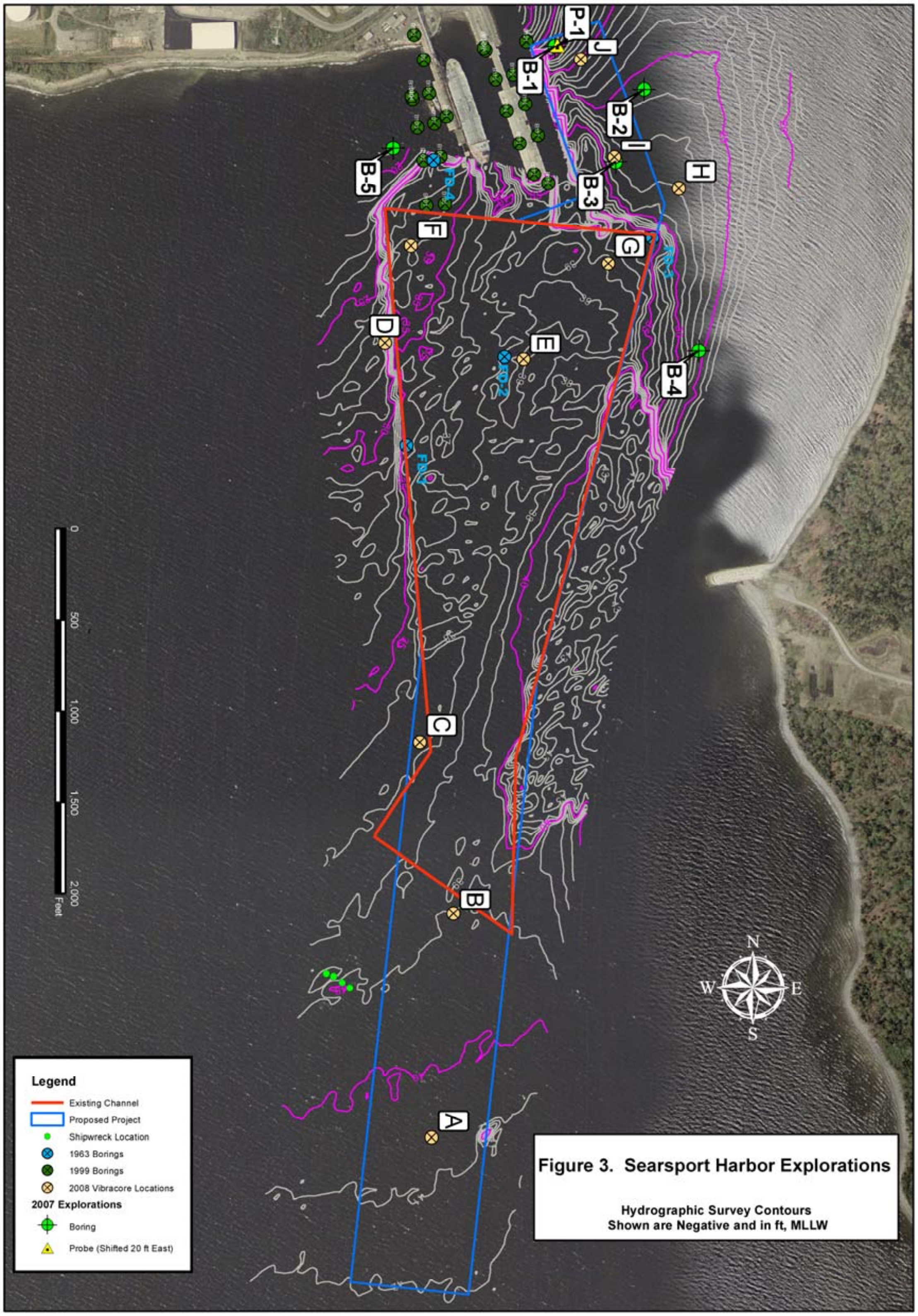


Figure 3. Searsport Harbor Explorations

Hydrographic Survey Contours
Shown are Negative and in ft, MLLW

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ATTACHMENT A

Haley and Aldrich, Inc., Boring Logs 1998

HALEY & ALDRICH South Portland, Maine	**TEST BORING REPORT**	BORING NO. **B101**

PROJECT Cargo Pier, Mack Point, Searsport, Maine
CLIENT Fay Spofford & Thorndike
CONTRACTOR Maine Test Borings, Inc.

FILE NO. 80687-000
SHEET NO. 1 OF 3
LOCATION

ITEM	CASING	DRIVE SAMPLER	CORE BARREL
TYPE	NW	SS	NQ
INSIDE DIAMETER (IN)	3	1-3/8	1-7/8
HAMMER WEIGHT (LB)	300	140	-
HAMMER FALL (IN)	16	30	-

DRILLING EQUIPMENT & PROCEDURES

RIG TYPE CME 45 on Barge
BIT TYPE Tricone Roller
DRILL MUD --
OTHER - 2"X7" Shear Vane

ELEVATION -35.9
DATUM MLLW
START 9 November 1998
FINISH 10 November 1998
DRILLER G. Lidstone
H&A REP B. Lawrence

DEPTH (FT)	CASING BLOWS PER FT.	SAMPLER BLOWS PER 6 IN	SAMPLE NUMBER & REC. (IN.)	SAMPLE DEPTH (FT)	ELEV./ DEPTH (FT)	VISUAL DESCRIPTION AND REMARKS
0	WOC	WOR WOR	S1 12	0.0 3.0		Very soft, black to brownish-gray ORGANIC SILT -SHALLOW MARINE DEPOSIT-
	WOC	WOR WOR				
	2	WOR 6			-38.4 2.5	Very soft, brownish-gray silty CLAY
	17					
	21					
5	26	6 8	S2 18	5.0 6.5		Very soft, brownish-gray silty CLAY -MARINE DEPOSIT-
	29	9				
	36					
	36					
	38				-45.9	
10	34	WOR WOR	S3 18	10.0 11.5	10.0	Medium stiff to stiff gray silty CLAY with black streaks FV1; 10-10.6 ft.,Su=850/150 psf FV2; 10.6-11.2 ft.,Su= 1670/630 psf
	27	3				
	26					
	19					
	18					
15	22	WOR WOR	S4 18	15.0 16.5		Stiff, gray silty CLAY with black streaks FV3; 15.0-15.6 ft.,Su= 1300/300 psf FV4; 15.6-16.2 ft.,Su= 1410/330 psf -MARINE DEPOSIT-
	35	WOM				
	26					
	23					
	28					
20	26	WOR WOR	S5 18	20.0 21.5		Stiff, gray silty CLAY with black streaks
	23	WOR				
	25					
	34				-60.1	
	49				24.2	
25						

WATER LEVEL DATA

DATE	TIME	ELAPSED TIME (HR)	DEPTH (FT.) TO: BOTTOM OF CASING	BOTTOM OF HOLE	WATER

SAMPLE IDENTIFICATION

O OPEN END ROD
T THIN WALL TUBE
U UNDISTURBED SAMPLE
S SPLIT SPOON

SUMMARY

OVERBURDEN (LIN FT)	44.5
ROCK CORED (LIN FT)	10
SAMPLES	9S, 2C

BORING NO. **B101**

HALEY & ALDRICH	South Portland, Maine	TEST BORING REPORT	BORING NO. B101 FILE NO. 80687-000 SHEET NO. 2 OF 3

DEPTH (FT)	CASING BLOWS PER FT.	SAMPLER BLOWS PER 6 IN	SAMPLE NUMBER & REC.(IN.)		SAMPLE DEPTH (FT)	ELEV./ DEPTH (FT)	VISUAL DESCRIPTION AND REMARKS
25	70	12 16 27	S6 2	▨	25.0 26.5		Dense, gray coarse to medium SAND and SILT, little gravel
	80						
	90						Cobble at 29.2 ft.
	98						
	97						
30	78	33 33 40	S7 8	▨	30.0 31.5		Very dense, gray coarse to fine SAND, some gravel, little silt
	85						Cobble at 34.5 ft.
	50						
	200						
	178						
35	27	22 51 45	S8 9	▨	35.0 36.5		Very dense, gray coarse to fine SAND, little gravel, trace silt
	23						Gray silty fine SAND, trace medium sand
	35						Wash ahead of casing to 40.0 ft., cobble at 37.5 ft.
	44						-GLACIAL TILL-
	45						
40	27	13 12 11	S9 11	▨	40.0 41.5		Medium dense, gray medium to fine SAND, little silt to fine SAND, some silt, little gravel at 41.3 ft.
	43						
	43						
	91/0.5					-79.3 43.4	Top of Bedrock at 43.4 ft., Seat NW casing at 43.5 ft. Wash ahead to 44.5 ft. Begin NQ rock core at 44.5 ft., See Core Boring Report.
45							
50							

BORING NO. B101

HALEY & ALDRICH	South Portland, Maine	CORE BORING REPORT	BORING NO. B101 FILE NO. 80687-000 SHEET NO. 3 OF 3

DEPTH (FT)	DRILLING RATE MIN./FT.	RUN NO.	DEPTH (FT)	RECOVERY/RQD		WEATH-ERING	ELEV./ DEPTH (FT)		VISUAL DESCRIPTION AND REMARKS
				IN.	%				
40									See Test Boring Report for Overburden Descriptions Top of Bedrock at 43.4 ft. Advance roller bit to 44.5 ft. Begin NQ Rock Core at 44.5 ft.
							-79.3 43.4	× ×	Medium hard, fresh, gray fine grained to aphanitic sulfidic, carbonaceous PELITE.
		C1	44.5 49.5	60/60	100/100	SL.		× ×	
45	8							× ×	
	5							× ×	
	5							× ×	
	5							× ×	
	5	C2	49.5 54.5	60/60	100/100	SL.		× ×	C2: Same as C1, except joints wide, dipping at horizontal to low angle
50	5							× ×	
	6							× ×	
	6							× ×	
	5							× ×	
	6						-90.4 54.5		Bottom of Exploration

HALEY & ALDRICH South Portland, Maine	**TEST BORING REPORT**	BORING NO. **B102**

PROJECT Cargo Pier, Mack Point, Searsport, Maine
CLIENT Fay Spofford & Thorndike
CONTRACTOR Maine Test Borings, Inc.

FILE NO. 80687-000
SHEET NO. 1 OF 1
LOCATION -

ITEM	CASING	DRIVE SAMPLER	CORE BARREL	DRILLING EQUIPMENT & PROCEDURES
TYPE	NW	SS		RIG TYPE CME 45
INSIDE DIAMETER (IN)	3	1-3/8		BIT TYPE Tricone Roller
HAMMER WEIGHT (LB)	300	140	-	DRILL MUD --
HAMMER FALL (IN)	16	30	-	OTHER - Barge

ELEVATION -27.8
DATUM MLLW
START 17 November 1998
FINISH 17 November 1998
DRILLER G. Lidstone
H&A REP B. Lawrence

DEPTH (FT)	CASING BLOWS PER FT.	SAMPLER BLOWS PER 6 IN	SAMPLE NUMBER & REC.(IN.)	SAMPLE DEPTH (FT)	ELEV./ DEPTH (FT)	VISUAL DESCRIPTION AND REMARKS
0	WOC	WOR WOR	S1 12	0.0 2.5	-28.3 0.5	Very soft, black ORGANIC SILT, trace sand Very soft, brownish-gray clayey SILT
	WOC	WOR WOR				
	WOC					
	WOC					
	WOC					
5	WOC	WOR WOR	S2 17	5.0 6.5		Very soft, brownish-gray clayey SILT, trace sand, occasional shells
	WOC	WOR				-SHALLOW MARINE DEPOSIT-
	2				-35.8 8.0	Medium stiff to stiff, gray silty CLAY
	15					-MARINE DEPOSIT-
	20					
10	16	1 2	S3 18	10.0 11.5		
	19	4				
	21					
	22					
	20					
15	22	2 4	S4 2	15.0 16.5		Medium stiff to stiff, gray silty CLAY
	24	7			-43.8 16.0	Brownish-gray coarse to fine SAND, little silt, little gravel
	42					-GLACIAL TILL-
	50					
	63					
20		22 31	S5 7	20.0 21.5		Brownish-gray coarse to fine SAND, little silt, little gravel
		33			-49.3 21.5	Bottom of Exploration No refusal

WATER LEVEL DATA					
DATE	TIME	ELAPSED TIME (HR)	DEPTH (FT.) TO: BOTTOM OF CASING	BOTTOM OF HOLE	WATER

SAMPLE IDENTIFICATION

- O OPEN END ROD
- T THIN WALL TUBE
- U UNDISTURBED SAMPLE
- S SPLIT SPOON

SUMMARY	
OVERBURDEN (LIN FT)	21.5
ROCK CORED (LIN FT)	0
SAMPLES	5S

BORING NO. **B102**

HALEY & ALDRICH South Portland, Maine	**CORE BORING REPORT**	BORING NO. B103 FILE NO. 80687-000 SHEET NO. 3 OF 3

DEPTH (FT)	DRILLING RATE MIN./FT.	RUN NO.	DEPTH (FT)	RECOVERY/RQD		WEATH-ERING	ELEV./ DEPTH (FT)	VISUAL DESCRIPTION AND REMARKS
				IN.	%			
45								
50								See Test Boring Report for Overburden Descriptions See Test Boring Report for C1: Cored through dense, glacial till with cobbles. Begin NQ Rock Core at 54.0 ft.
							-71.6 51.5	-WEATHERED BEDROCK-
55	3 4 5 6 6	C2	54.0 59.0	30/0	50/0	Highly	-74.1 54.0	C2, C3: Very soft, highly weathered to completely weathered, dark gray aphanitic, graphitic SCHIST, few joint surfaces observed dipping at moderate to high angles, open, planar
60	8 5 6 5 6	C3	59.0 64.0	28/0	47/0	Highly		
							-84.1 64.0	Bottom of Exploration

HALEY & ALDRICH South Portland, Maine	**TEST BORING REPORT**	BORING NO. **B104B**

PROJECT Cargo Pier, Mack Point, Searsport, Maine
CLIENT Fay Spofford & Thorndike
CONTRACTOR Maine Test Borings, Inc.

FILE NO. 80687-000
SHEET NO. 1 OF 2
LOCATION

ELEVATION -14.0
DATUM MLLW
START 26 October 1998
FINISH 27 October 1998
DRILLER G. Lidstone
H&A REP B. Lawrence

ITEM	CASING	DRIVE SAMPLER	CORE BARREL
TYPE	NW	SS	
INSIDE DIAMETER (IN)	3	1-3/8	
HAMMER WEIGHT (LB)	300	140	-
HAMMER FALL (IN)	16	30	-

DRILLING EQUIPMENT & PROCEDURES
RIG TYPE CME 45
BIT TYPE Tricone Roller
DRILL MUD --
OTHER - Barge

DEPTH (FT)	CASING BLOWS PER FT.	SAMPLER BLOWS PER 6 IN	SAMPLE NUMBER & REC. (IN.)	SAMPLE DEPTH (FT)	ELEV./ DEPTH (FT)	VISUAL DESCRIPTION AND REMARKS
0	WOC					Gray SILT (See B104 Test Boring Report) -SHALLOW MARINE DEPOSIT-
	WOC					
	12				-16.5 2.5	
	38					
	39					
5	74	58 90	S2 11	5.0 6.4		Very dense, grayish-brown silty SAND, some gravel, occasional cobbles
	92	94/12.5				
	180					
	70					
	59					
10	93	25 45	S3 10	10.0 11.5		Very dense, gray silty SAND, some gravel, occasional cobbles
	77	34				
	93					
	95					
	132					
15	49	22 37	S4 12	15.3 16.8		Very dense, gray silty SAND, some gravel -GLACIAL TILL-
	47	37				
	64					
	80					
	151					
20	56	18 50	S5 6	20.0 21.5		Very dense, gray silty GRAVEL, some sand
	44	86				
	100					
	72					
	105					
25						

WATER LEVEL DATA

DATE	TIME	ELAPSED TIME (HR)	DEPTH (FT.) TO: BOTTOM OF CASING	BOTTOM OF HOLE	WATER

SAMPLE IDENTIFICATION

O	▨	OPEN END ROD
T	▥	THIN WALL TUBE
U	▥	UNDISTURBED SAMPLE
S	▨	SPLIT SPOON

SUMMARY

OVERBURDEN (LIN FT)	51.7
ROCK CORED (LIN FT)	0
SAMPLES	11S

BORING NO. **B104B**

HALEY & ALDRICH	South Portland, Maine	TEST BORING REPORT	BORING NO. B104B FILE NO. 80687-000 SHEET NO. 2 OF 2

DEPTH (FT)	CASING BLOWS PER FT.	SAMPLER BLOWS PER 6 IN	SAMPLE NUMBER & REC. (IN.)	SAMPLE DEPTH (FT)	ELEV./ DEPTH (FT)	VISUAL DESCRIPTION AND REMARKS
25	71	49 78	S6 12	25.0 26.5		Very dense, gray silty SAND, little gravel
	119	69				
	220					
	170					
	222					
30	57	40 70	S7 12	30.0 31.5		Very dense, gray silty SAND, little gravel -GLACIAL TILL-
	53	116				
	53					
	178					
	73				-49.0	
35		42 42	S8 12	35.0 36.1	35.0	Very dense, gray SILT, trace sand, trace clay Cobble at 36.8 ft., wash ahead to 40.0 ft.
		100/2.5				
40		68 147	S9 11	40.0 41.0		Very dense, gray sandy SILT, trace gravel Wash ahead to 45.0 ft.
45		59 90	S10 13	45.0 46.2		Very dense, gray silty SAND, little gravel -GLACIAL TILL-
		48/5				
50		79 49/2.5	S11 7	50.0 50.6	-64.5 50.5	Very dense, gray silty SAND, little gravel -WEATHERED SHALE-
					-65.7 51.7	Bottom of Exploration at 51.7 ft.

BORING NO. B104B

HALEY & ALDRICH South Portland, Maine	TEST BORING REPORT	BORING NO. B105

PROJECT	Cargo Pier, Mack Point, Searsport, Maine	FILE NO. 80687-000
CLIENT	Fay Spofford & Thorndike	SHEET NO. 1 OF 2
CONTRACTOR	Maine Test Borings, Inc.	LOCATION

ITEM	CASING	DRIVE SAMPLER	CORE BARREL	DRILLING EQUIPMENT & PROCEDURES
TYPE	NW	SS		RIG TYPE CME 45
INSIDE DIAMETER (IN)	3	1-3/8		BIT TYPE Tricone Roller
HAMMER WEIGHT (LB)	300	140	-	DRILL MUD --
HAMMER FALL (IN)	16	30	-	OTHER - Barge

ELEVATION -34.6
DATUM MLLW
START 25 November 1998
FINISH 25 November 1998
DRILLER G. Lidstone
H&A REP B. Lawrence

DEPTH (FT)	CASING BLOWS PER FT.	SAMPLER BLOWS PER 6 IN	SAMPLE NUMBER & REC. (IN.)	SAMPLE DEPTH (FT)	ELEV./ DEPTH (FT)	VISUAL DESCRIPTION AND REMARKS
0	WOC	WOR WOR	S1 9	0.0 2.0		Very soft, grayish-brown clayey SILT, trace sand with occasional shells -SHALLOW MARINE DEPOSIT-
	WOC	WOR WOR			-36.3 1.7	Medium stiff to stiff, gray silty CLAY
	2					
	9					
	13					
5	14	WOR WOH	S2 18	5.0 6.5		Medium stiff to stiff, gray-brown mottled silty CLAY
	18	3				-MARINE DEPOSIT-
	21					
	21					
	19					
10	20	WOR WOH	S3 18	10.0 11.5		Medium stiff to stiff, gray silty CLAY, trace medium sand
	18	3				
	23					
	22				-48.6 14.0	
	24					Medium dense, gray silty coarse to fine SAND, little gravel
15	27	4 6	S4 8	15.0 16.5		
	51	8				
	38					
	50					
	54					
20	35	5 4	S5 12	20.0 21.5		Medium dense, gray silty coarse to fine SAND, little gravel
	43	6				-GLACIAL TILL-
	50					
	50					
	49					
25						

WATER LEVEL DATA

DATE	TIME	ELAPSED TIME (HR)	DEPTH (FT.) TO: BOTTOM OF CASING	DEPTH (FT.) TO: BOTTOM OF HOLE	WATER

SAMPLE IDENTIFICATION

O	▨	OPEN END ROD
T	▥	THIN WALL TUBE
U	▩	UNDISTURBED SAMPLE
S	☐	SPLIT SPOON

SUMMARY

OVERBURDEN (LIN FT)	52.2
ROCK CORED (LIN FT)	0
SAMPLES	8S

BORING NO. B105

HALEY & ALDRICH South Portland, Maine

TEST BORING REPORT

BORING NO. **B105**
FILE NO. 80687-000
SHEET NO. 2 OF 2

DEPTH (FT)	CASING BLOWS PER FT.	SAMPLER BLOWS PER 6 IN	SAMPLE NUMBER & REC. (IN.)	SAMPLE DEPTH (FT)	ELEV./ DEPTH (FT)	VISUAL DESCRIPTION AND REMARKS
25	32	18 13	S6 9	25.0 26.5		Dense, gray gravelly coarse to fine SAND, some silt
	46	18				
	51					
	46					
	44					
30	33	7 11	S7 4	30.0 31.5		Medium dense, gray silty coarse to fine SAND, little gravel, trace clay
	49	17				Note: Drive casing from 30.0-40.0 ft., Wash water contains coarse to fine SAND and GRAVEL, silt at ~37.0 ft.
	80					
	117					-GLACIAL TILL-
	70					
35	94					
	92					
	112					
	151					
	177					
40		50 48	S8 7	40.0 41.5		Very dense, gray gravelly coarse to fine SAND, little silt Wash ahead to 52.2 ft.
		71				
45						Note: Wash water contains medium to fine SAND; washed through quickly from 45.0-47.0 ft., changed to coarser sand and gravel at 47.0 ft.
50						
					-85.9 51.3 -86.2 51.6	-WEATHERED SCHIST- Top of probable Bedrock at 51.6 ft. Bottom of Exploration at 52.2 ft.

