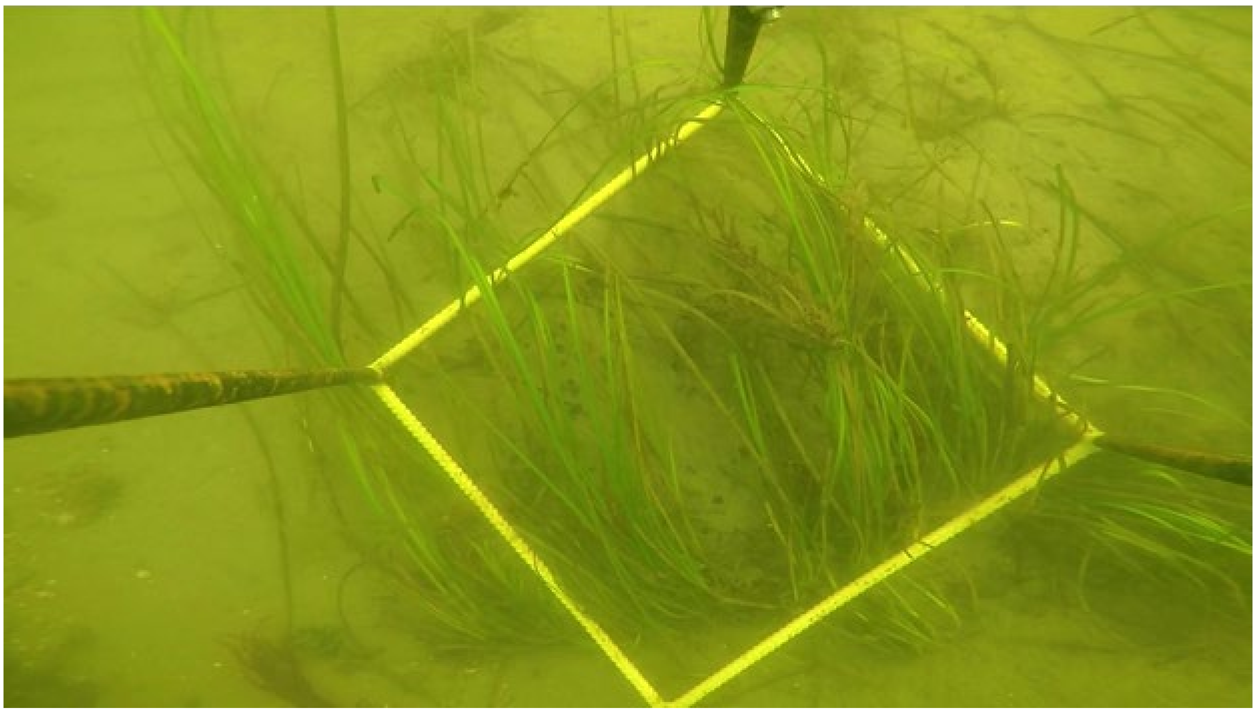
Portsmouth Harbor Navigation Improvement Project

Piscataqua River, New Hampshire and Maine

Eelgrass Mitigation Plan



US ARMY CORPS
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1.0 INTRODUCTION

The Piscataqua River forms a portion of the state boundary between Maine and New Hampshire. Portsmouth Harbor, located at the mouth of the river, is about 45 miles northeast of Boston Harbor, Massachusetts and 37 miles southwest of Portland Harbor, Maine. The existing Federal Navigation Project (FNP) in the Piscataqua River consists of a 6.2 mile long navigation channel that is 35 feet deep at mean lower low water (MLLW) and a minimum of 400 feet wide; a 950 foot wide, 35 foot deep MLLW turning basin located above Boiling Rock; and an 800 foot wide, 35 foot deep MLLW basin at the head of the project. The current width of the uppermost turning basin is too narrow for efficient and safe handling of the larger vessels that frequent upstream berths.

The New England District of the Army Corps of Engineers (USACE) is currently proposing to increase the width of this turning basin to a minimum of 1,200 feet, while maintaining the authorized depth of 35 feet MLLW (as shown in Figure 1). This would involve the mechanical dredging of approximately 628,000 cubic yards of sand and gravel, in addition to the blasting and removal of 14,700 cubic yards of bedrock.

2.0 PURPOSE

A Feasibility Report (FR) and an Environmental Assessment (EA) have been prepared for this project (USACE 2014). The 2014 FR and the EA determined that there would be no impacts to eelgrass resources resulting from the implementation of the proposed project as no eelgrass was found in the surveys that supported the study. In 2016 it was noted that the area proposed for dredging may have eelgrass present, so the area was surveyed (described below) in 2016 and 2018 by USACE. Eelgrass resources were found within the proposed impact area of the project. As such, this mitigation plan has been prepared to document the affected eelgrass resources, discuss the avoidance and minimization procedures considered, document the quantification of impacts to eelgrass, define mitigation alternatives, and make recommendations for compensatory mitigation.

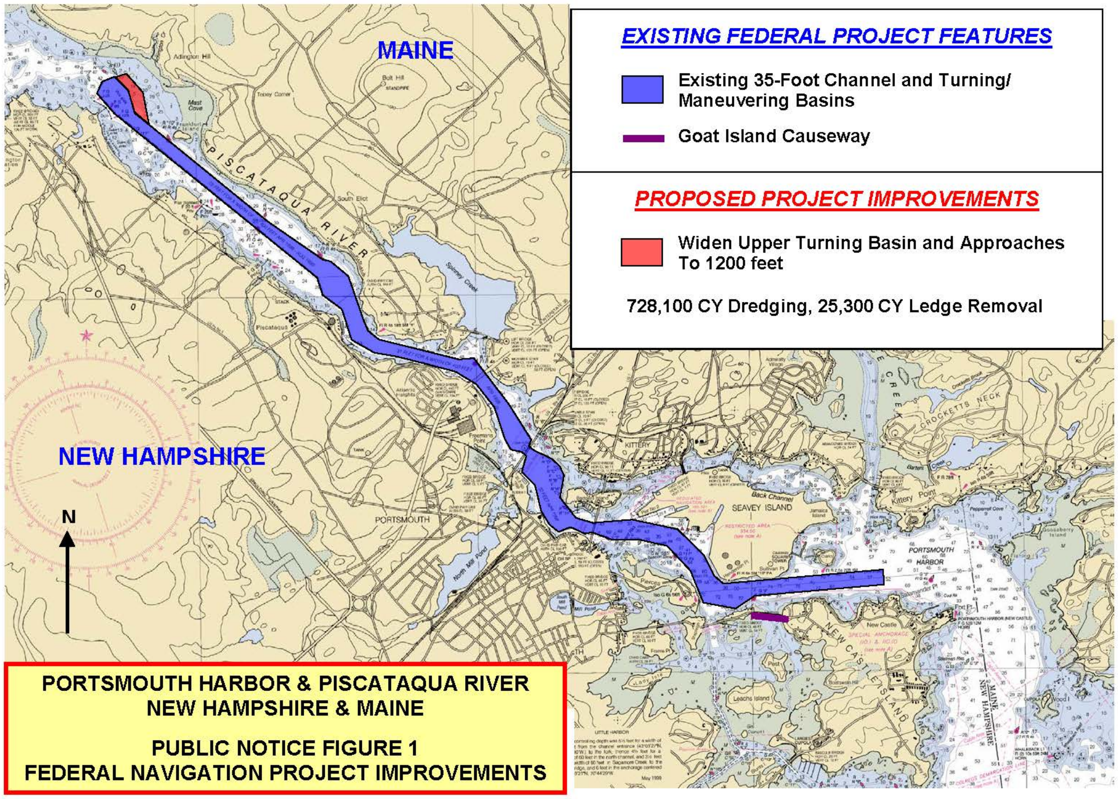

Figure 1. Proposed Portsmouth Harbor navigation improvement project.

3.0 EELGRASS IMPACT ASSESSMENT

3.1.1 Historic Eelgrass Conditions

The State of Maine Department of Marine Resources (MEDMR) periodically maps the eelgrass resources of the state. MEDMR eelgrass mapping data from the 1990s and the 2000s (Figure 2) shows that the eelgrass beds in the vicinity of the proposed project area declined within that timeframe (ME GIS, 2020).

Figure 2. Historic distribution of eelgrass in the vicinity of the proposed project.

3.1.2 Future Project Conditions

The Feasibility Report and Environmental Assessment (FR/EA) for this project discusses the future conditions of the project area with and without the proposed action (see Section 4.1 of the FR/EA). In general, future conditions in the project area will be affected by regional and national changes in climate. Tide heights are predicted to increase between 0.3 and 2.2 feet over the next 50 years and water temperatures are projected to rise over time.

Eelgrass in the western Atlantic Ocean ranges from the mid-Atlantic United States north to Canada and the Labrador Sea. Even though eelgrass prefers cooler waters compared to tropical seagrass species, the anticipated change in water temperatures within the proposed project area is not anticipated to impact the capability of the site to support eelgrass. Additionally, the change in tidal elevations within the project area (and mitigation site discussed below) are not anticipated to change the capacity of the site to support eelgrass. Assuming vessel drafts remain similar in the future, the need for dredging could be reduced as water depth increases with sea level rise.

3.2 Eelgrass Assessment Method

In September 2018, the USACE performed a hydroacoustic and video survey of the PHNIP project area to document eelgrass resources that may occur in the proposed project footprint. Figure 2 shows the result of the USACE eelgrass survey overlain on the proposed project footprint. The total amount of eelgrass within the proposed project footprint, which is located only in the proposed sides slope (3:1 ratio) area of the turning basin feature, is 39,200 square feet (See Section 3.3 for details.).

2018 Eelgrass Assessment Survey Methods

Survey efforts were conducted on 28 September of 2018 by staff from the USACE Environmental Resources Section. Thirty-four survey transects were pre-planned in

Hypack® survey software and transferred to the vessel's computer for navigation in the field. These transects were laid out to provide full coverage of the proposed project area using a spacing of 50 feet in an orientation roughly perpendicular to the shoreline. The length of these transects varied by location to include the top of the proposed dredge cut side slope as well as eelgrass beds previously identified by the USACE in a July 2016 survey. The planned survey transects and project features described above are presented in Figure 3.

All work was carried out onboard the R/V Nomad, a 25-foot SBI Defender outfitted for coastal survey operations. Vessel positioning was achieved using a Hemisphere Vector VS330™ position and heading system receiving real time differential corrections. Single beam hydroacoustic data was collected using a BioSonics MX echosounder with a 204.8 kHz, 8.7° calibrated transducer operating at a 5Hz ping rate. Side scan sonar data was collected using a Tritech StarFish 452F transducer with a mid-band 450 kHz compressed high intensity radar pulse (CHIRP) signal. Both transducers were affixed to an adjustable survey boom mounted along the starboard side of the vessel. The face of each unit was adjusted to be 16 inches below the water surface. Conductivity, temperature, and depth (CTD) profiles were collected from the survey area using a Sontek Castaway®–CTD in order to correct for speed of sound variations in the water column.

Sonar data was viewed in real time and recorded to the hard drive of a computer running Hypack® for side scan sonar and Biosonics Visual Acquisition software for single beam hydroacoustic data. Waypoints were created in Hypack® throughout the survey to mark changes in bottom type and features of interest to be investigated during the subsequent video survey. The vessel operator navigated all transects at a speed of approximately 4 knots (4.6 mph) while recording data. Transects were run in opposite directions to minimize non-recording time. Transect information including the number, file name, start and stop time, direction of travel, and other pertinent observations were recorded in a field log throughout the survey.

Video footage was collected at nineteen stations corresponding to waypoints created during the hydroacoustic survey. Video was collected using a GoPro HERO5 camera outfitted with a remote feed for real time viewing and mounted to framer with a 0.25 square meter (2.69 square foot) base. The camera assembly was maintained at a position just above the sea floor for approximately 5 to 10 seconds at each station, observing 5 to 10 linear feet of bottom with typical vessel drift. Depth and orientation adjustments of the camera assembly were made manually by the USACE personnel positioned on the deck of the survey vessel. Real time observations of substrate type and vegetation were recorded in the field log. Details on data processing of the hydroacoustic data and the video files are described in the Final July 2018 Predredge Survey for Submerged Aquatic Vegetation (see Attachment A).

2018 Survey Results

A total of 33 transects covering 4.5 linear miles were successfully surveyed to produce a cumulative 17,580 processed Visual Habitat output points. The water depths in survey area were sufficient to generate high quality side scan sonar imagery within a 130 foot swath (75 feet per channel) for each transect, resulting in full coverage of the survey area. Direct comparison between the Visual Habitat data, side scan sonar imagery, and video survey observations demonstrated excellent agreement.

Interpretation of the side scan sonar data documented an area of uniform low backscatter corresponding to fine grained sediments in the shallow portions of the survey area to the north and east. The central portion of the survey area exhibited uniform high backscatter corresponding to coarse grained sediments interspersed with individual targets corresponding to boulders, fishing gear, and isolated patches of macroalgae.

Three large areas consisting of complex patches of high and low backscatter corresponding to SAV were delineated from the side scan sonar mosaic. Two of these areas, situated along the top of the existing channel side slope, displayed a signal typical of low vegetation draped over a hard substrate. The third area, located along the transition between coarse and fine grained substrate displayed a signal typical of taller beds of moderate to dense vegetation.

Video survey footage documented the vegetated areas adjacent to the existing channel as moderate to dense brown and green macroalgae growing on a cobble, gravel, and coarse sand substrate. The northernmost of these areas was observed to transition from macroalgae to beds of sparse to moderate eelgrass on a substrate of sand and shell with distance from the channel.

The video survey documented that the vegetated area situated along the transition between high and low backscatter returns was as a bed of moderate to dense eelgrass on a substrate of fine sand. The deep-water edge of this bed was observed to correspond with 5-foot MLLW contour and was found to be approximately 20 to 50 feet outside the boundary of the proposed turning basin. Approximately 39,200 square feet (0.9 acres) of this eelgrass bed was determined to be within the area that would be dredged in order to create a 1:3 side slope in association with the proposed project.