HALEY & ALDRICH South Portland, Maine	**TEST BORING REPORT**	BORING NO. **B106**

PROJECT Cargo Pier, Mack Point, Searsport, Maine
CLIENT Fay Spofford & Thorndike
CONTRACTOR Maine Test Borings, Inc.

FILE NO. 80687-000
SHEET NO. 1 OF 3
LOCATION

ITEM	CASING	DRIVE SAMPLER	CORE BARREL
TYPE	NW	SS	NQ
INSIDE DIAMETER (IN)	3	1-3/8	1-7/8
HAMMER WEIGHT (LB)	300	140	-
HAMMER FALL (IN)	16	30	-

DRILLING EQUIPMENT & PROCEDURES
RIG TYPE CME 45
BIT TYPE Tricone Roller
DRILL MUD --
OTHER - Barge - 2X7 Field Vane, Su = Undrained Shear Strength

ELEVATION -30.0
DATUM MLLW
START 4 November 1998
FINISH 6 November 1998
DRILLER G. Lidstone
H&A REP B. Lawrence

DEPTH (FT)	CASING BLOWS PER FT.	SAMPLER BLOWS PER 6 IN	SAMPLE NUMBER & REC.(IN.)	SAMPLE DEPTH (FT)	ELEV./ DEPTH (FT)	VISUAL DESCRIPTION AND REMARKS
0	WOC	WOR WOR	S1 19	0.0 3.0		Very soft, black ORGANIC SILT, some clay (organic odor)
	WOC	WOR WOR				
	WOC	WOR WOR			-32.3 2.3	Very soft, brownish-gray clayey SILT(faint organic odor)
	WOC					-SHALLOW MARINE DEPOSIT-
	1				-34.2 4.2	
5	2	1 4	S2 19	5.0 6.5		Medium stiff to stiff, gray silty CLAY, brow-gray mottling with inclusions of SILT, trace fine sand from 5.8-6.5 ft.
	10	7				
	18					
	19					
	25					
10	18	3 4	S3 18	10.0 11.5		Medium stiff to stiff, gray silty CLAY
	31	6				-MARINE DEPOSIT-
	30					
	32					
	32					
15	28	WOR 4	S4 7	15.0 16.5		Medium stiff to stiff gray silty CLAY, little coarse to medium sand, trace gravel FV1; 15.0-15.5 ft., Su=1110/300 psf Vane resistance on sand at 15.5 ft.
	40	5			-46.8 16.8	
	41					
	64					
	95					
20	50	26 35	S5 10	20.0 21.5		Very dense, gray caorse to fine SAND, some silt, little gravel
	90	41				-GLACIAL TILL-
	124					
	112					
	110					
25						

WATER LEVEL DATA

DATE	TIME	ELAPSED TIME (HR)	DEPTH (FT.) TO: BOTTOM OF CASING	BOTTOM OF HOLE	WATER

SAMPLE IDENTIFICATION
O ▨ OPEN END ROD
T ▥ THIN WALL TUBE
U ▦ UNDISTURBED SAMPLE
S ☐ SPLIT SPOON

SUMMARY	
OVERBURDEN (LIN FT)	42.5
ROCK CORED (LIN FT)	20
SAMPLES	11S, 6C

BORING NO. **B106**

HALEY & ALDRICH South Portland, Maine

TEST BORING REPORT

BORING NO. **B106**
FILE NO. 80687-000
SHEET NO. 2 OF 3

DEPTH (FT)	CASING BLOWS PER FT.	SAMPLER BLOWS PER 6 IN	SAMPLE NUMBER & REC. (IN.)	SAMPLE DEPTH (FT)	ELEV./ DEPTH (FT)	VISUAL DESCRIPTION AND REMARKS
25	67	20 37	S6 12	25.0 26.5		Very dense, gray SILT, trace gravel, trace coarse to fien sand, trace clay Washed ahead to 30.0 ft.
	64	51				
	65					
	54					
	79					
30	75	21 17	S7 8	30.0 31.5		Very dense, gray sandy SILT, some gravel Washed ahead to 35.0 ft. -GLACIAL TILL-
	60	53				
	56					
	58					
	37					
35	56	27 38	S8 4	35.0 36.5		Very dense, gray silty coarse to fine SAND, cobble at 39.0 ft. Washed ahead to 45.0 ft.
	73	27				
	68					
	79					
	131					
40	165	115 43/2.5	S9 6	40.0 40.6		Very dense, gray silty coarse to fine SAND, some gravel Washed ahead to 45.0 ft.
	220					
	204				-72.5 42.5	
	179					
	123					
45	129	34 100/7.5	S10 7	45.0 45.7		Very dense, dark gray WEATHERED SHALE and GLACIAL TILL Begin core at 46.2-48.8 ft.(46.2-47.0 ft. Cobbles/Till; 47.0-48.8 ft. weathered SCHIST Glacial Till, cobble
	82		C1 14	46.2 48.8	-77.0 47.0	
	84					
	77					
	112					
50	63/0.5	140	S11 6	50.0 50.5		Very dense, gray completely weathered SHALE to severely weathered at 50.3 ft. Washed ahead to 56.0 ft. -WEATHERED ROCK-
55						
					-86.0 56.0	Begin NQ Rock Core at 56.0 ft. See Core Boring Report
60						

BORING NO. **B106**

HALEY & ALDRICH
South Portland, Maine

CORE BORING REPORT

BORING NO. B106
FILE NO. 80687-000
SHEET NO. 3 OF 3

DEPTH (FT)	DRILLING RATE MIN./FT.	RUN NO.	DEPTH (FT)	RECOVERY/RQD		WEATHERING	ELEV./ DEPTH (FT)	VISUAL DESCRIPTION AND REMARKS
				IN.	%			
45								C1: Cored through cobbles and glacial till from 46.2-48.8 ft. See Test Boring Report for Overburden Descriptions Top of Weathered Bedrock at 47.0 ft. Begin NQ Rock Core at 56.0 ft.
	9						-77.0 47.0	Weathered SHALE
	4							
	7							-WEATHERED ROCK-
50								
55								
	6						-86.0 56.0	
	7	C2	56.0 58.6	30/4	97/13	SL.		C2: Soft, slightly weathered, aphanitic, graphitic SHALE, Joints dipping at low to high angles, extremely close to close, partly open to open, planar to stepped, smooth to rough, discolored joint surfaces with occasional silt coatings, pyrite mineralization throughout.
	21							
	6	C3	58.6	5/0	83/0	Highly		C3: Very soft, highly weathered, dark gray aphanitic, graphitic SHALE, joints dipping at low to vertical angles.
	4	C4	59.1 59.1 61.2	36/0	97/0	SL.-Mod.		C4: Moderately hard, slightly to moderately weathered, dark gray aphanitic, graphitic SHALE, Joints dipping at moderate to vertical angles, extremely close to very close, tight to open, planar to stepped, smooth to rough, slightly to moderately weathered, occasional calcite veins, pyrite mineralization.
60								
	6							
	5							
	11	C5	62.2 64.0	18/4	83/19	SL.-Mod.		C5: Same as C4, except, joints dipping at high to vertical angles, extremely close to close, occasional pyrite veins.
	9							
	9	C6	64.0 66.2	26/19	100/72	SL.-Mod.		C6: Same as C4, except, joints dipping at horizontal to high angles, very close to close, partly open to open, pyrite and calcite veins.
65								
	1						-96.2 66.2	Bottom of Exploration

HALEY & ALDRICH South Portland, Maine	**TEST BORING REPORT**	BORING NO.	**B107**

PROJECT	Cargo Pier, Mack Point, Searsport, Maine	FILE NO.	80687-000
CLIENT	Fay Spofford & Thorndike	SHEET NO.	1 OF 1
CONTRACTOR	Maine Test Borings, Inc.	LOCATION	

ITEM	CASING	DRIVE SAMPLER	CORE BARREL	DRILLING EQUIPMENT & PROCEDURES
TYPE	NW	SS		RIG TYPE CME 45
INSIDE DIAMETER (IN)	3	1-3/8		BIT TYPE Tricone Roller
HAMMER WEIGHT (LB)	300	140	-	DRILL MUD --
HAMMER FALL (IN)	16	30	-	OTHER - Barge

ELEVATION	-20.6
DATUM	MLLW
START	17 November 1998
FINISH	17 November 1998
DRILLER	G. Lidstone
H&A REP	B. Lawrence

DEPTH (FT)	CASING BLOWS PER FT.	SAMPLER BLOWS PER 6 IN	SAMPLE NUMBER & REC. (IN.)	SAMPLE DEPTH (FT)	ELEV./ DEPTH (FT)	VISUAL DESCRIPTION AND REMARKS
0	WOC	WOR WOR	S1 14	0.0 2.6		Very soft, black organic SILT with wood particles (organic odor)
	WOC	WOR WOR			-22.3 1.7	Very soft, brownish-gray clayey SILT, little sand with wood particles -SHALLOW MARINE DEPOSIT-
	WOC					
	WOC					
	WOC					
5	WOC	WOR 5	S2 12	5.0 6.5	-26.6 6.0	Medium dense, brownish-gray to brown-gray mottled silty coarse to fine SAND, little gravel
	4	7 10	S3 0	6.5 8.0		
	10	5 5				
	17					
	35					
10	15	15 14	S4 0	10.0 11.5		Note: Basket in sampler not properly installed, no recovery
	18	13 16	S5 5	11.5 13.0		Very dense, light brown coarse to fine SAND, some silt, little gravel
	33	28 33				-GLACIAL TILL-
	60					
	57				-34.6 14.0	
15						
		16 28 39	S6 7	15.7 17.2		Very dense, gray silty coarse to fine SAND, some gravel -GLACIAL TILL-
					-37.8 17.2	Bottom of Exploration No refusal

WATER LEVEL DATA

DATE	TIME	ELAPSED TIME (HR)	DEPTH (FT.) TO: BOTTOM OF CASING	BOTTOM OF HOLE	WATER

SAMPLE IDENTIFICATION

O	▨	OPEN END ROD
T	▥	THIN WALL TUBE
U	▦	UNDISTURBED SAMPLE
S	☐	SPLIT SPOON

SUMMARY

OVERBURDEN (LIN FT)	17.2
ROCK CORED (LIN FT)	0
SAMPLES	5S

BORING NO. **B107**

HALEY & ALDRICH South Portland, Maine	TEST BORING REPORT	BORING NO. B108

PROJECT Cargo Pier, Mack Point, Searsport, Maine
CLIENT Fay Spofford & Thorndike
CONTRACTOR Maine Test Borings, Inc.

FILE NO. 80687-000
SHEET NO. 1 OF 3
LOCATION

ITEM	CASING	DRIVE SAMPLER	CORE BARREL
TYPE	NW	SS	NQ
INSIDE DIAMETER (IN)	3	1-3/8	1-7/8
HAMMER WEIGHT (LB)	300	140	-
HAMMER FALL (IN)	16	30	-

DRILLING EQUIPMENT & PROCEDURES
RIG TYPE CME 45
BIT TYPE Tricone Roller
DRILL MUD --
OTHER - Barge

ELEVATION -17.9
DATUM MLLW
START 11 November 1998
FINISH 16 November 1998
DRILLER G. Lidstone
H&A REP B. Lawrence

DEPTH (FT)	CASING BLOWS PER FT.	SAMPLER BLOWS PER 6 IN	SAMPLE NUMBER & REC. (IN.)	SAMPLE DEPTH (FT)	ELEV./ DEPTH (FT)	VISUAL DESCRIPTION AND REMARKS
0	7	5 4	S1 19	0.0 2.0	-18.2 0.3 -18.5 0.6	Very soft, black organic SILT, some sand Black coarse to medium SAND, little silt -SHALLOW MARINE DEPOSIT- Brown SILT, trace clay
	24	7 19			-18.8 0.9 -20.9 3.0	Brown coarse to fine SAND, some gravel, little silt
	41					
	55					
	82					
5	28	21 24	S2 12	5.0 6.5		Dense, gray silty coarse to fine SAND, little gravel Cobble from 10.0-10.5 ft. Washed ahead of casing to 10.5 ft.
	57	23				
	64					
	98					
	96					
10	51	20 23	S3 7	10.5 12.0		Dense, gray silty coarse to fine SAND, little gravel Cobble from 15.0-15.5 ft. Washed ahead of casing to 15.5 ft.
	60	24				
	120					-GLACIAL TILL-
	168					
	101					
15	50	8 14	S4 4	15.5 17.0		Dense, gray silty coarse to fine SAND, some gravel
	56	18				
	55					
	60					
	59					
20	40	20 30	S5 5	20.0 21.5		Very dense, gray silty coarse to fine SAND, some gravel
	50	27				
	50					
	58					
	68					
25						

WATER LEVEL DATA

DATE	TIME	ELAPSED TIME (HR)	DEPTH (FT.) TO: BOTTOM OF CASING	BOTTOM OF HOLE	WATER

SAMPLE IDENTIFICATION
O ▨ OPEN END ROD
T ░ THIN WALL TUBE
U ▩ UNDISTURBED SAMPLE
S ☐ SPLIT SPOON

SUMMARY	
OVERBURDEN (LIN FT)	53.5
ROCK CORED (LIN FT)	10
SAMPLES	11S, 2C

BORING NO. B108

HALEY & ALDRICH	South Portland, Maine	TEST BORING REPORT	BORING NO. B108 FILE NO. 80687-000 SHEET NO. 2 OF 3

DEPTH (FT)	CASING BLOWS PER FT.	SAMPLER BLOWS PER 6 IN	SAMPLE NUMBER & REC. (IN.)	SAMPLE DEPTH (FT)	ELEV./ DEPTH (FT)	VISUAL DESCRIPTION AND REMARKS
25	88	13 34	S6 6	25.0 26.5		Very dense, gray silty coarse to fine SAND, some gravel
	70	35				
	141					
	170					
	183					
30	71	65 75/7.5	S7 6	30.0 30.7		Very dense, gray silty coarse to fine SAND, little gravel Cobble from 35.0-35.5 ft. Washed ahead of casing to 35.5 ft.
	75					
	65					-GLACIAL TILL-
	66					
	67					
35	57	55 113	S8 6	35.5 36.5		Very dense, gray silty coarse to fine SAND, little gravel Drove casing to 35.0 Washed ahead of casing to 40.0 ft.
	46					
	57					
	75					
	65					
40	75	38 139	S9 11	40.0 41.0		Very dense, gray sandy SILT, some gravel Drove casing to 40.0 ft. Washed ahead of casing to 45.0 ft.
	50					
	32					
	154					
	120					
45	95	79 77	S10 7	45.0 46.0		Very dense, gray sandy SILT, some gravel Drove casing to 45.0 ft. Washed ahead of casing to 50.0 ft.
	106					-GLACIAL TILL-
	74					
	86					
	78					
50	83	55 97	S11 12	50.0 51.0		Very dense, gray silty SAND, little gravel Drove casing to 50.0 ft.
	80					
	76					
	90				-71.4 53.5	-WEATHERED ROCK- Drove casing to 55.5 ft. Washed ahead to 56.5 ft.
	90					
55	137/0.5					
					-74.4 56.5	Top of Bedrock at 56.5 ft. Begin NQ Rock Core at 56.5 ft. See Core Boring Report
60						

	BORING NO. B108

HALEY & ALDRICH	South Portland, Maine	CORE BORING REPORT	BORING NO. B108 FILE NO. 80687-000 SHEET NO. 3 OF 3

DEPTH (FT)	DRILLING RATE MIN./FT.	RUN NO.	DEPTH (FT)	RECOVERY/RQD IN.	RECOVERY/RQD %	WEATHERING	ELEV./ DEPTH (FT)	VISUAL DESCRIPTION AND REMARKS
50								
							-71.4 53.5	See Test Boring Report for Overburden Descriptions Top of Weathered Rock at 53.5 ft. Begin NQ Rock Core at 56.5 ft.
								-WEATHERED ROCK-
55								
		C1	56.5 61.5	59/16	98/27	SL.	-74.4 56.5	C1: Medium hard, slightly weathered, aphanitic, graphitic SCHIST, Joints extremely close to close, primary joints dipping at low to moderate angles, secondary joints dippping at high to vertical angles, planar to stepped, smooth to rough, tight to open, calcite and pyrite veins.
	7							
	8							
	8							
60								
	7							C2: Same as C1, except highly fractured zone from 61.5-65.2 ft.
	8	C2	61.5 66.5	48/10	80/17	SL.		
	8							
	7							
	7							
65								
	7							
	8						-84.4 66.5	Bottom of Exploration

HALEY & ALDRICH	South Portland, Maine	**TEST BORING REPORT**	BORING NO. **B109**

PROJECT	Cargo Pier, Mack Point, Searsport, Maine
CLIENT	Fay Spofford & Thorndike
CONTRACTOR	Maine Test Borings, Inc.

FILE NO. 80687-000
SHEET NO. 1 OF 3
LOCATION

ELEVATION -0.9
DATUM MLLW
START 16 October 1998
FINISH
DRILLER G. Lidstone
H&A REP B. Lawrence

ITEM	CASING	DRIVE SAMPLER	CORE BARREL
TYPE	NW	SS	
INSIDE DIAMETER (IN)	3	1-3/8	
HAMMER WEIGHT (LB)	300	140	-
HAMMER FALL (IN)	16	30	-

DRILLING EQUIPMENT & PROCEDURES

RIG TYPE CME 45
BIT TYPE Tricone Roller
DRILL MUD --
OTHER - Barge

DEPTH (FT)	CASING BLOWS PER FT.	SAMPLER BLOWS PER 6 IN	SAMPLE NUMBER & REC.(IN.)	SAMPLE DEPTH (FT)	ELEV./ DEPTH (FT)	VISUAL DESCRIPTION AND REMARKS
0	16	16 16	S1 10	0.0 2.0	-1.2 0.3	Medium dense, black silty medium to fine SAND, trace gravel, occasional snails -SHALLOW MARINE DEPOSIT-
	18	11 8				Medium dense, grayish-brown silty medium to fine SAND, trace coarse sand and gravel
	19					
	23					-GLACIAL TILL-
	21				-5.9	
5	19	16 16	S2 9	5.0 6.5	5.0	Dense, gray silty coarse to fine SAND, little gravel with occasional cobbles
	25	11 8				
	33					
	44					
	52					
10	19	12 16	S3 9	10.0 11.5		Very dense, gray silty medium to fine SAND, some coarse sand and gravel
	115	43				-GLACIAL TILL-
	59					
	120					
	95					
15	68	54 27	S4 13	15.0 16.5		Very dense, gray silty medium to fine SAND, some coarse sand and gravel, occasional granite cobbles Wash ahead of casing to 20.0 ft.
	57	34				
	53					
	58					
	60					
20	41	75 72	S5 9	20.0 21.0		Very dense, gray silty coarse to fine SAND, little gravel Drive casing to 20.0 ft. Washed ahead of casing to 25.0 ft. Cobble from 22.5-23.0 ft. -GLACIAL TILL-
	35					
	78					
	128					
	105					
25						

WATER LEVEL DATA

DATE	TIME	ELAPSED TIME (HR)	DEPTH (FT.) TO: BOTTOM OF CASING	BOTTOM OF HOLE	WATER

SAMPLE IDENTIFICATION

O	▨	OPEN END ROD
T	▥	THIN WALL TUBE
U	▦	UNDISTURBED SAMPLE
S	☐	SPLIT SPOON

SUMMARY

OVERBURDEN (LIN FT)	66.9
ROCK CORED (LIN FT)	0
SAMPLES	14S

BORING NO. **B109**

HALEY & ALDRICH	South Portland, Maine	**TEST BORING REPORT**	BORING NO. **B109** FILE NO. 80687-000 SHEET NO. 3 OF 3

DEPTH (FT)	CASING BLOWS PER FT.	SAMPLER BLOWS PER 6 IN	SAMPLE NUMBER & REC.(IN.)		SAMPLE DEPTH (FT)	ELEV./ DEPTH (FT)		VISUAL DESCRIPTION AND REMARKS
60								
		141 50/10	S13 8	▨	60.2 61.0			Very dense, gray SILT, little medium to fine sand, little gravel Washed ahead to 65.0 ft.
65		62 120	S14 7	▨	65.0 66.0	-66.8 65.9		
								-WEATHERED ROCK-
						-67.6 66.7		Top of Bedrock at 66.7 ft. Advanced roller bit to 66.9 ft. Bottom of Exploration

HALEY & ALDRICH	South Portland, Maine	TEST BORING REPORT	BORING NO. B110

PROJECT Cargo Pier, Mack Point, Searsport, Maine
CLIENT Fay Spofford & Thorndike
CONTRACTOR Maine Test Borings, Inc.