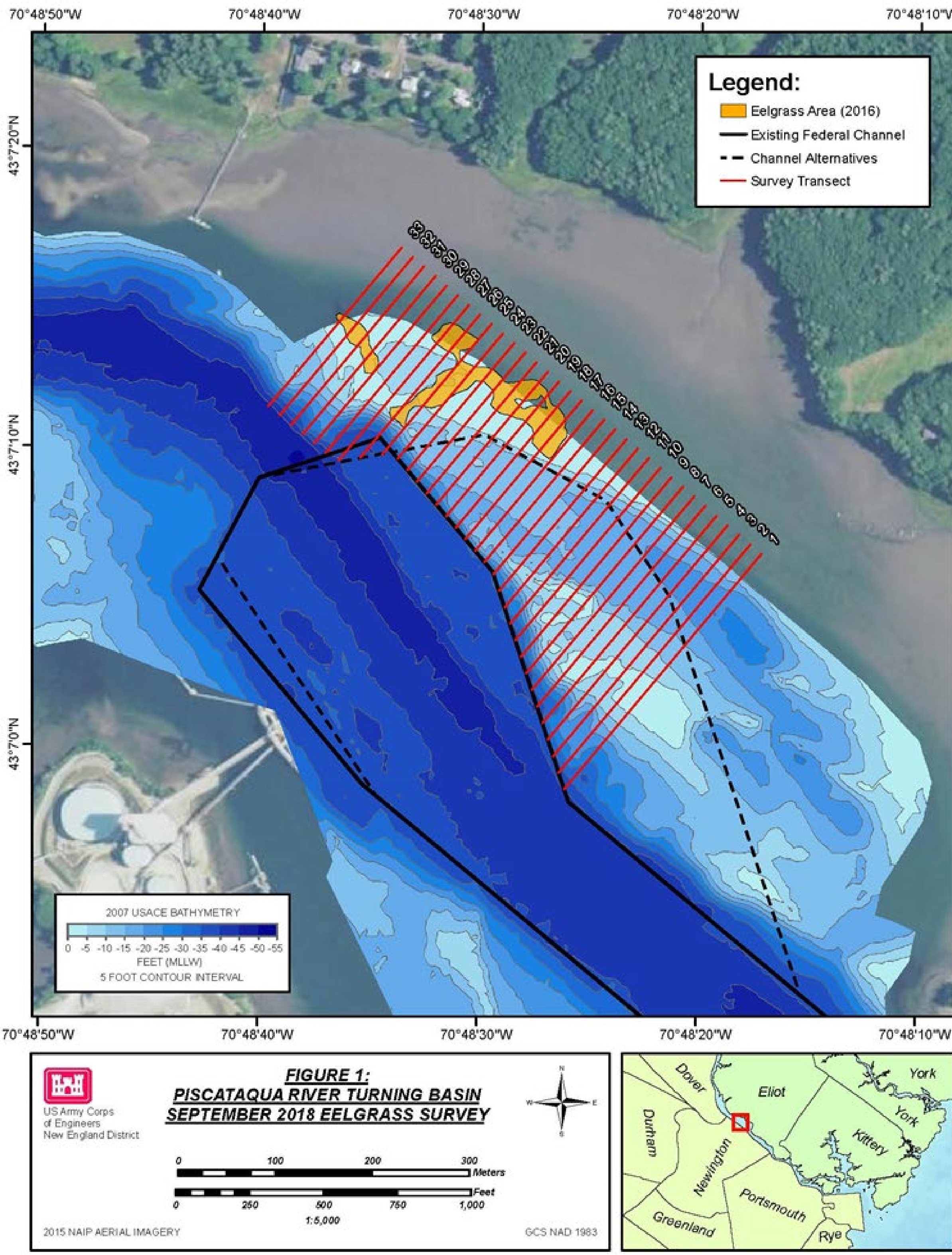

Figure 3. Survey transects and eelgrass distribution noted form the USACE 2016 survey.

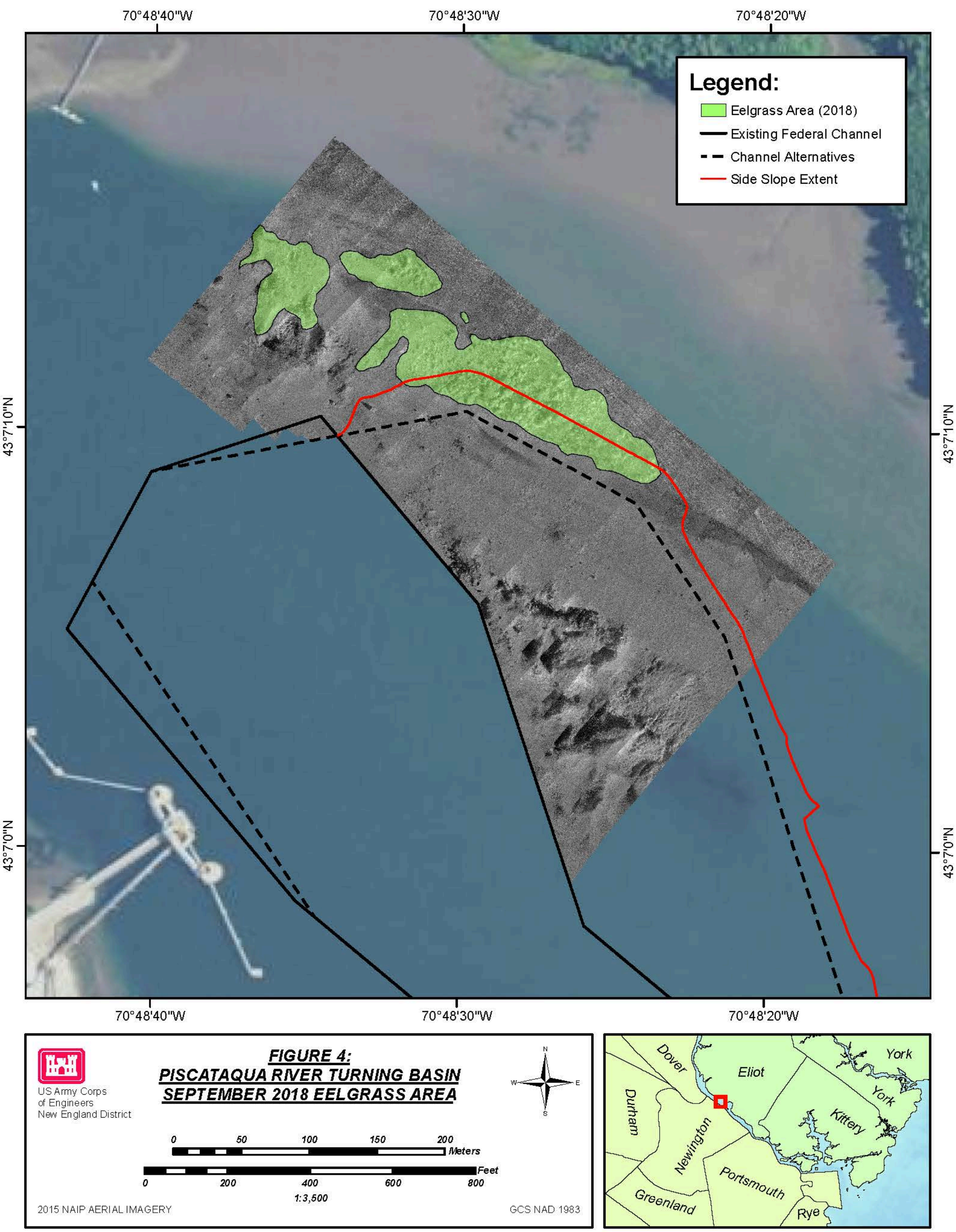

Figure 4. Distribution of eelgrass within the Portsmouth Harbor Navigation Improvement project in 2018.

Future Pre-Construction and Post-Construction Assessments

The USACE will perform a pre-construction eelgrass survey during the growing season (June-September) before the start of dredging operations. This survey will serve as the baseline condition for a final assessment of project impacts to eelgrass beds in the project area. A series of reference sites will be identified and surveyed during this effort in order to facilitate future assessments of natural variation within the system. These reference sites will be located outside of the dredging impact area but within the same system.

An identical post-construction eelgrass survey will be performed during the growing season following the completion of the dredging effort. Direct impacts to eelgrass in the project area will be quantified by comparing the spatial extent of eelgrass beds between the pre- and post-construction surveys. The natural variation of eelgrass at the reference sites will be used to interpret project area impacts that cannot be directly attributed to dredging operations. The measured loss of eelgrass as a result of the dredging project will be used in final mitigation compensation as described in Section 5 below. The USACE will provide the agencies with a full impact assessment report describing the pre- and post-construction survey data and results of analysis.

3.3 Eelgrass Impact Estimations

Permanent Impacts

The area of eelgrass that will be impacted by the creation of the expanded turning basin and associated 3:1 slope in the project area was calculated by estimating eelgrass resources within the features (Figure 4). There is no eelgrass within the proposed turning basin footprint, but the 2018 USACE survey discussed above found approximately 39,200 square feet of eelgrass habitat within the associated side slope footprint.

The spatial extent of impacts was estimated based on the anticipated direct result of dredging activities within the proposed project footprint including the side slopes. These estimates do not take sloughing of the dredge cut or other unforeseen physical impacts from dredging operations into account. Actual impacts may vary from the predictions in this document and the cost of any additional mitigation to compensate for these losses will be identified during monitoring and addressed through additional plantings. The cost of potential additional mitigation is covered by mitigation contingency funds.

Temporal Impacts

The permanent loss of eelgrass habitat associated with expansion of the turning basin will be mitigated for as described in the sections below. However, there will be a temporal lag in the development of the eelgrass resources at the mitigation site and with a corresponding delay in the functions and values the resource provides. To compensate for the temporal loss of eelgrass during this period, an additional amount of eelgrass mitigation is being provided.

We estimated that the time the mitigation site will take to establish itself will be four years based on research conducted by Evans and Short (2005) within the same system in which the mitigation is planned. Details of the mitigation plan are discussed below. Our estimation of temporal loss of eelgrass was calculated by regressing the amount of eelgrass that would theoretically be present per year over the four-year establishment period (Figure 5 and Table 1).

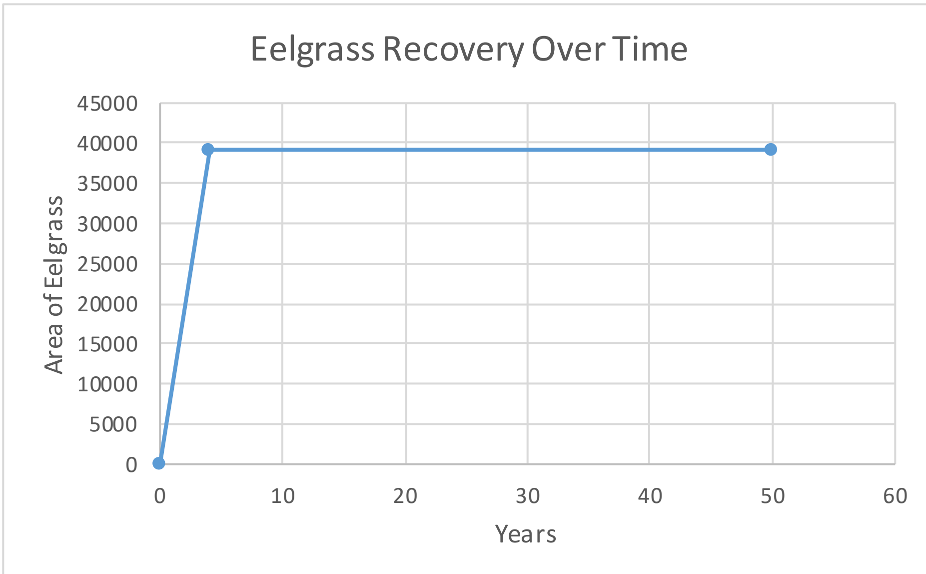

Figure 5. Areal extent of eelgrass at proposed mitigation site using a 4-year establishment period.

Table 1. Estimation of eelgrass establishment at a mitigation site.

With action	Year Post Dredging (YPD)	Area of Eelgrass at YPD (square feet)	Duration of Eelgrass at Area in the Previous Column	Area of Eelgrass at YPD Times No. of Years (square feet)
1	0	-	1	-
2	1	9,800	1	9,800
3	2	19,600	1	19,600
4	3	29,400	1	29,400
5	4	39,200	1	1,803,200
		Average Annual Area		39,200
		With Action minus Without Action		1,960 sf

Based upon predicted eelgrass establishment times, an additional 1,960 square feet of eelgrass mitigation is necessary to compensate for the time lag in the development of the mitigation site following planting. This value will be added into the overall mitigation needs for the proposed project.

4.0 MITIGATION PLANNING OBJECTIVE

The mitigation effort proposed will compensate for the permanent loss of 39,200 square feet of eelgrass habitat within the side slope of the proposed turning basin for the Portsmouth Harbor Navigation Improvement project, and the temporal loss of eelgrass habitat functions, estimated to equate to 1,960 square feet, for a total of 41,160 square feet of eelgrass. The proposed area of eelgrass habitat impact will be maintained in perpetuity as a Federal Navigation Project (FNP) and will be subject to future maintenance dredging. The maintenance dredging cycle is anticipated to be every 10-20 years. The compensatory mitigation proposed within this study will exempt future maintenance dredging efforts in the authorized FNP footprint from the need for mitigation pursuant to applicable laws and regulations governing impacts to eelgrass resources.

5.0 MITIGATION STRATEGIES

The proposed project will mitigate for approximately 41,160 square feet of eelgrass. USACE evaluated several alternative measures for mitigation, based on what is practicable and capable of compensating for the aquatic resource functions that will be lost as a result of the project. The alternatives considered are listed below.

5.1 Eelgrass Compensatory Mitigation Alternatives

5.1.1 On-Site, In-kind, Whole Plant Transplanting Mitigation

A practicable on-site, full scale whole plant transplanting, in-kind mitigation alternative was explored. Inquiries to the State of Maine's Department of Marine Resources, Department of Environmental Protection and Maine Coastal Program, the National Marine Fisheries Service, and the US Environmental Protection Agency were made in an attempt to find a mitigation site. Additionally, a study of eelgrass recovery and potential restoration opportunities in Great Bay estuary was reviewed (Burdick et al., 2020).

Three potential mitigation sites that would serve as compensatory mitigation for the proposed project were identified within the Piscataqua River: a site near Fishing Island (Kittery, ME) at the mouth of the Piscataqua River, a site "North of Defense Fuels" in the Piscataqua River just north of the Port Authority Pier, and a site in Tricky's Cove (Newington, NH). These sites are discussed in the following paragraphs.