FILE NO. 80687-000
SHEET NO. 1 OF 2
LOCATION

ITEM	CASING	DRIVE SAMPLER	CORE BARREL	DRILLING EQUIPMENT & PROCEDURES
TYPE	NW	SS		RIG TYPE Bombardier B-34
INSIDE DIAMETER (IN)	3	1-3/8		BIT TYPE Tricone Roller
HAMMER WEIGHT (LB)	300	140	-	DRILL MUD --
HAMMER FALL (IN)	16	30	-	OTHER - SS Auger through pavement

ELEVATION 22.0
DATUM MLLW
START 3 December 1998
FINISH 4 December 1998
DRILLER G. Lidstone
H&A REP B. Lawrence

DEPTH (FT)	CASING BLOWS PER FT.	SAMPLER BLOWS PER 6 IN	SAMPLE NUMBER & REC. (IN.)	SAMPLE DEPTH (FT)	ELEV./ DEPTH (FT)	VISUAL DESCRIPTION AND REMARKS
0	SSA				21.6 0.4	-Bituminous Concrete- Brown coarse to fine SAND, some silt, some gravel
	SS1	30 30 29	S1 16	0.8 2.3	21.1 0.9	Very dense, brown-gray mottled silty coarse to fine SAND, some gravel, occasional coal piece -FILL-
	SSA					
	SSA				18.0 4.0	Loose, black COAL, ASH, and SLAG fragments and particles, occasional brown-gray mottled silty coarse to fine SAND Drove casing to 8.6 ft., Cobble from 8.6-9.0 ft., auger through obstruction to 10.0 ft.
	1					
5	9	3 3 3	S2 14	5.0 6.5		
	25				15.0 7.0	Very dense, gray-brown mottled silty coarse to fine SAND, little gravel
	85					
	125					
	SSA					
10	SSA	36 28 44	S3 16	10.0 11.5	11.0 11.0	Black and petroleum odor from 11.0-15.3 ft. Auger to 15.0 ft., Cobble from 11.8-15.3 ft. Petroleum stained auger cuttings -FILL-
	SSA					
	SSA					
	SSA					
	SSA					
15	36	6 12 16	S4 18	15.0 16.5	6.7 15.3	Medium dense, brown silty coarse to fine SAND, little gravel, trace clay
	49					
	34					
	43					
	116					
20		12 20 25	S5 11	20.0 21.5		Dense, gray silty coarse to fine SAND, little gravel, trace clay with occasional fine sand partings -GLACIAL TILL- Washed ahead to 25.0 ft.
25						

WATER LEVEL DATA

DATE	TIME	ELAPSED TIME (HR)	DEPTH (FT.) TO: BOTTOM OF CASING	BOTTOM OF HOLE	WATER
12/4/98	07:30		20	25.3	5.4
12/4/98	08:09		20.0	31.5	5.0

SAMPLE IDENTIFICATION

O	▩	OPEN END ROD
T	▥	THIN WALL TUBE
U	▦	UNDISTURBED SAMPLE
S	▨	SPLIT SPOON

SUMMARY

OVERBURDEN (LIN FT)	31.5
ROCK CORED (LIN FT)	0
SAMPLES	7S

BORING NO. B110

HALEY & ALDRICH

South Portland, Maine

TEST BORING REPORT

BORING NO. **B110**
FILE NO. 80687-000
SHEET NO. 2 OF 2

DEPTH (FT)	CASING BLOWS PER FT.	SAMPLER BLOWS PER 6 IN	SAMPLE NUMBER & REC. (IN.)	SAMPLE DEPTH (FT)	ELEV./ DEPTH (FT)	VISUAL DESCRIPTION AND REMARKS
25		100/10	S6 2	25.0 25.3		Very dense, gray silty coarse to fine SAND, some gravel Washed ahead of casing to 30.0 ft. -GLACIAL TILL-
30		19 22 24	S7 16	30.0 31.5	-9.5 31.5	Dense, gray sandy SILT, some gravel, trace clay
						Bottom of Exploration No refusal

BORING NO. **B110**

HALEY & ALDRICH South Portland, Maine	**TEST BORING REPORT**	BORING NO. **B111**

PROJECT Cargo Pier, Mack Point, Searsport, Maine
CLIENT Fay Spofford & Thorndike
CONTRACTOR Maine Test Borings, Inc.

FILE NO. 80687-000
SHEET NO. 1 OF 1
LOCATION

ITEM	CASING	DRIVE SAMPLER	CORE BARREL	DRILLING EQUIPMENT & PROCEDURES
TYPE	NW	SS		RIG TYPE CME 45
INSIDE DIAMETER (IN)	3	1-3/8		BIT TYPE Tricone Roller
HAMMER WEIGHT (LB)	300	140	-	DRILL MUD --
HAMMER FALL (IN)	16	30	-	OTHER - 4.5" thinwall core bit, 0.9' PC concrete deck

ELEVATION -9.2
DATUM MLLW
START 4 December 1998
FINISH 4 December 1998
DRILLER G. Lidstone
H&A REP B. Lawrence

DEPTH (FT)	CASING BLOWS PER FT.	SAMPLER BLOWS PER 6 IN	SAMPLE NUMBER & REC. (IN.)	SAMPLE DEPTH (FT)	ELEV./ DEPTH (FT)	VISUAL DESCRIPTION AND REMARKS
0	WOC	WOR WOR	S1 6	0.0 4.2		Very soft, black sandy organic SILT, little gravel with shells
	WOC	WOM 1				
	2	0 0				
	WOC	0 0				
	WOC					
5	WOC	WOR WOR	NR 0	5.0 7.0		No recovery, replace sampler basket
	WOC	WOR WOR				
	WOH	WOR WOR	S2 3	7.0 9.3		Very soft, black sandy organic SILT, with shell fragments and particles
	WOH	WOR WOR				-SHALLOW MARINE DEPOSIT-
	WOH					
10	WOC	WOR WOR	S3 6	10.0 12.0		Very soft, black sandy organic SILT, with shell fragments and particles Brownish-gray clayey SILT from 11.8-11.9 ft.
	WOC	WOH WOH			-21.0 11.8	
	WOH					
	WOH					
	WOH					
15	WOC	WOR 3	S4 1	15.0 17.0		Medium stiff, brownish-gray clayey SILT, little sand and shell fragments and particles
	9	7 5			-26.2 17.0	-MARINE DEPOSIT-
	19					Medium dense, brownish-gray sandy SILT, little gravel
	27					-GLACIAL TILL-
	43					
20		20 15	S5 12	20.0 22.0		
		12 20			-31.2 22.0	
						Bottom of Exploration No refusal

WATER LEVEL DATA					
			DEPTH (FT.) TO:		
DATE	TIME	ELAPSED TIME (HR)	BOTTOM OF CASING	BOTTOM OF HOLE	WATER

SAMPLE IDENTIFICATION

O	▨	OPEN END ROD
T	▥	THIN WALL TUBE
U	▩	UNDISTURBED SAMPLE
S	☐	SPLIT SPOON

SUMMARY	
OVERBURDEN (LIN FT)	22.0
ROCK CORED (LIN FT)	0
SAMPLES	5S

BORING NO. **B111**

HALEY & ALDRICH South Portland, Maine	# TEST BORING REPORT	BORING NO. **B112**

PROJECT Cargo Pier, Mack Point, Searsport, Maine
CLIENT Fay Spofford & Thorndike
CONTRACTOR Maine Test Borings, Inc.

FILE NO. 80687-000
SHEET NO. 1 OF 3
LOCATION

ITEM	CASING	DRIVE SAMPLER	CORE BARREL	DRILLING EQUIPMENT & PROCEDURES
TYPE	NW	SS		RIG TYPE Bombardier B-47
INSIDE DIAMETER (IN)	3	1-3/8		BIT TYPE Tricone Roller
HAMMER WEIGHT (LB)	300	140	-	DRILL MUD --
HAMMER FALL (IN)	16	30	-	OTHER - 2"X7" Shear Vane

ELEVATION -12.6
DATUM MLLW
START 28 October 1998
FINISH 2 December 1998
DRILLER G. Lidstone
H&A REP B. Lawrence

DEPTH (FT)	CASING BLOWS PER FT.	SAMPLER BLOWS PER 6 IN	SAMPLE NUMBER & REC. (IN.)	SAMPLE DEPTH (FT)	ELEV./ DEPTH (FT)	VISUAL DESCRIPTION AND REMARKS
0	WOC	WOR WOR	S1 0	0.0 2.0		Sample attempted, No recovery, Very soft material
	WOC	WOR WOR				
	WOC	WOR WOR	S2 1	2.0 4.0		Very soft, black organic SILT, little sand, shells, strong organic odor -SHALLOW MARINE DEPOSIT-
	WOC	WOR WOR				
	WOC					
5	WOC					
	WOC	WOR WOR	S3 6	6.0 8.0		Very soft, black organic SILT, little sand, shells, strong organic odor
	WOC	WOR WOR				
	WOH					
	WOH					
10	WOC	WOR WOR	S4 19	10.0 12.0		Very soft, black to dark gray organic SILT, little sand, shells, occasional wood fibers -SHALLOW MARINE DEPOSIT-
	WOC	WOR WOR				
	WOC					
	1					
	WOH					
15	WOC	WOR WOR	S5 20	15.0 17.0	-27.9 15.3	Very soft, gray SILT, trace clay, trace coarse to medium sand
	WOC	WOR WOR				
	WOC					
	WOH					
	WOH					
20		WOR WOR	S6 24	20.0 22.0		Very soft, gray SILT, trace clay, trace coarse to medium sand with frequent shells and occasional wood fibers
		WOR WOR				-SHALLOW MARINE DEPOSIT-
	9				-34.6 22.0	Gray silty CLAY -MARINE DEPOSIT-
	24					
	35					
25						

WATER LEVEL DATA

DATE	TIME	ELAPSED TIME (HR)	DEPTH (FT.) TO: BOTTOM OF CASING	BOTTOM OF HOLE	WATER

SAMPLE IDENTIFICATION

O	▨	OPEN END ROD
T	▥	THIN WALL TUBE
U	▩	UNDISTURBED SAMPLE
S	▨	SPLIT SPOON

SUMMARY

OVERBURDEN (LIN FT)	70.2
ROCK CORED (LIN FT)	0
SAMPLES	15S

BORING NO. **B112**

HALEY & ALDRICH	South Portland, Maine	TEST BORING REPORT	BORING NO. B112 FILE NO. 80687-000 SHEET NO. 2 OF 3

DEPTH (FT)	CASING BLOWS PER FT.	SAMPLER BLOWS PER 6 IN	SAMPLE NUMBER & REC. (IN.)	SAMPLE DEPTH (FT)	ELEV./ DEPTH (FT)	VISUAL DESCRIPTION AND REMARKS
25	55	2 10	S7 21	25.0 27.0		Medium stiff, gray silty CLAY with wood fibers FV1: 25.0-25.6 ft., Su= 820/330 psf Attempted FV at 25.6 ft., unsuccessful
	58	12 11				
	51					-MARINE DEPOSIT-
	45					
	43					
30	98	WOR WOH	S8 4	30.0 32.0		Medium stiff, gray silty CLAY FV2: 30.0-30.6 ft., Su= 560/0 psf FV3: 30.6-31.1 ft., Su= 630/150 psf Note: Gray silty CLAY with black specks and wood particles in wash
	55	5 5				
	48					
	54					
	69				-47.2 34.6	Dense, gray fine SAND, little silt to Gray coarse to fine SAND, trace silt
35	58	36 23	S9 2	35.0 36.5		Note: Occasional fine sand layers (S9 and S10)
	48	20				
	70					-GLACIAL TILL-
	51					
	73					
40	58	16 34	S10 5	40.0 41.5	-52.9 40.3	Dense, gray fine SAND, little silt -GLACIAL TILL- Very dense, gray coarse to fine SAND
	80	28				
	112					
	194					
	181					
45	49	29 53	S11 7	45.0 46.5		Very dense, gray silty fine SAND, little gravel, trace clay, with occasional fine sand and silt layers Note: Cobble from 49.8-50.2 ft.
	54	40				
	85					
	90					
	189					
50	50	34 41	S12 13	50.3 51.8		Very dense, gray medium to fine SAND, little silt, little gravel, trace clay with occasional fine sand, trace silt layers Cobble from 53.9-54.3 ft. Washed ahead of casing to 55.0 ft.
	82	90				
	400					-GLACIAL TILL-
	199/26					
	37					
55	52	150/10	S13 3	55.1 55.4		Very dense, gray coarse to fine SAND, little silt, little gravel Drove casing to 55.3 ft. Washed ahead of casing to 60.0 ft.
60						

BORING NO. B112

HALEY & ALDRICH South Portland, Maine

TEST BORING REPORT

BORING NO. B112
FILE NO. 80687-000
SHEET NO. 3 OF 3

DEPTH (FT)	CASING BLOWS PER FT.	SAMPLER BLOWS PER 6 IN	SAMPLE NUMBER & REC. (IN.)	SAMPLE DEPTH (FT)	ELEV./ DEPTH (FT)	VISUAL DESCRIPTION AND REMARKS
60		150/10	S14 3	60.0 60.3		Very dense, gray sandy SILT, trace gravel, trace clay Washed ahead of casing to 65.0 ft.
65		150/10	S15 4	65.0 65.3		Very dense, gray sandy SILT, little gravel, trace clay Washed ahead of casing to 70.2 ft. -GLACIAL TILL-
					-82.0 69.4	-WEATHERED ROCK-
70					-82.8 70.2	Bottom of Exploration

BORING NO. B112

HALEY & ALDRICH South Portland, Maine	**TEST BORING REPORT**	BORING NO. **B113**

PROJECT	Cargo Pier, Mack Point, Searsport, Maine	FILE NO. 80687-000
CLIENT	Fay Spofford & Thorndike	SHEET NO. 1 OF 3
CONTRACTOR	Maine Test Borings, Inc.	LOCATION

ITEM	CASING	DRIVE SAMPLER	CORE BARREL	DRILLING EQUIPMENT & PROCEDURES
TYPE	NW	SS		RIG TYPE Bombardier B-47
INSIDE DIAMETER (IN)	3	1-3/8		BIT TYPE Tricone Roller
HAMMER WEIGHT (LB)	300	140	-	DRILL MUD --
HAMMER FALL (IN)	16	30	-	OTHER -

ELEVATION -17.1
DATUM MLLW
START 21 October 1998
FINISH 28 October 1998
DRILLER G. Lidstone
H&A REP B. Lawrence

DEPTH (FT)	CASING BLOWS PER FT.	SAMPLER BLOWS PER 6 IN	SAMPLE NUMBER & REC. (IN.)	SAMPLE DEPTH (FT)	ELEV./ DEPTH (FT)	VISUAL DESCRIPTION AND REMARKS
0	WOC	WOR 1	S1 12	0.0 2.0		Very soft, black organic SILT, little sand, mussels -SHALLOW MARINE DEPOSIT-
	WOC	1				
	WOC					
	WOC					
	WOC					
5	WOC					
	WOC	WOR WOR	S2 0	6.0 8.0		
	WOC	WOR WOR				
	WOC					
	WOC				-27.1 10.0	
10	WOM					Very soft, gray clayey SILT, trace coarse sand and gravel -MARINE DEPOSIT-
	WOM	WOR WOR	S3 17	11.0 13.0		
	WOM	WOR WOR				
	WOM					
	WOM					
15	10					
	14	4 6	S4 9	16.0 18.0	-34.1 17.0	
	18	12 13				Medium dense, brownish-gray sandy SILT, little gravel, trace clay, occasional root
	15					
	20					
20	39					
	12	8 11	S5 17	21.0 23.0		Medium dense, brownish-gray sandy SILT, little gravel, trace clay, occasional root -GLACIAL TILL-
	30	18 27				
	51					
	90					
25						

WATER LEVEL DATA

DATE	TIME	ELAPSED TIME (HR)	DEPTH (FT.) TO: BOTTOM OF CASING	BOTTOM OF HOLE	WATER

SAMPLE IDENTIFICATION

O	▨	OPEN END ROD
T	▨	THIN WALL TUBE
U	▨	UNDISTURBED SAMPLE
S	☐	SPLIT SPOON

SUMMARY

OVERBURDEN (LIN FT)	61.1
ROCK CORED (LIN FT)	0
SAMPLES	13S

BORING NO. **B113**

HALEY & ALDRICH	South Portland, Maine	TEST BORING REPORT	BORING NO. B116

PROJECT Cargo Pier, Mack Point, Searsport, Maine
CLIENT Fay Spofford & Thorndike
CONTRACTOR Maine Test Borings, Inc.

FILE NO. 80687-000
SHEET NO. 1 OF 3
LOCATION

ITEM	CASING	DRIVE SAMPLER	CORE BARREL
TYPE	NW	SS	
INSIDE DIAMETER (IN)	3	1-3/8	
HAMMER WEIGHT (LB)	300	140	-
HAMMER FALL (IN)	16	30	-

DRILLING EQUIPMENT & PROCEDURES
RIG TYPE CME 45
BIT TYPE Tricone Roller
DRILL MUD --
OTHER - Barge

ELEVATION -34.4
DATUM MLLW
START 18 November 1998
FINISH 19 November 1998
DRILLER G. Lidstone
H&A REP B. Lawrence

DEPTH (FT)	CASING BLOWS PER FT.	SAMPLER BLOWS PER 6 IN	SAMPLE NUMBER & REC. (IN.)	SAMPLE DEPTH (FT)	ELEV./ DEPTH (FT)	VISUAL DESCRIPTION AND REMARKS
0	WOC	WOR WOR	S1 20	0.0 2.0	-35.0 0.6	Very soft, black organic SILT with shells Brownish-gray SILT with wood particles and shells
	WOC	WOR WOR			-36.4 2.0	Brownish-gray SILT with wood particles and shells, probable sand layers
	4					
	WOH					
	WOH				-39.4	
5	24	9 11	S2 2	5.0 6.5	5.0	Very stiff, gray SILT, trace fine sand, trace clay
	24	12			-41.4	-SHALLOW MARINE DEPOSIT-
	26				7.0	
	30					
	28					
10	30	5 6	S3 18	10.0 11.5		Medium stiff to stiff, brown-gray mottled silty CLAY
	32	8				-MARINE DEPOSIT-
	37					
	36					
	36					
15	47	WOH WOH	S4 18	15.0 16.5		Medium stiff to stiff, gray silty CLAY, trace sand
	40	4				
	38					
	32				-53.9	
	55				19.5	
20	63	17 24	S5 0	20.0 21.5		
	61	20 20	S6 6	21.5 23.0		Very dense, gray medium to fine SAND, some gravel, little silt
	90	37 34				-GLACIAL TILL-
	72					
	89					
25						

WATER LEVEL DATA

DATE	TIME	ELAPSED TIME (HR)	DEPTH (FT.) TO: BOTTOM OF CASING	BOTTOM OF HOLE	WATER

SAMPLE IDENTIFICATION

O	▨	OPEN END ROD
T	▥	THIN WALL TUBE
U	▩	UNDISTURBED SAMPLE
S	☐	SPLIT SPOON

SUMMARY

OVERBURDEN (LIN FT)	61.7
ROCK CORED (LIN FT)	0
SAMPLES	11S

BORING NO. B116

HALEY & ALDRICH	South Portland, Maine	TEST BORING REPORT	BORING NO. B116 FILE NO. 80687-000 SHEET NO. 2 OF 3

DEPTH (FT)	CASING BLOWS PER FT.	SAMPLER BLOWS PER 6 IN	SAMPLE NUMBER & REC. (IN.)	SAMPLE DEPTH (FT)	ELEV./ DEPTH (FT)	VISUAL DESCRIPTION AND REMARKS
25	82	9 10 28	S7 6	25.0 26.5		Dense, gray silty coarse to fine SAND, little gravel, trace clay Cobble at 30.5 ft. -GLACIAL TILL-
	100					
	120					
	190					
	123					
30	26					
	27	41 33 31	S8 1	31.0 32.5		Very dense, gray silty coarse to fine SAND, little gravel
	28					
	60					
	80					
35	70	22 40 32	S9 8	35.0 36.5		Very dense, gray coarse to fine SAND, some gravel, little silt
	73					
	94					
	130					
	157					
40	28	41 35 100	S10 14	40.0 41.5		Very dense, gray fine SAND, some coarse to medium sand and gravel, little silt
	46					
	42					
	36					
	80				-79.1 44.7	
45	225		C1 12	44.7 49.7		Cobbles and -GLACIAL TILL-
	54					
	52					
	42					
	43				-84.1 49.7	
50	50	80 93/12.5	S11 11	50.0 50.9		Very dense, gray fine SAND, some coarse to medium sand and gravel, little silt -GLACIAL TILL-
	55/.3				-85.7 51.3	Top of Bedrock at 51.3 ft. See Core Boring Report
55						
60						

HALEY & ALDRICH	South Portland, Maine	CORE BORING REPORT	BORING NO. B116 FILE NO. 80687-000 SHEET NO. 3 OF 3

DEPTH (FT)	DRILLING RATE MIN./FT.	RUN NO.	DEPTH (FT)	RECOVERY/RQD IN.	RECOVERY/RQD %	WEATHERING	ELEV./ DEPTH (FT)		VISUAL DESCRIPTION AND REMARKS
									See Test Boring Report for Overburden Details and C1 Top of Bedrock at 51.3 ft. Advanced roller bit to 51.7 ft. Begin NX Rock Core at 51.7 ft.
50									
							-85.7 51.3	× ×	C2: Moderately hard, fresh, light gray aphanitic PELITE. Joints horizontal to low angle, close to moderately close, rough and undulating to planar and smooth, tight to partly open, fresh to slightly weathered, calcite veins throughout core, vugs in calcite from 54.6-54.8 ft.
		C2	51.7 56.7	60/58	100/97	Fresh		× ×	C3: Same as above except, joints low to moderately dipping, tight to open, and vug at 58.5-58.7 ft., pyrite mineralization, one high angle secondary joint at 58.2 ft.
55								× ×	
		C3	56.7 58.7	24/19	100/79	Fresh		× ×	C4: Same as C2 except, joints very close to close, one high angle secondary joint(continued from bottom of C3) from 58.7-59.1 ft.
		C4	58.7 61.7	36/26	100/72	Fresh		× ×	
60								× ×	
							-96.1 61.7		Bottom of Exploration

HALEY & ALDRICH South Portland, Maine	**TEST BORING REPORT**	BORING NO. **B117**

PROJECT	Cargo Pier, Mack Point, Searsport, Maine
CLIENT	Fay Spofford & Thorndike
CONTRACTOR	Maine Test Borings, Inc.