Fishing Island Site

The Fishing Island site, located in Pepperrell Cove on the Kittery, Maine side of Portsmouth Harbor, was a 15-acre eelgrass flat that was denuded of eelgrass in 2003 by overwintering Canada geese (Rivers and Short, 2007). In their application of the preliminary transplant suitability index model (PTSI), an eelgrass restoration site selection model, to Great Bay (Figure 6), Burdick et al. (2019) found and recommended the Fishing Island site as a priority site for eelgrass restoration. They noted that geese no longer visit the site and that eelgrass could be successfully transplanted here.

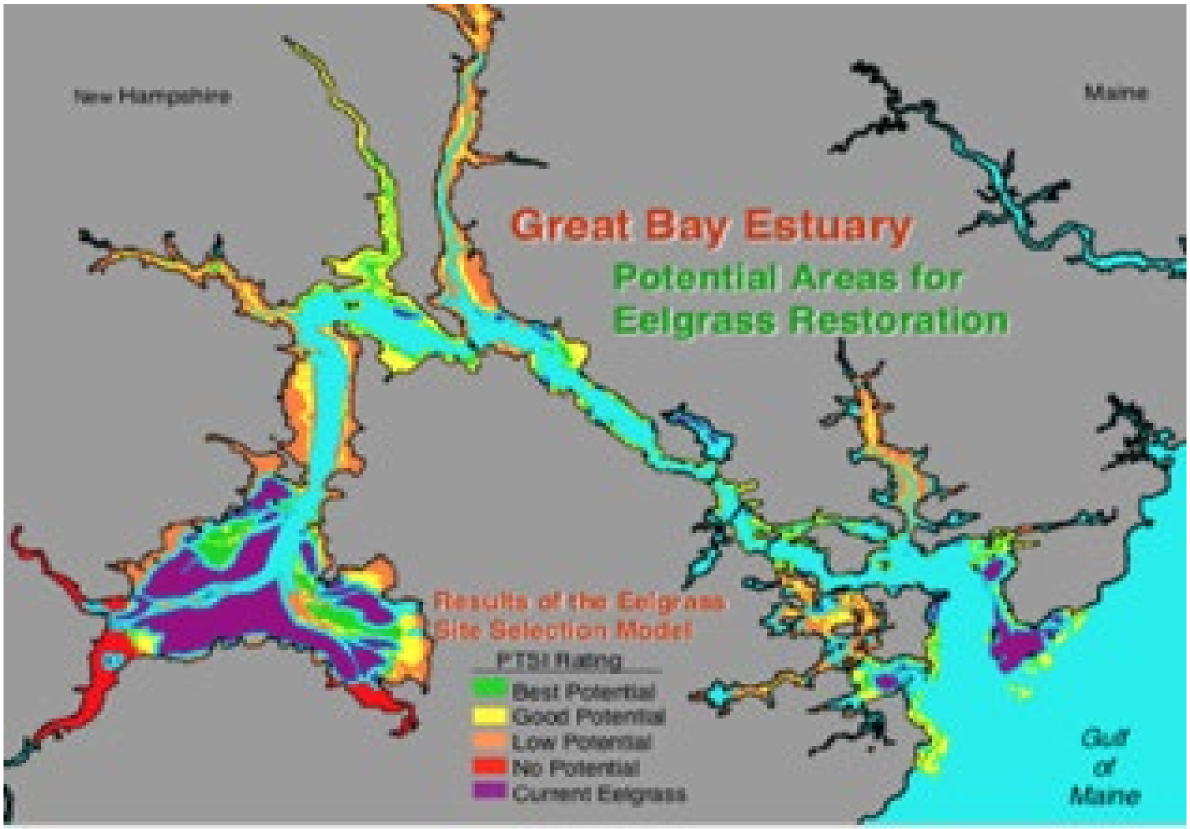

Figure 6. Preliminary Transplant Suitability Index model for Great Bay Estuary (from Burdick et al., 2020).

Historic distribution of eelgrass resources in the vicinity of Fishing Island are shown in Figure 7. Approximately 20 acres of habitat are available for restoration. This alternative is viable and practicable as mitigation for the impacts associated with the proposed project.

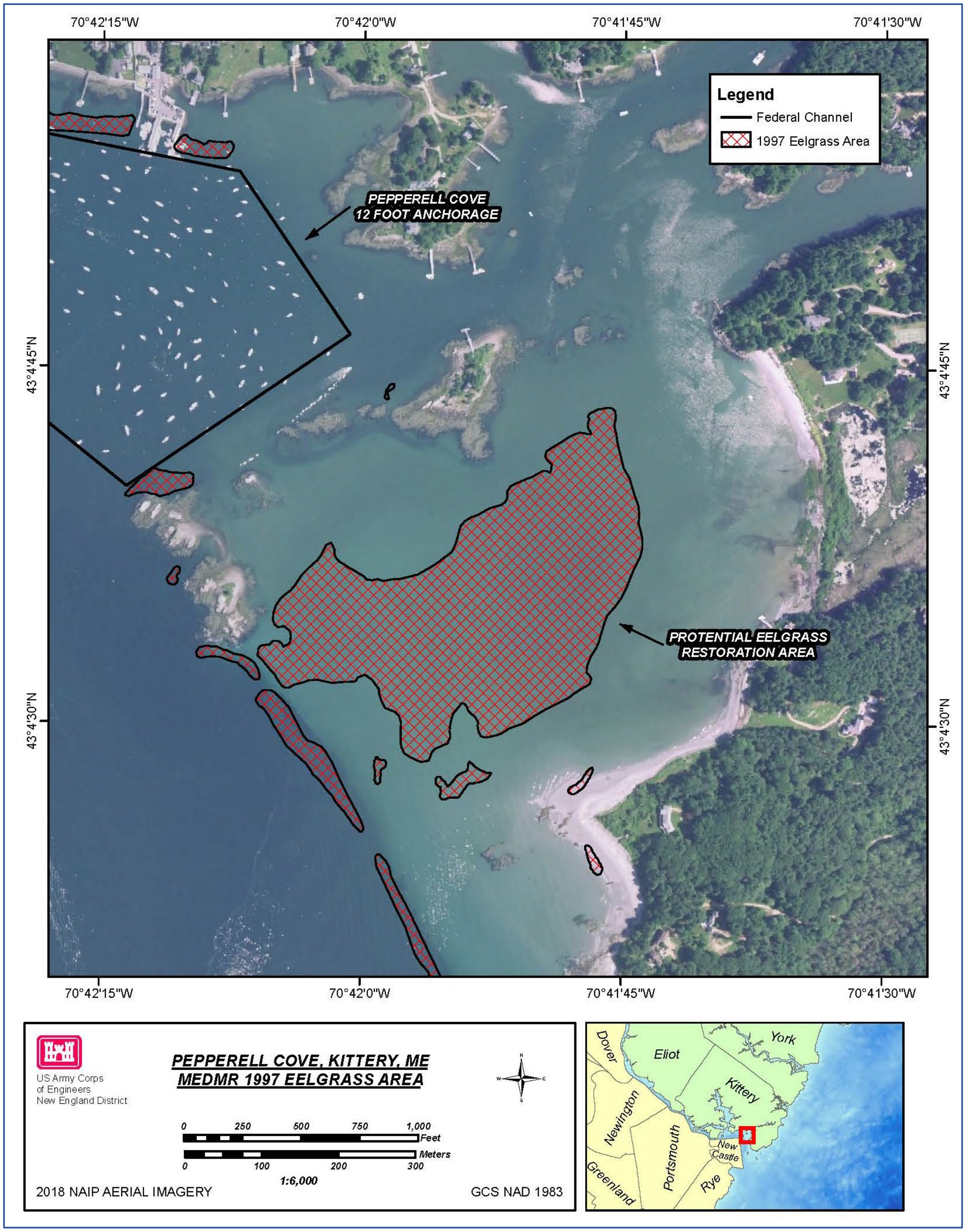

Figure 7. Historic distribution of eelgrass in the vicinity of Fishing Island Kittery, Maine shown in hatched shading. Eelgrass restoration area proposed as mitigation indicated by arrow.