FILE NO.	80687-000
SHEET NO.	1 OF 3
LOCATION	
ELEVATION	-35.8
DATUM	MLLW
START	6 October 1998
FINISH	
DRILLER	G. Lidstone
H&A REP	K. Stephenson

ITEM	CASING	DRIVE SAMPLER	CORE BARREL
TYPE	NW	SS	NQ
INSIDE DIAMETER (IN)	3	1-3/8	1-7/8
HAMMER WEIGHT (LB)	300	140	-
HAMMER FALL (IN)	16	30	-

DRILLING EQUIPMENT & PROCEDURES

RIG TYPE CME 45 Skid
BIT TYPE Rollerbit
DRILL MUD --
OTHER -

DEPTH (FT)	CASING BLOWS PER FT.	SAMPLER BLOWS PER 6 IN	SAMPLE NUMBER & REC.(IN.)	SAMPLE DEPTH (FT)	ELEV./ DEPTH (FT)	VISUAL DESCRIPTION AND REMARKS
0	WOC	WOR WOR	S1 18	0.0 2.0		Very soft, black organic SILT, little fine sand, shell fragments -SHALLOW MARINE DEPOSIT-
	2	WOR WOR				
	16				-37.8 2.0	Gray silty coarse to fine SAND, little gravel -SHALLOW MARINE DEPOSIT-
	29					
	52				-39.8 4.0	Very dense, gray coarse to fine sandy SILT, little gravel, occasional fine sand seams -GLACIAL TILL-
5	78	32 105	S2 10	5.0 11.0		
	60					
	38					
	55					
	72					
10	47	34 42	S3 12	10.0 11.5		Very dense, gray coarse to fine sandy SILT, little gravel
	115	65				
	185					Note: Probable cobbles 12.0-15.0 ft. Washed ahead of casing to 15.5 ft.
	255					
	350					
15	59	58	S4 7	15.5 16.8		Very dense, gray gravelly SILT, little coarse to fine sand
	45	67 50/10				
	43					
	56					
	67					
20	22	36 30	S5 6	20.2 21.7		Very dense, gray coarse to fine sandy SILT, little gravel, occasional medium to fine sand seams -GLACIAL TILL-
	19	68				
	20					
	23					
	22					
25						

WATER LEVEL DATA

DATE	TIME	ELAPSED TIME (HR)	DEPTH (FT.) TO: BOTTOM OF CASING	BOTTOM OF HOLE	WATER

SAMPLE IDENTIFICATION

O	▨	OPEN END ROD
T	▥	THIN WALL TUBE
U	▥	UNDISTURBED SAMPLE
S	▒	SPLIT SPOON

SUMMARY

OVERBURDEN (LIN FT)	42.3
ROCK CORED (LIN FT)	7.4
SAMPLES	9S, 2C

BORING NO. **B117**

HALEY & ALDRICH	South Portland, Maine	TEST BORING REPORT	BORING NO. B117 FILE NO. 80687-000 SHEET NO. 2 OF 3

DEPTH (FT)	CASING BLOWS PER FT.	SAMPLER BLOWS PER 6 IN	SAMPLE NUMBER & REC. (IN.)	SAMPLE DEPTH (FT)	ELEV./ DEPTH (FT)	VISUAL DESCRIPTION AND REMARKS
25	19	20 21	S6 7	25.0 26.0		Dense, gray silty fine SAND, little gravel, trace coarse to medium sand
	21	21			-62.8 27.0	
	115					
	24532					
	86					
30	64	55 108	S7 12	30.0 31.0		Hard, gray SILT, trace gravel, occasional fine sand partings
	75					
	92					
	78					
	65					
35	83	41 80	S8 12	35.0 36.2		Hard, gray SILT, little gravel, trace coarse sand and clay(well bonded) Probable cobbles at 39.0 ft. -GLACIAL TILL-
	130	50/7.5				
	245					
	330					
	560					
40	225	25	S9 6	40.6 41.8		Hard, gray SILT, little coarse to fine sand, probable cobbles Cored from 42.5-43.9 ft.
	280	55 50/7.5				
	200		C1	42.5 43.9	-78.3 42.5	Cobbles and Glacial Till
45					-81.4 45.6	Top of Bedrock at 45.6 ft. Advanced Roller Bit to 45.9 ft. Begin Nq Rock Core at 45.9 ft. See Core Boring Report

HALEY & ALDRICH South Portland, Maine

TEST BORING REPORT

BORING NO. B119

PROJECT Cargo Pier, Mack Point, Searsport, Maine
CLIENT Fay Spofford & Thorndike
CONTRACTOR Maine Test Borings, Inc.

FILE NO. 80687-000
SHEET NO. 1 OF 3
LOCATION

ITEM	CASING	DRIVE SAMPLER	CORE BARREL
TYPE	NW	SS	NQ
INSIDE DIAMETER (IN)	3	1-3/8	1-7/8
HAMMER WEIGHT (LB)	300	140	-
HAMMER FALL (IN)	16	30	-

DRILLING EQUIPMENT & PROCEDURES
RIG TYPE CME 45 Skid
BIT TYPE Rollerbit
DRILL MUD --
OTHER -

ELEVATION -25.6
DATUM MLLW
START 30 September 1998
FINISH 5 October 1998
DRILLER G. Lidstone
H&A REP K. Stephenson

DEPTH (FT)	CASING BLOWS PER FT.	SAMPLER BLOWS PER 6 IN	SAMPLE NUMBER & REC. (IN.)	SAMPLE DEPTH (FT)	ELEV./ DEPTH (FT)	VISUAL DESCRIPTION AND REMARKS
0	WOC	WOR WOR	NR 0	0.0 2.0		Attempted sample, no recovery Black to gray SILT, shells, trace fine sand in wash water 0-4.0 ft.
	WOC	WOR WOR				-SHALLOW MARINE DEPOSIT-
	WOC					
	WOC				-29.6	
	108				4.0	Very dense, gray coarse to fine sandy SILT, little gravel, probable cobbles (well bonded)
5	44	57 103	S1 7	5.0 6.0		-GLACIAL TILL-
	128					
	135					
	189					
	203					
10	24	60 74	S2 6	10.5 11.9		Very dense, gray sandy SILT, little gravel, trace clay
	32	100/12.5				
	34					Washed ahead of casing through probable cobbles to 15.2 ft.
	35					
	83					
15	64	52 115	S3 8	15.2 16.2		Very dense, gray coarse to fine sandy SILT, little gravel, probable cobbles
	51					Cobbles or boulders from 19.0-19.7 ft.
	39					
	42					
	150					
20	237	50/0		20.0 20.0		Split spoon refusal, advance casing through probable cobbles to 25.0 ft.
	132					
	99					
	265					
	210					
25						

WATER LEVEL DATA

DATE	TIME	ELAPSED TIME (HR)	DEPTH (FT.) TO: BOTTOM OF CASING	BOTTOM OF HOLE	WATER

SAMPLE IDENTIFICATION
O ▨ OPEN END ROD
T ▥ THIN WALL TUBE
U ▦ UNDISTURBED SAMPLE
S ☐ SPLIT SPOON

SUMMARY

OVERBURDEN (LIN FT)	45.7
ROCK CORED (LIN FT)	12.6
SAMPLES	8S, 3C

BORING NO. B119

HALEY & ALDRICH
South Portland, Maine

TEST BORING REPORT

BORING NO. **B119**
FILE NO. 80687-000
SHEET NO. 2 OF 3

DEPTH (FT)	CASING BLOWS PER FT.	SAMPLER BLOWS PER 6 IN	SAMPLE NUMBER & REC. (IN.)	SAMPLE DEPTH (FT)	ELEV./ DEPTH (FT)	VISUAL DESCRIPTION AND REMARKS
25		0.7	S4 5	25.0 25.7		Very dense, gray coarse to fine sandy SILT, little gravel, trace clay, probable cobbles -GLACIAL TILL-
30		1.4	S5 12	30.0 31.4		Hard, gray SILT, trace coarse sand, occasional fine sand partings
35		1.4	S6 17	35.0 36.4		Very dense, gray coarse to fine sandy SILT, little gravel -GLACIAL TILL-
40		1.1	S7 15	40.0 41.1		Hard, gray SILT, little coarse to medium sand, trace clay (well bonded) Note: weathered rock in tip of spoon Drove casing to 41.2 ft. advanced roller bit to 43.5 ft., cored cobbles from 43.5-45.7 ft.
			C1 5	43.5 45.7		Cored through probable cobble, gravel
45					-71.3 45.7	
		0.5	S8 12	45.7 46.2	-72.0 46.4	Very dense, gray WEATHERED ROCK(little quartz and pyrite) Advanced roller bit to 46.4 ft. Begin NQ Rock Core at 46.4 ft. See Core Boring Report
50						
55						

HALEY & ALDRICH South Portland, Maine	**CORE BORING REPORT**	BORING NO. B119 FILE NO. 80687-000 SHEET NO. 3 OF 3

DEPTH (FT)	DRILLING RATE MIN./FT.	RUN NO.	DEPTH (FT)	RECOVERY/RQD		WEATH-ERING	ELEV./ DEPTH (FT)	VISUAL DESCRIPTION AND REMARKS
				IN.	%			
40								
	5							See Test Boring Report for Overburden Descriptions Top of Weathered Bedrock at 45.7 ft. Advanced Roller Bit to 46.4 ft. Begin NQ Rock Core at 46.4 ft.
45							-71.3 45.7	-WEATHERED BEDROCK-
	5	C2	46.4 51.1	45/17	80/30		-72.0 46.4	C2: Very soft, gray aphanitic graphitic SCHIST. Primary joint set is very close to close, moderately dipping, planar and smooth to undulating, rough, close to wide, frequent areas of pyritization. (Most of core is moderately fractured) High angle secondary joint present. C3: Same as C2
	5							
	7							
	5							
50	5							
	5	C3	51.1 56.1	21/0	35/0			
	4							
	4							
	4							
55	4						-81.7 56.1	Bottom of Exploration
	5							

HALEY & ALDRICH

South Portland,
Maine

TEST BORING REPORT

BORING NO. **B120**

PROJECT Cargo Pier, Mack Point, Searsport, Maine
CLIENT Fay Spofford & Thorndike
CONTRACTOR Maine Test Borings, Inc.

FILE NO. 80687-000
SHEET NO. 1 OF 1
LOCATION

ITEM	CASING	DRIVE SAMPLER	CORE BARREL	DRILLING EQUIPMENT & PROCEDURES
TYPE	NW	SS		RIG TYPE Bombardier B-34
INSIDE DIAMETER (IN)	3	1-3/8		BIT TYPE Tricone Roller
HAMMER WEIGHT (LB)	300	140	-	DRILL MUD --
HAMMER FALL (IN)	16	30	-	OTHER -

ELEVATION 16.3
DATUM MLLW
START 9 December 1998
FINISH 2 December 1998
DRILLER G. Lidstone
H&A REP B. Lawrence

DEPTH (FT)	CASING BLOWS PER FT.	SAMPLER BLOWS PER 6 IN	SAMPLE NUMBER & REC. (IN.)	SAMPLE DEPTH (FT)	ELEV./ DEPTH (FT)		VISUAL DESCRIPTION AND REMARKS
0	16	12 20	S1 10	0.0 1.5		▨	Dense, brown to black gravelly coarse to fine SAND, little silt -FILL-
	21	16				▨	
	27					▨	
					13.3 3.0		Bottom of Exploration at 3.0 ft. due to obstruction(18" spike and wood in bottom of casing) See Test Boring Report B120A

WATER LEVEL DATA

DATE	TIME	ELAPSED TIME (HR)	DEPTH (FT.) TO: BOTTOM OF CASING	BOTTOM OF HOLE	WATER

SAMPLE IDENTIFICATION

O	▒	OPEN END ROD
T	▥	THIN WALL TUBE
U	▦	UNDISTURBED SAMPLE
S	░	SPLIT SPOON

SUMMARY

OVERBURDEN (LIN FT)	3.0
ROCK CORED (LIN FT)	0
SAMPLES	1S

BORING NO. **B120**

HALEY & ALDRICH South Portland, Maine

TEST BORING REPORT

BORING NO. **B120A**

PROJECT	Cargo Pier, Mack Point, Searsport, Maine	FILE NO.	80687-000
CLIENT	Fay Spofford & Thorndike	SHEET NO.	1 OF 2
CONTRACTOR	Maine Test Borings, Inc.	LOCATION	

ITEM	CASING	DRIVE SAMPLER	CORE BARREL	DRILLING EQUIPMENT & PROCEDURES
TYPE	NW	SS		RIG TYPE Bombardier B-34
INSIDE DIAMETER (IN)	3	1-3/8		BIT TYPE Tricone Roller
HAMMER WEIGHT (LB)	300	140	-	DRILL MUD --
HAMMER FALL (IN)	16	30	-	OTHER -

ELEVATION 16.3
DATUM MLLW
START 2 December 1998
FINISH 3 December 1998
DRILLER G. Lidstone
H&A REP B. Lawrence

DEPTH (FT)	CASING BLOWS PER FT.	SAMPLER BLOWS PER 6 IN	SAMPLE NUMBER & REC.(IN.)	SAMPLE DEPTH (FT)	ELEV./ DEPTH (FT)	VISUAL DESCRIPTION AND REMARKS
0	39					See B120 Boring log for soil description
	48					
	59					
	44					
	30					
5	26	15 13	S1 7	5.0 6.5		Dense, light brown gravelly SAND, trace silt, probable cobbles
	34	18				
	22				8.5	
	22				7.8 8.3 8.0	Black wash water
	22					
10	6	8 13	S2 6	10.0 11.5		Medium dense, light brown gravelly SAND, some silt
	14	8				-FILL-
	10					Note: Cobbles/boulders from 14.6-15.6 ft., and 15.8-16.4 ft.
	33					
	100/33					
15	116					
	43					
	50	25 90	S3 11	17.0 18.5	-1.7	Very dense, light brown fine SAND, little silt with layer of coarse to medium sand from 17.3-17.6 ft.
	107	60			18.0	Gray gravelly medium to fine SAND, little silt
	352					Cobble from 19.8-20.6 ft.
20	51					
	68	23 32	S4 10	21.0 22.5		Very dense, gray sandy SILT, trace clay to silty fine SAND, some gravel
	76	29				-GLACIAL TILL-
	102					
	206					
25						

WATER LEVEL DATA

DATE	TIME	ELAPSED TIME (HR)	DEPTH (FT.) TO: BOTTOM OF CASING	BOTTOM OF HOLE	WATER
12/3/98	10:30		25.0	35.3	7.3

SAMPLE IDENTIFICATION

O	▨	OPEN END ROD
T	▥	THIN WALL TUBE
U	▦	UNDISTURBED SAMPLE
S	▨	SPLIT SPOON

SUMMARY

OVERBURDEN (LIN FT)	35.3
ROCK CORED (LIN FT)	0
SAMPLES	7S

BORING NO. **B120A**

HALEY & ALDRICH

South Portland, Maine

TEST BORING REPORT

BORING NO. **B120A**
FILE NO. 80687-000
SHEET NO. 2 OF 2

DEPTH (FT)	CASING BLOWS PER FT.	SAMPLER BLOWS PER 6 IN	SAMPLE NUMBER & REC.(IN.)	SAMPLE DEPTH (FT)	ELEV./ DEPTH (FT)	VISUAL DESCRIPTION AND REMARKS
25		40	S5	25.0		Very dense, gray silty coarse to fine SAND, some gravel, trace clay
		45	10	26.5		Probable fine sand layers from 27.5-31.5 ft.
		32				
						-GLACIAL TILL-
30		17	S6	30.0		Medium dense, gray coarse to fine SAND, some silt, some gravel
		10	10	31.5		Note: Trace to little clay from 30.0-30.2 ft.
		19				
35		150/10	S7	35.0	-19.0	Very dense, gray coarse to fine SAND, some silt, some gravel, probable cobble
			2	35.3	35.3	Bottom of Exploration

HALEY & ALDRICH	South Portland, Maine	**TEST BORING REPORT**	BORING NO. **B121**

PROJECT Cargo Pier, Mack Point, Searsport, Maine
CLIENT Fay Spofford & Thorndike
CONTRACTOR Maine Test Borings, Inc.

FILE NO. 80687-000
SHEET NO. 1 OF 1
LOCATION

ITEM	CASING	DRIVE SAMPLER	CORE BARREL	DRILLING EQUIPMENT & PROCEDURES
TYPE	NW	SS		RIG TYPE CME 45
INSIDE DIAMETER (IN)	3	1-3/8		BIT TYPE Tricone Roller
HAMMER WEIGHT (LB)	300	140	-	DRILL MUD --
HAMMER FALL (IN)	16	30	-	OTHER -

ELEVATION -8.3
DATUM MLLW
START 13 October 1998
FINISH 13 October 1998
DRILLER G. Lidstone
H&A REP B. Lawrence

DEPTH (FT)	CASING BLOWS PER FT.	SAMPLER BLOWS PER 6 IN	SAMPLE NUMBER & REC. (IN.)	SAMPLE DEPTH (FT)	ELEV./ DEPTH (FT)	VISUAL DESCRIPTION AND REMARKS
0	2	4	S1	0.0		Medium dense, black silty SAND
		6	22	1.5	-9.2	-SHALLOW MARINE DEPOSIT-
	15	8			0.9	Medium dense, brownish-gray silty SAND, trace gravel
	28					
	46					
	82					
5		34	S2	5.0		Very dense, olive-brown coarse to fine SAND, some silt, little gravel, probable cobbles
		85	2	6.0		
	10					-GLACIAL TILL-
	6					
	11					
	25					
10		91	S3	10.0		Very dense, gray silty SAND, some gravel, probable cobbles
		50/5	3	10.7		
15		32	S4	15.0		Very dense, gray coarse to fine SAND, some gravel, little silt, probable cobbles
		50	8	16.3		
		50/10				-GLACIAL TILL-
20		70	S5	20.0		
		39		21.5		
		35			-29.8	
					21.5	Bottom of Exploration No refusal

WATER LEVEL DATA

DATE	TIME	ELAPSED TIME (HR)	DEPTH (FT.) TO: BOTTOM OF CASING	BOTTOM OF HOLE	WATER

SAMPLE IDENTIFICATION

O	▨	OPEN END ROD
T	▥	THIN WALL TUBE
U	▦	UNDISTURBED SAMPLE
S	░	SPLIT SPOON

SUMMARY

OVERBURDEN (LIN FT)	21.5
ROCK CORED (LIN FT)	0
SAMPLES	5S

BORING NO. **B121**

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ATTACHMENT B

USACOE, Baltimore, Boring Logs 2007

DRILLING LOG	DIVISION North Atlantic Division	INSTALLATION Baltimore District	SHEET 1 OF 2 SHEETS

1. PROJECT
Searsport Harbor Navigation Improvement Study
Searsport, Maine,

2. HOLE NUMBER B-1
LOCATION COORDINATES N 286,666.0 E 880,789.1

3. DRILLING AGENCY New Hampshire Boring

4. NAME OF DRILLER Manlea "Bub" Thompson

5. DIRECTION OF BORING ☒ VERTICAL ☐ INCLINED
DEG FROM VERTICAL ---
BEARING

6. THICKNESS OF OVERBURDEN 27.0

7. DEPTH DRILLED INTO ROCK

8. TOTAL DEPTH OF BORING 27.0

9. COORDINATE SYSTEM State Plane, ME East NAD 83
VERTICAL MLLW

10. SIZE AND TYPE OF BIT 4" Rollerbit

11. MANUFACTURER'S DESIGNATION OF DRILL Detrich D-50

12. TOTAL SAMPLES 6
DISTURBED 6
UNDISTURBED 0

13. TOTAL NUMBER CORE BOXES

14. ELEVATION GROUND WATER

15. DATE BORING
STARTED 10/2/07
COMPLETED 10/2/07

16. ELEVATION TOP OF BORING -13.0

17. TOTAL CORE RECOVERY FOR BORING N/A

18. SIGNATURE AND TITLE OF INSPECTOR
Maria Orosz

ELEV	DEPTH	Samp No.	TYPE	Blows/ 0.5 ft	N_{60}	% REC	CLASSIFICATION OF MATERIALS (Description)	LEGEND	Laboratory							REMARKS
									Gravel	Sand	Fines	LL	PI	MC	ASTM Class	
		J-1	☒	7 6 11 6	17	95	**J-1; 0' to 2'** Top 1.0', silty CLAY with fine sand and subangular gravel, wet, gray. Bottom 0.9' silty CLAY, some fine gravel, wet, brownish gray.									
																2' to 5' ROLLERBITTED
		J-2	☒	16 15 21 27	36	35	**J-2; 5' to 7'** Silty CLAY and fine gravel, wet, brown. Upper 0.1' fragments of broken up rock.									
																7' to 10' ROLLERBITTED
		J-3	☒	28 50 49 38	99	40	**J-3; 10' to 12'** Silty CLAY with fine sand and fine gravel, wet, gray and brown, medium stiff.									
																12' to 15' ROLLERBITTED
		J-4	☒	47 50 34 25	84	20	**J-4; 15' to 17'** Silty CLAY and fine to coarse sand, with fine to medium gravel, wet, gray, medium stiff. Rock jammed in shoe of splitspoon.									
																17' to 20' ROLLERBITTED
		J-5	☒	36 20 33 20	53	45	**J-5; 20' to 22'** Silty CLAY with fine to coarse sand, and fine to coarse gravel, wet, gray, soft									
																22' to 25' ROLLERBITTED

0.0
2.5
5.0
7.5
10.0
12.5
15.0
17.5
20.0
22.5
25.0

Boring Designation B-1

DRILLING LOG (Cont Sheet)	INSTALLATION Baltimore District	SHEET 2 OF 2 SHEETS
PROJECT Searsport Harbor Navigation Improvement Study	COORDINATE SYSTEM State Plane, ME East NAD 83	VERTICAL MLLW
LOCATION COORDINATES N 286,666.0 E 880,789.1	ELEVATION TOP OF BORING -13.0	

25.0

ELEV	DEPTH	Samp No.	TYPE	Blows/ 0.5 ft	N_{60}	% REC	CLASSIFICATION OF MATERIALS (Description)	LEGEND	Laboratory							REMARKS
									Gravel	Sand	Fines	LL	PI	MC	ASTM Class	
-40.0	27.0	J-6	☒	38 37 30 25	67	0	**J-6; 25' to 27'** No recovery (see note).									
							Borehole B-1 terminated @ 27.0 feet <u>Notes:</u> 1. Soils are field visually classified in accordance with the Unified Soils Classification System 2. Sampled using a standard 1 3/8" split spoon driven automatically by a 140 lb. hammer dropped 30". 3. Water depth at start of drilling from top of water to mudline was 14.0' 4. Boring was advanced using 4" casing and 4" rollerbit. 5. Roundness of gravel was subangular. 6. GPS coordinates were not processed and the raw data was utilized. 7. Drill rods running rough between 2.0' through 20.0'. Drilled through a cobble from 4.8' to 5.2'. 8. For sample J-5 (20.0'-22.0') initial SPT only recovered 0.1', switched to a 3" spoon and recovered 0.8'. 9. For sample J-6 (25.0'-27.0') there was no recovery using SPT. Attempted to use 3" spoon but upon retrieval, it got stuck downhole and snapped at the threads.									

Boring Designation B-2

DRILLING LOG	DIVISION North Atlantic Division	INSTALLATION Baltimore District	SHEET 1 OF 2 SHEETS
1. PROJECT Searsport Harbor Navigation Improvement Study Searsport, Maine,		9. COORDINATE SYSTEM State Plane, ME East NAD 83	VERTICAL MLLW
		10. SIZE AND TYPE OF BIT 4" Rollerbit	
2. HOLE NUMBER B-2	LOCATION COORDINATES N 286,431.6 E 881,279.6	11. MANUFACTURER'S DESIGNATION OF DRILL Detrich D-50	
3. DRILLING AGENCY New Hampshire Boring		12. TOTAL SAMPLES 5	DISTURBED 5 UNDISTURBED 0
4. NAME OF DRILLER Manlea "Bub" Thompson		13. TOTAL NUMBER CORE BOXES	
5. DIRECTION OF BORING ☒ VERTICAL ☐ INCLINED	DEG FROM VERTICAL --- BEARING	14. ELEVATION GROUND WATER	
		15. DATE BORING	STARTED 10/3/07 COMPLETED 10/3/07
6. THICKNESS OF OVERBURDEN	22.0	16. ELEVATION TOP OF BORING	-26.0
7. DEPTH DRILLED INTO ROCK		17. TOTAL CORE RECOVERY FOR BORING	N/A
8. TOTAL DEPTH OF BORING	22.0	18. SIGNATURE AND TITLE OF INSPECTOR Maria Orosz	

ELEV	DEPTH	Samp No.	TYPE	Blows/ 0.5 ft	N_{60}	% REC	CLASSIFICATION OF MATERIALS (Description)	LEGEND	Laboratory							REMARKS	
									Gravel	Sand	Fines	LL	PI	MC	ASTM Class		
		J-1		WOR WOR WOR WOR	WOR	100	**J-1; 0' to 2'** Silty CLAY wet, gray and black, soft. Bottom 0.5' contained fine to coarse sand.										0.0
-31.0	5.0															**2' to 5'** ROLLERBITTED	2.5
		J-2		13 16 22 25	38	30	**J-2; 5' to 7'** Silty CLAY, some fine to medium sand, and fine gravel, wet, gray and brown, medium stiff.										5.0
																7' to 10' ROLLERBITTED	7.5
		J-3		18 21 16 25	37	30	**J-3; 10' to 12'** Silty medium to coarse SAND with fine to coarse gravel, wet, brown.										10.0
																12' to 15' ROLLERBITTED	12.5
		J-4		25 19 40 35	59	20	**J-4; 15' to 17'** Silty fine, SAND and fine gravel, some rock fragments, wet, gray										15.0
																17' to 20' ROLLERBITTED	17.5
-48.0	22.0	J-5		25 45 31 30	71	40	**J-5; 20' to 22'** Silty fine, SAND some fine to coarse gravel, wet, gray										20.0
							Borehole B-2 terminated @ 22.0 feet Notes: 1. Soils are field visually classified in accordance with the Unified Soils Classification System 2. Sampled using a standard 1 3/8" split spoon										

NAE FORM 1836-A
SEP 05

DRILLING LOG (Cont Sheet)	INSTALLATION Baltimore District	SHEET 2 OF 2 SHEETS
PROJECT Searsport Harbor Navigation Improvement Study	COORDINATE SYSTEM State Plane, ME East NAD 83	VERTICAL MLLW
LOCATION COORDINATES N 286,431.6 E 881,279.6	ELEVATION TOP OF BORING -26.0	

ELEV	DEPTH	Samp No.	TYPE	Blows/ 0.5 ft	N_{60}	% REC	CLASSIFICATION OF MATERIALS (Description)	LEGEND	Laboratory Gravel	Sand	Fines	LL	PI	MC	ASTM Class	REMARKS
							driven automatically by a 140 lb. hammer dropped 30". 3. Water depth at start of drilling from top of water to mudline was 32.0' 4. Boring was advanced using 4" casing and 4" rollerbit. 5. Roundness of gravel was subangular. 6. GPS coordinates were determined through data processing. 7. Encountered a large cobble from 4.0' to 4.5'. 8. After sampling J-2 (5.0'-7.0') the barge had settled into the softer sediment causing the hole to become crooked. The casing was pulled, the barge was re-leveled, the casing was reset, and drilling commenced at the next sampling depth 9. After sampling J-3 (10.0'-12.0') only 0.1 was recovered due to a rock being wedged in the shoe. A second SPT was made and 0.5' was recovered. 10. Rods running rough from 17.0' to 22.0'.									

Boring Designation B-3

DRILLING LOG

DIVISION: North Atlantic Division

INSTALLATION: Baltimore District

SHEET 1 OF 2 SHEETS

1. PROJECT: Searsport Harbor Navigation Improvement Study Searsport, Maine,

2. HOLE NUMBER: B-3

LOCATION COORDINATES: N 286,034.2 E 881,122.1

3. DRILLING AGENCY: New Hampshire Boring

4. NAME OF DRILLER: Manlea "Bub" Thompson

5. DIRECTION OF BORING: ☒ VERTICAL ☐ INCLINED

DEG FROM VERTICAL: ---

BEARING:

6. THICKNESS OF OVERBURDEN: 19.0

7. DEPTH DRILLED INTO ROCK:

8. TOTAL DEPTH OF BORING: 19.0

9. COORDINATE SYSTEM: State Plane, ME East NAD 83

VERTICAL: MLLW

10. SIZE AND TYPE OF BIT: 4" Rollerbit

11. MANUFACTURER'S DESIGNATION OF DRILL: Detrich D-50

12. TOTAL SAMPLES: 5

DISTURBED: 5

UNDISTURBED: 0

13. TOTAL NUMBER CORE BOXES:

14. ELEVATION GROUND WATER:

15. DATE BORING: STARTED 10/5/07 COMPLETED 10/5/07

16. ELEVATION TOP OF BORING: -28.0

17. TOTAL CORE RECOVERY FOR BORING: N/A

18. SIGNATURE AND TITLE OF INSPECTOR: Maria Orosz

ELEV	DEPTH	Samp No.	TYPE	Blows/ 0.5 ft	N_{60}	% REC	CLASSIFICATION OF MATERIALS (Description)	LEGEND	Laboratory							REMARKS	
									Gravel	Sand	Fines	LL	PI	MC	ASTM Class		
-30.0	2.0	J-1	X	WOR WOR WOR WOR	WOR	70	**J-1; 0' to 2'** Silty CLAY little fine gravel, wet, gray, soft.										0.0
																2' to 5' ROLLERBITTED	2.5
-35.0	7.0	J-2	X	5 8 10 12	18	100	**J-2; 5' to 7'** Silty CLAY brown and gray, medium stiff.										5.0
																7' to 10' ROLLERBITTED	7.5
-40.0	12.0	J-3	X	3 3 3 4	6	100	**J-3; 10' to 12'** Silty CLAY wet, gray, soft.										10.0
																12' to 15' ROLLERBITTED	12.5
-45.0	17.0	J-4	X	WOR WOR WOH 1	WOR	100	**J-4; 15' to 17'** Silty CLAY wet, gray, soft.										15.0
-47.0	19.0	J-5	X	WOH 2 5 14	7	90	**J-5; 17' to 19'** Silty CLAY wet, gray, soft, From 0.9-1.8 silty clay with fine to medium sand and fine gravel.										17.5

Borehole B-3 terminated @ 19.0 feet

Notes:

1. Soils are field visually classified in accordance with the Unified Soils Classification System
2. Sampled using a standard 1 3/8" split spoon driven automatically by a 140 lb. hammer dropped 30".
3. Water depth at start of drilling from top of water to mudline was 34.0'
4. Boring was advanced using 4" casing and 4" rollerbit.
5. Roundness of gravel was subangular.

DRILLING LOG (Cont Sheet)	INSTALLATION Baltimore District	SHEET 2 OF 2 SHEETS
PROJECT Searsport Harbor Navigation Improvement Study	COORDINATE SYSTEM State Plane, ME East NAD 83	VERTICAL MLLW
LOCATION COORDINATES N 286,034.2 E 881,122.1	ELEVATION TOP OF BORING -28.0	

ELEV	DEPTH	Samp No.	TYPE	Blows/ 0.5 ft	N_{60}	% REC	CLASSIFICATION OF MATERIALS (Description)	LEGEND	Laboratory							REMARKS
									Gravel	Sand	Fines	LL	PI	MC	ASTM Class	
							6. GPS coordinates were not processed and the raw data was utilized. 7. Sediments were mostly very soft, except around 4.0' the sediments got a little stiffer. 8. For J-3 (10.0'-12.0') no sample was recovered using the SPT. A second attempt using the 3" spoon recovered the full 2.0'.									

DRILLING LOG	DIVISION North Atlantic Division	INSTALLATION Baltimore District	SHEET 1 OF 2 SHEETS

1. PROJECT
Searsport Harbor Navigation Improvement Study
Searsport, Maine,

2. HOLE NUMBER B-4
LOCATION COORDINATES N 285,000.0 E 881,578.8

3. DRILLING AGENCY New Hampshire Boring

4. NAME OF DRILLER Manlea "Bub" Thompson

5. DIRECTION OF BORING ☒ VERTICAL ☐ INCLINED
DEG FROM VERTICAL ---
BEARING

6. THICKNESS OF OVERBURDEN 34.0

7. DEPTH DRILLED INTO ROCK

8. TOTAL DEPTH OF BORING 34.0

9. COORDINATE SYSTEM State Plane, ME East NAD 83
VERTICAL MLLW

10. SIZE AND TYPE OF BIT 4" Rollerbit

11. MANUFACTURER'S DESIGNATION OF DRILL Detrich D-50

12. TOTAL SAMPLES 5
DISTURBED 5
UNDISTURBED 0

13. TOTAL NUMBER CORE BOXES

14. ELEVATION GROUND WATER

15. DATE BORING
STARTED 10/4/07
COMPLETED 10/4/07

16. ELEVATION TOP OF BORING -27.0

17. TOTAL CORE RECOVERY FOR BORING N/A

18. SIGNATURE AND TITLE OF INSPECTOR *Maria Orosz*

ELEV	DEPTH	Samp No.	TYPE	Blows/ 0.5 ft	N_{60}	% REC	CLASSIFICATION OF MATERIALS (Description)	LEGEND	Laboratory							REMARKS
									Gravel	Sand	Fines	LL	PI	MC	ASTM Class	
-29.0	2.0	J-1		WOR WOR WOR WOR	WOR	85	**J-1; 0' to 2'** Silty CLAY wet, gray, soft.									
																2' to 5' ROLLERBITTED
-34.0	7.0	J-2		WOR 4 4 2	WOR	100	**J-2; 5' to 7'** Silty CLAY little fine gravel, .wet, gray, soft.									
																7' to 10' ROLLERBITTED
-39.0	12.0	J-3		WOR WOR WOR WOR	WOR	85	**J-3; 10' to 12'** Silty CLAY little fine gravel, and shells, wet, gray, soft.									
																12' to 15' ROLLERBITTED
-44.0	17.0	J-4		WOR WOR WOR WOR	WOR	100	**J-4; 15' to 17'** Silty CLAY wet, gray, soft.									
																17' to 20' ROLLERBITTED
-49.0	22.0	J-5		WOR WOR WOR WOR	WOR	65	**J-5; 20' to 22'** Silty CLAY wet, gray, soft.									
																22' to 34' ROLLERBITTED. Talings from wash water were gray, silty, fine to coarse sand and fine gravel.

0.0
2.5
5.0
7.5
10.0
12.5
15.0
17.5
20.0
22.5
25.0

DRILLING LOG (Cont Sheet)	INSTALLATION Baltimore District	SHEET 2 OF 2 SHEETS
PROJECT Searsport Harbor Navigation Improvement Study	COORDINATE SYSTEM State Plane, ME East NAD 83	VERTICAL MLLW
LOCATION COORDINATES N 285,000.0 E 881,578.8	ELEVATION TOP OF BORING -27.0	

ELEV	DEPTH	Samp No.	TYPE	Blows/ 0.5 ft	N_{60}	% REC	CLASSIFICATION OF MATERIALS (Description)	LEGEND	Laboratory Gravel	Sand	Fines	LL	PI	MC	ASTM Class	REMARKS
																29' to ' Transition from softer sediments to harder sediments based on observations during drilling.
-61.0	34.0															
							Borehole B-4 terminated @ 34.0 feet									

25.0

27.5

30.0

32.5

Notes:
1. Soils are field visually classified in accordance with the Unified Soils Classification System
2. Sampled using a standard 1 3/8" split spoon driven automatically by a 140 lb. hammer dropped 30".
3. Water depth at start of drilling from top of water to mudline was 34.0'
4. Boring was advanced using 4" casing and 4" rollerbit.
5. Roundness of gravel was subangular.
6. GPS coordinates were determined through data processing.
7. Drill rods running a rough from 2.0-5.0'
8. Casing dropped approx 1.0' while pulling rods to sample J-3 (10.0'-12.0')

DRILLING LOG

DIVISION North Atlantic Division

INSTALLATION Baltimore District

SHEET 1 OF 2 SHEETS

1. PROJECT Searsport Harbor Navigation Improvement Study Searsport, Maine,

2. HOLE NUMBER B-5

LOCATION COORDINATES N 286,109.0 E 879,902.4

3. DRILLING AGENCY New Hampshire Boring

4. NAME OF DRILLER Manlea "Bub" Thompson

5. DIRECTION OF BORING ☒ VERTICAL ☐ INCLINED

DEG FROM VERTICAL ---

BEARING

6. THICKNESS OF OVERBURDEN 27.0

7. DEPTH DRILLED INTO ROCK

8. TOTAL DEPTH OF BORING 27.0

9. COORDINATE SYSTEM State Plane, ME East NAD 83

VERTICAL MLLW

10. SIZE AND TYPE OF BIT 4" Rollerbit

11. MANUFACTURER'S DESIGNATION OF DRILL Detrich D-50

12. TOTAL SAMPLES 6

DISTURBED 6

UNDISTURBED 0

13. TOTAL NUMBER CORE BOXES

14. ELEVATION GROUND WATER

15. DATE BORING

STARTED 10/3/07

COMPLETED 10/3/07

16. ELEVATION TOP OF BORING -20.0

17. TOTAL CORE RECOVERY FOR BORING N/A

18. SIGNATURE AND TITLE OF INSPECTOR Maria Orosz

ELEV	DEPTH	Samp No.	TYPE	Blows/ 0.5 ft	N_{60}	% REC	CLASSIFICATION OF MATERIALS (Description)	LEGEND	Laboratory							REMARKS
									Gravel	Sand	Fines	LL	PI	MC	ASTM Class	
-22.0	2.0	J-1		WOR WOR WOR WOR	WOR	100	**J-1; 0' to 2'** Silty CLAY wet, gray, soft.									
																2' to 5' ROLLERBITTED
-27.0	7.0	J-2		WOR 6 5 5	11	100	**J-2; 5' to 7'** Silty CLAY wet, gray, soft. Bottom 0.4' contains medium sand with fine to medium gravel.									
																7' to 10' ROLLERBITTED
-32.0	12.0	J-3		12 9 8 25	17	30	**J-3; 10' to 12'** Silty CLAY, some fine to coarse sand and fine gravel, wet, gray, medium stiff.									
																12' to 15' ROLLERBITTED
-37.0	17.0	J-4		12 15 21 25	36	40	**J-4; 15' to 17'** Silty CLAY, some fine to coarse sand and fine to medium gravel, wet, gray, medium stiff.									
																17' to 20' ROLLERBITTED
-42.0	22.0	J-5		23 14 21 30	25	65	**J-5; 20' to 22'** Silty fine SAND, little coarse sand, and fine gravel, wet, gray									
																22' to 25' ROLLERBITTED

DRILLING LOG (Cont Sheet)	INSTALLATION Baltimore District	SHEET 2 OF 2 SHEETS
PROJECT Searsport Harbor Navigation Improvement Study	COORDINATE SYSTEM State Plane, ME East NAD 83	VERTICAL MLLW
LOCATION COORDINATES N 286,109.0 E 879,902.4	ELEVATION TOP OF BORING -20.0	

ELEV	DEPTH	Samp No.	TYPE	Blows/ 0.5 ft	N_{60}	% REC	CLASSIFICATION OF MATERIALS (Description)	LEGEND	Laboratory Gravel	Sand	Fines	LL	PI	MC	ASTM Class	REMARKS
	25.0															
-47.0	27.0	J-6		33 29 28 29	57	45	**J-6; 25' to 27'** Silty fine, SAND, some medium to coarse sand, and fine to medium gravel, wet, gray.									

Borehole B-5 terminated @ 27.0 feet

Notes:
1. Soils are field visually classified in accordance with the Unified Soils Classification System
2. Sampled using a standard 1 3/8" split spoon driven automatically by a 140 lb. hammer dropped 30".
3. Water depth at start of drilling from top of water to mudline was 24.0'
4. Boring was advanced using 4" casing and 4" rollerbit.
5. Roundness of gravel was subangular.

6. GPS coordinates were not processed and the raw data was utilized.

DRILLING LOG	DIVISION North Atlantic Division	INSTALLATION Baltimore District	SHEET 1 OF 2 SHEETS

1. PROJECT
Searsport Harbor Navigation Improvement Study
Searsport, Maine,

2. HOLE NUMBER: P-1
LOCATION COORDINATES: N 286,672.0 E 880,803.3

3. DRILLING AGENCY: New Hampshire Boring

4. NAME OF DRILLER: Manlea "Bub" Thompson

5. DIRECTION OF BORING: ☒ VERTICAL ☐ INCLINED
DEG FROM VERTICAL: ---
BEARING:

6. THICKNESS OF OVERBURDEN: 47.0

7. DEPTH DRILLED INTO ROCK:

8. TOTAL DEPTH OF BORING: 47.0

9. COORDINATE SYSTEM: State Plane, ME East NAD 83
VERTICAL: MLLW

10. SIZE AND TYPE OF BIT: 4" Rollerbit

11. MANUFACTURER'S DESIGNATION OF DRILL: Detrich D-50

12. TOTAL SAMPLES: 0
DISTURBED: 0
UNDISTURBED: 0

13. TOTAL NUMBER CORE BOXES:

14. ELEVATION GROUND WATER:

15. DATE BORING: STARTED 10/4/07 COMPLETED 10/4/07

16. ELEVATION TOP OF BORING: -13.0

17. TOTAL CORE RECOVERY FOR BORING: N/A

18. SIGNATURE AND TITLE OF INSPECTOR: *Maria Orosz*

ELEV	DEPTH	Samp No.	TYPE	Blows/ 0.5 ft	N_{60}	% REC	CLASSIFICATION OF MATERIALS (Description)	LEGEND	Laboratory Gravel	Sand	Fines	LL	PI	MC	ASTM Class	REMARKS
-60.0	47.0															ASTM D2488 Classification used for field descriptions. **0' to 5'** Tailings: Brown, silty clay with fine to coarse sand and fine to medium gravel. **5' to 10'** Tailings: Brown, silty clay with fine to coarse sand and fine to medium gravel. **10' to 15'** Tailings: Brown, silty clay with fine to coarse sand and fine to medium gravel. Drilled through a cobble around 11.5'. **15' to 20'** Tailings: Brown and gray, silty, fine to coarse sand with fine gravel. Drilled through a cobbles at 16.0' and 18.0'. **20' to 25'** Tailings: Gray, silty fine to coarse sand with fine gravel. **25' to 30'** Tailings: Gray, silty fine to coarse sand with fine gravel. **30' to 35'** Tailings: Gray, silty fine to coarse sand with fine gravel. **35' to 40'** Tailings: Gray, silty, fine to medium sand with fine gravel. **40' to 45'** Tailings: Gray, silty, fine to medium sand with fine gravel.
							Notes: 1. Water depth at start of drilling from top of water									**45' to 47'**

DRILLING LOG (Cont Sheet)	INSTALLATION Baltimore District	SHEET 2 OF 2 SHEETS
PROJECT Searsport Harbor Navigation Improvement Study	COORDINATE SYSTEM State Plane, ME East NAD 83	VERTICAL MLLW
LOCATION COORDINATES N 286,672.0 E 880,803.3	ELEVATION TOP OF BORING -13.0	

ELEV	DEPTH	Samp No.	TYPE	Blows/ 0.5 ft	N_{60}	% REC	CLASSIFICATION OF MATERIALS (Description)	LEGEND	Gravel	Sand	Fines	LL	PI	MC	ASTM Class	REMARKS
							to mudline was 13.0' 2. Boring was advanced using 4" casing and 4" rollerbit. 3. Roundness of gravel was subangular. 4. GPS coordinates were not processed and the raw data was utilized. 5. Casing was set to a depth of 25.0' below the mudline. 6. Drill rods ran rough from 24.0 to 45.0'.									Tailings: Gray, fine to medium sand with few, fine gravel.

SEARSPORT HARBOR
SEARSPORT, MAINE
NAVIGATION IMPROVEMENT PROJECT

APPENDIX H

ENGINEERING DESIGN

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Engineering Appendix

Background

The project was authorized in October 1962 and construction completed by 1964. The existing project is for a 35-foot MLLW channel 500 feet wide leading to a 1500-foot turning basin. The existing Federal Navigation Project is shown in Figure 1.