Defense Fuels North

The “Defense Fuels North” site in the Piscataqua River is located just north of the Port Authority Pier (Figure 8). According to Burdick et al. (2020), the North of Defense Fuels site was successfully transplanted during the 1993 New Hampshire Port Mitigation Project. Eelgrass survived at the site for many years until 2007, when eelgrass completely died off throughout the entire Piscataqua River (Beem and Short, 2009). The period between 2005 and 2007 represents the high point for storms and nitrogen loading, so both sediment and nutrient levels were quite high and may have led to the die-off (Burdick et al. 2020).

Figure 8. Potential eelgrass restoration site in Defense Fuels North site in Newington, New Hampshire.

Historic distribution of eelgrass resources in the vicinity of the Defense Fuels North site is shown in Figure 9. Approximately 7 acres of habitat are available for restoration. This alternative is viable and practicable as mitigation for the impacts associated with the proposed project.

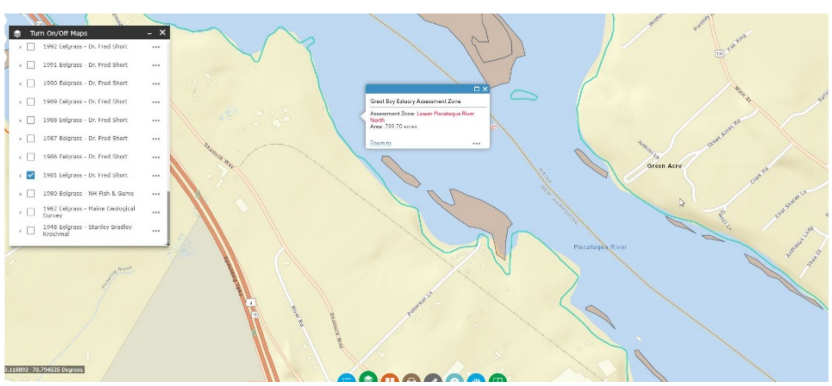

Figure 9. Historic eelgrass distribution (1981) at the North of Defense Fuels site.

Tricky's Cove Site

Tricky's Cove is located in Little Bay (Newington, NH), approximately 4,000 feet from the proposed navigation improvement project (Figure 10). The habitat type within Tricky's Cove is shallow subtidal waters. Eelgrass has historically been found in the cove (Figure 11) in the 1980s and 1990s (https://nhdes.maps.arcgis.com/apps/webappviewer/index.html). According to Burdick et al. (2020) the cove sustained eelgrass prior to peak nitrogen loads and increased storm activity seen in the Great Bay Estuary in the 2005-2010 timeframe. The area available for eelgrass restoration is approximately 5 acres.

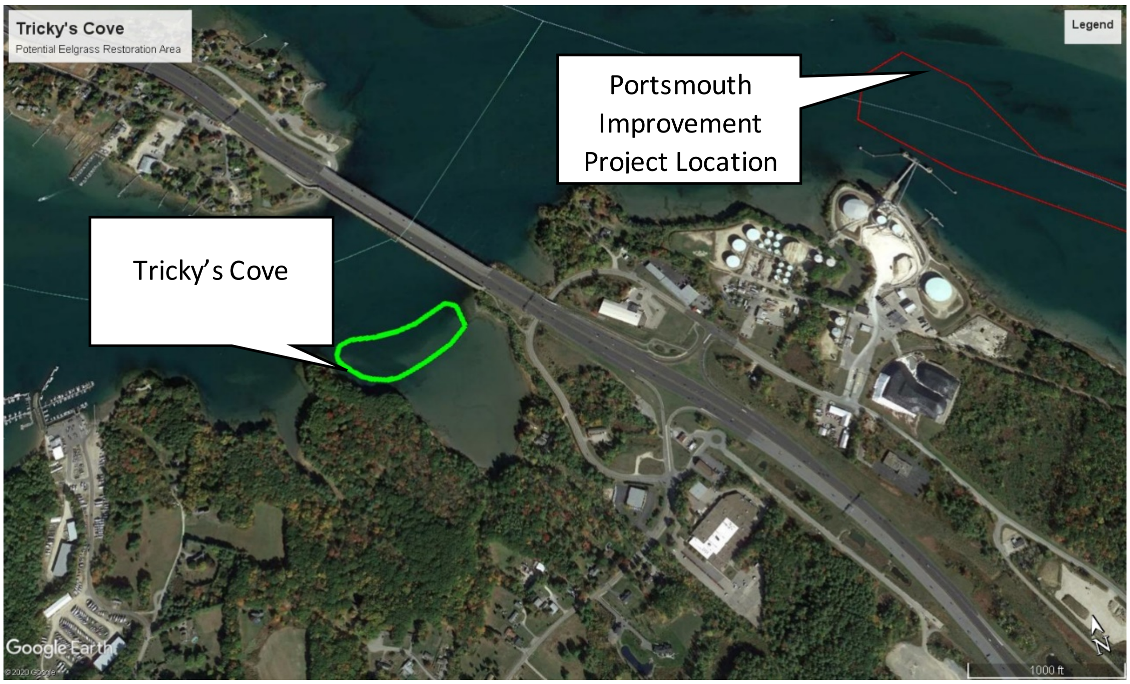

Figure 10. Potential eelgrass restoration site in Tricky's Cove Newington, New Hampshire and location of proposed Portsmouth Harbor navigation improvement project area.

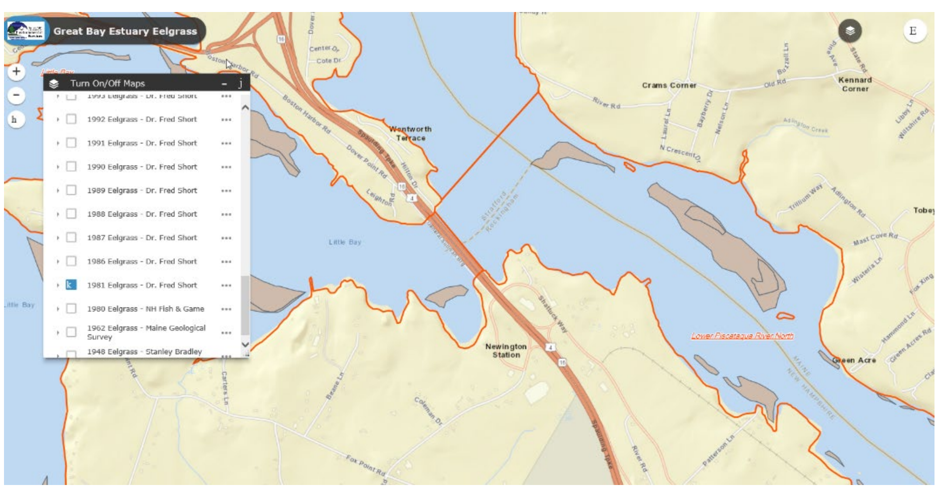

Figure 11. Historic eelgrass distribution (1981) in Tricky's Cove Newington, New Hampshire.