Searsport Harbor is located on Penobscot Bay, about 100 miles north of the city of Portland, Maine and halfway up the Maine coast. The western side of the harbor contains a municipal landing facility as well as mooring areas for commercial fishing and recreational vessels. The eastern side of the harbor, known as Mack Point is the location of the Federal navigation project. The project services two deep draft terminals, one of which is a liquid cargo pier and the other a dry cargo pier.

The liquid cargo pier at Mack Point is used by two oil companies, Sprague Energy and Irving Oil. The east and west berths have depths of about 37 and 25 feet MLLW. The dry cargo pier was constructed by the Maine Department of Transportation and it became operational in 2003. The east and west berths of the dry cargo pier currently have depths of about 40 and 32 feet MLLW. The harbor has a tidal range of 10 feet.

A reconnaissance report was completed in September 2004 which examined the possibility of a wider and deeper channel and determined there was a federal interest in performing a detailed feasibility study of a potential navigation improvement project.

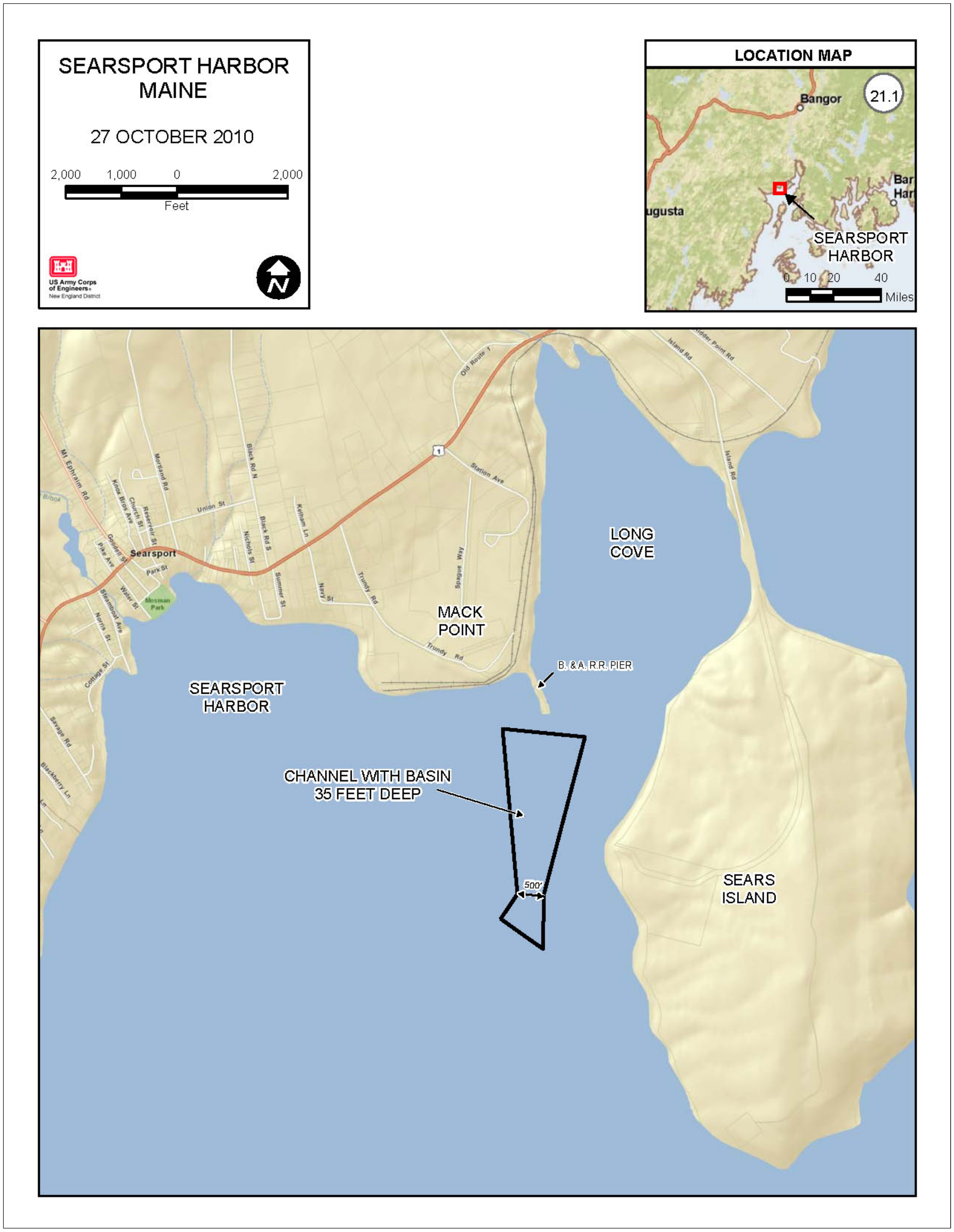


Figure 1. Existing Federal Navigation Project, Searsport, Maine

Engineering Data

As part of the feasibility study several investigations were performed. A hydrographic survey of the proposed channel location was done during June 2005. Subsurface investigations were completed by Public Archaeology Laboratory, Inc of Pawtucket, RI (PAL) and Ocean Surveys, Inc (OSI) Old Saybrook, CT in December 2006, by the Field Exploration Unit of the Corps' Baltimore District in October 2007, and by Battelle in May 2008. These investigations and the various reports generated are described in the Geotechnical Appendix. The Woods Hole Group collected tidal and current data in summer 2009. A shipwreck indentified during the subsurface investigations in 2007 was researched further by PAL and findings are included in the report prepared by PAL in 2008. The shipwreck was identified as the schooner barge, Cullen No. 18. lost in 1938. Reports on these investigations are included as the following Technical Reports included on CD with the Feasibility Report.

- Marine Geophysical Investigation, Channel Deepening Project Searsport, Maine, July 16, 2007 prepared by Oceans Surveys, Inc.

- Marine Archaeological Survey, Searsport Harbor, Maine, July 2007, prepared by David Robinson and submitted by Public Archaeology Laboratory.

- Field Sampling and Sediment Testing, Searsport Harbor, Federal Navigation Project, Searsport, Maine, September 30, 2008 prepared by Battelle.

- Preliminary Assessment, Searsport Harbor Shipwreck, Searsport, Maine, November 2008 prepared by Public Archaeology Laboratory.

- ADCP and Tide Data Collections Searsport Harbor, Searsport, Maine, December 2009 prepared by Woods Hole Group Inc.

Hydrographic Survey

The June 2005 hydrographic survey of the proposed channel area was augmented with survey data taken from a 1995 NOAA survey of the entire upper Penobscot Bay. The June survey was done using a multi-beam system thus providing very detailed soundings of any proposed channel alignment. The NOAA soundings were used at the outer 1400' of the entrance channel in waters deeper than 43 feet for the purpose of estimating quantities of material to be dredged for the alternatives involving depths of 44' or greater.

Multi-beam surveys provide a huge amount of sounding data. The number of data points or soundings resulting from this survey was 1,977,328. Typically the data is examined by assigning all the soundings in an area of the bottom usually three feet by three feet called “bins”. The shallowest sounding within the bin is used for plotting purposes and is sorted to show the shallowest sounding within a given radius for a particular plot scale to avoid overprinting. Thus drawings showing soundings are usually accompanied by a note saying the soundings shown should not be used for volume calculations (because there are many more soundings available and to use just those shown would provide a false and somewhat higher estimate of material in the area of interest).

Volume calculations are performed with the entire edited set of data. The data consists of three pieces of information for each sounding – Northing, Easting, and Elevation. With this data a virtual “surface” can be constructed representing the existing bottom on the date of the survey. Once this surface is established a design surface can be prepared and compared to the existing surface thus predicting the volume of material that would need to be removed to obtain the design surface. The design surface is usually a simple flat surface over the width and length of a channel, or proposed channel in this case, with a theoretical side slope of 1V to 3H sloping up and out from the channel bottom.

Subsurface Investigations

In 2006 the Corps contracted with PAL/OSI to perform marine geophysical and remote sensing archaeological survey, consisting of seafloor imaging (sidescan sonar and magnetometer), and subbottom profiling (seismic reflection) within the areas being studied in/along the Searsport Harbor Navigation Channel. See the Geotechnical Appendix (Appendix G) for a discussion of these investigations.

The Field Exploration Unit of the Corps’ Baltimore District performed five borings in October 2007. Results are provided in the Geotechnical Appendix G.

In 2008 the Corps contracted with Battelle of Duxbury, MA for physical and chemical analysis of sediment cores and grab samples taken from the proposed channel area and potential disposal areas. Results of the May 2008 investigations appear in the report entitled, “Field Sampling and Sediment Testing, Searsport Harbor, Federal Navigation Project, Searsport, Maine, September 30, 2008 prepared by Battelle”.

Hydraulics of Penobscot Bay

A 2009 study of tidal currents in the upper Penobscot Bay was completed in December 2009. The results of this study can be found in the report entitled "ADCP and Tide Data Collections Searsport Harbor, Searsport, Maine, December 2009 prepared by Woods Hole Group Inc".

Channel Design

The key components of a designed channel are its depth, width, and alignment which are dictated by the vessels expected to utilize the channel as well as physical conditions of the area.

Design Vessel

There were two types of design vessels examined during this study – tanker and bulk cargo. The Economics Appendix E addresses the existing and future fleet vessels in detail. Local pilots initially provided data for a 65,000 DWT tanker having a beam of 106', length of 700', and draft of 42' and a 80,000 DWT bulk cargo vessel having a beam of 116', length of 760', and draft of 45'. Eventually, the bulk cargo vessel was upgraded to a length of 800'.

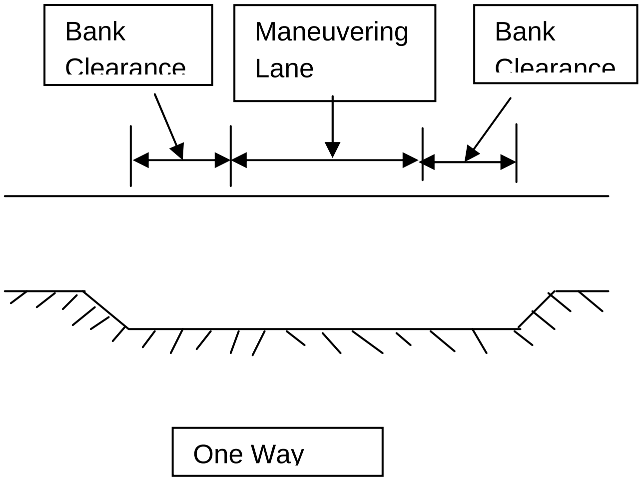
Channel Width

Until about 2006 Corps channel design focused on dividing the channel into a maneuvering lane and bank clearance lanes and determining the appropriate width for each lane. Indeed the reconnaissance report for Searsport Harbor used this method plus engineering judgment. The criterion was developed by assigning three levels of ship controllability and judgment as the main factors to consider in channel width design. This past method is illustrated below in Table 1 and is based on based on Engineering Manual (EM) 1110-2-1613 dated 3 Apr 1983, Table 7-1.

Table 1. General Criteria for Channel Widths

EM 1110-2-1613 (dated 1983) Table 7-1, General Criteria for Channel Widths

Lane Type	Minimum Width (percentage of beam)		
	Vessel Controllability		
	Very Good	**Good**	Poor
Maneuvering	160	180	200
Ship Clearance	80	60+	60+
Bank Clearance	60	60+	60+



Example:

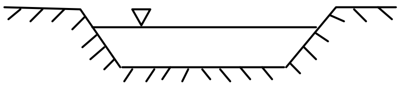
A vessel with a beam of 116' having good controllability requires a one-way traffic channel width of

(0.7+1.8+0.7)*116=371'

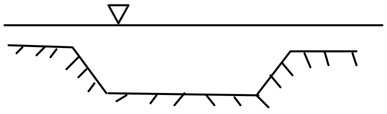
This EM was updated and Chapter 8 of EM 1110-2-1613 (dated 31 May 2006) suggests the "Lanes" used in earlier design are no longer appropriate and instead the "total channel" is considered. Usually channel width will be some factor times the vessel beam. The factor depends on several criteria but is governed by three channel types: Initially the entrance channel to Mack Point is to be considered "Shallow" but as dredging actually deepens the waterway the type shifts to "Trench".

Table 8-2 in the EM suggests the factor for Shallow-type channel to be 3 - 5.5 times the vessel beam depending on currents, cross section, and navigation aids. Likewise, the factor for Trench-type channel ranges 2.75 - 5. One way traffic was assumed.

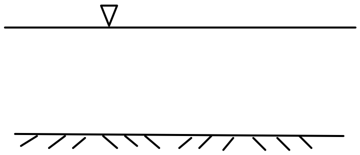
Discussion with Marine Safety International's Rick Comeau and Captain Skip Strong of the Penobscot Bay & River Pilots provided information on currents occasionally being in the range of 0.5 - 1.5 knots. Current information was later verified through data collection and is discussed in the Coastal Engineering Appendix F.



Canal



Trench



Shallow

Evaluation of many navigation project studies on the ERDC/WES Ship Simulator has shown that professional pilots do not think in a manner or control ships in a way that makes such channel width division logical. In fact, pilots routinely use the bank effects as a cue in determining ship position by deliberately moving the ship off the channel centerline toward the bank. Since there is no particular advantage in assigning a value to a maneuvering and a bank clearance lane, an alternative method has been developed by the Corps and is presented in the newer EM 1110-2-1613.

The new EM states that the total channel width calculations should incorporate six factors: traffic pattern (one- or two-way); design ship beam and length; channel cross section shape; current speed and direction; quality and accuracy of aids to navigation; and, variability of channel and currents. The existing and foreseeable traffic density using the Searsport channel does not support the need for design of a two-way channel so a one-way design was developed.

An initial “cookbook” design for a one-way channel can be developed from the factors used in Table 8-2 of the EM. These factors are derived from empirical tests and serve as a starting point for the channel design width and are presented below in Table 2.

Table 2. One-Way Channel Design

EM 1110-2-1613 (dated 31 May 06) Table 8-2
One-Way Ship Traffic Channel Width Design Criteria

	Design Ship Beam Multipliers for Maximum Current, Knots		
	0.0 to 0.5	0.5 to 1.5	1.5 to 3.0
Channel Cross Section	Constant Cross Section, Best Aids to Navigation		
Shallow	3.00	4.00	5.00
Canal	2.50	3.00	3.50
Trench	2.75	3.75	4.00
	Variable Cross Section, Average Aids to Navigation		
Shallow	3.50	4.50	5.50
Canal	3.00	3.50	4.00
Trench	3.50	4.00	5.00

Applying these factors for Searsport resulted in the following channel design.

For the initial design the navigation aids were assumed to be better than average.

	Vessel Beam (ft)	x	Factor	=	Channel Width (ft)
Shallow	116		4.00		464
Trench	116		3.75		435

If the navigation aids were only average the following is the suggested width:

	Vessel Beam (ft)	x	Factor	=	Channel Width (ft)
Shallow	116		4.50		522
Trench	116		4.00		464

If the average width of tugs (48’) was added to the calculation then the width for average navigation aids widens to about 570’.

Approach Channels A Guide for Design a June 1997 report for the Permanent International Association of Navigation Congresses (PIANC) provided another method for determining channel width using vessel maneuvering capabilities with additional factors for wind, current, etc. This approach was deemed slightly more conservative than the EM 1110-2-1613 approach discussed above. Due to pilot concerns and the quantity of petroleum product this conservative approach for determining the channel width was considered for Searsport and is presented below.

The design concept involved a basic maneuvering width plus additional widths. The basic width depended on vessel maneuverability and was some multiple of the vessel beam. Additional increments of channel width depend on where the channel is located i.e. open or protected waters and vessel speed. The environmental or operational conditions that can add width are: vessel speed; cross winds; cross currents; longitudinal currents; wave height; Aids to Navigation; bottom surface; depth; cargo; two way traffic; and, bank clearance.

Table 3. PIANC Channel Design

CHANNEL DESIGN
B = Vessel Beam T= Vessel Draft

Maneuverability	Good	**Moderate**	Poor	Searsport
Base channel width	1.3 B	1.5 B	1.8 B	1.5

Condition	Vessel Speed	Open Water	Protected Water	
Speed (knots)				
fast >12		0.1 B	0.1 B	
moderate 8-12		0	0	0
slow 5-8		0	0	
Prevailing Cross Wind (knots)				
mild <15	All	0	0	
moderate 15-33	Fast	0.3 B	-	
	moderate	0.4 B	0.4 B	
	Slow	0.5 B	0.5 B	0.5
severe >33	Fast	0.6 B	-	
	moderate	0.8 B	0.8 B	
	Slow	1.0 B	1.0 B	
Prevailing Cross Currents (knots)				
negligible <0.2	All	0	0	
low 0.2-0.5	Fast	0.1 B	-	
	moderate	0.2 B	0.1 B	0.1
	Slow	0.3 B	0.2 B	
moderate0.5-1.5	Fast	0.5 B	-	
	moderate	0.7 B	0.5 B	
	Slow	1.0 B	0.8 B	
strong>1.5-2.0	Fast	0.7 B	-	
	moderate	1.0 B	-	
	Slow	1.3 B	-	

Prevailing Longitudinal Current (knots)				
low <1.5	**All**	0	0	0
moderate 1.5-3	Fast	0	-	
	moderate	0.1 B	0.1 B	
	Slow	0.2 B	0.2 B	
strong>3	Fast	0.1 B	-	
	moderate	0.2 B	0.2 B	
	Slow	0.4 B	0.4 B	
Significant Wave Height H and length l (m)				
H<1 and l<L	All	0	0	
3>H>1 and l=L	Fast	2.0 B	-	
	moderate	1.0 B	-	
	Slow	0.5 B	-	0.5
H>3 and l>L	Fast	3.0 B	-	
	moderate	2.2 B	-	
	Slow	1.5 B	-	
Aids to Navigation				
excellent w/shore traffic control		0	0	
Good		0.1 B	0.1 B	
moderate w/infrequent poor vis		0.2 B	0.2 B	
moderate w/frequent poor vis		>0.5 B	>0.5 B	0.5
Bottom Surface				
depth > 1.5T		0	0	
depth < 1.5T				
and				
	smooth and soft	0.1 B	0.1 B	
	smooth sloping/hard	0.1 B	0.1 B	
	rough/hard	0.2 B	0.2 B	0.2
Depth of Waterway				
>1.5T		0	0	
1.5-1.25T or <1.5-1.15T		0.1 B	0.2 B	
<1.25T or 1.15T		0.2 B	0.4 B	0.4
Cargo Hazard				
low (dry bulk)		0	0	
medium (oil)		0.5 B	0.4 B	0.4
high (AVGAS LNG chemicals)		1.0 B	0.8 B	

Two-Way Traffic					
	vessel speed (knots)				
		fast >12	2.0 B	-	
		moderate 8-12	1.6 B	1.4 B	
		slow 5-8	1.2 B	1.0 B	
	traffic density				
		light (0-1/hr)	0	0	0
		moderate (2-3/hr)	0.2 B	0.2 B	
		heavy (>3/hr)	0.5 B	0.4 B	
Bank Clearance					
	sloping edges				
		fast	0.7 B	-	
		Moderate	0.5 B	0.5 B	
		slow	0.3 B	0.3 B	
	steep hard edge				
		fast	1.3 B	-	
		Moderate	1.0 B	1.0 B	1
		slow	0.5 B	0.5 B	
Factor Total					5.1

General Example of Factor Calculation:

To find the total recommended width of the channel add the various components. For instance, a vessel traveling at 8 knots in open water in 15 knot winds when there is frequently poor visibility traveling over a rough/hard bottom when the depth is less than 1.25T carrying oil in a channel with sloping edges would add 2.2 B to the basic 1.5 B width for a total channel width of 3.7 B.

Searsport Calculation using Total Factor for Channel Width

Searsport Factor Total	5.1
Design Vessel Beam (ft.)	116
Calculated Channel Width (ft.)	590
Allowance for Tug Width (ft.)	48
Channel Width (ft,)	640

Based on the PIANC method the selected entrance channel width is 650 ft.

Channel Depth

Channel depth “should be adequate to safely accommodate ships with the deepest drafts expected to use the waterway” according to EM 1110-2-1613. This statement not only addresses the physical characteristics of the design vessels but the economic projections of usage. See the economics appendix for discussion of the current and future vessels. The physical concerns are the draft of the vessel and how it operates when underway. Vessels will ride deeper in the water when underway than when at berth. The term for this is “squat” and conditions affecting the amount of squat can be water depth or channel cross-section. Ships also are impacted by the wave conditions and tend to roll, pitch, or heave. For instance, a long vessel can pitch forward or back and increase the depth required at the bow or stern by a foot or more in addition to the swell or squat additives. The EM provides technical guidance related to the design depth and this is considered by including about under-keel clearance* in the economics calculations. The alternatives analysis uses an economic approach of examining the costs of various channel depths compared to the economic benefits. Channel design depths examined began at 35’ (current authorized channel depth) and went to 42’ with 2’ of overdepth taken into consideration.

---

* The U.S. Coast Guard Captain of the Port, Sector Northern New England, in cooperation with the Maine and New Hampshire Port Safety Forum, Recommended minimum under-keel clearances for Penobscot Bay and River have also been established by the aforementioned group, in order to prevent groundings and to promote safety and environmental security of the waterway resources of Penobscot Bay and River. The group recommends that all entities responsible for safe movement of vessels in and through the waters of Penobscot Bay and River operate vessels in such a manner as to maintain a minimum under-keel clearance of 3 feet between the deepest draft of the vessel and the channel bottom when transiting Penobscot Bay and outer Penobscot River, south of Turtle Head on Islesboro island, and 2 feet when transiting Penobscot River north of Turtle Head, and a minimum under-keel clearance of 1 foot at all berthing areas.

Turning Radius

The EM recommends a turning radius of between 1.2 and 1.5 times the length of the vessel in addition to accounting for any drifting with the current while turning. Although the currents are relatively light at the end of the piers at Mack Point the upper range was selected due to pilots input and the potential of wind effect on high riding vessels. A 1200-foot turning radius was located at the upper end of the channel adjacent to the berth area.

Channel Alignment

Fortunately the alignment for the Searsport channel is simply a straight line. There is no need to widen the channel in a bend. The channel was oriented to avoid the shipwreck and to feed directly into the turning basin.

Long Cove Maneuvering Area

Due to the existence of the new berth along the state pier a maneuvering area was designed to the east of the berth as shown below. The maneuvering area was sized for the larger vessels plus tugs perpendicular to the vessel to assist with berthing operations. Turning of the vessels would take place in the turning basin.

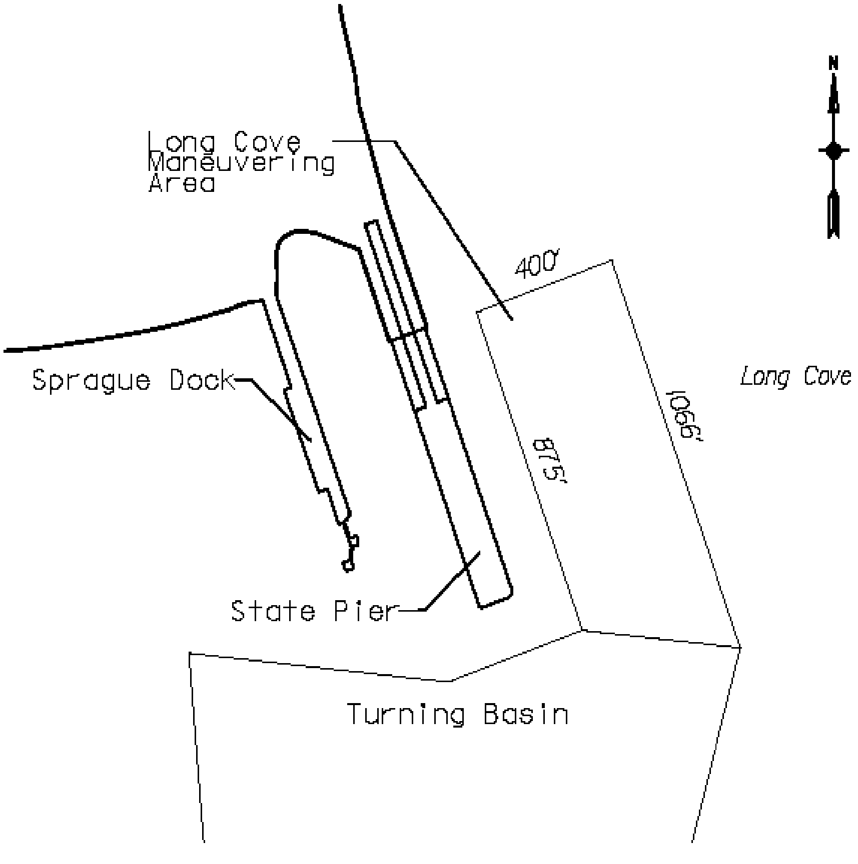


Figure 2. Maneuvering Area at State Pier

Quantities

Using the hydrographic survey taken in 2005 and a proposed channel alignment with widths of 650’ with a 1200’ turning radius at the upper end, quantities of material to be removed were developed with the aid of MicroStation’s InRoads. An existing bay bottom surface was compared to the proposed channel bottom and the difference, material to be removed, is shown in the following table. Also shown in the table are quantities for an additional maneuvering area in Long Cove which would service the eastern berths along the State pier.

The following quantities for channel widths of 650' plus a 400' wide Long Cove maneuvering area alongside the State pier berth and a turning basin in front of the Piers were calculated using an existing surface "Existing2_Vol.dtm" from the 2005 survey volume file.

Table 4. Dredge Quantity and Surface Area for Alternatives

37-FT PROJECT	Dredging Quantities (CY) by Plan			Dredging Areas (SF) by Plan
	Cut	2-Ft. OD	Total	Cut
Maintenance Dredging				
Entrance Channel	0	1,900	1,900	
Turning Basin	6,800	28,400	35,200	
Total Maintenance Dredging	6,800	30,300	37,100	
Improvement Dredging				
Entrance Channel	0	13,000	13,000	300,000
Turning Basin	10,400	104,900	115,300	2,507,200
Long Cove Maneuvering Area	191,300	36,000	227,300	458,500
Total Improvement Dredging	201,700	153,900	355,600	3,265,700
Total All Dredging	208,500	184,200	392,700	Note: Improvement Areas Include Maintenance Areas

38-FT PROJECT	Dredging Quantities (CY) by Plan			Dredging Areas (SF) by Plan
	Cut	2-Ft. OD	Total	Cut
Maintenance Dredging				
Entrance Channel	0	1,900	1,900	
Turning Basin	6,800	28,400	35,200	
Total Maintenance Dredging	6,800	30,300	37,100	
Improvement Dredging				
Entrance Channel	7,400	30,000	37,400	700,000
Turning Basin	47,800	155,200	203,000	2,507,200
Long Cove Maneuvering Area	209,200	36,500	245,700	459,600
Total Improvement Dredging	264,400	221,700	486,100	3,666,800
Total All Dredging	271,200	252,000	523,200	Note: Improvement Areas Include Maintenance Areas

Table 4. Dredge Quantity and Surface Area for Alternatives (continued)

39-FT PROJECT	Dredging Quantities (CY) by Plan			Dredging Areas (SF) by Plan
	Cut	2-Ft. OD	Total	Cut
Maintenance Dredging				
Entrance Channel	0	1,900	1,900	
Turning Basin	6,800	28,400	35,200	
Total Maintenance Dredging	6,800	30,300	37,100	
Improvement Dredging				
Entrance Channel	26,000	106,400	132,400	1,500,000
Turning Basin	115,300	182,700	298,000	2,507,200
Long Cove Maneuvering Area	227,300	37,100	264,400	460,800
Total Improvement Dredging	368,600	326,200	694,800	4,468,000
Total All Dredging	375,400	356,500	731,900	Note: Improvement Areas Include Maintenance Areas

40-FT PROJECT	Dredging Quantities (CY) by Plan			Dredging Areas (SF) by Plan
	Cut	2-Ft. OD	Total	Cut
Maintenance Dredging				
Entrance Channel	0	1,900	1,900	
Turning Basin	6,800	28,400	35,200	
Total Maintenance Dredging	6,800	30,300	37,100	
Improvement Dredging				
Entrance Channel	69,200	141,900	211,100	1,850,000
Turning Basin	203,000	194,400	397,400	2,507,200
Long Cove Maneuvering Area	245,700	37,800	283,500	465,300
Total Improvement Dredging	517,900	374,100	892,000	4,822,600
Total All Dredging	524,700	404,400	929,100	Note: Improvement Areas Include Maintenance Areas

41-FT PROJECT	Dredging Quantities (CY) by Plan			Dredging Areas (SF) by Plan
	Cut	2-Ft. OD	Total	Cut
Maintenance Dredging				
Entrance Channel	0	1,900	1,900	
Turning Basin	6,800	28,400	35,200	
Total Maintenance Dredging	6,800	30,300	37,100	
Improvement Dredging	0	0	0	
Entrance Channel	132,400	171,800	304,200	2,250,000
Turning Basin	298,000	200,700	498,700	2,507,200
Long Cove Maneuvering Area	264,400	38,400	302,800	465,300
Total Improvement Dredging	694,800	410,900	1,105,700	5,222,600
Total All Dredging	701,600	441,200	1,142,800	Note: Improvement Areas Include Maintenance Areas

Table 4. Dredge Quantity and Surface Area for Alternatives (continued)

42-FT PROJECT	Dredging Quantities (CY) by Plan			Dredging Areas (SF) by Plan
	Cut	2-Ft. OD	Total	Cut
Maintenance Dredging				
Entrance Channel	0	1,900	1,900	
Turning Basin	6,800	28,400	35,200	
Total Maintenance Dredging	6,800	30,300	37,100	
Improvement Dredging	0	0	0	
Entrance Channel	213,000	200,800	413,800	2,650,000
Turning Basin	397,400	204,100	601,500	2,507,200
Long Cove Maneuvering Area	283,500	39,000	322,500	465,300
Total Improvement Dredging	893,900	443,900	1,337,800	5,622,600
Total All Dredging	900,700	474,200	1,374,900	Note: Improvement Areas Include Maintenance Areas

Disposal Area

There are three alternatives initially considered for open water disposal of the dredged material. One area previously used in 1964 during initial construction of the project is located about two miles south and a second site in deep water was also identified located about 6 miles south. The current active disposal site at Rockland is located about 25 miles south. All sites are in open water and material has been determined to be suitable for disposal (see Suitability Determination included in Appendix D). The more distant site could have an impact on the amount of equipment required on site as a scow would be in transit for a round trip time of 8-10 hours. The 6 mile site (Penobscot Bay site) and the Rockland site were selected as alternatives for further consideration based on lobster habitat at the 2 mile site.

Costs

Dredging costs were developed in September December 2011 using the Corps of Engineers Dredge Estimating Program (CEDEP). This program requires input such as the number of cubic yards being dredged, the dredging area, the distance to the disposal site, cycle time of the bucket, size of the bucket, technical items such as bank factor, optimum bank, and subjective items such as useable scow volume and efficiency measured as a percent of working time. The program provides an estimate of mobilization costs and the unit cost of dredging.

Costs were prepared for the alternative depths considered (37, 38, 39, 40, 41, and 42 feet MLLW), for the entrance channel, turning basin, and maneuvering area. One set of costs were prepared for dredged material disposal at the Penobscot Bay Disposal site and a second set of costs were prepared for dredged material disposal at the Rockland Disposal site. The CEDEP summaries are included in Appendix I for each alternative. The unit cost for dredging and disposal are shown below in Figure 3. Units cost for the closer disposal site range from about $8 to $19 per CY and for the more distant site from about $15 to $28 per CY. The unit costs for dredging each of the features considered varied somewhat due to the quantities and dredge area involved.

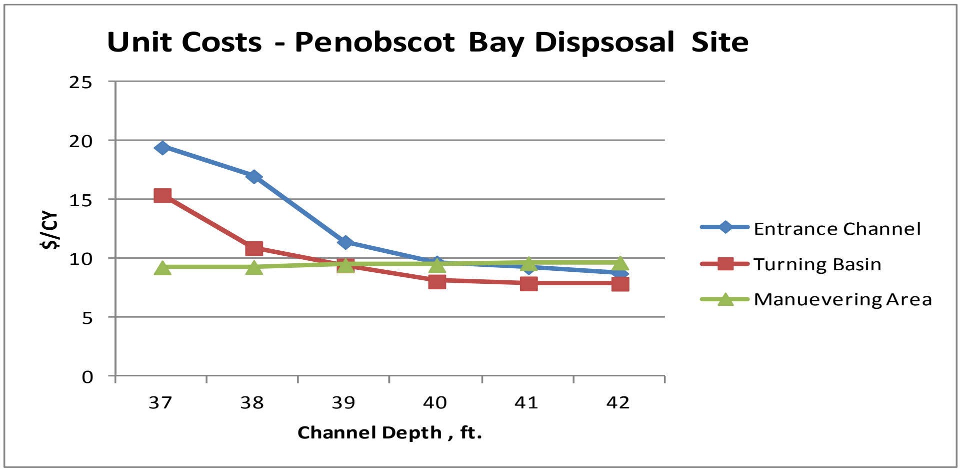


Figure 3. Unit Costs, Dredging and Disposal at Penobscot Disposal Site

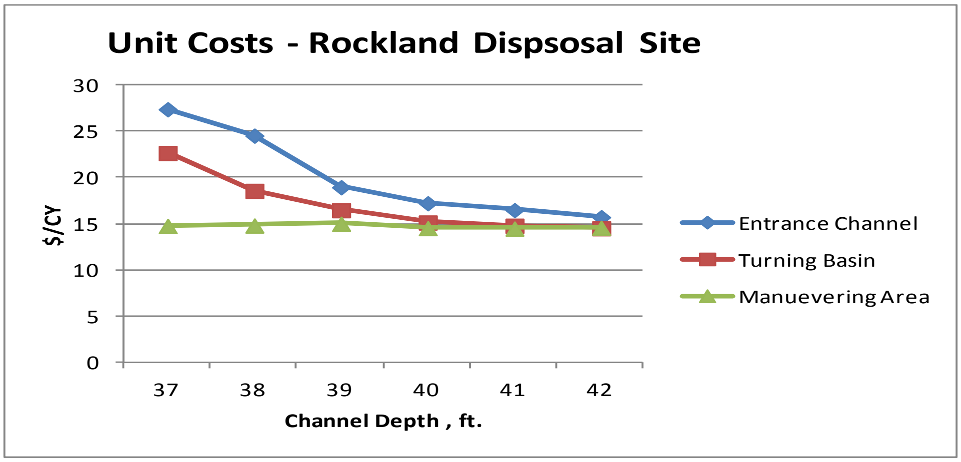


Figure 4. Unit Costs, Dredging and Disposal at Rockland Disposal Site

Selected Plan

This project consists of both maintenance dredging and improvement dredging. Dredging to -35ft. MLLW plus 2 ft. Over depth allowance within the foot print of the authorized Federal navigation project is considered maintenance dredging whereas dredging deeper than 37 feet and/or outside of the Federal navigation project is considered improvement dredging. Tables shown in the main report describe the breakdown between the two and the further allocation of costs. Benefits are detailed in the Economic Appendix E. Information presented in the Economics Appendix demonstrates that the maximum net economic benefit is achieved for a 40-foot project design depth. The feasibility level engineering layout of the 40-foot project including the entrance channel, turning basin and maneuvering area is shown in Figure 3 and quantities are shown in Table 5.

Table 5. Selected Plan, Dredging Quantities, 40-foot Project Design Depth, MLLW

Federal Maintenance and Improvement Dredged Material Quantities (cy)							
	Maintenance			***Improvement***			**Grand Subtotal**
Area	**Dredging**	**Over-depth**	**Subtotal**	**Dredging**	**Over-depth**	**Subtotal**	
Entrance Channel	0	1,900	**1,900**	69,200	141,900	**211,100**	**213,000**
Turning Basin	6,800	28,400	**35,200**	203,000	194,400	**397,400**	**432,600**
Maneuvering Area (Long Cove)				245,700	37,800	**283,500**	**283,500**
Subtotal	**6,800**	**30,300**	**37,100**	**517,900**	**374,100**	**892,000**	**929,100**
GRAND TOTAL **929,100**							

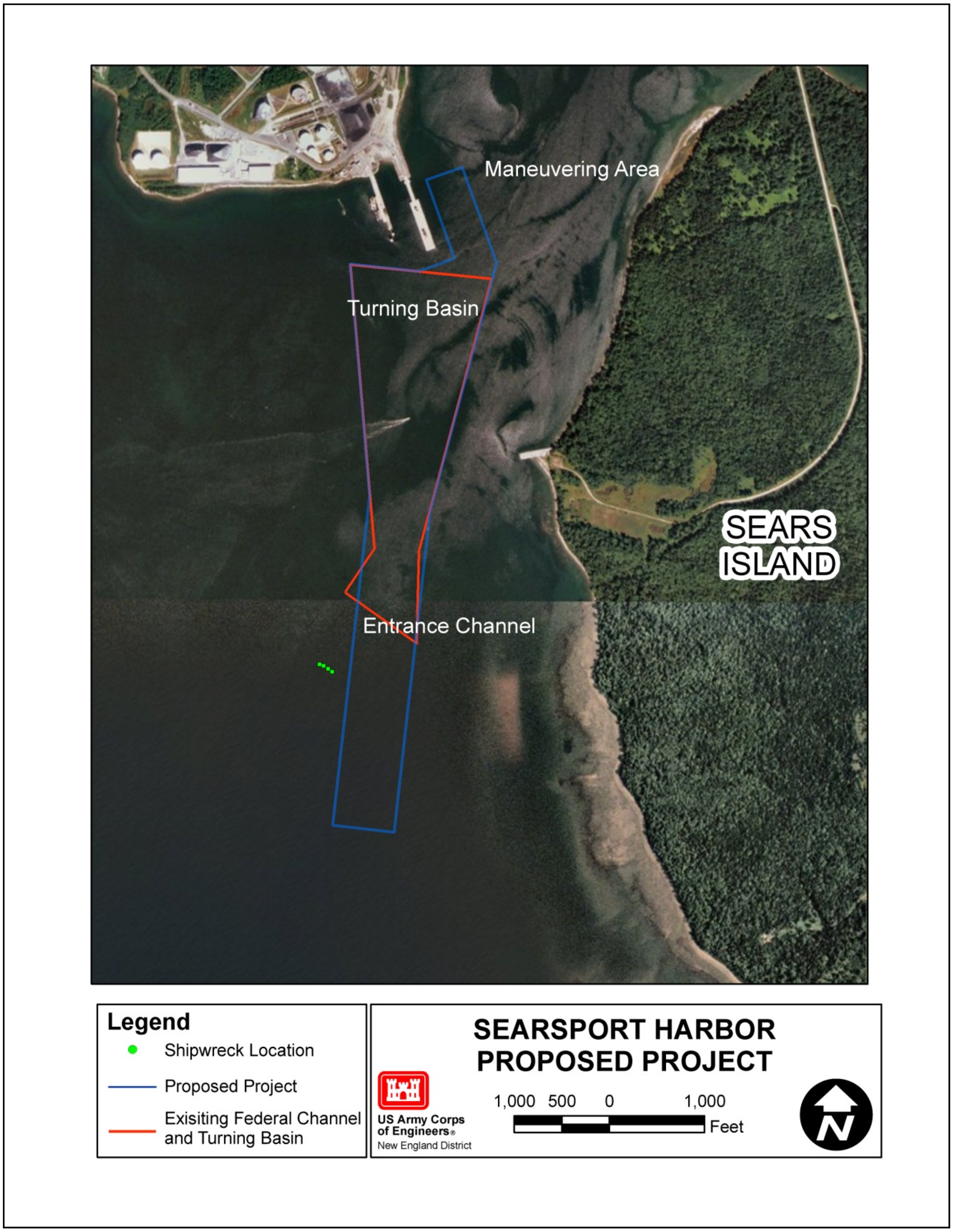


Figure 5. Navigation Improvement Project, 40-foot depth, Selected Plan

SEARSPORT HARBOR
SEARSPORT, MAINE
NAVIGATION IMPROVEMENT PROJECT

APPENDIX I

COST ESTIMATES
AND
COST SCHEDULE RISK ANALYSIS
FOR TENTATIVELY SELECTED PLAN

**** TOTAL PROJECT COST SUMMARY ****

PROJECT: Searsport Harbor Navigation Improvement Project
LOCATION: Searsport, Maine

DISTRICT: New England District
POC: CHIEF, COST ENGINEERING, xxx

PREPARED: 12/14/2012

This Estimate reflects the scope and schedule in report; Feasibility Rep. & EA for Navigation Improvement Project

WBS Structure		ESTIMATED COST				PROJECT FIRST COST (Constant Dollar Basis)				TOTAL PROJECT COST (FULLY FUNDED)				
						Program Year (Budget EC): 2014 Effective Price Level Date: 1 OCT 13				Spent Thru:				
WBS NUMBER	Civil Works Feature & Sub-Feature Description	COST ($K)	CNTG ($K)	CNTG (%)	TOTAL ($K)	ESC (%)	COST ($K)	CNTG ($K)	TOTAL ($K)	1-Dec-11 ($K)		COST ($K)	CNTG ($K)	FULL ($K)
A	*B*	*C*	*D*	*E*	*F*	*G*	*H*	*I*	*J*	*K*	*L*	*M*	*N*	*O*
12	NAVIGATION PORTS & HARBORS	$8,837	$1,105	12.5%	$9,942	1.5%	$8,969	$1,121	$10,090	$0		$9,164	$1,146	$10,310
	#N/A	$0	$0	-	$0	-	$0	$0	$0	$0		$0	$0	$0
	#N/A	$0	$0	-	$0	-	$0	$0	$0	$0		$0	$0	$0
	#N/A	$0	$0	-	$0	-	$0	$0	$0	$0		$0	$0	$0
	#N/A	$0	$0	-	$0	-	$0	$0	$0	$0		$0	$0	$0
	CONSTRUCTION ESTIMATE TOTALS:	$8,837	$1,105		$9,942	1.5%	$8,969	$1,121	$10,090	$0		$9,164	$1,146	$10,310
01	LANDS AND DAMAGES	$0	$0	-	$0	-	$0	$0	$0	$0		$0	$0	$0
30	PLANNING, ENGINEERING & DESIGN	$495	$8	1.6%	$503	4.4%	$517	$8	$525	$0		$526	$8	$535
31	CONSTRUCTION MANAGEMENT	$539	$23	4.2%	$562	4.4%	$563	$24	$586	$0		$590	$25	$614
	PROJECT COST TOTALS:	$9,871	$1,135	11.5%	$11,006		$10,048	$1,153	**$11,200**	$0		$10,280	$1,179	$11,459

Mandatory by Regulation CHIEF, COST ENGINEERING, xxx

Mandatory by Regulation PROJECT MANAGER, xxx

Mandatory by Regulation CHIEF, REAL ESTATE, xxx

CHIEF, PLANNING,xxx

CHIEF, ENGINEERING, xxx

CHIEF, OPERATIONS, xxx

CHIEF, CONSTRUCTION, xxx

CHIEF, CONTRACTING,xxx

CHIEF, PM-PB, xxxx

CHIEF, DPM, xxx

ESTIMATED FEDERAL COST:	65%	**$7,448**
ESTIMATED NON-FEDERAL COST:	35%	**$4,011**
ESTIMATED TOTAL PROJECT COST:		**$11,459**

*** Initial cost sharing is 75% F / 25% NF plus an additional 10% NF of the project cost over 30 years.**

O&M OUTSIDE OF TOTAL PROJECT COST: **$440**

(Federal channel maintenance cost.)