5.2 Out-of-kind Mitigation Alternatives

Mitigation guidance (e.g., 33 CFR Parts 325 and 332) indicates a strong preference for in-kind mitigation, but allows for out-of-kind mitigation where there are no practicable in-kind mitigation options are available. The USACE considered several out-of-kind mitigation alternatives for the proposed project. Alternatives included the Maine In Lieu Fee Program and several out of kind mitigation alternatives in the vicinity of the proposed project area such as land preservation and other ecosystem restoration projects. There are no in-kind In Lieu Fee mitigation options for eelgrass mitigation in Maine. As in-kind mitigation options are available for the eelgrass impacts, the out-of-kind alternatives were not fully developed for eelgrass compensation.

6.0 PROPOSED MITIGATION

The USACE intends to use whole plant transplanting as mitigation for resources that will be impacted by the proposed project. Following a test plot planting effort (described below), one of the sites noted in Section 5.1.1 will be selected for full scale restoration. A total of 41,160 square feet (approximately 1 acre) of eelgrass habitat will be created to mitigate for the 39,120 square feet of permanent eelgrass loss and 1,960 square feet of temporal eelgrass function loss. The estimated cost of the mitigation effort and subsequent 10 years of monitoring efforts would be approximately $226,000 ($226,000 per acre) for the 41,160 square feet of eelgrass mitigation. A full cost-effectiveness/ incremental mitigation analysis is not necessary for this project because there is only one practicable mitigation alternative available. The range of mitigation alternatives to be considered would simply be increments of the same plan with a straight-line relationship for additional cost per area. The cost of $226,000 per acre for mitigation is considered reasonable. This proposal will provide full mitigation for impacts. Any changes to the area of mitigation would only change the cost in a direct linear relationship.

7.0 MITIGATION IMPLEMENTATION

The following sections present the implementation procedures for the proposed mitigation effort.

7.1 Pre-planting Surveys and Test Plot Efforts

Pre-planting Surveys

Prior to any eelgrass plantings the potential restoration sites noted in Section 5.1.1 will be surveyed to assess the physical conditions within the site. Surveys will include bathymetric measurements within the site, side scan sonar of the bottom to assess bottom types, sediment samples to document the grain size of the sediments, and an underwater video survey to assess the bottom conditions and document any flora or fauna present. These data will be used to determine which areas within the sites are best suited for eelgrass.

Test Plot Planting and Test Plot Monitoring

A test plot planting effort will place 15 TERFS units (TERFS = Transplanting Eelgrass Remotely with Frame System) within selected areas of each of the three locations noted in Section 5.1.1 in the spring of 2021. The test plot effort is being undertaken to ensure that the site selected for full scale transplanting will support eelgrass. Plant material for the test plotting effort will come from the impact areas within the footprint of the proposed Portsmouth Harbor Improvement Project. Data loggers that record light attenuation and water temperature data will also be deployed with the test plots.

The test plot locations will be monitored at 1-month post-placement to determine if the plants and TERFS units have remained in place and if there was any shoot loss following planting. Shoot counts will be assessed in all 15 of the planted TERFS units at each of the sites.

Monitoring, in the form of shoot counts of all TERFS units, will also occur at +11 month after planting to determine which site performed the best and has the best chance of success for the full-scale planting effort.

7.2 Full-Scale Harvesting and Planting

Harvesting of Adult Plants

The adult plants to be used in the mitigation area for the full-scale planting effort will be harvested from the eelgrass beds within the Piscataqua River and Great Bay system. This effort will be coordinated with Federal and State resource agencies to ensure that no significant impacts from harvesting at donor beds will occur.

Adult eelgrass shoots will be collected by SCUBA divers and transported by boat to onshore processing stations in the spring of 2022. Diver collection will ensure that whole plants (leaves, roots, and rhizomes) will be collected and that damage to the uprooted plants will be minimal. The shoots will be bundled into groups of 50 for planting purposes. The plants will be held in totes filled with seawater which will be at ambient temperatures until transplanting. The time limitation between harvesting and planting will be no more than 72 hours.

Transplanting

Transplanting of the eelgrass in the mitigation area will be done by use of the TERFS™ method (Short et al., 1999) in the spring of 2022. The TERFS™ method involves attaching 50 eelgrass shoots in pairs to a weighted rubber-coated wire frame with biodegradable paper twine. TERFS are prepared on shore and then placed on the seafloor by wading into the water and placing the TERFS in the sediment. The TERFS are placed on the bottom so the eelgrass roots are in contact with the sediment and the eelgrass leaf blades extend into the water column. Four bricks attached to the frame provide weight to press the eelgrass roots into the top centimeter of sediment. The bricks also ensure the TERFS will remain on the bottom where they are placed. The frame protects the fragile shoots from being uprooted by burrowing animals such as green crabs. The TERFS, with the eelgrass shoots attached, are left on the sediment surface at the transplanting site for 3-5 weeks, enough time for the plants to root into the sediment. The frames will be removed when the plants have rooted securely into the sediment.

Approximately 270 TERFS will be placed in a planting mosaic throughout an approximately one-acre area (Figure 12). The actual design of the planting mosaic (i.e., number of rows and columns) will be determined based upon the data noted in Section 7.1.