Filename: Searsport_GNF-Improvement_TPCS_2012 r0.xlsx
TPCS

**** TOTAL PROJECT COST SUMMARY ****

**** CONTRACT COST SUMMARY ****

PROJECT: Searsport Harbor Navigation Improvement Project
LOCATION: Searsport, Maine
This Estimate reflects the scope and schedule in report; Feasibility Rep. & EA for Navigation Improvement Project

DISTRICT: New England District
POC: CHIEF, COST ENGINEERING, xxx
PREPARED: 12/14/2012

WBS Structure		**ESTIMATED COST**				**PROJECT FIRST COST (Constant Dollar Basis)**				**TOTAL PROJECT COST (FULLY FUNDED)**				
		Estimate Prepared:			10-Oct-12	Program Year (Budget EC):			2014					
		Effective Price Level:			1-Dec-11	Effective Price Level Date:			1 OCT 13					
				RISK BASED										
WBS	Civil Works	COST	CNTG	CNTG	TOTAL	ESC	COST	CNTG	TOTAL	Mid-Point	INFLATED	COST	CNTG	FULL
NUMBER	Feature & Sub-Feature Description	($K)	($K)	(%)	($K)	(%)	($K)	($K)	($K)	Date	(%)	($K)	($K)	($K)
A	*B*	*C*	*D*	*E*	*F*	*G*	*H*	*I*	*J*	*P*	*L*	*M*	*N*	*O*
	PHASE 1 or CONTRACT 1													
12	NAVIGATION PORTS & HARBORS	$8,837	$1,105	12.5%	$9,942	1.5%	$8,969	$1,121	$10,090	2015Q2	2.2%	$9,164	$1,146	$10,310
	#N/A	$0	$0	0%	$0	0.0%	$0	$0	$0	0	0.0%	$0	$0	$0
	#N/A	$0	$0	0%	$0	0.0%	$0	$0	$0	0	0.0%	$0	$0	$0
	#N/A	$0	$0	0%	$0	0.0%	$0	$0	$0	0	0.0%	$0	$0	$0
	#N/A	$0	$0	0%	$0	0.0%	$0	$0	$0	0	0.0%	$0	$0	$0
							$0							
	CONSTRUCTION ESTIMATE TOTALS:	$8,837	$1,105	13%	**$9,942**		$8,969	$1,121	$10,090			$9,164	$1,146	$10,310
01	LANDS AND DAMAGES	$0	$0	0%	$0	0.0%	$0	$0	$0	0	0.0%	$0	$0	$0
30	PLANNING, ENGINEERING & DESIGN													
0.6%	Project Management	$53	$2	4.2%	$55	4.4%	$55	$2	$58	2014Q2	0.8%	$56	$2	$58
0.6%	Planning & Environmental Compliance	$53	$0	0.0%	$53	4.4%	$55	$0	$55	2014Q2	0.8%	$56	$0	$56
2.5%	Engineering & Design	$221	$0	0.0%	$221	4.4%	$231	$0	$231	2014Q2	0.8%	$233	$0	$233
0.2%	Engineering Tech Review ITR & VE	$18	$0	0.0%	$18	4.4%	$19	$0	$19	2014Q2	0.8%	$19	$0	$19
0.2%	Contracting & Reprographics	$18	$0	0.0%	$18	4.4%	$19	$0	$19	2014Q2	0.8%	$19	$0	$19
1.0%	Engineering During Construction	$88	$4	4.2%	$92	4.4%	$92	$4	$96	2015Q2	4.8%	$96	$4	$100
0.5%	Planning During Construction	$44	$2	4.2%	$46	4.4%	$46	$2	$48	2015Q2	4.8%	$48	$2	$50
0.0%	Project Operations	$0	$0	0.0%	$0	0.0%	$0	$0	$0	0	0.0%	$0	$0	$0
31	CONSTRUCTION MANAGEMENT													
4.8%	Construction Management	$424	$18	4.2%	$442	4.4%	$443	$19	$461	2015Q2	4.8%	$464	$19	$483
0.0%	Project Operation:	$0	$0	0.0%	$0	0.0%	$0	$0	$0	0	0.0%	$0	$0	$0
1.3%	Project Management	$115	$5	4.2%	$120	4.4%	$120	$5	$125	2015Q2	4.8%	$126	$5	$131
	CONTRACT COST TOTALS:	$9,871	$1,135		**$11,006**		$10,048	$1,153	$11,200			$10,280	$1,179	**$11,459**

Searsport Harbor Navigation - PROJECT < $40M

Project Development Stage: Feasibility Study
Abbreviated Risk Analysis

Project Manager: Barbara Blumeris

Meeting Date: 16-May-11

PDT Members

Project Management: Barbara Blumeris, Mark Habel

Engineering & Design: Bob Meader

Cost Engineering: Mike Remy, Chris Lindsay

NOTE: Template provided by the Cost PCX entitled "07-Feb-2011 Abbreviated Risk Analysis TEMPLATE for Projects less than 40 M.xlsx" used for this Abbreviated risk analysis.

Searsport Harbor Navigation - PROJECT < $40M
Project Development Stage: Feasibility Study
Abbreviated Risk Analysis

	WBS	Item	Contract Cost		% Contingency	$ Contingency	Total
1	12 NAVIGATION, PORTS AND HARBORS	**GNF, Dredging and Disposal**	**$ 8,837,043**		12.5%	$ 1,104,630.38	$ 9,941,673.38
2		**LSF, Dredging and Disposal**	**$ 337,019**		12.5%	$ 42,127.38	$ 379,146.38
3		**Maintenance, Dredging and Disposal**	**$ 383,609**		12.5%	$ 47,951.13	$ 431,560.13
4		**Item Name**	**$ -**		0.00%	$ -	$ -
5		**Item Name**	**$ -**		0.00%	$ -	$ -
6		**Item Name**	**$ -**		0.00%	$ -	$ -
7		**Item Name**	**$ -**		0.00%	$ -	$ -
8		**Item Name**	**$ -**		0.00%	$ -	$ -
9		**Item Name**	**$ -**		0.00%	$ -	$ -
10		**Item Name**	**$ -**		0.00%	$ -	$ -
11		**Item Name**	**$ -**		0.00%	$ -	$ -
12		**Remaining Construction Items (Total Const. Contract Cost minus Σ of items #1-11)**	**$ -**	0.0%	0.00%	$ -	$ -
13	30 PLANNING, ENGINEERING, AND DESIGN	**Planning, Engineering, & Design**	**$ 495,000**		0.00%	$ -	$ 495,000.00
14	31 CONSTRUCTION MANAGEMENT	**Construction Management**	**$ 539,000**		4.17%	$ 22,476.30	$ 561,476.30

Total Construction Estimate	$ 9,557,671		$ 1,194,709	$ 10,752,380
Total Planning, Engineering & Design	$ 495,000		$ -	$ 495,000
Total Construction Management	$ 539,000		$ 22,476	$ 561,476
Total	$ 10,591,671		$ 1,217,185	$ 11,808,856

Weighted Construction Contingency = 12.5%
Planning, Engineering & Design Contingency = 0.0%
Construction Management Contingency = 4.2%

Searsport Harbor Navigation - PROJECT < $40M

Project Development Stage: Feasibility Study
Abbreviated Risk Analysis

Meeting Date: 16-May-11
Updated August 2011

Risk Level

2	3	4	5	5
1	2	4	5	5
0	1	3	3	4
0	0	1	2	4
Negligible	Marginal	Significant	Critical	Crisis

Risk Elem	Affected WBS Item	Concerns	PDT Discussions & Conclusions (Include logic & justification for	Likelihood	Impact	Risk Level
Project Scope						
PS-1	GNF, Dredging and Disposal	Change in dimensions of project during design.	Channel and turning basin layout is straight forward and no change anticipated	Very Unlikely	Marginal	0
PS-2	LSF, Dredging and Disposal	Change in dimensions of project during design.	Berths have fixed dimensions.	Very Unlikely	Marginal	0
PS-3	Maintenance, Dredging and Disposal	Change in dimensions of project during design.	Channel and turning basin layout is straight forward and no change anticipated	Very Unlikely	Marginal	0
PS-4	Item Name			Very Unlikely	Negligible	0
PS-5	Item Name			Very Unlikely	Negligible	0
PS-6	Item Name			Very Unlikely	Negligible	0
PS-7	Item Name			Very Unlikely	Negligible	0
PS-8	Item Name			Very Unlikely	Negligible	0
PS-9	Item Name			Very Unlikely	Negligible	0
PS-10	Item Name			Very Unlikely	Negligible	0
PS-11	Item Name			Very Unlikely	Negligible	0
PS-12	Remaining Construction Items			Very Unlikely	Negligible	0
PS-13	Planning, Engineering, & Design	Change in dimensions of project during design.		Very Unlikely	Marginal	0
PS-14	Construction Management	Change in dimensions of project during design.		Very Unlikely	Marginal	0
Acquisition Strategy						
AS-1	GNF, Dredging and Disposal	The acquisition strategy could impact the construction cost and schedule.	District has extensive experience with contracting this size and type of dredging project with both unrestricted and set-aside strategy.	Unlikely	Marginal	1
AS-2	LSF, Dredging and Disposal	The acquisition strategy could impact the construction cost and schedule.	District has extensive experience with contracting this size and type of dredging project with both unrestricted and set-aside strategy.	Unlikely	Marginal	1
AS-3	Maintenance, Dredging and Disposal	The acquisition strategy could impact the construction cost and schedule.	District has extensive experience with contracting this size and type of dredging project with both	Unlikely	Marginal	1
AS-4	Item Name			Very Unlikely	Negligible	0
AS-5	Item Name			Very Unlikely	Negligible	0
AS-6	Item Name			Very Unlikely	Negligible	0
AS-7	Item Name			Very Unlikely	Negligible	0
AS-8	Item Name			Very Unlikely	Negligible	0
AS-9	Item Name			Very Unlikely	Negligible	0
AS-10	Item Name			Very Unlikely	Negligible	0
AS-11	Item Name			Very Unlikely	Negligible	0
AS-12	Remaining Construction Items			Very Unlikely	Negligible	0
AS-13	Planning, Engineering, & Design	NA		Very Unlikely	Negligible	0
AS-14	Construction Management	NA		Very Unlikely	Negligible	0
Construction Complexity						
CC-1	GNF, Dredging and Disposal	Mechanical dredging and open water disposal. No Concern.	Standard Operation. NAE has extensive experience with mechanical dredging & open water disposal	Very Unlikely	Negligible	0
CC-2	LSF, Dredging and Disposal	Mechanical dredging and open water disposal. No Concern.	Standard Operation. NAE has extensive experience with mechanical dredging & open water disposal	Very Unlikely	Negligible	0
CC-3	Maintenance, Dredging and Disposal	Mechanical dredging and open water disposal. No Concern.	extensive experience with mechanical dredging & open water	Very Unlikely	Negligible	0
CC-4	Item Name			Very Unlikely	Negligible	0
CC-5	Item Name			Very Unlikely	Negligible	0
CC-6	Item Name			Very Unlikely	Negligible	0
CC-7	Item Name			Very Unlikely	Negligible	0
CC-8	Item Name			Very Unlikely	Negligible	0
CC-9	Item Name			Very Unlikely	Negligible	0
CC-10	Item Name			Very Unlikely	Negligible	0
CC-11	Item Name			Very Unlikely	Negligible	0
CC-12	Remaining Construction Items			Very Unlikely	Negligible	0
CC-13	Planning, Engineering, & Design	Mechanical dredging and open water disposal. No Concern.		Very Unlikely	Negligible	0
CC-14	Construction Management	Mechanical dredging and open water disposal. No Concern.		Very Unlikely	Negligible	0

Searsport Harbor Navigation - PROJECT < $40M

Project Development Stage: Feasibility Study
Abbreviated Risk Analysis

Meeting Date: 16-May-11
Updated August 2011

Risk Level

2	3	4	5	5
1	2	4	5	5
0	1	3	3	4
0	0	1	2	4
Negligible	Marginal	Significant	Critical	Crisis

Risk Elem	Affected WBS Item	Concerns	PDT Discussions & Conclusions (Include logic & justification for	Likelihood	Impact	Risk Level
Volatile Commodities						
VC-1	GNF, Dredging and Disposal	concern price of fuel may increase	Fuel cost estimate 2011 and declining from recent highs.	Unlikely	Significant	3
VC-2	LSF, Dredging and Disposal	concern price of fuel may increase	Fuel cost estimate 2011 and declining from recent highs.	Unlikely	Significant	3
VC-3	Maintenance, Dredging and Disposal	concern price of fuel may increase	Fuel cost estimate 2011 and declining from recent highs.	Unlikely	Significant	3
VC-4	Item Name			Very Unlikely	Negligible	0
VC-5	Item Name			Very Unlikely	Negligible	0
VC-6	Item Name			Very Unlikely	Negligible	0
VC-7	Item Name			Very Unlikely	Negligible	0
VC-8	Item Name			Very Unlikely	Negligible	0
VC-9	Item Name			Very Unlikely	Negligible	0
VC-10	Item Name			Very Unlikely	Negligible	0
VC-11	Item Name			Very Unlikely	Negligible	0
VC-12	Remaining Construction Items			Very Unlikely	Negligible	0
VC-13	Planning, Engineering, & Design	NA		Very Unlikely	Negligible	0
VC-14	Construction Management	NA		Very Unlikely	Negligible	0
Quantities						
Q-1	GNF, Dredging and Disposal	Reliability of quantities	High level of confidence in quantities based on 2005 survey and shoaling is very minimal	Very Unlikely	Marginal	0
Q-2	LSF, Dredging and Disposal	Reliability of quantities	High level of confidence in quantities based on 2005 survey and shoaling is very minimal	Very Unlikely	Marginal	0
Q-3	Maintenance, Dredging and Disposal	Reliability of quantities	High level of confidence in quantities based on 2005 survey and shoaling is very minimal	Very Unlikely	Marginal	0
Q-4	Item Name			Very Unlikely	Negligible	0
Q-5	Item Name			Very Unlikely	Negligible	0
Q-6	Item Name			Very Unlikely	Negligible	0
Q-7	Item Name			Very Unlikely	Negligible	0
Q-8	Item Name			Very Unlikely	Negligible	0
Q-9	Item Name			Very Unlikely	Negligible	0
Q-10	Item Name			Very Unlikely	Negligible	0
Q-11	Item Name			Very Unlikely	Negligible	0
Q-12	Remaining Construction Items			Very Unlikely	Negligible	0
Q-13	Planning, Engineering, & Design	NA		Very Unlikely	Negligible	0
Q-14	Construction Management	Reliability of quantities	High level of confidence in quantities based on recent survey	Very Unlikely	Negligible	0
Fabrication & Project Installed Equipment						
FI-1	GNF, Dredging and Disposal	NA		Very Unlikely	Negligible	0
FI-2	LSF, Dredging and Disposal	NA		Very Unlikely	Negligible	0
FI-3	Maintenance, Dredging and	NA		Very Unlikely	Negligible	0
FI-4	Item Name			Very Unlikely	Negligible	0
FI-5	Item Name			Very Unlikely	Negligible	0
FI-6	Item Name			Very Unlikely	Negligible	0
FI-7	Item Name			Very Unlikely	Negligible	0
FI-8	Item Name			Very Unlikely	Negligible	0
FI-9	Item Name			Very Unlikely	Negligible	0
FI-10	Item Name			Very Unlikely	Negligible	0
FI-11	Item Name			Very Unlikely	Negligible	0
FI-12	Remaining Construction Items			Very Unlikely	Negligible	0
FI-13	Planning, Engineering, & Design	NA		Very Unlikely	Negligible	0
FI-14	Construction Management	NA		Very Unlikely	Negligible	0

Searsport Harbor Navigation - PROJECT < $40M

Project Development Stage: Feasibility Study
Abbreviated Risk Analysis

Meeting Date: 16-May-11
Updated August 2011

Risk Level

2	3	4	5	5
1	2	4	5	5
0	1	3	3	4
0	0	1	2	4
Negligible	Marginal	Significant	Critical	Crisis

Risk Elem	Affected WBS Item	Concerns	PDT Discussions & Conclusions (Include logic & justification for	Likelihood	Impact	Risk Level
Cost Estimating Method						
CE-1	GNF, Dredging and Disposal	Reasonable CEDEP assumptions used in estimate	NAE has extensive experience with CEDEP	Very Unlikely	Marginal	0
CE-2	LSF, Dredging and Disposal	Reasonable CEDEP assumptions used in estimate	NAE has extensive experience with CEDEP	Very Unlikely	Marginal	0
CE-3	Maintenance, Dredging and Disposal	Reasonable CEDEP assumptions used in estimate	NAE has extensive experience with CEDEP	Very Unlikely	Marginal	0
CE-4	Item Name			Very Unlikely	Negligible	0
CE-5	Item Name			Very Unlikely	Negligible	0
CE-6	Item Name			Very Unlikely	Negligible	0
CE-7	Item Name			Very Unlikely	Negligible	0
CE-8	Item Name			Very Unlikely	Negligible	0
CE-9	Item Name			Very Unlikely	Negligible	0
CE-10	Item Name			Very Unlikely	Negligible	0
CE-11	Item Name			Very Unlikely	Negligible	0
CE-12	Remaining Construction Items			Very Unlikely	Negligible	0
CE-13	Planning, Engineering, & Design	NA		Very Unlikely	Negligible	0
CE-14	Construction Management	NA		Very Unlikely	Negligible	0
External Project Risks						
EX-1	GNF, Dredging and Disposal	Adverse weather potential as construction environmental window is November to April. Fuel supply interruptions due to global political situation.	Production rates adjusted to include down time. This is mitigated by disposal site at head of bay. Fuel costs considered above.	LIKELY	Marginal	2
EX-2	LSF, Dredging and Disposal	Adverse weather potential as construction environmental window is November to April. Fuel supply interruptions due to global political situation.	Production rates adjusted to include down time. This is mitigated by disposal site at head of bay. Fuel costs considered above.	LIKELY	Marginal	2
EX-3	Maintenance, Dredging and Disposal	Adverse weather potential as construction environmental window is November to April. Fuel supply interruptions due to global political situation.	Production rates adjusted to include down time. This is mitigated by disposal site at head of bay. Fuel costs considered above.	LIKELY	Marginal	2
EX-4	Item Name			Very Unlikely	Negligible	0
EX-5	Item Name			Very Unlikely	Negligible	0
EX-6	Item Name			Very Unlikely	Negligible	0
EX-7	Item Name			Very Unlikely	Negligible	0
EX-8	Item Name			Very Unlikely	Negligible	0
EX-9	Item Name			Very Unlikely	Negligible	0
EX-10	Item Name			Very Unlikely	Negligible	0
EX-11	Item Name			Very Unlikely	Negligible	0
EX-12	Remaining Construction Items			Very Unlikely	Negligible	0
EX-13	Planning, Engineering, & Design	NA		Very Unlikely	Negligible	0
EX-14	Construction Management	Adverse weather potential as construction environmental window is November to April. Fuel supply interruptions due to global political situation.	Production rates adjusted to include down time. This is mitigated by disposal site at head of bay. Fuel costs considered above.	LIKELY	Marginal	2

U.S. Army Corps of Engineers
Project SP Mat Dis: Searsport - Dredging Harbor & Berths - Ocean Disposal P6

Summary Report

This is an estimate for the cost to mechanical dredge suitable material from three areas in Searsport Harbor 40' depth (400' Long Cove 283,500 cy, 650' Channel 213,000 cy, 650' Turning Basin 432,600 cy) and two ship berths 43' depth (Searsport Harbor State Pier 9,789 cy, Sprague Pier 21,219 cy). Construction costs includes 37,100 cy of maintenance material from the Federal Navigation Channel. It is assumed that maintenance dredging and improvement dredging would be done at the same time. Assume one mob and demob cost for the maintenance, improvement and berths. Haul all dredged materials six miles and dispose of them at the Penobscot Ocean Disposal site. Labor rates are adjusted to statewide Maine Davis Bacon Labor Rates for dredging. These dredging costs are taken directly from individual CEDEP estimates for each dredging area. NO CONTINGENCY OR ESCALATION COSTS ARE INCLUDED IN THIS ESTIMATE. The markups included in this estimate are: JOOH 10%, HOOH 7%, Profit 10%,

Estimated by	Cost Engineering Section US Army COE
Designed by	CENAE
Prepared by	Michael Remy
Preparation Date	11/27/2012
Effective Date of Pricing	12/31/2011
Estimated Construction Time	150 Days

Summary Report

Description	UOM	Quantity	ContractCost
Searsport - Contract Summary Report			**9,557,675**
Mobilization and Demobilization for Dredging	**EA**	**1**	**959,144**
Mob and Demob - cost generated in CEDEP	EA	1	959,144
Dredge Berths-Ocean Disposal	**EA**	**1**	**345,117**
Dredge State Pier Berth	**CY**	**9,789**	**114,042**
Mechanical Dredge State Dry Goods Pier - sandy material, 16 cy bucket dredge, 3,000 cy scow, dredge to 43' depth	EA	9,789	114,042
Dredge Sprague Pier Berth	**CY**	**21,219**	**231,075**
Mechanical Dredge Sprague Wet Goods Pier - sandy material, 16 cy bucket dredge, 3,000 cy scow, dredge to 43' depth.	EA	21,219	231,075
Dredge Harbor-Ocean Disposal	**EA**	**1**	**8,253,414**
400' Long Cove 40'	**CY**	**283,500**	**2,687,580**
Mechanical Dredge Harbor - mud material, 16 cy bucket dredge, 3,000 cy scows, 6 mile haul to ocean disposal	CY	283,500	2,687,580
650' Entrance Channel 40'	**CY**	**213,000**	**2,066,100**
Mechanical Dredge Harbor - mud material, 16 cy bucket dredge, 3,000 cy scows, 6 mile haul to ocean disposal	CY	213,000	2,066,100
650' Turning Basin 40'	**CY**	**432,600**	**3,499,734**
Mechanical Dredge Harbor - mud material, 16 cy bucket dredge, 3,000 cy scows, 6 mile haul to ocean disposal	CY	432,600	3,499,734