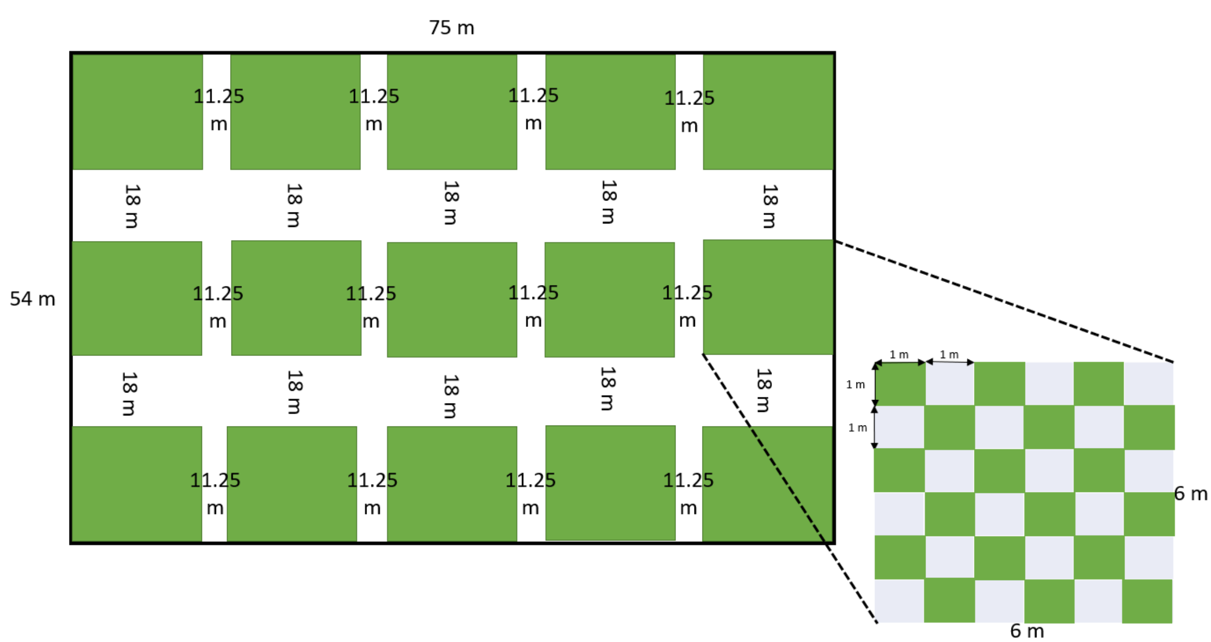

Figure 12. Conceptual planting mosaic for 1 acre of eelgrass restoration.

7.3 Monitoring of Full-Scale Plantings

Monitoring of the transplanted eelgrass will occur at the mitigation site immediately (within one month) following the initial planting effort as well as three reference sites within the Piscataqua River/Great Bay ecosystem. Subsequent monitoring at the mitigation site and reference sites will be performed during the summer for ten years following transplanting at intervals of +1 year, +2 years, +3 years, +4 years, +6 years, +8 years, and +10 years.

Monitoring of the full-scale mitigation site and reference sites will include:

- estimates of shoot density
- canopy height
- percent cover of eelgrass
- areal extent of eelgrass
- fish and invertebrate use
- water quality (light, temperature, salinity)
- sediment type

Shoot Density

The mitigation site and three reference sites will be evaluated one month following planting to assess shoot count. This initial assessment is to document any initial loss of planted material and allow for the calculation of the percentage of planted shoots that survived versus total shoots planted and to obtain a baseline data set for the reference beds. Shoot counts will be assessed in 25 randomly selected ¼ m^2 quadrats within the mitigation site. The expected habitat type will be shallow subtidal waters (~2 feet deep at mean lower low water) that can be accessed by wading. Counts will be made using random quadrats chosen by creating a GIS grid corresponding to the dimensions of the mitigation site. Monitoring personnel will count the number of live eelgrass shoots within each of the selected grids. Mean shoot counts will be compared to the initial planting shoot density to assess whether loss of plants has occurred. Shoot counts will also be assessed in 25 randomly selected ¼ m^2 quadrats within the reference sites for comparative purposes and to evaluate success (see below). The presence and number of reproductive shoots will also be noted should any be present. Shoot counts will be measured at the mitigation site and within the three reference areas using the methodology described above at intervals of +1 year, +2 years, +3 years, +4 years, +6 years, +8 years, and +10 years subsequent to the initial plantings.

Canopy Height

Canopy height will also be evaluated at the mitigation site and reference sites (reference sites will be within habitat with depths that correspond to the mitigation site). The canopy height (length of longest shoot blade) will be estimated within each of the 25 quadrats at which shoot counts are made. The estimated values will be averaged, and this value will be used to evaluate success in relationship to canopy height at the reference locations.

Percent Cover

Percent cover of eelgrass within the mitigation area and the three reference areas will be assessed by measuring the percentage of eelgrass within a ¼ m^2 quadrat. 25 randomly selected quadrats will be selected by creating a GIS grid corresponding to the dimensions of the mitigation site and the three reference sites. Percent cover data will be collected in the shallow waters by wading with a scallop spotter scope or by underwater camera.

Areal Extent

The dimensions of each planted grid will also be measured during each annual sampling event subsequent to the initial year of transplanting. These measurements will allow an assessment of whether or not the areas planted with eelgrass are increasing beyond the planted grids.

Fish and Invertebrate Use & Other Biological Observations

Percent macroalgae cover, percent epiphyte coverage on eelgrass, numbers and species of fish and invertebrate species (specifically crabs), and any wildlife present within the planted eelgrass will be noted and enumerated.

Water Quality

To the extent practicable, continuous water quality monitors will be placed at the mitigation location during the evaluation period to evaluate light and temperature conditions. Static measures of salinity and dissolved oxygen will be made every monitoring effort.

Sediment Type

Sediment type will be monitored at the mitigation site over time to see if changes in the physical composition of the sediments change.

7.4 Mitigation Performance Standards and Success Criteria

Performance Standards

The success of the mitigation project will be compared to the following performance standards (PS):

PS-A: The mitigation site has at least 50% survival of planting units after one year.

PS-B Shoot densities show increases towards mitigation success (defined below) are no less than 50% of the impacted site in the first two growing seasons, followed by continued increasing levels of success in subsequent years.

PS-C Canopy heights show increases towards mitigation success (defined below) are no less than 50% of the impacted site in the first two growing seasons, followed by continued increasing levels of success in subsequent years.

PS-D Planting units demonstrate at least 25% expansion of areal coverage within 1 year of transplanting. After the first 3 years, the parameters are on a trajectory approaching reference levels.

Success Criteria

For Performance Standard-A (PS-A), the total number of surviving plots and failed plots will be monitored. Success for this PS will be achieved if the mitigation site has at least 50% survival of planting units after one year.

To assess the relative success of the eelgrass mitigation area for PS-B and PS-C, shoot density and canopy height of eelgrass at the mitigation site will be compared to the impacted areas and three reference sites each year. The shoot count will be analyzed in accordance with the methodologies described in Short et al. (2000). These methodologies involve development of a success criteria (SC) based on characteristics of a natural, reference eelgrass bed, and a success ratio (SR) based on a comparison of characteristics at a restored eelgrass site and reference eelgrass sites as follows (from Short et. al., 2000):

Success Criteria (SC) =100*(mean of all reference sites – 1 standard deviation/ mean of all reference sites).

Shoot densities and canopy heights at the restoration and reference sites will then compared using the following equation for success:

Success Ratio (SR) = 100*(mean of mitigation site/ mean of all reference sites).

When the success ratio (SR) for a given indicator equals or exceeds the SC, the restoration will be considered to have met the performance standard for that indicator.

For PS-D, the dimensions of each planting grid will be graphically compared to the previous year (S) data to help assess whether there is a trend toward expansion of the mitigation area, which would indicate that the mitigation is on a trajectory toward success.

7.5 Adaptive Management

Adaptive management will be implemented if specific eelgrass restoration performance standards are not met or if actual conditions diverge sufficiently far from the intended conditions to threaten the achievement of overall project goals. The adaptive management program will consider the data generated from the monitoring of the site success criteria noted above. In the event that adaptive management is required, the following management procedures will be implemented:

Failure Condition	Adaptive Management Procedure
Performance standards not met, but eelgrass is persistent at mitigation site	Additional eelgrass will be planted. If issues of vegetation establishment persist beyond two years post construction, an ecologist will investigate the cause of failure and recommend modifications to the project as appropriate.
Performance standards not met, eelgrass is not persisting at mitigation site	An ecologist will investigate the cause of failure and recommend modifications to the project as appropriate.

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